

THE SINGULAR CENTURY

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by Walter Youngquist

There are major turning points in human history. Of special importance have been the transition from a hunter/gatherer existence to a settled agricultural economy, and the beginning of the Industrial Age which transition continues. These turning points have for the most part resulted in an improvement in the welfare of humanity. But this century will be the singular century in the definition of it “being like no other” with the coalescing of events that become in total the greatest turning point for mankind.

Within just the past two centuries an economic revolution, touching nearly everyone but not all equally, has seen improved living standards that could not have been imagined. These include the widespread use of fossil fuels in many applications including improved agricultural production, extensive electrification and related invention of myriad home and industrial appliances such as radio, television, computers, and much more. Indoor plumbing, air conditioning, motor vehicles, air transport, and huge medical advances have all made for a better world for humans. But can life improvements continue? This is the question posed in the epic volume by Robert Gordon (2016) [The Rise and Fall of American Growth](#). This book might well have been titled [The Rise and Fall of World Growth](#), as economic growth worldwide has slowed in comparison to the decades from 1870 to 2010. World economists and political leaders are aware of this, and by various means have tried to reverse this trend but so far to no avail.

The factors making this the singular century are many, some already apparent and making their way into our economies and way of life. This in contrast to many centuries that came and went and the course of humanity, economic and otherwise, changed very little.

There will have been three great revolutions in human history. The first two have already occurred. The agricultural revolution whereby humans abandoned the life of a hunter/gatherer in favor of settled agriculture which has gradually intensified to support more and more people. This transition took many centuries. Human numbers increased slowly so that about 10,000 years ago world population was only about 10 million. The Agricultural Revolution resulted in a great increase in population. By 1750 there were approximately 800 million people. The Industrial Revolution, generally dated from the time when coal in Great Britain came into widespread use to power machines, expanded as the advantages provided by coal, and later oil, became evident. This revolution continues to this day. The widespread uses of oil have allowed relatively few people on farms to provide for many

others who have moved on to cities. There they could engage in a great variety of activities, one notably being the development and great expansion of medical expertise. This in turn, along with ample food supplies, resulted in world population increasing to the now 7.3 billion and still growing. This revolution has been extended mainly by the discovery and use of electricity whereby machinery is electrically powered and controlled electronically, and with robots doing some of the work formerly performed by hand-controlled machinery. These revolutions were in a sense “happy revolutions” in that they made life better for many people, but note that they were accomplished with a smaller population than exists today.

The third and forthcoming revolution is that of sustainability. It will be the most important revolution of all in that its outcome will be the framework in which humanity will have to exist for the indefinite future. It, therefore, will be the final revolution playing out over several centuries in ways that cannot all now be predicted. But it will be profound and at times stressful.

In this Third Revolution a larger, and for a time at least, a growing population, will have to live indefinitely on renewable resources, most critically energy resources, which even in total can only replace a small amount of nonrenewable resources which are the major support of civilization as we have it now. This revolution, in comparison with the other two, will be difficult in that renewable energy sources are of lower density than the nonrenewable energy resources in use today. Compounding the problem is that it now takes nonrenewable resources to build the equipment to capture renewable resources, which are chiefly wind and solar, and deteriorate with age and have to be rebuilt.

Energy sustainability will be more difficult to achieve for it will initially have to contend with a much larger population than in the past. That population, projected by the United Nations to be 11 billion people by 2100, is unlikely to be sustainable on renewable resources. Population will be in an “overshoot mode” for a brief time as it exhausts the great inheritance of fossil fuels and borrows unsustainably from the future by degrading and losing topsoil and depleting both surface and groundwater supplies.

Energy is the key that unlocks all other natural resources. Without energy nothing happens. Energy powers modern farming, it mines, smelts and processes metals in myriad useful forms from automobiles, airplanes, railroads, to steel for the construction industry. It processes and transports our food, purifies and pumps our water, drills our oil and gas wells, and

much more. For the moment we live in an energy rich society.

In the energies, we now use, chiefly fossil fuels, in industrialized societies we each have the energy of hundreds of “workhorses.” Think of the human power it would take to push an automobile three hundred miles over mountains and plains in just a few hours. Energy has made the modern world. The future of mankind is largely bound up in the amount of energy we will have for myriad uses. But therein lies the rub as energy resources are being degraded and depleted.

The importance of fossil fuels now used in myriad ways can hardly be overestimated. The use of coal began the Industrial Revolution and sustained it in increasing uses. But its use gradually became supplanted by oil. Energy in this high density and liquid form greatly expanded the energy supplied to the world, and is the chief base for the industrialized economies we have today. The modern world was built and is now sustained by oil.

Over the centuries many ways of Earth resource extraction were slowly evolving. This exploitation has now reached exponential rates with the widespread use of fossil fuels to make extraction of Earth resources easy and in ever increasing quantities, a fact of great importance. The late Thomas Loving, mineral geologist with the U.S. Geological Survey, has made these observations: “The world is finite. It is already apparent that for many resources, an end to rich, quick assets will arrive during the 21st century, not only for the United States but for the world as a whole.” These trends will coalesce this century to make it a century like no other. In the process it will set humanity on a different course for the indefinite future, as nonrenewable Earth resources are depleted.

The use of fossil fuels over the past 250 years has transformed societies and economies. Oil in particular has had dramatic effects on industries and personal lifestyles. Energy now permeates most activities. But the oil interval will be vanishingly short and sorely missed. Generally dated from the drilling of the Drake Well near Titusville, Pennsylvania in 1859, it began onshore, first in the United States and then abroad to many countries, most notably the nations of the Persian Gulf region, and now to all regions of the world except Antarctica. Now activity is moving offshore, where most of future oil exploration prospects lie.

In 1950 worldwide, only about 2 percent of discoveries were in deep water (below 500 meters). But by 2015 this number reached 60 percent. This is especially true of the United States which rose to being the world’s largest oil producer led by the onshore discovery of the East Texas oilfield, and the Prudhoe Bay field in 1958. But now exploration has moved offshore into deeper and deeper water, as onshore fields are depleted.

The United States is now drilling in as much as 10,000 feet of water and then another 10,000 to 15,000 feet beneath the ocean floor in search of oil. It takes hugely expensive equipment to do this work. The Italian oil firm ENI, forced to explore in deep waters, had the offshore drilling rig Goliath

built at a cost of \$6 billion. Costs of daily operation of such equipment are high.

Oil produced by means of this sort of equipment is not cheap. Which brings up the matter of the current low price of oil. With the additional oil recently brought to market in the United States by “fracking” technology whereby the source beds of oil are exploited, and the fact that the OPEC countries, contrary to usual practice, have not reduced their oil production to ensure a higher price, the oil price has plunged. Oil price is very sensitive to either a temporary over supply or under supply. A one to two percent difference can be greatly magnified in price.

To illustrate: When the oil from the East Texas field came to market in 1930, the price of oil briefly fell to five cents a barrel. Not long ago, when demand slightly exceeded supply the price of oil rose to \$147 a barrel. The current drop on oil price is the result of a temporary over supply. Oil is a valuable substance for which, in many uses, there is no substitute. The world now consumes about 94 million barrels a day. Supply is only a million or so barrels/day more than that. World oil demand continues to rise and will soon equal supply. Also, given the continued depletion of existing oil fields (about 6 percent annually), the decreasing rate of discovery of large new oil fields, and the high costs of now having to pursue oil in ultra-deep water, this drop in price may be the last. The imbalance will soon be corrected. Crude oil prices have risen more than 100 percent from their recent lows. Long term the price of oil can only go higher – much higher.

Oil from “fracking” will see its peak production in both the Bakken oil in North Dakota and the Eagle Ford of Texas by 2020 if not before. These two “plays” now produce 80 percent of the fracked oil in the United States but even now only account for a small amount of United States’ daily oil consumption. Fracking abroad is proceeding slowly. France has banned it entirely. Elsewhere results have been mixed. Fracking will only to a temporary and small degree alter the current world oil imbalance between oil demand and supply.

Although it may be hard to visualize at the moment, the oil industry is beginning to enter its twilight years. The North Sea oil production for both Norway and the United States has peaked and is now declining, as has oil from the largest North American field, Prudhoe Bay. The world’s largest field, Ghawar, of Saudi Arabia, has its production now sustained by the injection of more than seven million barrels of sea water a day.

When we are now drilling in ultra-deep water, and in the case of “fracking” we are extracting oil from the very source beds of oil, we are approaching the end of the road for the current high rate of oil production. There is nowhere else to go on a finite Earth.

At the end of this century the oil industry as we have it now will no longer exist. As oil goes, so goes the airline industry, entirely dependent on jet fuel derived from oil. World air travel, and the related tourist industry important to many countries, may not survive much longer than the useful

life of some airplanes built today. Oil may still be produced in 2100 for high cost, high end uses. Discretionary income then, and probably sooner, will have to be used to purchase food and other basic needs.

The brief blip of affluence some of us enjoy now is largely the result of the availability of relatively cheap oil. These affluent times will be mostly in the rear view mirror by the end of this century, and gradually before. In the process the benefits of oil will largely bypass many of the world's people unable to afford the use of oil in their daily lives.

Of great importance is the dependence of many countries on taxes on oil production or on the direct sale of oil to support the ongoing costs of government including military expenditures and a variety of welfare programs. Some 90 countries now obtain significant income from oil, especially the Gulf nations of Iraq, Iran, Saudi Arabia, Kuwait, and the United Arab Emirates. Also included are Libya, Angola, Nigeria, Mexico, and Venezuela.

Some states in the United States are also dependent in part on oil-derived revenues. In Alaska, 90 percent of the state budget comes from oil taxes. In New Mexico normally a third of the budget comes from oil-derived revenues. As oil production declines, the loss of related revenues will have profound negative effects and may degrade or even destroy social structures and some governments.

The hue and cry against fossil fuels grows ever louder, but those involved have no grasp of how much they each depend on fossil fuels for their existence. The fact is that civilization now is the product of the widespread use of fossil fuels. The much lauded renewable energy sources, chiefly wind and solar, are diffuse and of low energy density, undependable and highly unlikely to be able to support industrialized economies and related lifestyles. What world economies and lifestyles will look like beyond the short time of fossil fuels is not known but they will surely be less affluent and much different than today. The post-fossil fuel time will arrive this singular century, within the lifetimes of many people living today.

All other sources of energy beyond fossil fuels, except nuclear and geothermal are categorized as renewables. Related literature is voluminous; some of it visualizes an easy transition to renewables. Renewables include solar, wind, waves, tides, currents, and hydropower.

All renewables have limitations not present in fossil fuels. The most cited renewables, wind and solar, are unpredictable in their availability, and are less energy dense than are fossil fuels. Waves, currents, tides, and hydropower are site-specific. Also, they are much less easily used than are fossil fuels which can be transported to where they are needed and are dependable energy sources available at all times. Solar and wind are intermittent, at times not available at all. Storing energy from intermittent sources is limited and expensive and cannot fully make up for occasional loss of these energy sources.

Biofuels can be put into liquid form and transported where needed, but here, along with other renewables, the factor of

energy returned on energy invested (EROEI) arises. The EROEI of biofuels is so low as to make discussion of them hardly worthwhile. Charles Hall has pioneered this concept and has compiled statistics on the EROEI of various energy sources. This study indicates that alternative energy sources may be our only future energy sources but when that time gradually arrives it will involve epic changes in our economies and lifestyles and they may bring us back again to the level of subsistence living as in earlier times.

Fossil fuels will be used as long as it is economical to use them. Their decline in availability and higher cost this century will permanently change the course of humanity, an event with no parallels. Only when they are no longer available will their full worth be understood and appreciated, a very sobering change.

Here we turn to consideration of other problems beyond energy which will coalesce to make this truly singular century.

Water is more valuable than oil. Humans lived for thousands of years without oil but they could not exist without water. But now nearly everywhere surface water supplies, the source of most of our water, are either being overdrawn or polluted or both. Some rivers at times do not even reach the sea. And others at times barely do. Egypt is particularly vulnerable as upstream nations divert more and more water for their own use, to support their growing populations. Egypt is facing a large increase in population, now 89 million and projected to grow to 164 million by 2050. The Nile is their only source of water which sustains Egypt's agriculture, and thus Egypt's food supply.

Many countries and regions now rely heavily on groundwater to meet their needs. But no country has managed its groundwater in a sustainable way. All water tables are falling, and in some regions the aquifers have collapsed, as in western portions of the Joaquin Valley of California where groundwater has been extensively used for crop production. Once collapsed, the aquifer is gone forever. This valley is the source of a substantial part of the nation's fruits and vegetables and the loss of groundwater in California affects the entire country.

Elsewhere, such as in Saudi Arabia, groundwater, slowly accumulated during past more moist times, has been totally depleted. With the aridity now in that region as well as in other areas, the recharge of the aquifers is unlikely to occur in the foreseeable future making import of food supplies imperative, which in turn raises the cost of world food supplies.

Soil, the thin veneer on the Earth, with fresh water, supports all humanity, is now being lost worldwide 10 times as fast as it is made by nature. Also, as crops are removed from the soil, these nutrients that formerly annually renewed soil fertility when vegetation remained over the season, are lost. This loss is now being partly compensated for by the extensive use of fertilizers, an important component of which is phosphorus. It was once obtained from the Phosphoria formation of Idaho and Montana, and from deposits in Florida, but these deposits

are depleted. Morocco is now the major world source of phosphates. But this source is projected to be exhausted by mid-century. Unfortunately, like many other nonrenewable resources, there is no visible solution to this problem.

Adjusting to the limits imposed by the Third Revolution, will, unlike the earlier two revolutions, bring on difficult times, until in some fashion population and sustainable resources will reach some permanent accommodation. How much above a subsistence level of existence can humanity maintain is a major question, in which population size is a very important consideration. How many of such good things as medical advances can be preserved in what may be a sea of poverty? What will life be like in the year 2100 and beyond? It is uncharted territory.

It is true that we live in the here and now, and not in the future, but the here and now, in comparison with past time, will involve a continuing series of major adjustments to a contracting mineral and energy resource base. This is in contrast to earlier times when centuries passed and Earth resources were exploited only to a very limited degree.

As a geologist, at one time involved in both oil and mineral exploitation here and abroad, when I view these coalescing trends of demands on Earth resources by the now 7.3 billion people, with the projection of 11 billion by the year 2100, that this is the singular century becomes ever more clear. I am unable to think of some mitigating circumstances to this dilemma. A common public answer is that “scientists will think of something” but thus far this has not happened.

You cannot “think” resources into existence beyond what now exist. This will be the century when total demands on Earth resources will exceed what the Earth can provide. The result will be a lower standard of living becoming progressively evident, especially in affluent societies, to the end of this century. The annual dividends provided from renewable resources will adequately support only a much

smaller population than at present. The sustainable capacity of the Earth to support even the current size of world population is already exceeded. The continued migration of people from impoverished countries testifies to this fact, and can only intensify as populations increase and supporting basic resources of oil and fresh water are depleted. Government of the more affluent countries toward which these migrants seek to go are trying various solutions for the answer, none of which seems to be successful as the human tide presses on. World demographics are changing as never before.

But population growth cannot go on forever. It will stop from one of two causes: a decrease in birth rate or an increase in death rate. What is needed is a concerted effort by all people to stop population growth by a reduction in the birth rate to a population the size that can live sustainably on renewable Earth resources. Efforts to this end should be supported.

Some of us have had the good fortune to live in regions where Earth resources were ample to support an affluent lifestyle at affordable cost, or in economies when, for the moment, needed resources could be imported. But these circumstances are fleeting.

This century will see the decline in both quantity and quality of fossil fuels to a point where they are no longer economically recoverable. This loss of fossil fuels will have a markedly negative effect on agricultural production. The combination of these two events will change the course of human history as nothing else has ever done.

It will be the beginning of a future of less, the contraction of world economies and eventually of population. Adjusting to this course of events will be stressful and at times chaotic, as advanced societies seek to preserve the amenities of living to which they have become accustomed. But this adjustment to living within the new paradigm of the resource limits of a finite Earth is inevitable. The affluent resource times we have briefly enjoyed will never be repeated. Times and events move on.



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