"Peak Oil": The short, medium, and long-term

"It took us 125 years to use the first trillion barrels of oil. We'll use the next trillion in 30. … The world consumes two barrels of oil for every barrel discovered. … Energy will be one of the defining issues of this century. One thing is clear; the era of easy oil is over...."

– David J. O'Reilly
Chairman & C.E.O.
Chevron Oil
From Chevron advertisements that began appearing in early July. The ads are partly in response to a bid by the Government of China to buy US oil company Unocal. The Chinese are also trying to take an increased ownership stake in Canada's tar sands.

"Everybody in OPEC is at full capacity—maybe Saudi Arabia has something left but it is heavy oil —so in practical physical terms we have nothing,"

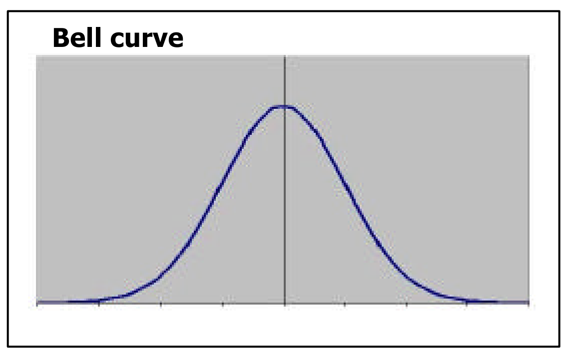
– Libyan Energy Minister Fathi Bin Shatwan
"OPEC runs low on ammunition to tackle oil price"
Peg Mackey and Simon Webb
Reuters, July 14, 2005

NFU Director of Research Darrin Qualman recently returned from a conference in Dublin, Ireland entitled "What Will We Eat as the Oil Runs Out?" Based on that conference and other research, he offers this brief primer on Peak Oil.

Hubbert's Peak

M. K. Hubbert (1903-1989) worked as a geologist at Shell Oil for 20 years and at the United States Geological Survey for 12. He also taught geology and geophysics at Stanford and Berkeley. He is best known, however, for predicting peak oil production.

Hubbert's first insight was that oil production would roughly conform to a bell curve—increasing slowly at first and then quite rapidly, then reaching a peak or plateau, after which production would fall. Further, he predicted that a given country or region would reach the peak of that production curve at approximately the point when half of its oil was used up. This means, ironically, that peak production might occur at the time when declared oil reserves are at their highest point.

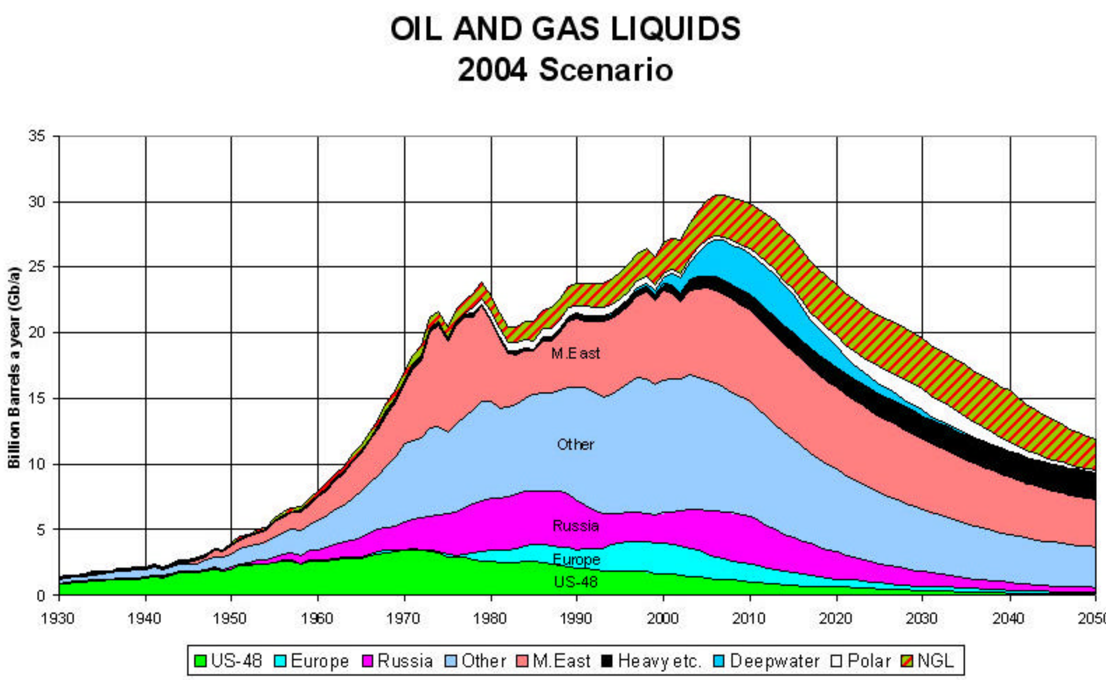


Hubbert's second notable insight came in 1956 when—based on data for US oil production, reserves, and discoveries—Hubbert predicted that US oil production (from the lower 48 states) would peak in the early 1970s. In the '50s and '60s, most geologists and policy makers dismissed his prediction.

But, as Hubbert predicted, US oil production peaked in 1971, right on schedule, although the peak was only visible several years later, in looking back at the data.

However, it's not only US oil production that will follow a bell curve—peaking and then declining. World oil (and natural gas) production will follow a similar pattern. Since the 1970s, many people have attempted to use variants of Hubbert's analysis to predict the year in which global oil and natural gas production will peak. There is a growing consensus among a significant number of those analysts that we are within years of reaching that peak. Many even say that the peak is occuring now.

The following graph is produced by the Association for the Study of Peak Oil (ASPO) and the Uppsala Hydrocarbon Depletion Study Group. This graph shows the production of oil and natural gas liquids peaking in about 2006 and trailing off thereafter. If this scenario comes to pass, declining oil production will run smack into rapidly increasing demand—demand from China, India, the US, and elsewhere. The effects of this supply and demand crunch on oil prices are easily predictable. The effects on food production, our economy, human population, and on the stability our civilization are harder to predict.



The creators of this graph, and many other Peak Oil prophets, want us to believe that global oil production is peaking now, or that it will peak in the next couple of years. That assertion is far from certain (see sidebar on "How much oil do we have"). What is certain, however, is the following:

- Peak Oil will probably come relatively soon—if not in the next few years, then in the next decade or two;
- Despite hype about hydrogen, ethanol, and biodiesel, there is no "plan B" when it comes to replacing oil and natural gas;
- Solar and wind can supply some of our electricity need, but only a fraction of the energy needed to power North America's strip mall, suburban McMansion, air conditioned, commuter jet, sport utility vehicle culture. (To visualize a solar and wind-based society, think Europe in the late-1950s.); and
- The effects of decreasing energy availability on our economy and society will be wrenching and transformative.

How much oil do we have?

Why the uncertainty over when oil production will peak? First, we don't know how much oil we will eventually find (although indications are that the vast majority of oil has been located). But there's a bigger problem: no one knows how much oil has already been found; no one knows the size of current reserves.

In the 1980s, OPEC changed its quota system and began basing production quotas on reserves. As a result, OPEC members began inflating their reserve estimates. In 1985, Kuwait announced a 50% increase in reserves. Saudi Arabia and others followed suit. And today, despite decades of pumping and billions of barrels of production, many reserve claims remain nearly unchanged. No one is allowed to audit such claims.

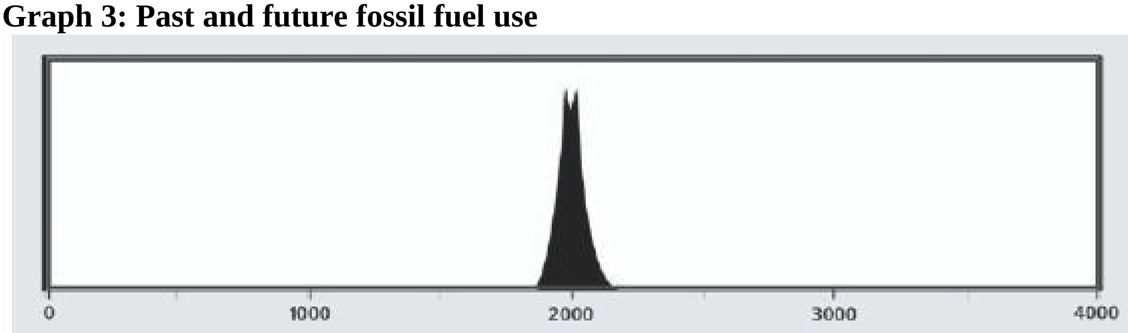
Some analysts predict that Saudi Arabia is about to hit peak production capacity, and that, globally, there is no significant excess production capacity.

Thus, whether we believe peak oil production will occur in 2006 or whether we believe it will occur in 2026, peak oil is a problem we must address immediately.

The longer term is more certain

When talking about the future of our energy supplies and about the shape of the economies and civilizations dependent on that energy, the long term is much more certain than the short term. For instance, Graph 3 shows the *very* long term—4,000 years—and it shows a dramatic increase in humankind's use of fossil fuel energy over the past 125 years. It also forecasts an equally rapid decline in the availability and use of energy over the next 125 years. While the decline need not be as absolute as Graph 3 predicts, there will almost certainly be a dramatic decline in energy use over the coming decades—either as a result of oil depletion or of the need to deal with climate change.

Graph 3: Past and future fossil fuel use

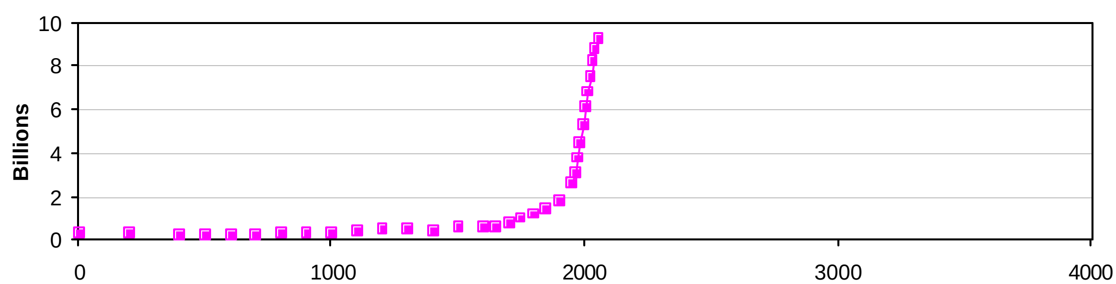


But energy use (fossil fuel and otherwise) is at the base of our economy, our civilization, and, to an increasing extent, of human biology. Food is energy, and energy is increasingly transformed into food for humans. Declines in energy availability and use will have dramatic effects on every aspect of our lives.

For many reasons, human population is closely tied to energy use. The most obvious reason for this linkage is that growth in human population will, other things being equal, bring with it a growth in energy use—more people will use more energy. But equally valid, reversing cause and effect, we could point out that a growth in energy use—especially energy used in food production—will allow an increase in human population.

The following graph plots human population over a timeframe similar to the energy graph above—showing human population growth (and projections) from about 0 AD to 2050 AD. Note the strong correlation between Graphs 3 and 4, between the sudden spike in energy availability/use and the spike in human population. This is no coincidence. Massive energy use has allowed us to multiply our numbers tenfold.

Graph 4: Human population



These two graphs beg the question: If population has risen as energy use has risen, will the reverse be true also? This is not to ask the trivial question: Will fewer people result in less energy use? The converse is much more important: Will declining energy availability drive down human population? Will population follow energy use on the downslope, as it has on the upslope? Put another way, one could ask, is a human population of 7 to 10 billion sustainable in the long term? Or are we merely in the midst of a brief exuberance of the human species? Will a human population at the current level be a long-term feature of the Earth? Or are we mimicking the boom-and-crash population dynamics of rabbits, lemmings, and fruit flies?

Energy and food

To understand whether Peak Oil might also mean peak population we have to better understand the tie between energy and food.

Currently, we are feeding 6.8 billion people, and projections are that global population will rise to 9 or 10 billion. And we will attempt to feed this increased population without any additional land (additions to the cropland base, in Brazil and elsewhere, will more-or-less balance losses).

Today, we are feeding about four times as many people than we fed in 1900 (about 6.8 billion today versus 1.6 billion in 1900). And at current population growth rates, we are adding the equivalent of a North America every 6 years. The amount of cropland per person is shrinking rapidly and significantly. <u>By 2025, we will have only half the cropland per person that we had in 1969</u>.

As population grows swiftly, there are growing signs that food production is not keeping up. In five of the last six years, globally, we consumed more grain than we produced. In just the past 6 years, we drew down global grain stocks from a 111 day supply to a 66 day supply. Current stocks/use ratios for world total grains are at their lowest level in 30 years. To be sanguine about the prospects for feeding 40% or 50% more people on a static landbase is to be reckless in the extreme. But to stare into the face of this looming food crisis (potentially exacerbated by energy shortages, climate change, or both) while simultaneously smashing family farms on the pretense of "oversupply" and "surplus" is a madness we will have much time to lament.

A cornerstone of our ability to feed 6.8 billion people on a planet that supported just 1.6 billion a hundred years ago is our use of nitrogen fertilizer. Nitrogen is produced from

Everything is energy

Nearly everything we value and desire in our economy is a form of energy. Energy=wealth. Let's begin with the classics needs: food, clothing, and shelter.

Food is energy: Solar energy is alchemized into carbohydrates within plants. Seen another way, the ditch digger eats a hearty breakfast and turns that food into the mechanical energy to move a ton of dirt.

Clothing and shelter are energy: Both take energy to produce, and one of their main roles is to modulate and manage the energy (temperature) of our bodies.

"Naked, hungry, and cold" is often used to evoke absolute poverty.

Travel is clearly energy.

War is energy: Fists, guns, and bombs are means to deliver energy to disrupt buildings, tissues, and societies. Security is the ability to deter the delivery of these disruptive energies.

Money is a system of energy storage tokens—potential food, clothing, heating, housing, travel.

Civilization, to a very real extent, is a reflection of energy manipulation. Our society is rooted in the industrial revolution and its discoveries of how to turn coal into linear, rotational, and geographic motion. Steam engines were then hooked to power looms and passenger trains—producing fossil energy-derived cloth and travel. As we leveraged more coal and oil to augment our muscles, the middle and working classes rose into relative privilege and comfort.

Some "goods" that seem to defy this energy=wealth equation. Books, movies, poems, and songs seem to have a low fossil fuel content. But these creative products are energy dependent. By multiplying the work that a farmer or worker can do (think assembly line, large tractor, fishing trawler, or chainsaw), fossil energy "frees up" other people to create the books, blueprints, movies, and music performances that constitute modern culture and form much of the "wealth" of our life. Without fossil fuels, most novelists and pop stars would be hoeing the fields.

Our lives of privilege depend on energy. A gallon of gas yields the equivalent energy of 120 hours of human labour, and this gasoline can be purchased with the wages from 30 minutes of work. The work we do with our muscles is augmented by the work done by energy. In Canada, each of us burns energy equivalent to the work of 361 human beings. This, more than any other factor, explains our affluence.

natural gas. Up to a third of the energy used in agriculture in the developed world goes into making fertilizer.[1] In a modern nitrogen fertilizer plant, a big natural gas pipeline goes in one side and a big ammonia (nitrogen fertilizer) pipe comes out the other side. In a fairly direct way, we are transforming natural gas into fertility, energy into food.

Leaving aside the argument about whether organic agriculture can feed the world, it seems clear that in the short and medium term, taking nitrogen fertilizer out of the food system will make a very tight food situation even tighter. US and Canadian corn fields fed by natural gas-derived nitrogen produce well over 120 bushels per acre. Remove the nitrogen, and the yields fall by as much as half. Seen another way, since we can't find more acres, we've been injecting energy (in the form of nitrogen fertilizer) to make one acre produce the food of two. Our population of 6.8-billion-going-on-ten-billion is supported by hundreds-of-millions of "ghost acres." Increasingly, our food supply is produced as much by our oil fields as by our grain fields.

An economy addicted to energy

For various reasons, including the way that interest must be paid on borrowed money and the way employment and investment are structured by corporations, our modern economies depend on growth. We have a word for a short-term cessation of economic growth: "recession." And the word for a longer period without growth is "depression."

Since economic growth usually parallels energy growth, energy contraction may lead to economic contraction. The effects of such contraction and instability could include: trillions lost as various stock market bubbles burst; recession after recession, each deeper than the preceding one because the expulsion of workers and the tightening of investment exacerbates the decline in each phase; and the beginning of an uncontrolled spiral downward, such as was seen in the 1930s.

And declines on the economic and energy fronts may be paralleled by disturbing developments on the political front. If privileged North Americans begin to see their economies sinking and their energy-enhanced lifestyles slipping away, out of fear they may be drawn to elect politicians who promise solutions, no matter how far-fetched. There will be deep political divisions over the wisdom of investing massively in nuclear power and nuclear-derived hydrogen fuels. There will be increasingly-desperate attempts to prolong the SUV culture and the consumerist American dream.

Oil depletion vs. climate change: Is there too much oil or too little?

Many people reading the preceding paragraphs will feel a growing unease with the idea that oil depletion is our gravest problem. These people will rightly point out: oil depletion threatens our economies and, perhaps, our societies and civilizations, but climate change threatens the *Earth*—the caribou and polar bears, the ocean currents and ice caps, the coral reefs and the rain forests. Since we absolutely must get greenhouse

[1] David and Marcia Pimental (eds.), *Food, Energy, and Society*, pp. 107-130.

gas emissions and climate change under control anyway, perhaps Peak Oil is, at least partly, a blessing—as much cure as disease.

Admittedly, running out of oil is preferable to destroying the planet with it. But pointing out that Peak Oil is the lesser of two evils is a long way from saying that Peak Oil is an unalloyed blessing. While Peak Oil may make the future better than the nightmare alternative of runaway climate change, Peak Oil will not necessarily make the future better than the present. And by many scenarios, Peak Oil will make the future a whole lot worse.

Perhaps a bit of nuance is necessary. The problem isn't simply Peak Oil. The problem is Peak Oil in the current economic and political context—in a growth-addicted, corporate-friendly, laissez faire economy overseen by a political class transfixed and corrupted by its economic system. The problem is the combination of Peak Oil and an economic system in which (the market ideologues rightly point out) "no one is in control." Ours is a system where it is no one's job to look past next year's profits, to take stock of how this year's production might affect next decade's weather, where we fish the last of the cod and then go after the haddock, where we become ever more dependent on energy despite the fact that no one is keeping an eye on the fuel gauge.

Here is an example of market-think: We need not worry about resource depletion because as resources become rarer, their prices will rise, making alternatives relatively more desirable. As oil and natural gas run out, they will become more expensive, making solar and wind power relatively more affordable. This is the miraculous invisible hand of automatic allocation and substitution.

But let's look at how that might work in practice. If the Peak Oil crowd is correct, it is probable that natural gas prices will triple or quadruple in the next decade. Some analysts predict that prices might increase ten-fold. According to the market ideologues, the automatic reaction to these high prices for oil and natural gas (and the electricity that is increasingly generated from natural gas) will be to make wind turbines more affordable, indeed, highly profitable.

But modern wind turbines are made of steel and aluminium. Aluminium is a relatively common element, but a huge amount of energy is needed to smelt aluminium to make it useful for construction. By some estimates, 97% of the cost of aluminium is the cost of the energy to smelt it. Thus, if we wait until oil, natural gas, and electricity prices double or triple before we begin to build our wind turbines, we will find that 1) the cost of the materials for those turbines has gone up dramatically, and 2) wind turbine construction capacity constraints will further increase the cost as everyone scrambles to buy and install turbines at the same time. Clearly, in a rational system, where it was someone's job to look forward and to make plans that take into account resource and environmental limits, we would be building wind turbines now, at the fastest possible pace. But this is not the case. For the most part, we are leaving such matters to the market. There is a faith (hardly more than a *superstition*) based on about 50 years of experience gained during the post-war period of unprecedented stability, that the undirected market is best able to make course changes for our increasingly global civilization.

Of course this is not true. The invisible hand of the global economy has been given far, far too much responsibility. This is apparent even in the relatively unchallenging times of stability and prosperity over the past two generations. It will become piercingly clear, however, when we are challenged by biological, resource, and environmental limits. The invisible hand is the hand of an idiot savant—talented at orchestrating the economy so long as the economy is free to expand without limit and to burn, consume, and degrade a bounty of resources that took billions of years to accumulate. But when faced with limits, disturbances, and the need to pursue and balance multiple, conflicting goals (not just a simple focus on growth and profit), the invisible hand will prove disastrously inept.

The problem isn't just Peak Oil, it's Peak Oil's impact on a world-wide mono-economy, an economy addicted to growth, an economy that, if it even sniffs economic contraction, may well begin hurling off workers and closing plants, passing the most devastating impacts of economic contraction and restructuring down to the people least able to absorb the effects and, at the same time, ensuring that each subsequent round of recession is deeper and more dangerous than the last. On both fronts—climate change and oil depletion—thoughtful analysis, careful planning, and a managed transition that utilizes the best of our technological options could bring us relatively comfortably to a high-tech version of a 1950s lifestyle. We might, if we work collectively and intelligently, be able to make a relatively smooth transition to a new way of living that could include a vast range of benefits. It is not utopian to suggest that a new economy that is respectful of both environmental and resource limits might include a four-day work week, more gardening, relocalized food and manufacturing systems that offer a greater variety of jobs and that capture and retain more wealth in local communities. We might rediscover train travel, bike paths, and diverse local shops. None of this is Utopian because all these ways of living and working and travelling have existed in our past—and *co*existed with much lower energy use and greenhouse gas creation.

We need not merely go back, however. In fact we cannot. Whereas in the 1950s we had 2.5 billion people on the planet, soon we will have 9 or 10 billion. To fully tackle the challenges of a growing population, resource depletion, pollution, climate change, and a host of other econo-pathologies, we will have to integrate a carefully-selected basket of our most promising cutting edge technology. The future won't be the '50s reprised; the future will include the internet; (a limited number of) cars that achieve 5 to 10 times the mileage of the '57 Chevy; smart homes that use a minimum of energy to create a maximum of comfort; manufacturing techniques that reduce energy and resource use several-fold; widespread recycling; new, low-energy materials technologies; telecommunications; and a vast range of resources-saving, life-enhancing technologies. We will need to learn about biodiversity in crops, about permaculture, and about reduced-input agriculture. We will have to rethink a global trade system where all of our shoes, toilet seats, T-shirts, and telephones are made on the other side of the planet. Finally, we will have to rediscover alternatives to consumption and accumulation as the primary means of personal growth and self-actualization. All of these can be positive developments. These changes are, perhaps, absolutely necessary, whether Peak Oil is a reality this year or next century. Many positive futures are possible. What seems certain, however, is that the short-sighted, growth-based economic system that has brought us to the brink of multiple calamities is not capable of leading us away from that brink. To find the way forward, we need to constrain "the markets" within a forward-looking, democratic decision-making process. Human beings need to do what human beings do well: look ahead, survey the terrain, see the dangers, make a plan, and cooperate to implement that plan. Sooner or later, the mania of unrestrained growth is bound to bang into some limit—if not Peak Oil, then climate change or water depletion. The challenge for us is not the narrow one of restructuring our energy supply; the challenge is restructuring the guidance systems of our economy and society.