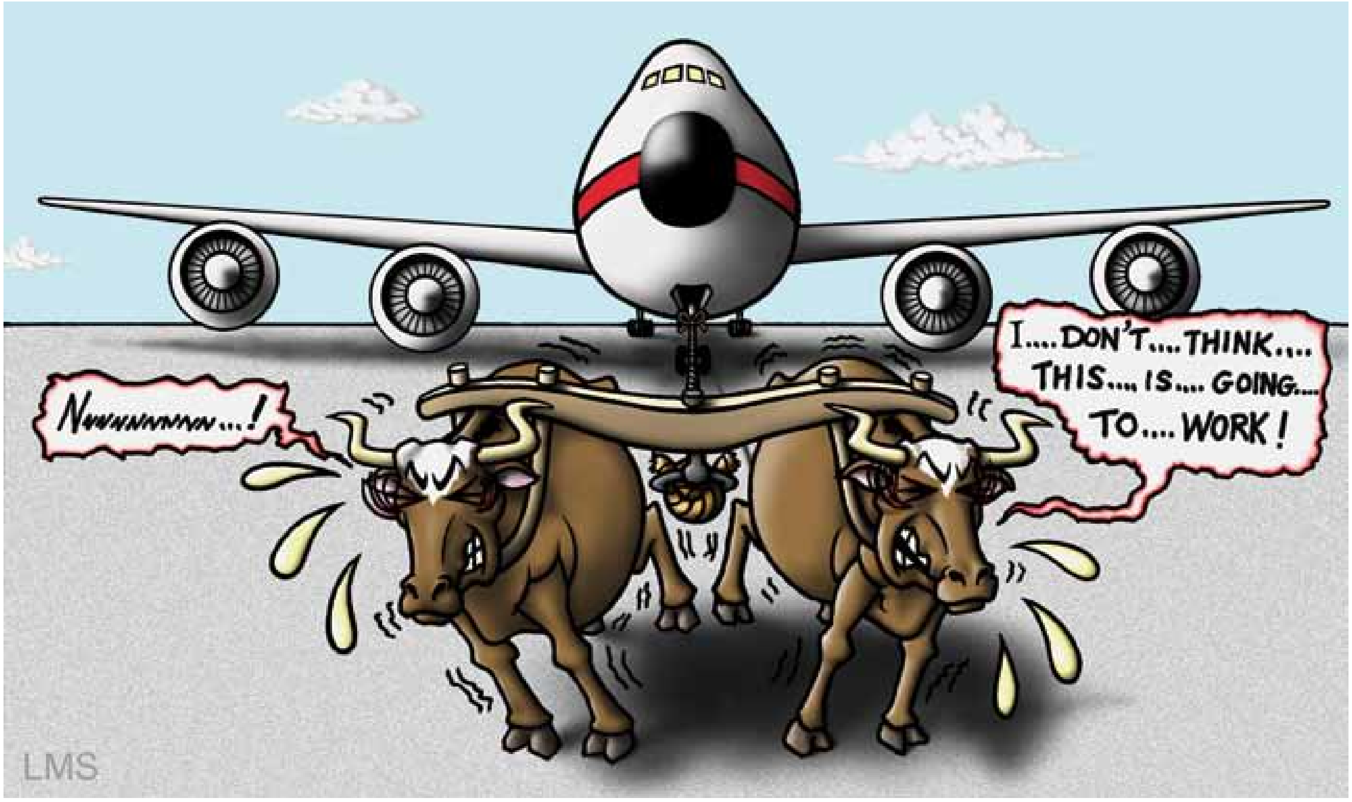

Illustration by Larry Stewart, Ottawa, ON

Looking at Our Future:

The Impact of Oil on Aviation and Daily Life

COMMENTARY FROM WALTER SHAWLEE 2

Readily available energy has been the catalyst for all industrial development since the 1800s. We have used livestock, waterpower, steam, coal, oil, electricity, nuclear and solar energy relentlessly as we moved our civilization up the industrial development ladder.

The increasing use and ready access to energy has transformed all our activities, both personal and public, and virtually no aspect of modern life is untouched or unaffected by it.

Powered aviation, in particular, was enabled only by the relatively recent creation of high-energy, low-weight petro-chemical fuels. There were no early generation oxen-powered or steam-driven aircraft to later abandon in favor of better Jet-A fueled ships.

For clarity and to help better understand our future situation, oil and natural gas are the chemically stored solar energy of millions of years. They are the result of the conversion of ages of biomass under heat and pressure below the Earth's crust, and therefore, is something for which no true equivalent waiting in the wings.

While there were billions of barrels of oil and billions of cubic feet of natural gas under the Earth, we have used almost all of the easily accessible material in only 120 years, an unfortunate global accomplishment and a bad timeline for our future.

Crude oil prices as high as $147 per barrel in the U.S. (a barrel is 42 U.S. gallons), which is about seven times the cost of 2002 oil, highlights three issues no one really wants to talk about. Keep in mind, September 2009 oil prices of $70 per barrel in the U.S. show how volatile this commodity is and how easily it can experience huge price swings simply because consumption is unavoidable.

First, there is only so much oil and natural gas, and no matter whose fantasy estimates you want to believe, the industry observers' consensus is, Air transport as we know it already is under fierce attack, as fuel prices are changing it from an everyday, affordable option to a scarcity tool of high necessity only.

we already have passed global peak oil in 2008, and now are on the downward slope of availability.

A few professional industry skeptics believe the real peak date is 2010, which is no comfort in our situation — and real data actually points at 2005 as the more likely date, which is even worse for us. Plus, new oil discoveries lag behind consumption by a considerable 6-to-1 barrel ratio. Unfortunately for our petrochemically based world, there just isn't much left to find.

The second issue is, demand and scarcity elevates prices, and with billions of people (especially in India and China) moving up economically to a more Western style of life (which includes cars, energy and food), the upward demand pressure is simply inescapable.

Prices today are nothing compared to where they will be when significant supply shortages really appear. It requires only a tiny shortfall (roughly 2 percent) for demand not to be met, and all prices inevitably will rise. A similar surplus, and prices drop. This is such a fundamental economic concept, it simply can't be legislated or dictated out of existence.

Price stability is only possible when there is at least some available oversupply, so no demand goes unmet. Miss this critical target, and all bets are off, as no one wants to be the guy left standing with the unhappy empty fuel tank and long face.

The third issue is, nothing else can possibly replace oil and all its products in our current economy. We will not be flying transport planes on battery power, charged by solar energy and lubricated with banana oil. In fact, virtually every aspect of modern aviation — unless it can be performed with balloons, gliders and dirigibles — eventually will pass away as viable technology, and probably no farther than 20 to 25 years from now. There simply won't be any way to power it — unless there is a truly astonishing Area 51 surprise in alien energy sources still waiting to be revealed.

Air transport as we know it already is under fierce economic attack, as fuel prices are changing it from an everyday, affordable option to a scarcity tool of high necessity only. The common movement of goods by air or by powered ship from far away is going to become an expensive proposition in a few years, and globalization is about to meet the unhappy reality of staggering petro-fuel shipping costs. The shock from this gigantic sea change will be profound to the world's economy.

Understanding Oil and How We Use It

Approximately 84 percent of raw petroleum volume from the wellhead is used directly for some kind of combustible fuel, including gasoline, diesel fuel, jet fuel, heating oil and related fuels, and liquefied petroleum gas, including propane and butane. The other 16 percent is used in everything from lubricants, solvents and pharmaceuticals to fertilizer, plastics and pesticides.

Critically, and hardest to replace, is the 16 percent of oil that is the raw feed stock for thousands of essential industrial processes. In addition, natural gas (converted to ammonia) is especially critical for the production of nitrogen rich fertilizer — although coal is a workable but less convenient alternative.

High oil and natural gas prices are dramatically affecting food prices because of their heavy use in fertilizers and the cumulative effect

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of rising transport, processing and machinery fuel costs. In addition, exacerbating an already bad situation is the diversion of key food crop production (soybeans and corn, in particular) to methanol production in huge amounts. This is being done by an Environmental Protection Agency mandate, serving as an imported oil substitute.

All of these factors are working together to massively elevate foods costs as an unintended consequence.

In the aviation world, Jet-A fuel or avgas are the key oil products (along with lubricants and hydraulic fluids), and their rising prices have had serious consequences.

According to the National Business Aviation Association, the high price of fuel has grounded many general aviation aircraft, cut aircraft movements by up to 50 percent in some locations, and made many pilots shift flights and FBOs in search of affordable fuel. With general aviation customers routinely being hit with twice the prices car drivers or airlines are paying, it's easy to understand the huge impact it is having on flight hours.

In July 2008, *Bloomberg* reported airlines are preparing their biggest cutback in fuel use since 1991, with plans to ground 413 aircraft (8.8 percent of global seating capacity). This is being forced by current period, industry-wide fuel-driven losses now estimated at a massive $13 billion, according to the Air Transport Association.

For most users, the only real approach now possible is simply to use less fuel, and a drop in aviation consumption of about 7.5 percent already was seen in 2008. In March 2009, *Forbes* forecasted a 12 percent further drop in airline revenues for 2009, and a combined loss of $4.7 billion, on top of existing debt of $170 billion — a direct result of decreased ridership and exploding fuel costs.

Trying to Find Oil Replacement Solutions

The oil replacement issue really is the killer for aviation. Because oil — in the form of jet fuel or aviation gasoline — represents such concentrated energy with a massive power-to-weight ratio, our existing flight technology for air transport is going to be dead on the runway — and not very long from now.

We simply have nothing light enough and powerful enough to serve as a viable turnkey fuel replacement, nor as a source for the wide range of required fluids and lubricants.

A battery-powered car only needs to overcome inertia and rolling friction to move and, like a train, can move large weights (such as heavy batteries or freight) with only modest amounts of energy if the grade remains low.

Planes and helicopters, however, must completely overcome gravity to operate, through enormous lift and thrust, and this is not destined for battery-powered application because the energy-to-weight ratio simply is inadequate for the task.

NASA has been sponsoring fuel-efficiency competitions to encourage the "greening" of aviation and, if possible, alternate energy techniques and improved efficiency; however, we remain a long way from any viable electric aircraft.

What about the hydrogen highway? What about fuel cells, which run on hydrogen? The crushing issue for all hydrogen technology is, while it is the most common element in the universe, it exists on Earth mainly as water and hydrocarbons, not as readily usable H2 gas.

Considerable energy is required to extract usable hydrogen for fuel; thus, hydrogen is more properly defined as an energy storage medium than as a viable fuel.

A great deal of hydrogen already is produced today, approximately 11 million metric tons in 2003, which has been rising at about 10 percent per year. Approximately half of this already is used in the Haber process for ammonia production to create nitrogen-rich, (ammonia-based) fertilizer. The other half is used to create lighter fractions (used for fuel) from heavy petroleum in a process called hydrocracking. This is critical for the use of oil shales and tar sands, and could not be diverted easily without making those critical sources unusable as a result.

Where does hydrogen production come from? Approximately 48 percent comes from natural gas, 30 percent from oil, 18 percent from coal, and only 4 percent from the electrolysis of water (breaking up water into hydrogen and oxygen by electrical force). While the electrolysis production possibly could be driven by some clean, renewable source, it's clear the overwhelming majority will disappear along with the petro-fuel world.

The supply-chain efficiency (sometimes called well-to-tank factor) for gasoline is roughly 80 percent; electricity is 90 to 95 percent, and hydrogen a dismal 40 percent. Electrical cars are typically at least three times as efficient as any hydrogen-powered type.

Fuel cells eat oxygen while they work, like combustion engines. Think this is non-polluting? You might dislike conventional engine exhaust and greenhouse gases, but just try to breathe without oxygen. This is one "green" issue sidestepped in virtually all hydrogen-fuel discussions, but of huge importance ecologically, especially when deployed on a large scale.

The energy required to split water is considerable, as is the energy to crack natural gas to extract hydrogen (not to mention the issue of where the gas itself comes from). Alas, there is no free lunch in physics. Or, to put it another way: A fuel that takes as much fuel to make as it generates is not really a good fuel for us because we are running out of fuel.

The point of fuel-cell technology is to generate electricity, which then runs electric motors, as in the prototype "green buses" already in Europe and Canada. But once again, this is not really a good fit for aviation, and it's not as efficient overall as all-electric systems.

Avoiding the electrical stage altogether, pure hydrogen scramjets certainly are possible to replace existing jet technology, but where would their massive hydrogen-fuel requirements come from in a shrinking petrochemical-world?

While I can picture helium dirigibles in the future with electric steering motors powered by fuel cells or other electrical sources, I have trouble with the basic science magically making the leap to fuel cells or secondary batteries running a Boeing 747, Beech Bonanza or Bell Jet Ranger.

Of course, the nagging issue remains: Where will the needed hydrogen come from and why not use direct electrical systems anyway?

Remembering the Hindenburg, let's not forget hydrogen is highly flammable and not so easy to contain or handle under the high pressure required.

The Social Side of Oil

Every aspect of North American modern life, including suburban living, high-output industrialized farming, distant food production, urban-centric

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industry, global sourcing of goods and large daily travel distances is completely and irreversibly dependent not only on available oil, but also on cheap available oil.

I can remember putting just a few dollars' worth of gas in my car as a kid and driving for days — that chapter in our history is now closed.

It is generally accepted that America passed its self-sufficient internal peak oil point (the point of maximum ready supply) in 1970, and natural gas in 1971, and it has been an inexorable and increasing net importer ever since. Unfortunately, nothing whatsoever was done in terms of conservation back then; so now, the situation is far more desperate with more than 30 years of added sprawling infrastructure and inefficient transportation.

In fact, every possible attempt at improving vehicle fuel economy, or general conservation, has been met by concerted industry attacks, and thus, has had almost no impact on mandatory standards.

Mandated North American vehicle efficiencies have been the lowest in the world; therefore, its oil consumption is the highest.

To check your vehicle's fuel consumption, visit the Department of Energy's www.fueleconomy.gov website.

There also is an excellent comparison study at www.theicct.org/documents/bellagio_english.pdf.

The issue now is, there simply isn't enough oil left worldwide to satisfy all willing customers if the world economy is operating well. And, each year, the available pool of oil will get smaller and more contentious as demand and population increases but remaining supplies decrease.

It always sounds like a lot when someone announces a new field has been found and it will produce 1 million barrels of oil a day. For example, the proposed drilling in the currently protected Arctic National Wildlife Refuge in Alaska is thought to be able to deliver this level for a few years, after about five to 15 years of preparation. However, because U.S. consumption alone now averages 18 to 20 million barrels a day, it will make only a small difference unless we radically alter our rate of consumption today.

In March 2009, current world consumption was estimated at approximately 83.9 million barrels a day, a truly staggering figure when considering any replacement.

To find regularly updated U.S. and world oil consumption data, visit the Energy Information Administration website at www.eia.doe.gov.

Oil Psychology

It is not necessary for there to be no oil or gas for there to be serious problems. Merely when there is just not quite enough oil, or the fear there is not enough, problems arise.

As recent price swings show, even the smallest shortfall triggers rising prices and stockpiling. And more dangerously, severe shortages or the thought of supply disruption or interference trigger desperation, hoarding, speculation and, sometimes, war.

Once the reality of a genuine end for a reliable supply is seen to be unavoidable, human behavior will become unpredictable and likely self-serving. Fear and greed are extremely powerful forces when scaled up to the volatile national level.

Because oil companies are making staggering profits during these huge price increases — and we can be certain there is every kind of price fixing, deceit and fear-mongering in play to suit various corporate and personal agendas — we easily forget it really makes no difference. In the end, when the tank is dry, it's dry for all of us.

Oil producers, especially in North America, know they are living on borrowed time with a rapidly vanishing resource. So, they are not shy about maximizing their revenues while they can, all the while convincing you no change in your high-consumption behavior is needed.

The strange thing is, when there just isn't any more, we all will be in the oil-driven world we created together, but with no oil left to run it. The windfall profits and high-share prices won't seem quite so important then.

It can be puzzling to watch the huge and rapid gyrations of oil prices when the actual shift in world consumption or supply does not change significantly. When demand first dropped in the U.S. — the world's largest oil-consuming country — as recession hit (down from 20-plus million barrels per day to 18 million), it was the catalyst for rapid price declines, just as new demand in China and India helped fuel the initial increases.

It is important to look past local patterns— look instead at total world consumption to clearly understand the full dynamics of the process. Studying the past few years of prices shows that swings of 50 percent in terms of barrel price can be linked to near-term shortages or surpluses of as little as 2 percent in terms of world consumption.

This is because of several factors — chiefly because oil, once extracted from the ground, must go somewhere.

Oil is too volatile and polluting to simply toss into a pond, so it must be put into costly storage tanks and be loaded into pipelines or onto tankers. In this way, it closely resembles the market volatility of fresh fruit — but think of it as highly flammable and vastly polluting "fresh fruit" that also is incredibly awkward to store.

Once "in transit," oil must be off-loaded in a timely manner, making firm commitments essential to the industry, as well as known current and future pricing contracts for purchase. Tankers simply can't sit around waiting for clients, nor can pipelines be stopped easily (pipeline failure could result); therefore, its sale, at whatever currently agreed price, must take place. This helps explain why even small shortages or surpluses have such a sudden and serious impact on pricing.

Producers have to scale back on primary extraction quickly to stabilize falling prices, then they have difficulty re-starting and re-loading the delivery system quickly if consumption suddenly rises, which pushes prices up rapidly. The entire oil extraction and delivery system has huge inertia issues, especially in terms of additional supply, and no easy way to accommodate extracted oil that has no quick customer, or to supply oil to unexpected demand.

Oil producers want to maximize sales and, ideally, ship the least oil for the greatest price. Consumers want assured oil at the lowest price. This delicate dance of conflicting desires is acted out mainly through the control of extraction rates, pricing control agreements and, to a lesser degree, government controls, such as mandated fuel economy ratings and various excise and use taxes, which can be a significant portion of the end-user cost.

Both suppliers and consumers are constantly adjusting their positions so they can be assured of customers and supply, and each is constantly looking for price advantage.

Pricing psychology is a critical market issue, and often, there is huge resistance from consumers regarding oil increases, while they seem to simply accept drops in pricing with little if any fanfare.

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Of real concern in a global sense is, as each "psychological threshold" price is passed, it can rebound to that point much quicker the second time, as it already is established the market will bear it. With it now established the world can survive $147 per barrel, the scenario is set for its rapid return and, eventually, its increase.

Europe has a far different consumption pattern, however, and fuel economy is considered one of the essential design criteria for a marketable car. Europe has readily accepted much higher fuel taxes (to fund infrastructure and deter consumption) and higher fuel prices, yet Europe's actual cost-per-mile traveled is about the same as North America. Much higher fuel economy helps achieved this.

Europeans also have shorter commuting distances, tend to do more joint commuting, travel mush more often by walking or rapid transit, and buy far fewer cars.

The fuel-efficient cars Ford now is thinking of quickly re-tooling to introduce in America to satisfy consumers (because demand for many of its U.S. models has collapsed) all are established and more economical European Ford models. The irony is considerable, as apparently what's impossible to achieve in fuel economy in the U.S. without "serious industry hardship" apparently is quite possible in the UK and Europe.

While U.S. automakers smiled indulgently at compact, fuel-efficient imports, then concentrated on the really important stuff — such as huge engines, cup holders and dual tires on pick-up trucks — an entire generation of new, high-efficiency automotive technology displaced U.S. designs worldwide.

Hybrids, compact high-performance engines, electric cars and much smaller, lighter designs became the rule elsewhere, leaving the U.S. with woefully inefficient vehicles.

GM had a wonderful electric car in 2002: the EV1, a highly regarded design that received rave reviews from the test-users of the vehicles. Then, GM completely scrapped the EV1 program and destroyed or disabled all the vehicles — most were crushed.

This bizarre behavior was covered well in the 2006 movie called "Who Killed the Electric Car?" This movie is a telling commentary on how oil companies and automakers acted to maintain the oil-based fuel monopoly.

Now, hoping to stave off the near collapse of its low-fuel-efficiency car offerings and attempting to regain its vehicle sales, GM will rush to introduce the semi-electric Volt car by 2010.

It appears the argument and demand for electric vehicles simply was inevitable.

Because of poor fuel economy and the high cost of ownership, collapsing vehicle sales paved the way for the shocking multibillion dollar bankruptcies of both Chrysler and GM this year. It is clear, no matter what industry pundits want and misleading commercials promote, consumer opinions and choices are the only ones that really count in the marketplace.

No amount of money can readily produce fuel when there just isn't any available. We can use many alternate energy sources for daily use, and this can be transformed for use in vehicles (although no electric transport trucks are yet on the horizon for the bulk movement of freight), chiefly through the transfer medium of electricity. This can be from secondary batteries charged via the grid or solar, or onboard primary generation from fuel cells, assuming someone actually solves all the highly problematic hydrogen fuel issues.

Energy, Physics and Arcane Things You Need to Understand

How much alternate energy actually is available to us free without burning any fuel? The total solar constant (incoming radiation of all kinds/unit area) ranges from roughly 1321W/m2 to 1412W/m2, depending on the time of year.

Keep in mind, only half of the Earth faces the sun at any one time, and there is a marginal energy zone at the twilight boundary. Therefore, a 24-hour daily average is less than half this figure for any given spot, and less as one moves up or down in terms of latitude from the equator.

So, about 500W/m2 represents a realistic 24-hour continuous average for North America, with Canada being a bit lower and Mexico a bit higher.

This represents all the solar energy that possibly could be captured passively, and the reality is, if we actually did this, the Earth's surface would soon freeze. Is not likely we suddenly will be able to convert the Earth as-is to a solar economy in an easy plug-and-play sense to replace our petro-fuel-based model — although, I am certain it will be a critical and essential tool for future survival.

Not really sure why this is true? One horsepower is equal to about 746 watts, which brings it into perspective. There just isn't enough energy there to be captured. Only about 0.67 horsepower per square meter per hour can be captured. It's just not much energy for doing work.

For solar to work, efficiency of both collection and the intelligent use of this energy is critical. Incidentally, 22 percent conversion efficiency currently is about the best for solar panels; so, make that only 0.15 horsepower/m2//h in the interest of full disclosure.

This is why directly solar-powered (only) cars are unlikely; however, large-scale power farming is quite practical if enough collection area is available.

Solar-energy "farming" already is under way in a serious fashion in Europe, especially Germany, as Europe has a high-density, very efficient and tightly coupled electric infrastructure easily converted to at least partial solar power.

Solar hardware and energy farming is highly encouraged and subsidized in Europe, and it already has had a significant impact on power generation and industrial development. In addition, Europe only has modest native energy sources (coal, some hydro, and North Sea oil and gas) to fall back on.

Europe likely will turn to solar, wind, hydro and nuclear energy as future primary energy sources.

Europe has a good chance of arriving at a workable oil-free model, although it will be painful. There is a good summary (although a bit dated) of European Union solar efforts on its website at http://ec.europa.eu/energy/res/sectors/photovoltaic_en.htm.

In the United States, the ITC (investment tax credit) for solar conversion of U.S. homes and businesses was set to expire at the end of 2008. Already passed by the House, it failed eight times to pass in the Senate. Finally, on the ninth try, in late September, it passed — but only received funding as a hurried last-minute addition to the $700 billion Economic Growth and Financial Stabilization Act (popularly known at the "Wall Street Bail-Out").

Uncertainty over the renewal issue had stalled thousands of larger-scale installations, which couldn't be completed by the year-end deadline.

Fighting backward federal policies, as it already has on mandated vehicle fuel economy and pollution, California has committed to several megawatt solar installations planned for deployment by 2012. These are to supply electric grid demands to meet its internally

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state-mandated, solar-power sourcing requirements, as it sees no practical alternative for energy.

In North America, where distances are much larger in urban settings and there are very distant food productions far from consumers, there is little electric rail or rapid transit. Therefore, a smooth transition is not really possible though a simple substitution of electrical energy sources for petrochemical sources.

Too much of North America's infrastructure is comprised of roads, making individuals vehicle-dependent. Too much work and energy must be expended for even the simplest food supply or living activity. Too much food is inefficiently processed. And everything is simply too far apart.

The physical infrastructure upheaval needed to arrive at a working model that can be powered by much less primary energy will be very difficult and extremely painful to achieve in the U.S., especially in large urban areas and suburban locations with spread-out building plans.

Wind power is largely a byproduct of solar heating, but it also includes planetary core heat, planetary rotation and gravity influences. So, while wind power offers another way to capture what significant free energy is present, it also will be limited, to some degree, by the solar constant. We simply are not going to pull more energy out of the total Earth ecosystem in real-time than the sun or planetary motion puts in on a daily basis — although, all non-polluting energy is very welcome.

This is the miracle of oil: It is the stored chemical energy of millions of years of solar radiation generating biomass, which then was converted by geologic heat and pressure to an easily combustible fuel and treasure trove of hydrocarbons.

The critical issue for us is the time it took to do that, versus the brief instant we use it.

The million-to-one time compression ratio from creation to consumption is what makes oil magical to us, and it is what makes replacement so incredibly difficult.

How Things Actually Get Fixed

Our current techniques for transportation, lighting, heating, insulation and cooling all have huge potential savings in energy consumption.

Our vehicles need to undergo a transformation from inefficient heat engines to more efficient electric ones. Rail and electric rail transport needs to be re-adopted.

Even short-term improvements in fuel efficiency offer us much more time to re-think our living patterns and stop the inexcusable waste that seems to be our trademark in modern civilization, especially in North America.

Every improvement is worthwhile, and each one we make will help to some degree. What is not possible is to just keep on the way we are, assuming some miraculous event will occur to allow us to continue our bad patterns.

We are somewhat like the frog in the slowly boiling pot of water — we can feel the heat, but we still are not taking it seriously enough to alter our actions.

I used to own a VW rabbit back in the 1980s; it routinely got 40 mpg. So, I am unmoved when U.S. automakers complain that better than 25 mpg fuel efficiency is an "industry hardship."

At the core of this problem is the issue of will. Tremendous social restructuring will be required, along with fundamental changes in business philosophy, to achieve any useful impact.

Interference with sound and truly responsible government policy has become institutionalized, with every special interest group pushing their agendas for the sake of individual profits or benefits.

We are nearing a phase where this self-serving strategy not only will collapse horribly, but also will cause such an erosion of public support for government and business that no useful action would be implemented and no one with good advice would be believed.

Every alternative technique has issues. The only stand-out irrefutable strategic winner right now is immediate conservation and improvement while we try to implement the best possible long-term escape from the oil trap we have created.

Google has proposed an excellent, ambitious and coordinated plan to completely eliminate fossil fuels by the year 2030. For read the complete proposal, visit http://news.cnet.com/8301-11128_3-10056099-54.html?tag=nl.e703.

The Problem of Time

What does all of this mean for all of us? The near-term window of five years will be difficult, as we are faced with the problems of worldwide economic recession, erratic price inflation and looming scarcity, while many of the people who are in the position to effect change remain in denial that there are any problems.

Both the U.S. and Canada recently had major elections, and what policies and actions might result from those elections are even less certain now, especially in the light of a serious global economic recession of unknown duration.

If we do not get some useful changes soon, it will be the same old, "stay the course, keep consuming foolishly, and ignore the looming cliff up ahead." This simply is not good advice.

Few in government or industry seem to believe they can discuss any part of this oil situation publicly, rolling out the tired old self-serving argument many use to cover their biggest and most wart-covered sins: "It would cause panic."

In fact, people really would like to know for a change what actually is going on — although, you can be certain they will not fail to detect who has been grotesquely misleading them once they know the details, and they will react accordingly.

It is interesting to note that it is mainly the "developed" world headed for trouble. Less developed, mainly agrarian nations will see little difference in their lives in the post-petroleum world, and some areas, such as South America, are sufficiently endowed with both original and substitute petro-resources that their situations are especially good compared to North America.

The Third World likely will have the last laugh in this global drama. The "First World" will suffer the most and fall the hardest in the years to come.

The year 2009 ushered in a wide range of economic problems, triggered first by subprime mortgage failures, then banking failures, and then secondary industrial and commercial failures made worse by constricting credit.

Many economists now are defining this situation as a global depression. Despite a staggering drop in the stock markets worldwide (more than 50 percent) and an estimated loss of $50 trillion in asset "value," one interesting fact remained true: Oil consumption was hard to stop.

From a high of 87.3 million barrels per day in early 2008, the world still is consuming a staggering 83.9 million barrels today (March 2009), despite this global collapse of economic activity. This is a drop of only 3.9 percent, trivial compared to world events, and it clearly illustrates how incredibly hard it will be to move away from a world run on oil.

The International Energy Agency still estimates world demand at 84.4 million barrels per day for 2009, even in the very bleak current economic conditions.

Cynicism among consumers will be high, while trying to educate and prepare everyone for needed changes, and constructive action probably will not be much in evidence, except on an individual or local level — unless we get very lucky in government.

You need to be part of an individual effort or part of a local effort.

The simple and inescapable fact is, our current petro-industrialized pattern of living will be replaced, and our daily life will have much less travel and much more time spent in the direct production of food, This likely will occur within 20 to 25 years.

Our world, in many ways, will become local, not global, and our settings will be more rural and less metropolitan. Our limits will be where you can walk or ride in one day, and our critical skills will be what we can make or grow locally.

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We could eventually find ourselves back in 1850, before oil, but with some electricity and modern communication. It would be a genuine Twilight Zone-like experience for all of us.

When does the tank run dry enough to cause real problems? This is a hard question to answer as so many have their vested interests tied up in the most optimistic answer, and truly accurate data for some issues is difficult to find.

For virtually everyone producing something that requires fuel, their adamant position as to when this will take place is: Never.

Keep in mind, however, actual fuel exhaustion or shortage is not required to trigger serious disruption, only the fear of it, which means the world situation would decay much quicker than physical circumstances actually would dictate. It requires only a 2 percent shortage or surplus to seriously destabilize the pricing in the petroleum market.

Based on the current high saltwater levels seen in Saudi oil pumping (caused by saltwater injection to force recovery on failing wells), I believe trouble is not very far away, perhaps only two to three years.

Of concern to many in the oil industry, is that since Saudi Arabia nationalized its oil fields in 1979, public access to levels of reserves and data about exploration has vanished. Saudi Arabia still reports the same reserves it did 30 years ago, despite pumping out billions of barrels with minimal new discoveries — which also is unverified.

This makes outsiders skeptical about the validity of these numbers, which have been the cornerstone of world price stability and availability.

You probably are thinking those production curves should lead out for a few years yet, but they are being seriously skewed from the ideal symmetrical Hubbert curve because of the double problems of a rapidly increasing population and its rapidly increasing demands for petroleum and its industrial benefits.

The falling slope of the production curve is steepening dramatically as a result, compared to the slower rising curve of early use. Production is being forced to the inefficient maximum to satisfy this demand, thus stripping supplies much faster. Yet, more unintended consequences of increasing urbanization and even global recession is not halting this trend.

The Problem of Where

To be useful, and affordable, fuel — in whatever form — must be close by. Long-distance shipping forces up the price of any fuel, and excessively so as fuel prices rise. Distant oil or gas is uncertain; adjacent fuel is attractive.

The North American Free Trade Agreement has a seldom discussed but critical element in it for the U.S., which is quite harmful to the other signatories.

During the 2008 election season, U.S. candidates said they would love to scrap NAFTA, thus somehow mystically saving some un-named U.S. factory jobs. The reality is, it would devastate the U.S. in terms of oil imports overnight. Of the top three countries exporting to the U.S., two are NAFTA members, Mexico and Canada, with Canada being the largest single oil exporter to the U.S.

Don't think it's true? To see the figures, visit the U.S. Department of Energy's website at www.eia.doe.gov/pub/oil_gas/petroleum/data_publications/company_level_imports/current/import.html.

In fact, about 35 percent of total U.S. oil imports comes from Canada and Mexico, and NAFTA prohibits them from scaling back export production or increasing prices to the U.S. unless they do the same internally.

As oil continues to skyrocket in value and decrease in availability, this is the only force keeping the U.S. adequately supplied with secure oil. Put simply, if NAFTA collapses, so will America's primary and most secure oil sources.

As a further annoyance, Canada actually has to import 55 percent of its own oil consumption to service mainly eastern provinces, as only marginal Canadian pipelines from Alberta feed all the way to the east — they are mainly to the south and west into the U.S.

NAFTA actually prevents the Canadian market from being better serviced internally.

American oil is in deep depletion mode, with only the offshore rigs in the Gulf of Mexico and the fields in Alaska still offering meaningful oil and gas in volume.

Canada has natural gas, but rapidly is reaching the point where it can no longer export and still meet internal demand; only the Alberta tar sands are truly significant net oil producers for export — and they are truly viable only above $60 per barrel.

Mexico also is in oil-depletion mode and soon will be completely exhausted (most estimates say in as little as six years). Because its own industrial development has exploded, dramatically increasing consumption, this poses a frightening future scenario for Mexico.

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A collapsing petroleum and economic situation in either Mexico or Canada is certain to trigger serious friction with the U.S., which somehow never sees conservation as an element in its long-term strategy, only continued and increasing supply.

North Sea production already is in rapid decline (having peaked in 1995), and will rock Europe, especially the UK and Norway, when it stops providing first oil, then natural gas in the next few years.

Russia is pumping oil and natural gas in a frenzy to generate needed hard currency, but an honest state of supply simply is unknown; although, production seems to have peaked last year, 2008, with the most optimistic forecast being 2010, followed by the inevitable decline thereafter.

Europe got a sudden surprise in early 2009, when Russia and the Ukraine were in disagreement over the transit of natural gas to Europe. Russia cut off pipeline supplies entirely, claiming the Ukraine was stealing gas. One quarter of Europe's natural gas now comes from Russia; however, 80 percent of it must pass through the deeply troubled economy of the Ukraine.

Currently, Europe is in an especially awkward political position, having become highly dependent on Russian natural gas and oil in the last decade, and with its easiest non-OPEC source (the North Sea oil fields) now headed toward a steady decline.

It is worth noting it is Russia, not Saudi Arabia, that now is the world's largest oil producer, with more oil produced than Saudi Arabia in 2008. Even 2007 data shows Saudi Arabia and Russian literally tied for oil production rates.

And Russia has used this new capacity to gain significant economic and political influence over both Europe and the U.S., as their other sources dwindle.

Within OPEC, member nations get group permission to export oil based on "proven reserves." So, for decades, everyone routinely inflated the numbers regarding the extent of reserves to get the highest possible production rates (and thus income) under their rules.

Now, however, we are at the point where every lie comes home to roost and every deceit is plainly exposed. We hope the optimistic stories are true, but more likely, we will be sorely disappointed by real events.

To learn more about how its operates, visit the OPEC website at www.opec.org.

There is some remaining untapped deep-sea offshore oil worldwide, and some possibility of Antarctic or Polar development. However, the pollution from extraction in these regions almost certainly would have a serious and immediate unwanted impact on global warming.

Even if the answer was somehow a smiling, "Yes, Virginia, there's a lot more oil (and a Santa Claus, too)," we simply are pushing back the event horizon slightly, not fixing it or improving our habits (which are the real issues). In any case, the costs and consequences are prohibitive.

Current fuel prices already have devastated car companies, crippled airlines, sent food prices soaring, crushed budgets, triggered widespread famine for the poorest in the world, and led to an irreversible fall in the value of distant suburban housing. Just imagine what the next round of increases or shortages will do. I don't believe anyone will escape or enjoy the varied effects to come.

We do still have considerable coal left (formed just as oil was, another stored biomass energy gift from millions of years ago), but its conversion to a liquid fuel is not really a net energy benefit, nor very practical unless all other sources fail or petrofeedstocks simply are not available.

Synthetic jet fuel (Sasol fuel) already is made by this method in South Africa.

Coal also remains the largest source of primary fuel to run U.S. electrical power generation. Most new plants, being built now, however, are switching to natural gas for reduced pollution, even though it is uncertain if continuing supplies will be possible in many locations. Our best long-term strategy for coal is not to simply burn it unless we need to, but to use it as an industrial feedstock as oil disappears.

We really are going to miss those complex hydrocarbons when they are finally gone somewhere down the road.

The Techno Band-Aid Technique

The "green-appeasement" strategy for oil scarcity, without any real structural or conservation changes (which actually would have been useful), has been the legislated use of ethanol.

Unfortunately, only slightly more energy comes from using ethanol in the U.S. (if all steps are considered) than is required to make it — the most optimistic net surplus energy figure is only 36 percent using corn.

In an amazing policy decision, the U.S. Environmental Protection Agency (EPA) mandated the U.S. to use 9 billion gallons (214 million

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barrels) of ethanol annually by 2008 (as an imported oil replacement for gasoline production), rising to an astonishing 36 billion gallons (857 million barrels) by 2022.

Many other countries, including China, Brazil, the European Union, and Canada also have developed large ethanol industries for fuel.

Brazil is the largest exporter of ethanol fuel in the world (using highly efficient sugar-cane feedstock, which gives six times more energy output than is required for production). Seventy percent of the world ethanol supply comes from the Western Hemisphere.

Theoretically, this might all have been very useful and a pollution improvement (although U.S. current annual production is less than 11 days' consumption) had the process used waste cellulose or unwanted crop byproducts. Unfortunately, prime critical food crops were used because they produced the most ethanol.

This meant corn, soybeans, sugar cane and sorghum prices exploded as these crops were diverted to ethanol production, and millions were left starving as the exports of these food crops disappeared worldwide and rose in price to the point of unaffordability.

Processes are not even developed yet for large-scale commercial generation using waste materials (referred to as cellulosic ethanol), although they are coming.

No one on the production side now wants to go back, as the much higher crop prices for government-subsidized ethanol production simply are far too appealing.

And continued high-volume, corn-based ethanol production in the U.S. simply is impossible without fertilizer to maintain viable soil, which requires oil or natural gas to produce, negating the entire strategy as an "oil-replacement" technique.

Coupled with other worldwide crop failures in 2007 and 2008, especially Asian rice crops, plus hoarding in countries that used to be exporters but which feared for their own citizens as world conditions worsened, recent price escalation of primary food has punished the world's poor like nothing ever seen before.

People with very little money simply die when they cannot afford basic food; the more fortunate just complain a bit and look for bargains, a big situational difference.

The state of Texas recently asked the EPA for a 50 percent reduction in the ethanol mandate because of concerns regarding the serious impact it was having on food prices. The request was turned down as the EPA said no real harm had been proven. What exactly would real harm look like?

Vehicles can run on up to a 10 percent ethanol content mixed with gasoline without any major modifications; however, beyond that level, significant fuel control re-design is needed. Keep in mind, ethanol has far less heat energy than gasoline or kerosene, and thus produces less engine output in terms of horsepower.

Recently, there have been some major experiments to arrive at bio-blended jet fuels. It is clear from this research, synthetic or FT (Fischer-Tropsch) fuels require hydrocarbon feedstock, such as coal or natural gas. Even blended (with existing fuel) bio-fuels have some significant problems in aircraft engines (freezing and lower energy) than readily available jet fuels.

These studies point out the inevitable effects of attempting to make high-volume bio-fuels, such as food crop destruction, pollution and soaring food costs.

In the near-term, it is not clear if any viable high-volume, cost-effective, plug-and-play solution exists once oil, natural gas or coal hydrocarbon feedstock is effectively depleted.

Oil extracted from jatropha seeds was used successfully as a petroleum substitute in aviation fuel during an Air New Zealand test flight in December 2008, according to a Boeing interview by Der Spiegel. (www.spiegel.de/international/business/0,1518,618859,00.html).

The significance of this flight was that the mix ratio to conventional aviation kerosene was 50:50, while virtually all other substitutes are only in the 1 to 6 percent range, of no real useful significance.

This blend also reduced CO2 emissions significantly and had a lower freezing point — all excellent factors in its favor. Whether it could be produced in sufficient volume without petrochemical fertilizer inputs is another matter.

For more data about the jatropha crop, visit www.jatrophatech.com and www.jatrophaworld.org.

I am not the only person who sees fuel trouble ahead for a petroleum-based flight industry. Swift Enterprises is hard at work on an alternative jet fuel made from landfill waste, sorghum, algae and similar feedstocks.

For more information about Swift Enterprises' efforts, visit http://cleantechnica.com/2008/08/27/swift-enterprises-joins-race-for-alternative-jet-fuel.

The Consumer Response

Soaring prices trigger "demand destruction," which is to say, at higher prices, some people simply decide they don't need the item or simply can't afford it.

We already have seen this concept in action in the past couple of years.

As U.S. automakers quickly learned, this meant any vehicle with high fuel consumption suddenly became undesirable. Retailers and restaurants also suddenly saw a big downturn in business activity.

ABC News reported Americans drove 12.2 billion fewer miles in June 2008 than the year before, a clear indication of a change in habits and demand triggered by steep gasoline price increases.

Many individuals also have sold or defaulted on loans for poor mileage cars. Some used and new car values, especially for trucks, big SUVs and inefficient sedans, now have completely collapsed.

In the aviation world, the NBAA reports nationwide sales data shows a 10 to 20 percent drop in Jet-A fuel sales, and a 30 to 40 percent drop in avgas. Pilots also reported 19 percent of them have cut back on flight hours; 28 percent are requesting more direct routing; 40 percent have reduced flight speeds to conserve fuel; and 76 percent have switched FBOs to locate lower-priced fuel.

In addition, airlines are dramatically cutting fleets, people and fuel use.

For consumers, higher fuel costs also mean less disposable income in general, which results in less overall business activity. This downturn in consumption of every kind causes a drop in oil prices, as demand simply falls off. This price drop generates considerable skepticism among consumers, who see it as evidence of "price manipulation," speculation and other artifice that drove the price up.

Then, many of these consumers simply revert to their old consumption patterns when prices do fall, but they fail to see the current price is still much higher than even a year ago, nor do they understand the critical message it carries.

The sawtooth-shaped cycle of price rises and drops ratchets relentlessly upward as true scarcity sets in; however, it is not always clearly visible to consumers for what it is because of the momentary relief over any temporary price reduction.

After oil prices rose throughout all of 2007, "demand destruction" choked off the use of oil and refined fuels dramatically in North America by the end of 2008. This pushed global oil prices back below the $100 per barrel level.

However, it did not result in any actual price relief for many consumers, as Hurricane Ike, in September 2008, severely interrupted Gulf-area refining activity around the Houston/Galveston area, resulting in explosive gasoline price hikes and massive shortages throughout the neighboring states as far as Georgia. Huge population evacuations simply amplified this problem.

Because of the tightly linked North American economy, prices rose nationwide in the U.S., and even in Canada, with the argument that cheap fuel simply would be bought locally and moved to affected areas, thus creating a shortage elsewhere. This event effectively models the future disruptive results that can be expected when supplies simply are not available in a more general way.

The global recession triggered by collapsing marginal credit transactions, subprime mortgages and worthless derivatives hammered the price of oil, and industrial and consumer demand evaporated. Every oil-producing country found itself in a sudden over-supply situation (of roughly 3 percent), with oil loaded on tankers and clogging pipelines, but with no deeply motivated buyers, thanks to the paralyzed economy.

OPEC scaled back production twice, then unilaterally, Saudi Arabia scaled back production, removing millions of barrels of oil per day from production, as prices tumbled all the way down to $40 per barrel by early 2009.

Meanwhile, in the background behind all the economic chaos, critical decisions were being made that will have consequences in the years to come. Virtually all petrochemical infrastructure additions and upgrades were stopped worldwide; a complete billion-dollar tar sands project was cancelled; and nearly every alternative energy project lost its critical cost and supply advantages. The entire alternate energy industry sector slumped as cheaper oil suddenly reappeared.

These moves all set the stage for much worse future oil cost spikes and new problems just over the horizon, now estimated to become critical by 2013.

We are lucky to be sitting in a moment where we can think briefly about our options, and try to make the very best decisions we can while there is enough supply, peace and stability to make them possible.

Once we enter the period of real supply disruption, rational thought and planning will go right out the window. There is an old saying,

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"There are only seven missed meals between civilization and chaos."

In my observation of recent human behavior, I think it's become more like one or two missed meals, and suddenly any behavior is somehow acceptable to obtain what people want.

As multiple problems begin to intersect in everyone's daily lives (global warming, water shortages, rising food costs, widespread financial problems, shrinking fuel supplies, etc.), anger and fear inevitably overtake, then overwhelm patience and planning.

The View From the Air

Except for the air transport world, which is working furiously to develop more fuel-efficient engines and aircraft to counteract the industry poison pill of high fuel prices, few in the aviation world seem to have been deeply focused on fuel economy as a critical design element.

As a result, many popular smaller aircraft (both fixed- and rotary-wing), with a significant and notable exception of Robinson Helicopter, are simply not optimized for low fuel consumption and rapidly are becoming too costly to operate in many situations.

Certainly, operating budgets are being shattered by the cost of current fuel bills for every aircraft user. Long design, test and certification cycles mean it will be years before any real improvements, driven by current prices, percolate down to the marketplace in the form of new fuel-efficient engines and airframes.

In terms of practical aviation examples, 2008 ATA figures showed a 265 percent increase in the price of airline jet fuel from 2000 to 2008, based on a current price of $3.29 (clearly, airlines have access to much cheaper bulk fuel rates than the rest of us). But 2008 survey prices for Jet-A fuel seem to be more like a higher retail average of $6 per gallon, as of Aug. 12, 2008.

LAX (Los Angeles) fuel prices. as of Aug. 12, 2008. averaged $5.94, with a range of $4.99 to $7.59. In KSFO (San Francisco), it was a whopping $7.98 for Jet-A.

For non-airline customers, fuel costs are much steeper and already deeply prohibitive.

More incredibly, from a cost-perspective, January 2009 Jet-A prices still averaged about $4 a gallon. (Remember, crude oil in January 2009 was only $40 per barrel, far less than it was in August 2008).

LAX area prices spanned $3.59 to $5.75, averaging $4.44, and the KSFO area averaged $3.99.

Refined fuels clearly are not tracking raw oil prices (because of accumulated high-cost reserves, refinery space shortages and other market forces) in the aviation sector. They are significantly elevated, and remain resistant to downward pressure.

A Typical Use Example

Those aviation fuel-price averages mean a full tank of fuel in LAX for a popular Bell 206B3 Jet Ranger (91 gallons) in January 2009 (after a huge drop in oil prices) still is about $404 for roughly 380nm of flight.

This puts a full daily eight-hour Jet Ranger flight program for a police department at about $808 just for fuel (more than a quarter of a million dollars annually) — a cost burden for any essential flight operation, such as law enforcement, and a dramatic change from about $200 a day only eight years ago.

Most government agencies and municipalities will have favorable price contracts for fuel, which should moderate these retail prices somewhat, but it's clear they simply will not be able to stop the rise of fuel costs beyond these levels over time. Few essential services have enough budget elasticity to absorb this kind of massive fuel-price increase, and the situation leads inevitably to a reduction in flight hours, services and coverage — and finally, personnel and aircraft.

Falling oil and gas prices have seriously damaged the aviation world. This happened in the following way: Airlines and major fleet operators suffering under rising fuel prices began to buy futures contracts for delivery at current prices, hoping to lock in known fuel costs and hedge against future skyrocketing fuel costs.

Southwest Airlines was especially good at this when prices first rose, and it was one of the few airlines to show profits as a result, while many other airlines suffered serious fuel-related losses.

This hedge strategy worked well as prices rose uncontrollably in 2007 and early 2008, but backfired when they dropped suddenly as the worldwide recession abruptly choked off demand.

Rapidly falling prices surprised virtually every airline, and late 2008 and early 2009 brought serious losses caused by over-priced fuel futures. Even Southwest was hurt and had its first loss in 17 years because of this problem.

UAL also was caught in this trap and wound up with a fourth-quarter loss of more than $1.3 billion, with more than $.9 billion in just fuel-related write-downs.

The incredible volatility and the unavoidable requirement for consumption have made all petrochemical fuels the delicate Achilles' heel of modern aviation.

Unavoidable Government Issues

To judge by the huge multi-billion-dollar budget shortfalls in states like California ($24 billion in June 2009, according to the governor), New York ($5 billion), Florida ($1.5 billion) and others, funds simply are not going to be available to put fuel in everything needing fuel.

Local police, medical and emergency services also are certain to suffer as states, counties and cities find themselves with skyrocketing budget deficits, decreasing revenues and no alternative but to do less with fewer resources, including aviation-related ones.

California has been especially sweeping in its forced expense cutting, shedding tens of thousands of employees and putting many of the remaining ones on minimum wage.

On the federal level, Washington is forecasting a 2009 budget deficit of $1.2 trillion, which is on top of the $11 trillion already accumulated with the passage of the recent Wall Street banking bailout.

Despite a federal willingness to toss out trillion-dollar stimulus packages, a point will be reached when governments can no longer fund or maintain their operations, as enough lenders will not be willing or available to make it possible.

Many financial institutions from Fannie Mae and Freddie Mac to Bear Sterns, Lehman Brothers and AIG insurance have been pushed to the brink of financial collapse, triggered by cascading debt defaults in the subprime real estate market. Only massive intervention from the U.S. government in direct loans and guarantees temporarily has stopped this effect. But where will the actual funds come from for this rescue and inevitably more when the federal deficit is already $11 trillion?

The hidden effect of such huge U.S. deficits is the gradual devaluation of the currency, especially in terms of globally traded hard assets, such as gold, food and oil. We already are witnessing this trend in a serious way, which causes these items to rise in price. This pressure further chokes off demand and damages every oil-related industry as a result.

Every decision you make now needs to be a thoughtful and long-term one, and you need to consider the worst-case scenario actually could be one of the nicer ones.

We are sitting in a brief (although expensive) calm period, created by a global recession, which triggered a dramatic drop in oil consumption, demand and prices.

This situation is a real gift, as it ensures supply. But it is a gift we cannot afford to waste by mistakenly thinking all will suddenly be well as oil momentarily drops to the $70 per barrel range because of massive worldwide recessionary forces.

You have some time to plan well, both for your business and your personal life; so, please don't ignore these issues, thinking everything will actually be OK with no extra effort or attention on your part.

The serious issues everyone felt back in the 1960s and 1970s are sitting on our doorsteps right now — right on schedule and waiting for attention. And they simply are not going away.

We failed to take any useful action when these problems first appeared, and the U.S. went past its own peak oil in the 1970s. Now, we are living in the unpleasant consequences of this massive inaction and subsequent deliberate industry and government misdirection about the true state of oil availability and what it really means for our way of life.

So, what are the key things to take away from all of this information? The most important is: Powered aviation is a special energy case, which can reap almost no benefit from either existing or planned alternate energy sources.

Neither solar, wind, hydrogen nor nuclear offer any effective solution as a petro-fuel substitute in-flight.

Bio-fuels have a serious oil-inked dependency and cannot be generated indefinitely without exhausting their growing areas, no matter what crops or techniques are involved. The choice for bio-fuels eventually would be for food or fuel, but not both.

Eventual effective oil exhaustion (where extraction is no longer cost-effective or practical) is a complete and inarguable certainty. The only discussion we can have is in regards to the date — and what life will be like on the way there and afterward.

Everything that follows oil scarcity and eventual exhaustion will be a difficult industrial transition for the human race and the biggest challenge we have faced, both socially and technically.

The key to getting through this stage is to fully understand it and plan effectively for it now, not to deny it, because our full attention — yours and mine— is needed right now on all these significant problems. ❑

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