CHAPTER 7

Gasoline Rationing, the Only Equitable Way

WHY RATIONING?

As an immediate antidote to the complex, intertwined, global, economic-energy crisis, **the United States Congress should legislate the reduction of gasoline consumption by some form of national coupon rationing.** This is a far better alternative than burning the remaining oil as quickly as possible, relying on wild market speculation, high-price polarization between rich and poor, or increased taxation (still another way of catering to wealth disparity). Gasoline rationing is the best move we could make to stem the hemorrhage of, at least, our own domestic oil.

At first this initiative seems counter-productive for a sluggish economy, but further examination shows why we need a bold about-face in our thinking and lifestyle, instead of attempting to continue business-as-usual as we enter the second (declining) half of the short two-hundred year oil age. **Today, Americans alone burn-through close to four-hundred million gallons of gasoline each day, an economic drain of one billion dollars at the depressed price of $2.50 per gallon.** Every gallon of gas consumed represents precious finite oil gone forever, instead of being available in the future for every link in the long food chain, essential transport, infrastructure maintenance, accessing other energy sources, national security, or providing feedstock for thousands of other materials. Our and our children's survival are being sacrificed to today's profligate waste. Figure 1 (page 2) shows that U.S. gasoline consumption alone is 9 million barrels per day or almost 11 barrels per person per year. The display in Appendix A reminds us of the many ways that oil, including diesel and gasoline, is woven into our modern lifestyle. Some are far more critical than others. For example, food production and oil-support for the production of other lesser energy sources are far more essential than petro-fueled entertainment or frivolous travel.

Gasoline rationing would help mitigate and insulate the U.S. from the inevitable post-oil age collapse of industrialized civilization by conserving our domestic supply. As disconnected as they may seem, closer examination will show why the decline of finite fossil energy (beginning with peak oil), a debt-based financial economy, and gasoline consumption are closely interactive. If the case for gasoline rationing seems preposterous, unnecessary, or unworkable, at least skip to the summary review and conclusions. Retain and refer back to this chapter for reference in the next several years after the failure of all other attempts to continue high-energy travel such as electricity, hybrids, biofuels, **or the myth that U.S. extraction rate will double back in four years to its peak in 1970**. None can rescue us from our love affair with gasoline-powered personal travel.

A brief history

Gasoline rationing is not a new concept. Typically, commodity rationing is a **temporary** expedient necessary to ensure equitable distribution of fuel or other needs in times of scarcity. As a boy, I remember gasoline (and food) rationing during WWII. These were perceived as precarious times and everyone pitched in to be sure no one was left out, or inflation restricted access to just a few. More recently, there was a faltering attempt to ration gasoline during the Arab oil embargo in the early 1980s. But this crisis quickly passed and the world continued on a path of inexorable growth fueled by plentiful conventional oil gushing from the North Sea, the North Slope, Mexico, Russia, the Mid-East, and Africa. This pattern continued through the Reagan/Thatcher years and any thoughts of oil (or gasoline) shortages were quickly forgotten.

A "depletion protocol"

During this remission, into the 1990s, new voices lead by Dr. Colin J. Campbell, a British petroleum geologist, warned that the sum of all world oil-extraction rates would eventually peak and the industrial age would soon enter a new phase of contraction. **This time, the decline of oil would not be a temporary scarcity, but instead, usher in a permanent and drastic change in the history of the world.** Campbell's work evolved into the world-wide Association for the Study of Peak Oil (ASPO) with many sub-chapters in different countries; for instance, ASPO-USA (.org).

(When this final book is published in 2016, Dr. Campbell has kindly offered his remarks in the included forward.)

As the quantitative facts regarding oil extraction rates and country-by-country depletion became more accurate, it was obvious that some type of world-wide oil consumption-curtailment would be best to match the imminent decline of world-wide extraction and avoid plunging the world into chaos. A comprehensive proposal to reduce consumption rates in synch with declining extraction rates was first proposed by Campbell as the Rimini protocol and then changed to an oil depletion protocol (ODP). This proposal was, in effect, a world-wide rationing plan meant to include all user and extracting countries. An excellent summary of this work can be found in Richard Heinberg"s book, *The Oil Depletion Protocol: A Plan to Avert Oil Wars, Terrorism, and Economic Collapse* (New Society Publishers, 2006). The sub title refers directly to the collateral damage caused by oil scarcity and increased cost.

Unfortunately, now in ten-year's hindsight, it is obvious that an international (or national) rationing plan could never be implemented for at least five reasons:

1. The combination of high cost, resultant "demand destruction", and enhanced recovery of non-conventional oil has kept us on a plateau of consumption for the last ten years.
2. The ODP was intended to be world-wide. As we enter the post-oil age, and similar to the Kyoto environmental protocol, it will be every country for itself. There is little hope for international cooperation on any issues, especially energy, climate, and population control.
3. Even if downsized for the U.S. only, the ODP attempted to include all oil uses, not just gasoline.
4. The ODP was too complex and impossible to administer globally.
5. The public is continually reminded by well-heeled energy-funded advertising that there will always be plenty of oil and/or easy substitutes. "Trust us. Don't worry, the Peak Oil theory is dead."

There is a new book, *The Impending World Energy Mess* by several ASPO-USA members and energy experts , Robert Hirsch, Roger Bezdek, and Robert Wendling. (2012 apogeeprime.com). A considerable portion discusses the merits and "complications' of gasoline rationing as a possible "mitigation" for the post-oil age.

Another excellent history and case for fuel and food rationing can be found on Sharon Astyk's blog site: scienceblogs,com/casaubon's notebook/2010/08/24. Sharon was a fellow ASPO-USA member and to quote from her comprehensive ten-page paper: "Rationing is both possible and potentially quite palatable, as long as it occurs in the context of public education and strong connection to current events."

AN ENERGY BALANCE

In late 2008, the world slipped into an economic recession exacerbated by the tension between the need for continued growth, but constrained by finite or declining resources; specifically, conventional oil extraction. **The basic absolute prerequisite (along with non-energetic raw materials) for economic growth, travel, and transport is readily-available energy.** This premise is expanded in Chapter 10. Beginning in about 2004, the world-wide extraction and consumption of finite oil, began to plateau and faced an unprecedented terminal decline. Superimposed on this geophysical reality is a debt-based economic system, predicated on continued future growth, and therefore can no longer continue. The geological limit of liquid, pre-stored energy dictates the rules we must obey. Temporary reprieves from new ways to search farther and deeper, or more-efficiently stretch the energy we have, only postpone the inevitable shortfall by a few additional years.

The Energy Barrel

A simple analogy of energy flow into and/or out of a storage reservoir exemplifies our predicament. This concept is shown in Figure 11. The concentration and storage of energy in any form are always difficult. Ancient sunlight-energy, stored as any of the three fossil fuel hydrocarbons, is by far the best way ever known. Energy is that elusive multi-faceted capacity of something to do any combination of work, heat, and growth. As with fossil fuels, wood, or food, energy can be stored in a real tangible substance. Energy should not be confused with currency and wealth, which are only convenient substitutes for conveyance or ownership of physical energy in many different forms as long as the system is stable and a quantitative equivalent value is agreed-upon and respected. But, without continued availability of readily available real energy, not a currency (money) surrogate, growth cannot continue (see following discussion of "false" energy inputs). A dynamic system will contract and cool if more energy is lost than is replaced. **In its most basic form, any real material thing, including its energy content, must first satisfy the essential requisites of life; that is, feed you, move you around, or keep you warm, otherwise it very quickly becomes lesser in importance and value.**

For easy analyses, scientists and engineers often avoid the internal, dynamic energy-interactions in a complex system by analyzing and quantifying **only the external ins and outs of energy over a period of time**. This avoids having to micro-analyze minute details inside the system. **Since energy cannot be created or destroyed, the difference between all the energy inputs, minus all the energy outputs,**

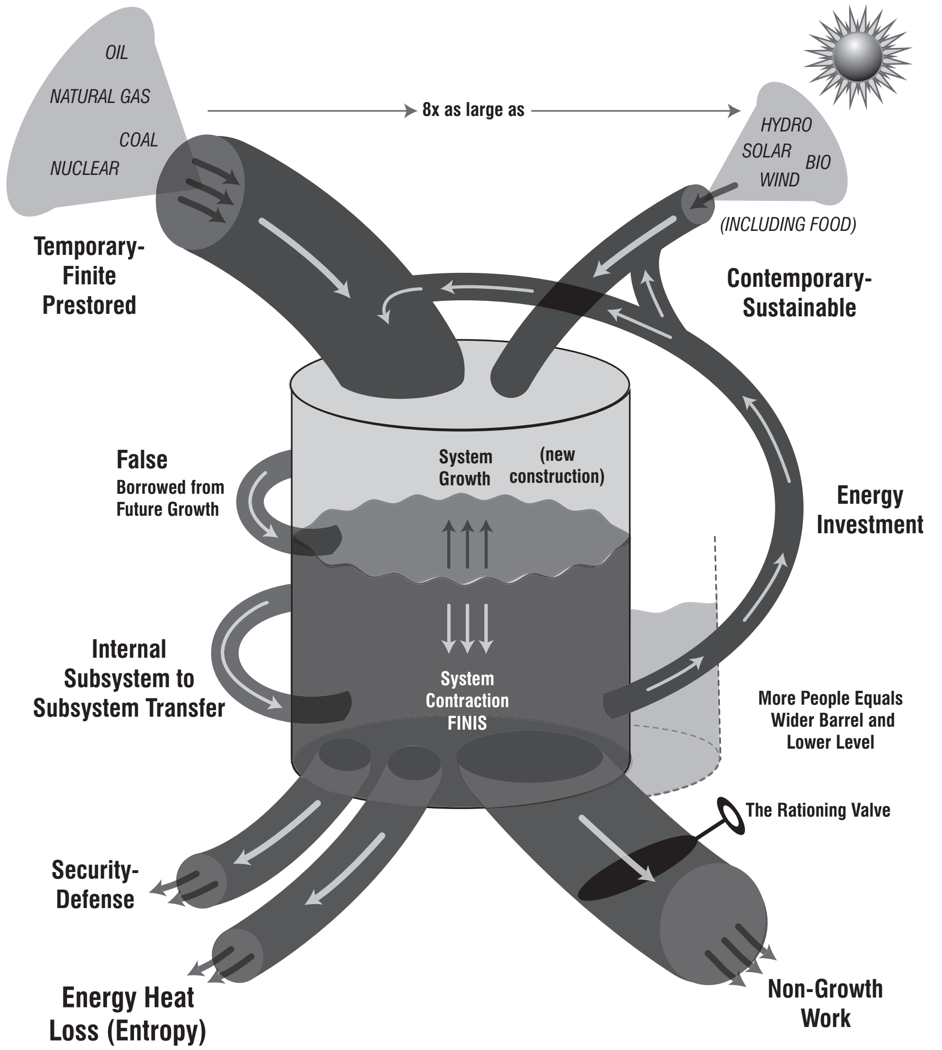

FIGURE 11 The Energy Barrel

must be accounted for as internal system growth, temperature change, storage, or contraction (decay) and can be summarized in an energy-flow model as in Figure 11. If temperature remains stable, in minus out equals growth or contraction.

This basic concept is no different than water flowing into and out of a barrel or electrical current flowing into and out of a storage battery which can, independently and sporadically, feed various loads. Another analogy is the amount of energy from food flowing into our bodies while energy in the form of work and/or heat, to maintain our metabolism and temperature, flows out. An excess of inflow over outflow, including waste, appears as growth (even obesity).

Yet, a misunderstanding or disrespect for the balance of energy in a finite system underlies many seemingly dissimilar problems like running out of gas, excess weight, economic recessions, or the entire collapse of civilizations. Understandably, much confusion arises because energy can hide in many different forms and is always trying to dissipate to a lower-energy form (a process called entropy). For instance, the barrel can leak, a warm body may cool, the water can evaporate, or we will starve for lack of food. Energy is the fundamental prerequisite for life and movement. Power is not synonymous. Power is only a measure of how fast the energy is added, dissipated, or is changing in form inside the system as explained in Appendix B.

Specifics (energy inflow)

By far the largest and most important factor either in or out of the model in Figure 11 is the overwhelming contribution (about 85%) from TEMPORARY-FINITE fossil fuels. Nuclear is also a smaller finite energy factor (about 6%) because fissionable uranium, which peaked in production about 1980 during the cold war, is also non-renewable. TEMPORARY-FINITE inputs must eventually and inexorably diminish to zero, by their very definition as finite. Internal system growth will cease and begin to decline **unless energy outputs also proportionally decrease, or other inputs increase enough to make up the shortfall** of TEMPORARY-FINITE energy and keep the entire system from contracting and soon collapsing.

We waste much valuable time trying to find new energy sources, arguing about how much is left, or how much the climate is changing while, in 2016, non-conventional oil extraction will begin to seriously decline because of low oil prices. All finite fuels (natural gas, coal, and fissionable uranium) will soon follow by 2035 at the latest (see Figure 6). We have clearly entered the second half of the brief industrial age. As would be expected, the first half provided the basis for un-precedented growth, including human population. **The second half will lead to oil (and total energy) contraction tempered by how well we restrain the outflow losses of the energy-balance system.** Since food is highly dependent on fossil energy there will be critical constraints on the human population that can be fed. Newborn babies will grow to be consumers in the same time frame that input energy decreases. The cover of this book shows this pictorially.

A significant concept, which should not be misconstrued as an energy input and which leads to economic crises, is the FALSE borrowing of wealth from the future based on the expectation and perception of continued growth of the complete system**. As explained earlier, wealth, as measured by paper currency or metal coins, is not energy. It can't do work or keep us warm.** It is only a temporary quantitative value assigned to real things like energy, food (another form of energy), goods, or services. Non-energetic wealth only represents the ephemeral, peaceful agreement of its contemporary worth as a surrogate for "real things." It is subject to inflation or collapse at any time.

Continued growth infers an increase of wealth as an indicator of additional "real things" and is equal to the original quantity (principle) plus interest, hence, "real growth." But real system growth **cannot** happen without a steady surplus (input over output) of either dependable TEMPORARY-FINITE energy inputs pre-stored from the past, or an increase in CONTEMPORARY-SUSTAINABLE inputs from the present.

Unfortunately, the borrowing of future wealth based on extrapolated past trends and expected continued growth is the backbone of our entire financial system. **But remember the basic premise: A system cannot grow without ever-increasing energy.** It may take time for this connection between energy and wealth to make sense. But think about it, you can't refill a pail of water today with next week's rain. You can't satiate today's hunger by thinking about next week's groceries or planning next year's harvest. Chapter 10 continues the discussion of the economics of energy.

The leveling or peaking, beginning in 2004, at about seventy-five million barrels per day of conventional crude oil production, and resultant steady price increase led to economic stress and decline, first of the growth-related housing and then of the entire, intertwined, debt-based, highly-leveraged, world-financial system. Everyone in the world started to spend more of their wealth on energy including all energy-related goods and services. This left less for non-energy spending and overall system growth.

By the last quarter of 2010, **the total of all liquid fuels** including non-conventional oil from tar sands, tight oil (fracked), deep-off-shore oil, polar oil, natural gas liquids, and bio fuels reached eighty-five million barrels per day. The total increased another six percent to over ninety million barrels per day by 2014 (see Figure 3, on page 35). The diminishing energy return on energy invested (EROEI) and much higher cost for non-conventional liquid fuels exacerbate the tension between higher extraction (production) costs and continued population growth (demand). The result for several years was a balanced world price of about $90.00 dollars per barrel. This was the price overlap high enough to continue total extraction but low enough for the market to bear … for several more years as American consumers went deeper into debt. The world market price may never go much higher because there is diminishing wealth available for purchase. In theory, the price of energy can't decline much lower either for any length of time because it costs more and more to extract increasingly difficult or non-conventional oil. And, there are those who choose to keep the oil in the ground for future generations and wait for higher prices. Only a small minority who have access to remaining wealth will eat, keep warm, travel, and attempt to perpetuate the lifestyle of the past surplus-energy age … as long as their paper wealth and non-energetic assets can be exchanged for "real" energy.

Further infusions of paper wealth, financial bail-outs, and stimulus packages based on the hope of growth-revival in the future can not work because future energy growth, dependent primarily on oil, is no longer possible. There will be local bonanzas and temporary remissions because of new energy finds, new extraction technology, decreased consumption ("demand-destruction"), or improved efficiency, but the long-term trend must lead to system contraction because of the decreasing and dominate contribution from finite fossil fuels, specifically oil.

Suddenly in the summer of 2014, the Saudis upset this percarious equilibrium by refusing to reduce their market share for the benefit of new, more expensive non-conventional sources. The resumption of low-cost oil combined with the growing resistance to $90 dollar per barrel oil, caused a sudden glut in the oil markets including gasoline specifically for U.S, the world's number one consumer bloc. (As clarified in Chapter 1). The result was an immediate fifty-percent plummet of price to the mid-$45 per barrel range which climbed back to around $50 per barrel by the spring of 2015, but then dropped below $40 per barrel by the end of 2015. This is a good example of the impossibility to store significant amounts of energy. The world's tankers and storage facilities can only store a few days worth of oil waiting for the price to go back up while the futures markets have a field day as speculators try to out-gamble each other as to what will happen next.

As a consumer, you would expect to fill your gasoline tank to take advantage of the bargain price, but how many gallons and miles-worth can you hoard … on-board?

Back to the Energy Barrel

At some time in the past, present, or future, all energy (except nuclear or tidal) came, comes from, or will come to the earth from the sun. In our short, fossil-energy age, CONTEMPORARY-SUSTAINABLE inputs account for less than ten-percent of our total energy input and consumption. **Because of the dilute, sporadic nature of incoming, annual solar energy in its common forms of direct solar, wind,**

bio-energy, or hydro power, "all of the above" (from the sun) can NEVER remotely approach the amazing quantitative level of conveniently stored fossil fuels, which represent millions of years of prehistoric solar energy. Other non-fossil inputs like tidal or geothermal are tiny, site-specific, and poor in energy return. They cannot amount to more than diversions from our main focus, the imminent decline of TEMPORARY-FINITE-PRE STORED energy inputs.

Referring again to Figure 11, the INTERNAL SUBSYSTEM-TRANSFER of energy between inclusive subsystems is another source of confusion. For smaller internal subsystems like nations or regional societies, this is a most important factor. "We want what you got." Whenever a closed group of bio-species exceeds or decreases its carrying capacity (in its most basic form, food), or expands through population growth and the over-powering urge to survive (the "Selfish Gene"); territorial energy transfer is the ubiquitous normal result. Sometimes the transfer from one subsystem to another is hidden as a seemingly benevolent interaction. **But the effect on the total system-energy balance is net-neutral, like robbing Peter to pay Paul.** INTERNAL SUBSYSTEM-TRANSFER is simply a contraction of one subsystem to support growth in another. Externally-sourced TEMPORARY-FINITE fossil fuels, like oil moved from Canada and Mexico to another subsystem like the U.S. are examples of this category. They are only transferred from one region to another with no effect or difference in the larger global closed system.

The INTERNAL SUBSYSTEM-TRANSFER category also holds true for non-energy resources, but these are inert raw materials, clean water, or arable land **which cannot be accessed (mined), transported, or processed into useful goods and growth without ... energy**. Open the history book to any page, and this last category underlies and explains much of the glory and tragedy of our past. Resource wars and the slave trade are examples. Unfortunately, as surplus fossil energy winds down, we are beginning to regress to past human-nature. **We will do whatever it takes to maintain our personal subsystem's status quo by keeping energy inputs maximized, so we can maintain a high level of outputs, and at the same time, avoid subsystem contraction and ultimate collapse**.

For a completely closed finite system, like our planet, INTERNAL SUBSYSTEM-TRANSFER inputs are meaningless. We can't raid the moon for energy except for a little tidal gravity. We can access a small amount of internal geothermal energy, but it is site specific and can't contribute more than a tiny fraction of our needs. **Our only sustainable energy input source always has been, still is, and will be … the sun.**

Specifics (energy outflows)

To postpone closed-system contraction (or "collapse") as TEMPORARY-FINITE inputs begin a precipitous decline in the post-fossil fuel age, our only legitimate option is to reduce (ration) the output losses just as with the water barrel or storage battery. We must try to control the leaks from the energy barrel.

ENERGY HEAT LOSS (entropy) from a warmer body to colder surroundings is a fundamental law of thermodynamics. On the earth macro-basis, there is no way to reduce this energy loss. Natural or industrial greenhouse gases only increase our planet's temperature a few degrees to a new equilibrium level. The resultant global warming does not reduce the overall quantity of energy output flowing back into cold outer space. However, the desired temperature of small sub-systems like living bodies or houses can be maintained with far less input energy by reducing micro-system HEAT LOSS through better clothes or insulation. This is the basis for efficiency savings and makes sense as long as decreased energy needs are not offset by continued overall system growth such as an increase in population. The common phenomenon of **increased efficiency leading to greater consumption** was clarified by W.S. Jevons at the beginning of the fossil-fueled industrial age in the 19th century, and bears his name, "Jevons Parodox."

ENERGY HEAT LOSS is a significant human concern because it is the ubiquitous energy output as we, individually and collectively, dissipate the heat from metabolized food or heated buildings. Higher food consumption for increased population results in proportionally more energy lost forever as heat and/or non-growth work.

SECURITY-DEFENSE energy output can be most important in any subsystem energy balance. Considerable precious energy may be expended by an individual, village, or nation. In some subsystems where energy inputs are copious, as in the fossil-fuel age, this is probably not a critical problem. But in other times, the energy cost to resist nefarious encroachments from other subsystems was often ruinous.

In future low-energy times, SECURITY-DEFENSE energy consumption and output will become more critical. An individual animal can exhaust itself by fighting for survival or to protect territory and food sources. The end result is the same: Sub-system energy contracts towards death. A nation subject to invasion like the Roman Empire can fail because of inadequate internal energy left after losses for SECURITY-DEFENSE. Should the last internal energy go to feeding people or defending them?

Another significant and often overlooked energy loss is the ENERGY INVESTMENT required (recycled) to acquire, and becomes included in, the input energy. The ratio of the two is named by the acronym EROEI (Energy Returned On Energy Invested). Sometimes this term is shortened to EROI and is usually analyzed for a specific energy source as the quantity acquired divided by the quantity expended for its aquisition.

When the ratio is greater than unity the acquisition is considered positive and the effort is energy-legitimate. The original extraction of conventional oil put this ratio over 100:1 but it is steadily declining for all fossil fuels as we deplete the easiest sources of prehistoric stored finite energy.

One example of a positive EROEI is wood. Otherwise our ancestors would not have survived. A few days with an axe could yield thousands of BTU's for warmth and the construction of shelter (system growth). In the fossil fuel age, it takes only a fraction of energy returned (invested as fossil fuel input in a chain saw or skidder) to harvest a much larger multiple of bio-energy. However, this loop is clearly unsustainable when more wood is harvested in one year (about one cord or 3000 pounds, wet, per acre) than slowly grows through the photosynthesis of incoming solar energy in the same period. In addition, soils, water, and minerals as ashes from the burned wood must be available and, in the case of nutrients, returned to where the wood is grown. Over-harvesting of wood beyond a steady-state sustainable level historically supported the overshoot of population and subsequent collapse of civilizations like Easter Island.

There are many other examples of marginal EROEIs, which contribute directly to contraction and decay. Confusion creeps in when other **subsystem** inputs or losses are combined with those used directly in an analysis. For instance, there is much argument concerning the EROEI of corn ethanol for fuel. Should all the inputs to grow the corn like irrigation energy, farm labor, fertilizer, fossil energy to manufacture farm equipment, and many more be included in the inputs? Should the heat from burning, rather than being returned to the source-land, the co-products (stalks, leaves, and ashes), be considered output? Depending on the methodology used**, the EROEI for corn to fuel-ethanol ranges from less than one to 1.5.** In addition, it is clear from our energy-balance model that the output energy for ethanol as fuel is finally lost as NON-GROWTH work rather than assimilated as INTERNAL GROWTH. **Using 30% of our corn for fuel instead of food for survival does not make sense from any quantitative or ethical view.** Yet, here we are. Drive up to the gas pump and fill up with 10% ethanol, a tragic testimonial to our short-sighted intelligence.

On a personal level, the ENERGY INVESTMENT to acquire new energy is different from NON-GROWTH WORK. Instead of going from point A to B and back again on the bike or a hike, we could expend the same food energy by growing more food or cutting firewood. Most energy loss is from energy consumers who do not work directly to facilitate energy inputs (including food from a farmer) but still use the energy. This has always been true of children, the aged, or infirm, but it is equally true for anyone not directly involved in the energy chain. **For instance, a productive adult who is suddenly out of work represents a continuing energy-system drain because he/she still has to eat, but contributes nothing to the input of energy into the system.** So, the system contracts.

This analysis could be carried further by questioning the energy requirements of (in no particular order) financial services, advertising, marketing, insurance, recreation, entertainment, management, building construction (except to save energy), space exploration, and so on. It may sound heretical to question traditional careers, but without copious surplus energy, any activity not directly related to essential transportation, food, or warmth will be greatly challenged.

All of the above occupations grew far out of proportion to basic farming. They flourished and grew only because of the abundant fossil energy age. Even essential needs like medical care and our judicial/penal system will be unsustainable as energy becomes scarce and expensive.

The effect of population growth

If there is no change in the energy inflow vs. outflow balance in our energy barrel analogy, there will still be a per capita lowering of energy level as long as the population increases. There will be less energy to accommodate each of more people. This could be simulated by imagining the barrel becoming wider in diameter.

THE CAR IS THE CULPRIT

This leaves NON-GROWTH WORK as the huge energy loss we could quickly control as if by turning a valve or fixing a leak. **If we were intelligent, we would immediately and equitably reduce vast quantities of wasted energy output by nation-wide coupon rationing of gasoline.** A close look at the energy flow model shows the TEMPORARY-FINITE flow of input (oil) energy matched by a massive gusher of outflow oil used for travel in all types of vehicles. As long as we had a fire hose filling our energy-system barrel we could tolerate a gaping hole in the bottom.

The age of easy travel is quite simply, the oil age. The two concepts are absolutely intertwined and inseparable because of the huge amounts of conveniently concentrated energy in a liquid fuel that can be carried along for the ride in a modern vehicle with an internal combustion engine.

As explained in Appendix 2, the mechanical definition of energy is the capacity, of some thing or substance to do work, where work is simply a force (to overcome drag or friction) while covering a distance. Distance is the most important term here because it implies movement or travel. If we use our personally stored energy (from food) for the work required to crawl, walk, bike, or run from point A to point B, at least we have an obvious result, we're in a different place B, unless we had just traveled back to point A. Our energy (to do the work) consumption is immediately apparent even if we only traveled around in circles wasting the energy through indiscriminate travel going nowhere.

Now, at the midpoint of the brief, profligate fossil-fuel energy age, we enjoy the luxury of riding in a 4000-pound chariot, cruising at seventy-miles an hour, enjoying the scenery, occupant warmth, and entertainment. Up to the last months of 2014, American drivers were burning gasoline at the rate of nine million barrels (almost four-hundred million gallons) … per day! On a personal basis, we use far more energy to travel a few miles to the supermarket than is in the food we bring home to feed a family of four for a week. In our overall energy balance, the EROEI in this case would be less than one which further contributes to system decay. In any other time in history, or in poorer parts of the world, such luxury would be a dream. There is no question that the vast American working and living lifestyle has evolved around the automobile as explained in Part I.

By 2005, oil and gasoline prices climbed to record highs as extraction and availability of inexpensive oil and related petro-products began to level off. The world entered a terminal recession with extreme geopolitical tension. Our future-growth-dependent-economic system ground to a screeching halt. Debt-based growth and expansion based on a continued energy surplus can no longer continue.

Other forms of energy cannot begin to substitute for the peaking production and consumption of oil. Yet our dependency and love affair with our cars continues unabated. As long as market forces control the price of gasoline, even if oil prices remain high because of production shortfalls all over the world, the wealthy can still out-bid the poor. But high gasoline consumption also affects the price of other related energy-intensive needs like food, diesel, and jet fuel. By 2014, there began a temporary surplus and price reduction called "demand destruction." Short-term price swings are exacerbated by speculative machinations of the commodity markets, which, in turn, lead to turmoil and further curtailment of world oil production whenever the price drops below profitable levels.

Why ration gasoline?

As long as market and speculative forces establish the price of oil while world extraction levels and then declines, we will continue to see erratic spikes. There are always fewer consumers who can bid the price back up. Price may not go much lower either because more expensive, non-conventional sources are financial losses. The various scenarios in Figure 2 predict just how quickly this end game will play out. It is certain that there will be less gasoline as oil extraction, the dominate component of TEMPORARY-FINITE input energy, inexorably declines. The tragedy of this inevitable scenario is that the love of the automobile trip, especially by those few who can still afford gasoline even at a higher price, will compete for the valuable energy required to produce essential food. Already this is happening as CONTEMPORARY-SUSTAINABLE ethanol and bio-diesel are substituted for oil.

High taxes on transportation fuels, as practiced for years in other industrialized countries, is a step in the right direction, but not much better than letting market forces balance price, supply, and demand. The wealthy can still outbid the poor. On the positive side, at least high fuel taxes encourage smaller cars, reduced travel by some, and alternative more efficient forms of travel. The price is somewhat stabilized, and a larger portion of fuel costs flows to the national treasuries.

Implementation of gasoline rationing

The devil is in the details, but in the electronic age national-coupon rationing could be done. No matter how inconvenient and unpopular, it is our only hope to quickly and significantly reduce energy output commensurate with the leveling and downward supply of all petro-fuels. We have no choice. We waste too much gasoline now for fast frivolous travel in huge vehicles. Our kids will wonder why we were in such a hurry to burn up the world's finite energy endowment and didn't save some for their survival. The present U.S. consumption of about two gallons per day per licensed driver should be halved to one gallon per day as soon as possible. **Perhaps a one-half gallon per day reduction would be an easier first step for several years. This would still allow for about fifty miles per day, per person, in an efficient car driven … alone! The immediate reduction would be one hundred million gallons (2.5 million barrels) per day!** This is four times the 600,000 barrels per day from the Bakken "fracking" bonanza and almost half the total U.S. conventional oil extraction of five and one half million barrels per day. If we just slowed down, doubled up our passenger load, and drove smaller cars, we could achieve a reduction of one-half gallons per day, per driver **with no reduction in miles traveled, or impact on the economy.** This first step of gasoline rationing would ensure we all participate equitably.

The second step of rationing to one gallon per day for each of two-hundred million licensed drivers, would reduce oil consumption by almost five million barrels per day (1.73 billion barrels/year). This is ninety percent of total U.S. conventional oil extraction, just for one- half of our gasoline consumption! I challenge you to memorize and think about these facts. We could still each be driving twenty-five miles a day alone in an inefficient, 25 mpg vehicle.

To repeat, a central theme of this chapter (and entire book) is that rationing to one gallon per day of gasoline per licensed driver, instead of the two gallons per day average consumption, as it is now, would postpone over seventy-five percent of U.S. present extraction of conventional oil for future generations and the prosperity of our country. This is astounding! To put the numbers in perspective, the five million barrels saved each day is also approximately equivalent to:

- Twice the entire extraction rate of Iraq (after a cost of billions of dollars and thousands of lives.)
- About four times the projected output from Canadian tar sands oil without the environmental impact or the extremely high input energy of all types to mine, process, and ship the diluted bitumen.)
- More than half of the nine million barrel per day extraction rate of each of the world's largest producers, Russia and Saudi Arabia.
- The International Energy Agency (IEA) amazing prediction of a sudden doubling (in four years!) of US extraction rate to a level exceeding Russia and Saudi Arabia.

It could be argued that the same reduction in overall consumption might also be achieved if fuel efficiency was increased from 25 mpg to 50 mpg. True. But this would never happen unless **every** driver could afford to buy a very efficient tiny vehicle and drive it accordingly. There would be no universal incentive to do this and Jevon's paradox (drive and consume more because it is more efficient and less costly) would rule. Also, the steady increase of licensed drivers (about two million per year) would offset the decrease of overall consumption from rationing. **A fifty percent**

decrease in gasoline consumption can only happen with nation-wide, legislated, participation by all drivers. Never before in peacetime have we so desperately needed this profound level of understanding, acceptance, and leadership.

Other advantages of gasoline rationing

- Immediately, the cost of gasoline would decline and remain predictably low because of the reduction in U.S. demand. Although the price of oil reflects world wide supply and demand, our domestic consumption is so huge that a one gallon per day reduction in the U.S. would take one-sixteenth of world demand off the market.
- The lower per-gallon cost **plus** the approximate eight million dollars/per day saved by not being spent on gasoline would be a massive jump-start for all other non-travel sectors of the economy. This would be just the opposite of the steady economic drain of the past few years as Americans have steadfastly resisted curtailing their love affair with large fast cars.
- Overall health would improve as Americans get out of their cars and walk or bike.
- Electric transportation of all types would be encouraged. Mass transit would be favored and small electric vehicles would become popular as long as the battery problem is resolved.
- Safety would be greatly improved because of slower speeds and fewer vehicles. Small, efficient cars would be much more safe and appealing because of not having to share the road with huge, speeding vehicles.
- CO_2 emissions would be curtailed.

Problems

Of course there will be many questions if we use gasoline rationing to mitigate the decline of oil.

- With only gasoline rationing, there will be increased demand for diesel. This loophole should be left open as it would take years to substantially convert the U.S. passenger car fleet. By then, the reduced availability and increased price of world oil will reduce the overall consumption of all liquid fuels including other sectors of consumption, construction, heavy transport, public transportation, commercial, municipal, and farming.

The premium for distillate fuels like diesel, kerosene, heating oil and jet fuel will continue to increase and effectively curtail their use as well. Those passenger-car owners who must drive long distances have the option of converting to diesel which will further reduce gasoline demand. It is my personal opinion that European-style small turbo-diesel (TDI) passenger cars are less expensive, simpler, and a better value at 40 to 50 mpg than electric or electric-hybrid vehicles. Any increased emissions from the scandalized VW emission testing are more than offset by their inherently better efficiency.

- Farming needs for gasoline could also be handled on a case by case basis depending on farm income and tax reports. The same procedure could be an alternative for other commercial, legitimate businesses including taxis that don't convert to diesel.
- Air travel will slowly grind down if fuel costs escalate, providing the traveler can get to the airport on non-rationed public transport. It will remain an alternative for the wealthy, business, or emergency traveler.
- Ultimately, every commercial activity dependent in any way on automobile travel will be in jeopardy. But why should they be allowed to inordinately hasten the end of the oil age? They are products of the oil age and should reflect their dependency on the world's most critical finite resource. In reality, mitigation of the end of the oil age with coupon rationing will help perpetuate business-as-usual in changing times. Besides if traveling somewhere else for recreation is that important, the creative and affluent public will find a way (see heading "Implementation" below).
- The immense cost and complexity of coupon rationing are necessary evils if we are to navigate the end of the oil age without abrupt and total chaos. A small fee at issuance, like one-dollar per card for twenty million cards per day, would be enough to pay for the necessary infrastructure and personnel. Gas stations would be restricted to sale only to unused coupons or portions left, similar to a Walmart charge card.

Implementation

Each licensed driver who owns at least one registered vehicle would receive, monthly, from the state motor vehicle department (DMV), a book of coupons (plastic swipe cards) called Tradable Fuel Coupons (TFC's) or something similar. There could be one coupon for every ten gallons. These must be presented (swiped) at the gas station along with the payment for gasoline before pumping. The number of cars registered beyond one by individual drivers has no bearing on coupons issued. This way, very efficient vehicles could be used wherever possible, but not necessarily for car-pooling, family trips, RV's, or vacations. Surplus coupons could be saved or purchased on the open (tradable) coupon market.

Each retail gasoline station would have a small electronic machine to record usage and ascertain the unused gallons available prior to pumping. Like a phone card, the same machine could count the total coupons used and reconcile the number with the gallons pumped for each day. The TFC's would be similar to a pre-purchased gift card. They are in effect, a negotiable instrument like a ten-dollar bill. There is no record of ownership after initial distribution by the DMV.

Obvious exceptions to rationing would be government, municipal, emergency, security, and essential needs. In short, gasoline rationing would only effect private consumption. City folks who don't use much gasoline could sell coupons to those who need to drive long distances.

A network of private-enterprise clearing houses would immediately appear to function as intermediaries similar to dealers for gold and silver coins. The hassel will cause some consternation but reflects the true energy cost and threat to our future survival from profligate gasoline consumption.

SUMMARY

1. American gasoline consumption is the largest, quickest, and easiest candidate for controlled downsizing of oil consumption in order to mitigate and delay the inevitable post-fossil-fuel crash.
2. Rationing is the best, most equitable way to reduce consumption ahead of the inevitable decline in world oil production. Rationing would help reduce wealth disparity, keep price lower and more stable, as well as minimizing wild market-price swings. Now, uncontrolled demand, production costs, alternative liquid fuels (some competing with food), speculation, world tension, and steadily declining oil fields all interact. We are totally unprepared and out of control as we enter a new era of diminishing energy from fossil fuels. As the most intelligent species we should recognize the facts and plan accordingly.
3. Since American drivers use about one-eighth of world petroleum just for gasoline, a positive action to downsize will send a huge message to the rest of the industrialized world.

4. National TFC rationing would provide the time and price stability for exploration and development of alternative energy sources. The wild price swings we now have discourage long-range planning.
5. The street value of TFC s would have the added advantage of putting instant cash in the hands of poor and/or frugal drivers. This would redistribute real wealth from those who can afford and choose to consume more, to those who do not.
6. The equitable sharing and reduction of gasoline consumption would benefit all energy consumers, rich or poor. Rationing is the only way for peaceful co-existence when diminishing essential resources face steadily increasing demand.
7. Considering the dire challenges we face as we enter the second half of the oil age, it is certain that some form of rationing will also have to expand to other critical oil uses like aviation fuel, commercial diesel, and industrial transportation fuel. If we ration gasoline now, that eventuality can be postponed.
8. The controlled reduction of discretionary gasoline consumption will leave future petroleum feed-stocks available at a more stable price for the development of renewable fuels, heating oil, plastics, lubricants, agriculture, wood harvesting, strategic material mining, and a thousand other things that are oil-dependent, ubiquitous, and now taken for granted.

CONCLUSIONS

A thesis is offered based on the following logic path:

1. Energy is required for the growth or movement of anything of substance.
2. Our debt-based financial system of principal plus future interest is an example of growth-dependency which can only work when there is a surplus and commensurate increase in availability of energy.
3. Presently, over ninety percent of our energy is derived from TEMPORARY-FINITE sources led by oil at thirty-seven percent. The overall world-wide oil extraction rate of conventional oil has peaked due to the natural constraints of our finite planet plus increased costs and difficulty of extraction. There are many who argue that peaking has not yet happened, but if that was true, we still have only a few more years to prepare and take advantage of the extra time.
4. Suggested alternatives for oil are minuscule, site specific, delusional, or limited by annual incoming solar energy. Finite fossil fuels also represent solar

energy but only after the concentration of hundreds of millions of years in the making into three convenient forms. These are the laws of physics and math. No amount of wishful thinking or research grants can change them.

5. In order to keep our energy-intensive society from overshoot and then collapse from reduced real-energy availability, we have only one immediate option, to reduce real-energy consumption (loss).
6. The most wasteful energy loss (one-eighth of world oil) is the American use of gasoline for fast travel in large cars.
7. We could make a giant first step in oil reduction and mitigation of the imminent real energy decline by rationing the availability of gasoline equally between the wealthy and poor. One gallon per day per licensed driver would halve our U.S. consumption with little decrease in miles traveled if we drove smaller cars more slowly.
8. Electronic tradable coupons (TFCs) could be saved or openly traded on the open market. This would immediately transfer wealth from those who can afford to extravagantly use tomorrow's energy today, to those who choose to conserve and soften the impact of the imminent post-oil age.

Please give these thoughts a chance. Let them sink in. Test them against other proposals and pass them along to others, especially to those in a decision-making capacity. Our best hope is rapid, exponential, diffusion of ideas and information now possible in the electronic age. Without your personal energy, nothing will happen.

SUPPORTING MATH AND SIMPLE PHYSICS

Today, in very rounded numbers, two-hundred million licensed American drivers consume, each day, four-hundred million gallons of gasoline (ten million 42-gallon barrels). This gives every driver an average of two gallons or at twenty-five miles per gallon, fifty miles of travel … each day! This quantity represents one-eighth of world oil production just for American gasoline. Does this unique level of gross energy consumption justify the premature demise of our energy-intensive civilization? **A better understanding of the following science will help reduce personal gasoline consumption even if rationing is not implemented:**

There are a number of ways overall consumption could decline, initially, with no reduction in distance traveled. For instance, let's look at the simple physics.

Starting back with the basic definition of work as expanded in Appendix B:

$$W = F \times D$$

Work (W) output is equal to the fuel-energy (used in the engine, minus heat losses) to provide the force (F) required to move the car, times the distance (D) traveled. **We can easily reduce the left-side (fuel required) to provide the necessary work (W) without reducing distance (D) by decreasing only the force (F) on the right side. This would initially leave the distance traveled (D) unchanged.**

When driving **on the level**, (F) consists of only two significant drag forces that require work (as fuel-energy): rolling resistence (R) and air turbulence (T). (T) might also be called wind resistance or air drag. (T) and (R) represent energy lost as heat, forever, from pushing air molecules aside as the car passes through the air or flexing the tire as it rolls over a surface.

In algebraic terms: $F = R + T$

If we take a minute to further contemplate these two terms, R and T, it will clear up much confusion, bogus information, and save much fuel.

Rolling resistence (R) is simply a numerical coefficient for a type of wheel (on a specific surface) times the weight on the wheel. For a hard rubber tire on pavement it is about 0.015 times the weight on each wheel. If tire pressure is increased, this coefficient is less. If vehicle weight is less, rolling resistance (R) is also reduced. This is why bike tires are pumped up to 100 psi, and bikes work best on hard pavement. Lighter vehicles use less fuel than heavier. That's all there is to it. Quantitatively, the rolling resistance of a car is not very much, about 45 pounds for a 3000 pound car. A human can push a car, albeit slowly, **on hard level pavement.** There is not much fuel/energy that can be saved by using a lighter vehicle or pumping up the tires for a few percent reduction of (R).

Air drag (T for turbulence) is a little more complicated but needs to be clearly understood as we move into a low-energy future. Air drag (wind resistance) is especially important in electric cars which have much less onboard energy. Air turbulence (T) only begins to be a factor above about 20 mph and is where and why we can make significant reductions of work (fuel) required**. We will rarely go fast after the oil age is over.**

There are three important factors multiplied together which make up the air drag (T). At very high altitudes, thinner air density also reduces T, but we will leave that advantage for airplanes out of our analysis. The total equation for air drag is:

$$T = A \times S \times V^2$$

The frontal area of a vehicle is (A). Simply put, a vehicle with twice the frontal area will have twice the air drag. This is why airplanes are packaged like a cigar and travel in thinner air, and why bicyclists crouch down to go fast.

Yet, we insist on driving cars (trucks) as big as barn doors because fuel has been so plentiful and inexpensive for the last 100 years. Smaller cars would immediately save a lot of work (fuel) with no change in speed or distance traveled.

The second term (S) is a factor which is determined by the shape of the vehicle and the way air (wind) flows around it. Intuitively we know that a streamlined egg shape will move through the air with less turbulence than a rectangular brick, yet we still waste gas driving cars (trucks) shaped like one. A modern streamlined car has a shape factor (known as the coefficient of aerodynamic drag) of about 0.3 and there is not much more we can do about this factor except drive well-shaped cars. In addition, both frontal area and shape factor are not significant **below speeds of about 30 mph because the total air turbulence (T) is small and less than rolling drag (R)**. We are not concerned about shape and frontal area while pushing a baby carriage or riding a lawn mower, but we certainly become aware when riding a road bike.

This brings us to the third factor, speed (velocity, V). This is the most important of all three terms because it is squared. If we go twice as fast (churning and heating air) it becomes four times as restrictive. (Two squared equals two times two equals four.) Do we really need to drive fast to get somewhere a little sooner? Fuel rationing would immediately encourage slower driving because speed will use up the coupons quicker over a shorter distance. President Carter was right with the 55 mph speed limit in the 1970s as the U.S. went over the peak of domestic extraction. If we go twice as fast, we require four times as much work, but we get there in half the time so the total energy consumed over a distance is four times one-half, or twice as much. **To drive eighty miles in one hour theoretically takes twice as much gasoline as taking two hours at half the speed. Are we Americans really so important we can justify using our future fuel just to get to our destinations sooner?** (This explanation is only basic physics and is not exactly true because the engine and drive train energy losses are only existent for one half the time. Higher gear ratios also reduce these internal losses so they are not proportionally higher.

The above basic analysis does not account for changing velocity or climbing hills**. If we use the car's brakes to slow the car or control speed on a descent, the energy loss from heat is considerable and lost forever with nothing to be gained but worn-out brakes.** This is why electric cars use regenerative braking to return some of the precious energy to the batteries. The answer is to think of the car as a pendulum, slowing as much as possible to let momentum crest the hill and pick up speed as much as possible to avoid braking at the bottom. Accelerate very slowly and anticipate stops way in advance so rolling resistance and wind drag substitute for heat loss from braking. Slower speeds and "hyper-driving" techniques are not always compatible with today's traffic, but this is the context for considerable fuel saving without having to reduce distance traveled. If you understand all this theory, go out on the interstate and try it today. **See how quickly you will be aggressively tailgated and passed by huge vehicles in a great hurry to get somewhere else. Only equitable coupon rationing will slow traffic, save great quantities of fuel**, **and make for safer, more relaxing travel.**

Reducing any combination of the three terms (A, S, V) offers the best possibility for considerable immediate fuel savings with no initial reduction in distance traveled or change in current lifestyle.

Remember, the fuel (energy) conserved is far more critical for other sectors of our energy system including food, heating oil, social services, commercial transport, national defense, petroleum-based products, and all the other ubiquitous uses of petroleum as a food or feedstock. Converting coal and natural gas to automotive fuel, converting to diesel passenger cars, or plugging in hybrids only avoids the issue by substituting other TEMPORARY-FINITE energy inputs and moves us farther down … the wrong road. Rationing would dictate changes in driving habits equitably between rich and poor. No other concept would yield as much significant energy reduction for our future survival; yet it needs to be legislated so all share the effort. We need to get started now to conserve our nation's remaining oil endowment for the coming oil crash.