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Modern Transitions in Saving Energy and the Environment

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1. Introduction

Although there have been numerous programs to reduce fossil fuel consumption, there is still tremendous potential for further reduction of energy consumption. Reduced consumption today will both lower prices in future, and increase availability for future generations. Renewable energies can hardly compare to fossil fuel in convenience and energy intensity. The developed world has moved only slightly from incandescent to fluorescent and LED lamps. Larger automobiles, owing to their greater safety in collisions, and the status they convey, have contributed to a "size race" among consumers for larger automobiles. Urban sprawl, as practiced in much of the world, has contributed to spread-out cities, and a car-dependent culture. Owing to rising fuel prices, urban sprawl is largely unsustainable, as could be evidenced by the recent crash in the suburban housing market in the developed world. Back-up generators and UPS by individual households and consumers may worsen problems, and even cause a vicious cycle of power shortages. Over the last few decades, forest and vegetation densities have increased, but marine life has decreased, for reasons which are unclear at this time.

2. Nature of the decline of fossil fuel

While fossil fuel is known to be in decline, the nature of the decline and future trends in prices is unclear. Since 1900, the world population has more than quadrupled, and primary energy consumption has increased by a factor of 22.5 (BP Statistical Review 2011). The consumption of fossil fuel has been increasing at the rate of about 1.6 % annually for many years, and oil companies expect consumption at this rate for another two decades (BP Energy Outlook 2030, 2011).

From these estimates of known and future reserves, it is only a question of time, before oil and gas reserves become largely depleted. At the present rates of consumption, it is generally acknowledged that fossil fuel, especially oil and gas, will decline greatly in a few decades. Oil and gas are being produced from increasingly deep reserves, leading to higher production costs. These greater expenses have been at the cost of disposable incomes, and quality of life.

2.1 Expected time to depletion

The size of fossil fuel reserves and their times to depletion are fundamental issues with conflicting answers given by experts. According to one estimate, the fossil fuel reserve

depletion times for oil, coal and gas are approximately 35, 107 and 37 years, respectively (Shafiee, 2009). Accordingly, coal is expected to be available up to 2112, and will be the only fossil fuel remaining after 2042.

The consumption of fossil fuel in the next few decades is complicated by uncertainties about known and future reserves, and our consumption rates. Speculation over the next few decades is further complicated by the large numbers of variables and unknowns, some of which are identified below:

a. uncertainty about known and yet-unknown reserves
b. uncertainty about the rise of fuel prices, over the next few decades, in the face of diminishing reserves
c. uncertainty as to the trends of the diminishing consumption of oil and gas, after it has reached well into its decline.
d. uncertainty as to how renewable energy such as solar and bio-fuels would replace fossil fuel in the next few decades.
e. importance of oil to the chemical industry

In spite of these uncertainties and unknowns about the future of fossil fuel, there is consensus as to the importance of conserving fuel today.

2.2 Coal

The issue of coal is somewhat different from oil and gas, because it is expected that coal will last for perhaps another 100 years, well beyond the expected life of oil and gas. The huge reserves of coal make coal the likely major replacement of oil and gas. As coal is particularly well adapted to electricity production at power stations, it is expected that coal-powered plants will be available well after oil and gas have gone into sharp decline. On the other hand, coal cannot be used for most of the transportation industry, such as for powering automobiles and airplanes (Table 1).

	Oil	Gas	Coal	Hydroelectric	Nuclear
Electricity Generation	Well suited	Well suited	Well suited	Well suited	Well suited
Automobiles	Well suited	well suited	Unsuitable	Almost impossible	Almost impossible
Trucks and Lorries	Well suited	Suitable	Barely suitable	Almost impossible	Almost impossible
Trains and Locomotives	Suitable but not for underground	Barely suitable	Barely suitable	Almost impossible	Almost impossible
Ships	Well suited	Suitable	Barely suitable	Almost impossible	Suitable only for large ships
Aeroplanes	Well suited	Barely suitable	Almost impossible	Almost impossible	Almost impossible

Table 1. Conventional Power Sources and their Applicability

2.3 Continuous decline, rather than total depletion

One popular perception about oil and gas (and coal) is that they will be suddenly depleted (Figure 1).

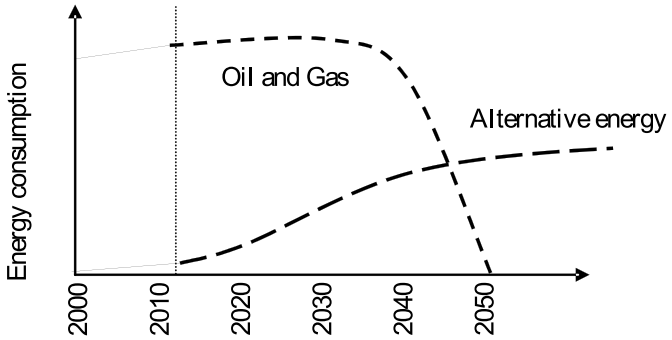

Fig. 1. Popular perception about Oil and Gas, and Alternative Energy. Fallacies are that there will be (a) a mostly complete depletion of oil and gas (b) Alternative energy production will be comparable to former levels of oil and gas.

In reality, the effect of diminishing supply and rising prices will soon cause consumption to decrease. Contrary to most existing speculations, the issue of depletion is complicated by the fact that, today it is commercially viable to extract at best about two-thirds of fuel in a reserve. There are large residual reserves of oil under the ground, which are not commercially feasible to extract today, but will become very attractive several decades later.

The reality is that rather than being completely depleted, fossil fuel will go into a long decline for many decades, during which prices will continue to rise. During this time, both fossil fuel and renewable energy will exist side by side (Figure 2). However, renewable energy will never come close to the energy production formerly by fossil fuel.

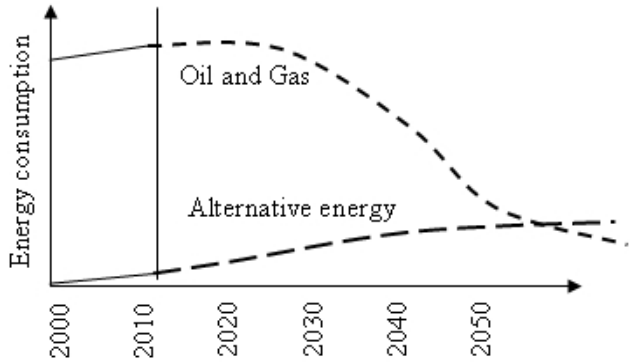

Fig. 2. A more realistic expectation of the decline where Oil and gas, rather than being completely depleted, will continue to decline, with rising prices, for a long time. Alternative energy will rise to levels much lower than former levels of oil and gas.

Petroleum is also one of the main sources of raw materials for the chemical industry today. An example is the bitumen used in paving roads, which is produced from petroleum. There are very few substitutes for petroleum-based bitumen, comparable to it in price and availability. In future, with the shortage and depletion of oil, there will also be a great shortage of other petroleum-based raw materials. The abandoned reservoirs of today will look very promising when there are real shortages of oil in future.

2.4 Nuclear power

After the three major nuclear reactor accidents (Three Mile Island, Chernobyll, and Fukushima), caution with nuclear power is at a high. However, with the impending decline of oil and gas, nuclear power will be an inexpensive option, which people and the government are more likely to accept.

3. Renewable energy

The focus today appears to have shifted from conserving fossil fuel to renewable energy. More literature today is dedicated to renewable energy, than to conserving the remaining fossil fuel reserves. This focus on renewables may create false expectations among consumers about the true capabilities of renewables. There is generally little awareness among consumers about the the limitations of alternative energy. The switch to alternative and renewable energy involves large capital investment, especially for solar and wind power. In spite of the research, renewable energy accounts for as little as 1.8% of global energy consumption today, up from 0.6% in 2000.

3.1 Solar energy

In spite of efforts at solar power for at least two decades, implementation has been difficult because of low power intensities, large capital costs, and difficulities incorporating with existing technology. Silicon panels are much the same as the silicon chips used for microprocessors, and have similar requirements and constraints for manufacture. Silicon panels are expensive, and the area needed for a household (excluding air-conditioning) is barely met by panels all over its roof. Consumers are mostly unaware that solar panels can at best about convert about 25 % of the solar energy falling on it. Usage at night requires expensive and bulky batteries, which must be replaced every few years. Dependence on batteries can be reduced or avoided, by selling solar energy to the grid, as being by practiced by some household users in Europe. The utilities are cautious about accepting solar energy from others, as it introduces noise into the power grid.

3.2 Wind energy

Limitations of wind energy include that it can only be implemented in areas of high wind, requires large investment and maintenance, and has relatively low energy densities compared to fossil fuel. Renewable energy used in power generation has grown this year by 15.5%, driven by continued robust growth in wind energy (+22.7%). The increase in wind energy in turn was driven by China and the US, which together account for nearly 70% of global growth. Opponents argue that wind turbines clutter scenic countrysides.

3.3 Biofuels

In areas of North America, biofuels account for up to 10% of automobile fuel, for the purpose of cleaner emissions. Compared to fossil fuel oil, production rates for biofuels are low and costs are high. Large areas of ancient rainforests have been cleared in Brazil for biofuels. Also, biofuels divert land which could otherwise have been used for food crop production. Globally biofuel production grew at 13.8 %, driven mostly by the US and Brazil. Biofuel may be the only substitute for oil and gas for transportation applications such as automobiles, airplanes, and shipping (Table 2).

	Solar panels	Wind energy	Biodiesel.	Battery power
Automobile	Barely suited, with batteries	Unsuitable	Suitable	Suitable
Trucks and lorries	Almost impossible	Almost impossible	Suitable	Barely suitable
Locomotives	Almost impossible	Almost impossible	Suitable	Highly unsuitable
Ships	Almost impossible	Almost impossible	Suitable	Highly suitable
Airplanes	Almost impossible	Almost impossible	Suitable	Almost impossible

Table 2. Renewable sources and their applicability for transportation

4. The transportation sector

The present prosperity of the world is much dependent on the rapid transportation of people across large distances. The transportation sector involves the automobile, trucking, locomotive (train), shipping and aviation industries. The vast majority of this transportation industry runs on oil. The exceptions are mass transit, such as city trains running on electricity, and large defense ships running on nuclear power. There is an ongoing transition from oil to natural gas power and electric power for automobiles.

4.1 Automobiles

As oil becomes more scarce, gas powered, hybrid, and fully electric vehicles are expected to gain popularity. Fully electric vehicles, which have been confined to special applications, are now moving on to everyday use. It is expected that conventional automobiles will be largely replaced by hybrid and fully electric vehicles. These may be rechargeable from distant power stations (figure 3). Owing to the inherent difficulties with electric vehicles, compared to oil-powered vehicles, the number of automobiles is expected to decline over future decades.

4.2 Locomotives and trains

Trains mostly run on diesel, with the exception of electric trains in city areas for mass transit. As oil and gas continue to be depleted, electric trains will become better options. However, the capital investment is prohibitive for copper and aluminum conductors over long distances, or cross country. Under these circumstances, the economical option may be a return to coal-powered trains, built much like coal-powered power stations.

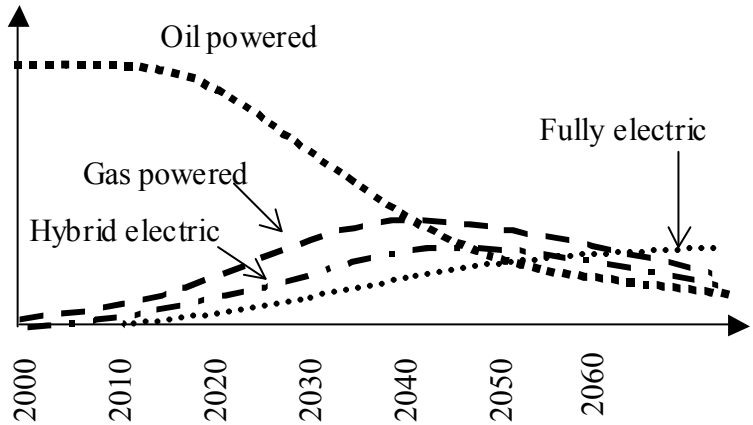

Fig. 3. A speculation into the number of automobiles powered by (a) oil (b) hybrid electric (c) gas (d) fully electric.

4.3 Shipping vessels

Shipping vessels range from recreational boats to the largest oil tankers and cruise ships. The vast majority of these are run by liquid fossil fuel (diesel etc.), the exception being nuclear powered defense ships and submarines. Compressed gas and its accompanying gas cylinders, while largely feasible for marine power, would present engineering and safety issues for vessels and ships.

4.4 Airplanes

As liquid (aviation) fuel continues its path to depletion, and rises in cost, we look to sources besides fossil fuel for the powered flight of airplanes. A gas powered airplane, would have the engineering problem of having a large number of gas cylinders to store the equivalent of the large quantities of aviation fuel formerly stored in the wings. The inherent risks of having gas cylinders all over the body and wings would be a major engineering problem, and a prohibitive risk for airplanes in the air.

A coal powered plane would require the likes of a coal-powered plant right inside an airplane. This would be prohibitive in various ways, such as in weight of the plant, electric motors, propeller-driven, and not jet-powered flight.

Solar panels on a plane may produce only about the order of a hundredth of the energy needed for flight, and would be propellor-driven, and have electric motors, clearly too heavy for flight. Also, night time flight would require batteries, which is another prohibitive addition to weight. For demonstration purposes, a solar-powered planes has circumnavigated the globe. (solarimpulse.com). This plane had the wingspan of an Airbus A340, the weight of a family car, and the power of a scooter.

A nuclear powered airplane is almost an impossibility, considering the great weight and space needed for a nuclear reactor. For powered flight, the only real alternative to liquid fossil fuel is biodiesel (Table 2).

5. Saving energy programs

The awareness for energy conservation has driven various programs and initiatives for long.A primary focus of this chapter is to increase fossil fuel conservation. Saving energy would tend to suppress the rise in prices, and cause the fuel to last longer (Figure 4).

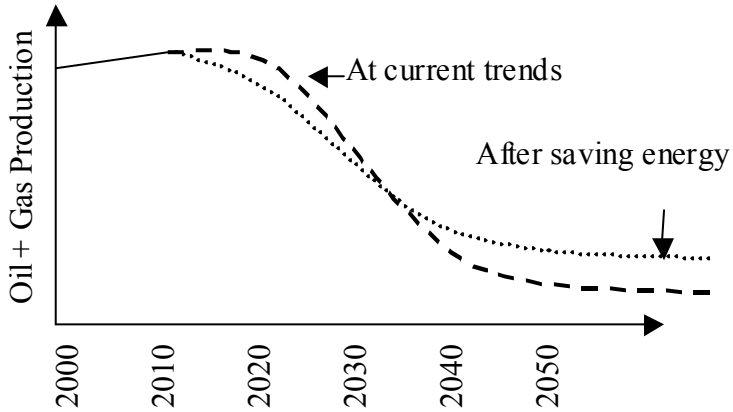

Fig. 4. Oil and Gas production at current trends, and after saving energy programs

5.1 North america

North America, besides being the driving force of the world economy, is also a proportionately large consumer of fossil fuel. A number of initiatives have been taken in North America for energy conservation (aceee.org). The Department of Energy has an official website on saving energy, energysavers.gov, which speaks of saving energy at home, at the office, in the vehicle, workplace, etc. It ranges from simple issues such as the advantages of CFL (compact fluorescent lamps), and LEDs to details such as how one would establish a hydroelectric plant in one's own property. The Environmental Protection Agency has sponsored at least two programs that promote the adoption of energy-efficient technologies through voluntary agreements with private sector firms (Howartha, 2000). Companies which advocate the saving of energy through their websites include Tampa Electric (tampaelectric.com) and Sempra Energy Utility (sdge.com/homerebates). In Canada, companies have similar partnerships with the government for reducing energy consumption. In spite of all these attempts, there is plenty of scope for further reducing energy consumption.

5.2 Europe

Saving energy is pursued at the government level in Europe and Asia. Outside of the USA, the government is more likely to be involved in saving energy programs (Martinot, 1998). Numerous energy conservation programs and studies have been conducted in Europe (Kaygusuz, 1999), of which the attempts in Hungary are among those well documented (Aunan, 1998, 2009). As in North America, there is still plenty of scope for reducing energy conservation.

5.3 Asia

China has rapidly increased its consumption to become the second largest largest fuel consumer in the world. Quite appropriately, there have been studies of saving energy in China also (YunXia, 2008). Developing and Third world countries, such as Bangladesh, present some different factors on the issue of saving energy (S. Khan, 2011, 2008).

5.4 Back-up generation and power supplies

In developing countries, the discrepancies between demand and supply may cause rolling blackouts, otherwise known as load shedding. This inability to meet load requirements induces consumers such as households and offices to install back-up gnerators and UPS (Uninterruptible Power Supplies). Back-up generators, create further problems, such as those described below.

1. Back-up generators require capital investment by consumers, likely to be much greater than the extra investment required in power stations.
2. The efficiencies of such back-up generators are much lower than that of power plants.
3. The smaller genertors normally operate at less than full load, causing the efficiencies to be even lower.
4. Back-up generators require diesel whereas power plants have the potential to operate on the more available coal.
5. Back up generators bring exhaust and pollution to the premises of the consumers, rather than having them at the distant power station.
6. Back-up generators create greater dependence on diesel or gas, which may create further fuel shortages for power station, creating even more black-outs. This may induce consumers to invest more on back-up generators, creating a vicious cycle shown below
7. Back-up UPS are at best about 50 % efficient, and therefore end up consuming twice as much electricity from the power stations.
8. Back-up UPS may contribute to a similar vicious cycle as back-up generators, inducing even greater rolling black-outs (figure 6)

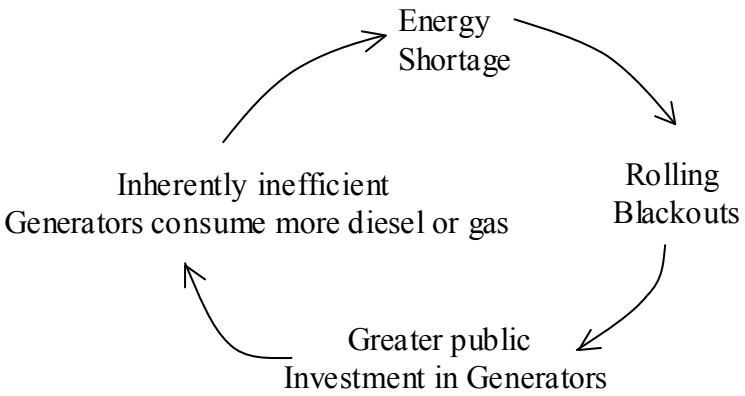

Fig. 5. The vicious cycle, where rolling blackouts induce more installation of generators, which consume more diesel or gas, otherwise usable in more efficient power stations.

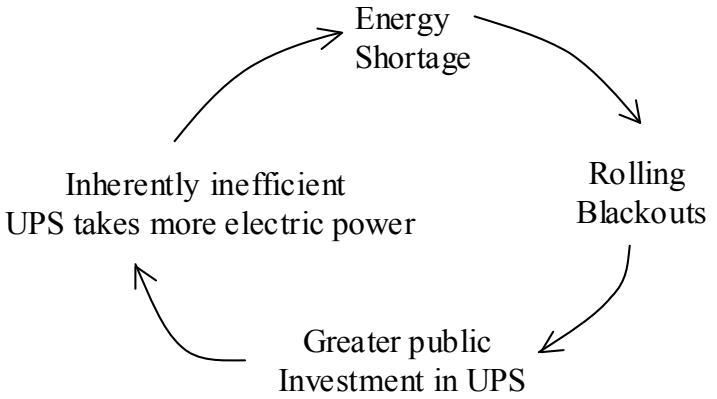

Fig. 6. The vicious cycle, where fuel shortage cause more rolling blackouts, causing installation of more UPS, which absorbs more electric power, causing more shortages.

6. Consumer behavior

In spite of all the energy-saving programs, there is great scope of reducing energy consumption by individuals. Since about 1981, surveys have indicated that a significant portion of North Americans believe the energy problem is real and serious. Since 1977, state agencies and universities in Virginia have been funded to provide energy conservation information to the general public (Geller, 1981). Large portions of the public also support relatively strong conservation policies. Two major reasons cited for conserving energy have been to save money, and to solve the energy problem (Marvin, 1981).

Energy may be saved by improving consciousness about the energy consumption of appliances and equipment. Along these lines, there have been attempts at "smart metering" which gives gives real time energy consumption information (Ehrhardt-Martinez, 2010). In Bangladesh, pre-paid metering has been implemented, which stops energy, when the pre-paid amount runs out.

According to a preliminary survey in developed and underdeveloped countries (S. Khan, 2011), offices and public buildings were more likely to have lights and air-conditioners on needlessly. Shopping complexes were found to use lights much brighter than required. The preliminary surveys indicated that air conditioning was used throughout the year, even during months or days, when plain ventilation was sufficient for health and comfort. Cooling fans were not installed or used, when in conjunction with outside ventilation, they were clearly sufficient to counter the warm weather.

The essence of saving energy programs is changing consumer behavior. Awareness must be created that saving energy will prolong availability of fossil fuel, and help keep prices low.

6.1 Telecommunication

While the land phone has had almost complete penetration in North America for the last few decades, there has been a dramatic rise in cell phones in more recent times. The rise in telecommunication has been particularly dramatic in developing countries, where

penetration has increased from a small minority of the population a decade ago, to most of the population today.

Personal and business communication over the phone and internet have gained popularity over the last few years, allowing people to be in touch across cities or continents. Better phone communication and video-conferencing (Skype.com etc.) reduce fossil-fuel required for personal travel. In this sense, telecommunication has greatly helped fossil-fuel conservation.

The improvements in telecommunication and the internet are a mixed blessing to energy conservation. The ease of internet communication induces personal and casual communication over the internet for prolonged periods. This induces consumers to keep their computers when not needed otherwise. The widespread popularity of websites like facebook.com induce people to keep their computers on for long periods. While laptops and mobile devices consume less power, desktops and their CRT monitors may consume several hundred watts of power. This energy has become a little-recognized cause for increases in power consumption today. The increasing popularity of energy-efficient hand held devices may favorably improve energy conservation over the next few years.

6.2 Air coolers and acclimatization

A major portion, or most of the energy consumed by households and offices is spent on air coolers. In view of this, there have been public service messages informing consumers of the great savings in reducing air-cooler thermostat temperatures by a few degrees. However, there have been very few messages, asking people to replace air-cooling with overhead fans and plain ventilation when possible. It should be recognized that air-coolers normally operate in closed rooms, and air-coolers must work extra to bring down closed-room temperatures to the outside ambient temperatures.

Owing to their great power consumption, air-coolers are unsustainable over the next few decades. It should be noted that humans are very capable of acclimatization, and can quickly adjust to high ambient temperatures when needed. Residents of colder Europena countries can quickly acclimatize to the higher temperature of the tropics, such as in Asia and Africa.

The notion that computer-related equipment last longer in cooler temperatures is now being changed. In a related research conducted in 1994 in Japan, it was seen that computers fared well in higher ambient temperatures of 28 C, as compared to the previous 23-24 C. Mobile phone Base Transceiver Stations (BTS) in Bangladesh are being installed without any air-coolers, as compelled by energy shortages in the country.

6.3 Consumerism

The lifestyle in much of the developed world consists of rapid consumption and replacement of consumer goods. Such consumer items include automobiles, appliances, electronics, computers, garments, etc. Spending by consumers generates revenue, jobs, taxes for the government, and stimulates the economy in general. Media, such as newspapers, and TV consist of much advertisements, which promote a lifestyle with rapid replacement of consumer items. The problem arises as the production of consumer goods heavily consumes fossil fuel.

While proponents of such a lifestyle argue that such consumption is a choice made by consumers, it is clear that such practices are unsustainable beyond the next few decades. In the past, increases in fossil fuel prices have contributed to price increases in consumer goods. Depletion of fossil fuel will tend to continue the upward trend in prices of consumer goods, forcing consumers to ultimately move away from such a lifestyle. A program to save energy should attempt to discourage unsustainable lifestyles promoting consumerism.

7. Barriers to energy conservation

One of the greatest barriers to energy conservation today is that it energy consumption generates revenue, wealth, and taxes. While individuals have an inherent and inbuilt concern for their own future, and the future of their children, companies are generally driven by the bottom line and have little inherent concern for the welfare of humanity. Even though the top management may have concern for the future, when these same officers think collectively as a company, the concern for the future takes second priority over maximizing the bottom line, or profits. Commercial organizations are not very well-built to recognize the potential fuel shortages and depletion many decades down the line.

Growth in fossil fuel consumption may be viewed positively by the oil-related industry. When oil and gas shortages cause prices to rise, the higher prices contribute further to the revenue. This may again be viewed positively by commercial forces, which generally direct themselves to maximizing immediate profits.

Companies related to fossil fuel production and distribution benefit from increased extraction and consumption through increased revenue, and consequently increased profits. Increased fossil fuel production generates greater wealth, and benefits the large numbers of companies related to the fuel industry.

It should be noted that much data on remaining reserves and future expected consumption is provided by oil companies. Their data should be considered as optimistic keeping in mind the financial forces which drive their growth.

The revenue from increased fossil fuel production in turn generates more taxes for the government. The government, which are entrusted by the people, to protect the assets of the country, may not be inherently sufficiently far-sighted to prioritze fossil fuel conservation. Governments have mandates for only a few years, leading them to be more concerned about what happens during their tenure, rather than what is good in the long term. To governments, increased oil revenue may be a quick solution for improving the economy and increasing employment, consequently improving popularity among voters.

7.1 Individuals

Individuals generally have the greatest concern for saving fossil fuel, as they may be concerned about what happens in their own lifetime, the lifetime of their children, or their children's children. There is general consensus, that consumers of today should have reduced consumption so that there is more fossil fuel left in the coming decades, and for future generations. The interest of individuals to conserve energy cannot be left entirely to companies or even governments for implementation. Efforts to save energy must include participation by conscious citizens, and academia.

8. Larger automobiles

There is much potential of reducing energy consumption in automobiles, by moving to smaller and more efficient automobiles. A recent StatsCan report indicated that Canadians spend 18 % of disposable income on transportation. The fundamental issue is that automobiles do not need to be as large with low gas mileage, as they are today. The present popularity of larger cars and SUVs are unsustainable, over the next few decades. Studies have shown that the popularity of larger automobiles and SUVs is largely due their perceived and real safety in case of a collision. This popularity is in addition to other factors, such as comfort and space, and the status they convey about the owners.

During an impact, the impulse on passengers of a heavier automobile is less than the impact on a lighter car. We consider an automobile of mass M_1 travelling at velocity V_I hitting a stationary automobile of mass M_2. We assume they move away with a common velocity V_F. From the law of conservation of momentum, their final velocity will be

$$V_F = \frac{M_1 V_I}{M_1 + M_2}$$

The impulse on passengers in the first car is

$$M_1[V_1 - \frac{M_1 V_I}{M_1 + M_2}]$$

The impulse on passengers in the second car is

$$M_2 \frac{M_1 V_I}{M_1 + M_2}$$

Analysis of the above shows the smaller impact forces on the passengers of the larger car, and consequently greater safety.

This safety during collision, and the status conveyed by larger automobiles, has at least contributed to a "size race" among consumers in pursuit of larger cars. There is much scope of reducing this "size race" among consumers, greatly favoring fossil fuel conservation.

8.1 Sports utility vehicles

The Sports Utility Vehicle (SUV) has been popular for at least 2 decades. Today, the largest SUV weighs as much as two mid-size SUVs and gets just 13 mpg on the highway. While there have great research and incentives on decreasing the size of cars, the SUV had initially exploited a legal loophole by being built on the chasis of trucks, bypassing the fuel efficiency required of cars. Consumers, eager for increased safety, had contributed to the great popularity of SUVs, owing to their increased safety arising from greater weight.

Numerous federally sponsored studies (speakout.com), show that car occupants are more likely to be killed when struck with by a SUV than by another car. Many SUV drivers have said they buy the big vehicles because they make them "feel safe."

These SUVs and large cars alongside more efficient cars today, are examples that there is great scope of improving energy conservation by implementing policies to discourage this "size race" by consumers in their pursuit of safety in collisions.

9. Urban sprawl

Another area with great scope for improvement of fuel consumption is what is popularly known as Urban Sprawl. Urban sprawl is the outwards spreading and development of a city and its suburbs (Wikipedia, 2011). It is characterized by low-density and auto-dependent development on rural land. It also has high segregation of uses (e.g. stores and residential), and various design features that encourage car dependency. Residents of sprawling neighbourhoods tend to consume more fossil fuel per person.

Urban sprawl is controversial, with supporters claiming that consumers prefer lower density neighbourhoods, with a suburban lifestyle with two or more cars. An opposing viewpoint is that urban sprawl forces residents to drive to conduct daily activities. Whatever the preferences of residents, it is clear that urban sprawl, and its car-dependent culture are very much unsustainable.

9.1 Employment sprawl

Employment sprawl is closely associated with urban sprawl and car-dependent communities. This is where jobs are located in areas of urban sprawl. This leaves employees little choice but to participate in the urban sprawl, by relocating to close to their suburban offices. Employment sprawl is prevalent both in cities with and without mass transit such as subways. Companies have set up employment centers well outside the subway system of Toronto, Canada. Employment sprawl causes the interesting phenomena, where residents living near city centers, must reverse-commute outside the city by cars. The mismatch of residences with employment areas is known as spatial mismatch.

9.2 Housing

Accompanying urban sprawl is the use of large housing that usually exceeds the physical needs of residents. Large housing costs more in heating and cooling costs. According to StatsCan, housing costs a further 30 per cent of disposable income of Canadians (Times Colonist, Dec. 18, 2011)

Compared to North America, urban and employment sprawls are less prevalent in Europe and Asia. The International Association of Public Transport policy indicates that in European and Asian counties 5-8 % of GDP is spent on transportation, compared to 13 % in North America.

The causes of urban sprawl are acknowledged to be mainly zoning laws. Sprawl generates much revenue for real estate, automobile and oil companies. A small number of policy-makers have spoken out about urban sprawl, but at this time, they are a minority (NZ Herald, Dec. 17, 2011).

Simply reducing urban sprawl by allowing employment and residences to be located close to city centers would greatly reduce fuel consumption by reducing dependence on cars, and

encouraging mass transit like buses and subways. This would be more sustainable in the long run.

9.3 Recent decline in housing market in North America

In the ongoing decline in the housing market in North America, prices in distant suburbs have gone down by 66 %, whereas prices in the urban areas have gone down by about 20 %. While many explanations have been given for this crash in the housing market, it could also be evidence of the non-sustainability of urban sprawl, in the face of rising fuel costs. Faced with fuel costs at $ 3 - 4 per gallon, commuting over long distances is becoming an increasingly expensive option. With high fuel costs, housing in distant suburbs, and an automobile-dependent lifestyle has lost much of its former appeal.

9.4 Role of trees to reduce cooling costs

The presence of trees and vegetation around and on houses and buildings is another simple proven method of keeping energy costs low (Akbari, 1992, 1997, 2001; Raeissi, 1999). Trees cool buildings both by shading the walls and roof from the sun, and by cooling the ambient temperatures by their evaporation processes. A rooftop garden on a five-story commercial building gave savings of 0.6–14.5% in the annual energy consumption (Wonga, 2003). Increasing of soil thickness and its moisture content would further reduce the building energy consumption substantially

10. Increasing density of forests

Increased fossil fuel consumption causes global warming. (Figure 7), and increased greenhouse gases, especially CO_2 (Figure 8). These may be used to analyze the changes in vegetation and forestry around the world, and the changes in marine life.

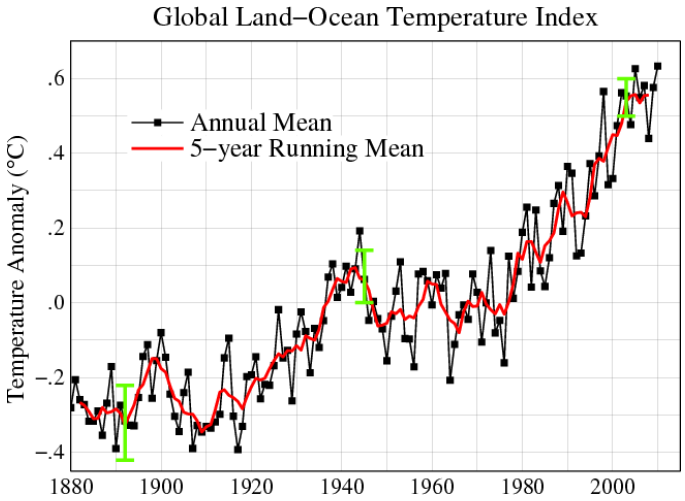

Fig. 7. Global mean land-ocean temperature index, 1880 to present, with the base period 1951-1980. The green bars show uncertainty estimates. [Courtesy: Wikipedia.com]

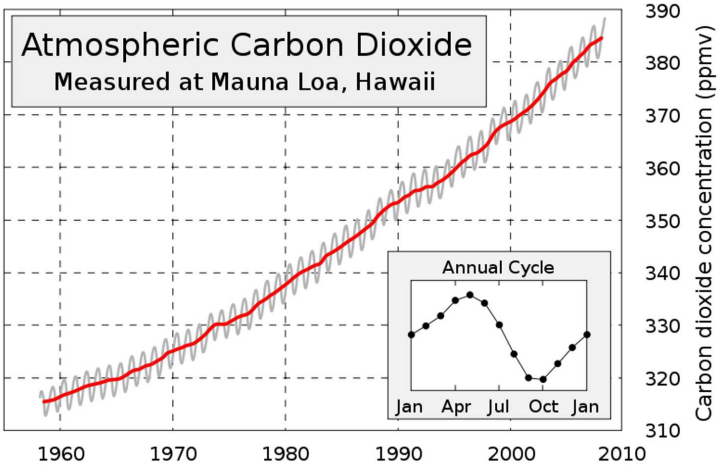

Fig. 8. Carbon dioxide concentrations as directly measured at Mauna Loa, Hawaii. (courtesy Wikipedia).

Deforestation over the decades and centuries has brought down naturally forested areas to less than 10 % of their prehistoric levels. Paradoxically, it has been observed that forest densities have significantly increased over the decades (Figure 9). Forests in many regions of the world have actuallly become of higher density, according to researchers in Rockefeller's Program for the Human Environment.

The reason cited in the above study is better management of the forests. One contradiction of the above explanation is that increased density of forests have also been observed in places where there has been no maintenance of forests.

Fig. 9. These photos from the same spot in Finland, taken in 1893 (left) and in 1997 (right) show that while the forest area is the same, the trees have become larger (Courtesy: newswire.rockefeller.edu).

10.1 Malaysia, 1975 - 2002

The author personally noticed significantly increased density of rainforests in Malaysia during the period 1975 - 2002. In the period of 1975-78 in the area of Tanah Rata, Cameron Highlands, it was noticed it was mostly possible to walk upright around in the rainforests without being significantly obstructed by the undergrowth. Paths in the forests frequented by people were relatively clear, allowing people to walk upright with little obstruction.

In 2002, in the same Tanah Rata region, it was found that the same natural rainforests had become significantly more dense. It had become much more difficult to walk around in the rainforests, because of obstruction from the undergrowth and vines. It was observed that passages in the forests had become more of tunnels allowing crouching and crawling through the undergrowth, crouching and crawling, rather than upright walking, through the undergrowth.

This expected increasing density of forests over the last few decades has also been observed by the author in the Sedona area of Arizona in 2012. This area has also been the backdrop of movie Westerns from close to 50 years ago, which form a basis of comparison for the vegetation densities we see today.

10.2 Global warming as cause of increased density of forests

One reason often cited for the increased forest densities is global warming. Plants are known to thrive with a number of factors, such as increased rainfall, humidity, higher temperatures and increased carbon dioxide. Freezing temperatures are known to kill off the plants, allowing mainly coniferous plants to thrive.

Gobal warming should cause shifts of vegetation and forestation patterns away from the equator to the poles as shown below (Figure 10). This changing patterns of vegetation and forests has generally been observed.

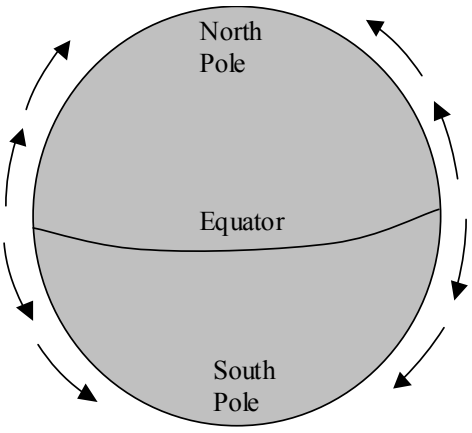

Fig. 10. Expected migration of vegetation and marine life, if global warming were the cause. Vegetation densities have increased as expected, whereas marine life has declined dramatically.

10.3 Increased carbon dioxide as cause of increase of forestation

An additional reason for increased density of forestation is proposed here to be increased carbon dioxide (CO_2) in the atmosphere. Besides increased temperatures, vegetation and forests are very dependent on CO_2 for photosynthesis, and creation of living tissue. The fossil fuel burnt artificially releases increased carbon dioxide into the atmosphere over the decades. This increasing carbon dioxide would cause a shift in the dynamic equilibrium of forest density, favoring the growth of forests. With other factors remaining unchanged, the increase in carbon dioxide levels would cause more dense vegetation and forests. It is known among aquarium enthusiasts that pumping CO_2 from a cylinder into an aquarium increases the density of aquatic plants. An increase in CO_2 into the atmosphere would be expected to cause a similar increase in forests and vegetation.

10.4 Wildlife

The global decline in wildlife over the last few decades is largely attributed to loss of habitat such as rainforests, and the encroachment of man. The decrease in wildlife has also been attributed to the pollutants and contaminants introduced into the atmosphere. **The large decline in the numbers predatory birds such as eagles and hawks was first indicated in the study some decades ago, where DDT introduced into the food chain was found to have been the cause.** Owing to a lack of other explanations, the huge decline of birds today could be attributed to their great sensitivity to toxins in the environment.

Also sensitive to environmental toxins are amphibians such as frogs. About a decade ago, mutations in frogs causing extra limbs were found to be have increased alarmingly. Pollutants and contaminants were cited as the reason for these mutations.

Animals such as bison, elephants, etc. deal with depleting grasses/vegetation and annual weather patterns by migrating over large geographic distances. The artificial fences criss-crossing our continents could be another reason for the large decline in wildlife populations.

11. Declining marine life

Having looked at the changes in global forests, we look at the present widespread decline in marine life, fisheries, coral ecosystems, etc. It is widely acknowledged that marine life has been decreasing at an alarming rate over the last few decades (Reynolds, 2005; Marinebio.com, 2011).

The most common explanation for the decline of marine life is global warming (SFGate.com, Dec. 2011). Global warming as the cause of declining marine life raises questions which cannot be easily answered. It implies that fish which used to live at the equator would shift to higher latitudes (Figure 10). Fish formerly of higher latitudes would now shift to the arctic circle. Instead, marine life, including plankton, is found to have decreased dramatically worldwide, strongly indicating a cause other than global warming.

The issue arises as to why trees and vegetation have benefited, at least marginally, whereas marine life has declined alarmingly over the decades.

11.1 Overfishing

Some decades ago, the decline in marine life was attributed to overfishing. International agreements were put into place to limit fishing in the oceans. Particularly well known are the bans on whaling, which were adhered to by most countries. In spite of these voluntary limits on fishing, marine life rather than rebounding, has continued it's steady decline. With the restrictions on fishing and whaling, plankton at the bottom of the food chain should actually have increased. The question arises as to why there has not been a corresponding increase in the plankton in the oceans.

Ocean plankton are at the bottom of the food chain, and are the ultimate source of food for most marine life. It is estimate that phytoplankton is responsible for about half of Earth's photosynthesis, a process that removes carbon dioxide from the atmosphere and converts it into organic carbon and oxygen that feeds nearly every ocean ecosystem.

Paradoxically, the plankton densities over the world have continued their steady decline. Clearly, there is some major factor besides global warming and overfishing which are causing the alarming decline in marine life. The increase in CO_2 has clearly not been sufficient to visibly benefit the CO2 dependent marine plankton.

Nine years of NASA satellite data published in the journal Nature show that the growth rate and abundance of phytoplankton around the world decreases in warm ocean years and increases in cooler ocean years. This has been used to support that global warming is the cause of the decline of the plankton. However, this explanation is insufficient, and the variation of plankton could have some other cause besides annual temperature cycles. Contrary to their explanation, global warming is clearly not the main factor leading to the decline of plankton.

11.2 Contaminants and pollutants in the sea

The evidence is clear that it is not global warming, but some other underlying reason behind the declining marine life. A possible cause, and that explanation offered here, is the pollutants and toxins being discharged into the oceans.

We now look at the effect of the garbage, sewage, and industrial wastes being dumped into the oceans in much of the world. The dumping of such waste into oceans was legal until the early 1970's when it became regulated and restricted. However, dumping still occurs illegally everywhere. The peak of sewage dumping was 18 million tons in 1980, a number that has decreased to 12 million tons in the 1990s.

Rivers, canals, and harbors are dredged to remove silt and sand buildup or to establish new waterways. About 10% of all dredged material is polluted with heavy metals such as cadmium, mercury, and chromium, and pesticides which ultimately find their way into the sea.

Today it is acknowledged that accumulation of waste in the ocean is detrimental to marine health. Ocean dumping can destroy entire habitats and ecosystems when excess sediment builds up and toxins are released. Although ocean dumping in critical habitats and at critical times is regulated, toxins are still spread by ocean currents.

One of the best explanations for the declining marine life could be this increasing contamination of the oceans, caused by disposal of these wastes into the sea. It is known that

the fishes are very sensitive to contamination in the water. Those in charge of aquariums, especially marine aquariums, are aware that fishes may be harmed or killed by even quantities of toxins. As any hobbyist with a fish tank may know, dropping a small contaminant such as a cigarette butt, could easily kill a tankful of fish. The exception to this could be fish which have coexisted with humans for a long time, (such as gold fish) and those that have learnt to survive well in contaminated waters (farmed fish).

Large numbers of fishes are known to wash up on shores, often for no apparent reason; a phenomena for which contamination is a likely explanation. A satisfactory explanation has not been found for why whales and other fish beaching, and ultimately killing themselves. This act of self-destruction is clearly highly destructive to the continuity of their genes, from an evolutionary point of view. One possible explanation for this counter-evolutionary behaviour of fishes beaching themselves could be to get away from chemically contaminated waters. The chemicals in the water may also confuse the fish into getting away from the water into the beach.

12. Rising ocean levels

A major concern associated with global warming, the melting of polar ice, and rising ocean levels, is flooding of low lying areas of the world. It is feared that within decades, ocean levels may rise over inches or feet, inundating low lying areas, especially river deltas such as Bangladesh.

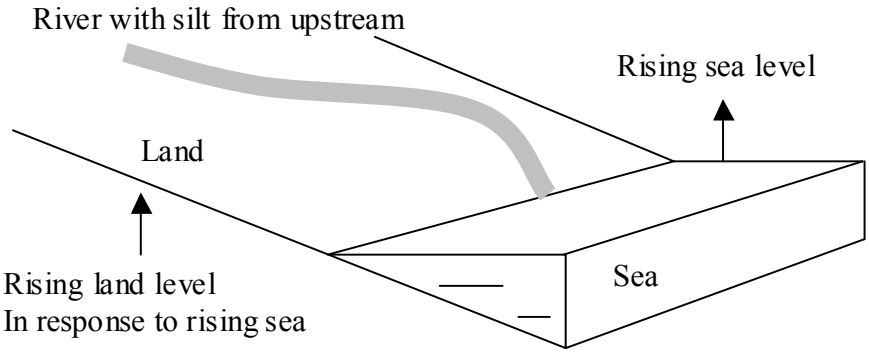

Fig. 11. Rising sea levels causing a shift in the equilibrium of the land river and sea in a river delta. The land level rises as sea levels rise.

It has been seen that river deltas (such as the Ganges delta of Bangladesh) are dynamic systems, where the land levels are the equilibrium point of the opposing forces of silt deposition and erosion (S. Khan, 1991) . This equilibrium concept of land level is also applicable to other deltas, such as for the Mississippi (in Louisiana), the Nile (in Egypt). It has been seen that for the last few decades, coastal land is being added at the rate of several feet every year. Considering that global warming rates have been mostly constant over decades, and is expected to be constant for the next few decades, it is likely that the trend of coastal land addition will continue at its present rates. It is unlikely that the coastal land addition will reverse over the next few decades causing coastal land loss or inundation. A

rise of sea level will shift the land-river-sea equilibrium, resulting in faster deposition of silt in and around the rivers. This will cause a rise of the land elevations of the river delta, that will at least match the rise of sea levels. This implies that the coastal land addition of river deltas will continue at their present rates over the next few years. Modern concerns of coastal land inundation is therefore not applicable to river deltas, as a rise of sea will cause land levels to continue to rise, and coastal land will continue to be added at their present rates.

13. Conclusion

Lack of fossil fuel conservation affects us both through increasing energy prices, and a faster depletion of the fossil fuel reserves meant for future generations. Although popular perception expects a sudden depletion of oil, reduced oil consumption at high prices is likely to continue for many decades, or even a century. Over the next few decades, coal is expected to replace gas and oil in producing electricity. The transportation industry, especially automobiles, which are heavily dependent on liquid fuel today are unsustainable, and are expected to decline in numbers. Renewable energy and biofuels can not compare with the ease and convenience of fossil fuel, which is a great incentive to fossil fuel consumption. Fossil fuel oil is the only feasible source of raw materials for the chemical industry. The status conveyed by larger automobiles, and their safety in collisions with smaller cars, has contributed to a "size race" for bigger cars by consumers. Modern consumer lifestyles with air-coolers, large automobiles, and generous consumption of consumer equipment needlessly consume fossil fuel, and are unsustainable in the long run. The increased carbon dioxide in the atmosphere from fossil fuel, may actually have contributed to more dense forestry and vegetation in the world. On the other hand, pollutants and toxins (not global warming or CO_2) are likely to be the cause for the alarming decline in marine life today. The alarm regarding global warming causing sea water encroaching into river deltas is mostly unfounded, as there will be a shift in the dynamic equilibrium of the river, land, and sea. This will cause faster silt deposition, causing a rise in land levels, and continued addition of coastal land.

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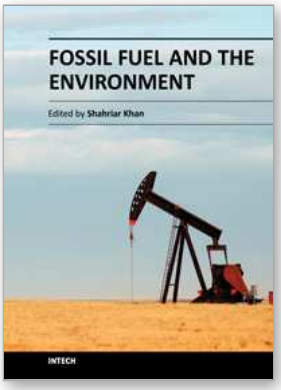

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The world today is at crossroads in terms of energy, as fossil fuel continues to shape global geopolitics. Alternative energy has become rapidly feasible, with thousands of wind-turbines emerging in the landscapes of the US and Europe. Solar energy and bio-fuels have found similarly wide applications. This book is a compilation of 13 chapters. The topics move mostly seamlessly from fuel combustion and coexistencewith renewable energy, to the environment, and finally to the economics of energy, and food security. The research and vision defines much of the range of our scientific knowledge on the subject and is a driving force for the future. Whether feasible or futuristic, this book is a great read for researchers, practitioners, or just about anyone with an enquiring mind on this subject.

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