

## CHAPTER 5

### ECONOMY, Natural Capital

#### A CASSANDRA STORY

Natural Capital is like God's benevolent garden.

It provides the planet with the energy, goods, and services essential for the growth of our societies.

Some of these are renewable, if cultivated with care, some are not renewable, some are usefully transformed, and some become too expensive or dispersed, and enter our waste stream only to return in harmful ways.

**STUPID!**

Our overconsumption and its waste have reduced the production of this garden to half.

**STUPIDER!!**

Yet our growing societies are evermore dependent on this production for their growth and wellbeing!

**SUICIDAL!!!**

Yet we continue to extract our energy source from these vast swamp-gardens of the Carboniferous Period; the best of which we are depleting, the rest is too expensive and dangerous to mine. Meanwhile, its gaseous emissions are changing our climate and destroying the habitability of life on Earth.

If we all will be impacted and God gave us intellect and the cooperative spirit to solve to this issue, what is stopping us from solving it?

## Chapter 5

### Why Include Natural Capital

#### 5.1 Why Treat Nature's Goods and Services as Free?

Addressing this question, Herman Daly observed: "*There is something fundamentally wrong with treating the earth as if it were a business in liquidation.*"<sup>1</sup>

**5.1a Our Wrong Assumption.** From its inception, capitalism has assumed that resources would be inexhaustible and also that financial capital could replenish them—or more recently, that technology could replace them. Consequently, in the supply and demand equation, the price of a resource reflects a consumer's willingness to pay rather than of any accounting of its physical exhaustion. This assumption that financial value is interchangeable with natural value is now causing serious environmental and social problems, for example:

1) The price of a species of fish goes up with dwindling supply - but never enough to pay the price for its extinction.

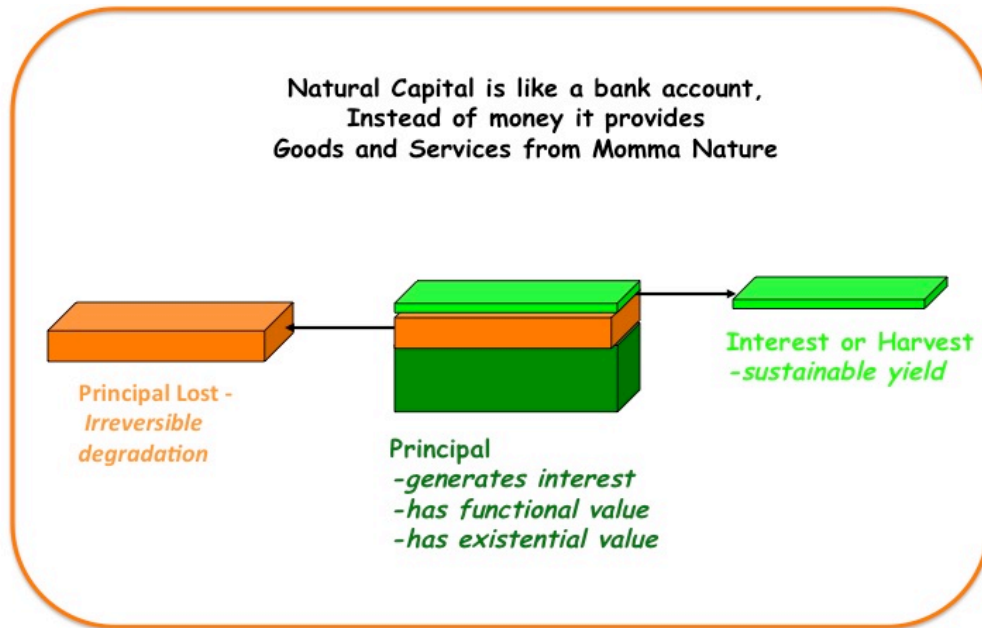
2) The practice of clearcutting lumber from public forests continues to meet public demand - without ever accounting for the cost of destroying the forest ecosystem's services, of the loss of species biodiversity, or the nutrient loss due to erosion of the land, and wild fires.

3) The price of the vital element phosphorus does not account for its limited supply or risk of permanent loss, on the impossible assumption that someone will invent an alternative to an element essential for life

4) The price of oil is not determined by the cost of its geological diminishing returns, nor by the increasing costs of the environmental and social damage caused by its extraction, refining, and combustion.

The concept of Natural Capital<sup>2</sup>, the natural goods, and services derived from the environment, can usefully be described as analogous to a bank account (Fig. 1). That is, natural capital represents the ecological assets that we use freely and on which the economy depends, but that is omitted from economic assessments. For example, Costanza<sup>3</sup>, et al. (2011) estimated the current value of the annual global ecosystems services and natural capital to be within a range of 16-54 trillion dollars, which was then more than comparable with the global GDP of 72.9 trillion.<sup>4</sup> As in Fig.1 of Chap. 1 we are now utilizing 150% of the annual global ecosystems' biochemical production and thereby spending down its global principal. This utilization derives from three categories of human activity: harvesting (e.g., overfishing), wasting (e.g., pollution), or modifying

(e.g., occupying)<sup>5</sup>. The combined effect of these activities, done in excess, is to weaken the hosting Earth Systems and lessen their function, production, and resilience to disturbances. By continuing to do this we are effectively reducing the annual production of renewable resources—that is, we are depleting the principal, thereby reducing its capacity to reproduce new Natural Capital.



**Figure 1. A Schematic of Natural Capital as a Bank Account.**

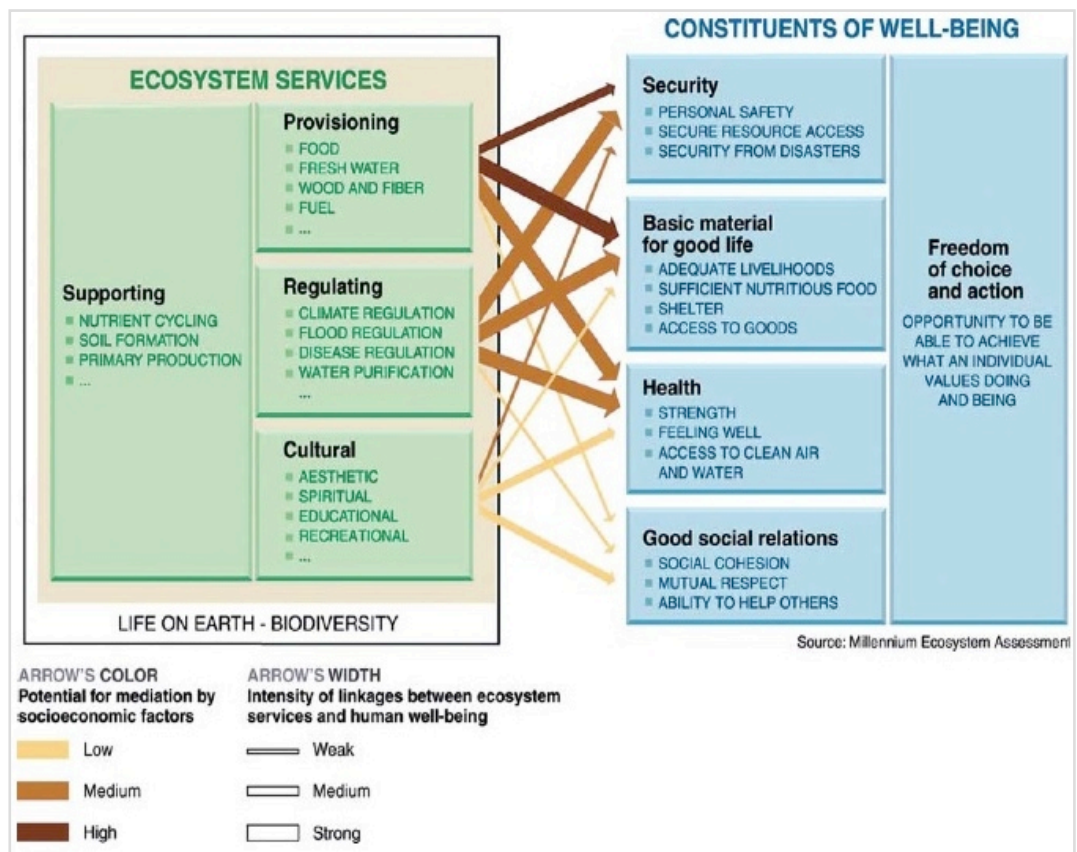
As the principal decreases so does the amount of interest. The amount of principal lost contributes to our global environmental debt.

Figure, Author-generated.

**5.1b. Are we misusing Renewables?** Humans use natural resources in several ways through harvesting, polluting, wasting, development, and enjoyment<sup>5</sup>. The first three uses have mutually interactive values in favor of humans, but with a cost to nature, and the fourth is more mutual and contributes as an existential or aesthetic value. Ecosystems produce goods that are harvested for e.g. agriculture, fisheries, forestry, and lumber products. Ecosystems also preserve these services for humans by their intrinsic capacity to self-renew through their reproductivity, their biodiversity, and their resilience such that they maintain their capacity to grow and maintain these goods and services. But when humans destroy ecosystems physically, over harvest them, or contaminate them, they also destroy the very services that humans enjoy. We develop land for urban and industrial purposes, and we pollute the soil. We use and pollute freshwater sources. We destroy the marine trophic chain from the top down through overfishing the

stocks of fish and large marine animals; and we destroy the trophic chain from the bottom up by reducing the photosynthetic marine production phytoplankton, which generate a huge percentage of atmospheric oxygen) through the effects of land-pollutant runoff, eutrophication, and ocean acidification all caused by excess carbon dioxide. By polluting the atmosphere, we are changing the climate's carbon cycle, reducing oxygen concentrations in the atmosphere and oceans, physically destroying marine coastal and coral-reef habitats, changing ocean current circulations, and raising global sea level.

**5.1c The Millennium Ecosystem Assessment<sup>6</sup>** categorized and described the interactions between ecosystems services and human needs (Fig.2). It is these 'renewable' goods and services that humans enjoy at no cost and continue to profit from beyond their capacity to renew themselves (cf. Fig.1). Unless ecosystems are protected in a manner that conserves their functionality and diversity, they fall prey to economic exploitation that invariably transgresses ethical and moral rights. Uncontrolled exploitation is leading to accelerating loss of species and function in the global ecosystem that puts the survival of life on the planet a risk. In other words, greed for profit, on the part of one group of humans, can endanger the survival of other life or lives. How serious is this threat? Enough that the renowned biologist E.O. Wilson insists that *"we set aside 50% of the earth's surface for other species to thrive in as the only possible strategy to solve the extinction crisis"*<sup>7</sup>



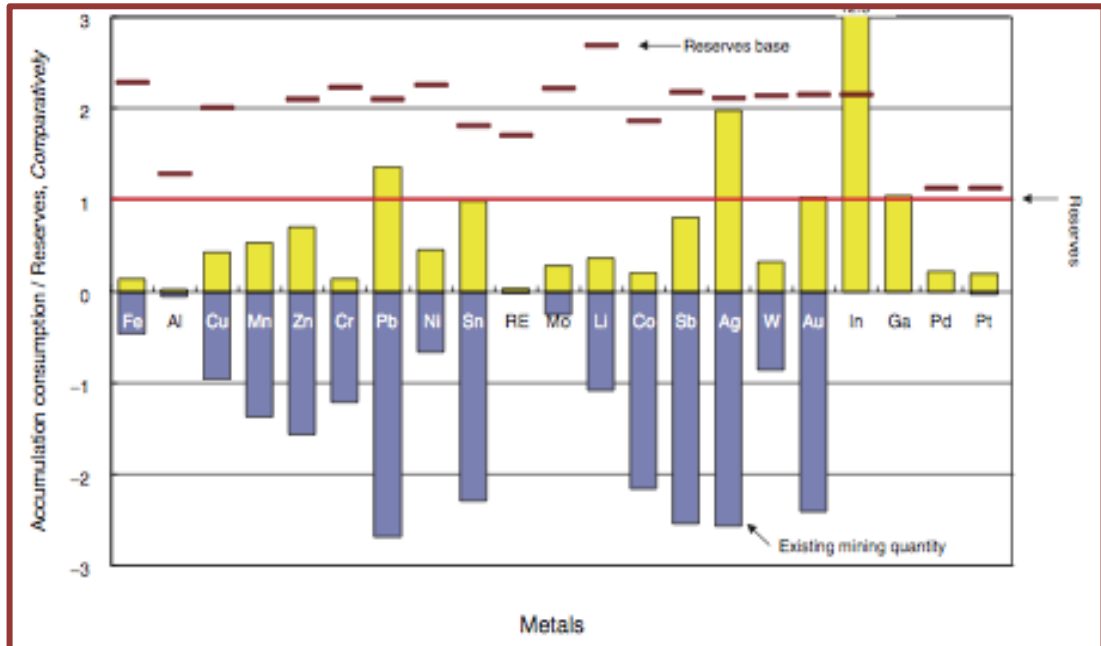
**Figure 2. Schematic of Ecosystems goods and services.** This schematic shows the Millennium Ecosystem Assessment's view of major linkages among categories of ecosystem services and constituents of human wellbeing. The graphic also examines possibilities that socioeconomic factors (the brown and yellow arrows) can affect the linkages. These services-to-wellbeing matrix is basic to quantifying the function and health assessments and is examined at length in the MEA reports. Source: Millennium Ecosystem Assessment.<sup>7</sup>

## 5.2 Why Worry about Nonrenewables?

**5.2a Minerals.** Minerals (e.g. copper, lead, etc.) are nonrenewable resources: that is, they differ from renewable resources in that they are geochemical substances that are not produced directly by sunlight but by chemical and geological processes that take eons, and hence they are not renewable. Non-renewables are similar to renewables only in that their continued use can pose very limiting constraints on our continued business-as-usual practices. They do differ in from renewables in an important entropic way: it takes energy to transform/organize the raw minerals into a usable form, to collect them, and to recycle them back to usable forms. In addition, it takes energy to repair environmental damage accrued during these processes. Some minerals can be reused or recycled by processes that require additional energy. However, technical advances have increased the energy efficiency of mining and production processes, but not necessarily at less environmental and social costs (e.g., tar sands removal). Technology has reduced the use of some minerals by substituting other substances, and by means of improved production design for reuse of parts. An example is the historical sequence of materials for water pipes: clay, cement, lead, iron, copper, plastic. All of these have had environmental and some social costs (e.g. lead poisoning).

The eventual cost to humans is due to source exhaustion, that is, when they become too scarcely distributed to mine feasibly. In 2008, Halada et al.<sup>9</sup> reported that the estimated consumption level of common minerals in 2050 will be five times higher than current levels. Crucially, the estimated demand for some of the more common minerals, namely, gold, silver, copper, nickel, tin, zinc, phosphorus, and silicon, will also be several times greater than their respective known reserves. The exhaustion process, therefore, is one of diminishing returns and will result in higher and higher costs until either these costs become prohibitive, or demand is reduced and then eliminated by use of a substitute material. Ultimately these losses will become *global resource debts*, which will reduce the

types and amounts of resources available for future generations. Currently, many of these mineral resources are approaching exhaustion (Fig.3).



**Figure. 3. The relation between cumulative demand and existing metal reserves by 2050.** The yellow bars are the expected demand in 2050 and the blue bars represent the existing mineable reserves in 2008. The short dark red bars indicate the reserve base of each when all its reserves are set at one. When a yellow bar graph crosses the solid red line, it signifies that the quantity of estimated reserves has been surpassed; and when it crosses a dark red bar, it means that the reserve base is depleted, as for example, Indium, that is used in metal alloys, and its exhaustion would place a severe if not complete constraint on its future use). From Hadala<sup>9</sup>

Human use of nitrogen, phosphate, and trace minerals that are essential for biological processes also can be limited in supply. However, most nonbiological phosphorus has a long geological cycle; it resides in deep ocean sediments and is thus effectively nonrenewable. This makes it important to recycle biological phosphorus before it is lost to the sea. In contrast, nitrogen is considered a plentiful element, but it requires energy to extract from the atmosphere, making it more expensive than if it were recycled. Consequently, much of it is needlessly wasted as runoff into water bodies, where it causes eutrophication (algae blooms), when it could be reused appropriately as fertilizer. Moreover, if it is not handled properly, its organic decomposition causes problems when it denitrifies to nitrous oxide<sup>10</sup> a powerful greenhouse gas.

### 5.3 Is the Public Aware of a Fossil fuel Crisis?

Please note, that the following descriptions attempt to present the facts objectively referencing recognized authorities. However, this attempt is made quite difficult by ambiguities of interpretation, the uncertainties of estimating fossil-fuel reserves and their consumption and depletion rates, as well as by their interdependence on an ever-changing economic and political factors.

**5.3a What is the Concern?** The development of our civilization has been based overwhelmingly on fossil fuel. This relationship is now at a critical bifurcation point requiring that we either continue at great risk to life on the planet, or greatly reduce its use and transition to non-carbon energy sources. The facts that fossil fuel remains the primary energy source for our modern societies and its declining geological availability are consequently becoming more expensive gives more reason for a transition<sup>11</sup> to renewable energy and a stronger emphasis on practices of energy conservation and efficiency. If we choose fossil fuel the costs will increase with time, carry the risk of higher costs for oil as the fields decline inability, and they are subject to growing costs to pay for climate related impacts, and to reverse policy towards sustainability. If we chose to transition<sup>12</sup>, the largest costs will be those for the initial conversion of an infrastructure for renewable energy distribution, the environmental footprint will decrease, and the health issues of fossil fuel, air pollutants will mostly vanish. If we chose to confront Climate Change, we will still have the costs of developing practices and that sequester CO<sub>2</sub>, and that conserve energy, which will require certain life style changes. But the positive aspect of adapting to renewable energy are changes we will eventually need for a sustainable future.

If we continue to delay serious action – as we have done since the 1970s - the future will be decided for us by Mother Nature, and we are passing through that tipping point. That is, if we continue we linger on this decision the more expensive will be the damage. Meanwhile, the combustion of fossil fuel is not lingering nor are the impacts of climate change, which in turn are causing Ocean and Land Systems to change in many invisible and irreversible ways that are destructive to human social and biological existence as well as to other life on earth. Both fossil-fuel depletion and climate-change, then, pose mega-threats to the stability and survival of modern societies. Fortunately, these two threats have a unique shared solution because they both originate from a misuse of natural capital through the combustion of fossil fuel and the release of GHGs into the atmosphere. They are also similar in that both their impacts are local-to-global in scale and that both will take decades to confront. Thus, many of the actions needed to confront them are synergistically

linked in a manner that could be a godsend or a curse, depending on when and how they are confronted.

Unfortunately, the public and for policymakers have not been well informed, and for whom these two profoundly interlinked crises might appear to be two different problems that might be dealt with separately and gradually. Instead, what the public needs to understand that their combined impacts are already growing more severe by the month, and that their common solution gets more difficult and expensive to implement the longer we wait. The public and policymakers should also be cognizant that solutions and reviewed implementation plans are already available, and in some cases, already in progress. Unfortunately, also is the risk that the time of a decade or more, estimated for the energy transition<sup>11</sup>, could be significantly longer than the time of a decade or less before a growing oil deficit develops between its consumption and its production, which would destabilize all world economies.

Even though there is a nearly total international agreement to start cutting GHGs emissions, real progress is still anchored in the fear politicians have of losing their potential for continued economic growth—which is the very thing such action would prevent, if done intelligently and cooperatively. The recent US denial of the of the Paris Agreement<sup>12</sup> constitutes a historic Type I error<sup>13</sup>, where one rejects a true hypothesis, which in this case would be an incalculable cost to all life and civilization on earth.

The first hurdle to overcome is to establish a clear understanding of the threat within the public, corporate institutions, and policymakers of the necessity and urgency to confront these combined threats. At the time of writing, however, the Federal government is moving in the opposite direction—suppressing information about climate change, erecting high tariff barriers to the importation of cheap solar panels, and increasing subsidies to fossil-fuel industries. Fortunately, the opposite is happening at lower levels of the government, and with organizations.

**5.3b Fossil Fuel Forever?** Fossil carbon resources are a special category of solar energy that is considered to be nonrenewable because its natural formation occurs on a geologic time scale. Fossil-fuel deposits derive from the photosynthetic production of plant carbon, circa 70 million years ago, that sedimented in swampy anoxic conditions and then buried under other types of sediments, until the pressure and temperature environment, chemically converts them to petroleum products. Consequently, these carbon deposits represent an immense reserve of ‘stored solar energy’—a gift to humanity! Deposits found in the form of concentrated sources of petroleum are referred to as “conventional” oil

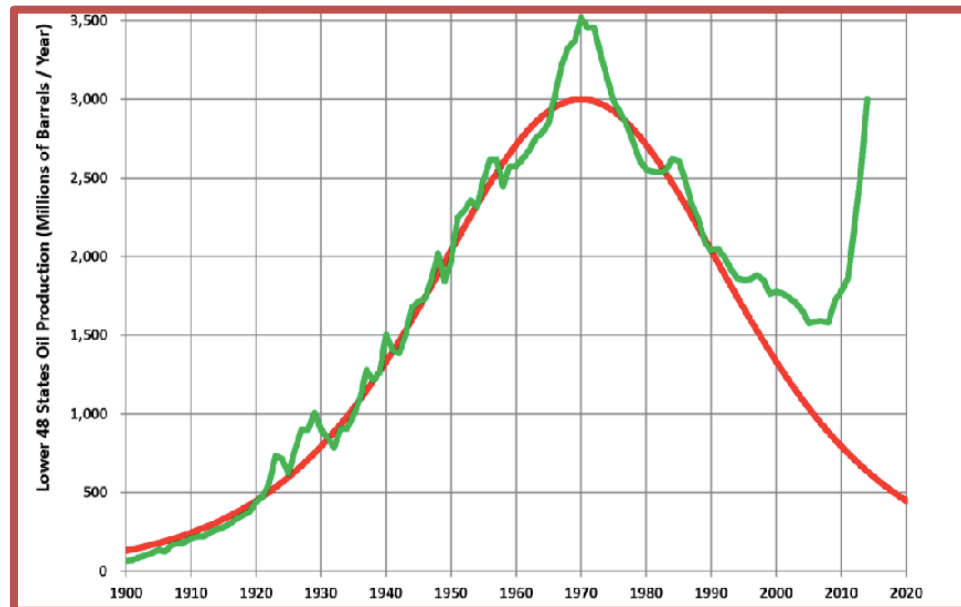


(light, medium, heavy, or extra heavy in density). Because they seemed to exist in inexhaustible quantities in the earth's geological crust, and they are easy to pump out, these deposits have been treated as if they were unlimited. However, these conventional-oil resources created through the very slow bio-geo-chemical processes should not be considered renewable. Their limits need to be considered, not solely from a geological point of view, but also strongly with respect to other limiting factors, such as energy quality, price, the impacts of their combustion, their contribution to air pollution, acidification of the oceans, and to climate change. More sensibly fossil fuel should, as much as possible, be preserved as an additional reserve of 'stored solar energy' for the exigencies of future human generations. The current administration, however, seeks to exploit every available fossil-fuel reserve in United States and its territories, including Atlantic and Pacific territorial waters, in order to achieve "global energy dominance" as part of a strategy that also includes further expanding the US military—already larger than those of the next eight countries combined—in order to stave off the nation's decline as a superpower.

## 5.4 Anticipating Peaks in Conventional Oil.

**5.4a. Evidence of Depletion.** An awakening to geographic limitation came, after a century of complacently accepting ever-increasing consumption, with M. K. Hubbert's<sup>14</sup> prediction that US production of conventional oil would reach peak by 1970 and thereafter decline (Fig. 4). His prediction was discounted, but has since been strongly confirmed by more recent data<sup>14</sup>. The fact of this emerging limit has not been well publicized to the general public, but it has generated controversy between pessimists and optimists within the oil industry. In fact, this controversy spurred a search to determine amount of remaining reserves scattered throughout the earth's crust and whether existing technology could retrieve them. These involve new wells and horizontal extensions of existing wells. Essentially these resources are more sparsely distributed and/or are less fuel-rich in quality, such as the oil or gas deposited within low-permeable rock, shale, and tar sands. These deposits are referred to as "unconventional oil" because they are more difficult to extract and require new, more expensive technologies, such as horizontal drilling and hydraulic fracturing or 'fracking'. Their gradual development from the 1990s on, has greatly boosted the US production and allowed the US to

import less foreign oil and forestalled concerns about US being more dependent on imported oil. However, the gradually realized drawback of unconventional oil is that it has additional limitations because the extraction, transportation, and production processes are much less cost-effective and cause expensive environmental and social impacts (Sect. 5.5e).

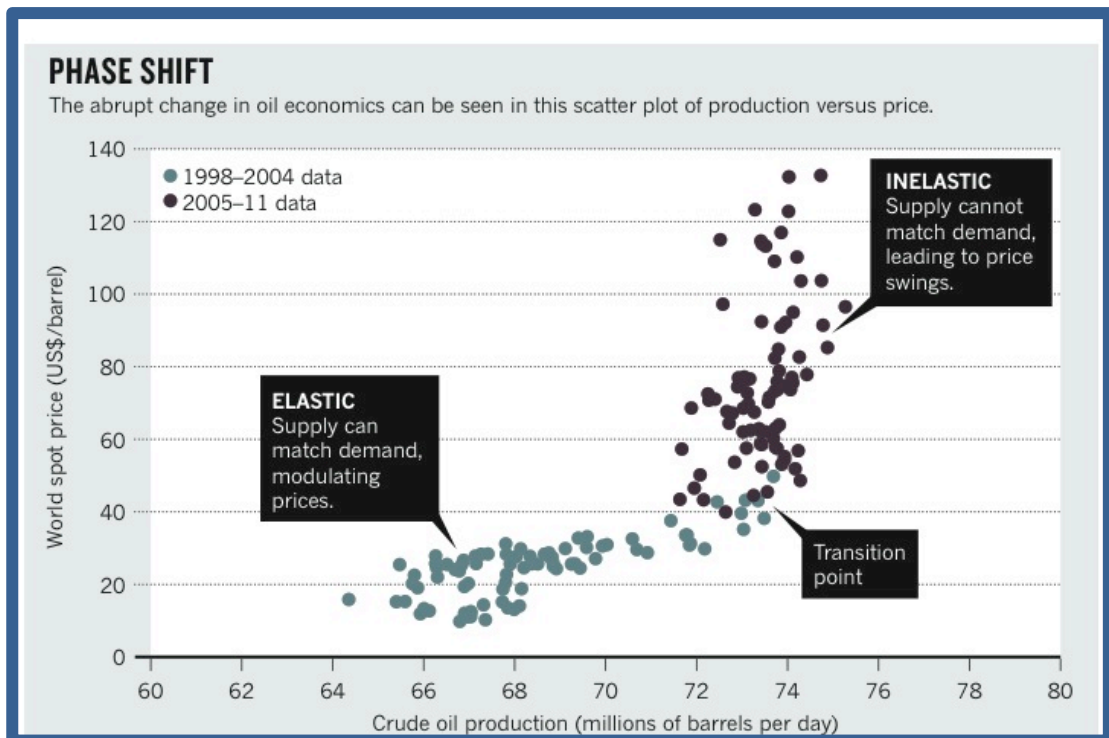


**Figure 4. Hubbert's 1956 prediction of peak in US crude oil production.** The red line is his prediction of US crude oil production (lower 48 states) and the green line is the historical actual data, both from 1900 to 2014. The reversal of the actual (to the right) is due to the gradual addition of unconventional oil production. Graph Source: Wikipedia.

**5.4b. Searching for the Global Final Peak?** This section deals with efforts to identify or predict when the global production of conventional oil will have a final peak. The term 'Peak Oil' is used to describe the point in time when the rate of oil production reaches a maximum and subsequently declines irreversibly. A peak implies that a well is about half way to exhaustion. Recent advances in horizontal drilling techniques can extend the lifetime of a well (the extension is called reserve growth). Production forecast models take these factors into account when estimating future production rates, which are essential to anticipating corresponding impacts on the economy; this is because both increasing and decreasing production requires considerable nation: to mandate lower consumption, which unless the, oil industry, public, market production understand the necessity to do and cooperate accordingly cooperates with the implementation. In other words, to ensure that prices remain

reasonably stable, production needs to at least match consumption or else the price will fluctuate and perturb the economy.

**5.4c. The 2004-2014 Minor Peaks in Conventional Oil.** In the decades succeeding Hubbert's success with predicting the 1970 US oil peak, more effort was put into forecasting a global peak in conventional oil. From 1985 on, global crude oil production was fairly stably increasing until 2005, when it peaked. In confirmation, the UK Energy Research Centre<sup>15</sup> has cited 25 peak oil predictions giving an average date of 2010  $\pm$  10.



**Figure. 5. The 2005 phase shift in the correlation between oil production and price.** The upper panel shows a scatterplot of the relationship between oil production and oil prices over this period. The grey dots indicate the 1998-2005 period, and the black dots indicate the 2005-2011 period. From Murray and King<sup>16</sup>

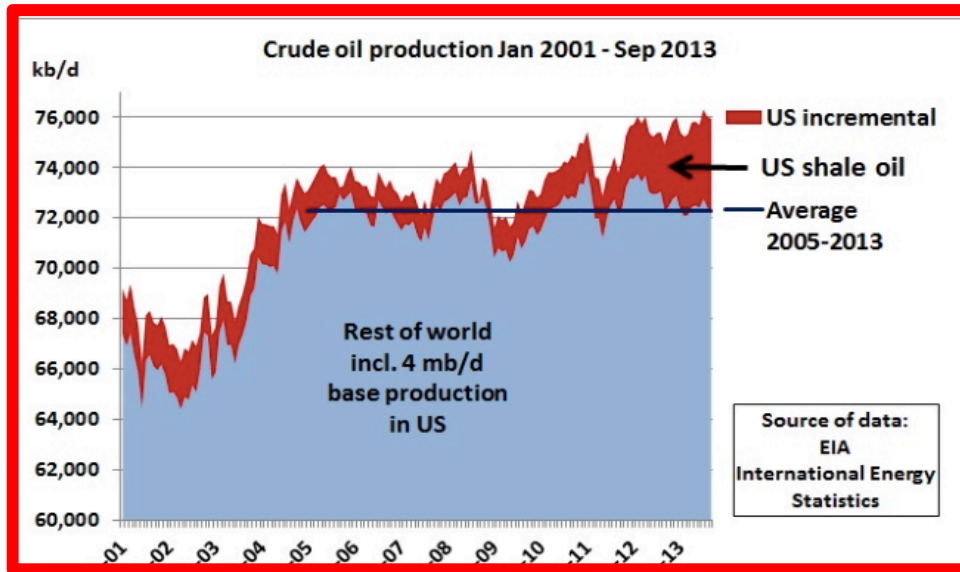
Instead of using a model based on oil resources, Murray & King, 2012<sup>16</sup> were able to demonstrate how price variability in relation to production could identify an oil peak in 2005 (Fig.5). The Murray and King's study illustrated (Figs. 5 & 6) the relationship between supply, demand, and price provides an example of the lack of correlation between these parameters and thereby demonstrates the complexity of balancing and pricing the oil equation; and it also serves as a prelude to the future management of the fossil-fuel resource. This period is marked by two levels of production: 1998-2004 with production being elastic enough to

match demand and kept the price stable; whereas during the 2005-2011 when production could not match demand (inelastic) causing the price to have some extreme deviations in price even though the demand remained smooth at about 73 million barrels per day (mb/d). To get an approximate sense of the lack of correlation occurring during this interval, one can look at the behavior of price during these two production periods. The first is the continuation of the 2005 up to the peak in 2014.



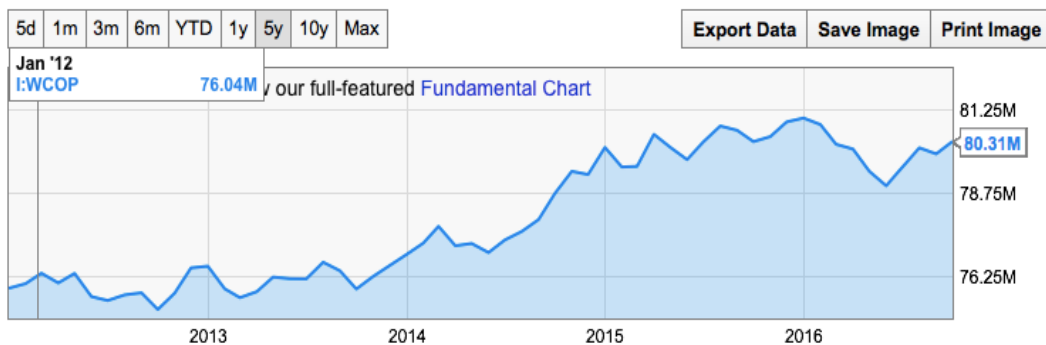
**Figure 6. Price and Production during the 2004 Phase Shift.** This chart illustrates the crude oil production (grey line) and its price (red line) over the 1998 – 2011 period. The distinct uncoupling of correlation between the production and (grey line), and less so for price (red line), is interpreted as an indication of a production peak because production was no longer able to match rising demand causing market uncertainty, that is reflected by higher and more variable prices. From Murray and King.<sup>16</sup>

During the plateau that followed the 2004 peak, the conventional oil supply was fluctuating and remaining around an average of 73 mb/d and conventional production was not meeting demand but was being incrementally augmented with the addition of US shale oil to balance demand growth (Fig. 7). In consequence, oil prices experienced extreme price fluctuations. As Figures 6 & 9 show, the oil price climbed from \$30 a barrel to a peak of over \$130 and then crashed back to \$35 in response to the 2008 economic crisis. During the recovery, the price reached another peak of over one hundred in 2011, and then slowly lessened, maintaining an average of around \$75 during 2004 to 2011.



**Figure 7. Total Crude Oil Production.** World crude oil production over the last five years (horizontal axis) from 2017; and the price per barrel indicated on the vertical axis from September 2016. Source: World Crude Oil Production, Historical data<sup>17</sup>.

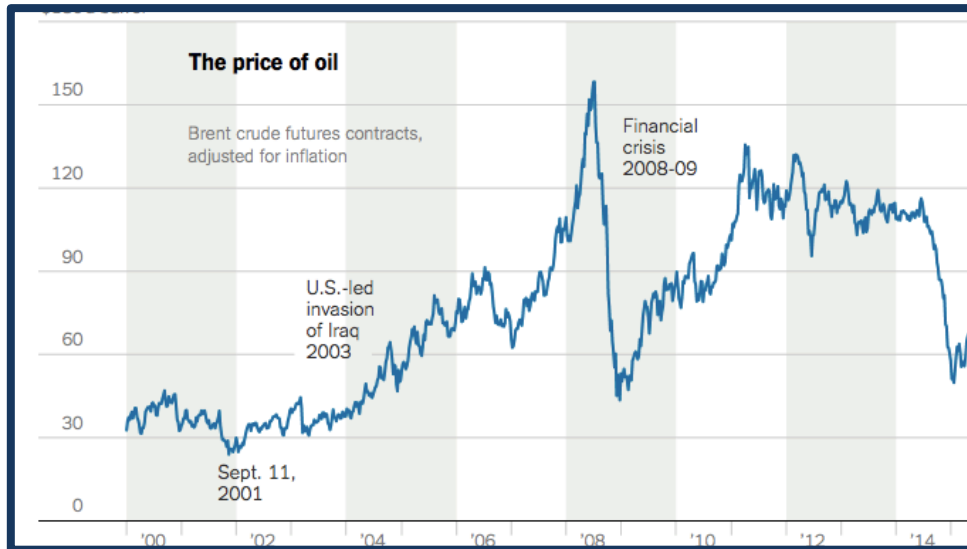
**5.4d. Another Shift and Plateau, 2014-2017.** The period of 2014 to 2017, began with an increase in production that grew to a peak in the first quarter of 2014 and continued to grow with intermediate peaks during 2015 until reach a final peak of ~ 80 mb/d in the first quarter of 2016, during the Financial Crisis. Notably, production exceeded demand throughout the entire period and accumulated stocks in 2016 (Fig.9). After the 2016 peak, production dropped to a mid-year minimum of ~ 79 mb/d and consumed the oil stock accumulation.



**World Crude Oil Production Historical Data**

**Figure 8. Total Crude Oil Production.** World crude oil production from 2000 to 2017 until reach a final peak of ~ 81 mb/d in the first quarter of 2016, during the Financial Crisis. Notably, production exceeded demand throughout the entire period and accumulated stocks in 2016. After the 2016 peak, production dropped to a mid-year minimum of ~ 79 mb/d and consumed the oil stock accumulation, indicated on the vertical axis from September 2016. Source: World Crude Oil Production, Historical data<sup>17</sup>.

At least two particular price events occurred during this second in production: the sudden 2014 price drop amidst high production, and the 2016 production drop amidst low prices. Variations in oil price (USD/barrel) before and after the 2004 to 2013 production plateau (Fig.8).



**Figure 9. Total 'crude Oil Price.** The total world price from 2000 to 2015. Note this chart extends that of Fig.6 to capture the timing of more recent events, for example, the huge price increase at the beginning of the Iraq War.

## 5.5 The Limits of Conventional Oil

**5.5a Problems and Questions for Managing Oil.** According to the US Energy Information Agency (EIA) 2017 Report, the 2014<sup>18</sup> price drop was due to a mixture of factors:

- 1) In 2014, global production began to surpass consumption. Consumption was leveling off after the rapid growth of emerging economies previous to 2014, notably Brazil, Russia, India, and China, the so-called BRIC countries. Meanwhile, oil production was increasing because nations like the US and Canada were increasing their shale oil production to avoid importing more expensive oil. Thus, a demand gap developed and generated surplus oil stocks. OPEC<sup>19</sup> refused to slow its production to bring it into balance with supply,

according to normal procedure, and in addition Iraq and Libya began to add their production. This surplus put pressure on other producers to cut their production, which did not happen.

- 2) In particular, the US increased its production of shale oil to take advantage of the combination of high production and high prices to generate more profit and to incite more investments in new technology for well expansions, as well as to encourage more financing.
- 3) Thus the three-year period of high prices before 2014 acted to weaken national economies, causing global demand to fall. Then, when global producers continued to increase production for profit, there was too much oil and too few customers, which caused prices to fall precipitously to \$30/barrel. (Fig. 23).

**5.b. What will happen after the 2016 peak?** To answer this critical question, several other necessary questions concerning oil management must be considered, for example:

- 1) Will the durability of the conventional-oil base and the reliability of unconventional oil and other supplements be sufficient and cheap enough to support inevitable increases in future demand?
- 2) Will the necessity of high prices set by producers not further increase economic inequality among nations?
- 3) With a reasonable risk that the answer to these questions will be negative, will nations be able to accelerate progress on a UN transition plan that integrates a common solution to both the Climate Change and Energy Crises?
- 4) Will Big Oil<sup>20</sup> invest in Renewables – yes, they have but it is only starting to get serious: for example, *“Exxon, Shell, and BP have announced initiatives to report the risks climate change pose to their business, bowing to shareholder pressure”*.

**5.5.c. Conventional Oil.** Because conventional oil has constituted roughly 90% of global production, there is reason for great concern about whether its current 2016 peak will continue as a plateau, and if not, what its depletion rate will be. Precise future forecasts for peaks in conventional oil are not yet possible due to the evolving geological, economic, and political uncertainties; the same is true for unconventional oil. However, forecasts are good enough to guide precautionary policy decisions in the short term. More accuracy in predictions requires greater clarity concerning the uncertainties of the three major limiting factors, geological, economic, and political, which are necessarily interdependent. These are

briefly described in the following paragraphs: *geological*, improving estimates of URR (Underground Reserve Resources)<sup>21</sup> and the depletion rates of post-peak wells; *economic*, estimating the buy-&-sell price limits in the global market that control the international trade of petroleum products; and *political*, projecting limits in national policies related to their objectives for economic growth, such as subsidies to support oil production, and/or related to their objectives such as reducing fossil fuel consumption, supporting energy efficiency, and transitioning to renewable energy as climate change solutions.

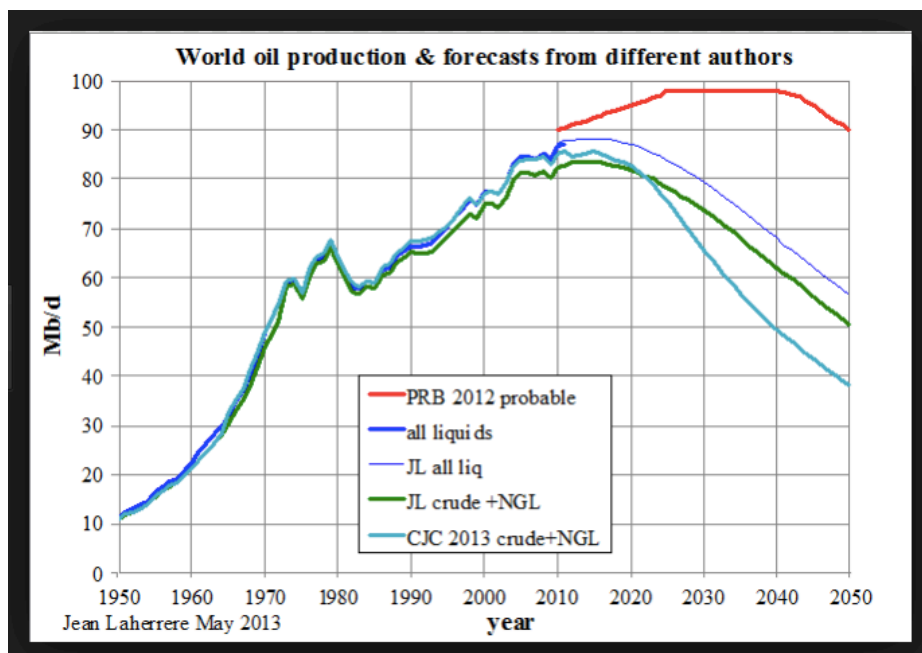
**5.5d Geological Limits.** Estimates and predictions of URR can be a valuable tool for managing the resource limits, as the Hubbert model proved. Certainly, modeling US conventional oil is a simpler case than modeling the future of the world's entire fossil-fuel resource. Current estimates of the global 'below-ground' resources of conventional oil have several uncertainties due to variability in estimates of the total 'below-ground' URR and of the timing of their peaks. Depletion rates of fields vary with differing geologic environments that are made difficult because not all national estimates are equally accessible for proprietary reasons. Depletion rates also vary with the mining efficiency used, and on the output demand, which is dependent on the variability in estimates of future consumption rates. These uncertainties somewhat circumvented by specifying the probability of a source being economically and technically feasible into three categories: 1P, proven at 90-95%; 2P, probable at 50%; and 3P, possible at 5-10%. Another URR uncertainty is the amount of expected discoveries, which currently turns out to be less significant, since the number of new oil discoveries peaked in the 1960s, with the exception of those found in horizontal extensions of existing fields and referred to as 'reserve growth'. Deep offshore fields hopefully will be preserved for present and future environmental and social concerns.

Current estimates of total fossil fuel reserves are influenced by the accuracy of reporting and the tendency on the part of many oil producers to report optimistic amounts. The crude-oil 2P URRs that are in a technically recoverable range from a half to two trillion barrels, with a 2015 estimate of 1.7 trillion barrels<sup>22</sup>. Without factoring in the inherent complexity, a mean consumption rate of 100 mb/d and a linear calculation with this URR, these 2P URRs would be exhausted after 27 years. Experiential evidence shows that post-peak decline rates are faster than the previously used linear rates, and that the price of extracting increases with resource depletion, both of which would act to reduce estimated lifetimes. On the other hand, such estimates represent only a small portion of the petroleum products tucked away in the earth's crust that are still not

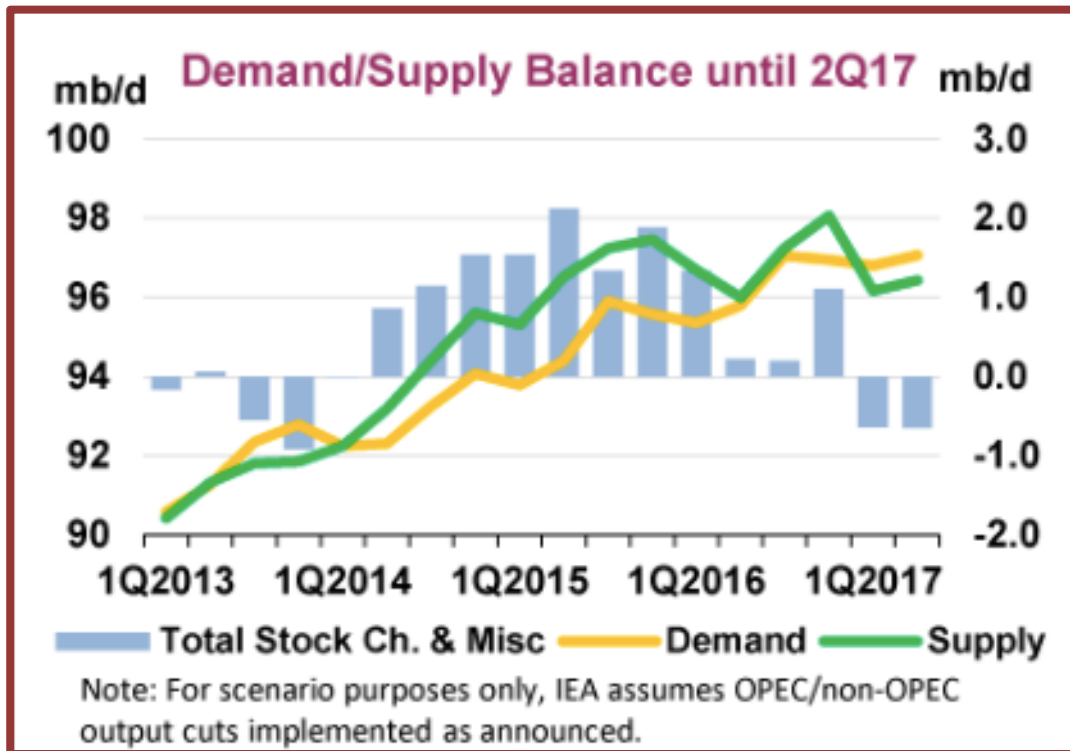


technically, economically, or politically available. The UK Energy Research Centre's exhaustive 2009 study<sup>15</sup> of peak-oil models from the period 1995-2005 indicated that the peak in 1P, proven conventional oil, would occur in 2013, and that there was a significant risk that conventional oil production would peak before 2020, or before 2030, and certainly . The indicators supporting this situation are, for example:

- 1) The peak of new (economically feasible) discoveries has already occurred, in the 1960s;
- 2) Many current conventional oil fields are already declining at 3-4% per year, and most untapped reserves are not economically feasible and/or would take a decade or more to bring online, and
- 3) These decline rates are much faster than the current business-as-usual global consumption rates, which are around 1.5% year and reaching up to 104 mb/d in 2030. Even though unconventional oil sources are still expected to close this growing gap between supply and demand for the next decade, but this has not yet been proven to be a long-term solution, leaving a considerable risk of being wrong. What has been shown is the emissions from proven reserves are more than sufficient at BAU rates to take atmospheric temperature past the 1.5% goal (cf. Fig.310)
- 4) For the of precautionary planning, it is critically important that oil companies and government agencies provide a range of best estimates of the optimum way to keep the gap from causing an economic collapse.



**Figure10. World Conventional oil production forecasts** all show a peak in production before 2020, except for the 2P reserves (red line). Estimates of these vary due to differing production. From Jean Laherrere. May 2013<sup>22</sup>



**5.5e. Consumption Limits.** The decline rates are faster than the BAU global consumption rates, which are around 1.5% year. In 2008, global oil consumption was 85 million barrels a day., and it is forecasted to reach around 105 million barrels per day in 2030 (Wiki). which would require the total potential production of 2018 plus estimated increases of around 35%% by 2035. As the rate of conventional oil production diminishes, a proportionate increase from amount must come from alternatives, namely, from unconventional and renewable sources.

According to International Energy Administration's Oil Report<sup>23</sup> as of 2017, world oil consumption was 86.4 mb/d and expected to rise to 99 mb/d. Assumptions about the nonconventional reserves and the economic feasibility of mining them. What is certain is that increasing consumption and continued depletion of conventional crude oil will increase the need for nonconventional oil and renewable energy sources. Present estimates of crude oil reserves technically recoverable range from a half to two trillion barrels, which would be consumed within 20 to 40 years at mean values of these consumption rates and reserves.

Because our economy is excessively energy dependent and our resource management style is demand-based (Chap.3.3), we are obliged to match the production with the growing energy consumption. Maintaining this balance constitutes a difficult challenge in that the dynamics between production and consumption are significantly different (cf. Fig. 11). While production depends on technical capacity, geopolitical availability, and on existing mining rights, the consumption depends directly on the number of consumers and indirectly on the means by

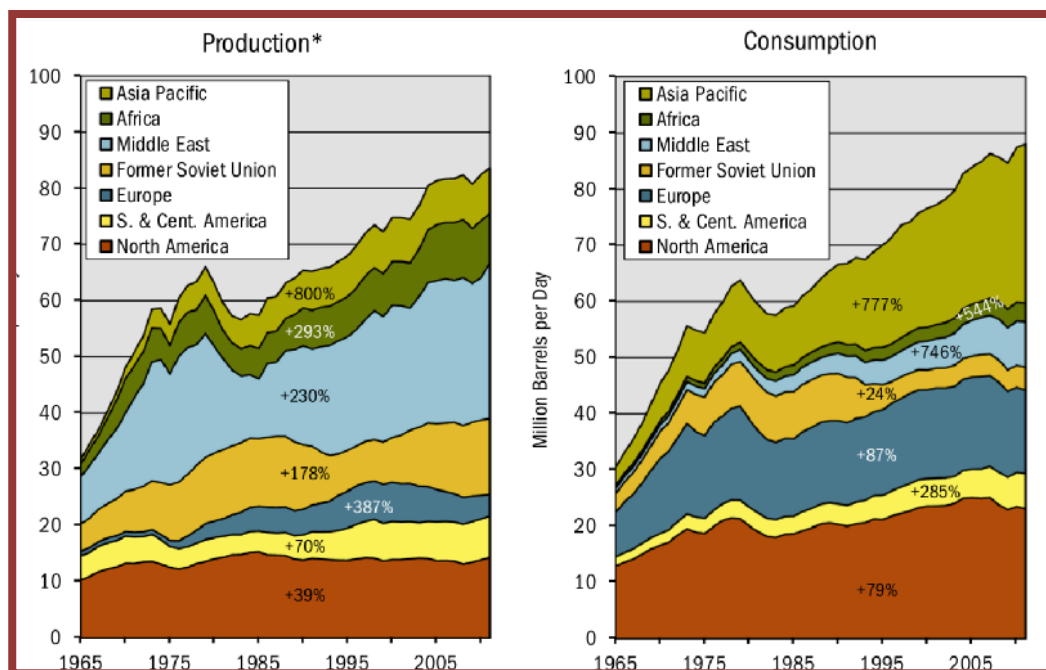
which consumers use energy. An additional difficulty for satisfying a sustainable energy-goal is the conflict with the economy that considers increasing production as a positive economic goal, and decreasing consumption as an economic deterrent and a social misfortune. With the global addition of ~78 million persons (population of Iran) per year, .The prospect of fossil fuel production meeting the expanding energy needs of developed and developing nations with their inevitably rising consumption is unlikely if, not critically dangerous.

**Figure11. Total Oil Demand & Supply from first quarter 2013 to first quarter 2017.** This chart portrays the changes in total oil production and demand over the four years from 2013 to 2017. The ticks on the bottom axis indicate seasonal quarters for each year. The left vertical axis is the total production in millions of barrels per day (mb/d). The right axis indicates the incremental changes for each quarter in relation to a base level of 94 mb/d. (Source: International Energy Administration) <sup>23</sup>

However, the decline rates of conventional are faster than the business-as-usual global consumption rates, which are around 1.5% year and reaching 104 mb/d in 2030. \The ability of oil/gas production to match consumption is controlled by two other dynamics, often described with the terms ‘tank’ and ‘tap’. The “tank” refers to the ultimate size of the resource whereas the “tap” refers to the rate at which the resource can be converted into useful energy and transported to a specific market. According to the analysis of Hughes<sup>24</sup> that: *“the global and United States energy taps are open very widely, whereas the tank of traditional conventional fuels is depleting rapidly. In 2015, the world was consuming 33 billion barrels per year. Notwithstanding, the issues with world conventional oil resource estimates discussed earlier, the tank would last just 39 years at current consumption rates if these estimates are correct, and a further 12 years if unconventional resources from Canadian tar sands and Venezuela extra-heavy oil are included. The life span of this oil tank will be much less, however, if the tap is opened yet further as forecasts of consumption growth suggest it will.”*

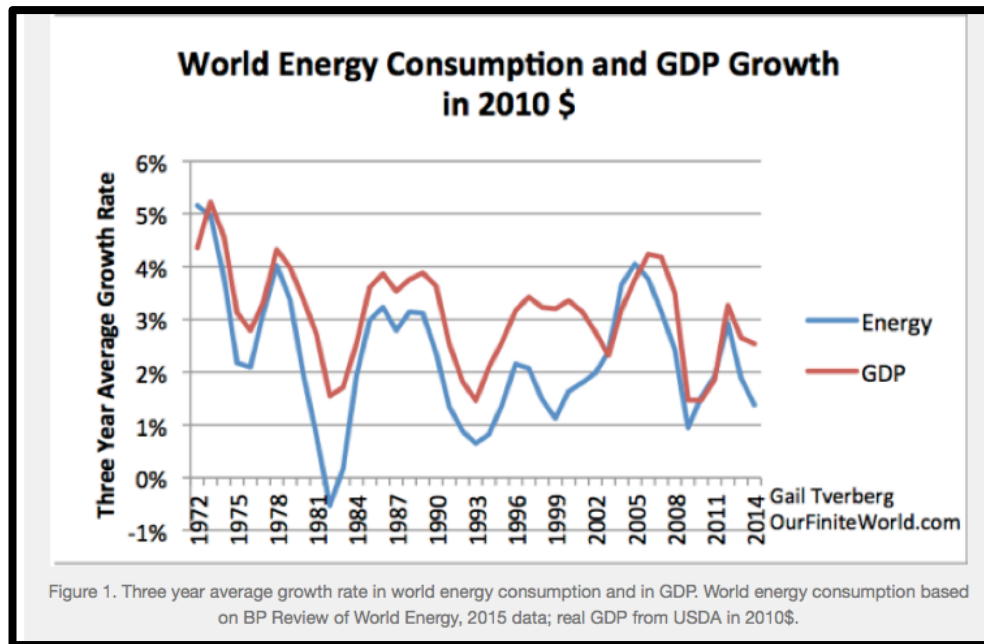
**5.4e. How much More can we Rely on?** Current estimates of total fossil fuel reserves (URR) are influenced by the accuracy of reporting and the tendency on the part of many oil producers to report optimistic amounts. The UK Energy Research Center<sup>15</sup> estimates of crude-oil 2P URRs that are in a technically recoverable range, are from a half to two trillion barrels, with a 2015 estimate of 1.7 trillion barrels. Without factoring in the inherent complexity, a mean consumption rate of 100 mb/d and a linear calculation with this URR, these 2P URRs would be exhausted after 27 years. Experiential evidence is showing that the post-peak decline rates are faster than the previously used linear rates, and that the price of extracting increases with resource depletion, both of which would act to reduce estimated lifetimes. On the other hand, such estimates represent only a small portion of the total petroleum products tucked away in the earth's crust that are still not technically, economically, or politically available. The UK Energy Research Centre's exhaustive 2009 study of peak-oil models from the period 1995 - 2005 indicated that the peak in 1P URR proven conventional oil would occur in 2013, and that there would be a significant risk that conventional oil production would peak before 2020, probably before 2030, and certainly before 2040. Indicators that support this situation are that:

- 1)** The number of new (economically feasible) discoveries had already peaked in the 1960s;
- 2)** Many current, conventional oil fields are already declining at 3-4% per year, and most untapped reserves are not economically feasible and/or would take a decade or more to bring online, and though unconventional oil sources are still expected to close this growing gap between supply and demand for the next decade, this has not yet been proven to be the case.
- 3)** For the purpose of precautionary planning, it is critically important that oil companies and government agencies provide a range management options to avoid a supply gap from forcing an economic collapse. Figure 13 illustrates the history of regional contributions to providing production to meet every growing consumption.



**Fig. 13. History of Global Production and Consumption by Region.** Production increased 163% in this period, and 1.3% from 2010 to 2011. Consumption increased 189% in this period, and 0.7% from 2010 to 2011. Global oil consumption has nearly tripled since 1965, as illustrated in Figure 13. Consumption has accelerated very rapidly in the developing world, particularly in the Asia Pacific, the Middle East and Africa. Although the Middle East and Africa are very large exporters of oil, the rapid growth in domestic consumption in these regions is providing limits on their ability to increase oil exports. Oil consumption in 2018 world totals are passing 100 billion barrels per year, up from 31 billion barrels per year. On an accumulative basis since the first oil well was drilled in the late 1850's through 2011, 90 percent of all oil consumed has been burned since 1960 and half since 1988. Source: Mother Jones. Hughes<sup>24</sup> \*This is higher in other data sources at ~ 38 billion in 1939, <https://transportgeography.org>

**5.5f. Economic Limits.** Gail Tverberg<sup>24</sup> has pointed out that oil cannot be considered a simple commodity in the supply and demand dynamic of a free market, because the consumption of oil is essential to the sustenance and function of our societies, to which there is no immediate alternative except to consume less, pay more, or do without. Co-existing uncertainties in the above-ground factors make the balancing of oil production and oil consumption more difficult in dealing with short-term fluctuations, but is insufficient for significant trends or large or sudden discrepancies that make it much more difficult to stabilize or to model longer-term forecasts.



**Figure 12 Correlation between global oil supply and US GDP.** The data are soothed with three-year averages so as to smooth the short-term fluctuations while preserving the times of the maxima and minima to elucidate peaks of economic growth and recessions with a narrow range in production or consumption. From Tverberg.<sup>25</sup> Data source British Petroleum

**5.5h. Variability** The fact that both production and supply are correlated implies that there exists a stabilizing (positive) and (negative) destabilizing feedback loops in the economic-geopolitical system of independent factors affecting both production and consumption. These feedback loops have differing intensities and time-responses that act as higher-frequency harmonics that modulate the energy-economy oscillation in production price. This time-cycling of economic decline and growth (Fig.12) in correlation depends on time-dependent factors such as oil price, mining costs, subsidies, international trade, government regulations, refinery shutdowns, reserves; consumption similarly depends on factors such as oil price, energy efficiency, international trade, consumer preferences, national debt, climate change, and so forth.

For stabilizing small discrepancies in the supply-and-demand balance, price adjustments and the use of reserve stocks can be sufficient . In fact, the purpose of stock reserves is to provide a quick supply when demand exceeds production and to store oil when demand is less than production thereby maintaining a fairly steady price such as existed during the 1998-2004 period shown above in Fig. 6. This mechanism can help to keep the price within a narrow range of fluctuations but is insufficient for

significant trends or large changes in production or consumption also shown in in Fig. 6.

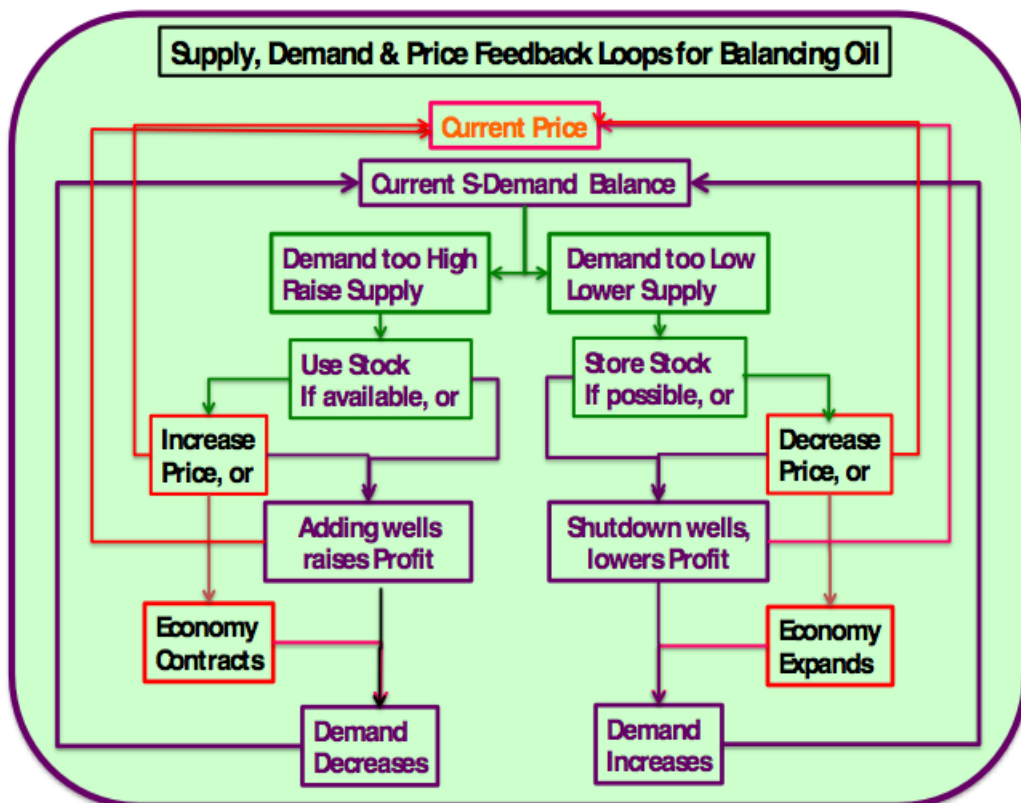
The fact that both production and supply vary implies that there does exist a stabilizing (positive) and (negative) destabilizing feedback loops in the economic-geopolitical system of independent factors affecting both production and consumption. These feedback loops have differing intensities and time-responses that act as harmonics that modulate the energy-economy oscillation in production price. This time cycling of economic decline and growth (Fig.12) in correlation depends on time-dependent factors such as oil price, mining costs, subsidies, international trade, government regulations, refinery shutdowns, reserves,, and consumption similarly depends on factors such as oil price, energy efficiency, international trade, consumer preferences, national debt, climate change, and so forth.

Simple manipulation of price, when assuming it to be an independent controlling factor, generates social side effects. The price varies with time because the variables of supply and demand also vary with time. For example, the supply can to lag directly with the management-efficiency of the wells-to-wheels time the time to; and with the slower to shut down and turn around oil wells. with the economy and consumer spending; Also it changes with the energy requirements of agriculture and of industry; with changes in policies on energy efficiency; and with response to climate change; and so on. An increase in oil price strongly influences the price of products and services that depend on oil, which forces consumers to cut their discretionary spending in order to spend less on other necessities, thereby weakening economic growth. On the other hand, a decrease in oil price stimulates consumer spending, and thereby strengthens economic growth and increases consumption. Increased consumption acts to habituate consumers to a life style of convenient energy inefficiencies, like not turning off the lights, or leaving the car engine running while stopped, that generate both material waste and energy loss.

As a result, changes in price have opposite effects on oil and the economy. oil prices over a significant period cause inefficiencies oil for companies to in adapting, for example, if the price is up they experience more profit allowing them they to expand their production. Contrarily, if lower oil prices continue over a significant period, oil companies gain less profit, requiring them to shut down some of their production so as to lower their maintenance costs. These two price scenarios may appear to be symmetric, but some of their impacts have a hysteresis in these impacts do not cancel out when the price returns to its previous value; for

example, high oil prices over an extended period can induce inflation across multiple classes of goods because energy and/or petrochemicals are involved in their production—food being a prime example.

These time dependencies need to be reflected in objective forecast models to be used by policymakers. Unfortunately, estimating the time dependencies affecting consumption and production is difficult and makes managing the oil price very tricky, especially on a global scale, where the goal is to manipulate these three variables so as to maintain a gap between supply and demand that is within a tolerable price range. Here, ‘tolerable’ implies enough elasticity in production or consumption to regain a balance, that is, achieving a price range that is a compromise between the oil companies’ need for higher prices and consumers’ need for lower ones. Fig.14 illustrates the feedback loops and interconnections needed to maintain a tolerable balance between supply and demand and thereby a price compromise that ensures only tolerable price swings in economic growth. Meeting this goal in the current situation of growing consumption, uncertain oil production, and insufficient energy alternatives will be difficult such that it will necessarily need the support of the best models, and more complete data, and require the best long-term policies that also include the redirection of government and private investments. to provide a more comprehensive guid for the energy transition away from fossil fuel to renewables and low carbon sources.





**Figure. 14. Dynamics Involved in Balancing Oil Production.** This diagram illustrates the major interdependent management options available to achieve a tolerable supply-and-demand balance for a tolerable price envelope. If the current supply-demand balance is tolerable, but the price is not, any change in price will influence the economy, consumption, and production. The same is true for any large changes in either supply or in demand, which adjust toward a balance. Obviously these actions necessarily must be coordinated by intelligent operators. For example, if current demand is more than supply (left side boxes), there are three options to improve the S-D balance:

- 1) Raise the price to decrease the demand (left side boxes);
- 2) Use reserve stock (green loop); or
- 3) Ramp up production (purple loop). Likewise, for the Demand case of being less than supply (right side boxes). (Author-generated)

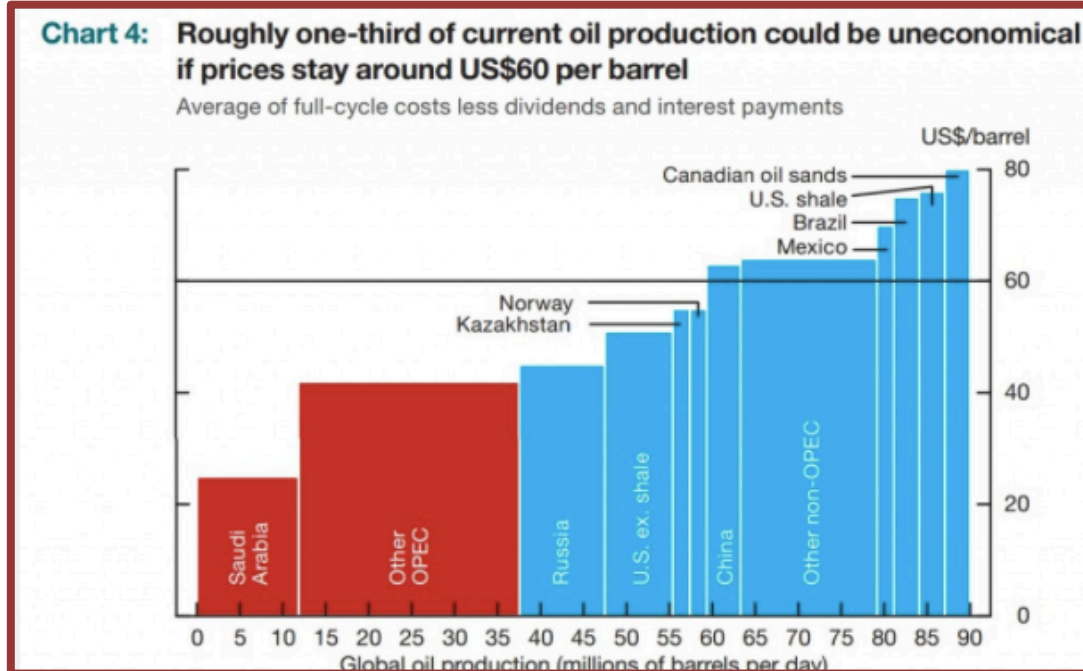
**5.5i. Diminishing Returns.** The fundamental reality of the impending oil crisis is supported by the ecological fact that a finite and diminishing resource requires increasingly more effort (cost) to reap a steady harvest in both quantity and quality. As one pursues more scarce distributions with more costly technology, a threshold is reached where the energy cost of continuing exceeds the value of the harvest. Economists often use the acronym EROEI<sup>26</sup> (energy returned on energy invested) to indicate the ratio of the amount of energy expended to acquire more energy, Sect. 4.5d. The basic difficulty of oil global pricing is finding an optimum price that is affordable enough to allow net oil-consuming economies to grow while yielding oil-producing countries high enough income to support increasing production costs.

Scraping up the last bad apples from the barrel?

The Bank of Canada Report<sup>27</sup> reads: “Based on recent estimates of production costs, roughly one-third of current production could be uneconomical if prices stay around US \$60 notably with the high-cost production in the United States, Canada, Brazil and Mexico. More than two-thirds of the expected increase in the world oil supply would similarly be uneconomical. A decline in private and public investment in high-cost projects could significantly reduce future growth in the oil supply, and the members of the Organization of the Petroleum Exporting Countries (OPEC) would have limited spare capacity to replace a significant decrease in the non-OPEC supply.” Figure 15 illustrates why this goal will be difficult.

**5.5j.** In the current period of uncertain geological limits to conventional and unconventional oil, oil companies are facing larger financial risks in responding to uncertain and sudden changes in the

Supply-&-Demand balance that are both expensive in labor and risky in timing. In responding the oil industries to, these changes will require additional funding, usually from investors who may be already hesitant to invest in depleting oil fields.



**Fig.15 Price limits for Global Oil Producers.** This chart compares the full-cycle (wells to wheels) price level at which oil production is no longer profitable for the country indicated. It underlines that are global oil production is past its peak, which may inhibit spending on of subsidies from national governments may be reluctant to increase their national debt. Source: The Bank of Canada Reports

There is the added risk that investing in a faltering energy resource that cannot reliably sustain the economic growth or the infrastructures on which a nation depends.. Well-intentioned attempts to develop poor nations that are oil-rich is also risky if their government are corrupt and the supporting infrastructure is weak, as was well demonstrated with the Chad-Cameroon Oil Pipeline Project<sup>28</sup>. In the long run, the most threatening risk is the probability that production will decline faster than alternative sources can help satisfy consumption. If such a situation would prevail it would precipitate a continually growing, unstoppable global recession and the consequent destruction of modern societies to which there will be no solution unless adequate precautionary measures have been taken.

Since OPEC production has sufficient elasticity to balance global demand and supply, it mostly manages pricing by raising or lowering the supply to meet demand. However, OPEC did refuse to slow its production

prior to the 2014 price drop to a low of \$30 a barrel, shown in Fig. 9. The current price “1Q17” has increased to about \$52/barrel, which was still below the price needed to keep all but OPEC, Russia, and US-Shale in profitable production (Fig. 15). The point is that the main non-OPEC producers have been forced to shut down the portion of their production that requires a price less than \$60/barrel. The lack of sufficient unconventional oil to satisfy the production gap will put a greater burden on OPEC to pick up the slack with oil preferably priced above \$100/b. This situation is compounded by reluctance to invest in future oil development, by the uncertain lag time and cost of bringing new fields, and by the increasing political (popular and legislative) urgency to cut the Total Cost that includes the associated environmental and social costs. Most importantly there is growing pressure to limit fossil to cut greenhouse gas emissions and air-pollution, as agreed by the 2015 Paris Agreement<sup>12</sup> (Chap. 1, A.2)

## 5.6 Will Unconventional Oil Solve the Energy Crisis?

This section describes additional reasons, why BIG OIL & Government should face the reality that conventional oil is becoming scarce and unconventional oil is becoming too expensive and too damaging, such that they should phase out expensive extensions and burn-down their ready reserves, which are more than sufficient to take us to a climate warming greater than our goal of 1.5°C; and involve themselves in the transition to sustainable energy, (cf. Chapter 1.A.2).

**5.6a. Changing the Mindset.** The recent boom in unconventional oil has appeared to be a milestone in the history of energy production and the oil glut that followed was heralded as a major step toward US oil independence. Instead, the fact that US and World resources of conventional oil have peaked or soon will not be able to provide the additional energy needed for growing economies, should have been a primary national and international concern. This is an Energy Crisis that is made more serious by coinciding with the Climate Crisis, and that if we fail with one it will make the other worse. Therefore, it is of dire concern that the public be well informed that the World, and the US in particular, are passing up their last chance “*to kill two crises with one policy*” for a

smooth transition to renewables. Instead the oil industries and the new US administration are focused on improving expensive extraction and transportation technologies, and on reducing restrictions that would permit them to mine 'unconventional oil' from here-to-for restricted areas, such as the deep offshore (oil company assets) on fracking for shale oil and natural gas (public and private property). From the point of view of Big Oil, the US unconventional oil boom seemed to prove to the public that they could still turn a profit, provide cheap oil, and negate the arguments that we should transition off of fossil fuel for reasons of resource limitation or climate change. Instead, the public should have been informed that this new supply has a very limited in duration, in profit, and incurs much higher environmental and social costs, cf. Sect. 5.6.

**5.6b. Can Unconventional Oil fill the Production Gap?** The seemingly ubiquitous geological distribution of thousands of sites with significant reserves of gas and oil have acted to reinforce the public's belief in oil's permanence and to dampen the perceived urgency to develop sustainable energy. Not surprisingly, just as the public was not being well informed that the world is passing an oil peak for conventional sources, we can anticipate that Big Oil will continue not to inform the public that unconventional sources are unlikely to satisfy our long-term dependence on fossil fuel or that we are using them at great expense to our environment and our society. For example, why are we building disruptive pipelines to transport our depleting oil and gas resources for export profit for to keep Big Oil in business, when we need to conserve what we have to ensure a successful energy transition? This and other issues, especially Climate Change, need to be thoroughly explained to the public and addressed by policymakers concerned with the exploitation of remaining fossil-fuel reserves and with their contribution to GHG (Green House Emissions)

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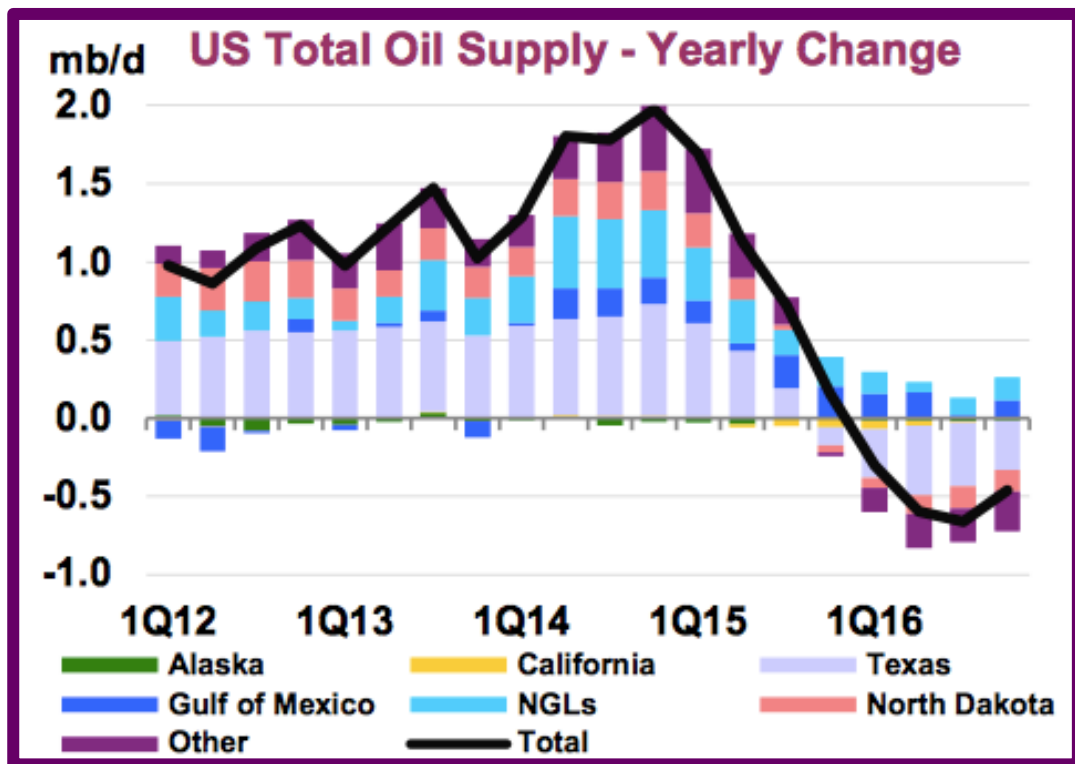
Like squeezing a sponge, the production rate diminishes with the remaining resource volume, and the consumption rate increases with economic growth, which causes Climate instability to increase and its impacts to increase. Hence, we are forced to find a long-term solution to this energy dilemma. Now that we have experiential evidence of the geological, quality, and cost limitations, we must address and plan on how we can address future energy needs. The financial costs of shale oil extraction and processing are up to ten times those of conventional oil. This, plus the shortness of mine-life, acts as a deterrent to the long-term investment needed to support the industry. Avoiding a global energy crisis would require an increasing supply of unconventional oil to fill the supply

gap. It would require sufficient renewable energy can be brought on-line. The fact that the geologic distribution of unconventional oil is vast tends to overshadow the fact that its mining costs will be extravagant and its energy quality low. The Alberta Tar Sands mine<sup>29</sup> is an inconceivably destructive example. Yet the oil industry is bent on pursuing more nonconventional oil, or extreme conventional oil that heretofore prohibited locations such as the Arctic National Wildlife Refuge or the Atlantic and Pacific coastal waters, in defiance of the “*law of diminishing returns*.” The conundrum is whether to pursue fossil fuel past its total-cost limit to the point of global collapse, or to pursue the inevitable transition to renewables as prudently as possible to achieve a sustainable level of energy use – that is the question. This is a make-or-break bifurcation point for the future of global energy. It is a question relevant for all nations individually and collectively, and not just a question for oil companies in a global free market.

**5.6c Other Rationales Supporting an Energy Transition.** The transition away from fossil fuel is already happening in reaction to the strong limitations of oil and gas sources with their increasing costs, and in reaction to the increasing technological improvements in the potential of renewable-energy and supporting policies that address climate change. These efforts can be viewed as temporarily mitigative steps because the transition of the energy infrastructure to renewable energy will require a much more comprehensive plan that includes energy efficiency and that minimizes the cost of waste and policy errors, in order to incorporate the future energy source under the umbrella-framework of Sustainable Development. This means that the transition must not and cannot continue to be done at the leisure of the oil industry and their benefactors. The current situation should be considered as an opportune entry point for policies that are guided by scientific and dedicated-political acumen to draft the transition plan and its implementation..The Transition Plan should be transparent and democratically supported. At the time of writing, as earlier noted, it appears that the new US administration is bent on dismissing this bifurcation point and accelerating a business-as-usual (BAU) approach in the wrong direction!

**5.6c. Maintaining the Balance?** As described in the last section, a constant supply of energy is essential to avoid large swings in the product’s price and economic stability. Conventional oil comes from large-volume sources that can have fairly steady production rates despite their slow depletion rates, although their supply to the market can fluctuate significantly due to geopolitical constraints and disruptions in delivery. This latter characteristic is worse for unconventional oil, because unconventional sources are clusters of multiple small sources, each of

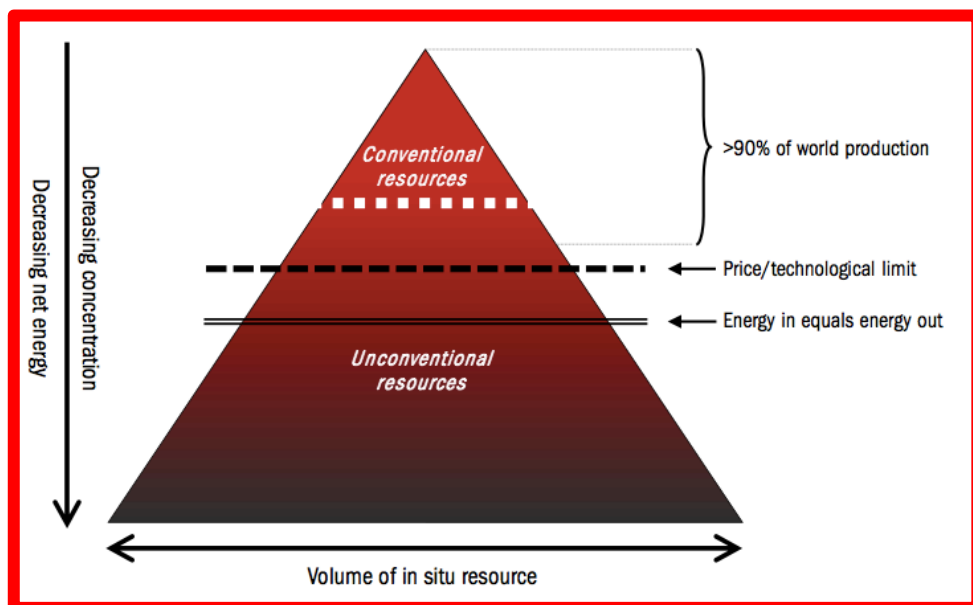
which have much shorter depletion rates; also, that make long-term predictions less dependable. For example, individual fracking wells have high depletion rates “ranging from 79 to 95 percent after 3 years”. A few of the larger shale US oil sites were assumed to have depletion rates of a decade or more but the performance of wells in 2016 has not yet substantiated this going into 2017. For example, the US Energy Information Agency reports<sup>18</sup> “that across the country’s seven largest shale deposits oil production are expected to fall to 5.2 million barrels a day next month, the sixth consecutive month of decline and a six percent drop since April. The fall marks a dramatic turnaround for a U.S. oil industry that had almost doubled its production since 2010. Through the use of advanced hydraulic fracturing and horizontal drilling techniques, drillers had accessed deposits long known by geologists but thought too difficult and expensive to drill” Fig. 16 illustrates the recent decline in a number of US shale oil fields.



**Figure 16. Recent Changes in US total oil supply.** Quarterly changes in total supply (millions of barrels/day) are shown 2014 to 2016. The colored bars indicate the major shale oil fields. This reflects the sudden decline of a number of shale oil fields, but it does not reflect the total potential production. (Source: IEA)<sup>18</sup>

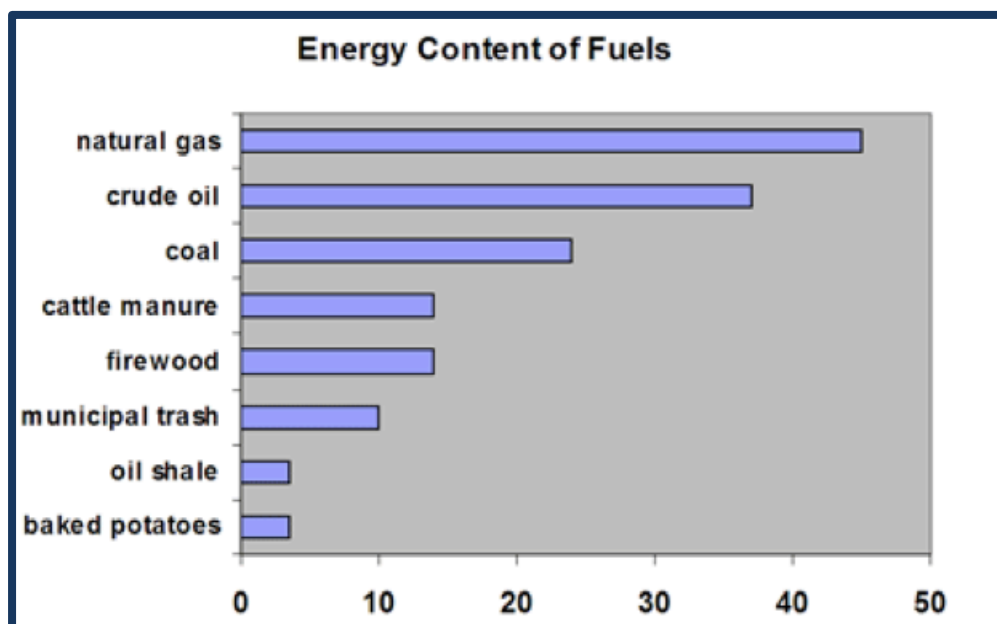
However, assuming that global production is not depleting, and that consumption will continue to rise at its current rate of 1.2-.1.5% per year or a total change of 30% by 2040, we would still have an inequality problem that would divide the world's nations between those that have oil or can afford it and those nations that have not and/or cannot afford it. The positive side of this consumption problem is that those nations that are not rigidly linked to fossil fuel can leap-leapfrog their energy source to directly renewables sources and lower their demand through increasing their energy-efficiency practices.

**5.6d. Financially Viable?** Large capital investments and subsidies are required to develop new discoveries and provide the necessary infrastructure for unconventional oil, and they still have to overcome aboveground obstacles. Investing the supporting infrastructure can be risky and expensive. This is because the unconventional oil sources are geographically scattered, so that extraction sites can interfere with other land uses, such as housing, agriculture, public parks, and water supplies. In addition, there are transportation costs and legal fees for public-domain rights that are different from and more expensive than those related to conventional-oil sources. The footprint left behind from an unconventional mine often creates large impacts on the local ecosystems and communities. The costs of undoing unproductive sites should be included in the total-cost equation. Thus, the insurmountable issue is that the financial value gained by the petroleum industry through the process of acquiring, mining, converting, and transporting unconventional oil to market at a financially viable rate is insufficient to offset the large environmental and social costs affecting the public.



**Fig. 17** The pyramid illustrates the relationship of in-situ resource volumes to the distribution of conventional and unconventional accumulations. The cost of recovery is inversely related to the concentration and the energy quality of the resource Image Source: Hughes, 2013<sup>24</sup>

The EROEI<sup>26</sup> is a complicated calculation, and results depend on the grade (energy quality) of the source and on the technologies used to get it to market. The two main parameters are the accessibility of the source and the energy used in the production process. This is depicted in Figure. 17 by a pyramid, where the bottom of the pyramid portrays a large volume of dispersed sources that are expensive and/or difficult to recover, whereas the conventional sources are highly concentrated and less difficult to recover. Thus, the extraction of conventional sources with high EROEI are significantly more cost-efficient than those from unconventional sources, like tar sands, that have a very low EROEI or those like fracking for natural gas, mining for coal or uranium that can have higher EROEI ratios from a purely financial-cost point of view, but from a total-cost point of view the EROEI estimates would result in much lower ratios, if the related environmental and social costs were considered. The EROEI for conventional oil is approximately ten times that for shale oil, which compares with that of a baked potato (Fig. 18). The EROEI for Tar Sands is almost zero, that is no return gain.<sup>24</sup> These differences are due to the large quantities of energy needed to process oil shale combined with the thermochemistry of the retorting process, which also produces more carbon dioxide and other greenhouse gases than the production of conventional oil. Consequently shale oil, unambiguously results in more greenhouse gas emissions than conventional liquid fuels from crude oil. The question is: why are we using tax-payers money to pay for very low-EROEI sources that bring little financial gain and generate severe long-term environmental damages, together with long-term, costly social impacts?





**Figure 18. Energy Returned on Energy Invested.** The bar graph compares the net energy content of various combustible sources. This is expressed as the EROEI ratio of the energy returned on energy invested. A ratio of one means that for every barrel of oil produced, one barrel is consumed, i.e. no profit. (Source: Cleveland and O'Connor)<sup>26</sup>

**5.6e. Changing the Mindset.** The recent boom in unconventional oil has appeared to be a milestone in the history of energy production and the oil glut that followed was heralded as a major step toward US oil independence. Instead, the fact that US and World resources of conventional oil has peaked or soon will be unable to provide the additional energy needed for growing economies, should have been a primary national and international concern. This is an Energy Crisis that gets little serious public discussion of its existence or how it coincides with the Climate Crisis, and further that if we fail with one it will make the other worse. Therefore, it is of dire concern that the public be well informed that the World, and the US in particular, are passing up their last chance *“to kill two birds crisis with one stone”* for a smooth transition to renewables. Instead the oil industries and the new US administration are focused on improving expensive extraction and transportation technologies, and on reducing restrictions that would permit them to mine unconventional oil from-former restricted areas, such as the deep offshore (oil company assets) on fracking for shale oil and natural gas (public and private property).

From the point of view of Big Oil, the unconventional oil boom seemed to prove to the public that oil industries could still turn a profit, provide cheap oil, and smother the arguments calling for an immediate transition off of fossil fuel for reasons of resource limitation and climate change. In addition the, public should have been informed that the public is paying for this new fossil fuel expansion, that it will a very limited duration, and it will generate much higher environmental and social public costs.

## 5.7 Environmental-Social Limitations.

Note, some of the citations cited in this section are quoted from US Environmental Protection Agency reports before the 2016 election and the subsequent reversals of EPA policies starting in 2017, when the new administration cancelled many policies and implemented other one contrary policies; these are identified by 2017, and previous ones with 2010 or 2016.

**5.7a Destroying Natural-Capital Function.** Environmental problems caused by unconventional fossil energy sources are significantly more

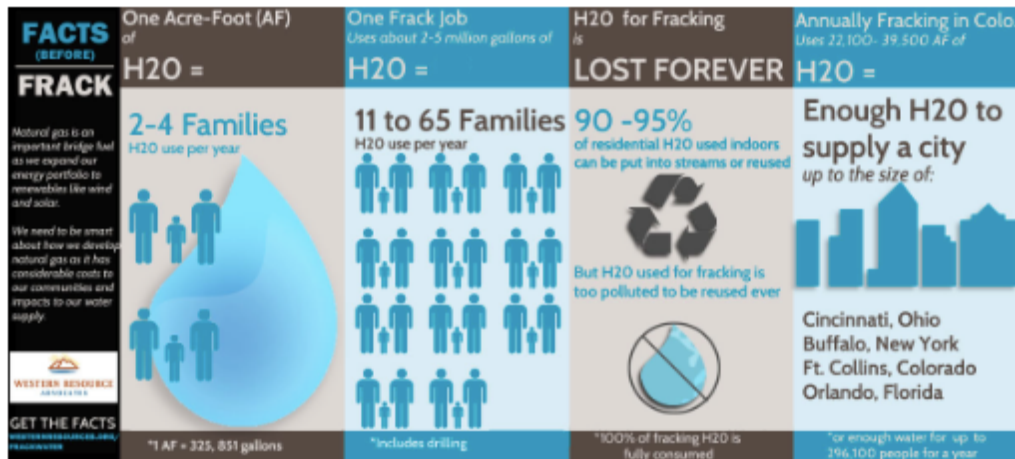
ostly than by conventional oil, and they are not well reflected included in the market price of the energy product, nor considered quantitatively by governments in forming policy. For example, 2005 exclusions to the Safe Drinking Water Act of 1974<sup>30</sup> have allowed the fracking industry to continue practices that can pollute or render unusable ground water, for example by:

1. Permitting underground injections of wastewater;
2. Creating underground natural-gas storage volumes that can leak
3. Using any fracking fluids (except diesel fuel) for mining gas or oil regardless of whether it jeopardizes local drinking water, private wells;
4. Fracking in earthquake sensitive protected public areas.
5. Occupying or destroying farm land and degrading valuable ecosystems..

Many of these practices can gain exclusions under what is known as the “*Halliburton Loophole*<sup>31</sup>”, and they have freed the oil industry from being sanctioned for grave abuses concerning freshwater use and contamination. The following description of impacts briefly explains some of the more complex socio-environmental issues related to the fracking process.

**5.6b. Water Use.** Both the fracking and shale oil mining processes consume and contaminate large quantities of water. The water issues include the amount of water that is used, its source, its disposal, and its contamination during the gas-fracking and shale oil extraction processes. An estimated one to five barrels of water are required per barrel of oil produced<sup>32</sup>. The fracking process used removes water from its normal hydrological cycle and causes the industry to compete with other users that withdraw water for domestic, agricultural, and industrial purposes and for sustaining local ecosystems. In water-scarce areas, mining threatens the very viability of these other users. The average fracking-well uses about 20,000 m<sup>3</sup> (5.2 million gallons) over its lifetime. As an example of competition with domestic use, Western Resource Advocates<sup>33</sup> estimated that Colorado’s statewide fracking water use was up to 27.5 million cubic meters, equivalent to the domestic use of 300,000 persons, which is about 6% of the state’s population of 5.2 million. This comparison is made worse by the fact that normally about 90% of water used for domestic use is reused on locally to replenish the underground aquifer, whereas about 90% of the fracking wastewater is transported away from the local area or buried deep underneath the site. Neither the amount of leakage to surface groundwater nor its chemical mixture used in fracking are sufficiently known, for proprietary reasons (another part of the (*Halliburton Loophole*)). As a result, the risks to health cannot be accurately evaluated. Groundwater depletion occurs when the

withdrawal rate exceeds the local recharge rate by surface rain. Over-pumping of surface aquifers leads to loss of moisture in the vadose, zone above the water table, which then leads to soil compaction. The more the compaction, the greater the surface runoff and the less the amount of ground-water recharge, a vicious-circle process that leads to desertification.

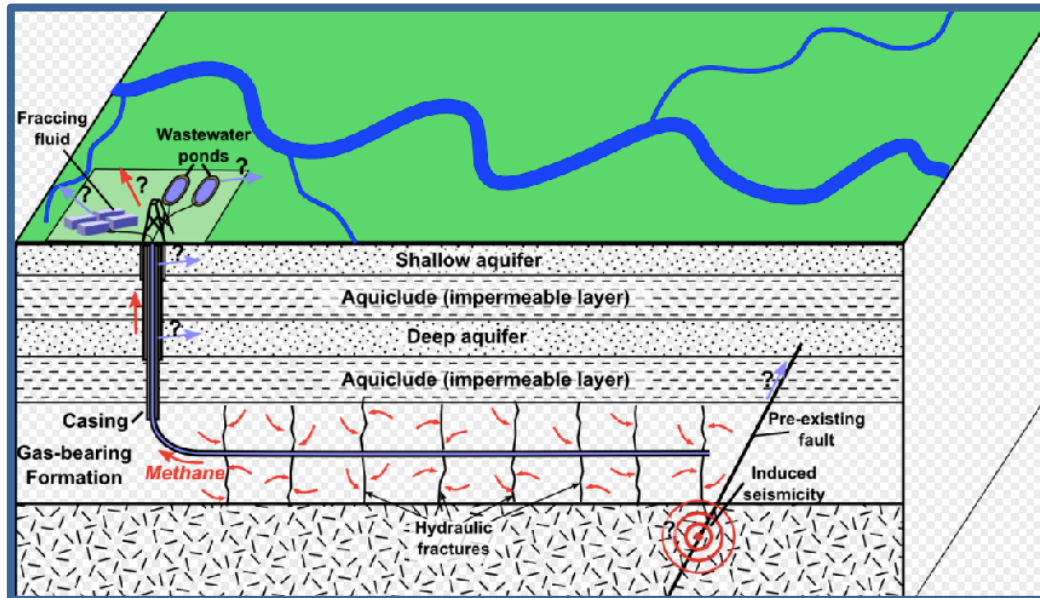


**Figure. 19. Water Consumption for Fracking.** Illustration of the amount of water required for an average fracking well (2-5 million gallons) and the high (>95%) amount of water annual water is removed from its local origin circulation – roughly equivalent to that needed to supply a medium-sized city.<sup>33</sup> desertification and can preclude aquifer recovery on a human time scale.

**5.6c Water Contamination.** Besides competing for water use, with the local population, the fracking process acts to contaminate local waters. Hydraulic fracking uses water as a medium for releasing natural gas that is trapped in deep layers of kerogen shale. The mining process necessitates construction of a vertical well down to the shale layer and then horizontal entry into that layer. By injecting water under high pressure that contains sand and chemicals, the shale formations are thus fractured and remain open long enough that the gas can migrate out toward and up the vertical well (Fig. 20).

The fracking industry has revealed some, but not all, of the chemicals mixed into the fracking water that contribute to a potential health risk for the public. Most of the wastewater is trucked out of the area. Some of the wastewater is pumped back to deeper-than-surface layers, and some is reused. An average fracking well returns about 60% of the water to the surface as wastewater, where it is disposed of in collecting ponds, pumped back underground, or trucked to some another location where it

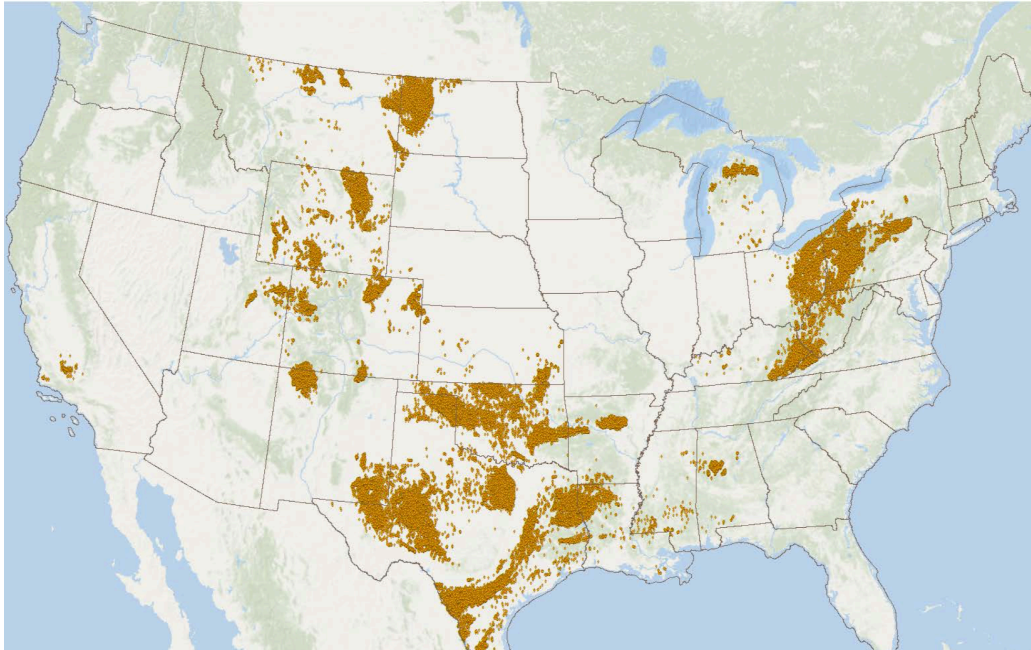
becomes someone else's problem. The US EPA 2010<sup>34</sup> reported that by 2010, 35,000 fracked wells had used 105 billion gallons of water, equivalent to the annual consumption of 60 cities each with a population of 50,000.



**Figure 20. Schematic Cross-Section of a Fracking Site.** Water and chemicals are forced into the gas-bearing shale formation to allow methane to seep back into the well casing (red arrows). The process can trigger seismic activity of a pre-existing fault in the vicinity. Figure from Wikipedia, *hydraulic fracturing*.<sup>35</sup>

**5.6d. Gaseous Emissions and Water Pollution.** During the fracking process, a portion of natural gas escapes and becomes a contaminant of drinking water and the atmosphere. Despite the oil industry's professed intent to keep the fracking water and the methane contained, leaks of water and methane remain common. Leakage into local water sources is combustible and poses a risk fire and explosion. Several studies conducted in Colorado<sup>36</sup>, Pennsylvania<sup>37</sup>, and Texas<sup>38</sup> on air and water pollution and on desertification as a result of fracking. The studies have summarized their main concerns of how local residents were experiencing health symptoms from exposure to the contaminants used in local drinking water and from air pollutants, and that continuing gas and oil development without full precautionary measures is causing a serious public health risk. On a larger geographic scale, Evans and Kiesecker<sup>39</sup> have undertaken a broader study of the Marcellus Shale Play that extends through six states in the Central Appalachians from northeastern New York to West Virginia that hosts ecosystems and the drinking watersheds for the mid-Atlantic population. At the time of their

study there were 10,419 wells (Fig. 22) To put these watersheds at greater risk, current development scenarios are considering over 100000 new well pads! This is just a sample of the 1 million wells planned or operating for the future.



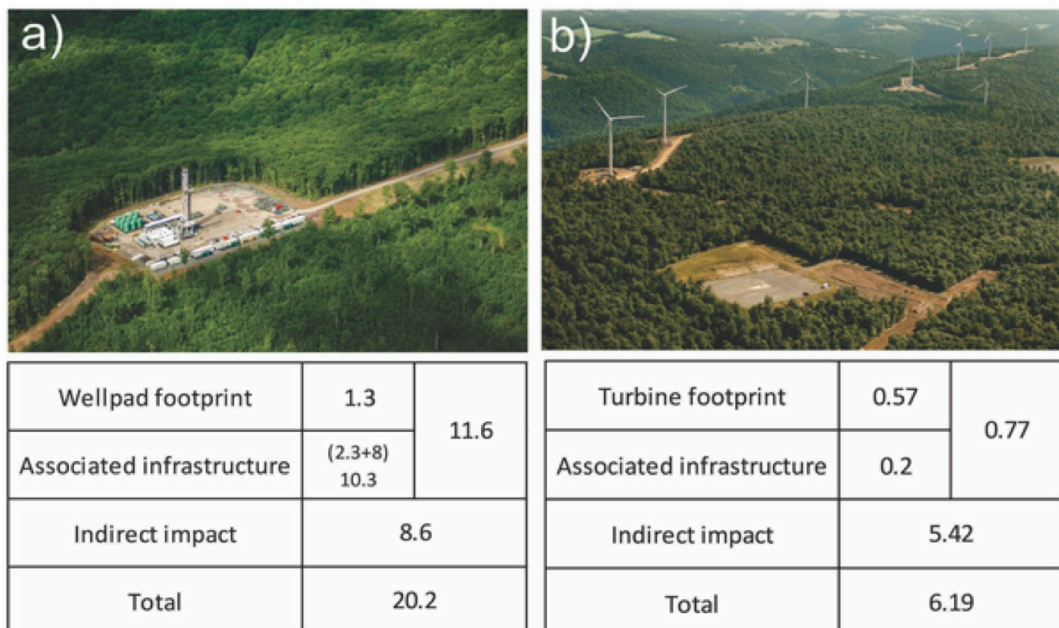
**Figure 21. Locations of the US national well data.** The map shows over 1.1 million active oil and gas wells in the United States, indicated by orange dots. Many of the Texas wells are not shown because FracTracker was unable to publish the data from the State. Figure source from FracTracker Alliance <sup>39</sup>

In addition, significant quantities of methane are emitted into the atmosphere from shale gas development. An estimated 12% of total production leaks into the atmosphere. The study covered the full life cycle from well to delivery to consumers, according to recent satellite data. The U.S. Environmental Protection Agency 2010 reported on the first update on emission factors for greenhouse gas emissions by the oil and gas industry by the EPA since 1996. This same report concluded that fracking gas production emits more fugitive methane (in GHG equivalent) than conventional oil and coal mining combined. On a life-cycle of well-to-wheels, the greenhouse gas emissions of the tar sands extraction process are three to four times those for the extraction of conventional oil; a large portion of these emissions take place during transportation from the mining site to the final user. R. B.W. Howarth<sup>40</sup> quotes that estimates of methane leaks, along the natural supply chain, range from one to ten percent of the volume of natural gas produced, which is more than three times the average EPA estimates, and indicates that shale gas may have a

greater greenhouse gas impact over the short term (40-50 years) than coal does in the production of electricity. Even this may be underestimated due to the amount of natural gas flared off and uncontrolled leaks, such as that from the 2016 California Aliso Canyon methane leak<sup>41</sup> from an underground storage facility, which is estimated to have had a larger carbon footprint than that from the Deep-Water Horizon leak in the Gulf of Mexico.

**5.6e. Surface Land disturbance.** In addition to competing for water use, the recent advent of mining of shale formations for fossil fuel products has become an invasive competitor for land use. The physical disruptions caused by drill pads, roads, mining pits, and pipelines are destroying the viability of ecosystems and the productivity of agricultural lands. The industrial footprint of truck traffic, compressors, and rigs in built-up areas with fracking and shale-gas extraction is also significant. By law, all USA tar-sands operations must be reclaimed eventually, but the proportion that actually has been reclaimed after more than forty years of operations is minuscule. Disruption from the land-use point of view is much greater for fossil fuel than for renewables. Evans and Kiesecker<sup>39</sup> reported on a comparative study of the use fracking and wind energy productions in the Marcellus region along the Appalachian flanks where the surface footprint of the fracking pad was over three times that of the wind turbine Fig.22., whose runoff of pollutants, sediments, and impacts on biodiversity are not visible.

Figure 2. Photographs of shale gas footprint and wind farm footprint.



**Figure 22. Impact assessment of Fracking & Wind Turbine Sites.**

Photographs of shale gas a) footprints and wind farm footprint b) in the upper left corner of the photograph. The inset table represents associated impacts in hectares used in the analysis. Differences in other non visible impacts are reviewed in the PLOS article.<sup>39</sup> To put these watersheds at greater risk current development scenarios are considering over 100,000 new well pads! This is just a sample of the 1 million wells planned or operating for the future..

**5.6f. Earthquake risks.** The fracking practice of injecting a pressurized water-chemical mix into a shale layer normally produces only insignificant tremors in the land surface. However, the practice of injecting fracking wastewater at deeper levels (1-3 km) leads to larger and damaging earthquakes. Using a network of seismometers, the Arkansas Geological Survey<sup>42</sup> demonstrated a direct correlation between deep wastewater injection near Guy, Arizona and the subsequent earthquakes in the local area of magnitude 3-5 on the Richter scale. Nearly a thousand quakes were recorded during the ensuing several months and public officials closed the injection wells. Such susceptibility depends on the deeper hydrology and aquifers, implying that considerable monitoring and mapping must be done prior to opening a wastewater deposition site. The costs of the earthquake damage are externalized and not considered in the specific economic valuation of fracking for gas. These environmental damages and disruptions are quite expensive, and are labeled as external costs that much of the time are not correctly included into cost-benefit analysis that should be comprehensively made by policy makers.

**5.7 Is Governance Ignoring the Oil Crisis or- -?**

What was considered a birthday gift to drive the engines of our societies over the last century is now becoming an unattended death knell echoing the lesson, "*Do not build a civilization on a single nonrenewable resource*", as have many of the great preceding societies ignored until too late.

**5.7a. Maintaining a Balance.** As discussed, because our economy is excessively energy-dependent and our resource-management style is Demand-Based instead of Resource Based where in we are obliged to match energy production to a growing energy consumption. Maintaining this balance constitutes a difficult challenge in that the dynamics strongly differ between production and consumption. While production depends on technical capacity, geopolitical availability,

subsidies, existing mining rights, consumption depends directly on the number of consumers and indirectly on the energy efficiency employed by those consumers. Our current economic goals are contrary to satisfying a sustainable energy goal. That is, our current economy is one that that measures increasing energy consumption as a positive economic indicator and decreasing energy consumption as an economic deterrent and social misfortune. This presents a conflicting momentum that must be overcome in order to arrive at a consentient sustainable-energy plan, that would increasing energy efficiency and a stable level of social wellbeing as a positive indicators. At the global level, continued support for increased consumption by the richer nations, the global increase of consumers (of another 80 million people - the population of Iran) every year, and the expanding consumption of developed and of developing nations, the prospect of maintaining enough cheap fossil-fuel production and continually balancing consumption is unlikely in the near future as well as critically dangerous to the earth's climate and population

The strategy for a Sustainable Society is to approximate the population size that allows maximum resource utilization (per capita wealth) without irreversibly damaging the carrying capacity of the supporting natural systems. This limit is difficult to define because of technological advances that change the limit on one hand, and cultural changes that impede a clear public vision on the other hand. It would be better to err on the side of less consumption and less people-- given that consuming less might lessen of a chore than raising babies.

Of the two options for maintaining a supply & demand balance: that of increasing production is more simple and feasible to implement, but it is more costly and dangerous, as the cause of Climate Change. Instead of political support for a transition to Sustainable Energy, the US government is increasing the use of fossil fuel, despite that it is depleting and costing more to mine without a concern for climate change, public health, and other externalities. Continuing with a business-as-usual (BAU) plan that supports growth in fossil fuel production, and it takes only a nod and a wink to gain financial support (using taxpayers money) from a sympathetic government with of a sense patriotic rationale for providing national security and stimulating economic growth. By expanding fossil fuel, they are in fact ignoring the inevitable energy gap between a depleting, and increasingly expensive resource, and a continuously growing consumption; and thus are putting the world at a far greater geopolitical risk than would a plan that cuts consumption. CO2 emissions, and its capture.

,



On the other hand, reducing consumption is not just a simple matter of money and politics but a complex change in societal behavior towards social responsibility, corporation, energy-efficiency, sustainable lifestyles that act to preserve fossil-fuel reserves, reduce GHG emissions, ease geopolitical conflicts, put renewables on a fast track, and increase carbon-capture practices, all of which would free up billions of tax-payer dollars, create far more jobs dispersed among more sectors, than would that of hanging on to the BAU Plan for increasing fossil-fuel production and its distribution infrastructure. Either Plan (BAU or Energy Transition) will be socially painful - but *it's better to be smart and safe than dumb and destroyed*.

Although unconventional fuels will be a necessary supplement to the declining conventional oil and gas reserves needed for the energy transition, they are simply not scalable to provide the levels required by forecasts that use BAU consumption rates, which vary in time significantly. Furthermore, the low net energy yields, short lifetimes, increasing extraction costs, large government subsidies, increasing destructive impacts on the availability of water for domestic use, agriculture, and ecosystems, on public health, and most of all on climate change, make the government subsidies to expand or even to maintain Big Oil poses an extreme risks for the stability of Environmental, Social , Financial Capitals.

**5.7b US Political Problems.** President Obama announced his Clean Power Plan<sup>43</sup> (CPP) on 3 August 2015, and it was largely applauded throughout the US and received with great relief by UN member nations as signaling a long-awaited leadership by the US for international action on Climate Change. However, the Conservative Party of Congress immediately opposed the CCP on the grounds that the EPA does not have the legal authority to implement it. The controversy continued until February 2016, when the Supreme Court ordered that the EPA halt its enforcement in response to the request of 27 states and various fossil-fuel companies and business groups that claimed regulations on emissions would have devastating impacts on their state economies. This attitude took another wrong turn when the new US president, declared Climate Change a hoax, and completely forbid any government activity or document to mention.

In opposition to Obama's CCP, President Trump has proposed a plan that would empower states to construct new coal fired plants and reduce the emission standards for coal-fired power plants. This differs from the CCP directive, which was to facilitate retirement of old plants, and to

reduce emissions by having utilities promote energy efficiency or build renewable power projects involving sources such as natural gas, sun and wind, of the Obama administration's signature climate policy. The Trump plan, which is projected to release at least 12 times the amount of carbon dioxide into the atmosphere compared with the Obama, plan despite the scientist's warning that the world will experience increasingly damaging effects without severe cuts in carbon emissions. By 2030, according to administration officials, Trump's proposal would cut CO<sub>2</sub> emissions from 2005 levels by between 0.7% and 1.5%, compared with a business-as-usual approach. Those reductions amount to an equivalent of taking between 2.7 million and 5.3 million cars off the road. By comparison, the Obama administration's CCP would have reduced carbon dioxide emissions by about 19% during that same time frame. That is equivalent to taking 75 million cars out of circulation and preventing more than 365 million metric tons of carbon dioxide from entering the atmosphere. Source Mother Jones <sup>44</sup> Data from International Monetary Fund.

**5.7c. Can we afford to be indecisive?.** We cannot yet estimate the costs of continued negation on these two crises until they are behind us, and we are not reacting quickly enough to lessen the growing costs of the damaging climate impacts. With regard to climate change, the current US administration is committing Type I errors by refusing that humans have created these climate change impacts, when in fact science has confirmed that they have, and that they are increasing. By rejection the science, we are making a fatal Type I error, that is, to assume that humans can fix these climate impacts more cheaply as they occur than to 'wait and see' if or when they lessen while not understanding that many of which are irreversible on a human timescale, for example, we have no technology and not enough money to solve the problem of lowering the sea level after the polar land glaciers melt and slide into the south-going Labrador Current, along the US Eastern seaboard, and who knows, to the help chill the flooding the state of Florida. We don't yet know the time line and costs of such scenarios. But we do know costly are the hurricanes which are short and disastrous to the coasts where they strike the coast. Figure 22 illustrates an example of the monetary costs due to Hurricanes.

With regard to the energy crisis, the US is committing another egregious Type I error by accepting the hypothesis and that we have enough oil to provide low-cost energy for several decades, when in fact scientific and economic evidence now suggests much shorter time limits for unconventional oil and higher cost limits. President Trump's continuation of obstructive policies are jeopardizing our window of opportunity the tide of the most important irreversible climate impacts, such as the melting of polar glacials, sea level rise, ocean acidification,

desertification, loss of agricultural land, its biodiversity, and a host of social sector impacts. Figure 22 gives an example magnitude of the costs incurred due to eleven major hurricanes from 2004 to 2012 that can jeopardize the stability of global economies and create unprecedented external costs.

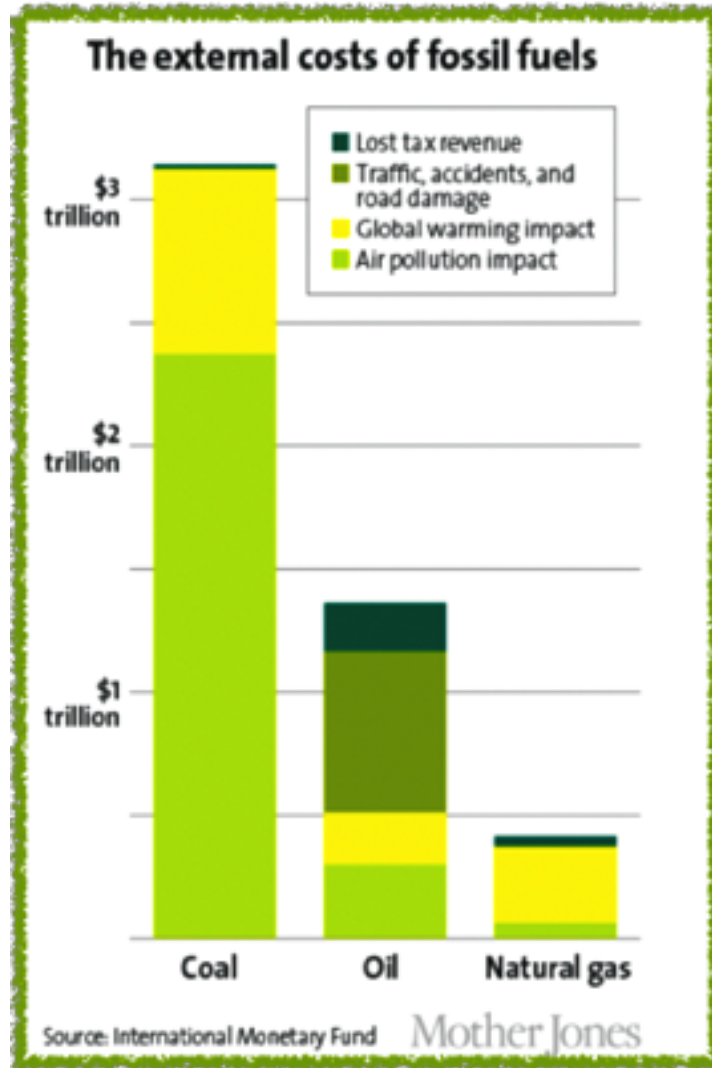
**Costliest Hurricanes to Hit the U.S.**  
Insured Losses in Billions

Hurricane	Year	Category	Deaths	Insured Losses	Total Losses
Katrina	2005	3	1,322	\$62.2 B	\$125.0 B
Ike	2008	2	170	18.5	38.3
Andrew	1992	5	62	17.0	26.5
Ivan	2004	3	125	13.8	23.0
Wilma	2005	3	42	12.5	22.0
Rita	2005	3	10	12.1	16.0
Charley	2004	4	36	8.0	18.0
Irene	2011	1	55	5.6	7.4
Frances	2004	2	50	5.5	12.0
Hugo	1989	4	116	5.1	9.6
Sandy	2012	1	117 (in U.S.)	\$35.0	70.0

**Figure 23.. Tabulation of Costs and Deaths** of 12 recent US Hurricanes. Just one example of the financial/human costs of Climate Change over the entire planet.due greatly to air pollution and to the impacts of CO2 emissions. From From Mother Jones<sup>44</sup> & International Monetary Fund.

**5.7d.Externalities.** The costs of damaging environmental or social are like side-effects and they often are not compensated, or not considered when evaluating health factors, policy changes, and so on, as shown in Figure 23. These costs can vary significantly when they are not evaluated thoroughly for reasons such as legality, property, safety, pollution, and poor due to their chemical composition. The fact that climate-change impacts have a wide spectrum that it affects directly or indirectly in varying intensities and the way it changes is not strictly linear in time making forecasting and planning even more complex and uncertain, when evaluating future costs for decision making. Given a history of good data these uncertainties can be lessened by computer simulation models..

For example, they should be used with a cost-benefit-analyses of all the externalities for the purpose of planing, new construction, production, transportation, coal for their energy source. The externalities caused by the oil industry are calculated by the industry and compensated within the governmental subsidies, which in turn are taxpayers' money.

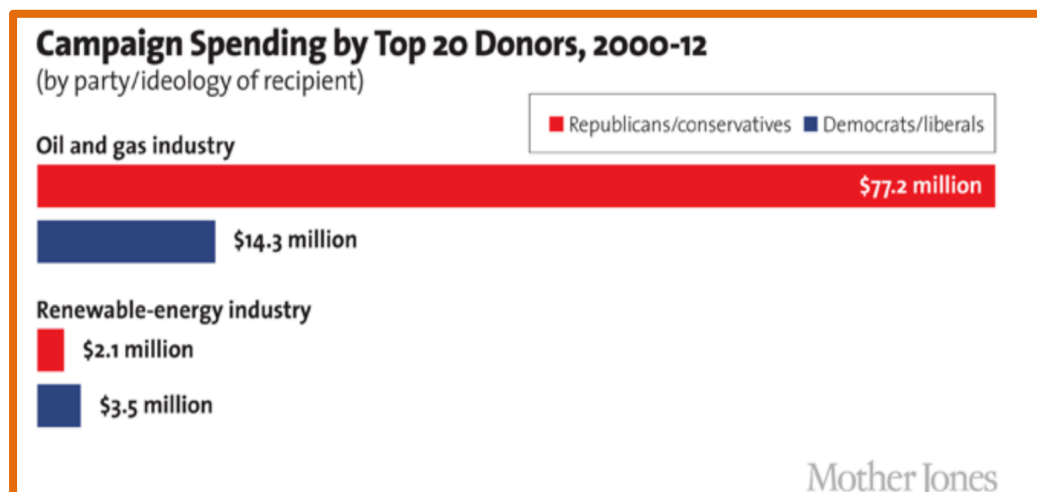


**Figure 24. Three Important External Fossil Costs** These of each of the three fuels have global costs in the trillions of dollars to social capital (Box Insert). Another important fact shown is the environmental-social damage caused by the combustion of coal is ~8 times greater than for coal than for natural gas, due their different chemical compositions.<sup>45</sup>

## 5.8 Is Ignoring the Oil-Climate Crises Logical?

Readers, please note that not all the cited monetary figures are concurrently available, in the same year, or estimated by the same methodology, and sometimes contrary.

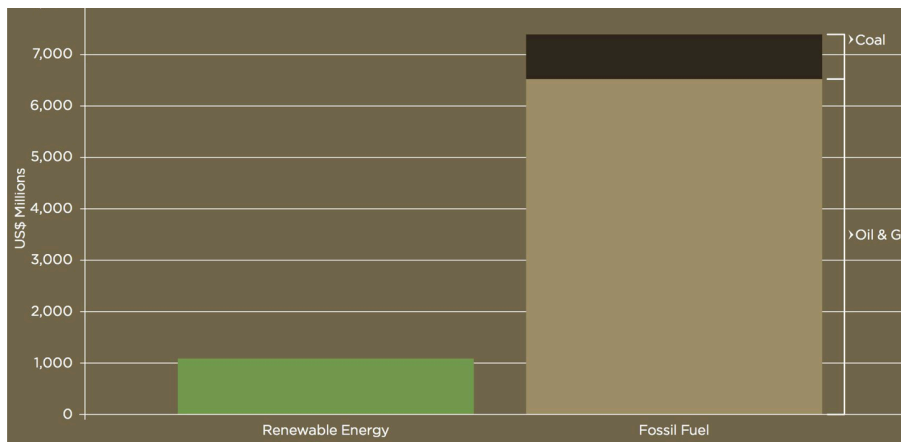
**5.8a. US Partisan Divide and its Marriage to BIG OIL.** A good majority of Americans accept Climate Change as real, but many lack the conviction to the degree of preventive action. The members of Congress members likewise are slow to react accordingly or to deny its existence, for seemingly ignorant or selfish reasons, such as lobbying-pressure, investments, and political beliefs. Figure 24 illustrates this partisan divide by comparing the difference in Party campaign spending between the conservative and progressive parties. This political division on Climate Change and fossil fuel-use has wavered but not significantly changed much, until the wider media like Al Gore's 2006 film "*An Inconvenient Truth*", which unfortunately spawned a lot climate deniers. and false news since Hubbert's warning-peak in the late seventies, until the more intense environmental events, the indecisive 2018 election, and Trump's rejection of the Paris Agreement, recent Climate related events and to the 2016 Election.



**Figure 24. Unequal Campaign Funding.** The dominant difference is mostly due the ideological differences and to Big Oil's mutualistic 'revolving door' where Big Oil wants policy support for subsidies, and politicians want financial campaign support for their elections. Graph from Mother Jones<sup>46</sup>

**5.8b Are Extravagant Subsidies and Tax ‘Breaks Justified?** It does appear so, for BIG OIL and the US administration, who are deaf to arguments for a sustainable future for all, choose to have a short economic orgy for a few. The Trump administration is continuing the permanent tax breaks for oil and gas companies up to 88% of all federal energy subsidies.<sup>47</sup> Taxpayers Currently Subsidize The Oil Industry by as much as \$20 billion a year, with about a half of that going to the BIG Five: ExxonMobil, Shell, Chevron, BP, and ConocoPhillips. - oh, yes, and a billion going to renewables - See Figure 26.

The permanent tax breaks locked into the federal internal revenue code favor the fossil fuel industry over those for renewable energy. The Oil Change International Report, entitled “Dirty Energy Dominance: Dependent on Denial ‘47,” lays out a comprehensive analysis of federal and state subsidies supporting the production of oil, gas, and coal. The analysis highlights some \$14.7 billion in annual federal subsidies and \$5.8 billion for a total of \$20.5 in yearly state-level incentives.

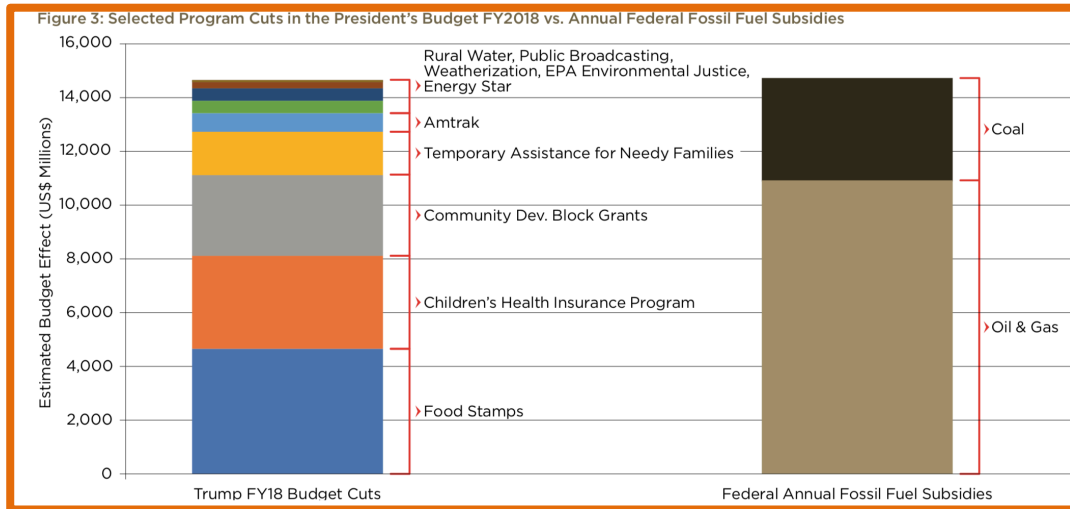


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**Figure 26. Permanent Tax Breaks for Fossil Fuels, FY2016** Tax Breaks for oil and gas (on right) compared to tax breaks for Renewable Energy (on the left).

The Trump tax plan, 2017) just approved by the Republican Party lays bare that, protecting American families and funding an energy transition is not as important to the current leadership Washington as handing out tax breaks to their corporate cronies instead to social programs (Fig. 26). Just eliminating the oil and gas subsidies would save the U.S. government on the order of \$20 billion every year<sup>48</sup>. To make

matters worse, replacement funding for these tax breaks are proposed to cut from the \$14 billion scheduled for Social Programs (cf. Fig. 27).



**Figure 27. Funding Fossil Fuel with Cuts from Social Programs.** The chart shows the selected social budget cuts (left bar) that in Trump’s FY2019 budget cuts to pay for Fossil Fuel subsidies (right bar). From OCI\_US-Fossil-Fuel-Subs-2015-16\_Final\_Oct2017.<sup>48</sup>

**5.8d. Where is the leadership for these Crises?** One might question why are governance doesn’t transform our consumptive economy to a sustainable economy that helps us preserve the remaining energy reserves for future generations and helps us transition to renewable energy sources? For example, Trump’s negativity has been extremely detrimental in regard to the climate and energy crises, and in his unwillingness to assist in national or global leadership. His rejection to act or recognize these issues is made worse by the loyal support from a Congressional majority for whom climate-change denial has become an article of faith and a polarizing litmus test that indicates the level of will or not for action on this double global crisis. Instead, his leadership is pushing for maximum exploitation of fossil-fuel reserves, and or eliminating regulations that lessen climate change. His proclaimed goal is for energy dominance with fossil fuel. The following sections demonstrate examples of this inverted leadership employed through subsidies and deregulation in negation of the Climate and Energy Crises.

## 5.9 International Denial?

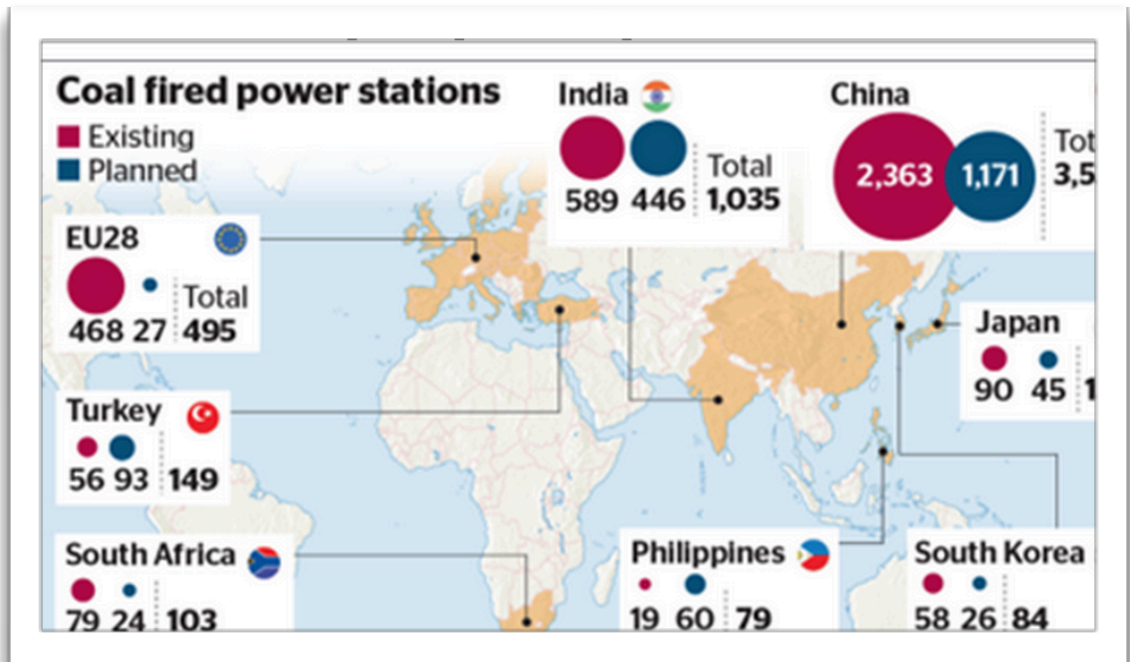
**5.9a Lack of understanding and political smarts?** Why, for example, are some nations backing away from the Paris Agreement by rationalizing illogically that if energy consumption grows then the economy and technology will allow fossil fuel to grow past its limits. Note that this rationalization is contrary to the ecological law that too much cheap energy eventually smothers or destroys a species' niche or an ecosystem's sustainability. This happens because a system that exploits cheap energy induces energy inefficiency, produces waste, and weakens the function of system making it vulnerable to losing its niche and to extinction. Climate Change is an excellent example of this law. For this reason we need to appreciate the large difference in energy efficiency between the types of energy sources, For example, vehicles using fossil fuel are only ~25% efficient and produce heat, air pollution and climate change; Whereas those using those using electricity are 70% efficient, produce only 20% heat, and are a more useful form of energy.

As if to prove otherwise, the Environmental Group 'CoalSwarm'<sup>49</sup> reports on a Chinese irreconcilable approach to Climate Change by which they are halting plans for over 100 coal fired plants this year (good), while China's energy companies are using satellite images to demonstrate that construction is well underway on 1,600 new coal plants (bad), in 62 nations, with a total capacity of 259 GW. CoalSwarm said the "commissioning of these coal plants would leave China with 1010 GW of operating coal capacity in 2045, the same year it had committed to have phased out coal energy to meet its Paris climate goals"!

Even clean-coal and carbon capture technologies would these new plants would not be successful enough, in terms of reducing CO<sub>2</sub> emissions, to compete with the low-to-zero level emissions of other energy sources such as nuclear, biogas, solar, hydrogen, and hythane. . The 1,600 new coal power plants were discussed in terms of the costs of externalities in Sect.5.7d. Figure 28 illustrates the extent of the coal-plant expansion that China and India are planning to install in 62 nations. This project is in obvious negation of the Paris goals, This case is made worse because of the striking difference in how much more polluting are coal fired plants, especially those emitting 'black carbon' than are natural gas natural gas plants (Fig. 24). The need for comprehensive cost-benefit analyses is certainly obvious and should be imperative for each and all of

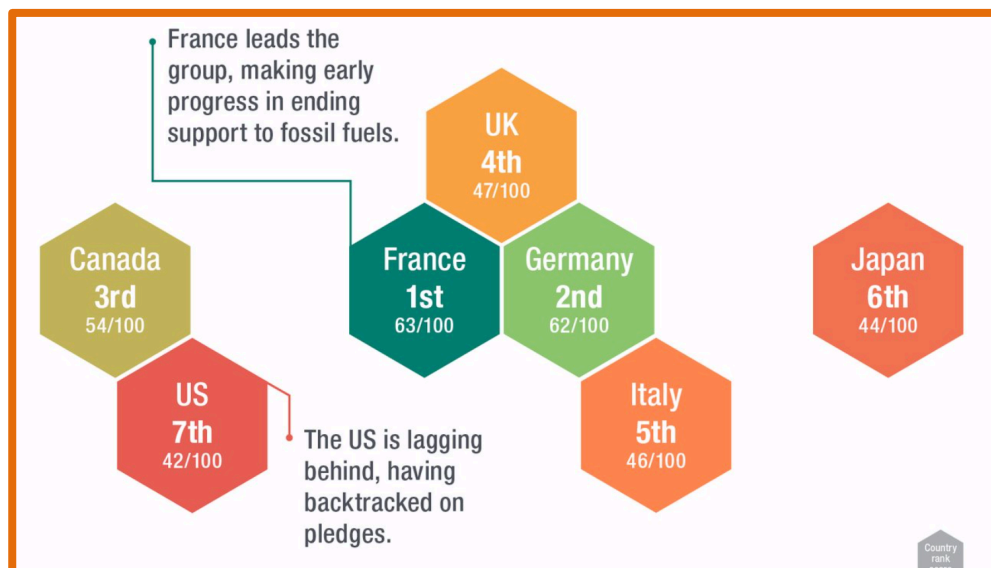


these plants; as discussed in Section 5.7c. One doesn't need a computer model to estimate that the resulting external costs of such a project would greatly exceed the benefit gained for the nations or the world.



**Figure 28. The Locations of the 1,600 Coal Fired Power Plants** that are planned under construction by Chinese Coal Industries in planning to install 62 nations over the next decade, in obvious negation of the Paris emission reduction goals.<sup>12</sup>

Another example of US non-cooperation with the Paris Agreement is its performance on phasing out fossil fuel subsidies. In this regard, the Oil Change International reported that France was the best and the US is the worst. Figure 30. Thirty G7 nations are falling behind on their emission reductions. Source, the Oil Change International June 26, 2018 Report <sup>52</sup>.

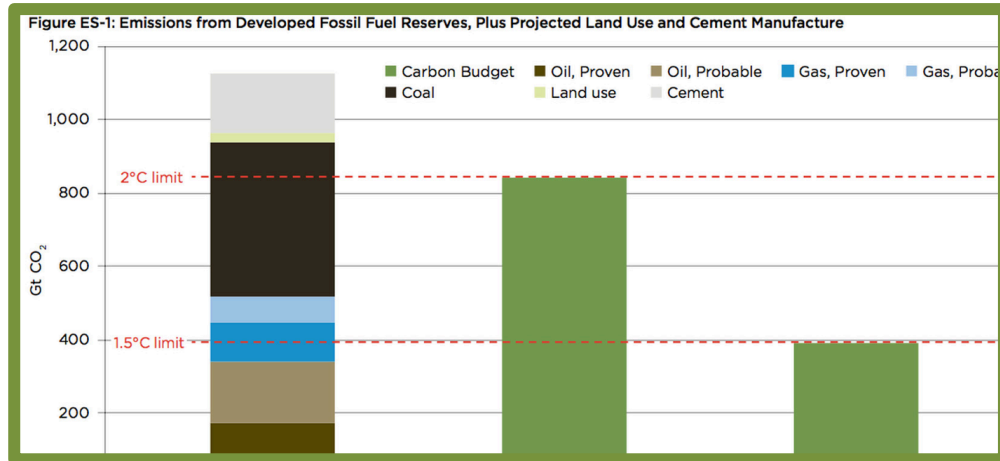


**Figure 29. Thirty G7 nations are falling behind** on their emission reductions. Source, the Oil Change International June 26, 2018 Report <sup>52</sup>

**5.9b. Is the Oil Industry Selfish or Deaf?** Obstructing a long-term plan like the Paris Agreement, accepting campaign funding from BIG Oil directly through campaign donations, and indirectly by lobbying for tax breaks favorable to fossil fuel, are sabotaging actions very destructive for the US & Global present and the future. They are wasting more money than we can afford and they are spending it in the wrong direction! To make the present US situation worse, there is no allocation or mention of Climate Change in the US Budget FY 2018. The EPA budget was cut from \$8.2bn to \$2.6bn. Funding instead comes from a number of US states, through institutions both national, international, and from individual donors.. Rightly, Climate change should come under the funding category of Nation Security, since it has the potential to damage the entire nation and to seriously impact the functions of Social and Environmental Systems.. In contrast the 2016 Obama budget pledged \$3bn to Green Climate Fund<sup>53</sup>. The GCF is working with 76 international projects to avoid 1.3 billion tonnes of CO<sub>2</sub> and to increase the resilience of over \$200 bn.

Meanwhile, the Rystad Energy Reports<sup>53</sup> on its reassessment of the “total global oil recoverable oil resources at 2.2 trillion barrels, or 73 times the current annual production rate”. This translates to approximately 70 years, using the current consumption rate. This estimate includes the “*Unconventional oil recovery that accounts for 30% of global recoverable oil resources, while offshore accounts for 33% of the total. As much as 40% of the recoverable oil requires oil prices higher than \$80/barrel to become profitable for the oil companies*”. These figures are a dangerously misleading estimate because it considers only the geological limits and not the price limits of production, growth of consumption, or the costs of externalities, and especially that of Climate Change, and not-to-mention large global inequalities in energy, and because it feeds a false hope for the Climate deniers. Source: Rystad Energy, International Energy Agency (IEA), World Energy Council, Intergovernmental Panel on Climate Change (IPCC).

**SURPRISE!** The recent research by Oil Change International<sup>54</sup> “*found that too much oil, gas, and coal production is already potentially locked in (invested) for governments to achieve the Paris goals. The oil, gas, and coal in fields and mines that have already been built – where the up-front capital is already invested – are sufficient to take the world 1.5°C goal and beyond the 2°C Celsius of warming*”, as shown in Figure 31, and especially that of climate change.



**Figure 31. More oil Than We Need Now!** On the left are global developed fossil fuel reserves available, expressed as gigatonnes of carbon in the atmosphere. The two solid green columns on the right indicate the carbon budget in gigatonnes. Figure from Oil Change International<sup>54</sup>

**Note, 'Carbon Budget'** is used to indicate the amount of carbon dioxide emissions we can emit while still having a likely chance of warming to a specified temperature Celsius. In this case, the two temperatures specified, 1.5°C and to 2°C are marked with red dotted lines .

The good news for climate because it means we could (should) begin phasing out fossil fuel and stop all extensions. However, The first to reject this blessing will be (or are already) the politicians, investors, oil and others who have economic connections with fossil fuel, and have continued to oppose a transition. The US climate-change funding was cut completely from the FY2018 budget. This led a number of European countries to increase their climate funding, and Bloomberg Philanthropies to pledge \$15 million to make up for the US shortfall. The US Federal budget also ignored the Intergovernmental Panel on Climate Change (IPCC), and provided no funding for the UN Framework Convention on Climate Change (UNFCCC ): These highly respected bodies, are responsible for synthesizing the-state-of-the-art of climate science and policy guidelines, which the US previously enjoyed US government funding.

**9.9c. Subnational Efforts - Building Coalitions..** The role of subnational actors could grow further still in the coming years - and they can link independently with international partners and be strong supplement, when the US returns to climate policies that are synchronized with the UN global. Climate is a global crisis that necessitates an all-hands-on-deck approach. The Green Climate Fund<sup>55</sup> is the largest and newest international climate fund receives no US funding. The Obama Administration pledged \$3 billion to the Fund in 2014, paying two \$500

million installments in 2016 and 2017. This leaves \$2bn still due, nearly 20 percent of the fund's \$10.3bn in total pledged. Federal-level policies that harness the leadership and unique strengths of local actors can help drive greater emission reductions than would otherwise be possible, and potentially even greater economic growth and other benefits. Briefs of some examples of Building Coalitions of cities, universities and businesses—such as:

**1) Renewable Energy Buyers Alliance** with the goal to help **energy buyers** purchase 60 gigawatts of new **renewable energy** in the United States by 2025. Ready for 100 campaign—to establish firm commitments and work with state public utility commissions and other decision makers to source electricity from renewable sources.

<https://www.linkedin.com/company/rebuyers>

**2) Expanding networks like the Science-based Targets Initiative<sup>57</sup>** in order to lower emissions across supply chains. Already, 74 U.S. companies representing a combined market capitalization of more than \$2.6 trillion have joined the initiative, which encourages companies to set emissions-reduction targets in line with what the science says is necessary to limit warming to 1.5-2 degrees C (2.7-3.6 degrees .[www.carbontrust.com/Science-Based/Strategy](http://www.carbontrust.com/Science-Based/Strategy)

**3) Gore's Climate Reality Project.** Our Mission Is To Catalyze A Global Solution To The Climate Crisis By Making Urgent Action A Necessity Across Every Level Of Society. The Climate Project is an educational, worldwide grassroots organization that trains volunteers to give public talks focused on the harmful effects of climate change and ways to address climate change at the grassroots level. The Climate Project is an educational, worldwide grassroots organization that trained volunteers to give public talks, similar to Gore's presentation in the film (Inconvenient Truth). Following their training, Leaders join a global network of over 15,200 activists from 141 countries (nearly 14,000 at the end of 2017) on the frontlines of the fight to expand renewables, cut emissions, and increase sustainability around the world. <https://www.climaterealityproject.org/>

**4) 350.org** is a successful advocacy group for preserving fossil fuel in the ground, reducing carbon emissions to zero, and to transition to a clean—energy economy. It has built a very large global grassroots climate movement to hold government leaders and policy makers accountable to science and justice. 350 uses online campaigns, grassroots organizing, and mass public actions to oppose new coal, oil and gas projects, take money out of the companies that are heating up the planet, and build 100% clean energy solutions that work for all. 350's network extends to 188 countries.

[350.org](http://350.org).

**5) Climate and Clean Air Coalition** to Reduce Short-Lived Climate Pollutants (SLCPs). These are chemicals, and particles, such as Methane, black carbon, tropospheric ozone, and some hydrofluorocarbons (HFCs)—commonly referred to as short-lived climate pollutants (SLCPs) that endanger human health and some act as GHGs. The coalition was launched by the United Nations Environment Programme and six countries — Bangladesh, Canada, Ghana, Mexico, Sweden, and the United States — on 16 February 2012. [ccacoalition.org/en](http://ccacoalition.org/en)

**4) Citizens Climate Lobby**, is a successful international grassroots environmental group that trains and supports volunteers to build relationships with their elected representatives in order to influence a bipartisan climate policy. to effectively price carbon through Congressional action. The group has been successfully organized widening public awareness and on the need for political action on Climate Change by advocating for a 'Carbon Fee and Dividend'. That is a national, revenue-neutral carbon fee-and-dividend system (CF&D). This would place a predictable, steadily rising price on carbon, with all fees collected minus administrative costs returned to households as a monthly energy dividend. Energy Innovation and in putting a Dividend Act, into the congressional agenda. This would put economic pressure on the consumption of fossil fuels and on increased use of renewables. [www.citizensclimatelobby.org/](http://www.citizensclimatelobby.org/)

**5) Regional Greenhouse Gas Initiative.** is the first mandatory market based program in the United States to reduce greenhouse gas emissions. (RGGI) is a cooperative effort among the northeaster states. to cap and reduce carbon dioxide (CO<sub>2</sub>) emissions from the power sector. RGGI compliance obligations apply to fossil-fueled power plants 25MW and larger within the ten-state region. RGGI establishes a regional cap on the amount of CO<sub>2</sub> pollution that power plants can emit by issuing a limited number of tradable CO<sub>2</sub> allowances.

<https://www.rggi.org/>

**6) Regulatory Adjustment for GHGs.** On the first day of his presidency of Donald Trump, the White House website announced that Obama's Climate Action Plan would be eliminated, stating it is 'harmful and unnecessary. In March 2017, Trump signed an executive order to officially nullify Obama's Clean Power Plan in an effort, it said, of reviving the coal industry. In Jun 23, 2014 the Supreme Court ruled EPA can and will regulate greenhouse gas emissions, with some limits. Recently The Trump administration announces its new that give authority to states to create narrower rules to limit greenhouse gas emissions from coal-fired plants. This plan is projected to result in the release of far more of the gases than the Obama rule would have

allowed. <https://www.epa.gov/nsr/clean-air-act-permitting-greenhouse-gases>

**5) World Resources Institute** reports “on seven urgent global challenges that must be addressed to reduce poverty, grow economies and protect natural systems”, all of which are impacted by climate change, through funding and activities at the sub-governmental levels. [www.wri.org/](http://www.wri.org/)

**6) A new report from the New Climate Economy** finds that, globally, bold action can yield a direct economic gain of \$26 trillion cumulatively through 2030, while avoiding more than 700,000 premature deaths from air pollution and generating more than 65 million new low-carbon jobs in 2030. [www.atlasnetwork.org](http://www.atlasnetwork.org)

**7) Develop and maximize the use BECCS** and other technical approaches for carbon capture and removable in situations where it is economically and ecologically suitable, such as in conjunction with power plants, agriculture, and with life style by the public. [https://en.wikipedia.org/wiki/Bio-energy\\_with\\_carbon\\_capture\\_and\\_storage](https://en.wikipedia.org/wiki/Bio-energy_with_carbon_capture_and_storage)

**8) Paul Hawkin, comprehensive book, DRAWDOWN** that stresses education on what and how to Educate and Incorporate present and **new technologies and strategies** can be implemented that can improve **energy-efficiency** practices into our day-to-day life style in all sectors of our society to reverse Global Warning. of the atmosphere. <https://www.drawdown.org/>

**9) Union of Concerned Scientists.** The UCS members power tough, smart, effective campaigns that push for practical solutions to some of our planet's most pressing problems—from fighting corporate and political attacks on science to combating global warming and developing sustainable ways to feed, power, and transport ourselves. <https://www.ucsusa.org/>

**10) Solar/Hydrogen/Hythane the Transition fuel.** Because hydrogen can be produced cleanly from solar and other renewable energy resources, it can be and used virtually with minimal pollution. It is a promising strategy for an energy transition to hydrogen, which is already developed and in use by the international hydrogen-energy community. It could facilitate the transition through a gradual replacement of present day gasoline, diesel, and natural gas, to hythane and hydrogen fuel cells. Most to the supporting infrastructure is similar to that of natural gas, as distribution, transfer and storage. The key feature of past energy transitions has been a progression toward fuels containing less carbon and more hydrogen; witness the shift from dried wood which is mostly carbon (10% hydrogen), to coal(38%hydrogen),to oil(64%hydrogen), and to natural gas (80%hydrogen) [https://openei.org/wiki/Hythane\\_LLC](https://openei.org/wiki/Hythane_LLC)

**5.9d Is Not Dealing with the Oil Crisis Good Governance?** What was considered a birthday gift to drive the engines of our societies over the last century is now becoming an unattended death knell echoing the lesson, “*Do not build a civilization on a single nonrenewable resource*”, as have the great preceding societies ignored. One might question why our consumptive economy is not helping us preserve the remaining reserves for future generations and helping us transition to Renewable Energy and Sustainable Development. But on the way, there are even more issues to address:

**1)** When atmospheric temperatures surpass the 1.5°C limit, making climate-change events worse by becoming more irreversible, and more damaging, such as hurricanes, megafires, floods, and droughts that are costing more tax payers money to deal with, while the government is actively supporting fossil fuel expansion, and pretending that we will not be able to stop the Greenland glaciers slipping into the Nordic Sea on their way to Miami on stilts !

**2)** When everyone knows that developed global fossil-fuel reserves are more than enough for us to surpass the warming goals of 1.5°C and even the 2°C; and we know that we know that we should not chase after the fossil fuel underground reserves that are declining, costing more to produce, and will gradually not be available for all future generations starting with the energy poor nations,

**3)** When we realize that with the BAU approach we are wasting billions of dollars on tax-payer’s money on fossil-fuel subsidies that should be spent on the renewable energy transition and related sustainable programs.

**4)** When we know that the solution for climate crisis coincides with that for the oil crisis, and that their combined solution will have a synergic coupling with society’s comprehensive Sustainable Development.

**5.9e. Negative and Positive Approaches.** If global governing bodies continue negate or delay preventive actions on both fossil fuel and climate change action, and continue the BAU approach, the effect will be compounded negatively on a devastating scale that is beyond postponement and reversal. Climate Science is at a turning point in terms predicting future impacts until we know the shape of the emissions curve, when it plateaus, when it reverses, and they understand what equilibrium state the atmosphere will be in. Presently we are in a very serious Type I,

by knowing what to do but in fact, continue with the BAU approach decision, for which we have no idea of the costs it will bring to humanity.

The synergistic linkage of the energy and climate crises precludes efforts to deal with them separately. However, if this linkage is well understood, governing bodies could take advantage of it to create an efficient and smooth transition to a comprehensive alternative energy plan and avoid the risk of an overwhelming collapse of our societal system.. The essential constraints on energy plans are that they should dovetail collectively with the other nations' Climate Change plans, and the UN Sustainability Development Goals of 7<sup>th</sup> (Energy) and of 13<sup>th</sup> (Climate).

A positive aspect of these slow responses at the top leadership level is that Sustainable Development goals are already active and growingly being incorporated and accepted at the level the general public. The transition to sustainability. initiatives at the lower sub-governmental levels. Even by industry and manufacturing with efforts to increase the energy efficiency of their production. These are positive signs because the transition to sustainability should grow from the bottom up, out of a cooperative public will that only needs integrative guidance and support from governance. (cf. Chap. 5, E.4). Unfortunately for the world, the Current US administration isn't headed in that direction.

**So the Oily Question  
of the Century is  
Business as Usual or  
Clean Energy for All?**



## . The Big Decision, 5.10 A Reality that We Must Confront

**5.10a. The Problem with Decisions.** This decade was destined to be the last exit for global sustainability, which necessarily includes an energy transition. As this decade fades into history, we still cannot decide whether we accept the threat and decide to confront it based on our scientific knowledge or do we accept a BAU approach based on a wait and-see if we get richer approach? The intersection on these two crises represents a bifurcation point in the human history after which there will be no return. We have had a similar precedent with The Treaty on the Non-Proliferation of Nuclear Weapons, in 1969, which even now is also being questioned by President Trump! The public well understands the gravity of the fact that the decision of one person or one nation could immediately devastate billions of people and could ruin the habitats of all life. With Climate Change, the result would be similar. Like the analogy of cooking a frog. in a pot of water; if you put him in beginning when the water is cool he swims around liking the cool fresh water until the water warms so much he can't think about options and he cooks to death. Whereas if you put him directly into the boiling water, he has no time to think about options and is cooked. Either way the cook wins unless the frog is so quick thinking to find an escape option With our climate problem, continuing with BAU approach would be like putting the lid on the pot -- it boils quicker.

**5.10b. Dissecting this Big Decision.** There are a few essential sub-questions involving actions and goals that need to be answered such that the general public well understands what needs changing, and how and why an energy transition is urgently necessary to change present BAU approach in order to preserve the global habitat for all life.. Here we pose several questions that must be understood by the general public before we start an Energy Transition Plan. These questions are actually meant to be talking points that need the general public and policymakers need to have answered sufficiently so that it will succeed.

- 1) Why would we ignore science and choose to risk squandering an incalculable amount of public money and civil wellbeing with the BAU approach that maintains Big Oil and disregards CC.
- 2) Why are we using billions of taxpayer's dollars to subsidize oil industries to expand fossil fuel production and pay for their externalities too, when we don't need to expand our mines,

especially when that money could be otherwise support clean energy transition!

- 3) Why are we chasing after shale oil and risking a Fracking Bubble in the economy, due to too much investment and too little return, and environmental havoc.
- 4) Why don't we halt all new production since our ready reserves, if burned, are more than enough to warm the atmosphere past the 1.5°C goal; and to be assured that we can close the energy gap without endangering the energy transition.
- 5) Why are we paying billions of taxpayers to subsidize for the increasingly destructive climate impacts and their externalities after they happen instead of a serious all-out effort to pay for reducing their cause (GHGs) itself.
- 6) Finally, why don't we realize that the answer to all these interconnected sub-problems are due to our lack of an overarching Sustainability-Development Goal that is inevitably the only energy path for a sustainable society? ( cf. Chapter 7)
- 7) **Why don't we have an effective Science-Policy Interface?** The scientific basis for urgent CC resolution has been doubtlessly described by scientific experimental data, calibrated in climate models, and confirmed by the current extra-normal impacts of storms, floods, droughts, and wildfires are, for example, providing sufficient verification that climate change does exist and that it poses increasingly grave risks to the global economies and ecosystems. At this point in climate change, it is imperative that policy accepts the best unadulterated information from our hard and soft science communities to guide policy for the transformation to sustainable energy and societies. .Oppositional efforts that seriously disrupt efforts of such scientific guidance could qualify as a crime against humanity!
- 8) Why are political leaders fumbling around and not implementing the changes that are urgently necessary-while we still have a chance. If the polar bears understand enough to go ashore, and captains know when to put lifeboats in the water, scientists can propose solutions, but only the politicians can't unite the public enough to lead us to sustainable solution?

Continuing the permanent tax breaks is a big part the problem. They have most of their origin is in helping the oil industry have enough oil supply in case of military or economic emergency. Thereby, why don't we consider Climate Change to be qualified as a major element of "National

Security”, since climate impacts threaten the existence of human society and its ecosystems. Consequently, we now have two man-made issues (Energy and Sustainability) that, are interdependent, and can only to be solved by man-made diplomacy, if supported by science-based policies, and if there exists a cooperative public attitude to preserve the wellbeing of humanity. ..

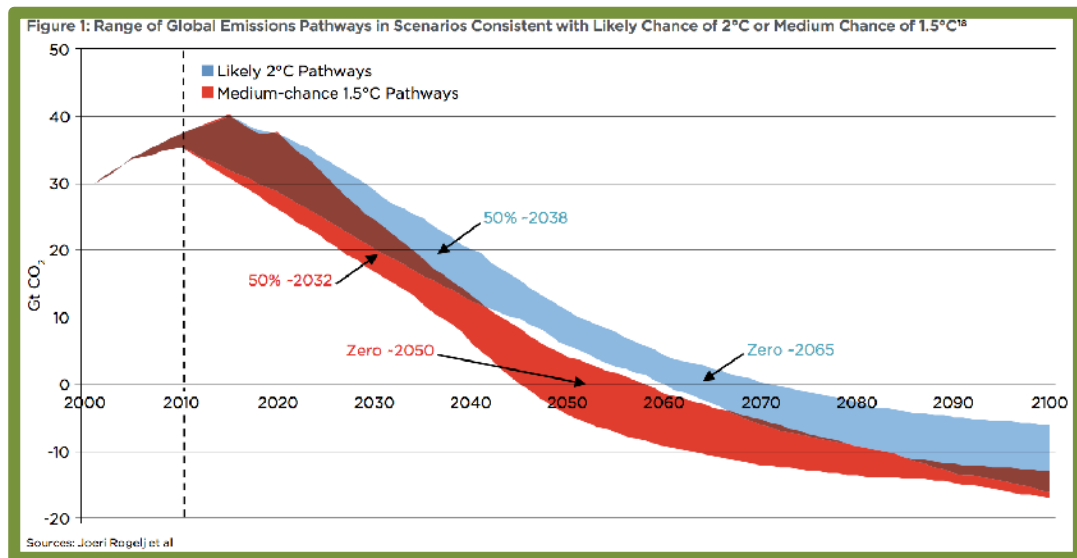
The political basis for urgent resolution has been dangerously polarized and delayed to the point near stagnation, as reflected by the two US political platforms<sup>56</sup> with the Republican Platform not even mentioning Climate Change, discounting cooperative international agreements, and directly rejecting all environmental concerns are expressed in the Democratic Party’s Platform, which quite thoroughly represents the current environmental, social, and unattended policy issues; and. It recognizes need the for the US to participate in the global leadership effort and cooperation on the climate, energy, and social issues.

The tragic irony with the US Republican Plan to gain world “Energy Dominance” by expanding<sup>70</sup> fossil fuel production defies common sense, is too expensive, not pragmatic, and it is politically dangerous to try to dominate the world’s depleting stock of economically viable fossil fuel.. In fact, it is the exact opposite of what we could be doing to avoid the inevitable energy and climate crises by halting all new production of fossil fuel, and using our developed reserves first, which are more than enough to warm the earth past the goal of 1.5°C goal. This would give us time and money, if also the energy subsidies are redirected to fund a science-based Energy Plan to build toward the goal of a sustainable energy system for future societies.(Fg. 26)

## 5.11 What about Climate Change?

This section explains some of the effort and confusion between Climate Science and the interests of the oil industry. Historically, institutes such as the IEA, WEO, have managed world oil.

**5.11a. Progress with Paris Agreement<sup>12</sup>.** In December 2015 world governments approved the Paris Agreement to reverse average global temperatures to well below or to 1.5° C above pre-industrial levels by 2100. This requires first reversing and then reducing emissions to zero by 2050. Figure 26 illustrates this time-frame with the New Policies Scenario (NPS) computer model that projects an emission-reduction curve to guide desired results and provides the probabilities of achieving the prescribed levels. For example, a 50% chance of remaining at the 1.5°C limit, it prescribes a peak in 2020, halfway in 2032, and zero emissions in 2050. Likewise, for a 66% chance of staying under the 2°C limit, it prescribes a peak in 2015, halfway in 2038 and zero in 2065.



**Figure 32. NPS Pathways Scenarios for CO2 Reduction.** This graph illustrates two pathways and chances of success for the two temperature goals of the NPS model in 2017, avoiding the 1.5°C level, but not reaching the 2°C level. The times for reaching zero-emissions are 2050 and 2065 respectively. The below-zeros values represent preindustrial emission levels. accordance with Paris goals: a 66% chance of staying under 2°C and a 50% of reducing the warming to goal of 1.5° .C

**5.11b. Are these emission goals Viable?** The answer is **NO**, if the progress continues as usual. That is to say that denial and obstruction will continue to interfere There is only the hope that the momentum of the progress to date can over come the obstruction and damage done. Examples of progress are in the monitoring, and modeling of climate change has made, and the accuracy of the climate-change processes

more understandable to the general public. The witnessing of its growing impacts and its increased discussion in the media, and help with a sense of urgency with its apparitional approach - like a slow tsunami. In addition, there is a governmental level where the only hope is for miraculous reversal in leadership to avoid warming above the 1.5°C goal. Aspects are discussed in the following paragraphs, (cf WEO-IEA Special Report 2018<sup>72</sup>).

### **5.11c. Is Big Oil joining Trump by Walking away from Paris?**

This is a bewildering story of considerable impact on our progress with confronting Climate Change. The answer is already **yes**, since they now have the encouragement of President Trump, his party, and other nations. However a good majority of the US public seem to be not satisfied, if not frightened, and are continuing their pressure for reversal, for example, with protests through nonprofits, by the media, actions to reduce their carbon footprint, lobby their governments, and by divesting in fossil fuel.

**Maybe Not**, a hopeful answer is possible but is a complicated one. For example, if we can hope the new 2019 US Congress can undue the damage already done by Trump's rampage of political denial, blocking, and a loss of global climate leadership. Even if we succeed in this effort, we will have to eliminate false news, and help the public have to cultivate a broader more cooperative world view of saving the planet. Most urgently we must resolve the conflict about who best can manage our future, that is, between climate and social sciences and the oil industry. Some of the relevant conflicting complications follow:

**1)** A scientific correction to the NPS 2015 model was made because the "Emissions under the NPS model would make the Paris goals unachievable: by exhausting the carbon budget<sup>55</sup> for the 1.5° Celsius limit too quickly by 2022 and for a 2 degree limit by 2034". That is, if we were to use the NPS model as a guide (Fig. 32), we would supersede these limits much sooner, because the global rate of emission-reduction was too slow and consumption too high to follow the NPS) as a guide. This mistake occurred because the due to persistent pressure for higher production rates from the representatives of the oil industries' and governments in the drafting of the report!.

**2)** These original warming limits were chosen on scientist's warnings that a warming higher than 1.5°C and up to 2°C, would more than likely that the atmospheric processes will become non-linear and irreversible to the degree that predictions as to make to anticipate impacts such as in widespread food shortage, available drinking

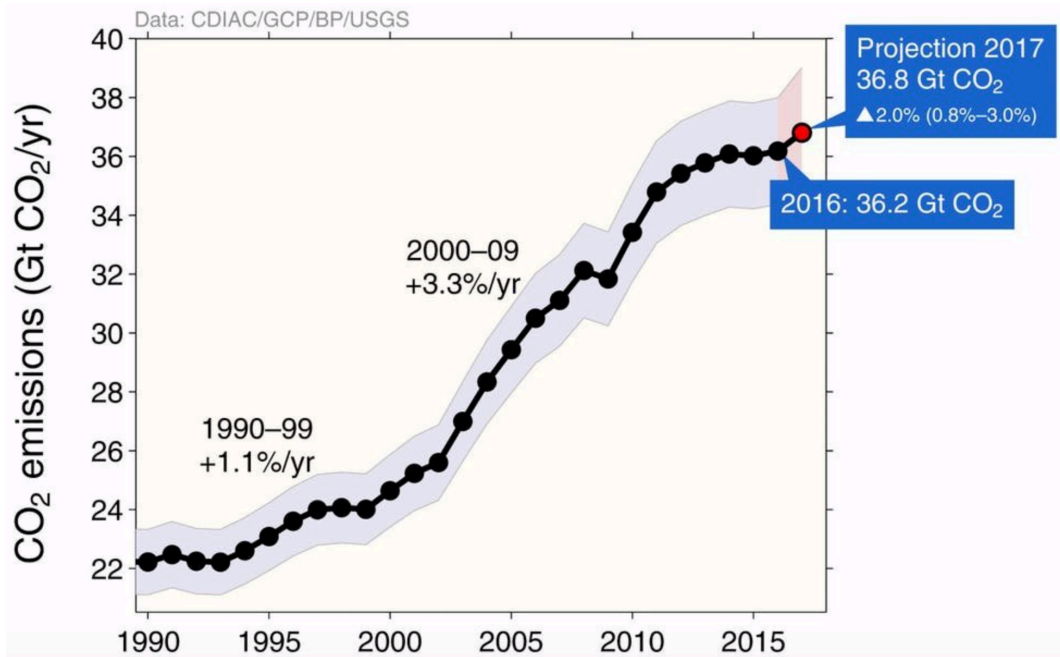
water, weather extremes, loss of biodiversity, rising sea-level, oceanic acidification, salinization of coastal farmlands, atmospheric interactions with the polar sea, and much more. It would also foster social impacts of mass-emigrations, armed conflicts, inhabitable CV, and inequitably distributed populations. More warming approaching and after 2°C, atmospheric dynamics would certainly become nonlinear as the atmospheric system loses its initial state, that is, before the fossil fuel era. These warnings dictate that in order to stay below a 2-degrees-warming would require an action plan for “immediately and rapidly declining emissions”.

3) Consequently, A major revision of the 2017<sup>57</sup> GHG emissions guidelines, was issued in April of 2018<sup>58</sup>, to correct the previous 2017 Report that had advocated the slower emission-reduction rates to meet the fossil-fuel industry’s goals, without regard to the Paris goals., and that these reduction rates must be significantly faster to achieve the 2015 Climate Change and Sustainability-Development obligations.

4) In 2017, Trump Administration introduced its “**energy dominance**” agenda that predicated increases in oil, gas, and coal production through deregulation and dismantling of existing environmental and human health and safety rules”. This was an other major setback after the universal hope that the US was really going to cooperate with other nations for action to help save our planet from devastating consequences.

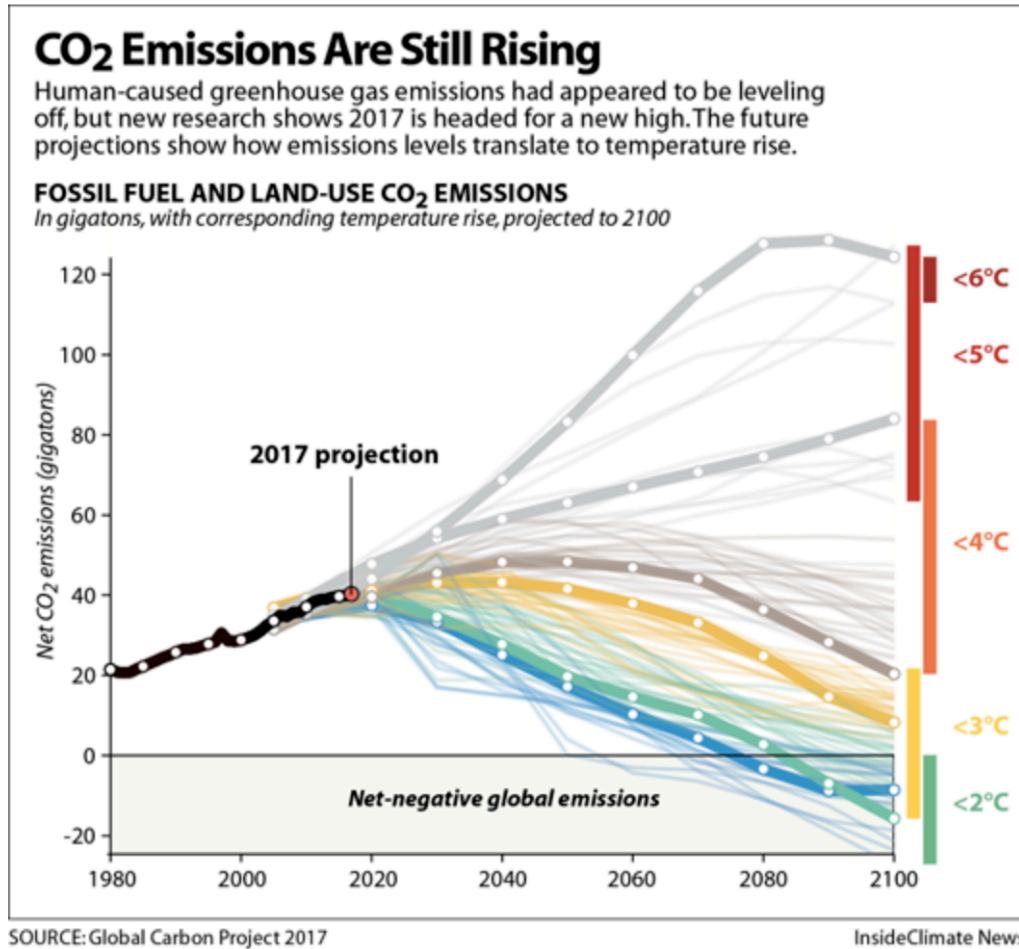
5) Three years after the Paris Agreement, in the summer of 2018, the US emissions-rate returned to climbing despite a three-year plateau that had occurred during 2015 and in to 2017. The plateau is mostly attributed to Obama’s Clean Power Plan, which phased out the lease needed coal power plants, and which carried over into 2017 until Trump’s much less stringent regulations on coal power plants were instituted in 2018, see Fig. 33.

6) The surprising fact that we have **more than enough oil reserves** such that if we used them up we would surpass the 1.5° C limit. This should give us the gumption to start the process of shutting down fossil fuel production with a cooperative plan that starts **NOW** with the developed reserves, renewables, a serious implementation of BECCS and DRAWDOWN and an energy-efficient economy instead of pursuing new construction of shale and tar fields that have very low EROEIs or negative EROEIs if the environmental/social costs are included.



**Figure 33. How Government polices can succeed.** Example of how government can change its emissions through regulations (Obama) or with deregulations (Trump). Figure source <sup>73</sup>

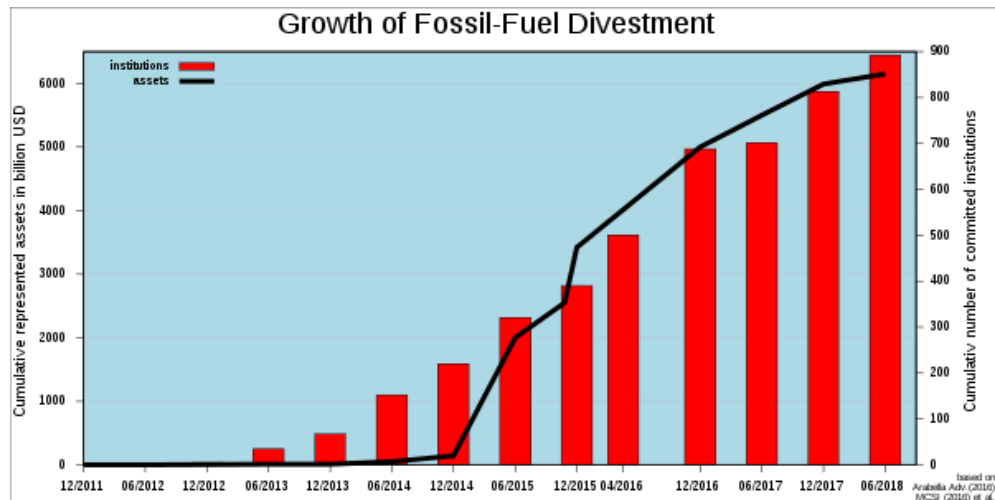
7) The Energy industry needs forecasts to extrapolate to the future demand by industry, the public, and for national security reasons. To keep this chain going, it needs to maintain the production supply chain of oil or gas from the ground to storage to customer. This requires storage capacity, elasticity to buffer spikes in demand or supply. This is a very expensive exercise, because of the close correlation between the economy and changes in energy supply shown in Figure 12. Future forecasts will be needed to provide precautionary guidance for governmental agencies and data, such as to National Ocean and Atmospheric (NOAA), Environmental Protection Agency (EPA), Department of Defense (DOD) Climate and Ocean University Research Departments, and etc. It is this information that climate scientists can model projections of future climate change, energy needs, and information for investing in fossil fuel. Because of physical uncertainties, these models prescribe probability envelopes such as to indicate the chance of deviation from projected guideline. Arguably, the greatest uncertainty is not the weird behavior of the atmosphere but the indecisive behavior of the humans who not responding intelligently enough to arrest and reduce Climate Change. A revised set of projections illustrated in Figure 34 that plots the expected outcome in terms of atmospheric temperature response to a set of emission reduction pathways.



**Figure 34. Options for CO<sub>2</sub> Reduction Emissions.** Because of the recent expansions in oil productions the popular BAU is winning (light grey path at top) and the losing one is the blue path. Variations are in-between that account for the participation of the largest contributory nations and the development and use of BECCS for sequestering CO<sub>2</sub>.

**8)** Numerous groups advocate fossil fuel divestment, which in 2015 was reportedly the fastest growing divestment movement in history, which began on campuses in The United States in 2010 with students urging their administrations to turn investments in the fossil fuel industry into investments in clean energy and communities most impacted by climate change, the movement soon spread across the globe. As of 2017, 800 institutions possessing 6 trillion dollars have divested from the fossil fuel industry. Fossil fuel divestment or fossil fuel divestment and investment in climate solutions is the removal of investment assets including stocks, bonds, and investment funds from companies involved in extracting fossil fuels, in an attempt to reduce climate change by reducing fossil fuel expansion. The loss of faith for investments for future fossil fuel is demonstrated in Fig. 35.





**Figure 35. Growth of Fossil-Fuel Divestments from the oil industry.** Fossil fuel divestment or fossil fuel in climate solutions is the removal of investment assets including stocks, bonds, and investment funds from companies involved in extracting fossil fuels, in an attempt to reduce climate change by tackling its ultimate causes.<sup>74</sup>

**8) But BeWare!** This would have difficult economic repercussions, due to the upstream investment for oil and gas of 12 trillion from 2018 to 2040. We should be smart enough to craft an energy-transition plan that can work around this difficulty by shifting investments and subsidies to renewables and their infrastructures and with the right political attitude and operation with Big Oil, and the economic sector's cooperation. Both the use of fossil-fuel and its investments should be redirected to support an energy transition that gradually maintains the energy gap between available fossil and renewable fuels and construction of their distribution-infrastructure.

**9) But Be Hopeful!** There is now an auspicious intersection of three actions needed to facilitate a Climate-Energy-Economy transition based on 1) that pursuing fossil fuel is becoming less economically available; 2) that renewables are becoming more available and less expensive; and 3) that the money that government spends on oil must be redirected to create a sustainable energy economy. **We can't pass up this once in world opportunity.**

## 5.12 Sustainable Energy?

Note, see also chapter 7.

. **5.12a Planning.** In the absence of a strong energy plan, the BAU approach is serving as a default, and will likely continue with implementing its damaging strategy. The industry will continue to mine conventional oil resources, expand unconventional-oil and gas resources, and further exploit what is left of the existing reserve base regardless of the costs and risks. Stubbornly, the oil industry is keeping a foot in the door of renewable energy, perhaps without realizing that the new infrastructure will be different in scale and in technology—but not pushing the door open and going through. It appears they are banking on public ignorance and political complicity to maintain the status quo for as long as possible. In fact, the messages from the current government and corporate “experts” generally support the belief that we can continue with a growth economy based on fossil-fuel consumption achieve energy independence with fossil fuel!

**5.12b Are we going to get together and DO IT?** Not having a national plan that dedicates the USA to sustainable development puts the entire world at risk. This cannot be correctly be done without the inclusion of the plans of all the UN to restructure to a sustainable economy and transition to sustainable energy. The timing and efficiency of these transitions are of paramount importance to the mega threats to our society, such as climate change, economic inequality, and continual war both civil and international—insofar as, in places like the Middle East and North Africa, such threats are real and are being realized now! Also, one nation alone cannot be successful in these transitions without concurrently pursuing international cooperation on sustainable development progress and on international plans to end civil unrest and nuclear proliferation. These challenges have far greater scale and significance than the problems we typically face and fail to resolve by attempting piecemeal, ‘fix-it’ policies that include efforts to protect our international geopolitical interests or trying to fix climate change without recognizing the severe limits on GHG emissions now required. Comprehensive Plans for Sustainable Energy, Economy, and Climate could simultaneously resolve these three imminent risks to modern societies because they strongly are interconnected synergistically. In sum, if we continue to accept a business-as-usual procrastinate the precautionary argument for formulating a long-term plan for sustainable energy, we should consider

**SO WHAT WOULD HAPPEN IF WE WAIT AND SEE?:**

- 1) until the rising price of oil and the rising costs of restoring externalities due to Climate Change events dominate our domestic budget and bankrupt our economy!
- 2) until Floridians live in stilt houses
- 3) until the stock market crashes because of uncontrolled divestment from the oil industry!
- 4) until energy inequalities proliferate civil wars, and regional ecological crises generate uncontrollable chaotic migration to richer nations!
- 5) until we can pull our heads out of the sand!  
and the unheard of happens!



Dear Cassandra,

**Help us to not commit a Type I Error**  
and Assume Mother Nature will  
continue to bless us with  
its goods and services  
ad infinitum!

## CHAPTER 5

### NATURAL CAPITAL END NOTES

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12. **The Paris Agreement.**• The 21st Conference of the Parties of the UNFCCC met Paris in December 2015 with the aim of adopting a new global agreement to limit greenhouse-gas emissions. The ultimate objective already adopted by governments is to limit global warming to

an average of no more than 2 °C, relative to pre-industrial levels. This must involve the transformation of the energy sector, as it accounts for roughly two-thirds of all anthropogenic greenhouse-gas emissions today. The Paris Agreement requires all Parties to put forward their best efforts through “nationally determined contributions” (NDCs) and to strengthen these efforts in the years ahead. This includes requirements that all Parties report regularly on their emissions and on their implementation efforts. From: WIKI, or World Energy Outlook Special Reports

- 13. Type I and Type II Errors.** In statistical testing, a Type I error is the rejection of a true hypothesis, while a Type II error is failing to reject a false hypothesis. In this case, Trump’s hypothesis is that Climate Change is a hoax and should not constrain his plan to have energy dominance.
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[https://ycharts.com/indicators/world\\_crude\\_oil\\_production](https://ycharts.com/indicators/world_crude_oil_production)
- 19. OPEC, Organization of Petroleum Exporting Counties**
- 20. Big Oil.** This term is used to describe the world's seven or eight largest publicly owned oil and gas companies that are associated with the Fossil Fuel Lobby.
- 21. URR,** Underground Reserve Resources. URR refers to the total volume oil in a field or well t is estimated to be economically produceable from during its lifetime.
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- 30. Safe Drinking Water Act, 1974.** The Safe Drinking Water Act (SDWA) is the principal federal law in the United States intended to ensure safe drinking water for the public. Pursuant to the act, the Environmental Protection Agency is required to set standards for drinking water quality and oversee all states, localities, and water suppliers who implement these standards. SDWA applies to every public water system (PWS) in the United States. There are currently about 155,000 public water

systems providing water to almost all Americans at some time in their lives. The Act does not cover private wells. Wikipedia.

- 31. Halliburton Loophole.** Named for the Halliburton Corporation, the bill exempted fluids used in the natural gas extraction process of hydraulic fracturing (fracking) from protections under the Clean Air Act, Clean Water Act, Safe Drinking Water Act, and CERCLA. [21]., [wikipedia.org/wiki/Hydraulic\\_fracking](http://wikipedia.org/wiki/Hydraulic_fracking).
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44. **The 12 Costliest Hurricanes to Hit the U.S.** Mother Jones - International Monetary Fund.
45. **The External Costs of Fossil Fuels.** Tim McDonnell These Charts Show the Hidden Costs of Dirty Energy. Adding up the costs in money – and in lives. Mother Jones, September/October 2015 ISSUE
46. **Political Difference in Campaign Spending.** 2014 Alex Park, Andy Kroll, Dave Gilson, Benjy Hansen-Bundy April 14, 2014, Jones Triumph of the Drill: How Big Oil Clings to Billions in Government Giveaways. Mother Jones Triumph of the Drill: How Big Oil Clings to Billions in Government Giveaways.
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49. **CoalSwarm.** Ted Nace, CoalSwarm is a global network of researchers developing collaborative informational resources on fossil fuels and alternatives. Current projects include the Global Coal Plant Tracker, the Global Fossil Projects Tracker (coal, oil, and gas infrastructure), the CoalWire newsletter, and the CoalSwarm and FrackSwarm wiki portals. CoalSwarm and Greenpeace International are working together to Phase out coal combustion power plants.
50. **Hythane.**
51. **Coal Fired Power Plants.** Charles M. Blow (Moderator), Forget Paris: 1,600 New Coal Power Plants Built Around The World, New York Times/ July 3, 2017.
52. **G7 Fossil Fuel Subsidy Scorecard. June 2018**



Tracking the Phase-out of fiscal support and public finance for oil, gas and coal. Shelagh Whitley, Han Chen, Alex Doukas, Ipek Gençsü, Ivetta Gerasimchuk, Yanick Touchette, and Leah Worrall

- 53. Green Climate Fund.** This important fund supports our crucial work around the world. Hear from Experts. Science-based Evidence. Nature-based Solutions. Get the Facts. Types: Climate Change, Greenhouse Gas Emissions, Nature-Based Solutions, Paris Climate Agreement. <https://www.greenclimate.fund/>
- 54. Rystad Energy Annual Review Of World Oil Recoverable**  
**Resources:** Saudi Arabia Adds Oil Resources Ahead Of Ipo, Magnus Nysveen, Head Of Analysis At Rystad Energy. June 20, 2017
- 55. Oil Change International OFF TRACK/ The IEA and Climate Change - Oil Change International**  
**Oil Change International**
- 54. World Resources Institute** is a global research organization that spans more than 50 countries, with offices in the United States, China, India, Brazil, Indonesia and more. Our more than 700 experts and staff work closely with leaders to turn big ideas into action to sustain our natural resources—the foundation of economic opportunity and human well-being. Our work focuses on six critical issues at the intersection of environment and development: climate, energy, food, forests, water, and cities and transport. [www.wri.org/](http://www.wri.org/)
- 55. Union of Concerned Scientists.** <http://www.ucsusa.org/UCS> members power tough, smart, effective campaigns that push for practical solutions to some of our planet's most pressing problems—from fighting corporate and political attacks on science to combating global warming and developing sustainable ways to feed, power, and transport ourselves.  
**55. Union of Concerned Scientists.** <http://www.ucsusa.org/UCS> members power tough, smart, effective campaigns that push for practical solutions to some of our planet's most pressing problems—from fighting corporate and political attacks on science to combating global warming and developing sustainable ways to feed, power, and transport ourselves.
- 56. World Resources Institute** is a global research organization that spans more than 50 countries, with offices in the United States, China, India, Brazil, Indonesia and more. Our more than 700 experts and staff work closely with leaders to turn big ideas into action to sustain our natural resources—the foundation of economic opportunity and human well-being. Our work focuses on six critical issues at the intersection of environment and development: climate, energy, food, forests, water, and cities and transport.

**57. Short Lived Climate Pollutants (SLCPs)** The main **short-lived climate pollutants** are black carbon, methane and tropospheric ozone, which cause the second most noxious main **short-lived climate pollutants** are black carbon, methane and tropospheric ozone, which are the most important contributors to the human enhancement of the global greenhouse effect after CO<sub>2</sub>. ... Other **short-lived climate pollutants** include some hydrofluorocarbons (HFCs). impact to humans after the long-term impact of climate change. s include black carbon, methane, tropospheric ozone, and hydrofluorocarbons (HFCs) and are commonly associated with refrigeration, diesel-fueled vehicles, and solid-fuel cooking fires.

**58.**

## **65. PARTY PLATFORMS**

**67. Off Track:** How the International Energy Agency Guides Energy Decisions Towards Fossil Fuel Dependence and Climate Change,” here: <http://priceofoil.org/2018/04/04/off-track-the-iea-and-climate-change/>

[https://www.google.com/search?](https://www.google.com/search?q=chart+of+US+plateau+in+CO2+emissions+2015+to+2017&tbm=isch&source=hp&sa=X&ved=2ahUKEwiKv-XU6p3gAhWJxFkKHeuED14QsAR6BAgEEAE&biw=1199&bih=677&dp r=2#imgrc=FtpcthmBzySdyM)

[q=chart+of+US+plateau+in+CO2+emissions+2015+to+2017&tbm=isch&source=hp&sa=X&ved=2ahUKEwiKv-XU6p3gAhWJxFkKHeuED14QsAR6BAgEEAE&biw=1199&bih=677&dp r=2#imgrc=FtpcthmBzySdyM:](https://www.google.com/search?q=chart+of+US+plateau+in+CO2+emissions+2015+to+2017&tbm=isch&source=hp&sa=X&ved=2ahUKEwiKv-XU6p3gAhWJxFkKHeuED14QsAR6BAgEEAE&biw=1199&bih=677&dp r=2#imgrc=FtpcthmBzySdyM)

**58. Republican Platform;**The United Nations' Intergovernmental Panel on Climate Change is a political mechanism, not an unbiased scientific institution. Its unreliability is reflected in its intolerance toward scientists and others who dissent from its orthodoxy. We will evaluate its recommendations accordingly. We reject the agendas of both the Kyoto Protocol and the Paris Agreement, which represent only the personal commitments of their signatories; no such agreement can be binding upon the United States until it is submitted to and ratified by the Senate.

**59. Democratic Platform:** We believe the United States must lead in forging a robust global solution to the climate crisis. We are committed to a national mobilization, and to leading a global effort to mobilize nations to address this threat on a scale not seen since World War II. In the first 100 days of the next administration, the President will convene a summit of the world's best engineers, climate scientists, policy, experts, and social scientists.

**60. Fossil Fuel Phase out.** Ban new leases or permits for new fossil fuel exploration, production, infrastructure, reject existing proposals and plan for the phaseout of existing fossil fuel projects in a way that prioritizes environmental justice.

End subsidies and other public finance for the fossil fuel industry;

**61. Renewable Energy Buyers Alliance**

[www.powerpastimpossible.org/](http://www.powerpastimpossible.org/)

**62. [www.carbontrust.com/Science-Based/Strategy](http://www.carbontrust.com/Science-Based/Strategy)**

**63.**

**. 64.**

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**69.**

**70. Energy Dominance** What does Trump mean? According to Time: “In Trump’s vision, the U.S. should become a net exporter of energy and use those resources as a vehicle for economic growth. His plan for “energy dominance” also means using the country’s resource — particularly liquified natural gas, or LNG — as a bargaining chip in the international arena to provide energy security to allies.

the “most likely” scenario and comments that it is not intended as a forecast, but rather that each scenario “depicts an alternative future, a pathway along which the world could travel if certain conditions are met.”<sup>107</sup>

Champion a Green New Deal that ensures a just transition to 100% renewable energy; and

Reject the influence of fossil fuel money over U.S. energy policy.

Every decision around a new fossil fuel lease, permit, subsidy, or setback is an opportunity for U.S. politicians to stop fossil fuel expansion and champion a just transition to an economy powered by clean energy. The U.S. fossil fuel industry is gearing up to swing a giant wrecking ball through global climate goals. U.S. politicians cannot afford to stand by and let them ... or worse yet, help swing it.

### **OFF TRACK: The IEA and Climate Change**

Greg Muttitt, April 4, 2018

to REFs Note the term carbon budget refers to how much CO<sub>2</sub> must be extracted or added to decrease or increase the atmospheric temperature, respectively to a certain temperature

OAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2018). <https://www.ncdc.noaa.gov/billions/>

- See our detailed analysis of the 2018 *WEO*, here: <http://priceofoil.org/2018/11/12/business-as-usual-ia-climate/>
- See the report

## Dirty Energy Dominance: U.S. Subsidies – Oil Change Int'l Oil Change ...

[priceofoil.org/2017/10/03/dirty-energy-dominance-us-subsidies/](http://priceofoil.org/2017/10/03/dirty-energy-dominance-us-subsidies/)

## RYSTAD ENERGY ANNUAL REVIEW OF WORLD OIL RECOVERABLE RESOURCES: SAUDI

### BECCS

come to dominate pathways to 1.5C.

The The oil and gas industry insists that it doesn't receive any government handouts. Technically, it's got a point: Its favorite giveaways are tax expenditures buried in the tax code. So the government isn't actually giving oil companies much money—it's just losing money it otherwise could be collecting from them. paper instead explores alternatives including lifestyle changes, agricultural intensification and lab-grown meat, as well as an even more rapid adoption of renewables and energy efficiency. Some of these have tended to be excluded from the conversation, because they are hard for scientists to model.

The debate over how to meet the Paris goals "should be broader", the lead author tells Carbon Brief, because there are risks to relying on negative emissions from BECCS.

46 Jair Bolsoro - leading presidential candidate has Threatened to pull out of the

Accord and he would not Host 2019 Climate Summit and threatened to open up the Amazon agricultural development Chinese companies to build 700 coal plants in and outside China

All the ice on land has melted and drained into the sea, raising it 216 feet and creating new shorelines for our continents and inland seas. <https://www.treehugger.com/climate-change/what-earth-will-look-if-sdsdssd>

**4.** [www.multpl.com/world-gdp/table/by-year](http://www.multpl.com/world-gdp/table/by-year)

<https://insideunreport.org/news/31102018/jet-stream-climate-change-study-extreme-weather-arctic-amplification-temperatures>  
[www.ipsos.com/ipsos/news/56/11/880.full.pdf](https://www.ipsos.com/ipsos/news/56/11/880.full.pdf)

### **'UN REPORT: WORLD WOEFULLY SHORT OF CLIMATE CHANGE**

Global temperature increase could be result  
 By: BRANDON MILLER, CNN METEOROLOGIST  
 Posted: Nov 27, 2018 09:50 AM CST

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“Dirty Energy Dominance: Dependent on Denial” can be found at: <http://priceofoil.org/2017/10/03/dirty-energy-dominance-us-subsidies>

In Trump’s vision, the U.S. should become a net exporter of energy and use those resources as a vehicle for economic growth. His plan for “energy dominance” also means using the country’s resource — particularly liquified natural gas, or LNG — as a bargaining chip in the international arena to provide energy security to allies.