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Status of the United States' Dependence on Oil

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Abstract

With media headlines including global warming, controversy in the Middle East, rumors of petroleum sources running dry, and consumers paying more and more for petroleum, Americans have come to question our strong dependence on oil. Status of the United States' Dependence on Oil, part one of a two-part review entitled Stemming the Oil Addiction, examines the sources of supply and demand, refining and distribution processes, and pricing. A critical analysis follows ultimately deciding whether the United States really needs to significantly reduce its oil consumption.

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Chapter 1: The Significance of Crude Oil

Black Gold…

Petroleum – originating from the Latin words *petra-* and *oleum*, meaning rock oil[1] – is an abundant, naturally occurring liquid that has undoubtedly become the most important natural resource on the face of the planet, affecting virtually every single human being in the world. The formation of petroleum, or equivalently crude oil, commences with the decomposition of tiny sea organisms, plants, and animals, in addition to some land matter that, somehow or another, is washed away to sea. When these plants and animals die, their remains either naturally sink or are carried to the bottom of oceans, where they ensnare with very fine silts and sands that compose the ocean floor.[2]

Over geological time, this organic mixture of decaying organisms is subjected to increasingly immense heat and pressure from inside the Earth. As the sediment gets thicker and new decaying matter deposits on top, the pressure on the older layers below increases several thousand times, and the temperature rises by several hundred degrees Fahrenheit.[3] Eventually, this extreme heat and pressure forces the mixture of proteins, lipids, and carbohydrates that the decaying matter contains into varying hydrogen and carbon molecules – hydrocarbons – creating so-called fossil fuels. Additionally, this same heat and pressure slowly converts the surrounding ocean sediment into shale rock, resulting in the transformation of clay into shale, where shale becomes the rock form of clay.[4]

Once petroleum forms, it flows upward in the Earth's crust because it is "less dense than the brines that saturate between the shale, sand, and carbonate rocks that constitute the crust of the Earth".[5] Occasionally, the rising petroleum encounters nonporous rocks (e.g., shale, sandstone, or limestone) – a trap – that prevents the oil from seeping out. If this rock formation also has a tight, well-closed seal (e.g., salt or clay) that keeps the oil from further migrating to the surface of the Earth, the crude oil becomes enclosed in an underground reservoir where it remains until the seal or trap is punctured.

As illustrated in Figure I: The Petroleum Window, which shows the combination of depth and temperature that is needed to generate and trap petroleum, more often than not, the temperature and pressure (i.e., depth) never reach the levels at which crude oil forms. If these critical elements are not less than the 5.5°C per 100 meter gradient or larger than 1.8°C per 100 meter gradient, petroleum is not trapped or may not form altogether. Therefore, in order for petroleum to actually form, all conditions, including organic decomposition, constant extreme temperature and pressure for millions of years, and the encountering of a sufficient trap, must be met.[6] For this reason, only two percent of the organic material lying on ocean floors is transformed into crude oil, and as a result, crude oil is a nonrenewable resource whose formation time is measured in tens of millions of years.[7]

Chemically, crude oil is typically a black, dark brown, yellow, or even greenish liquid mixture of variable-length hydrocarbon chains that naturally contain nonmetallic elements such as sulfur, oxygen, and nitrogen.[8] Depending on the amount of sulfur present, petroleum is classified for monetary-value purposes as sour or sweet, indicating more or less than one percent sulfur, respectively. Moreover, crude oil can be as thin as gasoline or as thick as tar, and consequently, the American Petroleum Institute has developed a specific gravity scale for measuring the relative density of petroleum at sixty degrees Fahrenheit in relation to pure water.[9] The scale, ranging from ten to seventy degrees, categorizes light crude oil as having an API gravity higher than 31.1°, medium crude oil between 22.3° and 31.1°, and heavy crude oil as having an API gravity lower than 22.3°.[10]

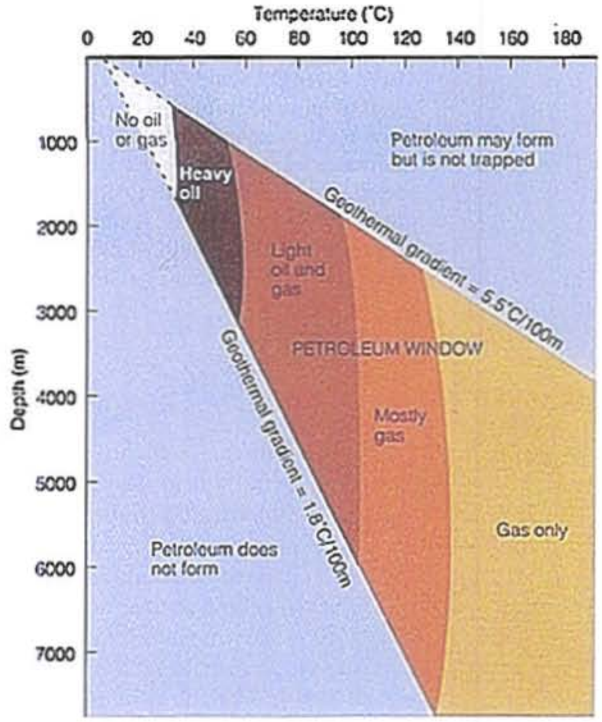

Figure I: The Petroleum Window
(Source: *The Blue Planet: An Introduction to Earth System Science*)[11]

Historically, petroleum has been in use for over 4,500 years, where the Babylonians in present day Iraq were the first civilization to use the fossil fuel instead of their traditional renewable resource, wood.[12] Thereafter and until the onsite of the Industrial Revolution, most people skimmed un-trapped crude oil off lakes, ponds, and streams,[13] using it to caulk boats, waterproof cloth, and fuel torches.[14] However, the Industrial Revolution brought about a prompt search for new, cheaper fuels for "people [who] wished to be able to work and read after dark".[15] By this time, however, whale oil was scarce and ultimately only available to the very wealthy.

In 1852, Canadian physician and geologist Abraham Gesner found a solution to this problem by developing and patenting a way to produce a "relatively clean-burning affordable lamp fuel" from petroleum called kerosene, which could replace the inadequate supply of whale oil.[16] Three years later, the American chemist Benjamin Silliman published a report indicating the wide range of other useful products, including gasoline and diesel fuel, which could be derived by distilling crude oil (a process now known as refining).[17] Accordingly, demand for petroleum products grew and as a result, a group of businessmen hired "Coronel" Edwin L. Drake to drill for crude oil. Eventually after months of trying, on August 27, 1859, Drake drilled the first successful oil well at a depth of 69.5 feet in Titusville, Pennsylvania, yielding about thirty-five barrels[†] of crude oil a day.[18]

This historic feat successfully marked the beginning of the rapid growth of the modern petroleum industry, in which oil was soon discovered in West Virginia in 1860, Colorado in 1862, Texas in 1866, and California in 1875.[19] By the turn of the twentieth century, the invention of the horseless carriage – the modern day automobile – drastically increased the demand for gasoline, and along with the energy needs brought on by World War I, the petroleum industry quickly became "one of the foundations of industrial society".[20] As a result, by 1920 there were more than nine million motor vehicles in America and "gas stations were opening everywhere".[21]

Since crude oil has an incredible energy density, is relatively abundant, and can be found in all climates all across the world, petroleum has become the world's most important source of energy since the mid-1950s. Today, "modern industrial societies use [petroleum] primarily to achieve a degree of mobility – on land, at sea, and in the air – that was barely imaginable less than 100 years ago, powering virtually all motor vehicles, aircraft, boats, and trains around the world".[22] Additionally, crude oil has found its way into consumer and industrial products such as alcohols, detergents, synthetic rubber, asphalts, glycerin, fertilizers, solvents, building

[†] One barrel of crude oil is equal to forty-two U.S. gallons.

materials, compact discs, telephones, and even sports equipment like footballs and golf balls. Even the feedstock (i.e., raw materials) for products such as medicines, toothpaste, shampoos, lipstick, deodorant, soft contact lenses, nylons, plastics, paints, polyesters, food additives and supplements, explosives, dyes, insulating materials, and cleaning supplies emanate from petroleum.

Thus, with more than 167,476 retail gasoline stations in the United States supplying Americans with billions of gallons of gasoline a year,[23] 5.9 trillion dollars worth of goods transported across the country in diesel powered tractor-trailers (more than seventy percent of the nation's consumer products),[24] and thousands of products fabricated from crude oil, petroleum has emerged as an extremely critical aspect to our way of life. In fact, the ability for our society to geographically diversify from large cities to suburban communities is only possible because of the simplicity and economic efficiency of petroleum.[25] Consequently, with a way of life that relies so heavily on an ample, inexpensive, and continuous supply of oil, we have fallen into a situation in which our society cannot physically survive without crude oil, a bottleneck that may very well impede any further substantial growth and advancement of our civilization.

Furthermore, with media headlines including global warming, controversy in the Middle East, rumors of petroleum sources running dry, and consumers paying more and more for petroleum, Americans have started to question our strong dependence on oil. Accordingly, Status of the United States' Dependence on Oil, the first part of a two-part review[‡] on whether our society needs to, and if it is even able to, significantly reduce oil consumption, examines the sources of supply and demand, refining and distribution processes, and how petroleum products are priced and sold to consumers. Although in and of itself a monumental and exceedingly

‡ The second part of this review is a 2007 Interactive Qualifying Project for Worcester Polytechnic Institute, entitled *Stemming the Oil Addiction: The Achievable Goal*, by Michael Sylvester, class of 2008.

complex issue, a critical analysis follows ultimately deciding whether the United States really needs to significantly reduce its oil consumption.

Notes

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The Source of Demand

The primary reason human civilizations around the world have been able to grow, advance, and thrive throughout the last century is due to humankind's ability to exploit the Earth's abundant natural resources for energy. For this reason, the hundreds of advanced technologies employed today would be both unimaginable and inconceivable if it were not for our ability to harness these resources, and to distribute and expend this energy. Because the growth of a nation has a tremendously strong correlation with energy consumption, and therefore petroleum consumption, it is critical in the analysis of crude oil to understand the many different and interrelated, yet equally important, factors that influence growth.

When one considers growth, population size and the strength of a nation's economy are the most prominent aspects referenced. However, literacy and employment rates, life expectancy, government stability, abundance of domestic natural resources, and the outcome of historic events (i.e., a nation's ability to overcome famine, economic depression, world war, terrorism, natural disasters, etc.) also play crucial roles in the growth of a society. Additionally, growth is an indication of wealth, freedom, happiness, and ultimately, quality of life. Keeping this in mind, an increase in energy consumption and exploitation of natural resources within a region and throughout the world is a natural process that runs parallel with the growth of both individual nations and humankind as a whole.

In order to properly examine primary energy and petroleum consumption, various nations and regions throughout the world must be precisely defined geographically. The best way to define these regions is by using the definitions set forth in the *Statistical Review of World*

Energy, a yearly publication by British Petroleum® public limited company (BP® p.l.c.), one of the world's largest energy corporations. This publication contains over fifty-five years of data on all primary energy sources, which includes only reliably documented energy stemming from crude oil, natural gas, coal, and nuclear and hydroelectric power plants.[1] Additionally, since the media, academia, governments, and energy corporations extensively use the *Statistical Review of World Energy*,[2] raw data from the most recent publication in 2006 is used extensively throughout this report.

As illustrated in Figure I: Country Groupings by Geographical Region, the *Statistical Review of World Energy* divides the world into nine different regions: North America, South and Central America, Europe, Former Soviet Union, Middle East, North Africa, West Africa, East and Southern Africa, and Asia Pacific.[3] Additionally, the hierarchal regions of Europe and Eurasia (countries listed under Europe and the Former Soviet Union) and Africa (countries listed under North Africa, West Africa, and East and Southern Africa) are used to further partition the world. Conforming to these geographical regions provides a foundation for understanding the supply and demand of crude oil, how prices of resulting products are affected based on world events throughout these areas, and determining whether it is necessary for our society to reduce its dependence on crude oil and petroleum products.

Since 1965 when BP® p.l.c. first began posting energy information from the *Statistical Review of World Energy* in searchable databases, world primary energy consumption has been rising nearly every year by an average of 2.6 percent.[4] The only period of decreasing energy consumption came in the years 1980 through 1982, corresponding to a major decrease in energy usage in the United States, the largest energy-consuming nation in the world that now accounts for over twenty-two percent of worldwide energy consumption.[5] This factor of a two and three-quarter increase in worldwide energy usage from 1965 to 2005, however, has been somewhat offset with a doubling of the world's population throughout the same period, with an average population increase of 1.63 percent per year.[6] Consequently, although the rather drastic increase in energy consumption has been offset by a similar increase in the world's population, as a whole, humans are still using about 41.5 percent more energy than forty years ago (i.e., since 1965, consumption has increased by more than 41.5 percent when normalized for population).

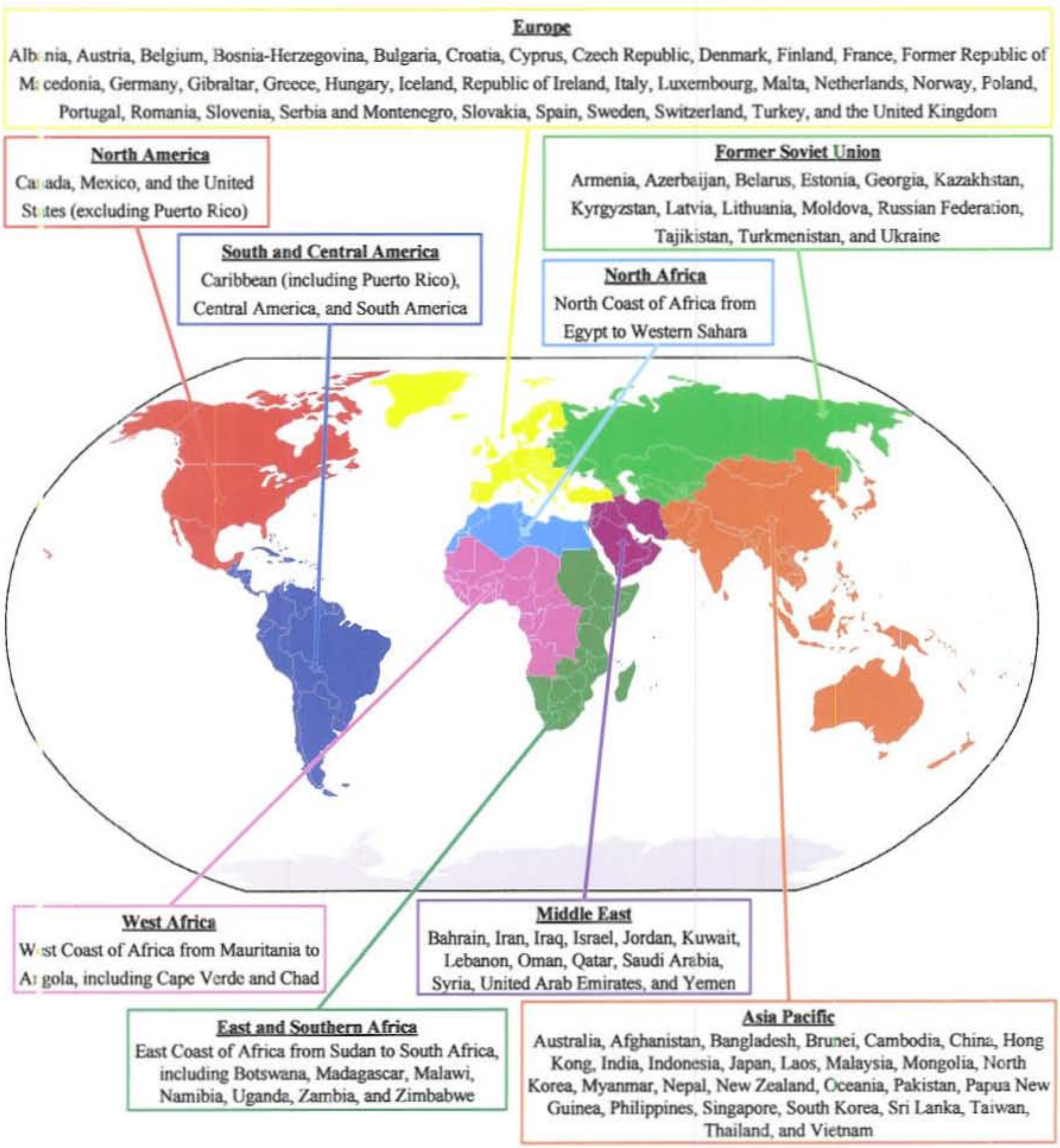

Figure I: Country Groupings by Geographical Region[7]

Utilizing energy data from the *Statistical Review of World Energy*[8] and population estimates from the United States Bureau of the Census,[9] the United States is only using 328 gallons of oil-equivalent energy per person more than in 1965. Spread out over an entire year, this increase equates to each person using nine-tenths a gallon more energy each day than forty years ago. Considering the billions of low-cost, energy-intensive products and technologies that are employed throughout the residential, commercial, industrial, and governmental sectors of the United States today to the relatively few in 1965, this is an extremely remarkable statistic.

Similarly, China, Asia Pacific's largest and the world's second largest energy-consuming nation is only using about 287 gallons of oil-equivalent energy per person[10] more than in 1965.[11] The difference between these two energy intensive nations, however, is that the United States is using 6.58 gallons of oil-equivalent energy per capita per day, whereas China is only using about one gallon per capita per day. Therefore, as illustrated with the world's two largest energy-consuming nations, major energy-consumption gaps arise throughout the world, the direct consequence of uneven worldwide growth and in the end, major differences in quality of life.

More recently, world primary energy consumption rose from 2004 to 2005 by 2.7 percent, just slightly above the long-term forty-year average of 2.6 percent.[12] This increase of 2.7 percent, however, is significantly less than the uncharacteristic 4.4 percent increase from 2003 to 2004, the highest energy-consumption growth rate in over twenty years.[13] Accordingly, growth in primary energy consumption from 2004 to 2005 slowed in all regions of the world for all types of fuel, including petroleum, which saw an approximate four-hundred percent decrease from the growth rate it experienced from 2003 to 2004.[14]

Surprisingly, North America recorded the weakest energy consumption growth at 0.3 percent, mainly due to a *decrease* of 0.1 percent in consumption in the United States.[15] Asia

Pacific, on the other hand, saw a 5.8 percent increase from 2004 to 2005,[16] well above the worldwide average of 2.7 percent. This remarkable increase is solely due to China using 5.8 percent more energy in 2005 than in 2004. In fact, their increase accounted for more than half of the overall increase in worldwide primary energy consumption from 2004 to 2005.[17] Therefore, it can readily be seen that China is the country that is driving worldwide energy consumption growth, whereas the United States is only slowly increasing its already remarkably-high rate.

At this time, before any misconceptions are drawn from these figures and statistics, it should be stated that it is neither bad nor wrong for a nation to experience increasing energy consumption. Whether it is the United States, which is now experiencing relatively slow energy growth, or China, which is experiencing tremendously rapid energy growth, every country should be able to develop their nation as needed and allow for quality of life to grow without bound. Therefore, in reality there is no ground for determining or quantifying energy consumption rates (i.e., whether a nation consumes a high, average, or low amount of energy); the only comparison that can be made is on a country to country or region to region basis.

As one can imagine, the approximately one percent per year increase of primary energy consumption since 1965 (normalized for population fluctuations) and the recent 2.7 percent increase is the direct consequence of increased crude oil consumption. Of the eighty-two billion barrels of oil-equivalent energy consumed throughout the world in 2005, approximately thirty billion (thirty-seven percent) was from crude oil.[18] Coal and natural gas were the only other major energy sources, accounting for twenty-eight percent and twenty-three percent of the total energy consumed, respectively.[19] To put this into perspective, the thirty billion barrels of petroleum consumed in 2005 contains enough gasoline (assuming a standard yield of 19.4 gallons of gasoline per barrel[20] and an automobile that gets fifteen miles per gallon) for a car to drive to and from the sun 46,935 times. In terms of volume, this enormous amount of crude oil is enough to fill 126 million 10,000-gallon[21] oil tanker trucks.

As illustrated in Figure II: World Crude Oil Consumption, worldwide petroleum consumption since 1965 has almost tripled, bringing the most recently recorded BP® p.l.c. total to 82,459,493 barrels per day (thirty billion barrels per year).[22] The only significant periods of decreasing consumption came in the years 1973 through 1975, and again in 1980,[23] corresponding to the Oil Embargo of 1973 and remarkably high oil prices in the early 1980s (largely due to the eight-year Iran-Iraq War). Viewing the data in this manner leads one to believe that humans are in a dire situation, in which citizens of developed counties are running existing oil reserves dry with their ever-increasing addiction to oil. However, one that mistakenly interprets the data this way does not incorporate a major factor that is the driving force for this behavior: rapidly increasing population.

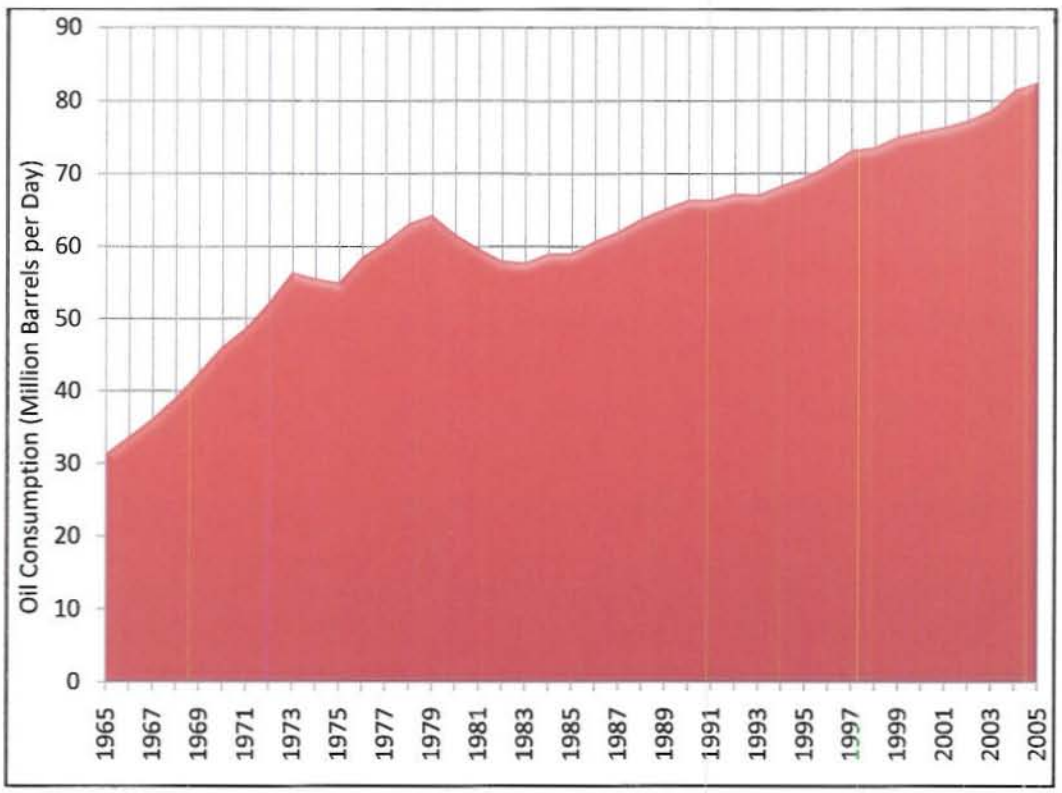

Figure II: World Crude Oil Consumption[24]

Accordingly, in order to fairly analyze petroleum consumption throughout time, raw crude oil data must be normalized for population fluctuations. As illustrated in Figure III: World Crude Oil Consumption (Normalized for Population), humans were consuming more and more oil until 1973.[25] However, once the oil embargo was declared, consumption per person dropped for a period of about two years. Unfortunately, most people (especially Americans) have very short memories and as a result, consumption per capita began to rise until it was abruptly halted by the extremely high crude oil prices in the early 1980s. This ultimately forced consumption to rapidly decline until 1983, when levels began to even out to their present day amounts. Thus, minus the insignificant monthly fluctuations that arise from temporary supply shortages and price spikes, human exploitation of oil over the last twenty-three years has remained at just over a half a gallon of crude oil per person daily.

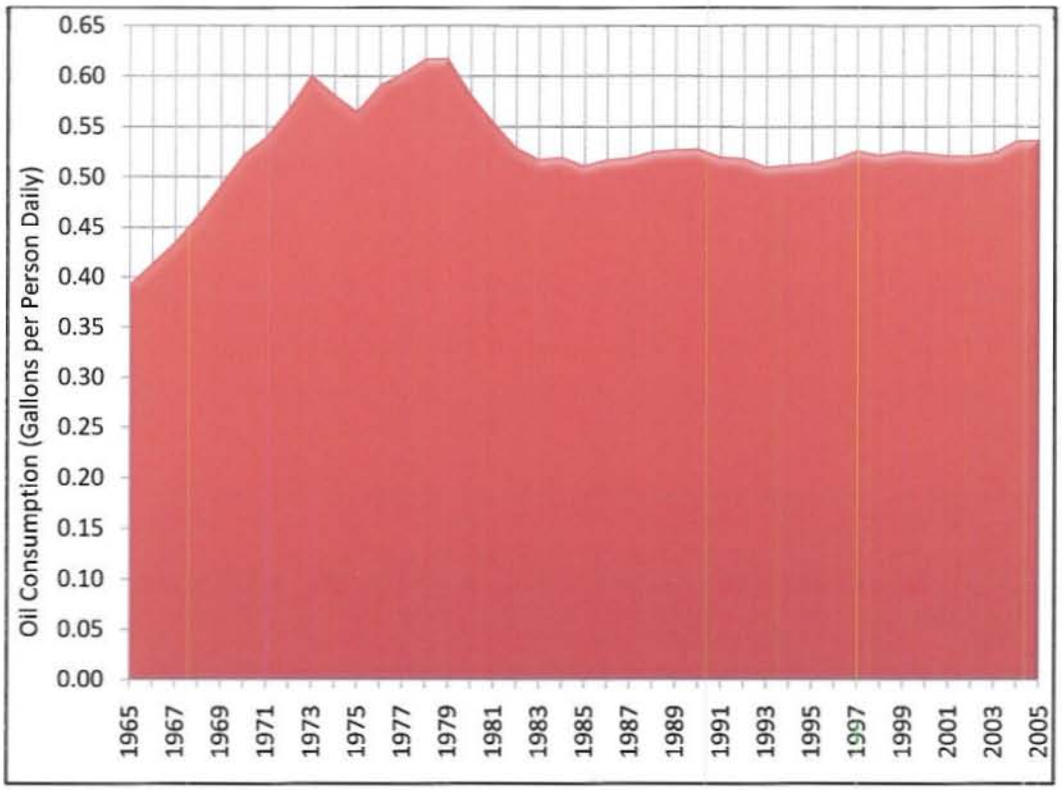

Figure III: World Crude Oil Consumption (Normalized for Population)[26 27]

As expected, crude oil consumption since 1965, including the 82,459,493 barrels consumed each day in 2005, is wildly dispersed throughout the nine geographical regions defined in the *Statistical Review of World Energy*. Unfortunately, it is extremely difficult to find reliable yearly population data on every country in the world to normalize this energy information. However, the United Nations does publish population estimates on a pent-annual basis, dating back to 1950. Therefore, the normalized data illustrated in Figure III can be broken down regionally into five-year blocks with a fairly good degree of accuracy. As follows, Figure IV: Regional Crude Oil Consumption (Normalized for Population), provides a graphical representation of oil consumption per capita between these six different regions.

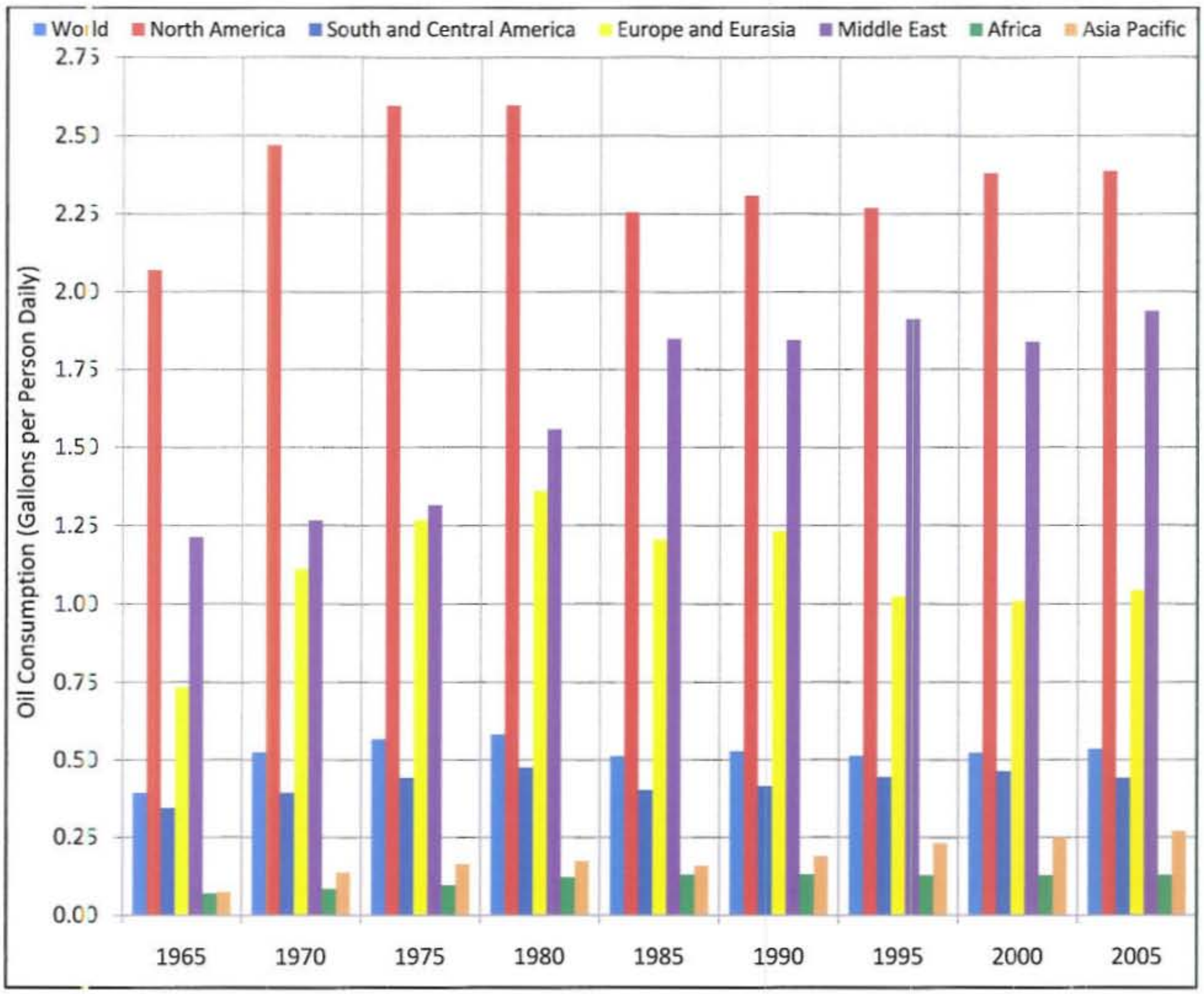

Figure IV: Regional Crude Oil Consumption (Normalized for Population) [28] [29]

From Figure IV, North America consumes the largest amount of crude oil per capita, followed by the Middle East, Europe and Eurasia, South and Central America, Asia Pacific, and Africa. Remarkably, this arrangement has stayed exactly the same throughout each of the five-year blocks from 1965 to 2005, indicating somewhat proportional growth throughout these regions. Due to the high quality of living experienced in North America and Europe and Eurasia, it is not surprising that these regions have very high consumption per capita. Observe, however, that following the sudden decline in North American consumption after 1980, consumption has risen by about an eighth of a gallon per person daily.[30] However, European and Eurasian consumption has been rapidly declining since its peak of 1.361 gallons per person per day in 1980.[31] This is actually the direct result of their governments enforcing outrageously high taxes on crude oil, bringing prices for fuel to six and even seven dollars a gallon.[32] As we will later see, absurdly raising taxes to force a decrease in consumption and an increase in conservation is not, by any means, the way to reduce our dependence on petroleum.

Also, due to China's strong regional leadership in growth, it is fitting that consumption per capita in Asia Pacific is continually increasing. As a result, they have roughly quadrupled their crude oil consumption since 1965.[33] It may also be astonishing to some that Middle Eastern consumption is extremely high compared to practically all other regions of the world. Since 1965, their consumption has increased by about three quarters of a gallon per person,[34] much more than any other region (this statistic is often hidden because of their very small population). Finally, and most regrettably, it is not surprising that Africa has a very low consumption per capita rate, although their levels are starting to rise. Hopefully their small, yet important increase is not solely the result of low life expectancy rates and genocide, which ultimately lowers the African population that does not consume oil, and therefore raises consumption per capita.

All in all, the top-ten largest petroleum consuming nations, in order of increasing 2005 oil consumption rates, are France, Mexico, Canada, South Korea, India, Germany, Russia, Japan, China, and the United States.[35] As illustrated in Table I: 2005 Top-Ten Crude Oil Consuming Nations, the United States, which is the third most populous country in the world, blows everyone out of the water using twenty-five percent of worldwide crude oil. China and Japan are the only other nations with a significant share of the total, consuming 8.49 and 6.50 percent, respectively.[36] The other seven nations, Russia, Germany, India, South Korea, Canada, Mexico, and France, each only accounted for two to three percent of the total oil consumed in 2005.[37]

On a per capita basis, Canadians and Americans consume about the same amount of crude oil, approximately 2.92 gallons each day.[38] Other than that, South Korea and Germany are the only other nations that consume more than a gallon and a half of crude oil on a daily basis.[39] Thus, even between these ten most developed nations whose citizen's have some of the highest qualities of life, enormous consumption per capita gaps exist. Furthermore, as listed in the second to last row in Table I, the top ten petroleum consuming nations account for 51.42 percent of the total population (roughly 3.32 billion people),[40] in which they are using 59.81 percent of all the oil consumed in 2005 (approximately fifty billion barrels).[41]

Rank	Country	2005 Population		2005 Daily Crude Oil Consumption		
		2005	Share of Total	Barrels	Gallons per Person	Share of Total
1	United States	296,410,404	4.59%	20,655,479	2.9268	25.05%
2	China	1,315,844,000	20.40%	6,988,895	0.2231	8.48%
3	Japan	128,085,000	1.99%	5,360,115	1.7576	6.50%
4	Russia	143,202,000	2.22%	2,753,482	0.8076	3.34%
5	Germany	82,689,000	1.28%	2,586,023	1.3135	3.14%
6	India	1,103,371,000	17.10%	2,485,668	0.0946	3.01%
7	South Korea	47,817,000	0.74%	2,308,491	2.0277	2.80%
8	Canada	32,268,000	0.50%	2,241,346	2.9173	2.72%
9	Mexico	107,029,000	1.66%	1,978,822	0.7765	2.40%
10	France	60,496,000	0.94%	1,961,300	1.3617	2.38%
Total		3,317,211,404	51.42%	49,319,621	0.6244	59.81%
World Total		6,451,429,868	100.00%	82,459,493	0.5368	100.00%

Table I: 2005 Top-Ten Crude Oil Consuming Nations[42 43]

Specifically, the United States consumed an average of 20,655,479 barrels of crude oil each day in 2005, three times more than any other nation in the world.[44] From Figure V: U.S. Crude Oil Consumption, this amount is up from the 11,522,188 barrels that were consumed daily in 1965. However, normalizing this for the increase in population (Figure VI: U.S. Oil Consumption (Normalized for Population)), equates to Americans only using four-tenths of a gallon of crude oil more each day than one did forty years ago.[45] Hence, from the endpoints of this data, Americans have somewhat increased their consumption since 1965, but for the most part, consumption remains in check with where it historically should be.[46]

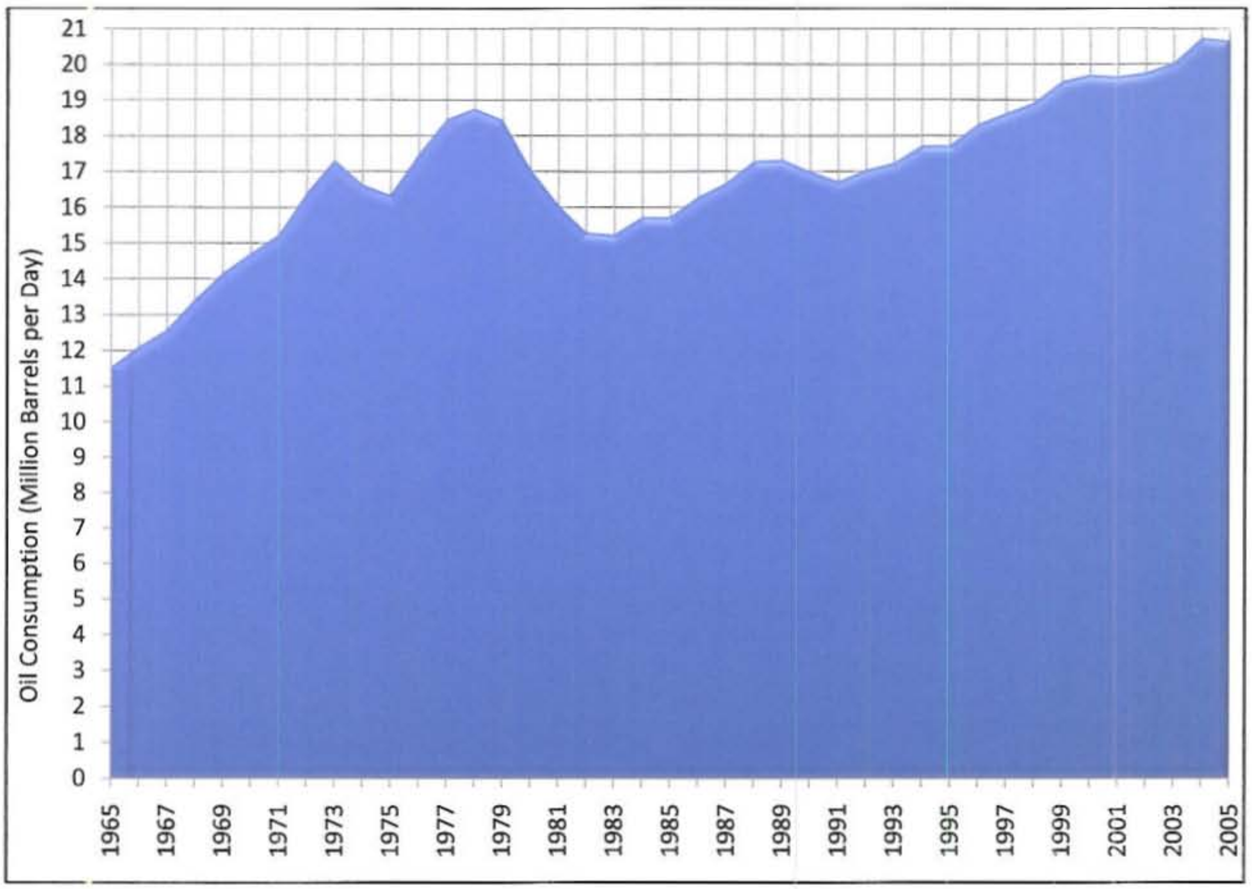

Figure V: U.S. Crude Oil Consumption[47]

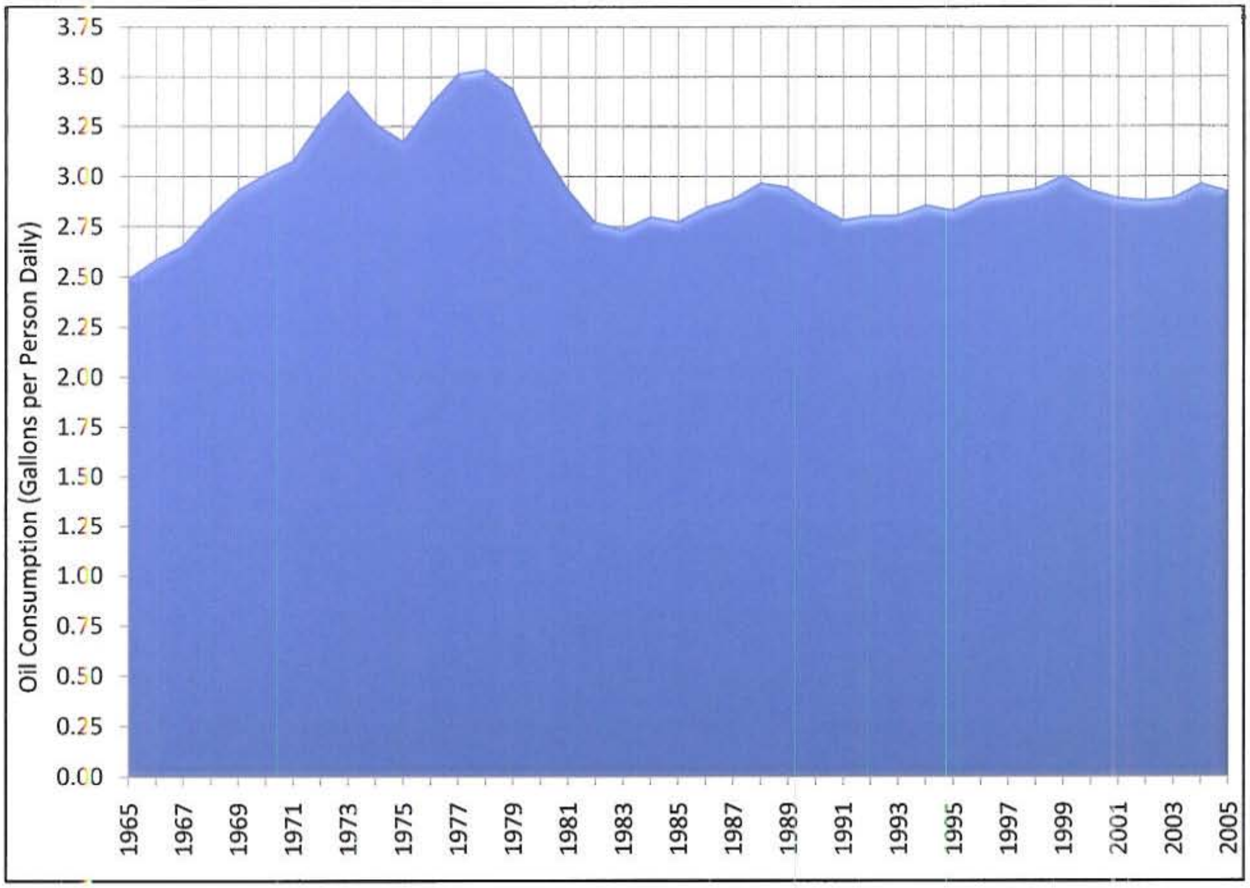

Figure VI: U.S. Oil Consumption (Normalized for Population)[48 49]

Further analyzing the normalized petroleum data in the United States (Figure VI), we see that, at times during the late 1970s and early 1980s, consumption reached unprecedented levels. The only thing that brought the consumption of three and a half gallons per person down to their present day levels were the oil embargo and record high oil prices. Thus, the justification for the many more rapid, short-term fluctuations in consumption per person in the United States (Figure VI) compared to normalized worldwide petroleum consumption (Figure III) is that American's are extremely susceptible to price spikes. And, as a result, minor disruptions ranging from war (e.g., the Persian Gulf War in 1990) to devastating natural disasters (e.g., hurricanes Katrina, Rita, and Wilma in late 2005) cause immediate instability and prompt fluctuations in consumption.

With over two hundred million motor vehicles in the United States traveling more than seven billion miles per day,[50] Americans are persistently driving more and more as we grow as a society and our way of life continuously improves. Consequently, the reason why our consumption per capita has maintained this constant over the last twenty-three years is due more in part to increased fuel efficiency than energy conservation. Nonetheless, rates are ever-so-slowly beginning to rise on a per capita basis, possibly an early indication that we are resuming to our old habits from the 1970s. As a role model for the world, the United States needs to embrace history and not resume to consuming petroleum too liberally, as Americans quite possibly did in the 1970s. With a national economy and a way of life that is so dependent on citizens being able to travel, consumption of crude oil needs to stay historically in check at around 2.875 gallons per person until another viable, less fragile energy source is discovered.

Notes

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The Source of Supply

Expectedly, the more than eighty-two million barrels of crude oil that is consumed throughout the world each day is supplied from a wide range of nations, some of which are net oil exporters, though most are net oil importers. Of the world's top-ten oil consuming nations in 2005, only Russia, Canada, and Mexico were net oil exporters.[1] The remaining seven countries, especially the United States, China, and Japan, were heavily reliant on other nations to supply their petroleum needs from which their domestic production could not fulfill.[2] Fortunately, several countries have both the resources and capacity to supply these petroleum requests as well as themselves. Essentially, these countries, along with a few of the net importers, constitute the vast majority of worldwide production of crude oil, which can ultimately be divided into two categories: OPEC production and non-OPEC production.

The Organization of Petroleum Exporting Countries (OPEC), debatably the most well-known and controversial organization in the world, currently holds about seventy-five percent of proven petroleum reserves and accounts for more than forty-one percent of the total crude oil produced in the world today.[3] Specifically, they are an international organization of twelve countries that extensively export crude oil, which their economies are profoundly reliant on. The organization, which is currently headquartered in Vienna, Austria, was founded by Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela at the Baghdad Conference in Baghdad, Iraq from September 10 – 14, 1960.[4] The five founding members were later joined by Qatar (1961), Indonesia (1962), Libya (1962), the United Arab Emirates (1967), Algeria (1969), Nigeria

(197), and most recently, Angola (2007).[5] Ecuador (1973) and Gabon (1975) were also members of OPEC, though they withdrew from the organization in 1992 and 1995, respectively.[6]

OPEC claims to "co-ordinate and unify petroleum policies among Member Countries, in order to secure fair and stable prices for petroleum producers; an efficient, economic and regular supply of petroleum to consuming nations; and a fair return on capital to those investing in the industry".[7] In other words, OPEC manages its members' collective supply of crude oil "through individual production quotas in order to influence world oil prices".[8] By cutting production and therefore limiting the amount of crude oil on the market, OPEC can increase prices to their satisfaction. On the other hand, it is extremely rare, if ever, for non-OPEC producing countries to manipulate production, however, some top producers such as Mexico, Norway, and Oman have announced intensions of doing so in the past.[9]

As illustrated in Figure I: OPEC and Non-OPEC Crude Oil Production, production from the so-called twelve-member cartel reached a maximum of 52.85 percent (i.e., non-OPEC production reached a minimum of 47.15 percent) of total production in 1973.[10] However, once the world realized the severe instability in OPEC production after the Oil Embargo in 1973, supplies from non-OPEC countries rapidly increased, even during periods of decreasing consumption. Therefore, from the time when crude prices were extraordinarily high in 1980 and through much of the 1980s and early 1990s, non-OPEC countries significantly surpassed OPEC countries in the production of petroleum. This inevitably led to non-OPEC producing nations taking as much as 70.95 percent of the share of worldwide crude oil production by 1985.[11] Unfortunately, the fate of crude oil production is swinging back to OPEC members as consumption reaches unprecedented levels and their seventy-five percent of proven petroleum reserves comes dangerously into play.

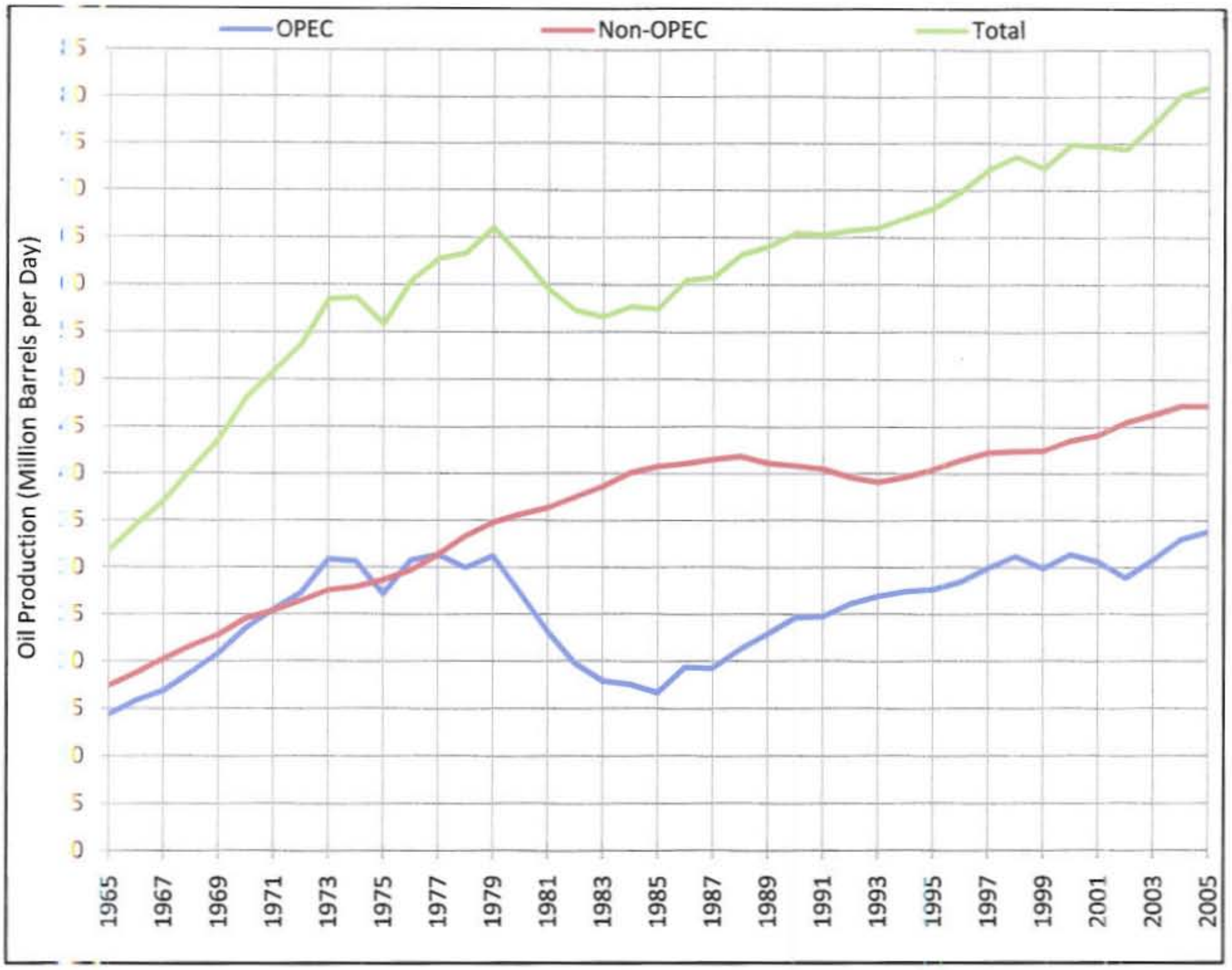

Figure I: OPEC and Non-OPEC Crude Oil Production[12]

In addition to focusing on petroleum production on an OPEC versus non-OPEC basis, a more geographical visualization (Figure II: Crude Oil Production by Geographical Area) reveals the fact that the Middle East, along with Europe and Eurasia, have dominated worldwide crude oil production for the last forty years. Behind the scenes of the production in these two regions are Saudi Arabia (a Middle Eastern OPEC member) and Russia, which together accounted for more than twenty-five percent of the total crude oil produced throughout the world in 2005.[13] Similarly, the United States drives North American production by providing anywhere between fifty and sixty percent of the region's total petroleum supply, and Venezuela, the only OPEC member in the Western Hemisphere, consistently supplies about half of all the oil produced in

South and Central America.[14] Thus, there is generally only one to two major nations in each sector of the world that account for an enormous percentage of the region's total production. This ultimately leaves the future of crude oil production, and more importantly, our way of life, in the hands of only a few countries.

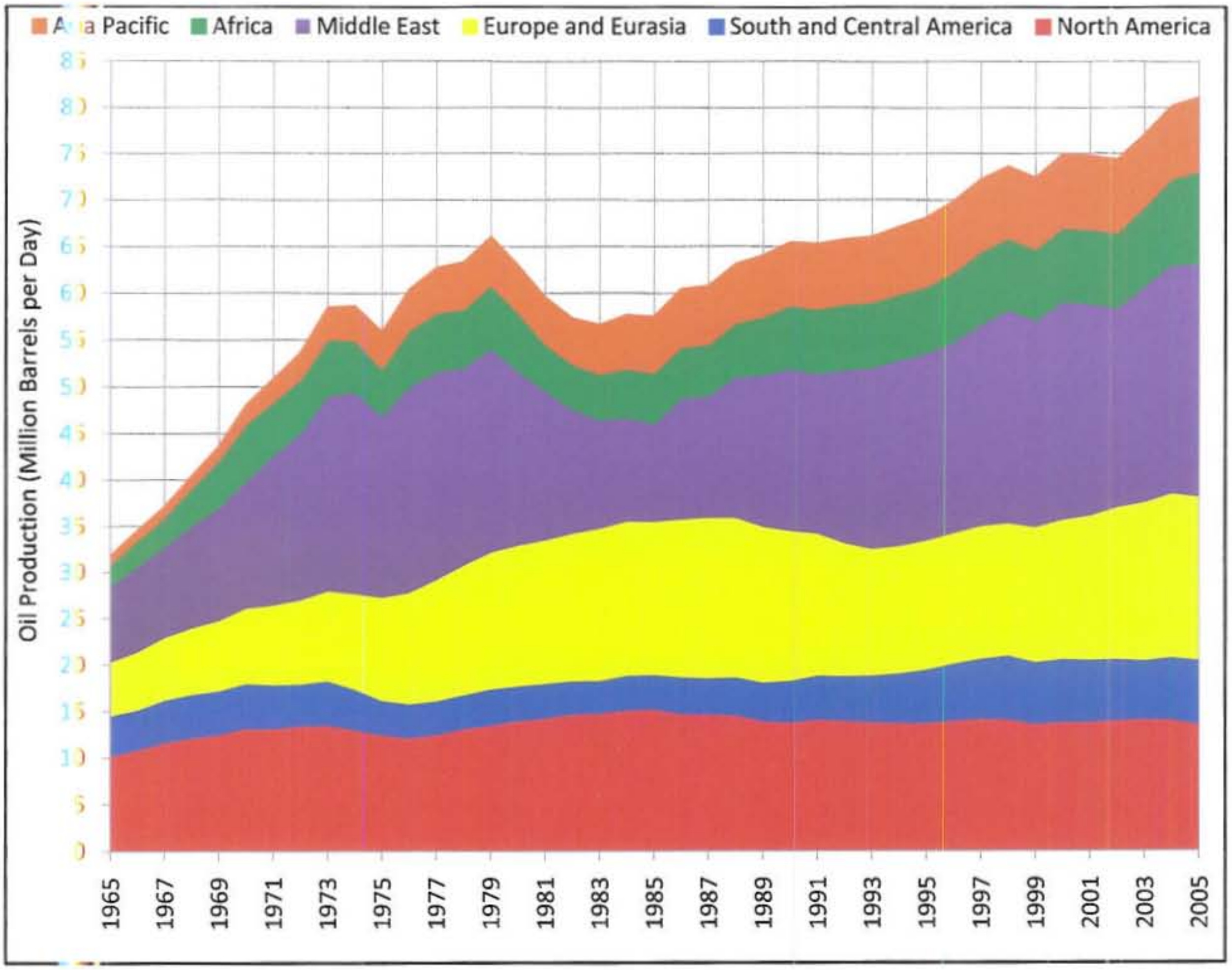

Figure II: Crude Oil Production by Geographical Area[15]

The most recent data on worldwide crude oil production, provided by the *Statistical Review of World Energy*, is from 2005, in which OPEC producers increased production from 2004 by 900,000 barrels per day.[16] This actually accounted for nearly all of the increase in global production in 2005. In particular, Saudi Arabia used existing and newly installed production capacity to increase its rate to more than eleven million barrels per day, with Kuwait and Qatar each putting an additional 100,000 barrels per day online.[17] Angola, who at the time was not a full-time member of OPEC, saw their crude oil production grow by more than 250,000 barrels per day, mainly due to new efficient deepwater crude oil production.[18] Nevertheless, due to the start of the now ongoing insurgency in Iraq, Iraqi production declined by nearly 200,000 barrels per day to bring its total average daily production level to just over 1.8 million barrels.[19]

Growth of crude oil production outside of OPEC, however, was the weakest since 1993, only increasing by about 50,000 barrels per day.[20] Accordingly, United States production fell by an average of 400,000 barrels per day,[21] a direct consequent of Hurricane Katrina, which on the first day alone brought 1.4 million barrels of production to a screeching halt.[22] Similarly, production in the United Kingdom and Norway, the first and second largest crude oil producing countries in Europe, fell by more than 200,000 barrels per day.[23] However, Azerbaijan, Brazil, and China helped offset these large deficiencies by each adding more than 100,000 barrels per day to their existing production levels.[24] Additionally, Russia added 260,000 barrels per day to its total production of crude oil, although this increase was only a third of that seen from 2003 to 2004.[25]

In terms of the largest petroleum producing nations, less than six percent of the countries in the world supplied more than sixty-two percent of the total crude oil produced in 2005.[26] These nations, in order of increasing petroleum production, were the United Arab Emirates, Norway, Venezuela, Canada, China, Mexico, Iran, the United States, Russia, and Saudi Arabia.[27] Of these top-ten producers, four were OPEC members (Saudi Arabia, Iran, Venezuela, and the United Arab Emirates), who alone accounted for more than a quarter of worldwide production.[28] The remaining six non-OPEC members (Russia, the United States, Mexico, China, Canada, and

Norway) supplied about thirty-seven percent of the total petroleum produced in 2005, with the United States and Russia producing more than twenty percent of the total.[29]

Furthermore, of the twenty-one countries in 2005 that produced more than a million barrels of crude oil per day, more than half were avid OPEC members (i.e., all eleven OPEC members, not including Angola, produced more than a million barrels of crude oil in 2005).[30] These countries essentially supply the bulk of the world's, and more prominently, the United States', thirst for crude oil.[31] Therefore, as illustrated in Figure III: Crude Oil Production by Country, and as described above, major production of petroleum lies in the hands of only a few select nations. As a result, diversification of petroleum supplies is in the end, heavily limited to countries in the Middle East and Africa, most of which are OPEC members with varying agendas, as well as the United States and Russia. Ultimately, these twenty-one countries provide more than eighty-six percent of the petroleum that is produced, and therefore consumed, throughout the world every single day.[32]

Most European countries, along with Japan and China, secure the vast majority of their crude oil from Middle Eastern, OPEC-member countries, such as Saudi Arabia, Iran, Kuwait, Qatar, and the United Arab Emirates.[33] These supplies, though unstable, are some of the geographically closest supplies available to these nations. Conversely, the United States, which in 1973 learned more than any other nation of the dangers of being overly dependent on Middle Eastern oil, gets more than half of their crude from countries in the Western Hemisphere, most notably Canada and Mexico.[34] This allows for a steady supply of petroleum that does not have to be shipped far, hence keeping crude oil prices lower and, as described in Chapter 6: Does Our Society Need to Significantly Reduce Oil Consumption?, eliminating nearly all transit chokepoints.[35]

Figure III: Crude Oil Production by Country[36]
(Source: *Understanding Today's Crude Oil and Product Market*)[37]

Unlike with the *Statistical Review of World Energy*, the Energy Information Administration (EIA), a division of the United States Department of Energy, provides specifics about imports and domestic production of crude oil in the United States more or less in real-time. The EIA, which was founded by congress a few years after the Oil Embargo,[38] maintains hundreds of thousands of monthly and yearly data entries on almost every form of energy produced and consumed in the United States. Most applicable is their information on crude oil and petroleum products, including data on domestic production, imports into the United States (including those for storage in the Strategic Petroleum Reserve), prices, supply and demand, refinery capacity, and refinery utilization.

Using this data as a stepping-stone into exactly where the United States gets their crude oil and petroleum products, we see from Figure IV: U.S. Crude Oil and Petroleum Product Imports by Geographical Area, that since the mid 1980s, approximately thirty percent of all imports have come from North America.[39] South and Central America have also provided the United States with substantial oil supplies, averaging about twenty-four percent of total imports over the last thirty-four years.[40] Imports from Africa and the Middle East have averaged about fifteen and twenty percent, respectively, although in the early 1980s, their supply to the United States was substantially less.[41] Moreover, petroleum supplies from Europe and Eurasia have increased exponentially by a factor of twenty-five since their minimum in 1977, while Asia Pacific has, at best, exported negligible amounts of crude oil into the United States.[42]

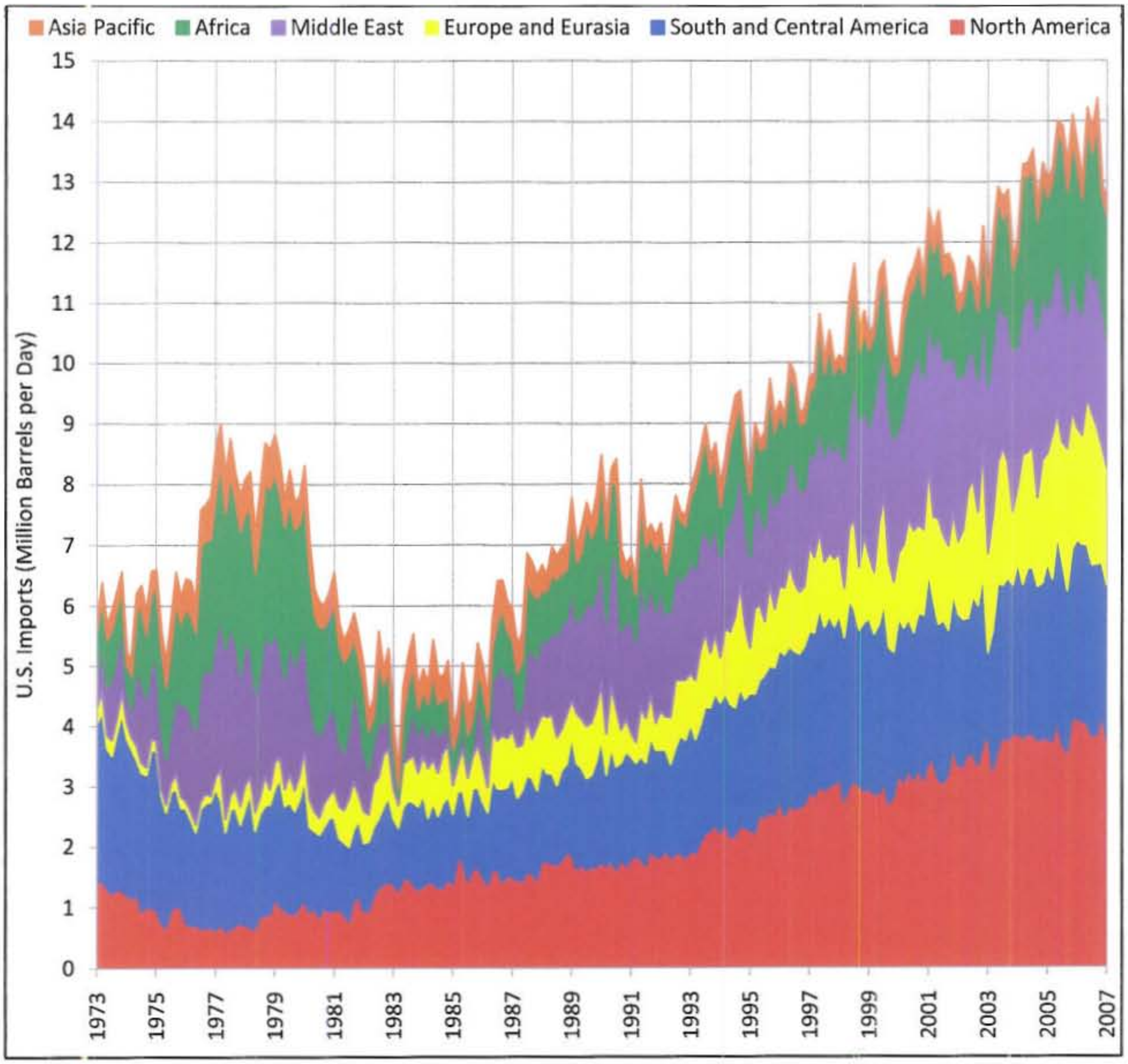

Figure IV: U.S. Crude Oil and Petroleum Product Imports by Geographical Area[43]

Looking at imports on an OPEC versus non-OPEC basis reveals that the United States' supply of crude oil and petroleum products over the last thirty-four years have remarkably, at some time or another, perfectly mirrored the individual imports from the two different suppliers. As displayed in Figure V: U.S. Crude Oil and Petroleum Product Imports, total imports from all countries precisely followed the supply from OPEC nations until 1990. Conversely, total imports since have followed the more secure source of petroleum that emanates from nations that are not members of OPEC. This type of behavior happens to be a very good thing for the United States; it means that our dependence on oil is now being complemented by OPEC production, not controlled by it, as it was in much of the 1970s and 1980s. This strong correlation with non-OPEC production may very well be significant if another oil embargo is declared.

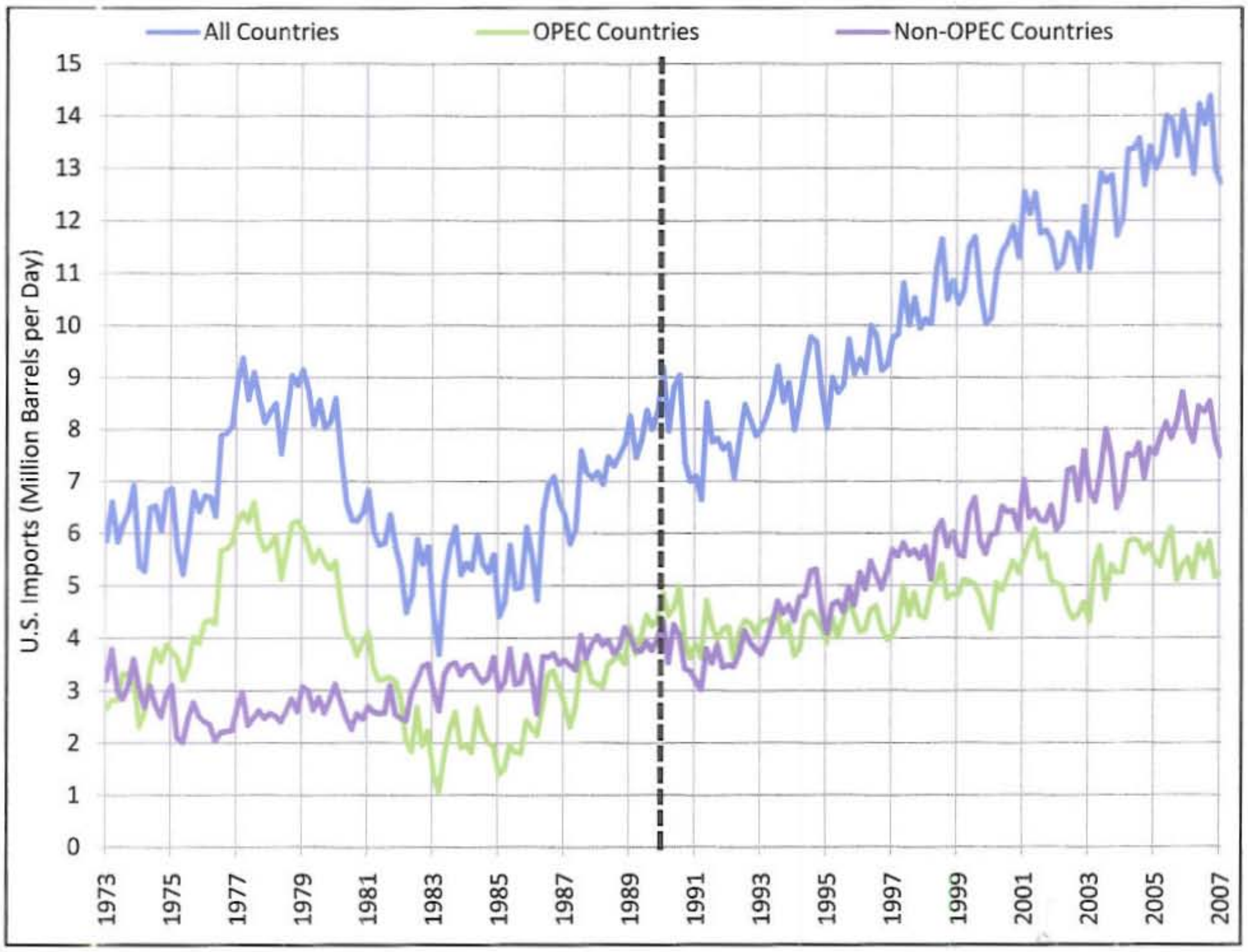

Figure V: U.S. Crude Oil and Petroleum Product Imports[44]

Since Venezuela, Saudi Arabia, Iraq, and Iran are the most controversial and publicly known crude oil producing nations to Americans, their imports into the United States have been further detailed in Figure VI: Notable U.S. Crude Oil and Petroleum Product Imports from OPEC Members. Iran, the world's fourth largest producer, has not exported a significant amount of crude oil to the United States in over twenty-seven years, and none since 1992. Iraq has followed a similar course; however, unlike with Iran, their exports into the United States have recovered following the Iran-Iraq War in the late 1980s, sanctions after the Persian Gulf War in the 1990s, and the Iraq War in 2003. Fortunately, the two other behemoth oil-producing nations – Saudi Arabia and Venezuela – were able to increase production during these times of decreased supply, especially during the 1990s following the aftermath of the Persian Gulf War.

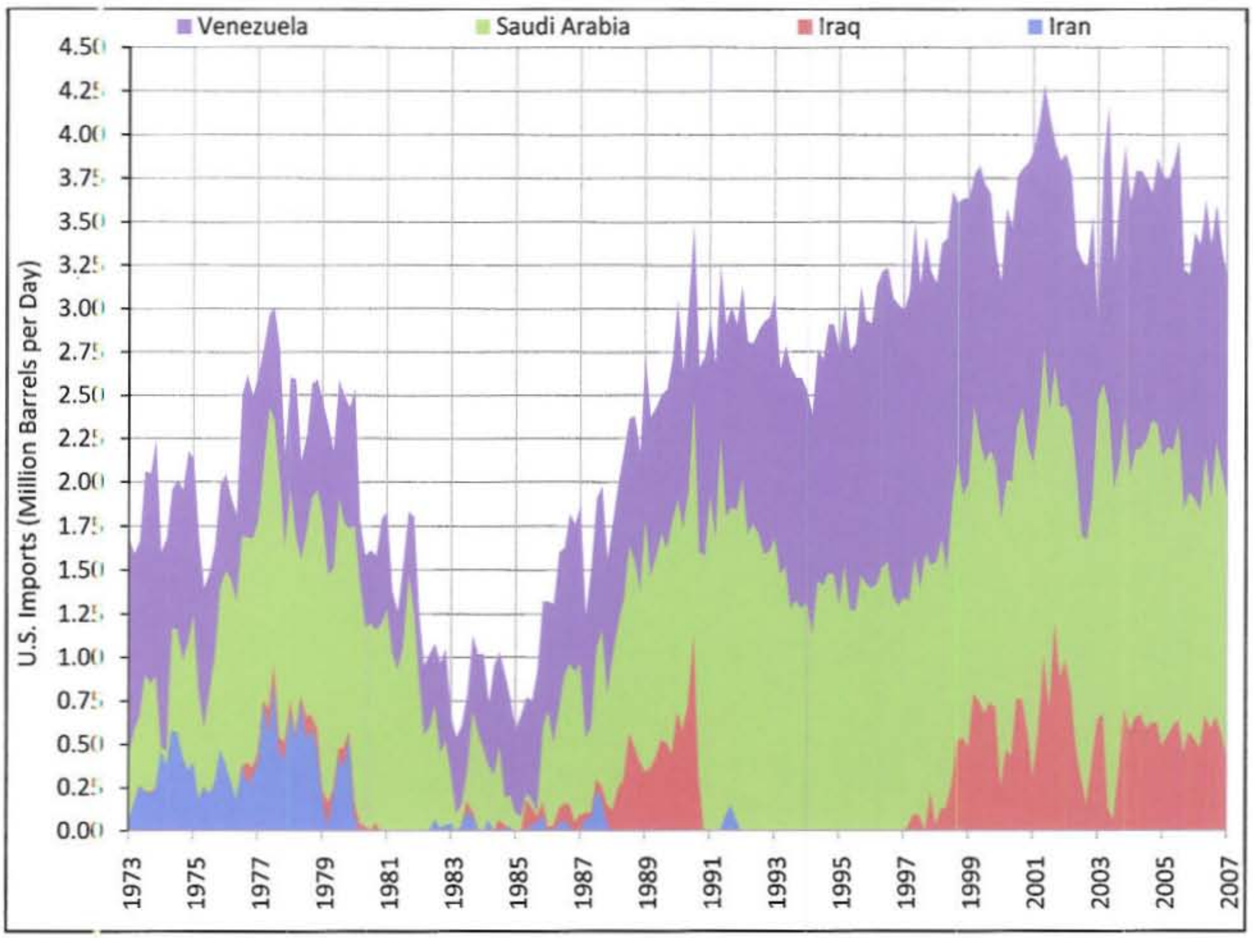

Figure VI: Notable U.S. Crude Oil and Petroleum Product Imports from OPEC Members[45]

Although the United States is importing between fourteen and fifteen million barrels of petroleum each day, consumption is in excess of twenty million barrels per day, leaving an enormous gap of five to six million barrels per day. Therefore, in order to meet the petroleum needs of Americans, the United States supplements their crude oil and petroleum product imports by domestically producing crude oil. This production, which today is accounting for about twenty-eight percent of the petroleum consumed in the United States,[46] is categorized by Petroleum Administration for Defense Districts (PADD's). These five different state groupings, which are illustrated in Figure VII: Petroleum Administration for Defense Districts, were defined by the Petroleum Administration for Defense in 1950, and are based on regional districts that were employed to administer petroleum rations throughout the United States during World War II.[47]

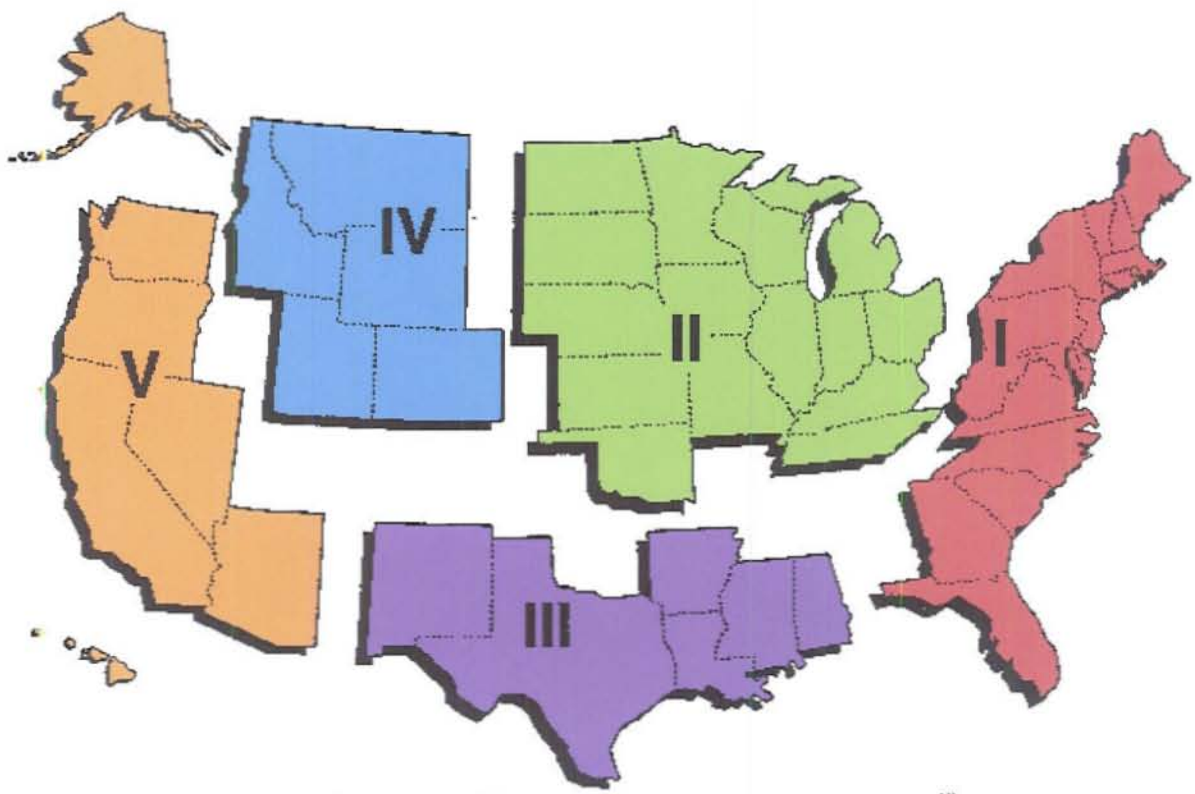

Figure VII: Petroleum Administration for Defense Districts[48]

In total, there are about thirty-one oil producing states, with production levels varying anywhere between 1,000 and 1,450,000 barrels per day.[49] Typically, the largest areas of domestic production of crude oil are in the Gulf of Mexico and Texas in PADD III, and Alaska and California in PADD V.[50] Furthermore, of the seventeen states in PADD I, only five states – Florida, New York, Pennsylvania, Virginia, and West Virginia – produced petroleum in 2006.[51] In PADD II, twelve out of fifteen states produced crude oil (Illinois, Indiana, Kansas, Kentucky, Michigan, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, and Tennessee), and in PADD III, all six states were producers (Alabama, Arkansas, Louisiana, Mississippi, New Mexico, and Texas).[52] Similarly, four out of five PADD IV states produced oil in 2006 (Colorado, Montana, Utah, and Wyoming), along with an additional four out of seven states in PADD V (Alaska, Arizona, California, and Nevada).[53]

Conveniently, the Energy Information Administration has kept monthly records on the domestic production of crude oil since January 1, 1920, specifics on individual PADDs and these thirty-one states since January 1, 1981, and has data up to January 1, 2007 (there is approximately a three month latency period from petroleum production to publication). Plotted over time (Figure VIII: U.S. Crude Oil Production), this data becomes by far, *the most significant source of information* en route to analyzing the current status of the United States' dependence on oil. This, together with the basic knowledge that consumption in the United States as a whole, not per capita, is progressively rising by about 225,000 barrels per year,[54] provides the history and quite possibly, the inevitable future, of our dependence on foreign sources of oil.

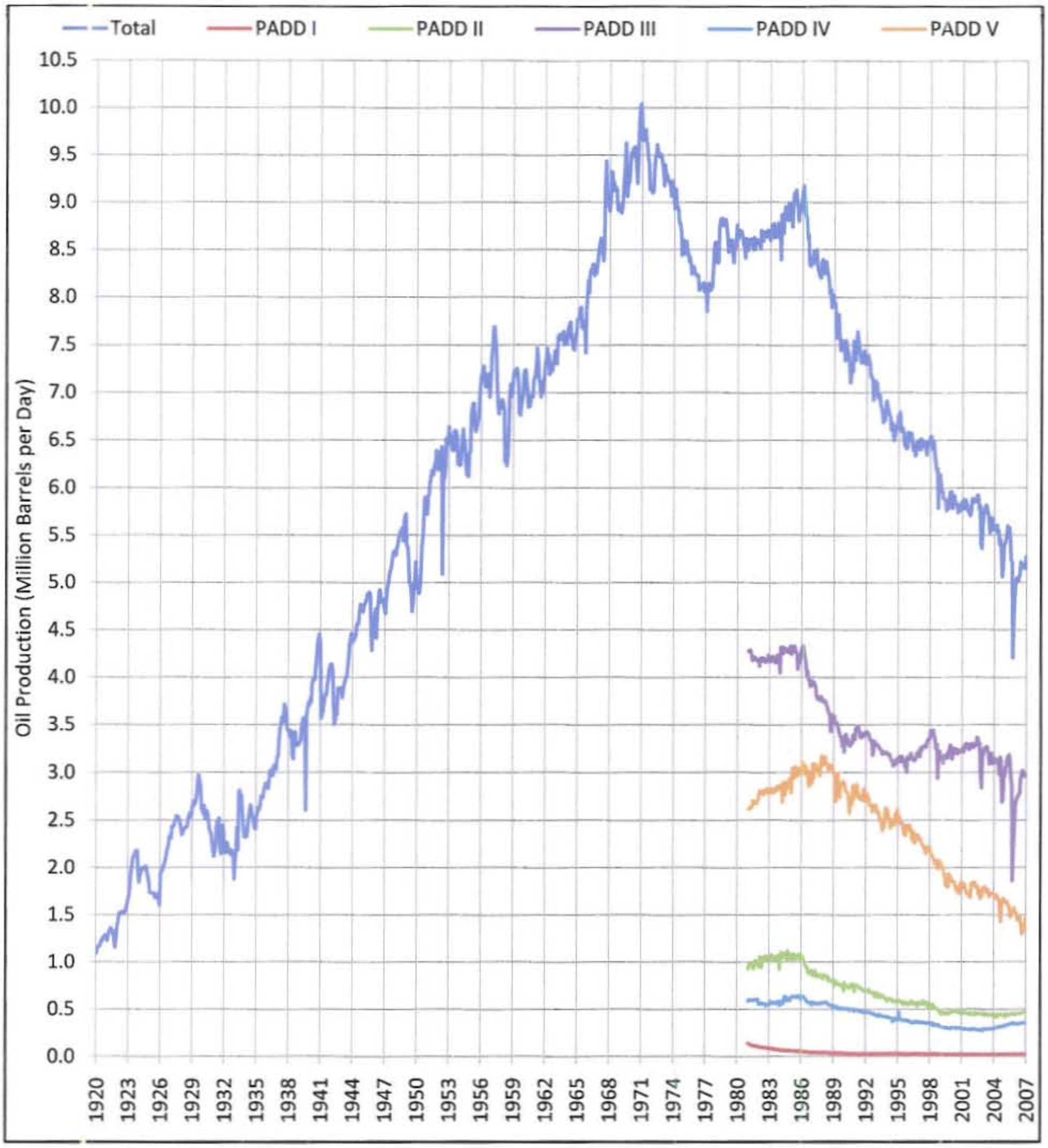

Figure VIII: U.S. Crude Oil Production[55]

Domestic petroleum production from 1920 to 1971 increased relatively linearly in the United States by roughly 150,000 barrels per year, reaching a peak of over 10,044,000 barrels per day in November 1971.[56] On the contrary, since their second maximum production echelon of 9,173,000 barrels per day in February 1986, supplies have radically descended by over 180,000 barrels per year, bringing current production levels to less than 5.3 million barrels per day (one reason for this decline in production is presented in Chapter 6: Does Our Society Need to Significantly Reduce Oil Consumption).[57] In particular, PADD V production has drastically fallen, with PADD III levels following in a similar manner, although not as severely. (It should be noted that the severe spike in total oil production in August 2005 is the direct consequent of Hurricane Katrina, Rita, and Wilma devastating some of the Gulf Coast states in PADD III, and is the sole reason why gasoline prices skyrocketed from late August through the end of 2005.)

Combining this domestic production with petroleum imports yields a very good insight into where the United States stands with respect to crude oil and its dependence on foreign countries to supply its energy needs. Table I: Top-Fifteen U.S. Crude Oil and Petroleum Product Importers in 2006, displays the average monthly supplies in thousands of barrels per day (TBPD) from the fifteen largest importing countries to the United States. It also shows each nation's oil imports as a percentage of the monthly total, as well as the total amount of petroleum products supplied to the market each month.

These fifteen countries – Canada, Mexico, Saudi Arabia, Venezuela, Nigeria, Algeria, Angola, Iraq, Russia, the Virgin Islands, Ecuador, the United Kingdom, Norway, Brazil, and Kuwait – along with a handful of other small exporting nations, provided 72.6 percent of the total crude oil and petroleum products that were delivered to the market in 2006.[58] The six OPEC suppliers – Saudi Arabia, Venezuela, Nigeria, Algeria, Iraq, and Kuwait – accounted for more than forty percent of the United States' petroleum imports; however, this was only about twenty-nine percent of what was delivered to the market. In other words, of the petroleum Americans consumed in 2006, 72.6 percent was from foreign sources and 27.4 was domestically produced. Furthermore, of the 72.6 percent of foreign oil consumed, 40.4 percent was from OPEC members, accounting for 29.3 percent of America's total oil consumption in 2006[59]

		Canada	Mexico	Saudi Arabia	Venezuela	Nigeria	Algeria	Angola	Iraq	Russia	Virgin Islands	Ecuador	UK	Norway	Brazil	Kuwait	Domestic	Total Imports	OPEC
	Rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	-	-	-
January	BPD	2,311	1,796	1,369	1,539	1,186	713	433	532	218	277	380	187	205	106	74	5,047	13,576	5,522
	% of Imports	17.0%	13.2%	10.1%	11.3%	8.7%	5.3%	3.2%	3.9%	1.6%	2.0%	2.8%	1.4%	1.5%	0.8%	0.5%	0.0%	83.4%	40.7%
	% of Supply	12.4%	9.6%	7.4%	8.3%	6.4%	3.8%	2.3%	2.9%	1.2%	1.5%	2.0%	1.0%	1.1%	0.6%	0.4%	27.1%	72.9%	29.7%
February	BPD	2,262	1,878	1,451	1,475	1,377	446	478	450	304	318	234	205	199	203	158	5,048	13,320	5,448
	% of Imports	17.0%	14.1%	10.9%	11.1%	10.3%	3.3%	3.6%	3.4%	2.3%	2.4%	1.8%	1.4%	1.5%	1.5%	1.2%	0.0%	85.7%	40.9%
	% of Supply	12.3%	10.2%	7.9%	8.0%	7.5%	2.4%	2.6%	2.4%	1.7%	1.7%	1.3%	1.1%	1.1%	1.1%	0.9%	27.5%	72.5%	29.7%
March	BPD	2,254	1,801	1,364	1,530	1,195	404	522	476	221	299	242	299	209	193	118	5,016	12,887	5,138
	% of Imports	17.5%	14.0%	10.6%	11.9%	9.3%	3.1%	4.1%	3.7%	1.7%	2.3%	1.9%	1.4%	1.6%	1.5%	0.9%	0.0%	85.4%	39.9%
	% of Supply	12.6%	10.1%	7.6%	8.5%	6.7%	2.3%	2.9%	2.7%	1.2%	1.7%	1.4%	1.7%	1.2%	1.1%	0.7%	28.0%	72.0%	28.7%
April	BPD	2,238	1,750	1,595	1,393	1,098	543	419	531	218	239	319	315	206	169	225	5,067	13,360	5,477
	% of Imports	16.8%	13.1%	11.9%	10.4%	8.2%	4.1%	3.1%	4.0%	1.6%	1.8%	2.4%	1.4%	1.5%	1.3%	1.7%	0.0%	83.3%	41.0%
	% of Supply	12.1%	9.5%	8.7%	7.6%	6.0%	2.9%	2.3%	2.9%	1.2%	1.3%	1.7%	1.7%	1.1%	0.9%	1.2%	27.5%	72.5%	29.7%
May	BPD	2,313	1,710	1,492	1,470	1,189	643	391	666	620	373	246	349	199	140	226	5,100	14,223	5,782
	% of Imports	16.3%	12.0%	10.5%	10.3%	8.4%	4.5%	2.7%	4.7%	4.4%	2.6%	1.7%	1.4%	1.4%	1.0%	1.6%	0.0%	83.5%	40.7%
	% of Supply	12.0%	8.8%	7.7%	7.6%	6.2%	3.3%	2.0%	3.4%	3.2%	1.9%	1.3%	1.8%	1.0%	0.7%	1.2%	26.4%	73.6%	29.9%
June	BPD	2,258	1,855	1,522	1,306	1,094	740	565	617	429	273	295	355	140	151	201	5,219	14,143	5,649
	% of Imports	16.0%	13.1%	10.8%	9.2%	7.7%	5.2%	4.0%	4.4%	3.0%	1.9%	2.1%	1.4%	1.0%	1.1%	1.4%	0.0%	82.3%	39.9%
	% of Supply	11.7%	9.6%	7.9%	6.7%	5.7%	3.8%	2.9%	3.2%	2.2%	1.4%	1.5%	1.8%	0.7%	0.8%	1.0%	27.0%	73.0%	29.2%
July	BPD	2,114	1,709	1,313	1,467	1,073	743	695	592	425	353	181	340	236	279	155	5,171	13,837	5,505
	% of Imports	15.3%	12.4%	9.5%	10.6%	7.8%	5.4%	5.0%	4.3%	3.1%	2.6%	1.3%	1.4%	1.7%	2.0%	1.1%	0.0%	83.3%	39.8%
	% of Supply	11.1%	9.0%	6.9%	7.7%	5.6%	3.9%	3.7%	3.1%	2.2%	1.9%	1.0%	1.8%	1.2%	1.5%	0.8%	27.2%	72.8%	29.0%
August	BPD	2,468	1,758	1,514	1,438	1,026	803	544	620	485	377	292	262	255	311	155	5,155	14,612	5,718
	% of Imports	16.9%	12.0%	10.4%	9.8%	7.0%	5.5%	3.7%	4.2%	3.3%	2.6%	2.0%	1.4%	1.7%	2.1%	1.1%	0.0%	83.8%	39.1%
	% of Supply	12.5%	8.9%	7.7%	7.3%	5.2%	4.1%	2.8%	3.1%	2.5%	1.9%	1.5%	1.3%	1.3%	1.6%	0.8%	26.1%	73.9%	28.9%
September	BPD	2,262	1,569	1,564	1,384	1,078	796	678	655	534	396	326	239	159	191	227	5,188	14,375	5,838
	% of Imports	15.7%	10.9%	10.9%	9.6%	7.5%	5.5%	4.7%	4.6%	3.7%	2.8%	2.3%	1.4%	1.1%	1.3%	1.6%	0.0%	83.6%	40.6%
	% of Supply	11.6%	8.0%	8.0%	7.1%	5.5%	4.1%	3.5%	3.3%	2.7%	2.0%	1.7%	1.2%	0.8%	1.0%	1.2%	26.5%	73.5%	29.8%
October	BPD	2,144	1,646	1,382	1,354	1,088	813	536	505	381	335	322	205	181	221	239	5,195	13,324	5,525
	% of Imports	16.1%	12.4%	10.4%	10.2%	8.2%	6.1%	4.0%	3.8%	2.9%	2.5%	2.4%	1.4%	1.4%	1.7%	1.8%	0.0%	85.0%	41.5%
	% of Supply	11.6%	8.9%	7.5%	7.3%	5.9%	4.4%	2.9%	2.7%	2.1%	1.8%	1.7%	1.1%	1.0%	1.2%	1.3%	28.1%	71.9%	29.8%
November	BPD	2,598	1,584	1,491	1,275	972	462	521	573	223	331	248	291	174	182	259	5,149	12,955	5,153
	% of Imports	20.1%	12.2%	11.5%	9.8%	7.5%	3.6%	4.0%	4.4%	1.7%	2.6%	1.9%	1.4%	1.3%	1.4%	2.0%	0.0%	85.5%	39.8%
	% of Supply	14.4%	8.7%	8.2%	7.0%	5.4%	2.6%	2.9%	3.2%	1.2%	1.8%	1.4%	1.6%	1.0%	1.0%	1.4%	28.4%	71.6%	28.5%

		Canada	Mexico	Saudi Arabia	Venezuela	Nigeria	Algeria	Angola	Iraq	Russia	Virgin Islands	Ecuador	UK	Norway	Brazil	Kuwait	Domestic	Total Imports	OPEC
	Rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	-	-	-
December	TBPD	2,412	1,366	1,491	1,271	1,066	677	620	419	369	334	256	199	178	162	169	5,275	12,711	5,232
	% of Imports	19.0%	10.7%	11.7%	10.0%	8.4%	5.3%	4.9%	3.3%	2.9%	2.6%	2.0%	1.4%	1.4%	1.3%	1.3%	0.0%	86.3%	41.2%
	% of Supply	13.4%	7.6%	8.3%	7.1%	5.9%	3.8%	3.4%	2.3%	2.1%	1.9%	1.4%	1.1%	1.0%	0.9%	0.9%	29.3%	70.7%	29.1%
Average	TBPD	2,303	1,702	1,462	1,409	1,120	649	534	553	369	325	278	271	195	192	184	5,136	13,610	5,499
	% of Imports	16.9%	12.5%	10.7%	10.3%	8.2%	4.8%	3.9%	4.1%	2.7%	2.4%	2.0%	1.4%	1.4%	1.4%	1.4%	0.0%	100.0%	40.4%
	% of Supply	12.3%	9.1%	7.8%	7.5%	6.0%	3.5%	2.8%	2.9%	2.0%	1.7%	1.5%	1.4%	1.0%	1.0%	1.0%	27.4%	72.6%	29.3%

Table I: Top-Fifteen U.S. Crude Oil and Petroleum Product Importers in 2006[60]

Though it is dangerous to extrapolate the petroleum data illustrated in Figure VIII and Table I beyond 2007, if history is any indicator, the fate of domestic production of crude oil in the United States is in a tremendously serious and dire situation. Unless something urgent is done, domestic petroleum production will fall below two million barrels a day by 2025 and will be completely gone by 2037 (assuming that there are adequate petroleum reserves in the United States to last until 2025 and 2037 (see Chapter 6: Does Our Society Need to Significantly Reduce Oil Consumption)). Worst of all, this will all happen while crude oil consumption increases to new limits as the population of the United States grows unboundedly. Thus, if for some reason we cannot continue to internally supply at least some of our petroleum needs, we will become extremely and dangerously dependent on foreign oil. Not only will this leave our country tremendously vulnerable, the growth of the United States and our way of life will be put in severe jeopardy.

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Bringing Petroleum to the Consumer

The fabrication of petroleum products, regardless of whether the original crude oil was extracted from domestic or international locations, entails a detailed and lengthy process commonly called the petroleum supply chain. This chain of processes – crude oil extraction (production), global transit, refining, domestic distribution, and marketing – is ultimately what it takes to bring crude oil from hundreds of feet beneath the ground to products that the everyday consumer can use.[1] As illustrated in Figure I: The Petroleum Supply Chain, this system incorporates dozens of companies and thousands of different people, all of which are responsible for supplying the world with a stable and economically efficient energy source.

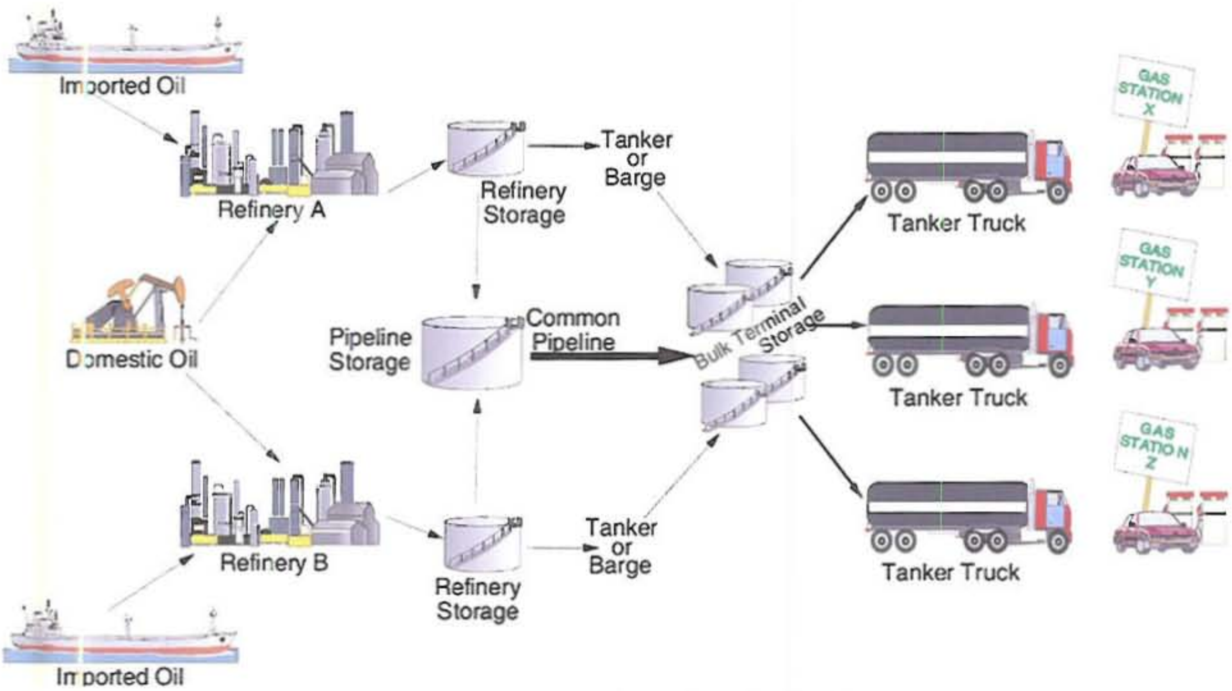

Figure I: The Petroleum Supply Chain
(Source: *Where Does My Gasoline Come From*)[2]

The first step in the petroleum supply chain, the extraction of raw crude oil from deep inside the Earth, begins with geologists that work for the oil and natural gas industries. Using different radio wave frequencies and measuring their reflection and refraction through the Earth, these scientists are able to study underground rock formations to determine probable locations that may contain oil.[3] Then, when they believe they have possibly found a rock formation containing petroleum, the oil company obtains permission from the government to physically explore the land, as oil drilling and production are regulated by state and federal governments. The company then leases this land from the government, and pays rent and a certain monetary percent of each barrel of oil they are able to produce to that government.[4] Nevertheless, although geologists are able to use these advanced technologies to search for crude oil, finding petroleum today requires a lot of intuition and can only be proven by drilling an exploratory well.[5]

Most oil wells in the United States, whether they are exploratory or full production wells, are drilled using a rotary method that was first patented in 1844 by the British engineer Robert Beart.[6] This type of oil rig (Figure II: Typical Rotary Oil Rig and Petroleum Reserve) uses a series of rotating pipes called a drill string that are rotated by a rotary table and supported by a fifty to one-hundred foot derrick.[7] The drill bit that is attached to the end of the string usually has three cone-shaped wheels with very hard teeth that are capable of grinding through the Earth. A mud-like fluid is also pumped and circulated around the drill bit to remove the rock and soil freed by the drilling process.[8] In general, the drill string can drill to an average depth of 6,000 feet, with some deepwater systems capable of drilling over 20,000 feet.[9]

Since a lot of pressure is needed for petroleum to form in the ground, as soon as the drill bit punctures the oil trap, crude oil "explosively rushes" straight up and out of the channel opened by the drilling rig (Figure II).[10] Eventually this pressure decreases as the oil leaves the petroleum reservoir; a pump is then installed inside the well to continue the extraction process. Eventually, the flow rate becomes so small and the cost of removing the crude oil is so great that the cost to operate the well surpasses the profit that can be gained from refining and selling it.[11]

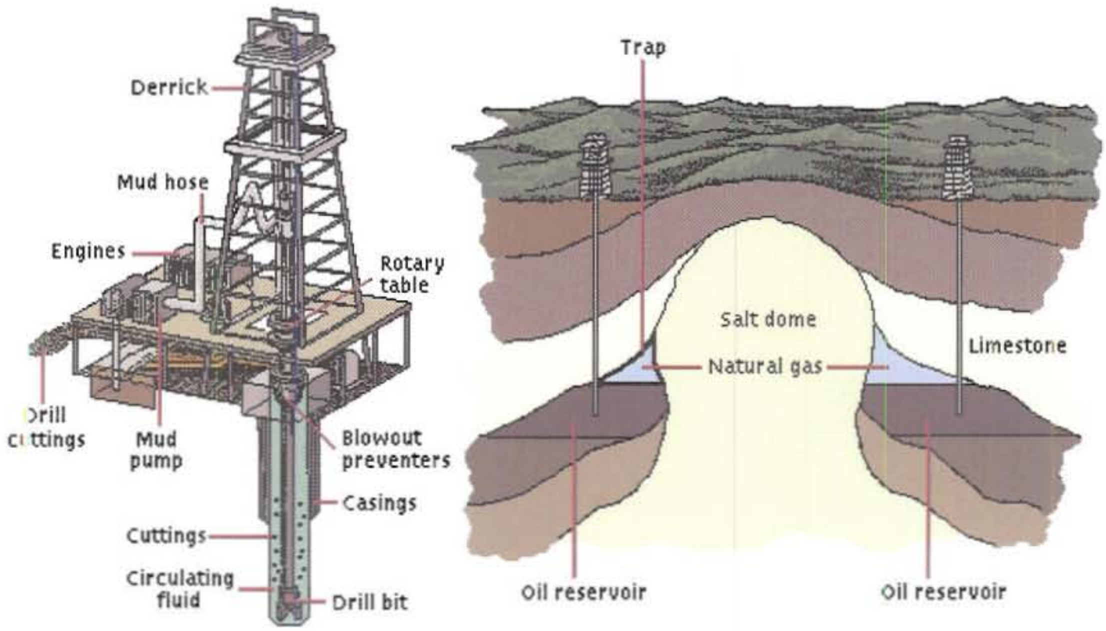

Figure II: Typical Rotary Oil Rig and Petroleum Reserve
(Source: Microsoft Encarta® - *Petroleum*)[12]

In primary production, no superfluous energy is added to the reservoir except what is directly required for removing petroleum from the producing wells. Unfortunately, by the time primary production reaches its economic limit, only a few to "no more than about twenty-five percent" of the total crude oil has been extracted from the reservoir.[13] Today, however, new technologies (e.g., water displacement and steam injection) have been developed, some accidentally, to increase the average amount extracted to more than thirty-three percent of the total oil in the reservoir.[14] In due time, however, these enhanced production methods reach their economic limits, and the well and / or reservoir is abandoned.

Following the production of crude oil, whether domestically or internationally, the raw product must be transported to temporary holding facilities until it is ready to be processed (i.e., refined and converted into useful consumer products. Fortunately, "a complex and carefully choreographed network is in place [in the United States] to move the raw materials, which are mainly crude oils, from where they are produced to where they are processed".[15] For practically all of the imports into the United States, with the exception of imports from Canada, the raw materials are transported along waterways via extremely large barges to coastal ports that serve as logistic hubs. These hubs have a substantial holding capacity and provide a way to merge with other modes of crude oil transportation, including large diameter pipelines carrying domestic products and petroleum from Canada.[16]

Once crude oil has made its way to logistic hubs, the location where domestic and international crude oil fuses, it is transported to refineries by means of large diameter pipes. With a network more than 200,000 miles long (Figure III: Major Crude Oil Pipelines), pipelines are the fastest, cheapest, and the most practical way to move large quantities of petroleum across land.[17] Additionally, since crude oil is fungible, that is, one crude oil supply can be mixed and transported with another supply without any contamination,[18] virtually all crude oil from domestic production fields and coastal ports are shipped to processing facilities via pipelines.

As illustrated in Figure III, the majority of crude oil shipments within the United States are relatively short, whose purpose are to transport aggregated supplies from local producers, collection points, and logistic hubs to refineries in the Midwest and along the Gulf Coast.[19] Cushing, Oklahoma, for example, is one of the largest logistic hubs in the country, bringing domestic crudes together with supplies imported from the Gulf Coast via the Seaway Crude System.[20] Following this blending, pipelines redistribute the oil northward to Chicago-area plants and south to Gulf Coast plants, where the transformation from crude oil to practical petroleum products transpires.

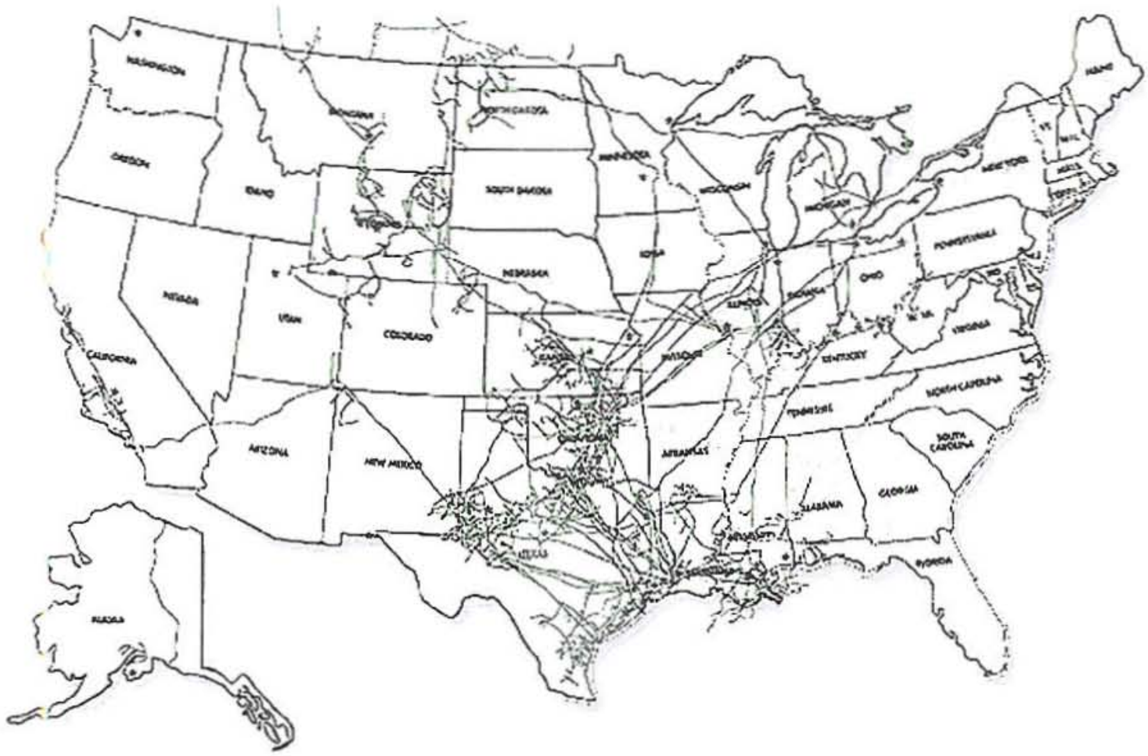

Figure III: Major Crude Oil Pipelines
(Source: *How Pipelines Work*)[21]

The conversion process of transforming raw crude oil into petroleum products that consumers can cleanly and efficiently use is a comprehensive procedure performed by a refiner. In particular, a refiner is "a firm or the part of a firm that refines products or blends and substantially changes products", as well as "sells those products to resellers, retailers, reseller / retailers or ultimate consumers".[22] Some of the largest refiners in the world include the Exxon Mobil Corporation® and the Royal Dutch / Shell Group® (the world's first and second largest oil corporations in the world, respectively),[23] in addition to the Chevron Corporation®, the CITGO Corporation®, and BP® p.l.c.. Although this is not always the case, refiners (especially these five foremost international corporations) are "responsible for finding, producing, and distributing the energy" that has become vital to our way of life and standard of living.[24] Ultimately, they account for more than ninety percent of the refined petroleum products used throughout the United States (the other ten percent is mostly imported from the Virgin Islands).[25]

Following the arrival of crude oil at a refinery, the product sits in huge storage facilities called tank farms until the oil is ready for processing. Since crude oil consists of mixtures of hydrocarbons of different chemical "lengths", refineries must be used to break these molecules and separate them into more useful products.[26] Therefore, the first stage at virtually all refineries is initial distillation, in which the crude oil is heated and separated into its components, gasoline being the first to distil. Since hydrocarbons with lower molecular weights vaporize at lower temperatures than those with higher molecular weights,[27] distillation physically separates the products contained in the oil by taking advantage of their different boiling points, beginning at temperatures slightly less than that of water.

After the initial distillation stage, other processes "focus on transforming lower-valued products into higher-valued products" by removing impurities (e.g., sulfur) to make the petroleum products more efficient and environmentally friendly, as well as converting products with less demand into ones with higher demand.[28] Refiners use a chemical process known as thermal cracking to break "longer" hydrocarbons into smaller, more useful ones, and alkylation to recombine small hydrocarbon chains into gasolines with advanced properties.[29] For that reason, lighter sweet crudes require less processing and are more desirable than heavier sour crudes, and as a result, many refineries are optimized for refining crude oil with specific qualities and properties.[30]

The refining process – principally distillation, thermal cracking, and alkylation – remarkably turns one not-so-useful product (i.e., crude oil) into dozens of different consumer products that are more efficient, cleaner, safer, and easier to use. The most common of these products are motor gasolines of different octane ratings (i.e., regular, midgrade, and premium grades of gasoline), and No. 2 distillates, including diesel and home heating fuels. Additional products that are refined from a barrel of crude oil, which are mainly used for businesses and industrial applications, include jet and aviation fuels, kerosene, and heavy fuel oils (e.g., No. 4, 5, and 6 distillates), asphalts, petroleum coke, refinery fuel, lubricants, and waxes.[31]

The vast majority of petroleum products consumed in the United States are motor gasolines, unlike in the rest of the world, where there is a much higher demand for No. 2 diesel, their main transportation fuel.[32] Accordingly, using technologies like thermal cracking and alkylation, American refiners have significantly increased the gasoline yield of a forty-two gallon barrel of crude oil from eleven gallons in 1920[33] to almost twenty in 2005 (Figure IV: 2005 Average Petroleum Product Yield from a Barrel of Crude Oil (Gallons)).[34] Consequently, diesel fuel and heating oil yields have dropped from twenty gallons in 1920[35] to approximately ten in 2005.[36] In fact, this ability to better refine petroleum has allowed the United States' crude oil consumption to not get out of hand, as less is needed to produce the most consumed product, gasoline. (Note that a forty-two gallon barrel of crude oil (Figure IV) produces about forty-four gallons of petroleum products.)[37]

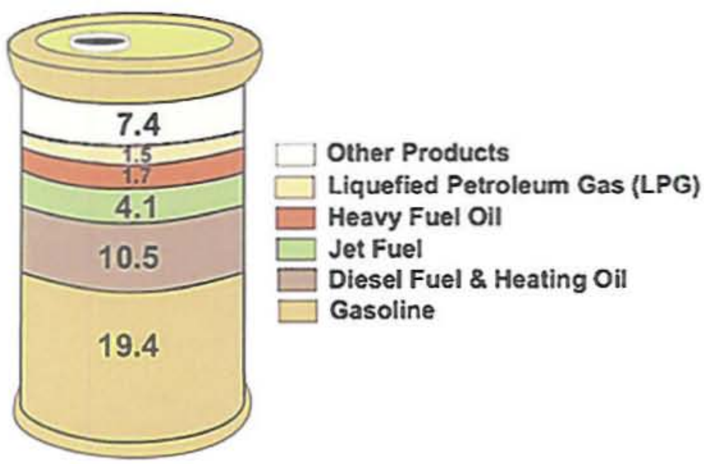

Figure IV: 2005 Average Petroleum Product Yield from a Barrel of Crude Oil (Gallons)
(Source: *Where Does My Gasoline Come From?*)[38]

The final two stages in the petroleum supply chain – domestic distribution and marketing – are the final two processes needed to transport and merchandise the various petroleum products described in Figure IV, and are what finally bring refined petroleum products to the everyday consumer. As with the transportation of crude oil to refineries, petroleum products are shipped around the United States through pipelines, and as a result, "many volumes are shipped more than once (as crude oil and again as refined product[s])".[39] Without pipelines, these refined oils would never be able to continually reach and fully supply the millions of consumers across the country.

The crude oil and petroleum product pipeline system in the United States is the largest network of any nation in the world, ten times longer than all of the pipelines in Europe combined.[40] Pipelines were originally developed as a joint industry and government effort during World War II, when German submarines began sinking tankers along the Gulf, Atlantic, and Caribbean coasts.[41] Other possible solutions that were conceived during this time were to use large oil trucks and railroad cars. However, trains are about twice as expensive as pipelines and are not as widely available throughout the United States. Furthermore, trucking costs "escalate sharply with distance", making them the most costly method of petroleum transportation and distribution.[42]

Today, an extensive network (Figure V: Major Petroleum Product Pipelines) supplements and fundamentally completes the major crude oil pipelines in Figure III by moving the "refined products [gasoline, diesel, jet and home heating fuels, kerosene, etc.] from where they are processed to where they are consumed".[43] In 2000, more than seventy percent of the products transported between PADDs were from petroleum pipelines, making them irreplaceable and an essential aspect of the petroleum supply chain.[44] Depending on the diameter of the pipe, the terrain, and the viscosity of the petroleum, these products are propelled by centrifugal pumps at three to eight miles per hour. At this rate, it takes between fourteen and twenty-one days for a shipment of petroleum products to travel from Houston, Texas to New York City.[45]

Figure V: Major Petroleum Product Pipelines
(Source: *How Pipelines Work*)[46]

Slightly different than the path crude oil takes, refined products first travel from refineries to major logistic hubs, including New York Harbor, Chicago, Los Angeles, and the Gulf Coast via trunk line systems.[47] These trunk line systems, including the 1,500 mile-long Colonial Pipeline, the 1,100 mile-long Plantation Pipeline (both traveling from the Gulf Coast to the North East), and the 1,400 mile-long Explorer Pipeline (traveling from the Gulf Coast to the Midwest), transport huge volumes of refined products going to a few different logistic hubs.[48]

From logistic hubs, smaller diameter pipelines known as delivering lines (e.g., Buckeye Pipeline, Wolverine, Marathon Ashland Pipeline, and West Shore) further distribute the petroleum products to more exact locations (terminals) all across the United States.[49] Unlike with trunk lines, delivering lines ship much smaller quantities to many more locations. These delivering lines also connect to more than one-hundred "Air Force, Army, Marine Corps, and Navy installations in the United States", which have "direct connections to the interstate pipeline network so they can get the [refined] petroleum supplies they need".[50] Conversely, New England is not connected to any major national pipelines, and therefore their supplies must be transported from New York Harbor via barge, train, and truck.[51]

Generally, oil pipelines provide transportation, temporary storage, and logistic services for refining companies and they do not own the product they are transporting. Shippers, such as refiners, marketers, and jobbers (the intermediaries who handle the wholesale distribution of petroleum products between some refining companies and consumers or retail outlets),[52] contract for space on an oil pipeline. These contracts are scheduled well in advance by pipeline operators; on a trunk line, a shipper usually requests space on the line on a monthly schedule, however on a delivering line, a shipper can secure space much faster, often on the same day.[53] Correspondingly, an oil pipeline cannot refuse space to any shipper that meets their published conditions of service, and moreover, if the pipeline has more product than it can carry, the pipeline operator must allocate the space in a non-discriminatory manner (i.e., neither to the highest bidder nor on a first come, first serve basis).[54]

The transmission of petroleum products through pipelines, especially the delivering lines, is a much more difficult and tedious process than with raw petroleum. Contrasting crude oil, most individual petroleum products (e.g., gasolines, diesel fuels, etc.) are not fungible among each other and must be kept segregated. Therefore, pipeline operators must ship different petroleum products or grades of the same product sequentially through pipelines in batches, typically ranging from 75,000 to 3.2 million barrels.[55] As imagined, this process becomes much more complex as new environmental requirements become laws, and more refined products are produced and sold on the market.

These so-called batches of petroleum physically abut one another, and, even though they are in a special turbulent flow designed to minimize contamination, mixing occurs, creating either compatible interfaces or transmixes (Figure VI: Transmission of Petroleum Products through Pipelines). If two neighboring batches are similar, the resulting mixture can be added to the lower value product; however, if the products are not similar, the resulting transmix must be channeled to separate storage and be reprocessed at a refinery. In the end, this unavoidable contamination increases operating costs, and reduces the capacity of refineries and distribution systems, adding unneeded redundancy in an already tight system.

Figure VI: Transmission of Petroleum Products through Pipelines
(Source: *Colonial Pipeline Frequently Asked Questions*)[56]

For example, the government's new standard for on-highway fuel – ultra-low sulfur diesel (ULSD) – requires that the fuel have no more than fifteen parts-per-million (ppm) sulfur to prevent further pollution of the environment. However, pipelines will continue to have to transport off-highway diesel fuel (a maximum of 2,000-ppm sulfur) and the new 15-ppm ULSD fuel, all while maintaining the integrity of the ULSD.[57] Traditionally, a pipeline will carry on-highway diesel fuel, which use to have a mandated maximum of 500-ppm sulfur (typically refined to around 300-ppm), next to off-highway diesel. Thus, with these two petroleum products abutting each other, there remains room for a 200-ppm margin of contamination, meaning that a batch of on-highway diesel can absorb as much as fifteen percent of the off-highway diesel.[58] However, new environmental regulations require ULSD to have 15-ppm sulfur (typically refined to around 10-ppm sulfur), and can therefore only absorb 0.3 percent of the 2,000-ppm off-highway distillate. This corresponds to only thirty barrels of ULSD mixing with ten thousand barrels of off-highway diesel, leaving very little room for contamination.[59]

Upon the acceptable arrival of petroleum products at terminals near consuming regions, the consumer products are temporarily stored in individual bulk storage terminals that are often serviced by many different gasoline stations.[60] Once consumer demand requires more of an individual petroleum product, it gets loaded into 10,000-gallon, multiple-compartment trucks that ship it to retail outlets and other consumers.[61] At this time, special company-specific additives are added and blended, especially to motor gasolines, in order to enhance the product's properties.[62] Therefore, in almost all cases, the only difference between a petroleum product at one retail outlet and the same type at another retail outlet is the additives that those companies added during transportation from the terminal to their outlet.[63] This eventually results because petroleum products from different refineries are often combined for shipment via pipeline (meaning that similar products are mixed together, in which the shipper receives the same quality of product, not the same exact molecules),[64] and retail outlets purchasing products at the same bulk terminals.[65]

Since most refiners use a mix of crude oils from domestic and foreign sources that are fused together at logistic hubs, it is virtually impossible to identify which companies (i.e., Exxon Mobil, BP® p.l.c., Shell, CITGO, etc.) are selling imported gasoline, only where (and how much) they import crude oil and refined products from. This foreign and domestic mixture is mainly based on availability, cost, refining capabilities and optimizations, properties of the crude oil and in the end, who owns the company.[66] Therefore, the fact that a given company imported crude oil does not mean that those particular imports will end up sold to consumers at that company's retail outlet. Additionally, approximately one-third of all gasoline stations in the United States are unbranded dealers (e.g., supermarkets, wholesale clubs, etc.) that may sell any brand of gasoline.[67] The other two-thirds are branded stations, though due to fungible products and grouping similar petroleum product batches, it still does not necessarily signify or prove that they are selling the products that were produced at their refineries.[68]

Notes

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From My Wallet To...

The price consumers pay for refined petroleum products is essentially split into four different sectors: crude oil, federal and state taxes, refining costs and profits, and distribution and marketing. As illustrated in Figure I: Typical Price Breakdown for Regular Gasoline, and Figure II: Typical Price Breakdown for Diesel Fuel, the price of raw crude oil is the most significant factor in determining the price paid for petroleum products, accounting for more than half of the overall cost. In fact, the Federal Trade Commission has concluded, "over the last 20 years, changes in crude oil prices have explained 85 percent of the changes in the price of gasoline in the U.S".[1] As a result, when consumers talk about the price of gasoline, diesel fuel, or any one of the other numerous refined products stemming from crude oil, they are fundamentally discussing the market value and ultimate cost of crude oil.

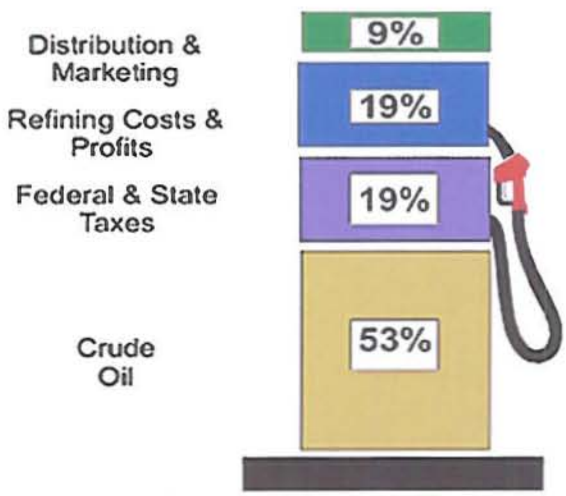

Figure I: Typical Price Breakdown for Regular Gasoline
(Source: *A Primer on Gasoline Prices*)[2]

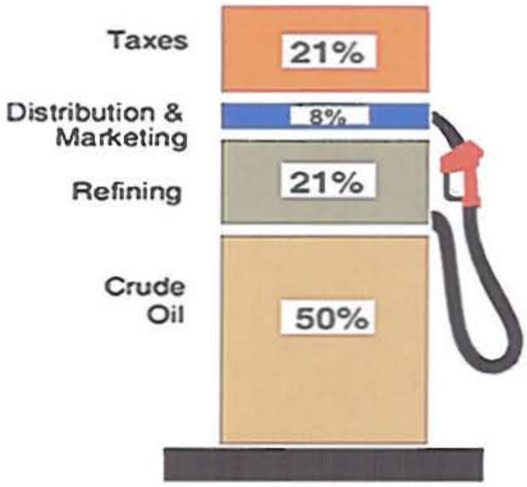

Figure II: Typical Price Breakdown for Diesel Fuel
(Source: *Diesel Prices, What Consumer Should Know*)[3]

"Every day hundreds of thousands of buyers and sellers of crude oil from around the world compete in the organized contract markets (sometimes called "futures" markets) and spot markets to ensure that they can meet their [consumers'] needs."[4] In a futures contract, the buyer agrees to take delivery and the seller agrees to provide a fixed amount of oil (at least 1,000 barrels) at a prearranged price, date, and location.[5] These binding contracts are only traded on regulated exchanges, most notably the New York Mercantile Exchange (NYMEX) and the International Petroleum Exchange (IPE Futures) in London, England. Spot markets, on the other hand, are where "crude oil is bought and sold without long-term contracts", in which excess crude oil producers are able to find buyers, negotiate prices, and start delivering the product, sometimes within minutes.[6]

"With so many competing needs in the market, there are plenty of buyers willing and able to pay to keep their countries, refineries, and economies running."[7] Thus, regardless of where a barrel of crude oil is produced, "its price is determined by the traders in those world markets".[8] These "trading centers offer a venue in which buyers and sellers place a value on oil based on the forces of supply and demand",[9] along with a complex set of external influences, many of which are described in the later end of this chapter. Consequently, the oil companies do not set the prices of crude oil; they are set on an open market with what traders feel the oil is ultimately worth.[10]

The overall determination of the value of crude oil entails an extremely sophisticated and active economic system, in its fullest detail, well beyond the scope of this report. Nevertheless, the value of oil "reflects the interactions of thousands of buyers and sellers"[11] occurring in past and future markets. Each trader brings forth "their respective knowledge and expectations of the demand for and supply of crude oil and petroleum products".[12] Inevitably, these two forces, which were discussed in detail in Chapter 2: Major Petroleum Consumers, and Chapter 3: Major Petroleum Resources, are by and large the two principal factors that influence world petroleum product prices.

The value of crude oil is also an indication of the overall quality of the product: the best and most desirable crudes – light, sweet oil – are sold first for more money than the heavier and less desirable products (e.g., heavy, sour crude oil).[13] In general, the higher an oils' API gravity, the more valuable the product is to refining companies. The reasoning behind this is that heavier and sourer crude oils require more processing time and energy because they consist of long hydrocarbons with a high sulfur content, which must be cracked and purified to meet environmental regulations and consumer demands.[14] On the other hand, a crude oil whose API gravity is too high (above approximately forty-five degrees), is less valuable to refiners because the molecular chains are shorter, requiring more advanced alkylation processes.[15] As a result, since there are over 161 different internationally traded crude oils, each with varying characteristics and qualities, such as API gravities and sulfur contents, buyers and sellers have found it easier to refer to a limited number of reference (i.e., benchmark) crudes.[16] Other varieties are then priced at a discount or premium, according to their quality and characteristics with respect to these benchmarks.[17]

The benchmark crude used in the United States is West Texas Intermediate (WTI), a light, sweet crude oil having an API gravity of 39.6° and a sulfur content of 0.27 percent.[18] On a per-barrel basis, the WTI price represents the market-determined value of a futures contract to either buy or sell 1,000 barrels at a specified time. WTI, whose production is on the decline because of decreasing reserves, is an ideal crude oil to be processed in the United States because a large portion of it can be refined into gasoline. Furthermore, the NYMEX market is where standardized contracts for future delivery of WTI are traded, a price which tracks within pennies of the WTI spot market price.[19] Accordingly, the NYMEX future price is the crude oil that almost every major newspaper and media station reports in the United States.

The major benchmark crude used outside the United States is Brent blend, a combination of crude oil from fifteen different oil fields around the North Sea.[20] Brent is generally accepted to be the world crude oil benchmark, and is used to price more than two thirds of the world's internationally traded crude oil supplies[21] The blend, which is slightly heavier and sourer than WTI, has an API gravity of 38.3° and contains about 0.37 percent sulfur,[22] and is ideal for refining gasoline and Europe's high-demand diesel fuels. Consequently, Brent blend, which is traded in future contracts on the IPE Futures, is priced about one to two dollars per barrel less than WTI.[23]

OPEC uses a different benchmark – the OPEC reference basket – to collect price data on their crude oils and to monitor world-oil market conditions. The reference basket represents the weighted-average price of the main export crudes of eleven member countries, not including

Angola. The basket blends include Algeria's Saharan Blend, Indonesia's Minas, Iran's Iran Heavy, Iraq's Basra Light, Kuwait's Kuwait Export, Libya's Es Sider, Nigeria's Bonny Light, Qatar's Qatar Marine, Saudi Arabia's Arab Light, the United Arab Emirates' Murban, and Venezuela's BCF 17.[24] The average API gravity is 32.7° and contains about 1.77 percent sulfur,[25] and as a result, the OPEC reference basket is five or six dollars per barrel less than WTI and about four dollars less than Brent blend.[26]

In the end, crude oil prices are set on what the product is worth, taking into account supply and demand, and the quality of the oil with respect to benchmarks such as WTI, Brent blend, and the OPEC reference basket. Thus, the price for crude oil, and consequently refined petroleum products, *is not what it cost to extract the oil from the ground.* Analogous to this economic reality, something every consumer needs to fully understand, is rare artwork. The value of art is based on how many paintings are available (i.e., supply), how many consumers want the painting (i.e., demand), and the overall quality of the painting. Therefore, whether it is gasoline and diesel fuel or a beautiful painting, the more consumers need or want a product, the higher its monetary value. As a result, consumers pay for oil based on value, not its extraction and production cost.

Another economic sector of the total cost consumers pay for petroleum products is the tax imposed by local, state, and federal governments. Today, state and federal taxes account for approximately nineteen percent of the total cost of consumer petroleum products, a value that varies from state to state due to their individual taxes.[27] As of October 2006, the nationwide weighted-average tax on motor gasoline is 45.5 cents per gallon, which is down by 1.3 cents from July 2006.[28] Motor diesel fuel taxes are about seven cents higher, with a nationwide weighted-average of 52.5 cents per gallon, which is also down from July 2006 by 0.7 cents.[29] As we will later see, some petroleum product taxes are calculated as a percentage of the total cost of the product, and as a result, taxes vary with the price of crude oil, and the cost of refining, distribution, and marketing.

The federal tax on motor gasoline (as of October 2006) is a flat rate of 18.4 cents per gallon, slightly more than the weighted-average state tax of 18.2 cents per gallon.[30] As illustrated in Table I: Gasoline Fuel Taxes as of October 2006, states in the southern part of the United States pay the least amount in taxes, averaging 19.3 cents in state excise tax and 0.2 cents in other state taxes, totaling 38.4 cents per gallon.[31] Western states, on the other hand, pay forty percent more in taxes than Southern states, totaling 53.6 cents per gallon.[32] Although Western states pay practically the same as Southern states in state excises taxes, they pay 14.8 cents per gallon more on other states taxes, many of which are due to stricter environmental regulations.[33]

Region	State Excise Tax	Other State Taxes	Total State Tax	Total Gasoline Tax
New England	22.8	5.6	28.4	46.8
Mid Atlantic	12.4	17.1	29.5	47.9
South Atlantic	13.1	12.7	25.8	44.2
Northeast	14.1	13.3	27.5	45.9
Midwest	21.1	4.7	25.8	44.2
South	19.3	0.7	20.0	38.4
Mountain	22.8	0.2	23.0	41.4
West	20.2	15.0	35.2	53.6
Weighted-Average	**18.2**	**8.9**	**27.1**	**45.5**

Table I: Gasoline Fuel Taxes as of October 2006[34]

The federal tax on motor diesel fuel (as of October 2006) is a flat rate of 24.4 cents per gallon, slightly more than the weighted-average state tax of 18.2 cents per gallon, and six cents higher than the federal gasoline tax.[35] As illustrated in Table II: Diesel Fuel Taxes as of October 2006, Southern states pay the least amount in diesel taxes, averaging 19.6 cents in state excise tax and 0.2 cents in other taxes, totaling 44.6 cents per gallon.[36] As with gasoline, Western states pay substantially more in taxes for diesel than Southern states, totaling 61.5 cents per gallon.[37]

Region	State Excise Tax	Other State Taxes	Total State Tax	Total Diesel Tax
New England	23.5	4.6	28.1	52.5
Mid Atlantic	13.1	19.1	32.2	56.6
South Atlantic	13.0	11.7	24.7	49.1
Northeast	14.4	13.6	27.9	52.3
Midwest	20.4	7.5	27.9	52.3
South	19.6	0.7	20.2	44.6
Mountain	22.1	0.2	22.3	46.7
West	20.5	16.6	37.1	61.5
Weighted-Average	**18.2**	**9.9**	**27.1**	**51.5**

Table II: Diesel Fuel Taxes as of October 2006[38]

The "other state taxes" listed in Table I and Table II, are additional taxes – "sales taxes, gross receipt taxes, oil inspection fees, underground storage tank fees, and other miscellaneous environmental fees" – that are imposed by state (and some local) governments.[39] For the cost of gasoline, these additional taxes add 8.9 cents per gallon to the average, and for diesel fuel, an extra 9.9 cents per gallon to the average.[40] Some of the more absurd examples of these "other" taxes, which most consumers would probably agree should be being paid by the oil companies and / or retail fuel stations, include a one cent per gallon and an 0.025 cent per gallon "inspection fee" in New Mexico and North Carolina, respectively.[41] Additionally, New York has a 0.05 cent per gallon "petroleum testing fee" on gasoline and Virginia has a 0.6 cent per gallon "petroleum storage tank fee",[42] all of which should not be placed on the consumer.

On a state-by-state basis (Figure III: Gasoline and Diesel Fuel Taxes as of October 2006), New York has the highest gasoline tax in the country, totaling 60.1 cents per gallon.[43] This includes 18.4 cents in federal taxes, eight cents for the state excise tax, and 33.7 cents in other state taxes."[44] Similarly, Hawaii has the highest motor diesel tax in the country, totaling 68.5

cents per gallon, which includes 24.4 cents in federal taxes, sixteen cents in state excise tax, a four percent sales tax, additional county taxes, and a 0.12 environmental response tax.[45] On the opposite end of the spectrum, Alaska has the lowest taxes on both motor gasoline and diesel fuel, totaling 26.4 and 32.4 cents per gallon, respectively.[46]

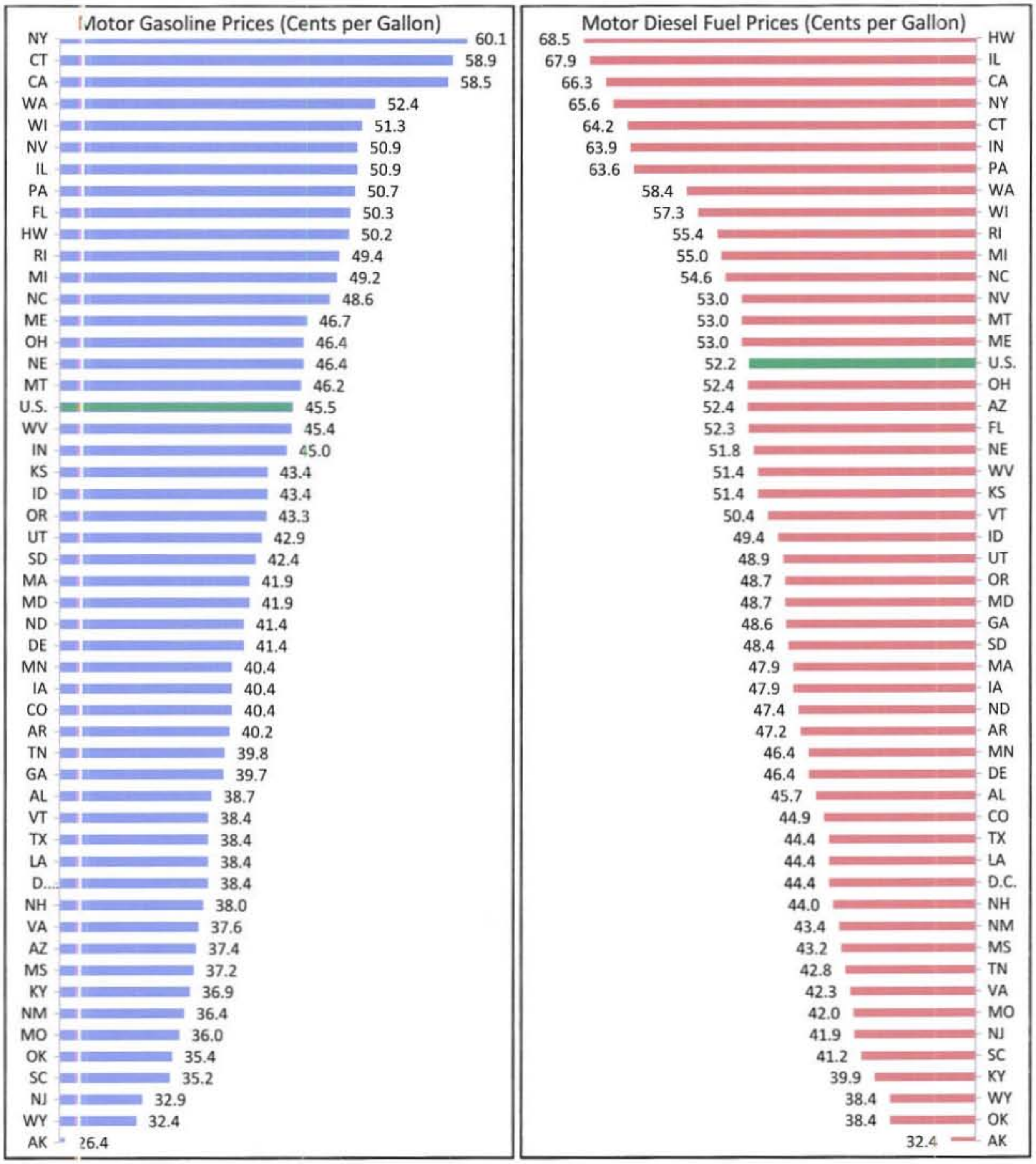

Figure III: Gasoline and Diesel Fuel Taxes as of October 2006[47]

The final two economic sectors of the total cost of petroleum products, which do not contribute to the day-to-day or even the week-to-week fluctuations in prices, are refining costs and profits, and marketing and distribution. Refining costs and refinery profits account for about nineteen percent of the retail price of gasoline, varying from region to region as different parts of the United States have an assortment of environmental requirements.[48] Additional charges for distribution (e.g., pipeline charges and tanker truck charges) account for a very small share of the total cost of the petroleum products, where the cost of moving a gallon of gasoline from Houston, Texas to New Jersey via pipeline, for example, is only about 2.5 cents per gallon.[49] Lastly, the final cost that makes up the total price consumer's pay for petroleum products is the marketing expenditure, which takes into account the location and size of the station, it's operating cost, commercial arrangements with their supplier, and whether the station sells branded or unbranded gasoline.[50]

Now having the knowledge of the four components that compose the price of petroleum products, most notably the motor gasoline and the diesel fuel used daily by millions of Americans for transportation, we can now begin to analyze the record economic events of 2005 and 2006. That is, in the fourth quarter of 2005 (July 1, 2005 to September 30, 2005), the Exxon Mobil Corporation® posted the largest quarterly profit ever recorded by a publicly traded U.S. company – $10.71 billion.[51] Nine months later in the third quarter of 2006 (April 1, 2006 to June 30, 2006), Exxon Mobil posted the second highest quarterly profit every recorded – $10.49 billion, just 220 million dollars less than their earlier astonishing record.[52]

Exxon Mobil's success in the fourth quarter of 2005 and the third quarter of 2006 was largely due to their "success in exploration and reduction of operating costs by billions of dollars",[53] in addition to stronger earnings at their branded retail stations and chemical segments.[54] Specifically, profits from refining and selling petroleum products grew $610 million to a total of $2.7 billion, with their chemical business profits improving the most by $879 million to $1.3 billion.[55] Moreover, profits from exploration and production rose by $764 million to total more than $6.4 billion, thanks to higher crude oil prices that topped out at $74.80 a barrel in July of 2006.[56] However, according to CNN's Time Magazine, "Exxon Mobil's earnings are less tied to high [crude oil] prices than are those of other major oil companies".[57]

Additionally, thanks to those high crude oil prices, the Royal Dutch / Shell Group®, which is corporately divided as forty percent Shell and sixty percent Royal Dutch,[58] beat all forecasts and analysts with a twenty-one percent rise in their underlying 2006 third-quarter profits.[59] Coming off two "very tough" fiscal years,[60] Shell's net profits for the third quarter were about seven billion dollars, $1.3 billion more than what most economic and market analysts expected.[61] This ultimately pushed Shell's market capitalization to more than $229 billion, beating BP® p.l.c as the world's second-largest fully publicly-quoted oil company.[62] The reason for their profits is similar to Exxon Mobil's: a twenty-five percent rise in refining and marketing profits, which were much higher than expected.

Now, undoubtedly these profits are enormous sums of money whose sheer magnitude could solve a number of the world's countless problems, however the economic reality of it is that these oil behemoths are publicly traded companies that are aggressively competing against each other, just as if they were any other business. Although the ethical behavior and underlying intensions of these corporations and their executives are at times very controversial (as with most large businesses and corporations), their overall objectives are to cut costs and spending in order to make a healthy profit and provide a large return on investment to themselves, their employees, and their shareholders. And this is exactly what Exxon Mobil, for example, accomplished, raising the price of each of their 5,693,398,000[63] shares by $1.58 in the third quarter of 2005 and by an additional $1.77 per share in the third quarter of 2006.[64]

Since many Americans sit down at night and wait for the daily stock quotes, it is important for consumers to realize that Exxon Mobil is one of the thirty corporations used in calculating the Dow Jones Industrial Average, just like the Walt Disney Company®, General Electric®, Microsoft®, and Coca Cola®. Therefore, chances are that you or someone you know directly or indirectly has shares in one of these public oil companies, since a large part of their stocks are held by individual retirement accounts and private pension funds, including T. Rowe Price, Henssler Equity, Turner Investment Partners, and Westwood Management.[65] In fact, in 2005 alone Exxon Mobil returned more than fifteen billion dollars in the form of share buybacks and dividends to their shareholders, almost one and a half times more than their 2005 record-total third quarter profit.[66] What's more is that, since "the oil industry is the classic boom-and-bust business", these corporations are reinvesting billions of dollars into new projects, including alternative fuel sources, and better, more efficient ways of finding, extracting, and refining petroleum.[67]

Additionally, although oil profits are remarkably and unimaginably high, their business accomplishments are not the result of price gouging or the exploitation of consumers. Unlike oil companies owned by OPEC member countries, major public oil corporations, such as the Exxon Mobil Corporation®, the Royal Dutch Shell Group®, and BP® p.l.c., have relatively small shares of global oil reserves and production capacity (e.g., Saudi Aramco, a Saudi-owned oil company, owns almost twenty-two percent of oil reserves, whereas Exxon Mobil owns only 1.09 percent, BP® p.l.c. 0.85 percent, and Shell only 0.61 percent).[68] This ensures that private oil companies behave competitively in the world oil market and cannot individually cut output and influence world oil prices.[69] Also, as previously stated, the oil industry does not set petroleum product prices. Their price, just as with crude oil, is based on what the product is worth, a value that is largely a factor of supply and demand, both on the refined product and crude oil level.

Further illustrating the fact that the oil companies are not price gouging is a look at how over the last fifteen years, marketing, manufacturing, and refining costs for a gallon of regular gasoline have remarkably decreased by over thirty-two cents.[70] As shown in Figure IV: Components of Retail Gasoline Products, refiners in the United States have made "great strides in efficiency to generate billions of dollars in savings for gasoline consumers".[71] Adjusted for inflation, at the peak of crude oil and petroleum product prices in 1981, it cost more than eighty-four cents to refine, market, and distribute a gallon of regular gasoline.[72] By 1990, however, this consumer expense fell to about sixty-five cents per gallon, in which it now averages about fifty-two cents per gallon.[73] For this reason, oil companies, which generated billions of dollars from refining profits in 2005 and 2006 due to better business practices and technologies, have saved the average American about five dollars a tank. Assuming one fills their fifteen gallon tank once or twice a week, this ultimately saves the consumers between $250 and $500 dollars per year!

Another notable observation from Figure IV is that the average tax on a gallon of gasoline has risen by more than forty-one percent since March 1981.[74] The weighted state and federal average today is 45.5 cents per gallon, however this is up from the inflation-equivalent 32.2 cents per gallon in March 1981.[75] The partial reason for this increase is the revelation of air and water pollution resulting from the use of fossil fuels and new additives that are blended with petroleum products to reduce carbon monoxide, smog, and other air toxins. Nonetheless, states such as Connecticut, Kentucky, Nebraska, Florida, and North Carolina have a variable tax rate that is taken as a percentage of the total price of gasoline.[76] Thus, when prices go up and consumers are faced with higher and higher costs at the pump, these states reap higher revenues, putting more pressure on the wallets of everyday Americans.

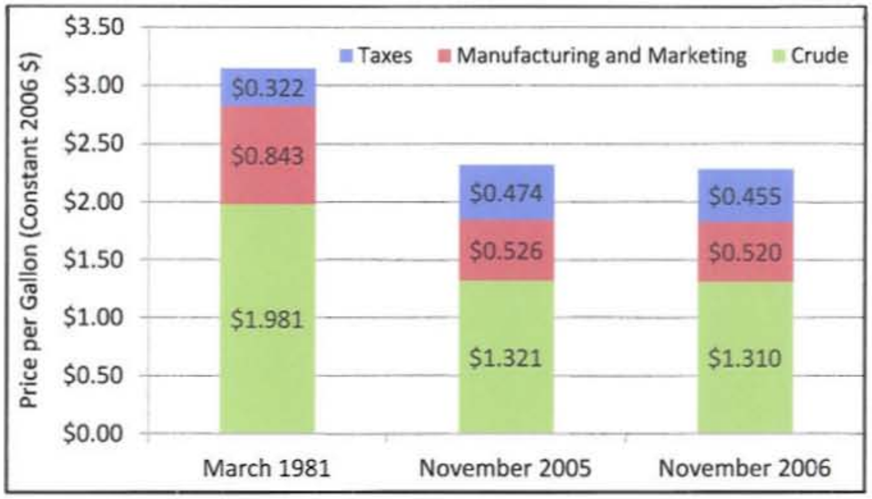

Figure IV: Components of Retail Gasoline Products[77]

Delving into the history of crude oil and petroleum product prices throughout time further exemplifies the fact that record profits are not the result of corporate price gouging, and that, although prices have recently been very high, they are well within the envelope of historic levels when adjusting for inflation. Figure V: Crude Oil Prices from 1881, illustrates that, although crude oil prices are on the rise, their current day levels around sixty dollars per barrel is well below the inflation-adjusted one-hundred dollars per barrel in the 1880s and the near ninety dollars per barrel in the late 1970s. Once again, since crude oil costs a certain monetary amount to extract out of the ground, oil companies *make or lose* money based on the value of the crude they are extracting, and this value is what transpires into the prices in the media and in Figure V. (It is worthy to note that the prices typically reported by the press as well as in Figure V are for the best quality crude oils like WTI, not the heavier, less expensive crudes.[78] Thus, the per-barrel prices consumers hear about each day are slightly higher than what the oil companies are actually paying for a barrel of crude oil (i.e., the refiner acquisition cost).)

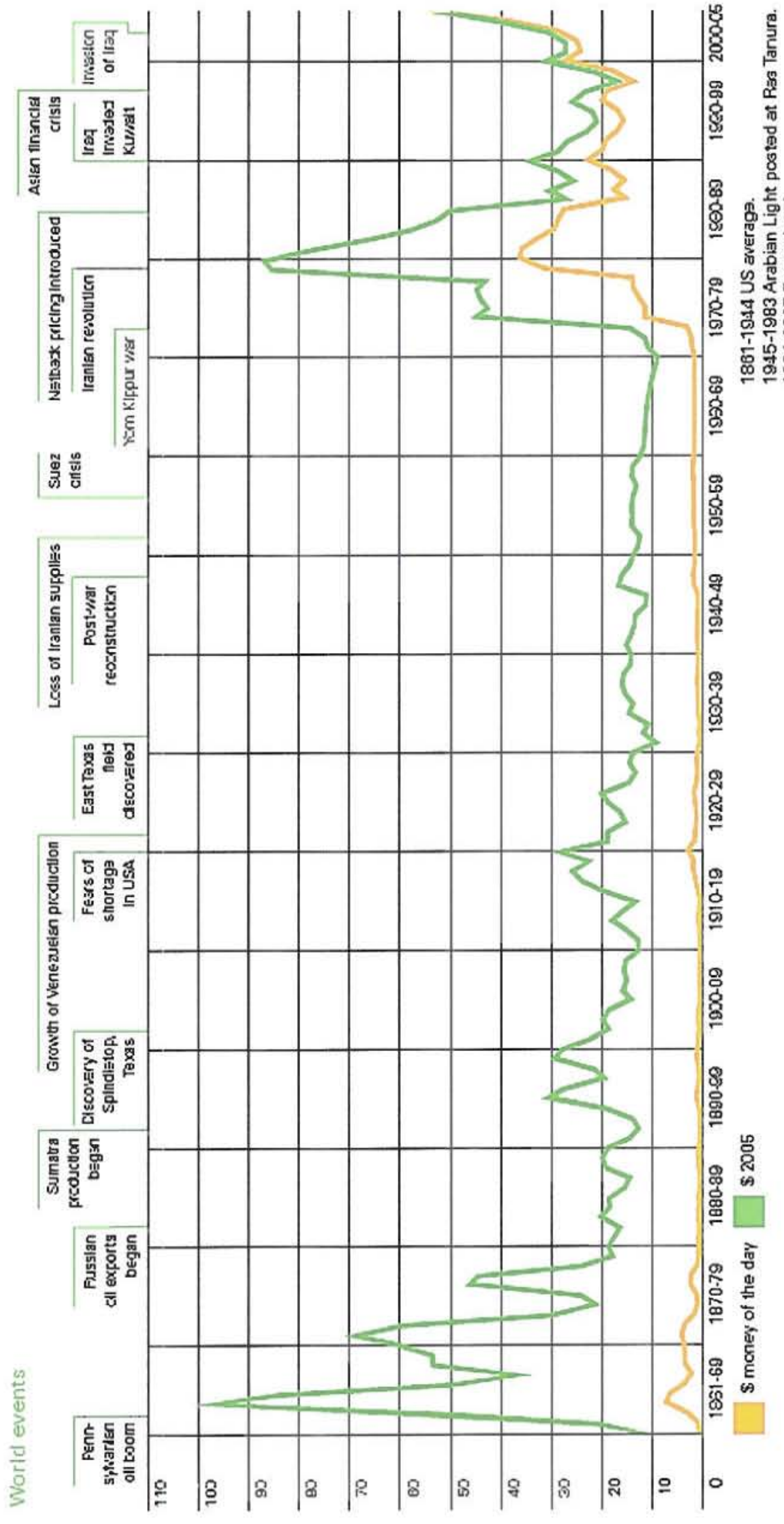

Figure V: Crude Oil Prices from 1881

(Source: *BP Statistical Review of World Energy*)[79]

Similarly, retail gasoline prices, which track crude oil prices with some minor lag, are well within their envelope of historic prices levels, with respect to both themselves and other petroleum products. As illustrated in Figure VI: Annual Gasoline Prices Adjusted for Inflation, yearly-average prices for gasoline are distinctively below pre-World War II and oil embargo years. In fact, the highest monthly average price for a gallon of gasoline was recorded at $3.15 at the start of the Iran-Iraq War in March 1981.[80] Since then, however, the highest price recorded was in July 2006 at $2.98 per gallon, the height of a summer marked with some of the highest prices in over twenty years due to fears of an active Atlantic hurricane season. (In April 2006 the average price was $2.74 per gallon, in May $2.91, in June $2.89, in July $2.98, and by August $2.95 per gallon; the prices fell sharply however, falling to less than $2.56 per gallon in September 2006).[81]

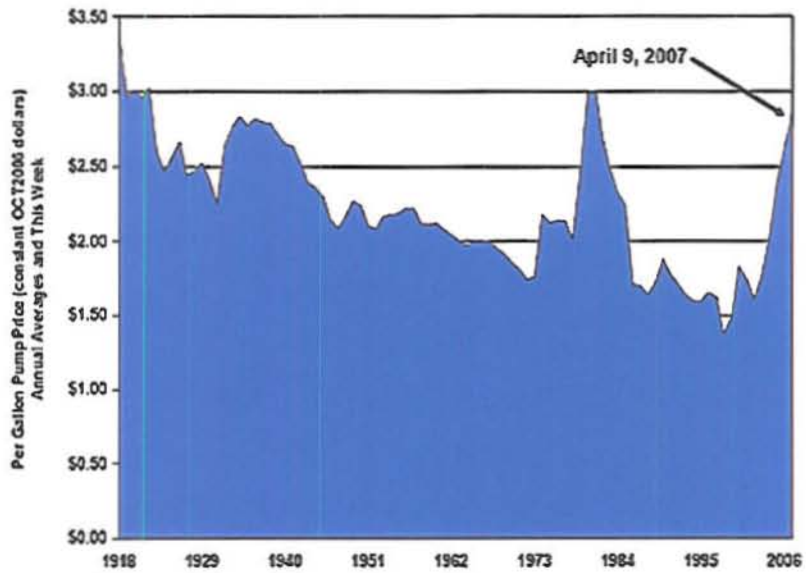

Figure VI: Annual Gasoline Prices Adjusted for Inflation

(Source: *U.S. Pump Price Update* April 9, 2007)[82]

Furthermore, when compared to other petroleum products throughout time (Figure VII: Retail Petroleum Product Prices Excluding Taxes (1983 to 2007, when available)), all three grades of gasoline – regular, midgrade, and premium – tightly fit within the price envelopes created by the historically most expensive petroleum product, aviation gasoline, and the least expensive, No. 4 Distillate. (Note that the prices in Figure VII are not adjusted for inflation and are merely to demonstrate the fact that all petroleum product prices are high, not just the more popular fuels that consumers use). Therefore, the high prices we face today, which when adjusted for inflation are not at record-setting levels, are propagating throughout all petroleum products, not just gasoline. As a result, everyone is facing higher prices, including consumers, small and large businesses, universities, and even the government.

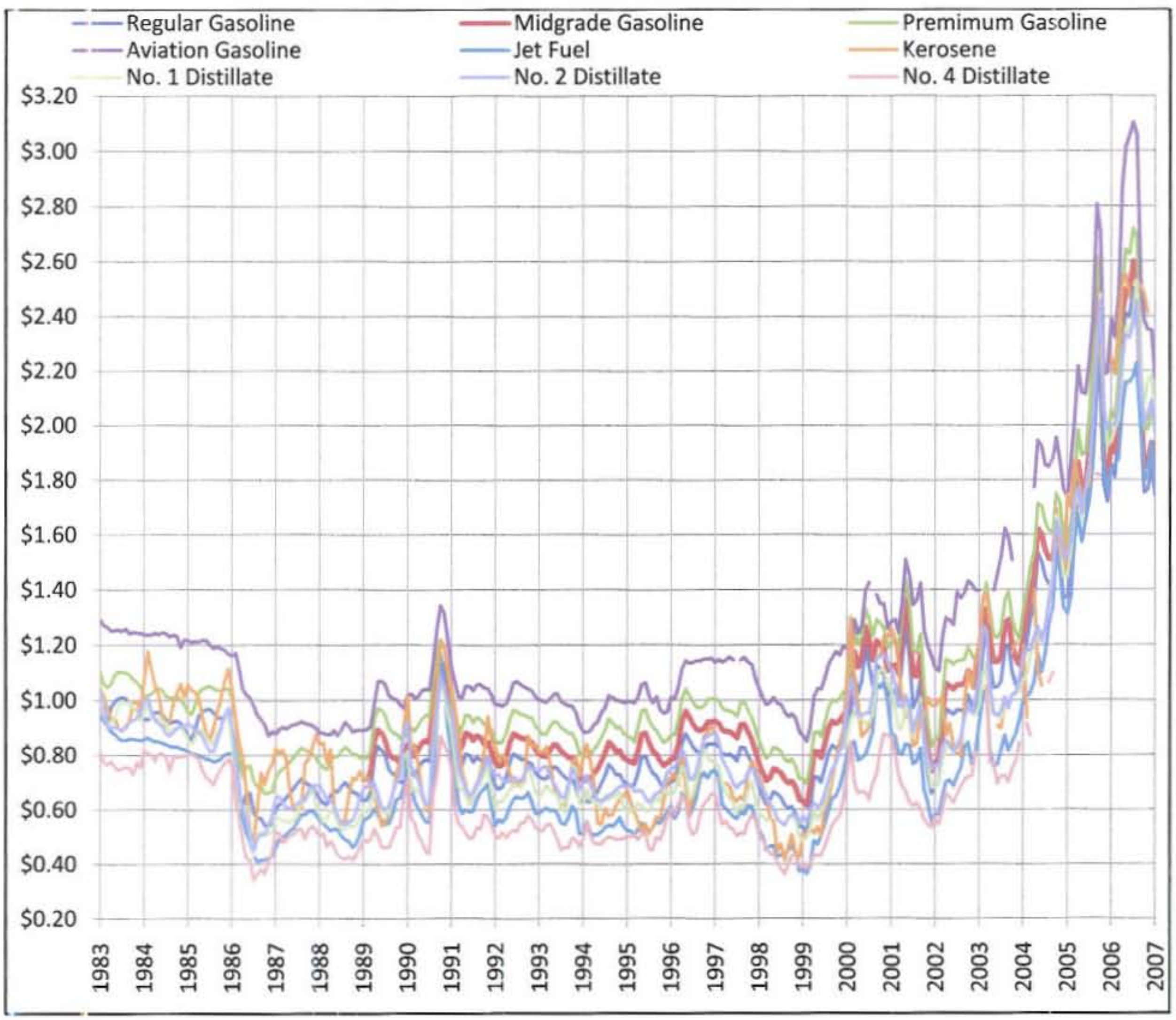

Figure VII: Retail Petroleum Product Prices Excluding Taxes (1983 to 2007, when available)[83]

As is illustrated in Figures V, VI, and VII, and as all consumers know from driving by their local gasoline stations, prices of petroleum products on a day-to-day and month-to-month basis can fluctuate extremely rapidly. These price spikes are the consequence of physical and psychological disruptions (e.g., Hurricane Katrina and the Iranian seizure of fifteen British sailors, respectively) in both international and domestic supplies of petroleum products and crude oil. Although there are dozens of reasons why prices fluctuate, the most notable are changes in OPEC production, global events such as political decisions and outcomes, wars and conflicts, and government actions, extreme or abnormal weather patterns such as hurricanes and colder than expected winters, and times of political uncertainty and civil strife. In general, these factors are responsible for the rapid price changes seen at the pump (e.g., a five to ten cent jump in prices overnight), whereas seasonality and local retail station competition are responsible for the small longer-term fluctuations (e.g., a five to ten cent rise in prices over a few months span).[84]

All of these factors in some way or another affect the worldwide demand for and supply of crude oil, which in turn causes instability in prices.[85] The supply and demand balance in a hub, which is essentially the difference between the amount of petroleum products flowing out of a terminal to the amount of products flowing into a terminal, is key to price levels in surrounding regions. Any imbalances are immediately reflected in prices; that is, when stocks (i.e., inventories of fuel stored for future use) are low and the supply and demand balance tightens, wholesalers bid higher for available products with concerns that supplies are not adequate over the short term. Fortunately for Americans, the supply and demand balance in the United States is "more comfortable" than in Europe and Asia.[86] And for that reason, the raising of petroleum taxes throughout Europe to try to stabilize the balance of supply and demand is ineffective at best.

In times of political uncertainty and little excess production capacity, the market has less "ability to absorb the loss of supply because disruption results in a shortage that cannot be made up by other sources. Buyers are, therefore, more willing to bid up prices to shore up existing supplies".[87] This political uncertainty currently includes war in Iraq, civil unrest in Nigeria and Venezuela, and even concerns about the political stability of Iran to continuously export crude oil into the market.[88] Furthermore, coinciding with this uncertainty is the production regulation by OPEC member countries, where in general, the less crude oil they produce, the higher the price of crude oil, and the more oil they produce, the lower the price of crude oil. However, some OPEC members want to produce less oil and raise prices (e.g., Iran and Venezuela who like to keep crude prices in the sixty-dollar per barrel range), whereas others want to flood the market with petroleum to "reap immediate returns" (e.g., Saudi Arabia who likes to keep crude prices in the fifty-dollar per barrel range).[89] As a result, OPEC members have a long record of failing to abide by their own production cutting decisions.

Weather also has an effect on supply and demand, both positively and negatively, and unlike with political uncertainty and OPEC cuts, seasonable weather changes only account for small fluctuations from month to month. When crude oil prices are stable, gasoline prices in the United States (more than most other petroleum product prices because of higher demand) tend to gradually rise before and during the summer months when consumers are on vacation and driving their automobiles more. These prices, which average about five percent higher than during the rest of the year,[90] tend to fall when school gets back in session, as well as when the fear of an active hurricane season become less of an issue, in mid to late September. Mild winters can then help keep these prices low as the warmer weather aids in the growth of petroleum stocks, especially home heating fuel. However, winters in the Northern Hemisphere that are colder than normal increase demand for home heating fuel, and therefore crude oil, causing supply and demand to stiffen, resulting in higher prices than are seen in the fall months.

Even though these factors affect the future conditions of crude oil and petroleum products, the instabilities they cause still propagate throughout prices for supplies that are sitting in refineries, logistic hubs, and retail stations. When these factors become a global issue with regards to supply and demand, the change in market conditions causes prices "to increase for crude oil that is not planned to be delivered until months into the future"[91] (i.e., the future markets). Those higher prices then cause the buyers and sellers of crude oil "to alter their perceptions of the current balance of supply and demand".[92] The general reaction is to build up inventories "in anticipation of tightness in the future market. Consequently, crude oil is taken from the current market supply causing the price to rise for the marker crudes [e.g., WTI and Brent blend] and equivalently all other crudes bought and sold" during the trading period.[93] Accordingly, prices for petroleum are a function of both current and future supply and demand conditions, not historical costs,[94] bringing us back to the economic reality that consumers pay for the value of petroleum, not its physical cost.

Logically from a market standpoint, the raising of petroleum prices immediately following natural disasters, world conflict, OPEC production cuts, etc., is an intelligent method and preemptive measure at abruptly reducing demand, with expectations of future supply shortages and tightness in infrastructure. Initially and to some degree, consumers conserve more energy when prices spike ten, twenty, or even thirty cents a gallon in a few short days, as was illustrated the first week of September 2006 following the devastation of Hurricane Katrina. This helps stretch out existing supplies and ensures that supplies do not run out, which is what occurred during the oil embargo in 1973 to 1974.

Additionally, "because crude falls on day one, it doesn't mean that on day two the consumer will see the lower price".[95] This gradual reduction in prices is a way to slowly increase demand, and not to flood the market with the lower price products. This ensures stabilization in supply and demand and that the lower prices do not cause a spike in demand, thus further tightening market conditions. Hence, paying more initially and slowly lowering prices back down, guarantees that a continuous and ample supply of petroleum can be delivered to consumers.

Having seen Figures V, VI, and VII, many consumers are probably wondering why petroleum product prices are currently on the rise. Figure VIII: Weekly Retail Gasoline and Diesel Prices, illustrates that although not being adjusted for inflation, prices have still considerably increased over the last eight years. The reason for this increase is that petroleum products represent a "critical source of fuel for the world's economy, which recently sustained a period of stronger-than-expected growth. This economic growth gave rise to stronger-than-anticipated global demand for these fuels, which reduced available excess production capacity as well as the quality of the barrels of crude available to the marketplace."[96] Not alone, this impact of strong global economic growth was felt across the steel, aluminum, concrete, and shipping industries as well.[97]

Unfortunately, the tightening of supply and demand was also "compounded by the unexpected losses in crude oil production and refining capacity" in the Gulf of Mexico from Hurricane Katrina, Rita, and Wilma in 2005.[98] Hurricane Katrina initially took out more than twenty-five percent of U.S. crude oil production and ten to fifteen percent of U.S. refining capacity. Furthermore, major pipelines that feed the Midwest and the East Coast were shutdown or forced to operate at reduced levels.[99] This loss of supply, however, was supplemented by repairing damaged facilities, increased imports, and loans and releases from the United States' Strategic Petroleum Reserve. As a result, average prices were back down to around $2.10 by the middle of November 2005, more than a dollar less than their peak levels in the last week of August and the first week of September 2005.

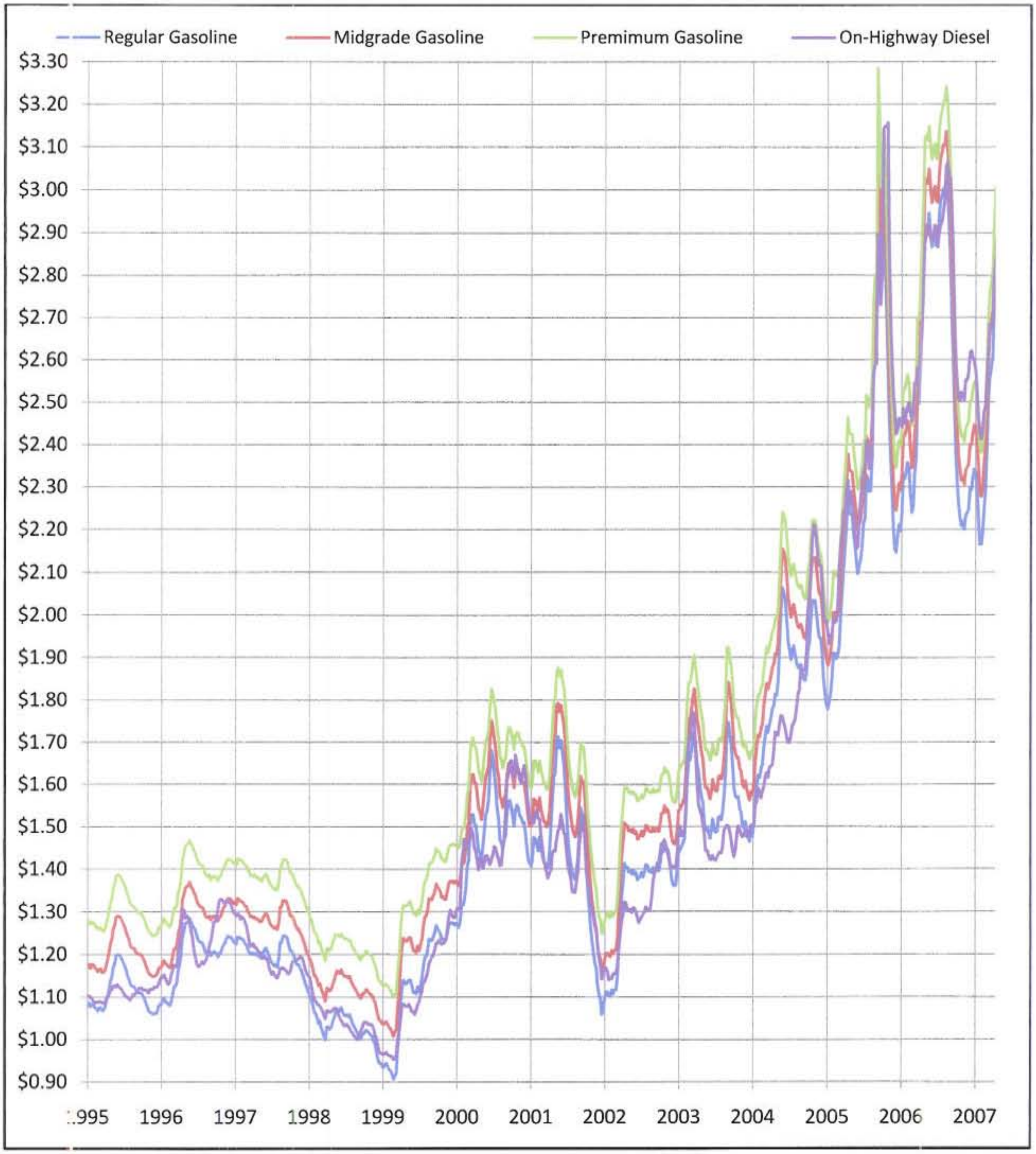

Figure VIII: Weekly Retail Gasoline and Diesel Prices[100]

Following the dip in prices from the rebuilding of petroleum infrastructure in the Gulf Coast, prices drastically rose almost as high as during the height of the hurricanes, on fears and expectations that more frequent and fierce hurricanes were headed for the Atlantic coast in the summer of 2006 (Figure VIII). However, when these fears and expectations were ultimately proved to be wrong, some of the instabilities in supply and demand balances were reprieved, and prices in the summer and fall of 2006 instantly dropped back down to post-Katrina levels, staying there through the early part of 2007 on the start of an unseasonably warm winter.

By late February and through all of March 2007, winter hit the Northeast both very late and very hard, raising petroleum prices as the demand for home heating fuel spiked. Compounding this unsteadiness in the crude and refined markets, was major turmoil between two key oil-producing and oil-consuming countries – Iran and the United Kingdom – with the Iranian seizure of fifteen British soldieries. At this time both buyers and sellers had concerns that either Iran would do something hastily in defiance of the United States and the United Nations, or Britain, possibly backed by the United States and other key allies, would resort to preemptive military strikes deep inside of Iran, with Iran retaliating by cutting all their supplies from the market (approximately 3,250 barrels per day). However, following thirteen days of British humiliation, and threats, propaganda, and political hearsay by the Iranian government, the fifteen British sailors and marines were released, though by this time retail prices were back up to over $2.85 per gallon.[101] Unfortunately, prices will likely remain at their current level and may even grow ten to twenty cents higher as the summer driving season approaches and the fear of a strong 2007 hurricane season surfaces.

Consequently, the price of crude oil has increased in the past few years because of global economic growth, severe weather, and political instability; supply has not fully kept pace and as a result, the world's space capacity of crude oil has reduced.[102] Consequently, oil prices have been raised, particularly for better quality crudes, in order to try and bring supply and demand back into balance.[103] Nonetheless, as we see in Figure IX: Changes in the Price of Major Consumer Items between 1982 and 2006, the jump in the price level of gasoline (and therefore all petroleum products (Figure VII)) from twenty-four years ago is far below that of almost all other consumer products, including educational, medical, and primary residence costs, and even the price for fresh produce.

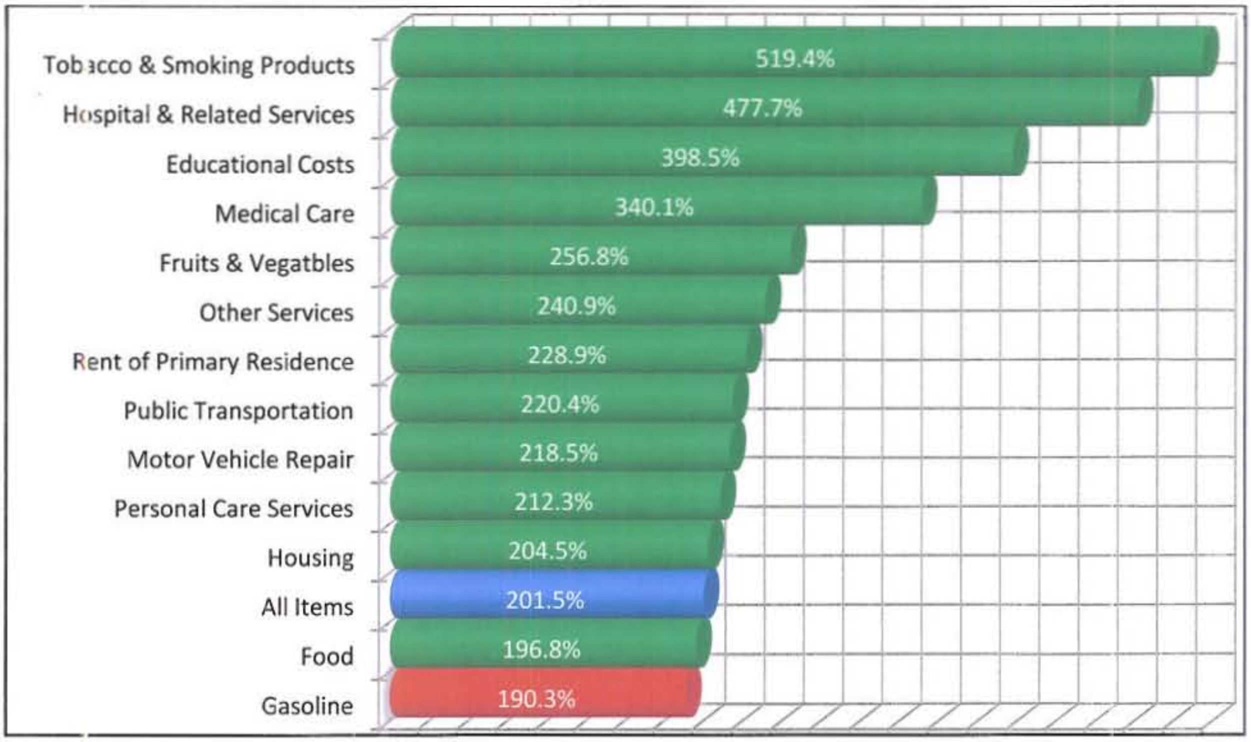

Figure IX: Changes in the Price of Major Consumer Items between 1982 and 2006[104]

Overall, the world crude oil market is tight and prices reflect this.[105] Being traded all over the world, the buying and selling of crude oil – as well as refined products – occurs within a global infrastructure, inevitably pulling the United States into a fragile, interdependent global marketplace. Thus, since fuels stemming from crude oil are global commodities, their prices are determined by supply and demand factors on a worldwide basis.[106] Exacerbating this is the fact that prices of basic energy such as gasoline, diesel fuel, home heating oil, and natural gas are "more volatile" than prices of other products since consumers cannot switch between different types of fuels.[107] Fortunately, as illustrated in the second part of this review, *Stemming the Oil Addiction: The Achievable Goal*, this lack of fuel diversification is a solvable problem, however until then, what cannot be avoided "is the economic reality that U.S. retail prices are fundamentally determined by the world oil market."[108]

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Chapter 6: Does Our Society Need to

Significantly Reduce Oil Consumption?

With the knowledge of the source of demand for petroleum products (Chapter 2: Major Consumers), the source of its supply (Chapter 3: Major Petroleum Resources), and how crude oil is refined and priced for consumers (Chapter 4: Refining and Distribution, and Chapter 5: Prices), we can now begin to accurately and objectively answer the question: Does Our Society Need to Significantly Reduce Oil Consumption? In order to thoroughly answer this question, we have to approach the situation from four different fronts:

(1) Global Warming

(2) Price Instabilities and Hidden Costs

(3) National Security

(4) Diminishing Supplies.

Due to the sheer size of each one of these topics, which are in no particular order, we will restrict ourselves to concisely analyzing each standpoint, with the ultimate goal of finding reasons why we may need to reduce oil consumption, not how.

Inevitably, all four of these issues have one major underlying factor – money – and are consequently profoundly affected by political motives, individual agendas, and people's opinions. Therefore, unlike with Chapters 1 through 5, which are objectively based on accurate and reliable data to determine the current status of the United States' dependence on oil, the conclusions this chapter draws are heavily opinion based. However, by approaching this exceedingly complex question from a multitude of angles, which the media often fails to do, we can accommodate many different viewpoints, and therefore conclude with solid reasons why (or why not) the United States' needs to reduce its oil consumption.

Global Warming

Today, global warming and the burning of fossil fuels – especially the four-hundred million gallons of gasoline that power our automobiles each day – dominates discussions and debates in the media, on Capitol Hill, and even in our homes. With the recent release of Former Vice President Al Gore's *An Inconvenient Truth*, which won the 2006 Oscar for Best Documentary Feature, global warming has become a mainstream issue in the United States. Having fears of melting glaciers, catastrophic increases in sea levels, extinction of living species, more frequent and extreme weather patterns worldwide, widespread outbreaks of malaria and dengue fever, and higher death tolls from malnutrition and heat stress,[1] many Americans are very concerned about our future and the condition we will leave the planet in for future generations. Unfortunately, the daily contradiction of reports, which are exacerbated with underlying political motives from both sides of the spectrum, makes it hard for Americans to separate fact from fiction, leaving the vast majority both ill- and misinformed.

Since we cannot begin to make rational decisions without knowledge of the entire situation, it is important to realize exactly what the greenhouse effect and global warming is. The greenhouse effect, likely the main cause of the global warming we are experiencing today, is responsible for the regulation of the Earth's average temperature, in which certain molecules in the atmosphere absorb heat (i.e., radiation from the sun), keeping the Earth's temperature higher than it otherwise would be. According to the National Oceanic and Atmospheric Administration

(NOAA), without a natural greenhouse effect, the Earth's average temperature would be −0.4°F, instead of its present day 57.2°F.[2] Thus, the greenhouse effect is "essential for life on Earth and is one of Earth's natural processes",[3] a reality that many Americans are not aware of.

The most abundant of these radiation-absorbing gases in the atmosphere is water vapor, which accounts for a large part of the greenhouse effect, *followed by* carbon dioxide. Nitrous oxide and methane, among other gases, are also contributors to the greenhouse effect, but their levels in the atmosphere are much lower than that of water vapor and carbon dioxide.[4] Consequently, the main contributors to the greenhouse effect, and therefore global warming, are water vapor and carbon dioxide. Although the concentration of water vapor in the atmosphere is virtually out of the control of humans, the amount of carbon dioxide – the main emission from burning fossil fuels like petroleum – in the atmosphere is.

Prior to the start of the Industrial Revolution in the late eighteenth century, a time before any significant use of carbon-emitting fuels, carbon dioxide levels were at about 280 parts per million by volume.[5] By the end of the 2005, this concentration was at a record setting 379.1 parts per million,[6] after an increase of 0.5 percent from 2004 and 35.39 percent in the 200 short years since the Industrial Revolution. According to the NOAA, current carbon dioxide levels in the atmosphere have definitely not been exceeded in the last 420,000 years, and probably not in the last twenty million years. However, it is important to recognize that these short periods of geological time only account for 0.00923 and 0.43956 percent of the Earth's life, respectively, based on the Earth's approximate age of 4.55 billion years. Thus, although carbon dioxide levels are at record highs based on twenty million years of data, these levels are almost certainly not the highest concentrations based on 4.55 billion years of data.

With the 35.39 percent increase in carbon dioxide levels, which has transpired linearly since 1950, it should not be surprising that the heat-trapping gas has assisted in the increase of the Earth's average surface temperature – global warming – by about 1.08°F (plus or minus 0.36°F) in the last century (observe that global warming is not uniform, and that some regions, particularly parts of the southeastern United States, are actually getting cooler).[7] With thirty-three to fifty percent of this temperature increase occurring over the last twenty-five years,[8] it is only logical to deduce that the increase in carbon dioxide levels, to some extent, have caused the Earth's temperature to rise. But there are external factors, such as varying solar output (which has only been measured since the late 1970s)[9], Milankovitch Cycles (i.e., varying changes in the Earth's position and orientation relative to the sun), volcanic activity, and other atmospheric dynamics that also affect global temperatures on a long-term scale. As a result, it is very unlikely that carbon dioxide, and therefore greenhouse warming, accounts for the entire 1.08°F increase, although to some unknown degree, *it is contributing to global warming.*[10]

Regardless of whether carbon dioxide is causing the entire 1.08°F increase or only a fraction of it, the fact is that global warming does exist, a non-debatable reality that all humans need to embrace. But it is imperative to realize that global warming is *not* human-made; it is a natural process that is being accelerated by human's exploitation of fossil fuels, especially crude oil. Consequently, greenhouse warming is not a new occurrence geologically speaking, and humans will never be able to completely stop it. However, by reducing human-derived emissions of carbon dioxide, we can control the concentration of greenhouse gases in the atmosphere that are contributing to increases of global surface temperatures, thus allowing the natural process to move at its own, much slower pace.

Although global warming is very much occurring, it is important to recognize that the ultimate outcomes of the Earth's rise in temperature are still unknown. While promoting his film, Former Vice President Al Gore told ABC's George Stephanopoulos that "… the debate [over global warming] in the scientific community is over".[11] However, after Mr. Stephanopoulos "pointed out that many scientists are debating some of the things Mr. Gore says are about to happen because of global warming", the former vice president "did an immediate about face and admitted that scientists "don't know… they just don't know"."[12] In fact, many scientists are "far less convinced about the severity and dire consequences of global warming than Mr. Gore is".[13] Unfortunately, this is where fact and fiction start to intertwine, and the debate about how much the Earth's temperature will rise and the consequences of it begins to heat up.

What scientists do know is that because of warmer temperatures, glaciers are retreating and ice shelves are melting. As a result, the global mean sea level has been rising at an average rate of one to two millimeters per year over the last century, a rate that is significantly faster than that of the last several thousand years.[14] Additionally, some research scientists – most notably Massachusetts Institute of Technology professor Kerry Emanuel – believe that one of the outcomes of global warming is already being seen through the increased intensity and frequency of extreme weather systems. Dr. Emanuel, who "pioneered much of the research linking global warming to an uptick in [Atlantic] hurricane strength", believes that the increase in recent Atlantic hurricane strength "is so beautifully correlated with sea surface there can't be much doubt that there's a relationship with [increasing] sea surface temperature[s]".[15]

However, other scientists – most notably Christopher Landsea, formerly of the Hurricane Research Division of Atlantic Oceanographic & Meteorological Laboratory at NOAA, now the

Science and Operations Officer at the National Hurricane Center – dispute Dr. Emanuel's findings, saying that extreme weather patterns, especially the 2005 hurricane season, are due to natural cycles, not greenhouse warming.[16] Supporting Dr. Landsea's theory is a recent NOAA and NASA-funded research by Gabriel A. Vecchi of the NOAA's Geophysical Fluid Dynamics Laboratory and Brian J. Soden of the University of Miami's Rosenstiel School for Marine and Atmospheric Science, who found that global warming may possibly diminish Atlantic hurricane activity because of escalating vertical wind shear (i.e., differences in wind velocity at different altitudes).[17]

Increased vertical wind shear, which is typically not taken into account when analyzing the affects of global warming and higher ocean temperatures on Atlantic hurricanes, prevents the warm core of these storms from staying stacked above their surface circulation center.[18] As a result, wind shear either abruptly caps the intensity of hurricanes,[19] or causes them to dissipate and weaken due to the physical breakdown of their warm center.[20] However, even though these findings dispute those of other research scientists and Former Vice President Al Gore, Dr. Soden adds that "this study does not in any way undermine the widespread consensus in the scientific community about the reality of global warming".[21]

Therefore, although we may not exactly know what increased temperatures and levels of carbon dioxide will bring us, "we know what the world was like when we had less in the air, and it wasn't a bad place".[22] What we know for sure today is that humans are burning a lot more fossil fuels – especially crude oil – than a hundred years ago. And, continuing at this rate, we can expect carbon dioxide levels in the atmosphere to be anywhere between 490 and 1,260 parts per million by 2100,[23] the later becoming more likely if we do not start curbing emissions in the near future. Additionally, at these concentrations, climatology models expect temperatures to rise between 2.52°F to a remarkable 10.44°F by the end of the century. Still, "there is much need to refine our understanding of key natural forcing mechanisms of the climate, including solar irradiance changes, in order to reduce uncertainty in our projections of future climate change".[24]

It is also important to realize that we all emit carbon dioxide into the atmosphere, including Former Vice President Al Gore. In 2006 alone (from public records), Mr. Gore's twenty-room primary residence and pool house in Nashville, Tennessee used nearly 221 megawatt-hours of gas and electricity, more than twenty times than the nation average of 10.656 megawatt-hours.[25] Averaging a $1,359 electricity bill and a $1,080 natural gas bill ($536 for the primary residence and $544 for the pool house) each month, the Gore's spend $29,268 in gas and electric bills in 2006.[26] Consequently, political hypocrisy and deception, including high ranking government officials altering text in scientific documents on global warming (e.g., President George W. Bush's former chief of staff Phillip Cooney)[27], scientists of the American Meteorologist Society threatening to pull memberships for those who are less certain about the consequences of global warming,[28] and the media crying wolf by blaming every uncommon weather event on global warming, is not beneficial for Americans or for the advancement of stemming greenhouse gas emissions.

Nonetheless, global warming is a very important issue, whose repercussions may very well be felt throughout the world for many decades to come. If we are going to solve this problem together, Americans need to be better and more appropriately informed, a hard task to accomplish with scientists in constant disagreement and politicians fruitlessly debating. We can sit here and argue whether it is occurring or not, but in the end we will never be able to pull together, stem greenhouse gas emissions, and ultimately slow down or even halt the increase in the Earth's temperature. All would agree that reducing carbon dioxide emissions (as well as other air and water pollutants emanating from the use of crude oil) is beneficial to our way of life, and since the United States is the source of about forty percent of the greenhouse gases emitted into the air each year,[29] Americans need to be the nation to lead the world in search for environmentally-friendly energy sources that do not compromise our way of life.

Price Instabilities and Hidden Costs

Perhaps the largest threat to the world's supply of crude oil, and therefore the stability of petroleum prices, is that about two-thirds of all oil – more than fifty-four million barrels a day – is moved by tankers that follow a fixed set of maritime routes.[30] Crude exports from the Middle East (i.e., "high volumes that travel very long distances")[31] are mainly moved by these tankers, many of which carry over two million barrels of oil per voyage (almost 2.5 percent of the total oil consumed in the world each day). Although they are of low cost, efficient, and very flexible, tankers encounter several geographic chokepoints that are crucial for a continuous supply of oil. However, due to the political instability of the countries controlling these chokepoints, many of which are controlled by nations harboring terrorists,[32] any blockade, even if it was temporary, would be devastating to the United States' economy. Furthermore, due to the physical size of these waterways, chokepoints are susceptible to pirate attacks and shipping accidents, compounding environmental problems that already plague the use of petroleum.

A major chokepoint in the southern part of the Middle East (Figure I: Map of the Middle East) is the Bab el-Mandab, which connects the Red Sea with the Gulf of Aden and the Arabian Sea (Indian Ocean). As illustrated in Figure II: Map of the Bab el-Mandab, this twenty mile wide chokepoint is the only way to move crude oil from West-African and Middle Eastern nations through the Red Sea and to the Suez Canal in Egypt (a small channel (Figure III: Map of the Suez Canal) connecting the Red Sea and the Gulf of Suez with the Mediterranean Sea.

Figure I: Map of the Middle East
(Source: *Microsoft Encarta*)[33]

With more than three million barrels per day flowing through the Bab el-Mandab, closure would force oil tankers destined for the United States, Europe, and Asia around the Cape of Good Hope, tying up spare tanker capacity and adding greatly to transit time and cost.[34] In dire situations, northbound oil traffic can use the East-West oil pipeline through Saudi Arabia (a maximum capacity of 4.8 million barrels per day), however all southbound traffic would be completely blocked.[35] Therefore, any blockade or other disturbance of the Bab el-Mandab, which besides for a French tanker that was attacked by terrorists in October 2002,[36] has yet to happen, would put a severe disturbance on the supply and demand of crude oil, pulling significant global supply from the market and raising prices worldwide.

Figure II: Map of the Bab el-Mandab
(Source: *Microsoft Encarta*)[37]

Figure III: Map of the Suez Canal
(Source: *Microsoft Encarta*)[38]

Northeast of the Bab el-Mandab is the Strait of Hormuz, probably the most infamous and strategically-important waterway in the world that supplies Japan, the United States, and Western Europe with more than seventeen million barrels of crude oil per day.[39] Between Oman and Iran, this six-mile wide channel (two, two-mile wide channels for inbound and outbound tanker traffic, with an additional two-mile wide buffer zone) connects the Persian Gulf with the Gulf of Oman and the Arabian Sea (Figure IV: Map of the Strait of Hormuz). Since more than a fifth of all crude oil consumption comes from this chokepoint, "the Strait of Hormuz is by far the world's most important chokepoint".[40]

The largest threat to the Strait of Hormuz is Iran, which geographically has the ability to seize the waterway, as the chokepoint is almost completely surrounded by Iranian territory. Iran, whose isolation and defiance to most of the world makes the danger even more of a reality, threatens to blockade the straight seemingly every week. If it did not completely halt the flow of Middle Eastern oil, a fact that Iran knows and uses as leverage against the rest of the world, any blockade would force petroleum through faulty and insecure pipelines in Saudi Arabia, Iraq, Turkey, Kuwait, and Lebanon. However, with the East-West Pipeline in Saudi Arabia only having a capacity of 4.8 million barrels per day, the Iraqi Pipeline across Saudi Arabia only 1.65 million barrels per day, Lebanon's Tapline of 0.5 million barrels per day currently inactive, and poor security conditions to effectively move supplies from Iraq to Ceyhan, Turkey,[41] the current infrastructure would just not be enough to significantly revive any damage caused by a blockade of the Strait of Hormuz. Consequently, the movement of oil through the Persian Gulf and the Strait of Hormuz leaves the fate, and therefore stability, of the world's economy in the hands of extremist nations.

Figure IV: Map of the Strait of Hormuz
(Source: *Microsoft Encarta*)[42]

Upon crude successfully exiting the Strait of Hormuz, some tankers travel west towards the Bab el-Mandab, though most continue traveling east towards Malaysia and Singapore. Connecting the Indian Ocean with the South China Sea and the Pacific Ocean, the Strait of Malacca (Figure V: Map of the Strait of Malacca) supplies Japan, South Korea, China, and other Pacific Rim countries with more than eleven million barrels of crude oil each day.[43] Considered a key chokepoint in Asia, at its narrowest point, the strait is only 1.5 miles wide, and is the "shortest sea route between the Persian Gulf and the Asian markets".[44] If closed due to piracy or shipping accidents, all oil tankers would be forced to travel down to Australia, immediately raising freight rates worldwide, and having a profound effect on world stock markets. Furthermore, with Chinese oil imports from the Middle East growing steadily, the Strait of Malacca is "likely to grow in strategic importance in the coming years".[45]

Figure V: Map of the Strait of Malacca
(Source: *Microsoft Encarta*)[46]

Although none of the crude oil flowing through the Strait of Malacca is destined for the United States, we know from Chapter 5 that the global supply and demand for crude oil has a much larger impact on oil prices than the actual trade flows.[47] Trade flows are mainly the result of the most efficient transportation costs, refiner preferences for different qualities of crude oil, and government relations with supplying countries. Thus, if the flow of crude from any one of these chokepoints were hindered, even if it was not being shipped to the United States, the loss of supply would immediately be felt in prices all over the world. Consequently, all transportation chokepoints add to the instability of crude oil and petroleum products prices, not just those with American supplies. For that reason, "the risks to our energy supply are frighteningly real and there is a limit to our ability to deal with them. Only by decreasing our energy dependence would we be able to minimize the need to transport oil across the globe and thus reduce our vulnerability to these types of attacks."[48]

In addition to the price instabilities caused by transportation chokepoints, there is a hidden cost of oil that consumers do not see at the pump but embedded in their taxes, an economic burden that has cost American's anywhere between $2.2 trillion and $2.5 trillion over the last thirty years.[49] In order to ensure that "domestic oil companies can compete with international producers and that gasoline remains cheap for American consumers",[50] the federal and state government "subsidizes the oil industry with numerous tax breaks and government protection programs worth billions of dollars annually".[51] According to the National Defense Council Foundation, an Alexandria, Virginia-based research and educational institution that recently completed a "comprehensive investigation" into foreign oil's affect on the United States' economy, this ultimately results in an annual loss of $13.4 billion in federal and state revenues,[52] a significant amount of money when considering the United States' budget deficit.

Furthermore, America's dependency on oil from countries that are either politically unstable or "at odds" with the United States forces the American military to maintain a constant presence in and around major oil producing countries, specifically those in the Middle East.[53] Militarily, in order to defend and maintain a constant flow of Middle Eastern oil, the United States is obligated to patrol waters in and around the Persian Gulf, supply military assistance to Middle Eastern dictators, and even deploy substantial U.S. forces to try to maintain peace in the region. In total, this annually amounts to an additional $49.1 billion in the Department of

Defense's budget, which would add about $1.17 to the price of a gallon of gasoline if reflected at the pump, not in taxes.[54]

Finally, the transfer of wealth from the wallets of Americans to those of oil-producing nations is currently over $100 billion per year,[55] and is estimated at approximately $1.16 trillion over the last thirty years. While significantly increasing our trade deficit (crude imports account for almost a third of the United States' total trade deficit), importing oil and the transfer of wealth has also resulted in the loss of more than 828,000 American jobs since the 1970s, and cost the United States $159.9 billion in gross national product annually.[56] As a result, the total economic penalties of America's dependence on foreign oil range between $297.2 to $307.9 billion per year, an amount that will increase exponentially as domestic production decreases further.[57] If reflected at the pump and not embedded in taxes, these "hidden costs" would almost double the price of gasoline, raising the cost to over $5.28 a gallon.[58]

National Security

"Oil and what it represents – energy – have always been a source of conflict".[59] In 1941, the Japanese attack on Pearl Harbor had its origin (in part) from a decision by the United States to stop exporting oil to Japan in response to the Second Sino-Japanese War in the late 1930s.[60] At the time, Japan was almost completely dependent on imported oil, mainly from the United States and the Dutch-held Indonesian islands.[61] Consequently, with the United States, Britain, China and the Dutch East Indies all placing an oil embargo on Japan in response to their aggressive military actions against China, Japan concluded that if their supplies were going to be cut off, they would have to respond militarily.[62] As a result, Japan attacked the United States' naval base on Pearl Harbor, Oahu, Hawaii on December 7, 1941, numerous British isles in the

South Pacific a day after on December 8, 1941, and the oil-rich Indonesian islands shortly thereafter. Quickly becoming a decisive moment in twentieth century history, the oil-fueled conflict ultimately resulted in the United States' declaration of war against the Empire of Japan, propelling them into the Second World War.

Almost thirty-two years later on October 17, 1973, oil again became the source of major conflict, where "in an attempt to influence U.S. Middle East policy, the OPEC cartel, spearheaded by Saudi Arabia, decided to cut oil supplies" to the United States and its allies in Western Europe.[63] Following the start of the Yom Kippur War, in which Syria and Egypt attacked Israel on October 6, 1973,[64] the United States and its Western European allies showed strong support for Israel. As a result, many Arab-exporting nations imposed an embargo on the nations backing Israel – mainly the United States – by curtailing production by five million barrels per day. Although about one million barrels per day were made up by increased production in other countries, there was still a net loss of more than four million barrels per day (seven percent of the world's production) for a stretch of five months through March 1974. A time still fresh in the minds of many Americans, within weeks of this embargo, petroleum prices nearly quadrupled, with shortages felt across the country by the end of 1973.

"At the peak of the drama, Secretary of State Henry Kissinger indicated that the United States was prepared to send military forces to the Persian Gulf to take over whatever country was needed to ensure oil supply."[65] From an intelligence assessment by the British government, the United States drew up plans to seize oilfields in Saudi Arabia, Kuwait, and the United Arab Emirates in 1973 to "counter the Arab oil embargo against the west".[66] However, since by the beginning of 1974 the United States was hit by the "worst slump since the Great Depression",[67] it would have been too late by the time any of these plans could have been fully implemented.

Furthermore, by the time the embargo was lifted in March 1974, the global economy was devastated, the United States' unemployment rate more than doubled, and the gross national product declined by six percent, with Europe and Japan suffering a similar fate.[68]

Today, the inevitable relationship between world conflict and oil transpires in a much broader and worldwide sense, terrorism. From the hidden costs of petroleum, we know that the United States' military must maintain a presence in the Middle East to ensure a continuous supply of oil that fuels our economy as well as our allies economy, a burden that costs Americans almost fifty billion dollars a year. As a result, this western military presence is a "rallying cry for anti-Americanism and Islamic fundamentalism"[69] – terrorism – that is ultimately funded by the "petrodollars" earned by countries like Saudi Arabia, Iran, and Libya.[70] Therefore, with twenty-two percent of the world's oil in the hands of state sponsors of terrorism that are under United States and / or United Nation sanctions, the United States' dependence on Middle Eastern oil greatly affects national security.[71]

Since the majority of Middle Eastern countries have vast oil reserves, the free flow of oil revenues into their dictator's pockets allow them to sponsor terrorism and sustain corrupt political systems. With fundamentalists controlling almost all of these governments, many Middle Eastern nations want the destruction of Israel and the West, and with their oil-generated wealth, they continue to use oil as a potential weapon and provide extremists the "capital to market and implement [these] ideas worldwide".[72] Unfortunately, the threat is very real where very recently, a Saudi wing of al Qaeda called for attacks on American oil sources across the world, including Canada, Venezuela, and Mexico, saying "it is necessary to hit oil interests in all regions which serves the United States not just in the Middle East. The goal is to cut its supplies or reduce them through any means".[73]

The fact is "oil and terrorism are entangled. If not for the west's oil money, most [Middle Eastern] states would have not have had the wealth that allowed them to invest so much in arms procurement and sponsor terrorist organizations."[74] Thus, the United States' best weapon against terrorism and improving national security is to "decrease its dependency on foreign oil by increasing its fuel efficiency and introducing next-generation fuels."[75] If the United States imported less oil, "the global oil market would shrink and [consequently the] price per-barrel would decline".[76] This would ultimately force "petroleum-rich regimes to invest their funds domestically, seek ways to diversify their economies and rethink their support for America's enemies."[77] Only then will financial support for terrorism radically diminish, and national security in the United States drastically improve.[78]

Diminishing Supplies

If the three pitfalls above – global warming, price instabilities, and national security – do not prove to be the downfall of crude oil, worldwide diminishing supplies ultimately will be. To date, it is estimated that approximately 800 billion barrels of crude oil have been pumped out of the ground.[79] Additionally, based on accumulated experience from the last century of drilling (i.e., by knowing the quantity of oil extracted from an intensively drilled area, experts are able to estimate probable volumes in other regions of the world with similar rock types and structures), geologists estimate that there is between 1,500 and 3,000 billion barrels of oil left to be extracted from the Earth, all of which is feasibly recoverable (Figure VI: Current and Potential Future Oil Reserves).[80] However, based on today's eighty-three million barrels of crude oil consumption per day, this quantity of oil will only suffice for forty-nine to ninety-nine more years, respectively. Furthermore, since consumption will continue to increase as the world's population per day, this quantity of oil will only suffice for forty-nine to ninety-nine more years, respectively. Furthermore, since consumption will continue to increase as the world's population grows exponentially, it is virtually certain that these diminishing supplies will prove insufficient before the end of the twenty-first century.

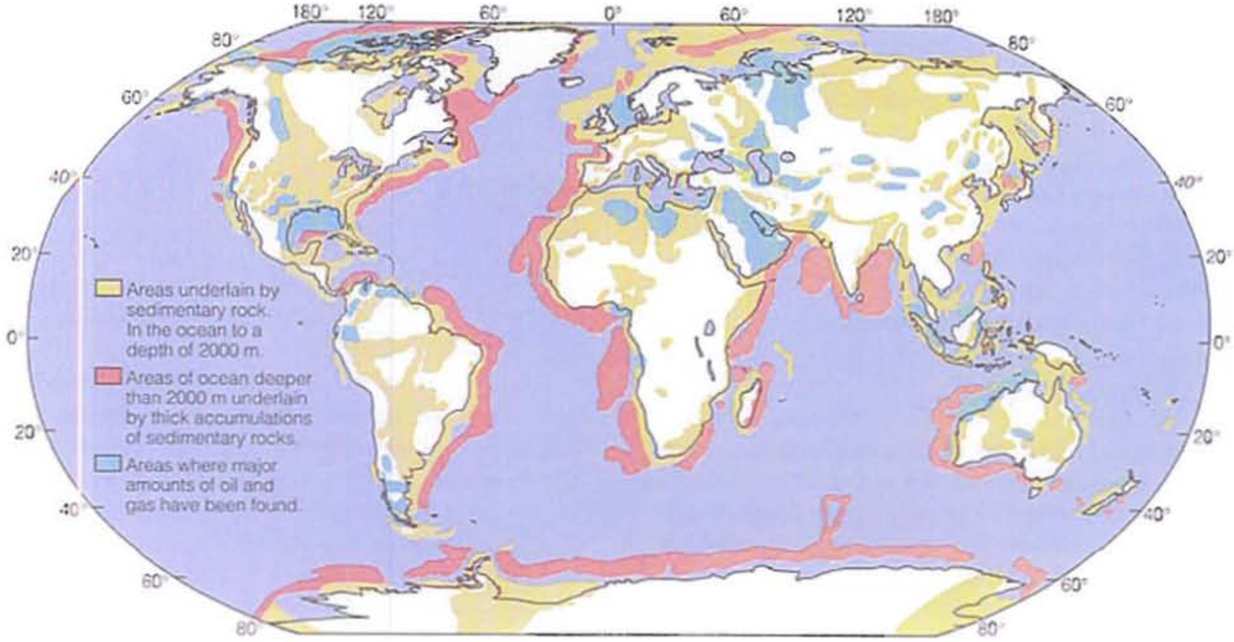

Figure VI: Current and Potential Future Oil Reserves

(Source: *The Blue Planet: An Introduction to Earth System Science*)[81]

As illustrated in Figure VII: Proven Oil Reserves, at the end of 2005, of the 1,500 to 3,000 billion barrels of oil left to be extracted, only 1,200.7 billion barrels are proven oil reserves that "geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions".[82] As a result, if the lower bound on the total amount of crude oil in the world proves to be more realistic than the 3,000 billion barrels, proven oil reserves are nearly at their maximum. Thus, if the estimation of geologists and other experts is correct, we can expect to see proven oil reserves in all regions of the world begin to decline, similar to the decreasing reserves in North America over the last eighteen years.

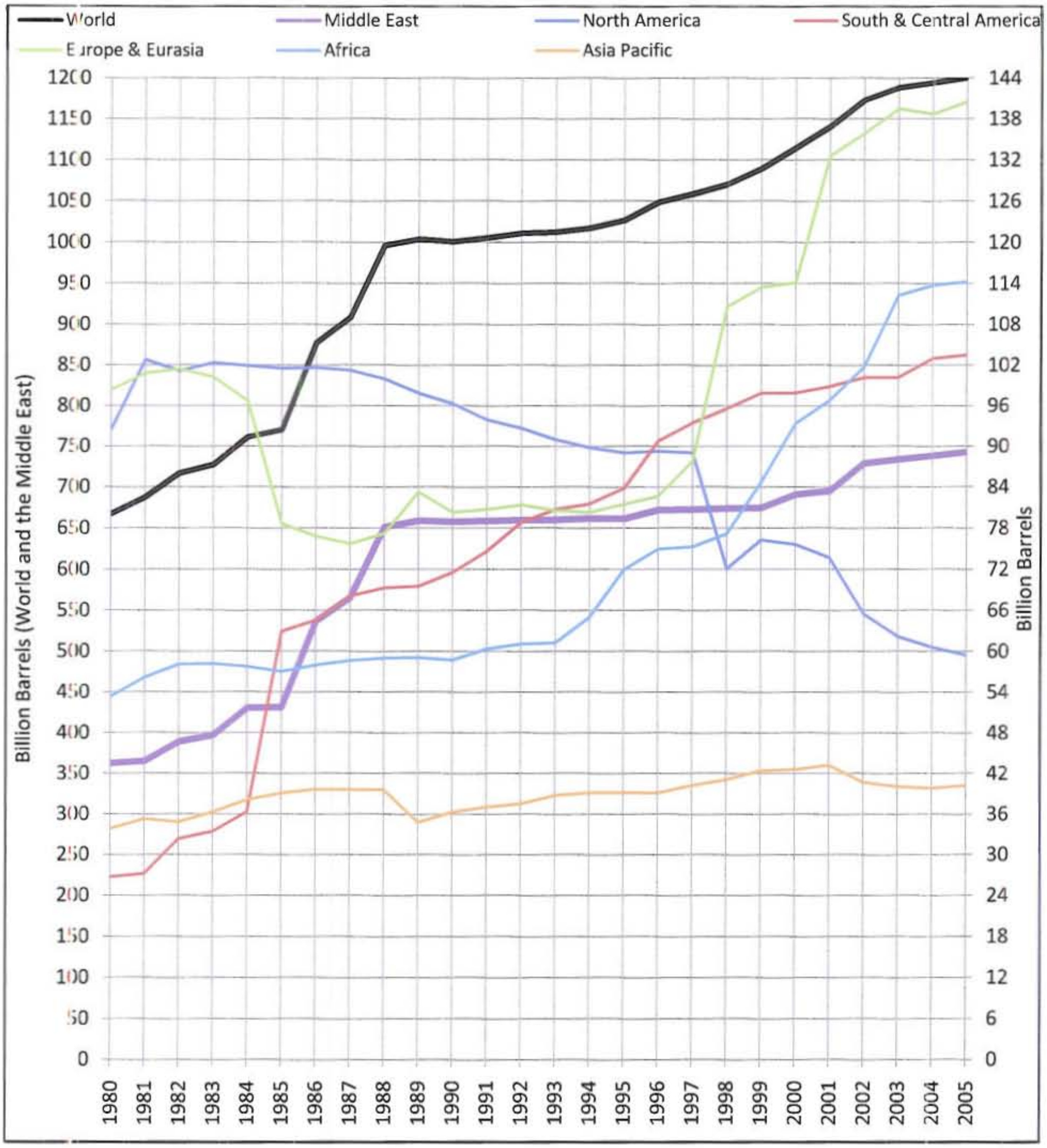

Figure VII: Proven Oil Reserves[83]

Delving deeper into the decline of North American oil reserves (Figure VIII: Proven Oil Reserves of North American Nations), we see that proven crude oil reserves in the United States have dropped by more than six billion barrels over the last twenty-five years.[84] Although this six billion barrel decrease may not seem that troubling with respect to that of other nations such as Mexico, it is enough to fuel the entire United States – free of imports – for more than nine months.[85] Consequently, the severe and consistent decrease in production levels since the early 1970s (Figure VIII: U.S. Crude Oil Production in Chapter 3: Sources of Supply) is in part due to decreasing reserves. It should be noted, however, that the United States could do more to curtail falling production levels by increasing nationwide exploration, especially in the Arctic National Wildlife Refuge in Northern Alaska, as well as by significantly shortening the acquisition time for petroleum corporations to receive government permits to drill for crude oil.[86]

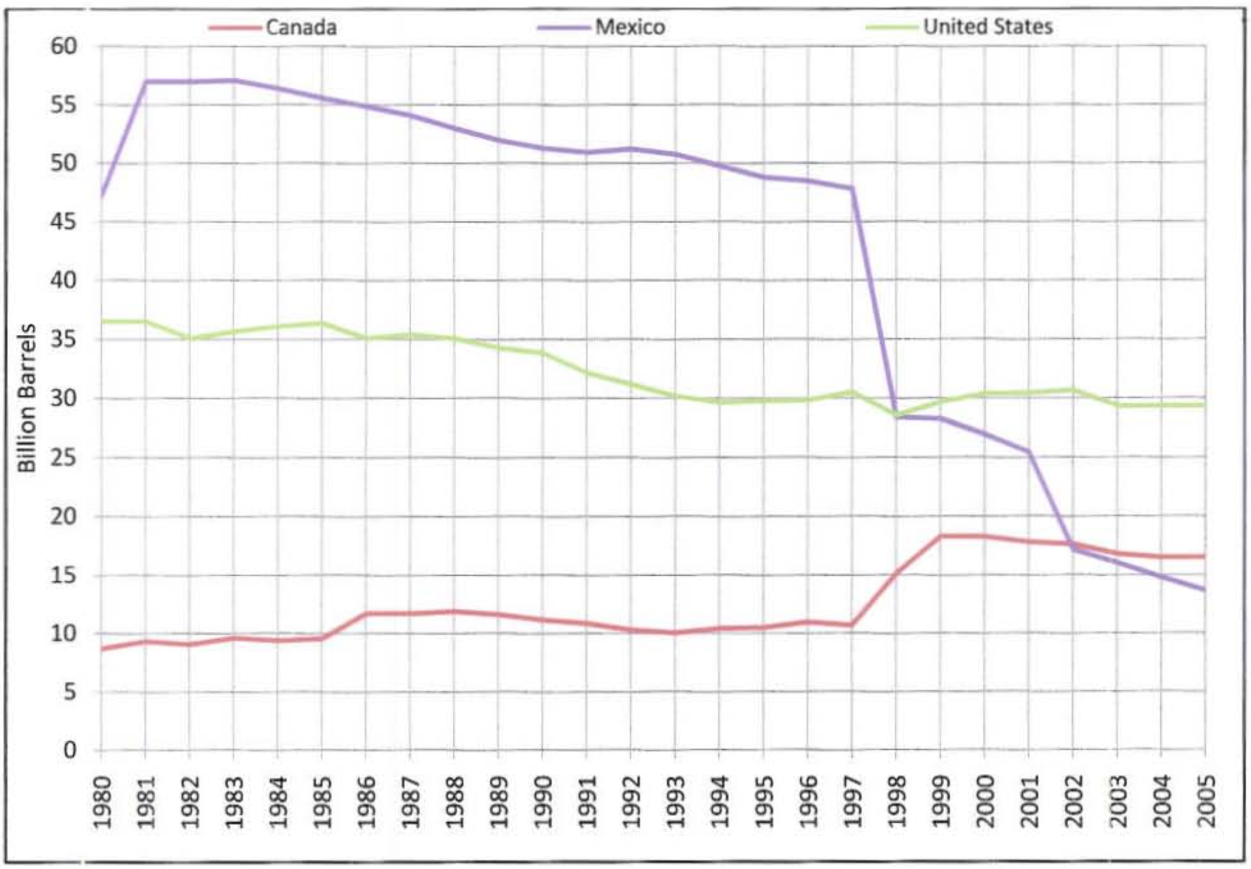

Figure VIII: Proven Oil Reserves of North American Nations[87]

With proven North American crude oil reserves sliding lower than sixty billion barrels, and those of the United States below thirty billion barrels,[88] the reality is that as time passes, the United States will become more and more dependent on crude oil imports from foreign countries outside of North America. Since OPEC-member countries hold more than seventy-five percent of the world's proven oil reserves and the Middle East† almost sixty-two percent,[89] diminishing supplies will ultimately make the problems with price instabilities and national security even worse. Furthermore, with the reserves-to-production ratio (i.e., the number of years that remaining reserves would last if production were to continue at their current (2005) levels)[90] of OPEC nations at seventy-three years and non-OPEC nations at seventeen years,[91] the entire world, not just the United States, can expect to see the vast majority of worldwide production stemming from Middle Eastern and other OPEC countries by the mid-2030s, before they all radically diminish sometime between 2050 and 2100.[92] As a result, petroleum – a finite resource whose formation time is measured in millions of years – does not have the capacity to meet long-term worldwide demands of energy.

Does Our Society Need to Significantly Reduce Crude Oil Consumption?

Due to the severity and ultimate consequences of global warming, price instabilities and hidden costs, national security, and diminishing supplies, we stand in front of an issue of such importance – an extraordinary dependence on crude oil – that our decisions and actions will forever define and shape our future. No one wants to see crude prices over one hundred dollars a barrel, or petrodollar-sponsored terrorist attacks in the United States and abroad; whether or not we really do run out of petroleum, or if the dire global warming predictions of scientists are true.

† The Middle East has substantial oil reserves due to the mere coincidence of the collision of continental Europe and Asia with Africa, which formed good traps, with the occurrence of the right thermal gradients over millions of years.

Therefore, our society can no longer tightrope walk the fine line of insecure and extremist oil-producing nations, or sustain burning a nonrenewable fuel that continuously emits greenhouse gases into the atmosphere. Consequently, only by immediately and significantly reducing our oil consumption can we:

(1) Curb the greenhouse gas emissions that are accelerating the natural greenhouse effect, and thus global warming

(2) Eliminate hidden petroleum costs and the "Achilles heel of the global economy"[93] – oil transportation through the Middle East and the South Pacific

(3) Improve national security, as well as the safety and prosperity of Americans whose bloodline lies in the hands of politically unstable countries that are at "serious odds"[94] with the United States and its allies

(4) Ensure that diminishing supplies do not prove to be the downfall of our civilization.

Thus, the answer to the question we so vividly sought to answer, something on the minds of all Americans, is yes, *Our Society Needs to Significantly Reduce Oil Consumption.*

Although "prosperity, democracy and security all hinge on a cheap, clean, uninterrupted flow of energy,"[95] the main energy source no longer needs to be petroleum. As covered in the second part of this review on crude oil by Michael Sylvester entitled *Stemming the Oil Addiction: The Achievable Goal*, there are many promising technologies currently being developed that can help stem our so-called addiction to oil. However, while striving to achieve this goal, "there is no reason for us to compromise our lifestyles, [or] settle for smaller, slower, or less comfortable vehicles."[96] Thus, by using a multifaceted approach including increasing domestic supplies of conventional energy resources, conserving energy by increasing fuel efficiency, and by implementing renewable, next-generation energy resources,[97] our society can go through an enormous technological transformation to integrate new feasible products into the consumer market, all while maintaining, if not improving, our quality and way of life.

Such an industrial and technological revolution will inspire an economic boom both in the United States and throughout the world. Building an infrastructure for next-generation energies will generate millions of jobs around the world, and revolutionize industries such as the automobile industry and the oil and natural gas corporations, who will be at the forefront of these new technologies and energy sources. As a result, "researching, developing, and introducing new transportation technologies that are cleaner, safer, and less economically destructive should, therefore, be our top national security and economic priority"[98] over the next several decades.

This will ultimately "require us all to pull in the same direction",[99] in which we can use the countless technologies that petroleum has provided us to search for a new energy source that builds upon the advantages of oil, though is not plagued with its dangerous weaknesses. While developing upon existing technologies, through technological growth and progression, our ultimate goal should be an energy source that emits zero emissions, is nearly one-hundred percent domestically available, and economically stable and efficient enough so that all Americans can benefit from it. Only then, upon striving to achieve this goal, will we be able to significantly reduce our oil consumption, setting us free from the energy source that has dominated us for over a century: crude oil.

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