BREAKING AMERICA'S ADDICTION TO OIL & FOSTERING AN AGE OF ENERGY INDEPENDENCE:

SUSTAINABLE AMERICA'S POSITION ON ENERGY

The United States sits at a critical juncture at which its food and fuel systems are running at a high utilization rate with little spare capacity, putting the nation and everyday Americans at risk of shortages of two of our most basic necessities. To decrease the risk, it is necessary to lower the demand for oil – no easy task, as mobility remains a key tenet of the American ideal, and our daily behavior mirrors this: we drive a lot. Fully 70% of our oil usage comes from transportation. Sustainable America has chosen to focus on decreasing the amount of oil Americans use each day for transportation – transportation of people and transportation of food and other goods. Among the ways we advocate reducing our dependency on oil are to increase fuel efficiency, to increase local food production and consumption, to use more advanced vehicles such as those powered by electricity and natural gas, and to foster the development of advanced biofuels. There are challenges involved in all of these proposed solutions – if they were easy, we'd all be doing it already – but the payoff of an America with a much-reduced reliance on oil makes these challenges worth undertaking.

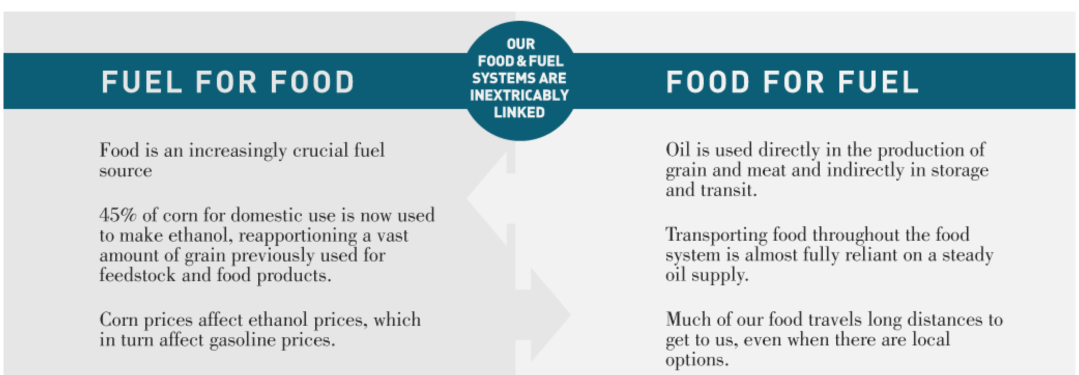
This paper aims to explain Sustainable America's position on Energy. Subsequent papers will examine the role of Food in the Food/Fuel nexus in more depth.

THE PROBLEM:

Though seemingly distinct, our food and fuel systems are inextricably linked. A shortage or disruption in one will lead to higher prices or physical disruptions in the other.

Food for Fuel: Food is an increasingly crucial fuel source as corn and sugar are used to produce ethanol, which is blended into our gasoline supplies (a staggering 45% of U.S. corn is now used to make ethanol[1], reapportioning a vast amount of grain previously used for feedstock).

Fuel for Food: Oil is a crucial input to our unsustainable industrial agriculture system (used directly in the production of grain and meat and indirectly in storage and transit). This interdependency is set against the backdrop of rising global demand and low spare capacity for the production of both food and fuel, driven in recent years by economic growth and the accompanying rise of consumerism in emerging market nations. The reality is that we're living on a very thin margin, where threats to each system, such as the drought of 2012 and tensions in the Middle East, can create physical shortages and/or drive increased price volatility. In addition to the headwind that high fuel and food prices create for our already vulnerable economy, spikes in food and fuel prices put additional strain on the budgets of low-income Americans, who spend approximately 37%[2] of income on these two basic commodities. At a time when the U.S. poverty rate continues to rise, the food / fuel nexus is particularly troubling.



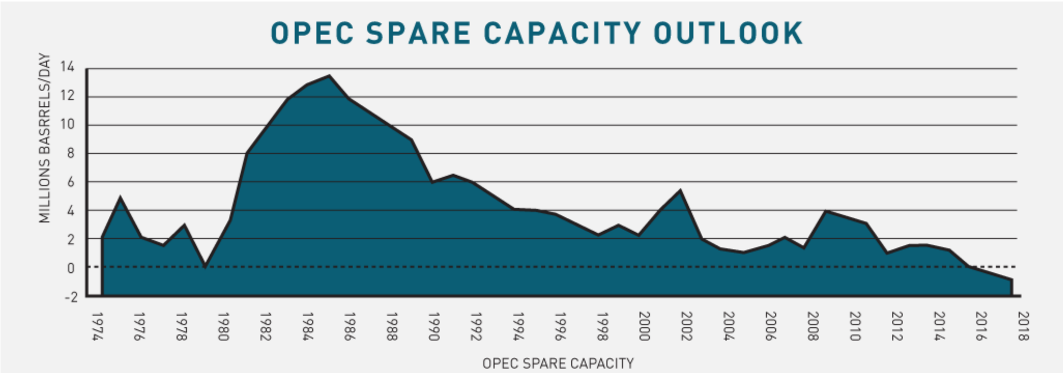
OIL: AN ADDICTION WE CAN'T SUSTAIN

The United States' rise to economic and superpower status in the 20th century coincided with a period of widespread oil usage (both industrial and consumer) as well as relatively cheap prices as compared to other commodities. Yet, due to unsustainable practices, oil could be the fuel that brings about a great deal of economic and strategic disruption in the 21st century. A lack of spare production capacity overlaid with a growing global demand, a reliance on imports from unstable or potentially hostile trading partners, an unfavorable environmental footprint,

[1] USDA data

[2] Bureau of Labor Statistics Consumer Expenditure Survey, 2010; Census Bureau; Peterson Institute

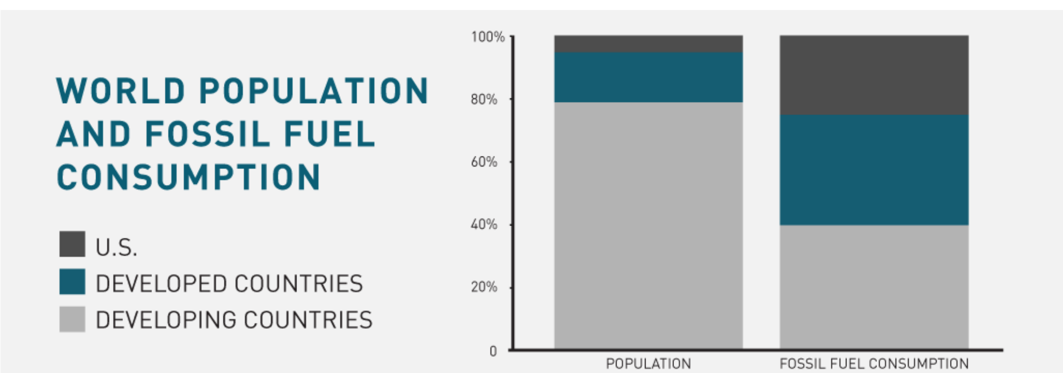
and a detrimental symbiotic relationship with our food system are just some of the unsustainable outcomes of the United States' addiction to oil. Sustainable America strives to be as realistic as possible in our outlook, and we realize that oil will likely always play a role in our economy. However, it is Sustainable America's position that the United States' current over-reliance on oil is ultimately untenable, and that new solutions and energy diversification are needed.



Crude Oil Supply & Demand System Realities.

The United States remains the world's largest single user of crude oil on a daily basis, but uncertainties about where future supply will come from set against the backdrop of rising global demand and rising global tensions lead Sustainable America to believe that our crude oil supply system is vulnerable to price spikes and potential physical shortages.

At 18.8 million barrels per day, the U.S. accounted for 21% of global oil consumption in 2011 while having only 5% of the world's people[3]. Despite growing domestic oil production in 2011 and 2012, the U.S. continues to import approximately 45% of its oil supplies[4], often from countries with competing strategic agendas, or from unstable regions of the world. Competition for oil supplies is likely to intensify as global crude oil production capacity remains just slightly ahead of demand, with major increases unlikely.



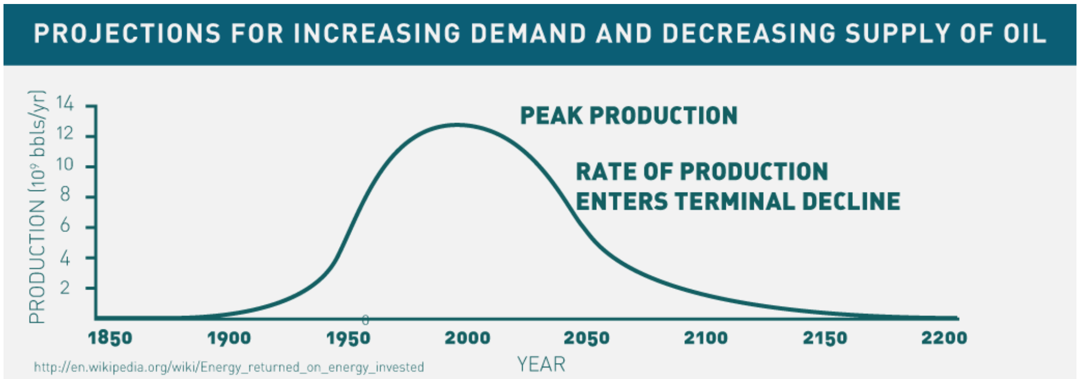
Supply. Sustainable America's view is that while global crude oil supplies will likely continue to rise from the 82 million barrels per day produced in 2010[5], future production will become more expensive as increasingly more geologically, geographically, and topographically challenging resources are tapped to keep pace with growing demand. As such, the spare production capacity of OPEC (the largest

[3] "World Petroleum Estimates", EIA, Oct 2009; Central Intelligence Agency; BP Statistical Review 2012; Population Reference Bureau

[4] EIA Energy In Brief, July 2012

[5] BP Statistical Review 2011

collective producing organization) and, particularly, **Saudi Arabia** (OPEC's largest producer and theoretically the country with the most ability to increase production) serves as an important buffer against supply disruptions and as a yardstick for measuring the vulnerability in our crude oil supply chain.



Saudi Arabia's actual spare capacity has been a matter of debate for several years. Sustainable America operates under the theory that Saudi Arabia has the ability to surge large quantities of crude into the market for a short period of 90 days or so. But Saudi Arabia's permanent spare capacity is likely lower than its surge capacity, with our best information pegging the Kingdom's permanent spare capacity in 2012 at a very thin 1 million barrels per day[6] (compared with a global market demand of 87 million barrels per day), leaving markets exposed to price and supply shocks in the eventuality of a physical disruption to production or exports in any of the world's major producing regions. Oil's capacity utilization rate is high compared with other major industries, such as steel, where the U.S. domestic capacity utilization rate was 74% in July 2012, and well below 80% historically over the last decade,[7] while the domestic mining and utility sectors have historical capacity utilization rates of about 87%.[8]

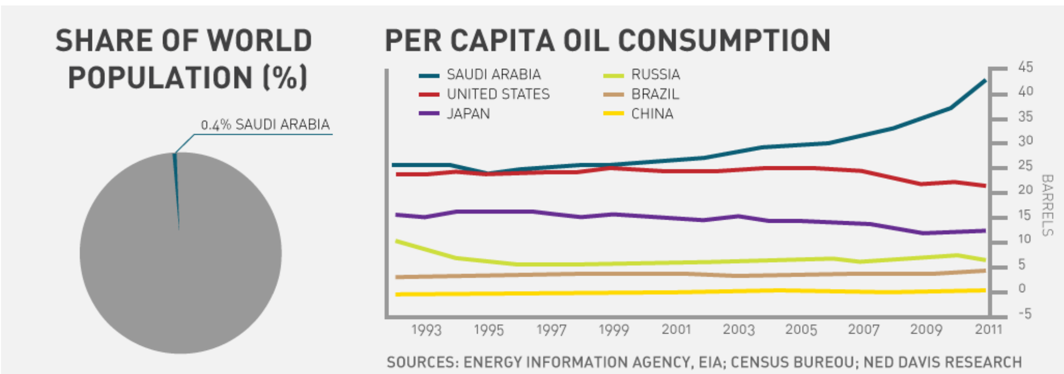
Saudi Arabia's true spare capacity continues to garner its share of debate in academic, strategy/policy, and commodity investment circles due to the Kingdom's importance to global oil production capacity. Influential author and energy policy maker Matt Simmons' widely read 2005 seminal work *Twilight in the Desert: The Coming Saudi Oil Shock and the World Economy*, argued that production at Saudi Arabia's massive Ghawar field would soon peak, or may have peaked already, based on evidence gathered in part from internal communications by Saudi Aramco, the Kingdom's national oil company. The Saudi government has consistently rejected Simmons' conclusions, as have other academics and petroleum engineers. However, one overlooked but important aspect of the Saudi debate revolves around the Kingdom's domestic consumption. The large population "bubble" of now underemployed and unemployed youths and twenty-somethings surging throughout the Middle East has been a topic of conversation in energy and policy circles for at least a decade. The practical manifestations of this are only recently being seen in phenomena like the "Arab Spring" – the early stages of which were sparked by people without hope for jobs or upward mobility in a region where the ruling elite has been largely ineffective at creating economic prosperity. The oil sector is not nearly labor intensive enough to provide employment for the millions of young people that comprise the majority of the regional population. The Saudi monarchy has reacted

[6] EIA, BP Statistical Review 2011, Goldman Sachs

[7] U.S. Department of Commerce / International Trade Association. Steel Industry Executive Summary, August 2012.

[8] Federal Reserve Board. Industrial Production and Capacity Utilization - G.17, August 12, 2012

to this social turmoil and seeks to prevent discord within its own borders by keeping its population under control with economic incentives, including inefficient fuel subsidies that artificially inflate domestic consumption. According to an insightful piece from the Ned Davis Research Group, Saudi Arabia has quickly and quietly become the 5th- largest consumer of oil in the world, despite being only the 20th-largest economy by GDP and having only 0.4% of the world's population.[9] While a good amount of this consumption is aimed at a growing petrochemical industry, the Davis report highlights that subsidies are pricing petroleum products far below world markets, including an average gasoline price at the pump of $0.50/gallon and crude oil being sold to cement and power companies at $2.70-4.30/barrel. Thus, with increasingly inefficient domestic consumption in Saudi Arabia, the Kingdom's true ability to supply global markets with 'spare' capacity may be even more limited than conventional wisdom suggests.



Growing **U.S. crude oil production**, largely a product of horizontal drilling and hydraulic fracturing in shale formations, has given rise to a debate about the potential for domestic oil self-sufficiency, which would make discussion of foreign imports and spare capacity largely a moot point. This much more recent development and debate comes as the U.S. has grown domestic oil production two consecutive years in a row (up 3.9% year over year in 2010, and 3.8% in 2011, respectively)[10] despite new production from the Gulf of Mexico being slowed by regulatory processes introduced after the BP Macondo/Deepwater Horizon disaster in 2010.

While freedom from oil imports would be a positive outcome in terms of safeguarding the U.S.'s oil supply chain and potentially reducing the cost of its military commitments globally, the jury is still out on whether that set of circumstances will come to pass, in our view. Much depends on the ultimate decline curve of wells drilled in shale, as well as in U.S. patterns of consumption. At this point, with a limited time to observe the performance of these wells, much is unknown about the final quantities of oil unconventional supplies will yield over time. Conversely, should oil from unconventional domestic resources ultimately be successful in supplanting foreign imports, the marginal cost of production of oil (seen in markets as a price support for the "floor" of oil prices) could actually go up (leading to higher gasoline prices at the pump), as producing oil from unconventional domestic resources like shale is frequently more expensive than producing from conventional reservoirs and more advantaged geologic formations more frequently found overseas. With so many variables, it seems that a continued effort to diversify our energy supplies is prudent.

[9] Ned Davis Research Group Report, June 5, 2012

[10] BP Statistical Review of World Energy 2012

Demand. The global population's demand for energy shows no signs of letting up, as we march from 7 billion people today toward 10 billion by 2050, according to some estimates.[11] Additionally, as the populations of developing nations get wealthier, those new middle- and upper-class consumers inevitably use more energy per capita, along the lines of their peers in developed economies. The number of global citizens making more than $6,000 per year is expected to rise from 2.5 billion people in 2010 to almost 7 billion people by 2050, and as consumers gain more buying power, an increase in energy consumption per capita will likely follow.[12]

Projections for global oil consumption growth vary, with widely used BP Statistical Review of World Energy projecting demand to grow 17% between 2010 and 2030, rising from the current 80 million barrels per day to almost 95 million barrels per day[13], and the U.S. Energy Information Administration projecting 108 million barrels per day of consumption in 2030.[14] Both studies show a slowing of U.S. and developed economy oil consumption, partly on expectations of lower economic growth rates and partly on increased usage of alternative fuels. Oil consumption rates in developing economies, led by China and to a lesser extent, India, are expected to far outpace developed economies in the 2010-2030 period as the large populations grow and become more wealthy in line with economic development.

As a result, we expect competition for each barrel of oil to increase with time, making diversification of our energy supply critical to insulating the U.S. from supply and price shocks in the future.

The Costs of Oil Addiction. Our over-reliance on crude oil and the products derived from it – gasoline in particular – results in a number of negative consequences for our environment, national security, budget, and food system.

Environmental. The environmental ills associated with widespread oil production and usage have been widely catalogued for decades. High-profile accidents like the Exxon Valdez and BP's Deepwater Horizon/Macondo explosion often make front-page news, but the list of other serious accidents, spills and other incidents (pipeline ruptures, refinery fires and explosions, etc.) is long. Science on the long-term health effects of air pollution from the burning of petroleum-based fossil fuels (primarily in our cars) is evolving but strongly suggests that the costs to our health and healthcare system are high. Carbon emissions resulting from the burning of fossil fuels is the leading suspect in climate change, and oil and its derivative products (gasoline, diesel, jet fuel, maritime bunker fuel, heating oil) are high in carbon content. By the numbers, coal has the highest CO2 content of the major fuels that we use to power our economy (at 227 pounds of CO2 per million Btu vs. 156 pounds of CO2 per million Btu for gasoline[15]). However, despite the disparity in CO2 emissions between coal and oil on an energy equivalent basis, CO2 emissions from oil products (42% of total) comprised a much higher percentage of the U.S.'s total carbon emissions in 2011 on an absolute basis (versus 34% of total for coal), due to our heavy reliance on the fuel.[16] Likewise, of the fuels we currently have available for commuting and transporting goods to market — oil and its derivatives, natural-gas vehicles, electric vehicles and other newer technologies — crude oil's carbon content is 25% higher than that of natural gas.

[11] UN population estimates range from 8 to 10 billion for 2050

[12] BP Statistical Review, Goldman Sachs Research, UN Population Division

[13] BP Energy Outlook 2030

[14] EIA International Energy Outlook 2011

[15] EIA

[16] EIA Monthly Energy Review July 2012

National Security. Our reliance on oil contributes to elevated national security costs, as vital shipping lanes must be patrolled, and access to crucial petroleum-producing areas must be maintained, both with direct military involvement and also via strategically situated allies that must be protected and funded. Precisely how much money the United States spends to ensure access to oil supplies globally is a matter of academic and political debate. Military budgets do not specify how many dollars are spent annually in its numerous deployments to protect various countries or vital transit points. Moreover, it can be reasonably argued that military deployments serve many purposes beyond protecting oil supplies, ranging from diplomacy to deterrence to humanitarian aid. Thus separating these issues and coming up with an exact figure of the military cost of protecting access to foreign oil supplies is difficult and imprecise. That has not stopped several organizations and scholars from trying, however, and their estimates range widely: In 1991, the U.S. General Accounting Office (G.A.O.) estimated that $366 billion was spent to defend oil supplies in the Middle East between 1980 and 1990; noted energy security expert Milton R. Copulos contends that the U.S. spends $52-62 billion per year in peacetime to secure oil supplies in the Middle East and spent $137 billion on that mission in 2006[17] during the height of the Iraqi insurgency; UC Davis professor Mark A. Delucchi estimates that the Persian Gulf defense related to oil costs the U.S. $47-98 billion on an annualized basis, including both periods of peace and war (in 2004 dollars)[18]; and Princeton professor Roger J. Stern estimated that the U.S. spent $6.8 trillion on military force projection in the Persian Gulf between 1976 and 2007[19].

Whichever set of estimates one chooses to side with, the numbers are eye-opening, particularly when compared with other components of our national budget. For instance, in 2006, the U.S. budget allocated $23.4 billion for spending directly on **energy** and $26 billion for spending on **agriculture**,[20] two areas of focus for Sustainable America. If Copulos' argument that the U.S. spent $137 billion on defending oil supplies in the Middle East in 2006 is correct, ***then spending on defending oil for just one year, in only one part of the globe, amongst a myriad of other costly military engagements, outpaced our spending on developing critical domestic energy and agricultural systems by 64%.*** These estimates of U.S. military spending to protect oil supplies only apply to spending on our own military, and do not account for direct foreign military aid in the form of grants to other nations, which topped out at roughly $15 billion in 2010 according to U.S. Agency for International Development, as well as preferential defense loan programs to key allies that are much harder to quantify. Thus, we can draw a fairly rational conclusion that the costs of our over-reliance on oil represent a multi-billion dollar per year hit to our national budget.

Economic. The U.S. also experiences economic disruption from its reliance on foreign oil at both the national and consumer levels. According to the U.S. Census Bureau, the U.S. had a $272.7 billion trade deficit in energy in 2010 (with 94% of that figure attributed to crude oil), which accounted for 43% of the overall U.S. merchandise trade deficit for that year. The effect on individual consumers in the U.S. is perhaps more tangible and certainly more dramatic. Gasoline price upticks frequently cause consumer grumbling and occasionally, albeit briefly, result in changes in driving behavior (periods of increased mass-transportation ridership, and so-called summer "stay-cations," etc.). However, to families on the low end of the U.S. income spectrum, rising fuel costs can be devastating. In 2010, the U.S.

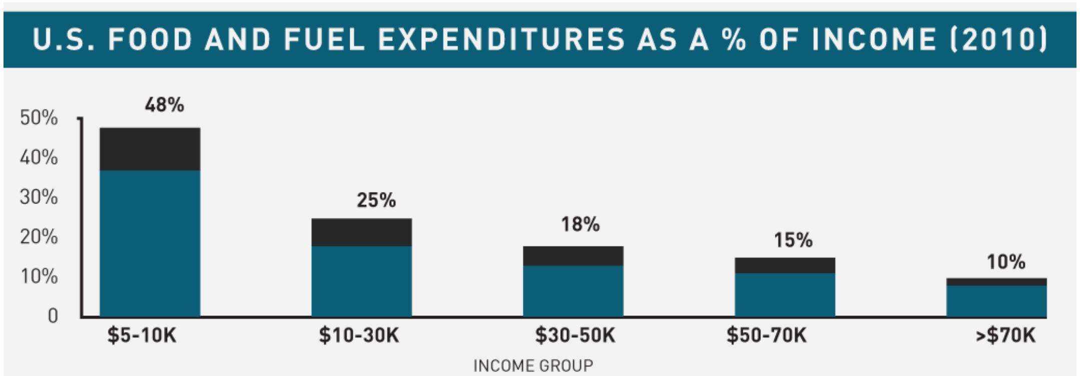
[17] Copulos, Milton R., for Set America Free.org

[18] Delucchi, Mark A. US military expenditures to protect the use of Persian Gulf oil for motor vehicles (2007)

[19] Stern, R.J., United States cost of military force projection in the Persian Gulf, 1976–2007. Energy Policy (2010), doi:10.1016/j.enpol.2010.01.013

[20] Congressional Budget Office

poverty rate jumped to 15%, the highest rate in 17 years. One-third of the increase was caused by rising gasoline prices that year, pushing nearly 1 million people into poverty.[21] Government statistics show why rising commodity prices hit the poor so hard: Among those earning less than $30,000 per year, food and fuel expenditures comprise 37% of income.



The U.S. Food System. Our reliance on oil also creates an unacceptable risk to the U.S. food system due to several factors, including the use of oil in storing and transporting our food, the widespread use of fertilizers derived from petroleum products, and the mandates to blend corn-based ethanol into our gasoline supplies. At the core of Sustainable America's mission is a desire to help mitigate the interconnectivity of the food/fuel nexus, thus reducing the risk of price shocks and physical shortages to Americans in both energy and food commodities.

The industrial production of food (large farming operations typically relying on some form of automation) comprises the overwhelming majority of food production in the U.S. and is very energy intensive, accounting for almost 16% of U.S. energy usage in 2007[22]. Imported food, often necessary to provide American consumers with food products that would otherwise be out of season (such as strawberries in winter), may travel as many as 5,000 miles to reach U.S. stores, which can account for another 5% of our total oil consumption. Noted author Michael Pollan famously claimed that it takes approximately 35 gallons of oil equivalent to grow one cow, when taking all related inputs into account.[23]

Food vs. Fuel. Ethanol, a topic getting much airplay in 2012 due to the devastating drought that gripped much of the U.S., further intensifies the linkage Using ethanol as a blend-stock in our gasoline is not altogether new – in fact it

[21] Bureau of Labor Statistics Consumer Expenditure Survey, 2010; U.S. Census Bureau; Peterson Institute

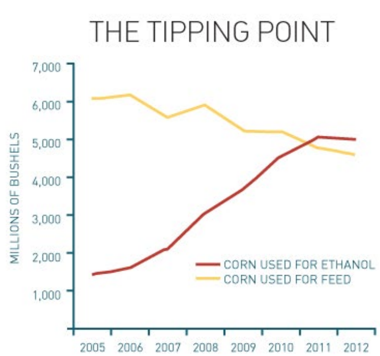
[22] Fuel for Food: Energy Use in the U.S. Food System", USDA ERS, 2010;

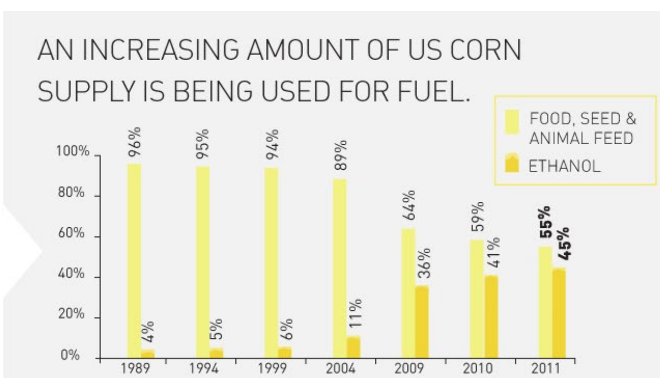
[23] Michael Pollan, Omnivore's Dilemma

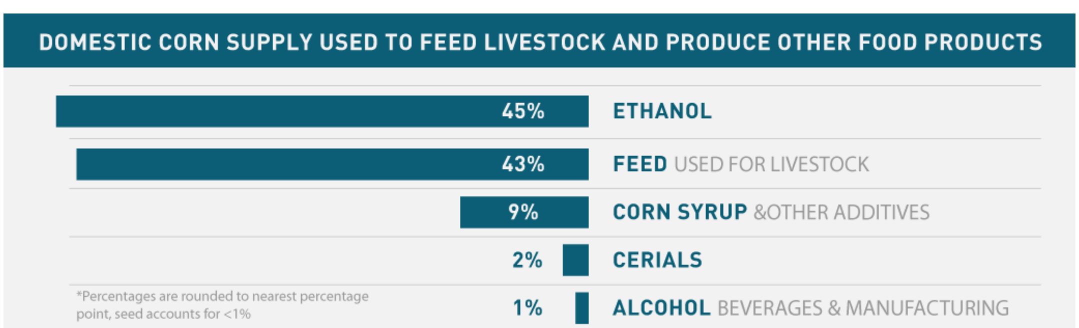
was used to overcome fuel shortages during World War II and during the oil crises in the 1970s (when it was referred to as "gasohol"). More recently, Congress has created mandates on ethanol usage, constructed partly to incentivize the use of domestic products in fuel supplies, and partly to pave the way for higher blends of more carbon-efficient advanced biofuels (yet to be commercially viable). The Energy Independence and Security Act of 2007 requires an increase in production of renewable fuels from 9 billion gallons in 2008 to 36 billion gallons by 2022, of which 21 billion gallons are expected to come from advanced (non-food-based) biofuels. However, this still represents roughly doubling the amount of ethanol derived from corn.

This is a tremendous allocation of one commodity crop to fuel. So much so that 45% of our domestic corn production now goes to create ethanol – almost as much as is now used for animal feed, seed and all other uses.[24] In that way, American corn farmers have become reliant on selling a large portion of their crops to ethanol producers. At the same time, the oil refineries that turn crude oil into gasoline have also become reliant on corn and ethanol. Refineries, which are multi-billion dollar facilities, once had to re-engineer their operations to accommodate ethanol blending and couldn't undo it today without billions more dollars spent in re-engineering costs.

Ethanol is now a must-run fuel in an industry that is critical to daily American life. In fact, ethanol now comprises approximately 10 percent of each gallon of fuel in the country, which is the most that older engines can use – something known as the "blender wall." The U.S. EPA is now allowing waivers for cars built after 2001 to use up to 15 percent ethanol, and engines designed for use in "flexible fuel vehicles" or FFVs can use up to 85 percent ethanol. However, ever higher use of ethanol will likely require additional engine modifications in the near future. Furthermore, to the American consumer, the linkages of the oil and food systems will inexorably result in higher corn, other food, and fuel prices at any juncture when there is a corn shortage (like in the 2012 drought), a physical disruption to crude oil supplies, or a spike in gasoline prices.







[24] USDA

THERE ARE SOLUTIONS.

Sustainable America believes that the best way to generate hope is from taking action, and that several solutions to reducing our oil usage are within reach. Our primary focus is on technology to improve transportation alternatives, such as natural gas-powered vehicles, electric-powered vehicles, advanced biofuels, increasing efficiency in our current and future technologies, and encouraging consumer practices that lead to conservation. There are hurdles to all of our proposed solutions, but knowledge and practical action can overcome the majority of them.

NATURAL GAS: PLENTIFUL AND CLEANER

Natural gas represents one of the most immediately available means of reducing oil usage. With current technology, the realms most suited to natural gas usage are in power generation, where a move away from coal and oil are already well underway, and in transportation, where the Unites States has barely scratched the surface (only about 1% of our current natural gas usage is related to transportation).[25] We view natural gas as one important component in a wider effort to diversify American energy supplies. This effort would include a wide array of alternative energy solutions, but also accommodate the economic realities and practical/technological constraints that necessitate the continued use of fossil fuels, at least in the near-term. Here, we view the benefits of natural gas over oil-derived transportation fuels as numerous and fairly clear. But the two most salient points are that the United States has a *plentiful supply*, and that natural gas has *lower carbon emissions than oil.* Similarly, burning natural gas causes less particulate matter to be released into the environment than either oil or coal (92% less than oil and 99% less than coal)[26], as well as less sulfur dioxide, a cause of acid rain. Displacing oil with natural gas for transportation would reduce the linkage between food and fuel by reducing the need for corn-based ethanol, and would make both our transportation and food systems less interdependent and more resilient to supply shocks from abroad. There is controversy about certain natural gas extraction methods (discussed in the following pages), but environmental concerns can be addressed by closer monitoring and improved industry best-practices, in our view.

Estimates for the United States' natural gas resource vary, but all major sources seem to agree that natural gas is a plentiful resource, with supplies ranging from between 75 and 100 years at current consumption rates.[27] Our natural gas resource comes from several types of geological formations, including limestones and other carbonate reservoirs both onshore and offshore (conventional resources), as well as from unconventional resources such as shale, other tight rock formations, and coalbed methane, which are based on newer methods of extraction made possible over the last decade or so by the combination of hydraulic fracturing and horizontal drilling techniques.

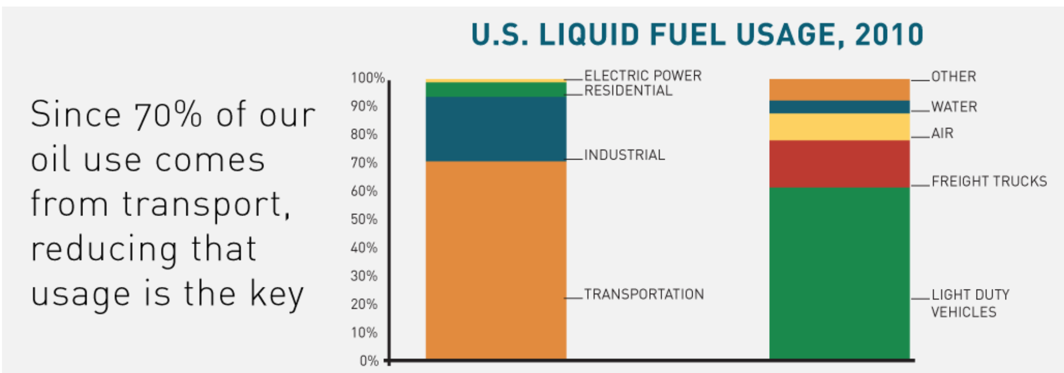
[25] EIA statistics

[26] EIA statistics

[27] EIA Annual Energy Outlook 2012; American Gas Association; Sustainable America

Unconventional natural gas resources have expanded the United States' supply base dramatically, which creates the potential to decrease our reliance on imported energy sources like oil if we choose to transition toward more natural gas usage. For an example of the impact of our unconventional natural gas resources, we need only look back to the late 1990s through 2000, when conventional industry wisdom had it that natural gas reserves in the United States were in a state of decline, and a race was on to build terminals to import seaborne liquefied natural gas ("LNG") from major overseas producers. If we fast-forward to 2012, several projects are now on the board to *export* natural gas from the U.S. and Canada, either by reverse engineering already constructed LNG import terminals or by building new export terminals entirely. *An entire supply-demand system, the U.S. natural gas market, has essentially been turned completely around in just over a decade.*

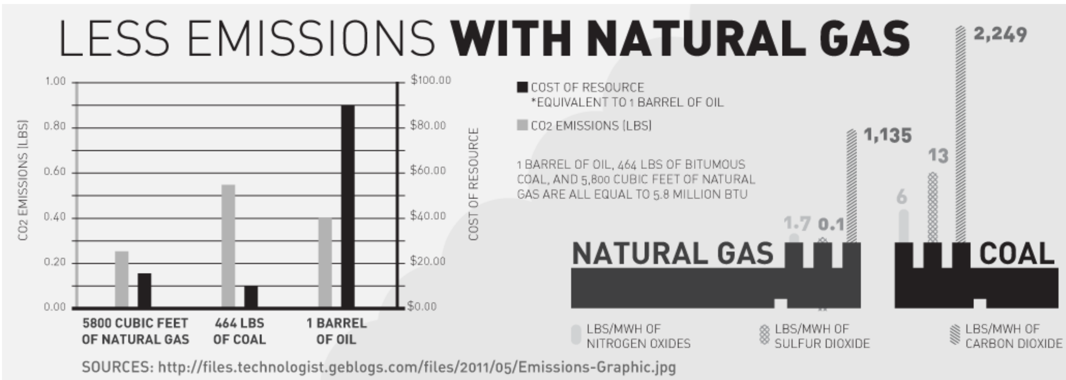
The Benefits of Natural Gas. We mentioned earlier that the majority of our crude oil usage (70%) is related to transportation, meaning that targeting transportation for a shift toward natural gas could be one of the most impactful ways to reduce oil usage.



By displacing oil usage, again with 45% of our oil coming from overseas, the United States can effectively increase its **energy security**, meaning that we would effectively control the production and dissemination of our own supply, making us less reliant on oil from vulnerable global hotspots or from suppliers that may be hostile to us. As an added benefit, the United States could see a reduction of its widespread global security commitments, reducing both the toll on our national budget and on military personnel. Concurrently, the aforementioned U.S. **Trade Balance** should improve, reducing the amount we spend on foreign energy sources, while potentially exporting our excess production. America's Natural Gas Alliance, an industry trade group, estimates that by 2035, shale gas will add more than $231 billion to the national GDP and contribute more than $57 billion in taxes. The group also argues that the large domestic supply should lead to low and stable prices for an extended time period, at least relative to oil, and that domestic manufacturers that use natural gas as a feedstock or other fuel will benefit, resulting in 3% and 4.7% growth in industrial production by 2017 and 2035, respectively.[28] Several recent studies point to a strong argument that expanded domestic natural gas production will contribute strongly to **job creation** at a time when our nation's manufacturing base has declined and the service sector on which our economy now relies remains sluggish. A recent study by PricewaterhouseCoopers finds that natural gas may contribute an additional 1 million jobs by 2025 to the 2.8 million jobs that it already creates. Respected research provider IHS Global Insight estimates that development of

[28] PricewaterhouseCoopers study for the National Association of Manufacturers. IHS Global Insight, The Economic and Employment Contributions of Unconventional Gas Development in State Economies

our unconventional natural gas resources will add more than 1.4 million jobs by 2035.[29] There are **tangible environmental benefits** of using more natural gas as well.



Recent data from the U.S. Energy Information Administration shows that the percentage of our nation's power generated with natural gas as a fuel source has increased (accounting for 37.3% of total power generation; up from 30.6% in 2011) at the expense of coal (down from 42.2% of total in 2011 to 24.8% in 2012)[30] due to commodities markets that have priced natural gas competitively with coal in recent years. That 'switching' of power plants from coal to natural gas has been largely responsible for a reduction in CO2 emissions from the energy sector nationwide (down 9% from 2007-2011), according to EIA data. Natural gas has only 49% of the CO2 content of coal. If we were to substitute natural gas for oil in our transportation system, we would also see tangible emissions benefits. Natural gas has 25% less CO2 per million Btu than gasoline. Burning more natural gas and less oil would lead directly to lower greenhouse gas emissions, helping to slow the effects of climate change until a truly renewable, non-carbon based form of energy is widely adopted. Similarly, burning natural gas causes less particulate matter to be released into the environment than either oil or coal (92% less than oil and 99% less than coal)[31], as well as less sulfur dioxide, a cause of acid rain.

The Challenges of Natural Gas & Proposed Solutions. Natural gas is not without challenges. First of all, it is not a renewable fuel, meaning that it, too, would eventually become less plentiful, leading to price uncertainty and the need to find "the next" fuel source. Natural gas also clearly has a carbon footprint associated with it, and thus is less desirable than carbon-free energy forms. However, until such alternative energy is widely available and an economically competitive option for our economy, Sustainable America believes that natural gas represents a strong near-term option to reducing our nation's more damaging reliance on oil. Below, we identify a number of near-term challenges to adopting wider natural gas usage, and then present a number of ways to overcome those challenges.

One of the most practical reasons drivers cite for not driving natural gas-powered vehicles (NGVs) is that there is not yet a widely distributed network of filling stations, inducing what social scientists call **"range anxiety,"** also a phenomena with electric vehicles, where a would-be driver fears that he'll be stuck on the road, far from home, without the ability to refill the tank (or, to recharge a battery in the case of electric cars). We point toward the build-out of a CNG filling network as being one of the most obvious and effective means of increasing NGV use. However, we recognize that absent a large government incentive or subsidy (which does not appear to be

[29] IHS Global Insight. The Economic and Employment Contributions of Unconventional Gas Development in State Economies

[30] EIA Short-Term energy Outlook, July 2012

[31] EIA statistics

on the horizon given our lack of overarching energy policy and budget realities), the market is likely to dictate the speed at which these stations are installed. To date, the most eager adopters of NGVs have been corporations or organizations with short-haul delivery fleets (such as the U.S. Postal Service, UPS, and FedEx), which have centralized depots where trucks depart from in the morning and return to in the evening, thus making a company-owned fueling station at the depot a cost-effective and efficient way to employ CNG. Individual consumers do have the ability to fill up CNG cars at home with the installation of a home fueling kit, typically installed in the garage, which runs off of the household natural gas or propane supply. Cost could be an issue for some potential consumers, at about $8,500, including installation. With more demand, we would expect the cost for home installation to decrease on a per-unit basis.

Almost any existing gasoline-powered vehicle can also be converted to run on natural gas. Conversion kits run from $7,000 to $8,000, thus making the economic break-even point dependent on the vehicle running for an extended amount of mileage, and thus not an appealing factor at present, even with $4/gallon gasoline. NGV drivers today tend to be aligned in spirit with other early adopters of other car technologies like the gasoline-electric hybrid (Toyota Prius and similar models), perhaps not as motivated by economics as by the desire to try something new and progressive. We expect that to remain the case until NGV prices on new vehicles or conversion kits either come down, or until gasoline prices become prohibitively high.

Environmental opponents of natural gas tend to focus on the process of extracting the gas from unconventional rock – the combination of hydraulic fracturing and horizontal drilling that has come to be known as "**Fracking**" in the popular lexicon. Critics of fracking, which is necessary to enable natural gas to flow out of shale and other unconventional or tight rock formations, fear that the process can pollute underground aquifers – the source of drinking water in many communities.

The crux of the issue with fracking, as we see it, is that the majority of shale formations lie 5,000 to 10,000 feet below the surface – almost two miles deep. Between the shale and the near-surface aquifer, which typically lies only about 500 feet below the surface, are one mile or more of dense, impermeable rock layers. To date, there's been no evidence that fracs have allowed contaminants to migrate up through one mile or more of rock to pollute aquifers. To wit, one of the industry's main challenges in fracking is to get each individual fracture (created by pumping water, sand and frac fluid at high pressure) to extend outwards from the wellbore as far as possible in order to increase the recovery of natural gas. To date, most fracs have only been successful in radiating outwards to about 500-1000 feet, which can be measured by micro-seismic monitoring equipment.

Fracking is not new, and to date, more than one million wells have been completed using the technique. Several major studies on the effects of fracking have been carried out to date, with no evidence of fractures migrating up to pollute groundwater. The Obama administration commissioned the Department of Energy to conduct a study in 2010, which concluded that poor surface practices, not fracking itself, are the likely cause of contamination in several incidents. Likewise, a pair of recent studies, one from University of Texas and another from Stanford University, have concluded that fracking itself poses a limited threat to drinking water. The studies do, however, agree that shoddy practices above ground may lead to contamination of water wells when there is a lack of oversight and regulation. In an interview with CNN, Mark Zoback, a geophysics professor at Stanford, who also served on the DOE panel, explained, "I'm not trying to deny the existence of contamination, but the mechanism by which that contamination occurred is not the hydraulic fracturing mechanism." The EPA's long-term study on fracking is due in 2013-2014.

Thus, the leading suspects in groundwater contamination continue to be: spillage of industrial pollutants on the surface at or near well sites, which is a by-product of either accidents or lax containment practices; improper cement and steel casings that isolate the well as it passes through the near-surface aquifers (unfortunately, not uncommon, and also the lead suspect for the cause of the BP Macondo/Deepwater Horizon disaster in the Gulf of Mexico); and naturally occurring methane contamination from existing near-surface rock formations (which have been widespread naturally occurring phenomena in several parts of the country for more than a century). The DOE panel recommended a number of proactive steps to improve industry practices and decrease the possibility of contamination, including the introduction of a manifest shipping system for trucks hauling wastewater from well sites and improved treatment facilities for wastewater. Likewise, Great Britain's Royal Society and Royal Academy of Engineering recently concluded a study finding fracking to be safe as long as it is properly conducted and regulated. The report stated that *"Our main conclusions are that the environmental risks of hydraulic fracturing for shale can be safely managed provided there is best practice observed and provided it's enforced through strong regulation. The UK regulatory system is up to the job for the present very small scale exploration activities, but there would need to be strengthening of the regulators if the government decides to proceed with more shale gas extraction, particularly at the production stage."*

The last sentence is key to Sustainable America's view on fracking: that fracking can be carried out safely with high benefit to our nation and people, as long as it is more closely monitored and regulations carry serious consequences for rule-breakers. In many respects, our view is in line with that of the Environmental Defense Fund, which also calls for tighter monitoring and stiffer penalties, but we also see the possibility for safe development of natural gas resources. At present, the regulatory framework covering fracking is a patchwork of state and federal rules and jurisdictions, which can vary quite widely. We suggest that a more robust and uniform regulatory environment would be effective in compelling all players to abide by industry best practices to ensure fracking is carried out safely.

ELECTRIC VEHICLES: CLEANER AND READY TO HIT THE ROAD

Electric vehicles are another readily available solution that could help reduce oil dependency by taking energy from the electric power grid, with the added benefit of a substantial reduction in emissions. With current battery technologies, electric vehicles are best used for commuters or for other short-trip applications. Some challenges remain, largely based around the cost of purchasing an electric vehicle (a product of battery costs), but increased demand for these vehicles could bring battery costs down on a per-unit basis over time.

The Benefits of Electric Vehicles. Of the current technologies available, electric vehicles comprise the closest thing available to a direct substitute for fossil fuel usage in transportation. Aside from the clear environmental benefits (reducing CO2 emissions), increased electric vehicle usage would also help reduce the nation's dependency on oil, resulting in a positive effect on some of the aforementioned topics such as security of energy supply, reduced military commitments and budgetary strain, and the U.S. trade balance. With more electric vehicle models, such as the Nissan Leaf, coming to U.S. markets, American consumers should expect to hear more about the technology in the future. President Obama, during his 2011 State of the Union address, stated that he expects the U.S. to have one million electric vehicles on the road by 2015.

Electric Vehicle Challenges & Proposed Solutions. Despite the clear appeal of using electricity over oil to drive our cars, even electric vehicles, as currently constructed, have a **carbon footprint** to consider. This is due to our electricity grid's dependence on fossil fuels for power generation. A recent study by the Union of Concerned Scientists finds that the carbon footprint of an electric vehicle depends largely on where you live, as different regions of the country tend to rely on different fossil fuels to run their power-generating stations. For instance, drivers who live in states with cleaner sources of power generation like Vermont, New York, California and the Pacific Northwest will have a carbon footprint from charging their electric vehicle that is roughly equivalent to driving a gasoline powered car that has a 70 MPG rating. Those charging their vehicles in the Rockies region, which relies heavily on coal for power generation, will have a carbon footprint equivalent to a car that gets 33 MPG – or, not much better than some of the more fuel-efficient compact cars on the road today. Those owners who have solar panels installed on their homes are able to indirectly offset some of the carbon footprint associated with charging an electric vehicle. This set of circumstances invariably leads to the argument for increased power generation from alternative energy sources such as solar, wind and hydroelectric where possible, and from natural gas for its emissions benefits over coal when alternative energy is not feasible. *Again, the potential value of natural gas to our nation's transport system becomes readily apparent.*

Other practical barriers to wider adoption of electric vehicles are the relatively high costs compared to traditional vehicles, as well as range anxiety. Here, we see a similar problem set and range of potential solutions as we do with NGVs. The higher cost of today's electric vehicles tends to be ascribed to the large size and advanced nature of the batteries necessary to effectively run a vehicle. Increased market demand for such vehicles should bring battery costs down on a per-unit basis, but as with NGVs, we aren't likely to see breakout demand for electric vehicles until the costs come down, gasoline costs become unsustainable for an extended period, or the concerns about vehicle/battery range are addressed. Further R&D on battery performance and the increased installation of electric charging stations hold promise to help overcome range problems. One out-of-the-box solution comes from futurist Garry Golden, a recent blogger for Sustainable America, who posits that a more effective wave of electric vehicles, which produce their electricity on board with fuel cells rather than charging batteries off of the power grid, may be on the way.[32] Golden argues that plentiful domestic natural gas may become the fuel source of choice for the next wave of electric vehicles and that several models are currently in development by major auto makers.

ADVANCED BIOFUELS: A RENEWABLE RESOURCE ON THE HORIZON

Advanced Biofuel Benefits, Challenges & Solutions. Sustainable America believes that advanced biofuels, particularly those made from cellulosic materials (such as agricultural waste or switchgrass) and from algae, hold promise as a source of energy that could reduce U.S. oil consumption and replace it with renewable, homegrown energy. "Advanced biofuels" is a catchall term for a number of emerging technologies that seek to produce fuel from renewable feedstock such as switchgrass, other cellulosic biomass, algae, and a host of other materials. Advanced biofuels are thought to represent an upgrade in sustainable desirability over so-called "first-generation biofuels" like corn- or sugar-based ethanols, which are produced from food crops, creating the dual problem of increasing the linkage between our food and fuel networks, and of consuming food that could otherwise be used for animal feed at a time when food stocks are low and demand for food is on the rise globally. Advanced biofuels are still largely in the development phase, with only a handful of commercial-scale ventures ready for wide use. While they represent an upgrade over oil and first-generation biofuels, advanced biofuels may not be a panacea. Contrary to conventional wisdom, biofuels do have a carbon footprint associated with them (although how much varies by fuel type and production process), and widespread production of certain forms of biofuels could create a host of potential unintended consequences, such as a lack of crop diversification, a need for vast swathes of arable land (which could lead to deforestation), and high levels of water usage.

Biofuels today vs. Biofuels tomorrow. At approximately 567,000 barrels per day of biofuel production, the U.S. is the world's leading producer of first-generation biofuel (mainly ethanol and biodiesel).[33] The amount of ethanol consumed (as a blend into E85 gasoline) rose 105% in the 2006-2010 period[34], spurred on by the government-mandated renewable fuel standards ("RFS") and by the increase in availability of flex fuel vehicles. A second government mandate, called RFS-2, requires that advanced biofuels enter the fuel supply in increasing amounts from 2013 onward. The mandate was intended to spur on the development and adoption of advanced biofuels, but unfortunately, large-scale commercial production is not yet ready. The difference is likely to be made up with first-generation ethanol, which could exacerbate the pressure on grain prices that the U.S. is currently experiencing.

[32] Golden, Garry. Xxxxx, blog for Sustainable America. Xxx 2012

[33] BP Statistical Review of World Energy 2012

[34] EIA data: Estimated Consumption of Vehicle Fuels in Thousand Gasoline Equivalent Gallons, by Fuel Type, 2006 - 2010

Recall that 45% of our corn crop already goes into the production of ethanol, and an increased call on the corn supply for ethanol production could cause increased competition for the valuable crop.

As currently conceived, advanced biofuels loosely fall into two main categories: ethanols as a replacement for gasoline, and biodiesels. Advanced ethanols produced from plant matter ("cellulosic ethanols") would be produced from a variety of non-food crop plant matter such as agricultural waste products, switchgrass or other low-maintenance grasses, and a variety of other cellulosic materials. Transportation fuels could also be produced from algae, which can be grown to generate biocrude as a feedstock for the creation of transportation fuels (including gasoline, jet fuel, diesel, etc.). A variety of biodiesel fuels are already under production, in use in the U.S. long-haul transport fleet, and widely used in Europe where diesel powers a much larger amount of passenger cars than in the U.S. Experimentation with the optimization of biodiesel production methods continues.

While commercial quantities of advanced biofuels are not yet widely available, there are many such projects in development or nearing completion. As of 2012, there were 25 operating next-generation biofuels pilot/demo plants in the U.S., comprised of: 18 cellulosic ethanol plants; 5 renewable diesel plants; and 2 for biogasoline or biojetfuel.[35] Two operating commercial plants (Gevo and Dynamic Fuels) are now producing 18 million gallons per year of butanol and 18 million gallons per year of renewable diesel, respectively.

There are notable distinctions between types of biofuel, notably in the concept of "alternative" fuels vs. "drop-in" fuels. Alternative fuels such as ethanol can be thought of as compounds that do not replicate the chemical properties of existing hydrocarbon-based transport fuels. While preferable from a renewable and emissions standpoint, alternative biofuels often require blending with traditional products because current engine technology – engineered to burn gasoline – isn't able to process them efficiently. This factor constitutes a barrier to wider usage of alternative fuels, as the current vehicle fleet is limited to blending limits, typically as low as 10-15% ethanol and 85-90% gasoline, for example. Automakers have not widely offered vehicles, at least here in the U.S., that are capable of running on higher ethanol blends. Any new technology offered would also likely entail a higher upfront purchase cost, which could create a barrier to wider adoption.

"Drop-in" biofuels are renewable fuels that replicate the chemical properties of existing fossil-based transport fuels so they can run in today's conventional engines. Biodiesels are the most prevalent form of drop-in biofuel on the market today, although other forms of drop-ins are being experimented with. In late August 2012, Sapphire Energy opened a demonstration algae plant in Columbus, New Mexico that will eventually scale up to commercial production with 300 acres of algae cultivation ponds, according to research from Raymond James & Associates. Sapphire's plant will eventually produce 1.5 million gallons per year of biocrude which can be refined into biogasoline, biojetfuel, and other transportation fuels. The plant should begin commercial operations in 2013.

The renewable advantages of biofuels over fossil fuels are clear by definition. But while biofuels are generally considered cleaner for the environment than fossil fuels,

[35] Presentation by Hart Energy's Terrence Higgins to the EIA, August 2012.

exactly how clean has become a matter of debate in the scientific community. Several studies weigh-in on the debate, but notable studies suggest that first-generation biodiesel usage results in a very wide range of carbon emission savings compared to traditional diesel fuel, ranging from as low as 20% to as high as 80% depending on the feedstock and production method used.[36] A recent research paper[37] calls into question the emissions characteristics of biodiesel made from rapeseed oil in relation to the greenhouse gas emissions standards of the European Union, which stipulate that biofuels are at least 35% lower than comparable fossil fuels. The study concludes that rapeseed biodiesel may struggle to reach a 30% emissions savings.

Second-generation biofuels are generally expected to fare better in terms of emissions. The U.S. government defines advanced biofuels as having at least 50% less than baseline lifecycle greenhouse gas emissions than comparable fossil fuels.[38] A study by European oil industry-funded research body CONCAWE puts the greenhouse gas emissions savings of advanced cellulosic-based biofuels at 90% compared with traditional fossil fuels.

Aside from emissions, there are concerns about the unintended consequences of large-scale advanced biofuel production, particularly that which might rely on fertilizer or water-intensive plant species, or those which require large acreage footprints. Two emerging technologies seem to offer the best hope to address these particular concerns – namely cellulosic ethanol made from agricultural waste products or from grasses which grow successfully without fertilizers in areas otherwise unsuited to agriculture; and biofuels created from algae, which can be grown in wastewater and typically needs only carbon and sunlight to replicate.

INCREASED EFFICIENCY AND CONSERVATION:
WASTE NOT, WANT NOT

Increasing fuel efficiency in the technologies we already use and introducing conservation into our daily routines can have a meaningful effect on the effort to reduce our nation's oil consumption. There is evidence that wider adoption of more fuel efficiency in vehicles in the last few years may be helping to reduce our oil usage as a nation. Fuel economy has been in the news again recently, as President Obama announced in August 2012 new fuel economy standards ("CAFE Standards") that require automakers to raise average fuel efficiency of new cars and trucks to 54.5 miles per gallon by 2025. Everyday Americans don't have to wait for leadership from Detroit or Washington, D.C., however, because we've got the ability to practice conservation through changes in our everyday behavior.

While economically disastrous to our nation, the economic crisis that began in 2008 has had the unintended consequence of improving our nation's fuel efficiency. Data from the most recent *BP Statistical Review of World Energy* shows that U.S. crude oil consumption is down meaningfully since the pre-recession levels of 2007 (down 9% in 2011 vs. 2007 levels), and that consumption fell by 1.9% in 2011 compared with 2010.[39] Decreased economic and industrial activity certainly accounts for a large portion of the decrease in crude oil usage, yet the EIA also acknowledges the role of higher fuel efficiency vehicles in the decreased demand and sees a continuation

[36] National Non-Food Crops Centre of Great Brittain: xx; study by industry body CONCAWE

[37] Penhelt, Gernot and Christophe Vietze, Uncertainties about the GHG Emissions Saving of Rapeseed Biodiesel, 2012, Jenna Economic Research Papers.

[38] Renewable Fuels Standard of the Energy Independence and Security Act of 2007

[39] BP Statistical Review of World Energy 2012

of the trend going forward. *"Gasoline consumption continues to fall because of slow growth in the driving-age population, the acceleration of improvements in the average fuel economy of new vehicles, and increased rates of retirement of older, less-fuel-efficient vehicles."*[40] Recall that, aside from the collapse of the housing market, the bank bailout and the stock market rout of 2008-2009, oil prices had also spiked upwards of $140 per barrel, bringing gasoline prices above $4 per gallon for the first time. High prices at the pump caused an economic headwind and had a detrimental effect on overall growth, but were also some of the most visceral and tangible negative effects on the daily routine of Americans, shaping attitudes and fears about the future of gasoline prices. Gasoline prices have spiked above $4 per gallon several times since 2008, validating both the strategies of automakers to put extra effort into their high mpg model offerings (and to make more models available), as well as the choice of many consumers to adapt to smaller cars instead of SUVs and trucks.

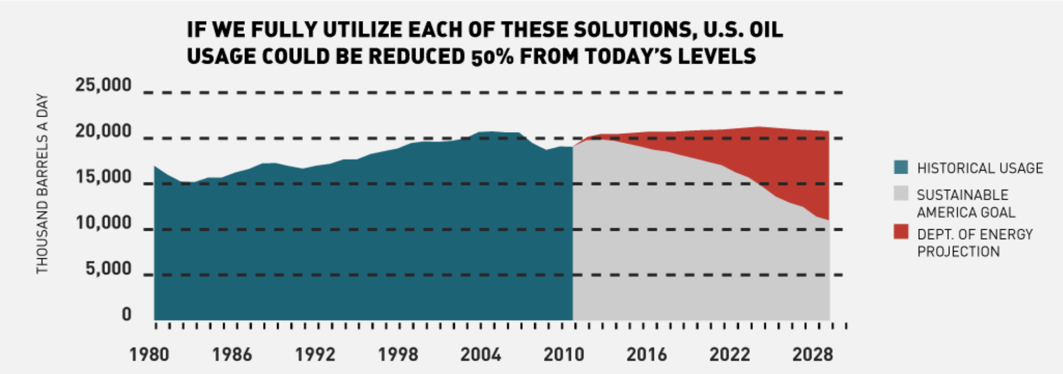
While the recent news about the changing CAFE standards is typically viewed through the lens of reducing emissions, we also see the new regulations as a chance to directly reduce oil usage, and thereby, to effect positive change on several fronts. Yet, challenges remain, even within the new regulations. For instance, the new CAFE standards, while a positive on the whole, allow much leeway in the way that "average miles per gallon" is ultimately computed by the government. The 54.5 average mpg standard by 2025 will be computed by taking the average mpg of a given automaker's product line, meaning that automakers can still put out low mpg SUVs and trucks as long as they are offset by higher mpg vehicles. The choice of what to drive, however, will still be up to the American consumer, meaning that we ultimately have a great deal of collective power over how reliant we remain on oil going forward.

What Individuals Can Do. Outside of fuel efficiency, there are a number of proactive steps individuals can take to help conserve our energy resources. Sustainable America recognizes that a solution in one locale may not be possible in another. For instance, city and suburban dwellers often have more options in changing the way that they commute to work than do those living in rural areas, where driving may be the only practical option. Other areas where conservation can be effective at the local and personal level include ***eating locally grown foods*** to reduce the amount of miles that our food travels to reach us (and therefore reduces oil usage), ***composting*** and ***reducing food waste,*** and adopting efficient transportation modes, including ***biking***, working from home, taking mass transit, ***hypermiling*** and ***ecodriving***.

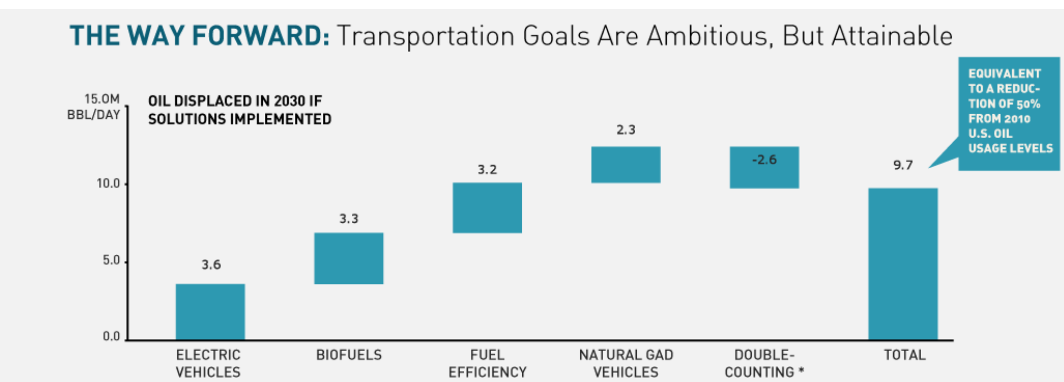
Hypermiling and ecodriving refer to techniques that can be used to drastically increase fuel economy of existing cars and trucks on the road. This can include proper tire inflation and regularly scheduled maintenance of car engines, particularly the air filter, spark plugs, and oxygen sensors. Fuel economy is also improved by removing excess weight in the car that is unnecessary, and can even include choosing NOT to completely fill the gas tank, as the extra weight of the fuel creates an efficiency penalty itself. Slower acceleration and braking, and keeping cars below 60 mph on the highway can also optimize fuel use. Additionally, when in line at a drive-through bank or restaurant, turning the engine off rather than letting it idle will save fuel and money.

[40] EIA, Short-Term Energy Outlook, August 2012

OUR VISION:



Sustainable America has set out an ambitious but attainable goal for the reduction of oil usage in the American economy and targets a **50% reduction from today's levels by 2030.** This goal will be achieved by increasing fuel efficiency and conservation efforts, using natural gas- and electric-powered vehicles, and developing advanced biofuels. This is an ambitious but attainable target. It stands in contrast to the government's projection, which holds overall oil usage about flat with today's 20 million barrel per-day level,[41] essentially taking the view that population growth and a corresponding increase in vehicles on the road will be offset by increases in fuel efficiency and biofuels mandates. Sustainable America's target sees a 9.7 million barrel per-day reduction in oil usage, to be achieved by: an offset of 3.6 million barrels per day through the increased usage of electric vehicles; a reduction of 3.3 million barrels per day of oil from biofuels; a savings of 3.2 million barrels per day from increased fuel efficiency; 2.3 million barrels per day offset by natural gas vehicles; and a 2.6 million barrel per-day adjustment for the benefits of converting fleet to electric and natural gas vehicles, improving fuel efficiency and replacing petroleum with biofuels.[42]



Sustainable America strongly believes in the power of change through action. We aim to help Americans achieve this reduction through both education and the funding of entrepreneurs who seek to solve some of the problems enumerated in this paper. We believe that market-based solutions, when combined with motivated citizens, work best to bring about change, and that together we can make a difference.

[41] EIA, Annual Energy Outlook 2012

[42] Source: EIA; SAFE Electrification Coalition; Sandia / GM "90B gallon biofuel deployment" study; Center for American Progress; Go60mpg.org; Union of Concerned Scientists; Bridgespan analysis