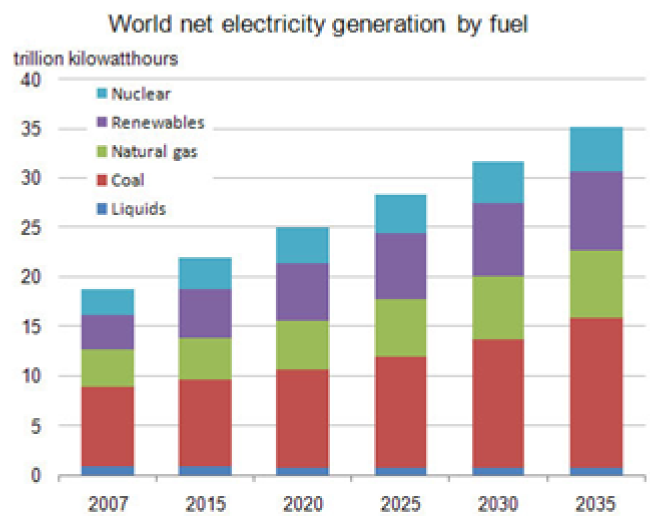
Arron B. Combs

Our Energy, Our Environment, Our Future

Worldwide energy demands are rising at an unprecedented rate. Total demand is expected to grow by 50% from 2005 to 2030. In just 4 years from 2004 to 2008, world population increased 5% while energy consumption increased 10%. Meanwhile, diminishing fossil fuel supply, nuclear apprehension, mounting global climate concerns, an abundance of conflicting or misleading information, and the gross inefficiency of "Green" renewable energy, has incited an almost blind compulsion to develop and refine new and improved energy solutions without adequate understanding of the long term implications. In some instances, these so called solutions have been equally or more detrimental than the conventional methods, while in other cases we have made significant progress. However, every solution we have posed so far has its own set of problems.

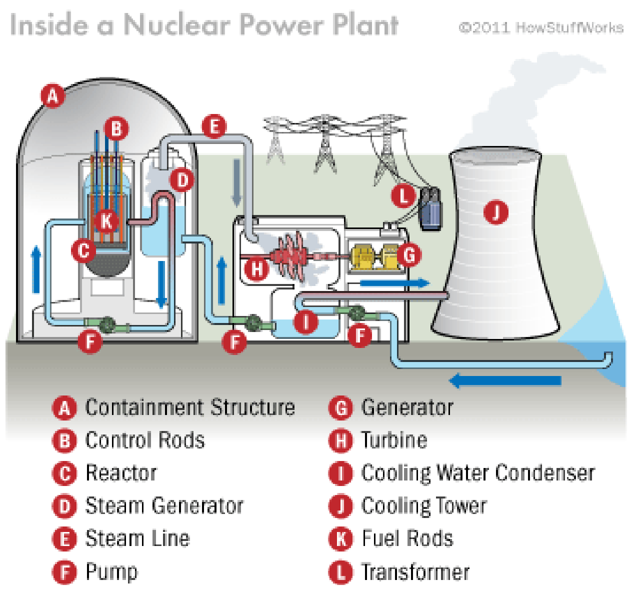


As we proceed in to the next century, two of the biggest problems we face are the growing energy demand and the environmental impact of our current energy generation facilities. To solve these issues we must closely examine all of the information so that we might better understand the options we will have for making the changes necessary to conquer these challenges. For starters, the approximate power usage for the entire world is 20,261 Terra Watt hours per year (TWh/yr). Approximately 41 percent of world energy is from coal burning with 21 percent from natural gas, 16 percent is from hydro, 13 percent from nuclear, 5 percent from oil, and the rest from renewable sources. In addition to this, our world energy consumption is growing at a rate of approximately 2.5% per year. With coal and natural gas making up over 60% of power generation, combined with the rapidly diminishing supplies and the obvious environmental impact of combustion emissions, it is increasingly important that we continue our search for a more stable energy solution. This chart makes it clear which power generation methods we rely on the most and helps us to start seeing what some of our options may be as we struggle to meet the rising global needs for energy and transition away from our dependence on fossil fuels. However, this poses a difficult problem since the majority of our demand comes from nonrenewable sources. As we work to build new, cleaner and lasting solutions, we find ourselves in a stalemate generating little more than we need to keep up with growing demands.

Coal has long been our cheapest and most abundant energy source. With vast global reserves just waiting to be mined, it would seem to make perfect sense to continue relying on this tried and true system. But regardless of its cost effectiveness, we can no longer afford to overlook the long term environmental impact. Additionally, with demand growing on an almost daily basis, it is only a matter of time until we run out. In recent years, public awareness of the environmental impact and various health risks associated with the burning of fossil fuels, has forced the EPA to adapt new guidelines and more stringent regulations for coal burning facilities. However, nearly all of their efforts have been concentrated on reducing air borne transmission with little or no regard to the increased solid waste that many of these processes create. Many of these waste products leach back into the ground water or are liberally released into nearby water supplies with an equivalent or greater impact than the air borne contaminates. Yet we continue to build new coal plants every year. This problem is compounded by the fact that implementation of the new controls is not cost effective. It is estimated that the building of new coal plants with compliant emissions controls will increase energy costs by 20 percent while retrofitting the older plants could raise it as much as 80 percent.

I have over 12 years of experience in power generation including 2 years as a plant supervisor at a coal burning facility in Central Illinois. During my time there, I was able to witness firsthand the inefficiencies of our environmental regulations. This particular site was located on the Illinois River and operated three coal fired Boilers with a combined output of approximately 750 MW. Half of that was from the newest and largest of the Boilers (Unit 3) while the other 2 aging units made up the rest. While there, we decided to install a new advanced air scrubbing system which was supposed to cut back on our carbon emissions as well as the release of other toxic pollutants. It was a very expensive project so it was decided that it would be added to unit 3. The new system would put us below the carbon emission limit required by the EPA and would give us additional carbon credits to make up for the excessive carbon emissions from the other 2 units. So, now that we were able to avoid the penalties associated with exceeding our carbon emission limit, there was no need to spend the money to upgrade the other 2 units. We had the ability to make our site cleaner and more environmentally friendly but the system made it more cost effective to continue polluting the environment. At times, we were even able to push the other 2 units to make more power and consequently more pollution since we knew that we were below our combined emission limits. Another area of concern that I noted during my time there, was the distribution of the solid waste. Most of these facilities, mine included, dispose of solid waste in a manner similar to that of most waste water treatment facilities. In our case we had a series of large ponds also known as the ash ponds where we mixed our solid waste with large amounts of water and pumped them to the ponds. Another similarity between us and the wastewater treatment plants was our huge flood gates which separated the ponds from the river. In the event of heavy rain or snow fall, we could open these gates to prevent the ponds from overflowing and allow the water to go directly back to the river. I could continue for several pages about the many questionable practices I witnessed during my time there but the bottom line is that everything that I saw fell within EPA guidelines as acceptable or standard practice.

The ugly truth is that Coal burning facilities are creating more and more waste and there is no where to put it. The large majority of this waste is extremely dangerous to humans and is contributing to increased instances of cancer in these areas. Some sites are installing new air scrubbers which convert much of the dangerous emissions to gypsum which can be used for the production of drywall but it is a costly process to clean the gypsum to a point where it can actually be used and usually costs more to clean than it can be sold for. Because of this, most facilities opt to use it for landfill material which, over time, will leach those toxins into our drinking water. The sites that do clean and sell the gypsum are left with an extremely toxic byproduct from the cleaning process and are actually introducing additional harmful substances during this process which are ultimately disposed of in the same manner. So what have we really accomplished? We remove the toxins therefore concentrating them while at the same time adding additional toxins. Once again we have removed some not all of it from the air we breathe, made it worse, and now we are drinking it.



The third largest source of electricity in the United States and one of the most controversial worldwide is Nuclear Power. Nuclear Power plants, another non renewable energy, can generate tremendous amounts of power in a relatively small space. This is done through a process called nuclear fission where a neutron collides with the nucleus of a Uranium-235 atom and is absorbed causing that atom to break apart releasing energy, approximately 200 MeV (million electron volts), in the form of heat. To make this easier to understand, one pound of enriched Uranium-235 has the energy equivalency of one million gallons of gasoline. After the fission occurs, the heat that is generated is transferred to the cooling medium which is most often water and is eventually converted to rotational mechanical energy in the form of steam traveling through a turbine which is then coupled to a generator which gives us our electrical output. However, as great as this may sound, Nuclear Power is also the source of many debates in regards to public safety and the inherent danger associated with radiation. Add in several major accidents involving Nuclear power plants in the past and this public debate starts to become wide spread fear. What many people do not know, is that in addition to the environmental effects of the combustion process there are also many health risks including exposure to radiation that are generated when burning fossil fuels for energy.

"For comparison, according to NCRP Reports No. 92 and No. 95, population exposure from operation of 1000-MWe nuclear and coal-fired power plants amounts to 490 person-rem/year for coal plants and 4.8 person-rem/year for nuclear plants. Thus, the population effective dose equivalent from coal plants is 100 times that from nuclear plants. For the complete nuclear fuel cycle, from mining to reactor operation to waste disposal, the radiation dose is cited as 136 person-rem/year; the equivalent dose for coal use, from mining to power plant operation to waste disposal, is not listed in this report and is probably unknown."

-Article from the Oak Ridge National Laboratory Review by Alex Gabbard

There has always been a large amount of fear and apprehension surrounding the use of nuclear power as a primary means of power generation. This is understandable since the term nuclear is so often used to classify weapons of mass destruction. The most catastrophic Nuclear Power incident to date took place at the Chernobyl Plant in April 1986. To date this incident has claimed approximately 50 lives. These incidents are rare however, and advances in technology coupled with increased safety regulations, continue to minimize the risks commonly associated with these facilities. On the other hand, Coal burning facilities which currently produce about 50% of the electricity in the United States and subject the public to radiation exposures nearly 100 times that of a comparable nuclear facility, are allowed to continue operation unchecked. The burning of coal produces hundreds of millions of tons of harmful emissions and byproducts every year but due to the low cost and current availability, it remains the most prominent form of energy production. As terrifying as these major accidents may be, there are many reasons to believe that these sites can be operated safely and successfully. I have personally spent over 8 years operating, maintaining, and studying nuclear power plants in the US Navy's Nuclear Propulsion Program. After WWII, the Navy took the lead in the peaceful development of nuclear energy. They were also the pioneers of the modern pressurized water reactor (PWR) and successfully deployed the USS Nautilus in 1955 as a fully nuclear powered submarine. Since then, Nuclear power has been used in most Submarines and Aircraft carriers as well as 9 Cruisers. Today, all US Submarines and Aircraft carriers are nuclear powered. The US Navy currently operates over 80 nuclear powered ships some of which have more than one reactor but, in over 50 years of operation, the US Navy has never had a nuclear accident. Because of this and other reasons, naval reactors are the only nuclear power plants in the United States that are not governed by the Nuclear Regulator Commission (NRC). Their success in part, has been due to their thorough understanding and rigorous safety measures. The Navy's long standing record of excellence and perfection in the safe operation of nuclear power is a testament to the future of nuclear energy.

Right now, the newest Nuclear Power plant in the United States was commissioned in 1974. So why do we continue to dismiss the idea of nuclear power when it can so easily provide an answer to many of the problems we are currently facing. This is in part due to the events at the Three Mile Island nuclear facility south of Harrisburg Pennsylvania. On March 28' 1979, just one year after it was commissioned, Unit 2 suffered from a cooling system malfunction. The loss of cooling resulted in a partial melt-down of the reactor core and the eventual release of radioactive material. The staff that was working during the incident took all the proper actions and as a result prevented a more sever outcome. Many studies have been done in the area since that time and have shown that there was no significant impact to the surrounding population but since that time, there has not been a single Nuclear reactor commissioned in the United States. To this day, Unit 1 at Three Mile Island is still in operation and generates enough electricity to power 800,000 homes.

Continued rising energy demands will require more and larger power plants in the future. While the over 600 Coal generation sites in the US provide for 50 % of our energy needs, over 20% of our energy is provided by only 104 nuclear power plants. That is because nuclear plants generally have a much larger capacity. If you consider the rising awareness of emissions controls and the immense cost of retrofitting our coal plants with equipment that basically takes some not all of the pollution out of the air and puts I right back into the ground. Now compare that to the zero emissions of the Nuclear Plant if you don't count some minor uncontrolled releases of contaminants which by the way is just as likely to happen at a nuclear facility as any other form of power production regardless of its size.

> **"… the probability for a particle of radiation entering a human body to cause a cancer or a genetic disease is only one chance in 30 million billion (30 quintillion)."**
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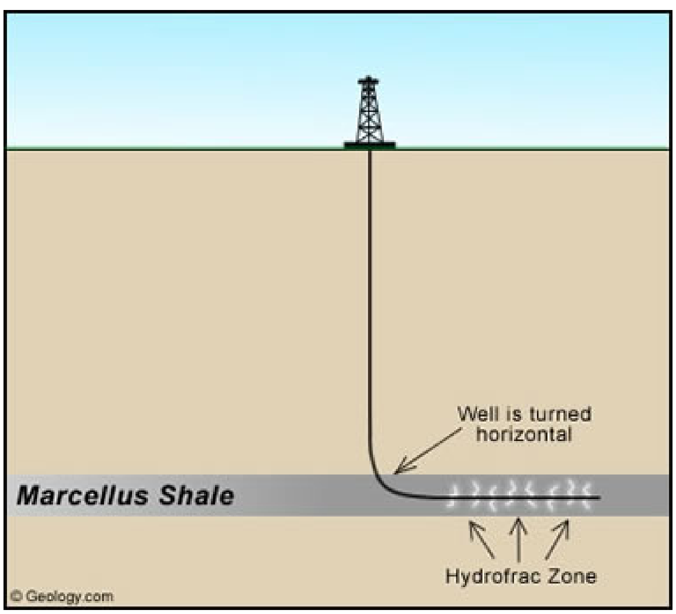
> **-Short essays by Bernard L. Cohen, Sc.D.**

Now let us examine the effect it has on human life. With nuclear Energy, health concerns are primarily limited to Cancer and occupational risks that would apply to any industrial facility while coal fired boilers create massive amounts of waste and exhaust many noxious and toxic gases and particulate. Coal is one of the most impure substances with a wide variance in the number and toxicity of mineral impurities. Many of these impurities include heavy metals such as Lead, Arsenic, and Mercury to name only a few. Many coals have large sulfur concentrations which when burned contribute to the production of acid rain. These and other impurities are either left behind and therefore concentrated in the combustion process or in the case of sulfur are converted to even more damaging by products. Many of these have been proven to contribute to various health issues especially in children and elderly. One especially dangerous bi product of coal combustion is Hexavalent Chromium which has been linked to increased instances of lung cancer when inhaled. New air scrubbers installed on Coal burning facilities are meant to remove this and other contaminants from the flue gas exhausted from these boilers but unfortunately it is then deposited in landfills or used for large scale construction projects. This will hopefully reduce the instance of lung cancer near these facilities but now the Hexavalent Chromium will just leach into the ground water to eventually be ingested causing an increase in liver, kidney, and other cancers.

Nuclear Energy has its own faults and like fossil fuels, is not a renewable resource. It is however a well developed process that we have already spent over 60 years refining and improving which could decrease environmental impact and adverse health effects on the general public while also more than providing for our ever increasing energy demands. As technology improves, I am confident that we will develop new, more efficient, and safer means of power production but we can't afford to wait until that day comes. In addition to cancer, we have seen increase in things such as asthma, autism, chronic illness, erosion of topsoil, and the almost complete loss of entire ecosystems. Large concentrations of mercury that are leaching into our water supplies have also made large numbers of fish no longer safe to eat. As energy demand rises the impact of these toxic byproducts will also increase exponentially. I do not believe that Nuclear Power is the solution to all of our energy and environment problems but so far, all other efforts to produce clean effective power have been less than adequate. Many of the so called "Green" or renewable energy options have made great advances in recent years but most of them are still grossly lacking in their production capabilities. That being said, any long term energy solution that is not sustainable will only offer a temporary solution to our current energy crisis. In the mean time, while some countries have embraced Nuclear energy as a potential solution, the United States has been fighting not to eliminate fossil fuel dependence but dependence on foreign fossil fuels.

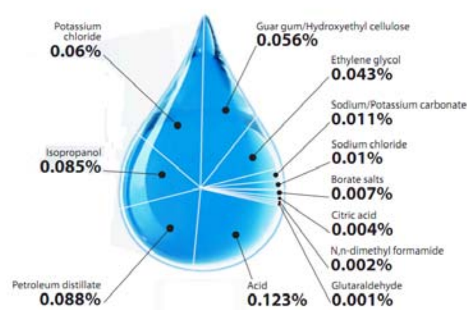


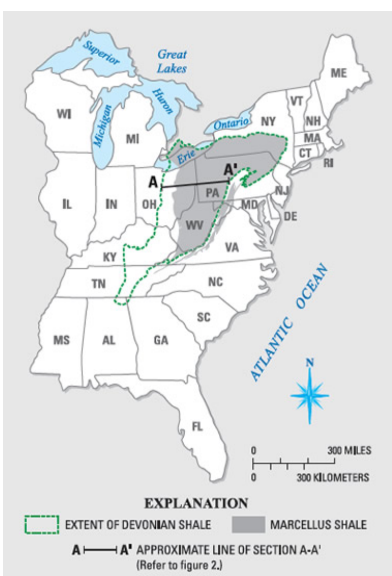
One such example, in our race to proliferate national reserves of affordable natural gas, lead to the use of a process referred to as Slick Water Hydraulic Fracturing. Slick Water Hydraulic Fracturing, or Hydrofracking, is the latest phenomenon in natural gas extraction developed by Halliburton Inc., Schlumberger Inc., and Messina Inc. Hydrofracking differs from conventional natural gas mining in the fact that it is designed to retrieve the gas from dense shale deposits, a process which previously, was not economically feasible. The process starts by drilling a traditional style well down to the dense shale formation. From there the well continues horizontally through the shale bed. At this point the Hydrofracking can begin. Since these large shale formations are extremely dense, the gas is trapped in small impurities within the rock and cannot flow through to the well. Because of this, water, or more importantly "slick water", is pumped into the well at rates as fast as 100 bbl/min causing the shale to fracture and release the natural gas. Slick water, is a mixture of water and chemicals such as polyacrylamide, and various biocides, surfactants, and scale inhibitors. These are added to reduce friction, prevent biological growth, and improve sand suspension. Polyacrylamide, which is used for friction reduction to increase pumping speeds, is a form of polymerized acrylamide. Polyacrylamide itself is not toxic; however, unpolymerized acrylamide remains in small quantities within the polyacrylamide and is a known neurotoxin. The complete list of chemicals used in the process is proprietary information and is not available to the general public. Even so, scientists have detected VOC's such as benzene, toluene, ethylbenzene, and xylene. Symptoms such as eye, nose, and throat irritation; headaches; loss of coordination; nausea; and damage to the liver, kidney, and central nervous system are just some of the side effects of exposure to VOC's.

At this time Hydrofracking is still used worldwide but here in the United States and especially in the Northeast, it has come under intense scrutiny and has even been temporarily suspended on several occasions. But, in the end, companies always seem to get approval to resume Hydrofracking operations. Currently, France is the only country with a complete ban on Hydrofracking and consequently, is also the country with the highest percentage of their power coming from nuclear plants (nearly 80%). In the United States, New Jersey is the only place with a statewide ban on Hydrofracking. July 1st of this year marked the end of the 1 year moratorium on Hydrofracking in New York and although it is still banned in several state locations, it is likely to resume operations in the northern parts of the state. If the goal is to reduce dependence on fossil fuels and seek alternative renewable energy sources, why would industry continue to develop new methods to mine fossil fuels and fight for the rights to continue operations even when they are clearly not wanted? Especially if those methods have been proven to cause potentially long term environmental risks.

Well, there are actually many good reasons for continued Hydrofracking operations especially in the United States. At a time when Americans are struggling to reduce their dependence on foreign fossil fuels and current clean renewable energy supplies are not abundant enough to replace the heavily polluting coal plants, increased natural gas retrieval could be the perfect solution. Parts of Pennsylvania, like many regions in the United States, were hit especially hard by the sinking economy in the last few years. But Hydrofracking has already stimulated the economies and slashed unemployment rates of many of the communities it has touched. Bradford County, once one of Pennsylvania's poorest regions, has witnessed its unemployment rate drop from 10 percent to less than 5 percent since Hydrofracking began in that region. Now, store fronts are littered with help wanted signs and wages are quickly increasing. Other benefits have included resurfaced and improved roads funded entirely by the gas companies. This should be a major consideration for NY which in some cases, has dire need for improvements to its inferior water and sewage-treatment plants which, if properly negotiated, could be accomplished at no cost to the taxpayers. Besides, there is so much water used in the slick water that all of the chemicals combined generally make up less than 1 percent of the total concentration. In most cases the other 99 percent is comprised of primarily sand and water. Not only are the chemicals highly diluted, much of the water can now be retrieved and reused in future gas wells. Since Hydrofracking makes many of the previously inaccessible U.S. natural gas reserves affordable to mine, it will go a long way toward eliminating our nation's dependence on foreign sources of fuel. Additionally, natural gas is the cleanest burning of all of the fossil fuels with an insignificant contribution to smog and acid rain and although it still releases CO_2 as a byproduct of combustion, CO_2 emissions from burning natural gas are 30 to 45 percent less than with other fossil fuels. Knowing this, a 30% reduction in carbon emissions could be a step in the right direction for "Global Warming"

In terms of drinking water contamination, natural gas deposits in shale formations are found well below aquifer levels and are separated from ground and drinking water by hundreds or even thousands of feet of solid rock. Even though Hydrofracking has recently drawn much attention, it has been successfully employed in over 1 million wells in the past 60 years and EPA studies in 2004 assessed that the contamination potential of underground water sources by hydraulic fracturing fluids, posed little or no threat and did not justify further investigation. That is because there is so much sand and water diluting the chemical mixture that all of the chemicals combined only make up about 1 percent of the total volume of fluid.





One of the largest shale deposits of Natural gas in the United States is the Marcellus Shale which extends from southern NY thru most of NJ, PA, and WV as well as parts of MD and OH. It is estimated that the retrievable natural gas deposits in this region are in the range of 363 (TCF) trillion cubic feet. For this reason is it critical that we thoroughly consider mining operations. Steady production from this region could go a long way toward finally eliminating our dependence on foreign fuel. For NY, this could not only bring new jobs to the state, but could also generate substantial tax revenue to help support schools and many state funded projects. As with any operation of this nature, there are always risks to be considered. However, with the latest developments in safety measures and the constant monitoring by state and federal agencies, most of these risks can be safely mitigated and the benefits will far outweigh any minor side effects.

Ok, now let's take a look at the facts surrounding the Hydrofracking industry. If the desired shale beds exist below the aquifers that provide our ground and drinking water supply, doesn't it stand to reason that in order to reach them, you would have to drill through and subsequently pump fracking fluid through the ground water supply to reach the shale. After all, when a well is drilled for water, you drill to a depth below the surface of the ground water reserve and the surrounding ground water drains into that hole and can be pumped out for use. So if you are drilling past the bottom of the ground water, wouldn't it drain into your well and mix with the fracking fluids, and eventually, wouldn't some of the fracking fluid leach into the ground as it passes potentially contaminating the ground water. There are supposed to be protective measures taken to prevent this but, as someone who worked in the drilling industry for several years, I can tell you these measures are not always as effective as some would lead us to believe. Weather drilling for oil or water or natural gas, the principal is the same. First you drill to some predetermined depth above the source you are after. Next you insert a casing, (the thing that is supposed to prevent contamination). The problem is that in many cases, the casing does not provide a perfect seal so there may be some leak by but at small insignificant quantities. Now, with fracking, you supply a high pressure fluid designed to find every minute crack and crevasse in solid rock and force it open to allow the free unobstructed transfer of fluids and expect it to not also affect the casing. In fact, a casing rupture is exactly what everyone was hearing about for 3 months during the BP oil spill of 2010 which released nearly 5 million barrels of oil into the Gulf of Mexico.

Casing blowouts are also responsible for the massive water contamination in Pennsylvania caused by fracking. An issue that inspired the 2010 documentary film "Gasland" focusing on communities in the United States impacted by natural gas drilling and especially Hydrofracking. In some of these cases the failure was so catastrophic that large amounts of natural gas were introduced into the ground water. There are even examples where people have been able to turn on their faucet and ignite the water that is running, watching astounded as it burns. In December 2010, residents of Dimock Township in PA were awarded a 4.1 million dollar settlement against Cabot Oil and Gas due to the contamination of their ground water supply when several casings failed during fracking operations.

There is no doubt about it; Hydrofracking for natural gas is a dangerous operation with potentially catastrophic long term consequences. However, the United States is the single largest user of energy in the world. Natural gas, which accounts for only a little over 20% of the total energy used in the United States, is consumed at a rate of 23 TCF per year. So if the Marcellus Shale contains 363 TCF, it would only be enough natural gas to supply the United States for 15 years. It seems almost depressing that a reserve of natural gas so large that we would risk destroying our water supplies in 6 of our 50 states, could only support our country for 15 years. With New York and Illinois tied as the 4th largest consumers of energy in the U.S. annually and New York also the 4th largest natural gas user at 1,142,156 MCF (million cubic feet) per year of consumption, it would appear to be a bit hypocritical to protest fracking operations when we use such a massive quantity of this dwindling resource. If we are not willing to mine our own natural gas resources because of the potentially dangerous impact it could have on our water supply, then is it fair for us to ask that it be mined somewhere else and affect some one else's water supply just so that we can continue to have access to this precious resource. Whether it's mining natural gas, building wind farms, or constructing a Nuclear Power Plant, Americans are clearly all for it as long as it is not in their backyard.

So where do we go from here? Well, with all of the focus on clean renewable energy, we actually find that some of our most innovative designs have actually been used for centuries and in most cases were developed long before electricity itself. Hydro and Wind energy are the oldest forms of energy generation. Although they have changed considerably over the years as to the type of energy created and their overall efficiency, they remain a very minor contributor to overall power demand. In the US alone, wind contributes less than 3% of our power while hydro-electric accounts for about 7% of the overall power grid. The biggest hurdle in building this infrastructure to replace coal plants is the fact that the fossil fuel sites are already in place while hydro and wind energy require large investments in initial infrastructure before they could ever hope to provide a significant contribution to our energy needs. Both of these offer clean sustainable solutions to nonrenewable energy generation but they are not without their faults.

Wind energy, a seemingly ancient technology, has been gaining in popularity and is one of the fastest growing alternative energy solutions. For many years, windmills were used to pump water from wells or for milling grain for food production. Now that they are more commonly used for power generation, they are usually referred to as wind turbines. These wind turbines have been seen in growing numbers all across the country in large groupings called wind farms. Wind energy is a clean, free, renewable resource that doesn't use or pollute our water supplies and creates no emissions. A large wind farm may be capable of creating 100's of megawatts or more of usable electricity. Wind energy is also the cheapest form of renewable energy on the market today. As long as we have the sun we will always have wind and as long as there is life on this planet then we obviously still have the sun.

Maybe this is the solution to our future energy needs. Maybe someday, every square inch of available land and most of our coast lines will be covered with towering wind farms. Sure, we will still reserve a few national parks for trees to grow and animals to live. It's not likely to happen anytime in the near future but as we continue to search for alternative energy solutions, we will continue to build wind farms. After all, these wind farms may not be aesthetically pleasing and maybe they make too much noise, but how else can we get the energy we need without destroying our environment. Although wind energy excels at the

environmental aspects of power production, it falls short on the economic and reliability portions. It may be considered the cheapest renewable energy form but that is due in most part to the large tax breaks and incentives that are awarded to the facilities. Since we are all taxpayers, maybe that energy isn't as cheap as we thought. Additionally, wind farms as it would happen, require wind to actually make electricity. This can cause additional problems since the electrical grid is designed to distribute power but not store it. For example, if the grid had a demand of 1000 MW (megawatts) and wind energy was providing 400 MW, while there was an additional 1100 MW of available power from conventional fossil fuel power plants, 500 MW of power from the conventional plants would be diverted to other grids if possible or shut down if there was no demand. Now imagine that those 500 MW were from a single coal burning plant that shutdown its boiler as a result of the lowered demand. Now, if the wind suddenly stops blowing, the grid would be calling for 1000 MW while only 600 were available. Since it can take anywhere from a couple of hours to a few days to get a power plant up and running after it has been shut down for an extended period of time, the utility provider would have to utilize diesel generators and other such facilities to make up for the power shortage. In the long run this can drastically raise energy costs due to the high cost of fuel to operate these generators. Wind energy may be a solution to fossil fuel dependency but we still have a long way to go if we hope to provide for our energy needs.

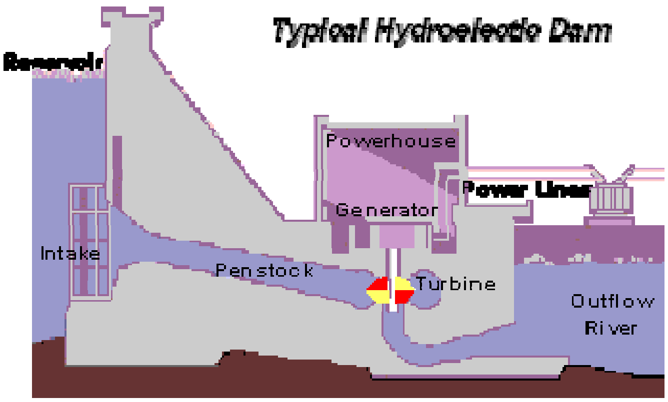
THE WATER MILL

OH! listen to the Water-Mill, through all the livelong day,
As the clicking of the wheel, wears hour by hour away;
How languidly the Autumn wind, doth stir the withered leaves,.
As on the field the Reaper's sing, while binding up the sheaves,
A solemn proverb strikes my mind, and as a spell is cast,
The mill will never grind, with water that is past."
Soft Summer winds revive no more, leaves strewn o'er earth and main,
The sickle never more will reap, the yellow-garnered grain,
The rippling stream flows ever on, aye tranquil deep and still,
But never glideth back again, to busy Water-Mill,
The solemn proverb speaks to all, with meaning deep and vast.
"The mill will never grind, with water that is past."
Oh! clasp the proverb to thy soul, dear loving heart and true,
For golden years are fleeting by, and youth is passing too,

Ah! learn to make the most of life, nor lose one happy day,
For time will ne'er return sweet joys, neglected, thrown away,
Nor leave one tender word unsaid, true love alone will last,
"The mill will never grind, with water that is past."
Oh! the wasted hours of life, that have swiftly drifted by,
Alas! the good we might have done, all gone without a sigh,
Love that we might once have saved, by a single kindly word,
Thoughts conceived but ne'er expressed, perishing unpenned, unheard,
Oh! take the lesson to thy soul, forever clasp it fast,
"The mill will never grind, with water that is past."
Work on while yet the sun doth shine, thou man of strength and will,
The streamlet ne'er doth useless glide, by clicking water-mill.
Nor wait until to-morrow's light, beams brightly on thy way,
For all that thou can'st call thine own, lies in the phrase to-day,
Possessions, power and blooming health, must all be lost at last,
"The mill will never grind with water that is past."
Oh! love thy God and fellow man, thyself consider last,
For come it will when thou must scan, dark errors of the past,
Soon will this fight of life be o'er, and earth recede from view,
And Heaven in all its glory shine, where all is pure and true,
Ah! then thou'lt see more clearly still, the proverb deep and vast,
"The mill will never grind with water that is past."

McCallum, Daniel Craig, **The Water-Millsad**

When this poem was written, Watermills were used to gene rate mechanical energy to grind grain and other tasks. Eventually, some of them were converted for energy generation and new mills were built to supply electricity for small communities. Hydro energy was very popular in the mid to late 1800's up until the 1920's. Hydro facilities were initially used for their mechanical energy to run various mills. As electricity grew in popularity many of these mills were converted into hydro-electric plants to power small communities surrounding the old mills. Eventually, as demand grew, larger capacity facilities and interconnecting grids were built and most of the smaller hydro plants were bought out and shut down. Coal and oil offered a cheap solution for powering the newly built infrastructure making it impossible for the small community hydro facilities to compete. Hydro-electric plants again gained in popularity in the 1970's during which time many of the old hydro facilities that had been shut down were reconditioned and returned to service. Today, most hydro electric plants would hardly be recognized when compared to the traditional Watermill but in some remote areas you may still find some of the original style plants in operation. Today there are several methods employed for harnessing the power of hydro-electric energy. The most obvious, simply because of it size, is the use of dams which restrict the flow of a river thereby storing the potential energy for a more controlled and regulated use. This is accomplished by releasing water from the newly formed reservoir and directing it through large turbines before it rejoins the river below. Another method is to divert a portion of a river thru the use of channels where it passes through large turbines or paddle wheels then rejoins the river downstream. Still other facilities, referred to as "run of the river" hydro plants, utilize a much smaller water storage called pondage or none at all. These are ideal in a stream or river with minimum dry weather flow and are also use in areas where flow can be controlled by larger upstream dams. So why is it that hydro-electric provides so little power to the national and international grids when it appears to be an abundant free source of clean energy?



There are several reasons why we do not see rising demand for hydro power in a time when energy demands skyrocket, fuel supplies dwindle, and public awareness of environmental impact are at an all time high. Dams, which have great energy potential also, have their own set of problems. They require huge initial investments and take many years to complete. They also displace large amounts of water which often overtake previously habitable lands and restrict the flow of water to users downstream of the dam. Damned hydro plants which can produce large amounts of electricity often bring about more damage than they are worth displacing entire ecosystems and posing huge flooding risks to downstream communities. Because of the impact that dams have on the surrounding area, they are not actually considered a source of renewable energy. Recently, studies

have even shown that dams may be a large contributor to green house gases. Studies suggest that the plant and trees that are flooded when the reservoir is filled release carbon dioxide as they decay. Then as they further decompose on the bottom of the reservoir, they create large amounts of methane which is absorbed by the water and released as it passes thru the turbines.

> **"Many hydroelectric plants use dams to create reservoirs. Big dams—Glen Canyon, Hoover, Grand Coulee—store water until demand for electricity is high, at which point the engineers who control them release it. These huge structures, called storage dams, have turned rivers like the Columbia, the Colorado, and the Tennessee into strings of elongated, stepping-stone lakes, transforming the landscape and displacing residents both human and wild. The dam the Chinese built at Three Gorges flooded 140 towns and 13 cities, displaced well over a million people, and turned the Yangtze River into a holding tank six hundred kilometers long. When the reservoir was filling up, scientists could detect a wobble in the Earth's rotation. Because these facilities transform river habitats so radically, the power they produce is not considered renewable by the U.S. Department of Energy."**
>
> **-Strand, The Poetry of Power**

A better solution would be the so called micro hydro facilities which can be found all over the world especially in smaller developing countries. These generally provide less than 100 Kw and are used to power single family dwellings and small communities. But, building new hydro facilities is a costly and time consuming project and aside from dams, most hydro-electric plants produce a very small amount of usable electricity. Additionally, these facilities are not always a reliable source of power since they depend on rain fall and snow melt to maintain river levels. In an effort to combat these setbacks in hydro power, a growing field in Hydro research is the water turbine. Today there are many designs and new ones are being designed all the time. Their uses vary from flowing rivers to tidal applications. One such project was attempted in the Hudson River in 2007. However, the turbine that was used was so large that the powerful currents in the Hudson River snapped the 20 foot turbine blades rendering the turbines useless. Currently there is a project underway in New York's East River where several improved designs have been operating for over 2 years with complete success. In addition to this the New York government supplied a 2 million dollar grant to study the possible environmental effects of these turbines and found that during this time there was no noticeable effect on the fish population. There are still a few drawbacks to this technology as it is in its relatively infant stage of development. The cost of these turbines, although similar in design to the wind turbines, is considerably more expensive due to the durability requirements for sustained operation in the harsher underwater environment. There are also major concerns for the impact that this will have on recreational use of our waterways. Areas operating large water turbine farms would be unavailable for swimming, fishing, and boat traffic. This same technology is gaining interest in several other areas including Hawaii and the Gulf of Mexico. There have been several proposals to place large water turbine farms in the Gulf of Mexico to harness the power of the

Gulf Stream. There are elaborate plans which depict everything from how the turbines will be anchored and equipped to handle storms to the method in which the underwater power grid will be laid out. It is proposed that the turbines will be deep enough in the water to prevent interference with shipping traffic.

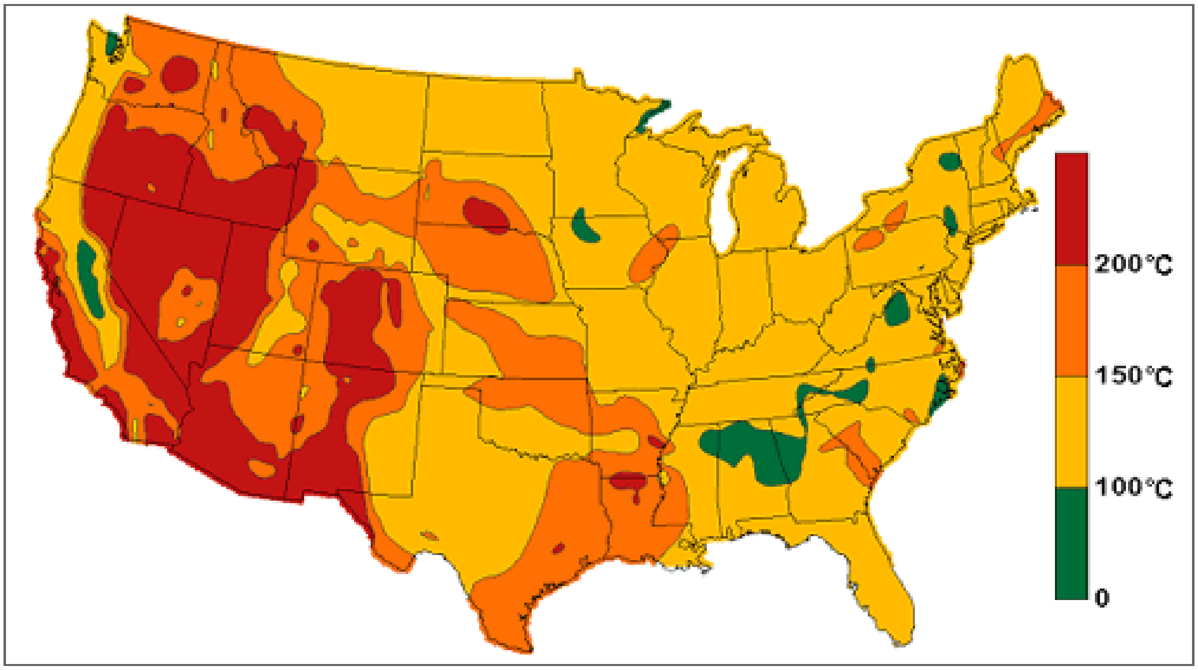
All that said, is it really any different that Wind energy? Sure it's more reliable and consistent but it is still a relatively low energy producer and requires a huge initial investment. In the end it will take up just as much space in our oceans and rivers as the wind turbines do with our farm land and scenery. With all this money being spent on renewable energy has any one even taken the time to figure out if the energy produce will even be sufficient to cover our needs. Picture a world covered in a blanket of solar panels, every inch of our countryside scattered with wind turbines, and our rivers and coast lines a massive continuous grid of water turbines. At least we're not reliant on fossil fuels and we're no longer polluting the environment. Everyone can stop worrying about nuclear accidents and where to store the spent fuel. So what if we can't fish in the rivers or surf in the oceans. We can continue living peacefully knowing that we saved the environment. We will continue living and growing increasing our population until we reach the threshold where once again we are having large brown outs and can no longer support our energy needs. Then what?

As our global energy demands continue to grow and we search for new environmentally sound methods of energy generation, one option that we must consider is the use of geothermal energy. Geothermal has the potential to provide a significant portion of our global energy needs however at this time it represents a relatively small portion. As of 2010, the largest producer of geothermal energy is the United States with approximately 3086 MW of electrical generation which accounts for only .3% of our power. Probably the most developed geothermal field is located at the Geysers in California which currently generate 725 MW using one of the earliest Geothermal Designs known as the dry steam type. Other countries such as the Philippines and Iceland with 1904 and 575 MW respectively, provide a much larger portion of their countries energy from geothermal sources.

Although today it is primarily associated with Power generation, geothermal energy was used by the ancient Romans for space heating. Iceland's geothermal sites provide 30% of the countries power, and in conjunction with power generation, Iceland also uses it to supply heat and hot water to the entire city of Reykjavik saving as much as 4 million tons of CO_2 annually. It may not seem like much but when it comes to inefficient energy abusers in the average house hold, regardless if it is gas or electric, a hot water heater ranks among the worst. There are other options such as solar water heaters but those are only useful in warm climates that generally get a lot of sunshine and even then they are usually supplemented with an electric system for cloudy days or night time. Using geothermal energy in this way to not only provide electricity for the community but to also eliminate the need for hot water heaters, is probably the most efficient energy production method I have seen put to use. Additionally, Iceland continues to work toward expanding their geothermal capacity while the majority of their remaining power is provided from hydro plants.

Geothermal essentially describes 2 different processes, geothermal energy and geothermal electricity. Geothermal energy has been used for many years; however, Geothermal Electricity is still a relatively new technology. Techniques have improved in recent years but traditionally, it is best suited to areas with high temperature geothermal resources available near the surface. New advances in drilling technology have allowed us to more easily drill to deeper depths allowing us the ability to access geothermal energy in areas where it was not previously used. Most geothermal electricity is generated using 3 primary methods. Dry Steam Geothermal Plants, such as those in California, are the oldest and simplest design which use steam from a hot aquifer to turn a turbine creating electricity. As the steam passes through the Turbine it is collected and condensed then returned to an adjacent well where it will eventually rejoin the ground water in the hot aquifer. The great thing about this design is the fact that it does not require pumps and therefore creates electricity without being a large consumer of electricity itself. Flash Steam Geothermal plants are a newer design and the most common type in use right now. They use pumps to bring the high temperature high pressure water up from the aquifer to a low pressure separator where much of the water flashes to steam and is then used to power the generator in the same fashion as the Dry Steam Plant. The condensed steam and residual hot water is then returned to a well to rejoin the aquifer or can be used to supply hot water like the example from Iceland. The newest design is the Binary Cycle Geothermal Plant which pumps the hot fluid up to a heat exchanger where it transfers its heat to another fluid which flashes to steam and operates the generator. The benefit to this is that you can use a geothermal site with a lower temperature since fluids with a lower boiling point can be used to operate the generator. Some of these sites are even being built where there is no hot aquifer by drilling the wells deeper then pumping water into the well to the new depth where the earth is hot enough to boil the water. With all of these options, startup costs are usually very high but the cost associated with maintaining a geothermal sight is relatively low compared to other power generation methods.

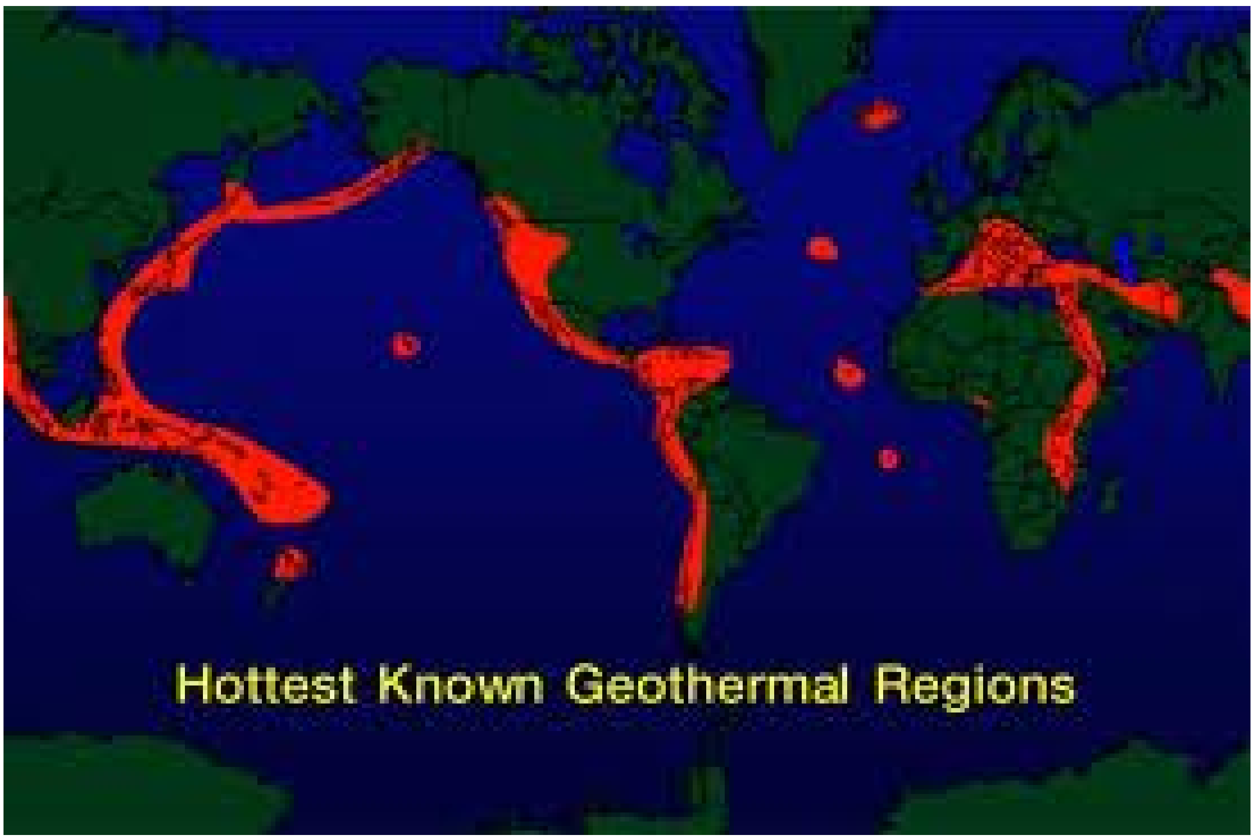
Geothermal energy can be used in conjunction with geothermal electricity as was done in Iceland but it can also be used on a much smaller scale. Regardless of where you are located, the temperature at about 15 feet below ground is approximately 65 degrees. Because of this, a properly installed geothermal system installed in a house can both heat your home in the winter and cool it in the summer. This can be done relatively inexpensively during new construction but will cost a bit more to install on an existing home. These small scale geothermal heating and cooling systems are a great way to conserve energy by minimizing energy usage for heating and cooling. They are also the most useful since they can be used anywhere regardless of location.



In the United States, the majority of the sites that are well suited for geothermal electricity are in the Midwest and along the California coast. This is primarily because this is also the location of our most active fault. One of the major concerns for drilling in these areas is the potential for triggering an earth quake. Traditional Dry Steam and Flash Steam plants have never been known to trigger seismic activity, but, the new Binary Cycle plants require drilling wells and using a procedure similar to Hydrofracking in order to break up the rocks and allow a larger surface area to contact the water and create the heat source for the steam. In December of 2006 a large scale geothermal plant was under construction in Switzerland. When they began injecting high pressure water into the well to break up the rock, it triggered 30 earth quakes the largest of which registered a 3.4 on the Richter scale. The project was placed on hold pending further investigation and in late 2009 it was abandoned altogether. To date, this is the only project that has had an out come with this severity. Any time a new geothermal well is drilled and subsequently injected with water; there will be some seismic activity. Experts believe the severity of this activity depends on the amount and rate at which the water is injected. So to sum this up, we are intentionally injecting water into the well knowing that it will cause seismic activity of some kind and we are hoping for the best.

In areas where deep wells and water injection are not required, geothermal electric plants are a great option especially if they can also be use to provide heat and hot water to surrounding communities. However, even if we deep drilled and accessed all available geothermal sites in the United States, it is estimate that we could only provide 10 percent of our energy needs. On the other hand the average home uses nearly 50% of their energy for heating and cooling. A properly installed geothermal heating and cooling system saves an average of 50% on heating and cooling energy in most homes. If even half of the homes and businesses in the

United States were equipped with these systems, we could save more energy that all of these new geothermal plants could provide. There are many locations in the country and worldwide that are ideal for geothermal power plants and those should be used. However, what may be considered acceptable risk to an organization building a new Binary Cycle Geothermal plant, is most likely not acceptable to the people who stand to lose their homes and family members because of a manmade earth quake. Geothermal energy is a great resource and could in time both save and provide us with vast amounts of energy. However, changing such a natural process to work in a completely unnatural manner is something we can do without.



There is however, one energy source which we have not yet discussed. It is the most powerful and abundant energy source in our entire solar system and has been responsible for providing energy to every living thing on this planet since the appearance of the first organism. It is responsible for nearly every form of Green energy we use and since it is responsible for sustained life, it is also responsible for our reserves of fossil fuel. Our Sun radiates more energy onto the Earth every hour than the entire world uses in one year.

Brilliant shines the light of the universe on earth

A bouquet of the world's magnitude
As precious as life
Given as a gift to an ungrateful people

A shimmering array of colors
Showering over the horizon
Indescribably captivating
Unutterably beautiful

No words,
No words can capture
The light of the universe that shines on earth

Jane Alice Bacon, Briliance

The ability of materials to convert light into energy was observed as far back as 1838. Approximately 30 years later, a man by the name of Auguste Mouchout, designed a device that converted the sun's energy into steam to operate an engine and later a refrigeration device in effect converting sunlight to ice. During this time, the pursuit of solar energy became more and more popular due to a belief by some that eventually the world's coal supply would run out which at the time was the fastest growing and most widely used form of energy generation. In 1868, U.S. engineer and solar power enthusiast John Ericsson stated; *"A couple of thousand years dropped in the ocean of time will completely exhaust the coal fields of Europe, unless, in the meantime, the heat of the sun be employed."* Ericsson was most well know as the designer of the Civil War battleship the Monitor but devoted the last 20 years of his life to the study of solar energy. By 1883 Charles Fritz had developed the first solar energy cell to convert sunlight directly to electricity. Unfortunately, this only converted about 1 to 2 percent of the energy it received from the sun to usable electricity. Still, throughout the end of the 1800 and the first half of the 20th century, many people continued to investigate the possibility of solar energy. Many of these people shared the concern that the world's supply of coal and fossil fuels would someday run out. During this time the process was refined and improved and 1904 when Henry Willsie developed the first solar plants that could store energy for night when the sun could no longer provide power. He accomplished this by heating hundreds of gallons of water in large plate collectors and storing it in insulated basins. Then in 1954, there was a breakthrough when Calvin Fuller, Gerald Pearson and Daryl Chaplin accidentally discovered the use of silicon as a semiconductor while working at Bell Laboratories eventually leading to the development of a new solar cell with an improved efficiency of 6 percent. By 1956 the first commercial solar cell was being offered in radios and toys with a cost of around $300.00 per watt. By the 1960's, the space program had begun to use solar energy to power their satellites and by the 1980's solar power had become available at a rate of approximately $20.00 per watt.

Because we are now running out of gas and oil, we must prepare quickly for a third change, to strict conservation and to the use of coal and permanent renewable energy sources, like solar power.

JIMMY CARTER, televised speech, Apr. 18, 1977

In addition to the current gross inefficiency high cost of solar energy production, there several other areas of concern which must be addressed. Although the actual generation of energy through the use of photo voltaic solar cells creates virtually no harmful byproducts, the production of polysilicon which is used to make these cells creates a waste product known as silicon tetrachloride. Silicon tetrachloride is a highly toxic substance that is very expensive to dispose of and proper disposal would most likely cause the cost of solar energy to sky rocket. Part of the reason prices have improved so much over the past few years is due to the fact that most of the polysilicon is produced in China where regulations to enforce proper disposal are not enforced. Right now, the Chinese are producing polysilicon for around 21k to 56k per ton but if proper disposal methods were used it would raise that figure to around 85k per ton resulting in high cost to manufacture solar cells therefore raising the total cost per watt of generation. Because of this, some plants are disposing of their silicon tetrachloride by dumping it in nearby villages. Wherever silicon tetrachloride is dumped will become infertile and nothing will grow there. Eventually it leaches in to nearby land continuing the cycle of infertility and destroying land that was previously used for agriculture. Additionally, if it comes in contact with humid air, it breaks down into acids and hydrogen chloride gas which causes severe respiratory problems when inhaled. Finally, due to the relatively long life (30 to 40 years) of these cells we often over look the fact that they contain cadmium, lead, and mercury, all of these are considered to be toxic and are harmful to humans. As these cells reach the end of their life and are disposed of, it will require a large scale recycling and disposal plan to prevent contamination.

Solar energy use continues to grow as does the field of research surrounding it. It is far from being a solution to our global energy demands but with time and technological advances it may yet surprise us. Until that time it may quite possibly surpass coal and all other fossil fuels in environmental impact especially when you consider that in the U.S., solar sources provide less than one percent of our total power. Right now the largest area of growth in the solar field seems to be geared toward photo voltaic cells. However, the original and oldest form of solar power, the use of the sun's heat to generate steam, does not require the production of poly silicon and subsequently has no future waste concerns for heavy metals such as those contained in the photo voltaic cells. Some even suggest that solar energy could account for 20 to 40 percent of our supply by as early as 2020. Only time will tell if this technology can advance to a level that will allow it to become the new standard in global power.

Today, as we continue to improve upon solar technology, the average solar cell achieves less than 12 percent efficiency. Still we continue to improve both solar cells and solar steam generation devices but both suffer the effects of a large initial investment and lack the substantial output capacity of their competitors. Estimates range between 12 and 15 years for a return on initial investment to install a large scale solar energy project. For conventional power generation methods, the average cost per kilo-watt hour of electricity in 2010 was approximately 12 cents compared to an average cost of $4.00 per DC watt for solar power. Right now, the U.S. government is offering incentives which help to offset these costs but the initial investment is significant.

"New York had 48 coal-fired generating units at 17 locations in 2005, with 4,273 MW of capacity - representing 10.0% of the state's total electric generating capacity" (sourcewatch.org). Additionally, there are currently 7 operating nuclear reactors at 4 locations in NY that provide approx. 5000 Mw of capacity. 12 locations burn gas or a gas/coal mixture and provide over 10000 Mw. Finally there are 8 petroleum burning facilities that produce 8000+ Mw. So the total combined capacity of all nonrenewable energy generation in NY is over 27000 MW. Since the average wind Turbine can produce 1.5 Mw under ideal conditions, it would take 18000 wind turbines to replace all nuclear and fossil fuel energy sources in New York. Since a typical Wind turbine may need as much as 25 Acres or more meaning it would require nearly 450000 acres to support NY wind farms. John Rancich a developer for Enfield Wind has proposed a NY wind farm consisting of twenty 2.5 to 3 Mw wind turbines with substation and service roads encompassing 925 acres an average of 46 acres per turbine. If we assume Rancich's model as the standard for all NY wind farms, it equates to an estimated 454090 acres. To make matters worse, a typical wind farm in NY is expected to perform at a capacity factor of less than 30% meaning that a wind farm rated at 100 Mw would on average produce less than 30 Mw. So at 30% capacity, it would require over 1.5 million acres of land (nearly 5% of the state) to replace the combined output of New York's current nonrenewable energy sources.

Now let's consider the option of other commercial renewable energy. The previously mentioned Water Turbine models being tested in NY's East river are rated for only 35 Kw. To bring this in to perspective, there are six of these turbines being tested and the combined output has been successful in powering a supermarket and parking garage on Roosevelt Island. The use of solar energy, both Solar Thermal and Photo-Voltaic require about 75% less space per Mw than wind energy, but would be greatly affected by the winter months in NY. New York currently has a Generation capacity of 37707 Mw, a 10% surplus for the needs of the State. Factor in planned and unplanned outages and this becomes just enough to provide for the current demand. However, 65% of this capacity is over 30 years old. If you combine this with the expected 10% increase in demand over the next decade along with the likely hood that the Indian Point Reactors will most likely be removed from service after the expiration of their current license period, it is urgent that we seek additional means of energy generation.

Energy consumption in New York is broken down into three main categories, 28% residential, 32% commercial/industrial, and 40% transportation. What if we could eliminate all of the residential and half of the commercial/industrial demand? That would be a nearly 45% reduction in energy usage for NY State. Now, supply NY with 500000 acres of wind farms, 75000 acres of thermal solar energy, another 75000 acres of Photo- Voltaic fields, install 20000 Water Turbines in rivers and off shore to harness the tidal energy, and continue to use the existing Hydro plants. With the new lower demand, this would leave the state with a conservative 20% surplus when all systems were operating at just below their expected capacity factors. This may seems like a rather unrealistic plan but is it? Suppose the state set aside half of the funds collected from the taxes, environmental compliance fines, and carbon credits paid by the fossil fuel and Nuclear plants in NY state and used that money to help subsidize affordable solar panels, solar water heaters, micro wind generators, and Micro hydro plants all across the state. Residential buildings and single family homes could then install solar water heating systems along with solar panels and micro wind generators to supply their own electricity. Cities and rural areas with adequate conditions for micro hydro plants could use them to supplement their power. Large commercial and industrial facilities could be mandated by law to install any combination of these to provide at least 30 percent of their energy usage

with penalties similar to the carbon credits for non compliance and tax benefits for those who provide 50% or more of their own power thru the use of these methods. Additionally, any person or company who produces more than they actually use, would be able to feed the extra power back to the grid and receive payment for that energy (this is already available in many areas). Finally, create a 5 to 10 year mandatory implementation period with additional incentives for early compliance and penalties for failure to meet the deadline. Now, implement this on a national level, coupled with the existing interconnected grid, and a cold rainy day with little wind in one area can be offset by the by the over production in other areas. I we can rise to the challenge and put a man on the moon in under 10 years, surely we could accomplish a task as simple as this.

As we look at all of the problems that face us today with growing energy demands, increasing population, and the deteriorating environmental conditions, we realize that we are in the midst of the next Global energy system transition. Although we have discussed many alternatives to modern fossil fuels and taken an inside look at some of the benefits and drawbacks for each of them, we have not really discussed the fact that the solutions for today, may not sustain our needs in the future. With that in mind I would like to take you into the possibly not so distant future with a look at several energy solutions which may not be ready for immediate use, but when properly developed and implemented, could provide quantities of cheap, clean, affordable energy thousands of times greater than any of the methods currently being used.

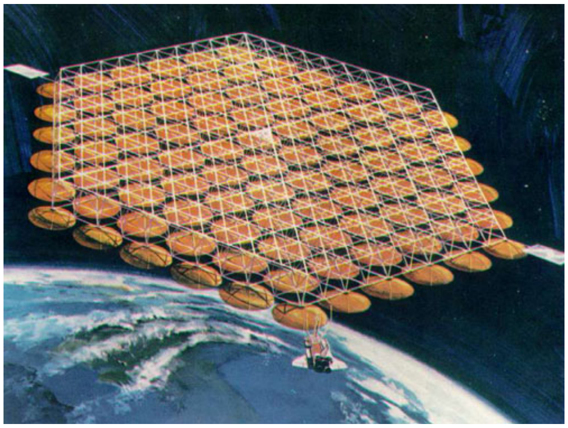
If you really truly look at modern energy generation, you may be surprised to discover that with only a few minor exceptions, all energy comes from the same source, the sun. Whether you’re talking about energy in the form of electricity or the energy to live and breathe, the sun is almost exclusively responsible for our energy needs. From the photosynthesis of plants which then enter the food chain to supply energy for all other life to the most obvious solar panel, life as we know it depends on the sun. The Law of conservation of energy tells us that “energy can neither be created nor be destroyed: it can only be transformed from one state to another”.

First let’s look at fossil fuels which can be classified in two major categories. The first is carbon or coal, which can be found in a varying quality or purity depending on the age of the coal. The older the coal deposit, the closer it will be to pure carbon and inversely the younger it is the more impurities it will contain. Coal is primarily plant based and is essentially stored solar energy. When plants absorb the suns energy through photosynthesis then subsequently grow and die, they decompose and return to the soil to provide nutrients for future plants to grow. When large quantities of plants die, they are gradually buried over 100's of thousands of years until they have been subjected to high temperatures and pressures and eventually form coal. The other form fossil fuels are found in is called hydro carbons more commonly known as oil, diesel, gasoline, and natural gas to name a few, and is created in the same manner as coal except that it is primarily animal based. Animals as we know originally got their energy from either plants or other animals that got it from plant which in turn got it from the sun. So without the Sun there would be no fossil fuels.

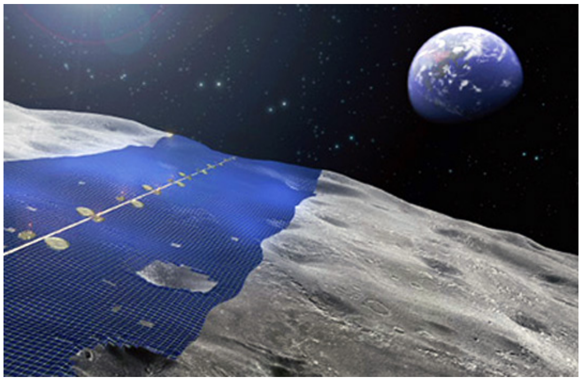
Both hydro electric and wind energy are also made possible by the sun. In order for us to have hydro power we rely on the sun to evaporate water from our oceans and return it to our mountains and lakes so that it can once again flow back to the ocean providing us with a source of mechanical energy. Wind energy is made possible by the heating of the earth by the sun. Since the sun does not actually heat the air but rather the earth which in turn heats the air, there is always warmer air closer to the earth which gets steadily cooler the farther you get from the earth's surface. As the relatively warm air travels up it generates currents which we know as wind.

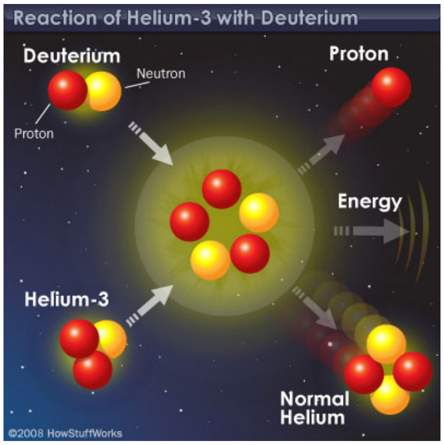
The various forms of solar energy are the most direct and obvious energy sources generated by the sun. However, although nuclear energy which comes from the process of nuclear fission and geothermal energy which in part comes from nuclear energy released by the decay of radioactive elements in the earth's core are not directly linked to the sun, if you follow the "Big Bang Theory", all of the matter and energy including what we know as our sun and all of the planets of our solar system originated from the same source. So with this knowledge, we will look into the ideas and in some cases successfully developed and tested methods which could be the answer to our future energy needs.

As we have already discussed, one of the biggest draw backs to solar energy through the use of photo voltaic cells is the incredible inefficiency. We have also found, that if we are able to get the cells closer to the sun, we can potentially increase that efficiency to 4 times that of what we are currently achieving. Of course, by closer, I mean beyond the interference of the shielding properties of the earth's atmosphere. This may seem farfetched but it has been in use for many years powering the satellites and unmanned space vehicles that we have used since our entry into space exploration. Ok, so it's easy enough to imagine satellites with solar panels generating electricity but how do we get that electricity back to earth so that we can use it to run our air conditioners or improve our lives with the thousands of electronic devices that have become an essential part of our culture. Obviously we can't run power lines from here to the solar grids which would ideally be about half way between here and the moon, so how do we tap in to this amazing potential? I will again remind you that "energy can neither be created nor be destroyed: it can only be transformed from one state to another". When you used to make phone calls on a device that was connected with wires all over the world, how was your voice transferred over hundreds or even thousands of miles? When you connected to the internet to surf the web with your phone, T1, DSL, or fiber optic network how do you think that information was transported? The answer is energy. Today, most of these functions are done wirelessly but the mode of transportation is the same. Energy from a satellite outside our atmosphere can easily be transmitted in the same manner. The energy collected by the satellite would be transferred in the form of micro waves which would then be sent back to earth, and when received, would again be transferred back to usable electricity. There have even been several successful test of electricity transmission thru microwaves as far back as the mid 1960's. As it stands, the biggest hold up for a massive deployment of solar satellites is the cost to get them into space. Unless we can develop a more efficient and cost effective form of space deployment, this massive energy resource is likely to remain untapped. That being said, this proposal shows enough potential that we continue to explore possibilities in hopes that soon it can become a reality.



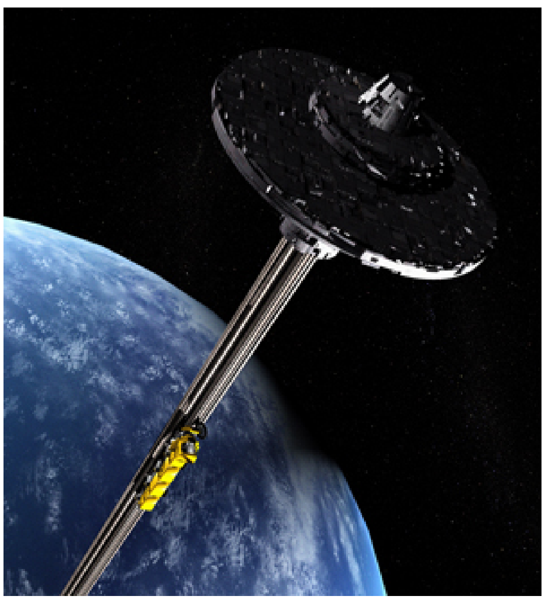
Other proposals for the use of long distance wireless energy transmission have included Lunar Solar Power (LSP) consisting of giant solar farms on the surface of the moon as well as vast wind farms on Mars where solar winds are constant. But, no matter how great this potential may seem, it cannot even come close to the potential energy of Nuclear Fusion. Not to be confused with Nuclear Fission which is what we know as modern nuclear Power, fusion energy comes from the combining of the nuclei of atoms instead of splitting them. Fusion has already been tested and shown to generate immense amounts of power using the hydrogen isotopes Deuterium and Tritium. This would be a natural choice since Hydrogen is the most abundant element in the universe and makes up about 75% of all matter. The problem is that the combining of these isotopes gives off the majority of its energy as radiation posing significant safety concerns. The next 2 most abundant elements are second Helium, and third Oxygen. Fortunately, the Helium isotope, Helium-3, can be combined with Deuterium to generate incredible amounts of energy with no



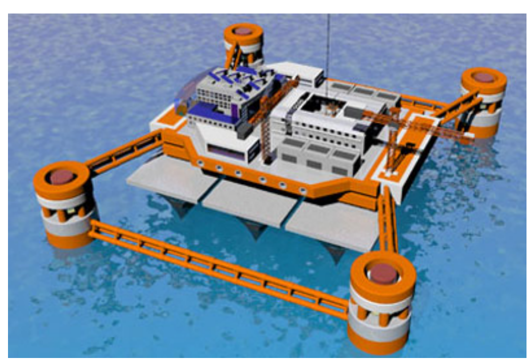


pollution, no radioactive waste, and no effect on the surrounding area. In fact, approximately 25 tons of Helium-3 and 17 tons of Deuterium could power the United States for a whole year. With the U.S. using approximately 25% of the world's energy, it is safe to assume that 100 tons and 68 tons respectively could power the whole planet for 1 year. This is great right? So why aren't we doing this right now? Sadly, the earth's composition is vastly different than the rest of the known universe, one of the reasons why it can sustain life, and Helium-3 is not readily available. The good news is that the Moon has massive quantities of Helium-3 and some scientists believe it may contain over 1 million tons. This would mean that at the world's current energy usage, the Moon could provide us with enough fusion energy to last ten thousand years.

So once again we are back to the issue of transportation costs being the limiting factor for our developing energy solutions. So what if I told you that a cost effective method that could drastically lower the cost of space deployment was first conceived by a Russian scientist in 1895 and today still generates enough interest that NASA now sponsors challenges with prizes totaling over 1 million dollars for technology which could lead to the successful deployment of this new space vehicle. Imagine for a second that you work on the top floor of a New York City high rise



and have to use a helicopter to get up there each morning. That could be a very expensive commute. So how would you solve this problem? Well you could obviously build stairs but it would take an awful lot of time and energy to get up to the 50th floor for work each morning and in comparison, travel outside the earth's atmosphere could hardly be accomplished with stairs. So you build an elevator and immediately all of your problems are solved. So why not build an elevator into outer space? Well, that is exactly what has been investigated for over 100 years now since Russian scientist Konstantin Tsiolkovsky was first inspired by the Eiffel tower. Ideas surrounding the implementation have varied over the years but today it is most commonly agreed that the basic design would consist of an anchor located somewhere at the equator that would be connected to a cable or ribbon as much as 62,000 miles long connected at the other end to a massive counter weight. The theory is that the rotation of the earth would keep the cable tight and the counter weight would remain in geosynchronous orbit. From that point it would simply be a matter of taking an elevator ride to space and then from there deploying shuttles which require very little fuel once outside the atmosphere. Advances in this technology could make solar satellites and moon mining an affordable reality. Right now,



every aspect of this elevator is easily achievable with the exception of the cable which must be capable of extreme tensile strength. Advances in carbon nanotube technology are showing promising results and countries like Japan and the United States are racing to solve the final pieces of the puzzle. Japan has even gone so far as to propose that they could build it for around 5 billion dollars.

Energy Means power for those who have it and since the earliest of times mankind's race for power has given birth to some of the greatest innovations. As we progress into the next energy system transition, there is no telling what lies ahead. The only thing we know for sure is that it promises to be filled with new and exciting things.

> **To truly transform our economy, protect our security, and save our planet from the ravages of climate change, we need to ultimately make clean, renewable energy the profitable kind of energy.**
>
> **BARACK OBAMA, Address to Joint Session of Congress, Feb. 24, 2009**

As we move forward with these new and exciting technologies, there is one truth that is unavoidable. The best way to beat the rising energy demand is by actually using less energy. With its many millions of residents, New York has a unique opportunity to accomplish this task. We are already well on our way in the city with our amazing public transportation system but even that has its limitations and we can't stop there. Every day I watch as thousands of cars and taxis fill the streets of New York when these people could just as easily have taken the subway or bus systems. I myself am not a native New Yorker and can therefore understand the convenience of having a car so that you don't have to rely on public transportation. But even in the more rural parts of the country where public transportation is not as well developed, there are many things we can do to minimize our energy consumption with little or no impact to our current standard of living. For shorter commutes, it can often be faster as well as more energy efficient to walk or ride your bike. As I walk in the evenings, I can't help but notice all of the lights. Often times I will look up at a building only to find that nearly every window is illuminated. In addition to wasting energy, these households are just throwing away money as the electric meter continues to add up there usage.

As previously discussed, a geothermal heating and cooling system can offer a tremendous energy savings for home owners and though I wouldn't expect people to buy new appliances, when the time comes to replace existing items, do your home work and make sure you are getting an energy efficient model. It's also important to make sure you buy appliances that are sized properly for your needs. Buying a smaller air conditioner may not necessarily be more energy efficient. If it is not sized sufficiently to cool you space then it will run continuously using a lot more energy than if you had bought the larger unit. Another great energy saver is to have a programmable heating and cooling system so it can be off when the house is not occupied. This can also be accomplished by simply turning off your air conditioner when you leave the house or at a minimum set it to a temperature where it will cycle less often. With the immense number of portable electronic devices in nearly every house hold, there can be any number of chargers plugged in at any time. Because these usually incorporate a transformer of some sort, they continue to draw power even when the device is not connected and charging. This is also true with televisions and can easily be avoided by unplugging the items when they are not in use. In recent years, many people have also noticed the huge savings by switching to florescent bulbs from the traditional incandescent type. As technology improves, the newer LED bulbs can save even more energy and though they are a bit more expensive, they can generally last up to 20 years without needing replaced. If saving energy isn't incentive enough, think of all the money you could save in the process. So if we can all do our part to conserve energy, and meanwhile focus our efforts on implementing an even mix of all renewable energy sources for New York, we can quickly overcome all obstacles and be better prepared for the future.

I have owned three homes in my life so far and largest of these also had the lowest energy usage. At the time I was living in a 3000 sq.ft. home near the top of the mountain in Kaploei Hawaii. My house was built into the mountainside so that the front of my home, which received the majority of the sunlight, was mostly underground. Additionally, the garage was on that side of the house so that helped to block another large portion of the house from the direct sunlight. All in all, less than 25% of my house was exposed to direct sunlight for most of the day. I redid the entire house in an engineered composite hard wood floor with a thick insulating pad between the flooring and the subfloor on the upper level. On the main level the subfloor was concrete so I glued the hard wood directly to the floor to enable the cool temperatures from the concrete to in turn cool the wood. I also installed a split central air system which gave me the ability to use a more efficient central air system and still only turn it on in the room I was occupying. I had a large solar water heater on top of the garage and the main water heater tank was also in the garage to prevent any escaping heat from making my air conditioner work harder. The solar heater was supplemented with an electric water heater which could be turned on and off as needed but living in Hawaii, I only had it on an average of 30 days per year. Next I had my washer and dryer placed in my Garage since the dryer is a huge contributor to heat in the house. Finally, off the back of the house I had a 1000 sq.ft. porch which was covered for the first 30 percent to provide additional shade in the afternoon when the sun was on that side of the house. As a comparison the house I owned previous to that was also in Hawaii and I purchase it new while it was still under construction. It was well built and well insulated with all appliances being of the latest energy star design. I had a traditional Central air system and the garage was under the house (i.e. it was half of the first floor). The total living space was 1200 sq.ft. and my average energy bill was around $220.00 per month. I lived there for 3 years before moving to the new house which I lived in for a little over 2 years. After moving into the new house and making the above mentioned changes, my average energy bill for the entire time I lived there was under $90.00 per month. I did most of the renovations myself so there was a significant cost savings but even so I spent around $15,000.00 for all of the renovations. I received several thousand dollars in tax credits for the upgraded energy efficient systems and the solar heater bringing my cost down to around

$12,000.00. The pay back was slow but if I had lived there for the full 20 year life of my mortgage, I would have save over $30,000.00 when compared to my previous home of less than half the size.

I hope that in reading this you are inspired to make just one change in your daily energy usage and encourage at least one other person to do the same. With just a little time and effort, I was able to cut my energy consumption by nearly 60% not every home will be able to see these kinds of results but if every New Yorker could cut their usage by an average of 10 percent, that's 45,000 acres of land that we won't have to fill up with wind turbines. This doesn't just apply to your home and saving money either. Conserve energy at work and other will start to ask you about it. When they hear of your success and the money you are saving they may be inspired as well. Regardless of what the future holds for New York's energy supply, if we all make a small change to conserve, together we can make a big difference.

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