# The Prospects of Wind and Petroleum Co-Generated Power

**An Alternative Green Renewable Energy Solution**

**By**

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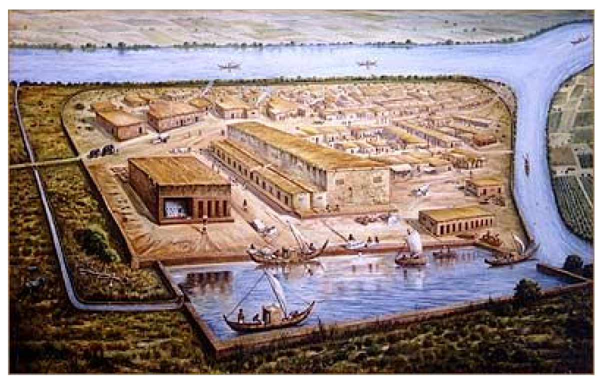
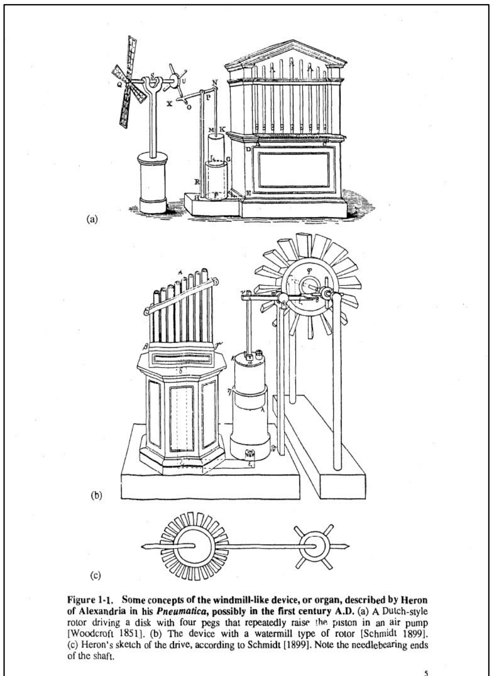
## Introduction and History

This paper will address the potential of cogeneration of power using wind and petroleum powered generation technologies. Although the sample system explored herein is a small scale wind system, the benefits highlighted readily scale to apply to large commercial systems as well. We will start out exploring some of the earliest known history of wind power and petroleum usage. Moving on we will look at how petroleum exploration is be reborn based on the modern proven theory of abiogenic production of petroleum in the earth's mantle creating a virtually unlimited supply. We will explore the data on greenhouse gasses to see that petroleum generation of electrical power has an almost totally insignificant impact on global warming. And, finally we will explore the specification and design of an effective and inexpensive small scale co-generation system that will power an average home and can easily be installed by competent do it yourselfer. So let's get started.


Harappan Civilization 7000 – 2000 BCE

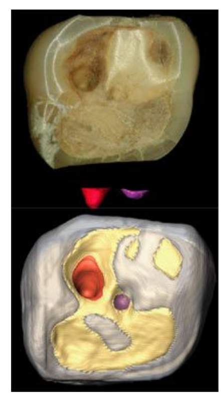


An artist's impression of the ancient city of Mehrgarh based on archeological evidence and ancient descriptions.




Wind device from the 1st Century AD.

Close to 9000 years ago (7000 BCE) a group of people know has the Harappan began to settle an area in the northwestern Indian in the area of modern Pakistan and Afghanistan known as the Indus Valley. Here in the area of Mehrgarh an ancient civilization began, was to spread it control over a vast area and was to establish trade with ancient Sumerian and other Mesopotamian civilizations. It was from these people that we learn of one of the first direct uses of wind power in the form of sophisticated windmills to produce products. The use of wind power can easily be expected from a civilization that had mastered the art of dentistry by being able to drill teeth with flint drills and apply crowns, as was discovered by Dr. A. Coppa and collogues in 2001 and reported in the Journal nature in April 2006.[1] . According to Dr. Walter Fairservis, of the Anthropology Department of the American museum of Natural History in New York, the Harappan people cultivated and processed many crops familiar to us such as cotton and rice, they domesticated the chicken and either invented or adapted the game of chess and one of the two of the great early sources of technology the windmill. Windmills can be used for grinding grain, pumping water, and other labor-intensive tasks. Today just like the people of the Indus Valley over 9000 years ago we are looking to the wind to power our civilization.



Teeth drilled by Harappan dentist 9000 years ago.

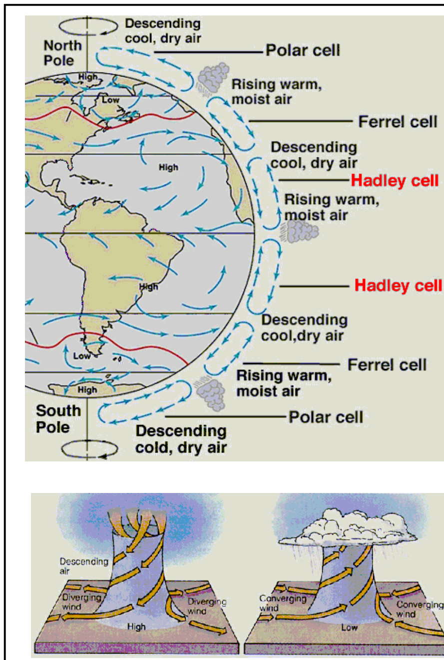
Persian wind of the type used before 1000 BCE. Courtesy of Flinders University, Australia, http://www.es.flinders.edu.au/~mattom/science+society/l e ctures/illustrations/lecture13/windmills.html

Petroleum our major source of energy today is has been in use by man since before 5000 BCE. Recent discoveries in Hacinebi in southeast Turkey show

The Magan a replica of an ancient reed boat that was use to ship petroleum products from Oman to India. A Joint Hadd Project sponsored by the University of Pennsylvania Museum Asian Section and Centre National de la Recherche Scientifique in Paris.

that even before the arrival of Mesopotamians the inland people of southeastern turkey had developed long distant trade relations as evidenced by the discoveries of traded goods such as copper, shell and chlorite. Thus the find of a river boat used to transport petroleum products further confirms the extent of man's dependency on petroleum for fuel and other products since before 3800 BCE. Similarly recent finds in Kuwait of ocean-going reed boats confirm that ocean going trade in the Persian Gulf of petroleum products dates even earlier to at least 5000 BCE.

Man has been using petroleum product to make his life easier for thousands of years. In China for example crude oil was refined to make lamp oil and home heating oil more then two thousand years ago[2]. Further the use of natural gas for heating and lighting dates back to at least 200 BCE when natural gas is recorded as being in China for these purposes. With the exception of producing electricity and modern plastics man has been using petroleum products the way we do today in modern times for thousands of years.




The Sun produces our wind power. Images courtesy of University of Oregon Department of Physics.

Wind and Oil mankind's workhorses can they continue to sustain us in the 21st century if used together? We know that as long as the sun continues to shine that the wind will continue to blow, powering everything from the smallest sail boats, to the largest mega-watt wind turbines. The questions that arise in the planning for our co-generation mix of wind and petroleum resources is; can we sustain the use of petroleum products over the long haul and how much does the use of petroleum effect our environment?

## The Origins of Petroleum

Contrary to popular belief it has been long been established by hard science that petroleum is not a fossil fuel but rather it is continually being produced in the earths mantle and seeping up ward. This author first became aware of the modern theory of Abiogenic (not formed by living organisms) formation of oil while studying geophysics at Harvard University in the early 1980's. At that time it had long been established in reputable scientific circles that oil was a renewable energy source as it was continually being produced in the earth's mantle. As early as the nineteenth century Russian chemist Dmitri Mendeleev and French chemist Marcellin Berthelot demonstrated that petroleum was produced deep in the earth's crust by a process referred to as genesis of petroleum hydrocarbons[3]. What does this mean? Basically this crude oil is a hydrogen-carbon (H-C) system that is exists in nature in nonequalibrium states, in other words per the laws of thermodynamics it has a very high chemical potential. This is because it is produced by the combined forces of high temperature and high pressure acting on the hydro-carbon bonds reducing the molecules from a more stable natural state to that of natural petroleum which has a high chemical potential, i.e. it release a lot of stored energy when burned. Laboratory experimentation has proven that hydrocarbon compounds (crude oil) are produced at depths of 100 miles or more in the earths mantle. When abiotic $CaC0_3$ and FeO solids, soaked with triple-distilled water (removes organic contaminates), absent any biotic molecules are subjected to pressures of 50kbar and temperatures of approaching 1,500°C the whole set of petroleum fluids are obtained. Included in this set of petroleum compounds is methane, ethane, propane, butane, pentane, hexane, branched isomers of those compounds, and the lightest of the n-alkene series.

> *Therefore, the theoretical results must be considered as the determination of minimum boundary conditions for the genesis of hydrocarbons. In short, the genesis of natural petroleum must occur at depths not less than 100 km, well into the mantle of the Earth. The experimental observations reported in section 5 confirm theoretical predictions of section 4, and demonstrate how, under high pressures, hydrogen combines with available carbon to produce heavy hydrocarbon compounds in the geochemical environment of the depths of the Earth (J. F. Kenney)[4].*

**Amount of Carbon (organic mass) required to the World's Produce Oil Supply by Fossil Fuel Theory**
**Assumes 100% of all organic carbon has bee consumed in the process.**
**Does not include Coal and other alleged "Fossil Fuels"**

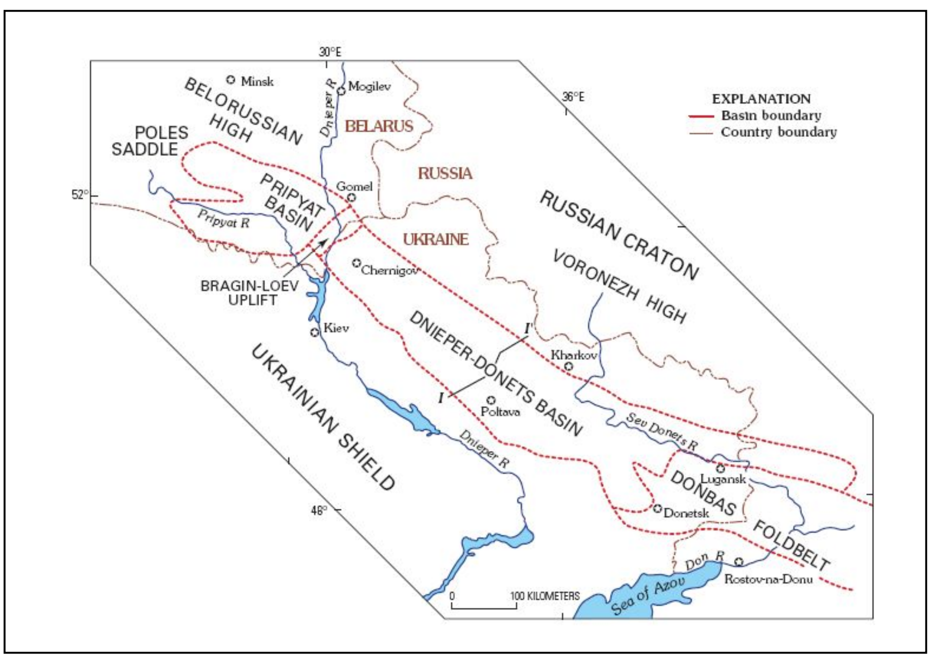
| | | | | | |
|---|---|---|---|---|---|
| Pounds of Biomass per gallon of oil | 150,000 | lbs | Gallons per Barrel | 45 | |
| Current Yearly Oil Consumption in gallons | 1,125,000,000,000 | gal | Oil Consumption to date in gallons | 45,000,000,000,000 | gal |
| Organic material to produce this year of oil | 168,750,000,000,000,000 | lbs | Estimated Reserves in gallons | 81,000,000,000,000 | gal |
| Total Mass of Earth's Crust Organic and Inorganic Crust = 16 Miles Deep on Average | 44,454,559,491,760,700 | lbs | Total Oil Produced by biological decay | 126,000,000,000,000 | gal |
| Carbon makes up about .27% of crustal mass | 4,556,250,000,000,000 | lbs | | | |
| Organic Carbon makes up about .1/5 of crustal carbon | 911,250,000,000,000 | lbs | Organic material to produce oil consumed to date | 6,750,000,000,000,000,000 | lbs |
| Deficit of Total Crustal Plant Mass per year | 167,838,750,000,000,000 | lbs | Organic material to produce all known oil | 18,900,000,000,000,000,000 | lbs |
| **Assumes 100% of all organic carbon has been consumed in the process (no organic carbon left for life forms).** | | | | | |
| Years required to produce this years oil supplies if all carbon available in the crust is consumed | 185 | yrs | Years required to produce all oil supplies if all carbon available in the crust is consumed | 20,741 | yrs |
| **Assumes 25% of all organic carbon has been consumed in the process (no organic carbon left for life forms).** | | | | | |
| Years required to produce this years oil supplies if all carbon available in the crust is consumed | 741 | yrs | Years required to produce all oil supplies if all carbon available in the crust is consumed | 82,963 | yrs |
| **Assumes 10% of all organic carbon has been consumed in the process (no organic carbon left for life forms).** | | | | | |
| Years required to produce this years oil supplies if all carbon available in the crust is consumed | 1,852 | yrs | Years required to produce all oil supplies if all carbon available in the crust is consumed | 207,407 | yrs |

Approximate amounts of organic carbon and carbon containing mass necessary, to have produced the current known amounts of Petroleum by the biological theory of Hydrocarbons production. Robert L. Straitt, December 2007

## Renewable Petroleum

If petroleum is a renewable resource as is demonstrated by theory and experimental evidence, then we should be able to find evidence of the proofs of this theory in successful oil exploration based on the techniques postulated. As it turns out just such evidence is available in oil fields around the world. The White Tiger oil field just of the coast of Vietnam is a mega-field. This reservoir is located in granite rock without any sedimentary rock formations that could account for the oil by Biogenic process. Only Abiogenic process can accurately account for this geologic formation. Likewise in oil fields on the border of Georgia and Azerbaijan, oil has been being pumped for more then 100 years. Beginning in the late 1890s the first oil well began producing and did so unit the 1950s when the field, after producing a 100 mm tons of crude was considered dried up. Today the wells in the field are filled again with oil. Locals are drawing crude oil from the old wells in hand buckets and ecologist fear a potential disaster for the city of Gronzy the capital for Chechnya if the oil continues to spill out of the ground the city could become flooded with oil.

Another example of proof of the validity of the abiogenic process is the Dnieper-Donets Basin in the Ukraine. This region had been thoroughly surveyed and the data analyzed in light of the biogenic hypothesis of hydrocarbon formation at shallow depths in the crust. As a result of the 45 years of extensive study, this area has been "condemned as possessing no potential for petroleum production;"[5] based on the hypothesis is of biogenic hydrocarbon production. Beginning in 1991 however a new survey of this area was commissioned by the Russian and Ukrainian governments based on the principals of the modern Russian-Ukrainian Abiogenic Theory that had been successfully locating large commercially viable oil fields in other parts of the former Soviet Union. Within the first five years of this modern survey 37 out 57 (57% ) of the deep wells began producing oil of superior quality and quantity. The wells of the Dnieper-Donets Basin were producing between 40-350 metric tons of oil per day and 100,000-1,600,000 cubic meters per day of gas. While industry averages were running at of 1 out of 28 wells that produce oil (3.5%) for drill sites selected, in the absence of seismic data actually showing oil pools, according to the biogenic hypothesis. Further analysis of the oil revealed that there were no biological marker molecules or porphyrin molecules, which are often misconstrued as evidence of biological origin, even at the ppm level. In 1951 Russia was an oil poor nation looking for cheap abundant supplies of oil. Western geologist and petrologist had been looking for supplies in Russia for more the 45 years and had found few. Today,



Russia is the larges producer and exporter of crude oil in the world, surpassing even Saudi Arabia in 2004, because of reliance on the abiogenic theory. With many new field already located and waiting to be tapped Russia will be supplying the world's oil for centuries to come, even at today's high rates of consumption.

## Global Warming and Petroleum

Assuming that the modern scientific theory of the petroleum is accurate, and petroleum is a renewable energy resource compatible with wind. Can be reasonably asked if cogeneration of electrical power by wind and petroleum based generation techniques can find an economically and ecologically profitable place in our society? However, can wind and petroleum based cogeneration really be ecologically sound? What of global warming and greenhouse gasses? Lets take a quick look at the some of numbers and see what effect petroleum has on the big picture. Based on the numbers indicated below, total "fossil" fuel consumption release about 25.5 billion metric tons of $CO_2$ into the atmosphere yearly. Yet that is only about 10% of the total $CO_2$ emissions shown and these numbers don't include many other natural sources such as

| Source | Daily | Yearly | Units |
|---|---|---|---|
| Human Breathing | 1.50 | 540 | kg of CO2 |
| Population of Humans | 6,600,000,000 | | |
| World Population Breathing | 9,900,000,000 | 3,564,000,000,000 | kg of Co2 |
| | | | |
| Humans | | 3,564,000,000 | metric tons CO2 |
| Animals | estimated at 10 times human rate | 35,640,000,000 | metric tons CO2 |
| Other bio emissions such decay of organic material in the forest etc | | 199,580,642,800 | metric tons CO2 |
| West Pasific Outgassing | | 5,669,904,625 | metric tons CO2 |
| Total Natural | | 244,454,547,425 | metric tons CO2 |
| | | | |
| "Fossil" Fuel Combustion | | 25,674,000,000 | metric tons CO2 |

volcanoes, Atlantic Ocean out-gassing, etc. Some of which are on an exponential rise geologist are warning us. But for our cogeneration scenario we only need to look at let say about ½ of the total for all the so-called fossil fuels used to generate electricity, which would be about 12.8 billion metric tons of CO2 a year or about 5% or less of all the CO2 released in to the atmosphere yearly. Now if we assume that ½ of all electrical use petroleum then we well be looking at 6.4 billion tons of CO2. If we can replace say 50% of that number with wind power then we are talking about less CO2 being released into the atmosphere be petroleum/wind cogeneration of electricity then the amount of CO2 released by humans just breathing[6]. Except for the current high cost of petroleum this hybrid solution looks like a winner all the way around. Relatively clean use of petroleum and clean free wind power. So with all this going for it, hold your breath while we look at some of the systems.

**Hybrid Petroleum and Wind Systems for Residential Uses**

As we learned in the introduction to this paper, wind and petroleum have a long history of being used together to achieve a technological objective. From the early days of wind powered sail boats with petroleum coated hulls that where used to ship petroleum products long distance to today's modern electrical grids with massive petroleum powered generators at their anchor with standing armies of wind turbines generating megawatts of power in support of them. But what we want to look at now is how these to sources of power can be harnessed at the local level; let's say to power your home. For the sake of argument let us equate the grid to a petroleum component of our hybrid system, such that power supplied by the grid would be considered the same as power supplied by say a stand alone diesel powered generator. When one considers that a significant portion of all grid supplied power is produced by petroleum then this becomes a palatable argument. Now in our back yard we can create a hybrid system that is powered by the wind and backed up by a source of petroleum produced power.

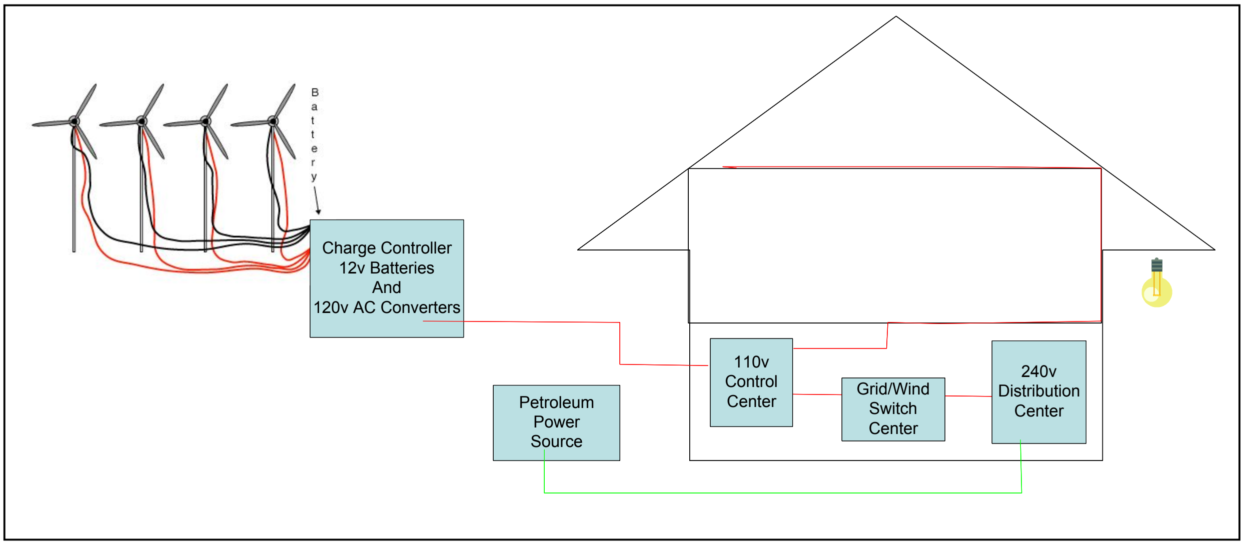
First we must determine what our need for power is. Depending on how we do the analysis the cost of our system can range from a few thousand dollars to several tens of thousands of dollars. Because many backyard installations be they just outside of town or on a mountain top are done by do-it-yourselfers then let us assume that cost is at the for front of this project. Most likely the cost of electricity is what is driving the project to begin with. With this in mind I would recommend a system that is scaleable, that is it can start off now providing a limited amount of power and then be scaled up to provide more power by basically adding plug and play components. This gives you the feeling of accomplishment now by allowing you to rollover any cost savings into future upgrades. Looking at the below chart you can see how our system requirements were defined. For the purposes of this example we determined that we would continue to power energy hungry appliances from the petroleum generation side of our system during phase one. From the chart below we can see that our house will be using in the neighborhood of about 40 kW if everything is running at the same time and based on a say 20% duty cycle we could say that the total average kWh requirement would be about 40k x .3 = 12kWh per day or for our wind designated portion of the system we take 19k x .5 = 9.5 kWh. I am using a high duty cycle for the wind segment because these loads are used more each day.

| Load | Voltage | Current (amps) | Power (watts) | Circuit | |
|---|---|---|---|---|---|
| Dryer | 240 | 23.0 | 5,520 | Grid | |
| Stove/oven | 240 | 30.0 | 7,200 | Grid | |
| Washer | 110 | 15.0 | 1,650 | Grid | |
| Hot Water Heater | 240 | 30.0 | 7,200 | Grid | |
| | | | Grid Total | | 12,720 |
| Coffee pot | 110 | 14.5 | 1,600 | wind | |
| Electric Heat 5 rooms@2000w | 110 | 90.9 | 10,000 | wind | |
| Refrigerator | 110 | 7.0 | 770 | wind | |
| Hair dryer | 110 | 13.6 | 1,500 | wind | |
| Lights 15 100w equiv. | 110 | 13.6 | 1,500 | wind | |
| Misc | 110 | 30.0 | 3,300 | wind | |
| | | | Wind Total | | 18,670 |
| | | | Grand Total | | 40,240 |

Sample of a simple load analysis.

Looking at your electric bill would give you a more accurate estimate of your personal usage but for our purposes we can work with a demand of about 10 kWh per day. Let's say that the maximum load on our system at any given time would be about 80% or 15kW and this is what we must design our wind power supply to meet. Now because we have a petroleum powered generator source we can draw energy from that system if needed to meet excessive demands. At a high level the system would be represented by the diagram below.

The problem for us then is to find the most economical way to produce about 10kWh of electricity a day and meet a peek demand of about 15kW. One way would be to buy a pre-specified system, but as we are some good ole do it yourselfers we are going to build the system

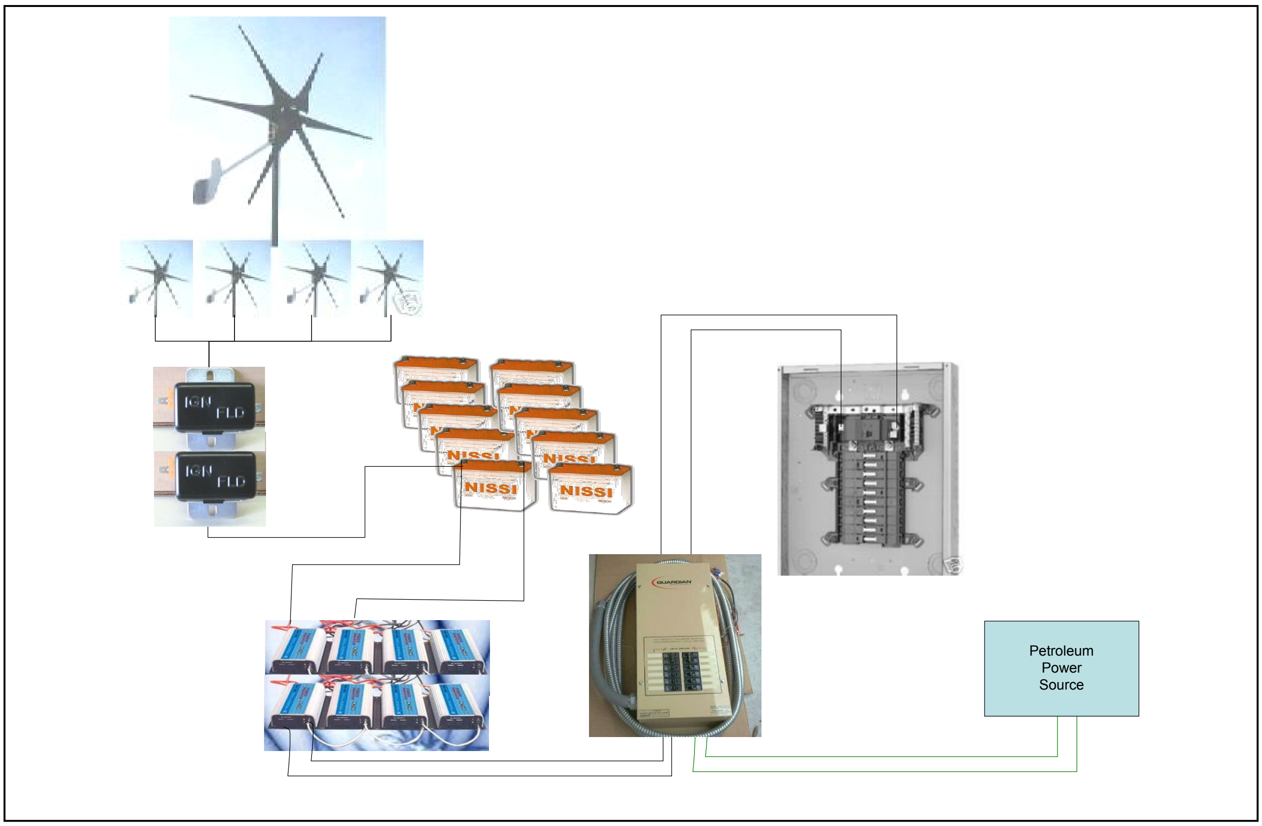



from off the shelf components ourselves. Now our system calls for batteries to supply our peek needs and calm wind needs, as we want to try to maximize our wind power while minimizing our reliance on the Petroleum Power Source. To do this we need a simple system schematic and a list of materials as shown below.

**Hybrid Wind System Parts List**

| Part | Supplier | # Require | Cost Each | Extended C |
|---|---|---|---|---|
| Batteries 800 Amp Hour 2 batt. = 1 hr of power 10 batt. = 5 hrs of power | Wal-Mart | 10 | $75.00 | $750 |
| Wind Turbine Farm 4 SC120 turbines by Hornet Power Systems | eBay seller - qaz661 | 1 | $1,000.00 | $1,000 |
| 2000 Watt stackable power inverters | eBay seller - powerkingshop(10611) | 8 | $189.00 | $1,512 |
| 12 VDC regulator CHRYSLER / DODGE / PLYMOUTH 60-69 VOLTAGE REGULATOR | eBay seller - elpasodiscountautoparts | 2 | $6.50 | $13 |
| Automatic Line/Generator Transfer Switch Model 04969 | eBay seller -bklynboy88 | 1 | $279.00 | $279 |
| 100 Amp Distribution Box with breakers | Menards | 1 | $100.00 | $100 |
| Misc, wiring, pipe, cement, and parts | Menards | 1 | $700.00 | $700 |
| | | | Total | $4,354 |

This project is based on the assumptions of using off the shelf, easily available, components wherever possible and to keep cost down. Another aspect of this system is that it should be scalable, that is we can add to generation, storage, or distribution capabilities by adding on additional components or substituting existing components for large compactly components into the existing configuration. As shown in the list of parts this project should cost under $5000. Reliability of the system is improved by having multiple components networked together to meet capacity demands, because this configuration also provides a level of redundancy and multi-pathing. The only single point failure point is the automatic switch that switches between wind and petroleum based power.




1. Beginning with the wind generators, 4 Hornet Power Systems SC120 turbines are utilized to provide up to 4000 watts of power or 48 kWh per day at maximum capacity. Even operating at 20% capacity they should produce about 9.6 kWh per day, which is within 5% or our estimated demand of 10 kWh per day. Should one unit fail then 3 others can continue to provide power to the system at a reduce rate until repairs can be made. These smaller turbines are considerably more economical then a turbine with a similar power rating and

require less construction related cost to erect. Although the manufacturer is advertising the benefits of being able to mount them on a 29-foot tower, they could easily be mounted twice or 3 times as high to take advantage of the increase quantity and quality of the wind resources at those heights, without breaking the budget. Towers are made of 2 - 3 inch galvanized iron pipe or 3 - 4 inch galvanized steel tube depending on height. Guy wires are required for all installations except for the minimum height configuration with the tower anchored into a cement foundation.

2. Voltage control for the generators is provided by a pair of mechanical low voltage regulators mounted close to the battery array, for easy servicing. Because the system is using a battery array operating at 12 volts, simple inexpensive voltage regulators that are found in automotive charging systems can be used to regulate the voltage. The regulators are wired in parallel to each other for redundancy and then wired in a parallel configuration to each of the 4 turbines. These regulators will cut out the power to the fields of the generators once the batteries reach the preset voltage of approximately 12-13 volts. Note: As many manufactures are going to self-regulating 12 VDC turbines this component of the system would be omitted if such a turbine is used. The use of mechanical voltage regulators instead of solid state is a reliability issue. Solid-state regulators are more susceptible to power surges that could be associated with atmospheric discharges. Mechanical regulators can withstand surges caused by near hit atmospheric discharges that can be associated with small generators sitting on top of a 30 to 90 foot pole. Mechanical regulators can also be calibrated or fine tuned to optimize voltage in the system.

3. The battery array is composed initially of 10 batteries rated at 800 amp hours each, arrayed in a parallel configuration. This should provide 8000 amp hours of power or about 3 to 4 hours of power form the invertors operating a peak capacity of 16000 watts. As it is assumed that peak demand will rarely if ever be seen as the system configured then this batter array should provide sufficient power for short periods (several hours) of low or no wind conditions.

4. Connected to the batteries is an array of eight 2000-watt stackable power invertors, configured in parallel, providing up 16000 watts of continuance power and up to 20000 watts of peak (spike) power. The invertors specified for this system are designed to be able to automatically match phase with each other so they can be directly hardwired in parallel to a

single distribution center. Again the reason for an array of smaller inverters is two-fold; 1 is system reliability, with multiple inverters if one goes down the system continues to provide electricity to the distribution center albeit at reduced power levels, 2 is costs it is considerably cheaper to buy 8 2000 watt inverters then it is to buy one 16000 watt inverter. Although the spec sheet on the Internet for these inverters did not address this issue, some stackable inverters are able to directly connect to the utility grid. This type of inverter has circuitry included that matches voltage in phase with the grid power. If this option were available and utilized then net metering would be obtainable if desired. The inverter automatically shut down when battery voltage drops below a preset minimum. Although it isn't specified in this system configuration, if net metering was desired a surge protector and an isolation transformer between the inverters and the grid would significantly reduce the risk of spikes from the grid damaging the inverters and/or turbines. For the system discussed here net metering was not a desired option so these components were not priced.

5. The automated transfer switch specified for this system is rated at 100 amps and matches the distribution center specified. This switch will automatically switch between the petroleum based power supply and the wind power. Although the manufacture designed the system to auto-switch to back-up power if grid power should fail. The system can be configured in reverse so that the primary power side is connected to the invertors. If the invertors shut down because battery voltage drops below a preset minimum then the switch will transfer the load to the petroleum based power source. If an actual petroleum generator is used then the switch has the capability to engage the starting mechanism and start the generator if needed.

6. The load distribution center is a standard distribution box with standard breakers that can be purchased at any electrical supply center. The number of breakers required is dependent on the house-wiring configuration.

7. Petroleum based power source for this cogeneration project can be privately owned diesel or gas powered generator installed on site. Because in many locals a significant portion of the available grid power available is produced by petroleum powered generation facilities a grid connection in principle equates to wind and petroleum cogeneration and can be used instead of a locally installed diesel or gas generator.

## Conclusions

We have explored the early history of wind and petroleum as it has influence mankind from more then 8000 years ago. It was interesting to see that wind was used to power machines and for transportation technologies that were needed to transport petroleum products for a variety of uses, just as we do today with our giant super tankers. We have evaluated the impact of petroleum based generation on the environment and found that it accounts for what can be considered an insignificant amount of emissions of green house gases when compared against natural sources of CO2 emissions. Even when combined with other forms of so called fossil fuel powered generation the total amounts of CO2 emissions fall so far below the know natural sources as to be considered statistically insignificant in the big picture. We have seen that the modern theory of abiogenic oil formation and its application in the identification of vast virtually unlimited amounts of crude oil and natural gases has rendered the old world hypothesis of "fossil" bases oil formation obsolete and useless. The combination of lower then previously thought detrimental impacts greenhouse effect and what is a virtual endless supply makes petroleum based generation a perfect co-generation partner for wind powered systems. And we have seen that it is possible for do it yourselfer to design and install a simple and reliable wind generation system based on easy to find, inexpensive components.

What we have discussed is the social/economic impacts of a sustained movement to install a significant capacity of wind and petroleum co-generation systems. The increased reliance on wind power, both large commercial generation and small private systems is already having an effect on the supply and demand ration for tightly controlled petroleum reserves. With the continued introduction of alternative power systems for transportation, such as hybrid cars, hydrogen fuel cell cars, and electric cars wind energy will have a continually increasing impact on breaking the strangle hold oil producing powers have on the everyday people and their pocket books. In addition the increased introduction of small scale wind systems will not only free many household from total reliance on centrally generated power for all their household needs but supply a power source to charge their electric vehicles or produce alternative fuels such as hydrogen right at home.

From the commercial wind production standpoint, small-scale wind systems provide two significant benefits. First they produce a solid grass roots movement within communities for support of wind power in general, which can have a significant positive political effect on the approval of large commercial wind farms. Owners of small-scale systems are hooked on wind and will fight to see it grow in all sectors. Secondly small scale systems help reduce grid load where it is needed most. Residential power is much cheaper then the same power being supplied to commercial and industrial customers. The cost trade-offs of building new generation facilities versus cutting residential demand in order to supply high profit commercial/industrial demand are an enormous plus for all commercial producers. When you can get that power to the higher paying customers for less overhead costs everyone profits. Most small wind systems are installed in rural areas where delivery costs of energy is much higher per kilowatt hour and the total demand is only a fraction of the urban demand where the user density makes delivery cost per user much lower.

In closing this author feels that wind and petroleum will continue to be partners in serving mankind's energy needs for many years to come just as they did more then 8 millennia ago. The benefits of combining these to energy resource in both small scale and commercial generation scenarios will continue to manifest themselves in new and more intriguing cogeneration scenarios on the grid and in our back yards.

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