# The False Promise of Renewable Energy

**A reality check on renewable's displacing fossil fuels.**

**(Includes section on cellulosic ethanol.)**

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# The False Promise of Renewable Energy!

## Executive Summary:

### Introduction

This paper examines the generation of electricity in the United States and whether renewable energy sources can reduce the use of fossil fuels. It also looks at liquid fuels; primarily whether ethanol can replace gasoline.

Invariably the issue is framed as energy independence or, more accurately, independence from foreign oil.

Since very little oil is used to generate electricity, the only way to achieve independence from foreign oil is to replace gasoline with an alternative fuel. Today, the only known technology that can replace all of America's gasoline usage is hydrogen. Renewable sources such as wind, solar and geothermal have no effect on America's independence from foreign oil; though this is often inferred in commercials and by the media.

The implied promise of renewable energy is that it can displace fossil fuels for generating electricity in the United States. This assertion is fallacious.

The assertion that renewables can allow America to achieve independence from foreign oil is **a false promise**: Renewables can not result in energy independence.

The question of whether ethanol, a renewable energy source, can displace gasoline is discussed beginning on page 12.

### Renewables for Generating Electricity

The hype says there is enough wind power, biomass, solar and geothermal to meet our energy needs, many times over. Extremists tout renewable energy sources every time there is an energy issue they oppose.

The facts belie the assertion that renewable sources can meet our needs for electricity. Extremists are doing our country a terrible disservice by misleading the public.

Renewable energy sources will have an almost inconsequential effect on generating electricity between now and 2020, and probably a negligible effect for at least fifty years after that.

It is time for Americans to recognize this fact.

Any energy policy that relies on renewables to displace fossil fuels is a prescription for disaster.

A quick summary of the prospects for renewable power generation in the United States by 2020 are as follows:

- Wind power can make a very small contribution, at a substantial cost to consumers.
- Hydropower could displace some fossil fuels but will not, because of licensing delays and restrictions.
- Geothermal is too small to make a difference, but may be worth limited further development, with R&D focused on "Hot Dry Rock" technology.
- Photovoltaic solar serves a niche, but without an unforeseen scientific breakthrough, will be nothing more than a novelty for the foreseeable future. Concentrating Solar Technologies have potential
- Biomass for generating electricity, other than in small quantities, is not credible. Biomass feedstock would be better utilized making ethanol (see page 12).

If economic costs alone were used to evaluate renewable energy sources for power generation, there is no question that all of the renewables, except for hydro and possibly wind power, would be rejected out of hand.

Fossil fuels will continue to be the primary source for electric power generation for at least the next twenty years, unless changes in public sentiment permit the construction of new nuclear plants. Nuclear provides emission free and inexpensive power.[1] Public acceptance of nuclear energy could alter some of the conclusions reached in this paper.

Other policy initiatives currently being used or considered that should **not** be built into a national energy policy include "Net Power"[2] and "Renewable Portfolio Standards (RPS)". There are serious drawbacks to current proposals that require 10% of US power to come from renewables (excluding existing hydro power) by 2020. This RPS proposal does not differentiate between renewables that have some potential for displacing fossil fuels and those with little or no potential.

In addition, **Table I raises serious questions about whether the proposed federal RPS legislation is workable. The optimistic forecast in Table I puts renewables in 2020 at 3.4% rather than 10% (excluding Hydro) of total KWHrs generated[3].**

Table I demonstrates that renewable energy sources will continue to make a negligible contribution to US electric power generation.

**Conclusions at the end of this paper contain detailed assessments of renewable energy.**

| Type plant | Current installed capacity in MW | Current percentage of US generating capacity | **Optimistic forecast** percentage of US generating capacity in 2020 (Note: Essentially reflects production except for Hydro.) |
|---|---|---|---|
| Wind Power | 4,261 MW | 0.3 % (a) | 2.0% (a) |
| Hydro Power | 99,478 MW (b) | 12.3% | 8.7% |
| Geothermal Power | 2,800 MW | 0.3% | 0.5% |
| Solar Power | | 0.1% (d) | 0.1% |
| Biomass Power | 7,000 MW (c) | 0.9% | 0.8 (e) |

a. Reflects estimated output. Wind power only operates, on average, at 33% of rated capacity due to variation in wind speeds. The **estimate for 2020 far exceeds the DOE IEA** forecast of 0.1 % for wind energy in 2020
b. The capacity factor for Hydro, where plants operate at less than capacity due to variations in water flow (especially in recent years due to drought conditions) will result in fewer KWHrs of output.
c. Predominantly at long standing pulp and paper mills using scrap wood.
d. Energy Information Administration estimates, based on consumption.
e. Assumes that available biomass feedstock will be used to produce cellulosic ethanol. Pulp and paper mill generation of electricity will fall as a percentage of total electricity output.

**TABLE I**

# The False Promise of Renewable Energy!

## Introduction for Power Generation.

Two numbers are basic to any discussion on electric power generation and consumption. America used 3.4 Trillion Kilowatt Hours of electricity in 2000. It will use an additional 1.4 Trillion KWHrs of electricity in 2020. Except for hydro, less than 2% of the usage in 2000 came from renewable energy sources.

There are two basic questions.

- Can renewable energy replace enough of today's electric power to appreciably reduce our dependence on fossil fuels (primarily coal and natural gas)?
- Or, incrementally, can renewable energy significantly reduce the amount of fossil fuels required for generating the additional 1.4 Trillion KWHrs power needed by 2020?

The answer to the first question is no.

The answer to the second question is, a little: It depends largely on whether Hydro is set free from restrictive licensing requirements, which is not likely.

Any shifting of the locus of power generation away from population centers will further overload an overloaded and unbalanced transmission system. It is frequently said that the plains states (Montana, Nebraska etc.) could be the center of the wind power industry, but there is insufficient transmission line capacity to accommodate such a strategy. At least one wind power proposal has been tabled due to the lack of transmission line capacity.

Any national policy involving energy must strengthen and improve the transmission system. Transmission of electricity should be an integral part of any national energy policy not only due to current inadequacy of transmission lines but because transmitting electricity long distances results in losses, known as I squared R losses that turn power into heat that is dissipated in the air. Ideally, generating facilities should be located relatively close to the areas they serve.

The use of "Net Power' may be a short term expedient to encourage the development of variable power supplies such as photovoltaic or wind power but should not be built into any national or local energy policy.

"Net Power" can allow the owner of a photovoltaic or wind power system to sell excess power to the local utility at the same price the homeowner pays the utility, in effect reversing the direction of the electric meter when the home owner is using less power than is being generated. While government subsidies are paid from tax revenues, the cost of "Net Power" is born by all other customers on a utility's system. The utility is, in effect, paying an inflated cost for power that it could generate at a far lower cost. This inflated cost is passed on to other customers. So long as there are only a few people taking advantage of "Net Power" the increased cost to other consumers is minimal; But "Net Power" can become a consumer rip-off[4].

Some states base "Net Power" payments on the utility's "avoided costs" rather than retail price. This method more accurately reflects true economic value, but people using wind or solar object because payments to them are much lower: They complain that lower payments from "Net Power" discourage them from installing wind power or photovoltaic systems in their homes...Tacit admission that solar and wind are uneconomic

## Wind Power

Wind power holds some promise but is not a panacea for replacing conventional power generation in the United States. The hype says there is enough wind energy available to meet all of our 3.4 Trillion KWHrs of electricity needs. Though theoretically true, the reality of converting wind energy into electricity is an overwhelming task.

The development of wind powered generators has come a long way in the past twenty years. In 1980, the typical unit was rated 26KW with a rotor diameter of 32 feet. The typical unit used today is rated at 600 KW. The latest units are rated 2000 KW and have rotor diameters of 230 feet. Larger units are under development.

It would take 266,256 wind turbines rated 2000KW; or, over 600,000 wind turbines of the kind generally used today in the US to generate all the additional 1.4 Trillion KWHrs of power needed in 2020. In

(Wind Power Continued)

other words, an area the size of Vermont, New Hampshire, Massachusetts, Connecticut and Rhode Island combined (nearly all the New England states) would have to be devoted to wind towers rated 2000 KW; or, an even larger area would be required for the over 600,000 smaller units needed to provide all the additional 1.4 Trillion KWHrs required in 2020[5].

This is the theoretical area required for these wind turbines. Empirical data now shows that the amount of power actually produced in existing wind farms is 5kw per acre. Using 5kw per acre results in an area of 48,000 square miles being required for 266,256 wind turbines.

**Note this only supplies the incremental power needed in 2020 and has no effect on the 3.4 Trillion KWHrs currently consumed in the US.**

If actually built, these units would be in various parts of the country where wind speeds are conducive to generating wind power. Wind speed is fundamental to the design of wind power installations, where power is the cube of wind speed. Wind speeds are higher a few hundred feet above the ground so taller towers produce more power.

The best areas in the United Sates tend to be along the down wind side of the Rocky Mountains, in the plains states, and in a few isolated areas along the North East and North West coasts. (See Appendix for map of US wind resources.) These areas tend to be remote from population centers where electricity is used so that concentrating several hundred thousand wind turbines in these areas would vastly over load transmission line capacity.

There are two major problems with wind power. First, the cost effective units are large and obtrusive. Wind powered generators are mounted on towers that are often 400 feet tall. Towers such as these can harm the attractiveness of rural areas, especially those that rely on the tourism industry. A group has objected to a wind farm off Cape Cod for this reason; and the area off Cape Cod is one of the best areas to locate wind turbines in the US.

The second problem relates to how extensively wind power can be used to replace power from conventional means. Denmark has indicated that it will generate 40% of its power from wind by 2020 using extensive offshore wind farms installed in shallow waters. This is impressive but somewhat misleading where the United State is concerned. (Denmark is slightly smaller than the combined areas of Vermont and New Hampshire and has a population of 5.3 million which is approximately equal to that of Cook County IL.)

The largest number of wind turbines ever installed in the US in a single year was 1000. Compare this with the number required to merely supply the incremental load in 2020 together with the area required and it becomes clear that wind power cannot supply the incremental power needed in 2020: Let alone affect the use of fossil fuels for the 3.4 Trillion KWHrs currently consumed.

The economics of wind power are also unfavorable: The cost of wind power is generally 2 cents per KWHr higher than fossil generated electricity[6].

Wind power is a variable source of power. It is assumed here that the technical problems[7] involving variable power supplies can be resolved.

Consider what would happen when the wind exceeds the speed at which these units operate, especially when located in the same general area such as off the cost of Virginia or Cape Cod. These units would abruptly stop generating power which would severely disrupt the power grid. (They keep rotating but drop off the line.)

This shows why spinning reserves[8] are required to make up for sudden changes in power supplied by wind turbines (or any other variable power source) which adds costs that are not usually considered when calculating the cost of wind power[9].

Of all the renewables, other than Hydro, wind power produces the least costly electricity. It is hypothetically possible for wind power to provide as much as 2% of America's electricity needs in 2020. Achieving this target requires adding between 1000 and 3000 wind turbines every year between now and 2020. This is an aggressive agenda that exceeds the largest number of wind turbines ever installed in the US in a single year[10].

Achieving 2% is also costly in that, at a premium cost of 2 cents per KWHr over fossil fuels, consumers will pay $1.9 Billion more annually for this electricity than for electricity generated with fossil

(Wind Power Continued)

fuels[11]. This **hidden tax on consumers** has the greatest effect on those who can least afford it.

## Hydro Power

Hydro contributes about 10% of the United States' electric generating capacity[12]. It could contribute more except for the licensing process that has hamstrung hydropower. According to the Department of Energy, hydro could contribute an additional 29,780 MW or nearly one third more hydro generating capacity than is currently in place[13].

The possibility of 29,780 MW of added generating capacity would be exciting if it were not for the ponderous and time consuming federal licensing process. This process typically takes 8 to 10 years and can take longer, which would probably be the case where new dams are required.

Even more disheartening is that over half of current hydro generating capacity is scheduled to be relicensed by 2017. Past relicensing has resulted in a steady reduction of hydropower and there is no reason to believe that future relicensing will not result in further reductions; DOE says as much.

The above data for new capacity does not include pumped storage. Pumped storage uses off-peak power to store energy, like a battery, by pumping water uphill from a river to a reservoir. The stored water is released through hydro generators when power is required. It generally consumes more power than it produces. Pumped storage has been highly controversial and there are few prospects for any new pumped storage installations in the US.

While hydro could play an important role in reducing the need for additional fossil fueled power plants to provide the incremental power required in 2020, there is little prospect that this will happen. DOE in fact states "almost no new hydropower capacity is predicted through 2020[14]".

## Geothermal Power

Approximately 20 geothermal plants in the United States can generate 2,800 MW of electricity or .3% (three tenths of one percent) of total US power generation capacity. Geothermal resources currently identified in the United States could provide a total of 20,000 MW of capacity which is equal to 2.5% of total electric generating capacity in the US.

In addition to the existing 2,800 MW of installed capacity, there are 285 MW currently under construction with the potential for another 1,000 MW over the next ten years. Areas being explored for commercial viability could add some additional capacity by 2020. Realistically, US geothermal generating capacity in 2020 could reach 5,000 MW

Supporters of geothermal power say that undiscovered resources could produce five times the current capacity. It may be worth exploring for such resources, but unless they are found very quickly, they will have little impact on providing electricity before 2020.

"Hot dry rock" is a more futuristic proposal where fluids are pumped deep into the earth to create steam from the very hot rocks located well below the earth's surface. In 2003, an Australian company completed drilling its first well to a depth of 14,405 feet to reach hot rock having a temperature of 560 degrees F. A second well is now being drilled. This is a pioneering effort at hot dry rock geothermal electricity production in Australia.

Geothermal electricity is generated using three methods.

- Direct Steam

  Direct steam uses high temperature steam as it emerges from the earth to drive a turbine generator. These are the most cost effective plants but sites with steam are rare.

- Flash Steam

  Flash steam systems inject high temperature brine (above 400 °F) from the earth into a low-pressure chamber where the brine flashes directly into steam; where the steam drives the turbine generator.

(Geothermal Power Continued)

- Binary cycle

  The binary cycle method passes moderate temperature brine (below 400 °F) through a heat exchanger where its heat is transferred to another fluid which vaporizes; where the vaporized fluid drives the turbine generator.

Moderate temperature brine is the most common geothermal resource so Binary cycle plants will be the most common.

The cost of producing geothermal electricity is between 5 and 8 cents per KWHr (versus 2.3 to 3 cents for fossil fuel generated electricity). It will be difficult to lower this cost significantly since these installations use established technologies (heat exchangers, turbines and electric generators) in traditional ways. Drilling and exploration represents 24% to 50% of the cost so new drilling technologies may help slightly lower the cost of new plants.

The amount of energy available from a geothermal source gradually declines, though reinjection of fluids can help preserve the fluid volume of the reservoir and the reservoir should outlive the useful life of the equipment.

**Other Geothermal Possibilities.**

Other uses of geothermal heat do not generate electricity but can help reduce the need for electricity. They are mentioned here solely to ensure complete coverage.

Geothermal Heat Pumps. These systems use shallow ground energy to heat and cool buildings.

The upper 10 feet of the Earth's surface maintains a nearly constant temperature of 50 to 60 °F. A geothermal heat pump system consists of pipes buried in the ground near a building, connected to a heat exchanger and ductwork in the building. In winter, heat from the relatively warmer ground goes through the heat exchanger into the house. In summer, hot air from the house is pulled through the heat exchanger into the relatively cooler ground.

Direct-Use Piped Hot Water. Hot water taken directly from hot springs can be used to heat buildings, melt ice and grow plants.

## Solar Power

Solar currently supplies less than .1% (one tenth of one percent) of US power requirements with little prospect of supplying more than .1% in the near future.

To grasp the small likelihood of widespread use of solar power over the next twenty years, it is necessary to examine each of the solar power technologies. Broadly speaking, they are either used for local (home or commercial buildings) or centralized generation of electricity.

Local (i.e. home) generation of electricity uses photovoltaic cells that convert sunlight into electricity where cells are typically located on rooftops. Solar energy is also used in thermal and passive systems for heating water and buildings.[15] Thermal and passive can reduce the need for generating electricity but their effect in this regard is negligible.[16]

Centralized technologies use Concentrating Solar Power techniques. The three centralized systems currently under development are:

- Parabolic troughs
- Power towers
- Dish-engine

**Photovoltaic Power in the United States.**

The cost of a photovoltaic power supply for a residential house is between $10,000 and $40,000, depending on the amount of power required by the owner. The average household usage of electricity in the US[17] in 2000 was 11,400 KWHrs, which includes urban apartments etc. A typical single family home could expect somewhat lower usage unless the home is heated by electricity. Individual homeowners can determine their usage from their electric bills.

The amount of electricity produced by a system depends on the amount of sunlight and its intensity. Insolation is the measure of sunlight intensity in KWHr/Meter$^2$ . (See Appendix for map of Insolation levels in US.) A 600 square foot, roof mounted solar panel in Baltimore might generate 3650 KWHrs of power during a year[18] while a similar system in Arizona might produce more than twice this much power. Costs therefore will vary widely depending on location. Generally speaking, the cost of photovoltaic electricity[19] is between $.20 and $1.00 per KWHr versus the average price for electricity[20] of $.08 per KWHr.

There are government subsidies that vary by

(Solar Power Continued)

state that are intended to help foster the use of photovoltaic solar. In addition, some states permit "Net Power". "Net Power" can permit the owner of a photovoltaic system to sell excess power to the local utility at the same price the homeowner pays the utility, in effect reversing the direction of the electric meter when the home owner is using less power than is being generated by the photovoltaic system.

Even with subsidies and "Net Power", the economics of photovoltaic power are nearly always unattractive (with negative cash flows) and precludes widespread use of photovoltaic solar power.

So called second and third generation photo voltaic processes (e.g., plastic sheet) are still less efficient than silicon cells, though they may possibly be more cost effective.

**Concentrating Solar Power Technologies:**
These technologies use mirrors to concentrate sunlight to up to 5000 times its normal intensity.

<u>Parabolic trough</u> systems use linear parabolic concentrators to focus sunlight on a receiver tube filled with a heat-transfer oil. The heated oil passes through a heat exchanger to create steam, which turns a turbine generator…similar in this respect to traditional power generation.

<u>Power towers</u> use sun-tracking mirrors, called heliostats that focus the sunlight onto a receiver mounted on top of a tower. The solar heat is collected in a nitrate-salt fluid that is used to generate steam (as above) using a conventional turbine generator to produce electricity. The salt solution can store the heat energy for a period of time so that the turbine generator can be run after sunlight is no longer available.

Both the parabolic trough and power tower systems can be operated as hybrid systems using natural gas when sunlight is not available. Both are intended for use as large scale units rated 30 MW or above.

<u>Dish engine</u> systems use a parabolic dish with mirrors to focus the sunlight onto a receiver mounted on the dish (similar to a radar dish). Fluid in the receiver is heated to around 1,400 degrees F, which is used to generate electricity in a small engine connected to the receiver. The most common type of heat engine used in this system is the Stirling engine. The primary advantage of the dish-engine system is that it is relatively small, rated 10 to 50 KW, and can possibly be grouped as modules to form a large system.

All three of these CSP technologies (parabolic trough, power tower and dish-engine) are still under development. There are nine parabolic trough systems with a combined rating of 354 MW that have operated successfully in California. There is a power tower system under test in Southern California. Several prototype dish-engine systems have been built but do not have sufficient operating experience to indicate they are beyond the experimental stage.

Theoretically, a 100 MW power tower could be built on less than 1000 acres (approximately 1.5 square miles) of vacant land in the Southwest. Conceivably, 843 power towers operating at 65% capacity factor situated on 1270 square miles of desert could provide 10% of US electricity needs in 2020. (See Appendix for photographs.)

However, this technology is still in the developmental stage with many questions still to be answered, not the least of which is cost. Electricity produced by these three systems currently costs from over 11 cents /KWHr to 18 cents /KWHr, which is 4 to 7 times more costly than conventionally generated electricity; projected costs for 2020 remain over 4 cents per KWHr.

The DOE forecasts[21] that none of these technologies will be competitive with conventional power generation until well past 2020. A review by A. D. Little indicates there is no compelling reason to believe that the current cost of \$200 - \$250 /$M^2$ for the concentrator optics (the single most important cost elements for these systems) can be reduced by 50% (let alone the 75% reduction that seems to be necessary to make these systems competitive).

Concentrating Solar Power technologies are in the developmental stage. A few additional developmental systems may be built between now and 2020. In spite of their theoretical ability to supply large blocks of power, **power towers, or any concentrating solar power technology, will have little if any effect on our use of fossil fuels before 2020; and possibly long after that. They have enough potential however to warrant continued research and development.**

## Biomass for Electric Power

The rhetoric surrounding biomass creates confusion because biomass can be a resource for both liquid fuels and power generation. Liquid fuels include ethanol and high-cetane diesel. The rhetoric also fails to distinguish between the plants (feedstock) that support liquid fuels and those used for power generation. For example[22], corn is used to produce ethanol and soy-beans are used to produce high-cetane diesel, while a variety of fast growing trees and grasses and waste, such as wood chips and sawdust, are used as feedstock for power generation. Corn and soybeans are already cultivated as crops for food and the additional use for liquid fuels is accommodated without having to develop new crop technologies. (See page 12 for liquid fuels.)

The various trees and grasses used for power generation are not currently cultivated as crops and require development of entirely new crop disciplines that are only in the experimental stage. With the development of cellulosic ethanol these crops would be better used to produce ethanol rather than electricity. (See page 12)

Plants being studied by the Department of Energy for use as feedstock[23] for power generation include, switchgrass, hybrid poplars and willows. Today, most electricity derived from biomass uses wood waste primarily from pulp mills with an installed capacity of 7,000 MW[24] or less than 1% of total generating capacity in the US.

Three methods are used to generate electricity from biomass. They are direct burn, co-firing, and gasification.

<u>Direct burn</u> is the simplest method and is used in generating plants at pulp mills where waste wood products are chopped into the desired consistency for effective combustion and burned in boilers generating steam that powers the turbine generators.

<u>Co-firing</u> is the method that could result in near term increases in using biomass for power generation. Co-firing is where biomass materials are mixed with coal in the boiler's furnace. Between 5% and 15% biomass (by heat content) may be used at an additional cost[25] estimated at less than ½ cent per KWhr. There is also the possibility of reducing NOx emissions by co-firing with biomass or by using biomass as a re-burn fuel (injected above the primary combustion zone in the furnace). Co-firing and re-burn are still in the experimental stage.

<u>Gasification</u> converts solid biomass materials into gasses, much the same way that coal gas was generated from coal early in the twentieth century. The gas is then used as a replacement for natural gas in gas turbines to generate electricity. Potentially these gasses could be used in fuel cells. Gasification is still an experimental process.

An inherent disadvantage of using biomass for power generation is that the source of the biomass must be close to the power plant or the cost of transportation becomes untenable. Generally, the biomass source must be within 100 miles of the power plant. In addition, costs are inherently higher with small power plants while distances mitigate against large power plants using biomass feedstock's.

One rule of thumb is that it requires 1000 acres of poplar trees to supply a power plant with a generating capacity of 1 MW. If a 25 MW plant using biomass operates with an 80% capacity factor, it produces 175 million KWhrs of electricity per year[26]. It would require 194 such plants to produce only 1% of current US electricity usage in the US.

Extrapolating this data demonstrates that **it is not feasible for biomass to displace fossil fuels** for power generation in any significant manner. For example, it would require planting poplar trees in an area covering 301,000 square miles in order to supply enough electricity to just meet the increased electricity consumption forecast for 2020: And does not do anything to reduce current fossil fuel usage. To place this in perspective, 301,000 square miles is an area that covers every state from Maine through South Carolina…In other words, an area equal to nearly all the East Coast would have to be devoted to growing poplar trees to merely meet the increase in electricity usage in 2020.

DOE currently projects that 30,000 MW of biomass generating capacity will be installed by 2020 which is less than 4% of total installed current generating capacity. **Given that nearly every facet of biomass power generation is still in the experimental stage and that this forecast requires the construction of 1200, 25MW power plants, this forecast does not seem plausible.**

(Biomass Power Continued)

In addition, the forecasted cost for gassifier/gasturbine combined cycle power ranges from 4 cents to 7 cents per KWHr, compared to the coast of fossil generated power of 2.3 - 3 cents per KWHr. (Gassifier/gasturbine combined cycle should be the most economic method for producing power from biomass.)

All of the facts would indicate that generating electricity from biomass is a bad idea. It is costly and cannot have a meaningful impact on reducing our country's dependency on fossil fuels or on reducing harmful emissions such as NOx, sulfur or mercury.

Anaerobic digester systems that use animal waste to produce methane gas, where the methane gas is used as fuel for gas turbines to generate electricity, are better defined as a pollution control method with an economic by-product that happens to be the generation of electricity. If successful, such systems can help prevent animal waste from Animal Feeding Operations from polluting rivers, streams and lakes: And generate electricity on a small scale[27].

The prospect of growing switchgrass, poplar and willow trees as crops has held forth the prospect of a renewed agricultural industry. One organization predicts that 260,000 jobs will be created to supply biomass for 30,000 MW of capacity and states, "Rural economic development is one of the major benefits of biomass." Positioning biomass as an agricultural issue could create increased political pressure for developing biomass power generation.

## Renewable Portfolio Standards.

There is a proposal to adopt an RPS that requires each retail electric supplier for years 2005 through 2020 to provide a specified amount of electricity from renewable energy sources. Several states have already adopted RPS legislation[28].

Renewable Portfolio Standards are really a new "tax" on electric customers. The cost of generating electricity from renewable sources is almost always greater than from traditional sources. This increased cost will be passed on to consumers. The fines shown in Table II would also be passed along to consumers in their electric bills.

The proposal mandates a penalty of up to 3 cents per KWHr for not meeting the mandated targets. Table II shows the penalty that could be levied against retail electric suppliers in 2020 if the nation falls short of the 10% target but reaches the indicated target instead.

RPS will result in a huge wealth transfer from areas short on renewable resources to areas naturally endowed with resources such as wind. In an effort to meet their RPS requirements, utilities in poorly endowed areas will buy expensive green power from producers where renewable resources are available and pass this cost on to their customers.

| Targeted % | Potential fines (a) |
|---|---|
| 10% | $0 |
| 9% | $1.4 Billion |
| 8% | $2.9 Billion |
| 7% | $4.3 Billion |
| 6% | $5.8 Billion |
| 5% | $7.2 Billion |

(a) Maximum fine is "3 cents per KWHr or 200% of average value of credits" (where a credit is essentially equal to a KWHr).

**Table II**

## Liquid Fuels

Ethanol is the major liquid fuel that has been developed from renewable materials, almost entirely corn. Beginning in the 1970's congress established subsidies for the development of ethanol from corn. Today there are 78 plants producing ethanol from corn with 10 more planned. Over 3 billion gallons of ethanol from corn is expected to be produced in 2004.

Ethanol added to gasoline as an oxygenator increases performance and helps reduce pollution. The program has been controversial due to taxpayer subsidies and the concern that converting food to a gasoline additive is unethical. Approximately 10% of the corn crop is used in making ethanol.

The United States uses around 100 billion gallons of gasoline annually and ethanol has made a contribution, all be it very small, towards reducing America's dependence on foreign oil. The program has also been a boon to farmers.

**Cellulosic Ethanol**

A new technology has been developed that converts cellulosic materials to ethanol, referred to as cellulosic ethanol. This uses the cornstalks rather than the corn to produce ethanol. The ethanol itself is the same as produced from corn. The new process can also use other cellulosic materials such as switchgrass, poplar and willow trees to make ethanol.

This new process may evolve to the point where it doesn't require taxpayer subsidies and where market forces can take over in the production of ethanol: the new process being a profitable way to dispose of corn stalks and with the growing of switchgrass being a profitable venture for farmers.

In spite of their potential, liquid fuels are still not able to replace sufficient gasoline to make America independent of foreign oil: It is for this reason that promises by environmentalists that America can become independent of foreign oil by using ethanol are false promises.

Cellulosic ethanol does hold considerable promise in at least reducing the need for foreign oil.

There are approximately 250 million dry tons of corn stover (i.e., corn stalks) grown annually of which 100 million dry tons would be available for turning into ethanol. The other 150 dry tons are required by the farmer for soil erosion needs and other uses.

The new process uses enzymes to convert the cellulose into sugars and has been proven in a

**E10 and E85 gasoline.**.

E-10 refers to fuel that contains 10% ethanol and 90% gasoline.

E-85 refers to fuel that contains 85% ethanol and 15% gasoline.

All car manufacturers in North America warrantee the use of E-10 gasoline. It is too impractical and costly to retrofit gasoline fueled vehicles to E-85 vehicles. Since the combustion of ethanol and gasoline is different, different engine electronic systems are required, and need to be installed at the time of manufacture.

**Flexible Fuel Vehicles (FFV's)**

These are vehicles that can run on either regular gasoline or E-85 fuel. There is one fuel tank on a FFV, and the driver can fill-it-up as they would with a regular vehicle. An on-board computer monitors the fuel mixtures and automatically adjusts the spark timing and fuel flow to the engine.

(Cellulosic Ethanol Continued)

demonstration installation making a million gallons a year. A commercial plant is now under construction in Canada that will be able to produce 45 million gallons of ethanol a year. The plant requires approximately 600,000 dry tons of feedstocks to produce the 45 million gallons of gasoline.

The commercial plant being built in Canada has approximately the same capacity as the average of the 78 plants currently in operation in the U.S. making ethanol from corn.

Based on the commercial plant being built in Canada the following outcomes could be possible.

- Theoretically the 100 million dry tons of cornstalks available in the U.S. could produce 7.4 billion gallons of gasoline; or roughly 7.6% of the gasoline used annually in the U.S.
- If all 29 million of acres of land not currently being farmed were used to grow switchgrass, poplar and willow trees, approximately 132 million dry tons of switchgrass etc. could be grown. Theoretically this could produce 9.8 billion gallons of gasoline; or 10.1% of the gasoline currently used annually in the U.S.

Producing 17.2 billion gallons of gasoline from corn stalks, switchgrass etc. would require building 384 plants of the type being built in Canada.

The limiting factor therefore is the availability of feedstock (and the financing to build the plants).

Using all 100 million dry tons of cornstalks, essentially all that is available, and getting all 29 million acres of unused land producing 132 million dry tons of switchgrass, etc. is problematic at best: And even if all 232 million dry tons of feedstock was available, it would supply less than 18% of the gasoline currently consumed in the U.S., ignoring the increased gasoline usage from population growth.

Cellulosic ethanol is very promising, but it can not eliminate America's dependence on foreign oil. Again it is a false promise to say that renewables can eliminate America's dependence on foreign oil.

# The False Promise of Renewable Energy!

## Conclusions

If costs were the sole criteria on which to base an energy policy, renewables would not even be considered. National security and the need for developing an energy supply less dependent on foreign oil would suggest that government policy should support the development of **a few selected** renewable energy sources.

Any energy policy must recognize that renewables such as wind and solar do nothing to make America less dependent on foreign oil. The reason for this is that only a very small amount of electricity is generated using oil: all the rest of America's electricity is generated using, coal, natural gas, hydro and nuclear.

The only way to make America independent of foreign oil is to replace gasoline with another fuel. Today, only hydrogen has the potential for replacing all of America's usage of gasoline.

Cellulosic ethanol has the potential to reduce the amount of gasoline used by Americans.

1. **Renewables cannot displace a significant amount of fossil generated electricity**, **and except for Cellulosic ethanol have no effect on reducing America's dependence on foreign oil.** (Generally speaking international organizations agree with this assessment worldwide.[29])
2. **Wind power can augment in a small way, but not replace conventionally generated electric power.** It must be recognized that **the consumer will pay a substantial premium** for wind power generated electricity if it receives subsidies. The equipment is sufficiently proven that no additional support for R&D is appropriate.
3. Hydropower deserves support but is hamstrung by licensing requirements and is therefore limited in its potential for displacing fossil fuels. If licensing requirements were eased substantially, Hydro could offset an additional 3.5% of fossil fuel based electricity generation. However, we will lose more power from relicensing unless technologies are developed to retain capacity.
4. Limited support should be given to the implementation of Geothermal power, recognizing that it is costly (two to three times more costly than fossil fuels) with little prospect of significantly reducing these costs, and, at most, can only offset 2.5% of fossil fuel generating capacity. "Hot Dry Rock" geothermal is a futuristic technology with the potential to displace substantial amounts of fossil generated electricity and therefore deserves some continued funding for R & D. "Hot Dry Rock" is a high risk investment with large payoff if successful.
5. Photovoltaic solar is a niche source and cannot offset significant amounts of fossil generated electricity and therefore **should not receive support**. Private companies are developing photovoltaic for niche opportunities. Concentrating Solar Power technologies, though still experimental, have the potential to displace large amounts of fossil generated electricity and deserve support for R&D.
6. Biomass for electricity is very costly: It is also not practical on a scale that would displace significant amounts of fossil generated electricity. Biomass for power generation **should not receive** any additional regulatory or financial support.
7. Cellulosic ethanol should receive regulatory and financial support so as to accelerate the adoption of the technology on a wide commercial scale. These supports should only be in place long enough to kick start the development of these facilities. Market forces should be allowed to become dominant within a few years.
8. Renewable Portfolio Standards should not be established.
9. "Net Power" should not be required as a component of any energy policy, especially if it requires repurchase at rates above the utilities avoided costs.

Table III is a summary of these conclusions.

| Technology | Should support* for implementation be continued? (a) | Should Support* for R&D be continued? |
|---|---|---|
| Wind Power | No | No |
| Hydropower | Yes (Improve relicensing and ease environmental restrictions.) | Yes (For retaining or improving capacity) |
| Geothermal Power | Yes (Limited to take advantage of known sources) | Yes (Solely for Hot Dry Rock... Other geothermal have little prospect of being cost effective.) |
| Photovoltaic Solar | No | No |
| Concentrating Solar Power | No | Yes (For the construction of an intermediate sized [30 to 50 MW] plant.) |
| Biomass Electric Power | No | No |
| Cellulosic Ethanol (b) | Yes | Yes |

a) The only possible reason for supporting renewables to generate electricity is to reduce $CO_2$ emissions; however, to date, scientific evidence indicates that $CO_2$ has little if any effect on global warming.

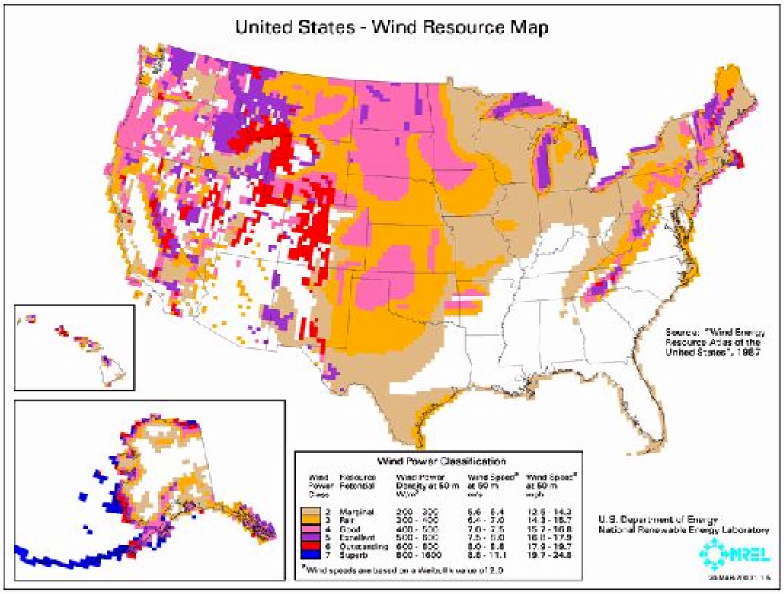
**b) This is the only renewable that can reduce America's dependence on foreign oil.**

∗ Government support in the form of tax relief, subsidies or regulatory relief.

**Table III**

# The False Promise of Renewable Energy!

## APPENDIX




**Wind Power in U.S.**

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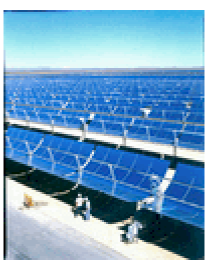
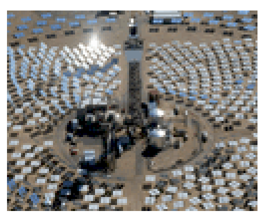
**Concentrating Solar Power Technologies**





**Parabolic Trough** **Power Tower** **Dish Engine**

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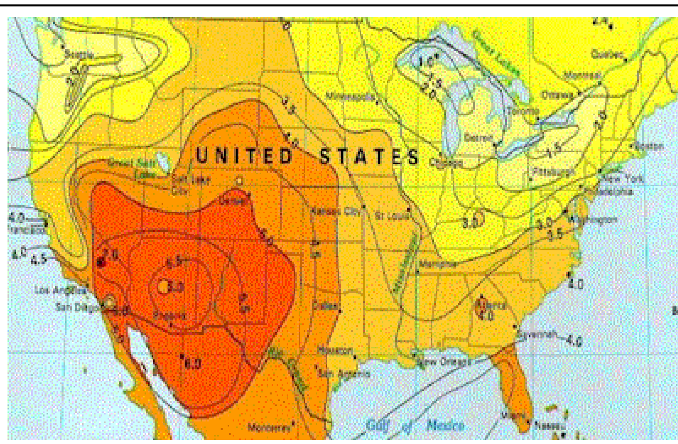


**Insolation Levels for U.S in December**

## NOTES

1. Nuclear's average production cost in 2001 was $1.76 per KWHr which was lower than coal's, which was $1.79 per KWHr. *Source, Nuclear Energy Institute, Vision 2020.*
2. "Net Power" (also called "Net Metering") has currently been adopted in various configurations by 39 states. Provisions vary from state to state as to the renewable energy sources covered by the program, whether investor owned or rural cooperatives are covered, the size of the generation facility covered (e.g., 10kw up to 1 mw) and whether it is monthly or annual metering. Some states require "Net Metering" using retail rates others require rates set at the utilities avoided cost. Some states limit participation to homeowners others allow commercial entities to participate. Most states currently cap the amount of "Net Power" that a utility must buy back. Detailed information can be found on www.eren.doe.gov/greenpower/netmetering.
3. The proposals for RPS are based on production and not on capacity. Table I forecasts, though based on capacity, are surrogates for the amounts produced by each source except for Hydro and Geothermal. In the case of Hydropower a capacity factor (as noted in the table) is hard to arrive at due to fluctuations in water flows so the amount shown for Hydropower overstates the amount of electricity that will be produced. Hydropower is essentially excluded from RPS proposals. Adjusting Geothermal for capacity factors that vary by system would have little affect on the forecast.

   The forecast in Table I is an optimistic forecast based on an aggressive installation of new renewable energy sources. (Municipal solid waste was not included in Table I for the reasons noted in the body of the report.) EIA's Reference Case forecast for 2020 assumes .64% for geothermal; 1.18% for wood; wood waste and Biomass; .63 for municipal solid wastes, including landfill gas; .02% for solar thermal; .03% for solar photovoltaic; .44% for wind. Total 2.95% (up from 2.13% in 2000).
4. "Net Power" can become a consumer rip-off when large users take advantage of "Net Power" at retail rates. Recently a large corporation in California installed solar and earned $300,000 using "Net Power" at retail rates. Obviously, the utility cannot absorb large credits such as this and will have to raise its rates to offset its higher costs if the practice were to grow: The net result of "Net Power" is that other consumers pay more thereby subsidizing the large user (corporate or government). Or, if many wealthy consumers install solar (or other variable power supply) and receive payments at retail rates for power they generate but do not use, the remaining consumers who cannot afford to install solar will end up paying higher rates.
5. Units should be spaced at distances equal to five to seven times the rotor diameter. Capacity factors range from .20 to .35 with .33 found to be the average in Denmark. This information was the basis for calculating the amount of area required for any specific number of wind turbines. *Source The Danish Wind Energy Association*.
6. When comparing costs published in the media, it is important to determine whether the cost cited for wind power has already added the current 1.8 cent per KW hour government subsidy (Production Tax Credit) to the actual cost.
7. Harmonics, Reactive Power, Voltage Regulation and Frequency Control have all been problems. Some have required utilities to incur additional costs while others have raised the cost of wind power investments. They represent continuing and increasingly complex problems as variable power supplies, such as wind power and solar power, become a higher percentage of any utilities total production.
8. Spinning reserves are turbine generators that are kept in operation but disconnected to the load i.e., transmission/distribution system. Steam is used to keep the turbines running which consumes energy with its associated cost. If additional load comes on line or if power generated by variable sources suddenly diminishes the spinning reserves can be quickly brought on line.

(Notes Continued)

9. See *"Total Costs of Electricity from Wind Power"* by Schleede, found at www.tsaugust.org
10. The American Wind Energy Association predicts that wind power can provide 6% of US electricity needs in 2020, or three times the amount predicted in this paper. The largest number of units ever installed in the US was 1000 in 2001 (rated 1694 MW). This number was inflated somewhat when units were rushed to completion before the expiration of the Production Tax Credit on December 31, 2001 AWEA's prediction appears highly over stated, especially when one considers that current worldwide capacity for manufacturing wind turbines is approximately 7,000 MW. Achieving the AWEA goal requires an average of 5,000 MW to be installed in the US each year, or over 70% of current worldwide capacity. Since less than 5,000 MW will be installed in the early years, the out years leading to 2020 will require an impossible amount of increased manufacturing capacity.
11. The 2 cent per KWHr premium assumes that the cost of fossil fuels does not increase and that the cost of wind power generated electricity does not decrease. It also does not include the Production Tax Credit that is currently 1.8 cents per KWHr granted to the owners of wind turbines that is born ultimately by taxpayers.
12. Total US generating capacity in 2001 according to Energy Information Administration was 811,625 Megawatts, of which hydro accounted for 91,590 (utility) and 7,478 (non utility ) for a total of 99,478 Megawatts of capacity. This is slightly less than the 103.8 GW claimed by the National Hydropower Association.
13. Installed hydropower capacity in the United States is 99,428 Megawatts.

    According to river basin analyses, there are nearly 70,000 Megawatts (MW) of potential hydropower generation in the U.S. when only engineering and economic factors are considered. After screening for environmental, legal and institutional factors at potential sites, the Department of Energy determined that it would be possible to increase hydropower capacity in the US by 29,780 MW, which is about 3 ½ % of total US generating capacity in 2001. Of this amount, there are 2,527 existing dams in the US without generating capabilities where an additional 16,998 MW of generating capacity could be installed. There are 389 existing hydropower installations where it is possible to install 4,316 MW of additional capacity. And finally, there are 2,761 locations where no dams are installed but where there is the potential for 8,466 MW of new generating capacity.
14. DOE Hydropower Annual Report for FY 2001 issued April 2002.
15. With photovoltaic systems, sunlight is converted directly to DC electricity. With thermal, heat from the sun is trapped in a liquid system where the liquid (usually water) can be pumped through heat exchangers or can be used directly, such as in a hot water heater. Passive solar uses the heat from the sun to warm stones, bricks or other heat sink materials within a building and where the trapped heat is given off, through radiation, during hours when there is no sun. Thermal and passive, can reduce the need for generating power but their effect in this regard is negligible.
16. Thermal is only viable in Southern areas of the US and has not met with much success because of its cost and inherent reliability problems. Passive is very costly and tends to be an architectural novelty.
17. Year 2000 residential sale of electricity = 1,193,380 million KWHrs. Number of US Households in 2000 was 104,700,000 (US Census Bureau). Average annual usage per household varies widely across the United States. In 1999 California had an average annual usage of approximately 7200 KWHrs, Illinois had an average annual usage of around 9600 KWHrs, while Florida had an average annual usage of around 13,800 KWHrs.
18. From BP web site.

(Notes Continued)

19. BP, one of the leaders in solar power development, asserts that the cost of solar photovoltaic power is between $5 & $30 per watt.
20. Average price of electricity to a residential consumer is $.08 per KWHr (US Statistical Abstract 2001)
21. DOE/EPRI Technology Characterization, Appendix B to Arthur D. Little Review May 2001.
22. Other plants, in addition to corn and soybeans, can be used to produce liquid fuels.
23. Theoretically anything that burns, such as corn husks, alfalfa stalks and sorghum, can be used to generate electricity. The plants selected by the DOE have favorable environmental qualities, are fast growing and have a relatively high amount of heat given their weight and volume.
24. There is an additional 2,500 MW of municipal solid waste-fired capacity that is usually not counted as biomass power because it tends to generate potentially hazardous emissions not found in pure biomass feedstocks.
25. Source, DOE.
26. ibid
27. It has been estimated that anaerobic digester systems could theoretically generate 4000 MW of electricity, which is equal to 0.5% (one half a percent) of currently installed US generating capacity. Such systems are expected to be relatively small, rated at 10 MW; with, for example, waste from 1200 cows having the potential to generate 1 MW of electricity.
28. The required annual Calendar Year percentages of electricity generated from renewable energy sources required by the proposal are as follows.

    2005 – 06, 1.0%

    2007 – 08, 2.2%

    2009 – 10, 3.4%

    2011 – 12, 4.6%

    2013 – 14, 5.8%

    2015 – 16, 7.0%

    2017 – 18, 8.5%

    2019 – 20, 10.0%

29. The International Energy Agency in its *World Energy outlook 2000, Paris France* noted that non-hydro renewable energy sources accounted for 2% of OECD electricity generation in 1997 and that this share is projected to reach 4% (Reference Scenario) to 10% (Alternate Scenario) by the year 2020. As quoted from the Nuclear Energy Agency, OECD, “the IEA concluded that, in general, electricity generation from renewables will remain a relatively expensive option, but that it could be cost effective in some niche markets”.

    The World Energy Council *(Energy for Tomorrow’s World – Acting Now! WEC Statement 2000, London UK 2000)* pointed to the high cost of renewable energy systems, including biomass, solar, and wind, as a barrier to their deployment on a large scale: And that, although their costs have been dropping in recent years, they will not be broadly competitive for many years.