WIND POWER

FOR ENERGY RELIANCE

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Informing America, One Vote at a Time

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ABSTRACT

This paper will specifically discuss the extent to which the USA relies on external petroleum imports and how this dependency could be alleviated in an environmentally friendly and economically stable way by replacing petroleum based electricity generation with wind power alternatives. This principle could pave the way to a brighter future regardless of your stance on Global Warming. All numerical sources were obtained directly from publicly available government reports. The calculations using this data are illustrated in the second appendix.

APPLICATION

Introduction

In the year 2006, The United States generated 22% of its electricity from petroleum products, 20.78% of which was imported. This breaks down to 20% from Natural Gas, 18.78% imported and 2% from imported Crude Oil derivatives. These totals accounts for 813 $Billion\ kWh$ for Total Natural Gas, 763 $Billion\ kW$ for imported Natural Gas and 81.3 $Billion\ kWh$ for imported Crude Oil This translates into 844.3 $Billion\ kWh$ of electricity created using petroleum imports.

Natural Gas

To generate 763 $Billion\ kWh$ of electricity using imported Natural Gas requires 3,177,260,000,000ft^3 of Natural Gas at an electrical conversion rate of 240.26 kWh per 1000 ft^3. At a cost of \$7.11 to convert 1000 ft^3 of Natural Gas to electricity equates to a cost of \$22,590,318,600. This number is then added to the cost of importing this quantity of Natural Gas at a cost of \$6.88 for 1000 ft^3 which calculates to \$21,859,548,800. This result yields a total cost of \$44,449,867,400 to produce 763 $Billion\ kWh$ of electricity using imported Natural Gas.

Crude Oil

To generate the Crude Oil contribution of 81.3 $Billion\ kWh$ of electricity requires 57,448,117 $bbls$ of Crude Oil at an electrical conversion rate of 1415.19 kWh per 1 bbl and accounts for 3.1% of the Crude Oil deficit. To convert 1 bbl of Crude Oil to electricity costs \$58.80 and translates into a cost of \$3,377,949,251 for the deficit amount. This number is then added to the cost of importing this quantity of Crude Oil at a cost of \$59.10 per 1 bbl resulting in an expenditure of \$3,395,183,686. The combination of these calculation yields a total cost of \$6,773,132,936 for producing 81.3 $Billion\ kWh$ of electricity using imported Crude Oil.

Alternative Analysis

At this juncture the final deficit is \$51,223,000,336 a year to import and then generate 20.78% of the US's electrical output. The objective now turns to the possibilities of creating this 20.78% from other greener sources while still remaining economically viable.

Wind Power

A wind turbine manufactured by General Electric can produce 1,500 kW, 2,500 kW and 3,500 kW depending on the model and geographic location of installation at a cost of roughly \$1,680 per kW. It is also estimated that any given windmill will operate at 25% efficiency year round. Using these figures to replace imported Natural Gas' electrical production of 763 $Billion\ kWh$ with Wind Power will cost approximately \$585,196,924,101; while the cost to replace imported Crude Oil's production of 81.3 $Billion\ kWh$ with Wind Power is \$62,324,435,318. The grand total required to establish this enormous Wind Power infrastructure would be \$647,521,359,420. Using the three GE models requires between 179,867,044, 259,008,544 and 431,680,906 turbines. If we also acknowledge the fact that energy can be resold at a rate of approximately $2¢/kWh$-$10¢/kWh$ additional funds can be raised. According to the US Department of Energy the average resale value for wind power is $\$36/MWh$ ($3.6¢/kWh$) and would equate to a resale value of \$32,194,800,000 a year. Based on these figures Wind Power could replace Fossil Fuel imports and recoup capital after 7.93 years if interest rates and inflation are ignored and even faster if they were considered.

Installation of Wind Turbines

The region in which a wind turbine is installed is an important factor to consider in achieving adequate electricity generation; for this section we will use farmland as an estimate because it is often flat and therefore windy as well as easily accessible. In 2002 there were $938.28\ Million\ Acres$ of farm land in the US. Using this information and the requirement for between $179{,}867{,}044$, $259{,}008{,}544$ and $431{,}680{,}906$ turbines to replace the electricity generation power of imported Petroleum leads to a turbine per acre ratio of $.487$, $.292$ and $.203$ respectively for the $1{,}500\ kW$, $2{,}500\ kW$ and $3{,}500\ kW$ models when applied to farmland data. If these same turbine quantities are applied to total land in the USA the numbers then become $.202$, $.121$ and $.084$ respectively for the $1{,}500\ kW$, $2{,}500\ kW$ and $3{,}500\ kW$ models. The kWh need per acre of farmland is $953.127\ kWh$ and the ratio per acre for all land is $395.016\ kWh$ in order to overcome the $844.3\ Billion\ kWh$ produced from petroleum.

CONCLUSION

The information provided in the body of this report clearly shows that replacing petroleum imports with wind power could be an economically viable option capable of alleviating the USA's dependence on foreign petroleum imports for electricity production. This environmentally friendly approach would greatly reduce hazardous emissions released when petroleum is processed; these same emissions disrupt the ozone layer and theoretically contribute to global warming. But despite its excellent economic outlook there exist inherent issues that need to be addressed. The turbine per acre ratios are simply too large to warrant serious consideration for installation on either farmland or for total land in the USA. For this project to become a reality it would require mass adoption by the general public which raises additional concerns. The baseline issue would be the steep initial cost preventing adoption by the working class while fundamentally benefiting the wealthy. A system would have to be devised that would level the playing field for all demographics.

Two main proposals rise to the top. The first would be to force all farmers to install the required number of windmills on their property, the installation and equipment would be paid for by the government, and the government would reap the resale profits of electricity sales. However those resale profits would go directly into the farmer subsidy fund and if a given farmer qualified they would receive financial assistance, similar to the current system, but preferably with larger benefits because they are sacrificing some of their resources, mainly land, to provide energy to the country. If the guidelines for farming assistance are not met, the government would simply be allowed to add that money to the budget. There could be different tiers of commitment for the farmers to choose each with different subsidy options requiring certain threshold turbine per acre ratios to be met.

The second proposal would function in accordance with how the current electricity buy back laws work. If a citizen generates excess electricity the utilities are required to buy it back. In this situation the owner of the windmill would directly reap the profits of the electricity resale, but they would also be required to fund the initial investment. This approach increases the time required for the government to breakeven but would also increase the focus on renewable energy and a stronger long term economic outlook. This plan would require moderation to prevent only the rich from benefitting. There could be a set number of windmills that all citizens were entitled to build or there could be some sort of moving multiplier, similar to the tax code that would place a cap on resale returns. In either case the Department of Energy could regulate the process and have the power to make exceptions where necessary.

If a combination of these two proposals were applied wind power could replace imported petroleum for electricity generation in the USA and create an infrastructure of clean, renewable energy for years to come. The only down side to such a proposal is the lack of analysis on other alternatives such as Solar Power that could potentially provide a greater advantage in cost and viability. To provide an alternative comparison to Wind Power, the next publication will focus on the viability of Solar Power.

APPENDICES

Appendix I: Data

Farming Statistics	
Total Land Area:	2,263.96 Million Acres [2002] (US Department of Agriculture, 2007)
Total Farm Area:	938.28 Million Acres [2002] (US Department of Agriculture, 2007)
Farm Land Percentage:	41.4% [2002] (US Department of Agriculture, 2007)
Number of Farms:	2,089,790 [2006] (US Department of Agriculture, 2007)
Average Farm Size:	441 Acres [2006] (US Department of Agriculture, 2007)

Commodity Usage Statistics	
Oil Production:	15.602 Million bbl/day [2006] (Energy Information Administration, 2007)
Oil Consumption:	20.687 Million bbl/day [2006] (Energy Information Administration, 2007)
Oil Deficit:	5.085 Million bbl/day [2006]
Oil Exports:	1.317 Million bbl/day [2006] (Energy Information Administration, 2007)
Oil Imports:	13.707 Million bbl/day [2006] (Energy Information Administration, 2007)
Strategic Oil Reserve:	21.37 Billion bbl [January 1, 2006] (Central Intelligence Agency, 2007)
Oil Import Cost:	$59.10/bbl, [2006] (Energy Information Association, 2007)
Natural Gas Production:	18,475,826 Million ft^3 [2006] (Energy Information Administration, 2007)
Natural Gas Consumption:	21,653,086 Million ft^3 [2006] (Energy Information Administration, 2007)
Natural Gas Deficit	3,177,260 Million ft^3 [2006]
Natural Gas Exports:	723,958 Million ft^3 [2006] (Energy Information Administration, 2007)
Natural Gas Imports:	4,186,281 Million ft^3 [2006] (Energy Information Administration, 2007)
Natural Gas Import Cost:	$6.88/1000 ft^3 [2006] (Energy Information Administration, 2007)

Electricity Usage Statistics	
Net Electricity Generation:	4,065 Billion KWh [2006] (US Department of Energy, 2007)
Electricity Consumption:	3,717 Billion KWh [2006] (US Department of Energy, 2007)
Coal Plant Generation:	49% [2006] (US Department of Energy, 2007)
Nuclear Generation:	19.4% [2006] (US Department of Energy, 2007)
Natural Gas Generation:	20% [2006] (US Department of Energy, 2007)
Hydroelectricity Generation:	7% [2006] (US Department of Energy, 2007)
Petroleum Generation:	1.6% [2006] (US Department of Energy, 2007)
Other Renewable:	2.4% [2006] (US Department of Energy, 2007)
Other Gases	.4% [2006] (US Department of Energy, 2007)
Other	.3% [2006] (US Department of Energy, 2007)

Energy Usage Statistics	
Oil Gross Heating Value (Diesel):	1708.07 KWh/bbl [2004] (USDA Forest Service, 2004)
Oil Efficiency (Diesel):	83% [2004] (USDA Forest Service, 2004)
Oil Net Heating Value (Diesel):	1415.19 KWh/bbl [2004] (USDA Forest Service, 2004)
Oil Electric Power Cost (Diesel):	$58.80/bbl [2004] (USDA Forest Service, 2004)
Natural Gas Gross Heating Value:	300.325 KWh/1000 ft^3 [2004] (USDA Forest Service, 2004)
Natural Gas Efficiency:	80% [2004] (USDA Forest Service, 2004)
Natural Gas Net Heating Value:	240.26 kWh/1000 ft^3 [2004] (USDA Forest Service, 2004)
Natural Gas Electric Power Cost:	$7.11/1000 ft^3 [2006] (Energy Information Administration, 2007)

Alternative Energy Statistics	
Wind Power Installed Cost:	$1680/kW [2006] (US Department of Energy, 2007)
Wind Power Resell Value:	$36/MWh [2006] (US Department of Energy, 2007)

Appendix II: Calculations

Crude Oil Required to Meet Electrical Generation Need:

$$Crude\ Oil\ Efficiency\ (Crude\ Oil\ \ Need) = \ Crude\ Oil\ Contribution$$
$$\frac{1415.19\ kWH\ @\ 83\%\ Efficiency}{1\ bbl}(Crude\ Oil\ \ Need) = \ 81{,}300{,}000{,}000\ kWh$$
$$Crude\ Oil\ \ Need = 57{,}448{,}117\ bbls$$

Power Generation Need for Natural Gas Total:

$$Total\ Energy\ Used\ in\ USA\ \times Percentage\ of Natural\ Gas\ Used = Natural\ Gas\ Contribution$$
$$4{,}065{,}000{,}000{,}000\ kWh \times 20\% = 813{,}000{,}000{,}000\ kWh$$

Natural Gas Required to Meet Electrical Generation Need:

$$Natural\ Gas\ Efficiency\ (Natural\ Gas\ Need) = \ Natural\ Gas\ Contribution\ of\ Imports$$
$$\frac{240.26\ kWH\ @\ 80\%\ Efficiency}{1000\ ft^3}(Natural\ Gas\ Need) = \ 813{,}000{,}000{,}000\ kWh$$
$$Natural\ Gas\ Need = 3{,}383{,}834{,}179{,}639\ ft^3$$

Power Generation Need for Natural Gas Imports:

$$Total\ Energy\ Used\ in\ USA\ \times Percentage\ of Natural\ Gas\ Used = Natural\ Gas\ Contribution$$
$$4{,}065{,}000{,}000{,}000\ kWh \times \frac{Natural\ Gas\ Deficit}{Natural\ Gas\ Need} = Natural\ Gas\ Contribution$$
$$4{,}065{,}000{,}000{,}000\ kWh \times \frac{3{,}177{,}260{,}000{,}000\ ft^3}{3{,}383{,}834{,}179{,}639\ ft^3} = 763{,}368{,}487{,}600\ kWh$$

Power Generation Need for Crude Oil Imports:

$$Total\ Energy\ Used\ in\ USA\ \times Percentage\ of Crude\ Oil\ Used = Crude\ Oil\ Contribution$$
$$4{,}065{,}000{,}000{,}000\ kWh \times 2\% = 81{,}300{,}000{,}000\ kWh$$

Power Generation Need of Total Petroleum Imports:

$$Natural\ Gas\ Contribution + Crude\ Oil\ Contribution = Crude\ Oil\ Contribution$$
$$763{,}368{,}487{,}600\ kWh + 81{,}300{,}000{,}000\ kWh = 844{,}668{,}487{,}600\ kWh$$

Percent of USA Deficit of Natural Gas Used for Electrical Generation:

$$\frac{Natural\ Gas\ Need}{Natural\ Gas\ Deficit} = Percent\ of\ Natural\ Gas\ Deficit\ Used\ For\ Electrical\ Generation$$
$$\frac{3{,}383{,}834{,}179{,}639\ ft^3}{3{,}177{,}260{,}000{,}000\ ft^3} = 106.5016\%$$

Percent of USA Deficit of Crude Oil Used for Electrical Generation:

$$\frac{Crude\ Oil\ Need}{Crude\ Oil\ Deficit} = Percent\ of\ Crude\ Oil\ Deficit\ Used\ For\ Electrical\ Generation$$
$$\frac{57{,}448{,}117\ \text{bbl}}{1{,}856{,}025{,}000\ \text{bbl}} = 3.0952\%$$

Percent of Imported Natural Gas Used for Electrical Generation:

$$\frac{Natural\ Gas\ Deficit}{Natural\ Gas\ Need} \times \%\ Electricity\ From\ Nat\ Gas = \%\ Imported\ Natural\ Gas\ Used\ For\ Electrical\ Generation$$
$$\frac{3{,}177{,}260{,}000{,}000\ ft^3}{3{,}383{,}834{,}179{,}639\ ft^3} \times 20\% = 18.78\%$$

Percent of Imported Petroleum Used for Electrical Generation:

$$\%\,Imported\ Natural\ Gas\ + \%\,Imported\ Natural\ Gas\ = \%\,Imported\ Petroleum\ Used\ For\ Electrical\ Generation$$
$$18.78\% \times 2\% = 20.78\%$$

Cost to Convert Imported Natural Gas Need to Electricity:

$$Natural\ Gas\ to\ kWh\ Cost \times Natural\ Gas\ Need\ up\ to\ the\ Deficit = Cost\ to\ Convert\ Natural\ Gas\ to\ Electricity$$
$$\frac{\$7.11}{1000\ ft^3} \times 3{,}177{,}260{,}000{,}000\ ft^3 = \$22{,}590{,}318{,}600$$

Cost to Convert Imported Crude Oil Need to Electricity:

$$Crude\ Oil\ to\ kWh\ Cost \times Crude\ Oil\ Need = Cost\ to\ Convert\ Crude\ Oil\ to\ Electricity$$
$$\frac{\$58.80}{1\ bbl} \times 57{,}448{,}117\ bbls = \$3{,}377{,}949{,}251$$

Cost to Import Natural Gas Need:

$$Import\ Cost\ Natural\ Gas \times Natural\ Gas\ Need\ up\ to\ the\ Deficit = Cost\ to\ Import\ Natural\ Gas\ Need$$
$$\frac{\$6.88}{1000\ ft^3} \times 3{,}177{,}260{,}000{,}000\ ft^3 = \$21{,}859{,}548{,}800$$

Cost to Import Crude Oil Need:

$$Import\ Cost\ Crude\ Oil \times Crude\ Oil\ Need = Cost\ to\ Import\ Crude\ Oil\ Need$$
$$\frac{\$59.10}{1\ bbl} \times 57{,}448{,}117\ bbls = \$3{,}395{,}183{,}686$$

Total Cost to Convert Natural Gas to Electricity:

$$Cost\ to\ Convert\ Natural\ Gas\ to\ Electricity + Cost\ to\ Import\ Natural\ Gas\ Need = Total\ Cost\ of\ Natural\ Gas$$
$$\$22{,}590{,}318{,}600 + \$21{,}859{,}548{,}800 = \$44{,}449{,}867{,}400$$

Total Cost to Convert Crude Oil to Electricity:

$$Cost\ to\ Convert\ Crude\ Oil\ to\ Electricity + Cost\ to\ Import\ Crude\ Oil\ Need = Total\ Cost\ of\ Crude\ Oil$$
$$\$3{,}377{,}949{,}251 + \$3{,}395{,}183{,}686 = \$6{,}773{,}132{,}936$$

Total Cost to Convert Imported Petroleum to Electricity:

$$Total\ Cost\ of\ Natural\ Gas + Total\ Cost\ of\ Crude\ Oil = Total\ Cost$$
$$\$44{,}449{,}867{,}400 + \$6{,}773{,}132{,}936 = \$51{,}223{,}000{,}336$$

Natural Gas Contribution Cost Using Wind Power (Installed Cost):

$$Natural\ Gas\ Contribution \times \frac{Cost\ per\ kW}{Hours\ in\ Year\ @\ 25\%\ efficiency} = Wind\ Power\ Cost\ of\ Natural\ Gas\ Contribution$$
$$813{,}000{,}000{,}000\ kWh \times \frac{\$1{,}680\ kW}{2191.5\ Hours} = \$623{,}244{,}353{,}183$$

Crude Oil Contribution Cost Using Wind Power (Installed Cost):

$$Crude\ Oil\ Contribution \times \frac{Cost\ per\ kW}{Hours\ in\ Year\ @\ 25\%\ efficiency} = Wind\ Power\ Cost\ of\ Crude\ Oil\ Contribution$$
$$81{,}300{,}000{,}000\ kWh \times \frac{\$1{,}680\ kW}{2191.5\ Hours} = \$62{,}324{,}435{,}318$$

Total Cost to Replace Imported Fossil Fuels with Wind Power (Installed Cost):

$$Wind\ Power\ Cost\ of\ Natural\ Gas\ Contribution + Wind\ Power\ Cost\ \ of\ Crude\ Oil\ Contribution = Total\ Cost$$

$$\$623{,}244{,}353{,}183 + \$62{,}324{,}435{,}318 = \$685{,}568{,}788{,}501$$

Resale Value of Wind Power Replacing Crude Oil:

$$\frac{Crude\ Oil\ Need\ kWh}{1000} \times Resale\ Price = Resale\ Value\ of\ Wind\ Power\ Replacing\ Crude\ Oil$$

$$\frac{81{,}300{,}000{,}000}{1000} \times \$36\ MWh = \$2{,}926{,}800{,}000$$

Resale Value of Wind Power Replacing Natural Gas:

$$\frac{Nat\ Gas\ Need\ kWh}{1000} \times Resale\ Price = Resale\ Value\ of\ Wind\ Power\ Replacing\ Nat\ Gas$$

$$\frac{763{,}368{,}487{,}600\ \ kWh}{1000} \times \$36\ MWh = \$27{,}481{,}265{,}554$$

Resale Value of Petroleum Replacing Natural Gas:

$$Crude\ Oil\ Resale + Nat\ Gas\ Resale = Resale\ Value\ of\ Wind\ Power\ Replacing\ Petroleum$$

$$\$2{,}926{,}800{,}000 + \$27{,}481{,}265{,}554 = \$30{,}408{,}065{,}554$$

Break Even Point for Windmill Installation:

$$Cost\ of\ Turbine\ Installation - (Resale\ of\ Electricity \times Years) = (Cost\ to\ Import\ Pertroleum) \times (Years)$$

$$\frac{Cost\ of\ Turbine\ Installation}{Cost\ to\ Import\ Pertroleum + Resale\ of\ Electricity} = Years$$

$$\frac{\$647{,}521{,}359{,}420}{\$51{,}223{,}000{,}336 + \$30{,}408{,}065{,}554} = 7.93\ Years$$

Number of 1500 kWh Turbines Needed to Replace Imported Petroleum:

$$\frac{(kWh\ Need\ to\ Replace\ Petroleum\ Use) \times \left(\frac{Cost\ per\ kW\ Installed\ for\ Wind\ Power}{Hours\ in\ Year\ @\ 25\%\ efficiency}\right)}{1500\ kWh\ per\ Turbine} = \#\ of\ 1500\ kWh\ Turbines$$

$$\frac{(844{,}668{,}487{,}600\ kWh) \times \left(\frac{\$1{,}680/kW}{2191.5\ Hours}\right)}{1500\ kWh\ per\ Turbine} = 431{,}680{,}906$$

Number of 2500 kWh Turbines Needed to Replace Imported Petroleum:

$$\frac{(kWh\ Need\ to\ Replace\ Petroleum\ Use) \times \left(\frac{Cost\ per\ kW\ Installed\ for\ Wind\ Power}{Hours\ in\ Year\ @\ 25\%\ efficiency}\right)}{2500\ kWh\ per\ Turbine} = \#\ of\ 2500\ kWh\ Turbines$$

$$\frac{(844{,}668{,}487{,}600\ kWh) \times \left(\frac{\$1{,}680/kW}{2191.5\ Hours}\right)}{2500\ kWh\ per\ Turbine} = 259{,}008{,}544$$

Number of 3600 kWh Turbines Needed to Replace Imported Petroleum:

$$\frac{(kWh\ Need\ to\ Replace\ Petroleum\ Use) \times \left(\frac{Cost\ per\ kW\ Installed\ for\ Wind\ Power}{Hours\ in\ Year\ @\ 25\%\ efficiency}\right)}{3600\ kWh\ per\ Turbine} = \#\ of\ 3600\ kWh\ Turbines$$

$$\frac{(844{,}668{,}487{,}600\ kWh) \times \left(\frac{\$1{,}680/kW}{2191.5\ Hours}\right)}{3600\ kWh\ per\ Turbine} = 179{,}867{,}044$$

Number of 1500 kWh Turbines per Acre of Farmland Needed to Replace Imported Petroleum:

$$\frac{\#\ of\ 1500\ kWh\ Turbines}{Total\ Acres\ of\ Farmland\ in\ USA} = \#\ of\ 1500\ kWh\ Turbines\ per\ acre$$
$$\frac{457{,}045{,}859\ Turbines}{938{,}280{,}000\ Acres} = 0.460$$

Number of 2500 kWh Turbines per Acre of Farmland Needed to Replace Imported Petroleum:

$$\frac{\#\ of\ 2500\ kWh\ Turbines}{Total\ Acres\ of\ Farmland\ in\ USA} = \#\ of\ 2500\ kWh\ Turbines\ per\ acre$$
$$\frac{274{,}227{,}515\ Turbines}{938{,}280{,}000\ Acres} = 0.276$$

Number of 3600 kWh Turbines per Acre of Farmland Needed to Replace Imported Petroleum:

$$\frac{\#\ of\ 3600\ kWh\ Turbines}{Total\ Acres\ of\ Farmland\ in\ USA} = \#\ of\ 3600\ kWh\ Turbines\ per\ acre$$
$$\frac{190{,}435{,}775\ Turbines}{938{,}280{,}000\ Acres} = 0.192$$

kWh Production per Acre of Farmland Needed to Replace Imported Petroleum:

$$\frac{kWh\ Need\ to\ Replace\ Petroleum\ Use}{Total\ Acres\ of\ Farmland\ in\ USA} = \#\ of\ kWh\ per\ acre\ Farmland$$
$$\frac{844{,}668{,}487{,}600\ kWh}{938{,}280{,}000\ Acres} = 900.231$$

Number of 1500 kWh Turbines per Acre of Total Land Needed to Replace Imported Petroleum:

$$\frac{\#\ of\ 1500\ kWh\ Turbines}{Total\ Acres\ of\ Land\ in\ USA} = \#\ of\ 1500\ kWh\ Turbines\ per\ acre$$
$$\frac{457{,}045{,}859\ Turbines}{2{,}263{,}960{,}600\ Acres} = 0.191$$

Number of 2500 kWh Turbines per Acre of Total Land Needed to Replace Imported Petroleum:

$$\frac{\#\ of\ 2500\ kWh\ Turbines}{Total\ Acres\ of\ Land\ in\ USA} = \#\ of\ 2500\ kWh\ Turbines\ per\ acre$$
$$\frac{274{,}227{,}515\ Turbines}{2{,}263{,}960{,}600\ Acres} = 0.114$$

Number of 3600 kWh Turbines per Acre of Total Land Needed to Replace Imported Petroleum:

$$\frac{\#\ of\ 3600\ kWh\ Turbines}{Total\ Acres\ of\ Land\ in\ USA} = \#\ of\ 3600\ kWh\ Turbines\ per\ acre$$
$$\frac{190{,}435{,}775\ Turbines}{2{,}263{,}960{,}600\ Acres} = 0.079$$

kWh Production per Acre of Total Land Needed to Replace Imported Petroleum:

$$\frac{kWh\ Need\ to\ Replace\ Petroleum\ Use}{Total\ Acres\ of\ Land\ in\ USA} = \#\ of\ kWh\ per\ acre\ Farmland$$
$$\frac{844{,}668{,}487{,}600\ kWh}{2{,}263{,}960{,}600\ Acres} = 373.093$$

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