Myths and Realities about Wind, Water, and Sun (WWS) Versus Current Fuels

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Several myths have developed around wind, water, and solar (WWS) energy resources. Just a few of these are addressed here.

1) **Myth:** Wind, water, and solar technologies are much more expensive than are fossil fuels.

   Reality: First, it is important to differentiate between the "business" cost and the "economic" cost of a fuel. The business cost is the direct cost that a consumer pays upon purchase of the fuel or use of electricity. The economic cost is the direct cost plus costs that the consumer pays through higher taxes, insurance rates, medical bills, workers compensation costs, and reduced property values, among other costs.

   Statistics from the Energy Information Administration (EIA) (http://www.eia.gov/electricity/sales_revenue_price/) indicate that, in the U.S., the five states with the highest fraction of all their electric power from wind (South Dakota, 22.3%; Iowa, 18.8%; North Dakota, 14.7%; Minnesota, 12.7%, and Wyoming, 10.1%) saw an increase in residential electric power direct costs from 2003 to 2011 of 2.0 cents/kWh. However, the remaining 45 U.S. states, whose electric power was dominated by traditional fossil fuels and nuclear power, saw an average increase in direct costs of 3.6 cents/kWh.

   In other words, those states that converted the greatest fraction of their electric power generation to onshore wind saw the lowest increases in electricity prices. A reason is that wind (and solar) have zero fuel cost, so once they are installed, their costs are fixed. Fossil fuels and uranium, on the other hand, are limited resources whose prices are bound to rise over time due to increasing exploration, mining, and transportation costs of the fuel. Hawaii is a case in point. Its energy is dominated by fossil fuels, which are not local to the islands. The high transportation costs plus the rising price of fossil fuels in general resulted in Hawaii's mean residential electricity prices more than doubling between 2003 and 2011, from 16.7 to 33.2 cents/kWh, the highest in the U.S.

   The relatively low direct cost of wind is the reason that onshore wind, for example, has been the second-largest new source of electric power in the United States on average for the last 5 years. Solar costs are rapidly decreasing and nearly cost competitive. This has caused a surge in solar energy production worldwide. Wind plus solar made up 68% of Europe's new electric power supply in 2011.

   The health and environmental costs of fossil fuel electricity is an additional 5-6 cents/kWh beyond the direct costs. The higher aggregate subsidies through the tax code and direct payments given to fossil fuels, biofuels, and nuclear than to WWS

energies have also contributed to the higher economic costs of these other fuels relative to WWS resources. For example, between 2002 and 2008, the tax code subsidies and payments by the U.S. government to fossil fuel industries amounted to about $72.5 billion, whereas those to WWS technologies were about $5 billion (http://www.elistore.org/Data/products/d19_07.pdf). In sum, the economic costs of WWS technologies in the aggregate is demonstrably less than those of fossil fuels, and the direct costs for several resources (onshore wind, geothermal, and hydroelectric) are less as well at this time.

2) **Myth:** Renewable energy can't possibly be used to provide the world's energy because there is not enough of it.

Reality: Renewable electricity powered by wind, water, and sunlight, and electric vehicles and electric-powered heating and cooling are ready today to be implemented to power the world. Good wind and solar resources over land alone can power the world for all purposes 6 and 30 times over, respectively. The land area required to power the world with wind, water, and sunlight is only 1% of the world's land, and much of this space can be used for multiple purposes. Materials are not limits to the solar, wind, battery, and fuel cell technologies needed. The conversion will create jobs and the overall costs of energy today would be similar to current costs and lower when hidden health, climate, and environmental costs of fossil fuels are accounted for. Since renewable fuel supplies will be available forever and renewable fuel costs are zero, renewable energy prices will stay low while fossil fuel prices will increase as their supplies dwindle.

3) **Myth:** There is no reason to transition quickly away from fossil fuels to wind, water, and sun.

Reality: A rapid conversion to clean, renewable energy is needed to prevent the disappearance of the Arctic sea ice, thus the potential for a catastrophic acceleration of global warming. It is also needed to eliminate 2.5-3 million air pollution related deaths worldwide each year, and to maintain economic, thus social and political stability in an increasingly volatile society where fuel shortages are becoming more common.

The Arctic sea ice will likely disappear within 20-30 years unless global warming is abated. Reducing the reflective sea ice uncovers the dark, absorbing Arctic Ocean surface below, accelerating global warming in a positive feedback. Above a certain temperature, a tipping point is expected to occur, accelerating the loss to complete elimination, possibly by 2040. Once the ice is gone, regenerating it may be difficult since the Arctic Ocean reaches a new stable equilibrium.

The only potential method of saving the Arctic sea ice is to eliminate emissions of short-lived global warming agents, including methane (from natural gas leakage, landfills, cattle, and rice paddies) and black carbon (from diesel, jet fuel, and kerosene burning, biofuel burning, and natural gas flaring). Twenty-one countries,

including the entire G8, recently recognized the importance of reducing methane and black carbon emissions to help save the Arctic and have started a coalition to address this. Black carbon controls for this purpose have also been recognized by the European Parliament.

Instead of reducing this problem, most fossil fuels contribute to it by emitting methane, black carbon, and carbon dioxide. The burning of fossil fuels and solid biofuels are also the cause of millions of annual air pollution deaths worldwide. Converting to clean energy sources eliminate these deaths. Such deaths cause not only grief but also result in higher medical costs, insurance costs, and taxes; reduced worker and school productivity; and lost agricultural productivity.

The health costs associated with fossil fuels together with the variability of fossil-fuel prices due to the fluctuation and limited nature of their supply, create uncertainty in markets. Over time, fossil-fuel prices will continue to increase as their supplies dwindle. This will cause economic, social, and political instability. It is important to prevent this from happening by converting to a more stable, infinite, and clean source of energy, namely wind, water, and the sun, which are not subject to long-term price fluctuations.

4) **Myth:** Natural gas is a "clean" fuel, so there is no reason to use renewable energy systems.

Reality: The mining, transport, and use of natural gas for electric power results in at least 60-80 times more carbon dioxide emissions and air pollution-related premature deaths per unit electricity generated than does wind energy over a 100-year time frame. Over the 10-30 year time frame, natural gas is an even greater warming agent relative to wind, water, and solar electric power sources and a danger to the Arctic sea ice, which is expected to disappear within 30 years from global warming due, to the methane leakage, black carbon-flaring emissions, and carbon dioxide emissions from natural gas. Continuous natural gas mining over the lifetime of a natural gas plant also degrades land, roads, and highways and produces water pollution. Wind, water, and solar technologies do not require mining for their fuel, which is naturally produced so do not result in these continuous environmental problems.

5) **Myth:** Natural gas reduces global warming relative to coal so should be used as a "bridge fuel" between coal and renewable energy sources.

Reality: Although natural gas generally causes less traditional air pollution than coal, its higher methane and lower sulfur dioxide emissions cause it to increase global warming more than coal per unit energy generated over both the short and long term. As such, both are damaging and should be phased out.

Natural gas emits less carbon dioxide but more methane per unit electricity or heat generated than does coal. Several studies have shown however, that even without

considering coal sulfur dioxide emissions, natural gas results in similar or more global warming than coal due to the higher methane emissions of natural gas. The reason methane is so important is that it warms the climate 85-105 times more than does carbon dioxide over a 20-year period and 31-33 times more over a century period. Traditional natural gas sources are also becoming increasingly depleted and replaced by unconventional sources such as from shale rock formations, which have larger methane emissions than traditional sources.

When sulfur dioxide emissions from coal are considered, the greater health effects of coal become apparent, but so do the greater global warming impacts of natural gas. Thus, both fuels are problematic. Natural gas does not emit much sulfur dioxide. Sulfur dioxide from coal converts to sulfate aerosol particles, which cause health damage but which also reduce some warming because they reflect sunlight and increase cloud reflectivity. A recent study found that electricity production from natural gas causes more warming than coal over 50-150 years when coal sulfur dioxide, methane, and carbon dioxide are accounted for.

Thus, whereas coal causes significant health damage, land degradation, and global warming, natural gas causes more global warming but less health damage. As such, both are bad and should be phased out in favor of clean technologies.

6) **Myth:** Electric cars don't go very far, take forever to charge, and cost a lot to drive

Reality: Battery-electric vehicles today are much different from those developed decades ago. For example, the Tesla Model S seats up to 7 people (two jump seats in the rear) and has a maximum range on a single charge of 310 miles. Most charging will be done with a 220 V charger over about 4-4.5 hours in a garage or on the street, but 440 V chargers are now available allowing about 310 miles of charging for this vehicle in about 1 hour.

Several electric vehicles are currently or will soon be available. Like with fossil-fuel cars, their prices range depending on size and sportiness. One mass-produced electric car is the Nissan Leaf, which in 2012 costs about $28,500 in the U.S. after accounting for a $7500 federal tax credit. Another is the Ford Focus, which costs about $32,500 after the tax credit. In both cases, some states offer additional tax credits, so the costs are lower. Commodity electric cars are currently being planned and built that will allow millions of even lower-cost electric cars to be sold throughout the world, eventually with no tax credits needed once mass production is in place.

An advantage of electric vehicles is that the fuel cost is $1/4^{th}$ to $1/5^{th}$ that of gasoline or diesel. The reason is that efficiency of electricity for transportation is 4 to 5 times the efficiency of gasoline or diesel. For example, of the energy in each gallon of gasoline put in a car, only 17-20% goes toward moving the car; the rest is waste heat. Of the electricity put in a car's battery, 75-86% goes toward moving the car; the rest is waste heat. As a result, the fuel cost of driving an electric car is much less

than that of driving a gasoline car. If the electricity is obtained from wind, water, and sunlight, then the fuel cost stays constant over time. With gasoline and diesel, it will increase over time due to decreasing fuel supplies.

7) **Myth:** Renewable energies such as wind and solar are uncontrollable so cannot be used to provide electric power reliably.

Reality: An electric power grid must be sufficiently reliable to supply minutely, hourly, daily, and seasonally-varying power demand. The replacement of coal, natural gas, and nuclear energy with wind, water, and solar energy can provide such reliable energy.

Several methods exist to match renewable energy supply with demand and to smooth out the variability of WWS resources. One of the most important is to combine wind, solar, and other clean resources as a single commodity rather than to treat them separately.

Bundling solar and wind, which are variable but complementary in nature; using geothermal as constant power; and using hydroelectric power and nighttime-stored concentrated solar power to fill in the remaining gaps has been shown to provide nearly all power reliably. Remaining gaps can be filled by utilities giving electricity users incentives not to use electricity when demand is high. Also, oversizing the grid to produce more overall power makes it easier to match demand with supply. In that case, excess electricity will often be produced, but this will be used to produce hydrogen for other sectors of the new energy economy, such as transportation and heating/cooling.

8) **Myth:** Renewable energy technologies won't create so many jobs as fossil fuel jobs.

Reality: A recent study out of the University of Massachusetts at Amherst found that, for each million dollars spent on energy production, oil and gas create about 4 jobs, whereas wind and solar create 9-10 jobs. In many cases, fossil fuels, such as oil or natural gas, are imported from one country or state to another, so jobs are lot local to the area using the energy. Since WWS electricity production is often in or near the location where it is used, jobs are created locally rather than exported.

9) **Myth:** Wind turbines kill more birds than do other energy sources.

Reality: Wind turbines reduce bird kills relative to natural gas, coal, and oil for electricity and cause about the same bird death rate as nuclear power. A recent study published in Energy Policy found that wind turbines kill less than one-tenth the bird deaths caused by each of natural gas, coal, and oil and similar deaths to that caused by nuclear power. As a result, wind turbines reduce bird kills relative to fossil energy sources. In addition, according to the American Bird Conservancy, the total number of bird deaths per year due to wind turbines (a few hundred thousand)

is orders of magnitude lower than the numbers due to communication towers (10-50 million), cats (80 million), or buildings (900 million).

10) **Myth:** Wind turbines and solar panels take up a lot of land.

Reality: Wind turbines take up virtually no footprint of land on the top of the ground. They are poles in the ground surrounded by an underground foundation. They only require space between them, and that space can be used for multiple purposes (grazing, agricultural land, open space). For example, the footprint of land required for wind to power the entire U.S. on-road vehicle fleet if it were electrified would be 1-3 square kilometers, and the space required would be 0.5% of the U.S. This space can be used for multiple purposes. Solar requires one-third the spacing as wind. Much of the solar can be placed on rooftops, where it does not take up additional land. For comparison, corn ethanol for E85 fuel requires one million times more footprint on the ground and 30 times more spacing than does wind and about 90 times more spacing and footprint than solar to power the U.S. vehicle fleet.

11) **Myth**: Renewable energy drains the government's capacity to offer other services.

Reality: The US government annually provides $4 billion in subsidies to the oil and gas industry alone. Subsidies for renewable technologies are much lower in magnitude. As such, conversion to wind, water, and sunlight will reduce overall subsidies rather than increase them.

12) **Myth:** Offshore wind will damage sea life.

Reality: A 2006 study of over a decade of experience of offshore wind in Denmark by the International Advisory Panel of Experts on Marine Ecology found little damage to wildlife:

"The comprehensive environmental monitoring programmes of Horns Rev Offshore Wind Farm and Nysted Offshore Wind Farm confirm that, under the right conditions, even big wind farms pose low risks to birds, mammals and fish, even though there will be changes in the living conditions of some species by an increase in habitat heterogeneity."