Written by Ed Hiserodt on July 22, 2019
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An Open Letter to Alexandria Ocasio-Cortez

Dear Representative Ocasio-Cortez,

Congratulations on winning your seat in the 14th Congression-al District of New York. You certainly made a name for yourself even before the House was turned over to the Democrats, with your activist demonstration against fossil fuels at House Speaker Nancy Pelosi's office prior to being sworn in. As a Democratic Socialist, we're aware you support single-payer health insurance, free college tuition, de-funding ICE, and several other issues of consequence. But our concern here is your proposal to transition the country, including the electrical grid, to run on 100-percent renewable sources of energy. We would like to take a look at what this would entail. Excuse us for being "numbery," but the scope of this project of the Democratic Socialists is not a matter of good feelings, but cold hard numbers.

You back a "Green New Deal" that would, according to the U.K. *Guardian*, "eliminate greenhouse gas emissions from electricity, transportation, manufacturing, agriculture and other sectors within 10 years. It would also aim for 100% renewable energy."

Since you have an educational background in International Relations and Economics, perhaps you would appreciate a brush-up on electrical terminology and what it would take to accomplish your proposal. First, let's define which energy sources the environmentalist Left says qualify as "renewable sources of energy." They are:

- Solar (thermal and photovoltaic)
- Wind power
- Small-scale hydroelectric
- Biomass (including ethanol)
- Hydrogen and fuel cells
- Geothermal

Of those power-generating sources listed above, wind-power generation, at 6.3 percent of U.S. electrical energy, currently leads the way as a percentage of our country's electric supply. Solar (both utility scale and small-scale) is in second place at 1.9 percent. Biomass is at 1.6 percent, but is not expected to have the potential of wind and solar. So for our purposes here, we will limit the discussion to the top two.

What Is a Watt?

The first bits of essential terminology you need to know have to do with rating electricity generation. Knowing these terms would put you head and shoulders above most of your colleagues, many of whom have law or political-science degrees and don't know a kilowatt from a kumquat. Your first lesson here is that *power and energy are not the same thing.*

Power is the ability to do work. Even though it's not necessary to own a car in the Bronx, you are surely familiar with "stepping on the gas," the action that increases the *power* of the engine up to its maximum to go faster, go up steeper hills, and get to those Green New Deal rallies on time.

Electricity generation and usage are measured in watts. For us the watt is a *measurement of power available to do work*. While physicists would likely say a watt is a *joule* per second, we fortunately don't need to dig that deeply for our purposes. The watt (W) is a tiny amount of power, like that of a flashlight. We more often work with kilowatts (kW) — thousands of watts — or megawatts (MW) — millions of watts.

Though in the United States we measure automotive power in "horsepower, (hp)" we could just as well express it in watts, or in this case kilowatts. A 100 hp engine is also a 74.6 kW engine. Our power grid, wind turbines, and power plants are usually rated in megawatts, though some coal and nuclear plants are rated in gigawatts (GW), billions of watts.

Now here's where you need to be careful to use the correct units lest you lose credibility — at least with the few congressmen who are engineers or physicists.

Energy is always expressed in terms of *power over a time period*, or if you want to get fancy, "the integral of power over a specified time." So we might say that the power of one watt produced or used over one second is one watt-second. Ten 100-watt bulbs operating over one hour consume one kilowatt-hour (1 kWh) of energy. The average residential customer uses 10,300 kWh of electrical energy per year, and a 1,000 MW nuclear plant produces about 8,322,000 MWh of electrical energy per year.

For the nuclear plant calculation above, it is assumed that the plant actually produced 95 percent of the energy it would have produced while running continuously at full capacity, because for about five percent of the time it would be being refueled, so the nuclear plant has a *capacity factor* of 95 percent.

The capacity factor is a vital number to understand, particularly when dealing with the energy produced by a wind or solar source. It is the output energy divided by the energy if operating at full nameplate capacity over a year. For example, if a wind generator has a nameplate rating of 2 MW, it is *capable* of producing 17,520 MWh per year. Suppose the wind turbine actually produced 5,256 MWh, slightly below a third of its total capability. It would have a capacity factor of 30 percent — about normal for a well-sited wind turbine. Except for a few nuclear plants that produce more than their designed output, all generators produce less energy than their "nameplate" rating. So to calculate the expected output of a wind machine or solar array — or for that matter any electrical generator — you need both its nameplate rating and its anticipated capacity factor.

Alexandria, if you were able to afford an apartment, though you said you were having financial trouble in doing so, you would likely have a kilowatt-hour meter somewhere where the meter reader can see it. There is a disc that spins and a number below it. The speed of the spin tells you the power (kW) you are using at that instant. The numerical value is the kWh — the energy you're being billed for.

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Converting the U.S. Electrical Grid to 100-percent Renewables

OK, Miss Ocasio-Cortez, we now have the tools and nomenclature to calculate what it's going to take to go to 100-percent renewable electrical generation. To determine the number of wind turbines, or solar arrays, that the country would require to "go green," we first need to determine the amount of energy that green energy sources need to provide by deducting the current approximately 0.361 billion MWh generated by renewables from the 4.034 billion MWh total U.S. generating capacity for the year 2017 (the latest U.S. Energy Information Administration data available). We learn that the country requires new renewable energy of 3.673 billion MWh. Note that currently we are 91.9 percent non-renewable and 8.1 percent renewable.

If we assume that any new renewable energy to power the country will be derived mainly via wind power (we'll address solar later), some relatively easy math will allow us to calculate how many turbines we'll need, after ascertaining how much energy each wind turbine creates.

In addition to wind speed and blade size, the output of a wind generator is a function of the rating of the turbine and the capacity factor. The rating for a typical onshore, modern machine ranges from 1.5 to 3 MW output power. Capacity factors are largely determined by where the turbine is sited, with the plains of the Midwest being one of the optimum locations. Most other locations are only marginally viable. In flying over the Eastern United States, one notices that a large percentage of the area is wooded. For wind-turbine sites, the forests must be cut back to allow wind to flow well, something environmentalists (and even normal people who don't align themselves with the radical environmental agenda) are against.

As an important side note, beware that there has been a backlash from the public against wind turbines, owing to decreased property values and to the many claims from nearby residents of ailments associated with the low-frequency noise the blades create. But if it means "Saving the Planet," we're sure you can sell the population to put up with these inconveniences.

To calculate a turbine's yearly wind energy, let's use a 2 MW machine. This is no midget, with its 171-foot blades reaching 259 feet above the ground, about the same height as a 25-story building.

As noted previously, a 2 MW turbine generates about 5,256 MWh per year. So how many wind turbines would the country require to make the 3.673 billion MWh (or 91.1 percent) energy generation currently not provided by renewable power? Hold onto your hat, Miss Ocasio-Cortez! And now, the envelope please. To convert the total non-renewable energy sector to wind power would require an additional 698,000 2 MW wind turbines.

But wait; we're assuming that energy is used at a constant rate throughout the day. It's not. The utilities realize this doesn't happen in the real world, so they figure their generating needs based on "peak power," the time of greatest energy demand. In New York, the peak is about 175 percent of the average demand. So using that figure as our base, the country actually needs 1,221,000 new wind generators, not 698,000. These turbines can't be stacked together lest their airflow "cover" the downwind turbines and the turbulence caused by the upwind blades then wreak destruction on the downwind machines. So for omnidirectional wind farms, the recommendation is 10 to 15 diameters of space between the turbines. Using an average value, we need an open area of 2,000 feet by 2,000 feet, or about 92 acres, for each turbine. (Coming from a less-agricultural part of the country, you may not be familiar with acres. An NFL football field is about 1.32 acres — including end zones.)

The total area covered with new wind farms would be 1,221,000 times 92, or 112,332,000 acres. Or 175,518 square miles. This would equal an area greater in size than New York, Pennsylvania, Ohio, New Hampshire, Massachusetts, New Jersey, Delaware, Rhode Island, and Maryland — along with another 77 Districts of Columbia thrown in. (Perish the thought.) Of course, in reality, much more space would be needed than that: Remember we are talking about an area where, unlike the geophysical region specified above, there aren't houses, roads, trees, buildings, parks, or airports — just wall-to-wall wind turbines. Nor does it even include space needed for power lines, transformers, or other switch gear necessary to serve the customers.

What If the Wind Doesn't Blow?

Problem is, Alexandria, after we spend trillions for the wind turbines for the Green New Deal — the nation would be *powerless* if the wind isn't blowing. No wind. No electricity. Wonder what the death toll in the recent record-cold temperatures would have been had there been insufficient energy for heating, lighting, hospitals — because of iced turbine blades?

It is true that the wind is always blowing somewhere, but that somewhere might not be in this country — at least not at the 10 mph needed for our wind turbines. In the summer months a "dome of high pressure" often settles in over the middle of the country. Probably gets pretty sticky in New York, and more so in D.C. — especially when Congress is in session and certain members are contributing large amounts of hot air.

Since there is little atmospheric pressure differential under this dome (the isobars are far apart), there is nothing to create wind — hence no wind energy generation.

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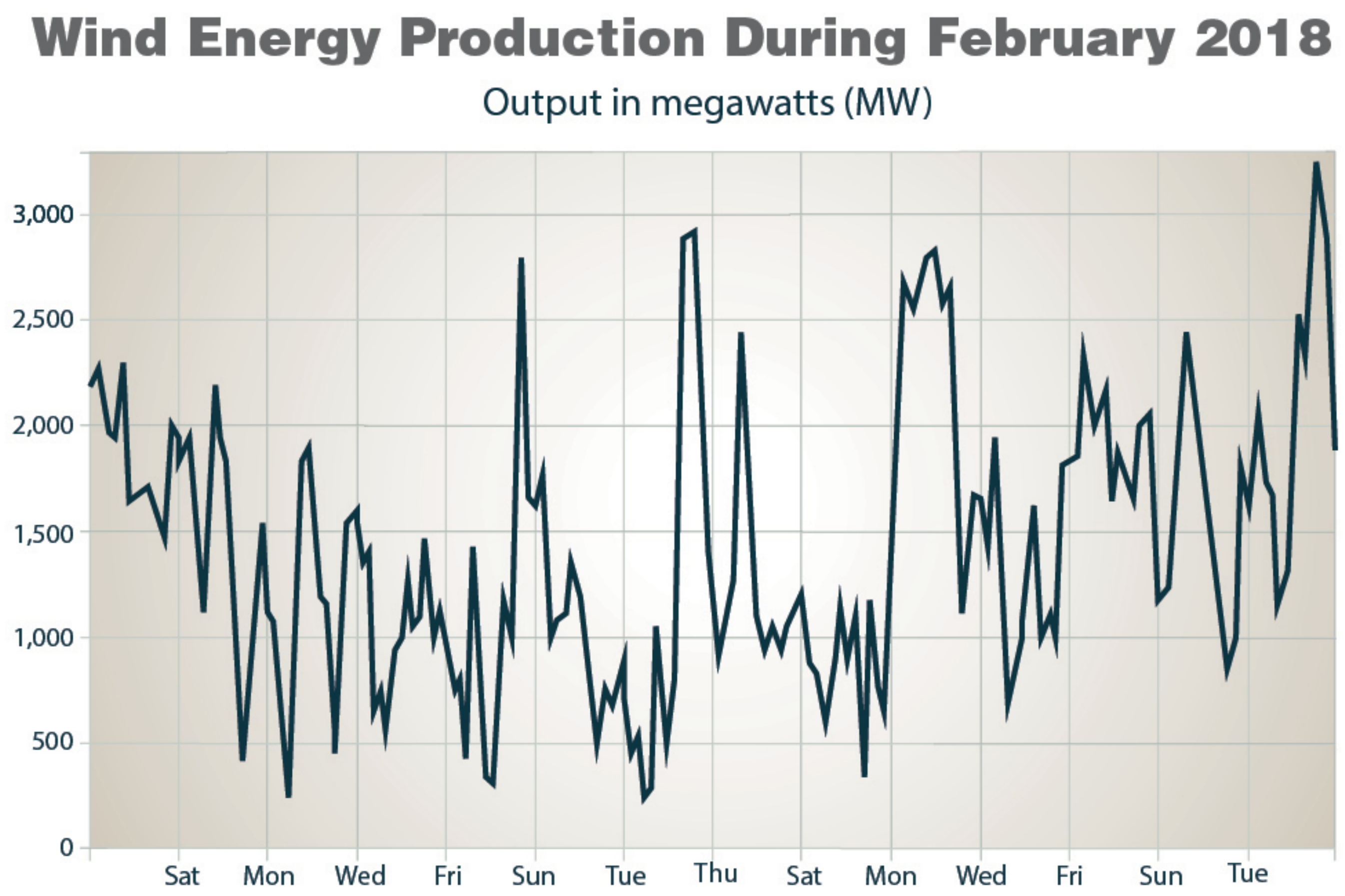

Wind worries: Wind electrical generation is variable and problematic. Shown here is the combined output of 60 wind farms in Australia. In this case, when the output is below 1,500 MW, fossil-fueled generators are called on to provide energy to make up for the loss of wind generation. When output is over 1,500 MW, the reliable generators must stop supplying (paid) energy to the grid and go into a "spinning reserve" mode during which they must keep their boilers or turbines on ready, burning fuel with no compensation.

Our mates in Australia have found out a similar lesson the hard way, as we can see on the graph above.

The graph shows the combined output of 60 wind farms in an area just smaller than the United States, clearly showing periods of insufficient wind to maintain the power to run the electrical network.

Maybe if we go to worldwide socialism, we can persuade the people in windy places to give up their energy to make us cool and comfortable or warm and cozy. Oh, we forgot: With socialism, the government can tell everyone what to do. Problem solved.

Energy Storage

We know what you're probably thinking: "If we don't have wind power and it is a cold night, we'll just have to store electricity and use it when we need it. Haven't you people at TNA heard about batteries?"

Yes, when considering energy storage, one's mind jumps immediately to rechargeable batteries that give us starting power for our autos, laptops, toothbrushes — all manner of things. So why not utility power? You may already know this, but when dealing with wind and solar you must determine the period of *autonomy* when the batteries must carry the entire load. This is a function determined not only by the capacity of the batteries, but also by the size of the power source that is required to charge the batteries while taking care of its normal loads. By some estimates it would take 30 to 40 percent additional wind generation to have the capacity to provide energy for immediate use and simultaneously charge backup batteries. But let us generously assume that only a 25-percent reserve charging capacity is needed. To provide that capacity, we'd now need to add an additional 283,000 wind turbines, pushing the total up to around 1,504,000. And of course another state or two.

Battery Storage: Batteries themselves are another problem. A typical car battery stores about 1.2 kWh of usable energy at 12 volts. It has a volume of about one cubic foot. A city of 700,000 requires an average of 1,000 MWh of energy every hour. So how many 1.2 kWh batteries are required to store one single MWh? About 833. How about for one hour of autonomy? About 833,000. And for a day? — 20 million.

Stacked 10 high, without space for cooling and maintenance, the batteries would cover more than 46 acres. Again for a non-farm girl, that's some 35 football fields, including end zones.

Lithium batteries are better in several respects than lead-acid cells, but they are costly, even for someone not planning to be stingy with taxpayers' money. Lead ore sells for about $400 per ton, lithium for $20,000. Tesla's Elon Musk aided thousands of South Australians who had been suffering from the vagaries of wind power by delivering to a South Australia authority lithium batteries with storage capacity of 129 MWh. And he did it for $50,000,000. It appears Musk hooked together some 400 of Tesla's power packs each the size of a refrigerator. (Musk's banks of batteries were not designed for *autonomy*, but to add capacity when the wind drops momentarily.)

Alexandria, you probably shouldn't hang your hat on some new battery technology to come up with a miracle battery. Some of the world's best chemists and physicists have been attempting to improve batteries for over 100 years. Those chemists might use some exotic rare-earth elements to improve hearing-aid batteries, but as far as *major* storage — it's just not going to happen.

Pumped Storage: With *pumped storage*, water is pumped, usually from a lake or river, to an elevated reservoir some 500 or more feet above the intake during a period when there is excess power available. Then it is released, spinning water turbine generators, providing additional energy during high-demand periods.

The largest of these in the world is not far from your Washington office, in Bath County, Virginia. It is described as the "largest battery in the world." The station is capable of generating 3,003 MW of power for 11 hours. The upper reservoir that stores the water until power is required holds the equivalent of 17,500 Olympic swimming pools. For 2017, it generated 935,000 MWh of energy.

Engineers love it as it is very efficient, but there is one problem. The topography of the United States has very few sites suitable for this storage technique. This is evidenced by the Bath County plant having 14 percent of the total U.S. pumped storage.

Sorry, Miss Ocasio-Cortez, you are going to have to carry the water on this one; we don't have a solution. You might consider this though: Even devout Democratic Socialists are not happy when the lights go out.

Outside the Grid

Even presuming the country finds the will and the wherewithal to commit to creating huge banks of lead or lithium batteries to take over the load for the turbines *for the entire country* when the turbines stop spinning — possibly for days — we're still not finished yet, sorry. We still need to eliminate *non-electrical energy generation*, which may be even more problematic than changing the energy grid over to renewables. Consider natural gas: Only 34 percent is used for grid electricity generation. Eliminating natural gas would greatly negatively impact many millions of consumers — even Democratic Socialists.

Natural gas is usually measured in Tcf — trillion cubic feet. This can be converted to Quads, which is short for quadrillion BTUs. In turn, this can be converted to MWh. You might be able to wow them in congressional debates by mentioning that the United States uses about 28 Quads of natural gas per year, the equivalent of 8.205 *billion* MWh.

Industrial and commercial usage of natural gas dwarfs that used for the electrical grid. It represents 49 percent of total usage and goes toward heating and as a feedstock to produce hydrogen, fertilizers, pharmaceuticals, plastics, and many other products. No doubt you would want to do away with plastic anyway, especially soda straws. And we would just have to find some other way to compound pharmaceutical drugs, or just do without as them as was the case in 1800.

Since most industrial-gas usage is for heating, we can assign 4.205 billion MWh to obtain the equivalent from electric heat, which means we need yet more wind generation. Holy moly, Batman! That is nearly as much wind energy as we had to add for converting the U.S. electrical grid to all renewables. Using our 5,256 MWh per wind turbine, we find we need to add another 800,000 wind energy sources — and hope Florida and North Carolina don't mind ripping up all their roads, razing their houses and buildings, and cutting down their forests to make way for the turbines and the open space they need.

As a word of warning, Alexandria, you might want to ask your neighbors about what they think about converting all their gas heating systems, hot water heaters, ovens, clothes dryers, and other gas appliances to electricity. I'll bet even Democratic Socialists would be annoyed at carting all their appliances to the street and getting new electric ones. But hey, such a move is necessary to get rid of the 4.76 Quads of natural gas used for residential purposes. And the transition would only require another 251,000 additional wind turbines. Solar-powered chainsaws coming to Indiana.

What does that bring us to? About 2,555,000 new wind generators — and a sizable portion of the United States.

Yet we still need to tackle the petroleum problems. Since we're both probably getting tired of the numbers, Alexandria, let's take a shortcut and only consider the percentage of oil products powering cars and trucks while ignoring the non-motor-fuel usages of petroleum. To figure the power needed by our new electric vehicles, we again do some simple math. We drive here in the United States some 3.22 trillion miles per year. The "Leaf" electric vehicle claims to consume 0.34 kWh per mile. A little very long division yields 1.09 billion MWh of energy. Again using our 2 MW turbine gives an increase in their number by 207,400 machines. Adios West Virginia.

The cost of all these wind turbines (at $2.8 million per turbine) is in excess of $7.7 *trillion* — hardly a trifle.

Solar Panels to the Rescue?

No doubt, with your sunny personality, you and your Green Energy coalition would want to consider a combination of solar and wind to offset the loss of non-renewable power. Let's see how this plays out.

The mix between solar and wind generation at this time is unknown, but we can look at the characteristics of a solar installation — in this case one that would be the equivalent of a 2 MW wind turbine at a capacity factor of 30 percent — to see if there is a sun-shiny lining in our environmentalist clouds.

The average *insolation* (solar energy) striking the continental United States is 5 kWh per square meter per day. When we do the math, we find that it takes about 11 acres of photovoltaic cells to replace one 2 MW wind turbine. Quite a reduction in area from 92 acres needed for each wind turbine. And solar has the advantage of doing well during the day when the load on the energy grid is the greatest. But whereas most of those 92 acres are open ground — grass maybe — all 11 acres of solar would be unusable for other purposes. And there are some other major scary bogeymen with solar. Not only are solar arrays not so good at night (there's that battery thing again), they don't even often work well during the day in the Northeast United States or on rainy days, and they don't work very well at all unless the sun is high in the sky (early morning and late day are out) and unless the solar array is pointed directly at the sun and the array is immaculately clean — lots of upkeep and equipment costs. We forgot. You are creating lots of cleaning jobs.

Moreover, where the sun shines most regularly and intensely is in America's southwestern deserts, while the industrial Northeast is where the energy is most needed. Even assuming scores of high-voltage power lines could be built to transfer the energy from one side of the country to the other, one might still remember that when the rising sun *starts* generating power in the West, the folks in the Bronx are at lunch. Perhaps you can convince northeasterners to shorten their workdays — that is a goal of socialism, right?

Of course, under socialist rule there would be no need for environmental impact statements or preservation of property rights, so there's a bonus. On the other hand, a drawback would be the huge banks of batteries needed to store all the energy that would be needed for when the sun is not shining.

Backing up either of our renewable energy sources for *only one day* — and only for the 4.034 billion MWh of electricity that goes toward energizing the nation's power grid — would take something on the order of 3.36 *trillion* car batteries, which, similar to car batteries, would likely have to be replaced every three to five years. At a cut-rate price of $5 each, the battery backup necessary would still cost the country $16.8 trillion each time the batteries are replaced. Sounds expensive — even for government. In the final analysis, going totally "green energy" is not a bright idea.

Let's Get Real

We are asked to give up our standard of living for the *unproven theory* that an insignificant increase in carbon dioxide from its current 0.04 percent of our atmosphere would cause Earth's temperature to rise to a deadly level. Meanwhile, all of the computer models relied on by the Intergovernmental Panel on Climate Change have predicted temperature increases much higher than satellite and ocean buoys have shown, which indicate a pause in temperature rise.

Moreover, a new peer-reviewed paper by Dr. Bjørn Lomborg published in the *Global Policy* journal shows that reducing CO2 production would make little to no difference in Earth's temperatures.

The online summary of Dr. Lomborg's research reveals:

The climate impact of **all Paris INDC** [Intended Nationally Determined Contributions] **promises** is minuscule: if we measure the impact of every nation fulfilling every promise by 2030, **the total temperature reduction will be 0.048°C (0.086°F) by 2100.**

Even if we assume that these promises **would be extended for another 70 years**, there is still little impact: if *every nation* fulfills *every promise* by 2030, and continues to fulfill these promises faithfully until the end of the century, and there is no 'CO2 leakage' to non-committed nations, the entirety of the Paris promises will **reduce temperature rises by just 0.17°C (0.306°F)** by 2100.

And even if Americans did stop producing CO2, Earth's CO2 levels would continue to rise because China, India, and other countries are building coal-fired power plants by the dozen, which will likely more than offset any reductions Americans make.

If your objective is a reduction in carbon dioxide, maybe you should consider untying government regulations restricting nuclear generation. Nuclear power plants produce no carbon dioxide, and no U.S. citizen has ever been harmed in any nuclear power incident. The same cannot be said for wind farm accidents, as is documented by the Caithness Windfarm Information Forum and the number of amateur solar panel installers who have taken fatal falls from their roofs.

As you've just learned (we hope), energy from the wind or sun is far from free — and far from reliable. In the case of nuclear power, the amount of uranium fuel to power a residence for a year is about one gram, equal to one-fourth of a teaspoon of salt — or a paper clip. Without costly government-encouraged lawsuits, nuclear power is one of the most inexpensive and reliable sources of electricity on Earth. And no need for batteries.

Miss Ocasio-Cortez, if your objective is to destroy our economy to abolish capitalism so socialism can rise on its ashes, then you are on the right track — just like socialists managed in starving Venezuela. And you will surely have plenty of support not only from other Democratic Socialists but from the leadership of the Democrat Party, the mainstream media, and academia. But if your objective is to help the environment while helping the poor in our country, you're on a dead-end street.

Photo: AP Images

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