I’d like to start today in the Iowa countryside at sunrise. When my brother sends me photos like this one, it’s easy to become jealous of his career choice, but then I remember that he had to climb up over 300 ladder rungs, 312 feet in the air to the top of this wind turbine to capture this photo, and, on second thought, I think I’ll stay on the ground behind my computer.

In 2016, when my brother had just started his training, the U.S. Bureau of Labor Statistics first named Wind Turbine Service Technicians the fastest growing occupation of the decade. It has remained near or at the top of this list since. Between 2019 and 2029, the number of jobs are expected to increase by 61%. But this wasn’t always the case, the wind energy industry had a rather slow start in the U.S. So, how did we get here?

The principles used the generate electricity from the wind have been used since the middle ages to pump water and grind grains and it has been used in United States as a source of electricity since 1850, especially in rural areas, but it wasn’t until the 1970s when the price of gas skyrocketed that the nation began to see a need to focus on renewable energy sources. In 1980, the first large, utility scale wind farm was built in California. Throughout the 80s, the industry continued to innovate, but funding from the government waned, until 1992 when the Energy Policy Act was passed, which authorized a production tax credit of 1.5 cents per kilowatt hour of wind-power-energy generated. This encouraged the production and sale of wind energy so from 2000 to 2019 we see a steady increase in the number of kilowatt hours of electricity generated from wind turbines. In 2019, the United States reached 300 billion kilowatt hours.

Now, if you’ve never spent time studying electricity or your electric bill, you may be asking ‘what exactly is a kilowatt hour?’ Everything in our homes uses a certain amount of watts of electricity. So, for example, 100 watt light bulb uses 0.1 kilowatts each hour, which is equivalent to 1 kilowatt hour of electricity after 10 hours. In the United States, the average home uses 867 kilowatt hours per month. But how does this translate to wind turbines? Each wind turbine has a rated capacity or the maximum amount of electricity it can generate at ideal wind speeds. Since wind speeds fluctuate, it is not always generating that maximum amount of electricity. This is where the capacity factor comes in. Wind turbines have a capacity factor of 25-40%. Simply, if we consider a 1.67 megawatt rated turbine at the average capacity factor of 33%, that turbine could produce enough energy in 94 minutes to power an average home for one month.

Before we continue with the analysis, I would like to point out a few parts of a wind turbine so we can better understand how their design and rated capacity has changed over time. First, we have the rotor diameter, illustrated on the left. And on the right we see, hub height, or the height from the turbine platform to the rotor or center of the blades.

This analysis focuses on utility scale, onshore wind turbines installed in the United States, and therefore does not include small residential wind turbines. In the 1980s hub height was on average 78 feet and by the early 2000s average height was 205 feet or the height of the Tennessee State Capital Building. Today that height has increased to an average of 280 feet. Some even reaching 429 feet, which just a few feet taller than the Pinnacle Building in downtown Nashville. This is significant because wind speeds increase at higher heights above surface level and with higher wind speeds bring more electricity generating potential.

Higher hub heights also allow for larger rotor diameters. By 2005, we see average rotor diameters of 262 feet or approximately the size of a Boeing 747. And today the average is 369 feet with some over 500 feet wide.

This chart shows the relationship between rotor diameter and rated capacity of the wind turbine. Using the averages from each year group we see that by doubling the rotor diameter from 92 feet to 194 feet, we see a quadrupling of the rated capacity from 0.25 megawatts to 1 megawatt.

Now we’ve seen how technology has changed to allow for more electricity production, but another key aspect is cost. Here we see the levelized cost of energy for onshore wind production in the United States. Levelized cost of energy takes into account the cost of building and operating a power plant of it’s lifetime and allows for comparison between energy sources. The cost for wind has fallen from nearly 30 cents per kilowatt hour in the 80s to less than 5 cents in 2019. Within the last few years the cost has become competitive with other sources of electricity and in many cases it is more cost effective to build new wind turbines than to continue operating coal-fired plants.

Wind energy is also safer