The Renewable Energy Fix

By Martin Hertzberg*, October 2017

The average fossil fuel power plants that were built or are in process of being built in the last several decades generate an average of 600 – 800 Megawatts each. Although no nuclear plants have been built in the U. S. recently, typical nuclear plants each generate about twice that. The high temperature inside a fossil fuel boiler generates about 600,000 Watts per square meter. That power heats high pressure steam flowing in tubes that line the boiler. That pressurized steam then powers a turbine that is coupled to a generator that produces electricity as conductors rotate through magnetic fields.

The efficiency of conversion of heat energy to electrical energy is about 30 %, and if you factor that into the mix, you need an internal boiler area of about 3,500 square meters to generate the 600 to 800 Megawatts of electrical power. That 3,500 square meters is about the internal area of a large utility boiler: a base that is 20 x 20 meters square with walls that are about 40 meters high. With natural gas as the fuel, efficiencies can double using a combine cycle system of gas turbine/boiler combination.

By contrast, the power available from the sun at zenith as it enters the atmosphere is only about 1,370 Watts per square meter compared to the fossil boiler's 600,000 Watts per square meter. If you factor in the atmospheric absorption, overhead angle and the various efficiency factors, the power density available from sunlight is some 4,000 times less than the power density available from the fossil fueled boiler.

That means that your solar collector needs to be about 4,000 times larger than the boiler area to generate the same amount of power. Thus, for example, a solar power plant designed to generate 800 Megawatts in the middle of a sunny day will require solar cells covering 12 square miles: that is an area completely covered with solar cells that is 3.5 miles wide by 3.5 miles long, or about double the area of Mt. Lebanon Township that must be completely packed with solar cells. That's for just one power plant: you would need 16 of them to generate 20 % of California's electric power, as its legislators and governor have mandated. And remember, they would function only for several hours during the middle of the day.

Wind power has essentially the same limitations and requires a similarly large area coverage for its wind turbines. The largest wind turbine recently built produces 4 Megawatts: it stands 600 ft high, and has a blade width of 400 ft. It would take about 200 of those turbines to generate 800 Megawatts and with the minimum spacing between them they would extend to a distance of 30 miles. To provide the 20% of the electric power California uses, you would need 16 of those 30 mile wide power stations. That is a distance of about 500 miles, so if they were in a single line, they would have to extend more than half the entire length of California's coast line, from just north of San Francisco to the Mexican border south of San Diego.

Apart from the enormous space requirements for such solar and wind power renewables, they have another major disadvantage: they have a low plant factor of only 20-30 %. That is, they only function on the average for about 5-6 hours per day: when the sun is shining nearly overhead on days that are not too cloudy, or during times of the day when the wind is blowing at a high enough velocity. If the wind is blowing at a very high velocity, wind turbines do generate more power; that is, until they fly apart and are destroyed by the force of the high wind.

Solar and wind renewables generate power under conditions and locations which nature dictates and not when we might require it. Fossil fuel power plants, on the other hand, operate continuously and the fuel feed rate to the boiler is controlled by the consumer's demand for electricity. Renewables can only rarely be located in sites that we would find convenient. Fossil plants on the other hand, can be conveniently located in sites of our choosing and close to existing transmission lines.

There are also other factors: aesthetics, supply, and health that should be considered. Natural gas firing beats them in all factors. It is clean, efficient, with an almost endless supply from shale gas in Pennsylvania. It has outpaced coal and will continue to increase – It is the most sensible future for electric power generation in Pennsylvania.

The one factor that should not however be considered is human CO2 emission and the effect it might have on "climate change", whatever that means. There is nothing in the totality of weather data that supports the supposition that CO2, at only 0.04 % of the atmosphere, is a driver of weather or climate [1], or that human emission controls the atmospheric CO2 concentration [2]. CO2 is not a pollutant[3] but rather an essential ingredient of the Earth's ecosystem on which all life depends via its vital role in photosynthesis. Natural sources and sinks overwhelm human emission.

Natural gas is indeed the "end game". Our system for the production of electricity "ain't broke" and if it ain't broke don't fix it!

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References:

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2. http://tech-know-group.com/papers/Role_of_GHE-EaE.pdf

3. http://tech-know-group.com/essays/Carbon_pollution.pdf