Energy 106 – Solar Thermal

Ken Johnson

Before becoming engrossed in the topic of this episode, there were some rather interesting recent occurrences associated with the last episode, “Energy 103 – Wind Turbines II”, which alluded to my theory that tornados which occur in ‘Tornado Alley’ in the Midwestern US, perhaps begin as small counter clockwise (CCW) Coriolis vortices generated by southwesterly winds sweeping down the eastern slopes of the southern Rocky Mountains. This was presented in my discussion of vortices produced by wind turbines and the suggestion that an effort should be made to arrange wind turbines so they produced CW vortices (in the Northern Hemisphere) and perhaps nullify the natural CCW vortices. I went on to describe the CCW whirlwinds which frequently cross my property that are probably generated by a southwesterly wind sweeping down the eastern slope of the mountain several miles west of my property. That episode was e-mailed to ECN on the evening of 6/18/10.

Just two days later (6/20/10), I was working in the yard, sorting a large number of empty plastic plant containers, from nurseries, that had accumulated over many years. I had just finished when I heard a loud rush of wind west of my property. I turned to look and it was the largest and most violent whirlwind I have seen in this area and it was heading straight for me from the southwest. I was soon engulfed by whirling dust, sand, debris, and scads of flying plant containers in a real “Auntie Em!” situation. It passed quickly, heading northeast and leaving me standing there with my eyes and mouth full of sand, my hair full of dried grass and weeds, and my carefully sorted plant containers scattered across the landscape. My wife later said the whole house shook, like from a small earthquake.

The next day (about 30 hours later on 6/21/10), 1000 miles to the northeast of my property, in southern Wisconsin, a severe tornado struck a small town, injuring many people and destroying their homes. Coincidence? I don’t think so. This is not to say it was the exact same vortex that hit us, but it probably was one of a group that perhaps combined with others and gained energy as they moved northeast across the hot Great Plains at an average speed of about 30 mph (1000 miles/30 hrs. = 33 mph).

Well, back to the subject of Energy. It may seem to many readers that this writer

works for an oil company and condemns all other sources of energy. This is not true on either count. I am simply trying to shine the light of scientific facts and realism on all these wonderful ‘free’ energy sources. It is abundantly clear they are being promoted and fossil fuels are being demonized for the purposes of the usurpation of our democratic freedoms, justification by arrogant politicians for their own financial/power gain, and raising taxes on all energy to pay for their out of control spending habits. All of these so-called ‘clean and green’ energy sources have been explored and exploited for centuries . . . and each have their own particular limited advantages and useful applications, but powering our general electrical Power Grid System with them is just not physically or economically feasible for most, otherwise it would have happened long ago.

This ‘Energy’ episode, as well as the next, involves the use of ‘solar’ energy directly. Although a previous episode of this series put forth the concept that any form of energy we utilize, had the Sun as its primary source, but the ‘Solar Power’ term, as generally used, involves the ‘on-line’ use of the Sun’s output. Since this on-line energy is almost all in the form of ‘thermal’ energy (radiation), converting it to mechanical or electrical energy must obey the Laws of Thermodynamics, as well as the conversion efficiency limitations of the Carnot principles. This means the maximum portion of the solar energy received that is ‘Available’ to do ‘Work’ (mechanical or electrical) can be only about 35% of the total solar received.

The first of these is often referred to as a ‘Solar Thermal Energy’ (STE) system and is simply a conventional steam power plant which derives its energy input (fuel) from the direct rays of the Sun rather than from fossil fuel combustion or nuclear reaction. Sounds great, but just how much of this energy is there? A generally accepted nominal number is about 2 cal/sq. cm/min. maximum, when and where the Sun is directly overhead and the atmosphere is clear of clouds, dust, smoke, and moisture. Of course it diminishes to zero as the Sun sets and then the energy radiation from the Earth’s surface goes into outer space and approaches a similar negative value as total darkness is reached. Otherwise the Earth would be constantly gaining (or losing) in average temperature.

It is a well known and accepted fact, among astrophysicists, that this number varies, seeming to increase as the number of sunspots increase on the Sun’s face and decrease as the sunspot number decreases. But, since our measurements of it have been for a tiny speck of time in the eons of its existence, any absolute quantification of that variance tends to be only speculation, with some overall trend indications from geological artifacts.

Looking at the maximum yield numbers for an STE plant and realizing that even with automatic positioning, on the solar energy pickup devices to track the Sun, one might expect perhaps a daily average of maybe 1/3 of that maximum input. Then there is the 35% thermal efficiency (Thermodynamic Laws) to be applied, so the approximate net result is a long range average plant output that may approach 2 watts per square meter of solar energy collection panels (on a clear day). You will find quite a variation of that stated number, depending on the source, because it is an important sales tool, so make sure you know what the conditions are for it. Nonetheless, in the US, millions of tax payer and utility customer dollars were spent

many years ago to design, develop, and build a couple of STE plants, mostly for R&D purposes:

I. California Solar One – Operational 1982 – 1986. 10 MW (peak) from 72,650 sq. meters of 1,818 individual remotely adjustable mirrors (heliostats), all focused on a 1 sq. meter sized black tubing bank collector mounted atop a tower. The facility was located 10 miles east of Barstow, CA, just off I-40 (Daggett, CA).

II. Solar Two – Operational 1994 – 1999. Modified California Solar One with increased mirror field to 82,170 sq. meters and a molten salt in the heat collection circuit instead of oil or water. Dismantled in 2009. (data from Wikipedia)

At about the same time, in 1984 a semi-commercial venture was begun by Luz Industries (aided by US tax dollars) called the Solar Energy Generating Systems (SEGS). It was the first of what eventually became 9 plants built over 6 years at 3 different locations in the Mojave Desert, two plants of which were next to the CA Solar One in Daggett. A much simpler energy collection technique was used on the SEGS utilizing the ‘Solar Trough’ heat collector pipes mounted at the focal point of the parabolic trough shape and running the length of the troughs, which could be a mile long. Troughs are placed parallel to each other, perpendicular to Sun’s path and automatically rotated about their focal point to track the Sun. Although this approach captures slightly less of the solar output, it eliminates the thousands of complex gear trains, drive motors, and controllers of the individual reflector mirror approach. It also reduced wind damage to the reflectors, and made keeping the mirrors clean much simpler.

The nine Mohave parabolic trough design SEGSs have a combined power output capability of 354 MW and the oil carrying the heat from the collectors to the steam boilers can be heated with natural gas in case of a cloudy day or collector Sun tracking problems. All in all, a very impressive viable system . . . but there was no indication of either the construction or operating costs.

I had need to travel many times on I-40 thru Barstow during the 1990s and saw CA Solar One (and the SEGS in the background) on those trips, but only once saw indications Solar One was operating, by the appearance of a strange aberration aura about 50 ft. in diameter centered on the top of the collector tower. Some literature I read said it was dust in the air being illuminated . . . but why in such a pattern? The reflectors were arranged in a semicircular pattern on the ground on one side of the tower, yet the aura appeared to be a spherical shell. It is possible it was not producing power but in a ‘standby’ mode, with the reflector beams parked in circular pattern around the collector.

Several years ago, I had the privilege of touring the Solar Power Research facility at the Sandia National Laboratory. It turns out most of the R & D for CA Solar One was done at that facility. They still had a large adjustable mirror field which they were using to create very high temperatures for materials research, as well a display area with lots of pictures and some associated hardware from the Solar One development.

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