Columns

The Solar Cycle: Moving Past the Fad?

Wednesday, May 20, 2009 | Don Cullen - Managing Director, Photovoltaics, MacDermid Electronics Solutions

"As I move close to the edge of death, I find myself getting more cheerful about the economic future. I see a final breakthrough that solves the main technical problem of man. By harnessing the power of the sun, electrical power will become more available around the world. That will help humans turn sea water into fresh water and eliminate environmental problems. If you have enough energy you can solve a lot of other problems."

~ Charlie Munger, Warren Buffet's Vice-Chairman, speaking at the Berkshire Hathaway 2009 annual meeting.

Sunspots, an indicator of the sun's energy output, are known to occur in 11 year cycles. Interest in solar energy, leading to increased R&D investment, might be calculated to occur in 25 year cycles. We know the sunspot cycles will have the physical effects of a brighter, warmer, more magnetic sun. Will the "solar interest" cycle have the economic effect of a frenzy of solar cell activity, only to result in a post-solar hangover of forgotten PV projects?

Our star, Sol, demonstrates a surprisingly complex biorhythm. Sunspots come and go on an 11-year Schwabe cycle, coinciding with the sun's magnetic field reversal. During each cycle, as photons hit the Earth, luminosity increases approximately 0.1% peak-to-peak with the sunspots' arrival. But, when the sunspots' shadow moves over the earth, luminosity has been found to decrease by as much as 0.3% on a 10-day timescale.

All this math is good for a fluctuation of 4 watts per square meter at the planet's outer atmosphere. The Schwabe cycle is just the briefest of six known cycles observed in solar variation. For example, we are now within the "Modern Maximum," and have been since 1950. Solar Forming, the variation in solar energy reaching Earth, is charted in Figure 1. Combine the solar variation with the three main variations in Earth's rotational orbit, and we begin to explain Earth's history of ice ages. I should say "interglacials" since Earth's normal state is a good deal more icy than we now experience. Pardon my dissent from politically correct orthodoxy, Mr. Gore.

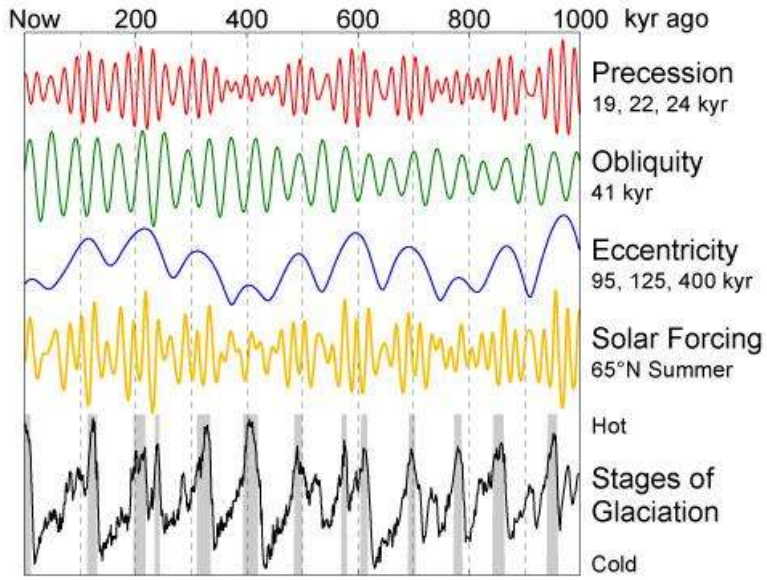
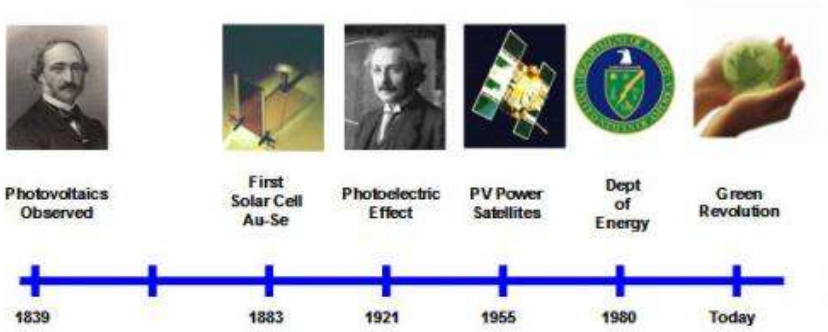


Figure 1: Solar Forming--the variation in solar energy reaching Earth.

Inspired by the idea of variations in solar power reaching Earth, I began to think about the solar cycles we, as Earthlings, create in our society. Reflecting on mankind's interest in solar power, I think of the promise of solar energy when I was a young lad watching President Carter on TV. I think of the first space satellites and their wings of solar modules and I think of the pioneers of photovoltaic theory. As if planned, according to a celestial calendar, these eras of increased interest in the sun tend to occur in a 25-year cycle.

Consider this: Jimmy Carter's energy epiphany (1980), the space race with Russia (1955), Einstein's identification of the Photoelectric Effect (1921), the construction of the first solar cell by Charles Fritts (1883) and Becquerel's observation of the photovoltaic phenomenon (1839.) These last two represent two 25-year cycles. I didn't look very hard, but I predict a significant solar event around the year 1863.



My (highly suspect) timeline predicts that we are in the tail end of a solar cycle right now. Whatever moniker we create to describe the current fascination in solar energy, perhaps, the "Green Revolution," can we expect that our infatuation with solar power will now fade quicker than a freshman's crush, retreating into obscurity for another 20 to 30 years? Is this current level of interest just another flash in the pan, like Carter, or a significant event, like Einstein?

This time, the peak is the real deal. Let me tell you why. The production of energy from the sun is now becoming a less expensive source of power than coal-fired, oil-fired, gas-fired or nuclear-generated electricity. Grid parity will happen over the next one to five years. There are those of you reading this, smugly sitting back in your computer chair, saying, "I've heard that story before," and you're right--during the 1970s, we had promises of the soon-to-be economic and efficiency breakthroughs enabling solar power's grid-parity. [For more explanation on grid-parity, please read my previous column, "Solarnomics: Grid Parity (Not a Football Term).]

The promoters of photovoltaics in the 1970s were wrong. Grid parity was not close at hand, but that was the only time solar energy was misrepresented as economically desirable. The space race was not interested in consumer affordability. The interest was in powering expensive, orbiting satellites to spy on Russia. Einstein was not promoting the purchase of solar modules for your local university's rooftop. He was outlining the blurred identity between photons and electrons. And Becquerel was not making a profit from Radio Shack solar calculators. He was trying to explain the charges generated when he opened the window blinds on his lab experiments.

1955	1979	2002	2009
$1785/Wp	$32/Wp	$3.10/Wp	$0.99/Wp

Historical Costs of Commercially Available Solar Modules (Wp = watts-peak)

Here is an incomplete list of why this solar cycle--part of the Green Revolution--is here for good. Grid parity will be achieved over the next one to five years as a result of these factors:

- Obama-bucks will subsidize residential and commercial solar installations.
- Economies of scale bring the price of installed modules from $5/watt to less than $2/watt.
- Recent silicon manufacturing capacity expansion, and the resulting oversupply, will bring substrate pricing to $30/kg.

- Attraction of competitive suppliers and cell makers will spur innovation.
- Deployment of new PV designs will radically decrease cost per watt. ($/Wp is declining at a compound annual rate of 10.9% since 1979.)
- The predictable increase in PV efficiency, growing at a compound annual rate of 5.9% since 1970, will interact with predictable decrease in costs.
- The soon-to-be adopted "carbon tax" will be written into law.
- Non-quantifiable factors, such as environmental awareness and political motivation, are driving the green-energy transition faster than even the economics can.
- The cost of solar generated electricity, at about $0.30/kWhr without subsidy, will soon plunge below the homeowners cost of power, which is now $0.19/kWhr on my electric bill.

The solar cell manufacturing industry has reached critical mass, borrowing a term from another type of energy. Solar cycles will come and go. Sunspots will continue their path across the surface of the sun. On that, you can bet the farm. Interest in solar energy will come and go as well, but the PV industry has now bridged that divide between fad and institution. It is here to stay. The next solar cycle will build on top of our current level of interest, as we chug along, putting solar modules on our supermarkets.

Reference: Willson, R.C., Hudson, H.S., *The Sun's Luminosity Over A Complete Solar Cycle*, *Nature*, 351, 42-44 (1991).

Don Cullen is Managing Director of Photovoltaics at MacDermid Electronics Solutions, where he has some time for playing in the world of interesting technology. His 20 years at MacDermid include R&D, project management and technical marketing roles for metallization, oxide and surface finish chemical processes. Don holds three patents in PCB manufacturing and has published more than 80 industry articles, peer-reviewed white papers, Webinars, workshops and conference articles; his most recent work appearing in Coombs' Printed Circuit Handbook. He coordinates MacDermid's variety of projects serving the PV industry, and looks forward to more use of this truly clean energy. To contact Don, ***click here****.*