

## An Alternative Energy News Source Interview with Professor Beckman of the Solar Energy Lab

Interviewed by Russell Hasan

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Professor Emeritus William A. Beckman is the Director of the Solar Energy Lab (SEL) of the University of Wisconsin - Madison. He received his PhD in 1964 and has gone on to become one of the internationally recognized leaders in the field of solar technology. Last year he won awards from both the ISES and ASES solar energy societies. We spoke with Professor Beckman about the solar silicon shortage, reducing pollution, helping developing countries, and technical aspects of solar technology.

Altenews: On the subject of the history of solar energy, who are the pioneers of the creation of solar technology, and what were the major historical events in the development of solar energy?

Beckman: The major technical advance was done at MIT in late 30s and early 40s, and into the 50s, under the direction of Professor Hoyt C. Hottel, and he had two major grad students who continued it. They were B. B. Wortz and Austin Whillier. Whillier continued for many years, he laid down foundations for all solar thermal, house heating and water heating. They were the leaders.

Altenews: How long have you been the Director of the Solar Energy Lab?

Beckman: I started in 1963. Professor John A. Duffie was director at the time. The Solar Energy Lab is the oldest continually operating solar lab in the world. Duffie retired 20 years ago, and I started then. I am still director now, although I officially retired from teaching.

Altenews: Last year you received an award from the International Solar Energy Society. What was that award for?

Beckman: There were a number of awards last year. There was the H. C. Hottel award, a couple years ago, and the Farrington Daniels award. Farrington Daniels was a chemistry professor here at the University of Wisconsin. He was a major force in the Manhattan project. After the war he was interested in helping impoverished nations, so he started working in solar energy research. He was a founding member of the International Solar Energy Society, he was its first president, and he supported the society not just with his own efforts, he supported it financially. He was a founding father of a major solar energy society.

Altenews: What do you consider to be your biggest achievement in the field of solar energy research?

Beckman: Personally, the publication of solar energy textbooks. The first one was in 1974, continuing on until last Friday, when I sent final revisions to the next edition due out in August. The name of the book is "Solar Engineering of Thermal Processes." In all honesty we have the international solar energy book market sown up, it has been for 30 years, and that's why most people know me and Duffie, who passed away last year.

Altenews: What have been the major advancements in solar technology during your time with the Solar Energy Lab?

Beckman: Well, things that I've had nothing to do with would be photovoltaic, problems in material science, physics. We were not involved in that, we have been involved in photovoltaic in the engineering part, such as how big, how much power, irregularity of sunshine, predicting the performance of solar energy systems, to design intelligently, for least cost or maximum power, we've done that for 30 years. The process we developed in the lab created two major software programs used internationally. One is called F-Chart, which predicts performance of solar heating systems, and it is used extensively by industry and government. The other is TRNSYS, transient simulations, this is doing detailed studies of solar energy dynamics, to graph the complete process of what's happening.

Altenews: Your website lists a study by the Solar Energy Lab concerning reducing emissions to reach levels required by the Kyoto Protocol. Which solar technologies do you see as having the greatest impact on reducing pollution?

Beckman: It's clear that solar water heating would be the country's best choice in reducing pollution, in my opinion, because to heat your water by a typical family of 4 generates as much CO<sub>2</sub> as a family car, and we can easily cut that in half with solar water heating. It would be virtually impossible to cut that in half on cars. Solar water heating is economically attractive, you save money with solar water heating, and that goes for the whole country. There is enough sun to do it.

Altenews: How does a solar water heater work?

Beckman: A solar water heater uses a metal plate with water tubes connected to it. A glass cover over the top allows solar energy to pass and heat the plate which in turn heats the water. The cover reduces the losses (both convection due to the wind and infrared radiation). The back side of the plate is insulated. There is a pump in the system that pumps cold water from the bottom of a storage tank (looks like a conventional hot water heater) through the collector and the hot water is directed back to near the top of the tank where hot water is stored. In cold climates we pump glycol through the collector and exchange heat with water in a heat exchanger located inside the house.

Altenews: What factors determine the efficiency of a solar panel?

Beckman: For electrical generation, the inherent efficiency of photovoltaic, which depends on materials and manufacturing skills. A PV (photovoltaic) cell is typically 15%

efficient, can be as low as 8%, lab cells can be as high as 30%. It is the dollars per watt that is important, not the efficiency, what costs less is a better buy. It is a materials and manufacturing problem, the question of how efficient. 25 to 30% is probably impossible in a manufacturing environment, it is extremely difficult in the near future. Solar thermal, the design of solar collectors, problems in fluid mechanics and heat transfer, is what half of my book is about, predicting solar systems. I have only one chapter on photovoltaic, thermal has more engineering decisions.

Altenews: There have been reports of a shortage of silicon that has had a negative impact on solar cell manufacturing. What do you think has caused this shortage, and when do you think it will end?

Beckman: It is not the silicon. Most of the cells are made by rejected wafers from the computer chip industry, if it is not quite suitable for a \$400 chip, they sell it to PV manufacturers, and their value is much less. There hasn't been much excess, it is a problem in supply. I believe that there are facilities developed just for silicon cells. PV cells are not just made of silicon, there are other materials involved, none of which are in shortage.

Altenews: There have been reports that Germany and Japan are more advanced in solar technology than the United States. How do you think the U.S. ranks compared to other countries in terms of solar innovation?

Beckman: Well, as public policy the EC (European Community) has really pushed solar technology, even though their climate is worse for it than the U.S. They have nothing like Arizona, it is more like Schenectady New York. There is not much sun, but they really pushed hard to get people to think environmentally about the benefits of solar. There are lots in Austria, Germany, Switzerland, and no systems going up in the U.S. In technology in photovoltaic, Japan took the lead because they were smart, they put solar cells in calculators, that gave them a fairly large market in which to learn to make efficient cells. Bell Labs invented these things, so we should have had the best chance of doing something with it, but the Japanese took it over for commercializing it. Germany is not ahead of us in PV, but Japan is, and Germany is ahead in solar thermal. Japan has gone a different route in thermal, with batch heaters, they heat during the day, but are not good sitting all night long, when they use water heated by electricity. When the sun is out there is a collector, they use that. There are lots of those systems. Most of the increase in use in China is solar water heating.

Altenews: Do you think that there is enough funding for solar research from the United States government?

Beckman: Absolutely not. They are putting less and less money in every year. I have not been following dollar values, but I know solar thermal money is tiny, it supports a couple of people. Photovoltaic get more, but it is pretty minor compared to nuclear research.

Altenews: It has been claimed that in one hour the Earth receives enough solar power to fulfill the energy needs of the planet for one year. Is that true?

Beckman: I've seen comments like that. Most of that falls in the Pacific Ocean. It is probably true but I would have to do some calculations. That is not a useful idea. Enough sunlight falls on a house to heat and cool, what comes in in a year is enough to do everything in your house. There are some zero energy houses, most of those use solar thermal and PV.

Altenews: Is making solar energy mainstream just a matter of building more solar power plants and installing more solar home systems, or are advances in solar panel efficiency needed?

Beckman: I don't think technology is holding us back, it's education. When is the last time we heard the President say we should push solar energy? I don't recall that being said, or any of them doing anything like that. We need broad-based education, for example California is putting a lot of effort into promoting solar. Wisconsin is doing very little. Most states are behind California. One of the reasons is that California is using our software to predict the performance of systems sold, for rebates.

Altenews: Your website says that in its early years the Solar Energy Lab was concerned with solar energy in developing countries. In what ways can solar power help Third World Countries?

Beckman: Well, in the generation of electricity, at the household or village scale, it is much cheaper to bring in PV panels, for individual houses or a village, to supply electricity for a few light bulbs and radios, that is much cheaper than to bring in power lines. A large part of the world is still without electricity, so solar can make an impact in remote villages. Bigger scale solar thermal systems can generate electricity. There is a very large system in the Mojave desert, built by an Israeli company called LUZ, at Kramer Junction, in the 1980s. It was since bought by FPL. It is also called SEGS, solar energy generating system. It is still producing electricity, and it is hooked to the California grid. That system can be replicated in Africa or India, where villages have no power, and small systems could bring substantial power, using the sun instead of coal.

Altenews: What changes and innovations do you see in the future of solar energy?

Beckman: The general problem is, nobody knows about solar water heating. They have to advertise, pound on doors, and spend lots of money to sell water systems. If state or federal government were to bring solar water heating to the public eye, it would be a good thing, selling costs would disappear, people would come to their door. Getting government involved in educating the public is not technological, but it will make solar really go.