Mallecia Hood

From: Ross McCluney [rmccluney@comcast.net]
Sent: Friday, April 25, 2008 10:02 AM
To: BellefonteCOLEIS Resource
Subject: Comments on NEPA scoping for Bellefonte
Attachments: Solar Alternative to Nuclear-Submitted.doc

Chief, Rules and Directives Branch
Division of Administrative Services
Office of Administration
Mailstop T–6D59
U.S. Nuclear Regulatory Commission
Washington, DC 20555–0001

2/21/08
73FR 9604
(59)

Attached is a digital version of the detailed comments I provided in paper form at the NEPA scoping hearing in Scottsboro, Alabama earlier this month. I think it was on the 2nd or 3rd.

In addition, since that hearing, I have become concerned about the karst topology of the region, the numerous caves and sinkholes near the site, and the sinkhole that appears as a pond, but is very deep, on a topo map that includes the site.

Coupling this with the earthquake that occurred in southern Illinois recently, with aftershocks that appear to have had an even higher reading on the Richter scale, I think you must take a very careful look at TVA's work on the combined geology, hydrology, seismic, and other safety issues at the Bellefonte site. None of these should be considered in isolation from the others.

Also, I refer you to the paper and Power Point slide presentation "Preliminary Dispersion Modeling for the NuStart Plant at Bellefonte" by TVA scientists Doyle E. Pittman and Kenneth G. Wastrack found at http://hps.ne.uiuc.edu/numug/archive/2006/presentations/pittman_doc.pdf.

SUNSI Review Complete
Template = ADM-013

E-RIDS=ADM-03
Add=M. Hood (mah2)

It refers to met data obtained fairly recently and seems to urge a relocation of the reactors, further away from the southern site boundary. I was not able to examine in detail what TVA says about the dispersion issue in their environmental report, due to limited time and to the difficulty I have had, reported to you previously, accessing material in the environmental report. All I can do is urge your scientists to look closely at what TVA has said about dispersion, in the light of the changing climatological conditions in our region, some attributable to global warming effects.

Living northeast of the site, in the direction of the peak fluke in the wind rose for wind speed and direction probability at the Bellefonte site, my wife and I are personally concerned about our safety.

Finally, the Bellefonte site is not the only one of concern to us in Chattanooga. There are numerous additional coal- and nuclear-powered electrical generating stations in our region. I worry about the clustering of these, and the combined risk to us of radioactive and other toxic emissions from all these plants. Perhaps there is a magnification effect that increases the risk, magnitude, and potential toxicities of radioactive and other emissions due to the presence of all these plants. Bellefonte should not be considered in isolation from all the other sources of radioactive and other toxic emissions in the area, including Oak Ridge National Laboratory. Any NEPA or radiological safety report will be inadequate if the clustering effect is not considered.

Dr. Ross McCluney
SunPine Consulting
3517 Elderview Dr.
Chattanooga, TN 37419
Home: 423-821-0981
Cell: 321-917-8292
RMcCluney@comcast.net
www.rossmccluney.com

Solar Alternative to the Bellefonte Nuclear Plant

By Ross McCluney, Ph.D.
BEST Chapter of Blue Ridge Environmental Defense League
Chattanooga, Tennessee
Statement for a Nuclear Regulatory Commission National Environmental Policy Act Scoping Hearing at Scottsboro, Alabama regarding TVA's proposed nuclear power at the Bellefonte Site
3 April 2008

I argue against the dismissal in TVA's Environmental Report for the Bellefonte nuclear reactors that solar is a viable alternative to nuclear at the Bellefonte site.

A recent revolution in photovoltaic solar electric cell manufacturing is producing dramatic decreases in the costs to manufacture and install solar electric generating arrays. Imbedded energy levels are also decreasing, meaning that it is taking far less fossil fuel energy to manufacture the cells. In one new case, the imbedded energy is so low that it takes only from 1 to 3 years for the power output of the solar cell to match the energy input to make the cell. [1,2] Along with this reduction of imbedded energy, the new cells also are associated with very low emissions of harmful pollutants during manufacture, compared with conventional power plants. The report cited concludes that "Overall, all PV technologies generate far less life-cycle air emissions per GWh than conventional fossil-fuel-based electricity generation technologies. At least 89% of air emissions associated with electricity generation could be prevented if electricity from photovoltaics displaces electricity from the grid."

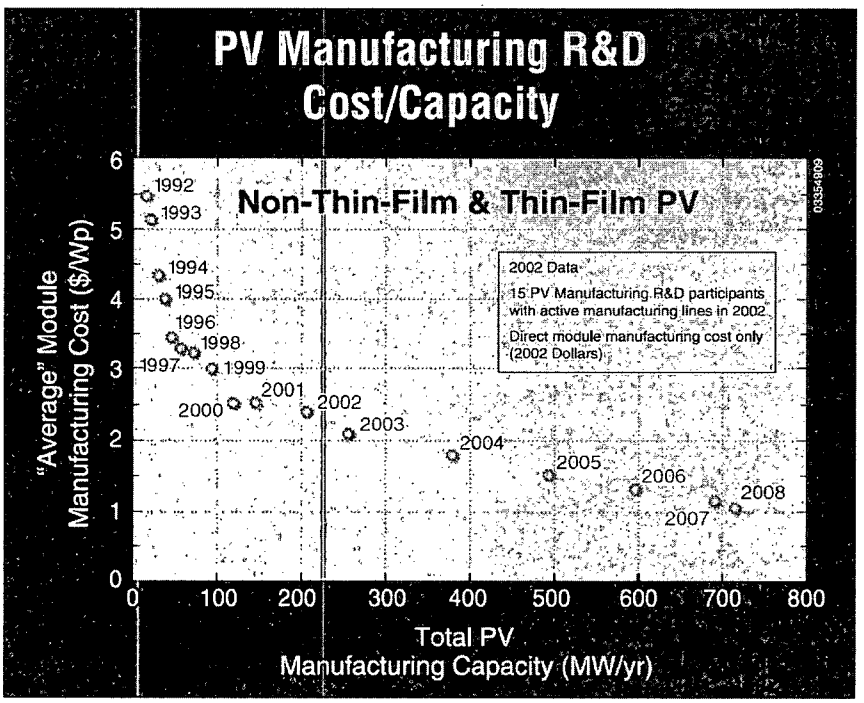

Figure 1. Average manufacturing cost of solar photovoltaic modules versus manufacturing capacity from 1992 to 2008. Source: Information Bridge: DOE Scientific and Technical Information , DOE's Office of Scientific and Technical Information

Additionally, PV manufacturing costs have been decreasing steadily for a number of years, as illustrated in Fig.1, from a U.S. Department of Energy report.[3]

Along with these improvements, solar cell energy conversion efficiency has also grown from around 14% for conventional crystalline silicon cells to 18.6% for a new Mitsubishi multi-crystalline silicon solar cell.

Nanosolar , Inc. has made recent breakthroughs in reducing the cost to manufacture solar cells, based on seven areas of innovation. The substrate can even be a flexible material, making it possible to place solar cells on curved surfaces.

With these improvements in the technology of solar cells, it becomes feasible to generate copious quantities of electrical power at modest cost, even when the solar resource is less than optimum.

There is a perception that the southeastern United States has too low a solar resource for economic viability. This is a misconception.

Using the National Renewable Energy Laboratory online solar resource calculator PVWatts, version 1, and for solar arrays facing south, tilted to the latitude angle, the annual average solar radiation availability is 6.57 kWh m^{-2} day^{-1} in Phoenix, Arizona, a region of very high solar availability. It is 4.95 kWh m^{-2} day^{-1} in Huntsville, Alabama. Thus the Phoenix resource is only 33% greater than in Huntsville, so that to collect the same annual amount of power from the sun, one only needs to expand a Huntsville solar array area by 33% for equivalency.

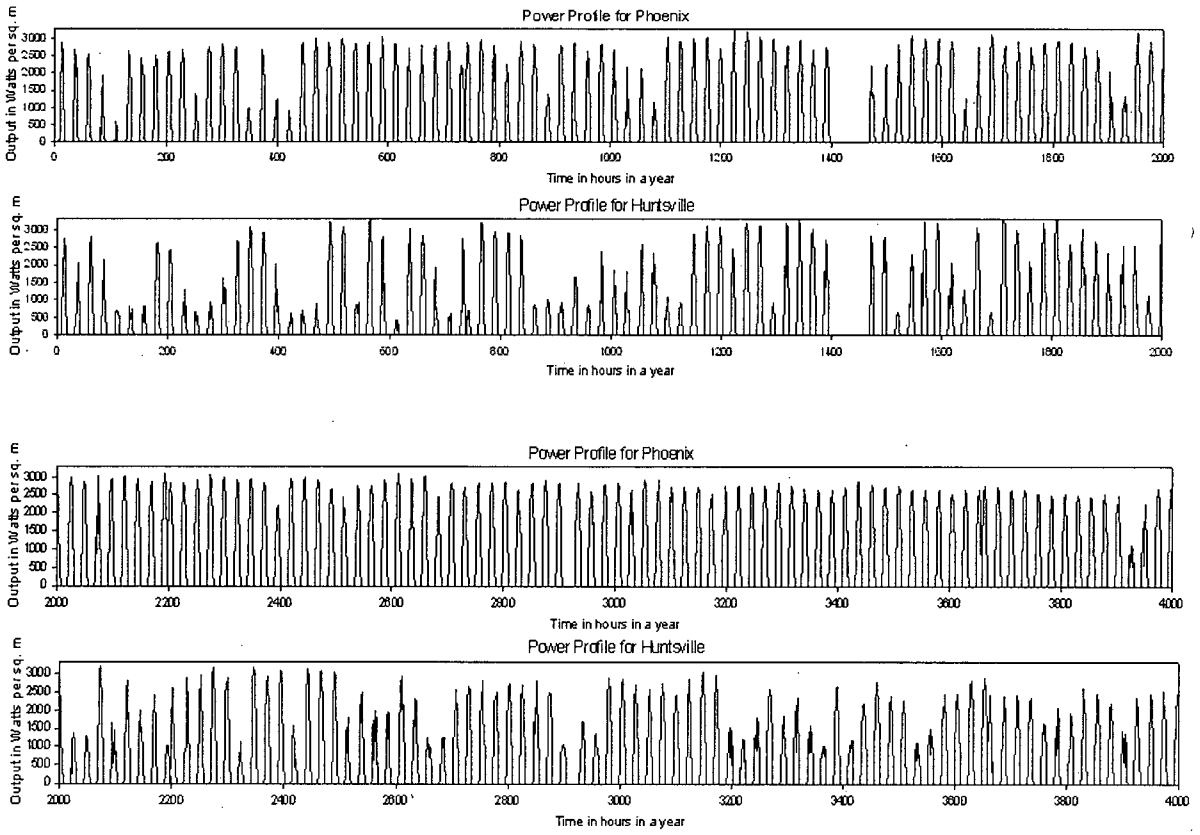

Figure 2. Hourly solar PV array output in Watts for hours 1 to 4000 in a single year for Phoenix, AZ and Huntsville, AL

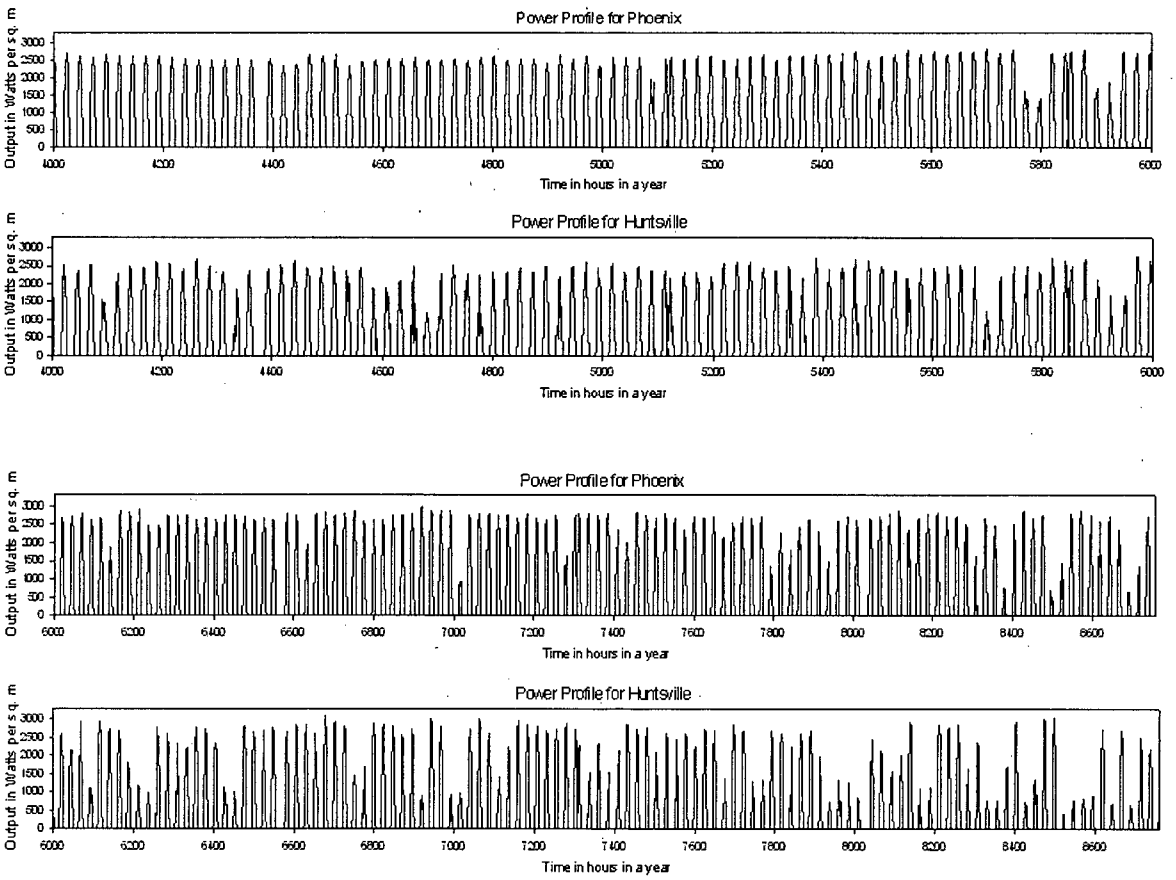

Figure 3. Hourly solar PV array output in Watts for hours 4000 to 8760 in a single year for Phoenix, AZ and Huntsville, AL

For a more complete assessment, I examined the time profiles of solar availability at the two cities. Solar availability in Phoenix has more constancy from day to day than the Huntsville site (with a few exceptions). I used data for a single year, 8760 hours, and compared the profiles for the two cities. The results are shown in Figures 2 and 3. Huntsville solar availability, though strong, is somewhat more changeable from day to day.

Need for Short Term Energy Storage

In summer months, the electricity demand is highest during the afternoon and early evening when air conditioning systems are working hardest. There is a slight phase shift, however, with the cooling demand lagging into the early evening hours as the sun is setting and solar output is diminished. Thus, there is a need for storage of the solar energy collected during the peak hours following solar noon and releasing it several hours later as the sun sets but the electric demand remains strong.

On periods of successively cloudy days, solar heating of buildings and the corresponding A/C demand will be low, so the lessened solar availability during those periods is not a problem, due to the lowered electrical demand. We are left with a need for only short term storage of electricity during the summer months.

TVA Uniquely Suited for Storage of Electrical Energy

TVA is well-suited for utilization of a variety of methods of short and longer-term storage of electrical energy. Its experience with pumped storage for both short- and long-term storage, coupled with ownership of huge areas of land on and near hilltops, make possible large arrays of solar electric generating plants coupled with pumped storage to better match solar electric output to the temporal demand profile of the utility in the region of the solar power plant.

I do not propose the destruction of forests to make way for solar collector arrays. However, there may be areas near existing dams that have already been disturbed and which could easily accept the new, less expensive, large solar PV arrays. These possibilities should be explored.

Solar energy, with short-term electrical storage, can be applied on smaller scales using a distributed power approach. Smaller-scale distributed energy storage may be more feasible and suffers smaller line losses, since the energy is stored and used near where it is generated.

Distributed Solar Electric Generation

An alternative to large-scale pumped-storage is to choose from a variety of alternative short-term electrical storage options. Investment by TVA into distributed solar electricity in this case makes a lot of sense as an alternative to the nuclear option.

TVA already has its "Generation Partners" program, through which businesses and homeowners invest in solar electric generation capacity on their properties, at no cost to TVA. In return, the local utility, working with TVA, meters the electricity generated at the local site and pays the property owner for every kWh generated at that site. The rate paid to the owner is approximately double the local rate they pay for the electricity they pay to the local provider. This is a win-win-win proposition. The electric utility gets new generating capacity that fairly well matches the summertime peak load profile (except for the few-hour time lag between the sun going down and A/C demand also dropping). The property owner gets paid for their investment in solar, and the public benefits from having a more secure (distributed) power system and the corresponding reductions in greenhouse gas emissions and emissions from other air pollution at fossil fuel fired generating stations.

Solar is Less Costly and Less Risky

TVA estimated the cost to build the two Bellefonte nuclear units at $2.5 billion to $3.5 billion each, for a total of $5 - 7 billion. A proposed Progress Energy nuclear venture in Florida escalated from an estimated range of $5-7 billion in 2006 to over $10 billion. A Florida Power and Light two-unit project, also using the Westinghouse AP1000 design, now ranges from $12 to $18 Billion.

TVA could spend a fraction of these costs to help customers install a large quantity of photovoltaic solar arrays on suitable rooftops of their buildings. If TVA would pay from 60% to 75% of the purchase and

installation costs, its contract with these customers could give TVA control over the solar power produced and especially the amounts and times of solar power stored onsite or sent into the electrical grid. By covering most of these costs, the generation partners program would expand dramatically, TVA customers would benefit from reduced electric bills, and new capacity could be built with this program that would be more than enough to cover anticipations of rising demand in the TVA system. Solar energy electrical power can be brought online and generating revenue in a small fraction of the time to get a nuclear plant up and running. Capital outlays come in smaller increments and payback much more quickly.

A plan to lease commercial building rooftop space for modest-scale distributed solar electric generating stations is being considered by Southern California Edison, with a specific aim to use these stations as "solar peaker plants," feeding into existing distribution assets. SCE announced 27 March 2008 a large scale solar energy program as a peak demand response mechanism that will require no transmission lines, a top feature of the new project according to SCE officials.[4] In a joint press event with SCE, Gov. Schwarzenegger called upon other utilities to follow Edison's example: "I urge others to follow in their footsteps. If commercial buildings statewide partnered with utilities to put this solar technology on their rooftops, it would set off a huge wave of renewable energy growth."

If some means can be found to provide short-term storage at these small distributed power stations, TVA will have an ideal alternative to its proposed new nuclear power plants.

Small Scale Electrical Energy Storage Options

There are several short-term (3-4 hour) storage mechanisms the utility can and should consider for use in a greatly expanded distributed power network based on solar power.

1. Flywheel storage
2. Advanced batteries
3. Ultra-capacitors
4. Compressed air
5. Superconducting magnetic energy storage

The U.S. Department of Energy has research programs on each of these storage technologies. Some are more advanced than others. Looking at just advanced battery technologies there is a large number of possible technologies, some very promising.

- Lithium-ion, lithium polymer, aluminum-iron
- Sodium metal chloride, sodium sulfur
- Nickel metal hydride
- Sodium sulfur
- Zinc-bromine, iron-air, zinc chloride
- Iron chromium, zinc-ferrocyanide, Li-FeS
- Flow Batteries

According to the U.S. Department of Energy, "Rechargeable lithium batteries are a very promising new energy storage technology. Lithium-ion batteries in laptop computers, for example, can provide twice as much operating time as conventional batteries.

Advanced batteries they take up less space and have excellent maintenance characteristics. New versions will offer longer lifetimes, greater operating ranges, and significantly less maintenance, making them more suitable for remote locations.[5]

Flow batteries are an interesting and promising new development. A central battery unit provides power, but total energy is furnished by a reservoir of rechargeable electrolyte which can be as large as needed, and situated where convenient. This offers potentially higher efficiencies and longer life than conventional lead-acid batteries. Their key advantage is that they can be a truly closed system with an electrolyte that is regenerated, rather than having to be replaced. In vanadium redox batteries, plastic containers can be used to store the electrolyte or it can be pumped to large buried storage tanks. A 15-MW, 120-MWhr sodium-bromide battery system is under construction in the United Kingdom. Zinc-bromine batteries are available off-the-shelf and have been widely deployed.[5]

Ultra-capacitors. Capacitors are essentially large sheets of conductor separated by large sheets of insulator. Usually they are wrapped into a cylinder with two electrodes exposed on the outside. They work by accepting, and storing, electrical charge when a direct current (DC) voltage is applied to their electrodes. These new devices can store amazing amounts of energy in a relatively small space, they are safe, and they can be discharged either slowly or very rapidly. Finally, ultracapacitors can remain on charge indefinitely with no adverse effects. Ultracapacitors extend the availability of solar energy, perfect for electric utility applications. [6]

Jobs for Scottsboro

The town of Scottsboro, Alabama, near the Bellefonte site, is experiencing economic hard times and is anxious to benefit from an economic stimulus, especially new jobs, which it hopes will result from the nuclear plant construction and operation there. If TVA follows the solar alternative proposed above, it wouldn't take much investment to attract many more new jobs and provide much more dramatic economic growth in Scottsboro, by making the town a thriving hub of solar electric generation systems and components manufacturing. Green technology is generally very labor-intensive. Though some of the manufacturing processes can be automated, it still takes skilled operators to keep the computers and robotic machines going. There are also a large number of jobs for metal forming machine operators, component assembly workers, and wiring specialists needed for such an industry. Mechanical and electrical engineers will be needed and warehousing and shipping facilities will have to be built and operated. The economic stimulus action of such a development, if the City of Scottsboro will embrace it, could far exceed the expected economic benefits of the proposed nuclear reactors. TVA has plenty of power to assist such a development and the State of Tennessee would be sure to offer assistance and financial incentives if asked.

Conclusion

Whether TVA uses large-scale solar electric arrays coupled with new mountaintop pumped-storage, such arrays at existing dam sites, or develops a new solar distributed power network, with on-site short-term electrical storage, any of these would go a long way toward bringing solar electric generation close to base load operation, while at the same time providing summertime peak load capacity.

It is clear this would be a better long-term investment for TVA than nuclear reactors, which have the following disadvantages compared with solar and other renewable power:

- Very large capital costs
- Much longer times between investment and revenue generation
- Much higher O&M costs, which include the high costs of operating a nuclear reactor around the clock, staffing the facility 24/7 for both operation and protection in the case of problems and emergencies, high security staff and equipment costs
- Much greater exposure to adverse publicity and to high short-term costs in the event of accidental releases of high levels of radioactivity
- Much higher environmental threats and costs associated with guarding against these releases
- Very high costs for security and protective force for prevention of terrorist attack
- Very high costs for recovery from terrorist attack or accident. Solar arrays are unlikely to be attacked and if they are, the consequential risks to the public are slight, the costs to repair will be low, and the time to get the facility back on line will be much shorter than is the case for a nuclear reactor
- High costs, publicity risks, and danger from accidents or terrorist attacks on the transportation of nuclear fuel and wastes to and from TVA nuclear reactors

Contrasted with nuclear power, solar energy is essentially inexhaustible, and is relatively benign environmentally. Rather than face massive opposition from the public, a major investment by TVA into solar power would make the utility a better friend of the environmental community as well as the masses of people concerned about, worried over, or downright scared of nuclear power. A distributed solar approach, with limited on-site storage, would be in keeping with TVA's original mandate to provide inexpensive electrical power with high reliability. The huge quantities of money the TVA will ultimately have to spend on building, fueling, protecting, and maintaining nuclear power plants would better be spent on energy conservation and solar energy of the sort envisioned here.

---

[1] "Study shows solar cells' energy payback is down to 1-3 years", Tuesday, March 11, 2008, http://www.edn.com/blog/1470000147/post/190023219.html?nid=2432&rid=783958873

[2] Vasilis M. Fthenakis, Hyung Chul Kim, and Erik Alsema, "Emissions from Photovoltaic Life Cycles" *Environ. Sci. Technol., 42* (6), 2168–2174, 2008. 10.1021/es071763q.

[3] U.S. Department of Energy, "PV Manufacturing R&D Project" trifold brochure http://www.nrel.gov/docs/fy04osti/35491.pdf, accessed 26 March 2008.

[4] "California Utility Touts Solar Peakers As Transmission Alternative", 31 March 2008, www.EnergyWashington.com, accessed 1 April 2008.

[5] http://www.eere.energy.gov/de/batteries_advanced.html, accessed 30 March 2008.

[6] http://www.ultracapacitors.org/, accessed 30 March 2008.