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December 15, 2017

Martha Lynn Jarvis
Chief Clerk
North Carolina Utilities Commission
430 North Salisbury Street
Raleigh, NC 27603

RE: Docket No. EMP-93, Sub 0
Wilkinson Solar LLC

Dear Clerk Jarvis:

Introductory Comments:

My comments in this testimony are related to two previous testimonies on the subject Docket:

- My testimony of July 26, 2017 and
- Mr. Brian Coble's testimony of September 22, 2017.

There appears to be some question as to which Capacity Factor to use in calculating the Megawatt-hours (MWh) to be generated by the proposed 74 MW Wilkinson Solar Power Plant. My earlier testimony indicated that the capacity factor would be in the range of 16 to 20%, whereas Mr. Coble supported the 27% capacity factor claimed by Wilkinson. This difference will have a significant impact on the projected annual MWh that Wilkinson believes their proposed 74 MW plant will provide.

Background:

I am an Emeritus Professor in Mechanical & Aerospace Engineering at NC State University. I retired on June 30, 2016. In late August of 2015, I received a phone call from an NCSU Extension Agent located in Eastern North Carolina. He called me because of my reputation in building the NCSU Solar House and my other solar teaching and research activities. He was very concerned about what was happening to his county. In his words, he stated, "They are covering my farmland and cutting down my forests to put in these solar panels. I don't know what is going to happen to my county." He ended his call by asking, "Can you help me?"

That is how I initially got involved with the Solar Farm Industry and why I am writing to you today. Most of my work in Solar has been as a professor, but today I am addressing you as a private citizen.

I have been an advocate for solar energy for the past 40 years. In the late 1970s, I led the fight to get funds to build the NCSU Solar House on campus. In 1987, I founded the NC

Solar Center to spread the solar message to the four corners on our state. I served as the Faculty Chair of the Solar Center for 15 years and directed its research programs. Gradually, people began to get the idea that solar was a good deal – to provide heat for their homes and later, to generate some electricity.

Capacity Factor:

Since this testimony will deal with a projected Capacity Factor for a proposed solar power plant, it is best to begin with the definition.

By definition, *the net capacity factor of a power plant is the ratio of its actual output over a period of time (say one year), to the potential output if the plant is operated at its full nameplate capacity continuously over the same period of time (one year).*

Since we don't have actual operating data , it is best that we begin by dealing with an "ideal case" (i.e., a solar power plant operating under perfect conditions as described below)

- From a solar point of view, "ideal" means perfect weather conditions (no rain, no snow, no clouds, no storms). (*Of course, that is not possible in the real world.*)
- From an equipment point of view, "ideal" means that the solar power plant operates at 74 Megawatts for each hour when the sun is available. *(This also is not the case in the real world.)*
- From an operational point of view, "ideal" means that the solar power plant's operating hours vary from an average of 3.5 hours per day in winter to 6.5 hours per day in summer. Using these figures as a starting point, the average daily operating time (over the entire year) would be in the range of 5 hours per day. NOTE: Some people may claim an average operating time of 6 hours per day. Others even more.

We all recognize that the above conditions are not realistic, but they give us a starting point to establish an upper bound for calculating a maximum capacity factor.

Under these ideal conditions, based on operating 5 hours per day,

- A 74 MW plant would generate 135,050 MWh per year.
  The annual capacity factor corresponding to these conditions would be **20.8%**

Some may argue that the solar power plant really operates 6 hours/day.

- If that were the case, the capacity factor would increase from **20.8% to 25%.**

But others will argue that these ideal capacity factors are not realistic. They claim that the sun doesn't shine all the time and that the solar power equipment doesn't operate at 74 MW all the time. These statements are also true.

So, let's first take weather into consideration. What if we have good solar weather about 80% of the time. That seems like a reasonable assumption. If that were the case, the capacity factor would drop:

- **from 25% to 20%.**

We also know that the sun is low in the eastern sky in the morning and low in the western sky in the evenings. This means that the solar power plant doesn't operate at 74 MW all the time. This means that the average hourly MW output of the solar power plant may be in the range of 59 MW (rather than the former 74 MW.) Taking changing solar insolation into account, the real world capacity factor will drop:

- **from 20% to 16%.**

Still other people may claim that the solar power plant really operates 7 hours rather than 6 hours/day. Taking this increase in hours into account, estimated capacity factor increase from:

- **16% to 18.6%**

In Conclusion:

The purpose of the above analysis is to identify the various factors that affect the Capacity Factor of a solar power plant and to determine their impact on that Factor. The various steps taken in the analysis are listed below in step-by-step fashion:

I. The "Base" Ideal Case is 74 MW operating 5 hours/day:	**CF = 20.8%**
2. Increase Case 1. operating hours from 5 to 6 hours/day:	**CF = 25%**
3. Take weather into consideration and reduce annual operating hours from 365 to 292hours/year:	**CF = 20%**
4. Reduce average hourly plant capacity from 74 to 59 MW/hr:	**CF = 16%**
5. Increase daily operating hours from 6 to 7 hours/day:	**CF = 18.6%**

Each step has taken us closer to real world operation. And try as we might, we can see no justification for claiming a 27% capacity factor. Consequently, we don't see the Wilkinson claim of 175,377 MWh/year as being realistic.

Sincerely,

Herbert M. Eckerlin, Ph.D.
Emeritus Professor