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Utility Scale Solar Energy in Pennsylvania

Comments for Joint Hearing of the Pennsylvania Senate Environmental Resources & Energy and Agriculture and Rural Affairs Committees

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Senators Yaw and Vogel, honorable members of the Committees, good morning and thank you for the opportunity to address a number of energy-related issues at this joint hearing today, specifically in the area of utility scale solar. I am Tom Murphy, Director of Penn State's Marcellus Center for Outreach and Research(MCOR). MCOR is focused on energy transitions in the State and beyond, particularly at the convergence of shale gas and renewables. Our scenario development work with the PA Energy Horizons project in 2018/19 clearly projected that we would see an energy future in the State through the year 2040, defined largely by more gas and more renewables. This energy paradigm shift has been occurring in the last ten years largely from reduced cost for natural gas due to supply, and increased deployment of wind and solar due to advances in technologies lowering the cost of market entry.

As many are now aware, Pennsylvania is on the front edge of what appears to be a significant solar energy buildout due to early investment trends and applications to construct solar facilities. My colleagues have estimated there are now over 5000 landowners in PA which have already signed solar option contracts and the underlying leases. They forecast there could be an additional 10,000 landowners involved with ongoing leasing in the near future. Solar leases typically are written for a 25 year timeframe with the option to renew them for an additional like term. In numerous ways, there are many similarities between the solar energy development taking place now, with the shale gas exploration process which proceeded it. Similar forecasts indicate this investment in PA solar could reach $13 billion between now and 2030.

To reach the Commonwealth's energy policy goal of 10% of electrical power being sourced from solar, that would entail upwards of 80,000 acres of land surface to be transitioned from its present use, to that of solar generation. These "surfaces" could take many forms from large warehouse rooves, to brownfield sites like old strip mine locations or landfills, to sides of buildings with some of the newest technology still emerging from the lab. Presently, most of the utility scale solar is being situated on agricultural land due to its availability, willing landowner partners involved in the leasing process, and proximity to presently built infrastructure, such as electrical substations and overhead high voltage transmission lines. Present solar conversion efficiency is under 25% with most technology but is increasing incrementally due to new research, so land use needs to produce a MW of electricity are currently between 5 and 8 acres. That is expected to drop as efficiency gains increase over time. There are over 300 of these

projects in the PJM queue and seven have been built in the state. Industry projections are that 10-20% of what is proposed is actually built in the end. Utility scale solar facilities are normally several hundred to several thousand acres in size.

To fully appreciate the lifecycle of a utility scale solar facility, it is important to appreciate the technology at the field level. Currently, most panels being used are monofacial, meaning they capture and transform a portion of the sun's rays which hit the top surface of the panel. There are also bifacial panels which are able to capture the same surface light, as well as, reflected light from below the installed array. Some panels track, or "follow" the sun across the sky during the day, whereas others are fixed and set at a predetermined angle to maximize their capacity to generate power. Along with the solar panels, and the steel racking systems which support them, a common solar facility will also have inverters to change the power generated from DC to AC, so it can be utilized by the consumer. Buried cabling to move the power across the solar facility, and possible onsite battery units to storage off peak supply for peak consumption. Lastly, it is possible in the next 10 years, that there might be green hydrogen units co-located as a method of storage and/or as an alternative low carbon fuel option.

In our educational outreach with various public stakeholders tied to solar, we have received many questions about end of life with the technology. How is it decommissioned, what does that mean, are the panels landfilled, or is there a process in place to recycle the panels similar to other industrial products. It must first be recognized that most of the solar panels installed in the U.S. are relatively new and have a projected life expectancy of 25+ years. So by 2030, the U.S. and other countries will start to see the larger surge in decommissioned panels. And as panels being placed in the field have a cost, they also have a potential value at the end of their technical life.

In Europe, by mandate in most countries, solar panels have to be removed and recycled at the end of their lifecycle. Current solar industry estimates show that a ton of solar panels have approximately $550 in potential value if separated into their individual components and resold. Technologies to do that are still being perfected but are in place and operating. Most of the value is derived from the silver, aluminum, silicon, and copper in the panel along with its associated operating modules. But the process is expense in its current state and has not yet reached its maximum commercial efficiency. The processes to do the recycling normally involve a physical separation of exterior materials like the aluminum frame around the panels and attached wire. Then there is a thermal process to heat the panels to breakdown the glass backsheet, removing some of the encapsulated materials. And lastly a chemical processing can be used to extract and refine some of the more valuable metals for resale or reuse. In the end, only 10-15 percent of the original panel volume is waste needing final disposal. At this time in the U.S. there is one company which is offering solar panel recycling services but that is expected to increase as additional European technologies find application in the U.S.

Another question we commonly receive, is how can decommissioning be assured or guaranteed at the end of the lease term, once the panels are no longer efficient to operate due to technological advances. Or midstream, if a solar company abandons an operating project. For these reasons and others, a decommissioning bond is normally put in place as a performance guarantee. It is likely worth noting here

that the economics of deploying and running a solar facility have most of the costs on the front-end during construction and right after start-up. From there, the cost to the company is greatly reduced due to relatively low maintenance and no related fuel costs. That likely lessens the chance of a company completely walking away from a project in total but it doesn't assure who will own the project at the end of its life, since it is not uncommon for companies to sell projects before or after they are built. For that reason, a decommissioning bond is typically referenced in most leases with landowners, and is finding its way into more solar ordinances as they are being developed, or revised in municipalities across the Commonwealth.

One of the challenges with a solar decommissioning bond is determining 25 years into the future, the cost to remove the panels, all the related infrastructure, and offsetting that cost against the recaptured potential value of the recycled materials, particularly the more valuable metals. Many landowners don't have the market savvy to assess that outcome, and likewise, many municipalities don't have it either. Although the insurance industry covers bonds on other long-term scenarios which could appear similar, solar of this scale is relatively new in the U.S. Various approaches are employed in the State and beyond, to place a value on what a decommissioning bond should look like, and how it might have an inflation escalator built into it to account for costs over time. Active research by one of my law school colleagues, indicates that most PA solar ordinances which mention decommissioning, also commonly have a bonding requirement. So, there is some precedent in the State to use as a basis for other counties and/or municipalities with an interest in this issue. Other states also show examples where there is an ongoing periodic review and a decommissioning bond requirement in place can be adjusted to reflect new market realities and technological advances.

As we continue to expand our educational program related to the opportunities and challenges with solar in the Commonwealth, land use and technology lifecycle issues will be featured priorities, as those are consistently key issues for elected officials, policy makers, and community members across Pennsylvania.

Thank you for the time to discuss these topics of ongoing importance for many of your constituents in the Commonwealth and those beyond. I would be glad to address any related questions.