BEFORE THE
PUBLIC SERVICE COMMISSION OF WISCONSIN

Application for a Certificate of Public Convenience and Necessity of Silver Maple Solar, LLC to Construct a Solar Electric Generation Facility in the Townships of Eldorado and Rosendale, Fond du Lac County, Wisconsin, and Nekimi Township, Winnebago County, Wisconsin	Docket 9813-CE-100

DIRECT TESTIMONY OF MICHAEL J. VICKERMAN

ON BEHALF OF RENEW WISCONSIN

Q. Please state your name and business address.

A. My name is Michael J. Vickerman, and my business address is 214 N. Hamilton St., Suite 300, Madison, WI 53703.

Q. By whom are you employed, and in what capacity?

A. I am employed by RENEW Wisconsin (RENEW). My current position is Clean Energy Deployment Manager.

Q. On whose behalf are you testifying?

A. I am testifying on behalf of RENEW.

Q. Please describe your educational background.

A. I have a Bachelors of Arts degree in History and Art History from the University of Wisconsin-Madison.

Q. Please describe your work experience.

A. I began working for RENEW Wisconsin in October 1991 as its Advance Plan 6 intervention manager. I became RENEW's Executive Director in 1994, and served in that capacity until 2012. I continued working for RENEW as its Policy Director, a position I held until early 2023. In my current capacity as RENEW's Clean Energy Deployment Manager, I engage in regulatory and permitting proceedings at the state and local level involving either approvals of individual renewable generation projects or broader issues affecting clean energy development across the state. My professional qualifications are further summarized in Ex.-RENEW-Vickerman-1.

Q. Please describe RENEW.

A. RENEW is a domestic, nonprofit corporation headquartered in Madison that works to advance the renewable energy goals adopted by the State of Wisconsin over the years. Since its founding in 1991, RENEW has worked to increase access to and development of renewable energy sources in Wisconsin to power homes, businesses, and vehicles. To that end, RENEW formulates and advocates for policies and programs to expand the use of solar power, wind power, renewable natural gas, local hydropower, ground-source and air-source heat pumps, energy storage, and electric vehicles.

Q. How does RENEW advance solar power as a general policy matter?

A. In recent years, solar generation has emerged from the margins of the electric power landscape to become a reliable and cost-effective energy resource for a wide variety of applications and circumstances. Solar power's emergence owes much to its remarkable scalability, unmatched by any other generation source

today. Many RENEW members are active in solar electric development. They include contractors and consultants specializing in behind-the-meter installations for retail customers, solar arrays directly feeding utility distribution systems, and large-scale solar power plants supplying multiple electric providers. To a degree unmatched by any other state-based organization, RENEW works to increase the accessibility of solar energy, in all sizes and configurations, to all citizens of the state. In furtherance of that aim, RENEW became the Wisconsin state chapter of the Solar Energy Industries Association in 2020.

Q. What is the purpose of your testimony in this proceeding?

A. The principal purpose of my direct testimony is to discuss the importance of the Silver Maple Solar project (Silver Maple Solar), proposed by Leeward Renewable Energy, an independent power producer. As a utility-scale source of zero-carbon renewable electricity, Silver Maple Solar is yet another example of the ongoing transition to replace older fossil generation sources with in-state renewable generation. This transition is, in RENEW's view, very much aligned with the public interest. I will also provide an estimate of the project's likely impact on carbon dioxide emissions attributable to Wisconsin's electric power sector.

Q. Have you prepared any exhibits with your direct testimony?

A. Yes. In addition to Ex.-RENEW-Vickerman-1 referenced above, I am sponsoring the following exhibits:

- Ex.-RENEW-Vickerman-2, RENEW's Solar Project Tracker dated July 2023.

- Ex.-RENEW-Vickerman-3, a table listing utility-scale projects in Wisconsin and their respective land coverage totals.

Q. Were these exhibits prepared by you or under your supervision?

A. Yes.

Q. Please describe the advances that utility-scale solar power has achieved in recent years as a core generation resource in Wisconsin.

A. As a component of our public education efforts, RENEW tracks solar development activity occurring in Wisconsin and periodically publishes updates on our website. As indicated in Ex.-RENEW-Vickerman-2, the state is in the early stages of a significant buildout of solar generating capacity. Though the scale of the buildout was modest at first, it has been accelerating since 2020. The largest category of solar power projects—those totaling a minimum of 100 megawatts (MW) of capacity—require a Certificate of Public Convenience and Necessity (CPCN) issued by the Public Service Commission (Commission) before they can proceed to construction. From April 2019 through June 2023, the Commission approved 16 CPCN applications acounting for 2,950 MW of solar generating capacity. Several of these solar project proposals are paired with battery energy storage systems (BESS) designed to provide grid support during the late afternoon and early evening hours. As of today, three of the solar projects that received CPCN approval—Two Creeks Solar , Point Beach Solar Solar, and Wood County—are fully operational, totaling 400 MW. Over the next 12 months, five additional plants with CPCN permits—Badger Hollow Solar 2 (150 MW), Onion River Solar (150 MW), Paris Solar (200 MW), Grant County Solar (200

MW), and Springfield Solar (100 MW)—should become fully operational. In addition, the Commission approved two applications from Wisconsin Power and Light to construct and operate eight solar plants that had already received siting approval from local jurisdictions. All eight plants, totaling 489 MW of capacity, are expected to be operational by June 2024. When distributed solar generation projects are added to the mix, Wisconsin could see upwards of 1,300 MW of new solar generation capacity come online before July 2024.

Q. How does Silver Maple Solar fit into the solar buildout underway in Wisconsin?

A. With the recent approvals of Portage Solar, Saratoga Solar, Northern Prairie Solar, and High Noon Solar, there are, as of this writing, three solar generation projects undergoing review via the Commission's CPCN process, including Silver Maple Solar. The other two are Elk Creek Solar (9819-CE-100) and Langdon Mills Solar (9818-CE-100). If approved, the combined capacity of these projects would amount to 700 MW (see Table 1 on page 6), with Silver Maple Solar accounting for 200 MW of that total. All in all, I estimate that there are approximately 4,286.3 MW of utility-scale or front-of-meter solar generation projects in Wisconsin today that are either (1) operational, (2) under construction, (3) permitted but not yet under construction, or (4) undergoing siting review by either the Commission or a local jurisdiction.

Table 1

Solar (and storage) projects undergoing Commission review as of July 2023

Project	**Solar Capacity** (in MW(AC))	**BESS Capacity** (AC capacity except where noted)
Langdon Mills	200	50 MW/200 MWh
Elk Creek	300 (at POI)	76 MW(DC)/304 MWh
Silver Maple	200	None
Total	**700**	**126 MW**

Q. How important are in-state sources of utility-scale solar power to the broader policy aims of Wisconsin's energy policy?

A. In RENEW's view, the solar projects listed in Ex.-RENEW-Vickerman-2 will serve the public interest by tilting Wisconsin's renewable generation portfolio, now weighted in favor of out-of-state sources, firmly in the direction of in-state facilities. In docket 5-RF-2022, the Commission staff's 2022 Renewable Portfolio Standard Report, issued in June 2023, contains a breakdown of 2022 renewable generation between in-state and out-of-state sources.[1] In all of 2022, Wisconsin electric providers derived only 36% of their supplies of renewable electricity from sources located in Wisconsin, while an eye-opening 64% of the renewable electricity sold in Wisconsin that year originated from another state. Indeed, according to the same report, more than half (59%) of Wisconsin's renewable

[1] *See* Commission Memorandum, Appendix E, PSC REF# 470111.

electricity came from windpower projects located in Illinois, Iowa, Minnesota and South Dakota, some of which are owned by or are operating under contract to Wisconsin electric providers.[2] This outsourcing of renewable power results in the export of manufacturing opportunities, local government revenues, landowner income, and workforce participation that could otherwise yield direct and indirect economic benefits to Wisconsin communities.

The emergence of solar energy as a reliable, low-cost source of electric power presents an opportunity to build a geographically dispersed portfolio of zero-emission plants within Wisconsin's borders. As noted earlier, this portfolio has already started to take shape. In southeastern Wisconsin, where Silver Maple Solar would be located, there is sufficient land and transmission infrastructure to accommodate additional bulk sources of solar power, whereupon they would cost-effectively serve rural and urban communities across the state. Solar power at this scale and in this region can contribute substantially to the generation transition underway to fill in the capacity holes created by retiring fossil generating plants planned for later this decade.

Q. How much electricity do you estimate will be generated by this group of projects over their first 10 years of operation?

A. In calculating the future output from these projects, I must make several assumptions regarding their productivity. For the first 29 projects listed in Ex.-RENEW-Vickerman-2, I used a capacity factor of 22.5%, even though the applications for a substantial portion of these projects assumed higher net capacity

[2] *See id.*

factors. While my capacity factor assumption may seem conservative, I selected 22.5% as a capacity factor to internalize both project-specific losses as well as the slight degradation in performance that will occur over the course of a solar panel's operating life. That degradation factor is assumed to be 0.5%/year, or 5% over a 10-year period. That said, all of the 28 projects in the first group except the 417 kW project serving Superior Water, Light and Power will utilize single-axis tracking devices to maximize the capture of the solar resource in the early morning and late afternoon hours. Most of these projects will make use of bifacial panels, which should result in increased output in the winter months relative to fixed-mount arrays. With these assumptions in mind, the combined output from the 3,522.4 MW of capacity represented in that group should average 6,942,650 megawatt-hours (MWh) per annum over their first 10 years of operation, for a total of 69,426,500 MWh over a ten-year period.

For the second group of projects (Nos. 29-58), I reduced the capacity factor to 22.0% to account for the handful of installations in operation that rely on (a) fixed-mount racking, which is slightly less productive relative to projects that use single-axis tracking devices, and (b) monofacial panels, which are slightly less productive than bifacial panels. However, since most of the solar capacity represented in the second group operates with single-axis tracking devices, the reduction in aggregate output should be slight. With that assumption in mind, the combined output from the 763.9 MW of capacity represented in the second group should average 1,472,188 MWh per annum over the projects' first 10 years of operation, for a total of 14,721,880 MWh over a ten-year period.

When the subtotals from each group are added together, the combined total should average 8,414,838 MWh per year over the projects' first 10 years of operation.

Q. What percentage of Wisconsin power generation do those numbers represent?

A. Acccording to the most recent State Electricity Profile of Wisconsin published by the U.S. Energy Information Administration (EIA), the state's electricity sector generated 64,276,480 MWh in 2021.[3] When the estimated 8,414,838 MWh of solar generation is divided by the statewide electric generation total in 2021, that increment of solar power would have accounted for 13% of the electricity produced in Wisconsin that year.

Q. What percentage of Wisconsin electricity sales do those numbers represent?

A. A comparison of the estimated output from the solar projects listed in Ex.-RENEW-Vickerman-2 to Wisconsin electricity sales yields a similar though smaller percentage, as Wisconsin is a net importer of electricity. According to the Commission staff's Renewable Portfolio Standard Report for 2022,[4] annual retail sales reported by Wisconsin electricity providers over the 2019-2021 period averaged 68,684,190 MWh. When the estimated 8,414,838 MWh of solar generation is divided by the electricity sales average cited above, that increment of solar capacity would have accounted for 12.2% of the electricity sold in the state of Wisconsin during that three-year period.

[3] *See* Wisconsin Electricity Profile 2021, Energy Information Administration (https: // www .eia .gov/ electricity/state/Wisconsin/).
[4] *See* Commission Memorandum, Appendix C-4, PSC REF # 470111.

To put the above numbers in perspective, in-state solar generation accounted for 1.0% of total electricity sales in Wisconsin in 2022 (681,854 MWh out of 69,934,417 MWh). These numbers also appear in the Commission staff's 2022 Renewable Portfolio Standard Report.[5]

Q. What is your estimate of Silver Maple Solar's expected contribution to that total?

A. To estimate Silver Maple Solar's output over its first 10 years, I used a net capacity factor of 20.25%, consistent with the estimate of Year 1 production contained in Silver Maple Solar's application (PSC REF#: 460330, page 31). I note that the anticipated net capacity factor for this project is lower than the estimate contained in the application for the 100 MW Northern Prairie Solar project, also developed by Leeward Renewable Energy. Operating at a 20.25% net capacity factor, Silver Maple Solar would produce an average of 355,000 MWh/year over the first 10 years of its operating life, accounting for approximately 4.2% of the solar generation represented by the 58 projects listed in Ex.-RENEW-Vickerman-2.

Q. Does the EIA report emissions data attributable to Wisconsin's electricity sector?

A. Yes. EIA's 2021 profile for Wisconsin tracks carbon dioxide emissions, sulfur dioxide emissions and nitrogen oxide emissions from electricity generators in the state. The profile expresses the emissions both in terms of annual volumes and per-MWh rates. In its most recent state electricity profile of Wisconsin, EIA

[5] *See* Commission Memorandum, Appendix E, PSC REF # 470111.

reports that the state's electricity sector emitted a total of 36,408,000 metric tons of carbon dioxide in 2021.[6] That works out to an emissions rate of 1,246 pounds, or 0.566 metric tons, of carbon dioxide per MWh generated in Wisconsin. The emission rate reported in 2021 is higher than the numbers from the previous two years (1,188 lbs. in 2020[7] and 1,233 lbs. in 2019[8]). I estimate that it will take two more years before the cumulative impact from this wave of solar generation translates into lower CO_2 emissions as reported in EIA's electricity profiles for Wisconsin.

Q. As a zero-carbon source of renewable electricity, how much carbon dioxide would Silver Maple Solar displace through its operation?

A. If EIA's emission rate of 1,246 lbs./MWh were multiplied by Silver Maple Solar's expected output over its first 10 years, the project would avoid or displace an average of 201,059 metric tons of CO_2 per year over its first 10 years of operation, all other things being equal. While this is admittedly a crude methodology that does not take into account expected power plant retirements in the next five years, it is a reasonable approach for producing a ballpark estimate of emissions reductions from a power plant fueled by a noncombustible renewable energy source. Moreover, the calculation I provide can be updated each year when EIA publishes a new state electricity profile for Wisconsin, and can be cross-checked with every new iteration of the Strategic Energy Assessment.

[6] *See* Wisconsin Electricity Profile 2021, Energy Information Administration (https: // www .eia. gov/ electricity/state/Wisconsin/).
[7] *See* Wisconsin Electricity Profile 2020, Energy Information Administration (https: // www .eia. gov/ electricity/state/archive/2020/Wisconsin/).
[8] *See* Wisconsin Electricity Profile 2019, Energy Information Administration (https: // www . eia. gov/ electricity/state/archive/2019/Wisconsin/).

Q. How will Silver Maple Solar contribute to system reliability?

A. Utility-scale solar plants built with single-axis tracking devices are designed to follow the sun's daily path during daylight hours, starting with the first minutes of sunrise and continuing through to the final minutes of sunset. This design feature optimizes the solar plant's ability to capture sunshine in the early morning and in the late afternoon/early evening hours. The latter attribute is particularly valuable for utilities that have significant summer peaks, which tend to occur between 3:00 pm and 7:00 pm in those months. This particular atttribute will be valuable to Wisconsin electricity customers given the volatility of natural gas prices experienced over the last 12 months and the effects of that fuel price volatility on wholesale electricity costs.

Q. How does Silver Maple Solar's footprint compare with other utility-scale solar projects in Wisconsin?

A. Ex.-RENEW-Vickerman-3 is composed of a list of utility-scale solar projects in Wisconsin and the amount of acreage each project is expected to cover. The acreage totals in Ex.-RENEW-Vickerman-3 were pulled from Commission documents such as Orders and Environmental Assessments. The 28 projects listed here are either (1) online, (b) under construction, (c) permitted, or (d) currently under review by the Commission. The aggregate capacity of these projects is 4,163 MW, covering a total of 31,945 acres. From those totals, I derived the per-MW land requirements of utility-scale solar generation in Wisconsin based on the average. Looking at the current crop of solar power plants, one MW of solar generating capacity will take up 7.7 acres. According to

the application, Silver Maple Solar is expected to cover up to 1,296 acres, which, when divided by 200 MW, results in a per MW footprint of 6.5 acres. Thus, Silver Maple Solar's footprint is less than the statewide average.

Q. How does the anticipated output per acre from Silver Maple Solar compare with other renewable generation facilities in Wisconsin?

A. Compared with three nearby sources of renewable generation, Silver Maple Solar would be an efficient source of renewable electricity on a per acre basis. Table 2 on page 14 compares Silver Maple's anticipated output and footprint against those of Forward Wind Energy Center, jointly owned by several Wisconsin electric utilities, and the Petenwell and Castle Rock hydroelectric plants, owned by the Wisconsin River Improvement Company. Compiled from publicly available data including utility websites, Table 2 demonstrates that utility-scale solar in general and Silver Maple in particular can be counted on to generate substantially more electricity on a per-acre basis than existing wind power and hydropower projects. This aspect of utility-scale solar is underappreciated, likely an outgrowth of solar's lower capacity factor relative to wind and hydro. Though hydroelectric generation continues to provide a significant contribution continues to Wisconsin's energy landscape, we tend to discount the large expanse of land needed to impound and concentrate the water resource that feeds the turbines. Regarding wind generation, we also need to account for the spacing required between turbine towers to maximize project output while complying with the siting standards specified in PSC Chapter 128. Doing so will lead to a fuller understanding of solar's land use impacts relative to other generation and

nongeneration alternatives for agricultural land. But, for the time being at least, it is quite apparent that utility-scale solar is the most space-efficient pathway forward for achieving substantial reductions in greenhouse gas emissions using locally available renewable resources.

Table 2

Comparison of Silver Maple Solar's likely output and footprint compared with three nearby renewable power projects

	Silver Maple	**Forward**[9]	**Petenwell**[10]	**Castle Rock**
Resource	Solar	Wind	Hydro	Hydro
Location (by county)	Fond du Lac, Winnebago	Fond du Lac, Dodge	Juneau, Adams and Wood	Juneau, Adams
Capacity (in MW)	200	137.8	20	15
Land coverage (in acres)	1,296	4,000	25,180	14,900
First year of operation	2026 (estimated)	2008	1948	1951
Capacity factor	20.25% (estimated)	27.7%[11]	58%	71%
Expected annual output in 2027 (in MWh)	354,780	335,000	101,616[12]	93,216[13]
Annual output per acre (in MWh)	273.7	83.6	4.0	6.3

[9] *See* https : // www.wisconsin publicservice. com/environment/pdf/forward-wind.pdf.

[10] See http : // www. wvic.com/Content/Hydroplants.cfm.

[11] *See* https : // en. wikipedia. org/wiki/Forward Wind Energy Center

[12] *See* https : // en. wikipedia.org/ wiki/ PetenwellLake#:~:text =Lake%Petenwell%20is%20an%artificial,next%20%to%20Castle%20Rock%20Lake.

[13] *See* https: // en. wikipedia.org/wiki/ Castle_Rock_Lake#:~:text= Castle%20Rock%20Lake%20is%20an,Adams%20County%20and%20Juneau%20County.

There are two other points worthy of consideration. Even though the footprint for Silver Maple Solar would take up only 3.2% of the acreage presently submerged under Lake Petenwell and Castle Rock Lake, the solar project would generate more electricity annually (~355,000 MWh/yr) than the hydro projects combined (~195,000 MWh/yr). In fact, if all 28 solar projects listed in Ex.-RENEW-Vickerman-3, with a combined capacity of 4,163 MW, were built and placed in service, they would occupy less land than the Petenwell and Castle Rock reservoirs.

Q. What is your view on the project's impact on Fond du Lac County's agricultural land base?

A. As noted earlier, Silver Maple Solar's land footprint could total up to 1,296 acres, though it would undoubtedly amount to less than that once the alternate arrays are removed from the calculation. It is not clear from the application how many acres of land in Winnebago County the project would affect, but it is apparent that the bulk of the project's land-based footprint lies within Fond du Lac County. To simplify the computational exercise that appears below, I assumed that the totality of Silver Maple Solar's land footprint lies within Fond du Lac County.

Fond du Lac County has a total land area of 725 square miles, according to its website.[14] Multiplying 725 by 640, the number of acres in a square mile, results in a total of 464,000 acres. Of that total, there were 317,371 acres in active cultivation, according to the U.S. Department of Agriculture's county-by-county

[14] *See* https : // fdlco.wi.gov/ about-the-county/ county-facts.

census of farms and farming operations from that year.[15] The 317,371-acre total amounts to 68% of the total land area available in Columbia County. A project footprint of 1,296 acres or less equates to about 0.4% of the actively cultivated land identified in the Agriculture Department's 2017 census. In reality, since a small portion of Silver Maple Solar extends into Winnebago County, the actual percentage would be less than 0.4%

Q. Does RENEW support approval of the Silver Maple Solar project?

A. Yes. RENEW wholeheartedly supports Commission approval of Silver Maple Solar. In our view, this project, like other large solar generating facilities that the Commission has approved, would protect human health and the natural environment while strengthening the state's economy. As noted in the Environmental Assessments prepared for High Noon Solar[16], Elk Creek Solar[17], and Langdon Mills Solar[18], "solar electric generation facilities in the upper Midwest typically have vegetation growing on the array sites around the site perimeter as well as between and underneath panels. This vegetation decreases the amount of impervious surface associated with the site and assists in managing storm water runoff and erosion." Assuming input and guidance from Wisconsin Department of Natural Resources staff, Silver Maple Solar's vegetation management plan should yield substantial environmental benefits to the area,

[15] *See* https: // www. nass. usda.gov/Publications/ AgCensus/2017/Online_Resources/County_Profiles/ Wisconsin/cp55039.pdf.

[16] *See* Environmental Assessment, 9814-CE-100 (PSC REF:# 455955).
[17] *See* Environmental Assessment, 9819-CE-100 (PSC REF:# 462044).
[18] *See* Environmental Assessment, 9818-CE-100 (PSC REF:# 463475).

including improved water quality and soil health, as well as increased biodiversity.

The project's economic benefits would come in two forms. Initially, during its construction phase, the project has the potential to create up to 350 well-paying jobs. Silver Maple Solar plans to recruit local laborers to the greatest extent possible.[19] Second, Silver Maple Solar will, once energized, provide $800,000 annually in utility local aids over its operating life, split among the five local jurisdictions hosting the installation.[20]

Consistent with Wisconsin's Energy Priorities Law, this project will provide these benefits by converting a locally available, noncombustible renewable energy resource—sunshine—to electricity, and feeding its output into the eastern Wisconsin grid. Coal and gas-fired power plants constitute the primary sources of utility-supplied electricity in eastern Wisconsin. Thus, for the foreseeable future, electricity generated by Silver Maple Solar will displace some fossil-fueled generation during daylight hours, improving air quality and reducing greenhouse gas emissions.

Finally, as an example of utility-scale renewable generation, Silver Maple Solar is wholly consistent with the objectives articulated of the State of Wisconsin Clean Energy Plan. As stated on page 109 of the Clean Energy Plan, "[u]tility-scale renewable generation plays a disproportionately large role in

[19] *See* Application of Silver Maple Solar, LLC, for Certificate of Public Convenience and Necessity (PSC REF:# 460330).
[20] *See id.*

decarbonization, as it is very cost-effective, helps reduce the energy burden for all customers, and reduces emissions from fossil plants ….”[21]

Q. Does this complete your direct testimony?

A. Yes, it does.

[21] *See* https : // osce.wi.gov/ Documents/SOW-Clean EnergyPlan2022.pdf.