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# EVALUATING POTENTIAL LAND USE OF UTILITY-SCALE PHOTOVOLTAICS (SOLAR PANELS) ON FARMLAND IN TENNESSEE

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# EXECUTIVE SUMMARY

Photovoltaic (PV) cells, commonly referred to as solar panels, absorb energy from sunlight and convert it to electricity. PV energy generation has increased drastically in the United States (U.S.) in the last decade, growing from 26.5 gigawatt-hours in 2014 to over 207 gigawatt-hours in the last 12 months, or from 0.6% to 4.8% of total U.S. electricity production (U.S. Energy Information Administration, 2023a). The combination of increasing cost-competitiveness of PV energy generation (U.S. Department of Energy [DOE], 2021) and efforts to decarbonize the U.S. electric grid suggest even more rapid growth. For example, the U.S. DOE (2021) projects that solar generation could grow to as much as 40% of the U.S. electricity supply by 2035, given aggressive decarbonization policies. At a more local level, the Tennessee Valley Authority (TVA) has set a goal of adding 10 gigawatts (GWs) of solar production capacity from 2022 to 2035 (Tennessee Valley Authority, 2023b).

The rapid production growth coupled with aggressive targets for decarbonization and increased solar capacity has focused attention on the amount of land currently being converted to PV energy production and the amount that will ultimately be needed to accommodate future growth. This report attempts to quantify the amount of land currently used for utility-scale PV energy production in Tennessee and to project the amount likely to be used under different scenarios for future growth. More specifically, this report estimates the amount of land in Tennessee used by: (i) existing utility-scale PV production, (ii) contracted but not yet operational utility-scale PV production, and (iii) utility-scale PV production if TVA were to reach its PV electricity generation goals. Given that farmland could be a location of PV electricity production, the report considers the possible effects of growth on the amount of available farmland in Tennessee.

In Tennessee, operational utility-scale PV production currently produces 344 megawatts (MWs) of energy (TVA, 2023a). Contracted, but not yet operational, utility-scale PV production in Tennessee will account for another 1,130 MWs of energy (TVA, 2023a). Following industry and academic literature (e.g., Solar Energy Industries Association, 2023; Bolinger and Bolinger 2022), a range of 5.56 to 10 acres per MW of generated power was used to estimate PV land use. Thus, current operational and contracted utility-scale PV facilities in Tennessee would generate 1,474 MWs of energy and require 8,197 to 14,743 acres of land. Tennessee has 26.4 million acres of land and 10.8 million acres of farmland (USDA, 2023). Therefore, operational and contracted utility-scale PV land use equates to 0.031 to 0.056% of Tennessee's total land mass or 0.076 to 0.137% of Tennessee's farmland if all these facilities were located on farmland.

If by 2035 TVA reached their sustainability goal and added an additional 10 GWs of PV generation to the existing 344 MWs of PV production in Tennessee, and assuming that TVA placed all PV developments in Tennessee, 57,514 to 103,443 acres of land would be required for utility-scale PV installments (i.e., an amount equivalent to 0.22 to 0.39% of Tennessee land or 0.53 to 0.96% of Tennessee farmland if exclusively placed on farmland). However, not all of this additional production would be located in Tennessee, which occupies a little more than half of TVA's 80,000 square mile service region.

To provide greater context, this report also contains information on the location of existing and contracted utility-scale PV developments, the extent of Tennessee farmland being converted to other uses, PV development considerations for agricultural communities, and the potential for collocation of PV power generation and agricultural production, or what is commonly referred to as agrivoltaics.

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# INTRODUCTION

Solar power primarily originates from photovoltaic (PV) cells, more commonly referred to as solar panels (U.S. Department of Energy [DOE], 2022). PV cells absorb energy from sunlight and convert it into electricity using semiconductive materials. PV energy generation has increased drastically in the United States (U.S.) in the last decade, growing from 26.5 gigawatt-hours in 2014 to over 207 gigawatt-hours in the last 12 months, or from 0.6% to 4.8% of total U.S. electricity production (U.S. Energy Information Administration (EIA), 2023a). This rapid growth in PV energy production accompanied significant technological advances, including an approximately 82% decrease in the cost of utility-scale PV systems since 2010 (U.S. DOE National Renewable Energy Laboratory, 2021).

The solar power industry and the U.S. DOE anticipate a continued drastic increase in PV growth in the next decade. For example, the Solar Energy Industries Association (2022) has set a target of PV power representing 30% of U.S. electricity generation by 2030. The U.S. DOE (2023a) suggests that "solar could account for as much as 40% of the nation's electricity supply by 2035 and 45% by 2050" given the adoption of aggressive policies to decarbonize the U.S. electric grid. The rapid expansion of PV energy production coupled with expectations for continued growth has focused attention on the amount of land needed to accommodate the increase in PV installations.

The remainder of this report proceeds as follows. Section 2 examines the megawatts (MWs) of energy production and acres of land use associated with the existing and contracted utility-scale PV facilities in Tennessee. Section 3 estimates the additional land use requirements of utility-scale PV facilities if the Tennessee Valley Authority (TVA) were to reach its sustainability goals for electricity generation from PVs. The extent that Tennessee farmland has been lost to urban and residential uses is examined in Section 4. Section 5 evaluates possible PV development considerations for agricultural communities. Finally, Section 6 discusses agrivoltaics, which is the collocation of PV and agricultural uses on the same land, and Section 7 concludes.

## 2. TENNESSEE UTILITY-SCALE PV DEVELOPMENTS AND ASSOCIATED LAND-USE

The energy capacity of PV developments is measured in MWs. Each PV development has an associated nameplate capacity indicating the maximum output the development can produce when operating at full power. An estimated range of acres required per MW installed is used to estimate how many acres of land are associated with each PV development. This estimated acreage not only takes into consideration the installed PV modules and installed racking that holds the PV modules but also the square footage required for fencing, transformers, inverters, inter-row spacing for shade mitigation, the required fire perimeter (by fire permit) and access points for ingress and egress.

According to Bolinger and Bolinger (2022), the most efficient PV systems (i.e., single-axis trackers or panels that tilt as sunlight moves) are estimated to produce 0.18 MW of energy per acre of land. Thus, 5.56 acres of land are required for each MW of PV production. However, individual developments may require greater amounts of land due to a variety of site conditions, including setback requirements imposed by local codes or ordinances, avoidance of wetlands, flood plains, or other areas of concern due to runoff or erosion, changes in topography that limit the installation of long rows of panels, and shading from natural and artificial features. The Solar Energy Industries Association (2023) suggests that a reasonable maximum land use estimate would be 10 acres of land per MW of PV energy generation. Therefore, 5.56 acres of land per MW of PV energy production is used as a lower bound acreage requirement estimate, while 10 acres per MW of production serves as an upper bound. By setting the lower-bound land use estimate to 5.56 acres of land per MW of PV production, this range also takes into consideration future efficiencies that may be gained in PV production.

### 2.1 Operational PV Facilities in Tennessee

Table 1 shows the utility-scale PV facilities in Tennessee currently generating power for the TVA electrical grid (TVA 2023a). The list of operational PV developments in Table 1 was cross-checked with the operational PV developments as documented by the U.S. EIA (2023b). The U.S. EIA (2023b) list is available through 2021 and appears as Table A in this report's appendix. Specifically, the information provided in Table A comes from U.S. EIA (2023b) Form EIA-860 that collects generator-level specific information for electric power plants with 1 MW or greater of combined nameplate capacity. The Table A entries highlighted in blue are facilities that also appear in Table 1. Those on the Table A list that do not appear on the TVA list are PV developments that operate "behind the meter" and their PV power generation is used on-site rather than by the TVA electrical grid. Thus, those few facilities were not included in Table 1 since this analysis is only focused on utility-scale PV developments that provide power to the TVA electrical grid. Finally, the amount of total MWs of PV energy in Table 1 exceeds those listed on Table A, because the data in the former goes through April 2023 while the data provided in the latter only goes through 2021.

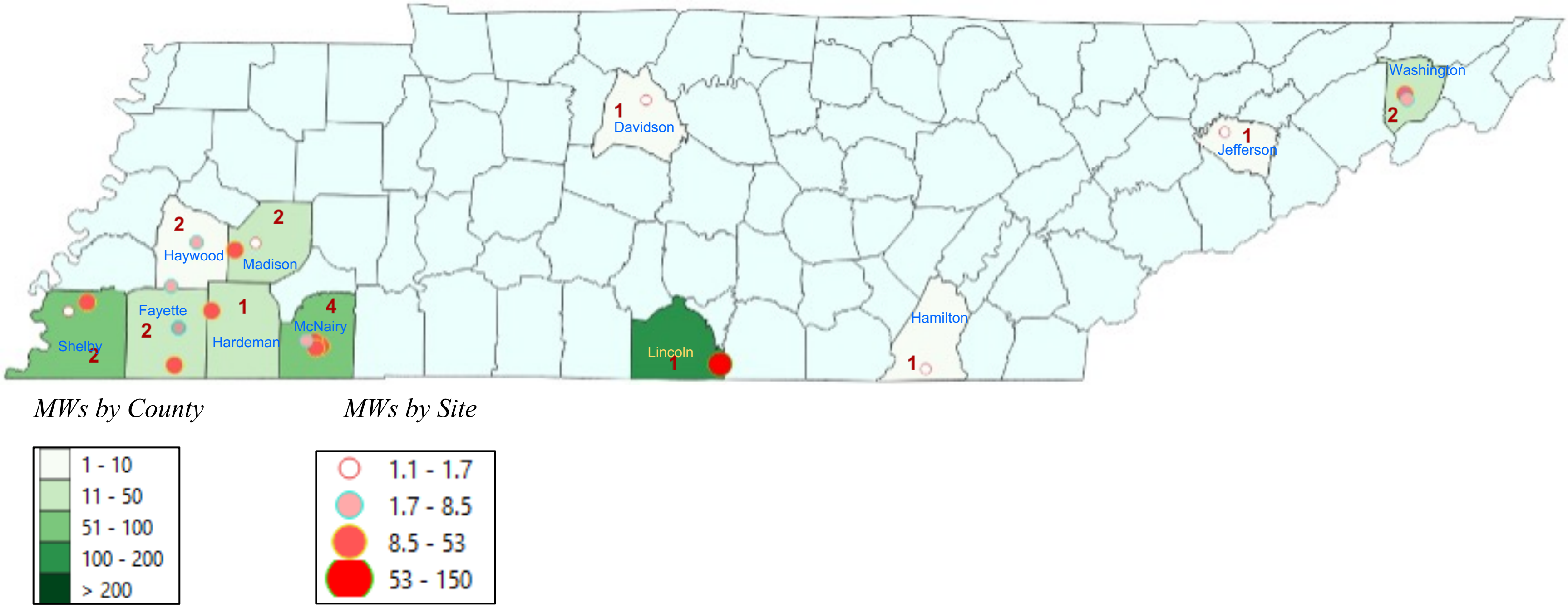
In addition to the PV developments listed in Table 1, there is also a column showing the land required under the most efficient PV-to-land-use scenario (5.56 acres for each MW of PV energy generated) and the land required for a more conservative PV-to-land-use scenario (10 acres for each MW of PV energy generated). From the listed 19 operations, the total nameplate capacity is 344 MWs and the associated land-use required is 1,914 acres to 3,443 acres. Figure 1 shows where these facilities are by county and the associated MWs of PV production by county. Most operational utility-scale PV facilities in Tennessee are in the western portion of the state.

**Table 1. Operational Utility-Scale Photovoltaic (PV) Facilities in Tennessee with Land Use Estimates**

| Name | County | Nameplate Capacity (MW) | Lower Bound Acreage[1] | Upper Bound Acreage[2] |
|---|---|---|---|---|
| Music City Solar | Davidson | 1.7 | 9.45 | 17.00 |
| Somerville Solar Center | Fayette | 2.3 | 12.79 | 23.00 |
| Wildberry Solar Center, LLC | Fayette | 17.0 | 94.52 | 170.00 |
| Oak and Greenwood Helioscope | Hamilton | 1.1 | 6.12 | 11.00 |
| Latitude Solar Center, LLC | Hardeman | 17 | 94.52 | 170.00 |
| Haywood County Solar Farm | Haywood | 3.3 | 18.35 | 33.00 |
| West Tennessee Solar Farm | Haywood | 4.5 | 25.02 | 45.00 |
| Appalachian Community Solar LLC | Jefferson | 1.2 | 6.67 | 12.00 |
| Elora Solar | Lincoln | 150.0 | 834.00 | 1500.00 |
| JEA Industrial Community Solar | Madison | 1.7 | 9.45 | 17.00 |
| Silicon Ranch Providence | Madison | 17 | 94.52 | 170.00 |
| Mulberry Farm, LLC | McNairy | 17.0 | 94.52 | 170.00 |
| RSO 2013 Selmer | McNairy | 17.0 | 94.52 | 170.00 |
| Selmer Farm, LLC | McNairy | 17.0 | 94.52 | 170.00 |
| Selmer North II | McNairy | 8.5 | 47.26 | 85.00 |
| Silicon Ranch Millington Solar | Shelby | 53 | 294.68 | 530.00 |
| Silicon Ranch Innovation NIKE | Shelby | 1.7 | 9.45 | 17.00 |
| Silicon Ranch BrightRidge I | Washington | 4.3 | 23.91 | 43.00 |
| Silicon Ranch BrightRidge II | Washington | 9.0 | 50.04 | 90.00 |
| **Total** | | **344.30** | **1,914.31** | **3,443.00** |

Notes: [1]5.56 acres=1 MW; [2]10 acres=1 MW. Source: TVA (2023a).

**Figure 1. Operational Photovoltaic (PV) Facilities in Tennessee**




**Notes:** MW stands for megawatt. There are a total of 19 operational PV facilities on this map that produce 344 MWs of energy and utilize an estimated 1,914 to 3,443 acres of land. The number of facilities in each county appears in red. Source: Tennessee Valley Authority, 2023a.

Tennessee has 26.4 million acres of land, including 10.8 million acres of farmland (U.S. Department of Agriculture (USDA), 2023).[1] Thus, the land needed to produce the 344 MWs currently being generated is an area equivalent to 0.007 to 0.013% of the state's land mass or 0.018 to 0.032% of the state's agricultural land (Table 3).

### 2.2 Contracted PV Facilities in Tennessee

Table 2 lists the Tennessee PV developments that have been contracted with TVA (TVA, 2023a).[2] The total power that will be generated by these facilities is 1,130 MWs with the associated potential land use ranging from 6,283 to 11,300 acres. If all of these contracted facilities became operational, the estimated land use requirements would represent from 0.024 to 0.043% of Tennessee's land mass or from 0.058 to 0.105% of Tennessee's agricultural land (Table 3). Figure 2 shows the location of the contracted PV facilities and the MWs of PV

**Table 2. Contracted Photovoltaics (PV) Facilities in Tennessee and Land-Use Acreage**

| Name | County | Nameplate Capacity (MW) | Lower Bound Acreage[1] | Upper Bound Acreage[2] |
|---|---|---|---|---|
| Bell Buckle Solar Farm | Bedford | 35 | 194.60 | 350.00 |
| Yum Yum Solar Energy Center | Fayette | 147 | 817.32 | 1,470.00 |
| Canadaville Solar Farm | Fayette | 16 | 88.96 | 160.00 |
| Ridgely Energy Farm | Lake | 177 | 984.12 | 1,770.00 |
| McKellar Solar Farm | Madison | 70 | 389.20 | 700.00 |
| Tullahoma Solar Farm | Moore | 200 | 1,112.00 | 2,000.00 |
| Skyhawk Solar | Obion | 100 | 556.00 | 1,000.00 |
| Millington II Solar | Shelby | 75 | 417.00 | 750.00 |
| WR Graceland Solar | Shelby | 150 | 834.00 | 1,500.00 |
| Four Silicon Ranch Projects | NA | 160 | 889.60 | 1,600.00 |
| **Total** | | **1,130.00** | **6,282.80** | **11,300.00** |

Notes:[1]5.56 acres=1 MW; [2]10 acres=1 MW. Source: TVA (2023a).

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[1] USDA (2023) defines farmland as consisting "primarily of agricultural land used for crops, pasture or grazing. It also includes woodland and wasteland not actually under cultivation or used for pasture or grazing, provided it was part of the farm producer's total operation."

[2] A TVA contracted PV development indicates that TVA and a solar company have signed a long-term, usually 20-years-plus contract, to purchase power from the project. This is called a Power Purchase Agreement (PPA) and is typically required before a solar company can secure the financing to build the project.

production by county. Similar to the operational PV facilities, the contracted facilities are primarily located in West Tennessee.

Adding the required land for operational facilities (Table 1) to those for contracted facilities (Table 2) provides a total range of 8,197 to 14,743 acres or the equivalent of 0.031 to 0.056% of Tennessee land or 0.076 to 0.137% of Tennessee farmland (Table 3). Figure 3 shows the map of all operational and contracted facilities and what the resulting MWs of PV production would be by county if all the contracted facilities were constructed.[3]

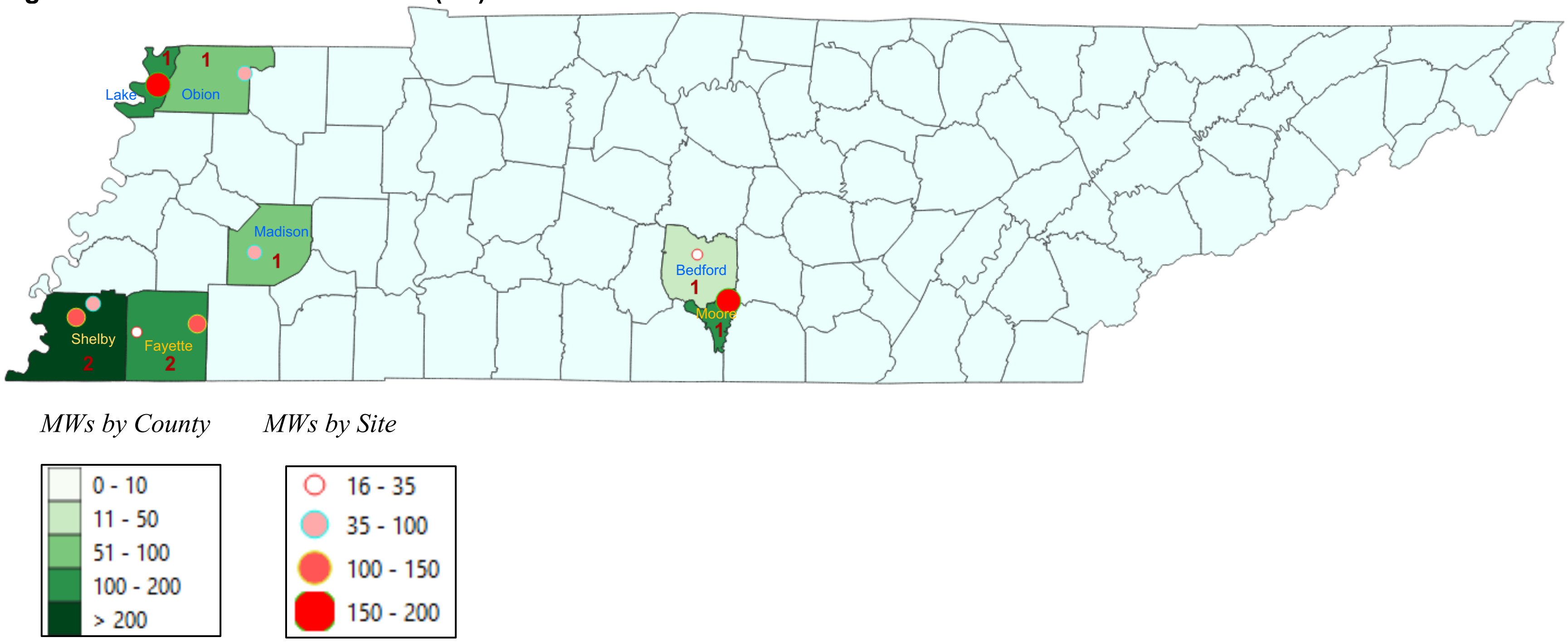
**Table 3. Total Operational and Contracted Megawatts of Photovoltaics (PV), Estimated Land Use, and Associated Percentage of Tennessee Land and Farmland**

| Type | Nameplate Capacity (MW) | Lower Bound Acreage[1] | Upper Bound Acreage[2] |
|---|---|---|---|
| **Operational** | **344.30** | **1,914.31** | **3,443.00** |
| % Share of TN Land | | 0.007% | 0.013% |
| % Share of TN Farmland | | 0.018% | 0.032% |
| **Contracted** | **1,130.00** | **6,282.80** | **11,300.00** |
| % Share of TN Land | | 0.024% | 0.043% |
| % Share of TN Farmland | | 0.058% | 0.105% |
| **Total** | **1,474.30** | **8,197.11** | **14,743.00** |
| % Share of TN Land | | 0.031% | 0.056% |
| % Share of TN Farmland | | 0.076% | 0.137% |

Notes: [1]5.56 acres=1 MW; [2]10 acres=1 MW. Source: TVA (2023a) and authors' calculations.

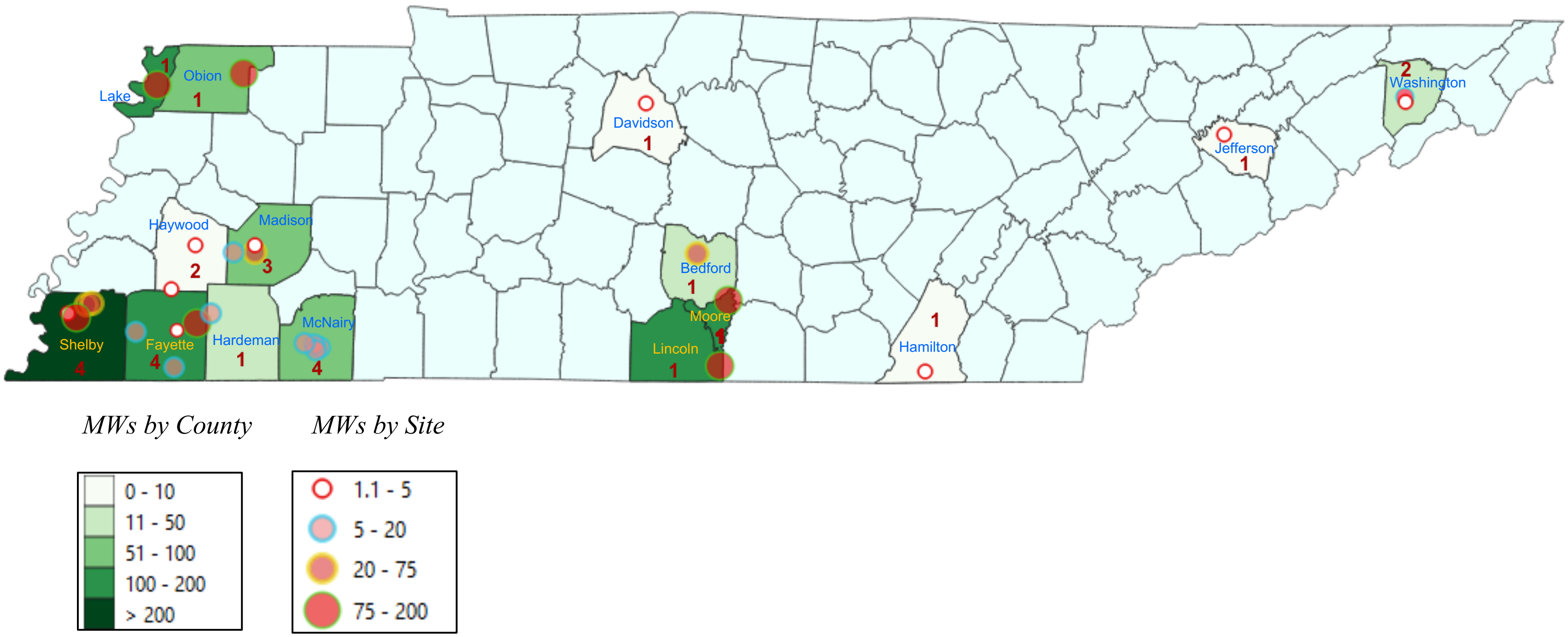
[3] In addition to solar projects that sell their power directly to TVA, it is worth noting that the electric cooperatives and municipals that buy the power from TVA and distribute it to the residential and commercial customers of TVA are allowed to do limited self-generation. This program is known as Generation Flexibility, and while the average project is much smaller than those where the power is purchased by TVA, these do add to the total demand for land. According to TVA, as of April 2023 there were seven projects built and in operation for a total of 31 MWs and another 14 solar projects in the approved/approval process for an additional 130 MWs.

**Figure 2. Contracted Photovoltaic (PV) Facilities in Tennessee**




**Notes:** MW stands for megawatt. There are a total of nine contracted PV facilities on this map. The four Silicon Ranch project facilities listed in Table 2 are excluded from the map because their location is yet to be determined. Combining production from the four Silicon Ranch project facilities with production for the nine facilities on this map, the 13 contracted facilities would amount to 1,130 MWs of energy and would utilize an estimated 6,283 to 11,300 acres of land. The number of facilities in each county appears in red. Source: Tennessee Valley Authority, 2023a.

**Figure 3. Operational and Contracted Photovoltaic (PV) Facilities in Tennessee**




**Notes:** MW stands for megawatt. There are a total of 28 PV facilities on this map. The four Silicon Ranch project facilities listed in Table 2 are not on the map because their location is yet to be determined. Combining production from the four Silicon Ranch project facilities with production from the facilities on this map (and assuming all contracted facilities became operational), the 32 facilities would produce 1,474 MWs of energy and utilize an estimated 8,197 to 14,743 acres of land. The number of facilities in each county appears in red. Source: Tennessee Valley Authority, 2023a.

## 3. PV POTENTIAL GROWTH IN TENNESSEE

TVA's 2022 Sustainability Report goal is to add 10 GWs of solar power by 2035 "to meet customer demand and TVA system needs" (TVA, 2023b). Using the acres to MW conversion range of 5.56 to 10 acres of land per MW, 10 GWs of PV energy generation would mean another 55,600 to 100,000 acres of land would be required. If 100% of this solar energy production was located in the approximately 50% of the TVA power service region of Tennessee (as opposed to being spread across all seven TVA states), the resulting additional land use would represent from 0.21 to 0.38% of Tennessee's total land mass or 0.52 to 0.93% of Tennessee's farmland. The actual amount of Tennessee land used to support expansion of PV development for TVA green energy goals will ultimately depend on the extent of progress toward the goal, the share of the production located in Tennessee, and potential technological advances in PVs which could reduce the amount of land needed to generate PV energy. Appendix B provides a discussion and list of the PV projects in the current TVA generator interconnection queue to further examine the proposed PV projects in Tennessee and their associated land use.

## 4. TENNESSEE AGRICULTURAL LAND IN TRANSITION

According to the USDA's 2017 Census of Agriculture, from 1997 to 2017 Tennessee's land in farms decreased from 11.99 million acres to 10.87 million acres, a reduction of 1.11 million acres, or about 9% of Tennessee’s farmland (USDA, 2017a). The American Farmland Trust (AFT) ranks Tennessee third among all U.S. states in terms of acres of nationally significant agricultural land projected to be converted to urban and highly developed and low-density residential uses by 2040 (AFT, 2022). Between 2016 and 2040, the AFT (2022) is projecting Tennessee will convert another 420,000 farmland acres to these uses. Four Tennessee counties (Rutherford, Sevier, Williamson and Wilson) are listed in the top 50 of all U.S. counties in terms of projected agricultural land loss by 2040 (AFT, 2022).

A primary contributing factor to Tennessee’s farmland loss is its increasing population. As of July 1, 2022, Tennessee had an estimated 7.05 million residents (U.S. Census Bureau, 2023a), which represented an increase of nearly 700,000 residents since 2010 (U.S. Census Bureau, 2023b). The University of Tennessee’s Boyd Center projects that Tennessee will add another 370,000 residents by 2030 (University of Tennessee, 2023). The AFT (2023) estimates that up to 659,000 acres of Tennessee farmland was lost to other uses from 2001 to 2016 and projects similar levels of loss into the future. Meanwhile, operational utility-scale PV developments have used an estimated 1,914 to 3,443 acres of Tennessee land. TVA goals would result in the use of an additional estimated 55,600 to 100,000 acres of land within its seven-state TVA area.

## 5. AGRICULTURAL COMMUNITY PV DEVELOPMENT CONSIDERATIONS

In 2017, the average Tennessee farmer was 57.5 years of age (USDA, 2017b). As farmland transitions to the next generation, landowners may consider the income associated with a PV development easement/lease to be attractive, especially if there are no heirs interested in continuing to farm. It should be noted that many PV development lease/easements offered to farmers are 20–40-year contracts. Many states, including Tennessee, have passed laws mandating that legal agreements must be in place to guarantee the removal of solar equipment at the end of the life of the PV development to properly restore the land to its original condition to help transition the land back into agricultural uses, if desired. Tennessee's "Decommissioning Law," Public Chapter 866, states that the solar company must provide the landowner with a decommissioning plan detailing the performance of the decommissioning obligation and that the solar power facility agreement must set forth the acceptable forms of financial assurance (e.g., cash and surety bonds) to properly remove (decommission) the PV development at the end of the solar agreement (Tennessee General Assembly, 2023).[4]

It is possible PV developments are most cost-effective on the best farmland. Both PV and large-scale farming benefit from the efficiencies of large, flat, contiguous lands. However, no known current data provides any indication regarding the possible type (i.e., land use) or soil quality of agricultural land that is ideal to be devoted to solar development. An analysis of land use for existing 2020 utility-scale solar energy development in New York state indicated that 24% of the previous land use had been devoted to cultivated crops and 20% to hay or pasture (Katkar et al., 2021). In terms of soil quality, 58% of the land was designated as good soil, 23% as poor soil and 19% as medium quality soil. Future research could examine the soil quality of

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[4] Additional information on solar decommissioning is available from the following: Center for Rural Affairs (2023) and American Clean Power Association (2023).

Tennessee land being used for PV facilities to further estimate the impact of PV developments on the agricultural community.

PV developments are also limited in that they require access to the electrical grid or large power users in close proximity. Thus, proximity to existing electrical infrastructure such as substations and high voltage power lines is a limiting factor to PV developments and hence a limiting factor of farmland susceptible to potential changes in use. PV developments also often require local government approval. Therefore, local decision-making bodies play a fundamental role in limiting PV development parameters.

## 6. AGRIVOLTAICS CONSIDERATIONS

Agrivoltaics is the collocation of PV power generation with agriculture, such as crop production, livestock grazing, beekeeping or pollinator habitats (Graham, 2021) on a given piece of land (U.S. DOE, 2023b). At least in some cases, the simultaneous use of land for both agriculture and solar energy production can provide mutual benefits and ease concerns over the removal of productive land from agriculture (U.S. DOE, 2023c; Macknick et al., 2022). Figure 4 shows examples of agrivoltaics projects in Tennessee.

Solar arrays can be constructed at a sufficient height to allow for equipment, workers, crops, and grazing animals underneath. In addition, proper spacing and angles also allow sufficient sunlight to reach crops and pastures while providing shade during periods of high temperature (Rosen, 2022). While with current solar systems it is not feasible to collocate certain large-scale row crop operations such as cotton farming, a corn-soybean crop rotation or certain large-scale animal operations such as feed lots, agrivoltaics can provide agricultural and environmental benefits. Researchers at the University of Arizona (Barron-Gafford et al., 2019) determined that an agrivoltaics system led to cooler daytime and warmer nighttime temperatures and reduced plant water demand compared to a traditional system. Agrivoltaics systems can also be used to provide plant pollination services (Walston et al., 2022). In addition, producers of certain vegetables, fruits and meat animals (especially sheep) may experience gains in productivity and cost savings when farming operations are conducted jointly with solar arrays. For example, Lytle et al. (2021) found that the collocation of solar arrays on a rabbit farm reduced operating costs by up to 8% and increased revenue by 17%, partly by cutting fencing-related costs. Combining solar and agriculture on one piece of land has also been shown to improve ecosystem services, including regulating local climate, air quality, water retention, biodiversity, carbon sequestration, and water and soil conservation (Walston et al.).

Agrivoltaics can benefit solar developers via improved efficiency of photovoltaic arrays, reduced operating costs associated with vegetation maintenance and erosion control, and, most importantly, increased siting opportunities for solar deployment (Hernandez et al., 2019; Barron-Gafford et al., Lytle et al., Walston et al.). However, combining large-scale row crop farming with PV developments presents economic challenges, given the increased costs and/or reduction in solar production per acre associated with modifying solar arrays to accommodate field operations (Rosen, 2022).

**Figure 4. Examples of Agrivoltiac Projects in Tennessee**

**Notes:** The far left picture is from Silicon Ranch’s Volkswagen Chattanooga Solar Farm in Chattanooga, Tennessee. Photo credit Appalachian Land Design. The top right photo is from Silicon Ranch's Millington Solar Farm that includes a habitat of a wide variety of wildlife. Photo credit Cabriejo Ranch, LLC. The bottom right photo is from Silicon Ranch’s Providence Solar Farm in Denmark, Tennessee, and includes adaptively managed sheep to restore pre-grazing erosion. Photo credit Cabriejo Ranch, LLC.

# 7. CONCLUDING REMARKS

PV technologies absorb and convert sunlight into electricity by using semiconductive materials. The U.S. DOE (2023a) suggests that PVs have the potential to meet 40% of U.S. electricity demand by 2035. However, concerns have arisen because of the demand that PV facilities place on land in general and agricultural land in particular. Based on assumptions of 5.56 acres to 10 acres per MW of generated power, current operational and contracted utility-scale PV facilities in Tennessee would use an estimated 8,197 to 14,743 acres of land, which is the equivalent of 0.031 to 0.056% of Tennessee's total land mass or 0.076 to 0.137% of the state's agricultural lands. Making strong assumptions regarding future utility-scale solar development (such as all TVA projects occurring only in Tennessee and not the other six TVA states), utility-scale PV developments could require 57,514 to 103,443 acres of Tennessee land, a size equivalent to 0.53 to 0.96% of Tennessee farmland.

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## APPENDIX A. U.S. ENERGIES INFORMATION ASSOCIATION (2023B) TENNESSEE SOLAR FACILITIES

Table A lists the operational solar facilities in Tennessee according to the U.S. EIA (2023b). Included on this list are several "behind the meter" developments that are not part of the formal electricity grid and whose energy is kept on site. Therefore, they are excluded from Table 1.

**Table A. Operational Solar Facilities in Tennessee According to U.S. EIA (2023b)**

| Utility Name | Plant Name | County | Nameplate Capacity (MW) |
|---|---|---|---|
| Nashville Electric Service | Music City Community Solar | Davidson | 1.6 |
| Adapture Renewables, Inc. | Wildberry | Fayette | 15.0 |
| Somerville Solar, LLC | Somerville Solar | Fayette | 2.3 |
| CD Arevon USA, Inc. | Latitude Solar Center | Hardeman | 15.0 |
| UT West Tennessee Solar Farm | West Tennessee Solar Farm | Haywood | 4.2 |
| Haywood Solar | Haywood Solar | Haywood | 3.0 |
| Silicon Ranch Enterprise South LLC | Volkswagen Solar System | Hamilton | 9.6 |
| Chattanooga Metropolitan Airport | Chattanooga Metro Airport Solar | Hamilton | 1.0 |
| Chattanooga Metropolitan Airport | Chattanooga Metro Airport Solar | Hamilton | 1.1 |
| Chattanooga Metropolitan Airport | Chattanooga Metro Airport Solar | Hamilton | 0.6 |
| Onward Energy | Mulberry Farm LLC | McNairy | 15.8 |
| Onward Energy | Selmer Farm LLC | McNairy | 15.8 |
| Selmer North Solar I, LLC | Selmer I | McNairy | 16.0 |
| Selmer North Solar II, LLC | Selmer II | McNairy | 8.0 |
| Providence Solar Center, LLC | Providence Solar | Madison | 16.0 |
| Silicon Ranch Millington, LLC | Millington Solar Farm | Shelby | 53.0 |
| IKEA Property Inc | IKEA Memphis 508 | Shelby | 1.1 |
| Silicon Ranch Innovation, LLC | Silicon Ranch Innovation - NIKE | Shelby | 1.5 |
| Silicon Ranch Jonesborough II, LLC | Silicon Ranch BrightRidge I | Washington | 4.4 |
| Silicon Ranch Washington I, LLC | Silicon Ranch BrightRidge II | Washington | 9.0 |
| | | **Total** | **194** |

Notes: Those highlighted in light blue also appear on the Table 1 list provided by TVA (2023). Those not highlighted in blue are suspected of being "behind the meter" and keeping the electricity generation within their region and not connecting to a grid.

# APPENDIX B. PV DEVELOPMENTS IN THE TVA QUEUE

We also examined the PV projects listed in the TVA current generator interconnection queue to determine how much land may be required for further planned PV developments in Tennessee. Before TVA contracts to buy the power from a utility-scale project, TVA undertakes a number of studies, including a study on environmental impacts under the National Environmental Policy Act because contracting with TVA is considered a federal action. The interconnection studies to model the potential impacts on the transmission grid is a complicated multiyear process that solar and other generation projects interested in connecting to the TVA grid must go through. As this modeling and feasibility study process is conducted, projects are considered “In the Queue.”

The information regarding projects in the TVA queue was accessed through the OATI (2023) webSmartOASIS® platform and appears in Table B. The projects listed in the queue would add an additional 4,216 MWs of power generation and require an additional 23,440 to 42,160 acres of Tennessee land. This would amount to an additional 0.089 to 0.16% of total Tennessee land or 0.217 to 0.390% of Tennessee farmland potentially being used for further PV developments. When adding this to the land requirements of operational and contracted PV developments found in the previous report sections, this would amount to 31,638 to 56,903 acres of Tennessee land devoted to PV developments, which is equivalent to 0.12 to 0.22% of total Tennessee land and 0.29 to 0.53% of Tennessee farmland. It should be noted that, historically, only about 50% of the projects listed in the TVA queue are built. Provided many of the projects drop out of the TVA queue and are never undertaken, we rely on TVA's 2022 Sustainability Report goals upon which to base our future PV development land use estimates.

**Table B. PV Projects in the TVA Queue and Land-Use Requirements**

| Queue # | Forecasted ISD | Request Type | POI | Phase | Generator Type | County | Nameplate Capacity (MW) | Lower Bound Acres Required[1] | Upper Bound Acres Required[2] |
|---|---|---|---|---|---|---|---|---|---|
| 292 | 3/31/2023 | New Generation | Highway 412-New Tiptonville 161-kV TL | Interconnection agreement | Solar | Lake | 80 | 444.8 | 800 |
| 299 | 03/01/2020 | Incremental Increase | Highway 412-New Tiptonville 161-kV TL | Interconnection agreement | Solar | Lake | 67 | 372.52 | 670 |
| 305 | 10/29/2021 | New Generation | Cordova-S. Jackson 161-kV TL | Under construction | Solar | Fayette | 147 | 817.32 | 1470 |
| 337 | 03/01/2020 | Incremental Increase | Highway 412-Tiptonville 161-kV TL | Interconnection agreement | Solar | Lake | 30 | 166.8 | 300 |
| 342 | 09/30/2022 | New Generation | Weakley-Union City No2 161-kV TL | Under construction | Solar | Obion | 100 | 556 | 1000 |
| 345 | 04/15/2023 | New Generation | Cordova-Hickory Valley No2 TL | E&P Agreement | Solar | Shelby | 66 | 366.96 | 660 |
| 373 | 06/01/2027 | New Generation | Covington - Alamo 161-kV TL | Facilities Study | Solar | Haywood | 120 | 667.2 | 1200 |
| 374 | 06/02/2028 | New Generation | Iron City, TN 161-kV Substation (future) | E&P Agreement | Solar | Lawrence | 195 | 1084.2 | 1950 |

| Queue # | Forecasted ISD | Request Type | POI | Phase | Generator Type | County | Nameplate Capacity (MW) | Lower Bound Acres Required[1] | Upper Bound Acres Required[2] |
|---|---|---|---|---|---|---|---|---|---|
| 395 | 05/31/2022 | New Generation | Montgomery - Springfield 161-kV TL | Facilities Study | Solar | Montgomery | 154 | 856.24 | 1540 |
| 401 | 06/01/2023 | New Generation | Johnsonville Fossil Plant - 161kV Yard | Facilities Study | Solar | Humphreys | 494 | 2746.64 | 4940 |
| 430 | 07/01/2023 | New Generation | Highway 412-Tiptonville 161-kV TL | Facilities Study | Solar | Lake | 68 | 378.08 | 680 |
| 434 | 07/15/2023 | New Generation | Covington - Alamo 161-kV TL | Facilities Study | Solar+ Storage | Haywood | 175 | 973 | 1750 |
| 436 | 05/01/2023 | New Generation | John Sevier FP - Tusculum No. 1 161-kV TL | Facilities Study | Solar | Greene | 200 | 1112 | 2000 |
| 439 | 05/01/2023 | New Generation | Athens - Charleston 161-kV TL | Facilities Study | Solar | McMinn | 200 | 1112 | 2000 |
| 445 | 10/01/2024 | New Generation | Franklin - Warchase No 2 161-kV TL | Facilities Study | Solar | Moore | 200 | 1112 | 2000 |
| 460 | 11/04/2020 | New Generation | Winchester - Smith Mountain SW STA 161- | Facilities Study | Solar | Grundy | 150 | 834 | 1500 |
| 462 | 02/07/2024 | New Generation | Lawrenceburg, TN 161-kV Switching Station | System Impact Study | Solar | Lawrence | 80 | 444.8 | 800 |

| Queue # | Forecasted ISD | Request Type | POI | Phase | Generator Type | County | Nameplate Capacity (MW) | Lower Bound Acres Required[1] | Upper Bound Acres Required[2] |
|---|---|---|---|---|---|---|---|---|---|
| 468 | 05/26/2024 | New Generation | Winchester Dist - Cowan 46-kV TL | Facilities Study | Solar | Franklin | 53 | 294.68 | 530 |
| 469 | 09/15/2026 | New Generation | Johnsonville FP - S Jackson 161-kV TL | Facilities Study | Solar+ Storage | Henderson | 125 | 695 | 1250 |
| 473 | 07/20/2023 | Incremental Increase | Highway 412 - Tiptonville 161-kV TL | System Impact Study | Solar+ Storage | Lake | 9 | 50.04 | 90 |
| 477 | 05/15/2024 | New Generation | Selmer - Bolivar 161-kV TL Cordova - Hickory Valley No 2 161-kV TL | Facilities Study | Solar+ Storage | Hardeman | 200 | 1112 | 2000 |
| 481 | 10/15/2024 | New Generation | Cordova - S. Jackson 161-kV TL | Facilities Study | Solar | Fayette | 60 | 333.6 | 600 |
| 482 | 11/15/2024 | New Generation | Plateau - Peavine 161-kV TL | Facilities Study | Solar | Cumberland | 110 | 611.6 | 1100 |
| 485 | 11/01/2024 | New Generation | Kedron Rd SW STA - Unionville SW STA 161- | System Impact Study | Solar+ Storage | Bedford | 150 | 834 | 1500 |
| 495 | 10/01/2024 | New Generation | Cordova - South Jackson 161-kV TL | Facilities Study | Solar | Fayette | 70 | 389.2 | 700 |

| Queue # | Forecasted ISD | Request Type | POI | Phase | Generator Type | County | Nameplate Capacity (MW) | Lower Bound Acres Required[1] | Upper Bound Acres Required[2] |
|---|---|---|---|---|---|---|---|---|---|
| 496 | 05/01/2024 | New Generation | Cordova - South Jackson 161-kV TL | Facilities Study | Solar | Haywood | 70 | 389.2 | 700 |
| 501 | 02/01/2025 | New Generation | Great Falls HP - Spring City 161-kV TL | System Impact Study | Solar | Bledsoe | 150 | 834 | 1500 |
| 503 | 03/01/2024 | New Generation | Weakley - Dyersburg No1 161-kV | Feasibility Study | Solar | Gibson | 70 | 389.2 | 700 |
| 505 | 03/01/2025 | New Generation | Widows Creek FP - Winchester No 1 161 kV | System Impact Study | Solar | Franklin | 146 | 811.76 | 1460 |
| 507 | 10/13/2025 | New Generation | Winchester - Smith Mountain SW STA 161- | System Impact Study | Solar | Grundy | 160 | 889.6 | 1600 |
| 510 | 06/12/2025 | New Generation | Huntingdon - Milan 161-kV TL | System Impact Study | Solar | Carroll | 140 | 778.4 | 1400 |
| 511 | 10/17/2025 | New Generation | Covington - Alamo 161-kV TL | System Impact Study | Solar | Crockett | 55 | 305.8 | 550 |
| 515 | 09/12/2025 | New Generation | Covington - Alamo 161-kV TL | System Impact Study | Solar | Haywood | 67 | 372.52 | 670 |
| 518 | 10/17/2025 | New Generation | Jackson - Milan 161-kV TL | System Impact Study | Solar | Madison | 55 | 305.8 | 550 |

| Queue # | Forecasted ISD | Request Type | POI | Phase | Generator Type | County | Nameplate Capacity (MW) | Lower Bound Acres Required[1] | Upper Bound Acres Required[2] |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | **Total Acres Required** | | **23,440.96** | **42,160** |

Notes: [1]5.56 acres=1 MW; [2]10 acres=1 MW. Total nameplate capacity of all plants in this table sum to 4,216 MWs.

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