Shading Study - Fusion Solar Center, LLC
Potash Hill Road, Sprague, CT
06/30/15

The shading study process for Fusion Solar Center involved the coordination of several parties, including Fuss and O'Neill, who produced a qualified shading model that is the heart of the analysis, All Points Technology, who surveyed tree heights in order to provide an accurate average estimate for use in the model, and the Petitioner, who provided energy analysis based on the results of Fuss and O'Neill's model. The process is detailed as follows.

Fuss & O'Neill prepared a survey base map which included, but was not limited to, existing site aerial topography provided by others, site features such as buildings, stone walls, roads and driveways, existing vegetation and wetland delineations. The proposed solar array layout provided by Fusion Solar Center, LLC was then added to the survey base map in AutoCAD utilizing a real-world coordinate system. The digitized files were then imported into Trimble SketchUp, a 3D modeling program that interfaces directly with AutoCAD, to simulate accurate solar conditions.

Within the modeling program a ground plane (or surface) was created utilizing the surveyed site topography. The locations for the solar arrays and clearing limits of existing vegetation were then overlaid onto the modeled surface. The existing vegetation was then vertically extruded 95 feet from the surface depicting mature growth of surrounding vegetation based on qualified data from All Points Technology's field survey of average tree heights using a clinometer.

SketchUp's geolocation and shadow tools work together to create an accurate portrayal of real world-shadows in the computer model. The shadow tools also allow the user to gain accurate shadow patterns for specific times throughout the year. Visually represented in the shading exhibit are the shadow profiles on December 21, the winter solstice, when shadows are longest in the northern hemisphere. The minimum design philosophy of the array is to limit shading as much as possible between the hours of 10AM and 2PM on the solstice day. This limits the energy loss from shading of nearby objects to acceptable levels. Shadows cast from the proposed new tree line onto the PV system for each of those times is shown. Though it is undesirable, shading does occur on the parts of the PV system during these times but this is unavoidable due to environmental considerations, such as minimizing impact to vernal pool buffer areas, as well as proximity to property boundaries.

Using Fuss and O'Neill's validated shading model data, Fusion Solar Center, LLC, was able to model the total approximate annual impact of shading to the array via simulations done using PV Syst, which takes a more granular approach to the analysis by examining individual inverter impacts. Figure 1 represents the worst case shading as seen in the SW corner of the array area on the Houle parcel, with shading loss on a clear day represented by the graph in the bottom left corner. Figure 2 represents the average inverter shading profile of the array in areas with more ideal clearing limits, also with shading loss on a clear day represented by the graph in the bottom left corner. Finally, Figure 3 represents the yearly shading loss at different times of year and hours of day on a sun chart.

The average annual percentage of PV panels shaded due to trees is approximately 4.6% when looked at across the entire system's operational hours. Although the ideal scenario is that the shading loss due to trees is kept to near 0%, this solution is not attainable based on the aforementioned site constraints. Despite these compromises in the overall design, the modeling shows that Fusion Solar Center will be able to achieve the energy output numbers dictated by its Power Purchase Agreement (PPA) with Eversource and United Illuminating if it maintains this layout.

Figure 1 – Inverter-Level Shading Profile at Closest Point to Tree Line

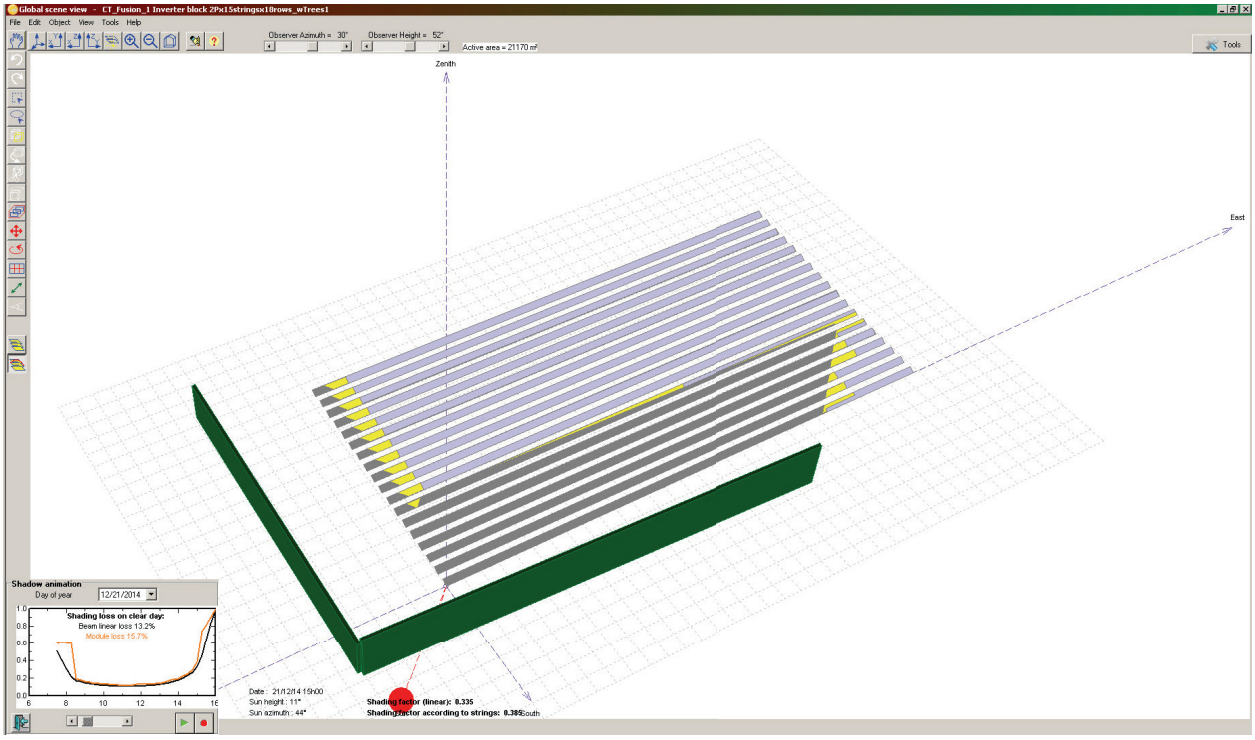

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Figure 2 – Average Inverter-Level Shading Profile

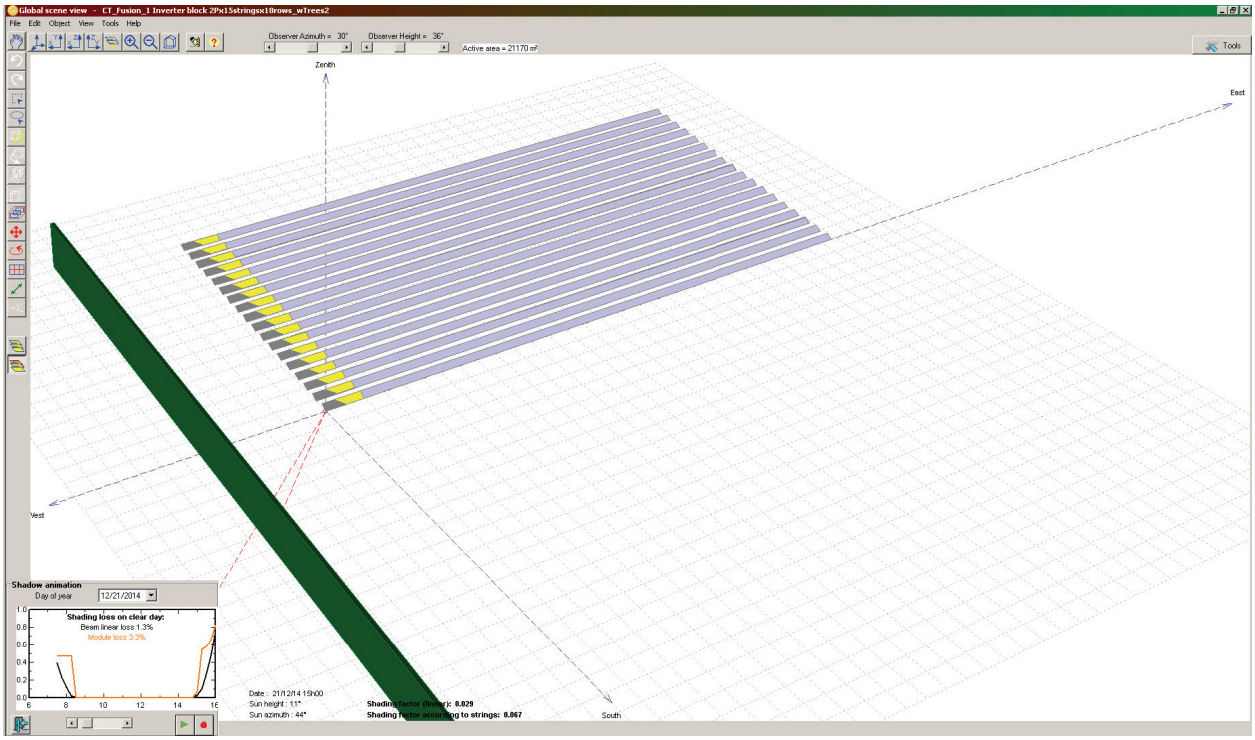
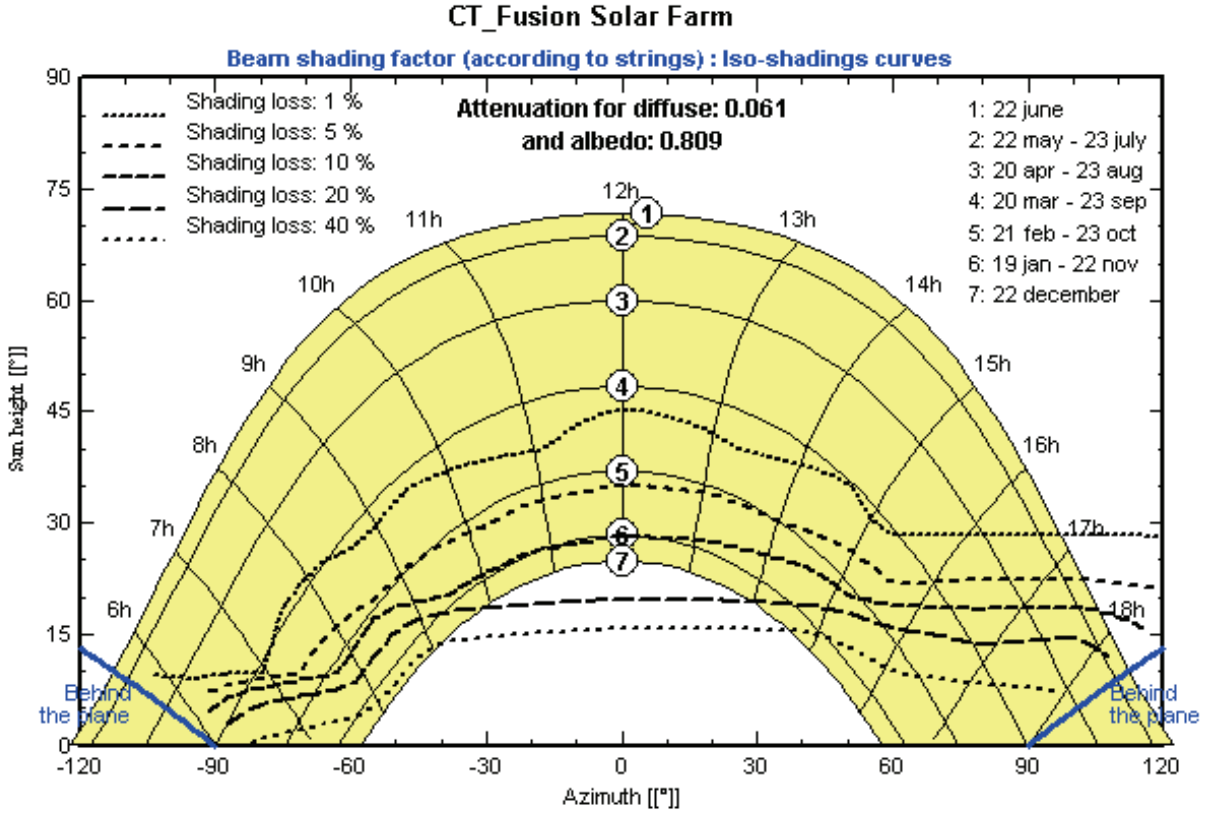


Figure 3 – Yearly Shading Loss



DECEMBER 21- 10AM

DECEMBER 21- 2PM