LARGE SCALE SOLAR

OVERVIEW OF A HIGH-IMPACT DRAWDOWN SOLUTION

Solar photovoltaic systems can convert solar energy into electricity. Utility-scale solar is defined as any ground mounted solar panel facility that has a capacity rating larger than 5 MW. Community-scale solar generally has a capacity of 0.5-5 MW. This solution also considers the possible advantage of coupled on-site storage to enhance reliability.

TECHNOLOGY AND MARKET READINESS

The technology is mature and market ready. In Georgia, the United States and globally, utility-scale solar is growing rapidly and costs have been declining. By mid-2019, total solar PV capacity in Georgia had risen to more than 1,570 MW, with more than 1,000 MW of that at utility-scale facilities. There is less experience with solar and storage projects in Georgia. Across the United States, at least 85 co-located solar and storage projects are in the planning stages, according to S&P Global Market Intelligence data, [1] pairing 4,175 MW of storage with 8,921 MW of solar. Roughly 40 such systems were in operation in the United States as of late September 2019, combining about 533 MW of storage with 1,242 MW of solar capacity. None of these hybrid facilities are proposed or currently located in Georgia (Hering, 2019).

LOCAL EXPERIENCE AND DATA AVAILABILITY

In 2014 Silicon Ranch Corporation and Green Power EMC constructed a solar farm located in Jeff Davis county in southeast Georgia near Hazlehurst, one of the first and largest solar farms in the Southeast. (Silicon Ranch is one of the nation's largest independent solar power producers and the U.S. solar platform for Shell.) This solar farm sits on 135 acres of land with a capacity of 55.2 MW. Georgia now has 8 solar farms with an operating capacity above 50 MW totaling 559.4 MW. Three of the largest solar facilities in the state have capacities of 100 MW or greater. In 2018, utility-scale facilities produced almost 90% of the state's solar PV generation (EIA 2019). Thus, there is ample documentation of the performance of solar farms in the United States and the Southeast.

Georgia Solar Farms with an Operating Capacity above 50 MW

Jeff Davis, 100 MW	Butler Solar Project, 100 MW
Decatur Parkway Solar Project, 80 MW	White Oak, 76.5 MW
Hazlehurst Solar II, 52.5 MW	White Pine, 101.2 MW
Sand Hills, 143 MW	Live Oak, 51 MW

Source: S&P Global Market Intelligence [1]

Community solar projects range from a few hundred kW to a few MW on the distribution grid (i.e., non-customer-sited) and are administered by the utility or a third-party entity in which multiple customers can participate. In 2015, approximately 60 MW of community solar was operating in the United States (Funkhouser, et al., 2015). Several community solar projects are currently operating in Georgia.

TECHNICALLY ACHIEVABLE CO2 REDUCTION POTENTIAL

Lopez, et al. (2012, Table 3) estimates that the total technical potential for rural utility-scale solar farms in Georgia is 3,088 GW and 5,492,000 GWh, covering 64,343 km [2]. It estimates an additional technical potential for urban utility-scale solar that might be suitable for community projects, totaling 24 GW and 43,167 GWh, covering 506 km [2] (Lopez, et al., 2012, Table 2). These estimates exclude sites with slopes over 3%, <0.4 square miles of contiguous area, and wetlands, federal parks, wilderness areas, wildlife areas, and many other incompatible land uses. Based on these estimates, only 16 states are estimated to have higher technical potential than Georgia. According to the Solar Energy Industries Association (SEIA), Georgia is 11th in potential for future growth. Georgia's solar resource of 4.5-5.0 kWh/m2/day is slightly less than that of Florida (NREL, 2012).

The Georgia Power IRP 2019 calls for 2,000 MW of new utility-scale solar by 2022. This would displace 1.36 Mt CO2 in 2030 [1]. GT-NEMS forecasts a growth of solar farms in Georgia from 11,600 GWh or 7.9% in 2020, to 12,800 GWh or 8.9% in 2030 (Source: GT-NEMS modelling). This growth would displace 0.47 Mt CO2 in the year 2030.

To displace an additional 1 Mt CO2 will require 2,580 GWh of additional solar generation. At a capacity factor of 25%, this would require 1,178 MW of new capacity, or 10 additional 100 MW solar farms and 36 additional 5 MW community solar projects. The total of these two estimates is a technical potential of 5,535,000 GWh from utility-scale solar. This could displace 2,145 Mt CO2, which is more than 10 times the current GHG footprint of Georgia

COST COMPETITIVENESS

EIA cost estimates for new generation in the SERC-SE Region is $37.6/MWh x 0.94 (regional multiplier) = $33.5/MWh. Utilizing data from S&P Global Market Intelligence and the Georgia Tech LCOE calculator, the estimated LCOE for utility-scale solar today is $85.6/MWh. Levelized energy prices for solar farms with lithium-ion batteries have dipped into the range of $30-$40/MWh for many projects scheduled to come online in the next few years in California, Arizona, and Nevada (Bolinger and Seel, 2018).

BEYOND CARBON ATTRIBUTES

The environmental and public health benefits of solar farms relate to air quality improvements from the reduction of fossil fuel pollution, particularly SO2 (a major contributor to acid rain), PM2.5 (a respiratory health concern), and NOX, besides CO2 (Millstein et al., 2017).

From an economic development standpoint, construction and operation of solar farms offer local and statewide employment. According to Georgia Solar Job Census 2018, there are 304 solar companies operating in Georgia. In 2019, Georgia was second to Florida in the number of new solar jobs, with 30% growth, bringing the total solar employment in Georgia to 4,798 [4]. For many of the solutions noted in this document, displacement of jobs from coal or other sources will need to be considered/addressed against these positive economic benefits.

Despite its jobs potential, the solar workforce is currently not yet representative of America's ethnic, racial, and gender diversity. Solar Jobs Census 2019 [4] found that only 26% of the solar workforce was made up of women, and the racial breakdown is dominated by the workers who are White, comprising 73.2% of the overall solar workforce.

Potential environmental costs may include the depletion of water resources due to solar panel cleaning (approximately 20 gal/MWh [5]), and land use concerns about displacement of native flora and fauna. While monitoring water use and seeking efficiencies are worthwhile endeavors, solar farms use of water is less intensive than traditional fossil fuel alternatives (Klise, et al., 2013)[6]. On land use, solar farms in Georgia can produce 18.5 MW per square mile (Lopez, et al., 2012). Thus, 1 Mt CO2 reduction via solar farms requires about 64 square miles of land.

Potential impacts (both positive and genitive) of intermittent solar generation on retail electricity prices are supported by mixed research findings.[7,8] Similarly the property-value impacts near utility-scale solar farms needs to be explored further [9].

Given the scale of current and potential solar panel installations, end-of-life disposability of PV panels is a pertinent environmental issue (Chowdhury et al., 2020) due to toxic materials contained within the cell, for example, cadmium, arsenic, and silica dust. 13,000 tons of PV panel waste is expected to be produced by the United States in 2020 [10].

References:

Bolinger, Mark, and Joachim Seel. (2018) "Utility-Scale Solar: Empirical Trends in Project Technology, Cost, Performance, and PPA Pricing in the United States – 2018 Edition.

Chowdhury, S., K.S. Rahman, T. Chowdhury, N. Nuthammachot, K. Techato, Md. Akhtaruzzaman, S. Kiong Tiong, K. Sopian, N. Amin, An overview of solar photovoltaic panels' end-of-life material recycling, Energy Strategy Reviews, Volume 27, 2020, 100431, ISSN 2211-467X, https://doi.org/10.1016/j.esr.2019.100431

Energy Information Administration (EIA). (2019). Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2019.

Funkhouser, E., Griselda Blackburn, and Varun Rai. (2015). "Business model innovations for deploying distributed generation: The emerging landscape of community solar in the U.S." Energy Research & Social Science 10: 90-101. https://doi.org/10.1016/j.erss.2015.07.004

Hering, Garrett (2019) "Solar-plus-storage power plant development accelerates in the U.S., October 16, 2019 https://platform.marketintelligence.spglobal.com/web/client?auth=inherit#news/article?id=54590775&KeyProductLinkType=http://www.thesolarfoundation.org/wp-content/uploads/2019/03/TSF_Georgia_State-Fact-Sheet-2018.pdf

Klise, Geoffrey T., Vincent C. Tidwell, Marissa D. Reno, Barbara D. Moreland, Katie M. Zemlick, Jordan Macknick. 2013. Water Use and Supply Concerns for Utility-Scale Solar Projects in the Southwestern United States, SAND2013-5238.

Lazard. (2018). "Lazard's Levelized Cost of Energy Analysis." Version 12.0. (November), https://www.lazard.com/media/450337/lazard-levelized-cost-of-energy-version-110.pdf

Lopez, Anthony, Billy Roberts, Donna Heimiller, Nate Blair, and Gian Porro. (2012) U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis National Renewable Energy Laboratory, NREL/TP-6A20-51946, https://www.nrel.gov/docs/fy12osti/51946.pdf

Millstein, D., R. Wiser, M. Bolinger, G. Barbose, 2017. The climate and air-quality benefits of wind and solar in the United States. Nature Energy, 2, doi:10.1038/nenergy.2017.134.

The Solar Foundation, Georgia Solar Jobs Census 2018.

Endnotes:

1. S&P Energy Market Intelligence. (2020). S&P Global Intelligence Energy Data. https://www.spglobal.com/marketintelligence/en/about/
2. EIA.gov. (2019). Georgia - State Energy Profile Analysis - U.S. Energy Information Administration (EIA). [online] Available at: https://www.eia.gov/state/analysis.php?sid=GA
3. NREL: Energy Efficiency and Renewable Energy Clearinghouse (EREC) DOE/GO-10096-050 FS 119 March 1996
4. The Solar Foundation, National Solar Jobs Report 2019. (2020). https://www.thesolarfoundation.org/national/
5. https://www.seia.org/initiatives/water-use-management
6. NREL: Water Impacts of High Solar PV Electricity Penetration, NREL/TP-6A20-63011, 2015
7. https://economics.mit.edu/files/16650
8. https://www.forbes.com/sites/brianmurray1/2019/06/17/the-paradox-of-declining-renewable-costs-and-rising-electricity-prices/#26d2229961d5
9. https://emp.lbl.gov/sites/default/files/property-value_impacts_near_utility-scale_solar_installations.pdf https://www.greenmatch.co.uk/blog/2017/10/the-opportunities-of-solar-panel-recycling

Corresponding Author:

Dr. Marilyn A. Brown
Interim Chair, School of Public Policy
Georgia Institute of Technology
Email: mbrown9@gatech.edu
Twitter: @Marilyn_Brown1
Phone: 404-385-0303
www.marilynbrown.gatech.edu
Climate and Energy Policy Lab:
www.cepl.gatech.edu