GREATER RICHMOND REGION COMMUNITY SOLAR FEASIBILITY STUDY

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Virginia Solar United Neighborhoods (VA SUN)

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EXECUTIVE SUMMARY

Community shared solar installations, also referred to as 'solar farms' or 'solar gardens,' are gaining popularity as consumers' desire to lower their energy costs and reduce their carbon footprint grows. This study examined the relevant regulatory and policy environment in the United States (U.S.) and Virginia concerning community solar. We outlined four community solar case studies, conducted informational interviews with policy experts, and used GIS mapping to determine the feasibility of starting a community solar program in the City of Richmond, Virginia, under the auspices of Virginia Solar United Neighborhoods (VA SUN).

More specifically, as part of this research, we reviewed case studies of community solar projects in other states and of various legal models such as utility-owned, non-profit owned, or limited liability corporations (LLCs). Further, we interviewed stakeholders in the Greater Richmond Region who were knowledgeable on the issues and challenges of establishing community solar projects in Virginia. These interviews were conducted with the Director of Development for Sigora Solar, a solar installer in Waynesboro, an Energy Attorney with GreeneHurlocker Law Firm in Richmond, and a Bank Loan Officer with Virginia Community Capital in Richmond. All interviewees indicated great difficulty of starting a community solar project due to lack of supporting state laws, low electricity prices, and a dominant utility provider who lobbies against community solar. However, these respondents were cautiously optimistic that the political landscape would change in the near future to enable community solar to progress in the state.

For our analysis of potential solar locations in Richmond, we used Geographic Information Systems (GIS) and Light Radar (LiDAR) data to identify suitable building rooftops to support the installation of productive solar arrays. Our analysis showed that there were at least 178 rooftops of sufficient size and insolation to support a community solar project in Richmond. However, the absence of enabling legislation and supportive policy, such as virtual net metering, as well as the near-monopolistic power of the state's largest utility, Dominion Virginia Power, preclude the establishment of a true community solar program by LLCs, non-profits, and similar organizations. Therefore, we concluded that a utility-owned community solar program showed promise as a model that could work effectively to bring solar electric power to residents unable to do so on their own due to a lack of suitable facilities or financial capital. We also concluded that policy changes should be enacted at the state level, such as formal virtual net metering policy, to encourage the LLC or non-profit models of community solar.

1. INTRODUCTION

1.1 PURPOSE AND OVERVIEW OF THE REPORT

In the fall of 2015, the non-profit organization VA SUN requested assistance in discovering areas in the City of Richmond where community solar projects may be effective, both in energy produced and cost. Therefore, our project reviewed and analyzed the existing solar policy environment at the national, state, and local levels, with specific attention paid to community solar policies. We assessed four community solar projects across the nation to determine what kinds of programs, policies, and incentives might work in Richmond. We also reviewed two community solar programs that have been initiated by electric utilities in Virginia. Additionally, our team collected and analyzed numerous types of spatial data in GIS to identify potential locations for community solar installations in Richmond. These targeted areas were graded and ranked on several variables, including their size, energy output, and total greenhouse gas (GHG) reduction potential. Our report concludes with a summary of these targeted sites, policy recommendations, and suggestions for future research.

1.2 COMMUNITY SOLAR

Community solar has developed as a strategy for solar photovoltaic (PV) projects since many are incapable of installing solar arrays on their own roofs. According to current estimates, 85% of Americans either have roofs unsuitable for solar panels, or do not outright own the building they occupy.[1] Community solar projects are “solar-electric system[s] that provide power and/or financial benefit to multiple community members.”[2] These types of projects are often ‘off-site,’ meaning various consumers can relish the advantages of solar energy without having to install a system on their own residential or commercial property. Characteristically, these types of projects have two or more subscribers, are larger than projects financed by one business or individual, and make a local economic impact.

Community solar is a relatively recent phenomenon, and it relies heavily on the input of members and customers with a common interest. However, community solar is still in its infancy; out of the 6,200 MW of solar energy installed over the U.S. in 2014, only 1% was from community solar.[3] Only 24 states have active community solar projects, totaling to just 66 MW of total installed solar PV capacity.[4] This amount to less than 0.3% of the cumulative installed solar energy capacity in the U.S.

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[1] Denholm, P., & Margolis, R. National Renewable Energy Laboratory. (2008). *Supply Curves for Rooftop Solar PV-Generated Electricity for the United States*. Retrieved from http://www.aimspress.com/article/10.3934/energy.2015.3.401/fulltext.html

[2] Coughlin, J., Grove, J., Irvine, L., Jacobs, J. F., Phillips, S. J., Sawyer, A., & Wiedman, J. National Renewable Energy Laboratory. (2012). *A Guide to Community Shared Solar: Utility, Private, and Nonprofit Project Development*. Retrieved from http://www.nrel.gov/docs/fy12osti/54570.pdf. p. 3.

[3] Gallucci, M. (2015, July 9). *U.S. Solar Boom: 'Community' Solar Energy Projects Are Accelerating America's Drive Toward Renewables*. Retrieved from International Business Times: http://www.ibtimes.com/us-solar-boom-community-solar-energy-projects-are-accelerating-americas-drive-toward-2001477

[4] Munsell, M. Greentech Media. (2015, June 23). *U.S. Community Solar Market to Grow Fivefold in 2015, Top 500MW in 2020*. Retrieved from http://www.greentechmedia.com/articles/read/us-community-solar-market-to-grow-fivefold-in-2015-top-500-mw-in-2020

Nevertheless, the future of community solar is bright. Since community solar can provide solar PV energy with consumers who might otherwise be unable to install panels on their properties, the market is seven times larger than traditional residential rooftop solar.[5] The U.S. Department of Energy has recognized this potential by funneling $14 million into the SunShot Initiative, which promotes technological and market research to help make solar energy affordable and accessible to all Americans.[6] The U.S. Internal Revenue Service (IRS) is also beginning to treat community solar as a legitimate endeavor, as it recently ruled that a Vermont man who purchased solar panels as part of a shared solar project can claim the federal Investment Tax Credit (ITC).[7] Although this particular decision applies only to this individual, it may signal a larger trend of government agencies embracing community solar.

Reports indicate that the community solar market is expected to grow dramatically over the next decade. Over the next five years, the estimated annual installation within the community solar sector will reach 500 MW, resulting in 1.8 gigawatts of new systems by 2020.[8] The predicted growth in community solar is expected to be concentrated among states that have forthcoming legislation to incentivize community solar installations.[9]

In other words, the success of community solar in Virginia and the City of Richmond depends heavily on the state-level policy environment concerning this issue. This is further important considering that many homes in Richmond, particularly in 'The Fan' neighborhood, have steep roofs where solar panels cannot be installed or are prohibited by historic preservation guidelines. The next sections of this introductory chapter work to outline national and state-level trends and policies relevant to solar PV, and then discuss the models and challenges related to community solar in Richmond.

1.3 NATIONAL SOLAR PV TRENDS

Solar PV installations in the U.S. have been increasing significantly since 2010, and are projected to continue to do so in the future. Installed solar capacity has grown from about 1,000 megawatts (MW) in 2010 to nearly 7,000 MW in 2014, with about 20,000 MW forecasted to be installed throughout 2015 and 2016.[10] Cumulatively, through the second quarter of 2015, the U.S. has more than 22,700 MW of solar PV installed. Overall, solar PV made up 40% of newly-

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[5] Trabish, H. K. Utility Dive. (2015, February 12). *Why Dept of Energy is going big on community shared solar*. Retrieved from http://www.utilitydive.com/news/why-dept-of-energy-is-going-big-on-community-shared-solar/361716/

[6] Ibid.

[7] Ring, W. (2015, September 02). *Group Says IRS Ruling Could Promote Community Solar Projects*. Retrieved from http://www.concordmonitor.com/readerservices/businessxml/18428931-95/group-says-irs-ruling-could-promote-community-solar-projects

[8] Gallucci, M. (2015); Munsell, M. (2015).

[9] Gallucci, M. (2015).

[10] Solar Energy Industries Association. (2015a). *Solar Energy Facts: Q2 2015*. Retrieved from http://www.seia.org/sites/default/files/Q2%202015%20SMI%20Fact%20Sheet.pdf

installed electric capacity in 2014, outpacing all other sources (e.g., coal, natural gas, and wind).[11]

The installed price of solar PV has fallen inversely with the number of new connections to the grid. According to the Lawrence Berkeley National Laboratory's annual *Tracking the Sun* report, national installed prices of solar PV have declined dramatically, at about 9% per year, through 2014 and into 2015.[12] Not only have the costs of PV panels and other materials decreased recently, but soft costs related to solar installations (e.g., inspection, labor, permitting, etc.) have dropped by $0.40 per watt (W) nationally over the last few years.[13]

Both the number of solar PV installations and the cost of installations are anticipated to continue their current trajectories over the next few years. Originally, the scheduled expiration of the federal Investment Tax Credit (ITC) (which provides a 30% tax credit for investors) at the end of 2016 had made the amount of solar PV installed in 2017 projected to decline by 55%.[14] However, in December of 2015, the ITC was extended for six more years, stepping down to 26% in 2020, 22% in 2021, and 10% in 2022.[15] The ITC was originally created as part of the Energy Policy Act of 2005 and was extended twice before, under the Tax Relief and Health Care Act of 2006 and the Emergency Economic Stabilization Act of 2008. This tax credit has been a primary driver of the increase in solar PV installations over the past decade.

1.4 VIRGINIA SOLAR PV TRENDS

A 2014 report ranked Virginia 30th in the U.S. for installed solar with 12 MW of cumulative solar PV capacity installed.[16] However, as of June 2015, Virginia had 15 MW of cumulative solar PV energy installed, indicating its upward trend in the state.[17] At this time, more than 169 solar companies were located throughout the state, employing about 1,800 people, and there was enough solar PV installed to power roughly 1,500 homes.[18]

Figure 1 shows the annual Virginia solar installations from 2006 through the first quarter of 2015. However, this figure does not accommodate for the various utility-scale projects that Dominion Virginia Power, as well as other electric utilities, have recently announced. Despite this progress for solar PV, Figure 2 shows that renewable energy resources remain a small

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[11] Ibid.

[12] Barbose, G., & Darghouth, N. Lawrence Berkeley National Laboratory. (2015). *Tracking the Sun VIII: The Installed Price of Residential and Non-Residential Photovoltaic Systems in the United States*. Retrieved from https://emp.lbl.gov/publications/tracking-sun-viii-install

[13] Ibid.

[14] Solar Energy Industries Association. (2015a).

[15] Williard, T. (2015). *ITC Extension: Big News for Renewables*. Retrieved from http://www.sagerenew.com/press/itc

[16] Springston, R. Richmond Times Dispatch. (2015, September 03). *Report Says Virginia Ranks 30th in Solar Power*. Retrieved from http://www.richmond.com/business/local/article_a6245592-df1d-57d2-8a30-36b066b89c60.html

[17] Solar Energy Industries Association. (2015b). *State Solar Policy: Virginia Solar*. Retrieved from http://www.seia.org/state-solar-policy/virginia-solar

[18] Ibid.

percentage of Virginia's overall energy source consumption for 2013 at 2.8 trillion British Thermal Units (Btus) compared to natural gas at 433.5 trillion Btus.

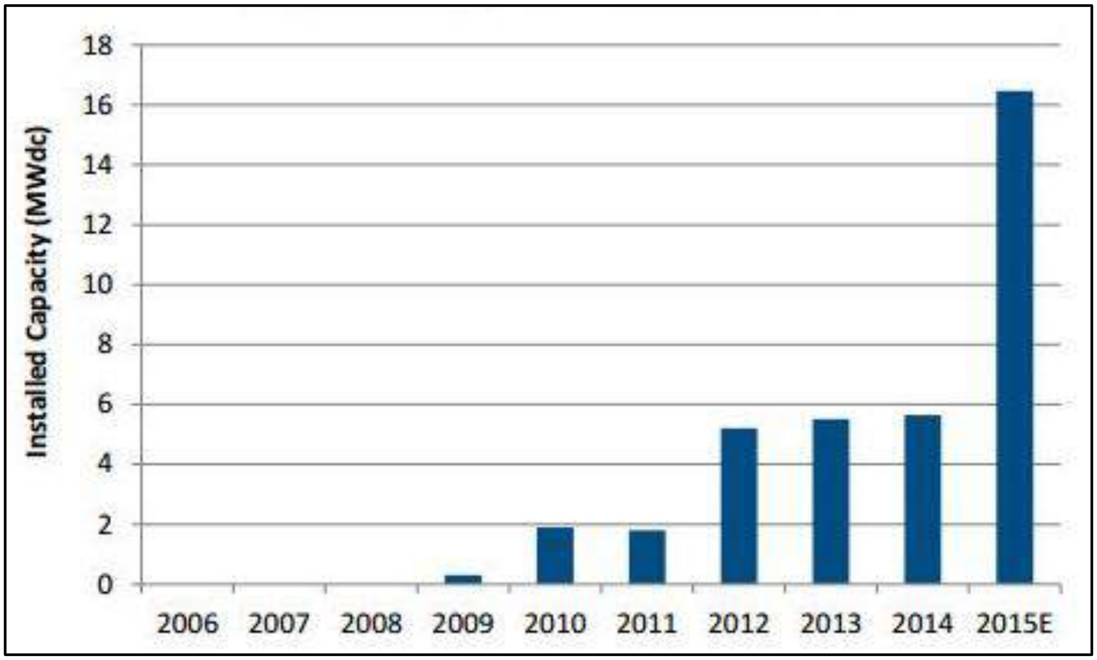

Figure 1. Annual Virginia solar installed capacity from 2006 to 2015 Q1.[19]

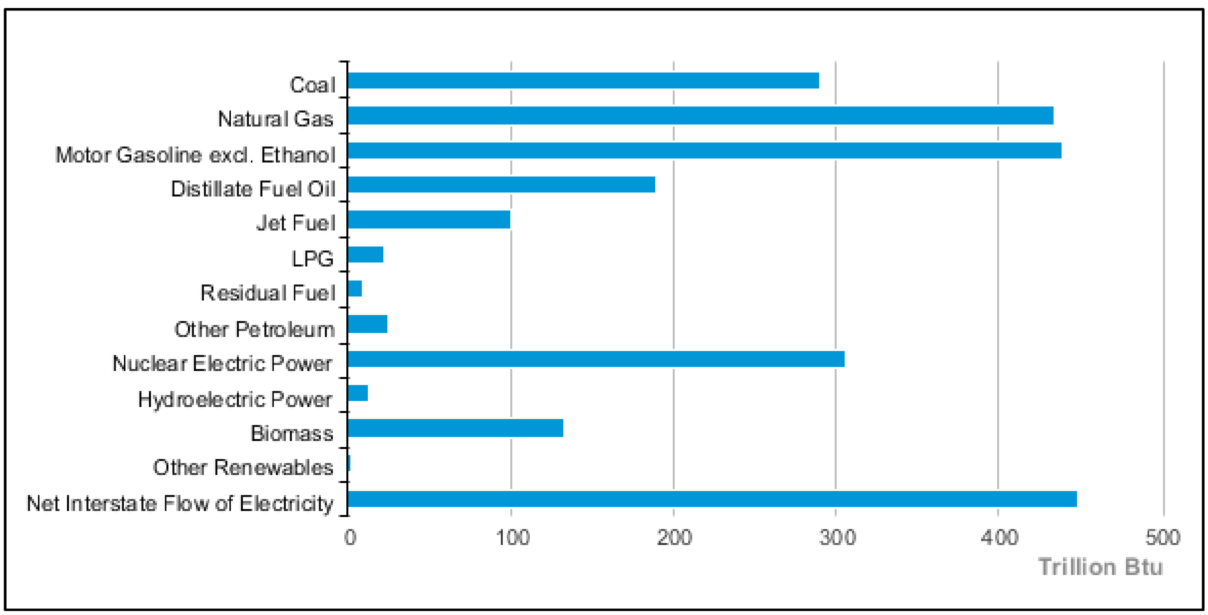

Figure 2. Virginia energy consumption estimates for 2013.[20]

[19] Solar Energy Industries Association. (2015b).

Virginia's solar profile is continuing to expand, with larger companies taking the lead. For instance, IKEA, the world's leading home furnishings retailer, installed a solar PV system installed atop its store in Woodbridge in July 2012, the state's largest such PV array. This 63,000 square-foot PV array consists of a 504 kilowatt (kW) system, built with 2,100 panels.[21] Overall, this project produces approximately 636,199 kilowatt hours (kWh) of clean electricity annually, the equivalent of eliminating the emissions of 86 cars, or powering 55 homes.[22]

Amazon Solar Farm U.S. East is another solar PV project of interest. Located on the Delmarva Peninsula in Accomack County, it is a cluster of projects across roughly 1,000 acres near the Oak Hall substation. Together, these clusters will generate 80 MW of electricity, which is enough to power 15,000 homes. Community Energy Solar, the project developer, chose the Delmarva Peninsula for the project site because it offers excellent solar resources and flat land ideal for constructing a solar project of this size. In addition, Community Energy Solar is utilizing single-axis tracker technology that follows the sun's path, providing high peak production. This project is on target to commence construction in late 2015 and reach commercial operation in 2016.[23] Dominion Virginia Power recently acquired the project and will add electricity generated from it to its grid so that it will count toward its federal Clean Power Plan (CPP) requirements.[24] Near the end of 2015, Dominion also announced an objective to install 110 MW of solar PV capacity in Virginia, by building 75% and working with third party developers to build the remaining 25%.[25]

2. POLICY REVIEW

2.1 FEDERAL POLICY

Solar PV energy has long been included as a source of clean energy in federal acts. The U.S. Department of Energy has specifically noted solar PV as a source that could not only enhance the country's energy security, but also help reduce GHG emissions and slow climate change. Some of the key policies related to the growth of solar and other renewables are noted below.

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[20] Energy Information Administration. (2015). *Virginia: Profile Overview*. Retrieved from http://www.eia.gov/state/?sid=VA

[21] Clabaugh, J. Washington Business Journal. (2012, July 11). *Ikea Plugs in Virginia's Biggest Solar* Array. Retrieved from http://www.bizjournals.com/washington/news/2012/07/11/ikea-plugs-in-virginias-biggest-solar.html

[22] Ibid.

[23] Community Energy Solar. (2015). *Amazon Solar Farm U.S. East*. Retrieved from https://communityenergysolar.com/project/amazon-solar/

[24] Blackwell, J. R. Richmond Times Dispatch. (2015, November 16). *Dominion Acquires Accomack Solar Power Project*. Retrieved from http://www.richmond.com/business/local/article_11f1ce21-ecde-5e33-a54a-b81f549da314.html

[25] Roselund, C. (2015). *Dominion to Put Online 110 MW of Solar PV in Virginia*. Retrieved from http://www.pv-magazine.com/news/details/beitrag/dominion-to-put-online-110-mw-of-solar-pv-in-virginia_100022567/#axzz3wvFq66Ut

2.1.1 ESTABLISHMENT OF THE U.S. DEPARTMENT OF ENERGY

The U.S. Department of Energy Organization Act of 1977 created the Department of Energy by consolidating the Federal Energy Administration and the Energy Research and Development Administration. The Department's stated mission was "to ensure America's security and prosperity by addressing its energy, environmental and nuclear challenges through transformative science and technology solutions."[26] With specific regard to energy, its mission was to "catalyze the timely, material, and efficient transformation of the nation's energy system and secure U.S. leadership in clean energy technologies."[27]

2.1.2 KEY ENERGY POLICY LEGISLATION

Leading up to the Department of Energy's establishment, in particular response to the oil crisis of 1973, President Nixon created 'Project Independence' with the goal of eliminating the dependence on foreign energy sources by 1980. A series of new policy acts were passed in subsequent years, including the National Energy Act of 1978, a solar plan put forth by President Carter in 1979, and the Energy Security Act of 1980.

Furthermore, the deregulation of state electricity markets began with the 1978 passage of the Public Utilities Regulatory Policies Act (PURPA), which allowed Independent Power Producers to generate and market electricity. The passage of the Energy Policy Act of 1992 further eliminated restrictions on wholesale electricity prices, which was crucial toward the growth of renewables by expanding consumer choice.

As previously noted, the Energy Policy Act of 2005 developed the federal ITC, which has been a major factor of the growth of the solar energy industry in the U.S. The Emergency Economic Stabilization Act of 2008 (the 'stimulus package') extended this credit for another eight years, leading up to the most recent ITC extension.

Most recently, the Environmental Protection Agency's (EPA) CPP called for pollution reductions from existing power plants throughout the country. The EPA and states worked to set targets based on the respective mixes of fuel types with the goal of reducing GHG emissions and addressing worldwide climate change.[28] Since states have the ability to determine their own strategies for achieving these targets, the ultimate impact on solar PV energy remains unclear. However, taken as a whole, all of these federal acts have worked to worked to set the stage for the development of solar in the U.S. over the past three decades.

2.2 VIRGINIA POLICY

Relative to other U.S. states, Virginia does not have strong policies regarding solar PV energy. Virginia only has a voluntary renewable portfolio standard (RPS), relatively poor net

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[26] U.S. Department of Energy. (2015). *Mission*. Retrieved from http://www.energy.gov/mission

[27] Ibid.

[28] Environmental Protection Agency. (2015). *Clean Power Plan for Existing Plants*. Retrieved from http://www.epa.gov/cleanpowerplan/clean-power-plan-existing-power-plants

metering policies (including capacity limits), and only a few state programs aimed to encourage solar PV deployment.

2.2.1 RENEWABLE PORTFOLIO STANDARD

An RPS is a legislative mandate that requires electric utilities within a state to meet certain renewable targets by a certain date. For instance, a state may require 15% of electricity generation to come from renewable sources by the year 2025. In 2009, Virginia passed a voluntary RPS that urged electric utilities to meet renewable energy targets of 7% by 2016, 12% by 2022, and 15% by 2025. Under this plan, utilities that met or exceed the incremental RPS goals would be eligible to receive a higher rate of return for their investments.[29] However, by nature, this RPS program is flawed in that it counts old, pre-existing hydro-electric plans and allows the banking of renewable energy credits (RECs), meaning that it has not adequately created an incentive for new renewable installations and generation. Further, since the RPS program is not mandatory, there are no strict penalties for utilities failing to meet the outlined percentages.

2.2.2 NET METERING

An increasing number of individuals are using net metering to generate electricity from renewable sources on their property. State net metering policies allow these customers to sell electricity to their utility provider (most often at the retail rate) and receive credit on their bill. In other words, these customers only pay the net amount of energy consumed from the electricity grid per month, effectively reducing the amount of electricity purchased from the utility.[30]

Currently, 41 of the 50 states have authorized net metering programs, including Virginia.[31] However, Virginia has a relatively modest capacity limit of 1 MW for commercial and 20 kW for residential systems, with a limit on overall enrollment cap of 1% of a utility's peak capacity. Due to this, *Freeing the Grid*, an annual report which examines each state's net metering policies, grades Virginia's net metering as a C on an A–F scale, ranking it among the bottom third of U.S. states.[32] Moreover, there are no state policies that allow community or virtual net metering in Virginia.

2.2.3 VIRGINIASAVES GREEN COMMUNITY PROGRAM

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[29] N.C. Clean Energy Technology Center. (2012). *Virginia Incentives/Policies for Renewable Energy*. Retrieved from http://www.dsireusa.org/incentives/incentive.cfm? Incentive_Code=VA10R&re=0&ee=0

[30] National Conference of State Legislatures. (2015). *Net Metering: Policy Overview & State Legislative Updates*. Retrieved from http://www.ncsl.org/research/energy/

[31] Inskeep, B., Kennerly, J., & Proudlove, A. North Carolina Clean Energy Technology Center. (2015). *The 50 States of Solar: A Quarterly Look at America's Fast-Evolving Distributed Solar Policy & Regulatory Conversation*. Retrieved from http://nccleantech.ncsu.edu/wp-content/uploads/The-50-States-of-Solar_FINAL.pdf

[32] Freeing the Grid. (2016). *Freeing the Grid 2015: State Grades – Net Metering*. Retrieved from http://freeingthegrid.org/#state-grades/

The VirginiaSAVES Green Community Program is a unique public/private partnership aimed to provide subsidized financing for energy efficiency, renewable energy, and alternative fuel loans. This program started with $20 million of Qualified Energy Conservation Bonds. This program covers several home improvement methods including renewable energy systems such as solar PV, biomass, geothermal, micro-hydroelectric, methane capture, combined heat and power co-generation technologies, and fuel cell technologies.[33]

2.2.4 SOLAR ENERGY TAX EXEMPTION CODE

This statute allows any county, city, or town in Virginia to exempt or partially exempt solar energy equipment from local property taxes. Eligible technologies include passive solar space heat, active solar water heat, active solar space heat, solar thermal electricity, and PVs. Localities offering exemptions in Virginia include: Albemarle, Alexandria, Charlottesville, Chesterfield, Dinwiddie, Fairfax County, Falls Church, Hampton, Hanover, Henrico, Isle of Wight, King and Queen, Loudoun, Lynchburg, Prince William, Pulaski, Roanoke, Spotsylvania, and Winchester.[34]

2.2.5 VOLUNTARY SOLAR RESOURCE DEVELOPMENT FUND

In April 2011, Virginia's General Assembly created the Voluntary Solar Resource Development Fund. Under this program, all electric utilities are required to provide a link on their web site to the Virginia Department of Mines, Minerals and Energy web site, where customers can contribute to the fund. The fund is used to provide loans for residential, commercial, or non-profit solar energy projects. Qualifying solar energy projects cannot be acquired, installed or operating before July 1, 2012. This fund will expire in July of 2016.[35]

2.3 UNSUCCESSFUL LEGISLATION FOR COMMUNITY SOLAR IN VIRGINIA

A number of bills proposing stronger policies for renewable energy in Virginia have been proposed in recent years, yet most have been unsuccessful in passing through the legislature. Specifically, to date, three separate bills have been introduced to support community solar, but all died in the Commerce and Labor subcommittee of the House of Delegates: House Bill 672 in 2012, House Bill 1158 in 2014, and House Bill 1729 in 2015.

Overall, all three bills would have authorized the establishment of community solar gardens in Virignia. A subscriber organization would have had to own community solar gardens, with a minimum of 10 subscribers. These subscribers would have received credits on their utility bills from energy generated at the solar facility in proportion to the size of their subscription. The output and RECs from a solar garden would have been purchased by the utility in the form of net metering credits allocated to the subscribers. To the extent that a subscriber's net metering

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[33] Virginia Department of Environmental Quality. (2015). *Incentives for Virginians*. Retrieved from http://www.deq.state.va.us/Programs/PollutionPrevention/VirginiaInformationSourceforEnergy/FinancialIncentives.aspx

[34] Ibid.

[35] N.C. Clean Energy Technology Center. (2014, November 11). *Voluntary Solar Resource Development Fund*. Retrieved from http://programs.dsireusa.org/system/program/detail/4876

credit exceeded the subscriber's electric bill in any billing period, the credit would have been applied against future bills. If the electricity output of the community solar garden was not fully subscribed, the utility would have been required to purchase the unsubscribed renewable energy at a rate equal to the utility's average hourly incremental cost of electricity supply over the immediately preceding calendar year.[36] In sum, the fact that all three Virginia community solar bills died with relatively little debate perhaps suggests that future bills may have trouble gaining enough support to pass.

2.4 COMMUNITY SOLAR PROGRAMS IN VIRGINIA

Despite the lack of formal enabling legislation for community solar in Virginia, two separate electric utilities have already initiated utility-owned programs within the past year. Dominion Virginia Power, the electric utility that serves the Richmond region, has implemented a community solar pilot program, while BARC (Bath, Alleghany and Rockbridge Counties) Electric Cooperative, in west-central Virginia, has developed a small community solar program.

2.4.1 DOMINION VIRGINIA POWER'S COMMUNITY SOLAR PILOT PROGRAM

Dominion Virginia Power submitted an application to the Virginia State Corporation Commission (SCC) on January 20, 2015 for the Dominion Community Solar Pilot (DCS Pilot). Under this application, Dominion Virginia Power proposed to build a 2 MW solar generation facility in Virginia and allow customers to purchase blocks of 100 kWh of generated solar electricity. These blocks will cost $4 each and be added to the customer's electricity bill. The goal of this project is for Dominion Virginia Power to gauge the interest of customers who support solar electricity but are unable to install it on their own property. The SCC granted their application, designated as Case No. PUE-2015-00005, for the pilot on August 7, 2015.[37]

The state's Attorney General, Office of Consumer Counsel, filed a letter with the SCC on July 16, 2015 stating its position that, under the DCS Pilot, customers will not, in fact, be purchasing solar generated power from Dominion's 2 MW facility. Instead, they would be paying an additional fee for the 100 kWh blocks on top of their normal electric bill and would not be receiving energy directly from the facility. This conclusion is based on hearings held on the application earlier this year. The Consumer Counsel's office stated that any marketing materials Dominion Virginia Power generates for this program should accurately reflect what the customer is purchasing and make it clear that they are not purchasing solar generated power.[38]

4.2.6 BARC ELECTRIC COOPERATIVE COMMUNITY SOLAR PROGRAM

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[36] Legiscan. (2015). *Virginia House Bill 1729*. Retrieved from https://legiscan.com/VA/bill/HB1729/2015

[37] State Corporation Commission. (2015a). *Annual Report on Solar Energy Distributed Generation Programs*. Retrieved from http://leg2.state.va.us/dls/h&sdocs.nsf/37d86b08b5098dd185256eec007a4359/6a164faab82ba6a385257d62005e84f0?OpenDocument

[38] State Corporation Commission. (2015b). *Comments of the Office of the Attorney General's Division of Consumer Counsel to the Hearing Examiner's Report filed on July 9, 2015, PUE-2015-00005*. Retrieved from http://www.scribd.com/doc/276921758/Dominion-Solar-Pilot-FAQ-and-SCC-Order#scribd

The BARC Electric Cooperative, headquartered in Millboro, Virginia, is a member-owned electric cooperative serving about 35,000 residents in west-central Virginia. It recently announced plans to start a community solar program in its service area. It will build, own, operate and maintain the 300–350 kW solar PV system, offering subscriber shares on a first-come, first-served basis to its customers, both small commercial and residential.[39]

Customers will pay a one-time administrative fee of $85 for the ability to reduce their electric bills by up to 25% while locking in future energy savings. The cooperative anticipates the average customer will save $2,000 over 20 years, or $100 annually. BARC will use a fixed kWh rate model, which it calculated to be the most economically viable for its project. A former elementary school on the property will be repurposed as a solar learning center. This program may very well be the first 'true' community solar project in Virginia.[40]

3. COMMUNITY SOLAR

Community solar has been developing throughout the U.S. in recent years as a means to overcome the barriers related to solar PV deployment (e.g., homeowners with shaded roofs, renters, etc.). There are various community solar models and mechanisms regarding costs, benefits, financing, taxes, and legal matters. The remainder of this section will discuss the three distinct community solar models (including various financing mechanisms and state policies), the U.S. states currently with enabling legislation, and the key challenges to more widespread implementation of community solar policy and projects.

3.1 COMMUNITY SOLAR MODELS

Although community solar projects can be administered many different ways, they all have the goal of providing reliable and renewable energy to customers who may be currently unable to install a solar PV system. The first step in this process is to identify an area suitable for a community solar installation, along with a specific site with high solar potential. A developer will then install the PV array, and is responsible for operating and maintaining the installation.[41]

The main difference between community solar and traditional large-scale solar installations is the connection between power source and consumer. Unlike most utility-owned solar farms that feed directly into the electrical grid, community solar installations are supported by consumer-members who buy into the project and receive a direct credit to their power bills. A member's benefits are calculated either by their original capacity buy-in, or by a proportional energy production offset.[42] This process not only allows previously 'solar-unfriendly' homes to

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[39] BARC Electric Cooperative. (2015). *Community Solar*. Retrieved from http://www.barcelectric.com/communitySolar

[40] Solar Electric Power Association. (2015). *BARC Electric Co-Op: Community Solar Leader in Virginia*. Retrieved from http://www.solarelectricpower.org/media/405084/SolarOps-Case-Study-BARC.pdf

[41] Feldman, D., Brockway, A. M., Ulrich, E., & Margolis, R. (2015). *Shared Solar: Current Landscape, Market Potential, and the Impact of Federal Securities Regulation*. Retrieved from http://www.nrel.gov/docs/fy15osti/63892.pdf

[42] Ibid.

draw in solar power, but it also saves individual homeowners from navigating complicated tax credits.[43]

Community solar installations are clearly unstandardized, meaning there are a number of different models through which these projects are organized. The three most common models are *utility-sponsored*, *special purpose entity* (SPE), and *non-profit*, which are all discussed below.

3.2.1 UTILITY-SPONSORED

Electric utilities or cooperatives may pursue community solar. If a utility chooses to develop a community solar project, it generally has two potential models: *customer-owned* or *rental*. Under the customer-owned route, the electric utility sells a portion of the project's solar panels to a member slightly higher than the average market rate, which helps fund the installation. Each customer receives a credit to their bill equal to the amount of power produced by their panels, minus a small percentage placed into an escrow account to cover operations and maintenance.[44] This model allows the panels to eventually pay for themselves, which creates equity for the consumer.

Under the rental approach, a utility builds a community solar project, connects it to the grid, and retains complete ownership of the system. An eligible consumer then subscribes to a share of the project's energy production, which is credited to their electric bill. The consumer faces no upfront costs and is usually guaranteed a certain savings rate by contract.[45] Although this system is more complicated for the utility to administer, it significantly lowers the financial entry barrier for consumers.

Overall, the utility-owned approach encounters the fewest legal and logistical hurdles because utilities have high access to human and financial capital.[46] These electric utilities already have the knowledge and infrastructure required to build and connect energy production facilities, along with an existing customer base and billing authority.

3.2.2 SPECIAL PURPOSE ENTITY (SPE)

A second community solar model is the SPE, which is a business founded with the sole purpose of building and operating a solar PV project. Since corporate law varies by state, there is a wide range of potential structures under which SPEs may incorporate (e.g., LLC, corporation, partnership, etc.). These SPEs have to raise their own capital, meaning they are most effective when investors have already committed to supporting the project.[47] In many cases, SPEs are simply subsidiaries of larger businesses that already exist.

[43] Cardwell, D. New York Times. (2014, June 19). *Buying Into Solar Power, No Roof Access Needed*. Retrieved from http://www.nytimes.com/2014/06/20/business/energy-environment/buying-into-solar-power-no-roof-access-needed.html

[44] Trabish, H.K. (2015).

[45] Ibid.

[46] Coughlin, J., et al. (2012).

[47] Ibid.

Although SPEs may be an efficient way to organize previously disparate capital to support a community solar project, there are several challenges. The largest obstacle is the inability for investors to easily take advantage of the federal ITC, because the IRS considers investments in SPEs to be passive, making them ineligible for the ITC.[48] Furthermore, SPEs often struggle with negotiating complex contracts, as well as overcoming the initial accounting and legal fees necessary to begin the project in the first place.

3.2.3 NON-PROFIT

Non-profit organizations may also participate in community solar, but they must use slightly different approaches because they are already tax-exempt and, therefore, cannot use traditional solar tax credits. One route is to simply use charitable donations as 'investments' that allow an existing non-profit, such as a school or museum, to build a solar array and potentially sell excess power and RECs.[49] This method is generally not considered 'true' community solar because donors might not receive electricity from the system. However, environmental stewardship and philanthropy often serve as intangible incentives for supporting non-profit solar.

A second method for non-profits relies on donors acting as both direct investors and consumer-members. In this scenario, a non-profit organization has a specific mission to provide community solar to a particular area, solicits donations in the form of membership subscriptions, and then builds a site.[50] Since members in this scenario would be ineligible for the ITC, this route is only feasible when other local or state incentives cover that difference and make the project economically feasible.

3.3 STATES WITH COMMUNITY SOLAR

As of 2014, 24 states had at least one community solar project in operation. As Table 4 indicates, 17 states currently have community solar or community/virtual net metering legislation, while the infectious nature of the market has prompted several other states to explore the viability of community solar.[51] Other than progressive outliers, like Minnesota and Colorado that have been leaders of community solar in their respective regions, these policies are concentrated on the West Coast, the Mid-Atlantic, and in New England.

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[48] Ibid.

[49] Ibid.

[50] Ibid.

[51] Honeyman, C. Greentech Media. (2015). *U.S. Community Solar Market Outlook 2015–2020*. Retrieved from https://www.greentechmedia.com/research/report/us-community-solar-market-outlook-2015-2020; Munsell, M. (2015).

State	Policy Name	Status
California	Senate Bill 43 / Virtual Net Metering	Enacted
Colorado	Community Solar Gardens Act	Enacted
Connecticut	Senate Bill 1243 Section 121 / Virtual Net Metering	Enacted
Delaware	Community Net Metering Provisions	Enacted
District of Columbia	Community Renewables Energy Act	Enacted
Illinois	Public Act 095-0420 / Community Net Metering	Enacted
Maine	Net Energy Billing to Allow Shared Ownership	Enacted
Maryland	House Bill 1087 / Senate Bill 481	Enacted
Massachusetts	Senate Bill 2768 / Virtual Net Metering	Enacted
Minnesota	Solar Energy Jobs Act	Enacted
New Hampshire	Senate Bill 98 / Group Net Metering	Enacted
New York	Reforming the Energy Vision / Virtual Net Metering	Enacted
Pennsylvania	Virtual Net Metering / House Bill 1203	Enacted
Rhode Island	Distributed Generation Standard Contracts Act	Enacted
Vermont	Group Net Metering	Enacted
Washington	Community Renewables Enabling Act	Enacted
Wisconsin	Solar Connect Community	Enacted
Hawaii	Senate Bill 1050 / House Bill 484	Proposed
Michigan	House Bill 4878	Proposed
Montana	House Bill 489 / Senate Bill 343	Proposed
Oregon	Senate Bill 1520	Proposed
South Carolina	Docket 2015-55-E	Proposed
Georgia	House Bill 657	Tabled
Iowa	Senate File 2017	Tabled
Nebraska	Legislative Bill 557	Tabled
New Mexico	Senate Bill 394	Tabled
Virginia	House Bill 1636	Tabled

Figure 3. States with enacted, proposed, or tabled community solar legislation, 2015.[52]

Figure 5 offers a better graphical representation of community solar legislation throughout the U.S. While a number of states have passed formal community solar policy, a number of other states (e.g., Virginia) are actively discussing such policy. California has been a leader in community solar, and has particularly encouraged solar installations on low-income, multi-unit housing properties through virtual net metering. This allows multifamily affordable building owners to install a single solar PV system, and the utility allocates the kWh's produced

[52] Sources: Durkay, J. (2014, December 18). *Net Metering: Policy Overview and State Legislative Updates*. Retrieved from http://www.ncsl.org/research/energy/net-metering-policy-overview-and-state-legislative-updates.aspx; Farrell, J. (2015, November 4). *Updated: States Supporting Virtual Net Metering*. Retrieved from https://ilsr.org/virtual-net-metering/; Honeyman. (2015); N.C. Clean Energy Technology Center. (2015). *Database of State Incentives for Renewables & Efficiency*. Retrieved from http://www.dsireusa.org/

by the PV system to both the building owners' and the tenants' individual utility accounts.

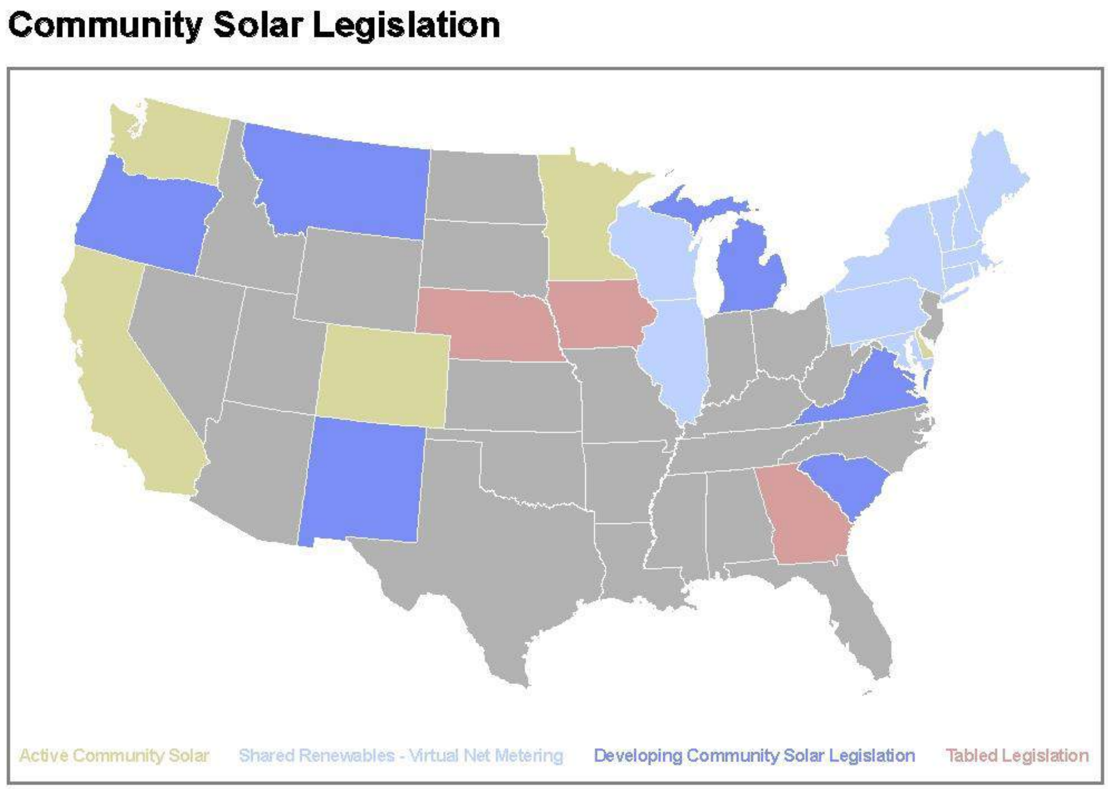

Figure 4. Map of community solar legislation in the U.S., 2015.[53]

3.4 ALLOCATION OF BENEFITS

While policies to encourage community solar vary considerably from state to state, specific financing and benefit allocation models have emerged. Currently, all state programs require that the participating solar array and its beneficiaries be located within the same utility service territory. Requirements to participate in ownership benefits vary, but may include a cap on system size, limit on the distance between participant and system, or limits on the type of ratepayers that can participate. With regard to financing, some programs offer a single aggregate bill for the entire group, while others assign a pro-rated monetary credit on each investor's bill.[54]

3.4.1 GROUP BILLING

Group billing arrangements in terms of community solar refers to an arrangement in which a landlord of a multi-unit building is responsible for allocating costs to individual tenants according to tenant leases. However, in some instances, participants are able to reside in buildings other than where the solar installation is located. An electric utility produces a group

[53] Sources: Durkay. (2014); Farrell. (2015); Honeyman. (2015); Munsell. (2015); Shared Renewables HQ. (2015). *Shared Renewable Energy*. (2015). Retrieved from http://www.sharedrenewables.org/community-energy-projects/

[54] Coughlin, J. et al. (2012).

bill for all participants' energy consumption and relevant charges, and the output from the PV system is netted against the bill. Under an agreement among the participants, remaining costs are distributed, and an intermediary customer representative serves as a point of contact between the utility and the group of participants.[55]

3.4.2 VIRTUAL NET METERING

Similar to group billing, virtual net metering allows net metering credits to be generated by a single renewable system to offset load at multiple retail electric accounts within a utility's service territory. The number of net metering credits that offset individual accounts is typically in proportion to the subscriber's ownership of the shared system. In some instances, a reasonable charge to account for the delivery, integration, and administration costs of the virtual net metering program are subtracted from the value of credits that offset the subscriber's bill.[56] Colorado, Delaware, Massachusetts, and California have relied on virtual net metering to distribute economic benefits of shared PV systems, among several other states.[57]

3.4.3 JOINT OWNERSHIP

Joint ownership programs for community solar draw inspiration from successful community wind programs. Joint ownership places greater emphasis on shifting solar from small-scale single-owned PV installations to utility-scale application. Under this program type, an electricity generating facility can have majority ownership by locally-qualified participants that enter into a long-term contract to sell output from the facility directly to a utility. The contract price for energy varies over the course of a year, but is weighted based on expected output of the PV system and only includes the value of the power sale and not the purchase of RECs. A downside to this approach is that a payment for power sales to a wholesale or retail purchaser results in taxable income at a federal and possibly state level.[58]

3.5 CHALLENGES TO COMMUNITY SOLAR IN VIRGINIA

Since community solar sites are, by nature, larger than most residential PV installations, they often entail higher initial costs, longer design periods, and extended construction timetables. Developers may also encounter trouble organizing a long list of potential investors and customers.[59] Next, since the community solar market is nascent, more marketing costs have been experienced related to education and customer-acquisition. There are additional complexities in structuring group programs and managing group projects in terms of operations, management, and legal structures.

Virginia faces all of these key challenges, yet one of the most obstructing barriers in this regard is the lack of enabling or supporting policy. Currently, as noted, Virginia has a strictly

[55] Ibid.

[56] Farrell, J. (2015); Coughlin, J. et al. (2012).

[57] Coughlin, J. et al. (2012)

[58] Ibid.

[59] Gallucci, M. (2015).

voluntary RPS program, meaning that solar projects are not pushed to meet these suggested goals. With a lack of a mandatory RPS, as well as no formal community shared solar or virtual net metering policy, Virignia has several barriers to community solar implementation.

Another noteworthy challenge is the cheap electricity that is generated from non-renewable sources. Virginia has some of the cheapest residential and commercial electricity rates in the U.S. due to coal and natural gas generation. Since electricity is so inexpensive, there is a lesser incentive for Virginians to offset their monthly bills through solar PV generation. Conversely, California has one of the highest rates of electricity in the U.S., causing (in part) more individuals to invest in solar PV energy.

4. ANALYSIS AND FINDINGS

For this research, we employed three unique methods to determine the feasibility of community solar in the City of Richmond. First, we conducted face-to-face informational interviews with local solar energy experts in order to determine some of the key barriers and challenges to implementation in the region. Second, we researched four specific community solar case studies from across the U.S. in order to understand best practices, as well as determine what may work in Richmond. Lastly, we used GIS data for the City of Richmond to find a small number of properties amenable to a community solar project.

4.1 INTERVIEWS WITH STAKEHOLDERS AND EXPERTS

We interviewed three knowledgeable individuals who conduct work in Virginia on solar energy policy. First, we spoke with Jeff Nicholson, who serves as the Director of Development with Sigora Solar in Waynesboro. Next, we interviewed Eric Hurlocker, an attorney with GreeneHurlocker who specializes in energy law and serves as a member of the Board of Directors for the Maryland, Virginia and Washington, D.C. Solar Energy Industries Association. Lastly, we talked with Bill Greenleaf, the former director of the Richmond Region Energy Alliance and now a loan officer with Virginia Community Capital bank, a source of financing for community and economic development.

The overarching theme of these interviews was that a lack of policy, cheap electricity, and working with the powerful Dominion Virginia Power are the biggest challenges to community solar development in the Richmond region. For instance, Jeff Nicholson discussed the lack of legislation and the role of cheap electricity:

"*A big barrier to community solar projects is legislation. The language current legislation provides is limiting… Another hurdle is that Virginia has very cheap traditional power. Renewable energy sources are fighting against economics by struggling to be cost effective*."

- Jeff Nicholson, Director of Development, Sigora Solar

Eric Hurlocker indicated how Dominion Virginia Power has a virtual monopoly over energy policy legislation in the state, which has pushed hard against community solar:

"*Dominion and APCO* [Appalachian Power Company] *have strong lobbyists and will prevent the community solar energy agenda from becoming strong*."

- Eric Hurlocker, Lawyer, GreeneHurlocker Law Firm

Bill Greenleaf discussed the financing for community solar, and stressed the challenge of financing such large projects, particularly if they were to be done via the SPE model:

"*From the bank's perspective we want to know, 'What is the source of repayment?' Banks like loan lengths of five to ten years, whereas solar needs 15-20 years to be cashflow positive.*"

- Bill Greenleaf, Loan Officer, Virginia Community Capital

Respondents agreed that a utility-sponsored community solar program would be the most feasible and cost-effective approach for a project in Richmond. Dominion Virginia Power essentially has an electricity monopoly and, thus, already has all the infrastructure capabilities and means to add solar energy to the grid. They have already implemented the DCS Pilot Program, but the interviewees believed this is more of a means to say they are doing something rather than being effective and offering their customers any benefits. The respondents discussed models that might work best in Virginia:

"*I recommend doing a 3rd party ownership community solar project because it would be the most efficient but a utility partnership would be the most cost effective in the state of Virginia. Dominion is a monopoly on providing power for the state of Virginia. Dominion offers aggregated net metering but it is not very effective. Dominion is not overly comfortable with the solar movement, fearing it will take away customers but they need to embrace solar in order to benefit financially from its increasing market share*."

- Jeff Nicholson, Director of Development, Sigora Solar

"*The model which has the most political practicality for Virginia would be utility owned because of Dominion's monopoly. The most economically effective would be privately owned because it can apply tax credits and would be more efficient. Dominion has already implemented a Pilot Program but is not a community solar program for that it does not have more than one customer*."

- Eric Hurlocker, Lawyer, GreeneHurlocker Law Firm

Community solar not only faces the challenge of determining which model to use, but also finding the most cost-effective location. We discussed what makes a property attractive for a community solar installation with Jeff Nicholson:

"An attractive property has the same distribution system as the provider. The property can handle an injection of new power and is able to increase stability in the lines. Marginal land of subdivisions for communities are promising and so are rural lands because they are cheaper. An attractive property has a very strong roof and ideal sunlight. Green and brown spaces are the most ideal locations because the construction is cheaper and do not have to deal with infrastructure. Parking decks are unattractive for solar installation because canopies must be built which increases the cost. A 400-500kW system on a green space is an ideal location for community solar."

- Jeff Nicholson, Director of Development, Sigora Solar

Lastly, for community solar to be implemented in Virginia, new legislation to support it is required. In Eric Hurlocker's opinion, there needs to be short- and long-term policy change.:

"An effective short term policy change would be authorizing third parties to retail sales of renewables. This would allow economics to take its course. The federal tax drops from 30% to 10% at the end of 2016 so extending that would help new solar installations. The long term driver for renewable energies is the Clean Power Plan. Strengthening the policies supporting the Clean Power Plan would be effective."

- Eric Hurlocker, Lawyer, GreeneHurlocker Law Firm

For complete interview transcripts, please refer to Appendix A.

4.2 CASE STUDIES

For the second aspect of this research, we examined four case studies to help assess the feasibility of developing a community solar project in the Richmond region. We selected these case studies based on the following criteria: level of success, type, and the degree of difficulty in implementing a similar project in Richmond. Our case studies also represent the three types of community solar models (i.e., utility-owned, SPE, and non-profit). We also searched for case studies focused on commercial buildings since Richmond has a healthy stock of office buildings and industrial sites.

4.2.1 SACRAMENTO MUNICIPAL UTILITY DISTRICT SOLARSHARES PROGRAM

The Sacramento Municipal Utility District (SMUD) SolarShares Program is a 1 MW solar array that was built in 2008. Under this program, interested customers pay a fixed monthly fee and receive a bill credit for the energy produced each month from their part of the system. The credit per kWh is the same as what the customer would earn from a net- metered rooftop system.[60] Financing for this utility-owned program comes from the SMUD, grants, and customer buy-in.

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[60] Northwest Community Energy. (2015c). *Sacramento Municipal Utility's (SMUD) Solar Shares Program*. Retrieved from http://nwcommunityenergy.org/solar/solar-case-studies/navajo-nation

The allocated SolarShares are based on each customer's energy consumption from the prior year. These customers can choose to meet anywhere between 20–40% of their energy use through the program. Once enrolled, they are locked in at the fixed monthly rate for as long as they wish to participate in the program which protects them from future price increases. Over the course of a year, this fee exceeds the amount SMUD customers would otherwise pay for electricity. However, the credit that SolarShares members receive for production can exceed the fixed SolarShares fee in any given month, depending on system performance. To balance the tiered rate structure, larger energy users pay more per kWh for SolarShares because they receive greater value from net metering. However, they still pay about the same annual premium as smaller energy users for participating in the program.[61]

By all accounts, this program has been successful, with over 700 customers and a waiting list of 60. The system has produced an average of 1,745 megawatt hours (MWh's) per year, of which about 86% has been sold to the SolarShare customers.[62] Overall, this utility-owned community solar program gives many community institutions the potential to serve as system hosts and perhaps receive revenue in the form of space leasing, thus forging new partnerships between the utility and its customers.[63]

4.2.2 SOLAR PIONEER II IN ASHLAND, OREGON

Solar Pioneer II builds upon an earlier program, Solar Pioneer I, which gave the residents and businesses of Ashland, Oregon an opportunity to purchase locally-generated solar PV energy. Solar Pioneer I was launched in 2000, and installed 30 kW of PV generation on the Oregon Shakespeare Festival, Southern Oregon University, and the Civic Center. The Pioneer II project was built in 2008 on the City of Ashland Service Center, adding 63.5 kW to the original system.[64]

These projects are also utility-owned, as both Solar Pioneer installations are owned by Ashland's Municipal Utility, which is governed by the City Council. In November 2008, only four months into the program, 100 panels had already been sold. Currently, customers are able to purchase the output of Solar Pioneer II panels for the remaining 17 years of the project for $701.75.[65] Customers can make upfront purchases of one-fourth, one-half, or full solar panel increments and receive payment for the value of the corresponding energy produced for a term of 20 years. They can also receive the rights to the associated RECs. These RECs are retired by the utility and, as a result, the members can claim the environmental attributes as their own but cannot trade or sell them.[66]

[61] Ibid.

[62] Coughlin, J. et al. (2012).

[63] Northwest Community Energy. (2015c).

[64] Northwest Community Energy. (2015a). *Ashland Oregon's Solar Pioneers II*. Retrieved from http://nwcommunityenergy.org/solar/solar-case-studies/the-vineyard-energy-project

[65] Ibid.

[66] Ibid.

According to the Solar Pioneer II website, a customer who purchases one panel with an upfront cost of $825, at current electricity prices, is projected to produce about $480 worth of savings over 20 years. This return does not meet the original program goal, which was to have a return at least equal to that achieved by individual system owners that use existing incentive programs. However, the Solar Pioneer II program was, in fact, successful at increasing access to PV technology. Further, by participating in this program, customers are protected against rising electricity prices.

4.2.3 MID VALLEY SOLAR ARRAY PROJECT (CLEAN ENERGY COLLECTIVE)

The Clean Energy Collective (CEC), LLC, is a member-owned community solar organization with several projects in Colorado and Massachusetts. It works with local utilities to develop community solar projects that combine on-bill credits typical of utility-owned projects with the tax benefits that come with individually financed solar installations. The CEC's first project, the Mid Valley Solar Array, was a 77.74 kW, 331-panel system in Carbondale, Colorado. The CEC leased the land and has a power purchase agreement with Holy Cross Energy, with rates that will increase in line with regular electricity rates.[67]

This project, which cost $466,000, was internally financed with CEC capital. Panels started at $725 each and customers were allowed to purchase enough to provide up to 120% of their electricity needs. In lieu of the federal ITC, the CEC used a 1603 Treasury Grant. This grant, combined with rebates and RECs from Holy Cross Energy, brought the installed cost of $6/Watt (W) down to $3.15/W for customers. Holy Cross Energy purchased the rights to all of the RECs up front for $500/kW. The simple payback period for the project is 12.8 years, which is excellent relative to similar projects.

There are currently 18 customers associated with this project, who will be receiving monthly credits for electricity produced for 50 years. Holy Cross Energy will credit these customers at or above the retail rate. The customers can transfer their ownership, either keeping it themselves if they move within the service area, or reselling it if they move out of area, either to another Holy Cross customer or back to the CEC. The CEC manages the project and maintains the solar panels and equipment. Part of the purchase price and monthly credit value goes toward escrow accounts to fund insurance, operations and maintenance. The project is fully subscribed and, to date, has saved customers an estimated $2.6 million with a lifetime production of over 6.4 million kWh.[68]

4.2.4 PARK GARDEN APARTMENTS IN ROHNERT PARK, CALIFORNIA

The 28-unit Park Garden Apartments in Rohnert Park, California, are a two-building property that is master-metered, with utilities included in each apartment's rent. After making roofing repairs to improve drainage and support the weight of the solar array on the 1960s-

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[67] Northwest Community Energy. (2015b). *Clean Energy Collective LLC, Colorado*. Retrieved from http://www.nwcommunityenergy.org/solar/solar-case-studies/CEC_colorado

[68] Clean Energy Collective. (2015). *Mid Valley Solar Array*. Retrieved from http://www.easycleanenergy.com/communitysolarprojects.aspx?project=88efbe52-6944-4dbb-b1ec-2bd90d8b5da4

vintage buildings, the owners of these apartments had a 71.7 kW PV rooftop array installed in 2004.[69]

The solar PV system in this case study generates enough power for roughly 30 homes. There are 180 panels facing southeast on one building and 330 panels facing southwest on the other, all tilted at 15 degrees to maximize sun exposure.[70] The California Public Utilities Commission's Self Generation Incentive Program paid for 50% of the system's cost. Reports estimate the overall electricity savings to be approximately $20,000 annually. After the solar PV system was up and running, the local electric utility provider, Pacific Gas & Electric, discontinued the master meter rate tariff, and would not allow the apartments to use a Time of Use rate unless each apartment was individually metered. The system designers, Cooperative Community Energy, petitioned and were successful, as the cost to add meters and wiring to each unit would have made it financially unfeasible.[71]

4.3 POTENTIAL COMMUNITY SOLAR LOCATIONS IN RICHMOND

For the last aspect of this research, we built a suitability model to identify unique parcels within Richmond that might support community solar, and determined potential PV capacity, costs, and emissions reductions associated with each chosen location. We gathered data for this analysis from several sources. The City of Richmond GIS data portal provided files for parcels, building structures, and land use. Neighborhood population density was collected from the U.S. Census Bureau. To determine the solar insolation values for specific buildings, we used LiDAR data from the U.S. Geological Survey.

4.3.1 METHODOLOGY

Traditionally, GIS has been used to find geographic locations suitable for large-scale solar installations. However, spatial data continues to be produced with increasingly higher detail and resolution, making GIS useful for much more targeted analyses. One example of highly detailed data is LiDAR, which is an incredibly dense collection of three-dimensional surface points created by laser beams emitted from an aircraft flying overhead. From these points, a remarkably accurate model of the earth's surface can be obtained, which incorporates buildings, vegetation, and several other features. The following analysis incorporates methods used by several researchers who used LiDAR data to determine solar suitability for specific buildings.[72] [73] [74]

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[69] Cooperative Community Energy. (2015). *Commercial Case Study - Park Garden Info*. Retrieved from http://www.ccenergy.com/commercial-case-studies/park-garden-info

[70] Ibid.

[71] Ibid.

[72] Brandt, D. C. (2014, January 15). *Rooftop Solar Capacity Modeling using GIS Within the City of Stillwater, MN*. Retrieved from https://minds.wisconsin.edu/handle/1793/68317

[73] Iler, S. (2012, April 27). *Assessing the Potential for Community Solar in Durham, North Carolina*. Retrieved from http://dukespace.lib.duke.edu/dspace/handle/10161/5326

[74] Leitelt, L. R. (2010). *Developing a Solar Energy Potential Map for Chapel Hill, NC*. Retrieved from https://cdr.lib.unc.edu/indexablecontent/uuid:6e5c0eac-e631-4741-b038-d7e9c3e4da41

Our first step was to find parcels with land uses that would be the most amenable to large-scale community solar projects. Based on our research, five land use categories were selected: Commercial, Government, Industrial, Institutional, and Multi-Family. Out of the 74,017 individual parcel records in Richmond, only 11,783 fell into at least one of these land use categories.

Though community solar projects have been successfully installed on undeveloped green fields, this analysis assumes that any community solar projects in Richmond will be on building rooftops. Since solar PV policies and incentives are lacking in Virginia, market forces will likely guarantee more traditional development options for unbuilt parcels in urban areas, like Richmond, where land values are high. Therefore, we excluded all parcels that did not have any structures on the property. Once that selection was applied, only 10,676 parcels remained, as shown in Figure 6.

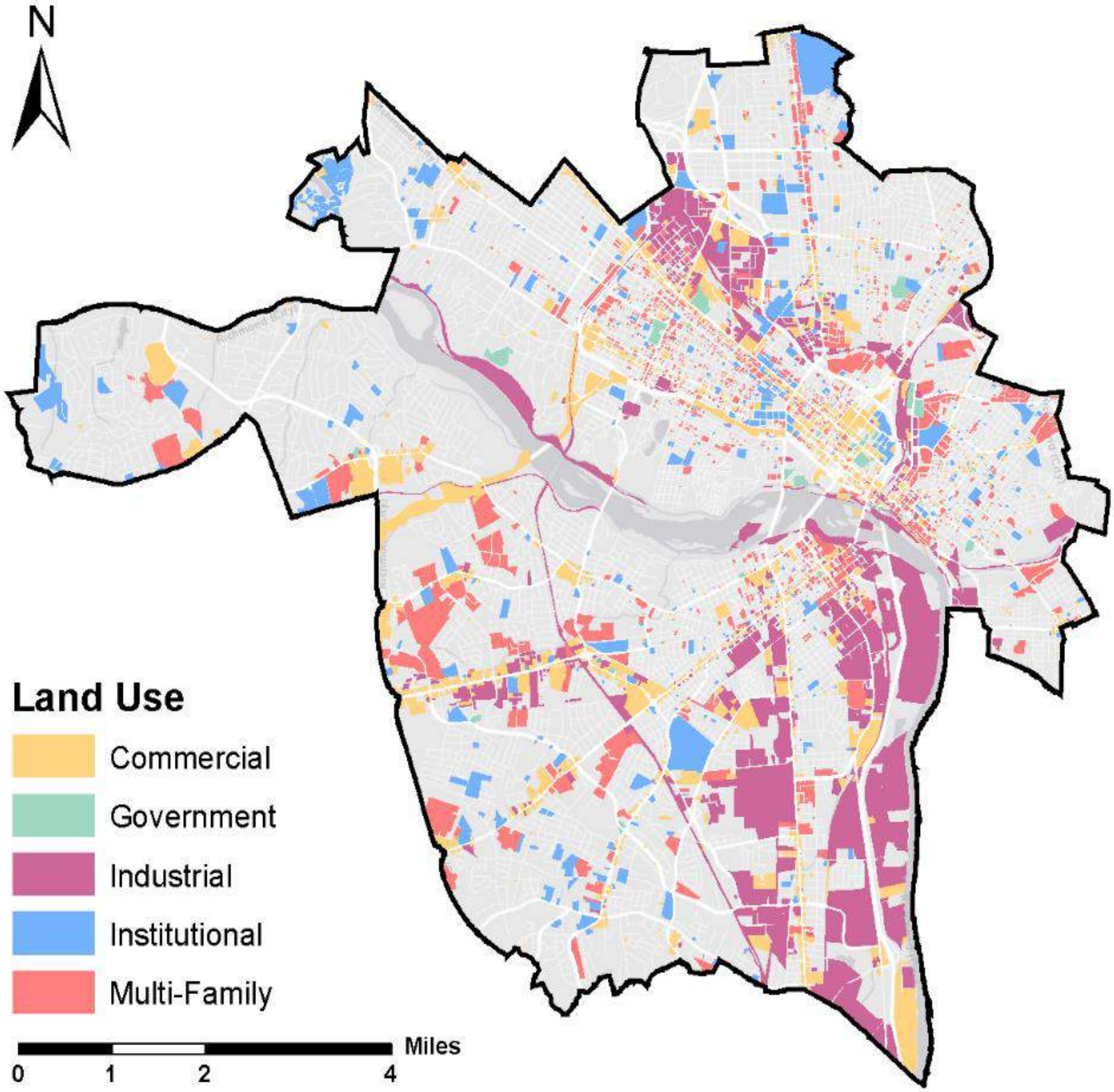

Figure 5. Eligible parcels for community solar in Richmond.[75]

Based on our informational interviews with solar energy experts in Virginia, we learned that larger installations would be more viable in Richmond to achieve economies of scale and to distribute the costs among a larger number of subscribers. Therefore, we initially chose a minimum community solar installation capacity size of 500 kW. According to the U.S. Energy Information Administration, the average annual single-family residential energy use for an urban home in Virginia is 13,393 kWh, which would require a residential PV system of about 10.4

[75] Author calculation using data from: City of Richmond, Virginia. (2015). *Geographic Information Systems*. Retrieved from http://www.richmondgov.com/GIS/

kW.[76] Hence, a 500 kW community solar system in Richmond would support nearly 50 households. However, this subscriber base would, more than likely, be much larger, since many subscribers would only be replacing a portion of their electricity use with solar.

Assuming a conservative PV panel efficiency of 15%, the two-dimensional area needed to support a 500 kW array is roughly 35,000 square-feet. As a result, we then excluded all remaining structures that had a roof footprint less than 35,000 square-feet. The remaining structures (those over 35,000 square-feet) are shown in Figure 7. Next, we used U.S. Census data to find the median population density for Census blocks in Richmond, which was 4,841 people per square-mile. Since community solar projects have a greater chance of success in more dense areas, we then excluded all remaining structures that were not inside or within a 1,000-foot buffer of all Census blocks above this median population density (see Figure 8).

[76] Energy Information Administration. (2009). *Residential Energy Consumption Survey (RECS)*. Retrieved from http://www.eia.gov/consumption/residential/data/2009/

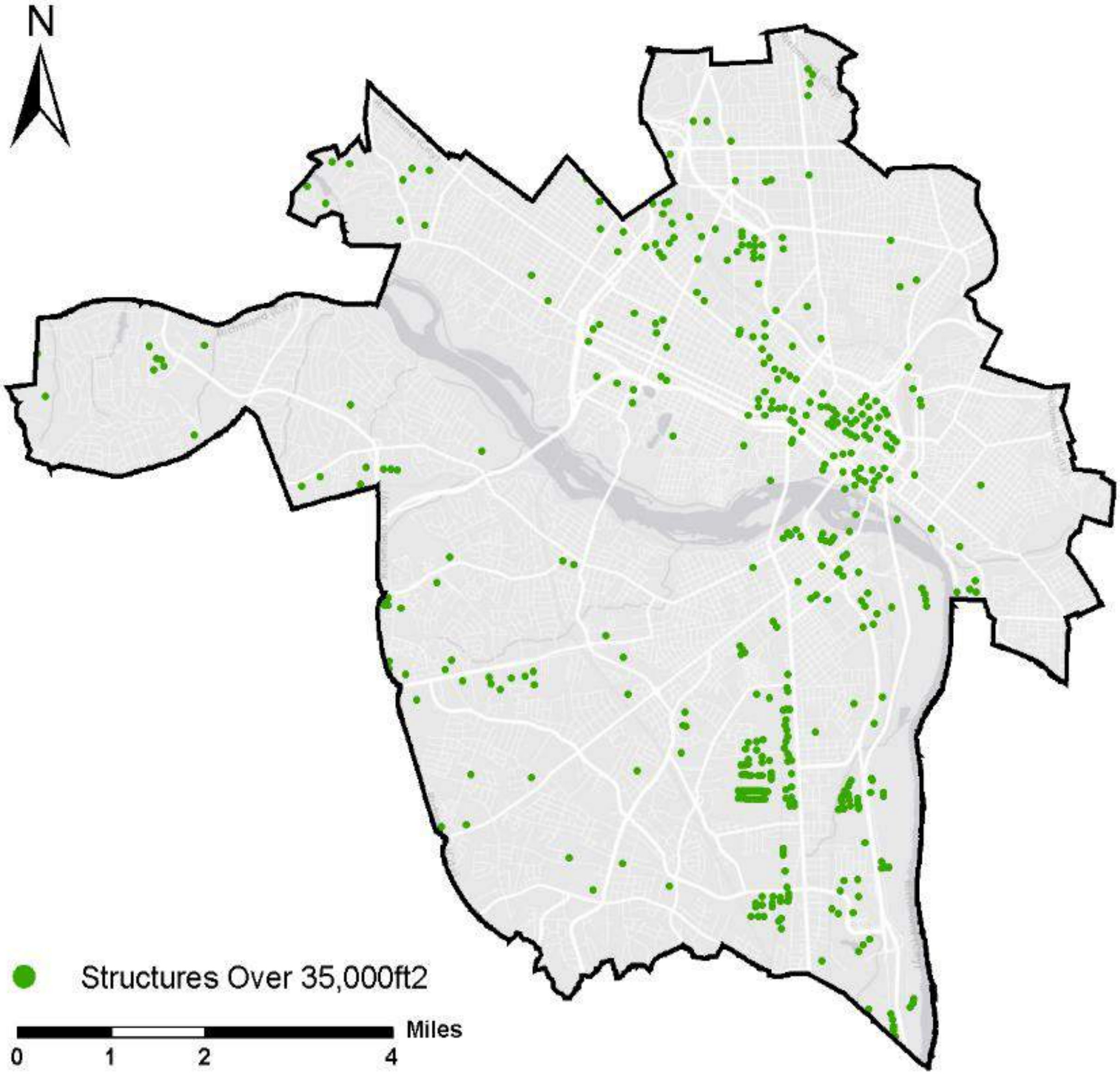

Figure 6. Structures with a roof footprint over 35,000 ft^2 in Richmond.[77]

[77] Author calculation using data from: City of Richmond, Virginia. (2015).

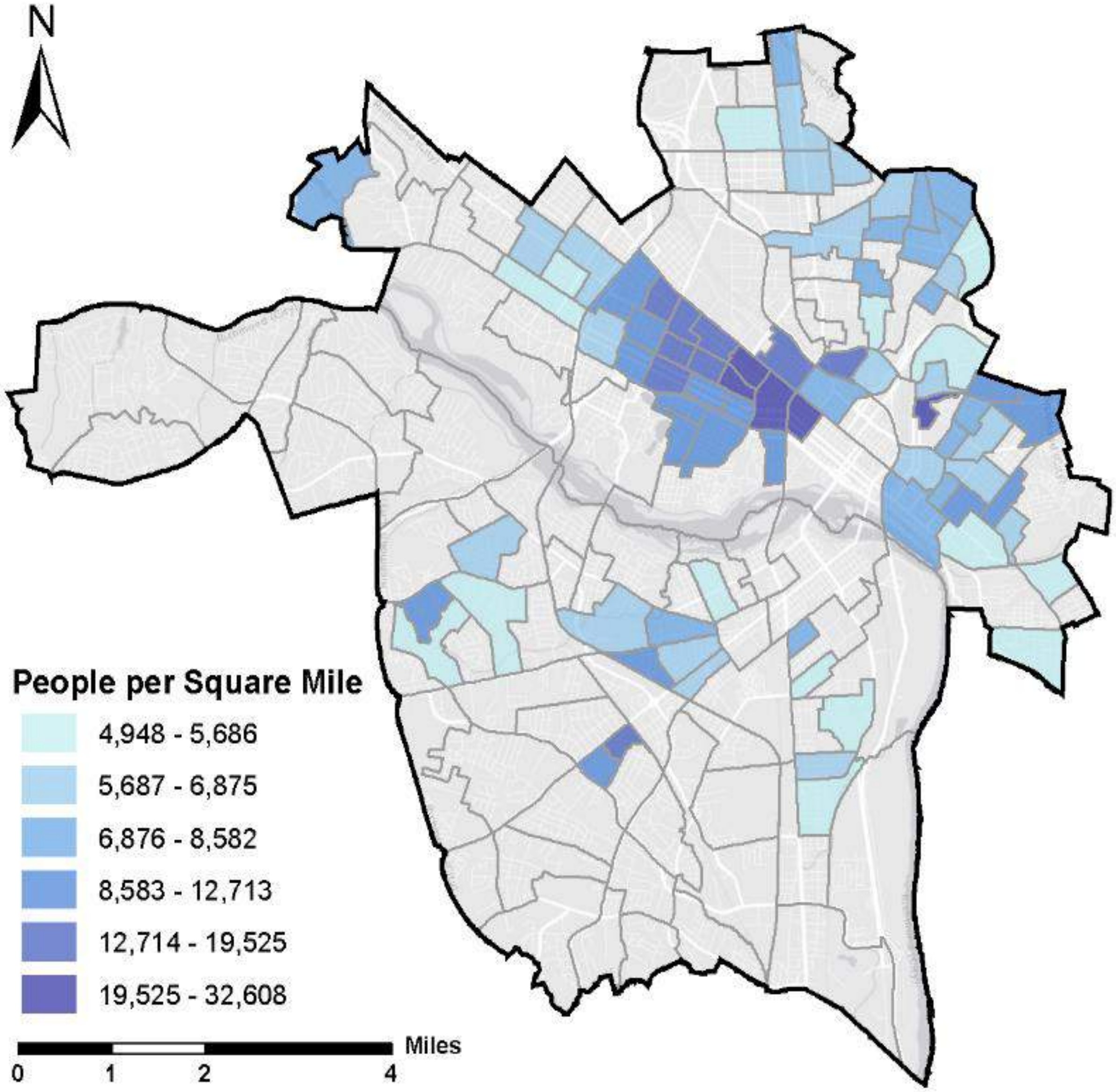

Figure 7. Richmond Census blocks with a population density above the city median.[78]

After this final selection, 178 structures remained that met the criteria for potential community solar sites within the City of Richmond. To narrow these sites even further, specific site-level analysis was necessary. To accomplish this, we used a recently-collected LiDAR point-cloud dataset published by the U.S. Geological Survey. From these three-dimensional LiDAR points, we created a detailed digital surface model (DSM) of Richmond, which included buildings and vegetation. This method allowed for the identification of buildings that had

[78] Author calculation using data from: U.S. Census Bureau. (2015). *Richmond city, Virginia*. Retrieved from http://quickfacts.census.gov/qfd/states/51/51760.html

suitable solar access, with minimal obstruction or shading. Finally, we used analysis tools included in GIS to find specific insolation values for these remaining sites, and selected one highly suitable structure for each of the five land uses we included.

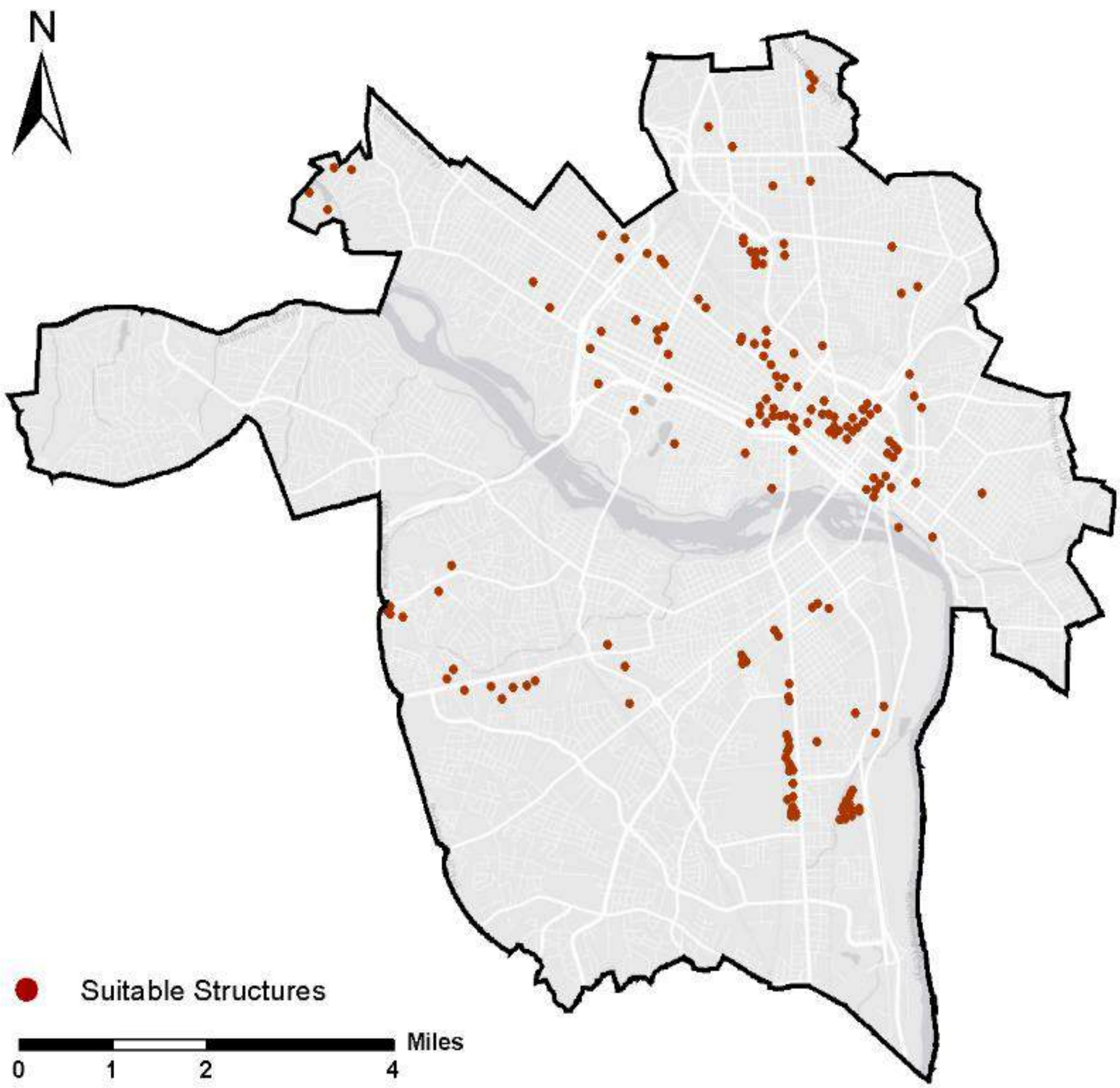

Figure 8. Final 178 suitable structures for a community solar project in Richmond.[79]

Raw LiDAR point-cloud files were first merged into one multi-point shapefile for the City of Richmond with an average point density of one per every 0.44 meters. Based on the methods of previous studies, we then created a raster file with a cell size four times that of the

[79] Author calculation using data from: City of Richmond, Virginia. (2015).

average point density (2 meters x 2 meters). Each raster cell contained elevation data, from which a city-wide DSM was rendered.

Figure 3. Raw LiDAR point-cloud data for the Virginia Commonwealth University neighborhood.[80]

[80] Author calculation using data from: U.S. Geological Survey. (2015). *Data Download and Visualization Services*. Retrieved from http://viewer.nationalmap.gov/launch/

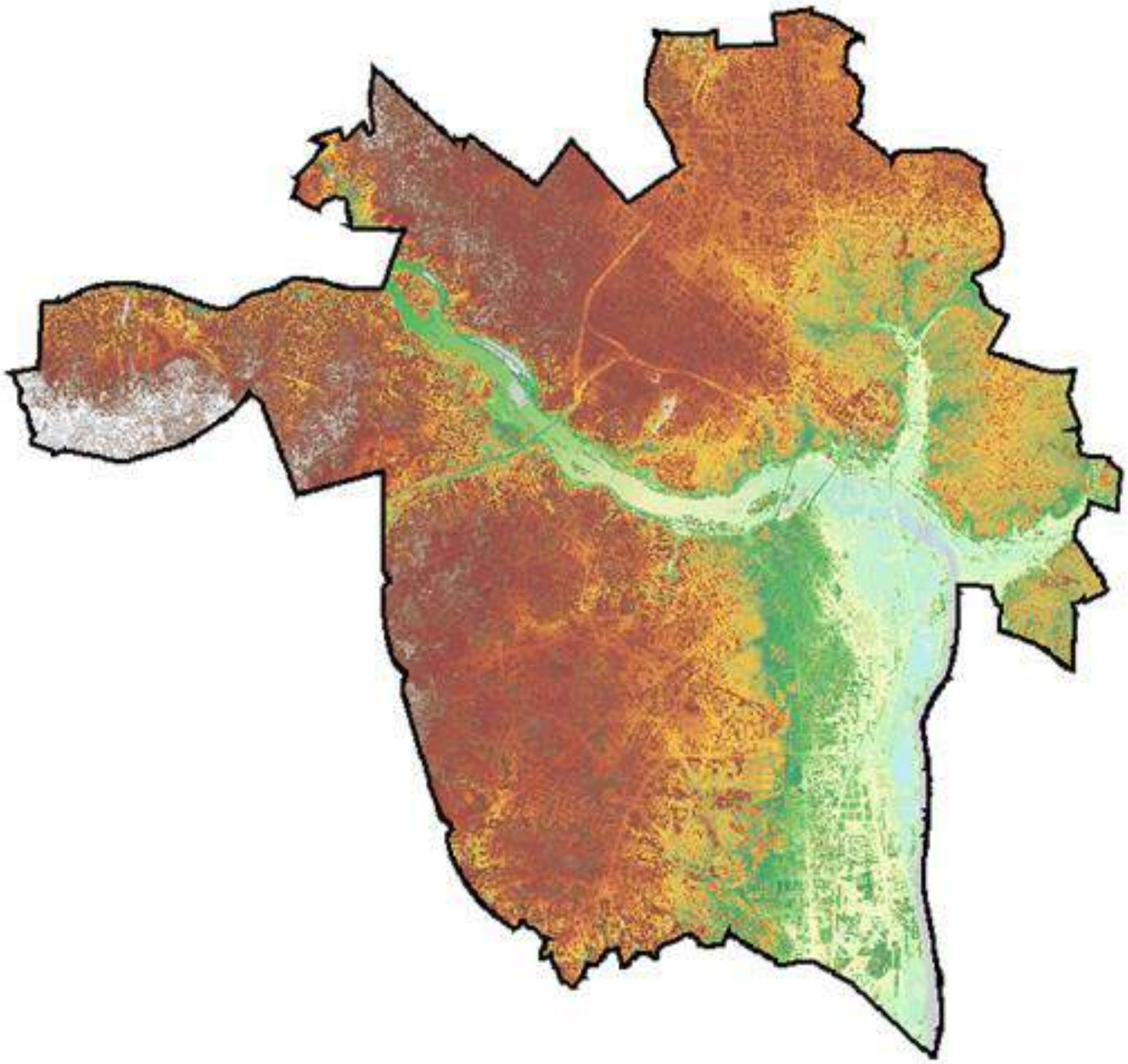

Figure 10. Digital surface model of Richmond.[81]

The *Area Solar Radiation* (ASR) tool within the Spatial Analyst toolset of ArcGIS was then used to calculate the total annual incoming solar radiation in W-hours per square-meter for each cell. An example output, which shows the annual insolation for the Virginia Commonwealth University neighborhood, is provided in Figure 12. However, due to the large size of the dataset, and the heavy processing needs of the ASR tool, it would have taken multiple days to produce an output for the entire Richmond region. Therefore, we used the outlines of the remaining 178 buildings as a 'mask' to exclude all areas outside of these structures' roof footprints. The ASR tool completed its analysis in roughly thirty minutes.

[81]Author calculation using data from: City of Richmond, Virginia. (2015); U.S. Geological Survey. (2015).

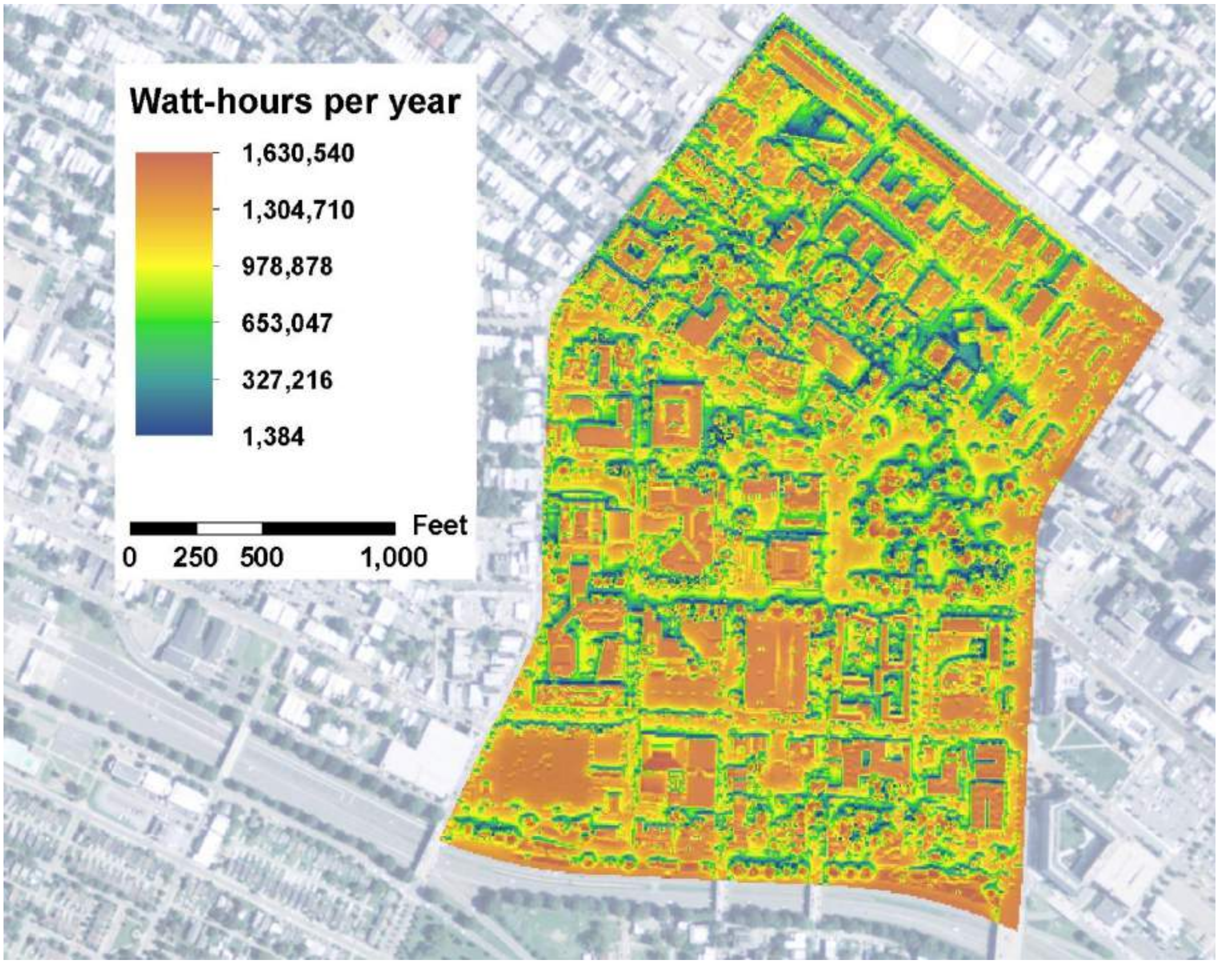

Figure 11. Output of area solar radiation tool for Virginia Commonwealth University.

We then converted the cells in the output raster to points using the *Raster to Point* tool. Each point contained a 'value' field for the annual insolation in W-hours per square-meter. We added a new 'insolation' field to this point feature class, and populated it using the expression below:

"insolation" = ("value"/365,000)*1.15

The 'value' field was divided by 365,000 to change the units from W-hours per square-meter per year (Wh/m^2/year) to kWh per square-meter per day (kWh/m^2/day), which is a more common unit for solar insolation. Since the ASR tool does not account for the potential tilt of panels in a PV array, we used the National Renewable Energy Lab's (NREL) PVWatts calculator to determine that a 30-degree panel tilt increases insolation and PV energy production by 15%. To account for this, we multiplied the original insolation by 1.15.

The final step was to select one site for each of the five suitable land uses. Because there were only several dozen structures for each land use type, we manually reviewed each option in ArcGIS by assessing their insolation potential, location, building type, and ownership. When a strong candidate was identified, we averaged the insolation value for the building, and calculated the potential system size,[82] energy production, and GHG reduction figures for each site based on this average value. Our top five sites, shown in Figure 13, are described in the following section.

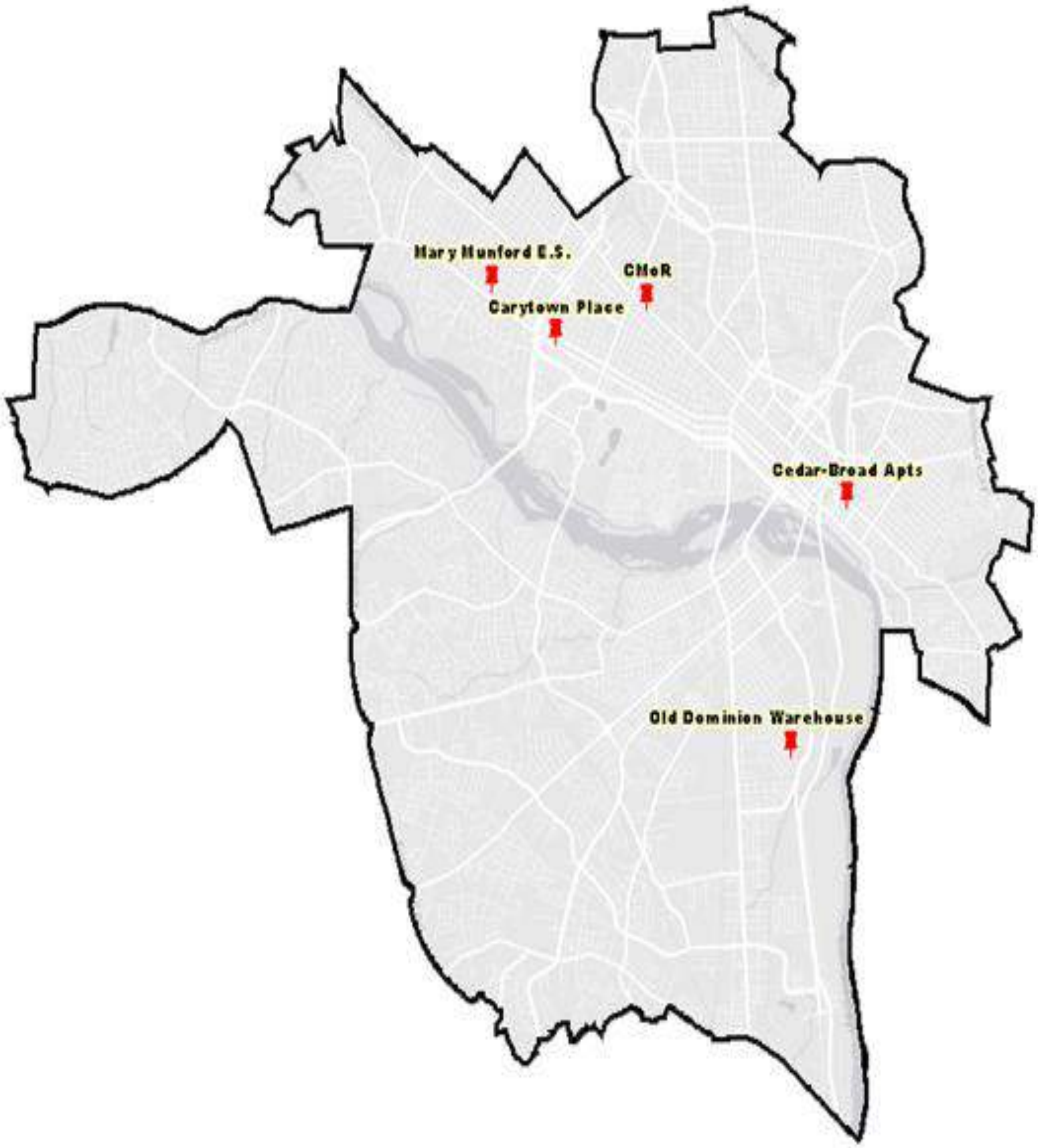

Figure 12. Five selected sites suitable for community solar in the City of Richmond.

[82] The potential system size was based on a 20% reduction in roof size to account for areas where panels cannot be installed.

4.3.2 RESULTS

Via the above methodology, we selected five final sites that were suitable for a large community solar project within the City of Richmond. We selected the best site for each of our five pre-selected land use categories (i.e., Commercial, Government, Industrial, Institutional, and Multi-Family). Each of the following sub-sections details the location, address, average insolation metric, potential PV system size, annual energy output, and annual GHG emissions reductions.

Using a standard 17% efficiency rating estimate for solar PV systems, we calculated the total potential PV system size based on the amount of available roof space in each location. Next, we used the identified solar insolation in $kWh/m^2/day$, as well as a standard de-rating factor of 0.75, to calculate the total annual energy output in kWh (i.e., kW x 0.75 x insolation x 365 days/year). Lastly, using this energy output, we multiplied by 10^{-4} metric tons CO^2/kWh to determine the annual GHG emissions reductions.

Of course, one limitation to these calculations is the fact that parts of each building's roof might not be able to house a PV system. This also explains why some of our system sizes are below the initially identified 500kW. Ideally, we would be able to take an additional step to identify specific rectangles on the individual building roof that have the best unobstructed insolation and are not already occupied by HVAC or other systems, and then calculate the potential system size, etc. for those rectangles. However, this was not feasible in our case due to the numerous buildings we investigated, and the complications with making certain assumptions. Our locations and estimates below still offer viable recommendations for a community solar installation in Richmond.

<u>Location #1 - Commercial: Carytown Place</u>

10 North Nansemond Street, Richmond, VA 23221

Average Insolation: 4.38 $kWh/m^2/day$
Potential System Size: 511 kW
Annual Energy Output: 612,840 kWh
Annual GHG Emissions Reductions: 259.87 metric tons

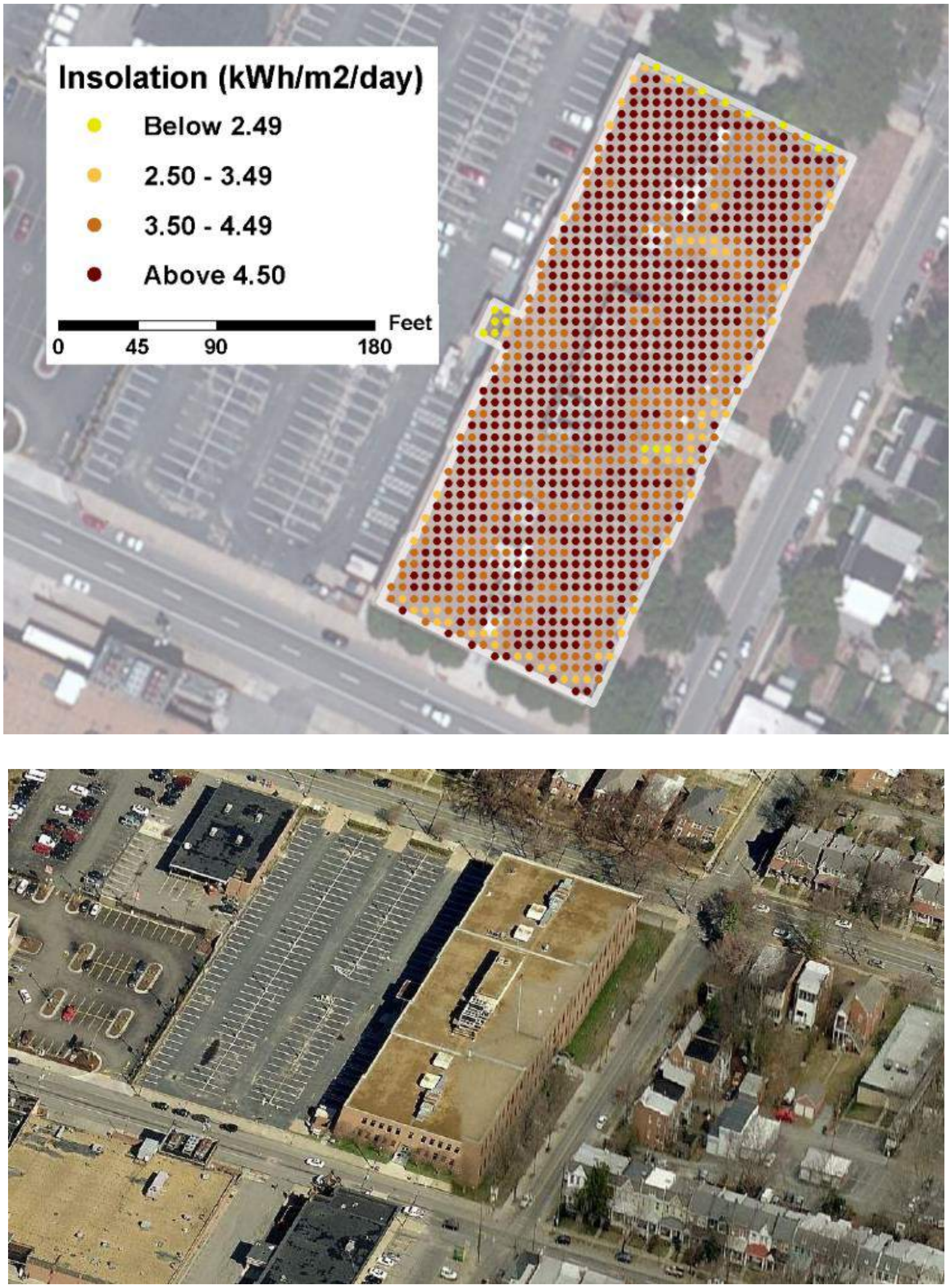

Figure 43. Insolation and aerial map of Carytown Place.

Carytown Place, a large retail building that was formerly a Verizon Communications operations center, is an example of adaptive reuse in Richmond. Current tenants include Fresh Market, Petco, and Chipotle. These tenants, along with residents from the surrounding Museum District neighborhood, theoretically form a strong subscriber base. Further, the roof geometry is simple, and the average insolation is the second highest of the five selected sites.

Location #2 - Government: Children's Museum of Richmond

2626 West Broad Street, Richmond, VA 23220

Average Insolation: 4.16 kWh/m^2/day
Potential System Size: 471 kW
Annual Energy Output: 536,973 kWh
Annual GHG Emissions Reductions: 227.70 metric tons

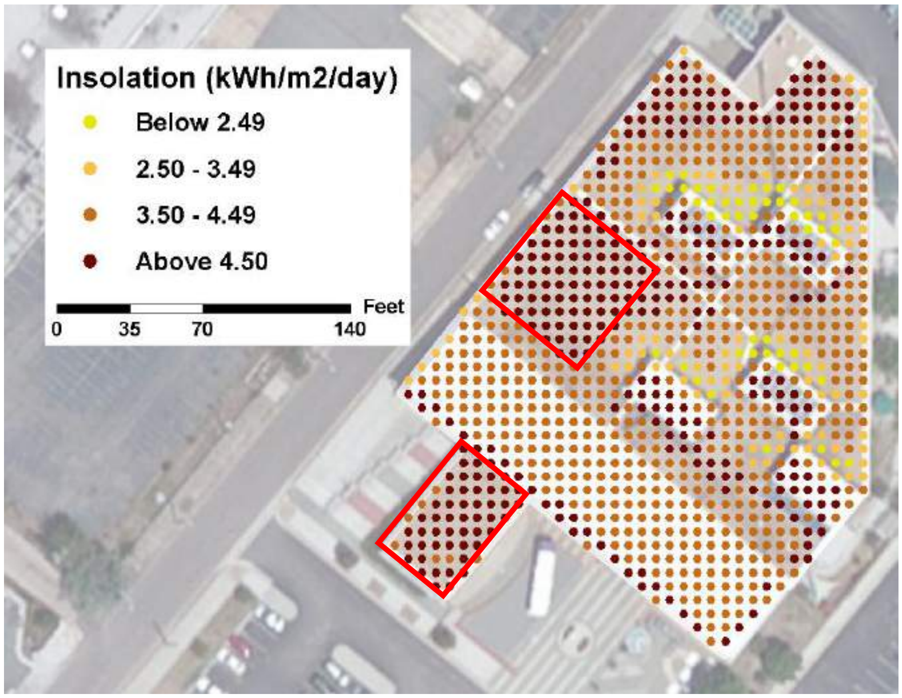

Figure 54. Insolation and aerial map of the Children's Museum of Richmond.

Although the Children's Museum of Richmond does not have extremely-high insolation values, it still has the capacity to support a large solar PV array. Located directly north of the

Fan District, it could potentially serve customers in that neighborhood, where vegetation and older buildings are obstacles to residential solar installations. If a community solar array were to be installed at the Children's Museum, it could also serve as an educational exhibit to teach local children about the demonstrable benefits of solar and renewable energy production. We have also highlighted key areas (see red boxes) that might make the most sense for an installation on this building, particularly due to their high insolation and lack of roof equipment. The smaller one has the added benefit of presumably being visible from the street and parking lot. This might be a better targeted approach on the Children's Museum as opposed to a large PV array covering all free spaces on this roof.

Location #3 - Industrial: Old Dominion Freight Warehouse

1598 Carter Creek Road, Richmond VA 23224

Average Insolation: 4.46 kWh/m^2/day
Potential System Size: 4,470 kW
Annual Energy Output: 5,460,583 kWh
Annual GHG Emissions Reductions: 2,315.56 metric tons

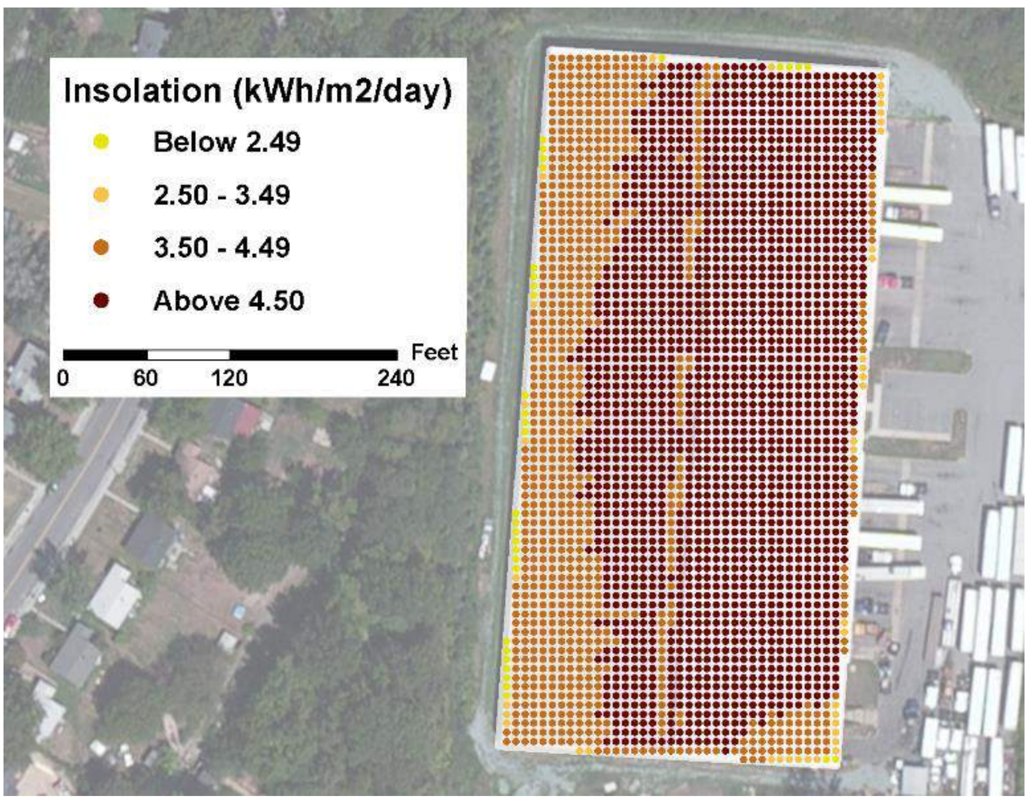

Figure 65. Insolation and aerial map of the Old Dominion Freight Warehouse.

Many industrial warehouse buildings have high potential for solar installation due to their large square-footage and flat roofs. The Old Dominion Freight Warehouse in South Richmond is no exception, with a potential capacity roughly ten times larger than our other selected sites. However, this warehouse was chosen specifically for its proximity to the Bellemeade neighborhood, which has many single-family homes and larger apartment buildings.

<u>Location #4 - Institutional: Mary Munford Elementary School</u>

211 Westmoreland Street, Richmond, VA 23226

Average Insolation: 4.26 kWh/m^2/day
Potential System Size: 482 kW
Annual Energy Output: 561,890 kWh
Annual GHG Emissions Reductions: 238.27 metric tons

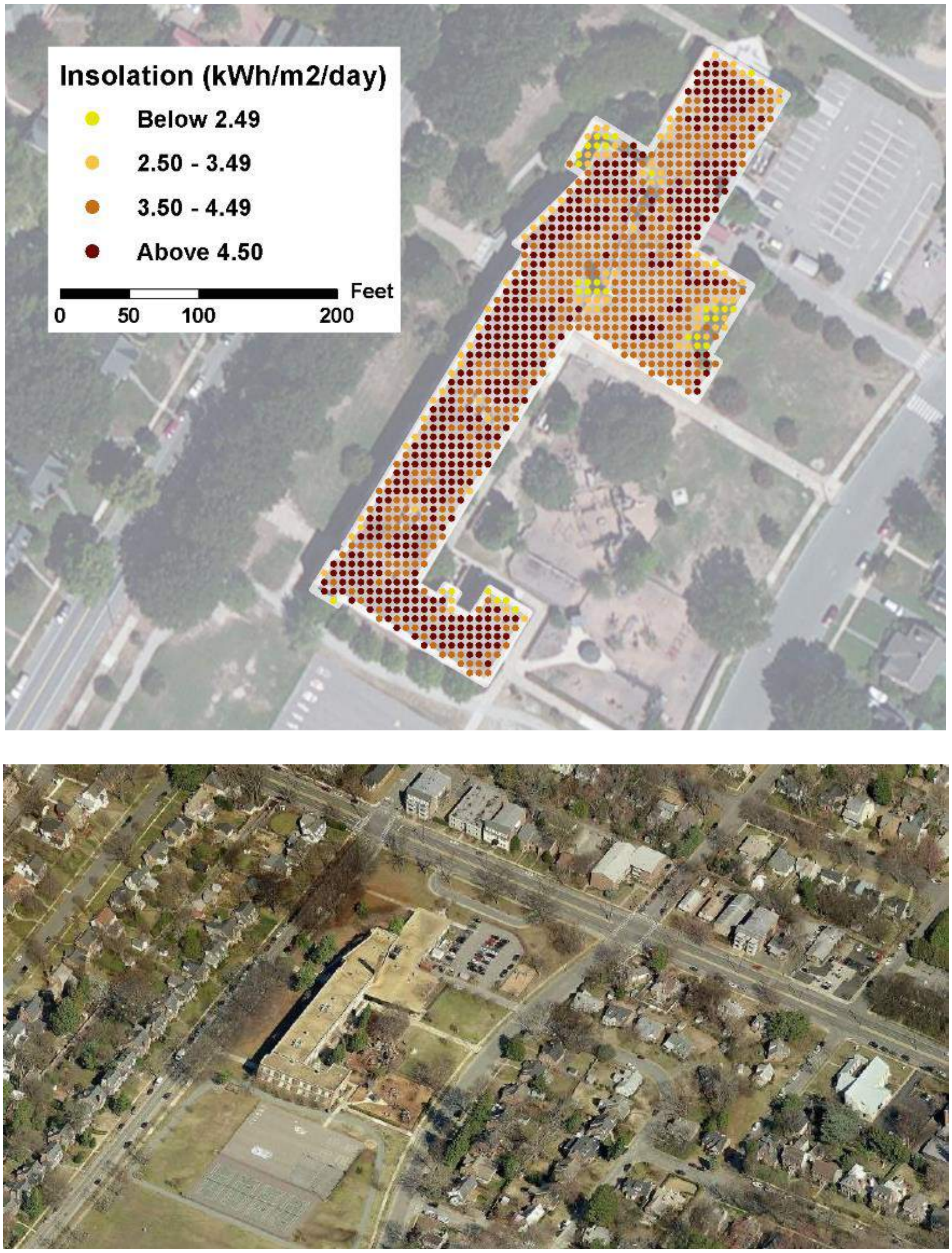

Figure 76. Insolation and aerial map of Mary Munford Elementary School

Located in the Near West End, Mary Munford Elementary has one of the most active parent communities for any elementary school in Richmond. The neighborhood also has many older single-family homes surrounded by large trees, owned by higher-income households. Therefore, Mary Munford Elementary could be a great site for residents who might be interested in solar energy but who are unable to install it. However, the school was built in 1951 and has a complex roof structure, which might constrain a larger solar PV system. Similar to the Children's Museum of Richmond site, it might make more sense to have a targeted installation on the south side of the building.

Location #5 - Multi-Family: Cedar-Broad Apartments

1820 East Broad Street, Richmond, VA 23223

Average Insolation: 4.20 kWh/m^2/day
Potential System Size: 469 kW
Annual Energy Output: 538,502 kWh
Annual GHG Emissions Reductions: 228.35 metric tons

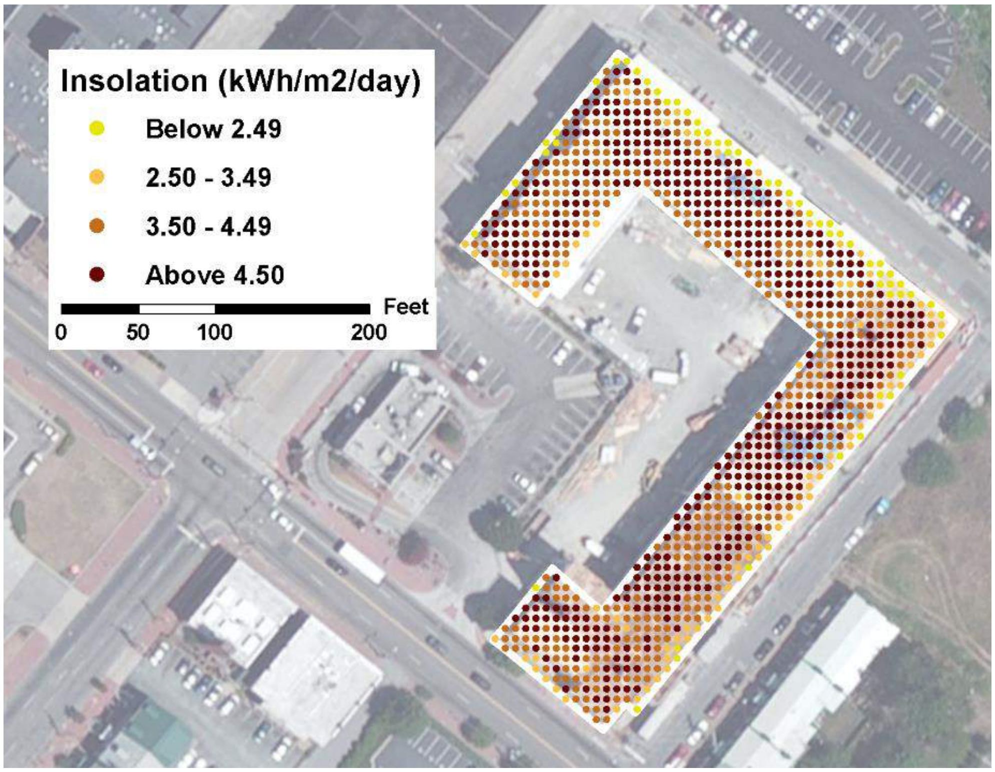

Figure 87. Insolation and aerial map of Cedar-Broad Apartments.

The Cedar-Broad Apartment buildings are a 204-unit complex in the Shockoe Bottom neighborhood of Richmond, completed in 2010. We chose this site due to the new construction, relative roof simplicity, and the presence of an on-site subscriber base of at least 200–300 people. Unfortunately, many of these tenants are not permanent residents and, therefore, might not have an incentive to invest in a community solar project. In this scenario, a more creative solution to connect renters with energy production may be necessary. However, we still felt like this was a great example of a multi-family building in Richmond that would be feasible for such an installation and may produce impressive results.

5. CONCLUSIONS

Community solar is a great opportunity for those who are not able to install solar panels at their current residence. In this way, individuals under a wide variety of circumstances and geographies can access solar energy from a centralized location and reap the associated financial and environmental benefits.

Examining other case studies throughout the U.S. has shown that all models of community solar demonstrate effectiveness given the right circumstances. Reflecting upon these case studies, we believe there is an opportunity for master-metered apartment buildings in Richmond to house a community solar project, similar to the Park Garden Apartments. However, current policy in Virginia provides a key obstacle to implementation in this regard. Therefore, perhaps the best opportunity in Richmond is to develop a utility-owned community solar project similar to SMUD's SolarShares Program and Solar Pioneer II. Dominion Virginia Power and the BARC Electric Cooperative have already embarked on such projects, though the results of these programs remain to be seen.

According to our interviews, the largest barriers for implementing a community solar project in Richmond are policy and the presence of a dominating investor-owned utility, Dominion Virginia Power. Virginia's solar policies are relatively weak when compared to surrounding states, as the voluntary RPS program, poor net metering laws, and lack of community or virtual net metering offer an unpromising future for community solar PV deployment.

Utilizing GIS and LiDAR data, our analysis identified 178 buildings that are suitable for at least a 400 kW system within the City of Richmond. These sites were singled out because of their high insolation values, proximity to dense neighborhoods, roof size, and a lack of obstructions. Our five selected sites, Carytown Place (Commercial), the Children's Museum of Richmond (Government), the Old Dominion Freight Warehouse (Industrial), Mary Munford Elementary School (Institutional), and the Cedar-Broad Apartments (Multi-Family), all have the ability to support a large solar PV array and produce between 536,000 kWh and 5.4 million kWh per year.

While these sites may be appropriate and willing to implement a community solar project, the lack of policy still remains the largest barrier to widespread implementation. Based on our research, moving forward, we believe the rental utility-sponsored community solar model is the best path in Virginia, at least in the short-term. We believe Dominion Virginia Power's

DCS Pilot Program, as well as the BARC Electric Cooperative community solar program, are a step in the right direction for community solar in the state. However, it is inappropriate to comment on their details (e.g., number of subscribers, project size, allocation of benefits, energy produced, etc.) until the respective projects are online and more formal results can be assessed. Until community solar gardens or virtual net metering legislation is passed in Virginia, we believe the utility-sponsored model is the best way to move forward under the current legislative regime. Appalachian Power Company (the second largest investor-owned utility in the state) and other municipal utilities and electric cooperatives should also initiate community solar programs for their ratepayers. Group purchasing or community-driven financial models (e.g., co-ops or 'Solarize' programs) should also continue to be pursued in Richmond and Virginia as a whole, as they at least resemble some of the traits of our definition of community solar (e.g., collaboration, peer effects, etc.).

We further believe that the SPE and non-profit models of community solar could work in Richmond given certain state policy adoption and the right set of circumstances. Despite Virginia's legislative history on community solar gardens, we remain optimistic that enabling legislation can eventually pass. Our interview data supports this claim. Since prior proposed community solar legislation in Virginia focused on the establishment of community solar gardens, we feel as though future proposals should more narrowly focus on group billing and virtual net metering policies which would allow a single PV system to offset loads through multiple accounts. This would allow a customer with multiple meters to distribute credits to different accounts, such as renters in a multi-unit building. More narrowly focusing the bill language would allow legislators to utilize best practices from other states who have passed virtual net metering laws. Future proposals should also not require the utility to purchase the unsubscribed energy from the solar PV system, and should drop the minimum number of subscribers to two. We believe these are the most realistic and critical policy changes that should be pushed in Virginia's General Assembly in order to increase opportunities for community solar.

5.1 QUESTIONS FOR FUTURE RESEARCH

Lastly, our findings generated several important questions for future research. For instance, given the complex nature of our site selection methodology, our identified installation locations should be corroborated by a solar installation professional, particularly to evaluate roof structures (and any potential obstacles) for suitability. Aerial assessments may also be useful in identifying sites to target. This would help identify any changes to our model and calculations that should be made to fine-tune their predictive abilities. Second, future research should investigate whether there are any measures that can be taken at the city level to encourage community solar, such as zoning or property assessment rates. Lastly, a more in-depth investigation of other U.S. states community solar or virtual net metering policies should be conducted (e.g., number of subscribers, capacities, allocation of benefits, etc.), in order to determine the best path(s) forward given Virginia's unique regulatory and political landscape. As an organization, VA SUN should continue to investigate these issues to help understand how to best push for community solar in Richmond, Virginia.

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APPENDIX A. INTERVIEW RESPONSES

<u>Jeff Nicholson of Sigora Solar</u>

1. **Do you have any experience with "community solar" projects in Virginia or elsewhere?**
   a. **If yes, have these projects been successful? Why or why not?**
   b. **If yes, what type of organizational model was used (e.g., LLC, 501(c)(3), etc.) and how did that help facilitate the project?**
   c. **If no, do you have any sense of what organizational model (e.g., LLC, 501(c)(3), etc.) would be most viable in Virginia?**
   He has never done a community solar project. He recommended doing a 3rd party ownership community solar project because it would be the most efficient but a utility partnership would be the most cost effective in the state of Virginia.

2. **Have you encountered any barriers that prevent installation of community solar projects?**
   A big barrier to community solar projects is legislation. There is a fear that there will be a loss of jobs if policy does not change. Another hurdle is that Virginia has very cheap traditional power. Renewable energy sources are fighting against economics by struggling to be cost effective. Fear there will be a loss of jobs if policy does not change.

3. **How would you describe your perspective on how providers of electricity in Virginia view community solar?**
   Dominion is a monopoly on providing power for the state of Virginia. Dominion offers aggregated net metering but it is not very effective. Dominion is not overly comfortable with the solar movement, fearing it will take away customers but they need to embrace solar in order to benefit financially from its increasing market share.

4. **What state policies (or lack of policies) facilitate or impede the implementation of community solar projects?**
   The language current legislation provides is limiting. To utilize the tax credit that is ending in 2016 it is unclear if it needs to be fully functioning or just needs to begin construction. This tax credit needs to be extended five years to help Virginia comply with the Clean Power Plan.

5. **In your opinion, what features make a property attractive for a community solar installation? What features make a site unattractive?**
   An attractive property has the same distribution system as the provider. The property can handle an injection of new power and is able to increase stability in the lines. Marginal land of subdivisions for communities are promising and so are rural lands because they are cheaper. An attractive property has a very strong roof and ideal sunlight. Green and brown spaces are the most ideal locations because the construction is cheaper and do not have to deal with infrastructure. Parking decks are unattractive for solar installation because canopies must be built which increases the cost. A 400–500 kW system on a green space is an ideal location for community solar.

6. **Please describe any trends you have noticed among people who have actively pursued solar installations, along with people who have opposed solar projects.**
   He has not noticed any trends between those who support solar and those who do not. Individuals he has worked with cross political, ethnic, age and occupational spectrums. These individuals support solar for the financial opportunities and they wish to leave a better world for the next generation. A community feel strengthens the appeal to solar. He has had many instances where if one person in a community installs solar panels on their house he will be back to install it on their neighbors.

Eric Hurlocker of GreeneHurlocker Law Firm

1. **Please describe your familiarity with "community solar" and its associated policies.**
   Eric represents builders and residents. He is relatively new to the community solar programs as he comes from a subscriber perspective.

2. **There are three main sponsorship models for community solar projects: utility-owned, private-owned, and special entity-owned. Which of those models has the potential to be the most politically and economically practical in Virginia? Least practical?**
   The model which has the most political practicality for Virginia would be utility owned because of Dominion's monopoly. The most economically effective would be privately owned because it can apply tax credits and would be more efficient.

3. **What factors have made the political environment in Virginia traditionally unreceptive to the solar energy agenda?**
   Due to the Franchise Service Model any third party used by retail has met resistance. Dominion and APCo (Appalachian Power Company) have strong lobbyists and will prevent the solar energy agenda from becoming strong. Dominion's Pilot Program is not a community solar program for that it does not have more than one customer.

4. **Are county and city governments in Virginia able to incentivize solar projects on their own, or are more systematic state and federal policies of greater consequence?**
   Cities and counties can do tax exemptions and zoning but federal policies will have the largest impacts. The RPS can take costs out of the program but not put value in. For the RPS to become mandatory would be a major boost for solar but has met great resistance from Dominion and APCo.

5. **How should policy change in the short term (next 5 years) to make community solar more viable in Virginia?**
   An effective short term policy change would be authorizing third parties to retail sales of renewables. This would allow economics to take its course. The federal tax drops from 30% to 10% at the end of 2016 so extending that would help new solar installations.

6. **How should policy change in the long term (5 years and beyond) to make community solar more viable in Virginia?**

The long term driver for renewable energies is the Clean Power Plan. Strengthening the policies supporting the Clean Power Plan would be effective.

<u>Bill Greenleaf of Virginia Community Capital, Inc.</u>

1. **What is the bank looking for in deciding whether to make a loan for a solar PV system?**
   The bank wants to know what the source of repayment will be. It will run a credit check on borrowers and assess the financial soundness of the project. It looks for a debt coverage ratio of 1.2:1, meaning the borrower's ability to pay must be 20% above the loan amount in order to account for PV degradation and depreciation.

2. **What loan terms are available?**
   The bank likes to make loans generally in the 5–10 year range, potentially in 5-year increments. However, most solar projects need 15–20 years before they are cashflow positive, making them poor projects.

3. **What would make the bank more willing to lend money for solar projects?**
   If the project has a wealthy guarantor who will be liable for payment in case of default, or if there is land value that can be put up as collateral (PV panels do not have sufficient value for this over time), or if there is some other steady and verifiable revenue stream, such as that from a small utility, it will be viewed more favorably by the loan officer.

4. **What other considerations are there?**
   The solar project needs to have an alternative way to sell electricity to the grid and a steady supply of customers in case homeowners leave the corporation or cooperative. Comparing an apartment building to a solar farm, the apartment building has rents that are collected yearly as well as a generally increasing value. The solar farm, on the other hand, tends to lose value each year as the PV panels degrade somewhat and produce less energy. Ensuring sufficient collateral and guarantors can be problematic.