Brighter Maryland

A Study on Solar in Maryland Schools

The SOLAR FOUNDATION™

Sargent Shriver Elementary School
(Photo Courtesy of Meridian Construction Co.)

Acknowledgements

The Solar Foundation® (TSF) is an independent 501(c)(3) nonprofit whose mission is to increase understanding of solar energy through strategic research and education that transform markets. TSF is considered by the Congressional Research Office and others as the premier research organization on the solar labor force, employer trends, and economic impacts of solar. TSF is also one of the nation's leading providers of solar educational materials and technical assistance support for local government through its work with the U.S. Department of Energy's SunShot Solar Outreach Partnership. In late 2014, The Solar Foundation released the most comprehensive database of known K-12 solar schools throughout the United States, identifying over 3,700 K-12 solar schools in the nation.

TSF would like to acknowledge and thank the following organizations and individuals. Without their contributions, this report would not have been possible.

- The Town Creek Foundation for providing the financial support to produce this work.

- Our Maryland-based advisory committee for providing valuable time and resources to ensure the report reaches key individuals and organizations: Stuart Clarke at The Town Creek Foundation, Lynn Heller at The Abell Foundation, Marta Tomic and Kyle Haas at the Maryland Energy Administration, Anya Schoolman and Corey Ramsden at Community Power Network, and Kathy Magruder and Wyatt Shiflett at the Maryland Clean Energy Center.

- Finally, the individuals who contributed to the report by sharing their experience: Sean Gallagher with Montgomery County Public Schools, Joanna Pi-Sunyer and Rajeshri Bachubhay with Baltimore City Public Schools, Bill Merritt with the Baltimore City Government, Keith Gascon with North Point High School, Martha Barss with Roland Park Country School, Daniel Bresette with the Maryland Energy Administration, Andrew Cassilly with Harford County Public Schools, and Mary Yates with the Shore Power Project at Washington College.

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Please cite this publication as "The Solar Foundation. (2015). *Brighter Maryland: A Study on Solar in Maryland Schools*. Available at “http://mdschools.tsfcensus.org”

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Executive Summary

While over 3,700 K-12 schools nationwide have realized the multiple benefits of installing solar, the potential for still more schools to go solar is massive. In a seminal report entitled *Brighter Future: A Study on Solar in U.S. Schools*, The Solar Foundation identified 3,727 public and private K-12 schools across the U.S. with installed solar photovoltaic (PV) systems. An original analysis produced for the report found that up to 72,000 additional K-12 schools could cost-effectively adopt solar energy today.

The research effort underpinning the *Brighter Future* report found 36 Maryland K-12 schools with solar PV systems currently installed. Combined, these systems represent 8.35 megawatts (MW) of solar capacity and generate an estimated 9.5 million kWh each year at an annual energy value of nearly $1.02 million, or about $28,000 per school per year. Examination of the total national potential for solar PV on K-12 schools revealed that up to 1,867 more Maryland schools could cost-effectively deploy solar energy systems,[1] generating more than 165,000 megawatt-hours (MWh) per year and over $18 million in annual energy value – approximately equal to 421 starting teacher salaries or 36,000 tablet computers each year.

Recognizing this potential, The Solar Foundation sought to more fully explore the breath of potential for additional Maryland schools to "go solar", and to help school district administrators, teachers, and other public officials better understand which schools and districts stand to benefit the most from investments in solar energy. These benefits include:

School and Student Reinvestment. When schools and districts save money with solar, funds that would otherwise have been used to cover utility costs can be reinvested in infrastructure and other educational support services. This may be significant for the fifteen MD school districts that fall below the state average for per-pupil student spending.

Educational Opportunities. Solar energy systems installed on a school and included in lesson plans as an interactive, hands-on teaching tool can help improve student learning and performance. Six school districts - Baltimore City, Caroline, Dorchester, Prince George's, Somerset, and Wicomico – have graduation rates below the state average, and thirteen school districts have mean ACT science scores below the state average. These school districts may see solar as a means for improving student performance.

Economic Development. One of the most compelling reasons to invest in solar is the economic growth and job creation opportunity linked to solar. Maryland solar installers earn on average $22.67 per hour, or approximately $47,150 annually.[2] Four Maryland counties – Allegany, Dorchester, Garrett, and Somerset – along with Baltimore City have median incomes below this

[1] All 1,867 K-12 schools have some untapped solar potential and can cost-effectively install solar energy systems. This figure includes 29 solar schools that have not yet reached their maximum solar potential.
[2] The Solar Foundation. (2015). *Maryland Solar Jobs Census 2014*. Available at: www.thesolarfoundation.org

figure and unemployment rates higher than the state average. Targeting schools in these districts for solar development may help alleviate the economic strain felt in these areas.

Environmental Protection. A single 110 kilowatt (kW) solar PV installation (the median system size of the existing K-12 solar energy systems in the state) will produce nearly 150,000 kilowatt-hours (kWh) of electricity in its first year of operation.[3] This production will offset approximately 103 metric tons of carbon dioxide equivalent (CO_2e) emissions.[4] Furthermore, electricity derived from solar can also help reduce emissions of criteria air pollutants, such as nitrogen oxides (NO_x) and sulfur dioxide (SO_2), as well as help conserve natural resources.

Community Resiliency and Emergency Response. Solar schools also have the ability to act as centralized emergency centers during natural disasters and help build community resiliency. Maryland, like many states on the east coast, is susceptible to natural disasters such as flooding, hurricanes, tornados, and severe winter storms. Given energy storage capabilities, installing solar energy systems at many of the state's 50 emergency shelters can be one way to prepare for and recover from natural disasters.

Looking more closely at the untapped potential for public solar schools in Maryland, *Brighter Future* identified 1,232 schools that can cost-effectively deploy solar,[5] with a potential capacity of over 123,000 kW across 21 school districts. If these schools fully tapped their solar potential, the state would create over 1,440 one-time construction jobs, resulting in approximately $81 million in construction earnings and $189 million in total economic output.[6]

Furthermore, nine Maryland public school districts were identified as having the potential to each save $1 million or more over 30 years if schools in the district deployed solar to its full PV capacity potential. These nine districts largely correspond to the most populous school districts in the state, collectively representing approximately 645,000 students, or about 77 percent of K-12 school students in Maryland.[7] Together, these nine districts could net the state approximately $33 million in financial benefits over 30 years.

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[3] According to the NREL PVWatts Calculator, available at http://pvwatts.nrel.gov/pvwatts.php. Assumes 110kW system installed in Baltimore area with tilt of 30 degrees. All other inputs are PVWatts defaults.
[4] According to the Environmental Protection Agency's "Greenhouse Gas Equivalencies Calculator", available at: www.epa.gov/cleanenergy/energy-resources/calculator.html
[5] 1,232 public schools have some untapped solar potential and can cost-effectively install solar energy systems, including the 24 schools that currently have solar systems.
[6] According to the National Renewable Energy Laboratory's (NREL) Jobs and Economic Development Impact Models (JEDI). Available at: http://www.nrel.gov/analysis/jedi/
[7] Maryland State Department of Education. (2015). Fall Enrollment - Maryland Public Schools: September 30, 2013. *The Fact Book 2013-2014.* Available at: www.marylandpublicschools.org/msde/divisions/bus_svcs/docs/Fact_Book_2013-2014.pdf

Introduction

In September 2014, The Solar Foundation released a report entitled *Brighter Future: A Study on Solar in U.S. Schools*. This seminal report found that 3,727 public and private K-12 schools in the nation have solar photovoltaic (PV) systems, with a combined capacity of 490 megawatts (MW) and generating approximately 642,000 megawatt-hours (MWh) of electricity each year. Across all solar schools, this combined solar energy production represents $77.8 million per year in utility bills, or an average of about $21,000 per school each year.

While thousands of schools have realized the many benefits of installing solar, the potential for still more schools to go solar is vast. Many schools are excellent candidates for rooftop solar PV due to their large and flat roofs and may also be suitable for solar PV canopies on large parking areas. *Brighter Future* found that up to 72,000 more K-12 schools in the U.S. can cost-effectively adopt solar energy.[8] If fully tapped, this potential would result in 5,400 MW of total solar capacity on K-12 schools – a figure representing nearly one-third of the nation's current total solar PV capacity.[9]

The research effort underpinning the *Brighter Future* report found 36 Maryland K-12 schools with solar PV systems currently installed. Combined, these systems represent 8.35 MW of installed solar capacity, and generate an estimated 9.5 million kWh each year at an annual energy value of nearly $1.02 million, or about $28,000 per school each year. Examination of the total national potential for solar PV on K-12 schools revealed that up to 1,867 [10] more Maryland schools could cost-effectively deploy solar energy systems, generating more than 165,000 MWh per year and over $18 million in energy value each year. Additionally, nine public school districts were identified as having the potential to each save up to $1 million dollars or more over the course of 30 years, during which the system is completely paid off, if schools in each district deployed solar to its full PV capacity potential. These nine districts largely correspond to the most populous school districts in the state, collectively representing approximately 645,000 students, or about 77 percent of K-12 school students in Maryland.[11] **Together, these nine districts could net the state approximately $33 million in financial benefits over 30 years**.[12]

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[8] The Solar Foundation. (2014). *Brighter Future: A Study on Solar in U.S. Schools*. Available at: www.thesolarfoundation.org/solar-schools/

[9] SEIA/GTM Research. (2015). *U.S. Solar Market Insight: 2014 Year in Review*. Available at: www.seia.org/research-resources/us-solar-market-insight

[10] All 1,867 schools have some untapped solar potential and can cost-effectively install solar energy systems. This figure includes 29 solar schools that have not yet reached their maximum solar potential.

[11] Maryland State Department of Education. (2015). Fall Enrollment - Maryland Public Schools: September 30, 2013. *The Fact Book 2013-2014.* Available at: www.marylandpublicschools.org/msde/divisions/bus_svcs/docs/Fact_Book_2013-2014.pdf

[12] Estimates were simulated using the PV Watts model from the National Renewable Energy Laboratory's (NREL) System Advisor Model. The model assumes a $2.00 per watt solar system cost, a typical 20-year financing option, and operations and maintenance costs of $15/kW/year over a 30 year analyses period. For more information on modeling assumptions, please refer to page 25 of the *Brighter Future* report.

Solar provides a number of benefits beyond energy value. Solar arrays installed on school rooftops or grounds can provide teachers with unique opportunities to incorporate renewable energy concepts into lesson plans using real-world and hands-on examples. The increased use of solar could provide school districts across the state with an opportunity to help raise student achievement test scores and promote literacy in science, technology, engineering, and mathematics (STEM) fields. Highly-visible solar energy systems may also pique interest in the technology among younger students, introducing STEM concepts earlier in their education.

Furthermore, deployment of more solar on schools may also open up opportunities for solar jobs in the community or across the state, which may be of particular benefit to areas with high unemployment rates and low median household incomes.

Finally, the increased use of solar on schools can help move the state closer to its energy goals, specifically the state's Renewable Portfolio Standard (RPS) solar carve-out goal of producing two percent of the electricity sold by utilities in 2020 and each year thereafter from solar technologies. Attached to the increased use of solar on Maryland schools are significant environmental benefits – including a reduction in carbon dioxide emissions of up to 114,000 metric tons of CO_2 equivalent (CO_2e) per year – roughly equivalent to the annual greenhouse gas emissions from 24,000 passenger vehicles.[13]

Considering the significant untapped potential of Maryland solar schools, this report was produced to: (1) analyze the state's use of solar on schools and its untapped solar potential; (2) demonstrate to the state's schools and school districts the various opportunities for achieving community goals through investments in solar; (3) provide actionable information on specific financing mechanisms schools and school districts can use to get started on their own solar school projects, and; (4) help the state of Maryland understand the importance of deploying more solar energy systems on K-12 schools.

Solar Energy 101

Solar energy can come from a number of different technologies, including solar photovoltaics (PV), solar heating and cooling, or concentrated solar power (CSP). Solar PV, the most common technology, uses cells made from semiconductor material to collect the sun's photons and convert them into useable electricity for the consumer. Over 99 percent of solar school projects in the nation are solar PV systems.[14] Solar thermal technologies, including solar hot water and solar heating and cooling, harness the sun's heat energy to help meet residential, commercial, or industrial heating and cooling needs. CSP facilities – typically found in the desert Southwest – use large mirrors to focus light onto a single point to create steam to drive a turbine to produce electricity.

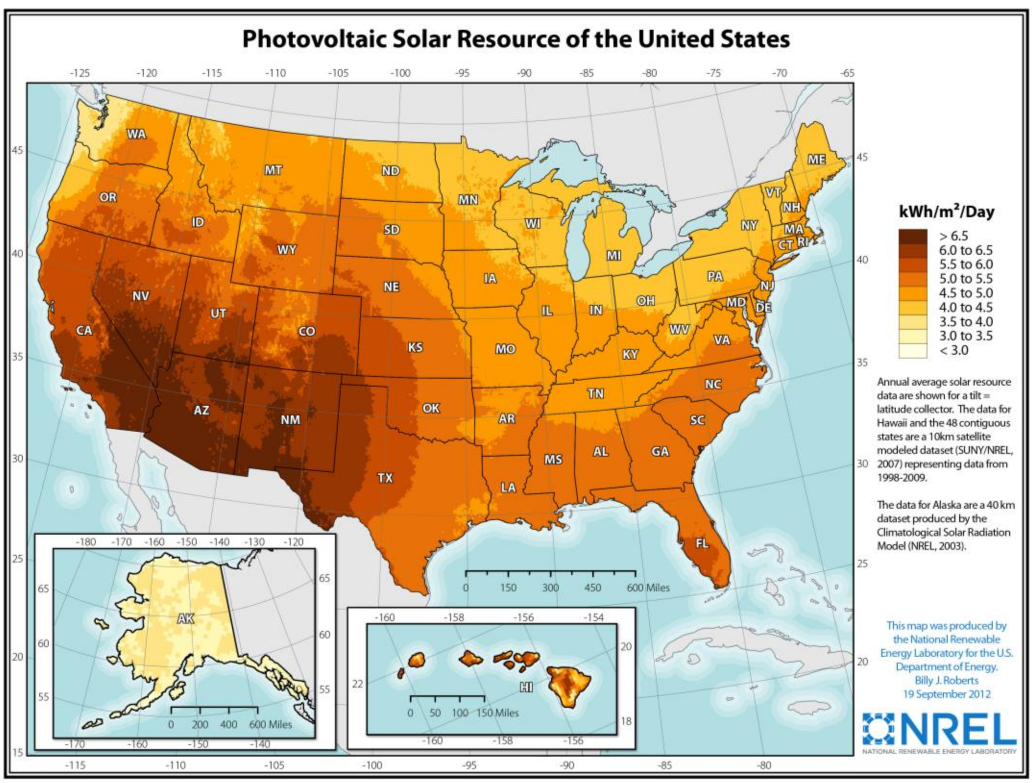
[13] According to the Environmental Protection Agency's "Greenhouse Gas Equivalencies Calculator", available at: www.epa.gov/cleanenergy/energy-resources/calculator.html
[14] The Solar Foundation. (2014). *Brighter Future: A Study on Solar in U.S. Schools*. Available at: www.thesolarfoundation.org/solar-schools/

The size, or capacity, of a solar energy system is measured in terms of power, with watts (W), kilowatts (kW; one thousand watts), and even megawatts (MW; one thousand kilowatts), as common metrics. The amount of energy these systems can produce is a measurement of power generated over a period of time, and measured in watt-hours (Wh), kilowatt-hours (kWh), and megawatt-hours (MWh).

Solar PV is a modular technology, and thus can be sized to fit the specific needs of the consumer. A residential solar system project can range from one to ten kW, with an average size of five kW. Office buildings and schools with greater energy needs can have projects several hundred kW in size. Large factory buildings and utilities may have projects with an even greater capacity, falling in the MW range.

One common misconception regarding solar energy is that the technology is not feasible in all communities and regions in the United States. Though the desert Southwest receives the most solar radiation in the U.S., all contiguous 48 states have a sufficient solar resource for producing electricity. As shown in Figure 1 below, most of Maryland receives about 4.5 to 5.0 kWh of solar radiation per square meter of land area every day, which is approximately 70 percent of that received in the desert southwest, which has the greatest solar resource in the nation.[15]

Figure 1. Photovoltaic Solar Resource of the United States



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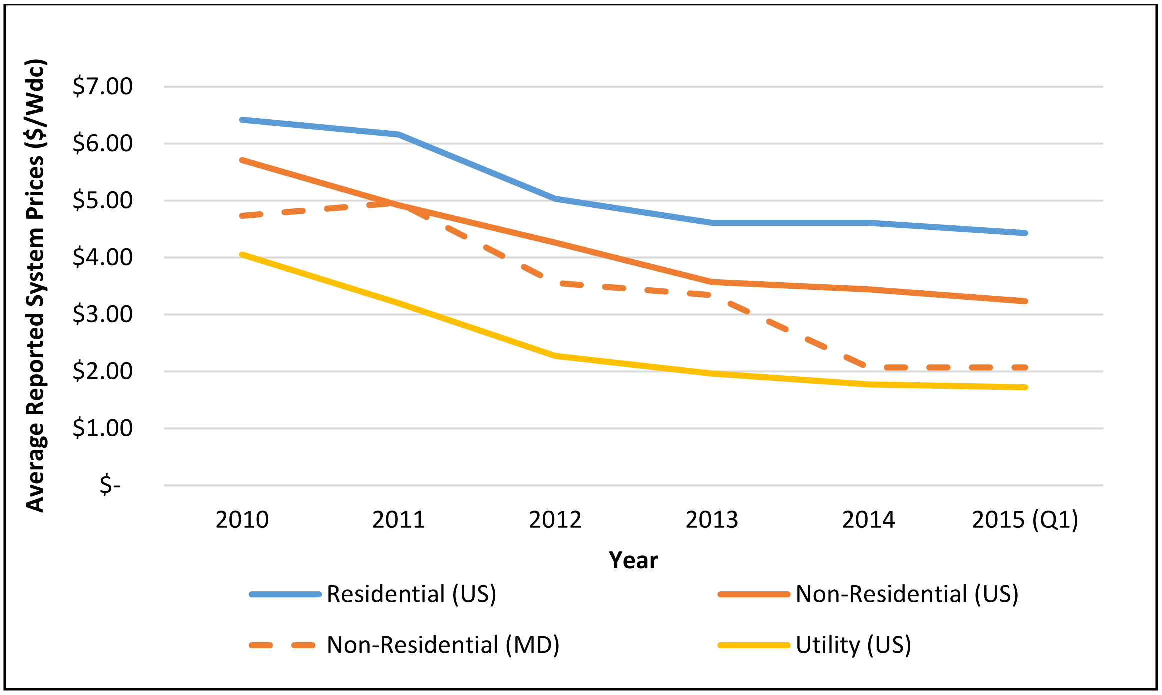
[15] Robert, B. J. (2012). Photovoltaic Solar Resource of the United States. National Renewable Energy Laboratory. Available at: www.nrel.gov/gis/images/eere_pv/national_photovoltaic_2012-01.jpg

One of the most oft-cited benefits of solar energy is the financial benefits these systems can deliver. After a solar energy system is installed, the electricity or other energy it produces comes at essentially no cost, as the fuel source behind the technology is free and practically limitless. As installed costs continue to decline (Figure 2),[16] many residential and commercial users are looking at solar technologies as a way to reduce high and volatile utility costs associated with fossil fuels. For example, there are currently nearly 650,000 residential solar PV systems installed throughout the U.S., representing 93 percent of the total number of solar energy systems installed to date.[17] Corporate use of solar is also on the rise. By the end of 2014, the top 25 corporate users of solar – including companies such as Walmart, Kohl's, Costco, Apple, and IKEA – had installed nearly 490 MW of solar.[18] If these companies collectively represented a U.S. state, it would be the seventh-largest solar market in the nation, ahead of strong solar states such as Hawaii, Colorado, New York, and Texas.[19]

Figure 2. Average Reported System Prices: US and Maryland, 2010-Q1 2015



Source: SEIA/GMT Research *U.S. Solar Market Insight* report series

[16] SEIA/GTM Research. (2015). *U.S. Solar Market Insight: Q1 2015*. Available at: www.seia.org/research-resources/us-solar-market-insight
[17] *Ibid.*
[18] SEIA. (2014). *Solar Means Business: Top U.S. Commercial Solar Users.* Available at: www.seia.org/research-resources/solar-means-business-2014-top-us-commercial-solar-users
[19] SEIA. (2015). 2014 Top 10 Solar States. Available at: http://www.seia.org/research-resources/2014-top-10-solar-states

The environmental benefits of solar must also not go unnoticed. In Maryland, a single 110 kW solar PV installation (the median system size of the existing K-12 solar energy systems in the state) will produce nearly 150,000 kWh of electricity in its first year of operation.[20] This production will offset approximately 103 metric tons of CO_2e emissions, roughly equal to taking nearly 22 passenger vehicles off the road for an entire year or the amount of carbon sequestered annually by almost 85 acres of U.S. forests.[21] Electricity derived from solar can also help reduce emissions of criteria air pollutants, such as nitrogen oxides (NO_x) and sulfur dioxide (SO_2), and help conserve natural resources such as land and water.

Maryland Solar Policy and Market Context

Since 2007, Maryland has established a number of environmental and energy objectives to decrease the use of conventional energy resources and reduce greenhouse gas emissions. The EmPOWER Maryland Energy Efficiency Act of 2008 set targets to reduce per capita electricity consumption by 15 percent by the end of 2015, based on 2007 levels.[22] In addition, the Greenhouse Gas Emissions Reduction Act of 2009 requires the state to reduce greenhouse gas emission by 25 percent compared with 2006 levels by 2020.[23] In support of this goal, Maryland has joined the Northeast Regional Greenhouse Gas Initiative (RGGI), a multi-state market-based regulatory program focused on reducing greenhouse gas emissions from conventional fossil fuel electricity generation.[24] Finally, the state renewable portfolio standard (RPS) requires that 20 percent of the state's electricity be generated from renewable energy by the year 2022, including a two percent solar 'carve-out' by 2020.[25] To facilitate attainment of some of these energy policies, Maryland has a robust net metering law, requiring that all utilities credit residents, businesses, schools, and government entities for electricity generated by a wide variety of renewable technologies and exported onto the electric grid.[26]

This collection of energy goals emphasizes the state's awareness and aspirations to increase the use of clean energy technologies, but they can nonetheless fall short of their annual benchmarks. In 2013, Maryland's RPS targets were set at 10.7 percent for all renewable energy generation, with at least 0.25 percent derived from solar energy.[27] Only 8.2 percent of Maryland's energy

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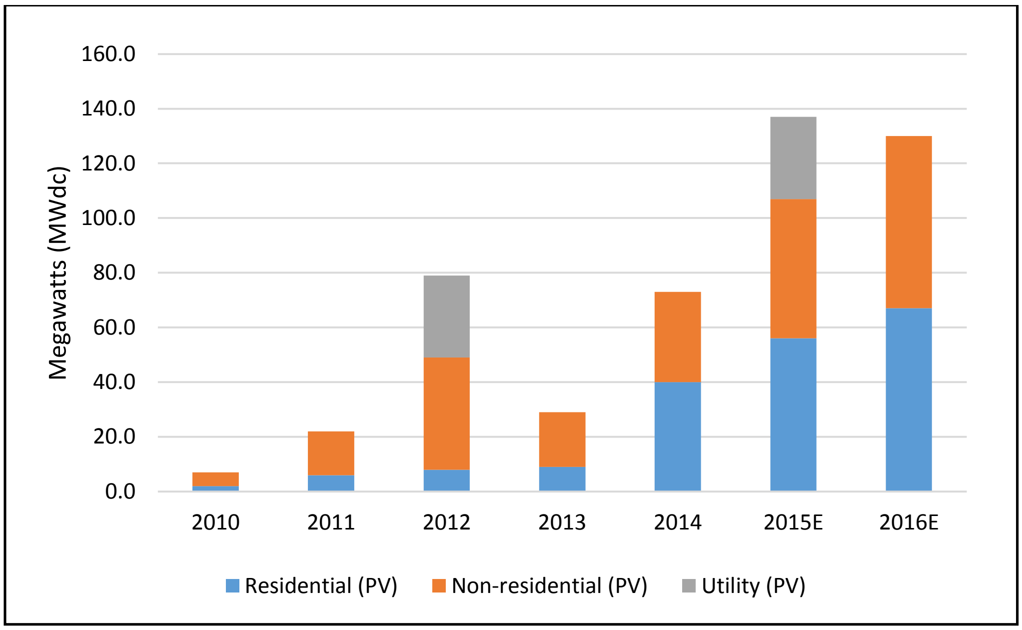
[20] According to the NREL PVWatts Calculator, available at http://pvwatts.nrel.gov/pvwatts.php. Assumes 110kW system installed in Baltimore area with tilt of 30 degrees. All other inputs are PVWatts defaults.
[21] According to the Environmental Protection Agency's "Greenhouse Gas Equivalencies Calculator", available at: www.epa.gov/cleanenergy/energy-resources/calculator.html
[22] Maryland Energy Administration. (2015). EmPOWER Maryland Planning. Available at: energy.maryland.gov/empower3/
[23] Maryland Department of Environment. (2015). Facts about the Greenhouse Gas Reduction Act of 2009. Available at: www.mde.state.md.us/assets/document/Air/ClimateChange/GGRA_factsheet.pdf
[24] Maryland Department of Environment. (2015). Regional Greenhouse Gas Initiative. Available at: www.mde.state.md.us/programs/Air/RGGI/Pages/Air/RGGI.aspx
[25] North Carolina Clean Energy Technology Center. (2015). Maryland Renewable Energy Portfolio Standard. Available at: http://programs.dsireusa.org/system/program/detail/1085
[26] North Carolina Clean Energy Technology Center. (2015). Maryland Net Metering. Available at: http://programs.dsireusa.org/system/program/detail/363
[27] Maryland House Bill 226. (2013). Available at: http://mgaleg.maryland.gov/2013RS/chapters_noln/Ch_3_hb0226E.pdf

generation came from renewable sources that year and approximately 0.52 percent of that electricity generation came from solar energy.[28] The state can benefit from investing in more of clean energy projects to meet the general renewable energy targets in coming years, a goal in which the deployment of solar on K-12 schools can help attain.

However, as evidenced by its progress with interim solar carve-out goals, Maryland has already experienced great success with solar. Annual solar capacity additions in Maryland have grown from around 7 MW in 2010 to 73 MW in 2014 (Figure 3), with another 27 MW added in just the first three months of 2015.[29] This brings the cumulative solar capacity from 2010-Q12015 to 242 MW, making Maryland 13th in the nation in terms of the total amount of solar installed to date.[30]

Figure 3. Annual Maryland Solar Photovoltaic Capacity Additions, 2010-2016E



Source: SEIA/GTM Research. (2015). *Solar Market Insight: 2014 Year in Review*.

[28] In 2013, Maryland generated 185,731 MWh in solar energy, and 35,717,500 MWh in electricity generation from all sources. Based on data from https://data.maryland.gov/Energy-and-Environment/Renewable-Energy-Generated-In-Maryland/79zg-5xwz?

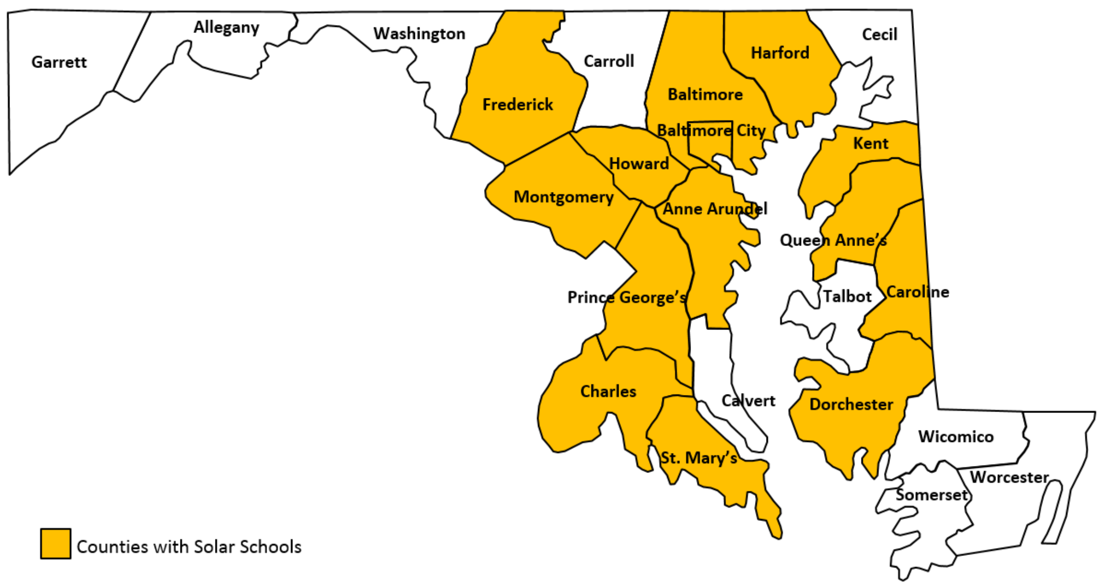
[29] SEIA/GTM Research. (2015). *U.S. Solar Market Insight: Q1 2015*. Available at: www.seia.org/research-resources/us-solar-market-insight

[30] SEIA. (2015). Maryland Solar. Available at: www.seia.org/state-solar-policy/maryland

Maryland Solar Schools: Progress to Date

Although they represent only a small portion of the state's total solar capacity (3.5 percent), solar schools have undeniably contributed to the state's solar success. As of September 2014, Maryland has 36 solar K-12 schools across 13 counties and Baltimore City, with a total solar capacity of 8.35 MW. While these figures put the state at only 20th in terms of the number of solar installations on K-12 schools, **the state is ranked ninth in total solar capacity on schools – with its 8.35 MW generating 9.5 million kWh each year, equivalent to over $1 million in annual utility costs and offsetting over 6,550 metric tons of CO_2e emissions each year.**

Figure 4. Map of Maryland Counties with K-12 Solar Schools



Progress with solar on schools varies from school to school and district to district. In an effort to describe solar schools with similar demographics, districts were grouped into five regions for discussion in the following sections.

Eastern Shore

Caroline, Cecil, Dorchester, Kent, Queen Anne's, Somerset, Talbot, Wicomico, Worcester

The Eastern Shore consists of nine counties predominately lying on the east side of the Chesapeake Bay, with just under eight percent of Marylanders living in the region.[31] There are a total of seven solar public schools (and no private schools) in the Eastern Shore: two elementary schools, three middle schools, and two high schools, accounting for more than 4,000 kW of installed PV capacity and saving over 4,615,000 kWh in utility-supplied energy valued at over half a million dollars each year (Table 1). Caroline County holds the largest single PV rooftop

[31] U.S. Census Bureau. (2015). Maryland State & County QuickFacts: 2014 Population Estimate. Available at: http://quickfacts.census.gov/qfd/states/24000.html

system in Maryland with a 919 kW system on North Caroline High School, producing electricity worth over $125,000 per year.[32] The Caroline County school district also has the most installed capacity of all Maryland counties, with its three solar schools representing a total PV capacity of 2,030 kW. Dorchester County holds the second largest single PV system in Maryland with an 803 kW system on Mace's Lance Middle School, saving over $107,000 every year.

Table 1. Eastern Shore K-12 Solar Schools

County	Name Of School	System Size (kW)	Annual Energy Production (kWh)	Annual CO_2e Emissions Reductions (Metric Tons)	Annual Energy Value ($)
Caroline	North Caroline High	919	1,045,822	721	$125,499
	Colonel Richardson Middle & High	796	908,968	627	$90,897
	Greensboro Elementary	315	358,470	247	$35,847
Dorchester	Mace's Lane Middle	803	893,675	616	$107,241
Kent	Kent County High*	1,200	1,370,712	945	$164,485
	Worton Elementary*	see note	see note	see note	see note
Queen Anne's	Sudlersville Middle School	33	37,952	26	$3,795
TOTAL		*4,066*	*4,615,599*	*3,183*	*$527,764*

*Kent County High School and Worton Elementary are two of five recipients of the 1,200 kW Worton Solar Field in Kent County

Capital

Frederick, Montgomery, Prince George's

The Capital region of Maryland consists of three counties located on the outskirts of Washington, D.C. and is home to over two million people (36 percent of the state's population).[33] Collectively, there are about 306,500 K-12 public school students in these counties, which is approximately 37 percent of the state's public school student population,[34] with Montgomery and Prince George's County together accounting for over 267,000 students. The Capital region has fourteen K-12 solar schools, with an installed capacity of 1,944 kW

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[32] 1,200 kW of solar capacity at the Worton Solar Field is distributed over 5 sites in Kent County.

[33] U.S. Census Bureau. (2015). Maryland State & County QuickFacts: 2014 Population Estimate. Available at: http://quickfacts.census.gov/qfd/states/24000.html

[34] Maryland State Department of Education. (2015). Fall Enrollment - Maryland Public Schools: September 30, 2013. *The Fact Book 2013-2014.* Available at: www.marylandpublicschools.org/msde/divisions/bus_svcs/docs/Fact_Book_2013-2014.pdf

producing over $230,000 worth of electricity every year (Table 2). Out of those 14 solar schools, ten are public schools with a solar capacity of 1,693 kW (87 percent of the region's capacity) and producing nearly $203,000 worth of electricity each year.

Montgomery County has greatest number of solar schools in the state – nine in total – with two elementary schools, three middle schools, three high schools, and one private day school for grades 2-12, representing a combined capacity of 1,255 kW and producing $155,000 worth of electricity each year.

Table 2. Capital Region K-12 Solar Schools

County	Name Of School	System Size (kW)	Annual Energy Production (kWh)	Annual CO_2e Emissions Reductions (Metric Tons)	Annual Energy Value ($)
Frederick	Mother Seton Elementary	1	1,337	1	$120
	Lucy School	12	13,600	9	$1,088
	Oakdale High	499	565,547	390	$50,899
Montgomery	The Bullis School	111	125,463	87	$10,037
	College Gardens Elementary	76	86,135	59	$10,336
	Lakelands Park Middle	110	124,670	86	$14,960
	Quince Orchard High	238	269,740	186	$32,369
	Richard Montgomery High	108	120,195	83	$14,423
	Francis Scott Key Middle	92	102,389	71	$12,287
	Sargent Shriver Elementary	92	102,389	71	$12,287
	Parkland Middle	151	168,051	116	$20,166
	Clarksburg High	277	313,941	216	$28,255
Prince George's	Dematha Catholic High	127	141,341	97	$16,961
	University Park Elementary	50	55,646	38	$6,678
TOTAL		*1,944*	*2,190,444*	*1,510*	*$230,866*

Central

Anne Arundel, Baltimore City, Baltimore County, Carroll, Harford, Howard

Central Maryland consists of five counties and Baltimore City with approximately 2.7 million Marylanders living in the region (nearly 46 percent of the state's population).[35] The region currently has 1,826 kW of combined installed capacity across thirteen solar schools (Table 3), but only four areas in the region – Anne Arundel County, Baltimore City, Harford County, and Howard County – have public K-12 solar schools. These eight public K-12 solar schools represent a combined installed capacity of 1,737 kW, accounting for 95 percent of the region's solar capacity. Harford County currently has six solar public schools, the second most solar schools in a single county, with a combined capacity of 1,274 kW producing nearly $160,000 worth of electricity every year.

Table 3. Central Region K-12 Solar Schools

County	Name Of School	System Size (kW)	Annual Energy Savings (kWh)	Annual CO_2e Emissions Reductions (Metric Tons)	Annual Energy Value ($)
Anne Arundel	Arlington Echo Outdoor Education Center	2	1,805	1	$90
	The Summit School	5	5,791	4	$637
Baltimore County	Park School Of Baltimore	37	42,766	29	$2,138
Baltimore City	Roland Park Country	36	46,700	32	$5,137
	New Song Academy	13	14,701	10	$1,617
	Grace United Methodist Preschool	11	12,885	9	$1,417
Harford	Aberdeen High	149	169,007	117	$18,591
	Bel Air High	107	121,753	84	$13,393
	Edgewood High	271	309,438	213	$34,038
	Fallston High	186	212,049	146	$23,325
	Magnolia Middle	299	341,764	236	$37,594
	Patterson Mill High	262	299,364	206	$32,930
Howard	Worthington Elementary	448	511,732	353	$56,291
TOTAL		*1,826*	*2,089,755*	*1,440*	*$227,198*

[35] U.S. Census Bureau. (2015). Maryland State & County QuickFacts: 2014 Population Estimate. Available at: http://quickfacts.census.gov/qfd/states/24000.html

Southern

Calvert, Charles, St. Mary's

The Southern region of Maryland consists of three counties representing approximately six percent of the state's population.[36] Charles County and St. Mary's County each have one public solar school with a combined capacity of 513 kW producing nearly $30,000 worth of electricity each year (Table 4).

Table 4. Southern Region K-12 Solar Schools

County	Name Of School	System Size (kW)	Annual Energy Savings (kWh)	Annual CO_2e Emissions Reductions (Metric Tons)	Annual Energy Value ($)
Charles	North Point High	3	2,894	2	$289
St. Mary's	George Washington Carver Elementary	510	591,841	408	$29,592
TOTAL		*513*	*594,735*	*410*	*$29,881*

Western

Allegany, Garrett, Washington

The Western region of Maryland consists of three counties with nearly four percent of the state's population living in the area.[37] As of September of 2014, no solar schools were identified in this region.

With 36 schools in Maryland already equipped with solar energy systems, schools and school districts across the state are working to bring solar to still more schools. In April 2015, Cecil County Public Schools installed the first school solar energy system in the county, completing a 2.5 MW system with funding through Maryland's Aggregated Net Metering Program, and signing a power purchase agreement (PPA) with SunEdison.[38]

In addition, Montgomery County is currently in the process of installing more solar on their public K-12 schools, marking it the second time the county has retrofitted schools with solar. Between 2008 and 2009, realizing the school district could save money through solar installations, the county signed a PPA with SunEdison to purchase electricity from solar systems

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[36] U.S. Census Bureau. (2015). Maryland State & County QuickFacts: 2014 Population Estimate. Available at: http://quickfacts.census.gov/qfd/states/24000.html

[37] *Ibid.*

[38] Standard Solar. (2015). SunEdison Completes 2.5 Megawatt System For Cecil County School Of Technology [Press Release]. Retrieved from: http://standardsolar.com/node/292

installed on eight public schools in the county. In 2014, with rapidly falling solar costs and a newly established environmental sustainability management plan,[39] the county once again saw a "window of opportunity" for more solar schools, currently going through the request for proposal (RFP) process and proposing fourteen additional projects.[40]

CASE STUDY: Montgomery County Public Schools

Montgomery County Public Schools (MCPS) is a school district that is composed of 147,500 students enrolled in over 200 schools. Within MCPS, one of the Department of Facilities' goals is to provide meaningful education for its students and create a healthy learning environment for students in the most cost-effective manner possible.[41] Before 2008, MCPS only had small demonstration solar systems, but wanted to move toward investments in larger, more substantial solar installations that could save the school money. The school district entered into a power purchase agreement (PPA) with SunEdison – through which MCPS agreed to purchase the electricity produced by eight solar energy systems throughout its elementary to secondary schools – and the district has been reaping the financial benefits of solar energy ever since, saving between $10,000 and $15,000 in the 2013 -2014 academic school year.

In 2014, Montgomery County Public Schools established an aggressive county-wide sustainability and energy plan aimed at eliminating volatility in utility costs. Given continued sharp declines in solar installed costs, and recognizing that still more schools could deploy solar cost-effectively, the school district saw a window of opportunity for putting solar on more schools. As a result, MCPS proposed several large rooftop and ground-mounted solar energy projects to achieve greater economies of scale. Learning from its previous experiences with solar schools, MCPS is expecting even greater returns on investment, anticipating $130,000 in total savings every year.[42]

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[39] Montgomery County Public Schools. (2014). *FY 2014 Environmental Sustainability Management Plan*. Available at: www.montgomeryschoolsmd.org/departments/facilities/facdocs/1072.14_environsustainmanagementplanweb.pdf
[40] S. Gallagher. Personal Communication. March 2015.
[41] *Ibid.*
[42] *Ibid.*

Other schools and districts across the state continue to make progress with solar schools as well. The Baltimore City Office of Sustainable Energy offered a grant to the Baltimore Polytechnic Alumni Association to install a small solar array on a parking lot, but city schools administrators have yet to approve the project.[43] Additionally, the Maryland Net Zero Energy Schools program, administered by the Maryland Energy Administration (MEA), is currently underway to identify, design, and build three net-zero energy schools – or schools that produce as much energy as they consume – in as many different counties across the state.[44] Although a solar energy system is not a requirement for a net-zero energy building (as other clean energy solutions may be used), solar technologies may help schools attain this net-zero energy status.

While Maryland continues to make great progress in deploying solar on K-12 schools, there exists a large untapped potential for still more schools to invest in solar energy systems. With this in mind, the following section will examine the economic, educational, environmental, and other opportunities possible through investments in solar energy through the lens of Maryland-specific demographic, income and employment, and educational indicators. Looking at these factors may help identify where the benefits of putting solar on schools would have the greatest impact.

A 510 kW system at George Washington Carver Elementary School, St. Mary's County (Photo: Standard Solar)

[43] B. Merritt. Personal Communication. June 2015.
[44] Maryland Energy Administration. (2014). *Maryland Net Zero Energy Schools Program Annual Report*. Available at:
http://webapp.psc.state.md.us/newIntranet/Casenum/NewIndex3_VOpenFile.cfm?filepath=C:%5CCasenum%5C9200-9299%5C9271%5CItem_421%5C%5CPSC9271.CIF.FY14NZSAnnualReport.pdf

Why Should Maryland Schools Go Solar?

Investments in solar energy on K-12 schools stand to deliver a number of significant benefits not only to those within the school system, but to the surrounding community as well. School and district administrators will see an obvious benefit in the energy cost savings achievable with solar, creating the potential for these funds to be reinvested in teacher and staff salaries or new curriculum and learning tools. Additionally, when properly incorporated into lesson plans, these systems can deliver a double educational dividend, providing a real-life demonstration of STEM concepts. The economic activity attached to the installation of these systems can provide a direct benefit to the community in the form of increased employment opportunities or wages for workers in related trades, and can contribute to community prosperity indirectly when these workers spend their income in the local economy. The community at large also receives part of the environmental benefits of solar, in the form of reduced emissions of greenhouse gas and criteria air pollutants and fewer demands on local natural resources, such as water and land. Finally, schools retrofitted with solar energy systems designed to continue to provide power for critical services during times of disaster can serve as emergency shelters for the surrounding community.

This section explores the specific benefits solar can provide to Maryland communities, and examines select employment, income, and educational indicators in counties throughout the state to identify areas that stand to gain the most from each benefit type.

School & Student Reinvestment

Perhaps the greatest benefit solar energy can offer is the opportunity for a school to realize significant savings on its energy bills. As the installed cost of solar continues to fall and utility rates keep rising (as they are expected to by 0.6 percent annually on average through 2040),[45] investments in solar will increasingly offer consumers an opportunity to save money. Utility cost savings can be reinvested back into the public school system in various ways, such as by hiring new teachers, improving the district's transportation system, developing more comprehensive curricula, or obtaining additional resources (e.g. updated textbooks, tablet computers, and school field trips) – all of which contribute to increased per-pupil spending. As an example, in 2012 California's Firebaugh-Las Deltas Unified School District reinstated their music program, which was halted in 2009 due to the lack of funding, with savings from a solar installation. The school district installed nearly one megawatt of solar at three schools, expecting $900,000 in savings over the first five years.[46] Solar energy is a smart investment for communities or as Russell Freitas, Superintendent of Firebaugh-Las Deltas Unified School District stated, "Solar energy projects for public schools are essentially revenue enhancements for school districts which directly benefit the students and taxpayers."[47]

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[45] U.S. Energy Information Administration. (2015). Table A8. Electricity supply, disposition, prices, and emissions. *Annual Energy Outlook 2015.* Available at: www.eia.gov/forecasts/aeo/pdf/tbla8.pdf
[46] Energy Digital. (2012). Schools Reinvest in Programs with Savings from Solar Power. Retrieved from: www.energydigital.com/renewables/3183/Schools-Reinvest-in-Programs-with-Savings-from-Solar-Power
[47] *Ibid.*

In fiscal year 2013, Maryland spent nearly $12 billion in public elementary and secondary education on 836,000 students, with approximately $7.3 billion of this spent on instruction and $4.2 billion on support services.[48] On average, the state spends about $13,600 per pupil,[49] and although this figure is high compared with much of the rest of the nation (the national average is approximately $10,700 per pupil), a total of fifteen school districts fall below the Maryland state average for per-pupil spending (Table 5 and Figure 5). Energy cost savings from investments in solar energy project may be reinvested in instruction and other educational support services, and as a result may help bring school districts in these counties closer to the state average.

A 127kW system at DeMatha Catholic High School, Prince George's County (Photo: Altus Power America)

[48] U.S. Census Bureau. (2015). Table 6. Current Spending of Public Elementary-Secondary School Systems by State: Fiscal Year 2013. *Public Education Finances: 2013.* Available at www2.census.gov/govs/school/13f33pub.pdf

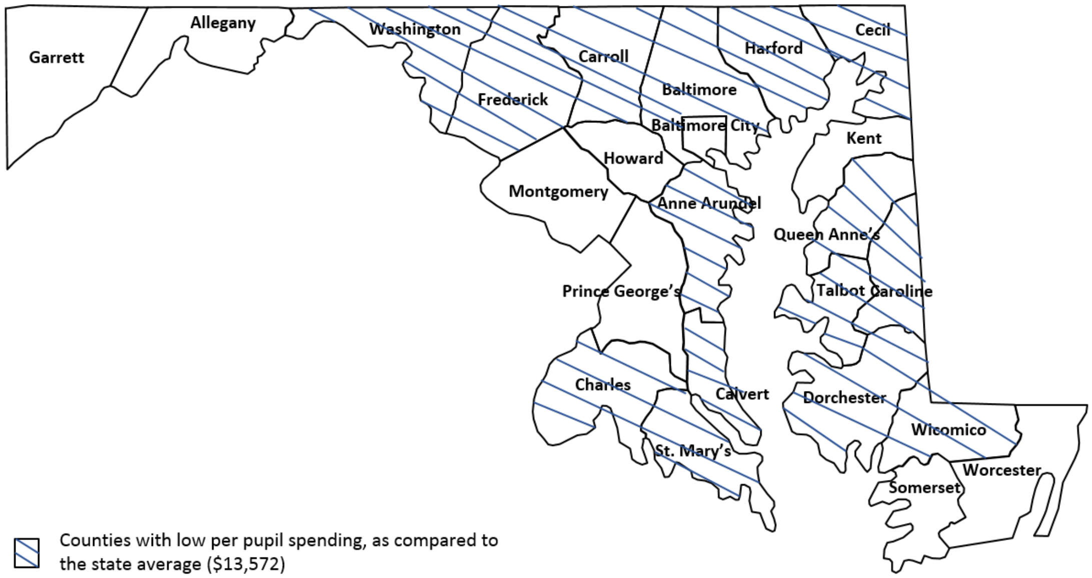
[49] Maryland State Department of Education (2015). Cost Per Pupil Belonging Maryland Public Schools: FY 2013. *The Fact Book 2013-2014.* Available at: www.marylandpublicschools.org/msde/divisions/bus_svcs/docs/Fact_Book_2013-2014.pdf. Excludes equipment, tuition payments, and interfund transfer expenditures.

Table 5. County Per Pupil Spending (2013)

County	Per Pupil Spending ($)[50]
Allegany	13,751
Anne Arundel	12,687
Baltimore City	14,631
Baltimore County	13,012
Calvert	13,074
Caroline	11,792
Carroll	12,763
Cecil	12,327
Charles	12,742
Dorchester	13,105
Frederick	12,268
Garrett	14,251
Harford	12,534
Howard	14,694
Kent	14,271
Montgomery	14,891
Prince George's	13,784
Queen Anne's	11,593
Somerset	13,637
St. Mary's	12,313
Talbot	11,855
Washington	12,157
Wicomico	12,610
Worcester	16,220
State Average	13,572
National Average	10,700 [51]

[50] *Ibid.*
[51] U.S. Census Bureau. (2015). Table 8. Per Pupil Amounts for Current Spending of Public Elementary-Secondary School System by State: Fiscal Year 2013. *Public Education Finances: 2013.* Available at www2.census.gov/govs/school/13f33pub.pdf

Figure 5. Counties with the Greatest School Reinvestment Opportunities



When individual schools invest in solar, the energy cost savings often go back to the school district's general fund, leaving the decision of how to reallocate these savings up to the district. While the savings may not necessarily all go back into a school with a solar energy system, the district as a whole can realize the financial benefits for students, teachers, and staff.

Educational Opportunities

The Maryland public school system has been shown to have some of the best schools in the nation. According to *Education Week*, Maryland ranked third for the best public schools in the nation in 2014.[52] Maryland also led other states in the nation in the U.S. News 2015 Best High School Rankings, with 20 of its schools ranked in the top 500 schools nationwide.[53] Maryland has some of the highest performing students, with an 85 percent graduation rate in 2013 [54] (compared with the national average of 81 percent [55]) and an ACT college readiness assessment mean science score of 22.2, (compared with 20.8 nationally).[56]

Despite these successes, several Maryland districts have graduation rates and test assessment scores below state averages. Six school districts – Baltimore City, Caroline County, Dorchester

[52] Education Week. (2015). Maryland Earns a B on State Report Card, Ranks Third in Nation. Available at: www.edweek.org/ew/qc/2015/state-highlights/2015/01/08/maryland-education-ranking.html
[53] U.S. News. (2015). Best High Schools in Maryland. Available at: www.usnews.com/education/best-high-schools/maryland
[54] 2014 Maryland Report Card. (2015). Graduation Rate: 4-Year Adjusted Cohort Class of 2013. Available at: www.mdreportcard.org
[55] National Center for Education Statistics' Common Core Data. (2015). Public high school 4-year adjusted cohort graduation rate (ACGR) for the United States, the 50 states and the District of Columbia: School years 2010-11 to 2012-13. Available at: https://nces.ed.gov/ccd/tables/ACGR_2010-11_to_2012-13.asp
[56] ACT Inc. (2014). 2014 ACT National and State Scores: Average Scores by State. Available at: www.act.org/newsroom/data/2014/states.html

County, Prince George's County, Somerset County, and Wicomico County – have graduation rates below the state average. In addition, a total of thirteen districts have mean ACT science scores below the state average (Table 6). A solar energy system installed on a school and included in lesson plans as a teaching tool can help improve student learning and performance. Studies have shown that interactive, hands-on curricula can enhance student learning and retention.[57] For example, math and science curricula that include modules on renewable energy systems were found to increase student performance on the math and science portions of state assessments relative to control classes that did not receive this curriculum.[58] As another example, in 2011, Antelope Valley Union High School District in Northern Los Angeles County saw construction finish on a 9.6 MW solar PV system. As part of this effort, the district partnered with the solar developer to integrate the system into algebra and science lesson plans. Using the system as a "real-world application" of concepts in these subjects helped improve student test scores by 60 percent during a week-long trial period.[59]

Six school districts – Baltimore City, Caroline County, Dorchester County, Prince George's County, Somerset County, and Wicomico County – have both low graduation rates *and* ACT science scores compared to state averages (Figure 6). Some of these districts also represent a large number of students, creating the potential for a large educational impact, such as Baltimore City Public Schools with nearly 85,000 students,[60] and Prince George's Public Schools with over 127,000 students.[61] As more districts deploy solar on schools, there will be a greater opportunity for more students to become exposed to and learn about renewable energy and other STEM-related concepts.

[57] Ibrahim, M. and O. Al-Shara. (2007). Impact of Interactive Learning on Knowledge Retention. *Human Interface and the Management of Information*. SpringerLink. Accessed April 22, 2014.
[58] Dewaters, J., S.E. Powers. Improving science and energy literacy through project-based K-12 outreach efforts. In Proceedings of the 113th Annual ASEE Conference & Exposition (Chicago IL June 2006, paper number 2006-262).
[59] Schueneman, T. (2011, August 19). How One School District's Solar Array Raises Student Test Scores. *Triple Pundit.* Available at www.triplepundit.com/2011/08/school-solar-array-raises-student-test-scores/
[60] Baltimore City Public Schools. (2015). *Baltimore City Public Schools: District Profile*. Available at: www.baltimorecityschools.org/cms/lib/MD01001351/Centricity/Domain/8048/DistrictDataProfile.pdf
[61] Prince George's County Public Schools. (2014). *Enrollment Reports by School and Grade: Official September 30, 2014 Report*. Available at: www1.pgcps.org/pasb/index.aspx?id=20160

Table 6. County 4-Year Adjusted Cohort Graduation Rates (2013), and Science Mean ACT Scores (2014)

County	Graduation Rate[62]	Science Mean ACT Score[63]
Allegany	90.1	23
Anne Arundel	85.6	23
Baltimore City	68.5	16
Baltimore County	86.3	21
Calvert	91.8	23
Caroline	84.2	22
Carroll	94.4	23
Cecil	86.7	21
Charles	89.8	20
Dorchester	83.8	19
Frederick	93.3	23
Garrett	92.6	25
Harford	89.5	23
Howard	93.3	24
Kent	88.0	22*
Montgomery	88.3	23
Prince George's	74.1	18
Queen Anne's	93.5	22
Somerset	77.0	18
St. Mary's	91.5	23
Talbot	91.2	23
Washington	91.5	20
Wicomico	82.0	19
Worcester	90.9	21
State Average	85.0	22.2
National Average	81.0 [64]	20.8 [65]

*Figure represents the 2013 ACT score. Fewer than five students surveyed indicated a 2014 graduation year.

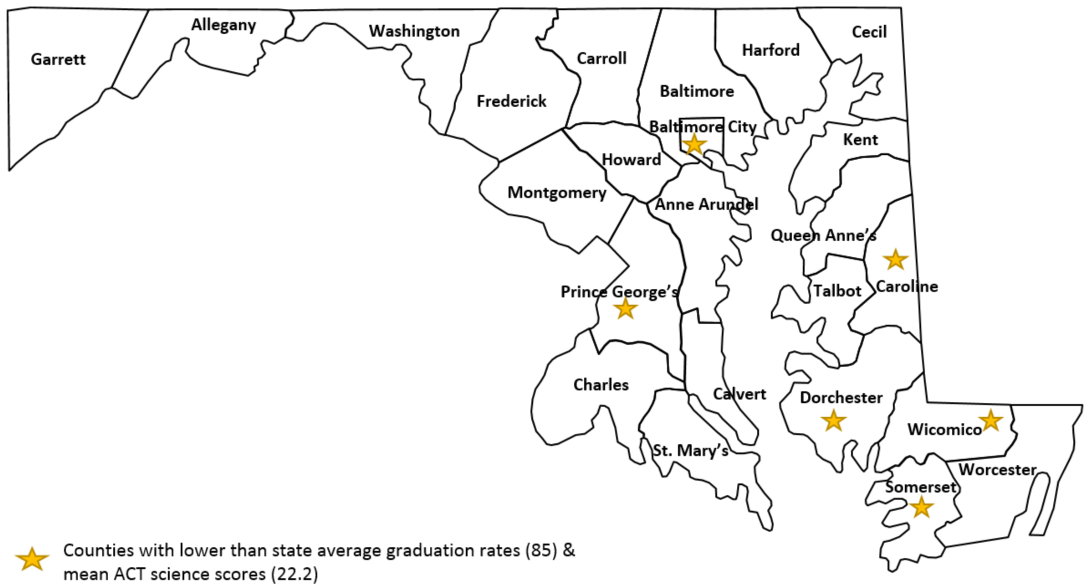
[62] 2014 Maryland Report Card. (2015). Graduation Rate: 4-Year Adjusted Cohort Class of 2013. Available at: www.mdreportcard.org. Graduation Rates are based on the number of total diplomas earned by the 2013 cohort, matriculated in Fall of 2009. Students who have dropout remain in the adjusted cohort.

[63] 2014 Maryland Report Card. (2015). ACT Graduating Class Means Sore Trends by Year: 2014 Science Mean. Available at: www.mdreportcard.org. Scores based on students who indicated to ACT that they would graduate in the given year.

[64] National Center for Education Statistics' Common Core Data. (2015). Public high school 4-year adjusted cohort graduation rate (ACGR) for the United States, the 50 states and the District of Columbia: School years 2010-11 to 2012-13. Available at: https://nces.ed.gov/ccd/tables/ACGR_2010-11_to_2012-13.asp

[65] ACT Inc. (2014). 2014 ACT National and State Scores: Average Scores by State. Available at: www.act.org/newsroom/data/2014/states.html.

Figure 6. Counties with the Greatest Educational Opportunities



<u>CASE STUDY: North Point High School</u>

Keith Gascon, an Electrical Construction Program Instructor at North Point High School in Charles County, teaches students enrolled in his program using a 9-panel, 2.6 kW PV system donated by the Washington, D.C. Joint Apprenticeship and Training Committee (JATC) and the International Brotherhood of Electrical Workers (IBEW) Local 26.[66] Gascon also uses the system to teach night classes with members of JATC and IBEW. The system donation was originally made as a way to attract more people into the Electrical Construction Program, and now the small solar energy system is part of Gascon's lectures on alternative energies each year.

"While the system does not provide a great amount of energy to power the school, it is most valued as an instructive tool to better prepare students interested in pursuing an electrical career. This was an opportunity to give potential apprentices a hands-on experience, especially in the growing green sector of our industry," said Ralph Neidert, a Master Electrician in Virginia, Maryland, and West Virginia and Assistant Director at the JATC.[67]

[66] K. Gascon, Personal Communication. January 26, 2015.
[67] Southern Maryland Online. (2011, December 6). New Solar Array Provides Learning Tool for North Point Students. *Southern Maryland Online*. Retrieved from: http://somd.com/news/headlines/2011/14692.shtml

CASE STUDY: Roland Park Country School

From the very beginning, students enrolled in the Sustainable Design elective class at Roland Park Country School (RPCS) led the effort to install solar on the school.[68] When Martha Barss, the school's Environmental Education and Sustainability Coordinator, received a request for proposal (RFP) from Lockhart Vaughan Foundation to fund projects that supported the school's commitment to environmental sustainability, she recommended her elective class get involved with writing the proposal with help from the school's development office. After several revisions and solicited bids, the proposal was sent, and by the summer of 2011, the school was awarded a grant to install a 36 kW PV solar array on the school's roof. "I definitely think the initiative should come from students who are interested and want to know how to go about getting solar for their school," said Barss.

RPCS has integrated solar into the curriculum in various ways. The lower school students, representing kindergarten to fifth grade, received moving toys powered with solar energy. Ninth grade students in a STEM class studied how solar output (viewed through the school's real-time energy use website) relates to the leaf color changes in the fall. The high school physics students study solar PV in the classroom, visit the installation on the building's roof, and then calculate the energy produced. Aside from educational impacts, the 36 kW solar energy system generated nearly 43,000 kWh of electricity during its first year in operation,[69] offsetting over 65,000 pounds of carbon dioxide annually.

Economic Development

Looking to community-wide benefits, one of the most compelling reasons to invest in solar is the economic growth and job creation opportunities attached to the industry. In less than a decade, the national solar industry has grown over 1,000 percent – from a $1.5 billion industry in 2006 to a nearly $18 billion industry by the end of 2014.[70] This economic growth has in turn fueled steady increases in solar employment. In 2010, the U.S. solar industry employed 93,502 solar workers. By the end of 2014, this number had grown to nearly 174,000, representing 86 percent growth in employment in just five years.[71]

Overall, employment and incomes in Maryland are strong compared with national averages. Between 2011 and 2013, Maryland had the highest median household income of any U.S. state at $72,345, approximately $20,000 more than the national median income of $52,176 during the

[68] M. Barss, Personal Communication. January 2015.
[69] Based on data found on https://enlighten.enphaseenergy.com/pv/public_systems/bFN341543
[70] SEIA/GTM Research. (2015). *U.S. Solar Market Insight: 2014 Year in Review*. Available at: www.seia.org/research-resources/us-solar-market-insight
[71] The Solar Foundation. (2015). *National Solar Jobs Census 2014*. Available at: www.thesolarfoundation.org/national-solar-jobs-census-2014/

same time period.[72] As of April 2015, the state's unemployment rate of 5.3 percent[73] is slightly lower than the U.S. average of 5.4 percent.[74] These state averages, however, conceal county-level variations that may help prioritize certain areas for increased solar development.

According to the *Maryland Solar Jobs Census*, solar installers in the state earn an average wage of $22.67 per hour (approximately equivalent to an annual salary of $47,150),[75] which is significantly higher than the living wage in the state of $13.39 per hour.[76] In other solar sectors, the national average salary for salespeople and system designers is around $75,000, while an individual working in production or assembly earns about $36,600.[77] Over 78 percent of Maryland solar workers are employed in the installation sector[78] and while many parts of the state have median household incomes above the $47,150 typically earned by these workers, four counties – Allegany, Dorchester, Garrett, and Somerset – in addition to Baltimore City have median incomes below this figure (Table 7). In addition, eleven Maryland counties have unemployment rates higher than the state average. Together, four counties – Allegany, Dorchester, Garrett, and Somerset – as well as Baltimore City have both high unemployment rates and low median household incomes compared with state averages (Figure 7). Targeting schools in these districts for solar development may help alleviate the economic strain felt in these areas. See Table 9 for more detailed information on Maryland-specific jobs and economic impacts of solar.

A 796 kW system at Colonel Richardson Middle and High Schools, Caroline County (Photo: REC Solar)

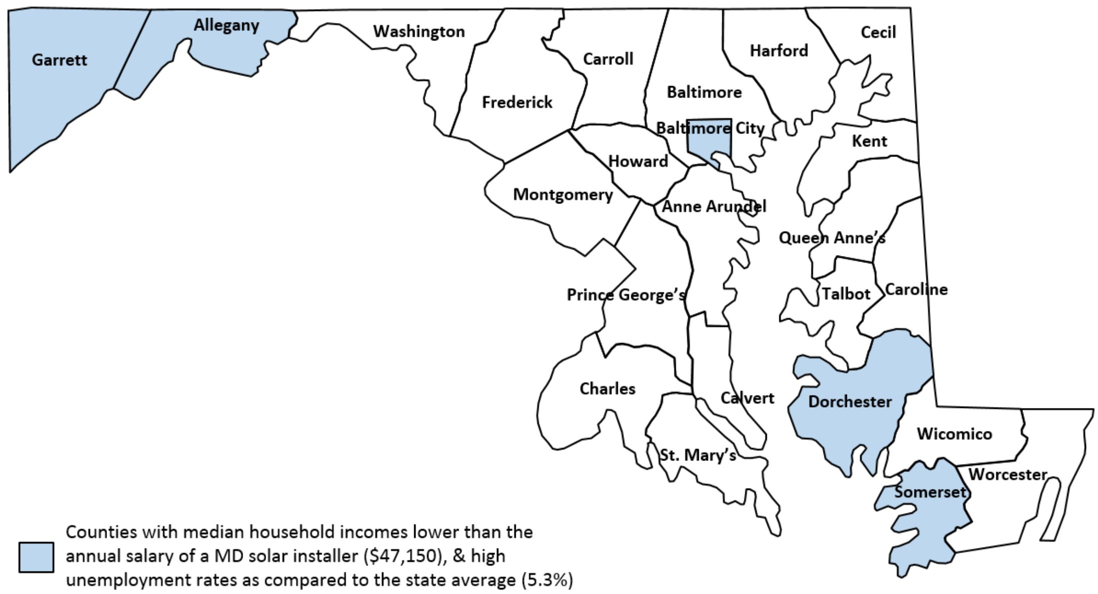
[72] U.S. Census Bureau. (2015). 2011-2013 Income in the Past 12 Months (In 2013 Inflation- Adjusted Dollars). *American Community Survey 3-Year Estimates*. Available at: http://factfinder.census.gov
[73] U.S. Department of Labor Bureau of Labor Statistics. (2015). Local Area Unemployment Statistics Map: Maryland Counties April 2015 Unemployment Rate. Available at: www.data.bls.gov/map
[74] U.S. Department of Labor Bureau of Labor Statistics. (2015). Labor Force Statistics from the Current Population Survey [Database]. Available at http://data.bls.gov/timeseries/LNS14000000.
[75] The Solar Foundation. (2015). *Maryland Solar Jobs Census 2014*. Available at: www.thesolarfoundation.org
[76] *Ibid*.
[77] The Solar Foundation. (2015). *National Solar Jobs Census 2014*. Available at: www.thesolarfoundation.org
[78] The Solar Foundation. (2015). *Maryland Solar Jobs Census 2014*. Available at: www.thesolarfoundation.org

Table 7. County Median Household Income (2011-2013) and Unemployment Rates (April 2014)

County	Median Household Income ($)[79]	Unemployment Rate (%)[80]
Allegany	39,846	6.3
Anne Arundel	87,460	4.3
Baltimore City	40,798	7.4
Baltimore County	64,700	5.3
Calvert	92,601	4.2
Caroline	52,967	5.4
Carroll	81,600	4.1
Cecil	66,575	5.6
Charles	90,789	4.6
Dorchester	45,508	7.7
Frederick	82,061	4.3
Garrett	41,728	5.8
Harford	79,091	4.9
Howard	107,452	3.7
Kent	58,157	5.5
Montgomery	97,181	3.7
Prince George's	72,098	4.8
Queen Anne's	84,309	4.4
Somerset	32,997	8.1
St. Mary's	85,174	4.6
Talbot	58,618	5.0
Washington	55,700	5.6
Wicomico	50,473	6.5
Worcester	56,279	10.1
State Average	72,345	5.3
National Average	52,176 [81]	5.4 [82]

[79] U.S. Census Bureau. (2015). 2011-2013 Income in the Past 12 Months (In 2013 Inflation- Adjusted Dollars). *American Community Survey 3-Year Estimates*. Available at: http://factfinder.census.gov
[80] U.S. Department of Labor Bureau of Labor Statistics. (2015). Local Area Unemployment Statistics Map: Maryland Counties April 2015 Unemployment Rate. Available at: www.data.bls.gov/map
[81] U.S. Census Bureau. (2015). 2011-2013 Income in the Past 12 Months (In 2013 Inflation- Adjusted Dollars). *American Community Survey 3-Year Estimates*. Available at: http://factfinder.census.gov
[82] U.S. Department of Labor Bureau of Labor Statistics. (2015). Labor Force Statistics from the Current Population Survey [Database]. Available at http://data.bls.gov/timeseries/LNS14000000.

Figure 7. Counties with the Greatest Economic Development Opportunities



Maryland has already started reaping some of these economic development benefits. In late 2014, the state solar industry employed 3,012 solar workers, representing 29 percent growth in employment over the previous year.[83] Several recent projects and industry developments help to illustrate the job creation potential of solar. In 2012, the state completed a 160-acre, 20 MW solar farm, located at the Maryland Correctional Institution (MCI) in Hagerstown. As the state's largest solar power facility, it was estimated that the project created 125 temporary construction jobs and at least three full time project maintenance jobs for the lifetime of the system.[84] Howard County-based Direct Energy Solar, a full service solar provider, is planning to add 240 new jobs by the end of 2017, tripling the size of their current workforce.[85] SolarCity, a leading solar energy provider, opened a Baltimore County Operations Center in Hunt Valley in September of 2014, with 35 open positions at this location and more than 70 other positions across the state.[86] The solar industry in Maryland is growing quickly, and local governments can use this as a smart opportunity to grow their local economies.

[83] The Solar Foundation. (2015). *Maryland Solar Jobs Census 2014*. Available at: www.thesolarfoundation.org

[84] First Solar. (2012). Governor O'Malley Celebrates Groundbreaking on State's Largest Solar Power Project [Press Release]. Retrieved from: investor.firstsolar.com/releasedetail.cfm?ReleaseID=689787

[85] Direct Energy Solar. (2015). Howard County's Astrum Solar Plans Expansion, 240 New Jobs. [Press Release]. Retrieved from: www.directenergysolar.com/pressreleases/press_release_Astrum_Solar_plans_expansion_240_new_jobs

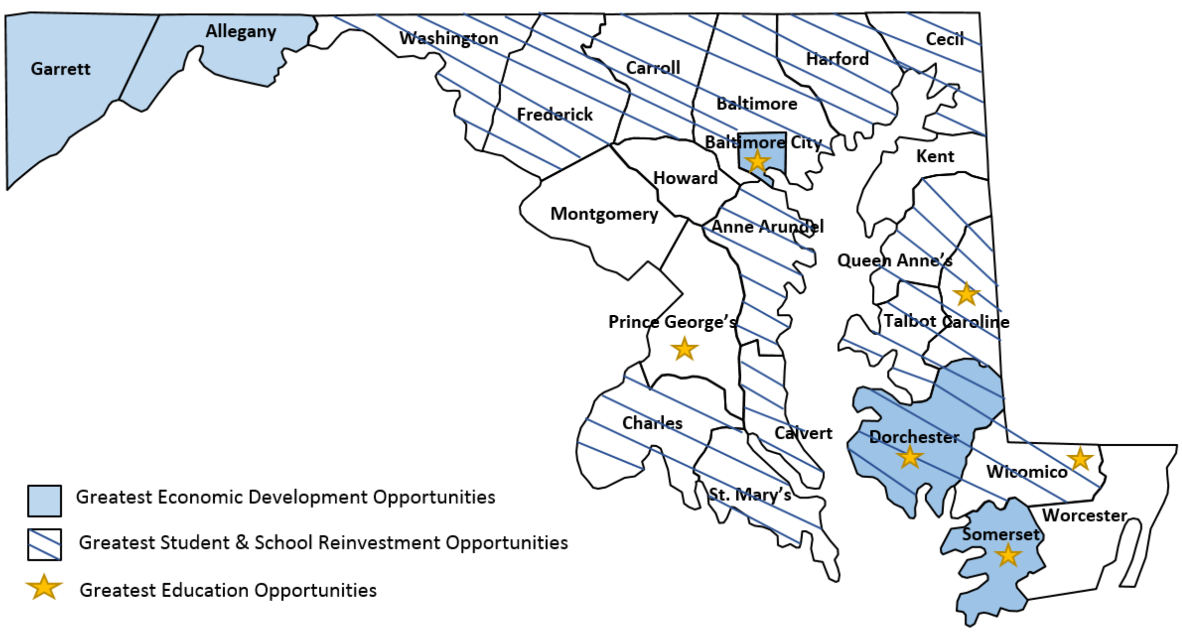
[86] SolarCity. (2014). SolarCity Launches Baltimore County Operations Center [Press Release]. Retrieved from: www.solarcity.com/newsroom/press/solarcity-launches-baltimore-county-operations-center

CASE STUDY: Oakdale High School, Frederick County Public Schools

Oakdale High School in Ijamsville, located in Frederick County, was one of sixteen awardees of the Maryland Energy Administration's Project Sunburst, a grant program designed to fund the installation of renewable energy systems on public buildings in Maryland in 2011.[87] Awarded with nearly $500,000, Frederick County Public Schools (FCPS) installed a 499kW solar energy system on Oakdale High, entering into a 20-year power purchase agreement (PPA) with Nautilus Solar Energy. Under the PPA, FCPS will only pay $0.055 per kilowatt-hour (as opposed to of $0.0914/kWh with their current supplier), and is expected to save up to $317,000 over the contract's 20 year lifetime.[88]

The map shown in Figure 8 below is an overlay of Figures 5-7, showing how each county or district could benefit from an investment in solar. The overlaid indicators are: economic, education, and school reinvestment. Dorchester County is the only county that can benefit from all three indicators, while three counties – Caroline County, Somerset County, and Wicomico County – and Baltimore City can benefit from two. Nevertheless, the majority of Maryland counties (20 out of 24) can benefit from solar in at least one way.

Figure 8. Overlay of Selected Indicators in Maryland Counties



[87] Maryland Energy Administration. (2015). Project Sunburst. Available at: http://energy.maryland.gov/Govt/sunburst.html

[88] Neal, M. (2011, March 20). Grant funds Oakdale solar project. *The Frederick News-Post*. Retrieved from: www.fredericknewspost.com/archive/grant-funds-oakdale-solar-project/article_8803ffc3-dc8c-51f6-98f3-e01183bea8b9.html

Environmental Protection

Solar energy can also help the state achieve its energy and environmental goals by both contributing to attainment of the renewable portfolio standard and by avoiding emissions of air pollutants and impacts on natural resources. As noted earlier, a single 110 kW solar PV installation (the median system size of the existing K-12 solar energy systems in the state) will produce nearly 150,000 kWh of electricity in its first year of operation.[89] This production will offset approximately 103 metric tons of CO_2e emissions, roughly equal to taking nearly 22 passenger vehicles off the road for an entire year or the amount of carbon sequestered annually by almost 85 acres of U.S. forests.[90] Electricity derived from solar can also help reduce emissions of criteria air pollutants, such as nitrogen oxides (NO_x) and sulfur dioxide (SO_2). The 150,000 kWh of annual production expected from a median-sized solar school installation can reduce NO_x emissions by nearly 225 pounds and SO_2 emissions by up to nearly four pounds annually.[91]

In addition to reducing air pollution, producing electricity with solar can also help conserve natural resources. The annual production from the 110 kW system in the example above can save over 30,000 gallons of water each year, which would have otherwise been used for cooling at a natural gas combined-cycle power plant.[92] And finally, rooftop solar PV can help avoid the need to site conventional power plants on previously undisturbed land. The Natural Gas Supply Association estimates that generating one million kWh from a natural gas combined cycle plant requires just under 1,000 square feet of land each year.[93] Rooftop solar, by contrast, can be implemented on sites already being used for another purpose.

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[89] According to the NREL PVWatts Calculator, available at http://pvwatts.nrel.gov/pvwatts.php. Assumes 110kW system installed in Baltimore area with tilt of 30 degrees. All other inputs are PVWatts defaults.

[90] According to the Environmental Protection Agency's "Greenhouse Gas Equivalencies Calculator", available at: www.epa.gov/cleanenergy/energy-resources/calculator.html

[91] According to the Environmental Protection Agency's "eGRID Year 2010 Data Files", available at: www.epa.gov/cleanenergy/energy-resources/egrid/. Figures cited assume solar offsets electricity from existing Maryland natural gas plants at the median emissions rates of these facilities.

[92] Macknick, J. Newmark, R., Heath, G, and Hallett, K C. (2012). Operational water consumption and withdrawal factors for electricity generating technologies: a review of existing literature. *Environmental Research Letters, 7 (2012).* Available at: http://iopscience.iop.org/1748-9326/7/4/045802

[93] Natural Gas Supply Association. (2013). *Comparison of Fuels Used for Electric Generation in the U.S.* Available at: www.ngsa.org/download/analysis_studies/beck%20enviro%20factors%20-%20updated.pdf

CASE STUDY: Mace's Lane Middle School

Mace's Lane Middle School, one of eleven public schools in Dorchester County, has an 803 kW solar energy system that was completely financed through a 20-year power purchase agreement with Washington Gas Energy Systems and was designed and installed by Kenyon Energy and Rec Solar.[94] The 3,276-panel project is expected to reduce 764 metric tons of carbon dioxide emissions, equivalent to the annual carbon sequestration potential of over 625 acres of forests or taking 161 passenger vehicles off the road for a year.[95] The school district is no stranger to environmentally-friendly initiatives and technologies, having previously implemented a single-stream recycling program in all district buildings and being the first school district in Maryland to use geothermal technologies to heat and cool five facilities.[96]

Chris Hauge, Dorchester County Public Schools' Facilities Engineer, said the solar project was created "in concert with a theme we have in Dorchester County [of]… being interested in green technologies, sustainability, environmental preservation, and doing what is right for Dorchester County and the larger community."[97]

The solar panels were seen as the next logical choice in the district's pursuit of sustainability measures at its schools. As Dr. Henry V. Wagner Jr., Dorchester County School District Superintendent stated, "This successful public/private partnership is resulting, each day, in clean energy at a lower than market price to meet the energy demand for our already environmentally friendly Mace's Lane Middle School. This solar array field is a welcome and complimentary addition to the existing geothermal system, which is designed to deliver comfortable and energy efficient heating and cooling to this school facility. Now we have green electricity to power the pumps and fan systems in our geothermal HVAC systems."[98]

The solar energy system is but one piece of an effort to implement an energy management program designed in 2007 to save the district more than one million dollars in avoided energy costs. As of June 2010, Dorchester County Public Schools had saved a total of $1.5 million by also participating in a multi-party energy trust for the lowest possible prices and implementing energy management best practices such as automatic monitoring systems to regulate heating and cool systems in all schools.[99]

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[94] Anderson, L. (2013, March 26). Mace's Lane Middle Now More Eco-Friendly. *The Dorchester Banner*. Retrieved from: http://maryland.newszap.com/cambridgedorchester/121065-92/maces-lane-middle-now-more-eco-friendly

[95] According to the Environmental Protection Agency's "Greenhouse Gas Equivalencies Calculator", available at: www.epa.gov/cleanenergy/energy-resources/calculator.html

[96] Anderson, L. (2013, March 26). Mace's Lane Middle Now More Eco-Friendly. *The Dorchester Banner*. Retrieved from: http://maryland.newszap.com/cambridgedorchester/121065-92/maces-lane-middle-now-more-eco-friendly

[97] *Ibid.*

[98] *Ibid.*

[99] Office of Legislative Audits. (2011). *Financial Management Practices Performance Audit Report: Dorchester County Public Schools.* Available at: www.ola.state.md.us/Reports/schools/DCPS11.pdf

Community Resiliency and Emergency Response

The value of solar on schools can extend far beyond cost and emission savings. Solar schools also have the ability to act as centralized emergency centers during natural disasters and help build community resiliency, given energy storage capabilities. There are multiple energy storage technologies although they exist at different maturity levels. Currently, pumped hydro represent 95 percent of installed storage capacity, while compressed air energy storage (CAES), batteries (NAS, Li-ion, PB-Acid), and flywheels make up the remaining five percent.[100] Residential and non-residential solar systems mostly rely on batteries to store excess electricity and the market for these batteries have recently been growing (including Tesla's battery,[101] and Daimler's Mercendez-Benz energy storage unit [102]), allowing customers to store solar PV energy for later use.

Although no Maryland schools currently act as solar-powered shelters during emergencies, schools in other states have already tapped into this benefit of solar. The Florida Solar Energy Center (FSEC) has installed more than 115 10-kW PV systems on schools serving as emergency shelters across Florida through the SunSmart E-Shelters Program.[103] In addition to providing power during emergencies, one of the program's goals was to incorporate the solar energy systems into lesson plans, educating students about renewable energy and energy efficiency. Inspired by this program, Wells Junior High School in Peaks Island, Maine is looking into installing rooftop solar panels on the island's only school. Peaks Island hopes to use this system to produce and store solar power in batteries. During storms or other emergencies, the system will provide a backup source of electricity until power from the mainland can be restored.[104]

Maryland, like many states on the east coast of the United States, is susceptible to natural disasters such as flooding, hurricanes, tornados, and severe winter storms. According to the Federal Emergency Management Agency (FEMA), Maryland has experienced 25 major disasters since 1962, including seven hurricanes, and eleven severe storm declarations.[105] As evidenced by the state's continued efforts to adapt to the changing environment and prepare for future natural disasters – such as through providing state funding to install backup power systems in service stations and volunteer firehouses to help protect community resiliency in times of disaster[106] – the need for more reliable ways to provide emergency power is extremely crucial. Solar energy

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[100] U.S. Department of Energy Office of Electricity Delivery and Energy Reliability. (2014). *Energy Storage Safety Strategic Plan*. Available at: http://energy.gov/sites/prod/files/2014/12/f19/OE Safety Strategic Plan December 2014.pdf

[101] See Tesla Motors at http://www.teslamotors.com/powerwall for more information.

[102] Coxworth, B. (2015, June 5). Daimler to offer Mercedes-Benz energy-storage system. Gizmag. Retrieved from: http://www.gizmag.com/daimler-mercedes-benz-energy-storage-battery/37909/

[103] Florida Solar Energy Center. (2014). SunSmart E-Shelters Program. Available at: www.fsec.ucf.edu/en/education/sunsmart/index.html

[104] Ellis, C. (2014, October 21). Peaks Island School eyed for emergency solar array. *Bangor Daily News*. Retrieved from http://bangordailynews.com/2014/10/21/news/portland/peaks-island-school-eyed-for-emergency-solar-array/

[105] Federal Emergency Management Agency. (2015). Disaster Declarations for Maryland. Available at www.fema.gov/disasters.

[106] Maryland Energy Administration. (2015). Energy Resiliency Grant Program. Available at: http://energy.maryland.gov/Business/fuelupmd/index.html

systems with battery storage installed at many of the state's 50 emergency shelters[107] can be one way to prepare and recover from natural disasters.

Maryland Solar Schools: Untapped Potential

Despite Maryland's continued progress in installing solar on schools, there remains a significant untapped potential for deploying solar on more schools in most districts in the state.

Of the 2,873 K-12 schools in the state,[108] nearly 99 percent do not have solar. Of these non-solar schools, about 65 percent (or 1,838 schools, both public and private) can cost-effectively install solar energy systems.[109] However, a total of 1,867 schools have the potential to cost-effectively install solar energy systems in the state, as 29 current solar schools have not reached their maximum solar capacity potential, and as a result have the opportunity to deploy more solar energy systems. **Solar installations at each of these 1,867 schools would result in over 143,500 kW of new solar capacity, generating more than 165,000 MWh per year. To put this into perspective, the entire state generated over 35,000,000 MWh of electricity in 2013.**[110] **This solar electricity would equal an annual energy value of over $18.3 million – approximately equal to 421 starting teacher salaries or 36,000 tablet computers each year.**[111] Additionally, this combined electricity generation would offset over 114,000 metric tons of carbon dioxide, equivalent to taking 24,000 passenger vehicles off the road or the amount of carbon sequestered by over 93,000 acres of U.S. forests each year.[112]

Looking specifically at Maryland's public schools, *Brighter Future* identified 1,232 schools that can cost-effectively deploy solar, with a potential capacity of over 123,000 kW across 21 school districts.[113] This solar school capacity could generate over 142,500 MWh per year, or a 30-year

[107] Maryland Department of Human Resources. (2015). *Directory of Maryland Emergency Shelter and Transitional Housing Programs.* Available at: www.dhr.state.md.us/blog/wp-content/uploads/2015/01/Homeless-Shelters_Update_01-2015.pdf

[108] Maryland State Department of Education. (2015). Number of Public and Nonpublic Schools in Maryland: 2013-2014. *The Fact Book 2013-2014.* Available at: www.marylandpublicschools.org/msde/divisions/bus_svcs/docs/Fact_Book_2013-2014.pdf

[109] The Solar Foundation. (2014) *Brighter Future: A Study on Solar in U.S. Schools*. Available at: www.thesolarfoundation.org/solar-schools/. This report only identified 2,178 K-12 schools in Maryland, and as a result more schools may cost effectively deploy solar. For the purposes of this report, a school can cost-effectively install solar if it had a positive net present value (NPV) – the difference between project costs and benefits, adjusted to reflect inflation and the time value of money – after a solar installation. Modeling assumptions include a $2.00 per watt system cost and a PV system size proportional to the school's student population.

[110] Based on data from https://data.maryland.gov/Energy-and-Environment/Renewable-Energy-Generated-In-Maryland/79zg-5xwz?

[111] Maryland State Department of Education. (2015). Salary Range for Ten-Month Teachers in Public Schools: 2013-2014. *The Fact Book 2013-2014.* Available at www.marylandpublicschools.org/msde/divisions/bus_svcs/docs/Fact_Book_2013-2014.pdf Assuming an average tablet cost of $500 and an average starting teacher salary in Maryland of $43,375.

[112] According to the Environmental Protection Agency's "Greenhouse Gas Equivalencies Calculator", available at: www.epa.gov/cleanenergy/energy-resources/calculator.html

[113] 1,232 public schools have some untapped solar potential and can cost-effectively install solar energy systems, including the 24 schools that currently have solar systems.

net present value (NPV) – the difference between project costs and benefits, adjusted to reflect inflation and the time value of money – of over $37 million (Table 8).

A 110 kW system at Lakelands Park Middle School, Montgomery County (Photo: InEnergy Inc.)

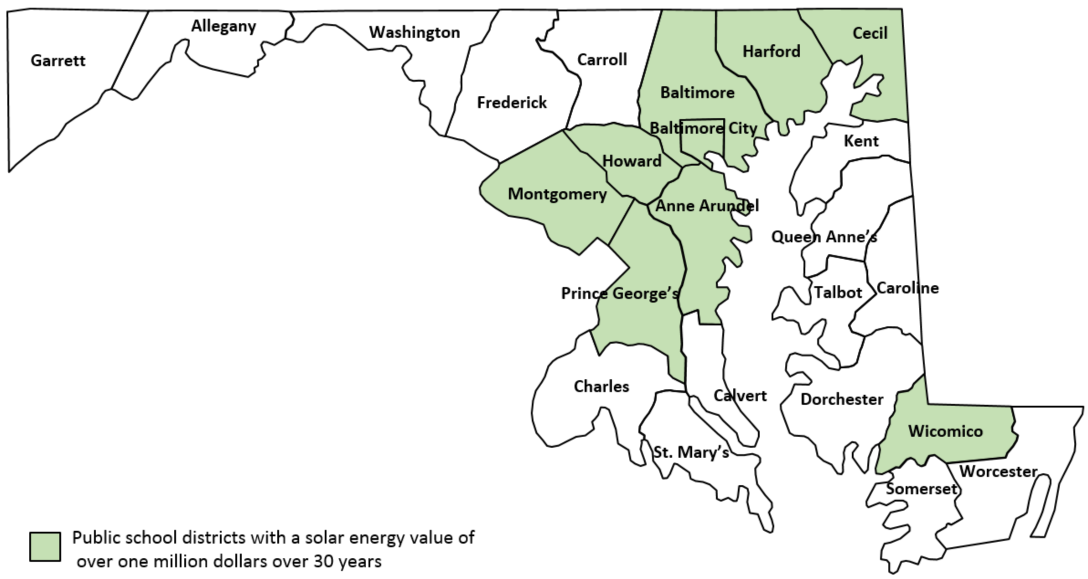
Table 8. Additional Cost-Effective Solar School Opportunities per Maryland Public School District – Energy and Environmental Value

Public School District	PV Potential Capacity (kW)	Potential Energy Savings (kWh)	Potential CO_2 Emissions Reduction (MT)	30 Year Solar NPV ($)	Potential Annual Generation Value ($/yr)
Allegany County†	n/a	n/a	n/a	n/a	n/a
Anne Arundel County	12,886	14,704,174	10,139	3,879,890	1,617,459
Baltimore City	14,125	16,149,137	11,136	4,277,463	1,776,405
Baltimore County	17,702	20,220,181	13,943	5,301,410	2,219,744
Calvert County	2,931	3,303,532	2,278	412,749	332,367
Caroline County	583	1,090,909	752	116,612	115,653
Carroll County	4,378	5,000,764	3,448	239,925	468,035
Cecil County	2,793	3,178,049	2,191	1,200,737	377,724
Charles County	4,612	5,136,030	3,542	520,371	513,603
Dorchester County	707	896,970	619	302,841	107,636
Frederick County	149	170,275	117	73	15,325
Garrett County†	n/a	n/a	n/a	n/a	n/a
Harford County	5,682	7,566,877	5,218	1,636,034	826,459
Howard County	8,649	9,968,654	6,874	2,595,169	1,094,733
Kent County	205	365,172	252	79,891	42,856
Montgomery County	17,202	20,230,685	13,950	6,805,380	2,398,452
Prince George's County	21,843	24,458,936	16,866	6,616,680	2,751,389
Queen Anne's County	1,310	1,533,232	1,057	565,345	181,101
Somerset County	499	577,182	398	237,392	69,262
St. Mary's County	2,522	2,887,020	1,991	390,595	288,702
Talbot County	775	882,836	609	178,492	93,094
Washington County†	n/a	n/a	n/a	n/a	n/a
Wicomico County	2,519	2,876,886	1,984	1,142,388	345,226
Worcester County	1,148	1,310,430	904	520,361	157,252
TOTAL	123,220	142,507,933	98,266	37,019,797	15,792,476

† Denotes County has solar PV potential but under the assumptions of $2.00/W, it is currently not cost-effective for these schools to deploy solar

Nine public school districts stand out with a potential NPV of up to one million dollars or more over a 30-year period (Figure 9). Together, these nine school districts, with 103,402 kW of solar capacity potential across 1,024 schools, could deliver nearly $33.5 million in annual energy savings. This is not to discourage other school districts from installing solar on their schools, but rather to offer more encouragement to those districts with greater potential financial gains.

Figure 9. School Districts with the Greatest Cost Savings Potential



In addition to cost savings, solar deployment on schools will have the potential to boost the local economy. Using NREL's Jobs and Economic Development (JEDI) model, if all 1,232 public schools fully tapped their solar capacity, the state would create over 1,440 one-time jobs in construction and nearly 30 ongoing jobs in operations and maintenance (O&M) over 30 years. This activity would result in approximately $81 million in construction earnings (and $189 million in total economic output), in addition to $1.5 million in O&M earnings over 30 years (with nearly $2.6 million in total economic output) (Table 9).[114]

[114] To obtain these results, school capacity figures were sorted into "buckets" of 5kW or 50-500kW (in 50kW increments). The number of jobs created includes construction and maintenance workers over a 30 year analysis period. Worker earnings assume MD state average of $22.67 for construction worker wages. Other altered JEDI assumptions include a Base Installation cost of $2000/$kW_{DC}$ and a 6% cost of capital.

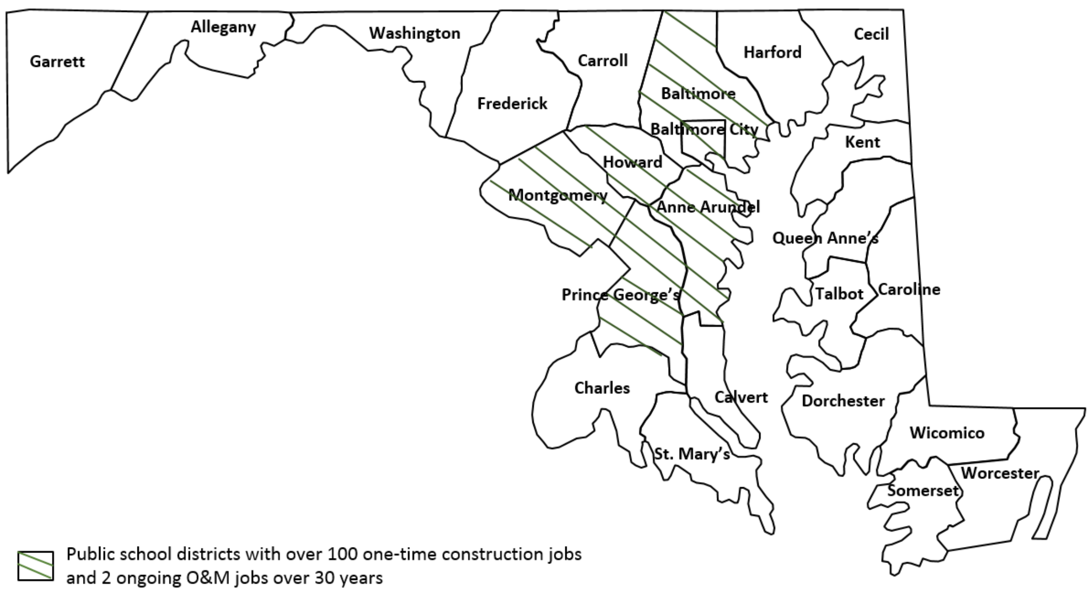
Table 9. Additional Cost-Effective Solar School Opportunities per Maryland Public School District – Economic Value

Public School District	PV Potential Capacity (kW)	Total Construction Employment (FTE)	Total Construction Earnings (1000$)	Total Construction Output (1000$)	Annual O&M Employment (FTE)	Annual O&M Earnings (1000$)	Annual O&M Output (1000$)
Allegany County†	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Anne Arundel County	12,886	148	8,353	19,441	2.7	160.5	267.9
Baltimore City	14,125	152	8,538	19,966	2.9	158.3	266.5
Baltimore County	17,702	203	11,407	26,572	3.8	217.7	364.1
Calvert County	2,931	34	1,934	4,491	0.6	37.7	62.7
Caroline County	583	10	585	1,363	0.2	11.1	18.6
Carroll County	4,378	49	2,754	6,407	1.0	53.0	88.5
Cecil County	2,793	32	1,808	4,215	0.6	34.3	57.5
Charles County	4,612	54	3,019	7,019	0.9	58.5	97.5
Dorchester County	707	8	444	1,042	0.1	8.1	13.6
Frederick County	149	2	89	209	0	1.5	2.6
Garrett County†	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Harford County	5,682	78	4,374	10,156	1.5	85.4	142.1
Howard County	8,649	106	5,971	13,868	2.0	116.5	193.8
Kent County	205	2	103	239	0	2.0	3.3
Montgomery County	17,202	211	11,914	27,704	4.0	230.3	384.0
Prince George’s County	21,843	251	14,142	32,910	4.7	271.9	454.0
Queen Anne’s County	1,310	15	851	1,989	0.2	15.9	26.7
Somerset County	499	6	343	802	0.2	6.4	10.8
St. Mary’s County	2,522	29	1,628	3,785	0.6	31.5	52.6
Talbot County	775	10	545	1,269	0.2	10.5	17.5
Washington County†	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Wicomico County	2,519	28	1,596	3,713	0.5	30.8	51.3
Worcester County	1,148	13	726	1,698	0.3	13.5	22.7
TOTAL	123,220	1,441	81,124	188,858	27	1,555	2,598

† Denotes County has solar PV potential but under the assumptions of $2.00/W, it is currently not cost-effective for these schools to deploy solar

Six school districts were identified as those who could support over 100 new construction jobs (and $13 million in economic output), and over two ongoing O&M jobs for over 30 years (and $150,000 in economic output) (Figure 10). Again, this is not to discourage other public school districts from installing solar on schools, as all 21 school districts stand to realize some financial benefit from going solar, but rather to identify the school districts that can provide the greatest employment opportunities through solar school projects.

Figure 10. Public School Districts with the Greatest Economic Impact Potential



Overlaying Figures 9 and 10 shows six school districts – Anne Arundel County, Baltimore City, Baltimore County, Howard County, Montgomery County, and Prince George's County – that could save the most money and have the greatest economic output through solar schools (see Figure 11 and Table 10). **Collectively, these six school districts could support a solar PV capacity of 92,407 kW – with a 30 year NPV of nearly $30 million – and support 1,071 one-time construction jobs and approximately 20 annual O&M jobs over 30 years, with an economic value of $140 million and $1.9 million in construction and O&M respectively.**

Figure 11. School Districts with Greatest Cost Savings and Economic Impacts Potential

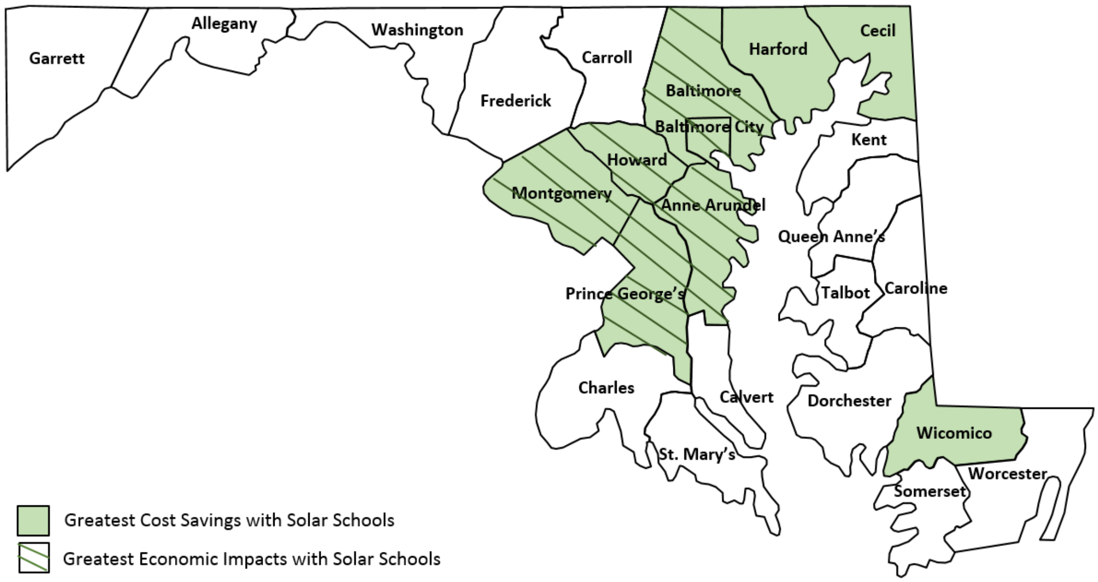


Table 10. MD Public School Districts with the Greatest Value in Energy Savings and Local Economic Development

Public School District	PV Capacity (kW)	30 Year Solar NPV ($)	Total Construction Employment (FTE)	Total Construction Output (1000$)	Annual O&M Employment (FTE)	Annual O&M Output (1000$)
Anne Arundel County	12,886	3,879,890	148	19,441	2.7	267.9
Baltimore City	14,125	4,277,463	152	19,966	2.9	266.5
Baltimore County	17,702	5,301,410	203	26,572	3.8	364.1
Howard County	8,649	2,595,169	106	13,868	2.0	193.8
Montgomery County	17,202	6,805,380	211	27,704	4.0	384.0
Prince George's County	21,843	6,616,680	251	32,910	4.7	454.0
TOTAL	92,407	29,475,992	1,071	140,461	20.1	1,930

To further target areas where an investment in solar can have the greatest impact, it may be useful to see how the six districts that stand to realize the greatest cost savings, jobs, and economic impacts compare with the demographic indicators discussed earlier (i.e., per-pupil spending, high unemployment/low wages, and low science test scores – recall Figure 8 on page

30). Anne Arundel and Baltimore County stand to realize the greatest benefit from reinvesting solar cost savings back into the school and increasing per-pupil spending. Baltimore City can gain the most with solar job creation, as well as boosting the local economy with solar schools. And finally, Baltimore City and Prince George's County have the most to gain from using solar schools as an educational opportunity (Table 11).

Table 11. Potential Leading Benefits of Solar Schools

Public School District	Economic Development	School & Student Reinvestment	Educational Opportunity
Anne Arundel County		X	
Baltimore City	X		X
Baltimore County		X	
Howard County			
Montgomery County			
Prince George's County			X

Financial Analysis Case Study

Although deploying solar energy remains highly promising on schools throughout Maryland, it may not be feasible for all schools or districts to install solar energy systems to the fullest potential. For example, PV rooftop systems require that the school's roof be in good condition to support the installation, which may not be the case for older schools. Additionally, because a solar PV system can generate electricity for several decades, it would be most beneficial to site solar on schools that will not close down in the foreseeable future. Even with these challenges, hundreds of schools across the state would likely be good candidates for solar energy. **If five schools in each of the nine districts that stand to save up to $1 million or more over 30 years by going solar were to install a 110 kW system with a total of 4.95 MW in solar capacity, each school district could receive nearly $80,000 in annual energy value.**[115]

Additionally, Maryland is expected to add approximately 139 MW of solar capacity in 2015, which would bring the state's cumulative installed capacity to 354 MW.[116] If the public school system were to deploy an additional 4.95 MW of solar throughout 45 schools across the state, solar schools would account for 13.3 MW (or 3.8 percent) of the state's solar capacity. Although these systems would represent only a small percentage of all the solar in the state – and an even smaller proportion of the state's total renewable energy generation – the benefits to the schools hosting these systems could be significant.

[115] According to the NREL PVWatts Calculator, available at http://pvwatts.nrel.gov/pvwatts.php. Assumes a system installed in the Baltimore area with tilt of 30 degrees. All other inputs are PVWatts defaults.
[116] SEIA/GTM Research. (2015). *U.S. Solar Market Insight: Q1 2015*. Available at: www.seia.org/research-resources/us-solar-market-insight

In order to illustrate the benefits of solar on K-12 schools at a level of refinement beyond that achievable in the *Brighter Future* report, The Solar Foundation collected 12 consecutive months of electricity utility bill data from Bowie High School in Prince George's County and produced a system production and financial analysis using the NREL System Advisor Model (SAM).[117] This analysis found that **a 518 kW solar PV system would produce over 690,000 kWh of electricity in its first year of operation (nearly 29 percent of that used by the school on an annual basis), providing Bowie High School with a net present value of up to $617,000 over 30 years and a payback period of 8.8 years.**[118]

According to the NREL Jobs and Economic Development Impacts (JEDI) model,[119] **such a project would support 7.7 full-time equivalent (FTE) workers during the construction period, who would receive $433,200 in combined wages. Total economic output from the construction and installation period of the project is just over $1 million.** The project would support a combined total of 3 FTEs over the course of the 30-year operations period (i.e., 0.1 FTE per year). Combined worker earnings over this period would total $251,700, with a total economic output of $416,400.

The 690,000 kWh of **annual solar electricity produced by the system would offset 476 metric tons of CO_2e emissions each year**, equivalent to taking 100 passenger vehicles off the road for a year or the annual carbon sequestration potential of 390 acres of U.S. forests.[120] This amount of generation would also reduce annual NOx emissions by over 1,000 pounds and SO_2 emissions by almost 20 pounds.[121] Finally, the electricity generated by the project would save over 140,000 gallons of water each year.[122]

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[117] National Renewable Energy Laboratory. System Advisor Model 2014.1.14. Available at: https://sam.nrel.gov/

[118] August 2015 Update: This financial analysis on Bowie High School was competed on 5/20/2015 using the then-current rate schedule for BG&E's Schedule GL (Secondary Voltage), effective 2/1/2014 through 5/31/2015. BG&E have since changed this rate schedule (effective on 6/1/2015), which has consequently altered the long-term value of an investment in solar. Using the most current rate schedule, a 518 kW solar installation at $2.07/W would provide Bowie High School with a net present value of up to $327,100 over 30 years and a payback period of 10.5 years.

[119] National Renewable Energy Laboratory. Jobs and Economic Development Impact Models (JEDI). Available at: http://www.nrel.gov/analysis/jedi/

[120] Environmental Protection Agency. "Greenhouse Gas Equivalencies Calculator." Available at www.epa.gov/cleanenergy/energy-resources/calculator.html

[121] According to the Environmental Protection Agency's "eGRID Year 2010 Data Files", available at: www.epa.gov/cleanenergy/energy-resources/egrid/. Figures cited assume solar offsets electricity from existing Maryland natural gas plants at the median emissions rates of these facilities.

[122] Macknick, J. Newmark, R., Heath, G, and Hallett, K C. (2012). Operational water consumption and withdrawal factors for electricity generating technologies: a review of existing literature. *Environmental Research Letters, 7 (2012)*. Available at: http://iopscience.iop.org/1748-9326/7/4/045802

Table 12. Bowie High School Solar Project Modeling Assumptions

SAM and JEDI Modeling Assumptions	
Weather Station:	USA MD Baltimore (TMY 2)
System Size:	518 kW_{dc} (estimate based on student body size from *Brighter Future*)
Tilt:	30 degrees
Azimuth:	158 degrees
Installed Cost:	$2.07/Watt (average reported MD non-residential price in SEIA/GTM Research *Solar Market Insight 2014 Year in Review)*
O&M Costs:	$20/kW/year
Degradation Rate:	0.5% per year
Financing:	100% debt; 6% loan rate for 20 year term (consistent with tax-exempt lease-purchase financing); 100% exemption from property and sales taxes
Analysis Period:	30 years
Inflation Rate:	2.5% per year
Real Discount Rate:	5% per year
Nominal Discount Rate:	7.63% per year
Incentives:	Performance-Based Incentive of $0.07/kWh. Represents a weighted average value of revenue from solar renewable energy certificate (SREC) value over 30 years.
Rate Schedule:	BGE Commercial Schedule GL (Secondary Voltage)
Net Metering:	Enabled; Net Excess Generation valued at $0.0807/kWh (the energy commodity supply rate from latest BGE utility bills)
Annual Electricity Cost Escalation:	0.6% (EIA 2015 Annual Energy Outlook estimate through 2040)
Percentage of Materials Purchased Locally:	25%
Construction Worker/ Installer Wages	$22.67 (average wage for Maryland installers from *Maryland Solar Jobs Census*)

Recognizing that the installed cost assumption included in the SAM analysis represents an average for the state – suggesting some schools may face higher prices – we performed a sensitivity analysis to estimate system production and investment value across a number of price points. The results of the sensitivity analysis, which show that even installed costs as high as $2.85 per watt would yield a significant positive net present value, are shown in Table 13 below.

Table 13. Installed Cost Sensitivity Analysis for Bowie High School Solar Project (As of May 2015)

Results	Installed Cost Assumptions			
	$2.07/W	**$2.25/W**	**$2.50/W**	**$2.85/W**
Net Present Value	$617,000	$527,918	$404,193	$230,978
Payback Period	8.8 years	9.5 years	10.6 years	12.0 years

Financing Mechanisms

As solar installations typically represent a large upfront investment, financing remains one of the biggest barriers to going solar, especially for schools and districts with limited budgets. Fortunately, there are a number of options available for financing solar on public K-12 schools in Maryland. While not intended to be an exhaustive list of financing mechanisms for solar on schools, the options listed below represent some of the most feasible and easily accessible options for Maryland schools and districts.

Private Financing Options

Several private financing options exist for school districts to leverage external funds. The leading private option for many school districts, and in fact the most common form of solar school financing, is third-party ownership through power purchase agreements. Financing solar through energy services performance contracts can also be another strategy for overcoming the high upfront cost barrier.

Third Party Ownership - Power Purchase Agreements (PPA)

Power purchase agreements (PPAs) are a type of third-party ownership financing mechanism where a solar developer owns, operates, and maintains a solar PV system, and then sells the electricity produced by the system to the host (such as a K-12 school) over a fixed term at a predetermined rate. PPAs remain one of the most popular financing mechanisms for schools (with approximately one-third of school installations 200 kW or greater in size financed through PPAs), as these agreements allow customers to go solar at low or no upfront cost, which is attractive given the high upfront cost of solar systems. In addition, PPAs can provide solar customers with a lower degree of risk, as the PPA provider is typically responsible for guaranteeing a minimum level of electricity production, and must pay for any shortfalls even if the providers must purchase more expensive power from the utility during these periods.[123] PPAs also allow for solar developers or investors to leverage the federal investment tax credit (ITC) – an income tax credit equal to 30 percent of total system installation costs – as well as accelerated depreciation benefits, which combined can reduce system costs by up to 55 to 60 percent. As public schools do not pay income taxes, these solar customers would otherwise be unable to take advantage of these solar tax incentives. Additionally, because PPAs typically range from 10 to 25 years in length, schools can purchase electricity at more stable and even lower rates over time, as electricity prices are determined when the agreement is signed. Electricity prices can be determined based on a rate escalation schedule, where the annual price per kilowatt-hour of electricity increases 2-5 percent or a fixed rate schedule for the entire term of the PPA.[124]

[123] Coughlin, J., and A. Kandt. (2011). *Solar Schools Assessment and Implementation Project: Financing Options for Solar Installations on K-12 Schools*. National Renewable Energy Laboratory (NREL/TP-7A40-51815). Available at: www.nrel.gov/docs/fy12osti/51815.pdf
[124] *Ibid.*

Another benefit attached to PPAs is that under these agreements, the solar developer is responsible for system operations and maintenance work.

Several public school districts and counties, such as Caroline, Cecil, Dorchester, Harford, Kent, Montgomery, and St. Mary's, have used PPAs in the past to help finance their solar energy systems. For more information about these schools, please see the list of press releases in the appendix.

Getting Started with a Power Purchase Agreement

There are several resources available to help local governments and school districts understand the PPA process, including The Solar Foundation's *Steps to a Successful Solar Request for Proposal*,[125] and the National Renewable Energy Laboratory's (NREL) *Power Purchase Agreement Checklist for State and Local Governments*.[126] The Interstate Renewable Energy Council (IREC), under the SunShot Solar Outreach Partnership program, has developed a PPA Toolkit designed to help local governments and other public entitles overcome the common challenges and costs associated with PPAs.[127] This comprehensive, user-friendly guide is an excellent resource through which school districts can learn about procuring solar under a PPA, with annotated model PPA documents and templates, and general guidance on request for proposal design and implementation. In addition, NREL's Solar Access to Public Capital (SAPC) working group has developed model PPA and lease contracts to serve as templates for commercial solar customers and installers.[128] Learning from the numerous experiences of other Maryland solar schools can also be useful in understanding more nuanced opportunities for (or challenges to) solar deployment.

If school districts decide to finance a solar installation through a PPA, a number of solar developers are available to work with school districts throughout Maryland. Schools can identify solar companies in their area through the Solar Energy Industries Association's "National Solar Database" (www.seia.org/research-resources/national-solar-database) or on the "Find a Solar Professional" page on the Maryland-DC-Virginia Solar Energy Industries Association (MDV-SEIA) website (http://mdvseia.org/directory/).

Energy Services Performance Contracts (ESPCs)

Energy services performance contracts (ESPCs) can also provide schools with another means of financing solar projects. ESPCs are an agreement between a client and an energy services company (ESCO), and while ESPCs typically involve energy efficiency measures with short

[125] The Solar Foundation. (2012). *Steps to a Successful Solar Request for Proposal.* Available at: www.thesolarfoundation.org/steps-to-a-successful-solar-request-for-proposal/

[126] National Renewable Energy Laboratory. (2009). *Power Purchase Agreement Checklist for State and Local Governments* (NREL/FS-6A2-46668). Available at: www.nrel.gov/docs/fy10osti/46668.pdf

[127] Interstate Renewable Energy Council. (2015). *Solar Power Purchase Agreement: A Toolkit for Local Governments*. Available at http://solaroutreach.org/wp-content/uploads/2015/04/FINALFINALNew-Cover_041015.pdf

[128] National Renewable Energy Laboratory. (2014). Renewable Energy Project Finance – Solar Securitization and the Solar Access to Public Capital (SAPC) Working Group. Available at: https://financere.nrel.gov/finance/content/solar-securitization-and-solar-access-public-capital-sapc-working-group

payback periods, solar PV installations can be included in these contracts as well. The process of completing an ESPC is relatively straightforward: school district members approach an ESCO to perform a comprehensive energy audit of a specific, or set of, school(s) to identify and implement a number of energy-saving measures. Through an ESPC, the ESCO often covers the upfront cost of these measures, receiving compensation in the form of a portion of the energy cost savings achieved through the upgrades. After the length of the contract is over, the school will be able to accrue all the cost savings.[129] Under ESPCs, school districts can finance a solar system by paying for the project themselves, or working directly with the ESCO to arrange for upfront financing.[130]

As an example, Mahopac Central School District in Mahopac, New York approached ConEdison Solutions (CES) in April 2008 to complete an energy audit on the district's six schools and two administrative offices. CES implemented several energy savings projects including lighting and heating upgrades, building envelope infrastructure improvements, and a solar PV system installation. CES guaranteed the district $546,000 in annual savings.[131]

Getting Started with an Energy Services Performance Contract

In Maryland, seven ESCOs have worked with the Department of General Services (DGS) and Maryland Energy Administration (MEA) to qualify under the state's existing Indefinite Delivery Contract (IDC).[132] Under an IDC, ESCOs are prequalified by the state to help accelerate vendor selection timelines by allowing government agencies to bypass much of the traditional procurement process. While principally designed to support energy performance contracting for state agencies, local governments can utilize the IDC for their own large-scale energy improvement projects. Under the IDC process, an ESCO submits a proposal to complete a feasibility study and to develop a guaranteed savings program. Once the proposal is accepted and a fee negotiated, the ESCO performs the proposed study and identifies project costs and guaranteed annual energy savings. If the feasibility study shows the project will delivered the desired savings and meet other project objectives, the ESCO can proceed to the construction phase. If not, the ESCO must cover the cost of the study.[133] However, school districts still have the option to pursue ESPCs through more usual means, i.e., by issuing an request for proposal to solicit bids from other ECSOs.

For those interested in learning more about ESPCs, the Pacific Northwest National Laboratory and Portland Energy Conservation, Inc. have prepared a guide titled *A Guide to Performance*

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[129] U.S. Department of Energy – Office of Energy Efficiency & Renewable Energy. (2015). Energy Savings Performance Contracts. Available at: http://energy.gov/eere/femp/energy-savings-performance-contracts
[130] U.S. Department of Energy – Office of Energy Efficiency & Renewable Energy. (2015). Energy Savings Performance Contracting. Available at: http://energy.gov/eere/slsc/energy-savings-performance-contracting
[131] ConEdison Solutions Inc. (2011). Mahopac Central School District (CSD) Cast Study. Retrieved from: http://energyservicescoalition.org/Data/Sites/1/documents/casestudies/Mahopac%20Central%20School.pdf
[132] Maryland Energy Administration. (2015). Energy Performance Contracts. Available at: http://energy.maryland.gov/Govt/epc/
[133] Maryland Energy Administration. (2015). *Energy Performance Contracting*. Available at: http://energy.maryland.gov/incentives/allprograms/epc/energy_performance_contracting.pdf

Contracting with ESCOs,[134] which provides a general overview of ESCOs and the ESPC process. In addition, the Maryland Energy Administration (MEA) has a state-specific *Guide for Energy Performance Contracting for Local Governments* – as well as template requests for proposals (RFPs) for these contracts – available on their website.[135] And finally, the North Carolina Clean Energy Technology Center has a guide on performance contracting for local governments, including case studies of successful public projects, available through the SunShot Solar Outreach Partnership.[136]

Public Finance Programs

In addition to private financing options, numerous public incentives and financing mechanisms exist for schools to defray costs before and after a solar energy system has been installed.[137] These include tax credits, deductions, and exemptions, as well as grants, loans, rebates, and bonds.

MCEC's Maryland Capital Program (MCAP)

The Maryland Clean Energy Center's (MCEC) Maryland Capital Program (MCAP) allows schools to leverage the private bond market and borrow funds at low interest rates for energy efficiency projects.[138] This program relies on energy services performance contracts, but instead of working directly with an ESCO to arrange funding, schools approach MCEC to finance the project. MCEC finances these systems by selling tax-exempt bonds on the private bond market, raising project capital which is then passed onto the ESCO periodically to finance the project.

Under MCAP, MCEC writes up one performance contract with the ESCO and one energy savings contract with the client or school. A performance contract with the ESCO ensures that the ESCO can provide energy savings to the school and will be responsible for any short-falls in savings. Additionally, the ESCO is responsible for completing, measuring and verifying actual energy savings after the project is completed. A shared energy savings agreement with the client (e.g., school or municipality) states the school is responsible for bond payments to MCEC, with any excess in energy savings beyond bond payments retained by the client.

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[134] Baechler/ Pacific Northwest National Laboratory, M., and Webster/Portland Energy Conservation, Inc., L. (2011) *A Guide to Performance Contracting with ESCOs* (PNNL-20939). Available at: www.pnnl.gov/main/publications/external/technical_reports/PNNL-20939.pdf

[135] Maryland Energy Administration. (2015). Energy Performance Contracting Assistance Program. Available at: http://energy.maryland.gov/Education/EnergyPerformanceContractingAssistanceProgram.htm. See under Resources.

[136] North Carolina Clean Energy Technology Center. (2014). *Integrating Solar PV Into Energy Services Performance Contracts: Options for Local Governments Nationwide*. Available at: http://icma.org/en/icma/knowledge_network/documents/kn/Document/306953/Integrating_Solar_PV_into_Energy_Services_Performance_Contracts

[137] North Carolina Clean Energy Technology Center. (2015). Maryland Net Metering. Available at: http://programs.dsireusa.org/system/program/detail/363

[138] Maryland Clean Energy Center. (2014). MCEC Maryland Clean Energy Capital Financing Program FAQs. Available at: www.mdcleanenergy.org/maryland-clean-energy-capital-financing-program-FAQs

Benefits of financing solar through the MCAP are similar to those of completing an ESPCs, including a reduced burden on schools to raise their own project capital and the ability for utility cost savings to go towards bond obligations to MCEC.[139] The school does not incur any additional debt, as MCEC owns the solar installation, and the bond rates are generally attractive relative to other sources of capital, at typically three to four percent for an average of ten years.[140]

MCEC's MCAP has completed three energy efficiency and conservation projects at the University of Maryland – Baltimore County, Coppin State University, and the National Aquarium, ranging from $3.4 to $6.2 million projects, but no school district has yet approached MCEC to pursue a solar school project under MCAP.[141]

Getting Started with the Maryland Capital Program

To learn more about how a school district can take advantage of MCAP, schools or districts can visit the program webpage at www.mdcleanenergy.org/maryland-clean-energy-capital-financing-program-FAQs, which contains additional program details as well as contact information for program staff who can answer questions and provide guidance on next steps. In addition, MCEC may be able to provide case studies of successful projects funded under the program, as well as insight on commonly proposed projects and example cost savings for different project types.

Schools or districts interested in pursuing projects under MCAP must partner with an ESCO to complete a feasibility analysis on the site(s) before approaching MCEC. Once such an analysis has been completed, MCEC will be able to provide school districts and the participating ESCO with the next steps moving forward, if both parties agree to complete the projects under MCAP.

Qualified Energy Conservation Bonds (QECBs)

Qualified Energy Conservation Bonds (QECBs) are taxable bonds issued by the U.S. Department of Treasury with reduced interest rates for state and local governments.[142] QECBs were originally authorized by Congress in the 2008 Energy Improvement and Extension Act, and later the American Recovery and Reinvestment Act of 2009, to finance renewable energy and energy efficiency projects. Most of these bonds are direct subsidy bonds where bond issuers (such as a local school district) receive cash rebates from the Treasury to subsidize their net interest payments on the bond. Another option is for bond holders to receive tax credits. Bond holders make a payment of the lower amount of the interest on the issuance, or 70 percent of the 'qualified tax credit rate', which is set periodically. QECBs may be attractive for local government renewable energy projects, as these bonds can allow for borrowing large sums of money at lower interest rates than traditional bonds.

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[139] W. Shiplett, Personal Communication. March 2015.
[140] Maryland Clean Energy Center. (2014). MCEC Maryland Clean Energy Capital Financing Program FAQs. Available at: www.mdcleanenergy.org/maryland-clean-energy-capital-financing-program-FAQs
[141] W. Shiplett, Personal Communication. March 2015.
[142] Energy Programs Consortium. (2014) *Qualified Energy Conservation Bonds (QECBs).* Available at: www.energyprograms.org/wp-content/uploads/2015/01/FINAL-QECB-Paper-December-2014-.pdf

In 2009, Congress allocated $58,445,000 in bond authority to the State of Maryland. As of December 2014, only 18 percent ($10,665,000) of this had been used: $6.5 million to finance capital improvements at St. Mary's County Public Schools and $4.165 million to finance an equipment lease-purchase for Montgomery County.[143] The majority of the bond authority earmarked for the State was allocated to large local governments with a population of 100,000 or greater (Table 14). However, much of this has gone unused due barriers including budget concerns, relatively small sub-allocation amounts to local governments, and difficulty navigating the QECB application process.

Table 14. Remaining Maryland QECB Sub-Allocations

Local Government	Amount
Anne Arundel County	$5,324,796
Baltimore City	$6,659,180
Baltimore County	$8,188,030
Carroll County	$1,761,908
Charles County	$1,463,345
Frederick County	$2,340,341
Harford County	$2,499,895
Howard County	$2,850,689
Montgomery County	$9,793,890
Prince George's County	$8,662,178
St. Mary's County	$1,044,425
Washington County	$1,508,357
Balance to State	$6,347,968

Small sub-allocations are a common problem because small allocations often mean smaller-sized projects, and therefore a higher ratio of transaction costs (which remain relatively fixed regardless of issuance size) to capital raised.[144] As a result, many local governments in Maryland hold on to their allocations without completing any qualified projects, and furthermore, are often hesitant to direct their allocations back to the state because of the perceived loss of funds without any beneficial gains in return.[145] Strategies for overcoming this barrier include bundling QECBs with issuances of other bonds or pooling allocations with other jurisdictions, both of which can help spread transaction costs over a larger amount of project capital.[146]

Another common barrier for local governments is the lengthy and often difficult QECB application process, and many municipalities simply choose other projects that have easier and more streamlined application processes over school energy projects.[147] In addition, local

[143] *Ibid.*
[144] *Ibid.*
[145] D. Bresette. Personal Communication. January 21, 2015.
[146] *Ibid.*
[147] *Ibid.*

governments may have budget concerns or wish to avoid what they perceive as risky or unfamiliar projects like solar installations.

However, these barriers should not discourage Maryland public school counties from using QECBs to fund solar projects. In 2011 and 2012, solar installations at six California high schools came online in Oxnard Union High School District, financed largely with QECBs. In 2010, the district began looking for relief from its $1.3 million electricity bill in the face of a decreasing general fund, as well as for ways to reduce the district's reliance on fossil fuels.[148] The installations were financed with $19 million in QECBs, along with $6 million in Measure H General Obligation Bond funds. The project was also eligible for an additional $6 million in California Solar Initiative rebates, payable for five years after the project's completion.[149] While the solar energy policies in California were certainly different than those found in Maryland, one cannot ignore the opportunity for public school districts to take advantage of QECBs to finance a solar energy system, especially in conjunction with other financing mechanisms.

Getting Started with a Qualified Energy Conservation Bond

A good first step in financing solar using QECB's is to review the Energy Programs Consortium's (EPC) biannual *Qualified Energy Conservation Bonds* report on the current status of QECBs.[150] This resource lays out the details of QECBs, as well as common barriers and solutions to QECB issuances in communities around the nation. The report also lists case studies of various completed projects, new projects that have since come online from the last published report, and the remaining QECB amount for project allocation in each state.

Solar Renewable Energy Certificates (SRECs)

Maryland's Renewable Energy Portfolio Standard (RPS) requires 20 percent of the state's electricity to be generated from renewable energy by 2022 and every year thereafter, including two percent for solar energy by 2020. This two percent solar 'carve-out' gave rise to a market for Solar Renewable Energy Certificates (SRECs), which provide solar customers (including schools) another financing method to recoup costs following project completion. Certificates are created for every megawatt-hour (MWh) of solar energy generated, and traded in the open market per the state's RPS. School districts can sell SRECs to retail electricity suppliers or investor-owned utilities, who are required to retire a certain number of these certificates to be in compliance with the law. In late May 2015, Maryland SRECs were selling for $170 per MWh, with the current theoretical price ceiling, or Solar Alternative Compliance Payment (SACP), at $350 per MWh.[151] This price ceiling is expected to decline steadily through 2023, when it will be set at $50 per MWh permanently thereafter.[152]

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[148] Zoltak, J. (2011, October 21). Nearly $4 million solar field opens behind Oxnard High. *Ventura County Star*. Retrieved from: www.vcstar.com/news/education/new-4-million-solar-field-opens-behind-oxnard
[149] *Ibid.*
[150] Energy Programs Consortium. (2014) *Qualified Energy Conservation Bonds (QECBs).* Available at: www.energyprograms.org/wp-content/uploads/2015/01/FINAL-QECB-Paper-December-2014-.pdf
[151] Based on latest MD SREC bid prices published by SRECTrade at www.srectrade.com/srec_markets/maryland
[152] North Carolina Clean Energy Technology Center. (2015). "Solar Renewable Energy Certificates." Available at: http://programs.dsireusa.org/system/program/detail/5688

Although SRECs can be used as a financing mechanism for solar school projects, school districts may be hesitant to completely rely on SRECs due to fluctuating trading prices that are difficult to predict over time. Should actual SREC prices prove to be lower than those included in the solar contractor's financial analysis, actual system cost savings may be lower than anticipated. Though SREC markets in some states have experienced some volatility in recent years (such as New Jersey, which saw prices plummet from over $600 to less than $200 in just a few months in 2011),[153] Maryland has enjoyed a fairly stable SREC market over the past several years, with prices consistently in the $120-140 range until very recently, when the beginning of 2015 saw a sharp uptick in prices.[154] In fact, SRECTrade, a leading SREC transaction and management firm, notes that the Maryland SREC market has been "relatively stable since its inception in 2008."[155]

Getting Started with Solar Renewable Energy Certificates

More information on SRECs can be found in NREL's *Solar Renewable Energy Certificate (SREC) Markets: Status and Trends*,[156] as well as through SRECTrade[157] or Flett Exchange.[158] Solar installations in Maryland will only begin producing SRECs once the system has been certified by the Maryland Public Service Commission[159] and is registered under the PJM-EIS Generation Attribute Tracking System.[160]

Solar Collaborative Procurement

Although not a financing mechanism in itself, school districts have the option to collaboratively purchase solar together. Solar collaborative purchasing addresses the issues of high transaction costs, a potentially long procurement learning curve, and fragmented solar demand among many individual sites.[161] One of the main benefits of collaborative purchasing is the ability for one or more school districts to lower overall costs through economies of scale, as larger projects have smaller transaction costs per watt installed. Bundled projects also allow for collaboration between individuals with diverse experiences in the solar energy industry, and access to a larger pool of resources from different stakeholders in the project, and as a result lower overall project risk.

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153 SRECTrade. (2011, September 14). New Jersey looks to address SREC volatility, but does it know where to look? [Blog Post]. Retrieved from: www.srectrade.com/blog/srec-markets/new-jersey/new-jersey-looks-to-address-srec-volatility
154 SRECTrade. (2015, May 19). PA, NJ, and MD Solar REC Update. [Blog Post]. Retrieved from: www.srectrade.com/blog/srec/srec-markets/maryland
155 SRECTrade. Maryland. Available at: www.srectrade.com/srec_markets/maryland
156 Bird, L., Heeter, J., and Kreycik, C. (2011). *Solar Renewable Energy Certificate (SREC) Markets: Status and Trends* (NREL/TP-6A20-52868). Available at: www.nrel.gov/docs/fy12osti/52868.pdf
157 SRECTrade. (2015). Available at: www.srectrade.com
158 Flett Exchange. (2015). Available at: www.flettexchange.com/
159 Maryland Public Service Commission. (2015). Renewable Portfolio Standard Documents. Available at: http://webapp.psc.state.md.us/intranet/electricinfo/home_new.cfm
160 PJM Environmental Information Services (EIS). (2015). Available at: http://www.pjm-eis.com/
161 Goodward, J., Massaro, R., Foster, B., and Judy, C. (2011). *Purchasing Power: Best Practices Guide to Collaborative Solar Procurement.* Retrieved from the World Resources Institute website: www.wri.org/sites/default/files/pdf/purchasing_power.pdf

In 2010, the U.S. Environmental Protection Agency (EPA), the Metropolitan Washington Council of Governments (MWCOG) and Optony, Inc. launched an initiative to collaborative procure a large number of solar projects in the metro Washington, DC area (including neighboring areas in Maryland and Virginia). This effort ultimately identified four organizations (three in Washington D.C., and one in Montgomery County, MD) that are suitable for solar, and these organizations are currently soliciting proposals for project developers for a number of sites, including a bid for nearly 30 Washington D.C. public school buildings.[162] As another example, in 2011 the San Ramon Valley Unified School District in Alameda County, California joined five schools together to install solar carports designed to meet two-thirds of the district's electricity needs and save over $11.6 million over 20 years. The district leveraged $25 million in Qualified School Contraction Bond (QSCB), and contracted with SunPower for the design and construction of the 3.3 MW system.[163]

Getting Started with Collaborative Procurement

Solar collaborative purchasing may be difficult for schools because multiple school districts need to agree to pool resources together for the development of multiple solar schools project, which may span across different regions of the state. However, numerous resources exist for those interested in working with other school districts, including *Purchasing Power: Best Practices Guide to Collaborative Solar Procurement* from the World Resources Institute.[164]

Community Shared Solar

Community shared solar allows multiple community members, organizations, or companies to pool investments and resources to share one local energy system. Community shared solar is particularly important to those unable to install solar energy systems on their own sites, which may have too much shade or otherwise be inadequate sites for solar, may be rented as opposed to owned properties, or may have owners unable to afford the cost of a full system. Currently, there are 13 states and the District of Columbia with enacted shared solar and renewable policies, with three other states currently with active campaigns proposing such policies.[165] Solar schools have also been financed with community solar, such as Sidwell Friends School in Washington, D.C. The school installed a 120 panel system on the Lower School, with funding provided by the School's alumni who can purchase "solar bonds" in $5,000 increments and receive a three percent annual return for an estimated of ten years. Through community solar, Sidwell Friends School had no upfront costs to install the system, and after the investors are paid off, will receive free and clean renewable energy for the 30 year expected lifetime of the project.[166]

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[162] District of Columbia, Department of General Services. (2015, March 25). Request For Proposals On-Site Solar Power Purchasing Agreement. *Solicitation Number: DCAM-14-CS-0123*. Available at: http://dgs.dc.gov/

[163] San Ramon Valley Unified School District. (2015). Solar Overview. Available at: www.srvusd.net/solar

[164] Goodward, J., Massaro, R., Foster, B., and Judy, C. (2011). *Purchasing Power: Best Practices Guide to Collaborative Solar Procurement.* Retrieved from the World Resources Institute website: www.wri.org/sites/default/files/pdf/purchasing_power.pdf

[165] Shared Renewables HQ. (2015). USA Shared Energy Map. Available at: www.sharedrenewables.org/community-energy-projects/

[166] Sidwell Lower School. (2010). New “Solar Bonds” to Pay for Lower School’s Solar Panels. Available at: www.sidwell.edu/news/article/index.aspx?pageaction=ViewSinglePublic&LinkID=20449&ModuleID=640

Getting Started with Community Shared Solar

On May 12, 2015, Maryland enacted legislation to create a three-year community shared solar pilot program. The Maryland Public Service Commission will soon begin developing and adopting regulations governing the program, after which applications can be made for interconnection and operation of community shared solar projects.[167]

Conclusion

The potential for additional Maryland K-12 schools to go solar is significant. Fully tapping this potential by installing solar on the more than 1,200 public schools that can go solar cost-effectively would add nearly 123 MW of new solar capacity across the state – a figure equal to just over 50 percent of all the solar capacity installed in Maryland to date. As this report has demonstrated, such solar growth would deliver significant economic, environmental, educational, and other benefits to schools and the surrounding communities. The 142,500 MWh of electricity that would be produced by these systems each year – enough to power around 12,000 average Maryland homes – would be valued at $15.8 million annually and offset over 98,000 metric tons of carbon dioxide. This new source of demand for solar would also support construction and operations and maintenance jobs across the state, resulting in a total of $270 million in economic activity. Finally, the integration of solar energy systems on K-12 schools into STEM curricula can also help increase student performance or interest in these subjects.

Because school and district resources are limited, this report has attempted to more narrowly target solar deployment to counties and school districts where the benefits of solar would be most felt. And while it is certain that not all these public schools will deploy solar immediately, or even over the next five years due to roof age or other physical limitations, the start of a solar schools conversation in Maryland is necessary. Given the significant benefits of solar schools, as well as the many public and private financing options available to schools to overcome the high upfront costs of solar systems, the local governments and school officials should consider a plan to most appropriately bring solar to K-12 schools in Maryland.

Following the release of this report, The Solar Foundation will complete an educational roadshow, traveling to a number of counties and offering school district members, city officials, and community members the opportunity to hear about the solar school opportunities in their county. Furthermore, through the Department of Energy's SunShot Solar Outreach Partnership, The Solar Foundation will offer technical assistance support for local governments looking to deploy solar at their schools.

[167] General Assembly of Maryland. HB1087 – 2015 Regular Session. Available at: http://mgaleg.maryland.gov/webmga/frmMain.aspx?pid=billpage&stab=01&id=hb1087&tab=subject3&ys=2015RS

Appendix

Solar Schools Financed with Power Purchase Agreements – Press Releases

This list includes a number of press releases from various news outlets identifying public schools who have used, to some extent, power purchase agreements to finance their solar installations.

Caroline County – North Caroline High School
PPA with Washington Gas Energy Services, Inc. (WGES)
http://www.wglholdings.com/releasedetail.cfm?ReleaseID=687243

Cecil County Public Schools
PPA with Standard Solar, Inc.
http://standardsolar.com/about-us/news/press-releases/4805

Dorchester County – Mace's Lane Middle School
PPA with Washington Gas Energy Services, Inc. (WGES)
http://www.wglholdings.com/releasedetail.cfm?ReleaseID=711359

Harford County Public Schools
PPA with SunEdison
http://andrewcassilly.com/downloads/Solar-panels-activated-at-six-local-schools_Aegis_6-17-2011.pdf

Kent County – Kent County High School
PPA with Washington Gas Energy Services, Inc. (WGES)
http://www.wges.com/page/press_detail.php?p=99

Montgomery County Public Schools
PPA with SunEdison
http://www.montgomeryschoolsmd.org/press/index.aspx?pagetype=showrelease&id=2742&type=archive&startYear=2009&pageNumber=3&mode

St. Mary's County – George Washington Carver Elementary School
PPA with Standard Solar, Inc.
http://www.businesswire.com/news/home/20101201005488/en/St.-Mary%E2%80%99s-County-Public-Schools-Solar-Perpetual#.VXCqbc9VhBc