A Social & Economic Assessment of the Shugart Solar Project

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Origis Energy
Submitted to: MDE

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SHUGART SOLAR PROJECT SOCIAL ECONOMIC JUSTIFICATION REPORT

This Social Economic Justification (SEJ) report is prepared in response to the approved Shugart Solar, Certificate of Public Convenience and Necessity Condition (CPCN) (Proposed Order of the Public Utility Law Judge, Case No. 9464 dated August 21, 2018) and at the request of the Maryland Department of the Environment.

SHUGART SOLAR: OVERVIEW OF FINDINGS

The report is written to comply with Maryland Department of the Environment (MDE) requirements of the CPCN Condition 4, which requires "Construction and operation of the solar facility shall be undertaken in accordance with this CPCN and shall comply with all applicable local, State, and federal laws and regulations…." MD Solar 1, LLC prepared this social and economic justification consistent with Maryland's antidegradation implementation procedures (COMAR 26.08.02.04-1).

Solar energy is a gentle and responsible use of land. Impervious surfaces are low. Establishment of meadow-like conditions is the norm, often enhanced with professionally-designed pollinator seed mixes and habitat. On-site human activity during operation is infrequent for the project life. Landscape maintenance practices are designed to adopt a minimalist approach. This report will characterize the very low level of stream impacts from Shugart Solar that will remain after applying mitigation within its civil engineering design. Set against these low impacts, this report will demonstrate that beneficial economic values to the community are very high at Shugart Solar. The report will easily establish carbon offsets that are also very high, with offset multiples 100 to 200 times the current use. Solar projects are an excellent use of private land and commonly deliver all of these results. There is no stretch required to provide very low impacts as well as high social and economic benefits.

We also cannot forget the purpose of Shugart Solar is, to a very large extent, to fight against climate change. Climate change is in everyone's back yard and we all must balance our desires against our needs and work together in this fight. The people of Maryland have collectively and democratically elected to implement the Maryland Renewable Portfolio Standard (RPS), which became law in 2004 and was dramatically raised by Marylanders legislation again in 2019, because the climate fight is so important and so impactful on Maryland and the Chesapeake Bay watershed. The project was developed with the view towards on-site and off-site alternatives, inherent in any solar energy development process, with climate change and the Maryland RPS in mind. Shugart Solar, with all its fact-based outcomes, is an important tool in the climate change fight.

To be responsive, a brief analysis of the Maryland Department of Natural Resources (DNR) Charles County Ecosystem Services Report is included in this SEJ. It is important to keep in mind that the value of Ecosystem Services has no legal bearing on the permitting process in Maryland, is intended for evaluating tradeoffs and informing decision-making, and, according to DNR's own documents, does not in indicate actual market value or compensatory value to private landowners in any sense. DNR methodology evaluation figures thereby are indicative and notional only.

However, solar is a an environmentally sensitive and gentle use of the land. This report will demonstrate that, taking variation into account, it is easy to see that at least 78% and more likely 88% or more of original notional ecosystem services value is maintained prior to carbon offset calculations. In addition, this report shows that any amount "lost" will certainly be lower than the real value of actual economic activity generated by Shugart Solar, approximately $19,700,000 during construction and $654,000 per annum thereafter. Finally, using DNR's own methodology, including the carbon offset value contribution of Shugart Solar to the environment is on order of magnitude $3,200,000 to $5,500,000 per annum, equating to 2.5 to 4.3 times higher than its current use. The social and economic value of Shugart Solar under this analysis is decisive and, in our view, easily justified.

SECTION 1: CHARACTERIZATON OF ENGINEERED STREAM IMPACTS

Site Description

The MD1, Shugart Valley Place, Solar project consists of the proposed development of a photovoltaic solar generation facility in Charles County, Maryland. The project area lies within portions of the properties identified on Tax Map 41, Grid 11, as Parcel 24 and on Tax Map 42 as Parcel 188.

The overall property area is bounded to the west by an existing stream, Wards Run, and Mason Springs Road. Areas north of the property are generally comprised of residential land uses. Areas east and south of the properties are generally wooded. The property area consists of portions comprised of the FEMA 100-yr floodplain for Wards Run along the western property boundary and south of Mason Springs Road.

The property area primarily consists of wooded land cover with some cleared open space areas and access trails. Based on the USDA Web Soil Survey, the properties consist predominantly of 'C' rated hydrologic soil group soils, with areas of 'A' and 'B' as well, and the topography varies from gradual to steeply sloped areas; however, the steeply sloped areas are generally located within or adjacent to Resource Protection Zones (RPZ's), which were intentionally protected outside of the proposed project area as a stream management consideration.

The property area is located within the Nanjemoy watershed and generally drains north and west via overland flow to channelized tributaries of Wards Run.

The Shugart Solar project includes the development of a single-axis tracking ground mounted solar array facility, supporting utility infrastructure, limited gravel access drives and equipment pad areas, fencing, landscape buffers, and ground cover (meadow) establishment. The project also consists of the construction of on-site interconnection equipment, generation tie line, and a new interconnection substation to be constructed by SMECO within its existing right-of-way.

The proposed groundcover under the solar array will prioritize pollinator friendly, native and naturalized species and a controlled maintenance program to promote this habitat's creation. Areas of broad pollinator coverage will be enhanced with more intensive habitat areas. Instead of gravel or turf grass, the pollinator habitat's native vegetation captures nutrients and prevents their movement into receiving streams. Unlike shallow-rooted turf, deep-rooted native flowers and grasses significantly increase organic matter and the quality of soils. Some of the species selected for pollinator benefits have deep root systems (up to 7' at maturity) that provide a pathway for surface water to infiltrate into the soil. Species with deep roots can improve infiltration rates by slowing runoff, breaching the surface, and providing root passages for water percolation.

Engineering Parameters

The total impervious surface area of the Shugart Solar project is very low due to the total site area and standard Maryland Department of the Environment treatment practices for solar panel arrays. The latest site layout and design for Charles County Department of Planning and Growth Management Site Development and Site Stormwater Management (Step II) plans consists of approximately 12.45 acres of proposed impervious area within the proposed disturbed 249.00 acres of site area. This equates to an impervious cover percentage of 1.6 %. Please refer to Table 1, below for a breakdown of the proposed impervious area for the site.

Table 1. Proposed Impervious Area Breakdown - Step II

Impervious Area Description	Length (ft)	Width (ft)	Area (SF)	Quantity	Total Area (SF)	Comments
Inverter/Equipment Pads (Concrete)	53.5	74	3540	14	49560	Inverter Pad Site
Array Field Access Drives (Gravel)	31609	15	474142	1	474142	Gravel Access Drives
Proposed Entrance Improvments	-	-	3500	1	3500	Paved entrances
On-Site Substation Equipment Pad/Area (Private)	120	126	15120	1	15120	Equipment Pad
					542322	SF
					12.45	Acres

Grading will be largely limited to smoothing during tree removal. Drainage improvements required to support the proposed facility, the existing topography and drainage patterns within the project area will generally be maintained in the post-development condition.

As required by Chapter 274, Stormwater Management, of the Charles County code, the project will be designed to meet or exceed the requirements of the local Department of Planning & Growth Management (PGM) Stormwater Management Ordinance and Maryland Department of the Environment (MDE) Stormwater Design Manual. As outlined in the Charles County Stormwater Management Ordinance, the stormwater management planning and design approach has been or will be reviewed at Concept, Site, and Final stages of design for consistency with the applicable stormwater management requirements.

The stormwater management practices proposed to support the development of the proposed facility will include:

Stormwater Quality Control

- Stormwater Management will be implemented based on Section 1.2 of the Maryland Stormwater Management Design Manual
    - Standard No. 1 – The proposed site layout minimizes impervious area and associated runoff. Pervious area is maximized across the site.
    - Standard No. 2 – Stormwater runoff is adequately treated across the site prior to being discharged from the site into waters of the State of Maryland.
    - Standard No. 3 – Annual groundwater recharge requirements based on pre-development conditions are met on-site through the implementation of non-structural stormwater management practices.
    - Standard No. 4 – Water quality requirements are met on-site through the implementation of environmental site design practices; specifically, non-rooftop disconnects for all impervious areas.
    - Standard No. 5 – N/A
    - Standard No. 6 – Per Charles County requirements, the 2 and 10-year frequency storm events are controlled to pre-development levels. Safe conveyance for the 100-year storm event is provided.
    - Standard No. 7 – The proposed site provides stormwater management to meet ESD to the MEP and Channel Protection Volume (CPv). Remaining channel protection volume is provided in level spreader facilities throughout the site.
    - Standard No. 8 – N/A
    - Standard No. 9 – operation and maintenance agreement for stormwater management facilities will be provided for Charles County approval
    - Standard No. 10 – project will provide adequate pre-treatment; as required
    - Standard No. 11 – N/A
    - Standard No. 12 – N/A
    - Standard No. 13 – N/A
    - Standard No. 14 – project must obtain Charles County Concept, Site, and Final stormwater management approvals.

- Environmental Site Design (ESD) will be implemented to the Maximum Extent Practicable (MEP) to promote 100% of the average annual predevelopment groundwater recharge and minimize nonpoint source pollution from the proposed facility.
- The proposed solar panel areas have been designed based on the MDE stormwater design guidance for solar panel installations, generally being located within gradual sloped areas, at appropriate spacing, with runoff directed through vegetated areas. This promotes filtration and groundwater recharge.

- All other access drives, equipment pads, and supports will be considered impervious requiring adequate stormwater quality control treatment. Adequate treatment for these areas will be provide through a combination of non-rooftop disconnect practices and additional level spreader facilities.

Stormwater Quantity Control

- After implementing ESD to the MEP, additional quantity control measures will be provided on-site to maintain or reduce post-development frequency discharge levels to predevelopment levels at all downstream points of investigation using 2- and 10-yr frequency events).
    - 2-yr event – has a 1 / 2 or 50% probability of occurring within any one-year period
    - 10-yr event – has a 1 / 10 or 10% probability of occurring within any one-year period.
- Based on the majority underlying hydrologic soil group ratings (C-soils), existing wooded conditions (RCN=70), proposed open-space establishment and maintenance (RCN=71, meadow), and proposed stormwater quality controls, the proposed facility results in increases to the frequency discharge levels. Therefore, the project will implement further Enhanced Stormwater Control.

Enhanced Stormwater Control

- As identified by the Maryland Department of the Environment, the project area is partially located within the Wards Run 2 Tier II watershed boundary (Hydrologic Unit Code 02070011); which appears to have limited assimilative capacity remaining.
- Due to the location within the Tier II watershed the following practices are proposed to further protect downstream waterways during both the construction and post-development operation and maintenance periods of the proposed facility:
    - **Expanded Resource Protection Zone (Riparian) buffers**
    - **Enhanced stabilization, filtering, and sediment trapping practices**
- Enhanced stormwater management quantity control includes control and/or partial-management for the 25-,50-,100-yr frequency events
    - 25-yr event – has a 1 / 25 or 25% probability of occurring within any one-year period.
    - 50-yr event – has a 1 / 50 or 2% probability of occurring within any one-year period
    - 100-yr event – has a 1 / 100 or 1% probability of occurring within any one-year period

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Engineering Results

Stormwater Quality Control for proposed impervious surfaces (access drives, equipment pads, and foundations/supports), Impervious Areas Requiring Treatment (IART), will be met through implementation of the following practices; summarized in Table 2 below:

- Non-rooftop Disconnects – Runoff from impervious surfaces will be directed as sheet flow across adjacent landscape/open-space areas. This promotes filtration and groundwater recharge.
- Grassed swales – Runoff from impervious surfaces will be directed as concentrated flow, if required, through vegetated grass channels. This promotes infiltration and groundwater recharge.

Table 2. Stormwater Management Treatment Summary - Step II

Stormwater Summary	Req'd	Prov'd
IART	12.45	12.45
ESDv	*85868*	*42934*
CPv	*36220*	*36220*
Total Volume	122088	79154
Recharge (Rev)	11163	42934
ESD to MEP Met?	-	Yes

Stormwater Quantity Control will be met through implementation of the following management practices to maintain, or reduce, post-development discharge levels; summarized in the Table 3 below:

- Level-spreader Control Structures – Control structures will be located within natural existing depressions and flow paths to control discharge levels/rates. The level-spreader control structures will consist of engineered openings to provide on-site detention and discharge/flow attenuation.

Table 3. Flow Rate Summary at Each Study Point - Step II

	1-Year Storm Event			2-Year Storm Event			10-Year Storm Event			25-Year Storm Event			50-Year Storm Event			100-Year Storm Event		
Drainage Area	Ex.	Prop.	% Change	Ex.	Prop.	% Change	Ex.	Prop.	% Change	Ex.	Prop.	% Change	Ex.	Prop.	% Change	Ex.	Prop.	% Change
	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)
DA-1	55.71	< 55.71	< 0%	103.5	< 103.5	< 0%	301.28	< 301.28	< 0%	464.52	< 510.97	< 10%	620.01	< 682.01	< 10%	799.34	< 879.27	< 10%
DA-2	2.44	< 2.44	< 0%	7.96	< 7.96	< 0%	41.44	< 41.44	< 0%	74.16	< 81.58	< 10%	106.97	< 117.67	< 10%	146.02	< 160.62	< 10%
DA-3	6.37	< 6.37	< 0%	26.29	< 26.29	< 0%	167.51	< 167.51	< 0%	312.93	< 344.22	< 10%	461.24	< 507.36	< 10%	641.51	< 705.66	< 10%
DA-4	45.14	< 45.14	< 0%	86.75	< 86.75	< 0%	259.43	< 259.43	< 0%	403.32	< 443.65	< 10%	537.56	< 591.32	< 10%	697.61	< 767.37	< 10%
DA-5A	8.2	< 8.2	< 0%	21.54	< 21.54	< 0%	87.13	< 87.13	< 0%	145.61	< 160.17	< 10%	202.64	< 222.9	< 10%	269.46	< 296.41	< 10%
DA-5B	7.42	< 7.42	< 0%	17.57	< 17.57	< 0%	68.05	< 68.05	< 0%	113.66	< 125.03	< 10%	157.63	< 173.39	< 10%	210.52	< 231.57	< 10%
DA-5C	18.14	< 18.14	< 0%	40.94	< 40.94	< 0%	150.06	< 150.06	< 0%	245.95	< 270.55	< 10%	339.79	< 373.77	< 10%	448.27	< 493.1	< 10%

Stormwater Step II and Step III Final Designs

Stormwater is approved in a three-step process. Conceptual stormwater has been approved by Charles County. Shugart Solar is working with county and state experts and advising engineers so that Step II and final design meets their own set of requirements and sense of balance that is most healthy for the stream. Actual figures may change under the guidance of these authorities as Step II and Step III become final. However, the practical range of outcomes and resulting effects will remain essentially the same.

Summary of Actual Stream Impacts

In conclusion, the proposed facility will be designed to meet and/or exceed the requirements of all local ordinances, specifically stormwater management, MDE requirements. While the effected Tier II streams have no or limited additional assimilative capacity, the effect Shugart Solar will have on the stream is very small due to the care and engineering designed in place.

SECTION 2: LOCAL ECONOMIC BENEFITS

Origis Energy commissioned Sage Policy Group, Inc. (Sage) to complete a social and economic assessment of its proposed Shugart Solar development in Charles County, Maryland for inclusion in this SEJ submitted to the MDE under the project's approved CPCN conditions. Sections 2, 3, and 4 of this report were prepared by Sage.

The Shugart Solar project plans to install approximately 32.5 MWac and 40 to 46 MWdc of solar panels mounted on single axis tracking technology on 249 acres within a 540-acre site in Charles County. With an installed generating capacity of 32.5 megawatts (AC), the power created by these solar panels is estimated to be approximately 70,000 megawatt-hours of electricity annually, enough to meet the needs of more than 4,400 homes based on the average household electrical use by customers of the Southern Maryland Electric Cooperative (SMECO).

The development of the solar farm will trigger significant economic and fiscal impacts during the period when the project is constructed. Those impacts will occur only once and will persist over the period of development. Once operational, the project will generate more permanent impacts that are presented as annual and ongoing within this report. An appendix to this section of the SEJ report supplies a primer on IMPLAN, the input-output modeling platform used to complete some of this analysis, and the principal terms associated with economic impact assessments.

Economic benefits of the Shugart Solar Project

The development of the Shugart Solar Project will involve nearly $15 million in construction expenditures made within the local economy for developing the site as a solar farm, purchasing forest conservation easements, and purchasing the project site. The purchase of the project site, which is currently forested, includes the value of the timber currently existing on the project site. The estimated value of these expenditures is presented in Exhibit 1.

It should be noted that the expenditures considered in this analysis are restricted to those made within the local economy. For the sake of this analysis, local is defined as occurring within Maryland, but in-state project expenditures will realistically be concentrated in Charles County and the surrounding area where firms with qualifications to conduct this work are likely to be located. Other costs for this project that will occur outside of Maryland are excluded from Exhibit 1. For example, solar farms use specialized photovoltaic solar panels that convert sunlight into electricity. There are no Maryland-based manufacturers of these panels. Consequently, the economic benefits associated with the purchase of this equipment will occur somewhere other than in Maryland.

Exhibit 1. Local expenditures related to the project development.

Type of expenditure	Value
Land Clearing and Preparation Costs	$1,900,000
Estimated Total Construction Labor	$5,250,000
Other Local Construction Spending	$5,750,000
Construction related expenses	**$13,900,000**
Forest Conservation Easements	**$344,000**
Land Purchase	$1,600,000
Timber Value Purchase	$145,000
Site Investment	**$1,745,000**
Estimated Near Term Local Expense	**$14,989,000**

Source. Origis Energy

Most, but not all, of these expenditures will create economic activity in the form of new business revenue to local companies that will in turn support employment and the income that employment creates. This economic activity will ripple through the local economy as companies hired to clear and prepare the site and construct the solar farm will make purchases of goods and services from other local businesses. These purchases are defined as the supply chain for the companies doing the direct work of site preparation and construction.

Wages paid to workers in the directly affected companies and to workers in the supply chain that are dependent on the spending tied to this project will be spent in large part in the local economy for a wide range of goods and services. All this spending—for the direct work in site preparation and construction, for the goods and services in the supply chain, and from workers' wages in the local economy—creates economic activity that is often termed the multiplier effect.

Two of the expenditures listed in Exhibit 1 do not create these types of effects. The payments for the site itself and for forest conservation easements are considered transfers of capital. While they are clear benefits to those who receive the payments, they are not associated with new demand for construction, site preparation, or other goods or services. Because the estimation of economic impacts is based on new demand for goods and services, such transfers of capital are not considered a source of economic impact.

One expenditure listed in Exhibit 1 that will create economic benefits is unusual and worthy of some discussion. Expenditures for timber on the site is in addition to the expenditure for the land itself. This timber, which will be harvested in the process of preparing the site for the construction of the solar farm, is expected to be sold to local firms that will use the timber to create mulch or other wood-based products, including lumber for any timber of appropriate size. Accordingly, this timber will become an input to local sawmills or similar firms that produce mulch or other wood products. Purchases of timber represent approximately 60 percent of the cost of sales for a typical sawmill. The $145,000 value of timber on the project site then equates to almost $242,000 in sales to a sawmill or wood products company. This constitutes another form of economic activity that would be created by development of the solar farm.

Exhibit 2 summarizes the estimated economic impacts associated with developing the solar farm. These impacts include an estimated total of 146 jobs—a job, in this context, is defined as one position that lasts for one year. Associated worker income will total in excess of $8 million.

Affected businesses will secure almost $20 million in augmented business sales. Most of these impacts are direct effects experienced by the companies directly involved in site preparation and construction as well as the firms creating mulch, lumber, or other wood products. Secondary impacts include the indirect effects experienced by companies in the supply chain and the induced impacts on companies operating in the local consumer economy when directly and indirectly affected workers spend their incomes.

These impacts are one-time effects that occur during the construction period. Each job created during that period represents the equivalent one-year's work for an employee in the companies affected by the spending generated by this project. As noted, these jobs represent a mix of full-time and part-time positions. Because most of the industries affected by the project employ workers on a full-time basis, the employment estimate is virtually equivalent to FTEs.

Exhibit 2. Economic impacts of site preparation, clearing, and construction (one-time effects)

Type of impact	Direct Impact	Secondary Impact	Total Impact
Employment (full- and part-time jobs)	98	48	146
Labor income (millions)	$5.9	$2.4	$8.2
Business sales (millions)	$13.1	$6.6	$19.7

Source. Origis Energy, IMPLAN; Note. Totals may not add due to rounding.

Once the solar farm is constructed and operations begin, there will be a relatively modest need for maintenance and other care for the facility. These activities include mowing the land where the panels are located. That land will be planted with native grasses and other vegetation that will, among other things, support the pollinator population. These activities also encompass repairs as required on equipment as well as such general overhead expenses such as security, waste management, storage, and equipment rental.

These expenses can be characterized as routine and reasonably predictable annual costs for the solar farm and are expected to remain relatively constant over the 35-40 year expected life of the facility. Exhibit 3 lists the estimated costs of these activities in the initial year of solar farm operation, which total $440,000. An estimated 95 percent of these expenditures are expected to be made in the local economy. These initial costs are expected to increase incrementally over that expected life as a result of inflation. Because major work for extensive re-construction of the facility might occur, but cannot be confidently predicted, the listed expenses may underrepresent the actual costs of maintenance and repair over the useful life of the project.

Exhibit 3. Ongoing expenditures for maintenance (ongoing, annual effects)

Type of expenditure	Value
Preventive Maintenance	$220,000
Corrective Maintenance	$176,000
Ancillary Services/Overhead	$44,000
Total	**$440,000**
Local share of total expenditures	**$418,000**

Source. Origis Energy

These ongoing maintenance expenses will also generate a set of ongoing economic impacts. These estimated impacts are summarized in Exhibit 4 and include a calculated total of 4 jobs with related income of $252,000. The total value of business sales is estimated at $654,000. As is true for the economic impacts of project development, the bulk of the impacts from the ongoing maintenance activities are classified as direct effects—that is, the workers conducting these maintenance activities, their incomes, and the business sales that flow from this work.

Exhibit 4. Economic impacts of ongoing maintenance (ongoing, annual effects)

Type of impact	Direct Impact	Secondary Impact	Total Impact
Employment (full- and part-time jobs)	3	2	4
Labor income (thousands)	$162	$90	$252
Business sales (thousands)	$418	$236	$654

Source. Origis Energy, IMPLAN

Fiscal impacts of the Shugart Solar Project

The economic impacts associated with the development of the solar farm, the sale of timber from the project site, and the ongoing maintenance of the facility also generate fiscal impacts in the form of new tax revenue for local and state governments. While the array of taxes can be wide and varied, the primary sources of impacts are income taxes and sales taxes.

Exhibit 5 summarizes the income and sales tax revenue generated by the total economic activity involved in site preparation, clearing, and construction. These impacts include an estimated $187,000 in the local share of income taxes and $314,000 in the State share of income taxes. In addition, the spending of wages and other compensation by the workers supported by the development of the solar farm is estimated to generate $158,000 in sales taxes. These are one-time effects that occur during the period when the project is developed.

Exhibit 5. Fiscal impacts of site preparation, clearing, and construction (one-time effects)

Type of tax revenue	Local impact	State impact
Income tax (thousands)	$187	$314
Sales tax (thousands)		$158
Total (thousands)	**$187**	**$472**

Source. Origis Energy, Maryland Comptroller

Exhibit 6 summarizes the tax revenue that is expected to be created by ongoing solar farm maintenance. Impacts include an estimated $6,000 in local income taxes and $10,000 in State income taxes. State sales taxes are estimated at $5,000.

Exhibit 6. Fiscal impacts of ongoing maintenance (annual, ongoing effects)

Type of tax revenue	Local impact	State impact
Income tax (thousands)	$6	$10
Sales tax (thousands)		$5
Total (thousands)	**$6**	**$15**

Source. Origis Energy, Maryland Comptroller *Note. Totals may not add due to rounding.

SECTION 3: CARBON OFFSET IMPACTS

Environmental benefits

A hallmark of solar power is that it does not generate pollution during the electricity-generation process. This characteristic is in sharp contrast to much power generation—particularly that based on the use of fossil fuels—that creates air pollution as a byproduct of the combustion of fuel. By not generating pollution during operations, solar power avoids generating several key pollutants. Reduced pollution generates environmental and health benefits. By not creating pollution as a by-product of its operations, solar power also avoids emission control costs required in fossil-fuel-based power plants.

- Avoided pollution

The most well-known of the pollutants associated with electricity generation from plants using fossil-fuels is carbon dioxide (CO_2), one of the principal causes of climate change. In addition, sulfur dioxide (SO_2) and nitrous oxides (NO_X) are common by-products of electricity generation.

The creation of these pollutants during the generation of electric power is monitored by the U.S. Energy Information Administration (EIA). Exhibit 7 summarizes EIA data for electricity generation in Maryland along with the estimated volume of three key pollutants: CO_2, SO_2, and NOx.[1] The largest source of electricity in Maryland, nuclear power plants, which account for 44 percent of all electricity generates, creates none of these pollutants. Coal-fired plants, which produce 25 percent of the State's electricity, create a majority or plurality of these pollutants as a by-product of their operations—69 percent of CO_2, 86 percent of SO_2, and 36 percent of NO_X. Natural gas, which has emerged as a more common fuel in recent years and is the source of 20 percent of Maryland's electricity generation, is also a significant source of CO_2 and NO_X, creating roughly a quarter of the state's volume of each of these pollutants.

Exhibit 7. Major pollutants from electricity generation, Maryland, 2017

Energy Source	Generation (Megawatt hours)	CO_2 (Metric Tons)	SO_2 (Metric Tons)	NO_X (Metric Tons)
Coal	8,514,009	9,240,340	13,361	3,852
Hydroelectric Conventional	1,965,459			
Natural Gas	6,729,174	3,465,319	14	2,860
Nuclear	15,106,988			
Other	321,712	554,777	179	1,290
Petroleum	102,181	118,710	136	237
Solar Thermal and Photovoltaic	267,090			
Other Biomass	415,940	0	0	1,775
Wind	561,349			

[1] U.S. Energy Information Administration, "U.S. Electric Power Industry Estimated Emissions by State" https://www.eia.gov/tools/faqs/faq.php?id=74&t=11 and "Net Generation by State by Type of Producer by Energy Source (EIA-906, EIA-920, and EIA-923)" https://www.eia.gov/electricity/data/state/

Wood and Wood Derived Fuels	120,338	0	1,850	664
Total	34,104,239	13,379,146	15,540	10,678

Source. Energy Information Administration

Information in Exhibit 7 allows for the calculation of average rates of creating each of these pollutants for each megawatt-hour generated in Maryland. These rates can be calculated for all energy sources as well as each of the energy sources used in the state.

As reflected in Exhibit 8, emission rates for coal-fired power plants are substantially higher than the rates for all fuels and for natural gas-fired power plants. By volume, CO_2 is the major pollutant and coal-fired plants create just over one metric ton (2205 pounds) of CO_2 for each megawatt-hour of electricity generated. This is twice the rate of CO_2 production of natural gas and almost three times the rate for all power plants in Maryland.

Exhibit 8. Emissions rates for major pollutants from electricity generation, Maryland, 2017

Energy Source	CO_2 (Metric Tons per MWh)	SO_2 (Metric Tons per MWh)	NO_X (Metric Tons per MWh)
Coal	1.0853	0.0016	0.0005
Natural Gas	0.5150	0.0000	0.0004
All fuels	0.3923	0.0005	0.0003

Source. Energy Information Administration

As noted above, the Shugart Solar Project will generate an estimated 70,000 megawatt-hours of electricity. This volume of power allows estimates of the emissions that would not be produced by this solar farm compared to other existing sources of electricity in Maryland. The volume of avoided pollutants would depend on which alternative source of electricity is considered. In the most extreme case, if the electricity from the Shugart Solar Project exclusively replaced electricity from coal-fired plants, almost **76,000 metric tons of CO_2, 110 metric tons of SO_2, and 32 tons of NO_X** would be avoided. If this solar power replaced power from natural gas-fired power plants, the volumes of avoided pollutants are considerably lower, but still substantial: **36,000 metric tons of CO_2 and 30 metric tons of NO_X.**

Exhibit 9 supplies these estimated volumes of pollutants, including avoided pollutants assuming the overall mix of fuels used to create electricity in Maryland and a midpoint calculation that averages the emissions from coal-fired plants (the highest rates of pollution) and those of all fuels, which represents a relatively low rate of emissions. **These avoided pollutants represent an important element of the proposed project's socioeconomic justification.**

Exhibit 9. Avoided pollutants from Shugart Solar Project output

Energy Source	CO2 (Metric Tons)	SO2 (Metric Tons)	NO_X (Metric Tons)
Coal	75,972	110	32
Natural Gas	36,048	0	30
All fuels	27,461	32	22
Midpoint of coal and all fuels	51,716	71	27

Source. Energy Information Administration

Another significant pollutant from coal-fired power plants is particulate matter (PM). Particulate matter is measured in microns. A micron is one-thousandth of a millimeter. Particulate matter pollutants are defined as PM 2.5 (2.5 microns) and PM 10 (10 microns). For comparison, a human hair is approximately 45 microns thick.[2] These particles are so small that they can be inhaled and can become lodged deep in lungs. The health impacts of particulate matter range from asthma to heart attacks. More than 3 million deaths worldwide are attributed to PM 2.5 annually.

The total release of particulate matter from U.S. coal plants is estimated at more than 311,000 metric tons—in excess of 132,000 metric tons of PM 2.5 and nearly 179,000 metric tons of PM 10.[3] Assuming Maryland coal-fired plants reflect national averages, these plants emit roughly 2,400 metric tons of particulate matter annually.

If the power generated by the Shugart Solar Project completely replaced coal-fired power in Maryland, the reduction in total particulate matter would total approximately 18 metric tons per year. This total encompasses roughly 8 metric tons of PM 2.5 and 10 metric tons of PM 10.

- Carbon absorption at the project site

Another factor in the avoidance of CO_2 emissions from the Shugart Solar project is the natural ability of plants to absorb carbon. Because the project site will be converted from forest to cleared land, there will be a loss of trees that sequester carbon.

A U.S. Environmental Protection Agency analysis estimates that the average U.S. forest sequesters 0.85 metric tons per acre per year.[4] Alternatively, the cleared land will be planted with grasses and other low-lying plants between the solar panels. This grass also has the capacity to capture carbon and, as a result, offset some of the loss of carbon sequestration from trees. Estimates of the ability for grasslands, meadows, and similar spaces to sequester carbon vary widely. Among the factors that affect these rates are the types of grasses planted. Certain grasses produce roots that are relatively shallow and reduce the ability of the grass to sequester carbon. Other grasses produce roots that extend several feet into the soil, significantly increasing carbon sequestration. One study found that turfgrass can sequester 800 pounds per acre per year.[5] Another study found grass sequestering carbon at the rate of 8,000 pounds per acre per year.[6] The midpoint of this range—4,400 pounds—is about two metric tons.

These estimates of the carbon sequestration ability of forests and grasslands can be used to estimate the change in carbon sequestration of the 209-acre project site when the forest is cleared and the solar farm is partially converted to grassland. If half of the solar farm is planted as grassland, there

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[2] "Diameter of a human hair" https://hypertextbook.com/facts/1999/BrianLey.shtml
[3] Pierre-Louis, Kendra, "There's no such thing as clean coal," Popular Science, October 13, 2017 https://www.popsci.com/coal-power-plants-cpp/
[4] EPA estimate of forest sequestration of carbon cited in Origis Energy, "MD Solar 1, LLC, Shugart Solar Energy Project: Frequently Asked Questions"
[5] Bremer, Dale, "Carbon Sequestration in Turfgrass: An Eco-Friendly Benefit of Your Lawn," Turfnews, quarterly Kansas Turfgrass Foundation Newsletter, October 2007 http://www.walterreeves.com/uploads/pdf/turfsequestration.pdf
[6] Donovan, Peter, "What grass farmers have known all along—research shows grass sequesters carbon," Grassfed Gazette, published by the American Grassfed Association, Summer 2008 https://soilcarboncoalition.org/holdridge/

would be very little change in the site's carbon sequestration. As shown in Exhibit 10, the greater sequestration of grassland more than compensates for the loss of the forest's carbon sequestration.

Exhibit 10. Net change in carbon sequestration at the project site

Surface coverage	Acres	Coverage	Net acres	Sequestration/acre (metric tons)	Total sequestration (metric tons)
Forest	249	100%	249	0.85	212
Grasses	249	50%	124.5	2.00	248
Net gain/(loss) in absorption					37

Source. Origis Energy, Bremer, Donovan

- The benefits and costs of removing CO_2 from the atmosphere

Removing carbon from the atmosphere benefits the environment by limiting global warming, which in turn generates a range of impacts. One measure of the impacts of CO_2 emissions is an estimate that each metric ton of CO_2 emissions results in a sustained loss of three square meters of September sea-ice in the Arctic Ocean.[7] Given that the Shugart Solar Project is expected to avoid as many as 76,000 metric tons of CO_2, the area of sea-ice loss that would be avoided by this reduction in emissions could be as high as 56 acres in one year. Exhibit 11 shows the range of sea-ice loss that the Shugart Solar Project could help avoid each year that it operates.

Exhibit 11. Potential avoidance of sea-ice loss per year

Energy Source	Avoided CO_2 (Metric tons/year)	Avoided sea-ice melt (Square meters/year)	Avoided sea-ice melt (Acres/year)
Coal	75,972	227,915	56
Natural Gas	36,048	108,144	27
All fuels	27,461	82,383	20
Midpoint of coal and all fuels	51,716	155,149	38

Source. EIA, Notz

Creating electricity from a source that creates no emissions also avoids the cost of removing those pollutants from the atmosphere. Technology to remove CO_2 from coal-fired power plants has existed for years and has improved over time. More recently technology has been developed to remove CO_2 from the air, which can then be transported to a site where it is permanently stored or sequestered. Each of these technologies is costly. Not creating CO_2 in the first place avoids these costs altogether.

[7] Notz, Dirk, and Julienne Stroeve, "Observed Arctic sea-ice loss directly follows anthropogenic CO_2 emission," Science, November 11, 2016 https://science.sciencemag.org/content/354/6313/747.full

A 2015 Carnegie Mellon University publication summarizes the cost of capturing and storing CO_2 in new fossil fuel power plants.[8] That article updated an earlier review of studies regarding CO_2 capture and storage using technology that was being used in power plants or that was expected to be available in the next few years. Costs estimated in these studies included those associated with the capture of CO_2 as well as the costs of transporting CO_2 (primarily by pipeline) and its geological storage. The geological storage technology also included an option of using CO_2 for enhanced oil recovery (e.g., fracking), which generates a value for captured and stored CO_2.

Exhibit 12 presents the range of costs of capturing, transporting, and storing CO_2 from two types of fossil-fuel power plants. Because the review encompassed many studies, there were a range of costs for each type of plant as shown in the exhibit. The midpoint of each range is presented and assumed to be representative of all plants of that type. Costs have been adjusted to 2018 dollars.[9]

Exhibit 12. Costs of mitigating CO2 emissions from power plants per metric ton in dollars

Type of power plant	Capture, transport, and storage			Capture, transport, and storage with enhanced oil recovery		
	Low	High	Midpoint	Low	High	Midpoint
Natural gas combined cycle	68	145	107	41	114	77
Supercritical pulverized coal	48	122	85	18	82	50
Average			**96**			**64**

Source. Rubin, E.S, et al

Removing CO_2 from the emissions of power plants is a well-established technology that has been used by the power industry for many years. More recently, a wide range of technologies have been developed or researched as concerns with climate effects of CO_2 have heightened. Some of these technologies have been implemented while others might be characterized as experimental. Many of these technologies tend to rely on the chemical or biological characteristics of CO_2 that allow it to be converted into solidified materials or into other, more benign carbon compounds. Unlike the technology designed for power plants, these technologies tend to seek to capture carbon from the atmosphere.

A recent article published by Columbia University's Earth Institute looked at many techniques for removing CO_2 from the atmosphere. [10] The costs and benefits of new and emerging technologies were summarized as were the effects of forests and other plants. One well publicized approach is direct air capture technology, which removes CO_2 from the air by moving large volumes of air over

[8] Rubin, E.S., et al., " The cost of CO2 capture and storage," International Journal Greenhouse Gas Control (2015) http://dx.doi.org/10.1016/j.ijggc.2015.05.018

[9] Adjustments have been made using the index for "Gross private domestic investment." See Bureau of Economic Analysis, "Table 1.1.9. Implicit Price Deflators for Gross Domestic Product" https://apps.bea.gov/iTable/iTable.cfm?reqid=19&step=3&isuri=1&1921=survey&1903=13#reqid=19&step=3&isuri=1&1921=survey&1903=13

[10] Cho, Renee, "Can Removing Carbon From the Atmosphere Save Us from Climate Catastrophe?" November 27, 2018 https://blogs.ei.columbia.edu/2018/11/27/carbon-dioxide-removal-climate-change/

substances that bind with CO_2. Operating direct air capture facilities exist in Switzerland and Canada with another under construction in Alabama as of late 2018.

Other technologies include carbon mineralization that uses the natural reaction between CO_2 and materials that results in the formation of solid carbonate minerals (e.g., limestone) that can store CO_2 for millions of years potentially on the seabed. A similar technology—enhanced weatherization—is based on a chemical reaction that converts CO_2 to bicarbonate, an alkaline, that can improve soil quality and reduce ocean acidification. Y Combinator, a funder of startup companies, has encouraged the development of new CO_2 removal technology including the modification of phytoplankton genes that would increase the ocean's capacity to sequester carbon and the creation of enzyme systems that would convert CO_2 into other useful compounds outside living cells.

Because these new and emerging technologies span a range from the known and implemented to the speculative, there are limited data regarding costs. When costs are available, they are subject to uncertainties emerging from the potential for lower costs as technologies mature and operate at larger scales to the potential for additional costs and negative effects if large-scale operations generate volumes of materials that create their own environmental challenges.

By one estimate, these technologies will be critical to removing 100 to 1000 gigatonnes of CO_2 in the 21st century. Exhibit 13 supplies information on costs for a forests and other plants as well as a limited number of the emerging technologies.

Exhibit 13. Technologies for CO_2 removal from the atmosphere

Technology	Range of costs per metric ton of CO_2 removal	Comments
Forests	\$0 - \$ 20	May compete with agricultural land as food production is expected to need to increase 70 percent by 2050
Soil carbon sequestration from other plants	\$0 - \$100	Might remove 2 to 5 gigatonnes/year by 2050
Direct air capture	\$100 - \$200	Future goals are to lower net costs to as low as \$50 if captured CO_2 can be sold or converted to useful products. Could remove 0.5 to 5 gigatonnes/year of CO_2 by 2050, perhaps 40 gigatonnes/year by 2100
Ocean alkalization/ enhanced weatherization	\$14 - over \$500	Could remove 100 tonnes to 10 gigatonnes/year, but ecological impacts unknown

Source. Cho.

SECTION 4: SUMMARY OF ECONOMICS & CARBON BENEFITS

The Shugart Solar Project would generate social and economic benefits in a number of ways. Among other things, it would:

- **Create jobs and income during construction and operational phases;**
  - 146 estimated total direct and secondary impact jobs (i.e. years of work) with associated income of $8.2 million in today's dollars during construction and an estimated 4 jobs with associated annual income of $252,000 in today's dollars during 35-40 years of operations
- **Expand local business sales;**
  - An estimated total of $19.7 million in business sales during construction and $654,000 per year in business sales during operations measured in today's dollars.
- **Create short term and long-term fiscal benefits;**
  - Approximately $476,000 in state fiscal impact and $189,000 in local fiscal impact during construction and $15,000 in state fiscal impact and $6,000 in local fiscal impact annually during operations measured in today's dollars. These impacts do not include property tax revenue and scholarships associated with the SMECO power purchase agreement which are outside the scope of this study.
- **Greatly reduce the balance of annual CO2 emissions**
  - Avoided CO2 per year could be as high as almost 76,000 metric tons if replaced electricity is from coal plans or over 36,000 metric tons if replaced electricity is from natural gas plants. A mid-point estimate between all coal-based power and the existing mix of all fuel sources is almost 52,000 metric tons of avoided CO2.
  - While tree stands are precious and important, the annual CO2 sequestration of the project site value is approximately 212 metric tons prior to accounting for any replacement vegetation. After accounting for carbon sequestration of open meadow underneath the solar project, it is possible that no net loss of or a small increase in carbon sequestration will occur. This change in carbon sequestration is independent of the CO2 that is avoided by solar panels compared to current sources of electric power.

The reduction of CO2 depends on how the electricity replaced by the Shugart Solar Project would be generated. Given Maryland's dependence on coal plants and their high rates of CO2 generation, the low estimate of reduced CO2 is over 27,000 metric tons, 130 times of CO2 absorbed by the existing forest at the project site. Using the midpoint estimate of almost 52,000 avoided metric tons, this solar project would avoid 244 times the CO2 absorbed by the existing forest at the project site.

SECTION 5: FIGHTING CLIMATE CHANGE

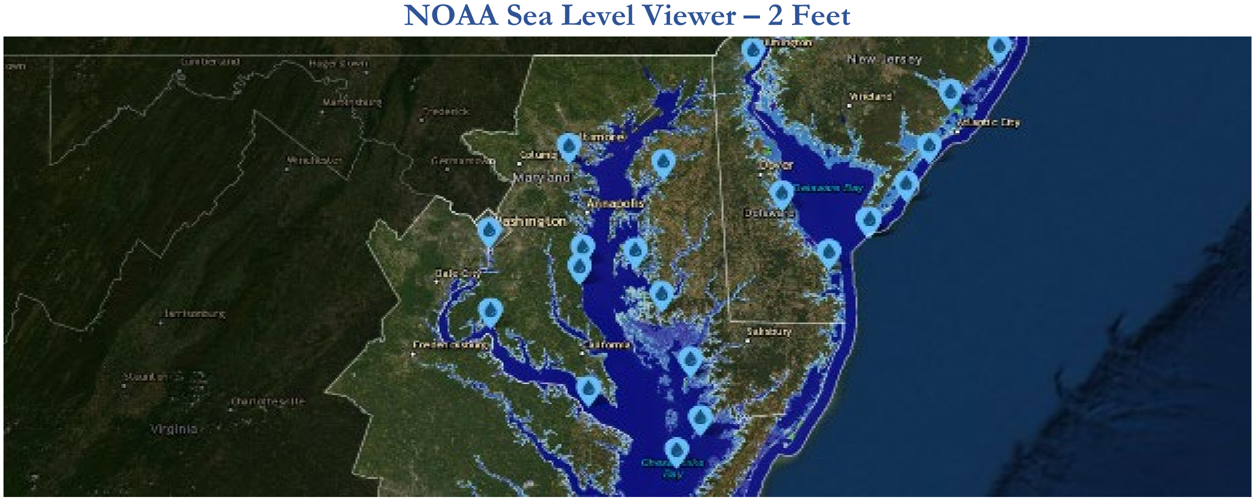
Climate change will affect everyone; all must do their part to balance their own and society's needs and desires to successfully fight it. The change in climate due to man-made emissions is a well-known and serious threat to the environment, including the Chesapeake Bay and its watershed habitat. Hundreds of studies document the effects of rising sea levels, salt water intrusion, rising water temperature, drops in dissolved oxygen and the list of negative environmental and human impacts from climate change goes on and on.

It is not the place of this report to incorporate all professional studies or enumerate all possible climate change outcomes, however, the data are clear and the ramifications are material that this change will affect everyone. For this study, we offer a simple illustration as a reminder that climate change is a major threat with ramifications far beyond the impacts of the Shugart Solar Project which are overwhelmingly positive on balance.

The NOAA Sea Level Viewer offers a simple tool to visually appreciate the magnitude of change and the acres of threat in the Chesapeake Bay watershed. By comparing the Current View to the 2 Feet View below, the dramatic threat to Marylander's and the Maryland environment is stark and apparent.

NOAA Seal Level Viewer – Current

NOAA Sea Level Viewer – 2 Feet



NOAA Sea Level Viewer Source: https://coast.noaa.gov/slr/

SECTION 6: MARYLAND STATE RENEWABLE PORTFOLIO STANDARD

It is clear that Marylanders view climate change seriously. Recognizing their own exposure to climate change and the value of positive socio-economic outcomes of utility scale solar energy, voters have democratically enacted aggressive legal and policy standards in pursuit of more renewable energy generation within its borders.

The State's goal and commitment is clear and widely considered to be among the most aggressive in the United States. Originally enacted in 2004, Maryland's RPS increase in 2017 its solar mandate from 25% of Maryland's electricity be generated from renewable energy sources by 2020, which must include at least 2.5% solar energy. In 2019, Marylanders increased the solar mandate again so that by 2030, the 50% RPS would include 14.5% solar.

It is not the place of this study to review the entire workings of the RPS system but as an illustration, solar renewable energy credit (SREC) prices have increased approximately 10-fold in the last year, from $6.00 to $60.00 per SREC. Due to the rise in RPS requirements as well as, reportedly, such as the rise of a vocal but far in the minority, anti-development and anti-solar coalition.

Marylanders have decided via the State RPS law that all constituents are exposed via their electric bills to the RPS system. The RPS is market based and prices SRECS by supply and demand. Many states choose an open market system believing it the most efficient way to achieve policy goals of reducing pollution and carbon emissions from thermal generation in the energy mix. Broad participation in the market is certainly allowed by law and generally expected as pricing signals are believed to attract new, clean energy supply.

The Shugart Solar Project is a responsibly developed, well-regulated, private property where voters on Charles County have determined it to be a permitted use. According to standard economic theory, increase in supply of SRECs has a potentially positive benefit for every constituent with RPS obligations as it will lower the clearing price of all Maryland SRECs.

Shugart Solar SRECs will be purchased by our Customer under Maryland's market based RPS system which may:

- Choose to retire them as received to meet their internal mandates,
- Sell excess SRECs back into the market, or carry them forward up to 3 years, per the Maryland RPS open market design to allow other entities to meet Maryland RPS obligations, or
- Allow SRECs to expire to maintain an optimum incentive to support the fight against climate change by attracting new utility scale solar supply

All in all, our Customer will manage their SREC portfolio based on their own mandates and objectives, but any outcome is a clear win for Marylanders overall.

SECTION 7: ALTERNATIVE SITE ANALYSIS

Site evaluation is an inherent part of the utility scale solar development process. While reported in various ways via testimony, presentation, and submission into the Maryland state and county permitting processes we summarize again for this study. As early as 2016, Origis began evaluating the state of Maryland seeking candidate sites for a proposed solar energy project. Candidate sites are subject to market forces and engineering and environmental constraints.

Demand for renewable energy, particularly solar energy, has been increasing over time in response to several factors, including:

- Solar energy wholesale price reductions based on falling costs and technical advances;
- Energy market reforms creating visible price signals for each energy technology and locational value on the electric system;
- Pressure from commercial & industrial customers to increase clean energy as an input component and reduce their products and services carbon content;
- Pressure from voters for society to reduce its overall carbon footprint and fight climate change;
- And in conjunction with Maryland's voters, to increase the state Renewable Energy Portfolio Standard (RPS) goals and technical requirements;

The goal of the Shugart Solar Project is to supply cost-competitive, clean, renewable energy that satisfies all its customer's needs in a competitive industry. To successfully source and develop a site, a rigorous search program was commenced using the following standard industry practice criteria:

- Magnitude of solar resource at the site location;
- Parcel(s) large enough support utility scale solar scale economies;
- Currently available on the real estate market or owned by a seller or lessor willing to agree to a standard 3-year option that meets PJM interconnect requirements;
- Accessible electric transmission lines or a substation at a minimum voltage of 69 kV so the project may be cost effectively interconnected to the PJM electric system
- Electric capacity on the power lines suitable for interconnecting 25-40 MW of solar without triggering material network upgrade costs;
- Zoned with utility scale solar facility as a permitted use; and,
- Generally flat topography in the solar area with slopes of 10% or less.

In addition, to screen parcels for environmental criteria, the site selection team sought to:

- Avoid land within the Chesapeake Bay Critical Area;
- Avoid land with Designated Critical Habitat for federally-listed species;
- Maintain sensitivity to ongoing Maryland constituency farmland concerns;
- Avoid and/or minimize affecting wetlands and floodplains; and

- Avoid and/or minimize adverse effects to designated public resource lands (such as state forests, parks, recreation lands, designated battlefields or historic resources, and designated state wildlife management areas).

Origis reviewed existing transmission lines throughout the Southern Maryland which includes Charles County, the Eastern Shore, and Western Shore counties east of Hagerstown. Each area is potentially subject to major constraints that would render a project non-viable or cost prohibitive. For example, Maryland's Eastern Shore, while having good available open land, has transmission constraints that make the market price of energy highly uncertain for customers on the Western Shore. In addition, Western Shore counties north of Baltimore have a solar resource that is not as economic as that found further south. Other Western Shore counties, as another example, contain a predominance of smaller parcels that would require many contiguous and willing participants, which creates a practical barrier to successful siting.

Beyond these examples, each candidate site must be evaluated for its unique risk to completion profile. All these factors, energy pricing needs, project cost parameters, interconnection conditions, permitability and site constraints must be successfully navigated to reach construction of a successful project. A myriad of barrier conditions may present themselves at any time. An alternative site analysis is an integrated part of the utility scale solar site evaluation and development process.

In May 2016, Georgetown University publicly issued a Request for Proposals (RFP) seeking renewable solar resources that would support their goals of satisfying a portion of its annual power consumption with of offsite renewable power. Our understanding is that they and their advisors reviewed financial, technical and environmental criteria as part of their evaluation process from all forms of renewable energy including wind, solar, etc. For our response to the RFP, Origis eliminated from consideration alternative sites that were not capable of price-competitive renewable energy delivered at a busbar within proximity to the potential customer's load zone so that customer basis risk was reduced to acceptable levels. Basis risk is exposure to wholesale market pricing differences between two locations and is always an important factor for consideration of PJM energy market participants. Proximity is a very important basis risk mitigation technique.

Origis searched for other candidate sites within proximity and SMECO's service area in particular; however, large areas of land were eliminated based on the selection criteria and RFP requirements. Origis examined and contacted owners for several potentially suitable sites but found that most sites were either unavailable for purchase or lease, exhibited various design constraints upon closer examination, and/or had no viable access to existing transmission lines. Ultimately, Origis selected two adjoining properties on Shugart Valley Place for inclusion in the proposal. The solar project tract was available and the site satisfied Origis' selection criteria and the RFP criteria while the generation tie line tract remained subject to optimization and finalization after the RFP award.

Origis submitted the MD Solar 1 - Shugart Solar Project, and it was ultimately selected with a power purchase agreement signed in June 2017, whereby the PPA counterparty becomes a new Origis customer (Customer}.

The interconnection study process between MD Solar 1, LLC, SMECO and PJM was initiated for physical interconnection on the Ripley-Nanjemoy 69 kV transmission line and full project development commenced.

Many alternative site layouts were also analyzed within Shugart Solar's two parcels. As stated in the project Environmental Review Document, Origis, with the assistance and guidance of a distinguished and experienced local Maryland development team of consultants and legal representatives, developed a site plan that avoided highly sloped areas and most known environmental constraints through a careful design process. The site plan established important environmental buffers and setbacks that meet or exceed requirements. For environmental resources that could not be avoided, Shugart Solar carefully considered alternative layouts, site designs and engineering measures that would minimize adverse impacts to natural resources.

Origis performed detailed environmental, geotechnical and engineering studies on the Shugart Solar site to support permit applications and inform an iterative design process. The goal of the process was to design a proposed facility in a manner that satisfied solar generation obligations to SMECO while minimizing adverse impacts overall.

Key studies and findings of the detailed study and permitting process follow:

- The Forest Stand Delineation found evidence of past timber harvest activities and fully characterized the site for using required industry standards.
- The Charles County Board of Appeals concurred with Origis that the project is in accordance with the objectives of the Charles County Comprehensive Plan and conforms to the applicable zoning and special exception regulations.
- During the Certificate for Public Convenience and Need (CPCN) process, the proposed site was reviewed by the Department of Natural Resources who concurred that no Rare, Threatened, and Endangered species would be affected by the project.
- Pursuant to county and state CPCN requirements for setbacks from Tier II water features, wetlands, and other areas, a one hundred foot (100') average setback (minimum 75') was incorporated into the site layout and site plans.
- Following the Power Plant Research Program (PPRP) issuance of an independent Project Assessment Report, all relevant State Departments issued a joint letter to the PSC indicating no objection to the issuance of a CPCN.

In summary, the selected parcels for the Shugart Solar Project includes two willing property owners able to meet PJM 3-year minimum option criteria, is favorable for interconnection on the 69 kV transmission system, meets customer needs at a competitively sourced price, avoids where able and minimizes environmental impacts throughout the site, minimizes visual impacts, and avoids prime farmland. Overall, the Shugart Solar site was determined to be the most suitable location after reviewing many alternative sites. Following site selection, various treatment options and best management practices were evaluated to minimize potential effects. In addition, various site layouts were evaluated, and an iterative process of studies, design, and application of avoidance measures resulted in a site layout that best balances the production of solar energy and minimization of environmental impacts while fully meeting all customer needs.

Finally, alternative mitigation opportunities were reviewed for feasibility and effectiveness. The mitigation alternatives analysis began with evaluating the amount of available forest onsite for mitigation. It was determined that all required forest mitigation could be met within the two tracts. Origis prioritized the selection of additional forest mitigation by seeking afforestation opportunities within the Wards Run watershed and conservation of forest within the watershed. Offsite mitigation opportunities are constrained by a landowner's willingness to agree to the placement of perpetual easements on their land for the purposes of forest conservation. Due to the limited market of these opportunities, no offsite forest mitigation planting opportunities were found to satisfy the forest afforestation requirement.

SECTION 8: PROVISION AND REPLACEMENT OF ECOSYSTEM SERVICES

Shugart Solar will alter the landscape and current use of the land parcels it will rest upon. However, solar projects are largely benign additions and an excellent complement to the local environment. Although Shugart Solar is on private land and is a permitted use under the permit system, valuable ecosystem services will continue to be provided. And, after the gentle additions required by any, typical, solar project plus engineered civil assets specific to the project, it will easily retain most of the notional ecosystem service value in place. Benefits from carbon offset will increase the notional value to three to six times the current land use.

Ecosystem Services Introduction

Ecosystem services can be broadly defined as those economic benefits that man receives from nature and existing environmental processes. The concept is often an attempt, used in the context of governmental policy making and decision support, to place a notional value where no market forces or regulatory actions have placed an actual value on an environmental asset. When the services provided by the natural environment are changed due to anthropogenic modifications, these services can be lost, diminished to varying degrees, or replaced through restoration with mand-made alternatives. An ecosystem services framework is one approach for a society to balance diverse objectives or understanding trade-offs associated with development.

In the context of Shugart Solar, Charles County commissioned an Ecosystem Services Report in 2017 (MDNR, 2017) that estimated the economic value of selected ecosystem services within the county. The report focused on those services supplied by the existing conditions of forests, wetlands and agricultural lands. It is important to in the report that:

- The values presented were "intended for evaluating tradeoffs and informing decision-making, but do not indicate market value or compensatory value." (MDNR, 2017);
- The report establishes minimum, maximum and average values across the entire County for the purposes of broad conservation policy-making at a County or watershed scale, but values supplied by specific parcels cannot be obtained from this report alone;
- The actual cost of manmade alternatives and associated mitigation measures is most relevant to the discussion of Shugart Solar due to its replacement values, and furthermore.

Ecosystem Service Component Values

Ecosystem services are categorized into the following categories:

- Provisioning services (products directly obtained from ecosystems such as timber);
- Regulating services (benefits obtained from the regulation of ecosystem processes such as climate or water regulation);
- Supporting services (indirect services necessary for provision of other services); and
- Cultural services (nonmaterial benefits such as aesthetic values) (Rolando, 2017)

Shugart Solar Component Values

For Shugart Solar, the relevant discussion focuses on provisioning, regulating and supporting services because the project parcels are not providing supporting or cultural services in any significant way. Shugart Valley Solar will be constructed on private lands that are not used for public recreation or aesthetic value and therefore have no impact to the supply of cultural services or community benefits.

- Provisioning Services

The provisioning services of the site are currently limited to timber production. No food or fiber is being produced from the site although it has previously hosted agricultural uses. Installing a solar facility will preclude future timber and on-site agricultural provisioning services for the life of the project within the footprint of the solar array. Because the undeveloped, "outside the fence" portions of the site will be placed in permanent forest conservation, these conservation areas will, in perpetuity, no longer provide any meaningful provisioning service with regards to timber production.

- Regulating and Supporting Services

Regulating and supporting services including air pollution offsets, carbon sequestration, storm water mitigation, groundwater recharge, and nutrient uptake, are currently supplied by the existing forested site. However, the Shugart Valley Solar facility will continue to effectively provide these services because the natural services are replaced by manmade alternatives.

Air Pollution Offsets

Air pollution is counted as defined as the pollutant removal value of:

- Carbon Monoxide (CO)
- Air Pollution Removal: Nitrogen Dioxide (NO2)
- Air Pollution Removal: Sulfur Dioxide (SO2)
- Air Pollution Removal: Ozone (O3)
- Air Pollution Removal: Particulate Matter (PM2.5)

The relative value per acre of the current land use at the Shugart Solar site is modest and the economic impact of many of these pollutants is made in a relatable way in Carbon Offset Magnitude section above. It is clear that solar energy is a practical offset to thermal electric generation stations which contribute to air pollution in a major way.

Carbon Sequestration

The valuation of carbon sequestration as an ecosystem service is related to the conclusions in our Carbon Offset Magnitude section above where a multiple of 100 to 200 times the current forest annual offset is clearly and easily established. Results of the carbon offset factor will be applied below to the DNR ecosystem services methodology.

Groundwater recharge

Groundwater recharge is one regulating service provided by a forest. However, added impervious surfaces are a very small component of the average solar energy project and pales in comparison to a typical residential community, parking lot or shopping center for example. The single axis tracking technology will move the solar panels every day following the sun. This will allow precipitation to infiltrate into the soil throughout the solar site and the infiltration rate of the existing soils are not modified. The slight increase in impervious surfaces due to roads, pads and substation will be offset by the storm water management facilities engineered to replace the forest coefficient values. Vegetation planned for the site will also include deep-rooted species that have been shown to improve infiltration.

Nutrient Uptake

Nutrient uptake is an important ecosystem service, especially regarding the Chesapeake Bay watershed system. The vegetation in the solar array will not contribute to additional nutrient loading in the receiving streams because fertilizer and other additives are minor and only selectively needed to maintain the vegetation. Application of fertilizer at the average solar energy project pales in comparison to practices and requirements found in food production on an agricultural site. The grasses, forbs and legumes under the solar array are efficient at nutrient uptake of nitrogen and phosphorus, in particular and nutrient uptake services would still be provided by the vegetation underlying the solar facility.

Stormwater Mitigation

Approximately 40% of the ecosystem service value, notionally applied in DNR's methodology, is due to the value of storm water mitigation. The existing forested condition provides stormwater retention services through mechanisms such as canopy interception, evapotranspiration, and infiltration.

At Shugart Solar, these services are replaced through manmade engineered stormwater management practices and infrastructure noted in the Characterization of Engineered Stream Impact section. This service is maintained through the implementation of engineered storm water facilities as part of the project permit process. Shugart Solar has worked with the state and county to balance stormwater protections beyond the standard requirements. Enhanced vegetated buffers between the solar facility and receiving streams continue to provide storm water mitigation through evapotranspiration, retention and infiltration. The cost to replace the ecosystem service of stormwater mitigation is part of the project cost.

Wildlife Habitat and Biodiversity

Wildlife habitat will not be the same as an open and untouched forested parcel. Neither will it be altered even near to the extent as it would were farming reintroduced, a housing community was developed, an industrial business such as the adjoining timbering and mulching plant were expanded, a road front commercial center was to be developed, or to the extent active timbering was commenced. This land is not a public park. Private property rights, as regulated via the democratically agreed permitting system, make all of these uses viable alternative land uses.

The site condition has been fully reported on the record and by impartial parties such as the Power Plant Review Board (PPRP) and is known to experience selective timbering, hunting and other common rural activities. The Shugart Solar Project has been sensitively designed to retain significant portions of forest land placed in perpetual conservation easements on site. Open meadow, a generous pollinator plan using native and naturalize plantings, modest fencing, and minimal operating activity on-site are known to be gentle usage of land and found commonly at solar energy projects. While a study of such contributions is not required by the permit process and has not been performed, Shugart Solar will clearly contribute material value to both habitat and biodiversity, including insect, flora and fauna.

Investments in Conservation

A factor not included in the comparative valuation but contributes additional positive value is Shugart Solar's investments in conservation. The mitigation for the Shugart Solar project itself includes onsite forest conservation of over 225 acres for an estimated easement market value over $500,000. The investment in these conservation areas is enabled and funded by the project. **Recent findings show that for every dollar invested in conservation, seven dollars of ecosystem service value is returned, resulting in a return of greater than $4,200,000 in Charles County (Lehigh Valley 2014, MDNR 2017).**

Shugart Solar Ecosystem Services Comparative Valuation

The Ecosystem Services Report in 2017 places an average value on an undefined parcel of land and DNR has followed up with a per parcel estimate. Using DNR's land tool, Shugart Solar's parcels are enumerated below as an Average Annual Notional Value Per Acre and then an Existing Condition Notional Value. Holding Air Pollution Offset and Carbon Sequestration out for further analysis a fair representation of the notional value per acre is $2,276 and a total Existing Condition Notional Value of $1,282,751 per annum.

Table: Ecosystems 1

Ecosystem Service Name	Units	Avg Annual Notional Value Per Acre	Existing Condition Notional Value	Representative Meadow and Stormwater Value Factors	Repesentative Adjusted Notional Value
Air Pollution Offset (SOx, NOx, etc)	various	$ 7.69			
Carbon Sequestration	mT per year	$ 88.95			
Groundwater Recharge	m3 per year	$ 248.64	$ 146,289.83	95%	$ 138,975.34
Nitrogen Uptake Potential Index	Indexed	$ 39.87	$ 23,457.91	79%	$ 18,531.75
Stormwater Mitigation Potential Index	Indexed	$ 911.55	$ 536,316.62	95%	$ 509,500.79
Wildlife Habitat and Biodiversity Potential Index	Indexed	$ 980.16	$ 576,686.94	79%	$ 455,582.68
Total Annual Economic Value		**$ 2,276.86**	**$ 1,282,751.30**		**$ 1,122,590.56**
% of Existing Condition Value					**88%**

It is important to note that of the 588 total acres at the two parcels, approximately 339 will be preserved and placed in perpetual conservation easements[11]. **Therefore, at minimum, approximately 58% of the notional parcel value would remain without any additional credit factor being applied to ecosystem services supplied by Shugart Solar.** However, the ecosystem services value will remain, per the discussion of each factor below.

- Groundwater Recharge Factor Discussion

Shugart Solar will be required under Maryland Stormwater Manual to maintain an engineered Groundwater Recharge value under Standard No. 3. In addition, the proposed groundcover will prioritize pollinator friendly, native and naturalized species which, unlike shallow-rooted turf, deep-rooted native flowers and grasses significantly increase organic matter and the quality of soils. Some of

[11] Shugart Solar is expected to provide land bank services to another solar project for approximately 85 acres.

the species selected for pollinator benefits have deep root systems (up to 7' at maturity) that provide a pathway for surface water to infiltrate into the soil. Species with deep roots can improve infiltration rates by slowing runoff, breaching the surface and providing root passages for water percolation. ***While it will be engineered to 100% compliance, it is easy and informative to assign a notional value of 95% to the Representative Meadow and Stormwater Value Factor.***

> *Standard No.* ***3*** *Annual groundwater recharge rates shall be maintained by promoting infiltration through the use of structural and non-structural methods. At a minimum, the annual recharge from post development site conditions shall mimic the annual recharge from pre-development site conditions.*

- Nitrogen Uptake Factor Discussion

The exact uptake of nitrogen in a comparative sense is not a required in the Maryland permitting system and is beyond the scope of this report. Literature will show that trees and plants vary greatly and are site specific. We note that general literature shows that common pollinator plantings, such are clover, compare favorably with many types of trees. And, also note that alternative uses such as farming and residential development generally produce very significant nitrogen and phosphate pollution into the ecosystem, which will be absent at a solar energy project such as Shugart Solar. ***In the interest of a comparative ecosystem services evaluation it is easy and informative to assign a total notional value of 79% to the Representative Meadow and Stormwater Value Factor by assigning a low value of half the Nitrogen Uptake efficiency to the solar area (equal to 42% of the project area) combined with 58% of the parcel that will remain the same in perpetuity.***

- Stormwater Mitigation Factor Discussion

Like Groundwater Recharge, Shugart Solar will be required under Maryland Stormwater Manual to maintain an engineered Groundwater Recharge value under Standard No. 6. ***While it will be engineered to 100% compliance and engineered further as reported in the Characterization of Engineered Stream Impact section above, it is easy and informative to also assign a notional value of 95% to the Representative Meadow and Stormwater Value Factor.***

> *Standard No.* ***6*** *Control of the two-year and ten-year frequency storm events is required if the local authority determines that additional stormwater management is necessary because historical flooding problems exist and downstream floodplain development and conveyance system design cannot be controlled. In addition, safe conveyance of the 100-year storm event through stormwater management practices shall be provided.*

- Wildlife Habitat and Biodiversity Factor Discussion

As noted above, wildlife habitat will not be the same as an open and untouched forested parcel. Neither will it be depleted as it would be for farming, housing, timbering, industrial or commercial businesses all of which are permittable in this private land. Bearing also in mind that enhanced wetland and stream buffers, where much of the most diverse activity is found, will be placed in conservation in perpetuity and may even grow in quality over time for this reason. ***In the interest of a comparative ecosystem services evaluation it is easy and informative to assign a total notional value of 79% to the Representative Meadow and Stormwater Value Factor by assigning a low value of half the***

Habitat and Biodiversity efficiency to the solar area (equal to 42% of the project area) combined with 58% of the parcel that will remain the same in perpetuity.

Conclusion: Shugart Solar Provision of Ecosystem Services

The value of Ecosystem Services has no legal bearing on the permit system in Maryland, is intended for evaluating tradeoffs and informing decision-making, but does not in indicate actual market value or compensatory value to private landowners in any sense, thereby it is notional only.

However, solar is a an environmentally sensitive and gentle land use. Taking a generous amount of variation into account by applying 95% Adjustment Factors to Groundwater Infiltration and Stormwater while applying a 79% Adjustment Factor estimate to Nitrogen Uptake and Habitat & Biodiversity it is easy to see in Table: Ecosystems 1 that **88% of original notional value is maintained by Shugart Solar prior to carbon offset calculations.**

Furthermore, applying the minimum 58% factor for land that remains the same plus crediting engineered groundwater and stormwater outcomes (in effect ignoring non-engineered value inside the solar array for Nitrogen Uptake Potential and Wildlife Habitat and potentially enhanced quality due to conservation easements in generous buffers around streams and wetlands, both of which are false premises in our opinion), it is easy to see in Table: Ecosystems 2 that **78% of original notional value is maintained by Shugart Solar prior to carbon offset calculations.**

Table: Ecosystems 2

Ecosystem Service Name	Units	Avg Annual Notional Value Per Acre	Existing Condition Notional Value	Representative Meadow and Stormwater Value Factors	Repesentative Adjusted Notional Value
Air Pollution Offset (SOx, NOx, etc)	various	$ 7.69			
Carbon Sequestration	mT per year	$ 88.95			
Groundwater Recharge	m3 per year	$ 248.64	$ 146,289.83	95%	$ 138,975.34
Nitrogen Uptake Potential Index	Indexed	$ 39.87	$ 23,457.91	58%	$ 13,605.59
Stormwater Mitigation Potential Index	Indexed	$ 911.55	$ 536,316.62	95%	$ 509,500.79
Wildlife Habitat and Biodiversity Potential Index	Indexed	$ 980.16	$ 576,686.94	58%	$ 334,478.42
Total Annual Economic Value		**$ 2,276.86**	**$ 1,282,751.30**		**$ 996,560.14**
% of Existing Condition Value					**78%**

Comparing Tables 1 and 2 above, the results suggest that $996,000 to $1,122,00 of ecosystem services will be supplied by the Shugart Solar Project every year of its viable project life, projected to be 35 to 40 years. If one considers the notional value "lost" it is expected to be $160,000 to $286,000 under these generous factor adjustments. Noting that these "lost" values have not withstood the test of market forces and contribute no compensation whatsoever to private landowner, whatever the precise value may be, **any true amount "lost" is well below the forecasted $654,000 real annual contribution to the local economy even before factoring climate change fighting carbon offsets.**

Turning to carbon offsets, in the Carbon Offsets Magnitude section it was relatively easy using commonly applied metrics to determine that a factor of 100 to 200 times the current use. Applying:

- A 100 times factor and a comparative 200 times factor;
- To the $88.95 average per acre value of the existing use;
- Times the 249 acres effected within the project limit of disturbance[12];
- **Shows results, according to the DNR methodology, of Shugart Solar creating a notional value between $2,214,895 and $4,429,710 of extra value based on carbon alone**.
    - *Note: Analysis of the Pollution Offsets is included above and does not need to be added here.*

To conclude, the Shugart Solar Project, like most solar projects, is a benign and environmentally friendly use of land. Within that context, notional values of ecosystem services may shift in small ways and natural benefits may possibly be substituted with equally beneficial man-made assets. At Shugart Solar overall, the site should supply 78% to 88% or more of the same value prior to consideration of tangible economic and carbon offset benefits to society. **With carbon offsets included the Shugart Solar project creates a massive, $3,211,415 to $5,552,300 positive notional value in every year of the project life.**

Which, in summary, is an extremely positive addition to the community and easily justified.

REFERENCES: Ecosystem Services

Lehigh Valley Planning Commission. *Lehigh Valley Return on Environment*. 2014.

Maryland Department of Natural Resources (MDNR). *Accounting for Ecosystem Services in Charles County, Maryland*. March 2017.

Rolando, Turin, et al. Key ecosystem services and ecological intensification of agriculture in the tropical high-Andean Puna as affected by land-use and climate changes. *Agriculture, Ecosystems & Environment*, Volume 236, Pages 221-233. 2017.

12 Note: In order to be conservative, the SEJ does not factor in recently farmed areas, open meadows and housing areas already found within the solar area.

SECTION 9: CONCLUSION AND SOCIAL ECONOMIC JUSTIFICATION

Shugart Solar is barely impacting the Tier II stream because solar is an inherently gentle use of the land and engineering tools are readily available to protect streams and the environment. At the same time Shugart Solar will add millions of dollars in real value to the local economy.

Shugart Solar has a carbon offset impact that is 100 to 200 times the existing site use and the fight against climate change is real and dire. Holding back these carbon benefits will have large impacts on Marylanders and the Chesapeake Bay.

Marylanders take climate change seriously and have democratically voted to fight via the Renewable Portfolio Standard and by the system of permitted land use regulations in Charles County. Many potential project sites were studied, which is natural and inherent in the solar development process. Shugart Solar is an excellent site for a solar project and has been carefully designed in a sensitive and responsible manner.

The value of Ecosystem Services has no legal bearing on the permit system in Maryland, is intended for evaluating tradeoffs and informing decision-making, but does not indicate actual market value or compensatory value to private landowners in any sense, thereby it is notional only. However, since solar is a an environmentally sensitive and gentle land use, and taking variation into account for illustration, it is easy to see that at least 78% and more likely 88% of original notional value is maintained prior to carbon offset calculations. Whatever the precise value, any true amount lost, prior to factoring carbon offsets in, is well below the forecasted $654,000 real annual contribution to the local economy even before factoring in carbon offsets.

With carbon offsets included at a factor shown to be 100 to 200 times the current use, Shugart Solar's ecosystem services provide a notional $3,200,000 to $5,500,000 of total value. Therefore, Shugart Solar creates a massive, positive value which is an extremely valuable addition to Charles County and to Maryland.

In summary, the very low impact and the very high value of real and social local benefits the project provides, makes Shugart Solar easily justified.

APPENDIX A: MEASURING ECONOMIC AND FISCAL IMPACTS

The expenses incurred in the building and maintenance of Origis Energy's Shugart Solar Project provide the basis for estimating a broad range of economic and fiscal impacts. These values reflect economic activity that is directly created by the development of the site for the solar farm as well as expenses incurred during the ongoing maintenance that accompanies operations. Impacts arising from these activities include not only the direct effects like clearing the site, constructing the solar farm, and maintaining the site, but also multiplier effects.

Jobs created by constructing and maintaining the Shugart Solar Project, for example, are considered a direct effect. Indirect effects occur when Origis Energy and its subcontractors purchase goods and services from other firms in Maryland. These purchases include a very broad range of activities from copy paper to advertising services from local firms. These purchases by Origis Energy and its subcontractors represent the beginning of the supply chain. These suppliers of Origis Energy and its subcontractors will in turn buy utility services and rent office space among many other items and services from other local firms. In its totality this succession of purchases by suppliers and suppliers of suppliers creates indirect effects.

Wages and income received by the employees of Origis Energy as well as the employees of its subcontractors and Maryland-based businesses in the supply chain whose work is linked to the Shugart Solar Project will create additional effects. A substantial share of these wages is spent in Maryland for a very broad range of consumer purchases from housing and groceries to entertainment and birthday gifts. The economic activity associated with augmented consumer purchases is termed the induced effect.

These direct, indirect, and induced effects can be measured along three dimensions: employment (measured in full-time and part-time jobs), income including benefits (measured in dollars), and output or sales of goods and services (measured in dollars). Because the mix of full-time and part-time jobs is heavily weighted towards full-time employment, the average estimated job is equal to 1 year of labor at an almost full-time rate. These effects are estimated using proprietary software and a computer model created for this analysis.[13]

This analysis looks at impacts relative to Maryland and its county-level political jurisdictions. Because the Shugart Solar Project will likely have impacts in many counties across the state, the economic and fiscal impacts on the county level are based on averages for all of Maryland's counties.[14]

In addition to economic impacts, the construction and operation of the Shugart Project will create fiscal impacts, streams of tax revenue and fees for Maryland and county-level governments. This analysis includes estimates of augmented income and sales tax collections. While other tax revenue will be generated, income taxes at the local and State level and State sales taxes represent the most important and significant tax revenues generated by the project. The Maryland Comptroller publishes extensive information regarding average effective rates for these taxes.

[13] The analysis is based on software and data created by IMPLAN. IMPLAN has become the industry standard for the kind of input-output analysis conducted for this project. Using IMPLAN software and data, Sage crafted a custom economic and fiscal impact model specific to this analysis.

[14] IMPLAN generates economic and fiscal impacts at the state and local level based on average conditions across the state.