

# Prospects for Large-scale Solar on Degraded Land in West Virginia

Joey James  
Evan Hansen

Downstream Strategies  
295 High Street, Suite 3  
Morgantown, WV 26505  
[www.downstreamstrategies.com](http://www.downstreamstrategies.com)



## ABOUT THE AUTHORS

### Joey James

Mr. James is a multi-disciplinary researcher with experience in a broad range of resource management topics. He has professional experience in the public, non-profit, and private sectors and has worked extensively in energy policy analyses, geographic information system development, database management, environmental data analysis, and environmental outreach.

### Evan Hansen

Mr. Hansen explores resource and environmental problems and solutions in three areas: water, energy, and land. He manages interdisciplinary research teams, performs quantitative and qualitative policy and scientific analyses, provides litigation support and expert testimony, develops computer tools, provides training, and performs field monitoring.

### Appalachian Stewardship Foundation

This project was made possible with the generous support of the Appalachian Stewardship Foundation. The Foundation, established as a result of a settlement with Longview Power in Madsville, West Virginia, was created to mitigate the damage to the environment caused by energy development and use, to reduce greenhouse gas emissions, and to protect freshwater streams and tributaries. Its vision is for environmental values to lead our energy future—clean streams, clear skies, and a stable climate, with the least amount of energy necessary to provide the goods and services we need.

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### Downstream Strategies

Downstream Strategies is a West Virginia-based consulting firm, with a full-time staff of 13, which offers services that combine sound interdisciplinary skills with a core belief in the importance of protecting the environment and linking economic development with natural resource stewardship. We are considered the go-to source for objective, data-based analyses, plans and actions that strengthen economies, sustain healthy environments and build resilient communities.

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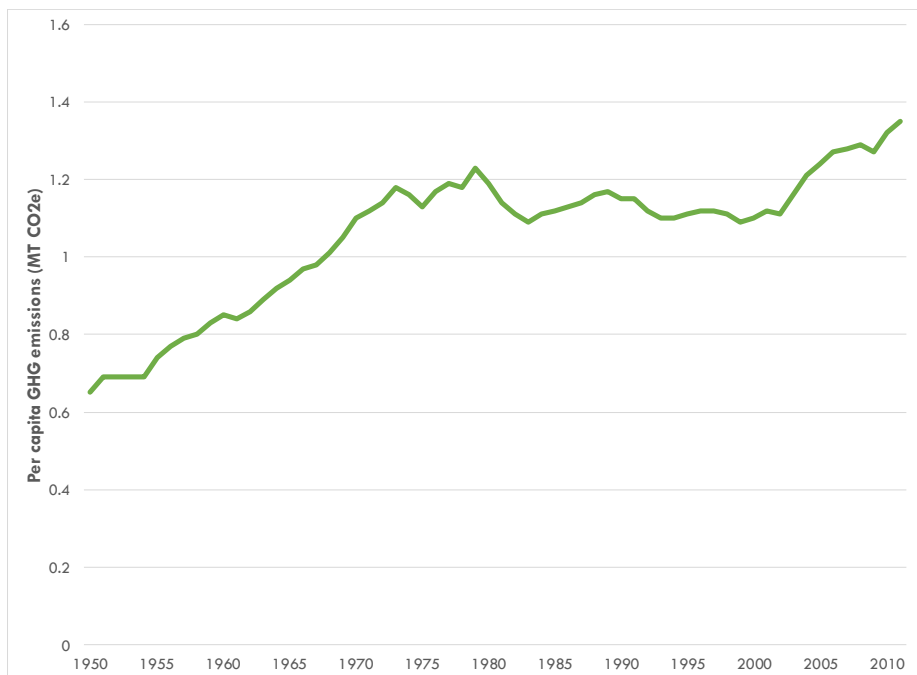
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# 1 INTRODUCTION

The upward trend of global greenhouse gas (GHG) emissions is a defining challenge of the 21st Century that requires leadership from the world's largest economies and high levels of cooperation throughout the international community. It also requires actions by state and local governments and electric utilities.

2016 was the hottest year on record, and 2014-2016 were the three hottest years on record (NASA 2017). If action is not taken to reduce GHG emissions, temperatures could rise by as much as 11.5 degrees Fahrenheit by 2100 (EPA 2015). As shown in Figure 1, global per capita emissions continue to rise. Today, the effects of climate change are visible around the world (EPA 2015). All landscapes are affected. If global GHG emissions continue to rise, the effects we observe today will continue to intensify, putting human health, infrastructure, and natural ecosystems at increased risk. (IPCC 2014; Van Nostrand et al. 2016)

**FIGURE 1: GLOBAL PER CAPITA GREENHOUSE GAS EMISSIONS, 1950-2011**

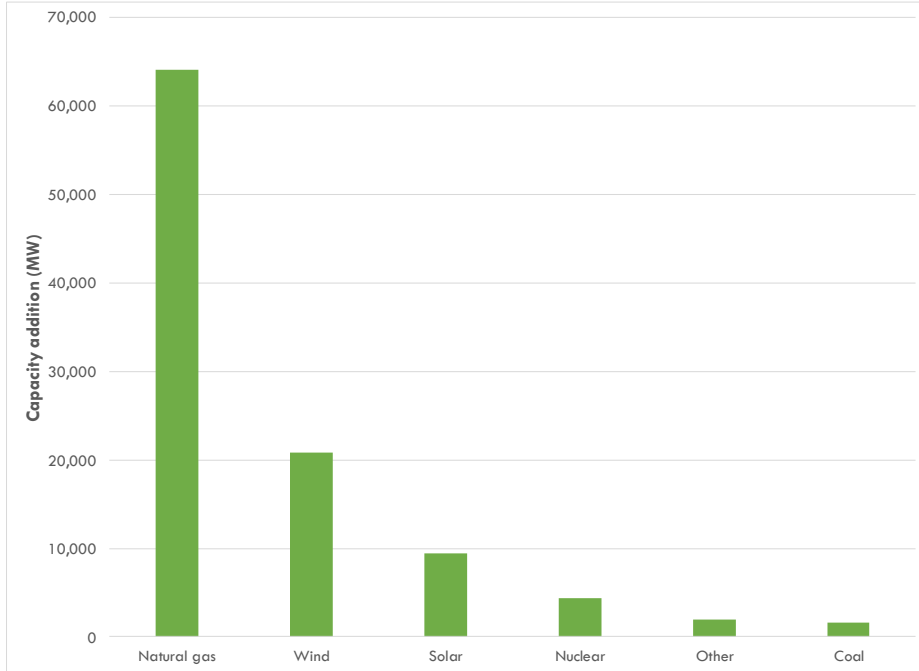


Source: Boden et al. (2015).

In the face of these challenges, investment in renewable energy is at an all-time high. In the United States, despite low wholesale electricity rates, uncertainty about policy and incentives, and low natural gas prices, growth in the renewable energy sector continues to outpace projections (Deloitte 2016). Solar energy, in particular, continues to have record-breaking growth year over year (Ola 2017). As shown in Figure 2, while most new electric power plants in the United States are projected to be fired by natural gas, wind and solar generation far outpace coal (EIA 2017).

Worldwide, as nations adopt ambitious goals to fight climate change, solar photovoltaic (PV) projects have emerged as a frontrunner in the new low-carbon economy (Goldman Sachs 2015), and despite political uncertainty, solar stocks are expected to have a bright future (Motley Fool 2016). In 2015, investments in renewable power capacity was more than double that of new coal and natural gas generation (UNEP 2016).

FIGURE 2 : PLANNED CAPACITY ADDITIONS IN THE UNITED STATES, 2016 – 2023



Source: EIA (2017).

As solar markets have exploded and the new low-carbon economy has improved its footing, West Virginia’s economy has crumbled. Rising costs, reduced demand, environmental regulation, and increasingly cost-competitive alternatives are leading to the rapid decline of what has long been considered West Virginia’s bread and butter: coal. The market share of coal in the national electric power sector declined from 50% in 2005 to 33% in 2016 (EIA 2016(a); Van Nostrand et al. 2016), and electricity generated from natural gas is on the rise (EIA 2016(b)).

As markets have shifted and demand has dropped, West Virginia’s miners and the once-prosperous companies that employ them have fallen on hard times. As shown in Figure 3, mining employment in West Virginia has dropped 43% since 2012 (MSHA 2016). Arch Coal, Alpha Natural Resources, and Patriot Coal have all gone through bankruptcy proceedings (Plummer 2016). These coal companies, among others, own a significant amount of land in West Virginia (WVCBP 2013). This has raised significant concern, statewide and nationally, about the management of environmental liabilities and future economic activity on these mine lands (Mufson & Warrick 2016).

**FIGURE 3: WEST VIRGINIA MINING EMPLOYMENT, 2000-2015**



Source: MSHA (2016).

In addition to post-mined land, West Virginia’s small towns and rural communities are dotted with other types of degraded lands, including abandoned mine lands (AMLs), hazardous waste sites,<sup>1</sup> landfills, Superfund sites,<sup>2</sup> and Brownfield sites.<sup>3</sup>

Large-scale solar development on these sites would take advantage of West Virginia’s readily available degraded lands and capitalize on the growing 21<sup>st</sup> Century energy market. Furthermore, this type of development would honor West Virginia’s rich energy production heritage, reduce state GHG emissions, and put West Virginians back to work.




As utilities such as Kentucky Utilities Company and multinational corporations like Amazon and Apple increase their investments in large-scale solar in the Appalachian region (See Figure 4), it is important that West Virginia position itself to attract this business. Here, we explore the opportunities for large-scale solar on degraded lands in West Virginia.

<sup>1</sup> Hazardous waste sites are Resource Conservation and Recovery Act facilities where property owners are currently, or have recently, managed, transported, or disposed of hazardous wastes.

<sup>2</sup> Superfund sites are contaminated by hazardous waste that poses a risk to human health or the environment.

<sup>3</sup> Brownfield sites are former industrial or commercial facilities where future use is affected by real or perceived environmental contamination.

FIGURE 4: SELECTED RECENT LARGE-SCALE SOLAR PV PROJECTS IN APPALACHIA

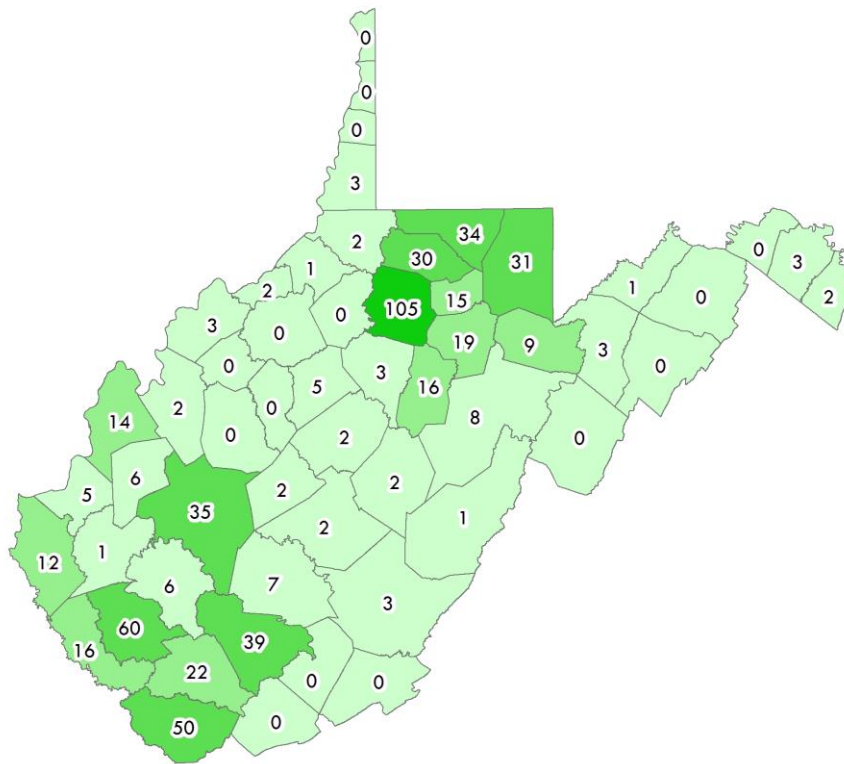
 <p>Photo: Clair (2016).</p>	<p>Kentucky Utilities Company recently added Kentucky's largest solar facility to its generation portfolio. The 10-MW facility, located at the utility's E.W. Brown Generating Station on the banks of Lake Herrington outside of Harrodsburg, Kentucky, boasts more than 44,000 solar panels on fixed tilt rack systems. The facility is expected to produce roughly 19,000 MWh of electricity annually, enough to power over 1,500 homes. (Kentucky Utilities 2015)</p>
 <p>Photo: Community Energy Solar (2016).</p>	<p>Amazon is currently constructing significant solar infrastructure in Virginia. Amazon Solar Farm US East is expected to generate approximately 170,000 MWh per year and is located in Accomack County, Virginia. An additional four solar farms—each with a capacity of 20 MW—located in New Kent, Buckingham, Sussex, and Powhatan counties in Virginia are expected to start generating more than 190,000 MWh annually by the end of 2017. Further, an additional solar farm located in Southampton County, Virginia is expected to start generating approximately 210,000 MWh of solar power annually by the end of 2017. (Amazon 2016)</p>
 <p>Photo: WCNC-TV (2012).</p>	<p>Apple has invested heavily in solar panels used to power its data center in North Carolina with the development of three 100-acre solar farms in the state. Collectively, these solar farms account for 58 MW of solar energy capacity. Apple's goal is for 100% of its operations to run on renewable energy sources and has already developed solar resources to power its facility in Nevada. (Fehrenbacher 2014)</p>

## 2 POTENTIAL SITES FOR LARGE-SCALE SOLAR PV DEVELOPMENT

AMLs, landfills, hazardous waste sites, Superfund sites, and Brownfield sites have enormous potential for siting renewable energy projects. The RE-Powering America’s Land Initiative (the “RE-Powering Initiative”)<sup>4</sup> developed national-level screening criteria for siting wind, solar, biomass, and geothermal facilities. It identified significant opportunities for solar PV.

The RE-Powering Initiative examined site suitability for three types of grid-tied solar PV deployments: utility-scale, large-scale, and policy-driven PV.<sup>5</sup> In this report, we consider large-scale PV sites: those with a generation capacity greater than 300 kW and that meet certain other criteria. Of the 2,445 sites assessed in West Virginia as part of the RE-Powering Initiative, 582 sites (Figure 5), totaling more than 61 square miles, were found to be viable for large-scale PV development.

**FIGURE 5: LARGE-SCALE SOLAR PV SITES BY COUNTY IDENTIFIED BY THE RE-POWERING AMERICA'S LAND INITIATIVE**



Source: EPA (2017)(a).

<sup>4</sup> The RE-Powering America’s Land Initiative was established by the United States Environmental Protection Agency’s (EPA’s) Office of Solid Waste and Emergency Response and Center for Program Analysis and the United States Department of Energy National Renewable Energy Laboratory (NREL).

<sup>5</sup> Large-scale PV viability is defined as a site with a generation capacity greater than 300 kW, greater than 3.5 kWh/m<sup>2</sup>/day direct normal irradiance (DNI), more than two acres of land, and less than a mile to transmission and graded roads. Utility-scale PV is defined as a site with a generation capacity greater than 6.5 MW, greater than a 5 kWh/m<sup>2</sup>/day DNI, more than 40 acres of available land, and a location less than 10 miles to transmission and graded roads. Policy-driven PV viability is defined as a site that has development potential due to state policies; these sites have a generation capacity greater than 6.5 MW, greater than 3.5 kWh/m<sup>2</sup>/day DNI, more than 40 acres of land, and a location less than 10 miles to transmission and graded roads.





FIGURE 7: SITES FOR FURTHER CONSIDERATION

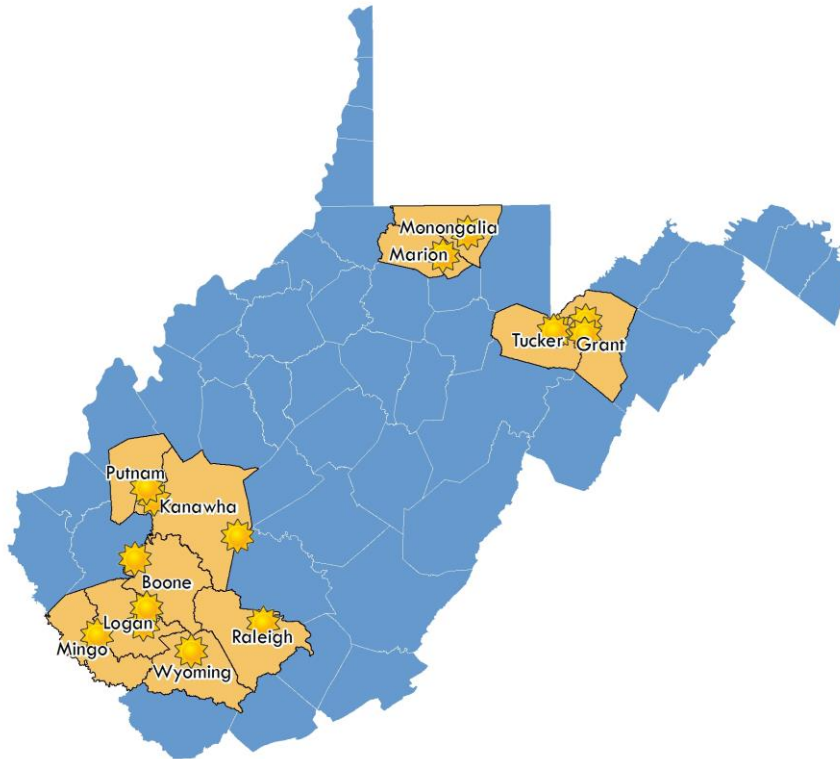
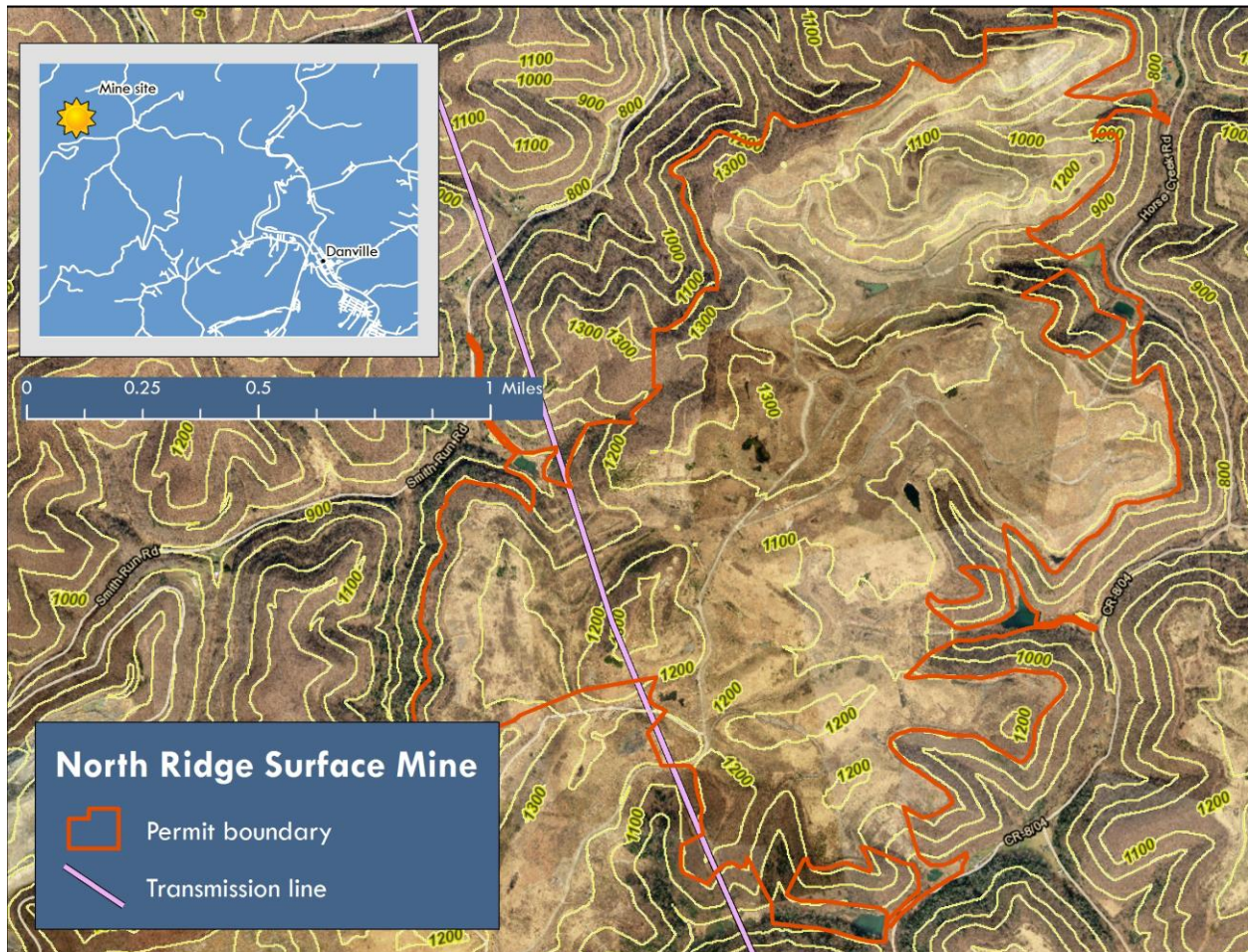


TABLE 1 : SITES FOR FURTHER CONSIDERATION

Site	County	Site type
North Ridge Surface Mine	Boone	Mine
Vepco Job Surface Mine	Grant	Mine
Buffalo Coal Surface Mine	Grant	Mine
Jack's Branch #1 Surface Mine	Kanawha	Mine
Union Carbide	Kanawha	Hazardous waste
Northwest Ruffner Surface Mine	Logan	Mine
Mingo Logan Surface Mine	Logan	Mine
Fairmont Coke Works	Marion	Superfund
Harless Industrial Park	Mingo	Mine
Morgantown Industrial Park	Monongalia	Superfund
Great Lakes Solutia	Putnam	Hazardous waste
Raleigh County Landfill	Raleigh	Landfill
Tucker County Landfill	Tucker	Landfill/Mine
Tucker County Industrial Park	Tucker	AML
Simmons Fork MTR Mine	Wyoming	Mine

## 2.1 North Ridge Surface Mine

The North Ridge Surface Mine, Permit S-50-2095, covers 1,079 acres in northwestern Boone County. The property, now under the responsibility of ERP Environmental Fund, is a part of the Rock Creek Development Park, a site touting over 12,000 acres of developable land, which has seen significant investment from the State (WVDEP 2017, WVDC 2017). This site could host a nearly 180-MW large-scale PV facility; however, given topographic constraints, a smaller facility is more likely achievable.



## 2.2 VEPCO JOB SURFACE MINE

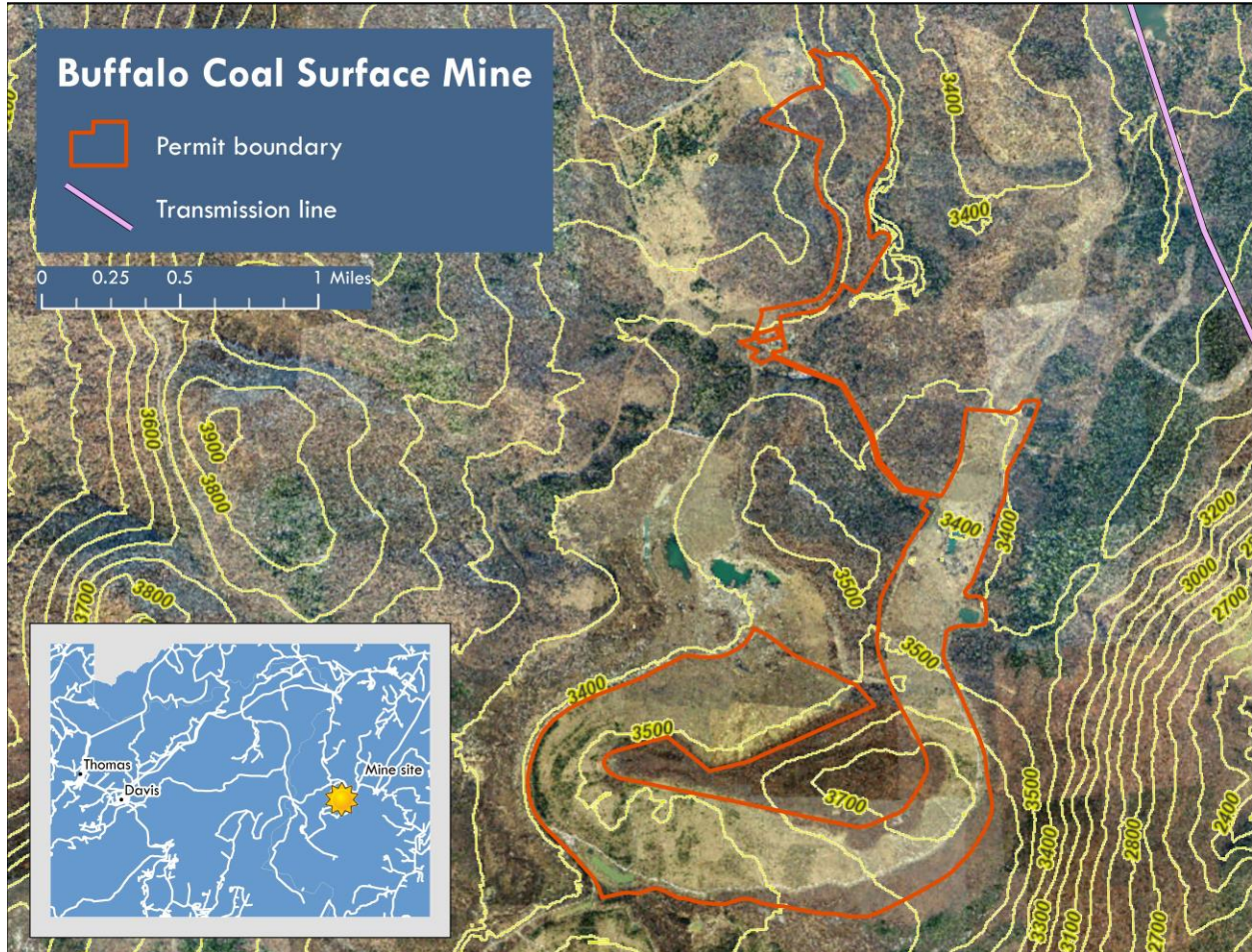
The Buffalo Coal Company mined a 595-acre property associated with permit S-20-0186 in Grant County (WVDEP 2017). The site could host a nearly 100-MW large-scale PV facility;<sup>6</sup> however, given topographic and land cover constraints, a smaller facility is more likely achievable.



<sup>6</sup> In this report, we estimate that six acres of land are required per MW of installed capacity.

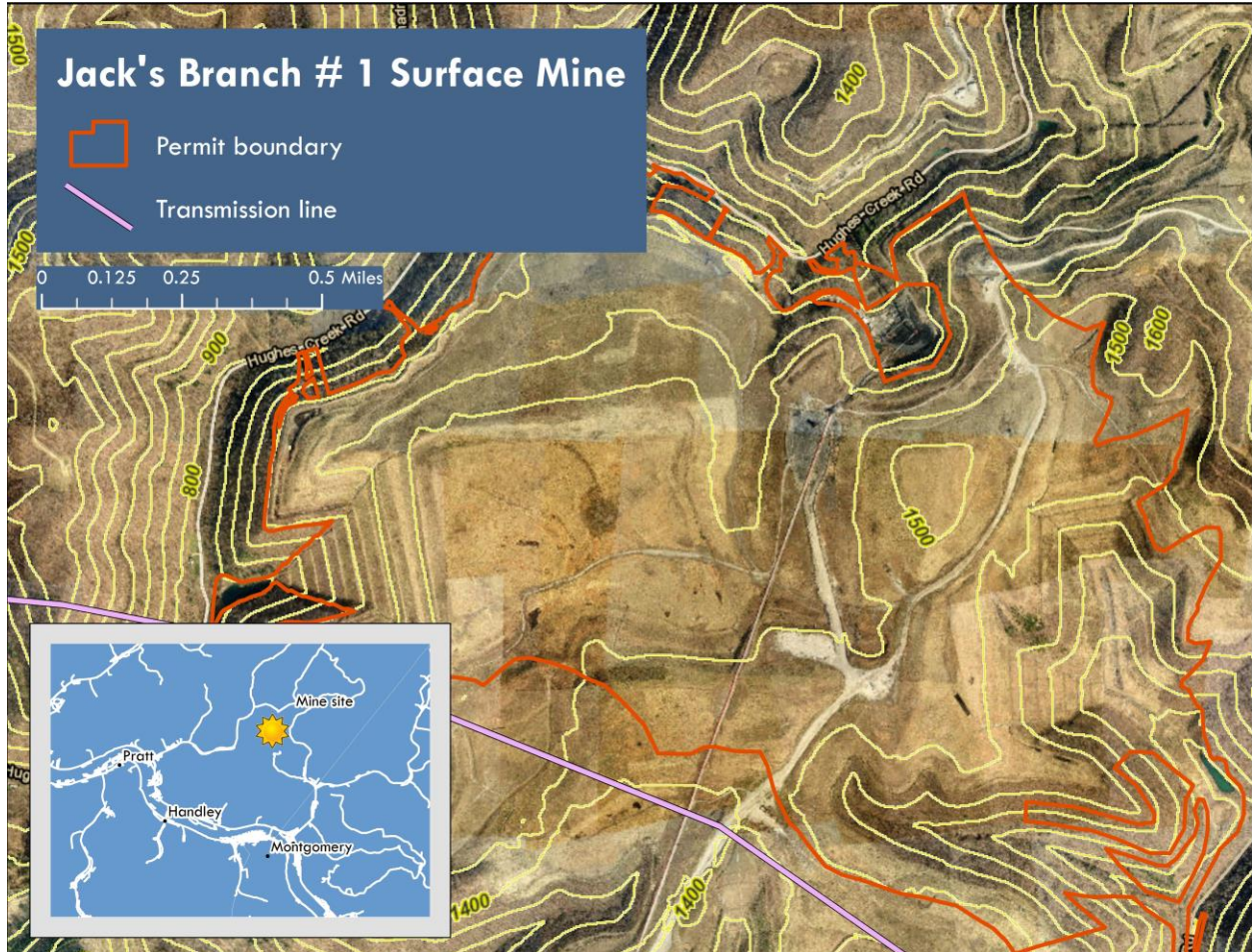
### 2.3 BUFFALO COAL SURFACE MINE

The Buffalo Coal Company mined a 934-acre property associated with permit S-01-0084 in Grant County (WVDEP 2017). The site could host a 155-MW large-scale PV facility; however, given topographic and land cover constraints, a smaller facility is more likely achievable.



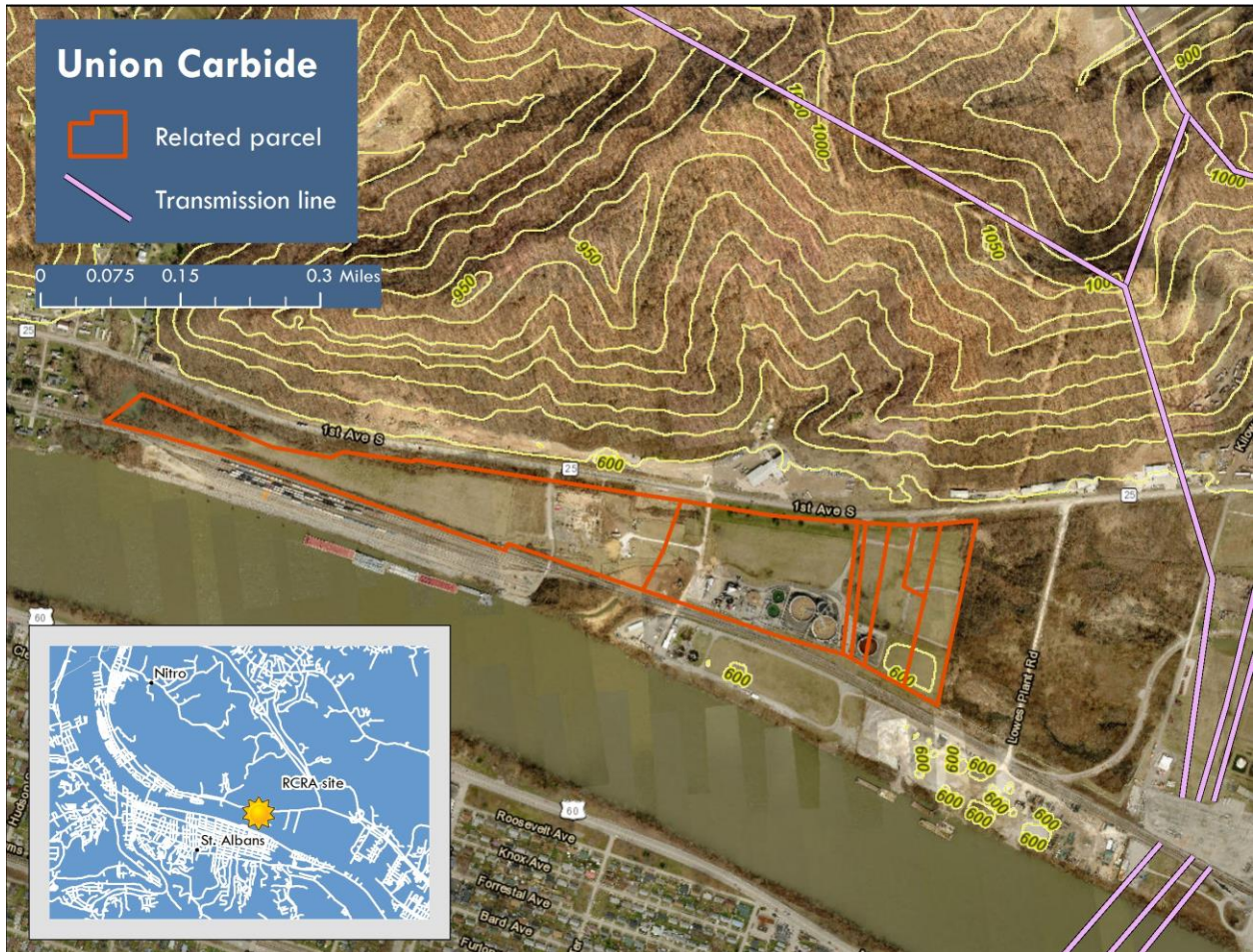
## 2.4 JACK'S BRANCH # 1 SURFACE MINE

An asset of the Jack's Branch Coal Company, permit #Z-00-0481, known as the # 1 Surface Mine, occupies 913 acres in Kanawha County (WVDEP 2017). The mine site could host a 150-MW large-scale PV facility; however, given topographic constraints, a smaller facility is more likely achievable.



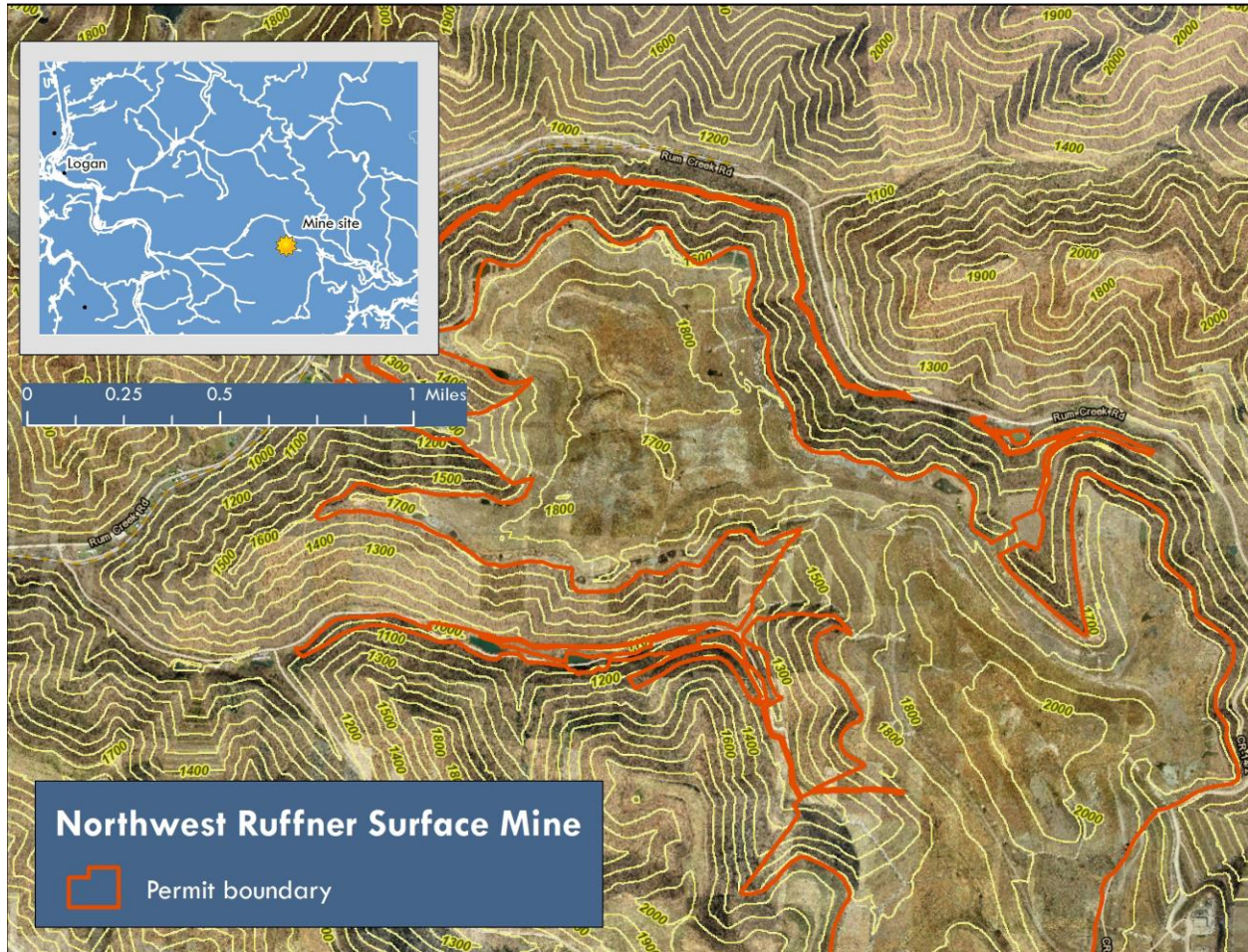
## 2.5 UNION CARBIDE

The Union Carbide/Bayer Cropscience facility is a recognized hazardous waste site in Kanawha County, just across the Kanawha River from St. Albans. While the property itself is quite large, approximately 45 acres is cleared and suitable for large-scale PV development. The facility owner, together with EPA and the West Virginia Department of Environmental Protection (WVDEP), have taken the appropriate steps to clean up or contain contaminants on this site (EPA 2017(b)). Developing large-scale PV here would be consistent with WVDEP's final remedy and institutional controls to maintain protection of human health and the environment. While the property is located near the river, the vast majority of the land is outside of the 100-year floodplain (WVGISTC 2017). Given existing land use and topographic constraints, a developer could easily fit 5 MW of solar on this site.



## 2.6 NORTHWEST RUFFNER SURFACE MINE

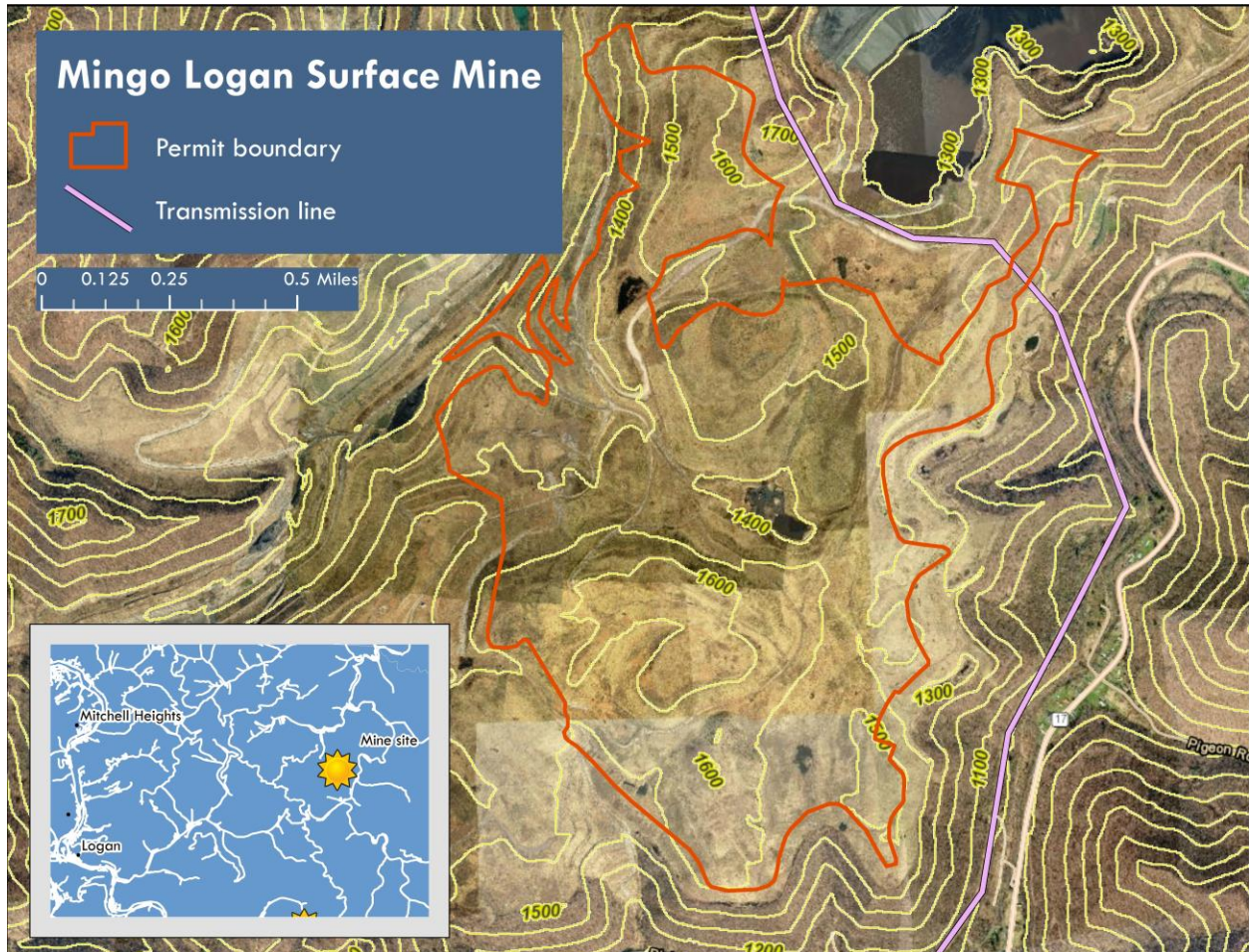
The Northwest Ruffner Surface Mine, Permit S-50-0593, covers 1,335 acres in Logan County. The property, now under the responsibility of ERP Environmental Fund, has passed hands several times since 1994 (WVDEP 2017). The site could host a 220-MW large-scale PV facility; however, given topographic constraints and the irregular shape of the permit boundary, a much smaller facility is more likely achievable.





## 2.7 MINGO LOGAN SURFACE MINE

The Mingo Logan Coal Company mined a 638-acre property associated with permit S-51-0186 in Logan County, just east of Logan and Mitchell Heights (WVDEP 2017). The site could host a nearly 105-MW large-scale PV facility; however, given topographic constraints, a much smaller facility is more likely achievable.



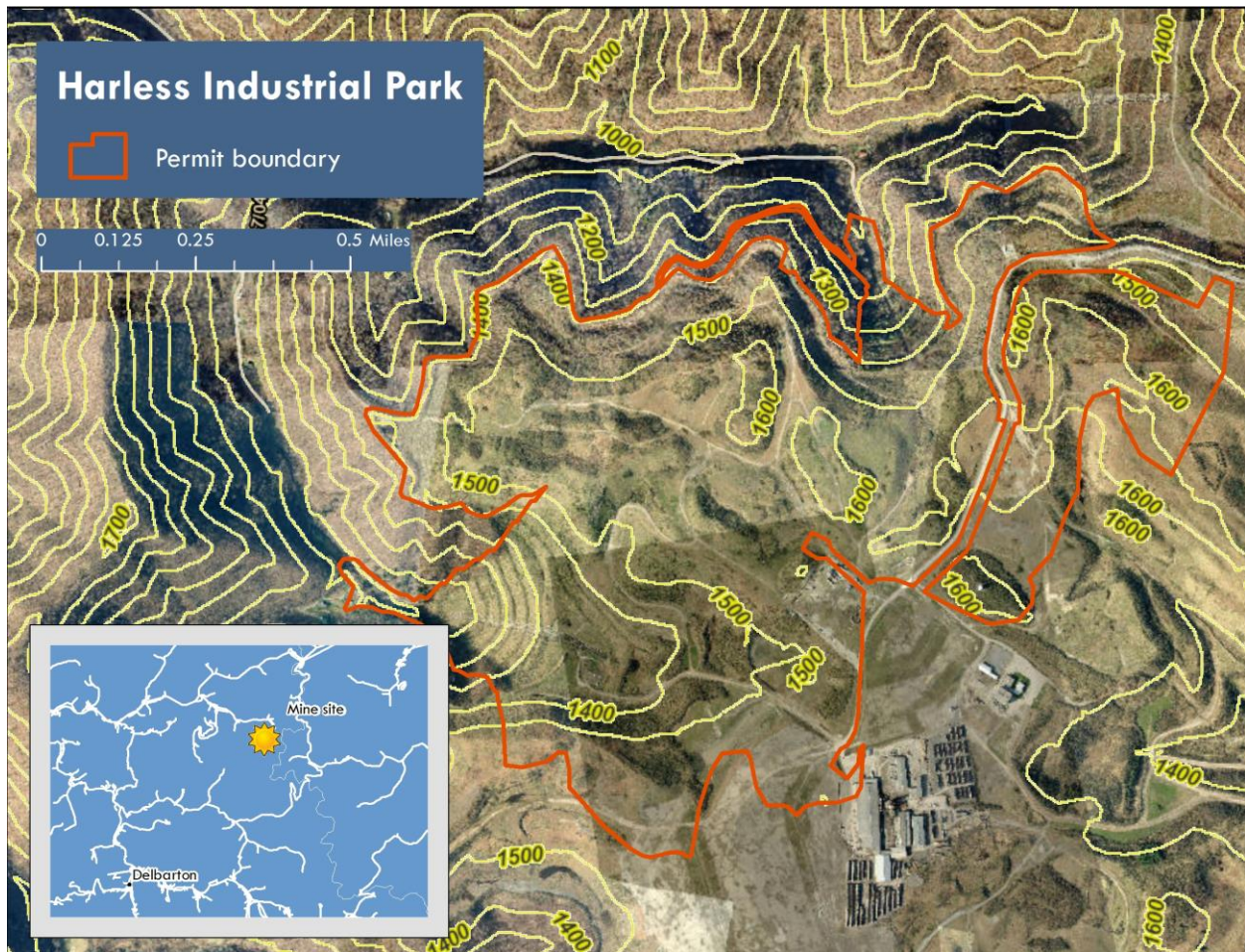
## 2.8 FAIRMONT COKE WORKS

The Sharon Steel Corporation's Fairmont Coke Works site is located along Suncrest Boulevard in Fairmont. Previously home to a facility dating from 1918, the site was placed on the Superfund List in 1996. Since then, significant actions have been taken to clean up the site, which was contaminated with phenol, ammonium sulfate, benzene, coal tar, toluene, xylene, and coke oven gas (EPA 2017(c)). While the cleanup is ongoing, the site would make the ideal location for a large-scale solar PV development. The site totals just under 100 acres. It could easily host 10 MW of large-scale solar.



## 2.9 HARLESS INDUSTRIAL PARK

The Harless Wood Products Industrial Park was Mingo County's first industrial park. The Mingo County Redevelopment Authority began redeveloping the reclaimed surface mine in 1999. Today, the industrial park is home to businesses like Wright Concrete; Coal-Mac, Inc.; and Crown Parts, and it currently supports 300 jobs (MCRA 2017). While economic activity here is significant, there are still significant development opportunities at the site. Part of the Industrial Park, former mining permit S-50-6286, covers 535 acres (WVDEP 2017). This site has great opportunity for large-scale solar PV development. The former mine site could host a significant amount of solar capacity, likely greater than 50 MW.



## 2.10 MORGANTOWN INDUSTRIAL PARK

Starting in the 1940s, the area now known as the Morgantown Industrial Park—located along the Monongahela River in Monongalia County—has hosted many chemical production facilities and other industrial or manufacturing operations. Early on, refuse from these operations was disposed of onsite in a landfill or various lagoons, contaminating the land with arsenic, chromium, cadmium, mercury, and other compounds (EPA 2017(c)). The RE-Powering Initiative estimates that this site could host a large-scale PV facility with a nameplate capacity of 140 MW, based on a total land area of 840 acres. Much of the area considered in that analysis has already been put into economic use. Based on observations of the site, its existing land use, land cover, and topographic constraints, this site would likely be suitable for approximately 5 MW of large-scale PV.



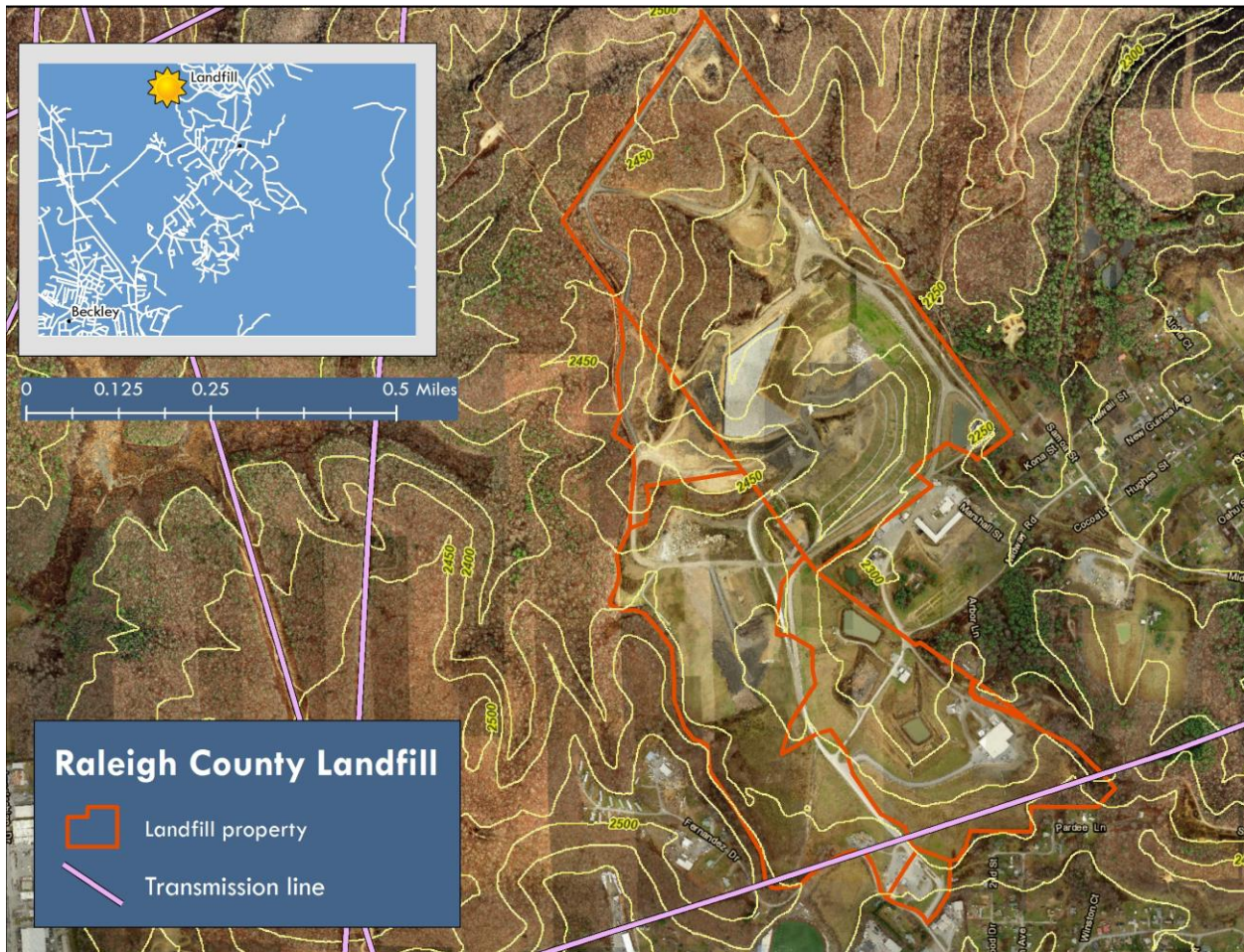
### 2.1.1 GREAT LAKES SOLUTIA

Located northwest of Nitro, the Great Lakes Solutia site is the combination of two adjacent hazardous waste sites. Formerly home to the Great Lakes and Solutia chemical companies, the once-prosperous site has been cleared of most structures and been completely inactive in recent years. The site is contaminated with volatile organic compounds, semi-volatile organic compounds, benzene, trichloroethene, vinyl chloride, and other contaminants, but corrective measures and institutional controls are either in effect or planned (EPA 2017(e) & (f)). While the property is located near the river, it sits completely outside of the 100-year floodplain. The site area totals more than 142 acres, but given existing contaminated groundwater treatment measures being taken at the site, less land is readily available for development. This site would make the ideal location for an approximately 10-MW solar PV facility.



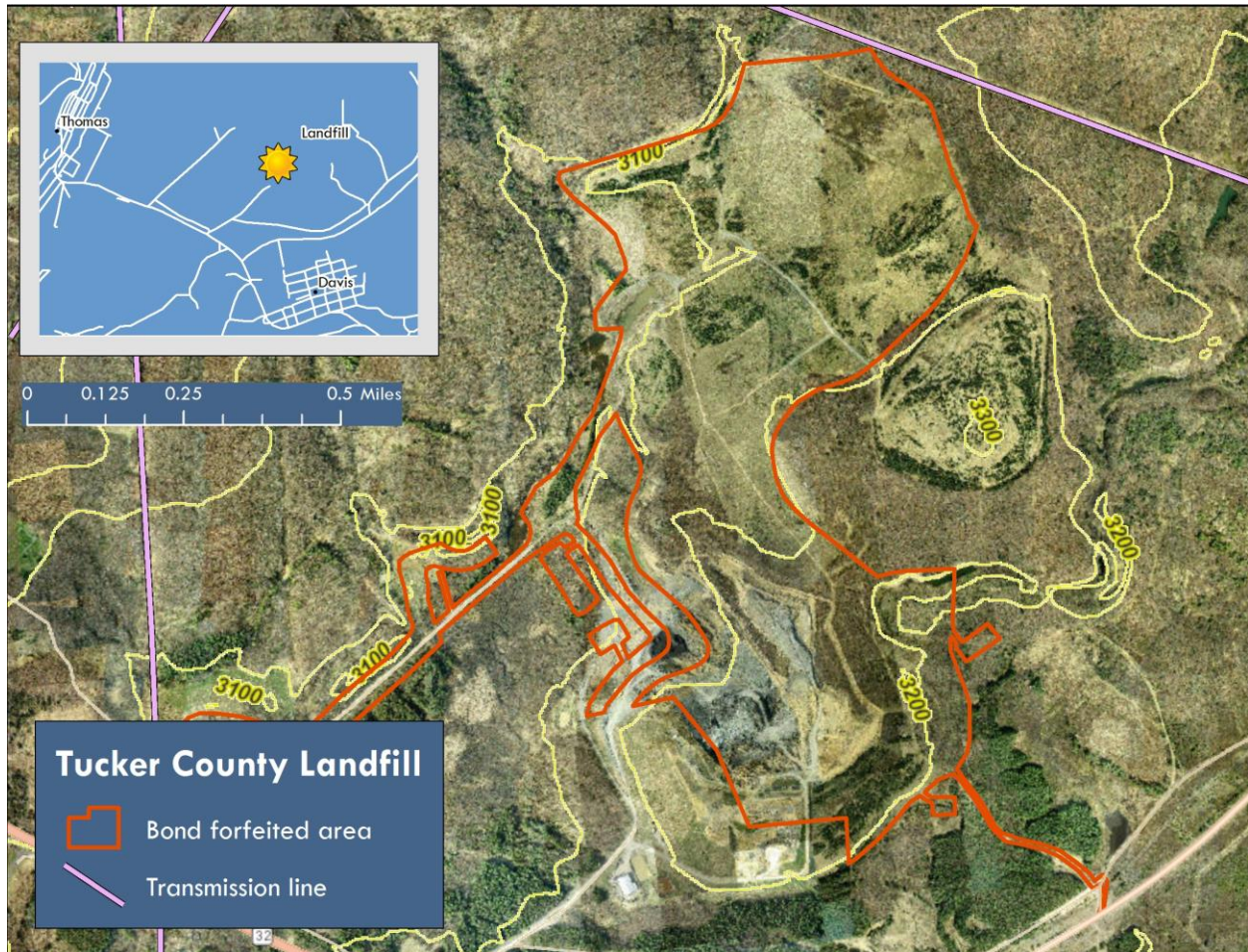
### 2.1.2 RALEIGH COUNTY LANDFILL

The Raleigh County Landfill is located just north of Beckley, along Fernandez Drive, in northern Raleigh County. The landfill has a total capacity of nearly 10 million tons and has been operational since 1964. While the landfill is located on many individual parcels, totaling nearly 300 acres, only a portion of the property is cleared, not in active use, and available for development. The RE-Powering Initiative estimates that this site could host a large-scale PV facility with a nameplate capacity of 13.3 MW; however, given existing topographic and land cover constraints, this site would likely be suitable for less than 3 MW of solar PV. A developer of this facility could work with the solid waste authority to prepare the land for a larger facility as landfill operations continue and landfill cells are closed and reclaimed. In addition to future solar development on the landfill, a 3-MW landfill gas project is planned for this site, which should be operational by 2018. (EPA 2016(a))



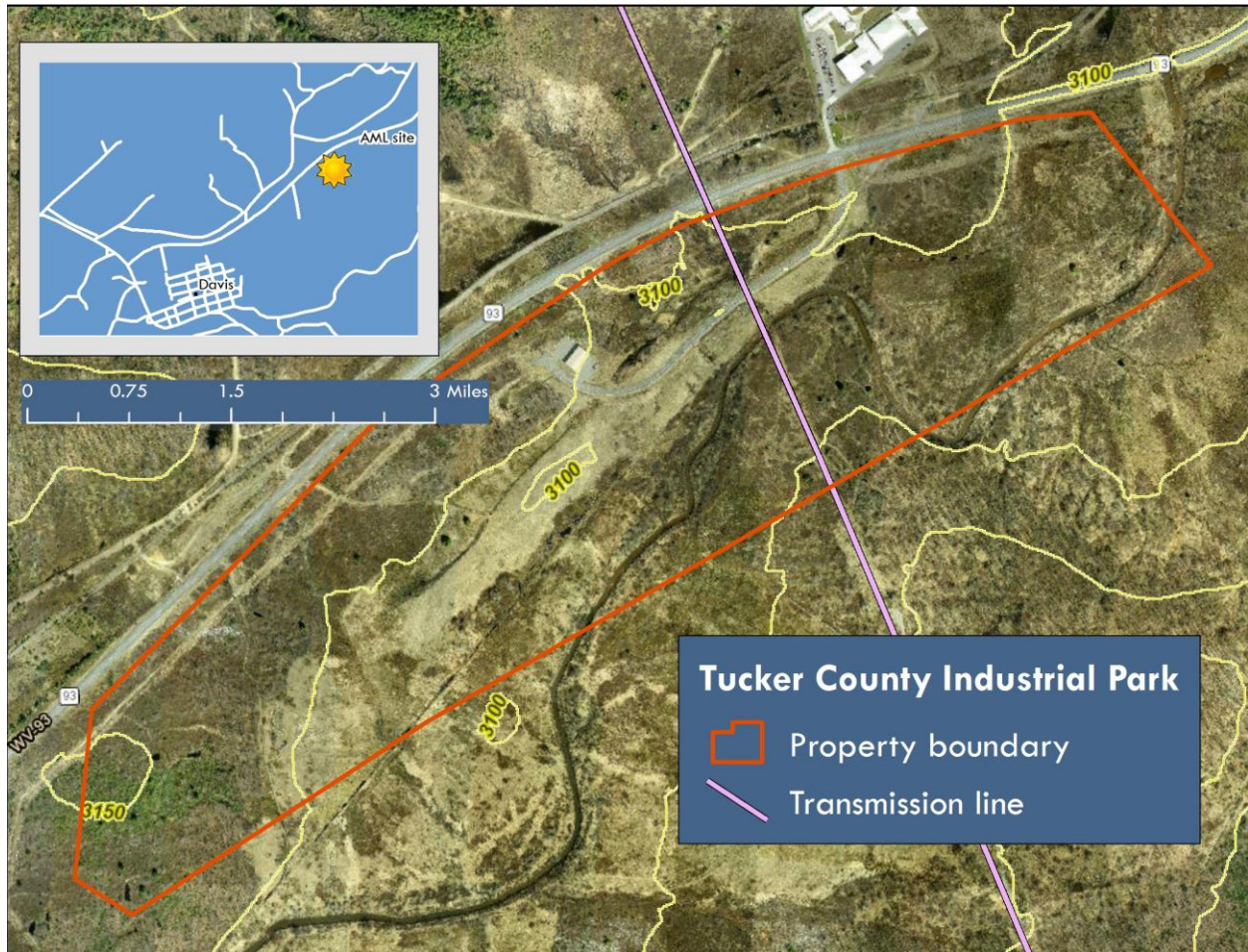
### 2.13 TUCKER COUNTY LANDFILL

The Tucker County Landfill is located just north of Davis, along Landfill Road in Tucker County. The landfill overlaps a bond-forfeiture surface mine site from the 1980s that totals nearly 350 acres (WVDEP 2017). The landfill itself has operated since 1985 and has a total capacity of 2.68 million tons (EPA 2016(a)). The RE-Powering Initiative estimates that the landfill portion of this site alone could host a large-scale PV facility with a nameplate capacity of 13.2 MW. Given existing topographic and land cover constraints of the landfill operation, it may be difficult to site a facility that large on the landfill; however, when taking into consideration the adjoining mine site, solar panels with total capacity of 13.2 MW or more should be able to be sited on this property.



### 2.1.4 TUCKER COUNTY INDUSTRIAL PARK

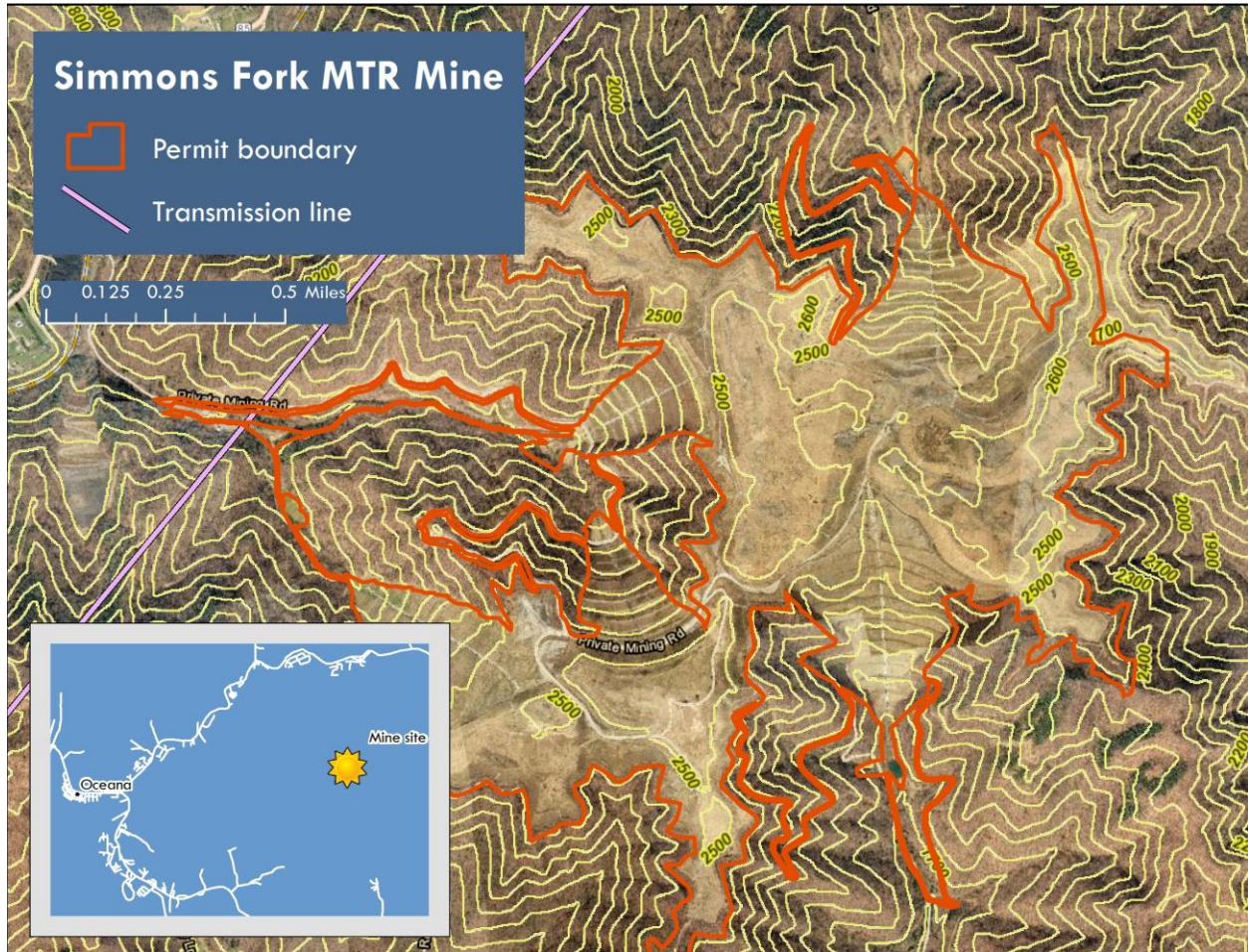
The Tucker County Industrial Park sits just northeast of Davis on Rt. 93. Formerly known as the Beaver Creek Refuse Area, the site is home to two remediated Priority 2 AML features: a dangerous refuse pile/embankment and a dangerous highwall. While the Industrial Park boasts more than 161 acres of barren or sparsely vegetated flat land, only approximately 80 acres are still available for development (TCDA 2016). The RE-Powering Initiative estimates that the AML area on this site could host a large-scale PV facility with a nameplate capacity of 7.85 MW. While it is not known which lots are currently available for development, given the total available area of 80 acres, there should be no problem fitting a facility of that size in the Industrial Park.





### 2.1.5 SIMMONS FORK MOUNTAINTOP REMOVAL MINE

The Simmons Fork Mountaintop Removal Mine, Permit S-40-0596, covers 868 acres in Wyoming County, just east of Oceana. The property, now a responsibility of the Pioneer Fuel Corporation, was originally an asset of Alpha Natural Resources (WVDEP 2017). The site could host a nearly 145-MW large-scale PV facility; however, given topographic constraints, a much smaller facility is more likely achievable.



### 3 IMPACTS OF LARGE-SCALE SOLAR PV DEVELOPMENT

Developing large-scale solar PV projects on degraded lands will have significant environmental and economic benefits. Not only will degraded lands be put to productive use, but also West Virginia’s GHG emissions and other emissions will be reduced, and jobs will be created.

These impacts will depend on the amount of degraded land on which solar is developed. To estimate these impacts, we consider two scenarios.

In the first scenario, enough large-scale solar PV projects are installed to offset the GHG emissions from Morgantown, which were estimated to total 805,694 metric tons of carbon dioxide equivalent (MT CO<sub>2e</sub>) in 2012 (Simcoe et al. 2014). Offsetting these emissions would require 1,163 MW of solar capacity, which would occupy approximately 7,000 acres, or 5% of the degraded land considered in this analysis (See Table 2).

In the second scenario, enough large-scale solar PV projects are installed to offset 10% of West Virginia’s total emissions from power plants in 2014. As shown in Table 2, offsetting these emissions would require 10,592 MW of solar capacity, which would occupy more than 63,000 acres, or about half of the degraded land considered in this analysis.

**TABLE 2 : SCENARIO SUMMARY**

Scenario	Solar capacity required (MW)	Land required (acres)	Percent of degraded land required
Offset Morgantown’s emissions	1,163	6,976	5%
Offset 10% of West Virginia’s power plant emissions	10,592	63,549	50%

Source: Morgantown emissions from Simcoe et al. (2014). West Virginia power plant emissions from EIA (2016(c)). Other values calculated in this report.

Increasing West Virginia’s solar electricity generation will reduce CO<sub>2</sub>, as well as emissions of other pollutants, including sulfur dioxide (SO<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>) (See Table 3).

**TABLE 3: ANNUAL EMISSIONS OFFSET BY TWO LARGE-SCALE SOLAR PV SCENARIOS (MT)**

Scenario	Carbon dioxide	Sulfur dioxide	Nitrogen oxides
Offset Morgantown’s emissions	805,694	1,279	620
Offset 10% of West Virginia’s power plant emissions	7,340,000	11,654	5,646

Note: CO<sub>2</sub> emissions for Morgantown are emissions from multiple GHGs in CO<sub>2e</sub>, from Simcoe et al. (2014). CO<sub>2</sub> emissions for West Virginia power plants from EIA (2016(c)). Emissions for sulfur dioxide and nitrogen oxides for both scenarios calculated by applying emissions factors from PJM (2016) to the generation that corresponds with the solar capacities for each scenario (See Table 2).

CO<sub>2</sub> accounts for 80% of all GHG emissions. While it is a natural part of the global carbon cycle, atmospheric CO<sub>2</sub> traps heat near the earth’s surface. As atmospheric concentrations of this GHG have increased since the industrial revolution, natural processes have been amplified, contributing significantly to climate change (Tox Town 2017; UCS 2017).

Similarly, increased concentrations of SO<sub>2</sub> and NO<sub>x</sub> from fossil fuel combustion have adversely affected the human and natural environments. SO<sub>2</sub> and NO<sub>x</sub> mix with oxygen, water, and other atmospheric chemicals to form sulfuric and nitric acids. These acids fall to the earth as acid rain (EPA 2016(b)). Additionally, in the presence of sunlight, NO<sub>x</sub> mixes with volatile organic compounds to create ground-level ozone (EPA 2017(g)). Ground-level ozone is the primary ingredient of smog. It can affect a person’s ability to breathe, increase sensitivity to allergens, permanently damage lungs, and damage plant life (LDEO 2017).

Over the next 15 years, the growing solar industry could help absorb coal industry layoffs and provide full-time work to many of those affected—often with a salary increase (Louie and Pearce 2016). As a whole, renewable

energy creates more jobs per unit of installed capacity, per unit of power produced, and per dollar invested than the fossil fuel energy sector (Sanders 2004). In the last five years, the number of solar jobs in the United States has more than doubled. The industry added 35,000 in 2015, alone. (Gillespie 2016) In 2016, a total of 260,077 people worked in the solar industry (The Solar Foundation 2017).

We estimate the direct job impacts of large-scale solar PV development in West Virginia by applying data from the Jobs and Economic Development Impact (JEDI) Model.<sup>7</sup> Generally, for large-scale PV, new jobs can be separated into two categories: (1) temporary jobs during construction of the facility and (2) full-time, permanent, post-construction positions. In this report, we focus solely on the temporary jobs. JEDI estimates the direct, construction and installation labor impacts to be 6.8 full-time-equivalent jobs per MW of large-scale solar installed (NREL 2016).

The construction of a large-scale PV facility typically lasts around 16 weeks (Vogt Solar 2016; Banks Group 2016). Jobs during this period include: project development, onsite labor, other installation-related services at the site, jobs created down the supply chain, and indirect and induced impacts in the surrounding community. While these are classified as temporary positions, workers may be consistently employed full-time if many large-scale PV developments are constructed in the future.

We estimate that if enough large-scale solar PV is installed on degraded sites across West Virginia to offset the City of Morgantown's emissions, approximately 8,000 skilled workers would be needed for direct construction and installation alone. Over 70,000 workers would be needed if enough large-scale PV facilities were built to displace 10% of West Virginia's GHG emissions.<sup>8</sup> Many skilled laborers once employed by the mining industry have compatible skillsets and experience to compete for these jobs.

The Bureau of Labor Statistics (BLS) does not track wage data for the solar industry; however, it does track data on selected occupations that would be impacted by temporary job creation at large-scale solar facilities. Table 4 lists some of these occupations identified by BLS.

In addition to temporary jobs created during construction, permanent full-time jobs are created. These include jobs for power plant operators, electricians, electrical and electronics repairers, as well as indirect and induced jobs. To remain conservative, the project team did not quantify permanent full-time job creation; however, JEDI estimates the direct, permanent PV project labor impacts to be 0.2 full-time-equivalent jobs per MW of large-scale solar installed (NREL 2016).

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<sup>7</sup> The JEDI Model is a high-level tool for estimating the job and economic impacts of solar PV and other types of renewable energy development (NREL 2017; NREL 2016).

<sup>8</sup> These estimates do not include the construction- and installation-related services jobs that would also be supported. Our estimates only represent direct construction and installation labor.

**TABLE 4: WAGES FOR TEMPORARY JOBS CREATED AT LARGE-SCALE SOLAR FACILITIES**

<b>Job</b>	<b>Wages</b>
Civil engineers	\$74,620
Coating, painting, and spraying machine setters, operators, and tenders	\$32,520
Computer-controlled machine tool operators, metal and plastic	\$31,470
Construction laborers	\$29,600
Construction managers	\$83,170
Electrical and electronic equipment assemblers	\$27,500
Electrical and electronics repairers, commercial and industrial equipment	\$47,480
Environmental scientists and specialists, including health	\$61,700
Glaziers	\$36,640
Industrial production managers	\$97,330
Operating engineers and other construction equipment operators	\$43,240
Real estate brokers	\$54,910
Semiconductor processors	\$32,880
Structural iron and steel workers	\$44,890
Welders, cutters, solderers, and brazers (construction)	\$45,990
Welders, cutters, solderers, and brazers (manufacturing)	\$27,590

Source: Hamilton (2016). Note: Wages are full-time-equivalent from 2010.

## 4 CONCLUSIONS

Drastically increasing electricity production from solar PV does not require covering West Virginia's cherished greenspaces and valuable agricultural land in solar panels. Former coal mines and other types of degraded lands dot our mountain landscape. These sites once acted as the life-force for the mountain communities they surround. But today they sit barren and empty. There is no silver bullet that West Virginia can deploy to create jobs and solve its financial woes. However, the strategic development of large-scale solar facilities on degraded lands can be one part of the solution. West Virginia must act now to capitalize on the growing 21<sup>st</sup> Century energy market and put our lands to valuable economic use once again.

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