ASSESSMENT OF SOLAR DEVELOPMENT ON PREVIOUSLY IMPACTED MINE LANDS IN PENNSYLVANIA – EXECUTIVE SUMMARY

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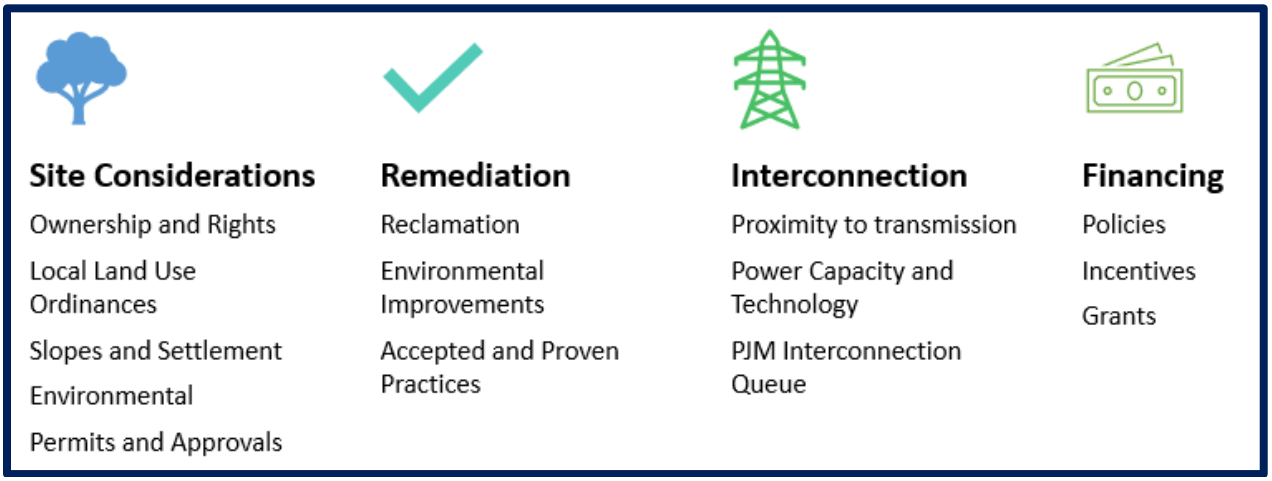
Background and Problem Definition

The deployment of solar energy facilities in Pennsylvania continues to accelerate. Over 17 gigawatts of grid-scale projects have been proposed in interconnect into the regional transmission grid, as well as additional large-scale installations connecting into local distribution grids as well as those directly servicing businesses and institutions. Preliminary analyses based on available data gleaned from sources such as the PJM New Service Request Queue as well as feedback from developers and local government officials indicates a majority of these projects will be sited on "greenfield" locations, including land currently classified as agricultural or forested in use.

The siting of individual projects is driven by a number of factors including land availability, the presence of existing grid infrastructure resources and capacity, and cost, but the site selection process is driven by relationships between solar developers and landowners, with land use regulation and oversight provided by local governments.



Although the Commonwealth of Pennsylvania has stated that its priority is to preserve agricultural land, forest land, and valuable habitat, there are limited regulatory and policy mechanisms currently available to guide the deployment of solar installations to lands to previously impacted sites, such as active, abandoned, or reclaimed mine sites (collectively referred to in this assessment as ***Previously Mined Lands***).

Since the siting process for solar facilities is driven by market forces such as land acquisition costs, access to transmission infrastructure, and the uncertainty of regulatory requirements, it is difficult to make general statements regarding the viability of previously mined lands, the majority of which is privately owned, as desirable sites for hosting solar facilities compared to greenfield sites, where most of the current development is occurring.

To help gain a better understanding of the challenges and opportunities associated with solar development on previously mined lands, the Pennsylvania Department of Environmental

Protection (DEP) Energy Programs Office (EPO) commissioned this assessment with the goals of:

- Exploring in-depth the different challenges associated with siting solar facilities on previously mined lands.
- Identifying factors that may be preventing sites that have favorable characteristics (site topography, access to existing transmission infrastructure, land acquisition costs) from being developed due to regulatory and administrative barriers
- Gaining a better understanding of the roles and responsibilities of the different stakeholders involved in the development process.
- Developing actionable recommendations to improve the processes and other factors involved in siting solar facilities on previously mined lands.

Current State of Solar Development in Pennsylvania

The deployment of grid-scale solar installations is a critical component in helping meet the Commonwealth's goal of increasing in-state solar generation to provide 10 percent of in-state electricity consumption by 2030 as stated in the *Pennsylvania's Solar Future Plan*. The plan estimates that between 7.1 GW to 9.9 GW of grid-scale solar capacity will be required to meet this target.

As of October 2023, there are 450 proposed grid-scale solar projects in Pennsylvania totaling 17.2 GW of grid-scale solar capacity at different stages of review in the PJM New Services Queue seeking regulatory approval from PJM and the Federal Energy Regulatory Commission (FERC) to sell electricity into the transmission grid. This represents over 200 additional projects and 7.7 GW of capacity compared to October 2020, when DEP began tracking this information.

During the scoping of this assessment, the initial focus was on "grid-scale solar", referring to installations connected to the transmission grid that generate energy for off-site use. A typical grid-scale solar installation is 20 MW and requires between 100 to 120 acres of land (but projects can be larger or smaller). However, it was recognized that community solar, if enabled through legislation, will have similar developmental processes and challenges on previously mined lands as grid-scale solar. Community solar projects are estimated to range between 3 and 5 MW and require 15 to 30 acres. Additionally, large ground-mounted commercial installations may also be sited on previously mined lands. Throughout this assessment, the term ***Solar Facility*** collectively refers to grid-scale, community-scale, and large commercial solar installations. The figure below provides additional information about the different scales of solar.

Residential & Commercial

- For on-site energy use
- Rooftop or mounted adjacent to structure
- Measured in kW
- Mature market – available guidance
- Through 2023, over 50,000 installations with 688 MW deployed in Pennsylvania

Community Solar

- For off-site energy use within community (distribution grid)
- Usually ground mounted requiring multiple acres but potential for rooftop parking lot installations
- Measured in 100s of kW up to 5 MW
- Requires enabling legislation (no systems currently deployed)

Grid-Scale Solar

- For off-site energy use distributed through transmission grid
- Ground mounted requiring significant acres to reach economies of scale
- Measured in MW
- Considered primary use system
- Emerging market – guidance in development
- Through 2023, 14 installations with 321 MW deployed in Pennsylvania
- Additional 450 installations with 17 GW in various stages of proposal

The deployment of solar facilities on previously mined land has additional benefits. These include:

- Leveraging existing infrastructure
- Preserving agricultural and forest lands
- Community revitalization
- Economic development and job creation
- Environmental benefits

Current State of Previously Mined Lands in Pennsylvania

Abandoned (Title IV) Mine Lands (AML)

The Pennsylvania Department of Environmental Protection Bureau of Abandoned Mine Reclamation (BAMR) administers and oversees the federal Abandoned Mine Reclamation Program to address the highest priority problems resulting from coal mining that occurred prior to the Surface Mining Control and Reclamation Act of 1977. BAMR applies annually for grants from the US Department of Interior Office of Surface Mining Reclamation and Enforcement (OSMRE). The Pennsylvania AML program has been operating since 1980 and has reclaimed thousands of dangerous sites left by abandoned coal mines resulting in increased safety and improved environmental conditions. Aside from emergencies, BAMR reclamation projects are

not prioritized based on the land use intent. Currently, there are three sources of federal funding for addressing problems associated with AML:

1. ***AML Fee Based:*** Available since 1980, this funding source is used for Priority 1 and Priority 2 health and safety hazards.
2. ***Abandoned Mine Land Economic Revitalization (AMLER) Program:*** Available since 2016, this funding source is used for the reclamation of Abandoned Mine Lands in conjunction with economic and community development and reuse goals
3. ***AML BIL:*** Additional appropriation funded through Bipartisan Infrastructure Law. Available since 2022, this funding source has similar requirements as AML Fee Based but can also be applied to Priority 3 land restoration activities.

In general, AML Fee Based and AML BIL funding can only be used to reclaim AML features so that the site is no longer a public health and safety issue and it is reclaimed and stabilized to the Approximate Original Contour (AOC). These funds cannot be used to make the site "solar-ready" (i.e. grading the site in a manner to host a solar facility). However, combining AML and AMLER funding enables funding to first be used to achieve the health and safety reclamation of the site, and then prepare the site for the economic development opportunity of solar installation. Solar developers are encouraged to alert BAMR to the future intent of solar development at the start of reclamation discussions to help guide the design and develop the most advantageous funding package.

The inventory of Title IV AML Program lands is tracked in two primary databases. The federal OSMRE e-AMLIS database provides an inventory of land and water impacted by legacy coal mining operations. The inventory contains information on the location, type, and extent of AML impacts, as well as, information on the cost associated with the reclamation of those problems and is used to allocate federal funding. Problems are inventoried as land area (acres), specific features (units), and as miles or gallons for water problems. For consistent year-to-year comparison, as well as evaluation across other states, OSMRE applies a conversion factor, known as GPRA, to express all problems in terms as acres, no matter the measurement type. When reporting publicly, this weighted GPRA acreage is often used to express the acres of Abandoned Mine Land in Pennsylvania, however this value far exceeds the surface acres of AML viable for solar development. Since 1980, a total of $896M of AML funding has been invested Pennsylvania, with over 149,000 GPRA acres of problems reclaimed. This value is a combination of problems like acres dangerous piles reclaimed, number of mine shaft sealed, and gallons of water treated. Additionally, another 335,000 GPRA acres of problems have been inventoried in e-AMLIS.

Pennsylvania also manages an AML Inventory. Within this inventory, the location of surface area features (acres) as well as point features (units) are tracked in a GIS system. This database estimates the surface area acres associated with problems reported in the OSMRE e-AMLIS database and may be eligible for Title IV Abandoned Mine Reclamation funding, thus providing the best starting point for approximating the acres potentially available for siting solar projects.

The Pennsylvania AML Inventory has inventoried approximately 216,00 surface acres of land with associated AML problems cataloged in e-AMLIS. 39,000 of these acres have been reclaimed since 1980, while 177,000 remain unreclaimed. As part of this assessment, a high-level suitability analysis for solar development was performed on these areas. AML site

characteristics such as flooded strip mines, subsidence prone areas, and burning refuse piles that would make solar development impractical were removed from the total acreage. Additionally, land use characteristics that would prevent solar siting such developed areas and water/wetlands were also removed. After removing these lands, a total of 169,00 surface acres of AML (27,000 reclaimed, 142,000 unreclaimed) could potentially host solar facilities. It should be noted that local factors that would further refine this analysis could not be applied to a state level data set of this size. These include factors such as: slope/terrain, aspect/orientation, and access to electric distribution infrastructure. Application of these factors would further reduce the area viable for solar development.

The Abandoned Mine Land Inventory does not include information on parcel ownership or number of parcels per problem area, which presents a challenge for the planning and development of solar installations. Understanding the relationship between AML sites and parcel / ownership data is critical because site control is required for solar development on AML. An analysis of data from one county (Luzerne) where parcel and land ownership data was available was performed. The analysis found that 38% of AML area features are less than 30 surface acres, with 37% between 30 and 150 surface acres. The remaining 25% are greater than 150 surface acres. Additionally, average area feature is comprised of 8.7 parcels, while the median area feature is comprised of 5 parcels. Limitations on the size of AML surface areas, as well as the fragmented ownership of these areas indicate that it may be difficult to develop grid-scale solar projects that generally require large, contiguous parcels of flat land. The typical 20 MW grid-scale solar project requires 100 to 120 acres of land. However, solar facilities in the 3 to 5 MW range (15 to 30 acres) are more likely to be able to be sited on previously mined lands. The availability of Community Solar in Pennsylvania may provide an opportunity to expand the use of previously mined lands for solar development.

Regulated (Title V) Mine Lands

Mining operations performed after August 3, 1977 are regulated through SMCRA and administered through the DEP Bureau of Mining Programs and Bureau of District Mining Operations. Reclamation plans are part of the mining permit, which defines the type of reclamation practices proposed (terracing, benching, approximate original contour), stormwater features to remain, haul roads to remain, vegetation type, etc., as well as the proposed postmining land use. Bond is also posted as part of the mining permit as a protection for the state in the instance that a mining operator abandons the site. Reclamation of regulated mine lands are the responsibility of the operator, and the mining permit cannot be closed out (and the bond released) until reclamation is achieved. Reclamation is not considered achieved until there is uniform vegetation throughout the site and a final inspection is completed with the operator and mining inspector to sign off that all areas of reclamation have been completed. Additionally, if the proposed postmining land use is industrial/commercial, all permits necessary to complete this work (E&S, NPDES, zoning, etc.) need to be obtained prior to close-out of the mining permit.

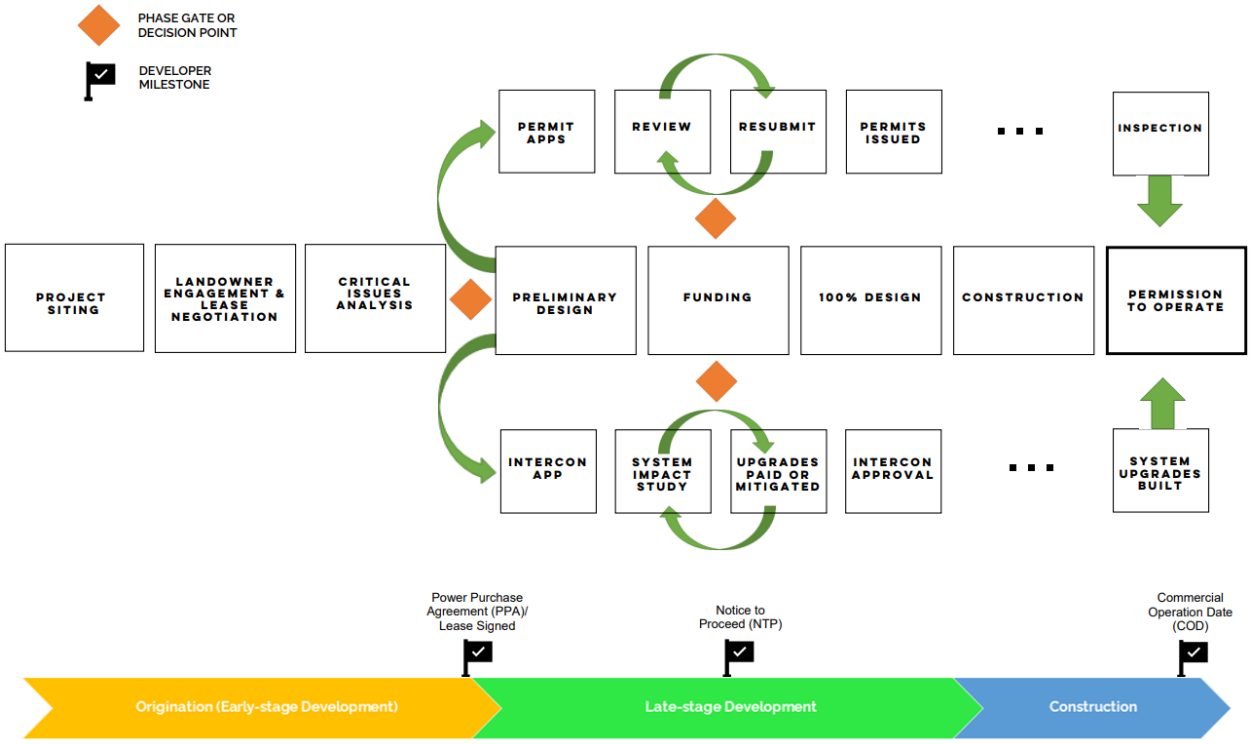
It typically takes 5 years to close-out a mine site from the start of reclamation. There is currently no specific guidance on how existing reclamation plans can be updated or revised to include solar development as a postmining land use, but it would fall within the current guidelines for commercial and industrial post mining land use activities. However, if solar isn't proposed at

the beginning of the 5-year reclamation window, the clock may be required to restart once the reclamation plan is revised and approved, prolonging the close-out of a mine site even further.

There are currently 64,000 acres of permitted active surface mines, and 20,000 acres of permitted coal refuse sites in Pennsylvania. It should be noted that active mines may continue operations well into the future, and not be suitable for solar development in the near- or long-term. However, if a coal operator decides to proceed with a solar facility as part of the post reclamation land use, these sites may be more attractive since they are larger, contiguous sites with one ownership group.

Solar Development Process on Previously Mined Lands

The graphic below illustrates the solar development process. Early stage activities include project siting and land leasing. This is followed by three parallel processes: permitting, project design, and interconnection, before finally progressing to construction and operations.



This assessment has found that there are no technical or regulatory challenges that cannot be overcome when siting solar facilities on previously mine lands. Existing processes and procedures for the reuse and reclamation of these sites can be utilized for solar projects, and projects are currently in the advanced design phase that will ultimately be sited in these areas.

However, there are additional costs, timeframes, and risks associated with solar development on these sites. The figure below provides outlines how different variables impact solar development on previously mined sites. The symbols utilized in the table represent Cost (💲),

Time (🕒), and Risk or Uncertainty (❓). The number of symbols shown in each category represents the amount of concern: 1-unit symbol denotes a low concern and 3 signifies a large concern.

Variable	Greenfield	Previously Mined Site	Discussion Summary
Leasing	$$ 🕒 ❓	$ 🕒🕒 ❓	Although previously mined land may have less economic value, it takes additional time to identify and secure interest of landowners.
Site Preparation	$ 🕒 ❓	$-$$$ 🕒🕒🕒 ❓❓❓	Previously mined land requires significant time to adequately reclaim site and requires costly reclamation (that may be offset by grants). Mined sites also incur additional costs for system components, such as racking and anchoring.
Permitting	$ 🕒 ❓❓	$$ 🕒🕒 ❓❓	Permitting on previously mined lands requires more time and costs due to the uncertainties of site conditions and lengthened duration of process
Geotech	$ 🕒 ❓	$$$ 🕒🕒🕒 ❓❓❓	Geotech on mined land requires costly investigation of mining practices, subsurface rights and conditions, surface conditions, subsidence risk, etc.
Interconnection	$$ 🕒🕒🕒 ❓	$$ 🕒🕒🕒 ❓	Because interconnection variables are site specific, there are no discernable difference between those at previously mined sites compared to greenfield sites.
Symbol Key:	Cost	$	Time 🕒	Risk/Uncertainty ❓

Stakeholder Feedback

To inform this assessment, a series of three focus group sessions were held in March and April of 2023. These focus groups allowed stakeholders to describe challenges associated with developing solar facilities on previously mined lands and suggest recommendations that may be incorporated into the assessment report. Each session attracted participants from coal operator/landowner, solar development, civil/site engineering, and non-profit communities. Additionally, a *Grid-Scale Solar on Previously Impacted Mine Lands Summit* was held in July 2023 that attracted 80 attendees. The summit provided an opportunity to share initial findings and recommendations and incorporate feedback into the final report.

Common themes that were expressed during these sessions include:

- *Community Solar enabling legislation is needed to unlock previously mined sites for solar development*
- *There is an additional cost siting solar on previously mined land – greenfield development is easier and less expensive*
- *Incentives are needed to develop solar on previously mined lands*
- *Projects that are developed on previously mined sites have additional costs that are passed on to customer*
- *There is a lack of understanding on the impacts of solar development at the local government level*
- *Lack of knowledge of ownership of previously mined sites is a barrier for project development*
- *BIL / IRA Legislation provides a once in a lifetime opportunity to further both reclamation goals as well as renewable energy development*
- *There is a need to streamline the permitting process and provide a single point of contact to address multiple regulatory requirements*
- *Due to the unique nature of solar development activities, modifications to existing policies and procedures could allow for more development to occur*

Recommendations

The following eleven recommendations are grouped into five categories. Each recommendation includes:

- **Costs:** Presented as costs to Commonwealth agencies:
  - *No to minimal cost* [$] for recommendations that can be completed using existing staffing and budgets.
  - *Moderate cost* [$$] for recommendations that may require additional staff or contractor support.
  - *High costs* [$$$] for recommendations that may require the creation of new programs or funding opportunities.
- **Timeframe:**
  - Short-term [🕒] (immediate-1 year), medium-term [🕒🕒] (1-3 years), or long-term [🕒🕒🕒] (>3 years)

Category	Recommendation	Cost	Timeframe
Policy and Incentives	1.1 Pass legislation enabling Community Solar Pennsylvania	$	🕘🕘
	1.2 Establish Goal for Solar on Previously Mined Sites	$	🕘
	1.3 Previously Mined Land Solar Grant Fund	$$$	🕘🕘
	1.4 State tax abatement or rebate program for qualifying projects on previously mined sites	$$$	🕘🕘
Education and Outreach	2.1 Incorporate content specific to solar development on previously mined sites into ongoing municipal outreach activities.	$	🕘
	2.2 Private Sector Power Purchase Agreement (PPA) Guidance	$	🕘
Program Development	3.1 AML Parcel Information and Mapping Tools	$$	🕘🕘
	3.2 Previously Mined Land Build-Ready Site Program	$$$	🕘🕘🕘
Investment of BIL/IRA Funds	4.1 Use of Assessment Findings to Guide Investment of BIL/IRA Funds	$	🕘
Process Improvements	5.1 Single Point of Contact for Solar Projects on Previously Mined Lands	$$	🕘
	5.2 Examine if policies and procedures can be modified within constraints of state or federal regulation.	$	🕘🕘🕘

The most common recommendation provided by stakeholders (and supported through analysis) is the need for legislation to enable Community Solar (1.1). Community solar provides a pathway for smaller solar facilities (3 to 5 MW) to be economically viable, and community solar scale facilities can more easily be sited on previously mined sites, which have smaller parcel sizes and are more fragmented, compared to the types of sites needed for grid-scale projects. These types of projects may also reduce interconnection and local permitting risks. It was also recommended that the Commonwealth establish a capacity (MW) or area (acres) goal for solar on previously mined sites (1.2).

Additional recommendations address the fact that solar development on previously mined sites is more expensive than greenfield development, even with the availability of current public funding for site reclamation and preparation. There are additional risks and uncertainties associated with these types of projects that increase costs, and without additional incentives, developers may continue to choose greenfield sites when other variables (such as interconnection costs) are equal. These recommendations help to mitigate these additional costs by providing direct incentives (1.3 & 1.4), providing justification of these additional costs for end users (2.2), or strategies to further reduce risks and uncertainties (3.2).

The remaining recommendations (2.1, 3.1, 4.1, 5.1 & 5.2) involve building capacity and expertise within the Department of Environmental Protection to assist stakeholders throughout the solar development process on previously mined sites.

The full assessment document is available at:
https://greenport.pa.gov/elibrary/GetDocument?docId=8421405&DocName=ASSESSMENT%20OF%20SOLAR%20DEVELOPMENT%20ON%20PREVIOUSLY%20IMPACTED%20MINE%20LANDS%20IN%20PENNSYLVANIA.PDF