Mining the Sun

Transforming mine lands and brownfields into clean energy hubs

The Nature Conservancy

ACKNOWLEDGEMENTS

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Most importantly we want to recognize the pioneering leadership provided by the EPA RE-Powering America's Land Initiative and the DOE Clean Energy on Mine Lands Program (CEML).[1] Established in 2008, the RE-Powering America's Land Initiative[2] has developed an impressive array of resources to facilitate the transformation of contaminated lands to clean energy uses that benefit the climate, local communities and conservation. It maintains a comprehensive inventory of brownfield, landfill, Superfund and other contaminated sites that are technically feasible for solar, wind, geothermal and biomass energy development that can be located through its recently updated interactive mapper.[3] The Initiative has representatives in each of EPA's administrative regions who can answer questions, provide guidance and facilitate technical assistance for those exploring possibilities to develop clean energy on brownfield sites.

The DOE Office of Clean Energy Demonstrations (OCED)'s Clean Energy Demonstration Program on Current and Former Mine Lands was established in 2022 with $500 million in funding from the Infrastructure and Jobs Act to provide competitive grants to establish up to five large scale clean energy demonstration projects on mine lands. In a strong sign of the growing interest by state governments, energy developers and local communities in clean energy sited on mine lands, CEML fielded 98 initial applications from 29 states. These applicants requested $9.3 billion in DOE grant funding matched by $27 billion in private capital.[4] After selecting grant finalists in 2024, OCED will work with grantees and other partners to harvest lessons, data, technical, economic and planning innovations and community benefit models that can expand clean energy deployment on mine lands.

Cover Photo: An array of solar panels at a quarry near Byron CA. © GettyImages

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MINING THE SUN IN CUMBERLAND FOREST

In 2019, The Nature Conservancy (TNC) in coordination with private equity investors established the Cumberland Forest Limited Partnership to acquire and manage 253,000 acres in the heart of the Central Appalachians – one of North America's most important biodiversity hotspots. Situated in Appalachian Coal Country at the convergence of Virginia, Tennessee, and Kentucky, the Cumberland Forest Project contains expansive forested mountains, but also 40,000 acres of former coal mining lands that are previously disturbed and in a non-forested condition. TNC seeks to manage these former mined lands in ways that create added value for nature and people, and some of these former coal mining lands may be suitable for solar and energy storage projects.

CUMBERLAND FOREST SOLAR Repurposing former surface coal mines for renewable energy, forest conservation and community benefits on TNC-managed lands in the Central Appalachians (VA, TN, KY). © TNC

The Cumberland Forest Project is designed as an impact investment fund, which means that the property is managed to generate positive conservation, social, and economic outcomes. This includes renewable energy deployment to address climate goals, generate revenue, and contribute to local economic diversification. The property is also managed for forest carbon sequestration, sustainable timber harvesting, wildlife restoration, and expanded outdoor recreation opportunities. The Central Appalachians are known for their ecological significance as well as a long history of coal mining that has fueled American industrialization for two centuries. In recent years, the steady decline of the coal industry has driven the region to explore and pursue a variety of economic diversification strategies, and the Cumberland Forest project seeks to connect with and support local economic needs where possible.

"Partners with shared visions for repurposing mined land lead to successful projects. Working together with The Nature Conservancy to deploy solar where coal was once mined is working toward the greater goal of an all of the above energy approach in Virginia."

– Daniel Kestner, Virginia Energy Economic Development Manager

In 2021, after TNC collaborated with the Virginia Department of Energy to complete a solar compatibility analysis for the property, and then ran a competitive procurement process, the Cumberland Forest Limited Partnership signed solar development agreements with two Virginia-based energy companies: Sun Tribe Development and Dominion Energy. Eight lease option agreements are now in place across 1,000 acres, with a planned generation of 130 megawatts. Sun Tribe's Wildcats Solar project is scheduled for construction in 2025, and other projects in the Cumberland Forest portfolio plan to come online between 2026-2029. To minimize impacts on forests, all solar development sites are situated on previously disturbed former surface coal mines. These former mining and future solar sites are relatively flat and in proximity to existing utility infrastructure that was put in place when the sites actively produced coal.

The solar projects being developed on the Cumberland Forest are among the first on former mined lands in Central Appalachia. The work on these pioneering projects is both exciting and challenging. Solar developers and TNC are collaborating to address a variety of unique hurdles presented by former coal mining sites including complex mineral titles, geotechnical considerations, topographic constraints, and some challenges to interconnection. Despite these headwinds, several enabling conditions have contributed to the progress of Cumberland Forest's solar development efforts. Notably, the Virginia Clean Economy Act has been a policy driver encouraging the expansion of the state's renewable energy economy.

"Responsible solar development strengthens a county's tax base with revenue that can support schools, libraries, parks, and other community priorities. These projects aim to do even more. By including additional funding for a community benefits plan, we are creating a vehicle for direct local investment and workforce training that is additive to the traditional benefits associated with solar development. And through continuous community engagement, which is now underway, we are going to ensure that funding is directed in a manner that the community itself agrees with."

– Danny Van Clief, CEO, Sun Tribe Development

CUMBERLAND COAL MINING a coal mine near Clairfield, Tennessee. © Cameron Davidson

The solar projects will also take advantage of the Inflation Reduction Act (IRA) tax credits designed to incentivize renewable energy investments in "energy communities". Additionally, several of the projects have been incorporated into a Virginia consortium application for the Department of Energy's (DOE) new Clean Energy on Mine Lands grant program. Cumberland Forest solar projects seek to generate new tax revenues, spending, temporary construction jobs, and a small number of permanent jobs in Central Appalachian communities that have experienced coal mine closures. Building on these important benefits, TNC and the solar developers have also agreed to an additional community benefits plan that will engage local stakeholders to inform other investments that developers will make in community-identified priorities. A local engagement process focused specifically on a project's community benefits plan and budget will initiate when a solar project achieves the fundamentals needed to go to construction and operational phases (e.g., power purchase agreement, interconnection agreement, etc.). The community engagement process is now underway with the Wildcats Solar project.

The Cumberland Forest Project seeks to demonstrate the potential for transforming former mine lands and brownfields into renewable energy hubs that integrate into wider economic diversification and conservation strategies in traditional energy producing communities. With its first tranche of projects moving forward, the Cumberland Forest is now soliciting competitive proposals for additional solar projects on former mine lands in partnership with LevelTen Energy, hoping to expand the possibilities for solar on the Tennessee and Kentucky portions of the property.

IRA AND ENERGY COMMUNITIES[5]

The Inflation Reduction Act (IRA) of 2022 provides a 10% tax credit for clean energy development built in "energy communities." Several land types fall into the definition of an energy community and are eligible for this incentive, including brownfield sites. This is in addition to other IRA tax credits for which clean energy projects may qualify.

SUN TRIBE SOLAR PROJECT Site of a former surface mine on TNC Cumberland Forest. © TNC

MINING THE SUN: **A WIN-WIN SOLUTION**

Researchers estimate an area the size of Texas could be needed to generate enough clean energy to meet U.S. net zero carbon emission goals.[6] Many proposals to site new renewable energy projects on undeveloped natural and working lands are met with controversy and opposition, resulting in lengthy and expensive delays.

The Nature Conservancy's Mining the Sun Initiative charts a win-win path to siting new renewable energy projects. While brownfields and mine lands cannot account for all renewable energy needs to reach net zero by 2050, siting on these degraded lands can significantly reduce the need to site on natural and working lands. As demonstrated by the Starfire Renewable Energy Center, by repurposing mines and degraded lands for renewable energy projects, we can provide clean power for the electric grid while supporting local communities and landowners with welcome economic development opportunities. And we can do so in a way that avoids impacts to undisturbed lands.

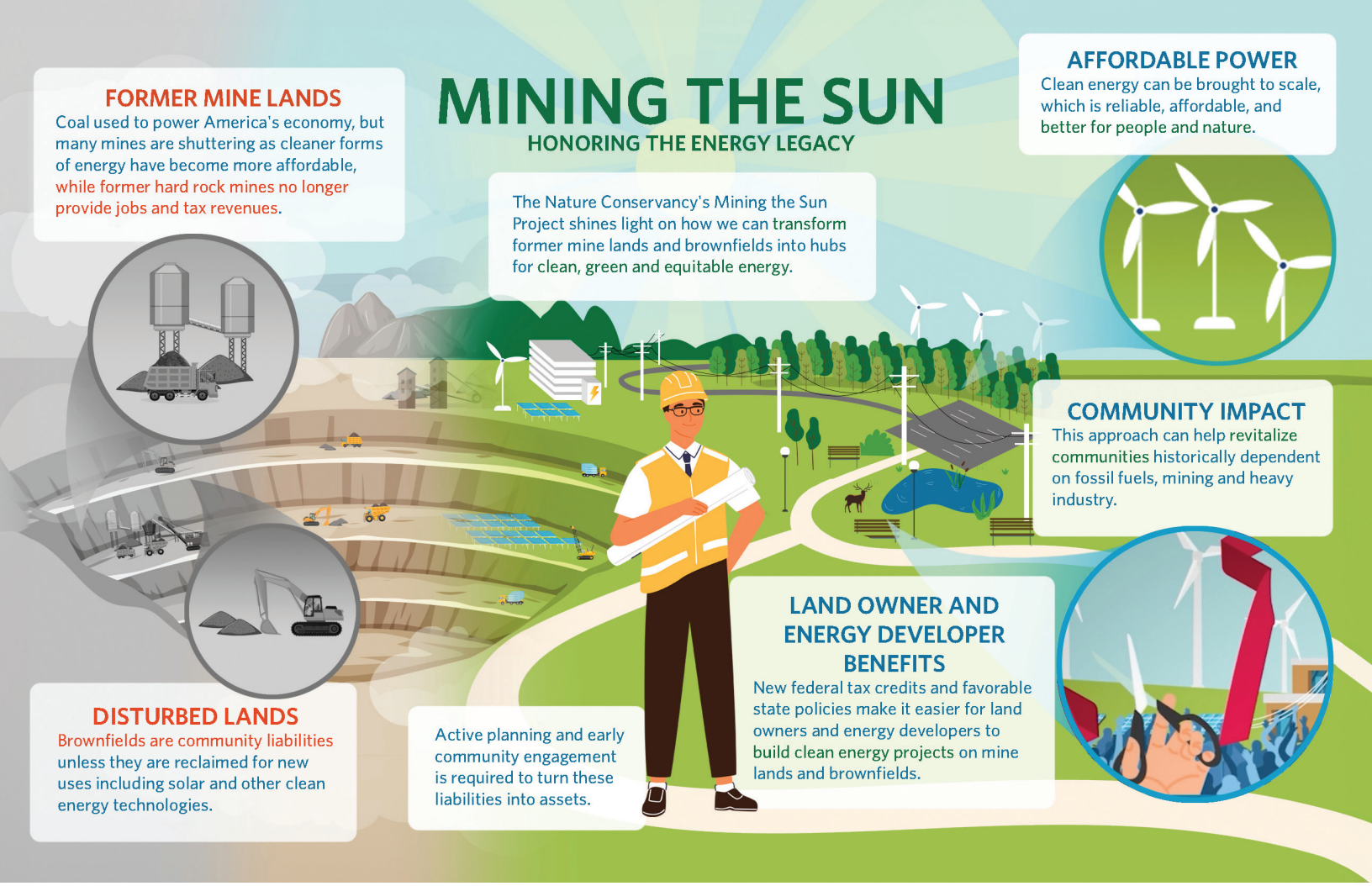
PURPOSE OF THE REPORT

The Mining the Sun project is a resource for anyone interested in advancing clean energy projects on mine lands, brownfields and landfills—thereby minimizing impacts to undisturbed lands. It includes overviews of relevant state and federal policies, programs and incentives; economic analyses; community engagement best practices; and maps showing viable brownfield and mine sites. The purpose of this report is to provide energy planners such as state energy offices and permitting agencies, developers and utilities, and community development organizations a concise guide to address the opportunities and challenges to siting renewables on brownfields and mine lands. The resources and analyses featured in this report are intended to both complement and provide a concise summary of the extensive body of work initiated by EPA, DOE and other governmental and non-governmental organizations looking to transform industrialized landscapes into clean energy hubs.

There are several *advantages* to siting new wind and solar projects on active and former mines and brownfields:

- Mines, brownfields and former industrial sites are typically equipped with transmission lines, roads, and may have graded land and other infrastructure that renewable energy projects can leverage.
- Revitalizing decommissioned mines and brownfields provides new economic benefits and revenue streams for neighboring communities and local landowners, such as tax revenue and short-term jobs.
- Communities with a long history of fossil fuel production can continue to contribute to the nation's future energy needs in a transition to clean energy production.
- Renewable energy development on brownfields and mine lands can play an important role in meeting the country's growing need for clean and reliable electricity supplies.
- Negative impacts on natural areas and working lands can be minimized.
- Remediating and reclaiming mines and brownfields for clean energy production can spur clean-up of contaminated lands and pollution that are directly affecting nature and local communities.
- Renewable energy developers can capitalize on new federal incentives to develop at a lower cost, more comparable, in some but not all cases, to the cost of developing on greenfields.

All told, building renewable energy projects on mine lands and brownfields holds great promise to bypass the opposition and controversy that accompanies many proposed solar and wind projects. Unfortunately, increased permitting requirements and higher costs associated with developing on mine lands and other degraded lands can deter or prevent renewable energy developers and land managers from pursuing this approach. The Nature Conservancy's Mining the Sun Initiative provides a roadmap to help overcome the barriers that can hinder progress.



TRANSFORMING BROWNFIELDS INTO CLEAN ENERGY HUBS

The National Renewable Energy Laboratory estimates there are enough contaminated and disturbed lands to achieve the DOE's SunShot goal of 715 GW of solar deployment by 2050. This could supply energy to power over 120 million homes.[7] U.S. EPA has even higher similar estimates of approximately 20 million acres of potentially suitable mine lands and brownfields in the U.S. that can house new clean energy projects, with the potential to supply 1,300 GW of clean and renewable solar power,[8] enough to power over 200 million homes annually. Due to contamination and other factors, these lands have limited development potential and might otherwise sit vacant. Repurposing mines and brownfields represents a major opportunity to advance clean energy projects in a way that has the potential to deliver real benefits to nearby communities.

The Opportunity

The Nature Conservancy's Mining the Sun Initiative outlines the major potential for siting clean energy projects on mines and brownfields across the country. These sites typically have several *features* that can make them attractive for new clean energy projects, including:

- Mine lands often feature large inactive sites with plenty of space for renewable energy projects.
- These sites often have transmission access and other energy infrastructure nearby, in addition to roads, graded land and water infrastructure.
- These sites often have zoning that allows for energy development, which means more streamlined permitting.

- The redevelopment of these sites may be attractive to nearby communities and would require local support for any needed zoning changes.
- The U.S. Environmental Protection Agency (EPA) has determined that brownfield redevelopment can increase nearby home property values by 5 to 15% within roughly a mile of the site.[9] In addition, transforming a reclaimed mine land or brownfield into a clean energy site can deliver real benefits to communities.
- Local communities may welcome new economic development and access to jobs that new clean energy projects have the potential to create.
- Many states have incentives for reuse of brownfields and other contaminated sites in addition to the IRA tax incentives.

The Challenge

Despite these benefits, renewable energy developers can encounter significant challenges when it comes to siting new projects on brownfields and other degraded lands. These include:

- Gaining site control at sites where complex ownership, contamination liabilities and other factors hinder leasing or fee acquisition.
- Navigating environmental risk as developers may incur liability for cleanup costs.
- A brownfield site may require additional agency oversight during permitting, which can be time-consuming.
- Environmental site assessments may require extensive upfront work to determine the history of the site, existing contaminants and potential threat levels to surrounding areas.
- Developers may need to take steps to remediate the selected site.
- Disturbing brownfields can worsen environmental conditions by dislodging contaminants, which can lead to additional cleanup costs and public health risks.
- Nearby communities may have complex relationships with disturbed sites, requiring developers to tread carefully, customize projects, emphasize co-benefits and move more slowly. Communities should be included in decision-making, and they should receive a fair share of benefits.
- Developers and regulators may dismiss reclaimed mines as candidate sites because they assume a solar project would disturb a mine cap. Site stability and other geotechnical factors can rule out or complicate renewable development in some but not all cases.

Thus, despite the many benefits to developing new clean energy projects on brownfields and other degraded lands, few developers have taken this approach because of the many challenges that can accompany this approach. Nationwide, there are 500 mostly small renewable energy projects sited on brownfields and mine land[10]—a fraction of what's possible. We are far from realizing the potential of successfully repurposing degraded sites for clean energy development. The following pages further detail why brownfields and mine lands are important and what it will take to further realize their potential.

LINCOLN COUNTY, NEVADA Aerial view of a wash with toxic tailings from the Caselton Mine near Pioche on June 29, 2023. Caselton is a brownfield site, some portions of which are being evaluated for solar.

CASELTON MINE AND MILL SITE in Lincoln County near Pioche, Nevada. Caselton is a brownfield site, some portions of which are being evaluated for solar. © Bridget Bennett

Why Brownfields & Mine Lands?

Worldwide there are an estimated 25 million acres of active and inactive mine lands, enough to accommodate 3.125 million MW of solar.[11] In the U.S, EPA estimates mine lands and brownfields could supply 1.3 million MW of solar energy, which is enough to power over 200 million homes annually.

WHAT ARE BROWNFIELDS?

Lands available for renewable energy development may include industrial sites that are no longer operational, those classified as contaminated (some of which have been cleaned up and others that have not) and other areas. These sites[12] include:

- Mine lands
- Landfills
- Former industrial sites
- Former military sites
- Locations at which chemical or oil spills have occurred

Factors influencing compatibility with renewable energy projects

The compatibility of a proposed renewable energy project on a mine land or brownfield depends on several factors including:

- Type of mine (coal, hardrock, other).
- Underlying land and mineral ownership (public, private or Tribal lands).
- Life cycle of mine (see illustration).
- Subsurface and topographical conditions.
- Official contamination status of mine or brownfield (e.g., state-listed or federally listed Superfund site).
- Status of control (i.e., whether liability for current or potential contamination is clear) and life cycle stage of the mine.
- Surrounding community's interest in renewable energy as a new way to use the site relative to other uses (e.g, housing, commercial development, open space, etc.).

Centering the Community

The nation's clean energy transition must progress in a manner that is inclusive and fair. Communities that may be impacted by clean energy development should be included in decision-making, and they should receive a fair share of benefits. For a variety of reasons, including the impacts - both real and perceived - that solar and wind projects can cause, many communities have been hesitant to allow new projects to move forward. Repurposing mine lands and brownfields for clean energy projects in lieu of siting projects in natural areas and working lands can help to avoid those development conflicts. The approach supports the energy transition and, by working with communities, can also bring benefits to nearby communities,[13] including:

- Creation of short-term site preparation and construction jobs and long-term operations and maintenance positions.
- Job skills training for local workers.
- New revenue for communities from taxes or payment in lieu of taxes (PILOT) agreements, land leases, project agreements, etc.
- Economic growth from businesses attracted by new clean energy projects and associated activity. This is key since wind and solar projects themselves will generate relatively few permanent jobs.
- Site cleanup that remediates contaminated sites.
- Reduced air and water pollution.
- Preservation of natural and working lands in the area.
- In some cases, reduced electricity costs.
- Increased energy resilience and reliability from locally generated power.

Foundations for Centering the Community

Centering communities that may be impacted by renewable energy projects can help accelerate the clean energy transition. Centering the community creates a mutually beneficial relationship of equal partnership and shared responsibility[14] between the community and the developer. To center the community means that the people most impacted by the clean energy development will drive the conversations about needs, solutions, and how change occurs. The skillsets and lived experiences of community members are truly valued. Crucial elements for centering communities include: Robust outreach and engagement, particularly with communities that have been negatively impacted by energy development or who could be negatively impacted going forward; fair and inclusive processes to support decision-making that centers these communities; and ensuring communities benefit from projects in a fair and equitable manner. Wind and solar projects should ideally be linked to a broader community development strategy since the projects on their own will generate relatively few permanent jobs. These steps focus on ensuring communities are true partners when it comes to new renewable energy projects.

> By facilitating input, social buy-in, and accountability, such engagement can substantially reduce or eliminate stalls or slowdowns and minimize other risks associated with [a] project.[18]

Positive community impact and support are foundational to the success of renewable energy projects developed on former mine lands. New federal government programs that provide incentives and other financial support for renewable energy projects on mine lands prioritize centering communities through robust engagement and benefit sharing. Developers can increase project success by using the following strategies to center communities.

In 2022, TNC conducted an extensive literature review to inform best practices for community engagement and benefit agreements. In addition to a survey of peer-reviewed literature on community engagement for renewable energy projects worldwide, we integrate the guidance available from EPA RE-Powering[15] and the Department of Energy.[16] We also draw from TNC's experience working with community development practitioners in the Central Appalachians on how to best engage and work with coal field communities to co-create desired benefits.[17] Below we summarize eight best practices that appeared consistently in existing research, guidance and practical experience.

Clockwise from Strengthen Your Capacity: © Tim Calver, © Joanna Kulesza (courtesy: Jack's Solar Garden), © Bridget Bennett, © Annette Ruzicka, © Bridget Bennett, © Joanna Kulesza (courtesy: Jack's Solar Garden), © Dave Lauridsen, © Michael D-L Jordan.

Best Practices for Centering the Community

Strengthen Your Capacity

- Examine and augment your knowledge, skills and capacity for engaging authentically with local communities and particularly groups representing underserved, overburdened or disadvantaged communities in the area.
- Integrate principles of diversity, equity, inclusion and justice into your business practices.
- Develop robust plans for community engagement and benefits from the start of project planning.
- Commit to project development that aligns with community values.
- Build in the time and budget to develop authentic partnerships with impacted communities and provide fair and equitable benefits.

Research the Community

- Develop an understanding of the community's current and historical social, cultural, economic, environmental, energy and workforce landscapes.[19]
- Identify and prioritize engagement with important community stakeholders, especially those who may be most impacted by project development, and include organizations representing underserved, overburdened or disadvantaged communities and members of those communities. Resources include the US Justice 40 Initiative,[20] IRENA Community Energy Toolkit[21] and CESA Solar with Justice: Connecting States and Communities.[22]
- Use planning tools that identify disadvantaged communities and cross-reference with mine lands and brownfields with potential for solar development.[23]

Build Trust

- Building trust is often cited as the most important factor for effectively partnering with a community.[24, 25, 26]
- Be humble and start listening to the community's perspective as early and as often as possible.
- Understand a community's past experiences with energy and infrastructure development.
- Participate in "radical listening." Proactively request that local community groups hold listening sessions and survey residents about past experiences and what they want and need from new development. Listen to understand a community's needs before even beginning the rest of the development process.
- Whenever possible, do not come to communities with pre-established plans. Invest time in building trust in a community first.[27, 28]

Support Community Participation

- Provide funding and access to expertise to help communities define project parameters they would support, including benefits. The Center for American Progress's Guide to Rural and Tribal Capacity-Building Programs[29] provides an example of a resource designed to expand capacity and bridge the gap between federal resources and rural and Tribal communities.
- Facilitate networking with other communities that have received desired benefits and have embraced local clean energy development.

CASELTON MINE AND MILL SITE A tour group of Caselton Mine Site near Pioche, Nevada. Caselton is a brownfield site, some portions of which are being evaluated for solar. © Bridget Bennett

- Hold listening sessions, workshops and other meetings at times, locations and in formats that will maximize community participation.
- Assist with transportation, childcare and meals to support participation by community members from overburdened, underserved or disadvantaged communities.
- Value community expertise and compensate local experts fairly for their time and contributions to the process, especially representatives of overburdened, underserved or disadvantaged communities. Support *local* community organizations to do local outreach.

Be Transparent and Consistent

- Announce meetings and other forums for engagement early through a variety of announcement mechanisms to maximize participation.
- Respond to questions in a timely manner.
- Provide access to relevant information and support efforts to build energy literacy.
- Be transparent about the potential benefits of the project as well as the potential tradeoffs.
- Produce educational and informational material early, using clear language and avoiding jargon.
- Show the community how their input has guided decisions. Be transparent about decisions that do not reflect community priorities.

Value Local Knowledge

- Design the project in a way that can help meet locally identified needs.
- Invite community input into project planning and design within the physical constraints of the site.
- Be open to adjusting the project based on community input.
- Respect any local opposition. Reasons behind local attitudes towards a project are complex and often based on legitimate concerns.

Ensure Benefits for the Community

- Include a community benefits agreement in the plan and strive to share benefits equitably across various stakeholder interests.
- Practice robust engagement with community stakeholders to arrive at mutually decided upon community benefits agreements. Ensure community stakeholder representation is inclusive and equitable.
- Ensure project agreement benefits and funding are directed toward community priorities.
- Establish strong accountability and enforceability measures within community benefits agreements.
- Prioritize employing residents, utilizing local businesses as suppliers and subcontractors, and contribute to workforce development opportunities.

Follow Through

- Create a *written* commitment to honor any agreements for the life of the project.
- Provide a point of contact for the life of project and plans for briefing and transferring if a site is sold.
- Plan for handling conflicts or concerns that arise and document all contacts with the public.
- Have a decommissioning plan for the clean energy project. Examples are provided in *Planning & Zoning Guidance for Renewable Energy for Local Governments*[30] and the *Preliminary Decommissioning Plan for Calverton Solar Energy Center*[31] in Calverton, New York. Both are resources developed for specific communities, but with many applicable and helpful guidance for local governments.

COMMUNITY BENEFITS AGREEMENTS

Community Benefits Agreements (CBAs) codify the benefits to a community for a specific project and a defined period. CBAs are fundamental catalysts for realizing best practices and are highly valued tools for centering a community. Here are four core principles for effective CBAs:[32]

- It is negotiated by a coalition that effectively represents the interests of those living in the impacted area including disadvantaged communities.
- The CBA process is transparent, inclusive and accessible.
- The terms provide specific, concrete and meaningful benefits and deliver what the community needs.
- There are defined, formal enforcement mechanisms to ensure accountability.

STARFIRE SOLAR SITE The reclaimed coal mine in eastern Kentucky is planned for a solar facility that will provide clean, renewable energy. © Dean Hill

BROWNFIELD VS. GREENFIELD COSTS

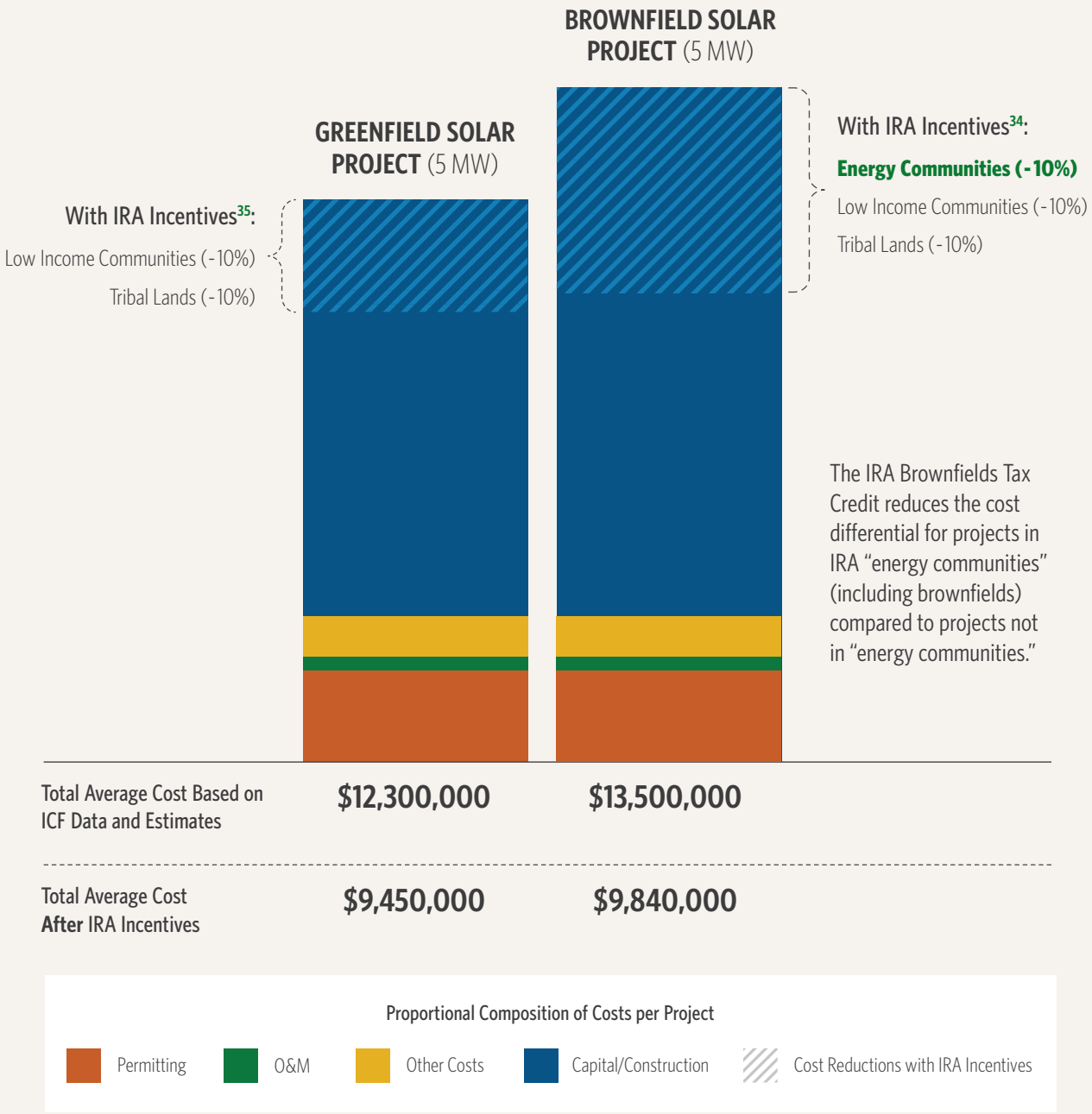
Many factors can influence costs when developing on brownfields versus greenfields (i.e. natural and agricultural lands). Economic analyses comparing solar development costs in the U.S. on brownfields vs. greenfields are sparse. The Nature Conservancy commissioned ICF to develop a financial analysis of solar development costs on brownfields compared to greenfields based on a limited data set from existing brownfield projects.[33] Since the ICF study was completed, the Inflation Reduction Act (IRA) passed, including a 10% tax credit for renewable energy development on brownfields, partially offsetting the 10–15% on average additional cost ICF determined would be required to site renewables on brownfields. A summary of cost implications is included below:

DEVELOPMENT CHALLENGES

ICF interviewed a select group of solar developers and generated a list of reported challenges for developing mine land and brownfield sites. These include:

- Heightened difficulties estimating land acquisition, site control and permitting timelines, with the potential for these timelines to lead to higher pre-construction spending.
- Complexities associated with divided surface and subsurface mineral estates.
- Potential significant increase in cost to construct mine land and brownfield sites due to subsurface and topographical conditions.
- Increased environmental liabilities of ground disturbance and operation.
- Specialized sub-consultants may be necessary to lead the project through permitting and development due to increased regulatory coordination and requirements.
- More unpredictable timeline from inception to revenue generation compared to greenfield sites. The quicker a project starts producing, the sooner the revenues are realized.

IRA TAX CREDITS OFFSET INCREASED COST OF BROWNFIELD SOLAR PROJECTS



ICF summarized the comparative costs of brownfield and greenfield solar projects as follows:

Based on the ICF analysis, projects on brownfield sites may cost 10 - 15% more than those on greenfield sites. The additional costs can be attributed to foundation design differences, racking, more expensive operational plans, indirect costs, and additional costs related to legal, permitting and development not considering site agreement/land costs.

As defined in the 2022 Inflation Reduction Act (IRA), the Energy Community Tax Credit Bonus applies a bonus of up to 10% (for production tax credits) or 10 percentage points (for investment tax credits) for projects, facilities and technologies located in energy communities, which includes communities with former coal mines and brownfields. Additional federal tax credits may be available depending on whether the site is in a low-income community, tribal reservation and other factors.[36]

COMPARATIVE COSTS OF BROWNFIELD AND GREENFIELD SOLAR PROJECTS[37]

MORE EXPENSIVE	**Site preparation** Brownfield sites may require more costly geotechnical investigations than greenfield sites. These additional site preparation costs may be offset at brownfield sites that have pre-existing infrastructure, such as roads and power lines, which could lower site preparation costs.	**Engineering, procurement and construction** EPC costs can vary significantly between brownfield and greenfield sites. Based on a small dataset of existing brownfield projects, the EPC costs were estimated to be about 12% higher for small projects (5 MW) on brownfield sites compared to same size projects on greenfields.	**Permitting** Permitting costs can be comparable between brownfield and greenfield sites. Many brownfield sites may need to conduct a Phase II Environmental Site Assessment before project permitting.[38]
SIMILAR COST	**Operational and maintenance** Operational and maintenance costs are typically the same between brownfield and greenfield sites.	**Total CapEx costs** Based on a limited dataset of existing small brownfield projects, CapEx (capital expenditure) costs were estimated to be about 9% higher for small scale projects (5 MW) on brownfield sites compared to same size projects on greenfields. This increased cost should be largely offset by IRA energy community tax credits.[39]	**Interconnection** Costs to interconnect energy generation projects to the grid are similar between brownfield and greenfield sites.
LESS EXPENSIVE	**Land** Brownfield land acquisition is typically less expensive than greenfield sites.		

STARFIRE SOLAR SITE A former coal mine is now a solar energy hub, generating 800 MW in renewable energy. © Dean Hill

FEDERAL POLICY LANDSCAPE

Federal Funding Mechanisms

Two new federal laws provide incentives to support renewable energy production on mine lands and brownfields. Specifically, the Infrastructure Investment and Jobs Act (IIJA, 2021) and Inflation Reduction Act (IRA, 2022) include significant tax credit and financing programs to offset the additional costs of developing on brownfields and other degraded lands:

- IIJA's *Clean Energy Demonstration Program on Current and Former Mine Land*[40] includes $500 million to be administered by the U.S. Department of Energy for five large scale clean energy demonstration projects on mine lands. DOE received 98 project proposals requesting $9.4 billion for proposed projects in 29 states. Grant awards will be announced in early 2024.
- IRA includes expanded production and investment tax credits for wind, solar and other clean energy technologies, with bonus credits for electricity produced in areas that meet any of the following criteria:
  - > Brownfield sites
  - > High rates of unemployment
  - > High tax revenue from fossil energy production
  - > Recently closed coal mines or coal-fired power plants
- IRA establishes a $250 billion loan program to finance projects that repurpose former fossil energy infrastructure to support clean power generation. Funds can be used to retool, repower, repurpose or replace energy infrastructure that has ceased operations, or enable operating energy infrastructure to avoid, reduce, utilize or sequester air pollutants and greenhouse gas emissions.

In addition to the new tax incentives, loans and grants, there are several existing federal grant programs for reclaiming mine lands and brownfields:

- The Abandoned Mine Land (AML) program assesses fees on each ton or mined coal and the Department of Interior distributes those funds based on a pre-set formula to states and tribes for mine reclamation. Priority grant uses include eliminating public safety hazards, remediating soil and water contamination, and restoring land and water resources.[41]
- The AML Economic Revitalization Program (AMLER) provides funds for productive economic and community uses in six Appalachian states and the Navajo, Hopi, and Crow Nations.[42]
- The EPA Brownfield Program has a half dozen programs to fund assessments, provide low interest remediation loans, clean up grants, job training, and state and tribal brownfield response programs.[43,44] Additional federal funding opportunities can be found at the Economic Development Administration[45] and the Appalachian Regional Commission.[46]

Federal Regulatory Landscape

A range of federal policies come into play when it comes to new energy projects on brownfields and mine lands. Laws that govern hardrock mining, surface mining and reclamation and hazardous waste sites can determine everything from required remediation before a new project can move forward, to responsible parties for liabilities associated with hazardous waste located on a potential site. Other laws pertaining to environmental and clean water protection determine required permitting and processes to protect wildlife, clean water and other natural resources.

HARDROCK MINING

Mining Act of 1872: The General Mining Act of 1872 regulates hardrock mining on federally owned lands. Hardrock mining is defined as "uncovering and extracting non-fuel metal and mineral deposits of solid ores or eroded deposits in streambeds."

COAL MINING & RECLAMATION

The Surface Mining Control and Reclamation Act (SMCRA)[47] regulates coal mining, reclamation and abandoned coal mines. SMCRA includes provisions to delegate the program to states (called primacy), and 24 states have primacy to administer their programs.[48] As of 2006, Tribes are eligible to achieve primacy, but no Tribe has achieved primacy to date. SMCRA allows states to enter into cooperative agreements with the federal government to regulate surface coal mining and reclamation on Federal lands within their states, and 14 states currently oversee coal mining operations in this way, including: Alabama, Colorado, Illinois, Indiana, Kentucky, Montana, New Mexico, North Dakota, Ohio, Oklahoma, Utah, Virginia, West Virginia and Wyoming.

SMCRA established an Abandoned Mine Land (AML) fund that assesses a reclamation fee on each ton of coal produced. Funds from the program are allocated to states and Tribes based on a preset formula.

SOLID AND HAZARDOUS WASTE SITES

Two federal statutes—the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)—govern federal management and cleanup of hazardous waste facilities and the response to abandoned, uncontrolled hazardous waste sites.

RCRA gives EPA (and qualifying states) authority to regulate solid hazardous and non-hazardous waste, including its generation, transportation, treatment, storage, disposal and clean up, primarily at active facilities. All 50 states and territories have authority to administer a base RCRA program; some states are authorized to implement newer aspects of RCRA. EPA maintains a database of all state RCRA authorities in its State Authorization Tracking System (StATS), which includes links to each state's RCRA program and state RCRA program reports.

CERCLA governs abandoned waste sites and liability for hazardous waste damages and cleanup. CERCLA includes a Hazardous Substance Response Trust Fund, commonly referred to as the "Superfund" program. Superfund receives monies from Congressional appropriations and other taxes, fines and penalties, which are used to compensate entities (including states) that undertake cleanup activities and pay for damages for sites under state or federal control. As with RCRA, states must meet "base" federal standards to administer the CERCLA program but can adopt more stringent standards.

ENVIRONMENTAL AND CLEAN WATER PROTECTION

The U.S. Clean Water Act comes into effect when proposed activities on federal lands will impact Waters of the United States.

The National Environmental Policy Act (NEPA) comes into effect if federal agency permits are required for activities on federal lands. NEPA also applies to energy projects with federal funding located on private lands.

Federal Path Forward

Federal policymakers can make it easier to site clean energy projects on mine lands and brownfields by doing the following:

Mitigate legal liability. Legal liabilities make it difficult or impossible to obtain project financing. Establishing a backstop insurance program by EPA or state agencies could reduce the costs of risk mitigation and spur greater solar development on brownfields at minimal costs on a per project basis. Several concepts in the Biden Administration's principles for domestic mining reform could also mitigate liability and incentivize clean energy development on mine lands.[49]

Pre-development due diligence. The environmental site assessment (see above) poses an early up-front cost to developing a brownfield site. This is risk capital because the assessment may find the site can't be used for a profitable solar project. While EPA's Brownfields Program can pay for some assessment costs, it would also be helpful if the AML Program could pay for due diligence at AML sites, including those on public lands.

Direct incentives. The Federal government can provide favorable incentives that go beyond the IRA tax credit, including lower tax rates, waived permitting fees or direct payments to mitigate the increased costs for solar projects on mine lands and brownfields.

Interagency coordination. Several federal agencies play important roles in regulating and funding the reclamation and redevelopment of mine lands and brownfields. The Interagency Working Group on Coal and Power Plant Communities and Economic Revitalization led by DOE has been helping coordinate federal support for reclaiming and revitalizing former coal mine lands. Additional interagency coordination between the Department of Energy, Environmental Protection Agency and the Department of Interior can help expedite permitting and funding for clean energy on coal and hardrock mines and brownfields.

Streamlined Permitting. This can include expedited permit review, one-stop permitting options, coordination between agencies or designated lead agencies and coordination/guidance/limits for local ordinances. Expedited NEPA permitting has been proposed by the Department of Energy for renewable energy and storage projects on disturbed lands and upgrades to existing infrastructure.[50]

Additional steps to advance federal policy in support of clean energy development on mine lands and brownfields, such as liability relief, a clean energy office within the Office of Surface Mining, Reclamation and Enforcement (OSMRE) and ongoing appropriations for EPA's RE-Powering America's Land Initiative and DOE's Clean Energy on Mine Lands (CEML) program are important. While federal policy reform is a vital component to realizing the full potential of these projects, the most impactful opportunities for policy and regulatory change, however, are at the state level. Many federal laws on brownfields, abandoned mine sites and landfills are delegated to the state regulatory authorities, which are responsible for the reclamation, management and repurposing of these sites. The following section details state policy initiatives that demonstrate tailored regulatory processes specific to individual states' geographies, economic drivers, energy requirements, and community needs. Policy priorities for states where The Nature Conservancy has been working on the Mining the Sun Project can be found in the state roadmaps.

WASHINGTON DC The United States Capitol © Devan King

MICHIGAN State Capitol Building © Michael D-L Jordan/dlp

ADVANCING STATE POLICY

State Policy Framework

Most federal policies described above are designed to delegate program administration authority to states if minimum requirements are met. As a result, many brownfields and mine lands are largely governed by state statutes and regulations. The Nature Conservancy has interacted with state agencies in nearly a dozen states and conducted research on specific state policies that facilitate clean energy siting on brownfields and mine lands. The following section outlines these policies; offers approaches to developing and implementing them; and summarizes the types of policies and programs still needed to fully realize the potential for these types of clean energy projects.

State programs must meet minimum requirements set by federal statutes but can be more stringent than the federal programs. This is true for the Surface Mining Control and Reclamation Act (SMCRA), Resource Conservation and Recovery Act (RCRA), and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

With respect to hazardous waste administration, states generally have solid and hazardous waste statutes and regulations that affect the economic feasibility of repurposing brownfields and other abandoned and degraded lands—both active sites and former sites—for renewable energy generation and storage. States may also have policies related to planning, defining eligible uses and setting bonding requirements for site cleanup and reclamation.

When considering a state for a potential project, the following questions can help assess opportunities and challenges related to hazardous waste regulation:

Planning

- Do state planning policies require consideration of renewable energy and transmission opportunities?
- Do state planning policies require identification of goals (e.g., protection of public health, safety, general welfare and restoration of land and water resources and the environment previously degraded by industrial use)? If so, are they required to consider goals related to renewable energy and transmission?
- Do state policies allow for revision of closure and cleanup plans and, if so, for revisiting renewable energy development and associated transmission?

Eligible uses

- Do the state solid and hazardous waste policies outline the eligible uses of former landfills and other brownfields?
- If so, is renewable energy development identified as an eligible use?

Bonding

- Strict rules about conditions for reducing or removing bonds on mining sites can be a major impediment. Are bonding requirements maximizing opportunities for renewable energy development and associated transmission? For example, are there opportunities for financial assurances and monitoring timelines to decrease if renewable energy is being developed and planned for future interconnection?

States also have statutes and regulations that affect the economic feasibility of repurposing lands regulated under CERCLA for renewable energy generation, transmission and storage. Again, when considering a specific state for a potential renewable energy project sited on brownfields and other abandoned lands, the following questions can help assess opportunities and challenges related to state implementation of CERCLA.

Planning

- Do state planning policies include consideration of renewable energy and transmission needs?
- Do the priority goals include those related to renewable energy and transmission?

Eligible uses

- Does the state Superfund program outline the eligible uses of former landfills and other brownfields?
- If so, is renewable energy development identified as an eligible use?
- Does the state have authority to direct funds for specific uses?
- If so, what can funds be used for (e.g., activities that support renewable energy deployment or carbon-intensive activities/uses)?

Prioritization and use of clean-up funds

- Is the state required to develop a list of priority sites for clean-up?
- If so, is the list used to prioritize how and where federal and/or state clean-up funds are used?
- Are renewable energy potential and access to transmission outlined as criteria for prioritizing these sites?

Local governments typically do not regulate mines and brownfield sites. However, they often have permitting authority over energy development projects and are often applicants or recipients for state and federal remediation and reclamation grants, and local governments and private waste management companies often finance and manage landfill sites. RCRA and state solid waste programs regulate the sites themselves.

All 50 states have policies governing hardrock mining. These state policies may require leases to make royalty payments, pay rental fees, develop and carry out reclamation plans and secure bonds prior to operation.

Aside from state policies specific to mine lands and brownfields, many states have policies and programs to incentivize or mandate renewable energy development on brownfields and other abandoned lands:

- New York's Build Ready Program offers 6-month expedited permit reviews for clean energy projects on landfills, brownfields and other "repurposed" commercial or industrial sites while applications for other (not "repurposed") sites are within 12 months.[51] Applicants also need to commit to negotiating Community Benefit Agreements with host communities.
- Connecticut has a targeted brownfield development loan program that offers 20-year loans for brownfield redevelopment; the 2020 solicitation included preference for projects that support use of renewable energy.[52]
- The Connecticut Property Assessed Clean Energy (C-PACE) program provides commercial, industrial and multi-family property owners with long-term financing for smart energy upgrades to their buildings, which can include siting renewable energy on buildings within brownfields.[53]
- The Solar Massachusetts Renewable Target (SMART) program incentivizes solar development in previously developed areas, such as brownfields.[54] The Environmental Protection Agency found that about 30% of all solar built on landfills has occurred in Massachusetts in part because of this successful program.
- Maine adopted legislation in 2019 directing the Maine Public Utilities Commission (PUC) to procure 125 MW of distributed generation associated with commercial or institutional customers and 250 MW of "shared" distributed generation by 2024. While the PUC must use a competitive solicitation and evaluate bids based on minimum costs, projects located on "previously developed or impacted land," defined as "covered by impervious surfaces, capped landfills or brownfield sites" must be evaluated at 90% of the offered rate. Maine also has a revolving loan fund for solar projects on brownfields.[55]
- In 2020, West Virginia enacted its first solar-friendly law[56] for utility-scale projects, which includes a provision to prioritize siting solar developments on former coal mines and other industrial lands and authorizing up to 400MW of solar development on these sites.
- The Virginia Clean Economy Act (2020) includes a provision that requires the state's two largest electric utilities to develop at least 200 megawatts of solar on mined lands and brownfields.[57] The Virginia Brownfield and Coal Mine Renewable Energy Grant Fund ("Brightfields Program") is established to provide funding towards these types of projects.[58]

State Policy Path Forward

Most states have not developed policies that go beyond the standard state policy framework for reclamation of mine lands and brownfields described above to encourage clean energy development on mine lands and brownfields. The U.S. EPA RE-Powering America's Land Initiative has identified eleven states[59] that have incentive programs to encourage clean energy development on these sites, and three states that have incentives ***and*** streamlined permitting for clean energy projects on mine lands and brownfields.[60]

The three states with both financial incentives and streamlined permitting—Massachusetts, New Jersey, and New York—account for an astounding 239 of 459 projects (52%) in the national RE-Powering project inventory.[61] This shows the powerful role that permitting reforms for these sites can play and suggests that incentives need to be substantially bolstered by other state programs and policies. Illinois and Virginia recently adopted policies targeted at directing more clean energy development to mine land and brownfield sites.

U.S. EPA has identified eight categories of state policies and programs that can stimulate increased clean energy development on mine lands and brownfields.[62] These include:

NEW HAMPSHIRE State House in Concord, NH © Eric Aldrich

Direct Financial Incentives. These can take various forms, including tax incentives, grants, offtake agreements with state agencies, rebates for permitting and environmental review costs, etc. (CT, DE, IL, MD, MA, ME, MN, NJ, RI, WV, VT)

Procurement Preferences or Requirements. States can include procurement preferences or requirements for generation projects on mine lands and/or brownfield sites in state or utility electricity procurements. (IL, NJ)

Site Identification and Project Support. These include databases, mapping tools, direct technical assistance from state government and/or contractors and public/private project development partnerships. (IL, MA, NJ, NY)

Education and Outreach. This may include training presentations, dedicated web pages, support for university research and extension, toolkits, etc. (IL, MA, NJ, NY)

Streamlined Permitting. This can include expedited permit review, one-stop permitting options, coordination between agencies or designated lead agencies and coordination/guidance/limits for local ordinances. (MA, NJ, NY)

Liability Relief. This may include laws, regulations and/or enforcement discretion to reduce clean energy developer, landowner and/or operator liability. (MA)

General Brownfield Reuse. These are loans, grants and technical assistance that states make available for redevelopment of mine lands and brownfields that are not specific to but applicable to clean energy development. (IL, MA, NJ, NY)

Interagency Coordination. Interagency task forces, meetings and processes to identify and remove development barriers and target technical assistance programs, streamline permitting requirements and expand incentives for clean energy on mine lands and brownfields. (IL, MA, NJ, NY)

The high voltage One Nevada line and another wooden transmission line run side-by-side in Lincoln County, Nevada. © Bridget Bennett

STATE ROADMAPS

The Nature Conservancy has advanced the Mining the Sun initiative in multiple states to better understand the challenges and opportunities facing clean energy deployment on mine lands and brownfields across the United States. Together these states represent the country's spectrum of mine land and brownfield conditions. Nevada hosts many hardrock mines, while Wyoming, North Dakota, Kentucky and West Virginia primarily feature surface coal mines. Illinois, Indiana, Ohio and Virginia are home to extensive coal mines and numerous brownfield sites. In each state, TNC met with a variety of stakeholders; organized webinars, listening sessions and workshops; mapped feasible mine land and brownfield sites; and developed policy priorities. In several states, most notably Virginia, Kentucky, Indiana, West Virginia, Wyoming and Nevada, TNC worked to facilitate specific clean energy projects on mine lands to appreciate more fully what it will take to catalyze wider development at these sites.

The following Mining the Sun state roadmaps provide a high-level summary of the context, opportunities, and most important next steps to advance clean energy on mine lands and brownfields in each state. You can find more information on mine land and brownfield clean energy development in these states:

Illinois
Indiana
Kentucky
Nevada
North Dakota
Ohio
Virginia
West Virginia
Wyoming

STATE ROADMAP: **ILLINOIS**

While Illinois has the second largest coal reserves in the country, mining has declined precipitously in the state. However, remnants of the state's economic past are evident on the landscape. Coal mining peaked in 1935 with over 1000 mines, leaving Illinois with over 200,000 acres of former strip mines across the state, especially in Southern Illinois.[63] In addition to abandoned mines, Illinois contains several thousand brownfield sites. Now, as Illinois seeks to meet ambitious clean energy goals, these sites can serve as locations for wind and solar. Reusing degraded lands for renewable energy development is a win-win solution for people and nature, providing the land for new energy development in lieu of prime farmland and open space.

Illinois has outstanding opportunities for clean energy deployment on mine lands and brownfields. In western and southern Illinois, TNC estimates there are up to 140,000 acres of former mine lands near the electric grid, making them good candidates for clean energy projects. Nearly 200 brownfield sites totaling 40,030 acres are sufficiently large to accommodate either community or utility-scale solar projects and are close to transmission lines and substations.

Recently enacted policies are also driving a clean energy boom in the state. The Climate and Equitable Jobs Act (CEJA) is forecast to drive a major expansion of wind and solar capacity by 2050, nearly five times the current capacity. CEJA includes a mandate to procure a portion of the state's renewable energy from utility-scale solar on brownfields, as well as a Coal to Solar Program to incentivize solar projects on or adjacent to coal generation facilities that were in operation as of January 2016. When combined with federal Inflation Reduction Act (IRA) and Infrastructure Investment and Jobs Act (IIJA) incentives, these state policies make Illinois a compelling location for clean energy projects on mine lands and brownfields. The success of these policies in prioritizing degraded lands for new energy development is especially important in Illinois given how little natural habitat remains and the high value of Illinois's prime agricultural soils.

ILLINOIS Former coal mine site undergoing reclamation. © Tami Heilemann

To further encourage clean energy development on mine lands and brownfields in Illinois, The Nature Conservancy supports the following policy priorities:

- Expand the CEJA "carve-out" requirement (currently 3%) for the Illinois Power Agency to award Renewable Energy Credits to brownfield solar projects.[64]
- Leverage $75 million in new federal Abandoned Mine Land (AML) funds in the IIJA to expand the Illinois Department of Natural Resources' ability to remediate additional AML sites to support renewable energy projects.
- Build awareness of the 10% federal tax credit available through the IRA for renewable energy projects built in "energy communities", including projects on brownfields.
- Amend relevant state environmental statutes, including the state Surface Mined Land Conservation and Reclamation Act, the state Abandoned Mine Land Act, and the Illinois Brownfields Redevelopment Loan Program, to include clean energy and storage as eligible uses for program funding.

STATE ROADMAP: **INDIANA**

Indiana has a rich history as an industrial and coal mining state. The Illinois Coal Basin, of which Indiana is a part, is one of the largest coal fields in the United States. Indiana's bituminous coal mines are concentrated in the southwestern part of the state. Mining started in the middle 1800s and expanded until it peaked during World War I. Mining slowly declined during the remainder of the twentieth century and shifted from predominantly underground to surface mining. As stricter sulfur dioxide emission regulations were implemented, Indiana's production fell steeply as low sulfur coal in the Powder River Basin replaced high sulfur Illinois Basin coal. Indiana ranked as the 8th largest coal production state in 2022.[65] Indiana's coal region has the state's best solar resource values and its lowest wind resource values. Brownfields are found throughout the state, with most concentrated in urban areas. They range from small sites associated with leaking tanks and localized contamination to very large former industrial sites. Brownfield sites provide opportunities for both wind and solar development as well as storage and other clean energy technologies.

Transmission towers in Southern Indiana. © Devan King/TNC

Indiana has seen rapid growth in solar development in the recent past. It was tied with Illinois as the most productive solar state in the Midwest.[66] Most projects have been sited on croplands, which has given rise to controversies over the transformation of croplands into large scale solar projects. The state has significant opportunities, however, to focus future clean energy development on mine lands and brownfields. Analysis by The Nature Conservancy indicates there are just over 150,000 acres of mine lands in southwestern Indiana within ten miles of transmission that could host solar and other clean energy technologies. Brownfields with an area greater than 10 acres and within proximity of transmission are found across the state and offer a similar area (155,000 acres) for future clean energy development. Federal incentives in the Inflation Reduction Act provide new reasons to consider clean energy development on these lands.[67] Recent polling commissioned by The Nature Conservancy shows 69% of Indiana residents support adding state incentives to facilitate solar and wind development on brownfields and mine lands. The Indiana Department of Natural Resources has an infusion of $385 million in federal grants available to reclaim Abandoned Mine Lands, and these developments have set the stage for clean energy development at these sites. An 800 MW battery storage project at the AES Petersburg coal generation site represents the first major investment in clean energy at a brownfield site in Indiana.[68]

Additional steps to accelerate clean energy on mine lands and brownfields in Indiana include:

- Update the Indiana State Reclamation Plan 2016[69] for the Abandoned Mine Lands program and include renewable energy and storage as one of the plan's goals for mine land reclamation.
- Revise state mine lands reclamation bonding and liability waiver requirements to facilitate renewable energy and storage projects on regulated mine and brownfield sites.
- Provide technical assistance for communities to participate in developing mine land and brownfield reclamation plans that include community benefits from clean energy projects in addition to other desired post-reclamation uses.

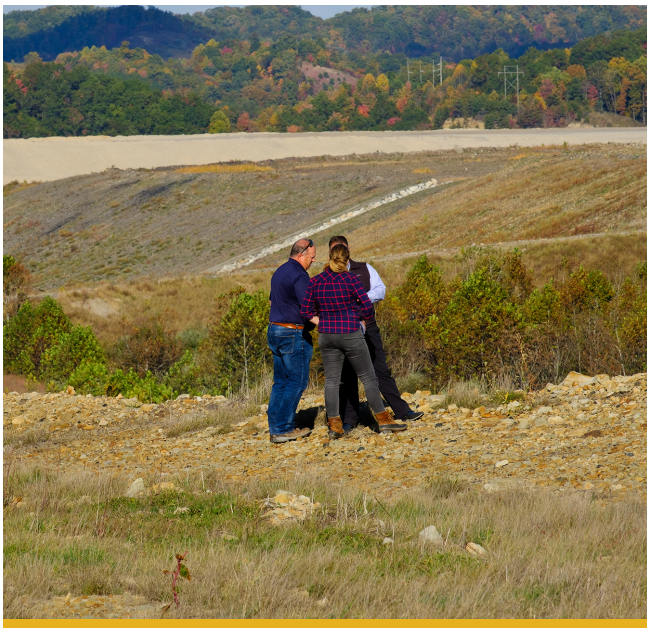
STATE ROADMAP: **KENTUCKY**

Kentucky has a long and proud history as a leading energy state. The earliest-known commercial coal production was in 1790—two years before the Commonwealth of Kentucky became a state.[70] Industrialization in the Midwest during the early 20th Century fueled rapid expansion of coal production from eastern Kentucky's Appalachian Mountains and mines in western Kentucky's Illinois Basin. By mid-century, Kentucky had become the nation's largest coal producer, with over 75,000 miners. Production peaked in 1990 and has declined steadily since. The state now ranks as the fifth largest producer with employment down to 4,800 miners.[71]

Another outstanding feature of Kentucky is the state's biologically diverse ecosystems, from the rich Appalachian forests in the east to a patchwork of prairies, glades, caves and bottomland forest in central and western Kentucky.[72] Already fragmented by mining, agriculture and other land uses, expansion of renewable energy poses a new challenge to the state's natural areas. Kentucky's legacy of mining and industrial development, however, could be key to helping the state play a leading role in the energy transition while protecting its rich natural areas. Siting solar, wind and other clean energy projects on mine lands and brownfields can also reduce the conversion of Kentucky's prime agricultural lands.

The EPA RE-Powering America's Land Initiative inventory[73] of technically feasible brownfield locations for solar projects in Kentucky includes 81 sites (>50 acres) encompassing 52,420 acres. TNC estimates approximately 123,000 acres of Kentucky brownfields are suitable for solar development and that up to 180,000 acres of mine lands are potentially suitable for clean energy development in Kentucky.

Kentucky currently ranks near the bottom in installed wind and solar capacity, but several major solar projects are moving forward on mine lands:



STARFIRE MINE SITE Planners discuss the restoration process for BrightNight's renewable power project in Kentucky. © Dean Hill

The Martin County Solar Project[74] was scheduled to break ground in the fall of 2023 on 1,200 acres. This 200-MW project, built by Savion and Edelen Renewables, will supply Toyota Motor with renewable energy to reduce its North American carbon footprint. The $1 billion project at the Starfire Mine developed by BrightNight[75] will supply solar energy to Rivian Motors and other off takers; it will be built in several phases culminating in a 800-MW facility.

These projects are some of the largest clean energy projects on mine lands and former industrial sites in the world and will help establish Kentucky as a leader in the clean energy transition.

Several steps that can help advance the deployment of clean energy on mine lands and brownfields in Kentucky include:

- Inventory and map coal mine lands and identify their reclamation and bonding status as well as their clean energy potential (e.g., distance to transmission, substations, energy resource quality, etc.).
- Establish a clean energy program in the DNR Division on Mine Reclamation and Enforcement that can access federal and state funding to facilitate mine land reclamation for possible clean energy development. This program would conduct due diligence, facilitate bond release and help market appropriate shovel ready sites to energy developers and buyers.

STATE ROADMAP: **NEVADA**

Nevada has a rich history of mining precious minerals like copper, gold and silver and has thousands of active and inactive hardrock mines. Nevada's hardrock mines—both closed and open—present important opportunities for renewable energy development. Closed heap leach piles and waste rock dump sites can be ideal places to install clean energy. For closed mines, tailings storage facilities and pit lakes can also be good sites for larger renewable energy projects. Closed and abandoned mine sites frequently have electricity infrastructure still in place, and many sites have large, flat areas suitable for clean energy infrastructure.

Nevada's energy and mining industries are governed by several state and federal agencies and many of Nevada's mine sites are located on federal land. Over 80 percent of Nevada is held in the public domain, and the Bureau of Land Management (BLM) manages 63 percent (48 million acres) of all lands in the state. Many existing and proposed industrial renewable energy projects are also on federal land. In 2022, there were approximately 9 gigawatts (GW) of permitted renewable energy projects on BLM-administered lands in Nevada.[76] The agency is on track to have as much as 13 GW permitted in the state by 2025, with much more anticipated in following years.

In Nevada, TNC estimates 370,700 acres of brownfields and 3,808 acres in mines have technical potential for renewable energy. Many brownfield and mine sites are too small for utility scale projects, but they offer great possibilities for community scale projects. This could be especially valuable for the state's widely scattered and remote rural communities. As Nevada's public utility prepares to expand transmission and renewable generation infrastructure, these land assets can be incorporated in the utility's statewide energy plan. The state also has numerous brownfield sites, many associated with mineral processing and smelting. These sites represent the best opportunities for avoiding and minimizing impacts to Nevada's diverse and sensitive ecosystems as renewable energy deployment accelerates.

NEVADA Mine tailings on public lands from the nearby Caselton Mine and Mill Site, some portions of which are being evaluated for solar. © Bridget Bennett

Policy changes would help incentivize and prioritize energy development on mine lands and brownfields, including:

- Include mine lands and brownfields in energy, infrastructure, and land use plans. The Nevada Public Utility Commission designated renewable energy zones in 2010, and they should be updated given newer data and the major growth in renewable energy demand from energy buyers since 2010. The amended zones should include mine land and brownfield sites as renewable energy zones. The PUC should also identify mine land or brownfield sites as priority locations for energy development that a utility proposes to meet future demand in utility Integrated Resource Plans.
- Incentivize clean energy development on mine lands. The BLM should include mine lands and brownfield sites in Solar Energy Zones as it revises the 2012 Western Solar Plan. The State Infrastructure Bank and the Nevada Clean Energy Fund should offer discounted loan rates for projects on mine lands and brownfields.
- Facilitate project development on abandoned mine lands and Superfund sites. Congress should pass The Good Samaritan Remediation of Abandoned Hardrock Mines Act of 2023,[77] which would address liability concerns for companies seeking to develop renewable energy on mine lands. Under CERCLA, federal lands are excluded from receiving assessment and clean up funds. CERCLA reforms should include exceptions to this exclusion for Federal mine land and brownfield sites since over 80 percent of the state is in the federal domain. The Nevada Department of the Environment should amend RCRA and CERCLA state regulations to add a new category of environmental cleanup standards for sites with clean energy infrastructure.

STATE ROADMAP: **NORTH DAKOTA**

Stretching across the Northern Great Plains, North Dakota has a long history as a major agricultural and energy producer, exporting wheat, cattle, coal and oil across the country and the world. Croplands dominate the eastern half of the state, while cattle ranching and energy production are prominent west of the Missouri. Native grassland ecosystems have been fragmented and greatly diminished during the past century driven by expanding cropland conversion and more recently by energy production.

Since the 1950s, the western half of North Dakota has experienced a series of energy boom and bust cycles. The state currently ranks as the nation's 3rd largest oil and 5th largest coal producer. Nearly 18,000 active oil wells are scattered across western North Dakota, and the hugely productive Bakken shale boom has impacted tens of thousands of acres with well pads, roads and production facilities. Since 1970, over 144,000 acres of coal mine lands have been permitted in west central North Dakota. Currently there are just three remaining large strip mines, including the Freedom Mine, which is the 4th largest in the United States. Fossil fuel energy is still an important part of the state's economy, representing nearly 13% of state employment. The state's wind and solar resources, however, are likely to become increasingly important in the next several decades as the national energy transition accelerates.

North Dakota is home to over 280,000 acres of previously developed sites where new energy development would not convert native habitat. A TNC analysis suggests that across North Dakota, there are 589 brownfield sites larger than 5 acres—identified as EPA- and state-designated brownfields, solid waste sites and landfills, abandoned mines, former gas plants and abandoned oil/gas sites. Of this area, about 24,000 acres are low-impact brownfields—those that do not intersect with sensitive natural habitats and wildlife species.[78] These low-impact land areas could provide nearly 3 GW of low-impact solar electricity generation capacity, assuming local nameplate capacity density of 30 MW/km^2.[79] The available land translates to significantly more solar than wind electricity generating capacity due to the assumed higher nameplate capacity—however, total energy generation potential is likely more similar between the technologies due to the extreme seasonality of solar generation.

FALKIRK MINE SITE Lignite coal mining in North Dakota. © Mark Staples

The Nature Conservancy believes the following actions can help North Dakota expand renewable energy development while protecting the state's natural areas and wildlife:

- Include renewable energy projects as an eligible use of solid and hazardous waste reclamation operations, including on sites like radioactive waste sites that likely cannot be fully remediated. Currently Century Code includes few specifications around reclamation of these sites and does not include renewable energy in its discussion.[80] Listing solar and wind energy as eligible uses could be an easy way for the state to prioritize efficient reclamation and reuse of sites—like radioactive waste facilities—that are otherwise challenging to reclaim.
- Include renewable energy as an eligible use in Abandoned Mine Land Reclamation processes. Current reclamation operations prioritize recreation, historic, conservation, and reclamation purposes and open space benefits.[81] Expanding eligible reclamation uses could encourage more diverse and faster reclamation processes of abandoned mine lands while supporting a wider range of economic investments in former mine areas.
- Update charge and duties of Public Service Commission in Century Code to include renewable energy work, especially as a means of enhancing surface mining reclamation.[82] This would give the Public Service Commission more direct oversight and ability to influence the penetration of renewable energy resources across the state.

STATE ROADMAP: **OHIO**

Ohio has a rich industrial and agricultural history, with diverse manufacturing in large cities and small towns across the state surrounded by productive agricultural lands. Renewable energy development has been focused on highly productive croplands, which feeds the state's largest industry and employs one in seven workers. Growing concern that wind and solar projects might displace agriculture has spawned state and local policies that restrict where utility scale renewable energy projects can be sited. These policies have had a dampening effect on renewable energy development, and Ohio now significantly trails most of its neighbors in wind and solar capacity. Meanwhile, over half of Ohio's largest employers have made public commitments to reduce their greenhouse gas emissions and buy renewable energy.[83] Increasingly, this means that Ohio's largest companies will need to source their renewable energy from out-of-state projects.

Fortunately, there is a path to encourage renewable energy development in a way that does not harm agricultural operations. The Appalachians rising in the eastern and southeastern part of the state have extensive coal reserves that were first mined underground before surface mining became prevalent in the 1960s. During the past two decades, many mines have shuttered or downsized operations as the U.S. shifts to cleaner energy sources. The Nature Conservancy has identified roughly 567,600 acres of mine lands mostly in eastern Ohio with access to transmission lines that are potentially suitable for renewable energy development. In other parts of the state, nearly 300 brownfield sites totaling over 50,000 acres are located near transmission and potentially suitable for both community scale and utility scale solar projects. Ohio has significant opportunity in its brownfields and previous mined land for a new clean energy future. Many Ohio businesses, utilities and communities want renewable energy in the state at a time when federal dollars from the Inflation Reduction Act are available to finance solutions. Ohio has significant opportunity in its brownfields and previously mined land for a new clean energy future. Many Ohio businesses, utilities and communities want renewable energy in the state at a time when federal dollars from the Inflation Reduction Act are available to bring solutions.

OHIO Former coal mine site with transmission lines in background. © Rebecca Mellino

The Nature Conservancy believes the following actions can help Ohio get back on track as a clean energy state while protecting the state's prime farmlands, rural communities and natural areas:

- Implement outreach and education programs for Ohio's "energy communities" as defined by the IRA to highlight opportunities for clean energy investment. The IRA tax credits for clean energy in energy communities, including on mine lands and brownfields, will catalyze hundreds of billions in new investments across the country, including in Ohio, as long as counties have not passed exclusion zones that were recently authorized by the Ohio General Assembly.
- Organize listening sessions with key stakeholders in energy communities to identify policy levers that would prioritize Ohio's ability to develop renewable energy on previously mined lands and to implement IRA funds. This includes AEP Ohio, the state's largest utility, which has expressed interest in developing renewable energy on mine lands it owns.
- Develop legislation with community groups to facilitate community solar in Ohio and work with clean energy advocates and other stakeholders to ensure future renewable energy legislation prioritizes clean energy development on brownfields development over greenfields. Prioritizing community solar on brownfields protects community values, avoids impacts to natural areas, and does not convert agricultural lands.

STATE ROADMAP: **VIRGINIA**

Virginia offers significant opportunities for solar development on previously mined lands and brownfields. In the mid-18th Century during the early industrial era,[84] Virginia was the country's top coal producer. Mining has declined dramatically in recent decades, and the state is now the country's 13th largest coal producer, with most production coming from southwestern Virginia.[85] Additionally, the VA Department of Environmental Quality tracks over 1,700 former industrial sites scattered across the state. While some lower priority greenfields will still be converted to support Virginia's clean energy transition, a 2020 analysis by The Nature Conservancy found it is possible for Virginia build the solar and onshore wind it needs to meet the Virginia Clean Economy Act goal of 16,100 MW of new renewable energy generation without converting its most important natural or prime agricultural lands.[86] The Nature Conservancy estimates roughly 170,000 acres of brownfields and 70,000 acres of mine land are potentially suitable for solar development in Virginia.

Demand for solar development in Virginia is strong. As of 2023, Virginia had 4,393 MW of installed solar generation.[87] The Virginia Clean Economy Act (VCEA) passed in 2020 mandates that the two major utilities in the state, Dominion Energy Virginia (DE) and Appalachian Electric Power (AEP), produce 100 percent renewable electricity by 2045 and 2050. The proliferation of large data centers in northern Virginia constructed by companies with 100% clean energy commitments has also increased demand for solar energy.

Virginia has a very conducive social and improving policy environment for facilitating clean energy development on mined lands and brownfields. Concern has emerged regarding the conversion of prime farmlands and forests to solar, leading to the 2022 passage of HB 206, which requires mitigation for impacts to these resources and thereby increases the cost of greenfield construction.[88] The VCEA requires DE and AEP to develop at least 200 MW of solar on brownfields and mined lands. The Virginia Brownfield and Coal Mine Renewable Energy Grant Fund would award $500 per kilowatt for projects on previously mined coal lands and $100 per kilowatt on brownfields, but this program has not yet been funded. Despite this, projects on mined lands are moving forward, including the operating 3.6 MW Mineral Gap project co-located with a data center,[89] and approximately 130 MW proposed on former mined lands managed by The Nature Conservancy. In addition, the DELTA accelerator lab intends to develop a variety of clean energy demonstration projects on 65,000 acres of mine lands in Wise County.[90]

SUN TRIBE SOLAR ENERGY PROJECT Former surface mine site on TNC Cumberland Forest.
© Sun Tribe

The Nature Conservancy believes the following actions can create additional momentum for clean energy deployment on mined lands and brownfields in Virginia while conserving the state's forest and natural areas:

- Fully fund the Virginia Brownfield and Coal Mine Renewable Energy Grant Fund. The fund was authorized to spend up to $35 million for qualifying clean energy projects on mined lands and brownfields, but no funds have been appropriated. The legislature should fund the program and the Virginia Department of Energy should identify and pursue possible federal funding sources that could be administered through the state fund.
- The legislature should appropriate funding for the Virginia Department of Energy to assess transmission capacity needs that are essential to unlock significant mine land and brownfield sites for clean energy development including wind, solar, small modular nuclear and advanced geothermal.

STATE ROADMAP: **WEST VIRGINIA**

West Virginia's long history of coal mining started in 1810 when the state became the nation's largest coal producer as the industrial revolution drove demand for both energy generation and steelmaking. The coal extracted from West Virginia and across the Central Appalachians was the base material that allowed the country to rapidly urbanize and build the steel skyscrapers and broader infrastructure that powered major east coast cities such as New York, Philadelphia, Pittsburgh and many more. Coal production in West Virginia peaked in 1997 with 181 million tons mined, but has since shrunk to 50% of peak production.[91] Even today, after decades of declining coal production, the state ranks as the second largest coal mining state in the U.S., with much of the coal now produced by large surface mining operations that require far fewer workers than historical underground mines.[92]

Much of West Virginia's land, minerals and other natural resources are owned by large out-of-state land holding companies, which collect lease and royalty payments from coal mining companies and other enterprises sited on their land, such as timber operations and natural gas wells. Some holdings are completely mined out or otherwise uneconomic, and with a downturn in coal mining, landholding companies are looking for replacement revenue streams. Local communities long reliant on coal mining as an economic mainstay are suffering the impacts of layoffs and shuttered coal mines and associated businesses. According to US Census data, household income and population growth are among the lowest in West Virginia, especially in rural counties long dominated by coal mining, making significant parts of the state some of the most economically distressed areas in the country.

Aerial view of mountain top coal mining in West Virginia. © Kent Mason

West Virginia has a timely opportunity to build on its legacy as a domestic energy provider for the 21st century by capitalizing on the vast land base of former surface coal mines as sites for new solar generation facilities. TNC's preliminary analysis suggests that up to 508,300 acres of mine lands and over 134,000 acres of brownfields could meet minimum site suitability requirements for large-scale solar across West Virginia. Until recently, West Virginia lagged far behind most states in the amount of renewable energy production. Legislation facilitating utility scale and rooftop solar passed in 2020. Recent investments for a renewable energy powered titanium smelter and a large battery storage manufacturing plant are another signal the renewable energy industry is starting to expand.

With the new Inflation Reduction Act investment tax credits in place, solar developers are now scrambling to find suitable sites across the region:

- If West Virginia were to implement a fair and predictable clean energy policy framework, the state has a unique and timely opportunity to become a global leader as the broader market transitions to a new energy economy.
- Adoption of new policies to incentivize solar development on former mine lands could create new jobs and attract new manufacturers and employers to a region that is increasingly demanding access to renewable energy to power their operations.
- This could in turn could help replenish the tax base of local communities and create new revenue streams for mine landowners.

STATE ROADMAP: **WYOMING**

Wyoming has vast energy resources, huge areas of intact habitat and abundant wildlife populations. Wyoming's economy has been deeply dependent on coal, oil and natural gas extraction, representing an opportunity and challenge for new wind and solar projects. While the state has some of the best onshore wind resources in North America and better than expected solar, they are some of the most country's most distant renewable resources from energy markets. Over a half-million acres of post-mining or post-industrial lands offer low-impact deployment possibilities, but many sites are remote or lack access to transmission and other infrastructure.

TNC's analysis shows there are approximately 118,000 acres of mine lands and 70,000 acres of brownfields that could be suitable for renewable energy development in Wyoming. The I-80 corridor has access to transmission capacity and high-quality wind and solar resources and has historically been an area of focus for renewable energy developers. While post-mining sites, degraded agricultural lands and depleted oil and gas fields present plentiful opportunities for brownfield siting, the region is also valuable habitat for Wyoming's big game wildlife and crisscrossed by some of the longest intact migration pathways for elk, mule deer and pronghorn in the lower 48 states. Reclaimed coal mining lands in the central and northeastern parts of the state represent additional opportunities for low-impact renewable energy siting.

Oil pumps and solar panels sharing space in Wyoming. © pan demin/Shutterstock

Some of the best low-impact opportunities for wind, solar and storage are associated with the state's 24 major industrial coal mining and power generation sites. These sites all enjoy rail access, high-voltage power lines, water infrastructure, leveled land and other infrastructure that can facilitate renewable energy projects.

Wyoming can advance low-impact renewable energy projects in several ways. These include:

- Incentivize brownfield siting through state and local tax breaks and streamlined permitting for projects at qualifying sites certified by state agencies, including the Wyoming Game and Fish Department, as being low impact for fish, wildlife and natural habitats.
- Require regulated utilities to source a specified percentage of renewable generation from projects sited on certified low-impact sites.
- Coordinate local and regional transmission planning to bring new capacity to northeast Wyoming's Powder River Basin. This region, with its reclaimed mine lands, has extensive low-impact solar and wind project sites, but lacks sufficient transmission needed to spur development. Linking up to the planned Northern Plains Connector between Colstrip, Montana, and central North Dakota could expand opportunities for wind and solar projects in northeast Wyoming to reach growing markets for renewable energy.

MINING THE SUN IN KENTUCKY

Transforming a coal mine into a renewable energy powerhouse

For over a decade, companies have been instrumental in driving the clean energy transition in the US. The Clean Energy Buyers Alliance estimates that demand from clean energy buyers has been responsible for about 40% of the US clean energy capacity deployed since 2014.[93] Given rising energy demands (electrification, data centers) alongside corporate climate commitments and action, these trends are expected to continue for the foreseeable future.

Now, companies are realizing that how they buy clean energy is just as important as how much they buy. Recently, companies representing over $500B in revenues announced their alignment to the Clean Energy Buyer's Institute (CEBI) "Principles for Purpose-Driven Procurement", which are intended to promote clean energy projects built from a sustainable, equitable, and resilient perspective – projects like the ones discussed in this Mining the Sun report. These commitments, alongside other voluntary efforts such as the Emissions-First Partnership[94], provide a roadmap to raising the bar across the renewable energy industry and optimizing for positive social and environmental impacts.

STARFIRE SOLAR SITE The reclaimed coal mine in eastern Kentucky is planned for a solar facility that will provide clean, renewable energy. © Dean Hill

TNC recently collaborated with the electric vehicle manufacturer Rivian on a joint procurement to test these principles in the current market. TNC and Rivian sought to find renewable energy projects that optimized economic value with 3C priorities. The goal was to create a model for procurement that companies could replicate and scale.

The project selected was the Starfire Renewable Energy Center, which will revitalize the Starfire mine, a historic coal mine in Eastern Kentucky. The BrightNight Starfire Renewable Energy Center in Perry, Knott, and Breathitt counties will ultimately have an 800-megawatt (MW) capacity, producing enough electricity to power over 500,000 households per year. When completed, it will be the largest renewable power project in Kentucky and the largest in the nation to be built on former mine lands, representing a $1-billion infrastructure investment. Rivian will purchase 100 MW of renewable power from the project. TNC will purchase a portion of those RECs from Rivian for TNC's energy emissions that cannot be reduced through energy efficiency and rooftop solar.

An output of this partnership is the Purpose Driven Toolkit[95], which offers a public guide describing the 3C procurement strategy. The toolkit includes resources for industry leaders to use and adapt this approach in order to accelerate environmentally and socially driven clean energy projects—such as projects on brownfields and mine lands.

While Starfire is a unique opportunity, it certainly is not the only one happening in Kentucky today. Several enabling conditions provide opportunities for similar projects in Kentucky, including Edelen Renewable's Martin County Solar Project which is producing renewable energy for Toyota's manufacturing facilities in the region. [96]

With the coal industry steadily declining, there is an opportunity to maintain Kentucky's role as a leading energy producer in the US, offering an opportunity for economic revitalization. The combination of energy buyer interest in environmental and community benefits, together with recent federal incentives, has opened the door for these projects to make important contributions to a clean energy future. The Starfire Renewable Energy Center can be a model for future clean energy projects that showcases how the transition to clean energy can be done sustainably, efficiently, and affordably and in ways that benefit communities historically known for energy production.

> "For decades, our miners labored at Starfire to provide the energy that powered the industrial development of this country. To think that the site can be reimagined as a new energy producer, facilitating hundreds of millions in private capital investment, and the creation of a skilled workforce in green energy is truly exciting."
>
> – Scott Alexander, Perry County Judge Executive

STARFIRE SOLAR SITE The solar facility being developed will be the largest renewable power project in Kentucky. © Dean Hill

CONCLUSION

The concept of "recycling" brownfields, mine lands, and other former industrial sites for clean energy development has received growing interest by landowners, energy developers, nearby communities, and state and federal agencies. A growing number of projects are coming online that will generate invaluable experience and lessons about how these projects can be developed more rapidly, at a lower cost, and using best practices to center communities.

As promising as recent developments have been, there are several areas where more progress is needed to expand the role mine lands, brownfields and other former industrial lands can play in the clean energy transition. These include:

Establishing and consistently using best practices for robust engagement of communities and Native nations in project planning, decision-making, and in fair and equitable benefit sharing. Energy developers should co-develop projects with relevant communities while local, state, and federal agencies should invest in providing communities with the resources they need to participate effectively in planning and proactively defining appropriate community benefits. Using best practices to center communities can also support projects delivering additional benefits to communities, such as job skills training, needed social services, or infrastructure.

Creating a virtual marketplace for candidate clean energy project sites on mine lands, brownfields and other former industrial lands. There are literally thousands of candidate sites across the United States, but it is difficult for energy developers to know which sites have the attributes that they need. A digital *Mining the Sun* marketplace could help landowners, communities, and government agencies provide the attributes of specific sites in a searchable database that includes the criteria for which energy developers are looking.

Sharing lessons from demonstration projects in a variety of venues to reach key audiences. The demonstration projects selected by the DOE Clean Energy Demonstration Program on Current and Former Mine Land in 2024 have the potential to generate a rich harvest of lessons learned from projects across the country. It will be vital to ensure that the data, experience, and lessons generated by these projects are accessible and widely shared with audiences that can most benefit—including communities, Native nations, and clean energy developers.

Focusing policy initiatives on regulatory reforms that can accelerate clean energy development on mine lands, brownfields, and other former industrial lands. Important incentives to develop these sites have been put in place by the federal Inflation Reduction Act and by several states. Evidence from EPA's RE-Powering America's Land Initiative suggests regulatory reforms to clarify and simplify permitting for clean energy projects on these sites is critical. New regulatory reforms are required to make federal and state permitting for clean energy development on these sites a less daunting process, while also ensuring environmental and community health are protected.

For more information and to access the full Mining the Sun toolkit, please visit **www.nature.org/miningthesun**.

The Nature Conservancy

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