RE-Powering America's Land:
Siting Renewable Energy on Potentially Contaminated Land , Landfills and Mine Sites

Solar Technologies

Through its RE-Powering America's Land Initiative, the U.S. Environmental Protection Agency (EPA) encourages renewable energy development on current and formerly contaminated lands, landfills, and mine sites when aligned with the community's vision for the site.

Building on an existing tool, the RE-Powering Initiative expanded screening to more than 80,000 EPA- and state-tracked sites, comprising over 43 million acres. Using screening criteria developed in collaboration with the U.S. Department of Energy's (DOE) National Renewable Energy Laboratory (NREL), each site was screened for the potential to develop solar, wind, biomass and geothermal facilities at various scales.

What is Solar energy?

Solar technologies generate electricity from the sun's energy. The following types of solar production technologies were evaluated:

Photovoltaic (PV) – Converts the sun's light energy directly into electricity. PV technology is scalable; the amount of electricity generated is directly related to the number and efficiency of installed panels. It can technically be sited anywhere, though the economics may make a project unfeasible in lower resource areas. Three scales of solar PV energy were evaluated:

A PV array at Fort Carson, CO

- ***Utility scale PV*** – Uses PV technology at the multi-megawatt (MW) scale at sites with the greatest resource and acreage availability. Electricity generated is typically exported to the grid.
- ***Large scale PV*** – Uses PV technology at the 300-killowatt (kW) scale or greater at sites with strong resource and suitable acreage availability. Electricity generated may be exported to the grid or used to offset onsite electricity consumption, depending on site requirements and market conditions.
- ***Off-grid PV*** – This category represents PV technology being used at a smaller scale, typically to power the energy needs of a single property when interconnection to the grid may not be feasible. Additional sites with lower solar resource may be technically and economically feasible depending on the potential for battery backup and cost barriers associated with grid interconnection (e.g., due to remote locations).

Economic viability of solar PV projects is closely tied to the policy and regulatory context of the jurisdiction where the installation would be sited. An additional parameter reflecting policies that incentivize solar PV projects was included to identify sites with similar characteristics to the "Utility scale PV" requirements.

Potential installed capacity based on percentage of acreage screened and reused for renewable energy development

10% OF ACRES	25% OF ACRES	50% OF ACRES	100% OF ACRES
OVER 670,000 MW	OVER 1,675,000 MW	OVER 3,350,000 MW	OVER 6,700,000 MW

How much solar potential exists on contaminated sites?

Utility Scale Photovoltaic (PV) – *2,112 sites*

Direct normal solar resource availability ≥ 5 kWh/m^2/day
Acreage ≥ 40 acres
Distance to transmission lines ≤ 10 miles
Distance to graded roads ≤ 10 miles

Policy Driven, Utility Scale PV – *5,062 sites*

This category only includes sites in states with a renewable portfolio standard (RPS) solar set-aside, solar multiplier or distributed generation incentive.

Direct normal solar resource availability ≥ 3.5 kWh/m^2/day
Acreage ≥ 40 acres
Distance to transmission lines ≤ 10 miles
Distance to graded roads ≤ 10 miles

Large scale PV – *18,794 sites*

Direct normal solar resource availability ≥ 3.5 kWh/m^2/day
Acreage ≥ 2 acres
Distance to transmission lines ≤ 1miles
Distance to graded roads ≤ 1 miles

Off-Grid Connected PV– *81,533 sites*

Direct normal solar resource availability ≥ 2.5 kWh/m^2/day

Utility scale concentrating solar power (CSP) Trough and power tower systems –*431 sites* Stirling engine system – *806 sites*

Direct normal solar resource availability ≥ 6 kWh/m^2/day
Acreage (trough and power tower systems) ≥ 250 acres
Acreage (Stirling engine system) ≥ 40 acres
Distance to transmission lines ≤ 10 miles
Distance to graded roads ≤ 10 miles

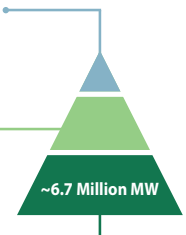
Estimating Total Technical Potential

Solar technical potential for EPA tracked sites: over 6,700,000 MW

Market potential – The portion of the economic potential that could be achieved given current costs, policies and technical constraints.

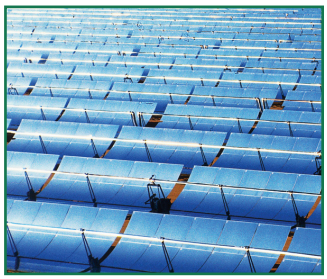
Economic potential – The portion of the technical potential that is economically viable, but requires additional policies to break down market barriers.

Technical potential – Potential that is technically possible, without consideration of cost or practical feasibility.



EPA

- ***PV Policy Driven*** – Represents sites that may have utility-scale development potential due to state policies, including sites in areas with lower resource availability. It includes states with a Renewable Portfolio Standard (RPS) that have one or more of the following provisions: a solar set-aside that requires a certain percentage of the state's electricity be generated from solar resources; a solar multiplier that gives additional credit for solar projects that contribute toward meeting the RPS; or a requirement for distributed generation (i.e., electricity generation close to the point of use). These incentives may help to make PV projects financially viable in areas with lower solar resource availability.



A CSP trough system

Utility Scale Concentrating Solar Power (CSP) - Uses the sun's thermal energy to heat a liquid that drives a generator to produce electricity. CSP technology is constructed at the MW or multi- MW scale, and electricity generated is typically exported to the grid. Three types of utility scale CSP technologies were evaluated:

The Solar Two CSP power tower system near Barstow, CA

- ***Trough System*** – Collects the sun's thermal energy using long rectangular, curved (U-shaped) mirrors. The mirrors are tilted toward the sun, focusing on tubes that run the length of the mirrors. The reflected sunlight heats a fluid flowing through the tubes. The hot fluid is then used to boil water in a conventional steam-turbine generator to produce electricity.
- ***Power Tower System*** – Uses a large field of flat, sun-tracking mirrors known as heliostats to concentrate sunlight onto a receiver on top of a tower. A heat-transfer fluid heated in the receiver is used to generate steam for a conventional steam-turbine generator to produce electricity. Some power towers use water/steam as the heat-transfer fluid, others use alternative materials such as molten salt.
- ***Stirling Engine System*** – Uses a mirrored dish to direct and concentrate sunlight onto a thermal receiver. A fluid heated inside the receiver moves pistons and creates mechanical power, which runs the Stirling engine to produce electricity.

A CSP Stirling engine system in Boulder, CO

What are some examples of solar facilities being successfully sited on contaminated land?

RE-Powering America's Land Initiative tracks the installation of renewable energy projects installed on contaminated lands, landfills, and mine sites. For example, a 10.8 MW solar PV installation was installed at Reilly Tar & Chemical Corporation in Indianapolis, Indiana. The Reilly Tar & Chemical Corporation produced specialty chemicals and related products and, for many years, the site also served as a wood treatment facility. In 1984, EPA placed the site on the National Priorities List due to groundwater and soil contamination at the property. Vertellus, the current owner of the property reached out to EPA to discuss the potential project and how it could be developed without negatively impacting the remedies in place. Hanwha Q CELLS, the solar developer, created an innovative soil disturbance minimization plan. In close coordination, all parties developed a plan that minimized soil excavation, trenching, and grading and that resulted in a 93% reduction in soil movement when compared to conventional construction methods. What makes this project a stand-out is the early collaboration between stakeholders and the fact that it was the largest such system installed at a Superfund site at the time.

There are several cases in which PV solar facilities have been used to power ground water remediation on Superfund sites, such as the Frontier Fertilizer site in Davis, California; the Pemaco site in Maywood, California; the Apache Power site near Benson, Arizona; and the Lawrence Livermore National Laboratory near Livermore, California. These solar projects provide significant energy cost savings and, in some cases, support ground water treatment in remote areas that would otherwise require the installation of costly power lines or generators.

For more information on completed solar and other renewable energy projects on contaminated lands, landfills, and mine sites, check out the RE-Powering Project Tracking Matrix.