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

Geothermal 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 geothermal energy?

Geothermal facilities use heat stored in the earth to generate electricity. This heat comes from the original formation of the planet, radioactive decay of minerals, tectonic activity, and solar energy absorbed at the surface. Geothermal energy is unique when compared to other renewable energy resources, in that it is more closely related to mineral or conventional fossil fuel resources, due to subsurface characterization. Three types of geothermal production were evaluated:

- ***Hydrothermal*** – Uses steam produced from existing reservoirs of hot water beneath the Earth's surface to power electrical generators. The steam rotates a turbine that activates a generator, which produces the electricity. Given the limited availability of onsite resource data, hydrothermal potential is screened for in a general sense and not linked to a particular technology or power plant design. For the purposes of this screening, the resource potential is screened based on geothermal resource favorability ratings, which take temperature, water resource, and permeability into account, and/or distance to known hydrothermal sites.
- ***Enhanced Geothermal*** – Provides geothermal power by tapping into the Earth's geothermal resources that are otherwise not economical due to lack of water, location or rock type. Enhanced geothermal systems (EGS) require engineering hydrothermal reservoirs in hot rocks for commercial use. The reservoirs are created by drilling wells into hot rock and fracturing the rock, to enable a fluid to flow between the wells. The fluid flows along these fractures and other pathways, picking up heat from the rocks, and exits the reservoir via production wells. At the surface, the heated fluid passes through a power plant where electricity is generated. Upon leaving the power plant, the fluid is returned to the reservoir through injection wells to complete the circulation loop. EGS offers the chance to extend use of geothermal resources across more areas of the United States. Resource potential is screened based on temperature at depth.

How much geothermal potential exists on contaminated sites?

Hydrothermal – *408 sites*

Distance to identified hydrothermal sites ≤ 10 miles Or
Favorability rating ≥ 4
Distance to transmission lines ≤ 10 miles Acreage ≥10 acres
Distance to graded roads ≤ 25 miles

Enhanced Geothermal Systems – *1,738 sites*

Resource temperature ≥ 150°C (300°F) at well depth ≤ 4.5 km
Distance to transmission lines ≤ 10 miles
Acreage ≥10 acres
Distance to graded roads ≤10 miles

Geothermal Heat Pump - *70,934 sites*

Near surface temperatures of 10°C (50°F) to 24°C (75°F) .

Note: All sites which have buildings or other heating or cooling needs (i.e., office buildings, warehouses, green houses) are generally considered favorable for geothermal heat pumps. This variable is not included in the prescreening.

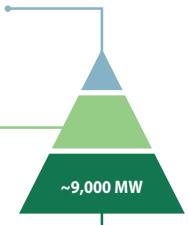
Estimating Total Technical Potential

Geothermal technical potential for EPA tracked sites: over 9,000 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.



For more information on geothermal technologies, visit: www.nrel.gov/learning/re_geothermal.html

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 900 MW	OVER 2,250 MW	OVER 4,500 MW	OVER 9,000 MW

A geothermal power plant in Mammoth Lakes, CA

EPA

- ***Geothermal heat pump*** – The upper 10 feet of the Earth maintains a nearly constant temperature between 50° and 60°F (10°-16°C). Geothermal heat pumps take advantage of this resource to heat and cool buildings and heat water. Geothermal heat pump systems consist of three parts: the ground loop heat exchanger, the heat pump unit, and the air delivery system (ductwork). The ground loop heat exchanger is a system of pipes buried in the shallow ground near the building (or in a vertical well if land for a horizontal loop is limited). Water source heat pumps work on the same principle as ground source systems, but use an adjacent body of water as the heat sink. A fluid (usually water or a mixture of water and antifreeze) circulates through the loop to absorb or relinquish heat within the ground. Geothermal heat pumps use much less energy than conventional heating systems, since they draw heat from the ground. Geothermal heat pumps typically serve a single property, though they may also be viable for use in multi-tenant applications such as integrated district heating systems.

What are some examples of geothermal 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, Guthrie Green Park, a former truck loading facility and brownfield, is now a green community park and meeting venue, with gardens, interactive fountains, an outdoor stage, a multi-purpose lawn for performances and festivals, and a café pavilion. A geothermal exchange well field was developed beneath the park site. The ground-source geothermal heat pump energy system includes 120 wells drilled to 500-foot depths to circulate water and bring it to a temperature of 66° F. The ground source heat pump serves the on-site cafe pavilion and bathrooms and several neighboring buildings, reducing their heating and cooling costs by approximately 60%.

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