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EPA United States Environmental Protection Agency

U.S. Environmental Protection Agency Office of Solid Waste and Emergency Response's Center for Program Analysis

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Contents

List of Project Profiles

List of Tables

List of Figures

List of Text Boxes

1. Introduction

EPA is committed to empowering states, communities, and other stakeholders to work together in a timely manner to assess, safely clean up, and sustainably reuse contaminated lands. In 2008, EPA's Office of Solid Waste and Emergency Response (OSWER) launched the RE-Powering America's Land: Siting Renewable Energy on Potentially Contaminated Land and Mine Sites Initiative (RE-Powering Initiative) to facilitate the use of potentially contaminated sites for renewable energy generation when it is aligned with the community's vision for the site. For this report, potentially contaminated land includes sites where contamination is suspected but has not been confirmed and sites where contamination has been identified.

Through the RE-Powering Initiative, EPA identified and mapped more than 11,000 potentially contaminated sites—and nearly 15 million acres that have potential for developing solar, wind, biomass and geothermal facilities. Together, the sites contain an estimated one million megawatts (MW) of renewable energy generation potential[1]—enough to power 1.5 to 2.5 million homes annually[2]. Figure 1-1 displays the locations of these sites. Table 1-1 summarizes the number of sites and acres mapped by program.

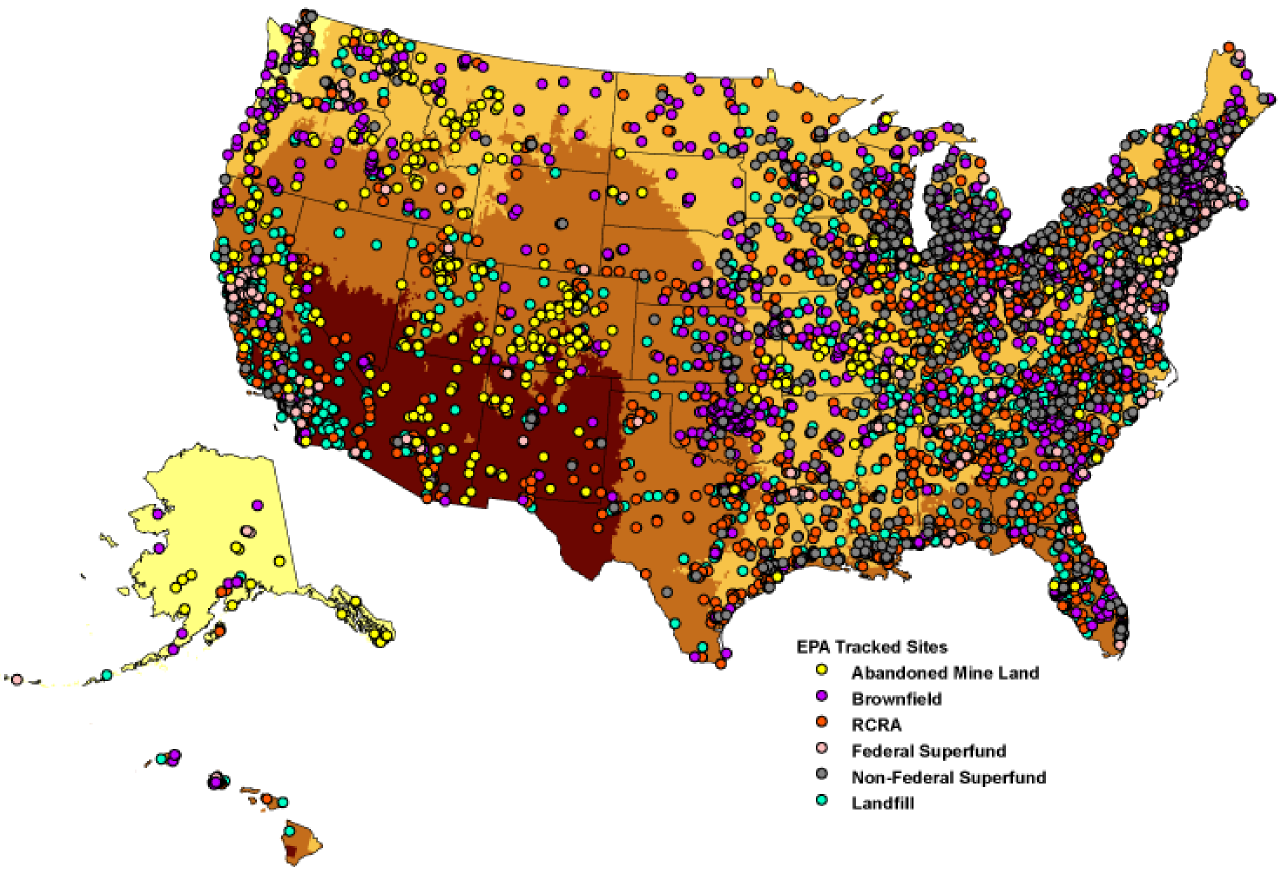

Figure 1-1: Potentially Contaminated Sites with Renewable Energy Potential

1 Estimated potential that is technically possible without consideration of cost or practical feasibility.

2 Based on the assumption that one megawatt of electricity generated from renewables can power 150 to 250 homes.

Table 1-1: As of 2012, Number of Sites and Acres with Renewable Energy Potential Mapped by EPA[3]		
Program	**Sites**	**Acres**
Abandoned Mine Land	450	2,596,015.76
Brownfield	4,099	31,190.06
Federal Superfund	170	1,030,609.96
Non-Federal Superfund	1,200	740,472.26
Landfill Methane Outreach Program	1,691	186,420
Resource Conservation and Recovery Act (2020 Corrective Action Universe)	3,747	10,159,686.52

Although some of these sites will undergo an environmental assessment and inevitably require little or no cleanup—others will require minimal to substantial cleanup before the sites can be returned to safe and productive reuse. However, unlike some reuses for contaminated land, choosing renewable energy generation for a site's reuse often allows renewable energy development activities and facility operations to occur prior to and even during cleanup activities (i.e. while addressing environmental issues).

1.1 Purpose

This *Handbook* is intended for EPA, other federal, local, and state cleanup project managers; communities, property owners, developers, and others with an interest in reusing potentially contaminated sites for renewable energy production. This *Handbook* provides tools to help interested parties determine the overall feasibility of siting renewable energy production and some key considerations for integrating renewable energy development during all phases of typical cleanup processes (e.g., during the environmental assessment, cleanup plan, or cleanup implementation) in the EPA Superfund, Brownfields, and Resource Conservation and Recovery Act (RCRA) Corrective Action programs.

1.2 Organization of the Handbook

Section 2 of the *Handbook* introduces EPA's conventional cleanup and reuse process and the renewable energy project development process including the unique siting opportunities and potential benefits associated with this reuse. Section 3 provides suggested steps and tools to help determine if a site is a good candidate for renewable energy production. Section 4 highlights considerations for integrating renewable energy development into the Superfund, Brownfields and RCRA cleanup processes. Checklists are included that provide step by step milestones for each stage in these cleanup processes that can facilitate renewable energy development. Throughout the *Handbook* successful demonstration projects are highlighted. The appendices include screening criteria decisions trees to help determine whether solar or wind development on a site is feasible, an overview of renewable energy technologies evaluated for siting on potentially contaminated land, maps of potentially contaminated sites with renewable energy potential identified by EPA, contacts for more information, and other useful resources.

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[3] *Data Guidelines for "Renewable Energy Generation Potential on EPA and State Tracked Sites" Maps.* For more information on the EPA date sets inventoried and mapped for renewable energy potential, please visit http://www.epa.gov/renewableenergyland or contact cleanenergy@epa.gov

2. Renewable Energy Production While Addressing Environmental Issues: The Fundamentals

EPA's RE-Powering America's Land Initiative is generating momentum for siting renewable energy production facilities on potentially contaminated land. These efforts are helping to restore hundreds of acres of land to safe and productive use. Since launching the Initiative, multiple renewable energy generation facilities have been sited on potentially contaminated land and mine sites across the U.S.; including several constructed on sites while cleanup efforts were ongoing. Some of those projects are highlighted in this *Handbook*.

2.1 What are the Benefits of Reusing Contaminated Land?

The cleanup and reuse of potentially contaminated properties provides many benefits, including:

- Preserving greenfields;
- Reducing blight and improving the appearance of a community;
- Raising property values, creating jobs;
- Allowing for access to existing infrastructure including electric transmission lines and roads; and
- Enabling potentially contaminated property to return to a productive and sustainable use.

In addition, renewable energy may provide a long-term source of energy at a stable cost. Developing renewable energy while environmental issues are being addressed at a site may also provide revenue to help cover cleanup costs or help offset costs of long-term operation and maintenance of the cleanup remedy.

2.2 EPA's Land Cleanup Process

Accidents, spills, leaks, past improper disposal and handling of hazardous materials and wastes have resulted in tens of thousands of contaminated lands in the United States. Contaminated lands can threaten human health and the environment and potentially hamper economic growth and the vitality of local communities. While OSWER is not involved in all contaminated areas, it tracks over 500,000 sites and 22 million acres across the 50 states, the District of Columbia, and U.S. territories. In addition, there are many sites that are tracked only at the state and local level. OSWER and its partners work to address contamination at these sites and restore them as useable parts of communities. It is OSWER's goal to work with communities to ensure that they can meaningfully participate in EPA's decision-making process and how contaminated areas should be reused. Environmental cleanup is the process used to respond to a hazardous material release or threat of a release that could adversely affect human health and/or the environment. EPA's land cleanup programs have different cleanup processes and requirements; however, the basic steps of each program's process are similar. Figure 2.1 displays the typical steps in the land cleanup process.

Figure 2-1: Typical Land Cleanup Process

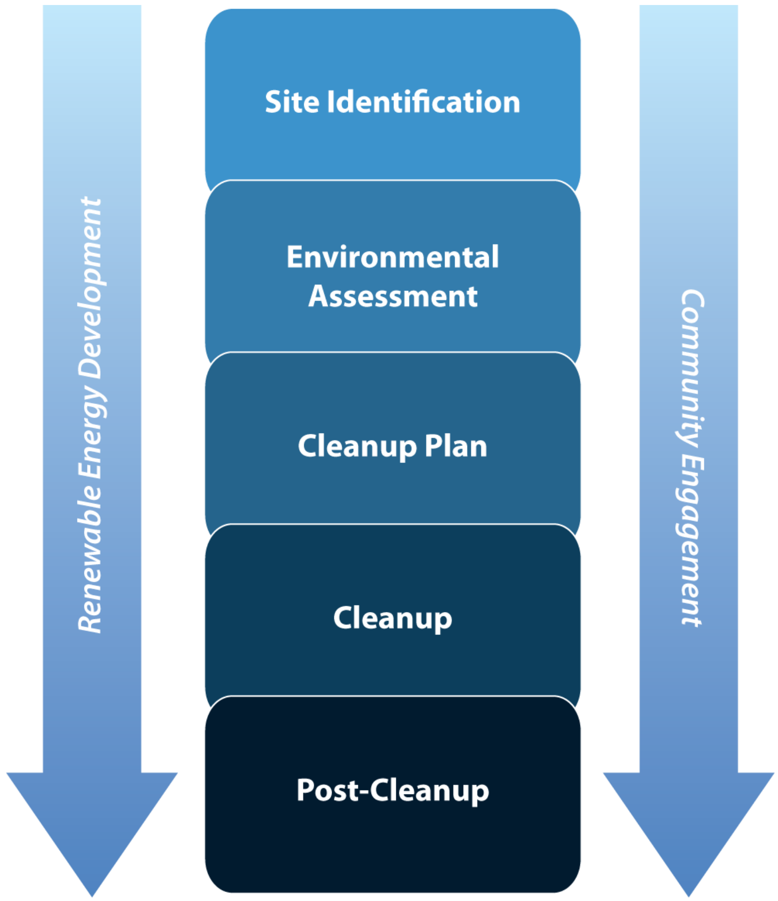
**Some sites may not require cleanup.*

Site Identification – The contaminated site is characterized in terms of location, types of structures, and potential contamination.

Environmental Assessment –The site is investigated to determine the nature and extent of contamination. If possible, future reuse of the site should be determined at this stage since it could significantly impact the cleanup process.

Cleanup Plan – If the site was found to have contamination in the preceding step, a cleanup plan is designed based on information gathered during the environmental assessment. However, not all potentially contaminated sites will require cleanup.

Cleanup – The cleanup plan is implemented. Cleanup technologies such as groundwater pump-and-treat can take several years but often require little of a site's useable acreage.



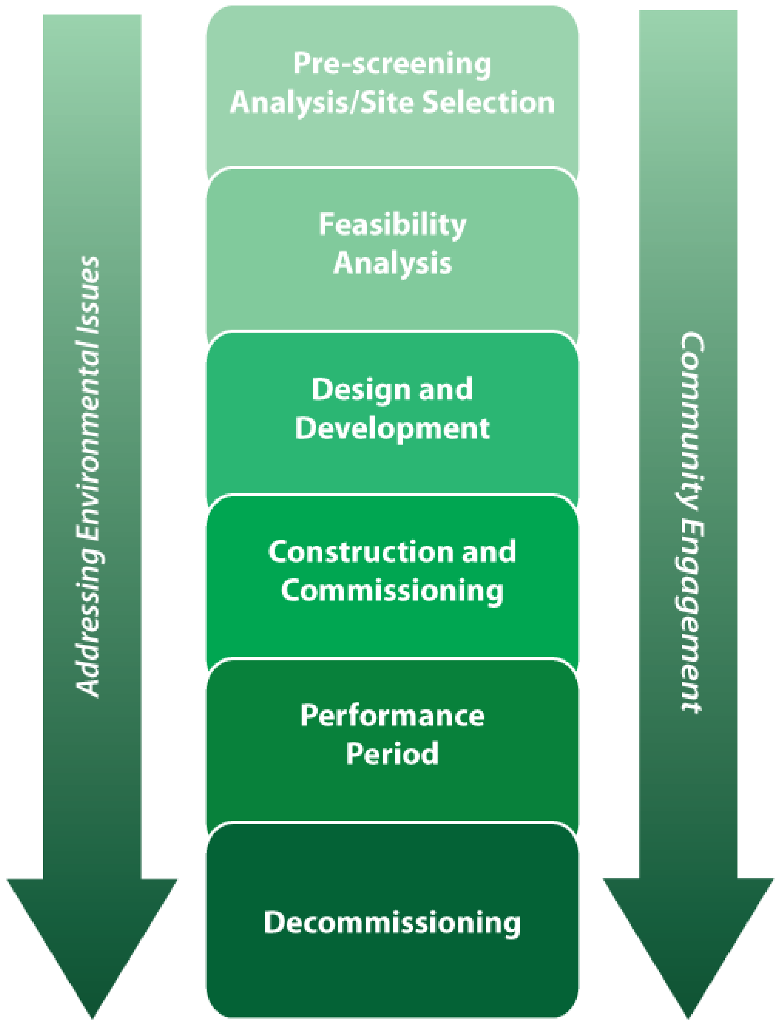
Post-cleanup –Some sites may require monitoring and institutional controls (ICs) to ensure protection of human health and the environment.

2.3 Renewable Energy Project Development and the Cleanup Process

Similar to EPA's various cleanup programs, the different types of renewable energy projects (e.g., solar, wind, etc.) have unique siting requirements. However, the basic phases across the different types of renewable energy projects are similar. Thus, the process allows for tailoring and adaptation to address unique or special-case needs inherent in site cleanup and reuse. In some instances, multiple phases can be combined or accelerated without compromising cleanup quality or development success— making it potentially possible to design and site a renewable energy facility, at any "step" in the land cleanup process. (See Figure 2-2.)

Figure 2-2: Renewable Energy Project Development Process

**Phases in the renewable energy project development process often overlap and are not necessarily completed in the order listed in Figure 2-2.*



Pre-screening Analysis/Site Selection – Screen sites to identify and prioritize locations for further study. Preliminary screenings are often based on maps of renewable energy resources, prevailing utility rates, and incentives to determine if the project merits a more serious investment of the time and resources required by a feasibility analysis.

Renewable Energy Feasibility Analysis (Site-specific assessment) – A detailed analysis of the project is designed to provide technology and financing recommendations; identify all physical issues, including space for the systems; determine technical performance potential and economic viability; and identify environmental, social or other constraints that may impede project execution.

Design and Development – Design and planning of the physical aspects of the project, including documenting the intent of the design and creating the protocol by which the system performance will be evaluated. This step also covers any required instrumentation; and the arrangement and negotiation of financial, regulatory, contractual, and other nonphysical aspects.

Construction and Commissioning – Construction or installation of the renewable energy facility, and assessment of the degree to which the system fulfills the intent of the design.

Performance Period – Operations and maintenance activities performed throughout the operating period of the facility, including regular confirmation that the facility is working according to specification and warranties through measurement and verification.

Decommissioning – Removing a facility at the end of a project's life. This process involves issues such as equipment replacement, permit revision, and new financing; and negotiating a new lease agreement, purchase power agreement (PPA), and buyer for the resultant renewable energy certificates (RECs), etc.

2.4 Opportunities for Siting Renewable Energy Production While Addressing Environmental Site Issues

There are several different scenarios under which renewable energy development may be appropriate and ensure continued protectiveness such as:

- **No Cleanup Necessary**: Initially, the site may have been considered contaminated. However, after assessing the site, it is determined that levels of contamination do not pose unacceptable risk to human health and the environment.
- **Before Cleanup:** There are areas of the site that have no contamination and/or it is determined that there are areas available for renewable energy development that do not pose unacceptable risk to human health and the environment.
- **Ongoing cleanup:** While cleanup occurs on contaminated areas, areas that do not pose an unacceptable risk to human health and the environment are identified where renewable energy could be developed.
- **After Cleanup**: After cleanup is complete on contaminated areas of a site, renewable energy may be installed as long as the site remains protective. Renewable energy development must be designed to accommodate any engineered (e.g., landfill cap) or ICs (e.g., restrictive covenants) implemented as part of the cleanup to ensure there is no risk to human health or the environment.
- **Groundwater Treatment Sites**: There may be no risk to human health and the environment on the surface of a site where active groundwater treatment activities are ongoing. In many cases, renewable energy equipment can be installed without disturbing the groundwater treatment system. If groundwater treatment is complete but monitoring is ongoing, renewable energy development may also occur as long as monitoring wells remain accessible and undisturbed.

Project Profile: Casper Winds, Evansville, Wyoming

Industrial operations on the 880-acre former Texaco Casper Refinery site in Evansville, Wyoming, began in 1922 and lasted until the early 1980s. Sitting idle since that time, the site underwent environmental assessments and was identified for Resource Conservation and Recovery Act Corrective Action (RCRA CA) by EPA in 1987. Subsequent cleanup activities were started by the Chevron Environmental Management Corporation, through the Wyoming Department of Environmental Quality's (WDEQ) Voluntary Remediation Program. Cleanup included the treatment of petroleum-contaminated groundwater, engineering controls to prevent contaminant migration, and institutional controls (in this case, a Use Control Area or UCA) prohibiting excavation of contaminated soils. With the push for renewable energy increasing, a portion of the former refinery site was determined as ideal for the installation of wind turbines. WDEQ determined that the targeted area did not have soil contamination and was sufficiently isolated from ongoing cleanup activities, and exempted the area from the UCA. Eleven 1.5 megawatt (MW) wind turbines were constructed approximately two miles away from an area of the RCRA CA site where groundwater cleanup is ongoing. The turbines began operation in December 2008 and generate as much as 16.5 MW during peak times. They deliver energy to the grid through a power purchasing agreement with Rocky Mountain Power.

For more information about the Casper Winds project, please visit: www.epa.gov/renewableenergyland/successstories.htm

3. Evaluating the Renewable Energy Potential of Potentially Contaminated Sites

As with all other site reuses, the evaluation of renewable energy as a reuse option for a potentially contaminated property should occur as early in the cleanup process as possible (e.g., environmental assessment). Early consideration allows for maximizing both time and cost efficiencies, as well as planning for the construction of a renewable energy facility even as cleanup strategies are determined. For example, EPA may be able to design and select a cleanup remedy that supports renewable energy development and accommodates that future land use. Furthermore, the siting of a renewable energy facility may be more challenging if initial cleanup activities did not accommodate renewable energy and if stakeholders did not consider renewable energy as a potential reuse. The entity that is responsible for selecting a redevelopment option (e.g. the property owner, potentially responsible party, or lessee) should consider the community's vision and technical and legal considerations provided in the laws and regulations that are specific to each cleanup program.

In order to assess the potential for siting a renewable energy facility on any site, including a potentially contaminated site, these steps are recommended:

- Use EPA's interactive Google Earth mapping tool to determine if an initial screen of the site has already been performed based on distance to transmission lines, resource potential, state incentives, etc.
    - If initial screening shows that a particular site may be viable for photovoltaic (PV) solar or wind development, use the appropriate decision tree to investigate the site further. (See Appendix A.)
    - If initial screening shows that a particular site may be viable for biomass or geothermal projects, conduct a renewable energy site-specific assessment to investigate the site further. (Additional decision trees for geothermal and biomass are under consideration for future development.)
- If the site appears to be viable based on applicable screening criteria, issue a Request for Proposals (RFP) based on the selected ownership and financing model for the renewable energy system. Include information compiled during the site screening process, as well as detailed information about the site (topography maps, soil reports, etc.) in order to improve the quality of bids.
- If it is determined that additional validation of the renewable energy resource is required prior to issuing an RFP, a renewable energy site-specific assessment should be done. This may be the case to confirm wind or geothermal resource at a particular site through long-term wind measurements or exploratory drilling, respectively.

Table 3-1: Renewable Energy Technologies Analyzed by EPA

Category	Technologies
Solar	Utility scale concentrating solar power (CSP) Utility scale photovoltaic (PV) PV policy driven Non-grid connected PV
Wind	Utility scale wind Community wind Non-grid connected wind
Biomass	Biopower facility Biorefinery facility
Geothermal	Flash power plant Binary power plant Geothermal heat pump
Landfill gas energy project	

The following sections provide details on available tools to determine if a site is a good candidate for renewable energy production, as well as other key factors (community involvement, institutional controls, etc.) to consider when evaluating a site for renewable energy development.

3.1 EPA's Interactive Google Earth Mapping Tool

In partnership with the National Renewable Energy Laboratory (NREL), EPA developed national site screening criteria to provide a rough estimate of how much of the projected renewable energy needs in the United States could be met by siting these facilities on contaminated land and landfills. The criteria include specific resource availability (e.g. solar, wind, biomass, geothermal; distances to roads, rail, and transmission lines; and size of the site). Using an inventory that EPA developed of abandoned mine lands, brownfields, RCRA sites, Superfund sites and landfills, the Agency extracted sites with viable acreage and latitude/longitude data. This subset of EPA tracked sites was then mapped against 14 different renewable energy technologies (see Table 3-1 and Appendix B) by using the aforementioned screening criteria. To date, this determination of viable sites and screening criteria resulted in EPA identifying and mapping more than 11,000 contaminated sites and landfills—covering nearly 15 million acres—with potential for siting renewable energy facilities. (Maps depicting the locations of these sites and their potential for supporting wind, solar, biomass, geothermal, and landfill gas energy generation can be found in Appendix C.) This information was used to develop a Google Earth Renewable Energy Interactive Mapping Tool. Through ongoing collaboration with EPA programs and state agencies, additional sites will be added to this database.

EPA's mapping tool makes it possible to view EPA's information about siting renewable energy on potentially contaminated land and mine sites, alongside other information contained in Google Earth. It enables the user to search by renewable energy type or by land type. In addition to a site's location, it also provides the following: site name and identification information; EPA Region and the EPA cleanup program overseeing cleanup activities at the site; a link to the site's cleanup status; and specific acreage and renewable energy resource information, as illustrated in Figure 3-1. These maps demonstrate that a large number of EPA tracked sites meet basic renewable energy siting criteria such as sufficient size, proximity to roads and transmission lines, a state-sponsored renewable portfolio standard (RPS) to encourage renewable energy development, and renewable energy resources. This information can be used to identify known or potentially contaminated sites with high renewable energy potential and to prioritize

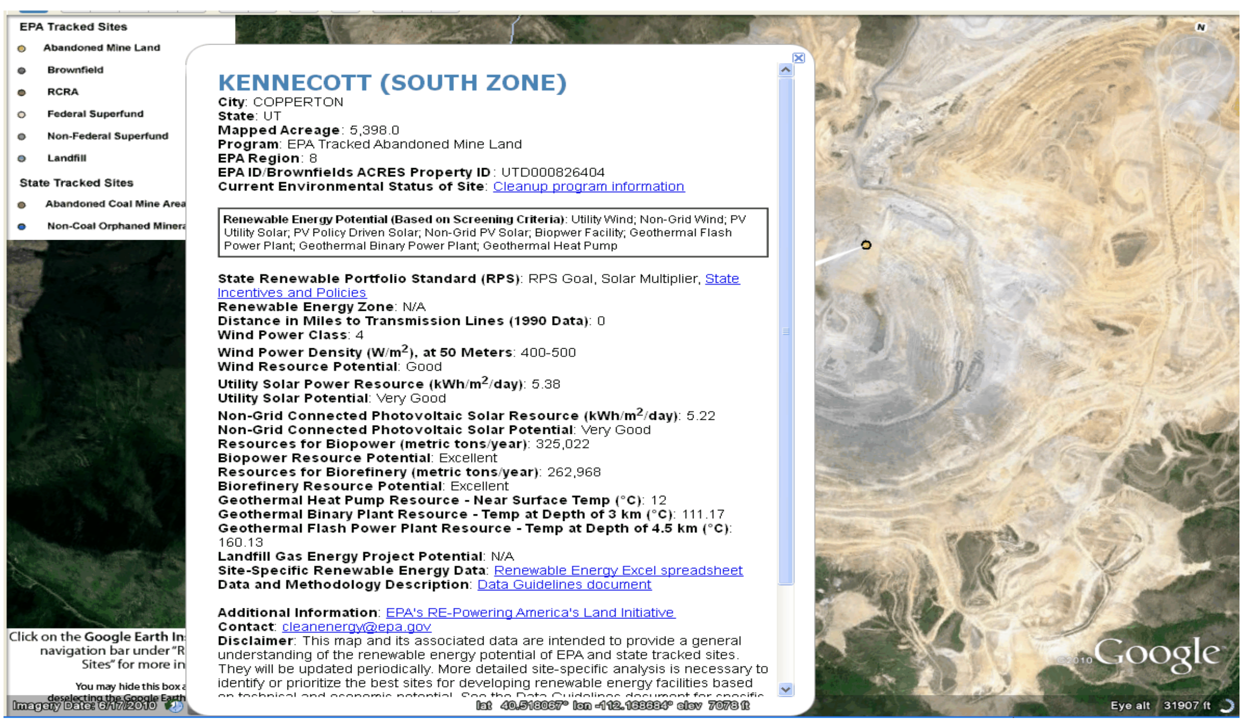


Figure 3-1: Renewable Energy Interactive Mapping Tool

land-use planning decisions. For more information on EPA's mapping tool, including directions for its use, please see: www.epa.gov/renewableenergyland/mapping_tool.htm. The data guidelines (e.g. methodology, data sources, and screening criteria), shapefiles, and Excel data spreadsheets are also available at this website.

While the mapping tool helps identify sites with potential for renewable energy development, its criteria and maps are not all-inclusive. Developers and site personnel may use the decision trees developed by EPA to initiate a more detailed analysis for entities seeking to site solar PV or wind projects on potentially contaminated lands and landfills.

3.2 Solar PV and Wind Energy Decision Trees

The solar PV and wind energy decision trees developed by EPA and NREL can be used by cleanup project managers, renewable energy developers, and state and local governments to conduct a more in-depth assessment for siting solar PV and wind generation facilities on contaminated lands. This is done to further evaluate and determine whether a contaminated site or area of the site will support renewable energy production as the reuse. The decision trees were developed specifically to evaluate the potential of siting solar PV and wind facilities on contaminated and underutilized sites. The decision trees can also be used to answer key questions to further evaluate whether a contaminated site will support solar PV or wind development. After using the tree, the user will have identified whether solar or wind is a viable reuse for a site. The decision trees are organized to guide users through a three-phase process to assess sites for renewable energy development based on technical and economic criteria. The process includes the following phases: (i) pre-screening (resource potential, available area, distance to existing infrastructure, site topography, redevelopment priorities, and land use exclusions); (ii) site screening (owner interest, system type, electricity costs, energy demand, and contaminated site considerations, status, and readiness); and (iii) financial screening (policy considerations, federal and state rebates and incentives, and installation costs).

Explanatory text and additional resources are provided for each section. For information on how to view and download copies of the solar PV and wind energy decision trees, please see Appendix A. Additional decision trees for geothermal, concentrated solar power (CSP) and biomass are under consideration for future development.

If the site appears to be viable for renewable energy based on the screening in the decision tree, the site may be ready to move into the development phase of the project. This phase will often include talking to developers and issuing an RFP to receive bids on developing renewable energy on the site.

3.3 Site-specific Assessment

If it is determined that a project merits a more serious investment of time and resources to attract renewable energy developers, an in depth site-specific assessment is recommended. This may be required if additional data is required to validate resource availability at a given site. For example, on-site sensors may be installed to gather data over a long period (approximately 1 year) to confirm wind resource availability and better characterize impacts of local terrain variation not captured by resource maps. EPA is collaborating with NREL on selected contaminated properties to analyze the feasibility of siting renewable energy. For more information, refer to http://epa.gov/renewableenergyland/studies.htm. Their analysis includes determining the best renewable energy

Box 3-1: Examples of Treatments and Engineered Controls

- Landfill soil caps
- Impermeable liners
- Other containment covers
- Underground slurry walls
- Fences
- Soil Vapor Extraction
- Bioremediation
- Ground water pump-and-treat and monitoring systems

technology for the site, the optimal location for placement of the technology, potential energy generating capacity, return on the investment, and overall economic feasibility.

3.4 Community Engagement

Community engagement is critical to match future reuse to desired community reuse opportunities. In order to ensure that redevelopment plans are compatible with the cleanup remedy and/or do not pose an unacceptable risk to human health and the environment, EPA recommends:

- Obtain early input from the community on how the site should be redeveloped;
- Hold discussions with local land use planning authorities, appropriate local officials, and the public to discuss options for the future use of the land (e.g., renewable energy production); and
- At sites requiring cleanup, work with EPA or the appropriate State agency that has the lead for site cleanup to ensure compatibility between renewable energy as a reuse option and the cleanup remedy.

The community engagement process is intended to help facilitate a decision regarding the future use of the site.

3.5 Working with Tribes

When renewable energy may make sense for a site located on tribal lands and fits into the community's plan for redevelopment, tribes may express a need for more specific information on what needs to be done to successfully site a project on potentially contaminated land. EPA's policy is to consult on a government-to-government basis with federally recognized tribal governments when EPA actions and decisions may affect tribal interests. Meaningful communication and coordination between EPA and tribal officials is essential prior to EPA taking actions or implementing decisions that may affect tribes. For more information on EPA's policy on consultation and coordination with Indian Tribes, refer to www.epa.gov/indian/pdf/cons-and-coord-with-indian-tribes-policy.pdf.

3.6 Treatment Technologies and Engineered Controls

Treatment technologies and physical or "engineered" controls include both the technologies to remove contamination from the environment as well as engineered physical barriers or structures designed to monitor and prevent exposure to the contamination. Certain engineered cleanups will involve ongoing operation and maintenance (O&M), monitoring, evaluation, periodic repairs, and sometimes replacement of remedy components. When considering renewable energy development at any step in the cleanup process, special attention should be paid to treatment technologies and engineered controls to ensure that a cleanup remedy remains protective. (See Box 3-1: Examples of Treatments and Engineered Controls.)

3.7 Institutional Controls (ICs)

When considering renewable energy development at any step in the cleanup process, special attention should be paid to ICs (e.g., easements and covenants). ICs often are implemented on a site-specific basis to minimize the potential for exposure to contamination and/or protect the integrity of the remedy components. If ICs have already been implemented, renewable energy development must be carefully planned to ensure adherence to IC restrictions or notices that are in place. This may be important when land is being returned to productive use prior to the completion of cleanup activities - where there may be an increased potential for human and ecological exposures to residual contamination or where human activity at a site may result in damage to the engineered response actions. For more

Box 3-2: Examples of Institutional Controls

- Zoning
- Deed notices
- Easements
- Restrictive covenants
- Fish advisories

information on ICs, including EPA guidance, please visit: http://www.epa.gov/superfund/policy/ic/. (See Box 3-2: Examples of Institutional Controls.)

3.8 Addressing Liability

When carefully planned, safe reuse of sites during cleanup can support longer-term redevelopment goals and return underutilized lands to productive use while environmental issues are being addressed. EPA is aware that some prospective purchasers, developers, and lenders are hesitant to become involved with the reuse of potentially contaminated properties because of fear they might be held liable for environmental contamination. EPA developed a variety of tools and policies to address these liability concerns and ensure protective cleanups while facilitating revitalization. In addition, private sector environmental insurance may be available to assist with addressing liability concerns. Given that most potentially contaminated properties are addressed under state programs, EPA encourages renewable energy developers to consult with legal counsel and their appropriate state, tribal or local environmental protection agencies. Since 2008, all states have programs or policies to provide some level of liability protection to new owners or lessees in specific situations. Please see: www.epa.gov/renewableenergyland/tools.htm for more information on the tools and resources available to address liability concerns.

4. Considerations for Integrating Renewable Energy Development into the EPA Superfund, Brownfields, and RCRA Cleanup Processes

EPA's land cleanup programs follow similar steps as those illustrated in Section 2; however, there are differences among the cleanup programs that can impact renewable energy development. This section highlights considerations for integrating renewable energy development into the Superfund, Brownfields and RCRA cleanup processes. Readers of this *Handbook* should note that while variations in approach for each of these EPA programs are discussed, the information provided is not all-inclusive, as every cleanup and development project presents unique challenges. For information and assistance beyond what this *Handbook* provides, cleanup project managers should contact a member of the EPA RE-Powering Rapid Response Team (see Appendix D for a list of contacts).

Box 4-1: Incorporating Renewable Energy Design Requirements into the Remedial Design

Incorporating Renewable Energy Design Requirements into the remedial design can be accomplished by considering a few additional site design criteria that may require minor changes in the design plan. For example, when considering siting solar PV on a site that is going to be capped:

- Consider designing access roads, groundwater monitoring stations, and other above ground protrusions around the edges of the anticipated footprint of the PV system.
- Consider a final site grade of less than 3%, and maximize the orientation of the grade for southern exposure
- Ensure that existing transmission and distribution infrastructure remains in place
- Consider final cap materials that are compatible with PV systems, i.e., compatible vegetation cover
- Consider contacting a PV developer or consultant to determine which type of PV system is most appropriate for the property and amend the cleanup design accordingly (i.e., modify cap depth, cover materials, or grading requirements)

4.1 Integrating Renewable Energy Development at Superfund Sites

Successfully integrating renewable energy development into the Superfund cleanup process requires careful coordination among EPA Remedial Project Managers (RPMs), Potentially Responsible Parties (PRPs)[4], developers, the

[4] A PRP is a possible polluter who may eventually be held liable under CERCLA for the contamination or misuse of a particular property or resource.

public, and other stakeholders. This section will examine different ways to coordinate renewable energy development into all stages of the Superfund cleanup process. In some instances—for example, with newly identified Superfund sites—there is a natural link between determining site characteristics for cleanup and identifying site conditions for optimal renewable energy development. In other instances, integrating renewable energy into the remedy may take additional time and coordination among all stakeholders, especially if cleanup is underway before renewable energy considerations are even discussed.

The Superfund cleanup process is initiated with site discovery or notification to EPA of possible releases of hazardous substances. EPA then evaluates the potential for a release of hazardous substances from the site through the typical steps in the Superfund cleanup process:

- **Preliminary Assessment/Site Inspection (PA/SI):** Investigations of site conditions. If the release of hazardous substances requires immediate or short-term response actions, these are addressed under the Removal Response authority of CERCLA.
- **National Priorities List (NPL):** A list of the most significantly contaminated sites identified for possible long-term cleanup.
- **Remedial Investigation/Feasibility Study (RI/FS)**: Determines the nature and extent of contamination and risk to human health and the environment. The purpose of the remedial investigation/feasibility study (RI/FS) is to assess site conditions and evaluate cleanup alternatives to the extent necessary to select a remedy. Developing and conducting an RI/FS generally includes the following activities: project scoping, data collection, risk assessment, treatability studies, and analysis of alternatives.
- **Record of Decision (ROD)**: Explains which cleanup alternatives will be used at NPL sites. When remedy cost exceeds $25 million, RODs are reviewed by the National Remedy Review Board of Remedial Alternatives.
- **Remedial Design/Remedial Action (RD/RA):** Develops the final design for the cleanup and includes preparing for and doing the bulk of the cleanup at the site.
- **Construction Complete**: Identifies completion of physical cleanup construction, although this does not necessarily indicate whether final cleanup levels have been achieved.
- **Post Construction Complete**: Ensures that Superfund response actions provide for the long-term protection of human health and the environment. Often included here are Long-Term Response Actions (LTRA), Operation and Maintenance (O&M), ICs, Five-Year Reviews, and Remedy Optimization. (O&M and Five-Year Reviews may also occur after deletion.)
- **NPL Deletion**: Removal of a site from the NPL once all response actions are complete and all cleanup goals have been achieved.

Renewable energy development can occur at any time in the Superfund cleanup process. By matching Superfund process steps and decision points with renewable energy development decisions, both cleanup and development decisions can be coordinated. For example, starting early in the process allows for incorporating renewable energy land use decisions in risk assessments, planning potential construction of a renewable facility, and accommodating future facilities during the remedial design. (See Box 4-1: Incorporating Renewable Energy Design Requirements into the Remedial Design.) This ensures that the design reflects compatibility between the renewable energy project, land reuse implications, and the cleanup remedy. It is important, therefore, that the RPM and the renewable energy developer communicate cleanup decisions, schedules, and site conditions during the cleanup process and construction.

For sites early in the Superfund cleanup process, a reuse assessment is an ideal opportunity to explore renewable energy as a reasonably anticipated future land use.[5] In addition, communities and other public stakeholders may choose to create a reuse plan. When identified early in the process, accurate land use decisions can be carried through baseline risk assessments, development of remedial action objectives (RAOs), and selection of a remedy.[6]

Box 4-2: Community Engagement Tools in the Superfund Program

- Community Involvement Coordinator
- Community interviews
- Community involvement plans
- Technical Assistance grants
- Community advisory groups
- Technical outreach services to communities
- Public outreach meetings

For each specific stage of the cleanup process, the RPM remains responsible for navigating through key Superfund cleanup decision points. The RPM should work closely with the Community Involvement Coordinator (CIC) to determine if renewable energy development is in-line with the community's vision for the site (See Box 4-2 Community Engagement Tools in the Superfund Program). The community may choose to use the visioning process, which is a tool that enables citizens to document their vision for the future of the site. This process encourages the full participation of all community members in goal development, action planning, and implementation. For additional information on the visioning process, refer to www.epa.gov/superfund/community/pdfs/9comvis.pdf. By considering a community's vision of future land uses for Superfund sites, EPA may tailor cleanup options to fit community goals. Refer to www.epa.gov/superfund/community/pdfs/9comvis.pdf.

In some cases, the RPM and CIC may need to work with community members and stakeholders to fully examine the community's questions regarding the applicability and feasibility of renewable energy development. The renewable energy developer, renewable energy stakeholder groups, and other federal, state or local renewable energy development experts (e.g., NREL) are excellent sources of technical information on renewable energy technology selection, design, and implementation. To the extent practicable, the lead agency—whether it is EPA or a state agency—should work with the renewable energy developer to incorporate renewable energy technical expertise and discuss how to ensure that renewable energy development is compatible with the cleanup plan.

Figure 4-1 illustrates how to integrate renewable energy development into the Superfund cleanup process for projects where renewable energy is the reasonably anticipated future land use. Specifically, it highlights types of information that will be needed when considering renewable energy during each stage of the Superfund cleanup process (key considerations) and when renewable energy development should ideally be considered (timing). The checklist in Table 4-1 provides a milestone for each step in the Superfund process that can help coordinate and integrate cleanup and renewable energy development activities while cleanup issues are being addressed.

5 http://www.epa.gov/superfund/programs/recycle/pdf/reusefinal.pdf

6 EPA OSWER. Memorandum: Considering Reasonably Anticipated Future Land Use and Reducing Barriers to Reuse at EPA-lead Superfund Remedial Sites. OSWER Directive 9355.7-19. March 17, 2010.

Figure 4-1: Integrating Renewable Energy Development into the EPA Superfund Process

**Renewable energy projects may still be successful if some of the key considerations are implemented during steps that differ from the steps specified below.*

COMMUNITY ENGAGEMENT

CLEANUP PROCESS	KEY CONSIDERATIONS	TIMING
Steps 1 and 2: Site Identification and Environmental Assessment Preliminary Assessment/ Site Investigation (PA/SI) → Placement on NPL → Remedial Investigation/ Feasibility Study (RI/FS)	• Identify potential non-contaminated areas based on sampling results • Identify potential renewable energy partners (e.g., developers, local utility) • Confirm willingness of PRPs (if applicable) and the community to consider renewable energy development • Conduct a reuse assessment and incorporate renewable energy development into the process	• The PA/SI phase offers time for renewable energy screening but uncertainties about the extent of contamination (and thus liability) will make renewable energy development unlikely. • The RI/FS phase is a key data collection and coordination step in the Superfund process. Because this step occurs before remedial decisions are made, it is an ideal time for stakeholders to begin planning for renewable energy development.
Step 3: Cleanup Plan ROD → Remedial Design	• Consider engineering requirements for renewable energy development • In the ROD, fully document engineering and ICs to the extent that they are relevant to the CERCLA remedy decision for renewable energy development • Incorporate renewable energy design requirements into the remedial design if appropriate	• The renewable energy development should take into account compatibility with the remedial design and the cleanup remedy.
Step 4: Cleanup Remedial Action → Construction Complete	• Hold meetings between remedy construction team (e.g., RPM, contractors) and renewable energy development team to examine ways to coordinate construction activities. • Inspect cleanup and renewable energy infrastructure to ensure cleanup protectiveness is not compromised • Confirm that ICs are in place	• If renewable energy is appropriately planned for in an earlier stage, it may be easier to plan and coordinate aspects of construction during this phase. • During cleanup, renewable energy development should not interfere with the implementation and protectiveness of the cleanup remedy.
Step 5: Post Construction Complete O&M/Five Year Review → NPL Deletion	• Inspect cleanup infrastructure to ensure remedy protectiveness is not compromised by renewable energy development activities • Ensure that engineering and/or ICs address renewable energy leases or other agreements	• Design renewable energy facility to be compatible with any monitoring activities (e.g. groundwater), ICs, and/or engineering controls in place. • After NPL deletion, when applicable, Five Year Reviews will continue to ensure protectiveness of the cleanup remedy.

RENEWABLE ENERGY PROJECT DEVELOPMENT

Table 4-1: Siting Renewable Energy Projects While Addressing Environmental Issues at Superfund Sites Checklist	
The following checklist provides considerations ("tips") for each step in the Superfund process that can help coordinate and integrate cleanup and renewable energy development activities. Note that site specific conditions may lead to implementing some key considerations during steps that differ from the steps specified below. This checklist is meant to be a guide and should be exercised with flexibility to accommodate site specific conditions. Some of the steps may be done as part of the decision tree screen.	
Remedial Investigation/Feasibility Study	
	Use the Google Earth Mapping Tool to perform an initial screen of the site.
	To screen sites further for solar or wind potential, use the decision trees provided in Appendices A and B to identify the favorability of site-specific conditions for renewable energy projects (e.g., resource, size, and distance to transmission lines). Consequently, it should be determined if a project merits a more serious investment of the time and resources required by an in depth site-specific assessment. If evaluating the site for geothermal or biomass, it is recommended to proceed with a site-specific assessment.
	If timing permits, conduct a reuse assessment to investigate potential reuse options and include renewable energy development as an option.
	Identify financing options and incentives, and potential barriers (e.g., access or permitting constraints), legal obligations, and clean-up liability.
	Identify potential non-contaminated areas based on sampling results. (These areas may be used for renewable energy development.)
	Identify willingness of site owners or potentially responsible parties (PRPs) to consider renewable energy development
	Work with PRPs and/or property owners to identify renewable energy partners (e.g., developers, investors, energy providers)
	Hold meetings with local land use planning authorities, appropriate local officials, and the public to discuss the future use of the land for renewable energy production
	Consider likely contamination and sources and their impacts on the feasibility of siting future renewable energy structures.
Record of Decision (ROD)	
	Conduct a more detailed analysis of incorporating renewable energy into cleanup options or alternatives (e.g., solar panel-integrated landfill caps) to the extent that it may inform the future land use considerations.
	External to the CERCLA process, gather final cost information on constructing a renewable energy facility separate from the cleanup budget
	Fully document ICs to the extent that it is relevant to the CERCLA remedy decision in the Record of Decision
Remedial Design	
	Assist developers to determine what permits are necessary and what environmental, engineering (e.g., an electrical engineering study may be needed to confirm that the utility grid can accept additional electricity,) and other studies are recommended. Permits may be required that include land use, environmental, siting, building and other permits. Review applications for interconnection and net-metering agreement to the appropriate local utility. [We are referring to permits related to the renewable energy development, which is not a part of the remedy—which would be exempt from permitting requirements.]
	Consider engineering controls for renewable energy development such as slope, grading, cap/cover design, stormwater management, soil stability, and anchoring to ensure compatibility with the remedial design.
	Incorporate or refine renewable energy design requirements into the cleanup design, if needed
Cleanup	
	If renewable energy development will coincide with cleanup activities, hold meetings between the remedy construction team (e.g., RPM, contractors) and the renewable energy development team to examine ways to coordinate construction activities.
	Synchronize the construction of renewable energy facilities with cleanup activities, ensuring that all parties are kept informed of schedules and processes
O&M/Five Year Review	
	Inspect cleanup infrastructure to ensure remedy protectiveness is not compromised by renewable energy development activities
	Confirm that ICs are in place
	Ensure that engineering and/or ICs address renewable energy leases or other agreements

4.1.1 Potential Renewable Energy at Superfund Sites Decision Partners

The following partners would typically be involved in the renewable energy development process at a Superfund site and would assist with the implementation of the key considerations in Table 4-1:

- Potentially Responsible Party (PRP)
- EPA RPM or On-Scene Coordinator
- Community and other public stakeholders
- Renewable energy developer
- Power generator and/or utility
- State and local governments
- Natural Resource Damage Trustees (when applicable)
- RE-Powering Rapid Response Team
- EPA's Land Revitalization Coordinators

4.1.2 Potential Challenges

- Recalcitrant or uninterested PRPs
- No viable site owner to negotiate a cleanup or renewable energy development (Fund lead site)
- In some areas, renewable energy development may not be the best use of the site.
- Complex Superfund cleanups may have schedules that are too prolonged to interest a developer in immediate investment.
- Inconsistencies in schedules (e.g., cleanup is almost complete and the reuse assessment has been finalized before renewable energy is considered).

4.1.3 Conclusions

Renewable energy development can be planned and incorporated into the remedial action while maintaining the primary goal of responding to hazardous waste and chemical releases. As noted throughout this section, careful planning and scheduling of cleanup and development, technical support from renewable energy stakeholders and experts, and early robust community engagement are essential to successful integration of development and cleanup actions.

Superfund timing considerations need to be fully examined and integrated throughout the cleanup process. Overall, as shown in Figure 4-1, prior to placement on the National Priorities List (e.g. during PA/SI), renewable energy screening may be considered and broadly assessed; but given the unknown extent of contamination and uncertainty about future liability, extensive renewable energy development (or even consideration by a serious developer) is unlikely. (Note that Superfund Alternative Sites will not be placed on the NPL but will still follow the Superfund cleanup process.) The RI/FS phase allows the opportunity to fully assess technical requirements and incorporate renewable energy development into reuse planning. At this point, the extent of contamination is better characterized and site cleanup alternatives are being considered. Thus, technical renewable energy development considerations can proceed with more clarity about future actions.

4.2 Integrating Renewable Energy Development at Brownfields Properties

Following are the typical steps taken in the brownfields cleanup process:

- **Brownfields Phase I Environmental Site Assessment:** A Phase I Environmental Site Assessment determines the likelihood that environmental contamination is present at the site. The assessment includes a visual site assessment; interviews with past and present owners and occupants; a search for any environmental liens; a review of historical documents; and a search of federal, state, and local databases regarding contamination at or near the site.
- **Brownfields Phase II Environmental Site Assessment:** A Phase II Environmental Site Assessment is a more thorough evaluation of site conditions that includes physical sampling to determine the extent and severity of contamination. Phase II assessments typically include soil and groundwater sampling and analysis.
- **Evaluate Cleanup Options:** The Phase II Environmental Site Assessment report will often make recommendations on options to cleanup contamination to levels that support the intended reuse. Cleanup approaches may differ depending on level and type of contamination, intended reuse, and other factors. Some brownfields may not require any cleanup and are determined to be ready for reuse.
- **Develop Cleanup Plan:** If cleanup is required, a cleanup approach is selected and a cleanup plan is created to outline the details for deploying it, including long-term operations and maintenance of the cleanup and long-term stewardship of the property.
- **Cleanup Implementation:** The cleanup approach is implemented according to the cleanup plan for as long as needed to support intended reuse of the property.
- **Post-cleanup:** Some brownfields sites may require monitoring and ICs to ensure protection of human health and the environment. Sustainable reuse to enhance a community's long-term quality of life is strongly encouraged.

Project Profile: Western Massachusetts Electric Company (WMECO), Pittsfield, Massachusetts

An eight-acre former Brownfield and an adjacent, two-acre former Superfund site in the City of Pittsfield, Massachusetts were used to build a 1.8 MW solar photovoltaic (PV) array. Cleanup of the Brownfield, owned by the Western Massachusetts Electric Company (WMECO) and the cleanup of PCB-contaminated soil and groundwater on the Superfund site—owned and managed by the Pittsfield Economic Development Authority (PEDA)—were already complete, but long-term institutional controls required that subsurface soils remained undisturbed. These requirements were met through WMECO's choice of the PV system installation: a ground mounted, ballasted rack specifically designed for locations where ground penetration isn't feasible. WMECO negotiated a surface right easement that defined liability limitations with PEDA, which retained site ownership. The surface right easement defined cost and terms which included clear limitations on subsurface liabilities. PEDA, the property owner, retained liability for all pre-existing contamination per the terms of the lease agreement. The rack design of this project's 6,500 solar panels not only ensures that soil will remain undisturbed where necessary, it also allows for continued access to the site's 53 groundwater monitoring wells—and can accommodate the installation of additional wells as needed. WMECO's PV system became fully operational in December 2010 and generates enough electricity to power over 300 homes annually throughout the utility's service area.

For more information about the Western Massachusetts Electric Company (WMECO) solar project, please visit:

www.wmeco.com/EnergyWise/LargeScaleSolar.aspx

By matching brownfields process steps and decision points with renewable energy development decisions, both cleanup and redevelopment decisions can be coordinated using similar implementing resources. It is important, therefore, that all stakeholders—EPA Brownfields Project Officers, Grantees, communities and developers—communicate cleanup decisions, schedules, and site conditions to the extent practicable in each stage of brownfields redevelopment. (See Box 4-3: Community Engagement Tools in the Brownfields Program.)

Figure 4-2 illustrates how to integrate renewable energy development into the brownfields process. Specifically, it highlights types of information that will be needed when considering renewable energy during that particular stage of the brownfields process (key considerations) and when renewable energy development should ideally be considered (timing). The checklist in Table 4-2 provides step by step milestones for each step in the brownfields process that can help coordinate and integrate renewable energy development activities to facilitate renewable energy development.

Box 4-3: Community Engagement Tools in the Brownfields Program

- Grant requirements (e.g., community notification and engagement plans)
- Partnerships with stakeholders and community groups
- Community vision and support
- Evaluation of community need
- Public notifications
- Public records and written responses to comments

Figure 4-2: Integrating Renewable Energy into the Brownfields Process

**Renewable energy projects may still be successful if some of the key considerations are implemented during steps that differ from the steps specified below. Also, some sites may not require cleanup.*

COMMUNITY ENGAGEMENT

CLEANUP PROCESS	KEY CONSIDERATIONS	TIMING
Steps 1 and 2: Site Identification and Environmental Assessment Brownfields Phase I Site Assessment ↓ Brownfields Phase II Site Investigation	• Identify potential non-contaminated areas based on sampling results • If applicable, confirm willingness of owner to consider renewable energy development • Identify potential renewable energy partners (e.g., state and local governments, developers, investors, energy providers) • Consider identified contamination impacts on siting future renewable energy structures	• Brownfields Phase I and Phase II assessments are key steps in the information gathering process for cleanup. • Information that is gathered during these two steps will provide a comprehensive understanding of site conditions such that renewable energy development may be appropriately designed and implemented.
Step 3: Cleanup Plan Evaluate Cleanup Options ↓ Develop Cleanup Plan	• Consider engineering requirements for RE development • Fully document ICs required for renewable energy development in the cleanup plan. • Incorporate renewable energy design requirements into the cleanup plan	• This step provides an opportunity to incorporate renewable energy development as part of the cleanup on brownfields properties. • Some sites may not require cleanup and thus renewable energy development could occur in the absence of cleanup efforts.
Step 4: Cleanup Cleanup Implementation	• Hold meetings between remedy construction team and renewable energy development team to examine ways to coordinate construction activities	• This step provides an opportunity to incorporate renewable energy reuse option on areas of the property where cleanup is not taking place or as a future use for the property when cleanup is complete.
Step 5: Post-cleanup Monitoring/ICs	• Confirm that ICs are in place • Ensure that engineering and/or ICs address renewable energy leases or other agreements • Inspect cleanup infrastructure to ensure remedy protectiveness is not compromised by renewable energy development activities	• Design renewable energy facility to be compatible with any monitoring activities (e.g. groundwater), ICs, and/or engineering controls in place.

RENEWABLE ENERGY PROJECT DEVELOPMENT

Table 4-2: Siting Renewable Energy Projects While Addressing Environmental Issues at Brownfield Sites Checklist	
The following checklist provides considerations ("tips") for each step in the Brownfield process that can help coordinate and integrate cleanup and renewable energy development activities. Note that site specific conditions may lead to implementing some key considerations during steps that differ from the steps specified below. This checklist is meant to be a guide and should be exercised with flexibility to accommodate site specific conditions. Some of the steps may be done as part of the decision tree screen.	
Brownfields Phase I and II Environmental Site Assessment	
	Use the Google Earth Mapping Tool to perform an initial screen of the site. (Brownfields sites will only be found in this tool if an EPA grant was awarded or an assessment or cleanup activity was completed that expended EPA brownfields funding.)
	To screen sites further for solar or wind potential, use the decision trees provided in Appendix A to identify the favorability of site-specific conditions for renewable energy projects (e.g., renewable resource, topography, size, distance to existing transmission lines). Consequently, it should be determined if a project merits a more serious investment of the time and resources required by an in depth renewable energy site-specific assessment. If evaluating the site for geothermal or biomass, it is recommended to proceed with a site-specific assessment.
	Identify financing options and incentives, and potential barriers (e.g., access or permitting constraints) as well as legal obligations and cleanup liability.
	Identify potential non-contaminated areas based on sampling results. (These areas may be used for renewable energy development.)
	If applicable, confirm willingness of owner to consider renewable energy development
	Identify potential renewable energy partners (e.g., state and local governments, developers, investors, energy providers)
	Hold discussions with local land use planning authorities, appropriate local officials, and the public to understand the anticipated future use of the land for renewable energy production
	Consider likely contamination and sources and their impacts on the feasibility of siting future renewable energy structures.
Evaluate Cleanup Options and Develop Cleanup Implementation Plan	
	Conduct a more detailed analysis of incorporating renewable energy into cleanup options or alternatives (e.g., solar panel-integrated landfill caps)
	Gather final cost information on constructing a renewable energy facility separate from the cleanup budget
	Incorporate or refine renewable energy design requirements into the cleanup design, if needed
	If renewable energy development will occur the same time as cleanup, hold meetings between the remedy construction team (e.g., contractors) and the renewable energy development team to examine ways to coordinate construction activities.
	Fully document ICs required for renewable energy
	Synchronize the construction of renewable energy facilities with cleanup activities, ensuring that all parties are kept informed of schedules and processes
Post-cleanup	
	Inspect cleanup infrastructure to ensure remedy protectiveness is not compromised by renewable energy development activities
	Confirm that ICs are in place
	Ensure that engineering and/or ICs address renewable energy leases or other agreements

4.2.1 Potential Renewable Energy Decision Partners at EPA Brownfield Sites

The following partners would typically be involved in the renewable energy development process and would assist with the implementation of the key considerations in Table 4-2:

- EPA Brownfields coordinator and/or project officer
- Grantee and/or property owner
- Community and other public stakeholders
- Renewable energy developer
- Power generator and/or utility
- RE-Powering Rapid Response Team
- EPA's Land Revitalization Coordinators

4.2.2 Potential Challenges

- Brownfield sites can be smaller in size (e.g., petroleum brownfields) and would be ill-suited for larger utility-scale renewable energy installations.
- In some areas, renewable energy development may not be the best use of the site

4.2.3 Conclusions

Due to the reduced complexity typically associated with Brownfields sites compared with Superfund or RCRA sites, the cleanup process may advance more quickly. However, as with Superfund or RCRA sites, the optimal time to consider renewable energy development is early in the process—in this case, during Phase I or Phase II site assessments. These phases will provide a comprehensive understanding of site conditions such that renewable energy development may be appropriately designed and implemented. In addition, it is important to understand whether the intended renewable energy application is interim, long-term or integrated as part of the remedy before the cleanup is actually implemented. Stakeholders must also consider whether the property will be dispositioned (e.g., retained, leased, or sold) because the appropriate stakeholders must be engaged as early in the process as feasible. Community engagement is a large part of brownfields reuse; stakeholders should determine whether renewable energy development fits community needs and is the most appropriate way to transition a property back to productive use.

4.3 Integrating Renewable Energy Development at RCRA Sites

Facilities regulated RCRA vary widely in the industrial processes conducted at their sites. When these processes result in the unpermitted release of hazardous waste, a facility can be required to undertake a cleanup or corrective action. The RCRA Corrective Action Program requires owners or operators of facilities that are subject to cleanup under the RCRA statute to evaluate releases of hazardous wastes and hazardous constituents, and implement cleanup actions to protect human health and the environment. Under the RCRA program 2020 Vision, EPA and its state partners are striving to construct final remedies by 2020 at 95% of the 3,747 facilities that potentially need cleanup under RCRA Corrective Action. This universe of sites presents an excellent opportunity

Box 4-4: Community Engagement Tools in the RCRA Program

- Public notices in newspapers
- As required by states via permitting process
- Public comment (e.g., draft remedial action plans)
- Public meetings and hearings
- Public repository and/or EPA Docket
- RCRA §7007 training grants to states, municipalities, educational institutions, or other organization
- Web posting

for renewable energy development both now and in the future.

While some RCRA Corrective Action sites will undergo cleanup and continue operations, other sites or portions of sites might not continue current operations and can offer opportunities for reuse. Parcels of a property can be cleaned up and reused even while other portions of the property continue to operate as a regulated facility or continue to undergo corrective actions.

Because many RCRA Corrective Action sites continue to operate as active facilities, reuse and land use planning need to include close coordination with the state regulator, facility owner or operator, EPA, the public, and other stakeholders. (See Box 4-4: Community Engagement Tools in the RCRA Program.) Some sites may have limited space for renewable energy development activities, or the active facility may limit site use for renewable energy development. Overall, development options and schedule will vary based on whether a parcel of an operating facility is available for reuse or if the whole site is available for reuse. Additionally, on some RCRA sites, many parcels may not be contaminated or may be cleaned up on a shorter timeline than the entire facility. As with Superfund and Brownfield sites, these parcels may provide opportunities for current or future renewable energy development.

Project Profile: Bethlehem Steel RCRA Corrective Action Site

At the 500-acre, Bethlehem Steel Corporation RCRA Corrective Action (CA) site in Lackawanna, New York, a 30-acre tract along Lake Erie was identified as a good location for a utility-scale wind farm due to its good resource potential and close proximity to existing transmission lines and roads. However, the tract was contaminated with steel slag and industrial waste. But as cleanup activities on the overall site continued, protective design elements were implemented on the targeted tract—including placement of a soil cap and positioning the wind turbines to accommodate existing groundwater monitoring wells and future groundwater cleanup if needed. Construction of the eight-turbine, 20 MW wind farm system began in 2006 and was completed in 2007; the energy is now routed to a utility grid and sold throughout New York. In February 2012, six additional wind turbines were installed to increase the system's output to 35 MW.

For more information about the Steel Winds project, please visit: www.epa.gov/renewableenergyland/successstories.htm

The RCRA cleanup process is initiated with a report of an identified release of a hazardous waste or when EPA or a state is considering a facility's RCRA permit. Typical steps in the RCRA cleanup process include:

- **RCRA Facility Assessment (RFA):** Initial site assessment based on a review of existing information, site visit, and limited sampling (if needed). The primary decision point is a determination of whether there is a potential for contamination at levels that would pose risks to human health and the environment.
- **RCRA Facility Investigation (RFI):** Detailed site investigation to understand the nature, extent, and potential migration of the release, if any. Provides data necessary for developing a contamination strategy (Site Characterization).
- **Interim Measures:** Used to control or abate ongoing risks to human health and the environment in advance of the final remedy selection.
- **Corrective Measures Study (CMS):** Provides an examination of corrective measures. Cost, schedule, public acceptability and other factors are considered. The primary decision point is the selection of the most appropriate corrective measure for the site.
- **Remedy Selection:** Selection of remedy that outlines the cleanup approach, technology, timeframe, expected outcomes, costs, and community acceptance. Will identify the short- and long-term effectiveness and ability to implement the remedy.

- **Corrective Measures Implementation:** Identification of detailed remedy design, construction, operation, and maintenance and completion
- **Remedy Complete:** Determination of whether cleanup goals were achieved and if cleanup is considered complete.
- **Post-cleanup:** Some RCRA Corrective Action sites may require monitoring and ICs to ensure protection of human health and the environment.

As a site moves through the RCRA cleanup process, it is important for developers and EPA (in their oversight role), to work closely with state regulators in the 43 states authorized to implement the RCRA Corrective Action program. It is important, therefore, that the state regulator, facility owner, EPA, and developer communicate cleanup decisions, schedules, and site conditions to the extent practicable in each stage of development.

Renewable energy development or any development must be coordinated with the current operator/owner and community. At the federal level, corrective action may take place under a RCRA permit or as an enforcement order under §3008 of RCRA[7]. In authorized states, corrective action may take place under a state-issued RCRA permit, a state cleanup order, a state voluntary cleanup program, or another state cleanup authority. Since authorized states may use a combination of state authorities to compel or oversee corrective actions, site owners and developers must work closely with their state agency at each step of the cleanup process outlined above to best determine integrating renewable energy development at RCRA corrective action sites.

The regulators and developers should engage in robust discussions with stakeholders to fully explore potential renewable energy development throughout the corrective action process and allow for a full, fair, and equitable public participation. In general, the community engagement process for RCRA sites is similar to that outlined in the Superfund section of this document. Similar to the other programs, community engagement should start as early as possible, and allow for robust discussions concerning site use and renewable energy development.

All work at RCRA sites needs to ensure that the program cleanup goals are met: in the short term, to achieve environmental indicators[8] and, in the long term, to achieve final remedies that protect human health and the environment. The majority of the highest-priority corrective action sites have met environmental indicators, and many have moved into the final remedy phase. Longer term cleanup actions at these sites, in particular, can be coordinated with renewable energy development activities where site conditions allow. Figure 4-3 illustrates how to integrate renewable energy development into the RCRA cleanup process. Specifically, it highlights types of information that will be needed when considering renewable energy during that particular stage of the RCRA cleanup process (key considerations) and when renewable energy development should ideally be considered (timing). The checklist in Table 4-3 provides step-by-step milestones for each stage in the RCRA cleanup process that can help coordinate and integrate renewable energy development activities to facilitate renewable energy development.

Over the years, the Corrective Action program has progressed and EPA has exercised flexibility in choosing cleanup options. Not every corrective action step outlined in Figure 4-3 will be followed at each site or in the same order.

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7 http://www.epa.gov/osw/hazard/tsd/permit/pubpart/manual.htm. Page 4-1.

8 Program goals through 2008 focused on two Environmental Indicators designed to stabilize the program's most threatening sites: (1) The Human Exposures EI ensures that people near a particular site are not exposed to unacceptable levels of contaminants. (2) The Groundwater EI ensures that contaminated groundwater does not spread and further contaminate groundwater resources.

Figure 4-3: Integrating Renewable Energy into the RCRA Corrective Action Process

**Renewable energy projects may still be successful if some of the key considerations are implemented during steps that differ from the steps specified below.*

COMMUNITY ENGAGEMENT

CLEANUP PROCESS	KEY CONSIDERATIONS	TIMING
Steps 1 and 2: Site Identification and Environmental Assessment RCRA Facility Investigation (RFI) ↓ Interim Measures	• Identify potential non-contaminated areas based on RFI findings • Confirm willingness of facility owner/ operator to consider renewable energy development • Consider how ongoing site operations may affect siting future renewable energy structures • Identify potential renewable energy partners (e.g., state and local governments, developers, local utility) • Work with local agencies and community to identify future land use options, which may be different from current land use	• The site identification stage offers time for renewable energy screening but uncertainties about the extent of contamination (and thus liability) will make renewable energy development unlikely. • The RFI step is a key data collection and coordination step in the RCRA process. Since this step occurs before remedial decisions are made, it is an ideal time for stakeholders to begin planning for renewable energy development. • When any interim measures are being considered, the question about the potential for renewable energy development should be asked.
Step 3: Cleanup Plan Corrective Measures Study (CMS) ↓ Remedy Selection	• Fully document engineering and institutional controls (ICs) required for renewable energy in the CMS. • Incorporate renewable energy design requirements into the remedial design if appropriate. • Work with regulators to consider renewable energy development along with permit changes, if needed.	• Renewable energy could be discussed during the evaluation of the remedy options, especially if renewable energy would be proposed as part of the remedy, not just an end use. • Once a remedy is selected, it becomes more difficult to incorporate renewable energy into the cleanup or propose as a final use since the remedy might impede certain types of RE development.
Step 4: Cleanup Corrective Measures Implementation ↓ Corrective Measures Completion	• If applicable, hold meetings between remedy construction team (e.g., site owners, state regulators, contractors) and renewable energy development team to examine ways to coordinate construction activities.	• Renewable energy potential may be dependent upon the remedy selected and whether the completed remedy would accommodate renewable energy development.
Step 5: Post-cleanup Monitoring/ICs	• Inspect cleanup infrastructure to ensure remedy protectiveness is not compromised by renewable energy development activities • Ensure that engineering and/or ICs address renewable energy leases or other agreements	• Design renewable energy facility to be compatible with monitoring activities, ICs, and/or engineering controls in place.

RENEWABLE ENERGY PROJECT DEVELOPMENT

Table 4-3: Siting Renewable Energy Projects While Addressing Environmental Issues at RCRA Corrective Action Sites Checklist	
The following checklist provides considerations ("tips") for each step in the RCRA Correction Action process that can help coordinate and integrate cleanup and renewable energy development activities. Note that site specific conditions may lead to implementing some key considerations during steps that differ from the steps specified below. This checklist is meant to be a guide and should be exercised with flexibility to accommodate site specific conditions. Some of the steps may be done as part of the decision tree screen.	
RCRA Facility Assessment (RFA), RCRA Facility Investigation (RFI), and Interim Measures	
	Use the Google Earth Mapping Tool to perform an initial screen of the site.
	To screen sites further for solar or wind potential, use the decision trees provided in Appendix A to identify the favorability of site-specific conditions for renewable energy projects (e.g., renewable resource, topography, size, distance to existing transmission lines). Consequently, it should be determined if a project merits a more serious investment of the time and resources required by an in depth renewable energy site-specific assessment. If evaluating the site for geothermal or biomass, it is recommended to proceed with a site-specific assessment.
	Identify financing options and incentives, and potential barriers (e.g., access or permitting constraints) as well as legal obligations and clean-up liability.
	Identify potential non-contaminated areas based on RFI results. (These areas may be used for renewable energy development.)
	If applicable, confirm willingness of owner to consider renewable energy development
	Identify potential renewable energy partners (e.g., state and local governments, developers, investors, energy providers)
	Work with local agencies and community to identify future land use options, which may be different from the current land use
	Identify how ongoing site operations may affect siting future renewable energy structures
Corrective Measures Study (CMS) and Remedy Selection	
	Conduct a more detailed analysis of incorporating renewable energy into cleanup options or alternatives (e.g., solar panel-integrated landfill caps)
	Gather final cost information on constructing a renewable energy facility separate from the cleanup budget
	Incorporate or refine renewable energy design requirements into the cleanup design, if needed
	Fully document ICs required for renewable energy
Corrective Measures Implementation and Completion	
	Synchronize the construction of renewable energy facilities with cleanup activities, ensuring that all parties are kept informed of schedules and processes
	If renewable energy development will occur the same time as cleanup, hold meetings between the remedy construction team (e.g., contractors) and the renewable energy development team to examine ways to coordinate construction activities.
Post-cleanup	
	Inspect cleanup infrastructure to ensure remedy protectiveness is not compromised by renewable energy development activities
	Confirm that ICs are in place
	Ensure that engineering and/or ICs address renewable energy leases or other agreements

4.3.1 Potential Renewable Energy at EPA RCRA Sites: Decision Partners

The following partners would typically be involved in any renewable energy development decision and would assist with implementing the key considerations in Table 4-3 at a RCRA Corrective Action site:

- Site owner/operator
- EPA project manager
- Community and other public stakeholders (e.g., local land use planning agency)
- Renewable energy developer
- State RCRA Program regulators
- Power generator and/or utility
- RE-Powering Rapid Response Team
- EPA's Land Revitalization Coordinators

4.3.2 Potential Challenges

- RCRA is a state-run program so implementation and enforcement will vary from state to state.
- ICs are sometimes used as part of the RCRA corrective action process, which makes evaluating the potential for renewable energy at the start of the decision process important.
- Facilities can enter the corrective action process during permitting when baseline testing can be done—allowing for additional planning—as well as when there is an identified release of a hazardous waste.
- Delays in cleanup and downtime during permitting are not uncommon for corrective actions. However, site owners, developers, and regulators are encouraged to use this time to discuss the community's opinions and ideas on site use and engage the public on renewable energy options for the site.

4.3.3 Conclusions

The evaluation of a site for renewable energy should occur as early in the RCRA process as possible in order to ensure cost and time efficiencies, as well as to plan for continued site use by the owner/operator and determine potential for renewable energy development. As a site moves through the RCRA Corrective Action process, decisions may be made regarding interim measures and remedy design that could interfere with the potential renewable energy projects at that site. The optimal time to consider renewable energy for a RCRA facility likely occurs during the RCRA Facility Investigation. Data collected during this phase will help identify any potential parcel(s) that might not continue in operation and may support a new use such as renewable energy. The facility owner/operator and community will be critical partners in any discussions and future considerations about land use at a RCRA site.

Appendix A: Solar and Wind Screening Criteria Decision Trees

The Environmental Protection Agency (EPA) and Department of Energy's National Renewable Energy Laboratory (NREL) have developed decision trees to guide state and local governments and other stakeholders through a three-phase process for screening potentially contaminated and underutilized sites for their suitability for future redevelopment with solar photovoltaic (PV) and wind energy. The decision trees can be used to screen individual sites for solar and wind energy potential or for a community-scale evaluation of multiple sites.

To view and download a copy of the solar PV decision tree, go to: www.epa.gov/renewableenergyland/docs/solar_decision_tree.pdf

To view and download a copy of the wind energy decision tree, go to: www.epa.gov/renewableenergyland/docs/wind_decision_tree.pdf

Appendix B: Renewable Energy Technologies Evaluated by EPA

A brief overview of these renewable energy technologies evaluated by EPA is provided below. For further information, please see the individual technology fact sheets at: www.epa.gov/renewableenergyland/develop_potential_fs.htm.

Wind

Wind energy is captured by wind turbines with propeller-like blades mounted on a tower. The force of the wind causes the rotor to spin and the turning shaft spins a turbine to generate electricity. Wind power can be well-suited to contaminated site redevelopment due to the widespread availability of the resource, cost-competitiveness of wind power, and the flexibility in the size and number of turbines that can be installed.

Three types of wind production were evaluated by EPA including:

- Utility scale: Uses large turbines at the megawatt or multi-megawatt scale on sites with the greatest resource and acreage availability. Electricity generated is typically exported to the grid.
- Community scale: Represents sites with less acreage than the utility scale wind sites, potentially using smaller or fewer turbines. Electricity generated is distributed to the local area through the grid system, often serving only adjacent properties.
- Non-grid connected: Uses smaller and fewer turbines on a much smaller scale, typically to power the energy needs of a single property or to power the cleanup.

Solar

Solar technologies generate electricity from the sun's energy, either by heating a liquid to produce steam to run a generator or by converting the sun's light energy directly into electricity. Two types of solar technologies evaluated by EPA are photovoltaic (PV), and utility scale concentrating solar power (CSP).

Photovoltaic (PV): Converts the sun's light energy directly into electricity. PV technology is scalable; the amount of electricity generated is related to the number and efficiency of installed panels, and can be an ideal candidate for contaminated site redevelopment due in part to its flexible installation options. State-level incentives for PV system purchase and installation can make PV an even more attractive choice (for a listing of state-level incentives, visit the Database of State Incentives for Renewable Energy and Energy Efficiency (DSIRE) at www.dsireusa.org). It can technically be sited anywhere, though costs may make PV projects unfeasible in incentive or resource challenged areas. Thus, the decision to install a PV system depends on the power requirements at a particular site, as well as site-specific economic considerations, including available incentives. PV technology can be a particularly financially attractive alternative for remote contaminated sites that are in an area where grid connection is not feasible because of distance to transmission infrastructure or cost. Three types of PV production were evaluated by EPA:

- Utility scale PV: Uses PV technology at the megawatt or multi-megawatt scale at sites with the greatest resource and acreage availability. Electricity generated is typically exported to the grid.
- PV policy driven: Represents sites that may have development potential due to state policies, including sites in areas with lower resource availability. It includes states with a renewable portfolio standard (RPS) or RPS goal 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 RPS requirements; or a requirement for distributed generation (e.g., 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.

- Non-grid connected PV: This category represents PV technology being used at a smaller scale, typically to power the energy needs of a single property or to power the cleanup.

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 megawatt or multi-megawatt scale and electricity generated is typically exported to the grid. The quality of the CSP resource is greatest in the southwestern United States; therefore, this technology is generally limited to the desert southwest region of the U.S., as it requires relatively high year-round solar insolation levels. Three types of utility scale CSP technologies were evaluated by EPA:

- Trough system: Collects the sun's thermal energy using long, rectangular, curved (U-shaped) mirrors. The mirrors are tilted toward the sun, focusing sunlight on tubes that run the length of the mirrors. The reflected sunlight heats a fluid flowing through the tubes. The hot fluid then is 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 focus and concentrate sunlight onto a receiver on the 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.

Biomass

Biomass is a broad category of renewable energy that can be well-suited to contaminated site redevelopment. There are multiple biomass applications with varying suitability to contaminated sites. Biomass energy or "bioenergy" is generated from organic feedstocks. Wood is the largest biomass energy resource; other sources of biomass include food crops, grassy and woody plants, residues from agriculture or forestry, and the organic component of municipal and industrial wastes. These feedstocks can be used as a solid fuel, or converted into liquid or gaseous forms for the production of electric power, heat, chemicals or fuels. The following two types of biomass production were evaluated by EPA:

- Biopower facility: Burns biomass resources to produce heat, which is used to boil water for a conventional steam-turbine generator to produce electricity. Biopower facilities utilize cumulative biomass resources that can include residues from: crops; forests; primary and secondary mills; urban wood waste; and methane emissions from manure management, landfills and domestic wastewater treatment.
- Biorefinery facility: Integrates biomass conversion processes and equipment to produce fuels, power, and chemicals from biomass. The technology utilizes residues such as those from crops, forests, primary and secondary mills, and urban wood waste.

Geothermal

Geothermal energy is generated from heat in the Earth's crust. This heat comes from the original formation of the planet, radioactive decay of minerals, tectonic activity, and solar energy. Geothermal generating facilities use this heat to generate electricity; the heat is collected by drilling into hot water or steam reservoirs near or moderately near the earth's surface. Typically most geothermal activity is associated with western states along the Pacific Rim; however, some eastern states are showing more potential with advances in both technology and geothermal surveying to locate hot spots. The following three types of geothermal production were evaluated by EPA:

- Flash power plant: Uses geothermal reservoirs of water at very high temperatures that flows up through wells in the ground under its own pressure. As it flows upward, the pressure decreases and some of the hot water boils into steam. The steam is then separated from the water and used to power a turbine that generates electricity. Any leftover water and condensed steam are injected back into the reservoir, making this a sustainable resource.
- Binary power plant: Uses the heat from lower temperature geothermal resources to boil a working fluid, usually an organic compound with a low boiling point. The working fluid is vaporized in a heat exchanger and used to turn a turbine to generate electricity. The water is then injected via a closed-loop system back into the ground to be reheated in the geothermal reservoir. The water and the working fluid are kept separated during the whole process, so there are no air emissions.
- Geothermal heat pump: The upper 10 feet of the earth's crust 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 pumps use much less energy than conventional heating systems, since they draw heat from the ground. These pumps typically serve a single property, though they may also be viable for use in multi-tenant applications such as integrated district heating systems.

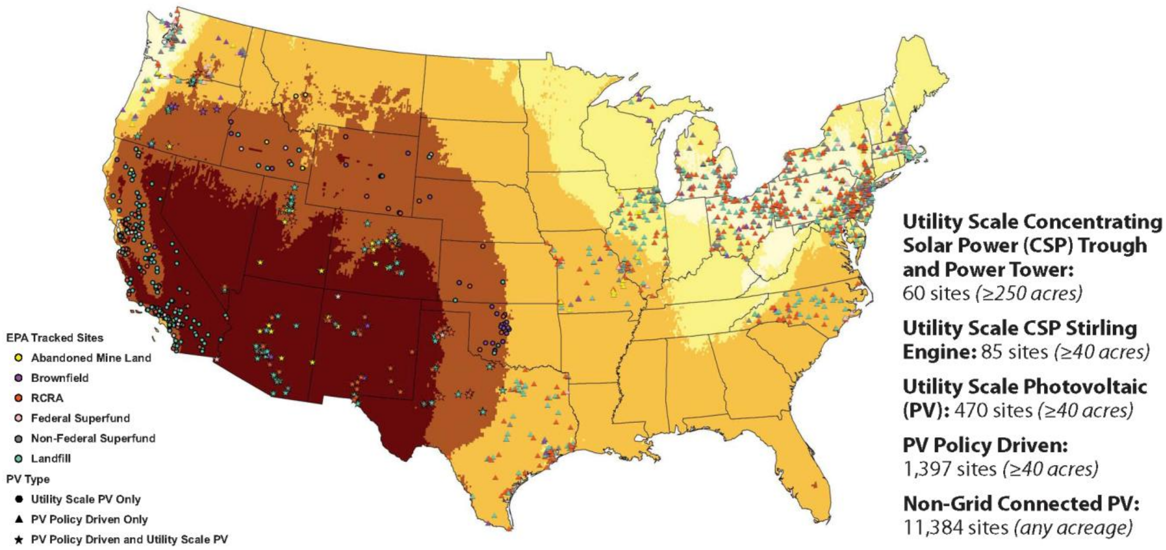
In the case of sites with contaminated groundwater, extra precautions need to be followed to ensure that contamination is not released or spread through the drilling of aquifers. Sites with groundwater contamination require working with regulatory agencies to ensure that ICs or other remedies are not be affected by activities associated with geothermal facilities.

Landfill Gas Energy Projects

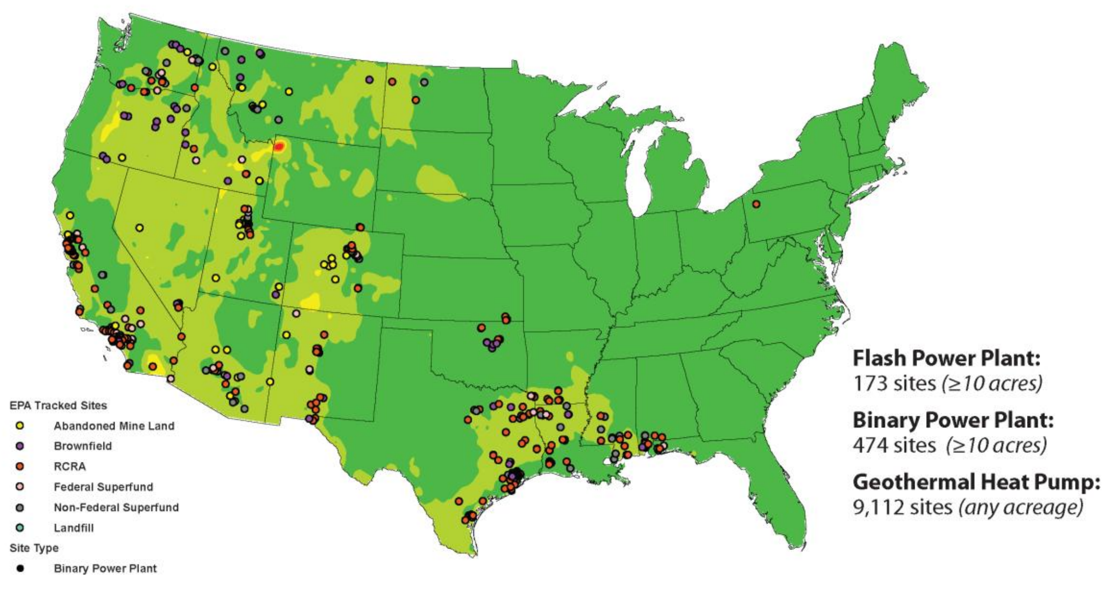
Landfill gas energy projects use gas that is created as organic solid waste decomposes in a landfill. This gas consists mostly of methane (the primary component of natural gas) and carbon dioxide. Instead of allowing landfill gas to escape into the air, it is extracted from landfills using a series of wells and a blower/flare (or vacuum) system. The gas is directed to a central point where it can be processed and treated to produce various forms of energy, including electricity, boiler fuel, steam, and alternate vehicle fuel and pipeline quality gas. The landfill does not need to be closed to be a candidate for landfill gas projects.

Appendix C: EPA Tracked Sites with Renewable Energy Potential Mapped

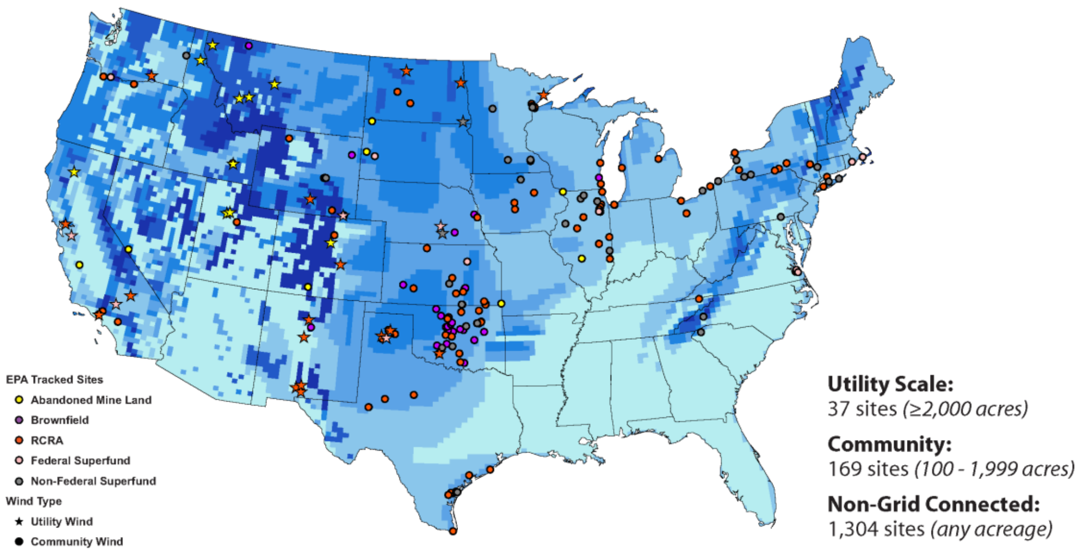
Solar and Photovoltaic (PV) Sites with Renewable Energy Potential



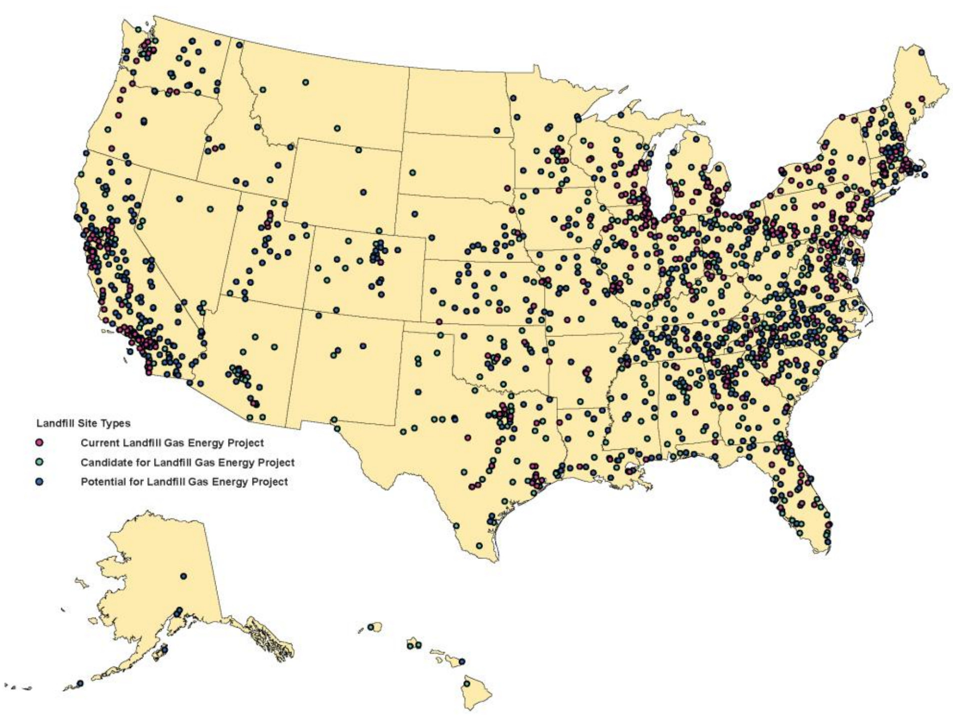
Geothermal Sites with Renewable Energy Potential



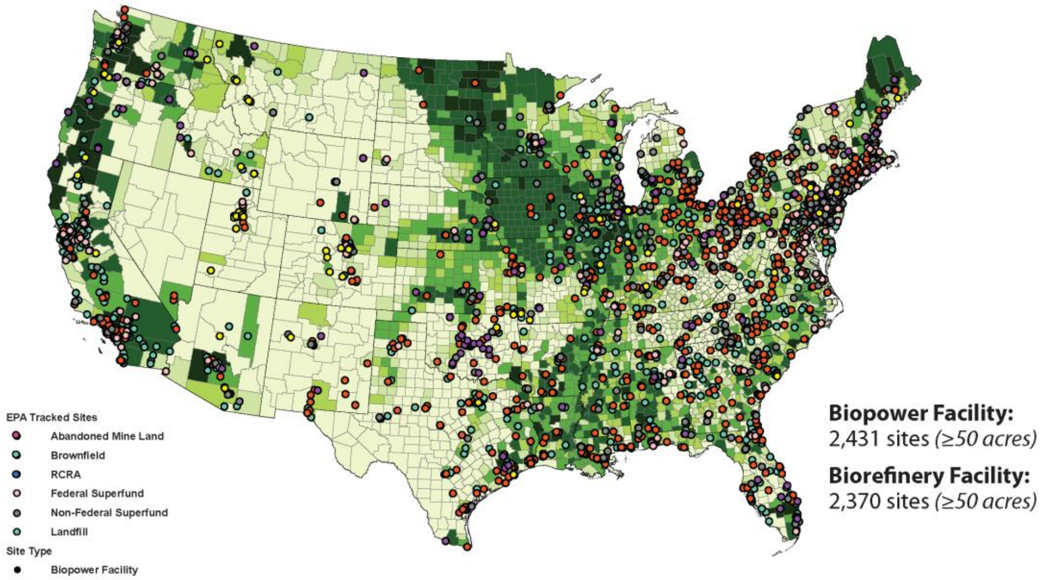
Wind Energy Sites with Renewable Energy Potential



Landfill Gas Energy Sites with Renewable Energy Potential



Biomass Sites with Renewable Energy Potential



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Appendix E: Resources

RE-Powering America's Lands: Siting Renewable Energy on Potentially Contaminated Land and Mine Sites Initiative - www.epa.gov/renewableenergyland

- **Reports and Fact Sheets –** The reports and fact sheets describe the purpose of the RE-Powering initiative and provide an overview of its analyses. www.epa.gov/renewableenergyland/develop_potential_fs.htm
- **Renewable Energy Interactive Mapping Tool** www.epa.gov/renewableenergyland/mapping_tool.htm
- **Success Stories –** The success stories highlight how contaminated land and mine sites that have been revitalized as viable source of renewable energy. www.epa.gov/renewableenergyland/successstories.htm
- **Frequently Asked Questions** www.epa.gov/renewableenergyland/faq_info.htm
- **For further information regarding RE-Powering America's Land: Renewable Energy on Potentially Contaminated Land and Mine Sites, please contact**: cleanenergy@epa.gov

Liability Relief Resources:

- **Siting Renewable Energy on Contaminated Property: Addressing Liability Concerns –** This fact sheet provides answers to some common questions that developers of renewable energy projects on contaminated properties may have regarding potential liability for cleaning up these sites.
- **Brownfields Liability Relief Act** – This Act provides certain relief for small businesses from liability under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. It promotes the cleanup and reuse of brownfields, provides financial assistance for brownfields revitalization, and enhances state response programs.
- **Enforcement Tools that Address Liability Concerns –** EPA has developed a number of policies and tools that address landowner liability concerns so that protective cleanups and revitalization can take place.
- **Lender Liability Fact Sheet –** Provides answers to frequently asked questions regarding Superfund, Brownfields and lender liability.
- **The Revitalization Handbook –** "Revitalizing Contaminated Sites: Addressing Liability Concerns (The Revitalization Handbook)" addresses environmental cleanup liability risks associated with the revitalization of contaminated property. www.epa.gov/compliance/resources/publications/cleanup/brownfields/handbook/index.html
- **Top 10 Questions to Ask When Buying a Superfund Site –** Provides answers to some of the questions that a prospective purchaser may have when considering whether to purchase a Superfund site. www.epa.gov/compliance/resources/publications/cleanup/superfund/top-10-ques.pdf

- **CERCLA Liability and Local Government Acquisitions and Other Activities**
  www.epa.gov/compliance/resources/publications/cleanup/brownfields/local-gov-liab-acq-fs-rev.pdf
- **Brownfields and Land Revitalization Cleanup Enforcement website**
  www.epa.gov/enforcement/cleanup/revitalization/index.html
- **CERCLA, Brownfields and Lender Liability Fact Sheet**
  www.epa.gov/swerosps/bf/aai/lenders_factsheet.pdf
- **Other Cleanup Enforcement Policies and Guidance**
  www.epa.gov/compliance/resources/policies/cleanup/index.html

Community Engagement

www.epa.gov/oswer/engagementinitiative

EPA Cleanup Program Sites:

- **Office of Brownfields and Land Revitalization**
  www.epa.gov/swerosps/bf
- **Superfund**
  www.epa.gov/superfund
- **EPA RCRA Corrective Action**
  www.epa.gov/waste/hazard/correctiveaction/index.htm

Long-Term Stewardship and Institutional Controls:

- **Institutional Controls Guidance Website**
  www.epa.gov/superfund/policy/ic/guide/index.htm
- **Long-Term Stewardship Task Force Report, September 2005**
  www.epa.gov/landrecycling/ltstf_report/index.htm

EPA Redevelopment Sites:

- **Abandoned Mine Lands Revitalization and Reuse**
  www.epa.gov/aml/revital
- **Brownfields and Land Revitalization**
  www.epa.gov/brownfields
- **Land Revitalization**
  www.epa.gov/landrevitalization/index.htm
- **Superfund Redevelopment**
  www.epa.gov/superfund/programs/recycle
- **RCRA Brownfields Prevention Website**
  http://www.epa.gov/waste/hazard/correctiveaction/bfields.htm

U.S. Environmental Protection Agency Office of Solid Waste and Emergency Response's Center for Program Analysis