Screening Sites for Solar PV Potential

Emphasis on Redevelopment of Potentially Contaminated and Underutilized Sites

RE-Powering America's Land Initiative: Solar Decision Tree

Through ongoing collaboration, the Environmental Protection Agency (EPA) and National Renewable Energy Laboratory (NREL) created a decision tree to guide state and local governments and other stakeholders through a process for screening potentially contaminated or underutilized sites for their suitability for future redevelopment with solar photovoltaic (PV) energy.

Through the RE-Powering America's Land initiative, the EPA encourages renewable energy development on potentially contaminated land when aligned with the community's vision for the site. A primary focus of this tool is the redevelopment of potentially contaminated sites. Potentially contaminated land includes sites where contamination is suspected but has not been confirmed and sites where contamination has been identified.

This decision tree can be used to screen individual sites for solar potential or for a community-scale evaluation of multiple sites. While the decision tree focuses on potentially contaminated sites, this tool also provides information on rooftop and other applications in order to support complimentary evaluations.

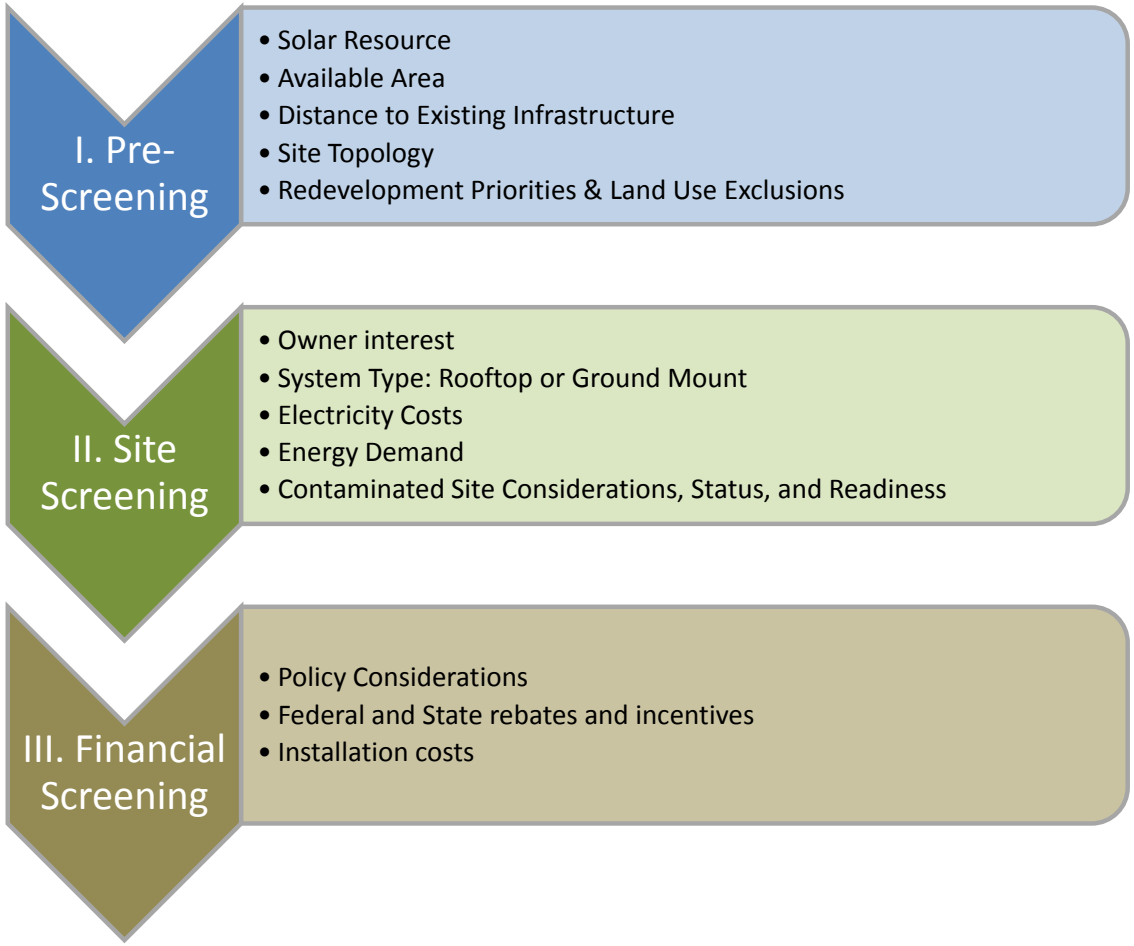
It is not intended to replace or substitute the need for a detailed site-specific assessment that would follow an initial screening based on the decision tree. Tips on how to obtain information relevant to various parameters in the decision tree are provided.

The EPA also promotes redevelopment of urban sites to achieve "Smart Growth" objectives. Community vision for the site, as well as the site's key attributes, should shape the redevelopment plan.

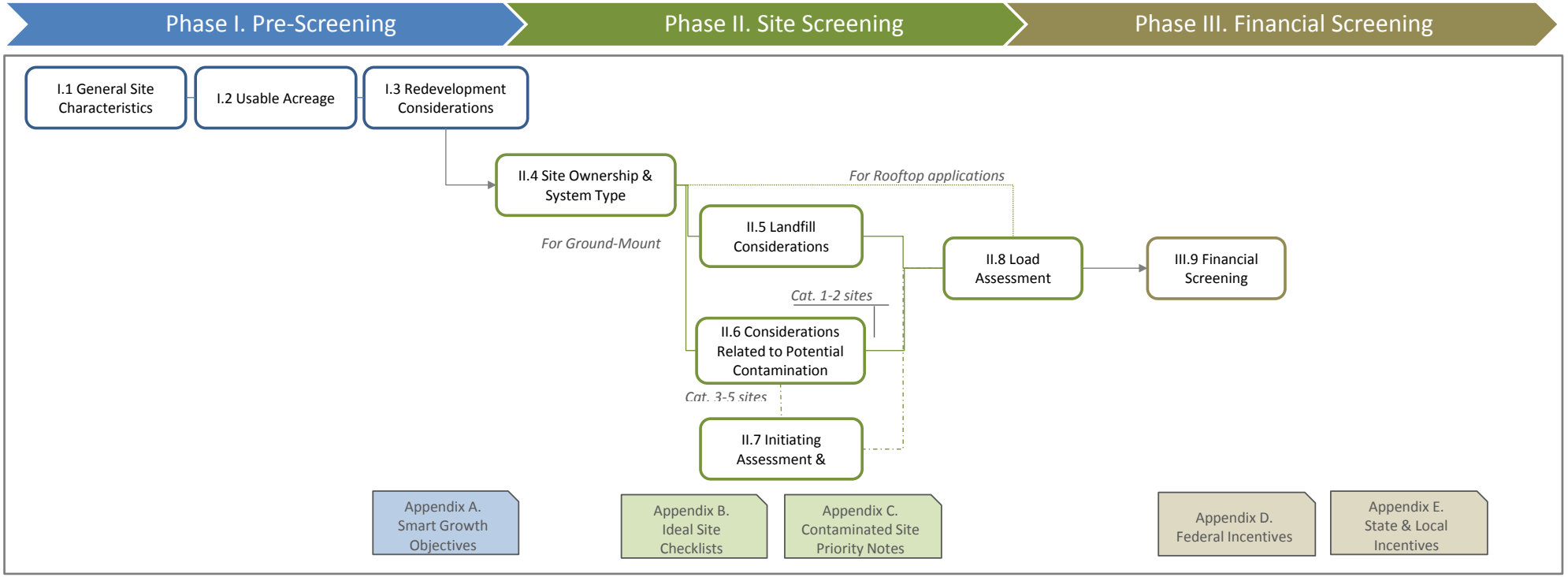
Many additional resources can be found on the following EPA and NREL websites:

www.epa.gov/renewableenergyland
www.nrel.gov/learning/re_solar.html

Process Overview



Key Audiences & Document Purpose	
Stakeholder	**Purpose**
State and Local Governments	To help states and municipalities screen and prioritize existing sites for their suitability for solar PV installations. Targeted sites include “greyfields”, brownfields, Superfund sites, RCRA sites, publicly owned facilities, abandoned parcels, and landfills.
Clean-up Project Managers	To aid clean-up PMs to screen their potentially contaminated sites for PV development potential.
Renewable Energy Developers	To introduce renewable energy developers to considerations unique to redevelopment of potentially contaminated sites and provide a common framework for discussions with state and local governments when in the project development phase for a PV installation.



Screening Process Overview	
Phase	**Explanatory Text and Additional Resources**
I	Pre-Screening: Addresses data readily available through GIS parcel maps and online databases, as well as information that can be easily obtained through visual inspection.
II	Site Screening: Addresses data that generally requires collecting information from property owners or site managers. May also require site-level investigation, potentially using specialized tools or equipment.
III	Financial Screening: Addresses economic, policy, and incentive factors that further influence payback.

Decision Tree: Tool Features

Guide to Decision Tree Features

The Solar Decision Tree is designed to guide users through a three-phase process to assess sites for redevelopment with solar PV.

This tool utilizes several components to facilitate the screening process and to provide users with additional information on each of the screening criteria.

Users navigate the decision tree by responding to questions in the "Evaluation" boxes. Depending on the response, the user is directed to the next criteria or alerted to an potential obstacle by the "Flags." The user is directed to the next process step by "Arrows."

Tips on how users can obtain information relevant to various parameters in the tree are provided in the "Notes" and "Highlights."

For each "Evaluation" box, the corresponding "Note" section provides a brief explanation associated with the question posed.

For each "Flag," the corresponding "Note" summarizes the potential impact of the obstacle to the viability of the PV redevelopment project. In some cases, the tool also provides information on alternatives or additional considerations that may mitigate the impact of a given obstacle.

Supplemental information related to many process steps is provided in the "Highlights" boxes.

Please provide feedback on the tool to Shea Jones of the RE-Powering team:

jones.shea@epa.gov

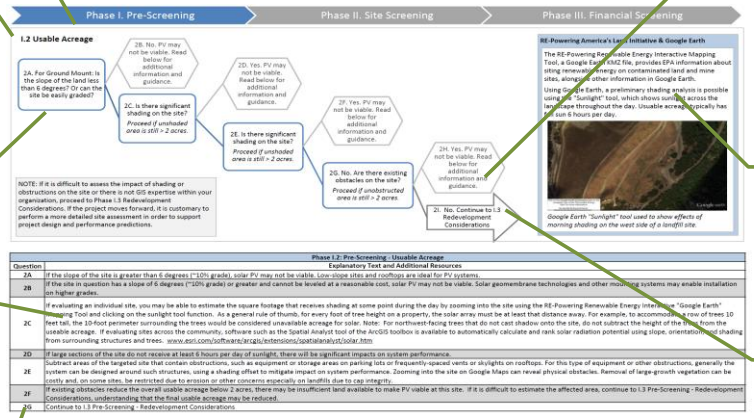
Process flow chart
Indicates active phase in the site screening process

Process Step title
Indicates process step number and title to aid navigation in decision tree

Evaluation box
Poses a question to guide the user through screening criteria

Notes
Provides information on the criteria, potential impact of "Flag" responses, and additional considerations that aid site screening.

Note labels
Link explanatory notes to each of the "Evaluation" boxes, "Flags," or "Arrows."



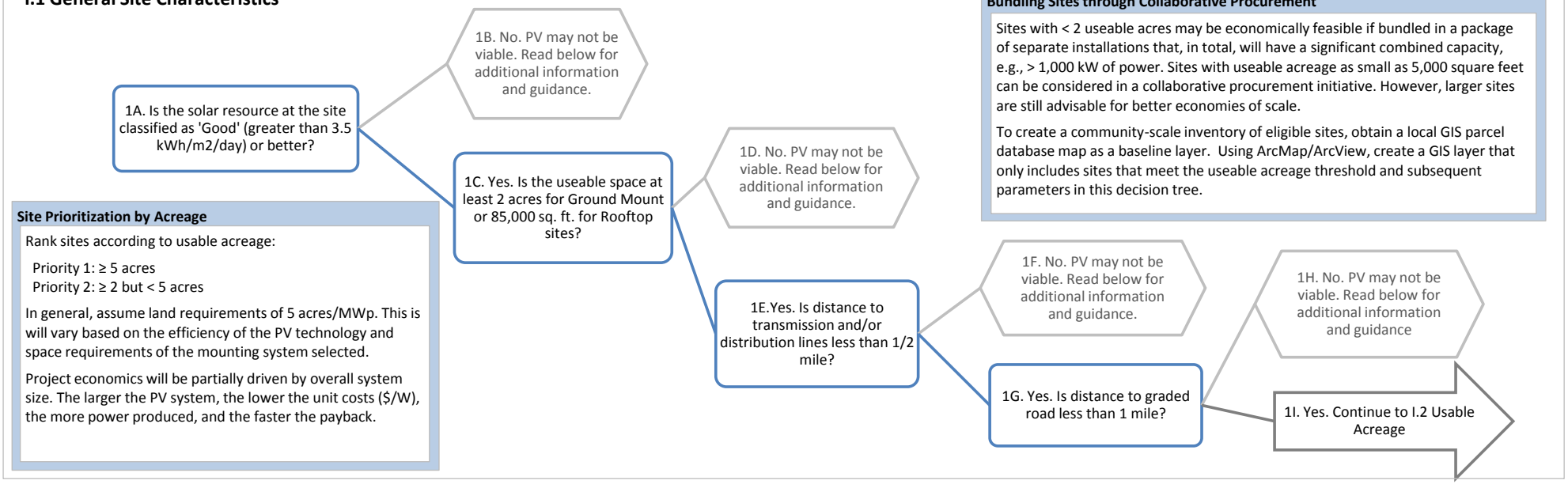
Flag
Indicates potential obstacle for redevelopment with solar PV based on user response. Points user to "Notes" for additional guidance and information.

Highlight
Provides supplemental information on topic pertinent to screening step

Arrow
Directs user to proceed to next step in screening process

Phase I. Pre-Screening | Phase II. Site Screening | Phase III. Financial Screening

I.1 General Site Characteristics



Site Prioritization by Acreage

Rank sites according to usable acreage:

Priority 1: ≥ 5 acres
Priority 2: ≥ 2 but < 5 acres

In general, assume land requirements of 5 acres/MWp. This is will vary based on the efficiency of the PV technology and space requirements of the mounting system selected.

Project economics will be partially driven by overall system size. The larger the PV system, the lower the unit costs ($/W), the more power produced, and the faster the payback.

Bundling Sites through Collaborative Procurement

Sites with < 2 useable acres may be economically feasible if bundled in a package of separate installations that, in total, will have a significant combined capacity, e.g., > 1,000 kW of power. Sites with useable acreage as small as 5,000 square feet can be considered in a collaborative procurement initiative. However, larger sites are still advisable for better economies of scale.

To create a community-scale inventory of eligible sites, obtain a local GIS parcel database map as a baseline layer. Using ArcMap/ArcView, create a GIS layer that only includes sites that meet the useable acreage threshold and subsequent parameters in this decision tree.

Phase I.1: Pre-Screening - General Site Characteristics	
Question	**Explanatory Text and Additional Resources**
1A	The solar resource potential is measured in kWh/m2/day. The majority of the US meets the 3.5 kWh/m2/day threshold. NREL's Renewable Energy Resource maps (www.nrel.gov/renewable_resources) provide information at the regional level. For a specific site, use one of the following mapping tools: (1) EPA Renewable Energy "Google Earth" Interactive Mapping Tool (www.epa.gov/renewableenergyland/mapping_tool.htm) and (2) In My Backyard (IMBY) (www.nrel.gov/eis/imby). Solar resource potential is not likely to vary significantly among sites in the same geographic vicinity and elevation.
1B	If the solar resource for this particular site is classified as less than "Good" (having less than 3.5 kWh/m2/day), a solar PV system may not be ideal for redevelopment at this site, unless the state also has strong incentives. We recommend exploring other renewable energy redevelopment options or infill redevelopment options. Note: Infill indicates redevelopment within an urban setting.
1C	Eligible space for PV includes under-utilized or unoccupied land, vacant lots, and/or unused paved area, e.g. a parking lot or industrial site space, as well as existing building rooftops. Usable acreage is typically characterized as "flat to gently sloping", southern exposures that are free from obstructions and get full sun for at least a 6-hour period each day. For an individual site to be viable for redevelopment with solar PV, the usable acreage should be at least 2 acres in order to install a system of at least 50 kW or greater in order to make the site economically feasible.
1D	If the usable acreage does not meet the size threshold, consider bundling rooftop and ground-mount systems at the same site or bundling multiple sites. If the useable area still does not meet the threshold, solar PV may not be viable at this site.
1E	In dense to moderately dense urban settings, assume that most properties meet this criterion. Depending on overall system size and economic factors, it may be feasible to build the necessary infrastructure to reach the grid tie-in location. If you are considering an off-grid (non-grid connected) system, distance to transmission is not a limiting factor, continue to Question 1G.
1F	If the system will be grid-connected and the distance to transmission is more than 1/2 mile, solar PV may not be viable due to the additional cost associated with connecting the system to the nearest grid tie-in. If the system will not be grid-connected (off-grid), move forward in the decision tree to Question 1G.
1G	In dense to moderately dense urban settings, assume that most properties meet this criterion. If you are considering an off-grid (non-grid connected) system, the distance to graded roads is not a limiting factor, continue forward in the decision tree to Question 1I. The distance to graded roads may only become a factor during the installation phase of development for an off-grid system as contractor vehicles may find it difficult to access the site. There may be additional requirements associated with emergency-vehicle access.
1H	If the system will be grid-connected and the distance to graded roads is greater than 1/2 mile, the additional cost associated with developing access roads may make solar PV development cost-prohibitive. If the site in question has access points/non-graded roads that you believe will not prohibit contractor vehicles from accessing the site during installation, operation and maintenance phases, you should answer "Yes" and continue forward in the decision tree to Question 1K.
1I	Continue to Phase I.2 Pre-Screening - Usable Acreage

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I.2 Usable Acreage

2A. For Ground Mount: Is the slope of the land less than 6 degrees? Or can the site be easily graded?

2B. Yes. PV may not be viable. Read below for additional information and guidance.

2C. Is there significant shading on the site?
Proceed if unshaded area is still > 2 acres.

2D. Yes. PV may not be viable. Read below for additional information and guidance.

2E. No. Are there existing obstacles on the site?
Proceed if unobstructed area is still > 2 acres.

2F. Yes. PV may not be viable. Read below for additional information and guidance.

2G. No. Continue to I.3 Redevelopment Considerations

NOTE: If it is difficult to assess the impact of shading or obstructions on the site or there is not GIS expertise within your organization, proceed to Phase I.3 Redevelopment Considerations. If the project moves forward, it is customary to perform a more detailed site assessment in order to support project design and performance predictions.

RE-Powering America's Land Initiative & Google Earth

The RE-Powering Renewable Energy Interactive Mapping Tool, a Google Earth KMZ file, provides EPA information about siting renewable energy on contaminated land and mine sites, alongside other information in Google Earth.

Using Google Earth, a preliminary shading analysis is possible using the "Sunlight" tool, which shows sunlight across the landscape throughout the day. Usable acreage typically has full sun 6 hours per day.

Google Earth "Sunlight" tool used to show effects of morning shading on the west side of a landfill site.

Phase I.2: Pre-Screening - Usable Acreage	
Question	**Explanatory Text and Additional Resources**
2A	If the slope of the site is greater than 6 degrees (~10% grade), solar PV may not be viable. Low-slope sites and rooftops are ideal for PV systems.
2B	If the site in question has a slope of 6 degrees (~10% grade) or greater and cannot be leveled at a reasonable cost, solar PV may not be viable. Solar geomembrane technologies and other mounting systems may enable installation on higher grades.
2C	If evaluating an individual site, you may be able to estimate the square footage that receives shading at some point during the day by zooming into the site using the RE-Powering Renewable Energy Interactive "Google Earth" Mapping Tool and clicking on the sunlight tool function. As a general rule of thumb, for every foot of tree height on a property, the solar array must be at least that distance away. For example, to accommodate a row of trees 10 feet tall, the 10-foot perimeter surrounding the trees would be considered unavailable acreage for solar. Note: For northwest-facing trees that do not cast shadow onto the site, do not subtract the height of the trees from the useable acreage. If evaluating sites across the community, software such as the Spatial Analyst tool of the ArcGIS toolbox is available to automatically calculate and rank solar radiation potential using slope, orientation, and shading from surrounding structures and trees. www.esri.com/software/arcgis/extensions/spatialanalyst/solar.htm
2D	If large sections of the site do not receive at least 6 hours per day of sunlight, there will be significant impacts on system performance.
2E	Subtract areas of the targeted site that contain obstructions, such as equipment or storage areas on parking lots or frequently-spaced vents or skylights on rooftops. For this type of equipment or other obstructions, generally the system can be designed around such structures, using a shading offset to mitigate impact on system performance. Zooming into the site on Google Maps can reveal physical obstacles. Removal of large-growth vegetation can be costly and, on some sites, be restricted due to erosion or other concerns especially on landfills due to cap integrity.
2F	If existing obstacles reduce the overall usable acreage below 2 acres, there may be insufficient land available to make PV viable at this site. If it is difficult to estimate the affected area, continue to I.3 Pre-Screening - Redevelopment Considerations, understanding that the final usable acreage may be reduced.
2G	Continue to I.3 Pre-Screening - Redevelopment Considerations

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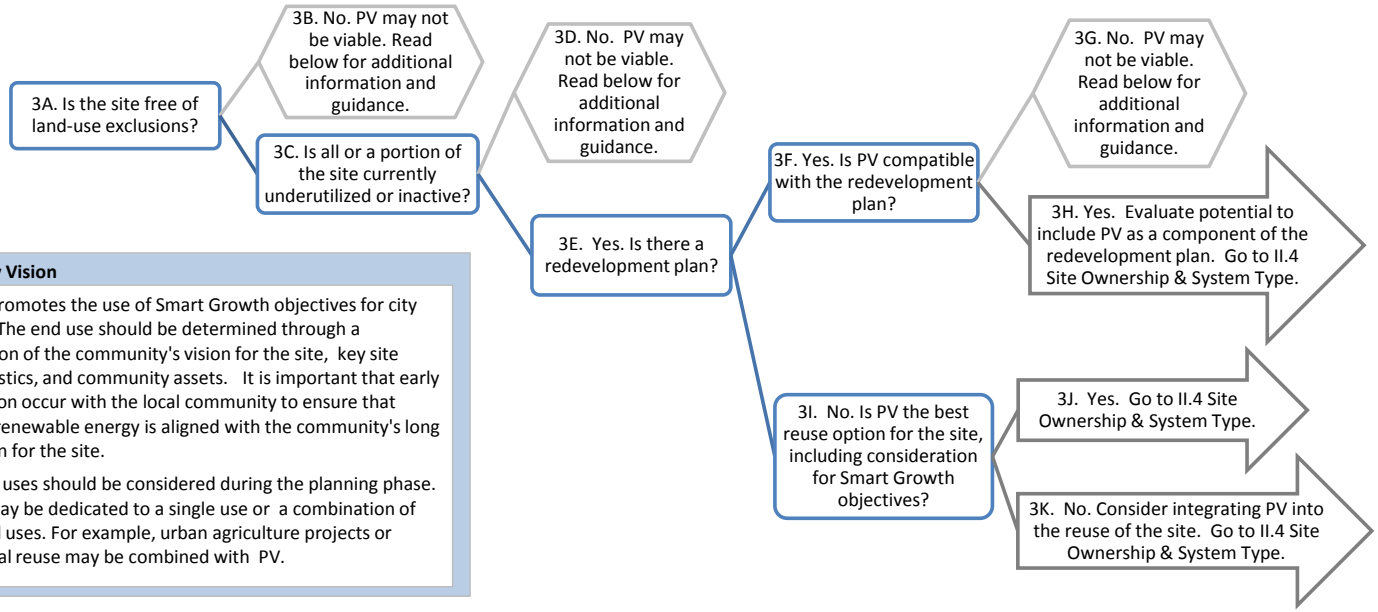
I.3 Redevelopment Considerations



Community Vision

The EPA promotes the use of Smart Growth objectives for city planning. The end use should be determined through a combination of the community's vision for the site, key site characteristics, and community assets. It is important that early consultation occur with the local community to ensure that reuse for renewable energy is aligned with the community's long term vision for the site.

Many end uses should be considered during the planning phase. The site may be dedicated to a single use or a combination of integrated uses. For example, urban agriculture projects or commercial reuse may be combined with PV.

Site Ownership

To proceed to the next step, you will need to engage with the site owner. Site ownership will drive the development path, impacts the structure of the system sale, and determines what incentives are available.

Site ownership information is readily available through checking either a local-level GIS parcel database or county-level parcel tax database. At this point in the process, simply take note of the site ownership and continue on in the decision tree. If evaluating sites across the community, a local-level GIS parcel database should include information on parcel ownership; sites that remain in the running can be categorically grouped according to public versus private ownership in preparation for Phase II.

Phase I.3: Pre-Screening - Redevelopment Considerations	
Question	**Explanatory Text and Additional Resources**
3A	Certain sites will be excluded from consideration for renewable energy development, such as environmentally sensitive or preservation areas, for example wetlands and wilderness preservation areas. If not readily known, this information can be obtained from the city land use planning department. Some land-use exclusions or restrictions include: - Exclusion of water, wetlands, wild and scenic rivers, and wilderness study area - Restrictions may be applicable for areas surrounding airports - Restrictions may also be associated for federal lands with special designation such as national parks, national preserves, national monuments, national conservation areas, and wilderness areas.
3B	If the site has land-use exclusions associated with it, the incremental cost associated with developing renewables on that site may make the site cost-prohibitive.
3C	Conduct a site visit to gauge whether a potentially contaminated site is currently underutilized or inactive. Check applicable EPA federal or state online databases for site listings and Project Manager contact information. Local redevelopment agencies or land-use planning departments may have additional information on the site and/or whether an inventory of brownfields has been completed in the community. The EPA maintains mapping tools to search for contaminated sites by region or by community (e.g. address, zip code, etc.) at www.epa.gov/cleanup. For state-managed sites, search databases through the applicable state Department of Environmental Protection.
3D	If the site is actively used (e.g. leased office space), surrounding land may be eligible for a ground-mounted PV system, if the site owner and/or user is interested.
3E	Check if the land area or rooftop being evaluated for solar potential is located on a parcel that the city has already targeted for redevelopment in the context of a land use planning process, e.g., a Redevelopment Plan or a Specific Area Plan. If evaluating sites across the community, seek input from the municipal land use planning department to compare the most current Redevelopment Plan map with sites targeted for solar. If a RCRA or Superfund site, check with Potentially Responsible Party (PRP) or property owner to inquire about existing redevelopment plans. Based on community vision for the site, consider the potential to incorporate PV into the redevelopment plans and continue to II.4 Site Ownership & System Type.
3F	PV could be evaluated as a potential component of a future redevelopment plan.
3G	Evaluate the potential to add PV as a component of the redevelopment plan for either residential or commercial end uses.
3H	Solar PV could be evaluated as a potential component of a future site re-use plan. If appropriate, continue to Phase II.4 Site Screening - Site Ownership & System Type.
3I	Important considerations for determining potential reuse options for a site include community vision for the site, market realities, existing infrastructure, and realities of existing contamination. Smart Growth objectives include guiding development to already-developed areas to foster walkable neighborhoods with a variety of services and transportation choices. See Appendix A for guidelines in evaluating whether the site may be a priority for future redevelopment based on Smart Growth objectives.
3J	Continue to Phase II.4 Site Screening - Site Ownership & System Type.
3K	Solar PV could be evaluated as a potential component of a future reuse plan. If appropriate, continue to Phase II.4 Site Screening - Site Ownership & System Type.

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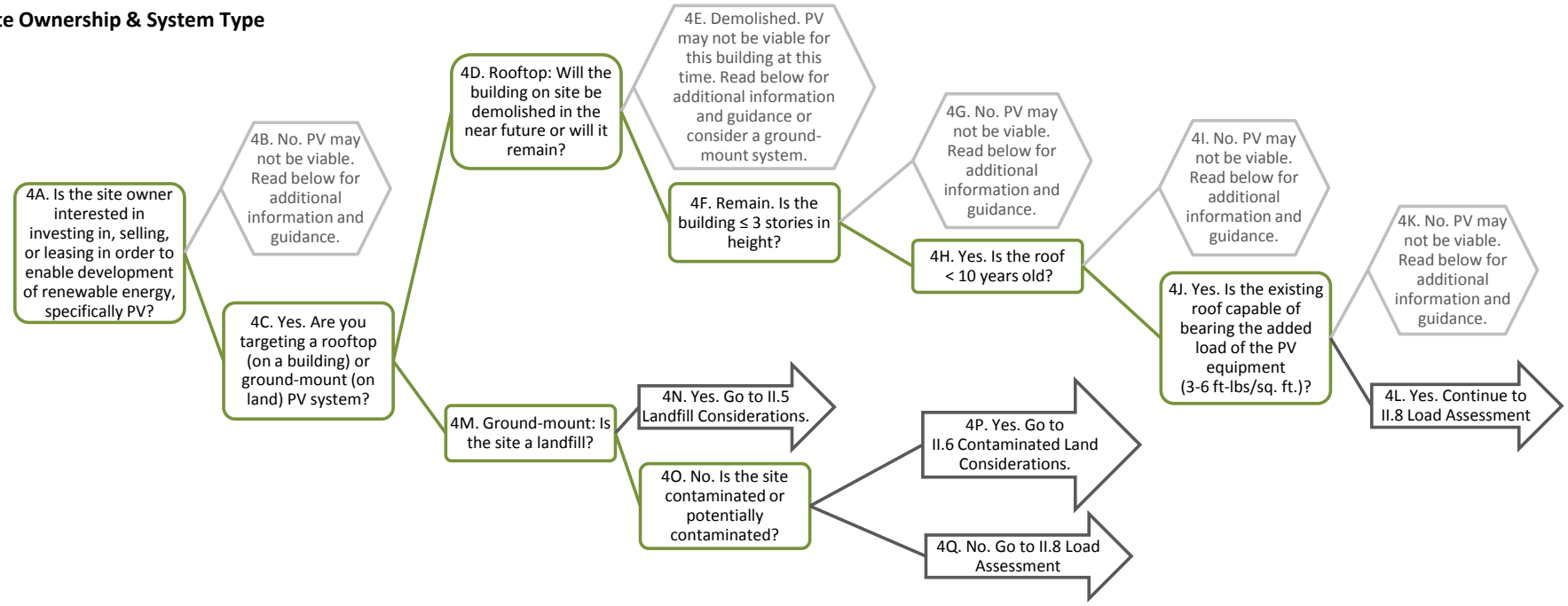
II.4 Site Ownership & System Type



Phase II.4: Site Screening - Site Ownership & System Type	
Question	**Explanatory Text and Additional Resources**
4A	When planning the strategic redevelopment of a contaminated site, site ownership will play a role in informing the decision to include renewables in the redevelopment plan. While site ownership may determine liability for remediation, it may also become a project's greatest asset or greatest barrier depending upon the site owner's interest in investing in renewable energy.
4B	If the site-owner is not interested in investing in redevelopment with solar PV, the project may not be viable at this time. You may wish to explore opportunities and resources to help inform the site-owner of possible benefits associated with redeveloping with renewable energy. Additional resources are available through the EPA and NREL websites referenced in the introduction.
4C	Determine whether the PV system is intended to be installed as a ground-mounted system (i.e.. on open, fairly flat land) or if it will be installed as a roof-mounted system on an existing building. If you intend to have both ground-mounted and roof-mounted systems, please utilize both branches of the tree to determine whether a PV system will be appropriate for one, both or neither.
4D	Speak with the site owner or conduct an on-site visit to learn about any future plans for the building on site. If the building is anticipated to remain and be in good structural condition for the foreseeable future, this may be a good option for a roof-mounted PV system.
4E	If the building is going to be demolished, PV may not be a viable option at this time. If a new building will take its place, consider solar PV as the new building is being designed and built.
4F	Coupled with wind zone, building height will impact overall design loads for the PV system. Many system types are limited to buildings with 3 stories or fewer. Taller buildings may have constraints due to the presence of competing equipment, issues with access for lifting materials, or inability to sufficiently offset energy consumption given available space.
4G	Certain mounting system designs may be capable of meeting building code requirements on taller buildings. Follow-up consultation with an installer is recommended.
4H	Consult facility manager to determine age of existing roof and planned replacement schedule.
4I	If the integrity of the roof is poor or if the roof is expected to be replaced within the next 2-15 years, PV may not be a viable option at this time. Coordinating PV installation with the roof replacement timeline will decrease overall costs associated with re-roofing and maintenance.
4J	Consult facility manager to determine bearing capacity of existing roof and structure.
4K	The building and/or roof may not be designed for additional load bearing capacity. Follow-up consultation with a civil engineer is recommended to determine if options for reinforcing the roof.
4L	Continue to II.8 Load Assessment
4M	Remediation and installation considerations are different for landfill applications, as compared to general contaminated sites.
4N	Continue to II.5 Site Screening - Landfill Prioritization
4O	Contaminated sites may require additional design, construction, and maintenance considerations. These potential considerations should be taken into account during the screening process.
4P	Continue to II.6 Site Screening - Contaminated Land Considerations
4Q	Continue to II.8 Site Screening - Load Assessment

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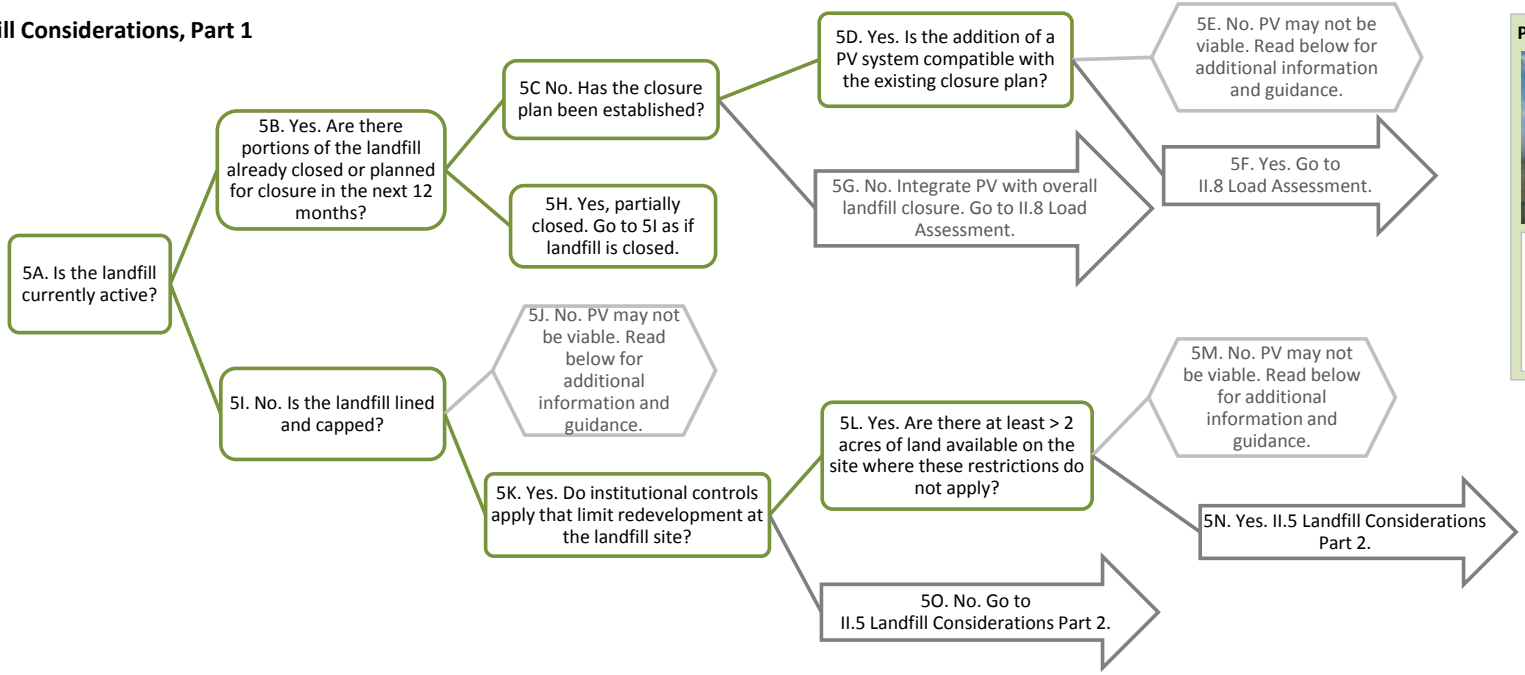
II.5 Landfill Considerations, Part 1



PV Geomembranes

For landfills that have not yet been capped or that have steep slopes, PV geomembranes can serve as the landfill cap integrated with solar modules.

Phase II.5: Site Screening - Landfill Considerations, Part 1	
Question	**Explanatory Text and Additional Resources**
5A	Candidate landfills should be carefully chosen based on status. There are opportunities for both active and closed landfills; each require special design considerations.
5B	Target cells that are (i) planned for closure or (ii) have been closed for near-term installations. For long-term planning purposes, consider designing a PV system integrated into the closure plan.
5C	For active sites, consider (i) installing PV in buffer zones on the site and/or (ii) integrating a PV system into the closure plan. Buffer zones will likely place fewer design restrictions on the PV system design, while integrating PV with the cap design, e.g. a solar geomembrane, provides an opportunity to focus on which PV technology works best with various landfill caps.
5D	If there is an existing closure plan, evaluate options to add a PV system as part of the design.
5E	If the closure plan is not compatible, reconsider use of buffer zones. See 5C notes for benefits of developing buffer zones.
5F	Continue to II.8 Site Screening - Load Assessment
5G	Integrating PV with the cap design allows for optimization of both systems by building the required infrastructure for the PV system into the cap design and vice versa. Continue to II.8 Site Screening - Load Assessment
5H	If the landfill has closed cells, target these portions for near-term development. Go to Question 5I.
5I	Obtain records associated with landfill design to determine overall construction. Modern landfill are well-engineered facilities that are design, operated, and monitored to protect the environment from contaminants that may be present in the solid waste stream. If the landfill was active prior to 1970, there is a high likelihood that the site may not be lined and may contain contaminants.
5J	In the case that the landfill is not lined and properly capped, there may be restrictions on redevelopment due to potential for exposure to landfill contents.
5K	Landfill caps range from highly engineered systems to simple backfill. Understanding the nature of the cap and its functional components is necessary to determine what options are available with respect to installing a PV system directly on the cap and what modifications to the cap and/or PV mounting system design to ensure cap integrity.
5L	Institutional controls include (i) proprietary controls, i.e. easements or covenants; (ii) governmental controls, i.e. zoning or building codes; (iii) enforcement and permit tools, i.e. restrictive landfill closure permits; and (iv) informational devices, i.e. deed notices.
5M	If institutional controls apply, evaluate the potential to amend the control to enable redevelopment with PV. For example, zoning has been successfully changed to facilitate PV installations. If appropriate, evaluate the impact to the usable acreage in order to confirm sufficient space is available.
5N	If the usable acreage does not meet the size threshold, consider bundling rooftop and ground-mount systems at the same site or bundling multiple sites. If the useable area still does not meet the threshold, solar PV may not be viable at this site. If there is the sufficient usable acreage, go to II.5 Landfill Considerations, Part 2.
5O	If redevelopment at the site is not limited by institutional controls, go to II.5 Landfill Considerations, Part 2.

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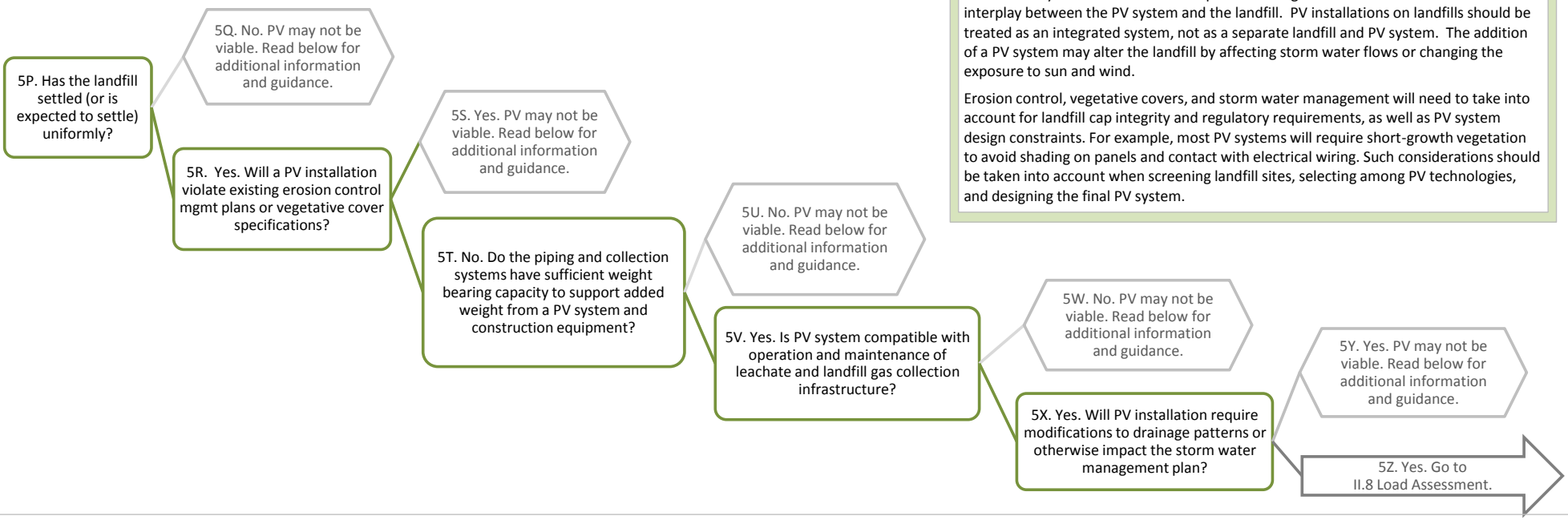
II.5 Landfill Considerations, Part 2



Treating the Landfill and PV as an Integrated System

The feasibility assessment and subsequent PV design must take into account the interplay between the PV system and the landfill. PV installations on landfills should be treated as an integrated system, not as a separate landfill and PV system. The addition of a PV system may alter the landfill by affecting storm water flows or changing the exposure to sun and wind.

Erosion control, vegetative covers, and storm water management will need to take into account for landfill cap integrity and regulatory requirements, as well as PV system design constraints. For example, most PV systems will require short-growth vegetation to avoid shading on panels and contact with electrical wiring. Such considerations should be taken into account when screening landfill sites, selecting among PV technologies, and designing the final PV system.

Phase II.5: Site Screening - Landfill Considerations, Part 2	
Question	**Explanatory Text and Additional Resources**
5P	All landfills are prone to settlement, but the type and magnitude of the settlement varies depending on landfill design, age, and composition of the waste materials. Uniform settlement refers to waste material decaying evenly, resulting in the landfill cap settling at a similar rate over large areas. Differential settlement refers to material decaying at different rates throughout the landfill, resulting in an uneven surface. As a general rule, developers target sites that have been capped for longer than 2-3 years due to the high rate of settlement expected after closure. If the landfill has exhibited uniform settlement in the past, the site may be viable. Settlement predictions will need to be adjusted to account for effects on the settlement rate and/or pattern due to the PV system.
5Q	Differential settlement is a significant concern for landfill PV projects. This type of settlement may result in uneven stresses on the mounting system and foundations, causing potential structural issues and impacting system performance due to misalignment. Consult a developer or civil engineer to evaluate feasibility concerns. If appropriate, go to Question 5R.
5R	Review the erosion control management plan and vegetative cover specifications in order to ensure compliance with post-closure plan requirements. During the proposal, design, and construction process, communicate these requirements clearly in order to avoid compliance issues and costly rework.
5S	The design and specification of erosion control measures may be modified to include placement of PV foundations and support structures when using ballasted or shallow-poured foundations. As an alternative, the use of a PV-integrated geomembrane can be investigated as a replacement for conventional erosion control and vegetative cover systems. If appropriate, go to Question 5T.
5T	Nearly all landfills incorporate the use of leachate and landfill gas collection and/or treatment systems. Both systems generally consist of a network of pipes imbedded through the waste material in the landfill cells. Obtain design documentation for these systems to confirm that additional loading from a PV system will not exceed the bearing capacity of these systems.
5U	Investigate the use of light weight systems or alternate foundation designs that may distribute the PV system weight to an acceptable level. If appropriate, go to Question 5V.
5V	The infrastructure for leachate and landfill gas systems will also need to be taken into account for laying out the PV system to ensure that there is not physical interference and proper clearances are maintained for operation, maintenance, and safety.
5W	Evaluate the impact of creating setbacks in specific portions of the landfill to avoid this infrastructure. If these considerations reduce the usable area below 2 acres, PV may not be viable.
5X	Review the storm water management plan incorporated into the landfill post-closure plan. Storm water management is closely tied to erosion control and vegetative cover systems. The landfill components are designed to (i) absorb a portion of storm water runoff; (ii) convey additional runoff to retention ponds either at or below the surface. This system is designed to prevent channeling of storm water runoff which can lead to erosion and fissures in the landfill cap.
5Y	Propose the development of an alternate storm water management plan that takes into account grading, fill, and compaction requirements for the PV system. Designing the storm water management and PV system as an integrated system can result in considerable savings. As an alternative to a conventional mounting system, consider installing a PV-integrated geomembrane for use as a primary storm water management system on targeted areas of the cap. If appropriate, proceed to II.8 Site Screening - Load Assessment.
5Z	Continue to II.8 Site Screening - Load Assessment

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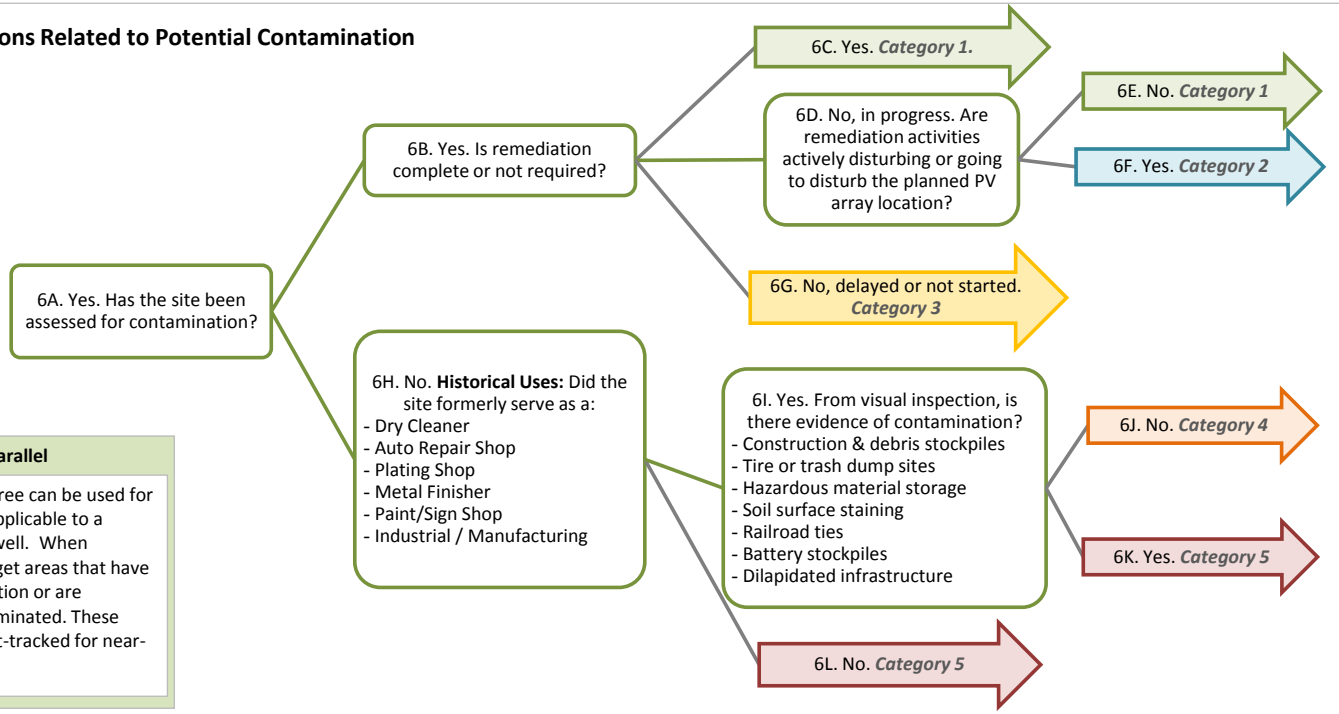
II.6 Considerations Related to Potential Contamination



Redevelopment in Parallel

While the decision tree can be used for an entire site, it is applicable to a portion of a site as well. When evaluating sites, target areas that have undergone remediation or are potentially uncontaminated. These portions may be fast-tracked for near-term construction.

Ranking by Project Readiness

Cat 1. Site assessed, and remediation is not a barrier to near-term PV project.

Cat. 2. Site assessed, and remediation must be completed prior to potential PV project.

Go to II.8 Load Assessment

Cat. 3. Site assessed but lacks active remediation plan. Option to tailor remediation plan for PV, if warranted.

Cat. 4. Site not yet assessed. Contaminants may be present that need to be cleaned up. Site conditions may pose fewer obstacles to potential PV project.

Cat. 5. Site not yet assessed. Contaminant investigation and characterization is required as a next step prior to further scoping for potential PV project.

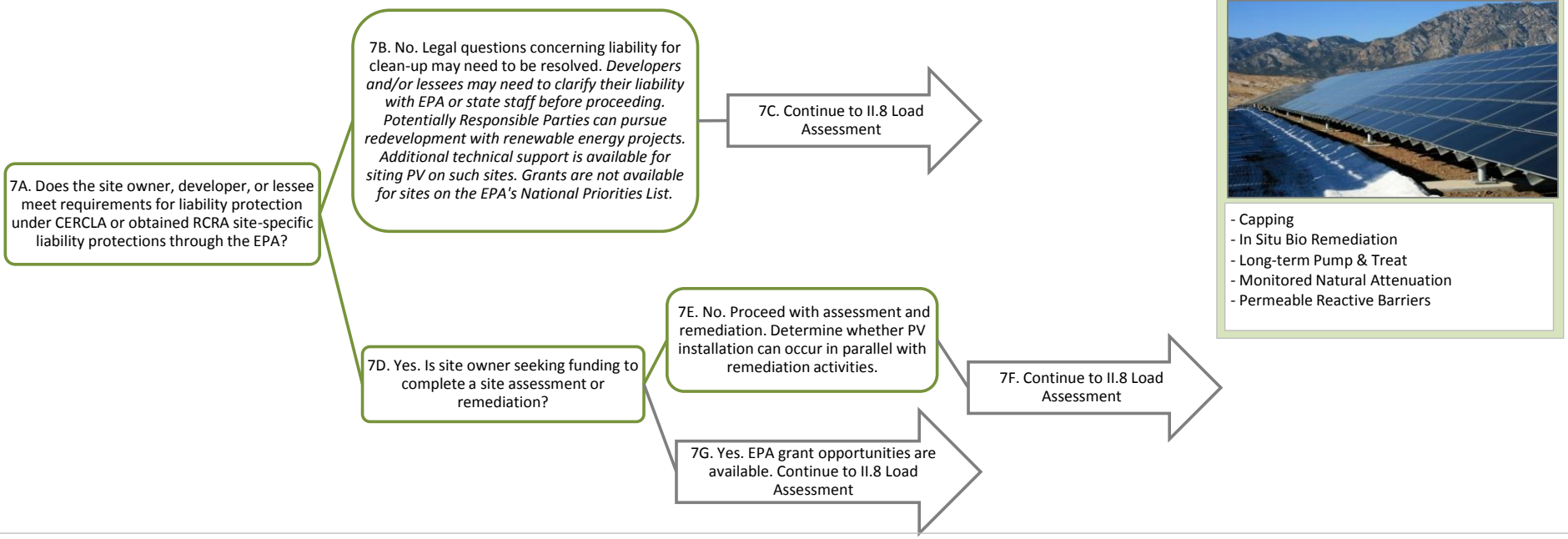
Go to II.7 Remediation

See Appendix C for additional information.

Phase II.6: Site Screening - Contaminated Land Prioritization	
Question	**Explanatory Text and Additional Resources**
6A	A site assessment and characterization will ensure that you are aware of any need for future cleanup, which areas on the site may be exempt from redevelopment, and estimated usable acreage. To find information on potentially contaminated lands and their status, search applicable Federal and State online databases. For community-scale evaluation of eligible sites, inquire about any brownfield grants from the State or EPA to determine which sites may have already been assessed or cleaned up, but not yet redeveloped.
6B	Determine status of remediation work on site.
6C	As remediation has been completed or determined to be not required, the site can be ranked under Category 1. Go to II.8 Site Screening - Load Assessment.
6D	For the targeted area, determine if remediation activities are expected to disturb the useable acreage for a period extending up to 20 years. For example, soil removal will need to be completed prior to initiating PV system construction. Once the PV system is installed, it may be difficult to access the area beneath the mounting system.
6E	Based on planned remediation activities, the site can be ranked under Category 1; see Appendix C. Go to II.8 Site Screening - Load Assessment.
6F	Based on planned remediation activities, the site can be ranked under Category 2; see Appendix C. Go to II.8 Site Screening - Load Assessment.
6G	If remediation activities have not yet started or are delayed, the site ranks under Category 3; see Appendix C. Go to II.7 Site Screening - Initiating Assessment and Remediation.
6H	If site characterization and investigation is not yet in the early stages, begin this process prior to developing a solar resource at the site. This screening list gives general guidance on how the site can be prioritized for future redevelopment with solar. Input from community stakeholders may also be helpful in understanding the site's historical uses, assessment prospects, and redevelopment priorities. Certain historical uses may be indicative of the type and extent of contamination, as well as degree of difficulty to clean-up the site. For more information on site investigation and characterization, see EPA's tools and resources to assist in contaminated site characterization and monitoring: www.epa.gov/superfund/remedytech/char.htm.
6I	Based on observations from the site visit, note any signs of contamination on the site and document locations within usable acreage identified during Phase I.1. Visible evidence of contamination may be an indicator of the extent of remediation. An assessment will be required to determine the contaminants present.
6J	Given historic use of the site and visual observations, the site ranks under Category 4; see Appendix C. Go to II.7 Site Screening - Initiating Assessment and Remediation.
6K	Given historic use of the site and visual observations, the site ranks under Category 4; see Appendix C. Go to II.7 Site Screening - Initiating Assessment and Remediation.
6L	Given historic use of the site, the site ranks under Category 5; see Appendix C. Go to II.7 Site Screening - Initiating Assessment and Remediation.
Cat. 1-5	See Appendix C for additional information and guidance on Contaminated Sites & Project Readiness

Phase I. Pre-Screening | Phase II. Site Screening | Phase III. Financial Screening

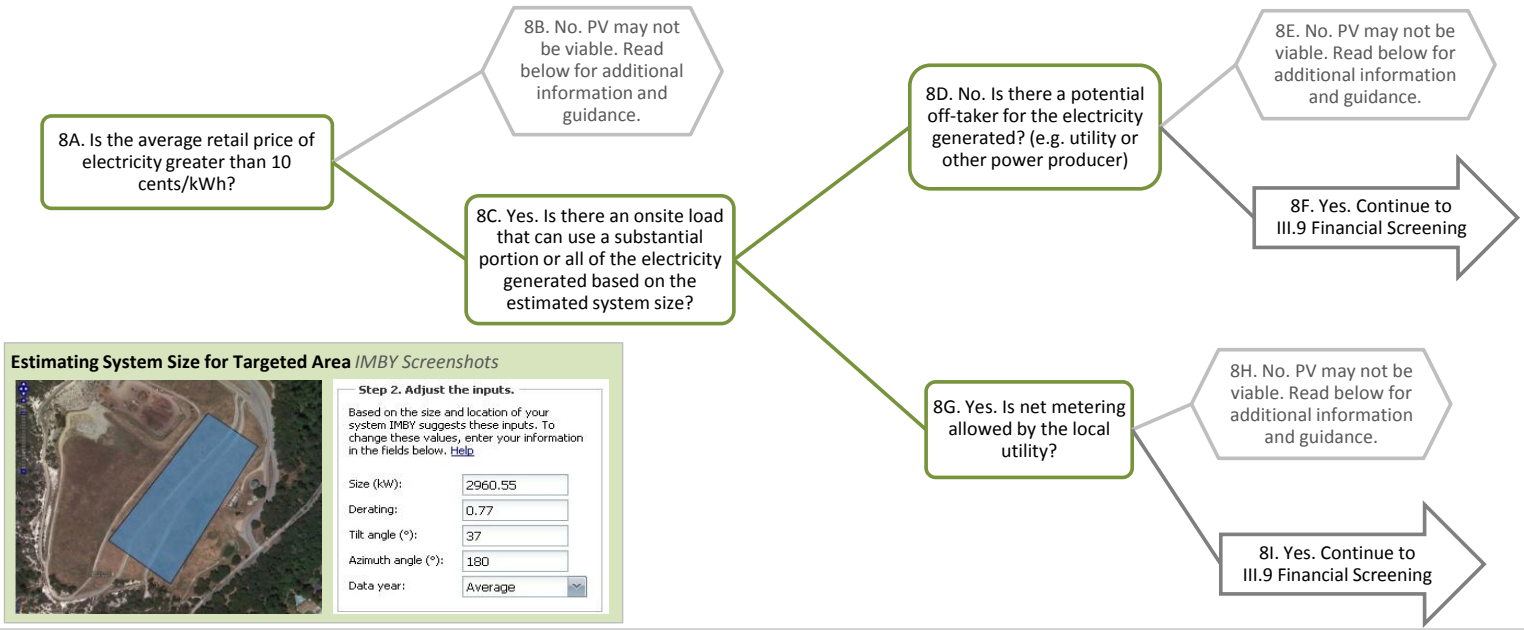
II.7 Initiating Assessment & Remediation *Potentially Contaminated Land Categories 3, 4, & 5*



Phase II.7: Site Screening - Remediation	
Question	**Explanatory Text and Additional Resources**
7A	***Following an initial assessment seek legal counsel to make final determination with regard to liability in coordination with the appropriate EPA office.*** There are two principle federal clean-up laws that govern contaminated sites: the *Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)* or the *Resource Conservation and Recovery Act* (RCRA). CERCLA and RCRA liability considerations and protections for renewable-energy development projects are addressed in EPA's March 2011 publication entitled, "Siting Renewable Energy on Contaminated Properties: Addressing Liability Concerns." Document No. EPA-330-F-11-001. For city-owned or to-be-acquired parcels, see EPA's March 20011 factsheet entitled, "CERCLA Liability and Local Government Acquisitions and Other Activities." Document No. EPA-330-F-11-003.
7B	If site owner, developer, or lessee does not meet liability requirements, contact the EPA for additional guidance on how to proceed with redevelopment plan for this site. Resources are available through the RE-Powering America's Land Initiative: www.epa.gov/renewableenergyland/contacts.htm
7C	Continue exploring project with knowledge that contamination issues may need to be resolved prior to redevelopment. Go to Phase II.8 Site Screening - Load Assessment.
7D	In some cases, lack of funding has delayed site assessment. EPA and other grant opportunities are available. For more information on assessment and clean-up opportunities through the Brownfields program, go to www.epa.gov/brownfields/grant_info/index.htm
7E	Continue exploring project with knowledge that contamination issues may need to be resolved prior to redevelopment.
7F	Continue to Phase II.8 Site Screening - Load Assessment.
7G	Proceed with grant application process. In parallel, continue site assessment. Continue to Phase II.8 Site Screening - Load Assessment.

Phase I. Pre-Screening | Phase II. Site Screening | Phase III. Financial Screening

II.8 Load Assessment



Estimating System Size for Targeted Area *IMBY Screenshots*

Estimating System Size

There are several publicly-available, online tools to help you determine potential system size, production and costs.

The U.S. Department of Energy created and maintains the "In My Backyard" (IMBY) tool.

IMBY enables users to estimated the electricity that can be produced with a solar photovoltaic (PV) array or wind turbine on a given property.

After entering the site address and selecting technology type, the user draws an area for the proposed system location. Based on this information the tool returns an estimated system size, assuming a fixed tilt PV system and provides energy prediction and basic financial information.

This output will provide a good first pass at estimating the potential for the site. Keep in mind that there may be capacity constraints in the existing utility infrastructure. System owners will need to engage with the local utility to discuss the project to determine potential impacts and appropriate mitigation measures.

Phase II.8: Site Screening - Load Assessment	
Question	**Explanatory Text and Additional Resources**
8A	If the average price of electricity is greater than 10 cents/kWh, solar PV may be economically feasible in this location. Typically, solar PV makes the best economic sense when it is being installed in an area where other energy costs are relatively high. The levelized cost of electricity (LCOE) is calculated by dividing the total system costs by the estimated lifetime production, yielding $/kWh. This analysis allows PV to be compared to other energy production sources, including existing retail electricity rates. The break-even cost for grid-connected, renewable energy is defined as the point where the cost of system-generated electricity is equal or greater than the cost of electricity purchased from the grid. Break-even cost is typically expressed in dollars per Watt ($/W) of an installed system. Generally, as retail electricity rates increase, the economics of a renewable energy project greatly improve. The predicted system performance (expressed as nameplate capacity, or estimated annual production) is a good indicator for determining the break-even cost for a renewable system.
8B	The economics of solar PV is greatly reduced when the retail electricity rate is very low. If there are incentives or other monetary and/or non-monetary benefits associated with installing solar PV at this site, continue on through the decision tree.
8C	For grid-connected systems, onsite power demands are important to consider but may not significantly impact the feasibility of a PV project. On-site power demands will drive the sale and finance structure, e.g. direct system sale vs. power purchase agreement. For a community-scale evaluation, this criterion can be evaluated based on individual loads and generation capacity, as well as cumulative demand across community customers.
8D	If there is no on-site load, the electricity generated by the PV array will need to be fed onto the grid and sold.
8E	If there is neither an on-site load or potential offtaker for the electricity, PV may not be viable at this site. It is recommended that you engage directly with the utility to determine if there is interest or other incentives that would compel the utility to purchase power from a renewable source.
8F	Continue to III.9 Financial Screening
8G	Determine if the local utility has a net metering program, which encourages development of PV and other renewable energy systems by allowing customers to offset on-site energy requirements.
8H	If the onsite load does not require 100% of the power generated and net metering is not an option, the project economics may not be favorable enough to proceed. Consider scaling the renewable energy project down to meet on-site requirements only.
8I	Go to Phase III.9 Financial Screening

Phase I. Pre-Screening | Phase II. Site Screening | Phase III. Financial Screening

III.9 Financial Screening

9A. Is there strong policy support for renewable energy development? Specific PV incentives?

9B. No. PV may not be viable. Read below for additional information and guidance.

9C. Yes. Can the system owner capture one or more of government incentives available for PV?

Note: Incentives may be available at federal, state, and local levels.

9D. No. Consider leasing the site and partnering with a private entity to own the system in order to take advantage of available incentives.

9E. Yes. Is the system price less than $8/Wp for small systems (50 kW) or $5/Wp for large systems (MW)?

9F. No. Request additional proposals to obtain more competitive pricing.

9G. Yes. The site appears to be a good candidate for redevelopment. Move into Project Development phase in coordination with a developer and local utility.

Scaling Up Collaborative Procurement

After completing a community-scale evaluation, the municipal, regional, or other local entity may serve as a catalyst for developing collaborative procurement partnerships among interested owners of eligible sites. Separate bundles should be led for publicly-owned versus privately-owned sites.

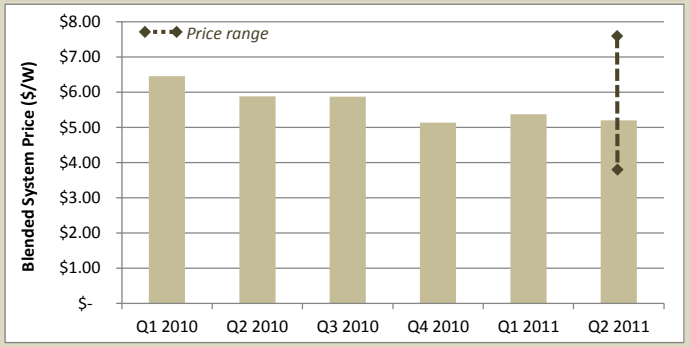
Collaborative procurement among neighboring communities or within a geographic region can reap significant benefits by leveraging shared resources, reducing system costs, and infusing the economy during the design, construction, and operation phases of the project.

PV System Price & Project Economics

The PV market has seen significant reductions in system pricing due to a emerging market conditions.

Project economics are generally assessed based on common economic measures (NPV and payback period) as well as the levelized cost of electricity (LCOE) compared to existing and projected electricity costs.

The U.S. Department of Energy created and maintains the "System Advisor Model" (SAM) tool, which enables users to calculate LCOE and other performance and economic metrics for PV, concentrating solar power, solar water heating, wind, and geothermal systems. https://sam.nrel.gov



Source: *U.S. Solar Market Insight 2nd Quarter 2011, Solar Energy Industries Association*

Phase III.9: Financial Screening	
Question	**Explanatory Text and Additional Resources**
9A	Strong state and federal policy support for renewable energy development can be critical to the overall feasibility and economic viability of a solar PV project. Strong state policies can support renewable energy development by driving markets, providing certainty in the investment market, and incorporating the external benefits of the technologies into cost/benefit calculations. The economic feasibility of solar PV depends on incentives, the cost of electricity, and the renewable resource. Targeted state and local incentives can provide a combination of low cost loans, grants or tax incentives to reduce the startup and operating costs of PV installations. Combined with federal programs, such as the Federal Investment Tax Credit, state incentives significantly decrease the cost of installing PV. If you are unsure of the policies and incentives available in your state to support renewable energy development and redevelopment of contaminated lands, check with the Database of State Incentives for Renewables and Efficiency (DSIRE) at www.dsireusa.org. To further explore the critical role of state policy in support of renewable energy development, please see NREL's Conference Paper "The Role of State Policy in Renewable Energy Development" at http://www.nrel.gov/analysis/pdfs/45971.pdf.
9B	Without strong policy support for renewable energy development at the federal, state, or local level, a solar PV project may be economically impractical.
9C	The ownership structure has a significant impact on the incentives available for the project, therefore significantly impacting the overall cost of the PV system. The system owner will be the eligible entity able to capture various federal, state, and local incentives. See Appendix D for a table of available federal incentives by eligible entity type. For information at the state level, use the Database of State Incentives for Renewables and Efficiency website: http://www.dsireusa.org.
9D	Explore options for partnering with a private entity which will enable use of more federal, state and local incentives. For example, financing through a power purchase agreement enables capture of many incentives for which public site owners may not otherwise be eligible.
9E	Renewable energy installation costs vary by site. Lifetime system costs are a function of many variables, and can be influenced by location, resource potential, land-use restrictions, and availability of installers within a particular area. The installation costs is typically expressed in dollars per watt ($/W) of an installed system and differs between various renewable energy technologies. Generally, installation costs should be less than $8/W for small systems and $4-5/W for larger systems. If you are unsure about a proposal or cost estimate you've received, or believe you may need a neutral third-party perspective, you may wish to contact the DOE Technical Assistance Program (TAP) to receive advice/feedback from a subject-matter expert. Check with the local utility on the interconnection fee. Interconnection fees are generally a small portion of the project cost and vary based on several factors. In general, standard fees are typically less than $1 per kilowatt.
9F	PV pricing has dropped considerably as new supply has entered the market. The market is continuing to evolve with prices adapting to a variety of factors from raw material costs to credit availability.
9G	Congratulations! This site or bundle of sites appears to be a good candidate for redevelopment with solar PV. Engage with potential developers and the local utility to move the project forward.

Appendix A. Smart Growth Objectives

Criteria for Smart Growth Objectives

Sites that meet all or the majority of the following criteria can be considered to have excellent (E) or good (G) location-based Smart Growth potential for redevelopment, e.g. residential, office, or retail use.

Criteria	"Yes" Rating
I. Location adjacent to existing infrastructure including water & sewer lines	
1. Is site located < 1/2 mile from existing water & sewer infrastructure?	G
2. Is site located < 1/4 mile from existing water & sewer infrastructure?	E
II. Road network layout	
1. Is site located in an interconnected road system or on an existing street that is interconnected? *Indicators of an interconnected road system include frequent street intersections per mile and a high percentage of 4-way intersections. In contrast, less well interconnected road systems have a predominance of cul-de-sacs and few parallel routes.*	E/G
III. Walkability (continuous sidewalk)	
1. Is there a continuous existing, walkable sidewalk within 1/8 mile radius of the site?	E
2. Is there a walkable sidewalk within a 1/4 mile radius of the site (even if not immediately adjacent to the site)?	G
IV. Walkability (block size)	
1. Is the block size (distance between intersections) within a ¼ mile radius of the site < 400 feet long (or, for non-rectangular blocks, is the total perimeter of street circling the site no greater than 1600 feet)?	E/G
V. Transit Friendly	
1. Is a bus commuter and/or rail line located less than 1/4 mile from the site?	E
2. Is a bus commuter and/or rail line located within a 1/2 mile of the site?	G
VI. Mixed Land Use Area	
1. Is there a diversity of retail, commercial, residential, etc. uses at or in the vicinity of the site, e.g., within 1/4 mile? *Mixed-use development, for example, might include retail-commercial on the first floor of a building or along major streets, with residential households located above the first floor and along side streets.*	E/G
VII. Public/Open Spaces	
1. Is a park or other public space located < 1/8 mile from the site?	E
2. Is a park or other public space located > 1/8 mile from but < 1/2 mile from the site?	G
VIII. Access to major institutions	
1. Are major city social, retail, commercial, and other (schools, churches, etc.) located < 1/4 mile from the site?	E
2. Are major institutions generally located > 1/4 mile but < 3/4 mile or less from the site?	G

Criteria	"Yes" Rating
IX. Bike Route	
1. Is there an existing bike route < 1/4 mile from the site?	E
2. Is there an existing bike route > 1/4 mile but < 3/4 mile from the site?	G
X. Community revitalization area	
1. Is the site located along a commercial strip corridor undergoing a local planning revitalization process or restructuring review?	G
2. If the answer to 1 is YES, is the site also located at or close to a crossroad identified in the local planning process or in an economic market analysis as particularly favorable to retail development, i.e., a "retail centered location"?	E

Additional References & Disclaimer

1. "Smart Growth for Brownfields Redevelopment: A Brownfields Screening Tool," prepared by GSG Consultants for the City of Chicago, May 2005. http://www.epa.gov/dced/publications.htm

2. "Restructuring the Commercial Strip: A Practical Guide for Planning the Revitalization of Deteriorating Strip Corridors," prepared by ICF International and Freedman, Tung & Sasaki, 2010, Section 2. http://www.epa.gov/dced/publications.htm

3. Smart Growth Project Scorecard, Smart Growth Leadership Institute, December 15, 2007. http://www.sgli.org/toolkit/tools/scorecard.pdf

NOTE: While quantitative criteria are used, this is not an official or comprehensive rating system but rather guidance to help users make qualitative judgments. These criteria can be addressed with information available through either Google GIS maps or local land use planning resources.

This evaluation tool is not comprehensive. For example, it does not take into account local zoning restrictions that may apply, how well the existing street infrastructure accommodates pedestrian and bicyclist safety and attractiveness, or other potential barriers to site redevelopment.

Appendix B. Ideal Site Characteristics Checklists

Landfills	
☑	- Capped & closed (at least the portion being evaluated for solar); ***OR*** - Capped & pre-remedy; closure plan can readily incorporate solar installation; ***OR*** - Uncapped & pre-remedy; solar installation can serve as a cap
☑	- Owner abandoned & no incentive for private redevelopment - Site available for lease; does not need to be purchased by a developer - Site does not have an expensive or short-term lease arrangement
☑	Landfill closed more than 2-3 years prior to planned construction start and has not experienced differential settlement
☑	Solar installation compatible with site's long-term monitoring and maintenance plan, including leachate and gas collection systems, erosion control and storm water management plans

Site definitions

Potentially Contaminated Site: Sites where contamination is suspected but has not been confirmed and sites where contamination has been identified.

Brownfield: Typically former industrial site that may have (or be perceived to have) contamination issues. "Brownfield" is an environmental designation that is often adapted in state or federal regulations to define concomitant requirements for the reuse of the site.

Potentially Contaminated Sites -- Pre-Remediation	
☑	-Assessment determines that levels of contamination do not pose unacceptable risk to human health and the environment; ***OR*** - Historic uses not likely to have caused significant contamination requiring expensive cleanup; ***OR***
☑	- Cleanup costs to redevelop site to residential or commercial space are prohibitive but would not be for solar reuse AND site otherwise meets all other solar eligibility criteria
☑	Usable acreage for solar at site is currently underutilized, inactive, or undisturbed
☑	-Site redevelopment plan supports renewable energy; ***OR*** -No site redevelopment plan in place and site not otherwise a priority for redevelopment for alternate uses

Contaminated Sites -- During Remediation	
☑	Remediation/cleanup will not require site surface to be actively disturbed or active disturbance limited to a small portion of usable acreage for solar
☑	Design and construction of PV system can be created in parallel with development and implementation of remedy

Contaminated Sites -- Post-Remediation	
☑	PV system will not compromise remediation solution in place during construction or operation phase
☑	Zoning or other institutional controls limit redevelopment for residential, commercial, or recreational uses AND allow for redevelopment for renewable energy

Appendix C. Contaminated Sites & Project Readiness

Ranking by PV Project Readiness		
Category	**Status Description**	**Explanatory Text and Additional Resources**
1	Site assessed, and remediation is not a barrier to near-term PV project.	Site conditions are conducive to installing a solar system in the near-term. See II.7 for examples of remediation plans compatible with PV installations.
2	Site assessed, and remediation must be completed prior to potential PV project.	Site conditions are conducive to installing a solar system following completion of remediation activities. Check the remediation plan to determine when remediation activities will be completed.
3	Site assessed but lacks active remediation plan. Option to tailor plan to potential PV project, if warranted.	Sites in Category 3 could be experiencing delays or inactivity for a number of reasons: - If the assessment revealed the site is not an immediate contamination threat to the community or groundwater and the responsible local or State agency is focusing on remediating other higher priority contamination sites; - If the site assessment revealed heavy contamination and estimated cleanup cost to redevelop the site to residential or commercial use is prohibitive; - If the site is on a long list of brownfields and is not a near-term priority for residential or commercial redevelopment; - If legal questions concerning liability for cleanup are yet to be resolved. The next step is to contact the site's Project Manager to check into the reason(s) behind the delay. Consider whether the potential for a solar installation would present a re-use alternative that addresses the reason for delay or inactivity in taking the next step towards remediation.
4	Site not yet assessed. Contaminants may be present that need to be cleaned up. Site conditions may pose fewer obstacles to potential PV project.	There may be sites in Categories 4 and 5 that are well suited for solar and should not be overlooked. Several of these sites may be low priority for residential or commercial redevelopment, which could explain why they have not yet been assessed. However, the prospect of re-purposing the site for a solar project may trigger interest to pursue funding for a near-term site assessment. The site investigation and cleanup cost analysis can be structured to include a comparison of cleanup costs that would be necessary to re-purpose the site to solar versus other potential redevelopment re-uses that may incur larger cleanup costs. See Appendix B. Ideal Site Checklists for characteristics that would make a **site** ideal for siting a solar project.
5	Site not yet assessed. Contaminant investigation and characterization is required as a next step prior to further scoping for potential PV project.	

Appendix D. Examples of Federal Incentive Programs

Incentive Program / Description	Residential	Multi-family	Commercial	Industrial	Manufacturing	Agricultural	Native Corporation	Schools	Non-Profits	Utility	Municipal Utility	Rural Elec. Cooperative	Public Power Entity	State Gov't	Local Gov't	Tribal Gov't	Non-Federal
	Eligible Sectors																
Investment Tax Credit (ITC)			X	X		X				X							
Production Tax Credit (PTC)			X	X		X											
Residential Energy Conservation Subsidy Exclusion (Corporate)		X															
Modified Accelerated Cost-Recovery System (MACRS)			X	X		X											
Tribal Energy Program Grant																X	
USDA – High Energy Cost Grant Program	X		X						X					X	X	X	
USDA – Rural Energy for America Program (REAP) Grants			X					X				X	X	X	X	X	
USDA – REAP Loan Guarantees			X			X											
Clean Renewable Energy Bonds (CREBs)											X	X		X	X	X	
Qualified Energy Conservation Bonds (QECBs)														X	X	X	
Qualifying Advanced Energy Manufacturing Tax Credit			X	X	X												
Renewable Energy Production Incentive (REPI)							X				X	X		X	X	X	

Appendix E. Examples of State & Local Incentive Programs

State Incentives
PV Incentive Programs
Tax Increment Financing (TIF)
State tax credit
3rd party solar power purchase agreement (PPA) policies
State Grant
Interconnection Standards
Loan Program
State-wide feed-in tariff (FIT) for renewable energy
Property Tax Incentive
Public Benefits Fund
Production Incentive
Rebate Program
Sales Tax Incentive
Clean-Up Programs
Clean-Up Loans
Revolving Loan Funds
Reimbursement for Orphan Shares
Underground Storage Tank (UST) Clean-up Fund

Local Incentives
Revolving Loan Fund
Loan Program
Tax rebate (Commercial and/or Residential)
Renewable Energy Feed-in-Tariff (FIT)

Additional References

For additional information on state incentives, see the Database for State Incentives for Renewables and Efficiency. This online database serves as a comprehensive repository on incentive programs on a state-by-state basis. In some cases, local programs are also listed, e.g. FIT programs through a specific utility.
www.dsireusa.org