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# Green Remediation Best Management Practices:
# Integrating Renewable Energy into Site Cleanup

Office of Superfund Remediation and Technology Innovation

Quick Reference Fact Sheet

The U.S. Environmental Protection Agency (EPA) *Principles for Greener Cleanups* outline the Agency's policy for evaluating and minimizing the environmental "footprint" of activities undertaken when cleaning up a contaminated site.[1] Use of the best management practices (BMPs) identified in EPA's series of green remediation fact sheets can help project managers and other stakeholders apply the principles on a routine basis, while maintaining the cleanup objectives, ensuring protectiveness of a remedy, and improving its environmental outcome.[2]

## Overview

Use of renewable energy resources provides a significant opportunity to reduce the environmental footprint of activities conducted during investigation, remediation, and monitoring of hazardous waste sites. Substitution of energy from fossil fuel resources with energy from renewable resources is a primary approach for addressing energy as one of the five core elements of green remediation strategies. In turn, lower consumption of fossil fuel will reduce emission of greenhouse gases (GHG) as well as particulate matter and other air pollutants.


*EPA estimates that operation of 12 common cleanup technologies at Superfund sites could consume an average of 631,000 MWh annually between 2008 and 2023,[3] a quantity equivalent to the electricity consumption in about 55,000 homes over one year.[4]*

| Technology | Average Annual Electricity Consumption (MWh) | Average Annual Cost ($)* |
|---|---|---|
| Pump and treat | 490,000 | 52,381,000 |
| Thermal desorption | 93,000 | 9,941,700 |
| Multi-phase extraction | 18,700 | 1,999,030 |
| In situ thermal treatment | 13,000 | 1,389,700 |
| Air sparging | 10,000 | 1,069,000 |
| Soil vapor extraction | 6,700 | 716,230 |
| Ex situ stabilization | 22 | 2,352 |
| Other** | 6 | 641 |
| Total | 631,428 MWh | $67,499,653 |

* Using the August 2010 national average of $106.90/MWh for commercial use

**Including ex situ bioremediation of soil, in situ bioremediation (source), in situ chemical oxidation (source), in situ bioremediation of groundwater, and in situ chemical oxidation of groundwater

Renewable sources of energy for production of electricity or direct power needed for site cleanup can include:

- *Solar* resources captured by photovoltaic (PV), solar thermal, and concentrating solar power systems
- *Wind* resources gathered through windmills to generate mechanical power or turbines of various sizes to generate electricity
- *Geothermal* resources, primarily through geoexchange systems such as geothermal heat pumps or by accessing subsurface reservoirs of hot water
- *Hydrokinetic* and *marine* resources, through the hydropower of rivers and streams or the tidal and thermal influences of oceans, and
- *Biomass* such as untreated woody waste, agricultural waste, animal waste, energy crops, landfill gas and wastewater methane, anaerobic digestion, and algae.

Methane captured from decomposing organic materials in landfills or wastewater treatment can also be used for direct heating rather than for electricity generation. Aspects of using this (ultimately finite) source of energy will be described in EPA's upcoming fact sheet on best management practices for addressing landfills at contaminated sites.

Evaluating the potential for integrating renewable energy at a hazardous waste site to achieve a "greener cleanup" typically involves:

- *Maximizing energy efficiency and monitoring energy demand* of remediation system(s), auxiliary equipment, buildings or sheds, and the supporting infrastructures for a new or existing project [page 2]
- Exploring potential applications for *onsite production of energy* from renewable resources [page 2]
- Conducting a preliminary renewable energy assessment to obtain site-specific information [page 6]
- Conducting a detailed *economic and technical feasibility study* for large or utility-scale renewable energy projects [page 6], and
- Considering *purchases of clean energy* from offsite resources through various mechanisms such as renewable energy certificates [page 7].

*Lighten the Energy Load First*

*Use your energy dollar wisely by beginning with an energy audit and consistently using BMPs for energy conservation and efficiency.*

## Maximizing Energy Efficiency and Monitoring Energy Demand

EPA's *Principles for Greener Cleanups* establish a goal to reduce the environmental footprint of cleanup activities to the maximum extent possible. To achieve this goal, a wide variety of strategies could be employed to *minimize total energy use and maximize use of renewable energy*, as one element of a greener cleanup. General BMPs for energy conservation and efficiency include:

- Retaining in-house experts or hiring a professional auditor to conduct an energy audit of existing systems for treating contaminated soil/sediment, ground/surface water, and air, as well as supporting buildings. A walk-through with an auditor using thermographic equipment, for example, can quickly reveal air loss from heating or cooling equipment. No/low cost energy audits may be available from a local utility provider, and many state or local agencies can assist in finding qualified auditors.

*The Association of Energy Engineers (AEE) offers a directory of professionals certified by AEE in specialized energy areas.*[5]

- Following equipment vendor recommendations for routine maintenance, conducting periodic inspections, and quickly repairing or upgrading industrial equipment such as fans, pumps, air compressors, dryers, and steam units, when needed.
- Periodically re-evaluating existing treatment systems to identify opportunities for remedial system optimization, which could involve changes such as equipment downsizing or shutoff. BMPs for optimizing efficiency of common cleanup technologies such as pump-and-treat (P&T), soil vapor extraction (SVE) systems, and bioremediation are described in other fact sheets of EPA's publication series on green remediation.[6a,b,c]
- Using Federal Energy Management Program (FEMP) energy conservation/efficiency tools such as the FEMP checklist of measures for office settings (including temporary modular or mobile facilities) and suggested processes for procuring industrial equipment.[7,8] Other opportunities for technical and planning assistance to add renewable energy sources at federal facilities may be available through energy savings performance contracts (ESPCs) with the U.S. Department of Energy (DOE).[9]

Increased awareness of a cleanup project's energy consumption often leads to increased use of energy efficiency/*conservation measures*. Project managers are encouraged to routinely track energy use through utility-provided meter readings and tools such as:

- Online calculators or software available from government or non-profit organizations at no cost, such as the NOx and Energy Assessment Tool (NxEAT); EPA offers an online compendium of such tools[10]
- Commercial software products
- A plug-based meter to measure power use of small devices consuming "vampire loads" (when the device is turned off) and connection of these devices to a switchable power strip or "smart" surge protector, and
- An inexpensive whole-building, whole-system, or sub-metering device installed at the electricity meter or service panel to record and display consumption information; this device also can be used to monitor onsite energy production. At the Pemaco Superfund Site in Maywood, CA, for example, an integrated DC/AC system supporting groundwater P&T operations and a roof-top PV array provides real-time data on daily and lifetime energy production, PV array voltage and current, and utility voltage and frequency.

Additional reductions in energy costs can be gained by modifying a treatment system to operate at a heavier load during nonpeak, lower-cost hours assigned by the local utility. This type of system optimization also will reduce loads on the utility grid during peak hours. Other information that can help an organization conduct a self audit of industrial processes is available from the EnergyStar® Program.[11]

*How Clean Is the Electricity at Your Site?*

*The Green Power Partnership offers the PowerProfiler tool to determine air emissions associated with your electricity supplier's particular fuel mix.*[12]

When designing a new remedial system or evaluating options to increase efficiency of an existing system, project managers can also consider offsite energy usage such as the electricity needed to manufacture remedial materials. Doing so may help avoid simply shifting the energy demand from an onsite to an offsite source or substituting one form of petroleum-based energy with another.

## Onsite Production of Renewable Energy

EPA encourages project managers to explore methods for producing energy from onsite resources during all stages of site investigation and remediation. Related BMPs include:

- Using micro-scale forms of renewable energy for small equipment and portable devices
- Implementing small-scale renewable energy systems (typically rated below 10 kW) that provide direct power for selected components of a treatment system, supplement energy drawn from the grid, or meet the power demand of "polishing" technologies
- Designing medium- and large-scale systems that meet more or all of the onsite energy demand or much of the demand over long-duration cleanups; system scaling should account for potential reduction in the demand as cleanup progresses, as well as the possibility to re-purpose the system over time

- Considering utility-scale facilities (rated above 1 MW) that meet onsite demand and/or feed to the grid for offsite use, through partnerships with utility companies and/or independent developers or through full ownership
- Using hybrid systems that produce power from multiple renewable resources
- Designing phase-in approaches that accommodate limited budgets for capital expenses or meet energy demands of activities on uncontaminated portions of a site over time
- Striving for 100% onsite renewable energy sources at remote locations to avoid increased utility loads and costs for grid connection, and
- Capitalizing on financial incentives such as federal or state tax credits and rebates; in some incentive structures, credits may be transferred from ineligible purchasers to eligible project partners.

## Field Applications

Use of these strategies and BMPs in various scales and combinations is illustrated at several ongoing or completed cleanups. At the GM Powertrain site in Bedford, IN, for example, *micro-scale PV equipment* was used to power weather stations and stream gauge monitors that guided removal actions along a five-mile stretch of contaminated soil. Information collected from both the weather stations and stream gauges was transmitted to an onsite trailer where it was recorded on a computer that operated data logging software. Use of this relatively inexpensive system avoided the need for frequent replacement of batteries or infeasible access to grid electricity at remote offsite locations. Solar-powered equipment such as this also could be used during site investigation, remediation feasibility studies, and monitoring of long-term remedial work.

The Lake City Army Ammunition Plant near Kansas City, MO, offers an example of *integrated units* comprising commonly used remedial equipment along with a renewable energy source. Five solar-powered skimmer pumps were used to recover approximately 200 gallons of non-aqueous phase liquid from depths reaching 180 feet. Each unit, which cost about $6,000, included a 65-watt PV panel and a vacuum/canister pump assembly. The recovery system fully operated off-grid and could be transferred from one well to another, as needed.

*Small-scale renewable energy systems* can be designed with or without intertie to the utility grid. Off-grid SVE at the former Ferdula Landfill in Frankfurt, NY, relies on a wind-driven vacuum process rather than electrically powered air blowers. Over the initial five years of operation, concentrations of target volatile organic compounds (VOCs) decreased by more than 90%. Based on the amount of energy provided by the system's single windmill, the $14,000 capital/installation cost of this wind system was recovered within the first year of operation due to avoided electricity purchasing. Operation and maintenance (O&M) cost for the wind-driven extraction system is below $500 each year. In contrast, the site owner estimates that installation of a conventional, 25-hp blower-driven SVE system achieving a comparable rate of VOC removal would have cost nearly $500,000 and involved an annual O&M cost of $75,000.

Small-scale systems can also introduce renewable energy at sites with limited space or in densely populated areas. At the Frontier Fertilizer Superfund Site in Davis, CA, a $35,000 5.7-kW PV array was installed in 2007 on the roof of a building used for ex situ groundwater treatment. Successful integration of solar energy and availability of American Recovery and Reinvestment Act (ARRA) funding led to 2010 expansion with a significantly larger (68-kW), ground-mounted PV system on 0.5 acres adjacent to the building. The PV system now meets 100% of the remediation system's annual energy demand, which encompasses operation of 16 wells that extract groundwater for treatment in granular activated carbon vessels.

Costs for the new PV system totaled approximately $350,000, which was fully covered by ARRA funding. EPA Region 9 also will receive approximately $100,000 in state renewable-energy rebates to be incrementally dispersed on a monthly basis over five years; these funds will be applied toward implementing the site's 25- to 30-year cleanup plan. Based on a current annual savings of $20,000 (due to avoided electricity purchases) and utility forecasts, the federal government will recover capital and installation costs for the new system in approximately 14 years. Substitution of fossil-fuel generated electricity with the onsite renewable energy is anticipated to reduce indirect emission of carbon dioxide (equivalent) by approximately 119,000 pounds each year over the PV system's anticipated 20-year lifespan.

Some renewable energy systems are designed to *operate on- or off-grid* to accommodate changing site conditions or project constraints. Decisions regarding grid-intertie also may be affected by whether production of excess energy can result in financial benefits such as utility net metering. At the former Nebraska Ordnance Plant in Mead, NE, for example, a 10-kW wind turbine powers groundwater circulation wells used for air stripping and ultraviolet (UV) treatment. The system reduces consumption of utility electricity by 26% during grid intertie mode but can also operate off-grid when needed. Over 15 years, the electricity savings could exceed $40,000. Estimates at the time of wind turbine installation (2003) suggested that a similarly sized system operating fully off-grid would cost approximately $45,000.

Corrective action at the former St. Croix Alumina Plant in St. Croix, VI, relies on a *hybrid system* that employs both solar and wind resources to recover hydrocarbons from groundwater. Since 2002, the system has expanded on a *modular basis* to include:

- Four wind-driven turbine compressors for powering seven pneumatic pumps; four of the pumps are set at the oil/water interface for skimming hydrocarbons, and three are set below the water table for total fluid recovery
- Four wind-driven electric generators (WEGs) to power four submersible pumps and the fluid-gathering system; at an average wind speed of 12 mph, each WEG provides 6.8 kWh/day
- A 495-watt PV system to provide additional electricity for the submersible pumps and fluid-gathering system, and
- Control panels that can draw electricity from either the WEGs or PV panels, or both, as needed.

Use of this direct drive electricity system avoids the need for storage batteries, consequently lowering the project's capital and maintenance costs and avoiding battery disposal. Capital costs (excluding wells and pumps) totaled approximately $50,000, or about 50% of the expected cost for grid connection. More savings were gained through federal tax credits received by the site owner. Each day, the system recovers approximately 113 gallons of free product and 25,000 gallons of groundwater.

At the Summitville Mine Superfund Site in Colorado, a new 36-kW *micro hydroelectric plant* will begin operating in 2011 after three years of construction. The plant will generate electricity for an onsite water treatment facility used for long-term treatment of mining-impacted water of the Alamosa River network. Electricity production will rely on energy of water diverted from Whiteman Fork Creek to the plant, over a 65-foot drop. Construction included installing an inlet structure and 16-inch penstock that delivers diverted water to the plant's turbine at an average rate of 10 cubic feet per second, although flow rates will vary through the seasons.

The water treatment facility uses approximately 1 million kWh of electricity each year to operate at a rate of 1,600 gallons per minute. (Due to snow buildup on nearby and onsite roads, the site typically shuts down for five months each year.) EPA Region 8 expects the new power plant to generate approximately 145,000 kWh/year (equivalent to powering about 20 homes) and avoid emission of 120 metric tons of carbon dioxide associated with regional electricity production. This production rate will meet 15-20% of the existing treatment facility's energy demand and is expected to reduce cleanup costs by approximately $15,000 each year due to avoided electricity purchases. Near-term completion of a more efficient water treatment facility is expected to additionally reduce the amount of needed grid electricity.

Integration of renewable energy for site cleanup can also involve *creative partnerships*. Groundwater remediation at the Aerojet-General Corporation Superfund site in Rancho Cordova, CA, for example, involves a public/private partnership among the property owner, the Sacramento Municipal Utility District (SMUD), and an energy developer. Groundwater extraction and ex situ treatment is powered by an onsite 6-MW solar farm. The 40-acre farm meets about 30% of the remediation system's total power demand, including electricity for air-stripping units, UV reactors, and ion exchange vessels treating over 20 million gallons of groundwater each day. Each year, substitution of grid electricity with power generated by the solar farm avoids an estimated 6,000 tons of carbon dioxide, 5 tons of nitrogen oxide, and 4 tons of sulfur dioxide.

Capital costs totaling approximately $20 million are offset by about $13 million in incentives to be provided by SMUD over a 10-year period. Over the project's 25-year life, use of solar energy is anticipated to save more than $10 million in electricity costs. Reuse plans for other parts of the site include residential and industrial properties that could benefit from future expansion of the solar farm.

## Lessons Learned

Based on information shared by project managers experienced in installation and use of onsite renewable energy systems, EPA has identified BMPs associated with *logistics*, such as:

- Carefully planning transport of large and heavy components such as wind turbine blades and nacelles; this can involve state/local permits, schedules for police escorts and suitable weather, navigation of structures such as bridges, and travel on unpaved roads
- Incorporating additional security measures to prevent damage or theft of system components, and
- Instituting clear maintenance plans for solar or wind equipment and auxiliary components such as data loggers (particularly components exposed to weather), forecasting sufficient budgets for the maintenance, and assuring the plan can continue during long-term O&M conducted by state or other organizations; large systems also need advanced plans for future decommissioning.

Other BMPs based on lessons learned relate to *improved remedial system designs and construction* that can better integrate renewable energy:

- Siting a new treatment facility/system to meet renewable energy system needs, even when onsite renewable energy is not used immediately; for example, south-facing orientation of a treatment building would maximize benefits of a future PV system
- Designing treatment systems that operate intermittently (while still meeting cleanup goals) to match renewable energy availability, consequently avoiding the need for storage batteries that typically result in efficiency loss
- Adequately freeze-proofing cleanup components such as groundwater circulation wells during construction, to avoid energy loss in pumps and auxiliary equipment used on a year-round basis, and
- Designing for maximum use of renewable energy to treat air with low concentrations of contaminants; examples include solar-powered flares for low volumes of passive landfill gas, small solar-powered fans for mitigating soil vapor intrusion into buildings, and vent stack-mounted wind turbines to reduce pressure within air stacks and draw soil vapor from beneath building slabs.

EPA also recognizes *general practices in the renewable energy industry*:

- Coordinating early with the local utility when designing a renewable energy system to be tied to the grid, to assure equipment such as circuit breakers and all installation methods meet the utility's standards and maximizes protection of utility lines as well as onsite power lines
- Scheduling sufficient planning time that accounts for operational permitting, availability of preferred installers, and potential backlogs in equipment manufacturing
- Taking advantage of economies of scale; for example, labor costs for installing each unit of a large "surplus energy" system may be lower than for a smaller system
- Considering use of several microinverters rather than a large central inverter for AC/DC conversion, to prevent full shutdown if an individual component fails, and
- Including solar thermal technology as an option, which can be used to heat water needed for industrial systems at a cost typically lower than PV systems.

Results from the Agency's remedial optimization studies indicate that increased use of *geothermal energy* can provide additional project efficiencies. Potential methods for tapping this renewable source of energy include:

- Using geothermal heat pump systems to condition interior air of buildings; these systems rely on a relatively simple ground heat exchanger and heat pump to capture the natural heat (or cold air) in shallow ground, which typically remains at 50-60°F
- Integrating a heat exchange system to capture thermal mass in pumped groundwater prior to treatment (and reuse excess heat generated by P&T processes)
- Using combined heat and power (CHP or "cogeneration") to drive a closed-loop P&T system
- Installing subsurface piping to access shallow aquifers that also can provide a heat exchange system
- Modifying equipment such as standard diesel generators to recover, store, and reuse energy otherwise lost as "waste heat," and
- Installing heat collectors within ground surface asphalt, from where a heat pump can recover and deliver heat to aboveground areas or to contaminated subsurface areas for enhanced biological degradation.

Managers of cleanup projects in the vicinity of suitable feedstock producers can also use *biomass resources* to generate energy. One simple application is the use of electricity generators that are converted to operate on material such as wood pellets instead of diesel fuel. In contrast, DOE's Savannah River Site provides an example of large-scale use of biomass resources. Two new biomass-fueled boilers have replaced fuel oil-fired boilers that support K Area and L Area cleanups. The new boilers operate on 100% biomass consisting primarily of forest logging residue and local wood waste.

More information about renewable energy technologies for remedial actions is available in EPA's *Smart Energy Resources Guide*.[13]

> *EPA's **RE-Powering America's Land** initiative identifies renewable energy development potential on current and formerly contaminated land and mine sites. Online information includes state and national maps displaying these sites and details about related incentives.*[14]

## Renewable Energy Assessments

A renewable energy assessment provides general information about how renewable resources could be used to meet the energy needs of a cleanup. A qualified third-party site assessor can fully analyze the site, its infrastructure, and past records on energy use. Although many assessors specialize in particular technologies such as PV systems, some are qualified to assess multiple resources. At sites where certain technologies are targeted, vendors or installers of these systems may offer site assessments for fees to be credited against future purchasing or installation costs. Yet others may provide no-cost assessment as part of a bidding process, particularly for large-scale projects.

> *The **Midwest Renewable Energy Association** offers an online locator for finding certified assessors.*[15]

Project decision-makers should assure that a renewable energy assessment includes:

- General analysis of the energy demand and additional recommendations for energy efficiency
- Preliminary evaluation of the site's renewable energy resources, which may include multiple sources
- Estimated output of the renewable energy system(s)
- Recommendations on specific locations at which to place the system, and associated site conditions
- An estimated cost range for the system, with a list of specifications or conditions that could influence costs, and
- A list of pertinent federal, state, and public utility incentives applying to the site.

> *Organizations such as the **American Wind Energy Association** and **Solar Energy Industries Association** and local chapters offer hands-on workshops and webinars.*[16,17]

Alternatively, in-house staff who are properly trained in planning and managing renewable energy systems (particularly small-scale applications) can be an asset to organizations that manage or oversee clean-up at multiple sites. Ready access to such experts may reduce the costs and additional time associated with procurement of outside consultants, improve treatment-system optimization efforts, and enhance plans for long-term remedial operations. In-house experts could also help organizations gain efficiencies concerning administrative and technical continuity among sites, including the potential to reuse a renewable energy system no longer needed for its original remedial purpose. During renewable energy resource assessment, specialized activities could include:

- Researching existing data available from DOE's National Renewable Energy Laboratory (NREL), which offers maps, geographical information system (GIS) data, and meteorological ("met") data from U.S. measurement stations[18]
- Investigating access to data that may be available from other organizations who routinely gather information at nearby met towers
- If insufficient data are available, conducting a detailed wind energy evaluation through installation of one or more met towers and interpretation of data collected over 12 months
- Using equipment such as radiometers and sun trackers for precise measurement of solar radiation and using online tools such as PV Watts[19] or RETScreen®[20] to calculate energy production and cost savings
- Integrating geothermal applications in treatment system and building designs
- Designing suitable specifications to include in materials for procuring equipment, installers, or maintenance providers of renewable energy systems, and
- Using software models such as NREL's CREST or SAM to assess renewable energy cost incentives.[21]

More information on assessing solar, wind, water, geothermal, and biomass resources is available from the DOE Office of Energy Efficiency and Renewable Energy (EERE).[22]

> *The **Database of State Incentives for Renewables and Efficiency** (DSIRE) is frequently updated with new information on state, local, utility, and federal incentives available in each state.*[23]

## Economic and Technical Feasibility Studies

A technical and economic feasibility study provides detailed, site-specific information on the potential to install a large or utility-scale renewable energy system. Based on electric load and cost data for existing or in-design treatment systems, the study will evaluate options and help assure long-term cost savings. The study should include:

- Detailed description of the anticipated energy resource
- Estimates of annual energy production
- Annual O&M costs, and
- Life-cycle cost analysis of initial expenses, energy savings, financial incentives, and simple payback.

> *NREL's **Feasibility Study of Economics and Performance of Solar Photovoltaics at the Stringfellow Superfund Site** in Riverside, CA, illustrates the detail involved in renewable energy studies.*[24]

The study also should compare costs and key technical considerations for alternatives such as:

- Continuing to purchase electricity from the existing utility
- Integrating the renewable energy system into the existing electrical distribution system with an appropriation or other available funds
- Integrating the renewable energy system into the existing electrical distribution system under an ESPC or utility energy savings contract, and

- Leasing a portion of the site to a third-party developer for renewable energy production while purchasing renewable electricity through a power purchase agreement (PPA). The Fort Carson military base in Colorado, for example, leases land to the local utility, which in turn supplies electricity to the base at a discount. Capital costs for the site's 2-MW solar farm, which is situated on a new evapotranspiration landfill cover, were paid by an independent developer. In addition to reducing the base's operational costs, installation of the solar farm provided the opportunity to productively reuse areas occupied by the properly capped landfill. Evaluation of the solar energy potential also led to installation of several small, off-grid PV systems for other onsite needs, such as pumping fresh water to drinking tanks for wildlife.

At the Massachusetts Military Reservation (MMR), multiple assessments of renewable energy resources have led to a comprehensive approach for installing renewable energy systems as part of the U.S. Air Force Center for Engineering and the Environment (AFCEE) optimization program. MMR's remediation program involves nine P&T systems (operating at a maximum flow rate of about 17-18 million gallons per day) and a widespread monitoring well network. Annual electricity costs for the treatment systems had reached approximately $2.2 million by 2008.[25] Under the Massachusetts net metering program, AFCEE anticipates a seven- to eight-year return on a $4.6 million, 1.5-MW wind turbine that began operating onsite in December 2009.

MMR completed a follow-on renewable energy study and environmental assessment and subsequently awarded a contract to construct two more 1.5-MW wind turbines. The turbines will collectively offset 100% of the treatment systems' energy use. In addition, NREL is conducting a feasibility study (under EPA's RE-Powering America's Land initiative) on viability of a solar farm at the MMR landfill.

*EPA's **Greener Cleanups Contracting and Administrative Toolkit** provides samples of specifications in service contracts executed by EPA and other agencies to help institute use of renewable energy during site cleanup. The Toolkit also contains related language incorporated in records of decision, consent decrees, and other administrative documents.*[26]

## Purchasing Clean Energy from Offsite Resources

EPA encourages voluntary purchases of clean energy for use at sites where onsite production of renewable energy is technically or economically infeasible or cannot meet the full energy demand of cleanup. Recent NREL studies estimate that the total retail sales of renewable energy in voluntary markets exceeded 30 million MWh in 2009, a 17% increase from the previous year.

Cleanup project managers can work with their utility procurement affiliates to purchase clean energy through a number of options involving electricity generated from offsite renewable resources ("green power") or *renewable energy certificates* (RECs). Also known as "green tags," RECS represent the clean energy attributes of renewable energy production. Sales of RECs accounted for approximately 62% of the clean energy market in 2009.

In many cases, green power equal to all or a share of a project's energy needs can be purchased directly from a utility through a ***green pricing program***. A list of utilities offering green power options is available from EERE.[27] In states with restructured electricity markets, renewable energy also is available from ***competitive providers*** of electricity or RECs. Additional information about utility green pricing, green power marketing, and RECs is available from DOE's Green Power Network.[28]

When considering REC purchases, the potential of a purchase to encourage development of new renewable energy projects should be evaluated. To additionally maximize a REC purchase's impact on growth of the renewable energy sector, managers of long-term cleanup projects can consider purchasing RECs as part of a five- to ten-year year contract from a renewable energy project that has not yet been built.

Many renewable energy products in the retail market are certified by independent parties as a means of increasing the credibility of renewable energy and environmental benefit claims. The Green-e Energy program administered by the non-profit Center for Resource Solutions, for example, provides clear criteria for renewable energy products and enables sellers of renewable energy products to voluntarily conform to the program's standard.[29]

*More insight on clean energy is available in the **Guide to Purchasing Green Power: Renewable Electricity, Renewable Energy Certificates, and On-Site Renewable Generation**.*[30]

Additional information, tools, and technical support are available online from EPA's Green Power Partnership, a voluntary program to encourage green power procurement.[31]

### A Sampling of Success Measures for Integrating Renewable Energy into Cleanups

- *Increased substitution of fossil fuels with fuel produced from renewable resources*
- *Lower emission of GHG, as well as particulate matter and other air pollutants*
- *Lower energy costs associated with petroleum fuel consumption*
- *Contributions to state renewable energy portfolios and national goals for energy independence*
- *Reduced loads on utility infrastructures*
- *Reduced environmental footprints associated with utility grid extension and road extension to remote sites*

## Integrating Renewable Energy into Cleanup: Recommended Checklist

**Maximizing Energy Efficiency and Monitoring Demand**

- ✓ Conduct an energy audit
- ✓ Conduct prescribed maintenance and inspections
- ✓ Re-evaluate opportunities for system optimization
- ✓ Track energy consumption through tools such as plug-in meters and whole-system meter devices

**Onsite Production of Renewable Energy**

- ✓ Integrate renewable energy sources at various scales and from multiple resources
- ✓ Pursue opportunities to "scale up" and generate surplus electricity for credit or sale
- ✓ Explore creative financing techniques such as tax credits, rebates, and community partnerships

**Renewable Energy Assessments**

- ✓ Assure preliminary assessments are conducted by qualified personnel
- ✓ Maintain in-house experts to assist with assessment and follow-up purchasing and maintenance of systems

**Economic and Technical Feasibility Studies**

- ✓ Assure a thorough study that includes energy production estimates, O&M costs, and return on investment over the life of a system
- ✓ Examine other options such as energy production that is integrated within the existing utility structure or a PPA

**Purchasing Clean Energy from Offsite Resources**

- ✓ Voluntarily purchase clean energy as a substitute for onsite production or to supplement offsite production
- ✓ Select clean power products certified through an independent third-party program such as Green-e

*EPA appreciates the many document contributions from project managers and others who are integrating renewable energy into site cleanup; contributing practitioners include representatives of EPA regional offices, AFCEE, USACE, and NY DEC.*

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