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PRACTICAL ASPECTS OF SOLAR FARMS ON LANDFILLS

Introduction

Solar farming is increasingly becoming a popular way to efficiently redevelop a landfill site following closure, although it requires long-term planning. Solar farms can provide an attractive reuse for landfills, given that other developments aren't always feasible. Several considerations that must be made before moving forward with planning solar reuse at a closed landfill include the total area of the surface oriented toward the sun, the duration of daily sunlight, proximity to the electric grid, minimum acreage requirements including the slope of the area, and local climate conditions. If those factors indicate that solar power reuse is a good option, then the remaining concern would be installation of the solar panels in a manner that does not damage the landfill cap or impede its performance.

Considerations for Siting a Solar Farm on a Closed Landfill

Administrative and Institutional Control Considerations

Closed landfills are generally administered in either the Resource Conservation and Recovery (RCRA) solid waste and hazardous waste programs. Additionally, there are Construction and Demolition Debris (C&DD) landfills, but those are outside of the scope of this memo. Therefore, activities such as solar farm installations will require some form of authorization. In most cases, an application is required and must be submitted to the Ohio EPA's Division of Materials and Waste Management, along with other local organizations prior to installation. The application is also known as a 513 authorization and should include the facility name, address, description of planned activities, cap maintenance and other operational changes. More information on submitting a request can be found here:
https://epa.ohio.gov/static/Portals/34/document/guidance/gd_631.pdf

Solar farms that are planned to be placed on closed hazardous waste landfills must also have an application submitted to the agency in the form of an amendment to the post-closure plan if the facility is in post-closure. These amendments should be submitted to the Division of Environmental Response and Revitalization. Some closed landfills may also have institutional controls, such as deed restrictions or environmental covenants. The terms of an institutional control may prevent the placement of structures and these restrictions would have to be removed prior to the placement of a solar farm.

A solar farm site also requires a long-term operation and maintenance plan to protect both the solar equipment and the landfill cap. Such a plan will likely include an environmental covenant with the agency and appropriate deed restrictions. As with the cap itself, solar panel installations should have long term financial assurance plans to provide their maintenance and eventual decommissioning. The regulatory issues for transmission and sale of the electricity, as well as zoning and building permits, are a separate matter handled by other agencies.

Engineering Considerations

Landfills are not designed to hold structures or bear continuous vehicle traffic. Therefore, the landfill cap design and the nature of the waste beneath the cap must be considered in siting a solar farm.

The typical cap approved consists of the following (from bottom to top):

- A subgrade of rock and debris free soil, typically 6 to 12 inches thick
- A geosynthetic clay liner
- A flexible membrane liner
- A geocomposite drainage net
- Two feet of cover soil with the top six inches being a vegetative layer to support a grass cover

The solid waste program regulations require a similar cap design, except that the final soil cover thickness would be 30 or 36 inches, depending on the location in the state. Also, a recompacted soil liner (18 inches) might be substituted for the geosynthetic clay liner and a granular drainage layer (12 inches) might be substituted for the geocomposite drainage net. The design rules for RCRA landfills (Subtitle C) are much less prescriptive but would generally require features similar to those of solid waste facilities (Subtitle D). For a solar farm, the most critical aspect of the cap design, regardless of the program, is the final thickness of the soil cover, which supports the photovoltaic arrays.

However, alternate cap designs have also been approved which may consist of clay cover with topsoil or asphalt. The final cap design should be reviewed by professional engineers in the initial scoping study for a solar farm. The waste beneath the cap is also a consideration for a potential solar farm. Wastes may have limited bearing capacity and the placement of structures or access roads may be detrimental to the landfill and to solar panels placed on the cap. The nature of the waste beneath the cap can be obtained from records at the facility or by submitting a public information request to Ohio EPA.

Placement of solar panels must be configured to not allow for penetration into the cover layer to minimize potential threats to human health and the environment. Thus, the support system for the solar panels should ideally sit on top of the cap. If penetration into the cap is necessary, the agency should be consulted during the design stage. A typical mounting for solar panels consists of concrete slabs over a gravel base, as shown in Figure 1. The gravel ballast can be included to promote drainage under the concrete blocks.

Settlement is a potential problem when installing solar panels. Settlement might change the orientation of the panels, reducing their efficiency. For that reason, any proposal for solar panel installation should include a settlement analysis for the landfill. Wind loading on the panels and their mountings should also be evaluated, as well as changes in drainage and runoff during storm events (the solar panels have essentially 100% runoff factors compared with lower values for grass cover). Also, access to the solar panels for cleaning and other maintenance must be considered, including roadways across the landfill cap. Solar panels should not impede operation and maintenance of the gas collection systems. On steeper landfills the effect of the added weight of the panels should be considered in slope stability analyses. Another item to consider during the siting and construction is the potential for gas migration and therefore the need to monitor due to the additional weight of the plans.

Case Study

Ohio has a successful landfill solar farm site at the old Brooklyn Landfill in Cuyahoga County. This system, which occupies about 17 acres of the 75-acre municipal solid waste landfill, generates a peak of 4 megawatts (MW) which is used by the county for its buildings. The solar system could eventually be expanded to generate another 8 MW of power. Figure 2 shows the panel racks during construction. Figure 3 shows a rack with the solar panels installed. The design called for the racks to sit on concrete blocks (9.5 feet long by 3.0 feet wide, 1.0 feet thick), underlain by an aggregate base. The existing landfill cover system consisted of a 33 inch recompacted soil layer covered with a 3-inch vegetative soil layer.

Additional examples of reuse of landfills for alternative energy sources may be found at: *https://www.epa.gov/superfund-redevelopment/alternative-energy-superfund-sites*

Figures

Figure 1. Typical Solar Panel Support Structure for Landfill Application (Ref. 1).

Figure 2. Racks For Solar Panels, Brooklyn, Ohio Site (Ref. 3)

Figure 3. Installed Solar Panels, Brooklyn, Ohio Site (Ref. 3)

References

1. Best Practices for Siting Solar Photovoltaics on MSW Landfills, USEPA/National Renewable Energy Laboratory NREL/TP-7/A30-52615, February 2013. *https://www.epa.gov/re-powering/best-practices-siting-solar-photovoltaics-municipal-solid-waste-landfills*

2. Solar Options for Landfill Cover Systems, Doering, H. and Regalbuto, D., Golder Inc., 2020. *https://www.esd.org/wp-content/uploads/2016/06/Regalbuto-and-Doering-2020-03_05_Solar-Options-for-Landfill-Cover-Systems.pdf*

3. City of Brooklyn Landfill Solar Array Construction, Civil and Environmental Consultants, Inc., July 2018. *https://www.cecinc.com/app/uploads/2020/01/pd_WM_OH_160-285_City-of-Brooklyn-Landfill-Solar-Array_7-19-18.pdf*

4. Rule 13 Authorization Application, Cuyahoga Urban Renewable Power Project, City of Brooklyn Landfill, April 2017. *http://edocpub.epa.ohio.gov/publicportal/ViewDocument.aspx?docid=609307*

5. Slope Stability and Bearing Capacity of Landfills and Simple On-Site Test Methods Atsushi Yamawaki et al, Waste Management and Research, Vol 35(7) 730-738, 2017. *https://journals.sagepub.com/doi/full/10.1177/0734242X17706055*