SOLAR ON CCR: RE-PURPOSING OF COAL COMBUSTION RESIDUAL UNITS

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Abstract

Development of solar PV power generation on former coal combustion residual (CCR) landfills, surface impoundments and basins (collectively referred to as “CCR Units”), as well as decommissioned plant sites is a timely issue for energy development. As the rate of coal-burning power plant decommissioning increases, there is both the need to replace the power generation capacity and the opportunity to repurpose the land. Estimates indicate there are more than 735 active CCR landfills and impoundments in the U.S., and hundreds more that have been retired.

The number of CCR Units and decommissioned plants will increase over the next decade, as more coal power plants are decommissioned or repurposed. CCR Units, averaging 50 acres per unit, represents fallow but potentially productive land at existing power generation stations. Decommissioned plant sites, if properly planned, can be repurposed for solar power by retaining key generation infrastructure. This presents significant opportunity for utilities and solar developers alike to install solar.

Introduction

With the growth of renewable energy development in the U.S., managing land use conflicts between need and perception is becoming increasingly challenging. The best and highest use of property varies widely by geography and community, and the placement of renewable energy assets may not be consistent with long-term land use planning or local preferences. Today, we see many instances of friction between energy developers and the local community, particularly with development of agricultural land.

One possible avenue to reduce this friction and ease land use constraints is to transform environmentally distressed properties into renewable energy host sites. Solar on brownfields, also known as brightfields, is already a popular alternative seeing

increasing development activity. These types of properties/projects can also include battery energy storage systems (BESS), especially on smaller properties in the right electricity markets, and even wind power in some cases. Re-Powering America’s Land (What is RE-Powering | US EPA) is a U.S. Environmental Protection Agency (USEPA) initiative aimed at supporting exactly this type of land use.

Integrating solar PV power generation on brownfields, landfills, and other environmentally distressed properties that do not have a good option for another productive reuse scenario is potentially transformative. Solar power plants may be the only option for some properties that have extremely limited future use, such as landfills and CCR (also known as coal ash) impoundments.

The Opportunity

Current estimates indicate there are 775 CCR basins and 310 landfill units that are closed at this time in the U.S. Hundreds more are active but will be closing in the future as the trend to decarbonize from fossil fuels continues.

CCR impoundments are an opportunity for utilities and other coal-fired power plant owners to repurpose portions of their facilities. CCR storage locations average 50 acres (impoundments) to 120 acres

(monofill) in area. Often, because they are already industrially developed sites, the threshold for natural resources and environmental permitting is lower, and interconnection is usually readily available.

If the CCR owner does not wish to redevelop the location for solar power, third-party developers have an appetite for sites and projects like these. Whether to offset capacity at the existing power plant, or to independently provide power to the grid, CCR Units provide an opportunity for power generation development.

Regulatory Approval

For all covered CCR Units, closure must be completed in accordance with the USEPA Federal Rule (40 CFR 257.102), unless the State has received USEPA primacy approval. Responsible parties must also check on State closure requirements that may be applicable (e.g., Georgia).

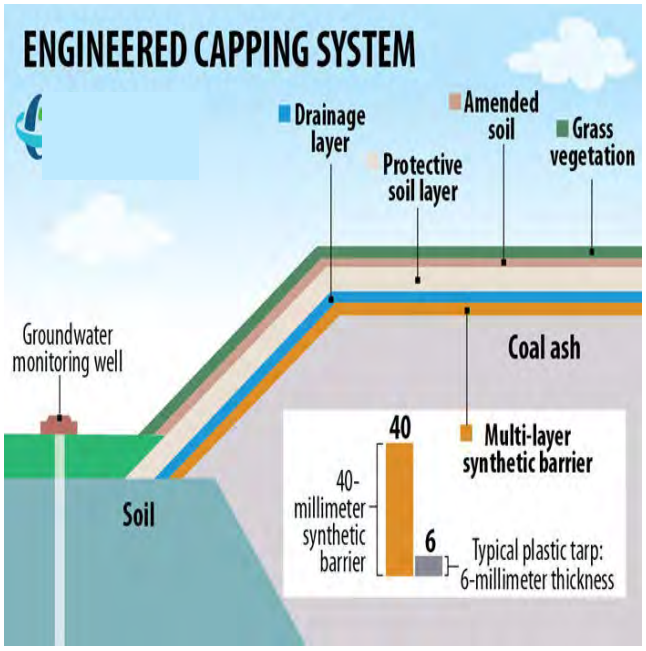
It is important that this closure be conducted in accordance with all applicable rules and regulations to ensure the solar plant can be reliably built on the site and not require removal at a later date to facilitate further closure activities. Dismantlement and temporary removal of even a portion of a solar array will cause significant impacts and penalties under power production contracts.

If the owner of the CCR facility is considering self-developing solar on the facility, a solar generation planning phase should be included as part of the closure activities. Accounting for the future land use during closure allows activities to be conducted in a manner that promotes the reuse on a faster timeline. This provides a quicker, more efficient transition to solar.

Landfill and Impoundment Closure

CCR closure activities when planned for solar repurposing can provide for a sound cover system in a manner similar to those closures that do not. Regardless of the end use, a good cover system is required. Free liquids should be evacuated, and the ash, if left in place, appropriately compacted.

The cover system (i.e., cap) should be low permeability (typically less than $1x10^{-5}$ centimeters per second is desired) and have an adequate drainage layer to prevent unstable conditions in the cover. A soil cover of at least six inches with turf is also warranted.



Source: Courtesy of Duke Energy, 2016

Settlement time period of the newly closed facility is important. Because of the near homogeneity of the material, CCR basins can be compacted and covered with a lesser amount of cap settlement than a sanitary landfill, which allows a quicker use transition. But to verify that the cover system has adequately settled and to protect the future solar array racking, it is reccomended that settlement survey plates be installed in the new cover system and that their elevation be routinely monitored until such a time it is determined the material is stabilized and it is appropriate to proceed with development.

When calculating the stress on the cover system, it is conducted at a depth of 12 inches above the liner.

The Schmertmann Method is used to determine the elastic settlement below the liner from layer stiffness, which should be consistent with the closure plans. The cover system and unit as a whole must be able to bear the solar array's weight without significant additional settlement.

Engineering and Solar Design Considerations

Design of the solar array must also take into account it is being constructed on a closed CCR facility. First, the bearing capacity of the cover system must be sufficient to carry the solar array. This should be considered in the CCR cover system engineering design and executed in construction. In addition, slopes must be stable, and those above 5% grade are usually not considered suitable for development due to stability and sliding risks. It is imperative the solar array not be the cause of a cap failure.

To date, only fixed tilt solar racking is used since there are not yet good ballast systems for tracker arrays. Piers and ground screws to mount the racking on cannot be used, as there cannot be penetrations of the new cover system which would allow the introduction of water into the subsurface and the compacted fill. Ballasted racking is used, and the ballast footprints are designed for the specific cover system's bearing capacity.

Also of great importance, and again should be considered in the cover system engineering design, is the stormwater management. While the solar panels are not considered to be an impervious surface in most States, the stormwater conveyances must account for their presence of potential channeling of flow. In addition, absorption buffers under the panel drip lines may be needed to prevent erosion of the cap.

Other solar design considerations include the cabling pathways (i.e., string lines) – usually provided via cable trays on the ground surface to avoid trenching into the cap – and placement of other equipment such as the array's inverters. Concrete equipment pads must be engineered and constructed similar to the racking ballasts so they 'float' on the cover

system and do not exceed the bearing capacity. Heavier equipment like transformers are usually off-cap.

Construction Considerations

Lastly, the construction methods for placement of the solar array must be consistent with the cover system construction and the regulatory requirements of the closure. Solar development plans for CCR Units include construction plans and methods that protect the cover system, maintaining regulatory compliance.

The proper equipment and its use during construction are necessary to execution. Low ground pressure equipment is used (i.e., less than 7 pounds per square inch), and careful tracking and turning techniques must be employed to prevent cap damage. Turf wear and ruts will occur; these should be repaired as soon as practicable consistent with the existing cover system materials. If required, hand excavation is preferred or the use of toothless buckets.

Ballast systems and equipment pads can either be pre-cast or constructed on-site. Both require some movement of materials by equipment that will wear on the turf cover. The same is true of setting inverters, but much of the rest of construction is conducted manually. Placing these structures on

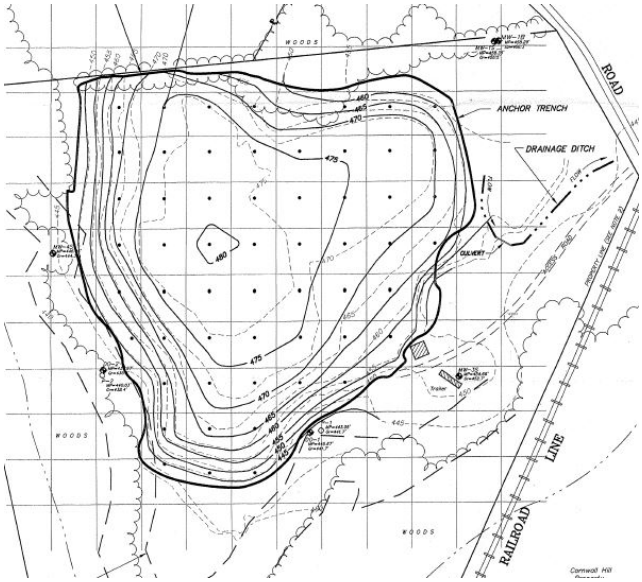
gravel pads above the cover system's surface prevents the need to cut into the cap to obtain grade.

Case History

TRC prepared a conceptual solar redevelopment plan on a CCR pond for a confidential Midwestern utility. The utility wished to use on-site solar to offset a portion of the coal-fired plant nameplate capacity as a means of working toward decarbonization goals. The ash basin in question had just been closed within the past six months.

The pond area was approximately 9 acres. TRC conducted a geotechnical engineering analysis of the cover system to verify it was appropriate to host a solar array. TRC designed a conceptual area on the closed pond cover totaling approximately 3 megawatts (MW).

TRC also conducted a critical issues analysis and prepared a preliminary permit matrix to guide further development planning activities. The plans depicted below and to the right show both the pre-solar construction cover system topography and the conceptual solar array layout. As depicted in the conceptual layout, the steeper slopes of the cap were avoided for panel placement.



TRC additionally recommended the installation of settlement plates in the newly constructed cover system to monitor settlement. We also recommended the use of cable trays for the array wiring and modification of the stormwater conveyances to manage surface flow during peak precipitation events with the solar array in place.

Landfills to Light Source

Currently, closed CCR basins and landfills are especially popular solar development sites. Whether for community solar, investor-owned or municipal utility power generation, or private development and power injection to the grid, these properties are being redeveloped as brightfields across the U.S. While challenging, seeing a completed solar plant on an otherwise underutilized open space is satisfying.