

Two Birds with One Stone – How an Innovative Closure Technology Can Address Coal Ash Closure Requirements and Renewable Energy Mandates

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REGULATORY BACKGROUND

On December 19, 2014, the U.S. EPA issued a pre-publication of a final rule on the disposal of coal combustion residuals (CCRs) from electric utilities. This action confirmed that moving forward, all coal ash, both existing and newly produced, destined for disposal, must be done so in compliance with Subtitle D of the Resource Conservation and Recovery Act (RCRA).

The technical requirements associated with closure in compliance with RCRA Subtitle D can be found in the Code of Federal Regulations (CFR), Title 40, Chapter 1, Part 258, Subpart F, Section 258.60 - Closure Criteria-

“(a) Owners or operators of all landfill units must install a final cover system that is designed to minimize infiltration and erosion. The final cover system must be designed and constructed to:

- (1) Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1×10^{-5} cm/sec, whichever is less, and*
- (2) Minimize infiltration through the closed landfill by the use of an infiltration layer that contains a minimum 18-inches of earthen material, and*
- (3) Minimize erosion of the final cover by the use of an erosion layer that contains a minimum 6-inches of earthen material that is capable of sustaining native plant growth.*

(b) The Director of an approved State may approve an alternative final cover design that includes:

- (1) An infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in paragraphs (a)(1) and (a)(2) of this section, and*
- (2) An erosion layer that provides equivalent protection from wind and water erosion as the erosion layer specified in paragraph (a)(3) of this section.”*

This rule issuance represents a significant development with respect to CCR disposal for many reasons:

- Prior to this rule, there were effectively no federal guidelines or requirements with respect to the disposal of CCRs. Utilities are now faced with aggressive timelines to close existing landfills and impoundments in a way that is far more technically burdensome than what has been done thus far with respect to these facilities.
- The volume of existing CCRs, in both landfills and impoundments, represents a staggering volume that will need to be closed, in some cases on very aggressive schedules. There are over 310 active CCR landfills, with an average size of approximately 120 acres (49 ha), and 735 active CCR surface impoundments, with an average size of roughly 50 acres (20 ha).¹
- The amount of coal ash likely destined for future disposal is expected to remain significant for years to come, leaving an ongoing disposal challenge that will require continuous management. For example, in 2012, there was approximately 110 million tons (100 million metric tons) of CCRs produced in the U.S. With roughly 40% of that being recycled through beneficial reuse activities, that leaves over 60 million tons (54.4 million metric tons) of CCRs being produced annually that require disposal in compliance with the new regulations.²

The federal regulations are complex and introduce complicated timelines with variable implementation schedules. This means utility companies are facing a new challenge that will require the highest level of priority within their organization. In addition, a key component within the guidelines issued by the Federal EPA is that enforcement will be left up to individual states, introducing the opportunity for variability in minimum requirements from state to state. An additional enforcement mechanism identified within the regulations is that of citizen lawsuits, a highly volatile and unpredictable variable to say the least. For a larger utility company, this presents a complex challenge of combining the most cost-effective method to satisfy the requirements within any given state in which it operates, with the needed efficiencies of a standardized approach necessary to satisfy the demanding timelines proposed in the federal rules. A daunting task, no doubt, which necessitates the highest level of attention with the organization. This focus, along with the active support of their critical partners, will be absolutely necessary to ensure full compliance and minimize exposure to underperformance and subsequent penalties.

While CCR disposal regulations, at least at the federal level, are relatively recent developments; renewable energy mandates represent requirements with which these companies have a little more experience, albeit at the state level. Due to the significant targets, at least in some states, they can also require the highest level of attention and focus of resources within the respective organizations.

Requirements for renewable energy generation are issued by states. Some states mandate a renewable portfolio standard (RPS). An RPS is a statutory requirement for electric utilities to source a certain amount of their delivered energy from qualified renewable energy sources or make an alternative compliance payment (ACP). Other states have a renewable portfolio goal (RPG), which is encouraged through policy but not required by law. As of September 2014, 29 states have an RPS and 9 have an RPG; 23 of them have additional provisions calling for solar and/or distributed generation (DG).

Two other regulatory policies are important for solar development. The first is net metering, by which customer-sited generation is credited against their consumption. The second concerns third-party power purchase agreements (PPAs). In such an arrangement, a private developer can build a project and sell the power generation to utility customers for net metering.

Policies and incentives vary widely, both between and within individual states, such as in different utility service territories. Four examples, shown below, illustrate this point effectively^{3,4}:

State: Arizona

RPS: 15% by 2025, 4.5% from DG

Net Metering: 125% of demand

PPA: Some applications

PV Capacity (through 2014): 2069 MW

State: Florida

RPS: None

Net Metering: 2 MW

PPA: No

PV Capacity: 234 MW

State: Massachusetts

RPS: 22.1% by 2020, with 1600 MW PV.

Net Metering: 60kW, 1 MW, 2 MW, 10 MW depending on application

PPA: Yes

PV Capacity: 751 MW

State: North Carolina

RPS: 12.5% by 2021 (Investor Owned Utilities), 0.2% solar by 2018

Net Metering: 1 MW

PPA: No

PV Capacity: 953 MW

Considering the available solar resources, one surprising fact illustrated above is that Massachusetts has significantly more installed solar power than Florida. In Massachusetts, the RPS creates economic incentives for solar and there is no

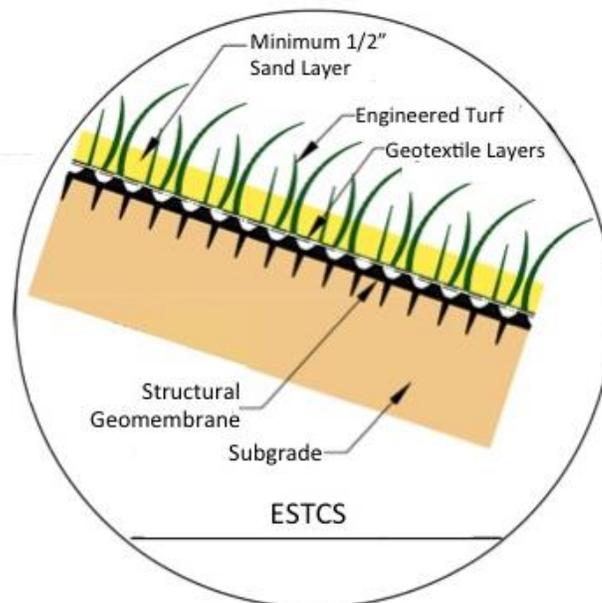
regulatory barrier to entry by private developers. In Florida, a utility would only construct or procure solar power if the cost of generation were competitive with its other sources.

As can be seen, the variability from state-to-state requirements with respect to renewable energy mandates can be dramatic. For a larger utility company with operations in multiple states, this variance can translate into significant logistic challenges from both a resource as well as a strategic planning perspective. Now, add to this mix the newly issued federal guidelines for CCR disposal, which include aggressive timelines as well as the fact that they, too, will ultimately be enforced at the state level. Separately, these two initiatives place significant demands on a utility company at every level of the organization; together, they run the risk of overwhelming the organization's core focus of providing cost-effective electric power to its customers. A solution that offers to synergize these two imperatives should be considered.

INTRODUCTION – ENGINEERED SYNTHETIC TURF COVER SYSTEM (ESTCS)

An innovative solution for final closure of landfills and impoundments that is fully compliant with the requirements of Subtitle D of RCRA has been developed that offers meaningful advantages specific to CCR disposal challenges. The system, which can be categorized generically as an Engineered Synthetic Turf Cover System (ESTCS), is comprised of three distinct components- a 50 mil (1.27 mm) structural geomembrane with a high-friction interface and integrated drainage layer; engineered synthetic turf cover layer, and a sand infill system. A cross-section of this innovative technology is shown below-

Engineered Synthetic Turf Cover System (ESTCS)



The individual components of the ESTCS and their respective functions are shown in bullet-point form below:

- 50 mil (1.27 mm) structural geomembrane –
 - Impermeable layer w/high friction-interface with subgrade.
 - Integrated drainage layer for efficient removal of water.
- Engineered Synthetic Turf –
 - Anchoring of Sand Infill
 - Aesthetics
- ~1/2” (13 mm) Sand Infill –
 - Ballast of the system (~6 lbs per Sq Ft (29.3 kg/m²))
 - UV Shielding of turf substrate
 - Drainage

To date, an ESTCS has received approval for and been installed on over twenty (20) landfills in sixteen (16) states across the United States. A performance-based summary of an ESTCS and Traditional Subtitle D Soil Cover is included in Table 1 (shown below). Based on this summary, the ESTCS exceeds the performance requirements of EPA’s Subtitle D Regulation.

Engineered Synthetic Turf Cover System (ESTCS)	Subtitle D - Prescriptive Cover System	ESTCS Performance Difference
Synthetic Turf with Sand Infill Surface Protection Layer	0.5-ft (150 mm) thick Vegetative, Surface Protection Layer	ESTCS Synthetic Turf Protection Layer will require significantly less maintenance of the final cover. It will provide for easier surface water management, better erosion control, and “clear” (no turbidity) runoff. It also has a 100+ year functional longevity with proper maintenance.
Integrated Drainage Layer in the Geomembrane	1.5-ft (450 mm) thick Infiltration Layer	The ESTCS drainage layer has higher transmissivity and lower water head than a traditional soil cover drainage layer. On account of the lower head, there is less driving force for water to infiltrate through the cover system.
50-mil (1.27 mm) Structural Geomembrane	40-mil (1.02 mm) Geomembrane	The ESTCS structural geomembrane is thicker and stronger. It will provide less punctures / holes, lower permeability, and less infiltration.
Low-Permeability Soil Layer not needed due to elimination of hydraulic head (1/2” versus 24” (13 mm versus 600 mm))	2-ft (600 mm) thick Low-Permeability Soil Layer	A low-permeability layer is not technically required beneath the ESTCS due to the elimination of hydraulic head that exists in the 24” (600 mm) traditional cover system.

BENEFITS – ESTCS FOR CCR LANDFILL AND IMPOUNDMENT CLOSURES

The ESTCS can provide several tangible benefits to CCR closure applications, due to the specific properties of the system, as well as the unique attributes common to these types of projects and the recent, applicable regulations. Specific benefits afforded by the ESTCS for CCR closure projects include:

- **Regulatory Compliance** – The recent regulations, which can be characterized as a “non-funded mandate”, leaves enforcement to individual state’s regulatory agencies. In addition, the EPA specifically identifies citizen lawsuits as an enforcement mechanism as well. This characteristic creates the opportunity for erratic and inconsistent enforcement of the regulations. The ESTCS ensures full and consistent compliance with all applicable Federal regulations relative to final closure requirements.
- **Accelerated Project Schedule** – The consistency offered by a standardized system such as the ESTCS provides efficiencies that can be easily realized, from pre-design through construction. From standardized construction details, to a reduction in site elevation surveys, including the elimination of the typical 24” (600 mm) soil layer across the entire surface of the closure cap. A significantly larger amount of closure acreage can be constructed versus a traditional soil cover, effectively allowing more projects to be constructed with a given set of fixed resources.
- **Economic Advantages** – The ESTCS can reduce the upfront capital costs associated with the construction of the final cover due to the significant reduction in soil requirements as with a traditional soil and vegetative cover system, as well as the acceleration in construction schedule and reduction in overall resources needed. In addition, the annual maintenance costs for the ESTCS run, on average, more than 90% lower than those for a traditional soil and vegetated cover system.

OVERVIEW – SOLAR PHOTOVOLTAIC (PV) ARRAY INSTALLATIONS ON LANDFILL SITES

Closed landfills have become popular sites to host PV arrays for several reasons. From an economic perspective, land lease rates on landfills are more favorable than greenfield sites. Topographical prominence leads to minimal shading and maximum energy production, whereas non-landfill sites often require tree trimming or removal.

One incentive for communities and governments to favor landfill projects is that they divert installations from virgin land. They make use of a lost resource – land – rather than disturb a forest, meadow, or scrub. Greenfield-sited projects can also face strong challengers from abutters who believe that a PV array is an eyesore. Landfill-sited projects can be considered out-of-sight and out-of-mind. This is especially important in highly developed and dense areas like the northeastern United States.

Incentive programs are shifting to encourage this application. For example, Massachusetts' SREC II program credits landfill projects approximately 15% more for their generation than equivalent greenfield projects. More importantly, landfill projects are guaranteed to receive SREC II qualification, providing a degree of certainty to project stakeholders. Large-scale greenfield projects, however, must queue for qualification. This 'Managed Growth' market sector has 18 projects queued, totaling 62 MW as of March 6, 2015. However, the 2015 allocation is fully subscribed, and only 20 MW will be available for qualification in 2016. Landfill projects do not face this significant market risk⁵.

Landfill projects do present some technical and procedural challenges. Non-penetrating, ballasted racking systems are more expensive to procure and install than penetrating foundations. Also, ballasted systems do not allow for the array to feature tracking. Remote sites will sometimes not have three-phase electrical distribution infrastructure in close proximity.

Obviously, a critical consideration is the geotechnical integrity of the landfill. Many agencies will require a review for a post-closure use permit. This creates another disadvantage in that many landfill projects require costly and time-consuming site work to prepare the vegetative cover and/or additional substrates to host the array. For example, gravel may have to be laid under the drip edge of the panels to slow and spread percolation of runoff into the cover.

BENEFITS OF THE ESTCS ON SOLAR PV ARRAY INSTALLATIONS

The ESTCS provides several benefits for solar projects. The system provides standardization of the closure component of a project, reducing site-specific variability from pre-design through construction. This reduces the overall closure construction schedule by at least half in most cases. This predictability and increased efficiency greatly benefit situations where the solar project is being developed before or during that process, as it reduces market and interconnection risk.

Additional site preparation to accommodate a PV project is essentially non-existent with the ESTCS, as it provides a stable and uniform substrate for array installation out-of-the-box. A ballasted racking system is engineered to support the array in local conditions without penetrating the cover.



The superior drainage performance of the system mitigates runoff from the drip edge of the PV panels. The load-bearing characteristics of the ESTCS provide greater geotechnical stability to host the array and also allows for equipment and trucks to be used more liberally in construction of the array.

The ESTCS also eliminates bare spots. Dust from vegetative covers, especially bare spots from shading, can reduce generation. In addition, maintenance activities necessary for vegetative covers create repetitive opportunities for damaging the PV panels. The ESTCS effectively eliminates this maintenance, and along with it the associated damage and subsequent repair costs. Near-zero site maintenance for solar, including reduced dust accumulation, ultimately reduces operating costs and helps maintain greater electrical power generation.

SUMMARY

Utility companies face ever-increasing complexities as they seek to provide cost-effective energy to satisfy growing demand and meet the requirements of new regulations in the form of coal ash disposal requirements and renewable energy mandates. While these two initiatives are very different in their focus, they are similar in that they: impose aggressive time-sensitive targets; vary in their requirements from state-to-state; occupy a meaningful position within the public's consciousness and thereby introduce the unpredictable and influential nature of public opinion and perception.

The Engineered Synthetic Turf Cover System (ESTCS) provides opportunities to synergize solutions across these two initiatives while bringing significant advantages in its own right both technically and economically.

REFERENCES

[1] EPA Coal Ash Final Rule Webinar Presentation Slides (March 4, 2015)

http://www2.epa.gov/sites/production/files/2015-03/documents/ccr_webinar_slides_508.pdf

[2] Ibid

[3] North Carolina Clean Energy Center, Database of State Incentives for Renewables and Efficiency, 2015.

<http://www.dsireusa.org/resources/detailed-summary-maps/>

[4] Solar Energy Industries Association

<http://www.seia.org/policy/state-solar-policy>

[5] Massachusetts Department of Energy Resources

<http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/solar/rps-solar-carve-out-2/>