TESSMAN ROAD LANDFILL
SOLAR ENERGY COVER

San Antonio, Texas

2010 Landfill Re-Use Excellence Award Nomination

Client: Republic Services, Inc. | Phoenix, AZ
Program/Facility Nominated:

Solar Energy Cover System - Tessman Rd Landfill

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Nomination submitted by (if different than information listed above):

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If selected for an award, how would you like the name of the organization to read on the award (limit of 50 characters)?

Republic Services, Inc. and HDR

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2010 Applications must be submitted to SWANA no later than Friday, April 2, 2010

*** PLEASE NOTE THAT ENTRY REQUIREMENTS HAVE RECENTLY CHANGED ***

See the attached Entry & Eligibility Requirements sheet for further information

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The Tessman Road Solar Energy Project represents the first design and installation of a solar landfill capping system, integrating modern photovoltaic technology with a landfill closure.

Executive Summary

The transformation of a portion of the Republic Services-owned Tessman Road Landfill outside San Antonio, Texas, from a landfill closure into the first-in-the-world landfill renewable energy park created a “solar moment” in solid waste management. This project represents the first design and installation of a solar landfill capping system, integrating modern photovoltaic technology with a landfill closure.

This innovative capping system allows a closed landfill to generate revenue while eliminating the ongoing maintenance costs of mowing and soil replacement associated with conventional Subtitle D caps. With this technology, long term care has a new positive economic and sustainable component that may change the way landfill closures are approached in the future.

The solar energy cover harvests solar energy while safely capping a landfill in accordance with all regulatory requirements. Building a solar park on a closed landfill is an ideal secondary use for land with limited potential for redevelopment and accomplishes more than many more complicated energy systems – efficient containment of potentially thousands of tons greenhouse gases while generating hundreds of megawatts of renewable solar electricity.

The solar energy cover offers built-in and affordable opportunities for truly beneficial secondary use of waste disposal facilities – a classic “lemons into lemonade” solution.
1. Design & Construction

The Tessman Road Landfill is an operating municipal solid waste landfill located outside of San Antonio, Texas, owned and operated by Republic Waste Services, Inc. (Republic). HDR Engineering Inc. (HDR) was hired to provide engineering design services to modify the existing closure design for a portion of the landfill that had reached its permitted final grades. Republic’s directions to HDR were to redesign the current closure system to incorporate an innovative geomembrane cover system that would serve as a superior closure system and provide a mounting system for flexible solar panels. This solar energy cover design project became known as the Tessman Road Landfill solar energy cover.

Designed With Expansion in Mind

The Tessman Road Landfill solar energy cover project was initially designed for installation on 5.6 acres of landfill sideslope on the southern side of the landfill, with ample room for later expansion of the solar covered area. In fact, the permit modification is for a build-out area of over 50 acres of solar energy cover as final cover. The design incorporates 1,050 flexible laminate solar panels mounted on a 60-mil reinforced thermoplastic polyolefin (TPO) geomembrane product. The solar panels are 15.5 inches wide by 216 inches long, with each panel approximately 23 square feet. Overall, the panels cover approximately 24,400 square feet, or around half an acre, about 1/10 of the total area of the solar energy cover permitted area.

HDR engineered the exposed geomembrane solar cap (solar energy cover) to meet all EPA landfill closure requirements while providing a stable surface on which to mount an array of thin, flexible photovoltaic laminates for large-scale renewable electricity generation. For the geomembrane portion of the system, HDR used a roofing material with a long history of successful application and performance characteristics, including UV resistance, seam strength, chemical and puncture resistance and interface friction.

The flexible solar panels selected for this application proved ideal to shift with the landfill surface.

The figure above shows the solar panel array design for the Tessman Road Landfill. By using a secondary geomembrane panel, each sub-array can be built off-site on a geomembrane panel which can then be welded into place on the solar cover. The 5.6-acre solar energy cover project area caps three tiers of south-facing landfill sideslope. There are benches, or relatively flat areas, separating the tiers. The panel layout design includes 35 sub-arrays made up 30 panels each. The panels are positioned to be parallel to the final grade contours. The geomembrane sideslopes on which the solar panels are mounted have an angle of approximately 15 degrees to the horizontal.
as the waste mass below settles over time. Applied directly to the geomembrane atop the landfill, the laminated photovoltaic panels are less than ¼-inch thick and can generate electricity in high and low light and under low and high temperatures, year-round. The system was designed so the solar panels can be easily replaced at the end of their usable life (with a 20-year standard product guarantee).

The solar panels are lightweight, with a distributed load of only 3.6 kg/m² (no point loading). The panels are manufactured in the United States in a low temperature environment with little silicon usage, reducing energy consumption at the front end. The result is a secure landfill cover that provides a stable surface for flexible solar panels.

**Designed for the Long Run**

For the Tessman Road application, the geomembrane material and the adhesive for the flexible solar panels were tested and guaranteed to work together under long-term outdoor conditions. They also were found to be well-suited to a landfill surface environment with machinery traffic. Adhering the solar panels directly to the geomembrane eliminates the need for (and cost of) a racking system to hold the panels. Anchoring the solar energy cover directly into the landfill limits the stress and strain of a design storm event – a great concern for conventional grass-topped landfill closure systems.

The solar panels and their accompanying infrastructure are installed on the exposed geomembrane to produce year-round renewable electricity during the 30-year, post-closure, long-term care period and beyond. The solar panels themselves are guaranteed for 20 years and can be replaced with relative ease when their usable life is expended.

For the Tessman Road Landfill, the solar energy cover design includes a bedding layer comprised of at least 12 inches of intermediate cover, which was in place prior to construction, and a final grading layer used for achieving the prescribed final grades. Before the geomembrane was deployed, the bedding layer was graded and compacted in order to achieve a smooth surface to place the geomembrane with the desired slopes and transitions.

**Designing the Electrical Connections**

The panels of each sub-array are attached to an above-surface raceway that groups the wires before they are connected to combiner boxes positioned at the toe of the slope via conduit located beneath the solar cover in the vertical anchor trenches. The conduit is placed in a continuous sleeve in the anchor trench to prevent infiltration of landfill gas that could migrate into the anchor trench.

The flexible laminated solar panels are connected together in strings to reach the system voltage. The strings are connected in parallel to increase the total amperage. The landfill’s solar energy conversion system consists of the solar array and equipment necessary to take the DC power generated by the solar array through either the utility grid or a battery back-up system. Grid-tied solar energy systems are designed to operate with the electric utility grid. The primary component in the grid-connected solar...
energy system is the inverter, which converts the DC power produced by the solar array into AC power and synchronizes with the voltage and power of the utility grid. The block diagram shown in the figure on the previous page illustrates the solar electricity generation system. The low profile of the solar panels also reduces threat of lightning damage.

**Permit Review and Approval Process**

Incorporating a solar energy cover design into the Tessman Road Landfill’s closure permit required a permit modification application be submitted to, and approved by, the Texas Commission of Environmental Quality (TCEQ). TCEQ’s executive director has the authority to approve an alternative final cover design that achieves an equivalent reduction in infiltration and provides equivalent protection from wind and erosion. The HDR-designed solar energy cover closure system for Tessman Road Landfill was determined to meet and exceed conventional landfill closure design.

**Exposed Geomembrane Materials**

The following criteria were used to evaluate the geomembrane specific to Tessman Road Landfill solar energy cover:

- Resistance to degradation due to exposure to direct sunlight
- Strength to handle wind uplift and potential landfill gas pressure forces
- Durability to withstand walking or low ground pressure vehicles, hail, birds and falling debris
- Compatibility with solar panel adhesion

The selected geomembrane material is a 60-mil flexible polypropylene-based thermoplastic polyolefin (TPO) reinforced with high strength nylon fiber scrim and is manufactured by Firestone Building Products. The scrim reinforced 60-mil TPO is a class of polymer made by polymerizing relatively simple olefins, including ethyl, propylene, butenes, isoprenes and pentenes. TPOs are highly resistant to tears, impacts, and punctures with flexibility to accommodate settlement beneath the geomembrane. TPO has long been used in outdoor roofing applications because of its durability and its long-term resistance to degradation by solar UV radiation. The suitability for the exposed outdoor application is supported by the manufacturer’s warranty on the material performance.

High density polyethylene (HDPE) has been used in numerous exposed geomembrane landfill projects in the United States and Florida. HDPE has been incorporated with photo-oxidants for limited UV protection and has performed well in exposed geomembrane cap systems at sites in Florida. Under some circumstances, HDPE may be a viable alternative to TPO. However, since HDPE membranes are unreinforced they are less resistant to the tensile forces that are imposed on the exposed geomembrane cap with the higher wind speeds. Another important factor is that TPO geomembranes have a much lower coefficient of expansion and contraction due to temperature changes, and can be used in both very hot and very cold climates with very little changes in their physical properties. This leads to another important issue in that it may be more problematic to bond the solar panels to HDPE than to TPO, which has been tested and used with the solar panel adhesive with guaranteed results.
2. Environmental Controls

The Tessman Road Landfill solar energy cover system represents a different and more effective design than the typical and traditional Subtitle D prescribed closure systems. Landfills are typically large brownfield areas not suitable for a wide range of re-use projects. The solar energy cover offers communities facing the need to close a landfill (or a portion of a landfill) long-term environmental and economic benefits. The solar energy cover also offers new opportunities for communities to meet renewable energy mandates while stabilizing the power grid.

The solar energy cover designed by HDR is engineered to outperform traditional landfill closure designs with greater environmental protection at less than half the material cost of a conventional landfill closure. Gas-powered mowing of a traditional grass-topped closed landfill releases harmful carbon dioxide, while differential settlement of the waste mass can lead to isolated saturated soil conditions that can compromise the integrity and stability of a closure system. With that as a backdrop, the idea to create a stable, commercial-scale solar energy park from a closed landfill is truly transformational as we reach for a future based on renewable energy.

The figure below illustrates the difference between the cross-section of a solar energy cover and a traditional final cover design. When comparing a solar energy cover to a traditional closure, what appears to be a missing component (no topsoil or vegetative support layers above the geomembrane) is actually a design strength. The solar energy cover anchors directly into the landfill, whereas a traditional Subtitle D closure drapes the geomembrane atop the landfill, holding it in place with soil layers that shift and erode over time. Landfills are well-suited for solar covers because the sideslopes are angled in a way to achieve high efficiency of sunlight conversion into renewable energy. The solar energy cover can incorporate as many solar panels as a community can afford and is easily expandable to incorporate more panels without additional design or permitting.

The solar energy cover system design takes advantage of the strength and flexibility of the geomembrane material to provide a final cover that is engineered to encapsulate the waste mass. A traditional cover system uses soil to act both as a ballast for the underlying geomembrane and also as a material to support the overlying vegetative growth. However, at many landfills it is difficult to consistently maintain the vegetative cover because of inconsistent weather patterns and severe weather events, which directly lead to an overall loss of top soil materials and organic nutrients.

Over time, extensive erosion can occur and the underlying geomembrane can be unintentionally exposed. Conversely, a solar energy cover is designed for both long term outdoor exposure and specific design weather events. The solar energy cover is anchored directly into the landfill with a
series of horizontal and vertical anchors that strengthen the overall liner system by limiting the stresses and strains the material encounters during a design storm. This design provides a stable landfill cover system that can protect the landfill during storms and wind events for a specific area.

Veneer type slope failures resulting from saturated soil conditions is a critical consideration inherent in conventional landfill closure systems particularly as large regional landfills are covered with traditional earthen and geosynthetic material combinations over relatively large surface areas with long flow lengths. Saturated cover soil conditions can occur for a number of reasons such as changes in flow due to differential settlement, erosion and clogging of the drainage layer. With a solar energy cover system, there are no soil or geosynthetic layers that can slip, slide and pull away from the liner in the event of saturated soil conditions.

Erosion Control and Soil Maintenance
A problem often encountered on traditional closed landfill covers is that major storm events can wash away soil cover material from the sideslopes, creating ruts and channels and potentially exposing the liner. Because the soil cover acts as the ballast to the geomembrane in a traditional design, the eroded material must be replaced, and the impacted area must be re-grassed before the next storm event to prevent further soil loss and a potential cap failure. In contrast, the Tessman Road Landfill solar energy cover designs do not rely on the grass and soils to cover the underlying geomembrane liner.

Rainwater Intrusion: In many traditional landfill caps, heavy rainfall events can increase the head on the underlying geomembrane and increase the potential of leakage of rainwater through defects and into the waste mass. The solar energy cover removes all rainfall that contacts the geomembrane as stormwater and provides no opportunity (time) for the water to pond and build pressure on the geomembrane surface. Stormwater on a solar energy cover system is designed to sheet flow directly into a perimeter drainage channel thereby leaving minimum head on the liner. To handle the increased flow off the geomembrane, perimeter drainage channels can be widened and/or pond storage volumes may need to be adjusted to avoid an increase in predevelopment discharges.

Inspections and Maintenance: The Tessman Road Landfill solar energy cover system can be easily inspected and maintained to ensure that it continues to meet its original design and performance specifications. This is not the case with traditional cover systems in which the upper soil and geocomposite layers do not easily allow for evaluation and repairs of subsurface layers critical for long-term performance. If damage to the geomembrane on the Tessman solar energy cover is discovered, it can be inexpensively repaired without the cost to remove the overlying protective drainage layers and then re-establish the final vegetative cover system.
Implementation of Sustainability
3. Implementation of Sustainability

More than just a win-win situation, the solar energy cover installed for closure at the Tessman Road Landfill is a win-win-win. Solar-capped landfill closures provide a triple play of benefits that includes generating renewable energy, creating a revenue stream and eliminating negative carbon dioxide emissions associated with maintaining (mowing, replacing fill dirt, etc.) a traditional grass-covered landfill cap.

Since it began operating in early April 2009, the solar energy cover system has performed as designed, with an estimated average annual energy output of 130 kilowatts. This capacity can easily be increased by adding more solar panels to the existing project area, which currently only covers 1/10 of available space on the geomembrane. Local and federal tax credits increase the net benefit of the solar energy cover installation. This project is an outstanding example of sustainable investment with a high benefit/cost ratio.

The combined renewable energy from the solar panels and the landfill gas-to-energy system at the Tessman Road Landfill is generating enough power to supply 5,500 homes, with ample room to expand the solar panel-covered landfill surface. The savings to the environment from this combined system equates to removing more than 1,700 metric tons of carbon dioxide per year compared to those same homes using traditional sources of electricity. Landfill owner Republic Services estimates that it could apply this technology to more than 2,300 acres of landfills it owns across the United States, with potential to generate more than 400 megawatts of solar energy while also preventing emissions from millions of tons of greenhouse gases from entering the atmosphere.

The success of the Tessman Road Landfill solar energy cover has sent ripples through the solid waste community. Republic Services is working on two more solar energy cover systems, with plans to move forward on many more acres of landfill underway.

A Solar Park as a “Solar Moment” in Landfill Re-use

The solar energy cover creates a solar park from a landfill in a single closure construction project, transforming a liability into a revenue stream with the following benefits:

- Landfill post-closure care cost savings
- Solar incentives and rebates for project construction
- Solar renewable energy credits
- Sale of renewable power
- Carbon cap and trade credits
- Positive image of sustainability and energy independence

The solar energy cover accomplishes more than many more complicated energy systems – efficient containment of potentially thousands of tons greenhouse gases while generating hundreds of megawatts of renewable solar electricity. The solar energy cover offers built-in and affordable opportunities for a truly beneficial secondary use to the world’s waste disposal facilities.

The Tessman Road Landfill renewable energy park created a “solar moment” for the solid waste industry. The April 13, 2009, issue of *Waste and Recycling News* heralded this innovation as “A Brilliant Cover” after attending the April 2 system dedication ceremonies. The solar energy cover was
The solar energy cover uses high-strength geomembrane materials and flexible photovoltaic panels for the landfill closure. Excess power is sold to local energy provider CPS Energy, which highlights this innovative generation of solar power as part of its renewable energy portfolio on its corporate website.

**Monitoring for Long-Term Outdoor Performance**

The geomembrane component of a solar energy cover has a relatively short history in long-term protection of landfills, with approximately 10 years of data available. However, the geomembrane materials used in landfill applications have been used in other long-term outdoor uses over a longer period of time. For instance, geomembrane materials have been used in long-term outdoor applications in exposed liners for water/wastewater ponds and roofing systems, and have been shown to retain their physical properties over extended periods of outdoor exposure. It is not uncommon for geomembranes used in outdoor conditions to have at least a 20-year manufacturer’s guarantee. The exposed geomembrane material and the adhesive on the back of the flexible solar panels have been tested and guaranteed to work together under long-term outdoor conditions. However, the Tessman Road Landfill solar energy cover project is the first to utilize these materials in a landfill final closure system. Therefore, the performance of these materials may differ from those of previous applications.

For testing purposes, the Tessman Road Landfill solar energy cover design includes 30 small (1 by 2 feet) test geomembrane panels that overlay the exposed geomembrane. Every year, one of these test panels will be removed for testing to determine how the strength of the exposed geomembrane as well as its flexibility parameters compare with original specified values. If these physical parameters decline below the minimum design criteria, then replacement geomembrane panels can be substituted into the system to maintain the design performance.
Public Acceptance, Appearance and Aesthetics
4. Public Acceptance, Appearance and Aesthetics

A solar energy cover landfill closure offers new opportunities for communities to meet renewable energy mandates while stabilizing the power grid and offsetting expensive infrastructure needs. A solar energy cover like that at Tessman can be applied to landfills worldwide, transforming what would otherwise be brownfields into sources of clean, renewable solar energy.

Solar energy from a landfill solar park like Tessman Road serves as a positive visual reminder of the beneficial reuse of a closed landfill. Perhaps one day, solar panels atop closed landfills will be as ubiquitous as wind turbines and a new iconic image of alternative ways to power the world. Project owner Republic Services is so pleased with the results of the solar energy cover that the company has already launched additional solar landfill park projects in Illinois and Georgia and is considering further application at more of its 213 landfills across 40 states.

The Tessman Road Landfill inaugural solar energy cover system was completed both under budget and ahead of schedule. With a construction budget of $1.6 million and actual expenses of $1,568,097, the system went live on March 25, 2009, a week before the April 2 dedication ceremonies.

Republic Services Project Manager Tony Walker says, “The benefits are clear. The Tessman Road Landfill solar energy cover provides a source of renewable energy and moves the landfill closer to energy independence,” adding, “This innovative cover generates revenue for the site and the community through investment, reuse of a commercial property and creation of new jobs, while reducing carbon dioxide emissions. Operation and maintenance costs are significantly less than a traditional landfill closure with a positive economic return from renewable energy generation.”

And It Saves Money, Too

Long-term economic benefits associated with post-closure care of a solar cap compared to a traditional Subtitle D closure are noteworthy. Initial installation costs for an exposed geomembrane closure are less than half the cost of a traditional landfill closure. The cost difference can be made up...
with solar panels affixed to the exposed geomembrane. Post-closure care cost savings are also significant. For a traditionalSubtitle D design, there are mowing, fertilizing, erosion control and cover maintenance costs averaging about a $1,000 per acre per year. However, these expenses vanish with the solar energy cover. A present worth comparison of initial closure and long-term care costs of a solar energy cover versus a traditionalSubtitle D landfill for a 30-year, post-closure care period shows the traditional closure can be almost nine times more expensive than the solar energy cover system.

The price of solar panels continues to fall as production skyrockets, and the landfill solar energy cover provides an ideal location to produce commercial-scale solar energy. Landfills are highly regulated and managed land areas that are self-contained, protected and sloped – an ideal and sizeable surface for application of solar panels and reuse of property that is otherwise unavailable for redevelopment. Transforming a closed landfill into a renewable energy park also displaces the cost to install and maintain soil and drainage layers and the grass cover of traditional landfill closure systems – costs that can climb to tens of thousands of dollars per acre.

**Offering a Sustainable Return on Investment**

The solar energy cover simply makes sense both at current cost and future cost-benefit comparisons with traditional systems, with worldwide application potential. The Tessman Road Landfill solar energy cover project is an outstanding example of sustainable investment, with a high benefit to cost ratio, relatively low risk and great potential to increase energy efficiency and produce green jobs. It will reduce energy consumption and therefore the emissions associated with combustion of fossil fuels.

From a purely economic perspective, a solar energy cover system compared with the cost of aSubtitle D prescribed closure system provides an economic benefit strictly on electricity sales in less time than the warranty period of the system of 20 years. It can be much less. There are a number other forms of credits and renewable energy incentives that may substantially increase the economic benefits and accelerate the break-even timeline. The economic benefit of the solar energy cover continues to increase the longer it is in place.

By creating a power source immune to supply disruption, the solarized landfill cap fosters energy independence. When using a solar energy cover as a modified landfill closure system, a solar energy landfill cap creates a solar park from a landfill in a single closure construction project, transforming a liability into a revenue stream with the following benefits:

- Landfill post-closure care cost savings
- Solar incentives and rebates for project construction
- Solar renewable energy credits
- Sale of renewable power
- Carbon cap and trade credits
- Positive image of sustainability and energy independence

The solar energy cover accomplishes more than many more complicated energy systems – efficient containment of greenhouse gases while generating renewable solar electricity. The solar energy cover offers built-in and affordable opportunities for a truly beneficial secondary use to the world’s waste disposal facilities.
Innovation and Creativity
5. Innovation and Creativity

This project represents the best in ingenuity and cooperation in the business community. Based on successful previous work together, leading solid waste services provider Republic Services, Inc. turned to engineering consultant HDR, Inc. to design a solar energy cover using high-strength geomembrane materials and flexible photovoltaic panels for a closed portion of its Tessman Road Landfill, which serves metropolitan San Antonio. The idea to apply thin, flexible solar panels directly to the surface of a landfill cap seemed feasible. The ability to tie the solar panels directly into an existing landfill gas-to-energy system – common at closed landfills – bolstered the project’s viability. A solar energy cover offers landfill owners the ability to generate revenue to pay for landfill expenses and to sell excess power to local power companies.

The result is the first-in-the-world renewable energy solar park built as a closure component of a landfill that had reached its capacity. The Texas Commission on Environmental Quality approved the solar energy cover in October 2008, and construction began in early December. By the end of March 2009, the solar energy cover was operating as designed and reliably and safely producing approximately 130,000 watts of solar energy.

The solar energy cover is also engineered to outperform traditional landfill closure designs at less than half the material cost required to provide environmental protection for a conventional landfill closure. The innovative design of the solar energy cover creates a flexible, durable and stable surface that conforms to landfill surface variations with long-term reliability for both energy generation and environmental protection. Also, the solar energy cover can incorporate as many solar panels as a community can afford and is easily expandable to incorporate more panels without additional design or permitting requirements.

This innovative landfill closure design applies solid science and engineering principles, while capping a closed landfill in an efficient an environmentally responsible manner with the ability to generate commercial scale renewable solar energy. The Tessman Road Landfill solar energy cover addresses two major issues facing the solid waste and energy sectors today:

- A solar energy cover creates a new source of renewable energy, helping communities pave the road to energy independence with creative land re-use, with potential for widespread application on many other types of brownfields.
- Closed landfills produce methane (a greenhouse gas) that requires systems to collect and control the unhealthy emissions. A solar energy cover effectively contains landfill gases and improves performance of landfill gas-to-energy systems.

**Tessman Road Solar Electricity Generation**

An estimate of PV system energy output can be obtained using software from the National Renewable Energy Laboratory (NREL). The default DC to AC derate factor provided by the online calculator was used to develop an annual AC energy output estimate for a fixed array set at 15 degrees in San Antonio, Texas. The result was approximately 182,319 kWh for an array rated at 134.4 kW (DC). A multitude of factors influence solar energy power output (both instantaneous power and annual energy). Soiling and dust build up can affect energy production. Given that this design is in a semi-arid environment at an industrial site, the potential for dust build-up and other soiling does exist. Other factors that can affect the solar array output of this design include wiring, inverter selection, diodes and connections, and PV module nameplate DC rating.
The Tessman Road Landfill solar energy cover has provided tangible evidence to local citizens that Republic Services and the local power utility are committed to the long-term environmental and energy portfolio of the community. The Tessman Road solar energy cover has been recognized by the engineering and renewable energy communities as an innovative breakthrough.

Using an estimated cost of $0.089 per kWh, the Tessman Road Landfill solar energy cover project is expected to generate approximately $16,200 per year in renewable energy sales, an amount that can be increased by adding more solar panels to the existing project area or by expansion of the solar energy cover while maintaining the 5 percent area coverage.

Local and federal tax credits can increase the net benefit of the installation. For example, the federal government recently extended the Section 26 USC § 48 business solar investment tax credit (ITC) of 30 percent through December 31, 2016. The Texas Tax Code (Title 2, Subtitle F, Chapter 171.107) allows a corporation to deduct the cost of a solar energy device from the franchise tax in one of two ways: 1) the total cost of the system may be deducted from the company’s taxable capital; or, 2) 10 percent of the system’s cost may be deducted from the company’s income. Locally, Austin Energy offers a rebate to residential and commercial customers meeting program requirements.

Gaining Recognition

The Tessman Road solar energy cover has been recognized by the engineering and renewable energy communities as an innovative breakthrough. The project received the following recognitions in 2009:

- Selected by the Texas Council of Engineering Companies as Gold level winner in the Environmental category for its 2010 Engineering Excellence Awards
- Selected as a finalist in the Renewable Energy Technology Innovation of the Year category for the Platts Global Energy Awards.
Landfill Utilizes First-of-Its-Kind Exposed Geomembrane Solar Cap

FOR landfill owners, finding a way to reuse their properties once the landfill reaches final grade can be a challenge. Many have begun harvesting methane gases produced by the waste as a means to produce energy from the otherwise useless land. But one landfill outside of San Antonio, Texas, is taking it a step further and generating another kind of energy—solar energy—by utilizing a unique exposed geomembrane solar cap design.

Republic Services, Inc., headquartered in Phoenix, Arizona, owns 213 active landfills in multiple states, including the Tessman Road Municipal Solid Waste Landfill near San Antonio. Republic has been a pioneer in the field of landfill innovations for many years, and the Tessman Road Landfill project offered an opportunity to explore a new way to reuse the land.

When a 5.6-acre section of the 600-acre landfill site located in an arid, windy area with bad soil reached final grade in 2008, Republic worked with its engineering design firm, HDR, Inc., Jacksonville, Florida, to redesign the current closure method. Instead of the traditional grass-covered composite final cover system, the new design would incorporate an innovative exposed geomembrane cover system that would serve as a mounting system for flexible photovoltaic panels.

“The system design required a lightweight solar collection panel that could be directly applied to a specially formulated, reinforced membrane,” said Tony Walker, project manager for Republic and inventor of the solar energy cover. “It was essential that the membrane be reinforced because it would remain exposed to extreme climatic conditions and potential animal traffic. The membrane also needed to offer decades of performance with minimal maintenance, provide superior containment, stability and protection for the environment, and meet the rules and regulations of the Texas Commission on Environmental Quality.”

Product Selection
Republic and HDR reviewed...
different membrane options including LLDPE, reinforced polypropylene and thermoplastic polyethylene. Firestone's 60-mil thermoplastic polyethylene geomembrane ultimately was selected because it met all the criteria for the project. "The thermoplastic geomembrane is thicker than the membranes that have traditionally been used in landfill applications. So, you get thicker, more durable product that still maintains its flexibility, which you don't get with the same thickness of LLDPE," stated Mark Roberts, project manager, HDR, Inc.

The geomembrane was available in the color the owner desired—patina green—in order to provide an aesthetic mask, according to Roberts. "Because the membrane would remain exposed, it was important to Republic that the membrane blend in with the surrounding landscape as best as possible without being an eyesore," he said. "When you see this hillside from a distance, it appears to be well-mowed grass."

Also, the photovoltaic cells that were selected for the application adhere perfectly to the thermoplastic. This was absolutely critical for the project's success. "Most solar panels are rigid, thick, glass structures that are heavy, costly and maintenance intensive. But these lightweight photovoltaic panels are less than 0.25 inch thick and are flexible. They are backed with an adhesive that adheres beautifully to the geomembrane," Roberts continued.

System Design and Installation

The project got underway in mid-December 2008. Republic Services appointed American Environmental Group (AEG), Richfield, Ohio, to serve as the contractor and construction management team for the landfill project. A separate earthwork contractor put down

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a 24-inch intermediate soil cover over the waste, then the soil was graded and compacted with a smooth-drum roller. Next 10-foot by 200-foot panels of 60-mil geomembrane were positioned into place over the intermediate cover.

Seams were fusion welded using a different method than most landfill cap projects, according to Chris Eichelberger, technical manager for AEG. “LLDPE geomembrane seams use a dual track fusion weld, but this reinforced thermoplastic product required a solid wedge weld. The solid wedge weld provides a larger ‘bonded surface area’ and greater strength within the weld. The thermoplastic product supports an increased weld speed, therefore increasing installation productivity and decreasing the overall project duration,” he said.

The AEG installation crew, consisting of 15 members, worked in 60-foot sections across the landfill slope. At every 60-foot interval across the cap, the crew excavated a ballast trench and placed the liner into the trench. The ballast trenches serve two purposes, according to Eichelberger. “First, because this is an exposed cap that will not be covered with soil, placing the liner into the trenches will provide ballast for the membrane preventing it from blowing away or shifting out of place,” he stated. “The second purpose for the trenches was to provide a place for securing the electrical conduit.”

Conduit wires for the solar panels were placed into each trench. Then the trenches were backfilled with soil and covered an additional strip of thermoplastic that was welded to the bottom sheet to produce a safe, dry environment for the wiring and protect the backfill material from wash outs. At the end of each trench, there is a 90-degree sweep that brings the conduit up out of the ground and into a PVC channel in which the wires travel down the slope to a converter. From there, the converted solar power is directed to CPS Energy’s electricity grid, an energy provider to the Greater San Antonio area.

Once the 10.92-acres geomembrane cap was installed—approximately 5.6 acres of which is exposed membrane—it was time to assemble the solar power system, which consisted of a total of 1,050 flexible solar panels.

acres of which is exposed membrane—it was time to assemble the solar power system, which consisted of a total of 1,050 flexible solar panels. AEG performed the installation of the flexible photovoltaic panels to the geomembrane.

The installation crew prepared a flat, smooth work surface, protected from the dust and wind to assemble the solar pods. Three panels of thermoplastic geomembrane were heat welded together and the length trimmed to create a sacrificial sheet 30 feet by 40 feet. The crew then applied a pre-wash chemical to the geomembrane and allowed it to dry before removing the protective tape from the back of the solar panels—each measuring 18 feet by 1.25 feet—to expose the adhesive.

The solar panels were constructed into solar “pods” (groups of 30 solar panels in two rows of 15 each) on the geomembrane and then positioned directly over a ballast trench. “Given the importance of the solar panel positioning to the solar energy cover, a template was constructed and utilized throughout the project to ensure correct orientation. The adhesive backing of the panels is very strong and unforgiving if a mistake would occur during the initial placement,” Eichelberger said. The geomembrane, which then weighed about 900 pounds, was carefully moved down the landfill slope and placed onto the base geomembrane. Finally, the top panel was heat welded around the perimeter to the base panel. These steps were repeated until all 35 solar pods were in place across the cap.

In addition to installing the geomembrane cap and solar panels, AEG also installed 24 passive gas vents across the span of the exposed geomembrane cap. According to Eichelberger, these vents were installed as a preventative measure against gas build up. “The vents will remain closed most of the time and will only be opened by site personnel, if needed.”

Installation Challenges

The installation went very smoothly, but as with most projects there were a few challenges. “We had several days of rain, which is unusual for south Texas in the winter, and we also had five or six days of winds upwards of 50 miles per hour,” Eichelberger recalled. “When working with large sheets of geomembrane, high

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winds can pose a dangerous situation for the crew, so we stopped work during those times.”

A second challenge for AEG was the project coordination. “Most cap installations simply require us to supply and install the various geosynthetic materials. But with this project, we handled the subgrade preparation; the geomembrane installation, excavation and relocation of waste within ballast/anchor trenches; backfill and compaction of the ballast and anchor trenches; gas system modifications; toe drain installation; the installation of the solar panels and electrical conduit; the construction of concrete pads that were necessary for some of the system equipment; and the installation of the passive gas vents,” Eichelberger said. “All parties sharing a common goal and a versatile construction crew assisted in the management, coordination, and successful completion of the project.”

The project was completed on schedule in March 2009.

**End Result Has Many Benefits**

The Tessman Road Landfill will house a 135 kW solar system that will complement the onsite landfill gas-to-energy technology to increase the overall renewable energy output, according to Tony Walker of Republic Services. “Combined, the two systems can alter the productive sites into renewable ‘energy parks’ offering multiple sources of environmentally friendly power production,” he stated. “The clean energy produced by this project translates into a reduction of 109 tons per year in greenhouse gases (CO2), or a reduction of 222,750 auto miles per year, and the two systems are also estimated to generate enough electricity to power 3,500 homes. The solar energy covers also generate revenue for the community through investment, reuse of commercial property and the creation of new jobs.”

The project has been recognized by the Texas Commission on Environmental Quality, and Republic intends to install solar energy covers to additional landfills across the nation, Walker reported. “There are a few considerations that need to be made before moving forward with a system like this,” he said. “They include power grid interconnectivity, solar array orientation and community and regulatory acceptability.”

This unique geomembrane installation was an all-around success according to Eichelberger and Roberts. “The Firestone thermoplastic polyolefin geomembrane was excellent to work with and provided consistent welding properties across the entire project,” Eichelberger said. “The geomembrane serves a very critical role in this application,” added Roberts. “It protects the solid waste from exposure, storm water infiltration and provides a stable surface for mounting the solar panels. This is the first time that flexible laminate photovoltaic cells have been mounted onto an exposed geomembrane cap, so compatibility of materials was essential.”

**For more information, contact Cindy Kun, Gibbs & Bing Public Relations, (847) 319-9150, ext. 2127 or CKun@gibbs-aeill.com.**

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**Land and Water**

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Republic Services Caps Landfill with Flexible Solar Cover
April 2, 2009 9:00 AM ET

First company to integrate solar technology to create energy-producing cover

Innovative Green Venture Turns Landfill Into EnergyPark

SAN ANTONIO, April 2 /PRNewswire-FirstCall/ -- Republic Services, Inc. RSG today embarked on an innovative new venture to greatly increase renewable energy output at its landfills. The company combined a first-of-its-kind solar technology with an existing biogas-to-energy system to turn its Tessman Road Landfill in San Antonio, Texas into a sustainable energy park.

(Logo: http://www.newscom.com/cgi-bin/prnh/20020531/RSGLOGO )

Republic's latest green energy venture will cover portions of soon to be closed areas of active landfills with flexible, laminate-type photovoltaic (PV) solar collection strips developed by United Solar. The flexible solar laminates, which capture the sun's rays for conversion into electricity, are adhered directly to a Firestone manufactured synthetic green-colored geomembrane used to cover and close a landfill as it reaches capacity. Unlike the more traditional rigid solar panels, which are bulky and frequently cost-prohibitive to install, Republic's system uses flexible nonreflective collection strips less than 1/4 inch thick.

The flexible solar strips can be configured to maximize the hours of sunlight exposure throughout the year, depending upon a landfill's design and site contours. For its demonstration project at the Tessman Road facility, Republic will partner with CPS Energy, Greater San Antonio's electric and natural gas provider, to deploy 5.6 acres of the 680-acre landfill with the solar energy cover, attaching over 1,000 Uni-Solar flexible solar strips to the landfill's south facing side slope. Republic and CPS Energy will study and document the results of this solar demonstration project for use in the deployment of solar energy covers on owned landfills throughout the region. Construction on the project, approved by the Texas Commission on Environmental Quality (TCEQ), began in December, 2008 and became fully operational in March, 2009.

"As the nation's largest municipally-owned gas and electric company, we're proud that our
customers' energy bills are among the lowest in the country," said Milton Lee, general manager and CEO. "We are able to do this by providing a diverse mix of fuels and renewable energy sources that combined offer reliable, cost-competitive electric service. Working together with Republic and the Texas Commission of Environmental Quality, we are at the forefront of yet another useful way to tap the energy resources of landfills for the benefit of our customers."

The new solar cover will complement the landfill's existing biogas-to-energy system, in operation since 2002. The system collects and processes biogas, which is naturally produced at the landfill through the decomposition of waste. The solar strips, which have flexible photovoltaic silicon cells that convert sunlight directly into electricity, will complement the amount of renewable energy provided by the landfill.

With over 300 days of sunlight in San Antonio per year, Republic estimates that the energy produced by the two fully-operational systems, will continuously create about nine megawatts of power - enough to power 5,500 area homes.

"As part of our commitment to creating cleaner, greener communities, we're continually researching, developing and implementing innovative technologies to help us preserve and conserve our natural resources," said Ted Neura, senior director, sustainable business planning and development for Republic Services.

"The solar energy cover is easier to inspect, maintain and repair than a traditional clay cap, and is technically superior in terms of odor control and storm water management," said Tony Walker, project manager for Republic. "Geomembrane covers are already in use across the country, but Republic is the first to integrate flexible solar cell technology to create an energy-producing cover system. We look forward to working with state regulators across the country to capitalize on the opportunities provided by landfills and, specifically, our efforts to further the country's energy independence movement through new sources of solar power."

Republic has 213 operating landfills in 40 states across the country. The company's research suggests that as much as 2,300 acres could be covered with solar energy covers, depending on regulatory approvals. That translates into enough solar energy to power up to 47,000 homes per year. Combine that with existing biogas-to-energy technology, and Republic has the potential to generate enough green electricity to power 300,000 homes across the country.

About Republic Services

Republic Services, Inc. has been building on success since its inception in 1998, becoming an industry-leading provider of waste and environmental services. The company provides trash collection services to commercial, industrial, municipal and residential customers in 40 states and Puerto Rico through its 400 collection companies. Republic Services owns or operates 242 transfer stations, 213 solid waste landfills and 78 recycling facilities. The company is headquartered in Phoenix, Arizona and has more than 35,000 employees. For more information, visit the Republic Services website at www.republicservices.com.

About CPS Energy

CPS Energy is the nation's largest municipally owned energy company providing both natural gas and electric service. Acquired by the City of San Antonio in 1942, the company serves approximately 650,000 electric customers and almost 320,000 natural gas customers in and around America's seventh-largest city. CPS Energy ranks among the nation's lowest-cost energy providers, owns the highest financial ratings of any electric system in the U.S. and stands number 1 in wind-energy capacity among municipally owned utilities across the country.

SOURCE Republic Services, Inc.

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**Solar Power Landfill Cover Goes Live in Texas**

By Tilde Herrera  
April 6, 2009

Republic Services Inc. has converted a landfill cover into a flexible solar power generating system in what could be the first of several projects in the South Texas region.

Republic Services and utility CPS Energy capped part of the Tessman Road Landfill in San Antonio with what they call the first-of-its-kind solar energy cover. It consists of a synthetic geomembrane typically used to seal a landfill that has reached capacity. Adhered to the cover on the landfill's south-facing side slope are more than 1,000 flexible strips with photovoltaic silicon cells measuring less than a quarter-inch thick.

"The solar energy cover is easier to inspect, maintain and repair than a traditional clay cap, and is technically superior in terms of odor control and storm water management," said Tony Walker, Republic Services project manager, said in a statement last week.

Landfills are familiar sites for biogas-to-energy power generation, but conventional solar projects at landfills are becoming increasingly common. For example, there's a two megawatt PV array at the Fort Carson, Colo. landfill, while New Jersey's Erie Landfill is slated to become the home of the largest solar energy farm in the state.

Republic Services' solar energy cover spans 5.6 acres of the 680-acre Tessman Road Landfill. Along with a methane gas-to-energy system in operation at the site since 2002, the solar energy cover will generate a combined nine megawatts of electricity. The system began operating last month.

Arizona-based Republic Services and CPS Energy will track the results of the demonstration project in the hopes of constructing others in the area. The waste management company operates 213 landfills in the U.S., and said its research indicates up to 2,350 acres could be suitable for solar energy covers under the right regulatory conditions.

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*Source URL:* http://www.greenbiz.com/blog/2009/04/06/solar-power-landfill-cover-goes-live-texas
Republic Services to Test Solar Covers at Texas Landfill

April 16, 2009

Republic Services, Inc. has embarked on a new venture to increase renewable energy output at its landfills. The company combined a first-of-its-kind solar technology with an existing biogas-to-energy system to turn its Tessman Road Landfill in San Antonio, Texas, into a sustainable energy park.

Republic's latest green energy venture will cover portions of soon-to-be-closed areas of active landfills with flexible, laminate-type photovoltaic (PV) solar collection strips developed by United Solar. The flexible solar laminates, which capture the sun's rays for conversion into electricity, are adhered directly to a Firestone manufactured synthetic green-colored geomembrane used to cover and close a landfill as it reaches capacity. Unlike the more traditional rigid solar panels, which are bulky and frequently cost-prohibitive to install, this system uses flexible nonreflective collection strips less than ¼-inch thick.

The flexible solar strips can be configured to maximize the hours of sunlight exposure throughout the year, depending upon a landfill's design and site contours. For its demonstration project at the Tessman Road facility, Republic will partner with CPS Energy, Greater San Antonio's electric and natural gas provider, to deploy 5.6 acres of the 680-acre landfill with the solar energy cover, attaching more than 1,000 Uni-Solar flexible solar strips to the landfill's south facing side slope. Republic and CPS Energy will study and document the results of this solar demonstration project for use in the deployment of solar energy covers on owned landfills throughout the region. Construction on the project, approved by the Texas Commission on Environmental Quality (TCEQ), began in December, 2008 and became fully operational in March, 2009.

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