Bowerman Power Project
County of Orange, California
Population 3,160,776
Cost per household: $60
Approximate Budget: $60 million

Contact Person: Peter Livingston
peter.livingston@ocwr.ocgov.com  714-834-3703
Executive Summary

OC Waste & Recycling’s Frank R. Bowerman Landfill (FRB) generates methane-rich gas from as many as 11,500 tons of waste that go into the landfill daily and decompose. The common landfill practice of collecting and flaring the landfill gas (LFG) is acceptable but does nothing to maximize the value of this gas, contribute to energy efficiency or improve the environment.

OCWR envisioned turning this landfill gas into renewable energy with a state-of-the-art landfill gas-to-energy facility. The County partnered with Montauk Energy and other industry and government entities to make the facility a reality. Bowerman Power Project became operational in March 2016. It delivers 20 megawatts of renewable energy to Anaheim Public Utilities—enough electricity to serve 14,700 homes.

As project host and source of the fuel, the County receives revenue that will help enable OCWR to continue providing industry-leading waste management services at stable consumer rates.

System History

The Frank R. Bowerman Landfill was opened in 1990. It currently has capacity beyond its anticipated closure date of 2053. The facility encompasses 725 acres with 534 acres permitted for refuse disposal.

FRB is permitted to receive a daily maximum of 11,500 tons per day and must comply with federal, state and local regulations. The landfill is subject to regular inspections from the California Integrated Waste Management Board, the California Regional Water Quality Control Board and the South Coast Air Quality Management District to assure compliance with those regulations.

The FRB landfill generates approximately 5,800 standard cubic feet per minute (scfm) of landfill gas. Before the Bowerman Power Project was developed, the gas was carried to the flare station through buried perforated pipes connected to a vacuum system. OCWR’s well-maintained LFG system provides a reliable source of fuel for a renewable energy project.

The project footprint is 113,000-square feet (2.6 acres) located on a native-soil plateau overlooking the landfill.

Developed by Montauk Energy of Pittsburgh, and hosted by the County of Orange, the project began construction in January 2015. HR Green of St. Paul, Minnesota was the design-build contractor. In a unique arrangement, Caterpillar provided both the engine-generators and $60 million in project financing, creating 60 construction jobs and 7 full-time employees for plant operations. During construction, operations continued at the ninth largest landfill in the U.S.

There are seven Caterpillar internal combustion engines that produce approximately 22 megawatts. The plant delivers 20 megawatts of renewable electricity to the City of Anaheim Public Utilities under a 20 year power purchase agreement, generating 160,000 megawatt-hours annually or the equivalent of serving 14,700 average U.S homes.
The Bowerman Power Project is the first to combine three proven technologies in a state-of-the-art renewable energy project meeting all environmental requirements. It is the largest landfill gas-fueled reciprocating engine project in California and Montauk’s largest power project to date. Moreover, with the completion of this project, all large landfills in California now operate landfill gas-based, renewable energy plants.

**Timeline for Construction and Opening of Bowerman Power Project**

**2011 to 2014**
- Secure permits.
- Secure power purchase agreement:
  - Anaheim Public Utilities
- Secure project financing:
  - Caterpillar Financial Services

**October 22, 2014**
- Board of Supervisors unanimously approves agreement with Montauk Energy to build gas-to-energy facility at Frank R. Bowerman Landfill

**January 22, 2015**
- Construction Starts on $60 million renewable energy plant.

**March 29, 2016**
- Ribbon-cutting ceremony.
- Plant fully operational in April.

**April 2017**
- OCWR begins receiving royalties.

**Design & Construction of the Facility**

The site selected for a landfill gas-to-energy project was based primarily on proximity to the existing flare station (where the main landfill gas header terminated), placement on native soil, distance to the electrical interconnect, visual and noise separation from residents and timeframe before the location would be receiving solid waste. A significant portion of the site had been prepared for a previous landfill gas-to-fuel project that proved uneconomical in a changing marketplace.

By using a site adjacent to the existing flare station and routing of the electrical interconnect in or above an existing roadway, environmental impacts were minimized.

The plant was designed during a historic drought in California. The facility uses water only for a staff restroom. Condensate produced from the compression and cooling of the landfill gas is processed and used for dust control, avoiding the use of potable water largely transported from Northern
California. The design is modular with seven engines, so if landfill gas production decreases, the engines can be relocated to another facility for energy production.

The existing flare station was modified to process the off gas from landfill gas processing, avoiding the expense of a new flare. Since the facility is new, no replacements have been needed.

Environmental Controls and Regulatory Compliance

OC Waste & Recycling performed a California Environmental Quality Act (CEQA) analysis to identify and characterize the environmental impacts of the project. After a public review and comment period, the CEQA document was approved.

Stormwater Control - Due to the design of the areas surrounding the equipment pad with gravel, storm water runoff is lower that before development.

Noise Control – Each engine-generator is housed in an insulated enclosure with a muffler on the exhaust stream. Compressors are covered in a sound-deadening blanket. These measures were taken to insure that the adjacency residential communities would not have a noticeable increase in background noise during the evening.

Water Use – All equipment is air-cooled, requiring no water use. Potable water consumption is limited to the operations staff restroom.

LFG Condensate Recycling – To the extent required by landfill operations, condensate is treated to meet
water quality permit levels and then used for dust control. Excess condensate, such as during rainy weather, is hauled off site.

The overall impact on human health by converting the landfill gas to electricity is positive compared to landfill gas flaring. Using the current generation mix of Southern California Edison, the power plant offsets 86,106 tons of greenhouse gas emissions each year. The Bowerman Power plant uses advanced gas clean-up and emissions reduction technology to meet local, state and federal air quality requirements. In addition, the power-generating operations require no water.

Minimizing emission of air pollutants such as greenhouse gasses (GHGs) and particular matters (PM) resulting from cleanup activities, including those needing fossil or alternative fuel, is a core element of green remediation strategies. The implementation of this new technology allows for a significant reduction in emission.

The plant is capable of processing approximately 11,000 scfm raw landfill gas. While the CO₂ goes through a cleanup process, raw landfill gas that contains a methane ratio of 45-55 is filtered to allow the separation of particulates from liquid droplets.

The compression then boosts the LFG gas to approximately 50 pounds per square inch gauge (psig). After pressurizing, air cooling and refrigeration allows a reduction in temperature of gas and drops it to 40 degrees Fahrenheit, then the condensate is removed.

Across the county, landfill gas projects reduce CO₂ emissions equivalent to 14.2 billion gallons of gas consumed by vehicles.

**Performance, Economics and Cost Effectiveness**

The 20 year contract between Bowerman Power and the Anaheim Public Utilities allows Anaheim to receive electricity from the FRB plant for the stated period of time with $87.40 per megawatt-hour as the first year product price. All is made possible by transferring energy from a MSW form to cleaned-up gas and then eventually electricity for Orange County’s cities.

The power purchase agreement (PPA) between Bowerman Power and Anaheim Public Utilities provides protection from fluctuations in the power market. The agreement includes fixed pricing.

The PPA also requires minimum electricity output and plant uptime to avoid penalties. If the plant is down, the utility will obtain the electricity from another source at the current market price and get reimbursed if the cost exceeds what they would have paid to Bowerman Power.

In addition, the plant has a targeted output of electricity in kilowatt-hours to meet the PPA requirements and revenue goals. Bowerman Power is currently exceeding the targeted output at 103 percent.

The facility is dependent on the quantity and quality of the landfill gas, which varies by season and weather conditions. By analyzing historical patterns, the plant staff can better predict how to operate the facility. For example, plant uptime suffered in 2017 from heavy rains after historical drought
Cost-effective operations are achieved when the revenue from the electricity sales covers the financing debt, O&M expenses and target profitability.

In exchange for hosting the renewable energy facility and providing the landfill gas rights, the County of Orange anticipates receiving $32 million ($1.62 million per year) in royalties during the initial 20-year agreement period, in addition to $1 million annually for operation and maintenance costs subsidies. 60 construction jobs, plus local purchase of building materials and services, and seven full-time employees for plant operations were created as a result of the Bowerman Power Facility.

Worker Health and Safety

Worker health and safety was foremost in the minds of the Bowerman Power Project developers and remains so in daily operations. The County of Orange’s required Health and Safety Plan reinforces the responsibility of Bowerman Power/Montauk Energy to provide safe working conditions for employees and visitors.

Site-specific safety requirements address hazards commonly associated with various work sites. At the Bowerman Power Project, for example, measures are identified to address the presence of landfill gas and its harmful components, including awareness of the location of the gas lines and ways to respond to a potential landfill gas release.

The Injury and Illness Prevention Program, a Cal-OSHA requirement and the cornerstone of the Health and Safety Plan, identifies requirements to ensure a safe and healthy workplace.
Public Acceptance, Appearance and Aesthetics

The FRB Landfill is restricted to commercial operations only and the public does not access to the landfill except for tours. The power plant facility’s location is visually shielded by hills that separate the facility from nearby communities. Nevertheless, the facility was designed to be lower profile, with the highest equipment at a lower height than the existing flares—and be visually pleasing. The new electrical interconnect runs two miles from the plant down the access road into the City of Irvine. Approximately half of the interconnect is run underground in duct banks, to eliminate its visual impact.

Educational tours of the landfill are conducted by OCWR staff on a regular basis. Click here to see an example of the type of materials used for landfill tours. Requests for landfills are frequent (46 tours with 716 participants in 2016) as the FRB Landfill is known for its state-of-the-art design and operation. Tour requests also specify the power plant as a point of interest to be included in the visit.
Innovation and Creativity

During project development, the renewable electricity market price dropped significantly, primarily due to the lower cost of solar photovoltaic systems. In order to make project economically viable, Montauk Energy partnered with Caterpillar to change to a lower capital cost technology while also providing project funding. The initial five gas turbines from another manufacturer were changed to seven Caterpillar reciprocating engines. In addition, Montauk Energy eliminated a dedicated off gas flare by using one of the existing flares to destroy the gas stream from the gas cleanup system PSA regeneration process. Lastly, the five exhaust stacks were combined into a common manifold.

Recently, a potential community issue served as a reminder to landfill staff that FRB’s and Bowerman Power/Montauk’s record of operational excellence is valued by the community. Following a years-long drought and a record rainy season last winter, a coincidence of circumstances caused foul odors in the neighborhood nearest the FRB landfill. Because the homes are more than a mile from the waste disposal area, it seemed unlikely that the landfill or the power plant were the cause. That did not deter the thinking of the residents who believed sincerely that they were smelling garbage—although only at night. And intermittently. It took engaging an odor consultant and robust communication with neighbors, other jurisdictions and homeowner associations to identify the primary cause—a slough that was overgrown with decaying plant material. While not directly related to landfill or power plant operations, OCWR’s resulting collaboration with neighbors, and sincere desire to help the community helped to build trust.
Click the images below to view media coverage from the Bowerman Power Ribbon-Cutting Ceremony.