QCL WATER SCIENCE

SENTRY

Real-Time VFA Monitoring

Advancements in Biogas Production through Real-Time VFA Monitoring and Increased Organic Waste Processing

The Central Marin Sanitation Agency (CMSA) operates an Anaerobic Co-Digestion facility in San Rafael, California with SENTRY sensors located in the feed line and recirculation. The requirement was to identify loading that can cause digester failure earlier than VFA analysis by utilising SENTRY data to optimize loading for increased biogas production.

CSMA wanted to safeguard the AD process and produce more energy through additional organic loading of food waste and FOG to digesters.

Anaerobic digestion has been difficult to monitor and control in real-time because the industry lacked a better alternative to 3-day VFA analyses. Most facilities wait 3 days to find out if there is an issue and are very conservative in organic loading. This lack of reliable and real-time data presents a challenge to operators and does not facilitate frequent digester feeding adjustments.

Figure 1 CMSA wastewater treatment facility

Background

CMSA provides wastewater treatment, disposal, and related environmental services to protect public health and enhance environmental quality for Marin County. CMSA wants to continue to develop resource recovery opportunities to achieve community, environmental, and economic benefits. The facility began planning to upgrade the digesters to allow for co-digestion (taking in multiple feed sources) in 2008.

Over the last decade CMSA has been co digesting external organic wastes such as FOG and food waste in increasingly higher percentages. The goal is to divert as much organic waste from landfills and increase renewable energy production. The challenge for CMSA is to ensure stable digester operations while continuing to increase this organic loading. Conventional monitoring solutions to detect digester upset (for example manual volatile fatty acid analysis) are not real-time and can take up to three days for results. CMSA historically produces over 100% of the facility's power needs, and at times, exports electricity to the grid.

Real-time monitoring of consumable VFA or Biomass Health enables facilities to increase and optimize loading leading to more energy production. CMSA and SENTRY took a three phased approach to optimize digester loading.

1. Place SENTRY sensors in pilot digesters and increase the digester organic loading systematically.

2. Move to the full-scale digesters to monitor variations in loading and the effects on biomass health and biogas production.

3. Use SENTRY sensors to support ongoing optimized loading and biomass health.

In Phase 1, the sensors were able to proactively identify digester stability issues up to three days in advance of conventional VFA testing. This was done in the pilot digesters that were accidentally being overloaded. This allowed for early detection confidence for operators that the sensors would respond to changing conditions in real time. The cost of unforeseen digester failures to CMSA is over $100,000 (per event) so the real-time, proactive SENTRY information adds significant value.

The team then moved the sensors to the full-scale digesters in Phase 2 where they were able to detect responses to various types of loading from the external sources. SENTRY clearly demonstrated the baseline conditions without additional FOG and food waste when CMSA stopped receiving those feedstocks. SENTRY was also able to identify the impact and magnitude of each load on the digesters. This allowed for increasing the organic load 30-50% more off-site organics and have doubled biogas production. The rise in biogas production is equivalent to a significant monetary value.

Figure 2 Sourcing and processing of off-site waste organics for the CMSA digesters

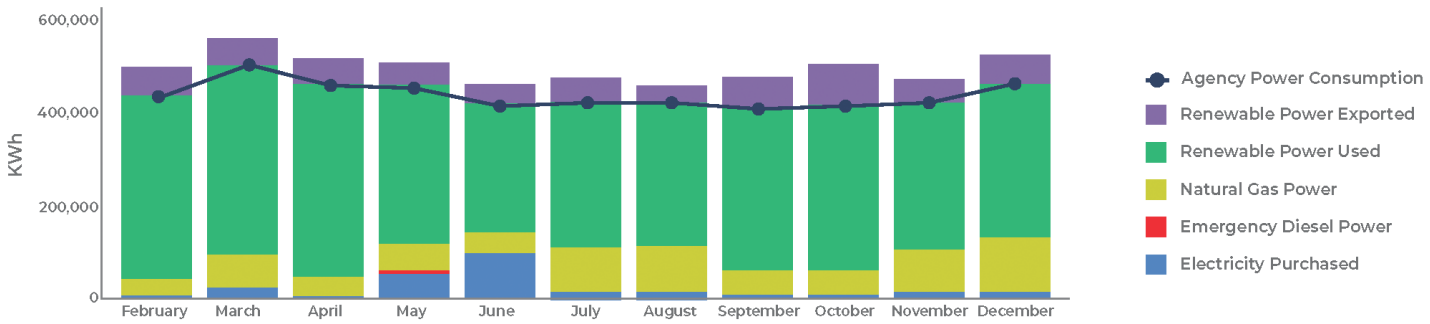

Figure 3 CMSA energy production, consumption and exportation for 2023[1]

Phase 3 Increasing Organic Loading Beyond 50%

In Phase 3, CMSA, in conjunction with researchers at Stanford University, will begin researching a predictive, short term biogas production model based on SENTRY signals and daily digester loading data. The ability to predict biogas production in the short term will help CMSA optimize its renewable power delivery systems. CMSA aims to operate its digesters at significant external organic waste loading percentages (potential to increase above the current 50%) for the long term and having real-time digester health information from the SENTRY sensors is a key part of that strategy.

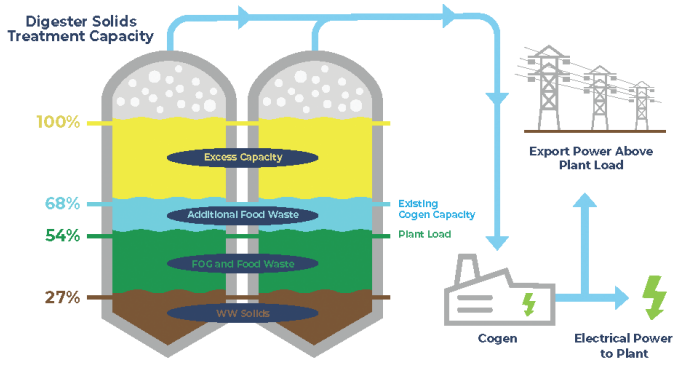

Figure 4 Estimation of organic loading fractions being added to the 2 CMSA digesters

Outcome

Over a three year period, CMSA has increased its reliance on the SENTRY platform to prevent downtime and optimizing loading. SENTRY initially flagged overloading events up to three days before traditional metrics in pilot-scale digesters and provided detailed insight into digester health during feedstock changes. Through working on optimized loading and using SENTRY sensors for real-time monitoring, CMSA is now taking in 30-50% more organic food waste, doubling biogas production. Additional organic loading like this could result in an extra $600,000 in revenue for municipal co-digestion facilities.[2]

During Phase 1, SENTRY initially flagged overloading events 3 days before traditional metrics in pilot digesters and provided detailed insight into digester health throughout feedstock changes. It demonstrated that SENTRY sensors helped prevent upset events that could cost over $100,000 (per event) in downtime. Phase 2 involved using the SENTRY signal to support increased organic loading. CMSA can load 30-50% more organics resulting in doubling the biogas production which equates to significantly increased revenue from energy production.

"With us having only 2 digesters we really can't afford to have a digester upset. Most important to us is minimizing digester disruptions and a second priority is optimizing how the digesters work so we make the most amount of biogas and maximize revenues. SENTRY sensors showed us an upset event several days before our traditional sampling metrics gave us a warning. This several day warning could be the difference between us losing a digester or not"

Peter Kistenmacher, Technical Service Manager, CMSA

1 https://www.cmsa.us/about-us/power-generation

2 This calculation is based on a California electricity price of 19.9 cents/kWh and an average methane content of 67% in the biogas

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