Co-Digestion of Biosolids: Potential Climate Impacts and Operational Lessons from Case Studies

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Goals and Objectives

What is co-digestion?

- Anaerobic treatment of biosolids combined with high-strength organic waste (e.g., food waste, FOG).
- Enhances biogas production, resource recovery, and operational efficiency at WRRFs.

Why air regulators and climate planners should care

- Co-digestion affects air emissions: increases in biogas, H_2S, VOCs, and potential odor challenges.
- Climate implications: biogas utilization can displace fossil fuels but also increases flare loads.
- Permitting relevance: changes in digester gas volume and composition may trigger permit modifications.

•Lessons learned from six facilities

- Case-based exploration of co-digestion practices at six WRRFs.
- Focus on how operational choices shape GHG outcomes and permitting needs.
- Real-world insights to inform policy, regulation, and future program design.

What is Co-Digestion?

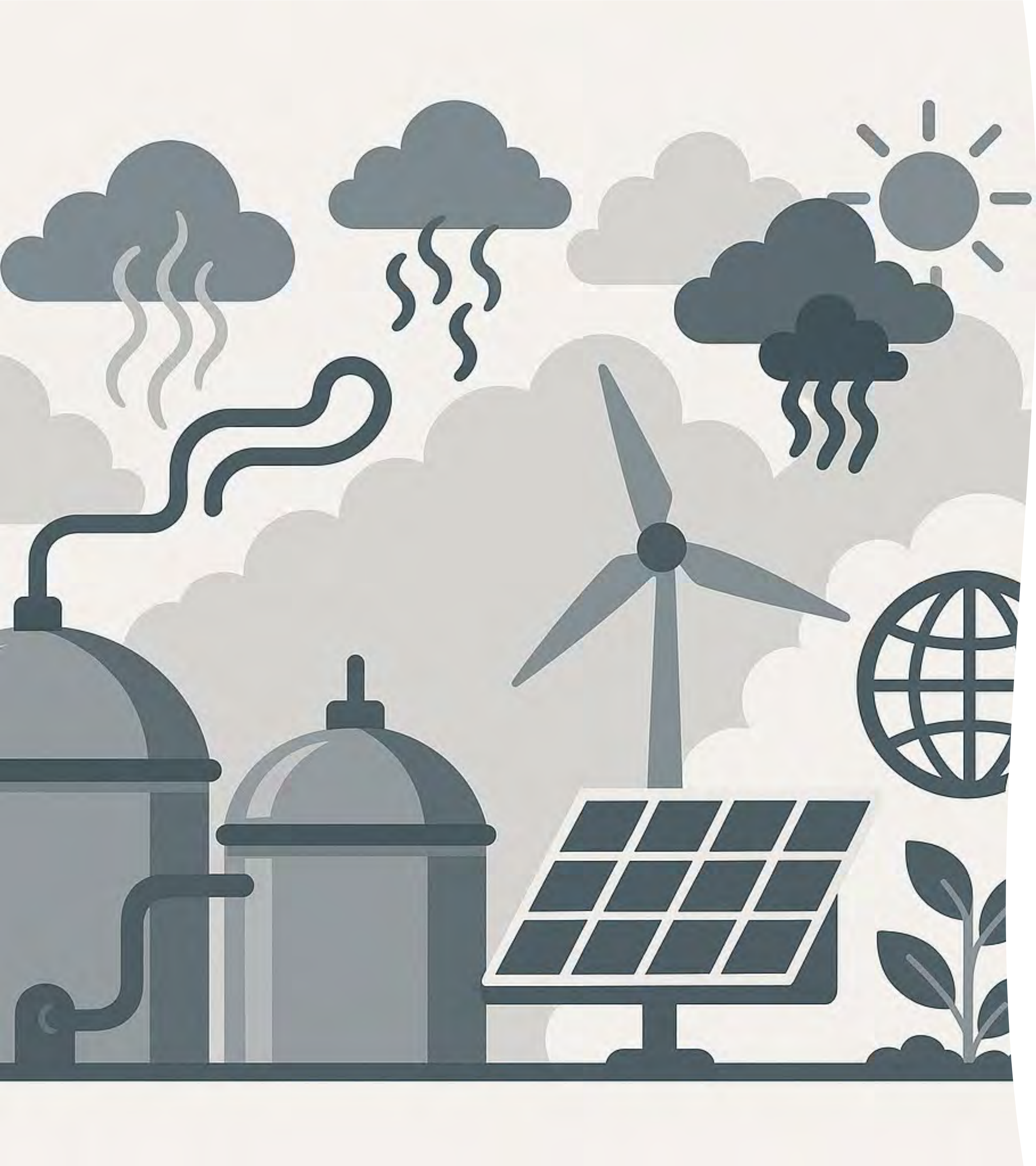
- “Co–digestion is the simultaneous digestion of a homogenous mixture of two or more substrates. The most common situation is when a major amount of a main basic substrate (e.g. manure or sewage sludge) is mixed and digested together with minor amounts of a single, or a variety of additional substrates. The expression co–digestion is applied independently to the ratio of the respective substrates used simultaneously.”[1]

Scientific Benefits of Co-Digestion[2]

- **Dilution of potential toxic compounds** present in any of the co-substrates.
- **Adjustment of moisture content & pH**, ensuring stability.
- **Enhanced buffer capacity**, preventing process failures.
- **Increased biodegradable material content**, improving digestion efficiency.
- **Wider range of bacterial strains**, enhancing microbial diversity.

Practical Benefits of Co-Digestion[3]

- **Enhanced Biogas Production** → Increased renewable energy generation.
- **Waste Diversion from Landfills** → Reduces organic waste disposal.
- **Greenhouse Gas Reduction** → Lowers methane emissions.
- **Operational & Cost Savings for WRRFs** → Reduces treatment costs & increases revenue.



The Air & Climate Nexus

Sources of GHGs in WRRFs

- Anaerobic digesters produce methane (CH_4) and carbon dioxide (CO_2) as part of normal digestion.
- Nitrous oxide (N_2O) emissions can occur during nitrification/denitrification or from biosolids handling.
- Flaring unused biogas contributes to CO_2 emissions.
- Leaks and off-gassing can release un-combusted CH_4, a potent G

How Co-Digestion Changes the Picture

- Biogas production = more renewable energy if used, but may:
  - Overwhelm flare capacity or engines if not planned.
  - Increase off-gas CH_4 if containment is poor.
- ↑ **Sulfur content in food waste or FOG** → elevated hydrogen sulfide (H_2S) → corrosive, odorous emissions.
- ↑ **Volatile organic compounds (VOCs)** → triggers odor complaints, air quality permitting needs.

Emissions Management Challenge

- Regulatory pressure is growing to quantify and reduce net GHGs.
- WRRFs must evaluate:
  - Flare vs. cogeneration balance
  - Odor/VOC controls (e.g., scrubbers, carbon filters)
  - Air permitting updates under state implementation plans (SIPs)

Regulatory Drivers in NJ

Co-Digestion = Cross-Permit Challenge

Regulatory drivers behind co-digestion adoption

- **Food Waste & Organics Diversion Laws:**
  - **NJ:** Food Waste Recycling and Food Waste-to-Energy Production Law [4]
- **New Jersey – Priority Climate Action Plan (PCAP, 2023–2024).**
  - Developing better GHG accounting for municipal operations.
- **Biosolids and Air Quality Regulations:**
  - **NY:** New York has developed specific guidelines for the management of biosolids under 6 NYCRR Part 361.

Regulatory Interplay for Co-Digestion

40 CFR Part 503 – Biosolids Rule:

- Regulates land application of digested solids.
- Co-digestion can change:
  - Volatile solids content
  - Pathogen & vector attraction reduction
  - May affect eligibility for land application or require further treatment..

Air Permitting Challenges

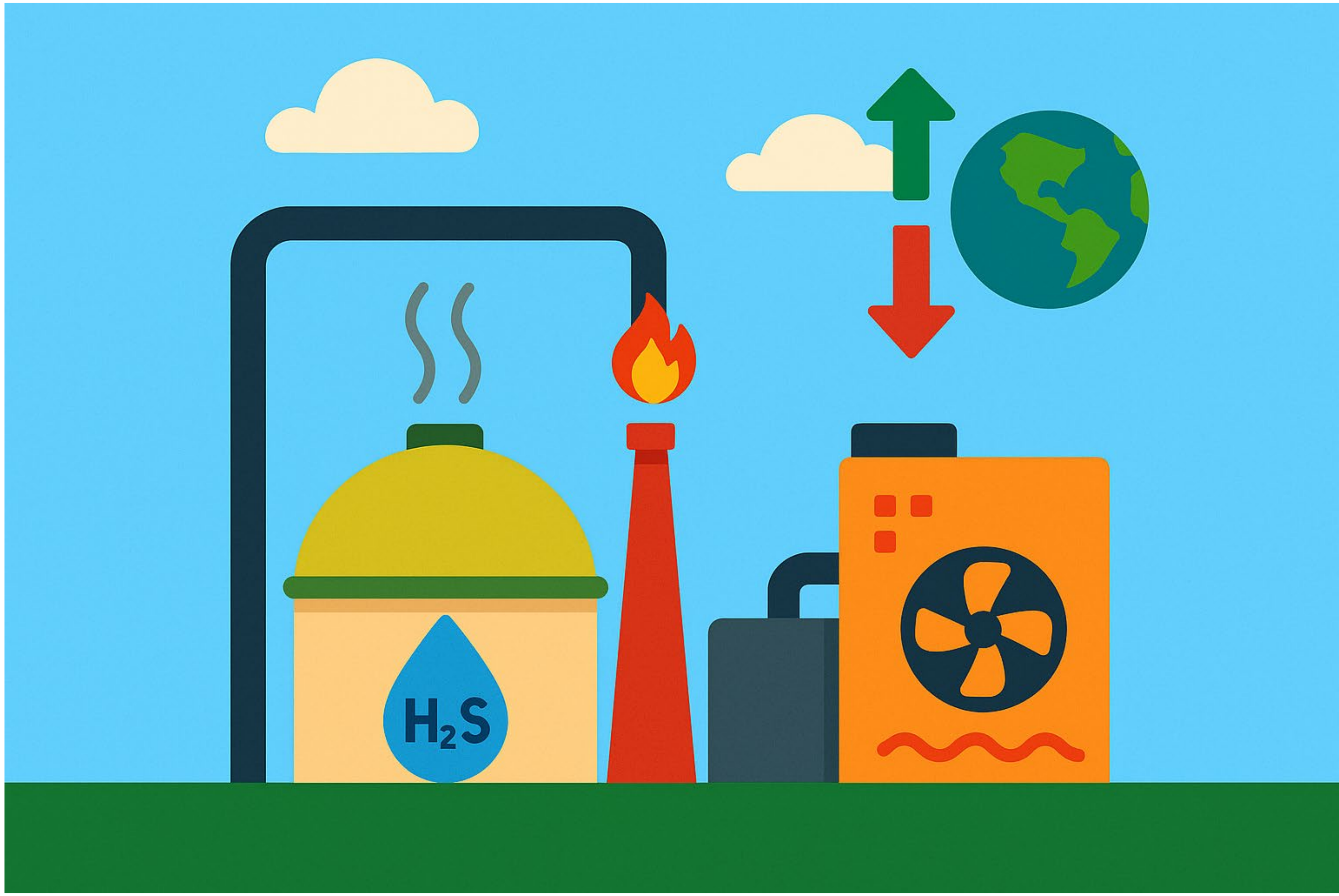
- **Odor and Air Pollutant Emissions**

- Co-digestion introduces high-strength wastes that may contain sulfur compounds (e.g., from FOG or protein-rich food waste), which are converted to hydrogen sulfide (H_2S) in digesters.
- Result: Need for odor control equipment, often including scrubbers, carbon filters, and sealed receiving stations.
- Facilities may also need to monitor and report volatile organic compounds (VOCs) due to increased biogas volume.

Air Permitting Challenges

Biogas Handling and Flaring vs. Energy Recovery

- Increased biogas production challenges existing flare capacity.
    - Uncontrolled or excess biogas must be flared, contributing to GHG emissions and possibly requiring flare permit updates.
- Facilities seeking to beneficially use biogas (e.g., for combined heat and power or renewable natural gas) must often undergo air permit modifications for:
    - Increased combustion volume
    - H_2S and siloxane removal
    - CHP engine or boiler emissions



Air Permitting Challenges

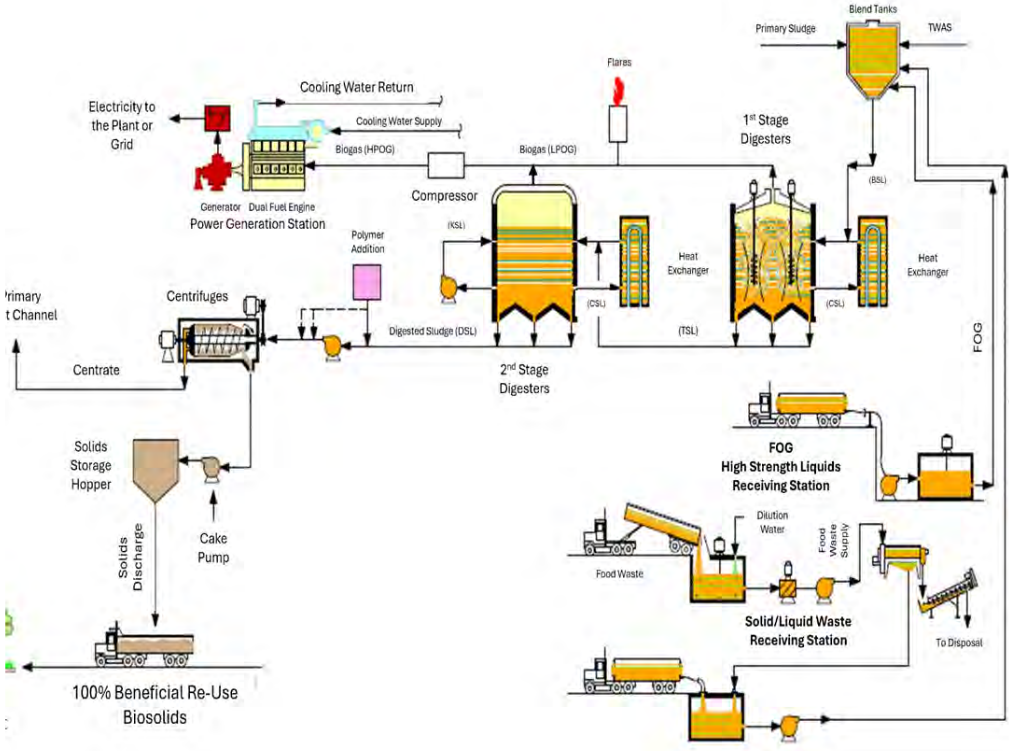
Permitting Bottlenecks

- Air permit modifications can limit the scale of co-digestion due to capped emissions.

- Some states require pre-approval of any changes to:

  - Gas combustion systems
  - Odor/VOC emission rates
  - Emergency venting protocols

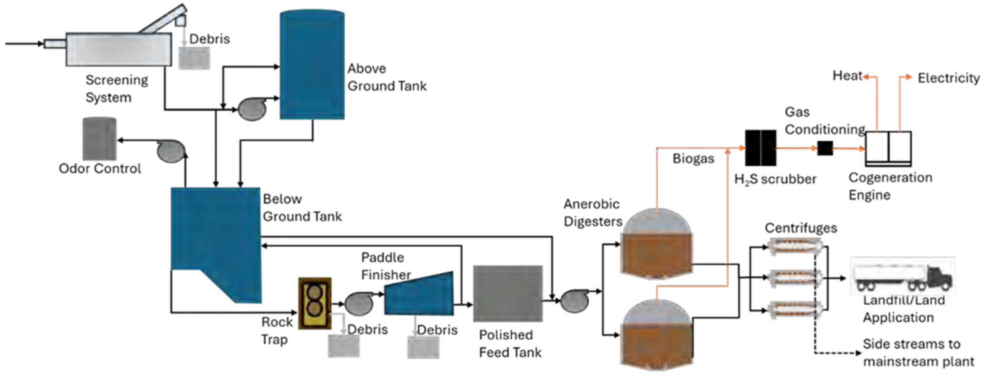
- Lack of clear permitting pathways for co-digestion-specific upgrades can delay implementation.



Case Study 1 – East Bay Municipal Utility District (EBMUD)

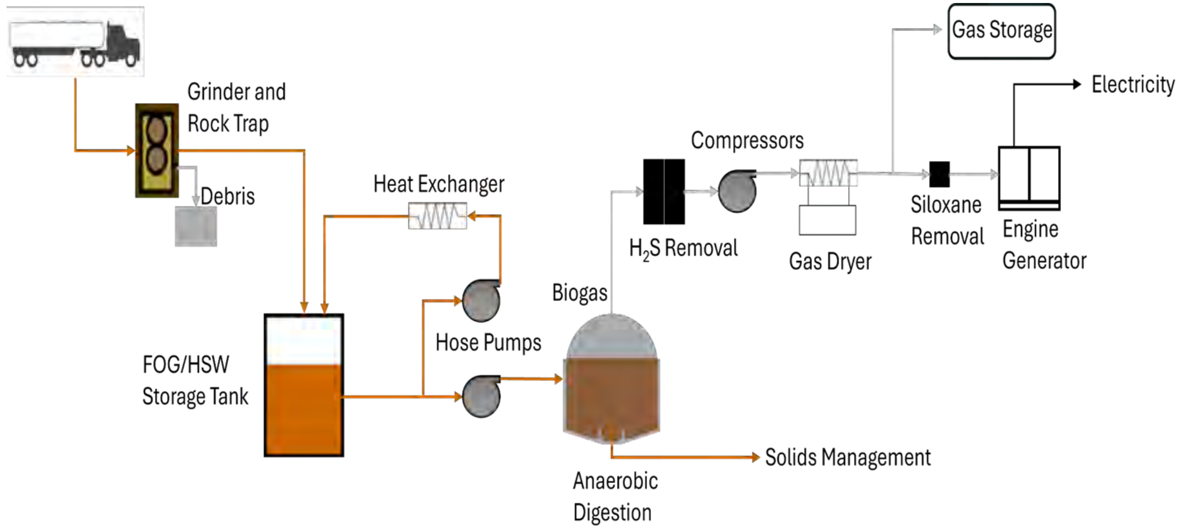
- **Location:** Oakland, CA
- **Regulatory Insight:**
  - **Careful permitting & waste monitoring** required for co-digestion.
- **Key Success Factors:**
  - **Revenue from tipping fees** ($16M annually).
  - **Software solutions** for tracking waste acceptance.
- Beneficially reusing the biogas produced from HSW can become challenging as it can be significantly more variable with a high fraction of HSW in the feed. EBMUD experiences both a daily and a weekly fluctuation in biogas flow as HSW generators typically follow a normal working schedule (Monday to Friday).

Case Study 2 – Central Marin Sanitation Agency (CMSA)



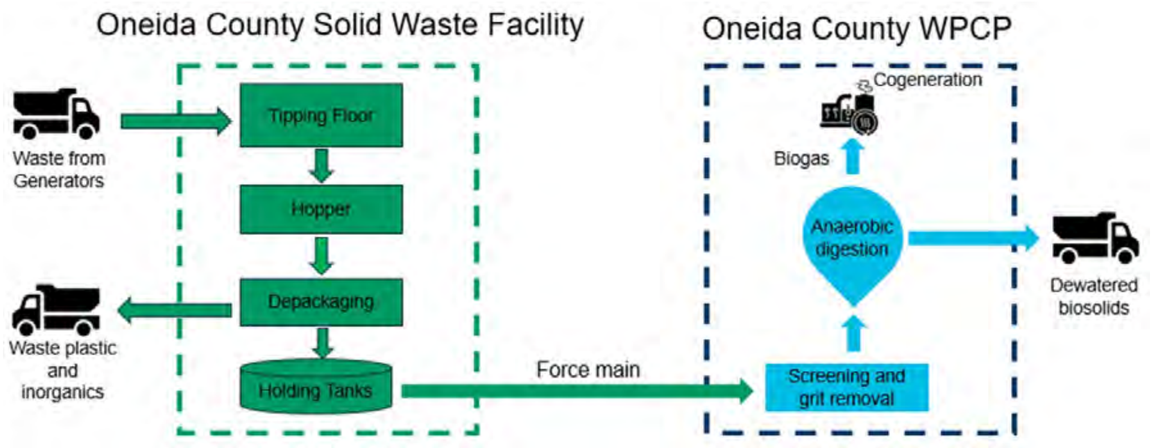
- **Location:** San Rafael, CA
- **Regulatory Insight:**
  - Compliance with **SB 1383 (California's Organics Diversion Law)**.
- **Key Takeaways:**
  - **Quality control & contamination prevention** through **pre-processing**.

The existing biogas treatment system consists of two (2) hydrogen sulfide removal vessels, gas compressors to pressurize biogas, a gas conditioning system that consists of two (2) chillers and a heat exchanger to remove moisture, and carbon media vessels for siloxane removal. Once pre-treated, the biogas is sent to a 995-kilowatt CHP engine to generate electricity and heat.



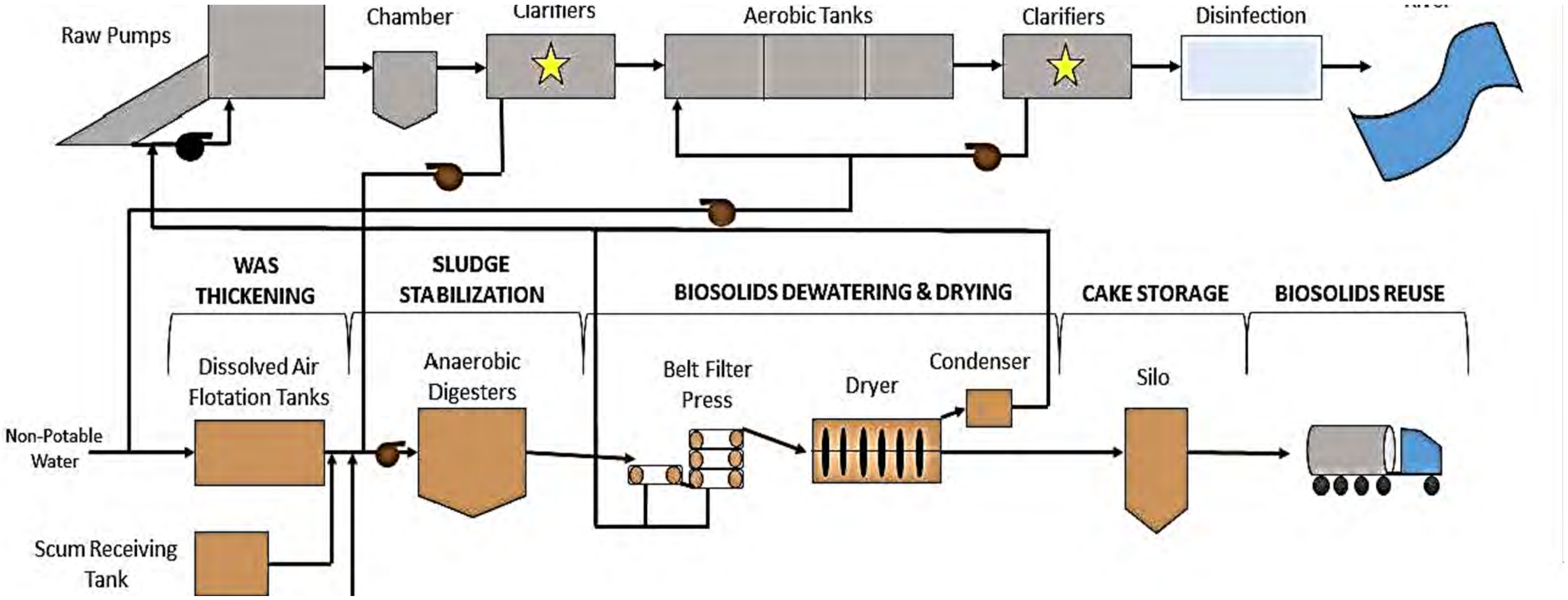
Case Study 3 – Gwinnett County, GA

- **Regulatory Insight:**
  - **NPDES permit modifications** for co-digestion.
- **Key Takeaways:**
  - Co-digestion driven by **economic necessity** (high energy costs).
- **Value of Biogas generated**: Potential revenue and reduction in cost due to biogas beneficial use



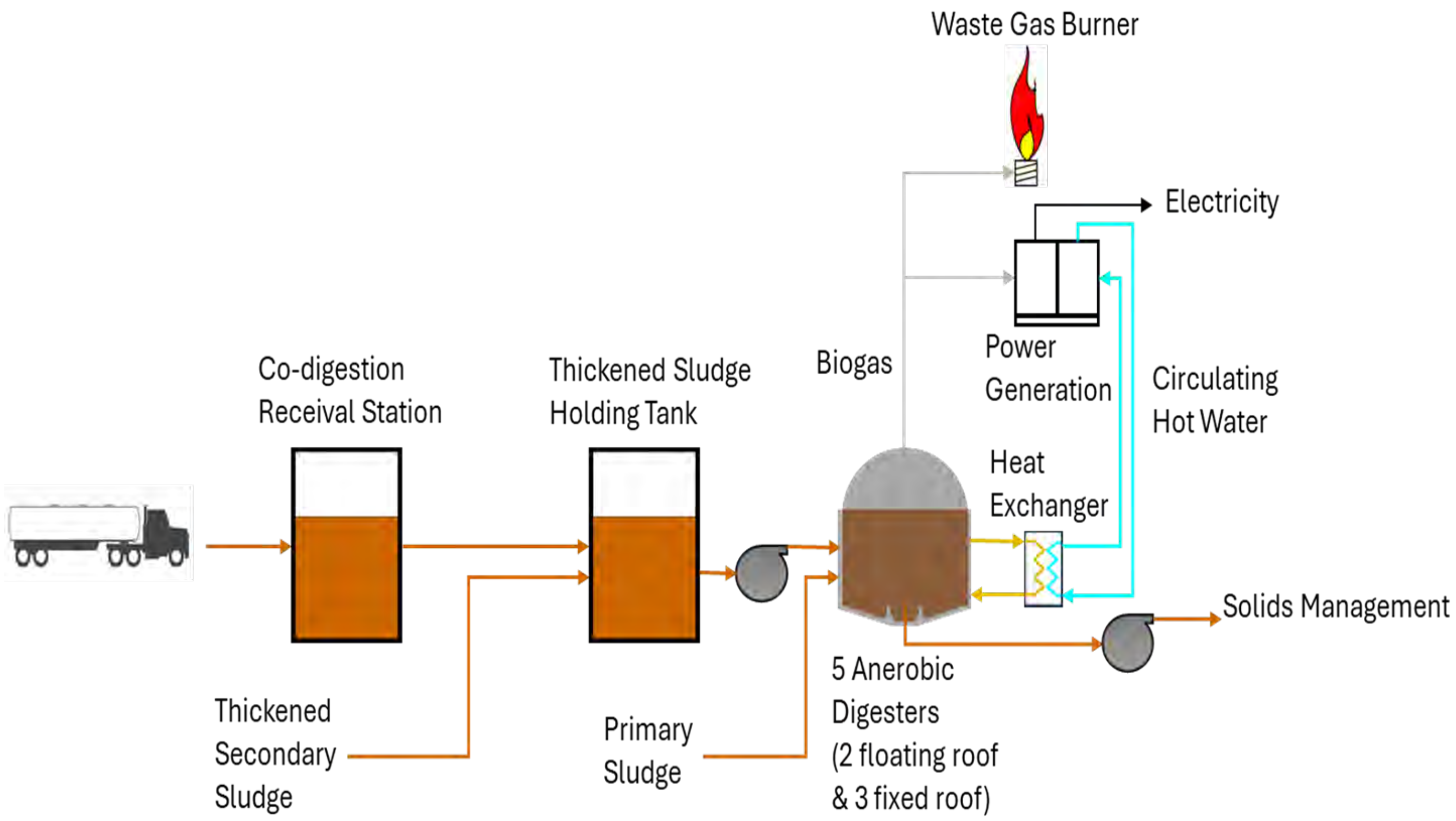
Case Study 4 – Oneida County, NY

- **Regulatory Insight:**
  - **NY's 2022 Food Scraps Law** required food waste diversion.
- **Key Takeaways:**
  - **Public-private partnerships** ensured project feasibility.
- **Biogas conditioning and beneficial use:** The biogas is conditioned for hydrogen sulfide and siloxanes removal, dried to reduce moisture and compressed before being used as fuel in Capstone C600S microturbine based CHP system with hot water recovery.



Case Study 5 – Stevens Point, WI

- **Regulatory Insight:**
  - No major **regulatory obstacles** but required **long-term planning**.
- **Key Takeaways:**
  - **Partnership with local brewery** helped **cut costs & increase energy recovery**.
- The SPWTP utilizes a dual fuel thermal oil boiler to heat and dry biosolids to Class A specifications using primarily biogas produced through co-digestion



Case Study 6 – SAWater, Glenelg WWTP (Australia)

- **Regulatory Insight:**
  - Compliance with **Australia's Environmental Protection Act**.
- **Key Takeaways:**
  - **SCADA system integration** improved process **control & monitoring**.
- H_2S concentrations increased from 1816 ppm to 2137 ppm following the implementation of co-digestion

Summary

Facility	Biogas Output	GHG Offset	Air Permit Needs	Odor/H_2S Mitigation
EBMUD	High	GHG offset achieved through displacement of grid electricity and capturing fugitive methane.	Monitored	Carbon & Sulfur Scrubbers
CMSA	Medium	Energy self-sufficiency helped avoid fossil-based grid reliance; reduced organic landfill emissions	Modified	Chemical Scrubbers
Gwinnett County	High	Reduced reliance on utility power; avoided landfill methane.	CHP Permit	Minimal (Low Sensitivity)
Stevens Point	Low–Medium	Indirect GHG benefit via biogas use for drying, replacing natural gas	Not Required	Not Applicable

Recommendations for WRRFs and Regulators

- **For WRRFs**
  - Design for GHG Capture & Beneficial Use – Not Flaring
    - Why: Flaring converts methane to CO_2 but wastes the energy value of biogas.
    - Best Practice: Prioritize combined heat and power (CHP) or renewable natural gas (RNG) systems.
    - Design Tip: Right-size gas storage, treatment (H_2S/siloxane), and utilization equipment upfront
  - Monitor VOCs and H_2S Routinely
    - Why: Sulfur-rich wastes (e.g., FOG, protein waste) → hydrogen sulfide (H_2S) → odor, corrosion, and regulatory violations.
    - VOC Risk: Can trigger air quality compliance issues or community complaints.
    - Action: Install gas monitoring systems at offloading, digester headspace, and exhaust points.
  - Integrate Air Permitting into Early Project Planning
    - Why: Delayed permitting can halt project commissioning.
    - Example: CMSA had to modify air permit for odor scrubber emissions after construction began.
    - Tip: Work with state permitting agencies early to clarify emission thresholds, flare capacity, and waste volume limits.

Recommendations for WRRFs and Regulators

For Regulators and Policymakers

- Create Clear and Aligned Permitting Pathways
  - Challenge: WRRFs must juggle NPDES, solid waste, and air permits.
  - Recommendation: Provide co-digestion-specific guidance on:
    - ✓ Thresholds for air permit modification
    - ✓ Odor/VOC control expectations
    - ✓ Flare and engine emissions factors.

Bottom Line

Co-digestion can reduce net GHG emissions, but only if energy recovery is prioritized and permitting is not a bottleneck.

Final Thoughts

❖ **Co-digestion is a climate tool, not just a solids tool**
→ It offers a strategic pathway to reduce methane emissions, capture energy, and support decarbonization goals.

❖ **Case studies show success with the right planning**
→ Programs like CMSA and EBMUD highlight that clear goals, monitoring, and design alignment drive performance.

❖ **Air permitting is not a barrier—it's a lever**
→ When addressed early, permitting can enable biogas recovery and unlock regulatory and economic benefits.

Thank You

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