

# **Increasing Biogas Production**

**at the**  
**Sacramento Regional Wastewater Treatment Plant**

## **DOCKET**

**09-IEP-1H**

DATE July 23 2009

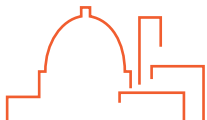
RECD. July 27 2009

## **California Energy Commission Combined Heat & Power Workshop**

**July 23, 2009**

**Kathleen Ave**  
**Advanced, Renewable & Distributed Generation Technologies**  
**Sacramento Municipal Utility District**  
*With thanks to SRCSD & Brown & Caldwell team members*

[kave@smud.org](mailto:kave@smud.org)  
916-732-5302



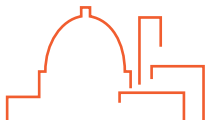
**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*

# Summary

- SMUD Overview
- Local Biomass Program
- Biogas Enhancement Pilot Test
  - Background
  - Initial Results
  - Planned Next Steps
  - Statewide Barriers



**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*

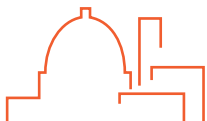
# The Conundrum of Abundance



*Things Being What They Are.* Chester Arnold.

Center for Contemporary Art, Sacramento

Image courtesy of the artist and Catharine Clark Gallery, San Francisco.



**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*

# About SMUD

- Publicly owned, non-profit electric utility serving Sacramento County for 60+ years
  - 5<sup>th</sup> largest electric utility in CA
  - 6<sup>th</sup> largest municipal utility in US, 2<sup>nd</sup> in CA
- Overseen by an elected board of directors
- Service Area
  - 900 square mile service area covering Sacramento County and a portion of Placer County
  - 590,000 customers within a 1.4 million service area population
  - 477 miles of Transmission lines, 9,736 miles of Distribution lines
- Other Facts
  - 2,100 employees
  - Operate Balancing Authority in Northern California
  - Operated Rancho Seco Nuclear power plant until shuttered by voter referendum in 1989
  - S&P Bond rating increased from A to A+ rating in April 2009
    - One reason cited was that SMUD is “ahead of most utilities in addressing climate change”



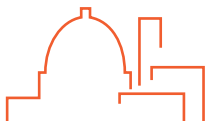
**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

**The Power To Do More.**

# Sustainable Power Supply Objective

A Sustainable Power Supply reduces SMUD's long-term greenhouse gas emissions from generation of electricity to 10% of its 1990 carbon dioxide emission levels by 2050 (i.e. <350,000 metric tonnes/year), while assuring reliability of the system; minimizing environmental impacts on land, habitat, water quality, and air quality; and maintaining a competitive position relative to other California electricity providers.



**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

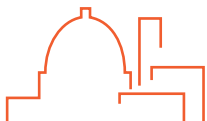
*The Power To Do More.*

# SMUD Renewable Energy Goals

- Renewables Portfolio Standard (RPS), and Green Pricing Program ('Greenenergy')

Renewable Energy Program	2008 Supply Goal	2008 Actual (estimate)	2010 Goal	2020 Goal
RPS	14%	16.5%	20%	33%
Greenenergy	3%	3%	3%	4%
Totals	17.5%	19.5%	23%	37%

- Biomass represents 41% of SMUD's 2008 RPS



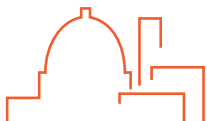
**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*

# SMUD's Local Biomass Program

- *Problem wastes* used as resources in local waste-to-energy projects
  - Sustainable fuel supply
  - Mature or commercial-ready technologies
  - Dairy manure, **grease, food**, landfills, fuel-loaded forests, agricultural waste
- Promote global and local environmental benefits
  - Reduce GHG emissions
  - Divert waste from landfills
  - Encourage alternative waste disposal methods
  - Reduce groundwater contamination
- Bring local economic benefits
  - Promote the creation of local jobs
  - Source of steady income to local business through electricity sales
- Leverage existing infrastructure where possible
  - **Wastewater treatment plants**
  - Landfills

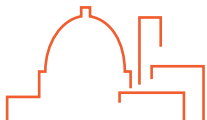
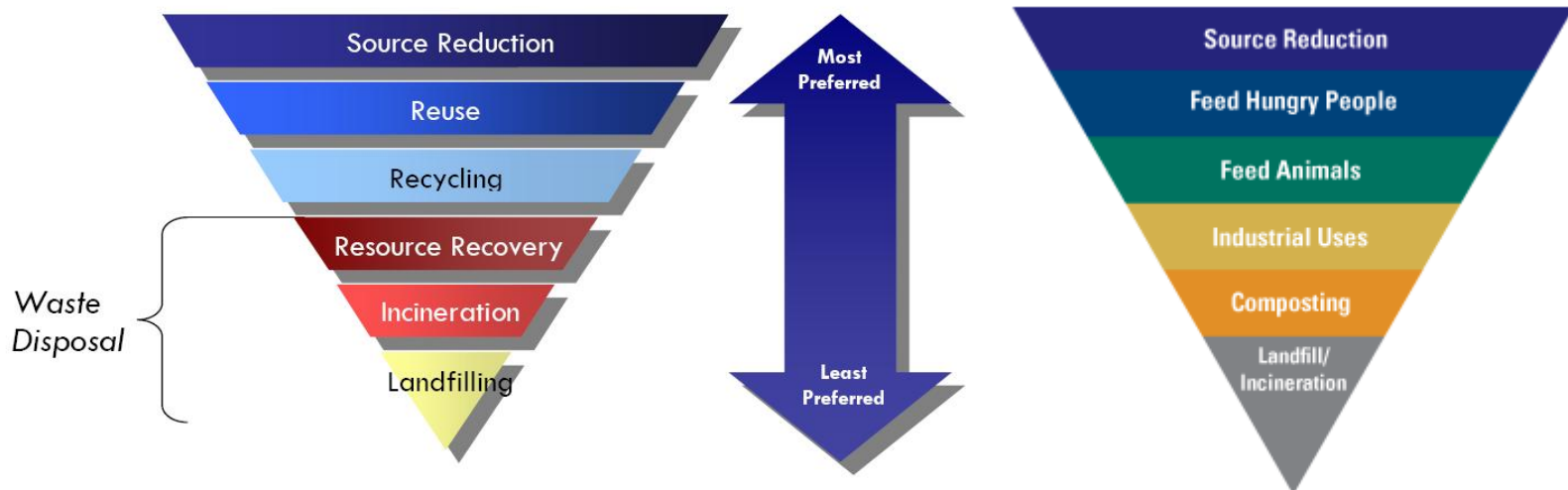


**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

**The Power To Do More.**

# Solid Waste Hierarchies



Source: US EPA



**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*

# WWTP Co-Digestion Biogas Enhancement Pilot Test



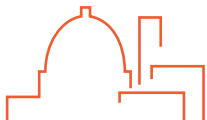
**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*

# Context

- Influent volume at CA WWTPs is down relative to population growth
- “FOG” in collection systems increases maintenance costs and sewer backups
- Co-digestion proven cost effective at multiple WWTPs
  - Productive use of excess capacity
  - Significant increases in biogas production (59%) and volatile solids destruction (47%), based on 25% grease solids load\*
- Food waste is 75% water, collected brown grease is typically 85-99% liquid (before thickening)
  - “solid waste” ?



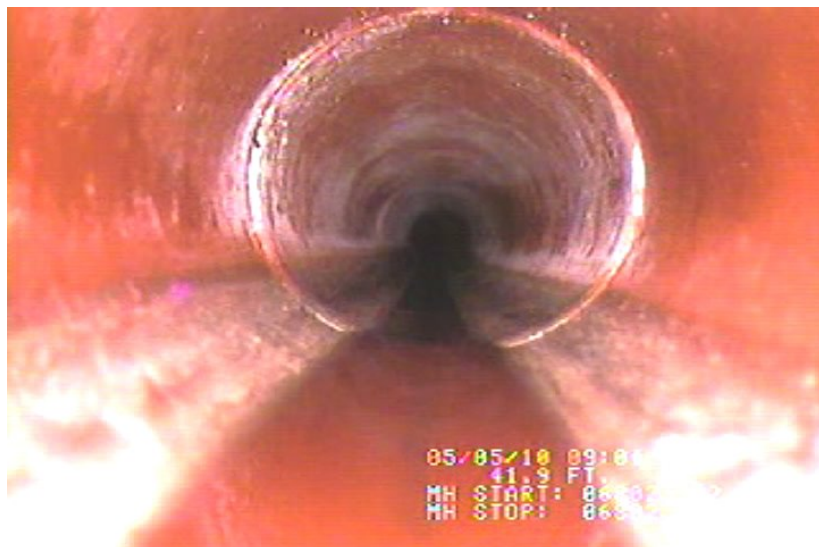
\* Source: Kester, Schafer & Gillette, BioCycle July 2008



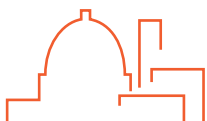
**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*



Source: [www.sacsewer.com](http://www.sacsewer.com)



**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

The Power To Do More.

# Project Background

- SMUD generates energy at the Carson Energy Cogeneration Plant adjacent to SRWTP
- Biogas produced in SRWTPs Digesters is used as fuel for the gas turbine duct burner at the Carson Plant
  - This gas is considered a renewable fuel
- In return, the Carson Plant provides steam to SRWTP to meet their heating needs, and to Glacier Ice to drive refrigerant compressors for ice production.
- SMUD and SRCSD partnered to evaluate new alternatives to enhance biogas production
  - Help SMUD achieve its renewable energy goals
  - Provide new revenue streams to SRCSD, utilizing excess plant capacity
  - Offer an advanced waste disposal option to local businesses, eliminating transportation expense and emissions associated with distant disposal



**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*



# Biogas Enhancement Pilot Test

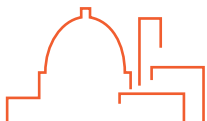
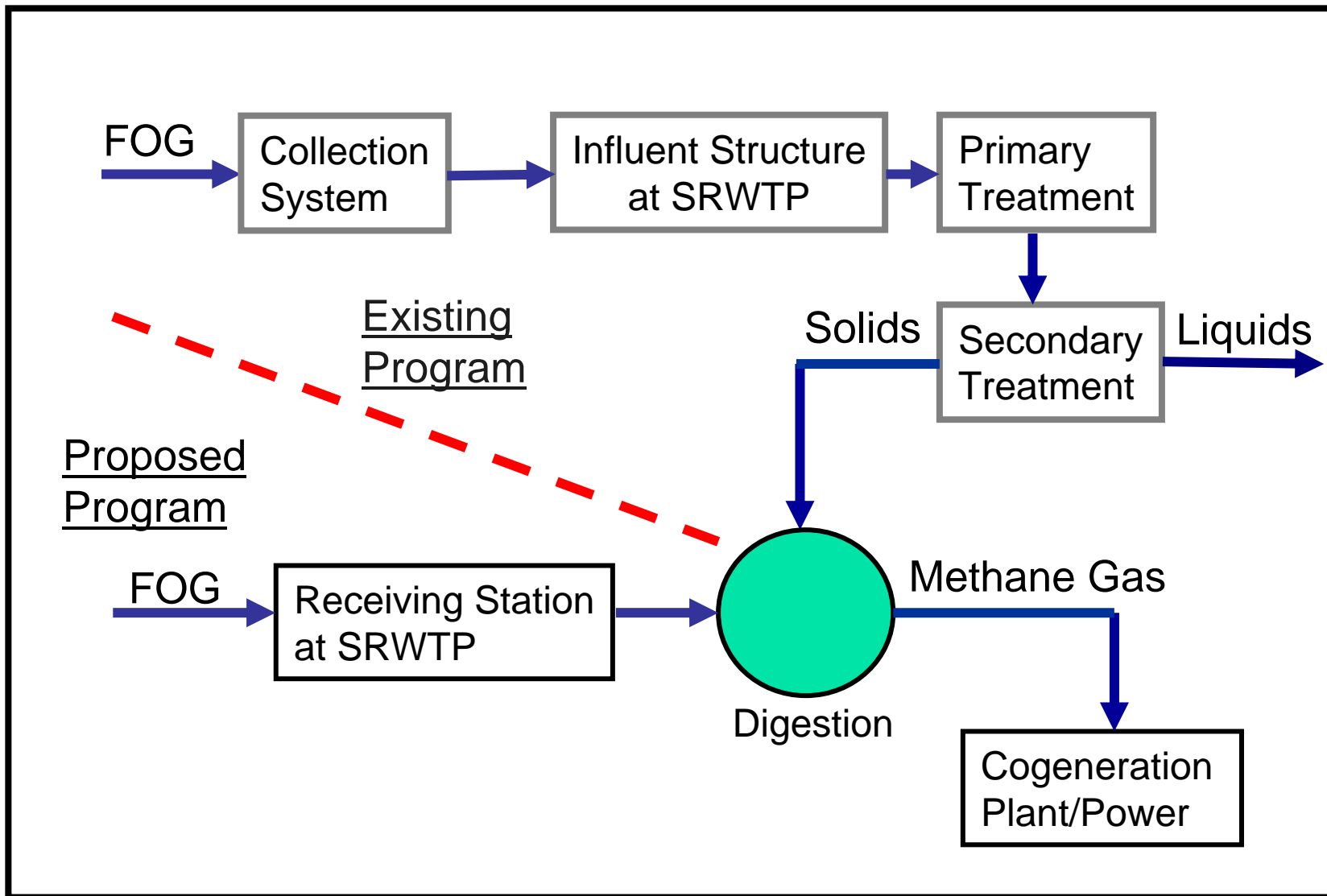
- Joint project with SRCSD at Sacramento Regional Wastewater Treatment Plant – Biogas already used at SMUD Co-Gen
- Utilizes excess capacity at largest inland water discharger in CA (180mgpt permitted capacity)
- Study Objectives:
  - Pump food processing waste and brown grease directly into the digester instead of primary and secondary treatment systems.
  - Increase gas production and methane content of the gas produced in the digesters.
  - Monitor biosolids characteristics in the digester, and potential operational issues for a full scale system
  - Obtain data on the economic factors to better assess economic feasibility of a full scale project
- Phase 4 will start in August 2009



**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*

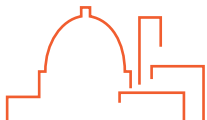
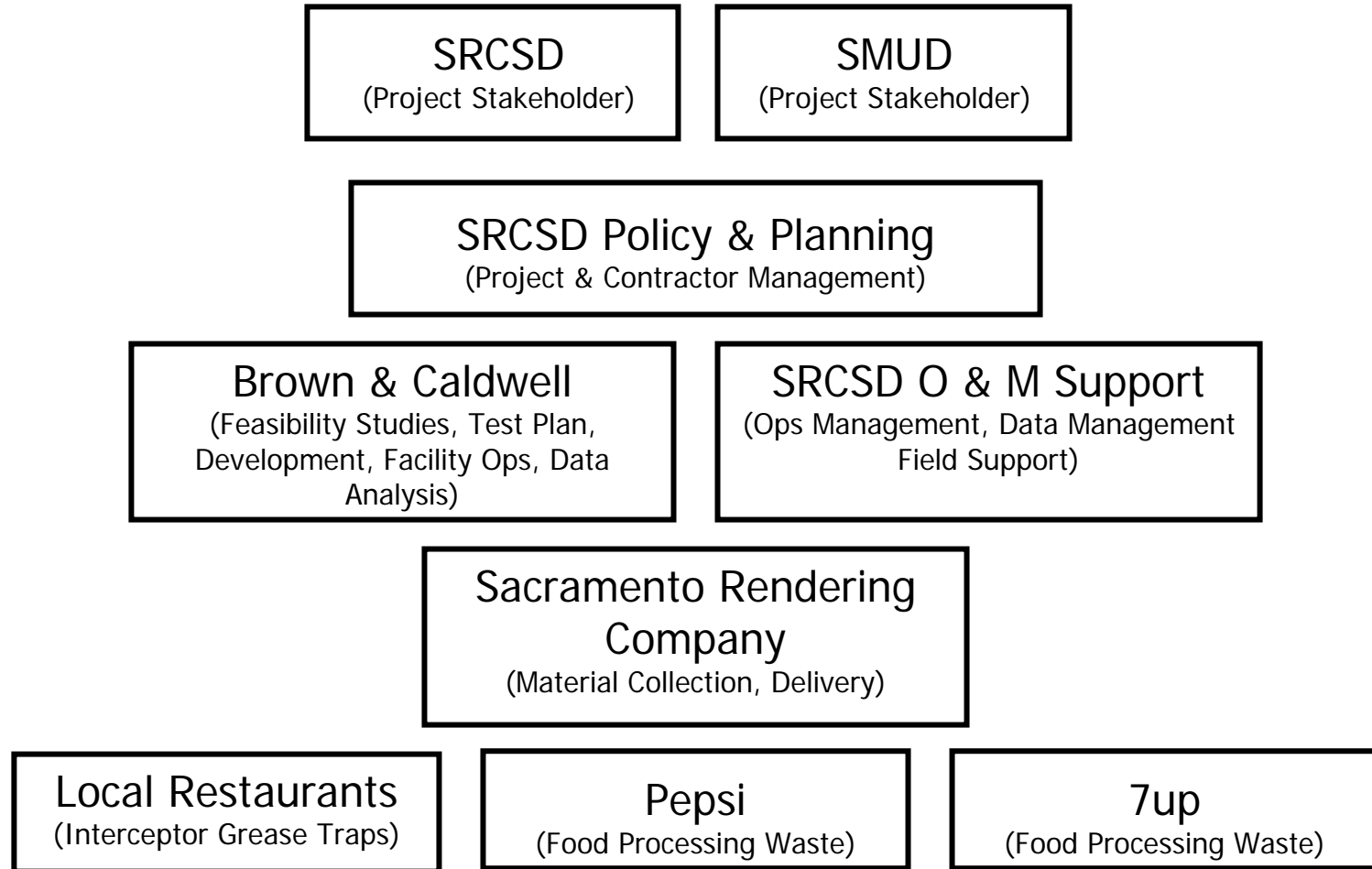


**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*

# Organizational Roles



**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*

# Project Set-up

- Pilot Study has a test and control digester
  - Characteristics of both digesters are monitored through an extensive monitoring program
  - Same operational parameters maintained in the two digesters except for the addition of the experimental feedstock
- Pilot Study broken into 4 phases
  - Phase I – Brown Grease Only
  - Phase II – Food Processing Waste Only
  - Phase III – Mix of waste to simulate full scale loading
  - Phase IV – NEW – Mix of waste with higher flow rate, glycerine, during nocardia season

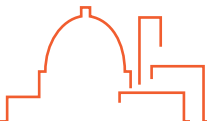


**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*

# Pilot Plant



**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

The Power To Do More.

# Pilot Study Timeline

- Feasibility Studies, 2006 - 2007
- Developed Test Plan, 2008
- Phase I – Brown Grease
  - Began 12/2/08
  - Completed 3/14/09
- Phase II – Food Processing Waste
  - Began 4/13/09
  - Completed 5/8/09
- Phase III – Mixed Waste
  - To begin 5/11/09
  - To end 6/1/09
- Phase IV
  - To begin approximately 8/10/09
  - To end approximately 8/28/09

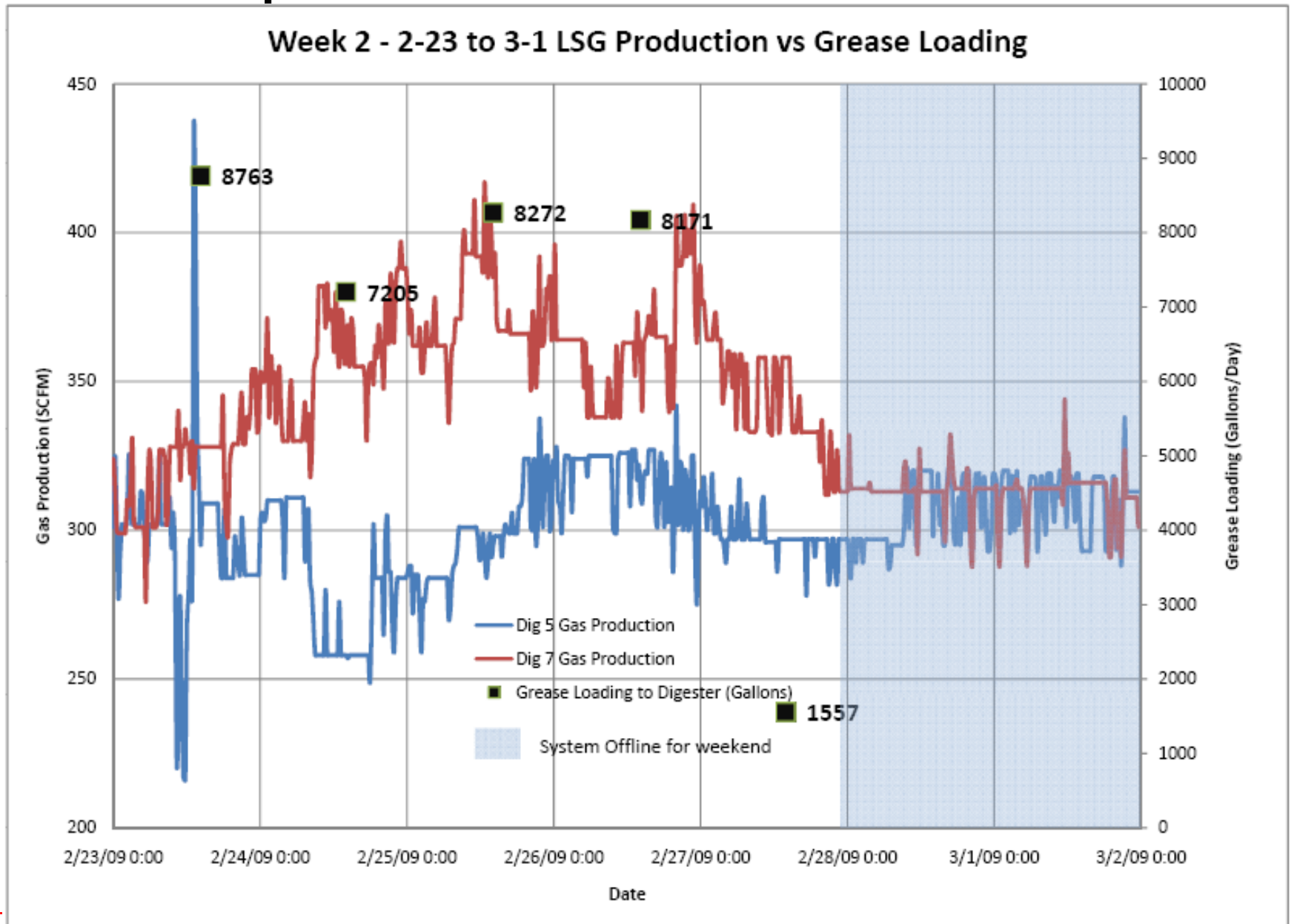


**SMUD**

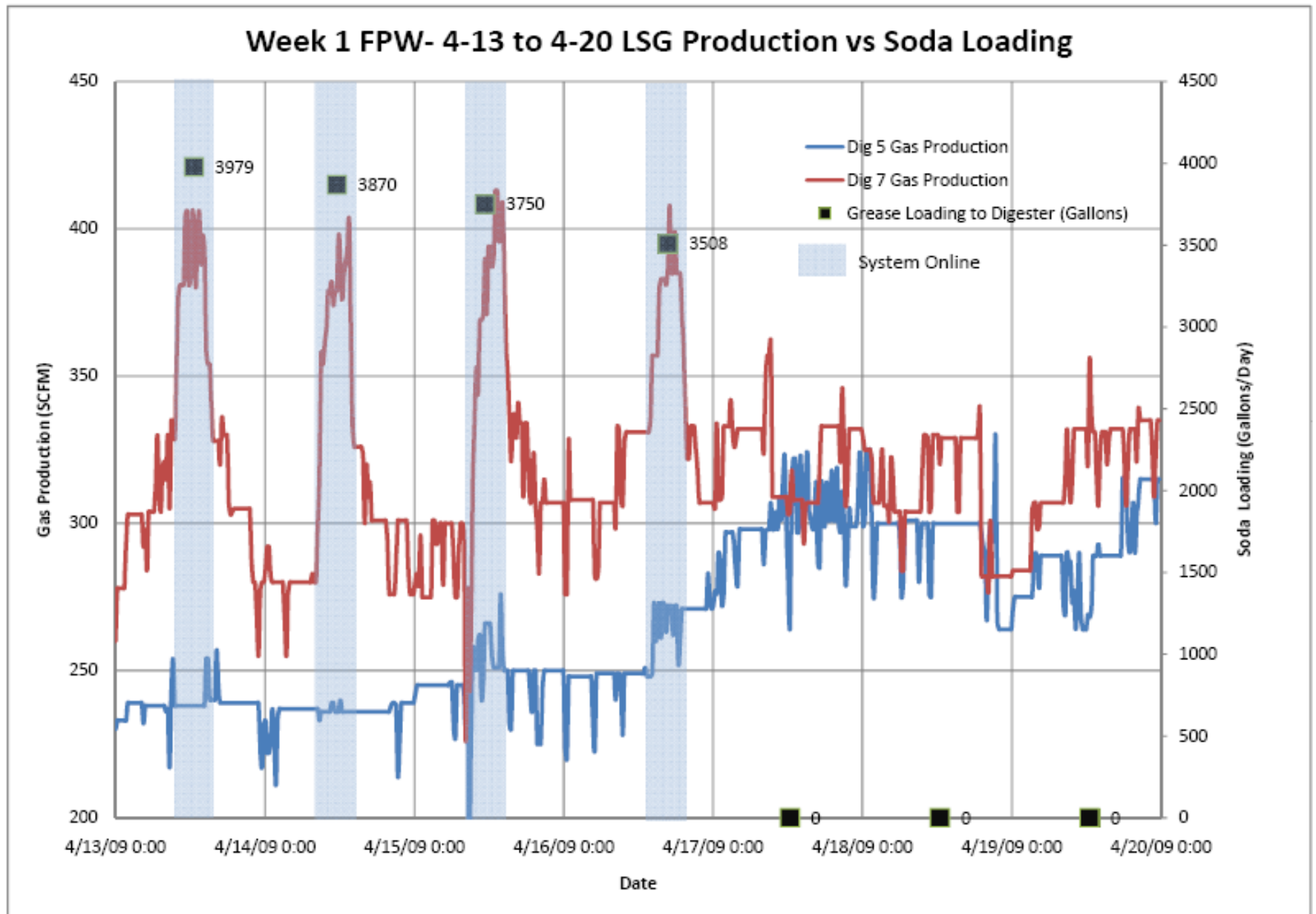
SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*

# Phase 1 Sample Data – Brown Grease

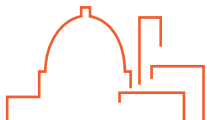


# Phase 2 Sample Data – Liquid Food Processing Waste



# Biogas Production Objective

- Current biogas yield at SRWTP = 16-21 Standard Cubic Feet per Pound of Volatile Solids (SCF/lb VS)
- Expected biogas production per gallon of feedstock = 10.8 SCF/gal
- Actual = 0-29 SCF/gal (initial analysis, results highly varied)
- The potential to match or exceed the 10.8 SCF/gal performance criteria was observed
  - Methane & energy content of the biogas stable



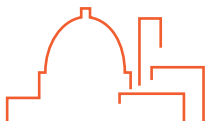
**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

The Power To Do More.

# Other Data

- No issues with digester stability, O&M, siloxane concentrations, foaming, odors, biosolids characteristics or output observed
- Variations in key feedstock assumptions:
  - Brown Grease
    - Expected 10% TS, Actual 7%
    - Expected 95% VS, Actual 97%
  - Liquid Food Processing Waste
    - Expected 22% TS, Actual <5%
    - Expected 85% VS, Actual 98%
- Feedstock flow rates lower than workplan objectives in all phases
  - Timing of deliveries, available volume, intermittent shutdowns

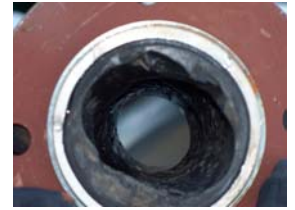


**SMUD**

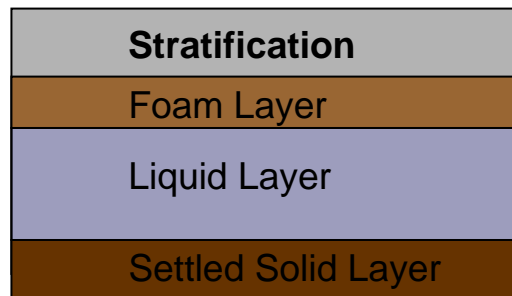
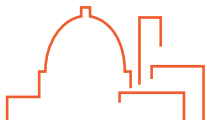
SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*

# Lessons Learned



- Brown grease presents many challenges
  - Less concentrated solids because of grease trap removal methods; Presents significant variation in feedstock
  - Stratifies in the tank unless mixed
  - Significant operational issues; Pre-Screening material could greatly improve experience
- Gas increases rapidly as soon as the material is added to the digesters
  - Contradictory to what other agencies have experienced
- Procuring adequate feedstock for a short term test problematic
- Education, involvement of WWTP staff is key



**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*

# Project Next Steps

- Complete Phase IV of the pilot study
- Review data / perform statistical analysis to determine how well the pilot facility worked
  - no fatal flaws expected
- Perform cost estimate based on information learned from the pilot study
  - Gas Production/Composition
  - Operational Costs
  - Cost/benefits of full scale facility
- Full Scale Facility ???
- SMUD evaluating pipeline injection



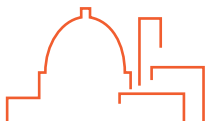
**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*

# Statewide Barriers

- Relatively low cost of landfill (in short term)
- Collection Programs
- Co-digestion, Materials Handling – Solid Waste Permitting
- Emissions – Air Permitting for onsite generation
- Effluent – Water Permitting, Salts



**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*



# Thank you!

**kave@smud.org**  
**(916)732-5302**



**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*

# Backup



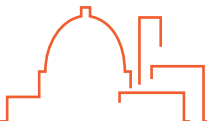
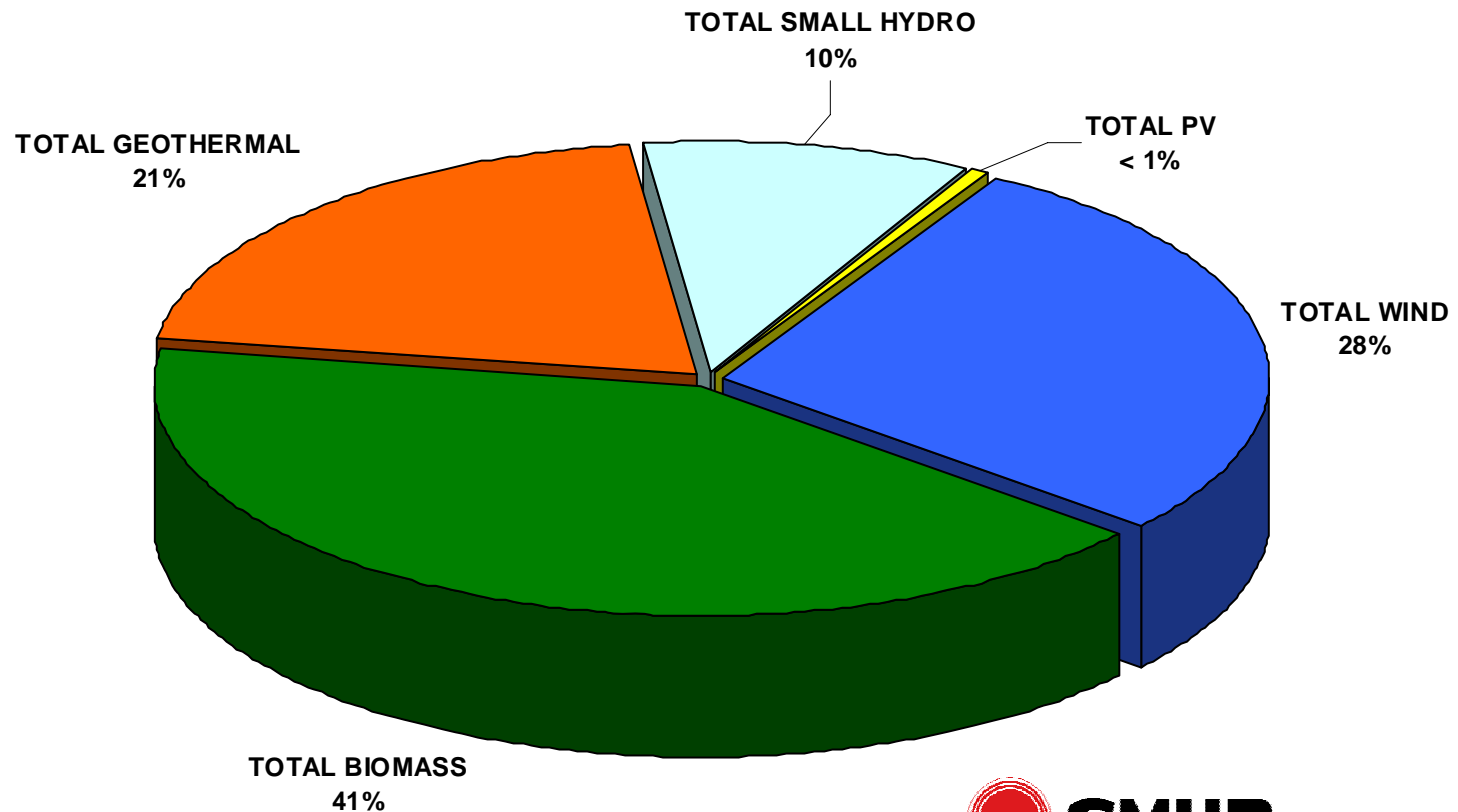
**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*

# SMUD's 2008 Renewable Energy Mix

(RPS and Greenergy)

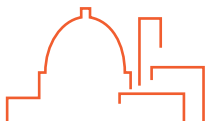
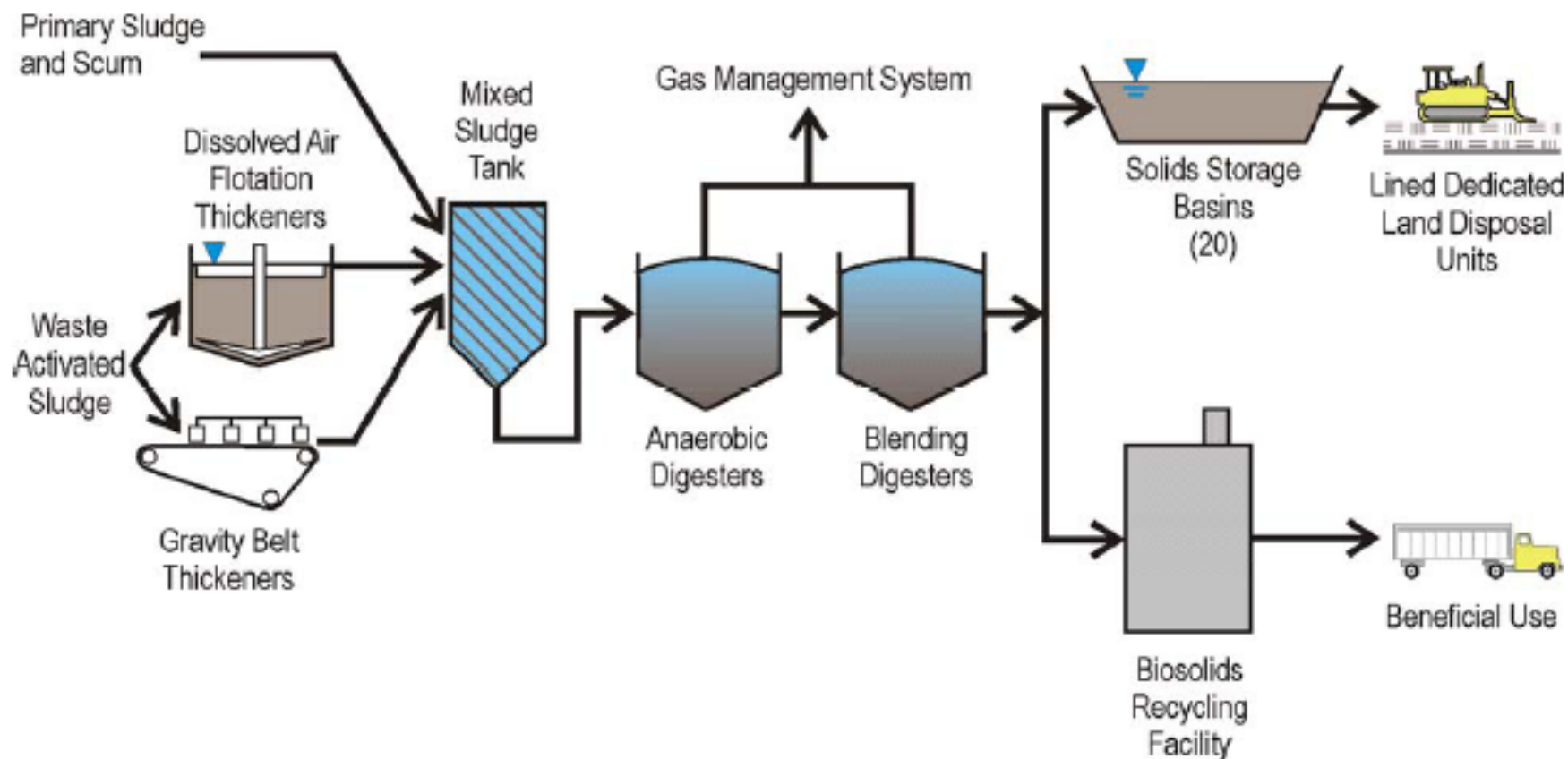


**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*

# SRWTP - Solids Management System

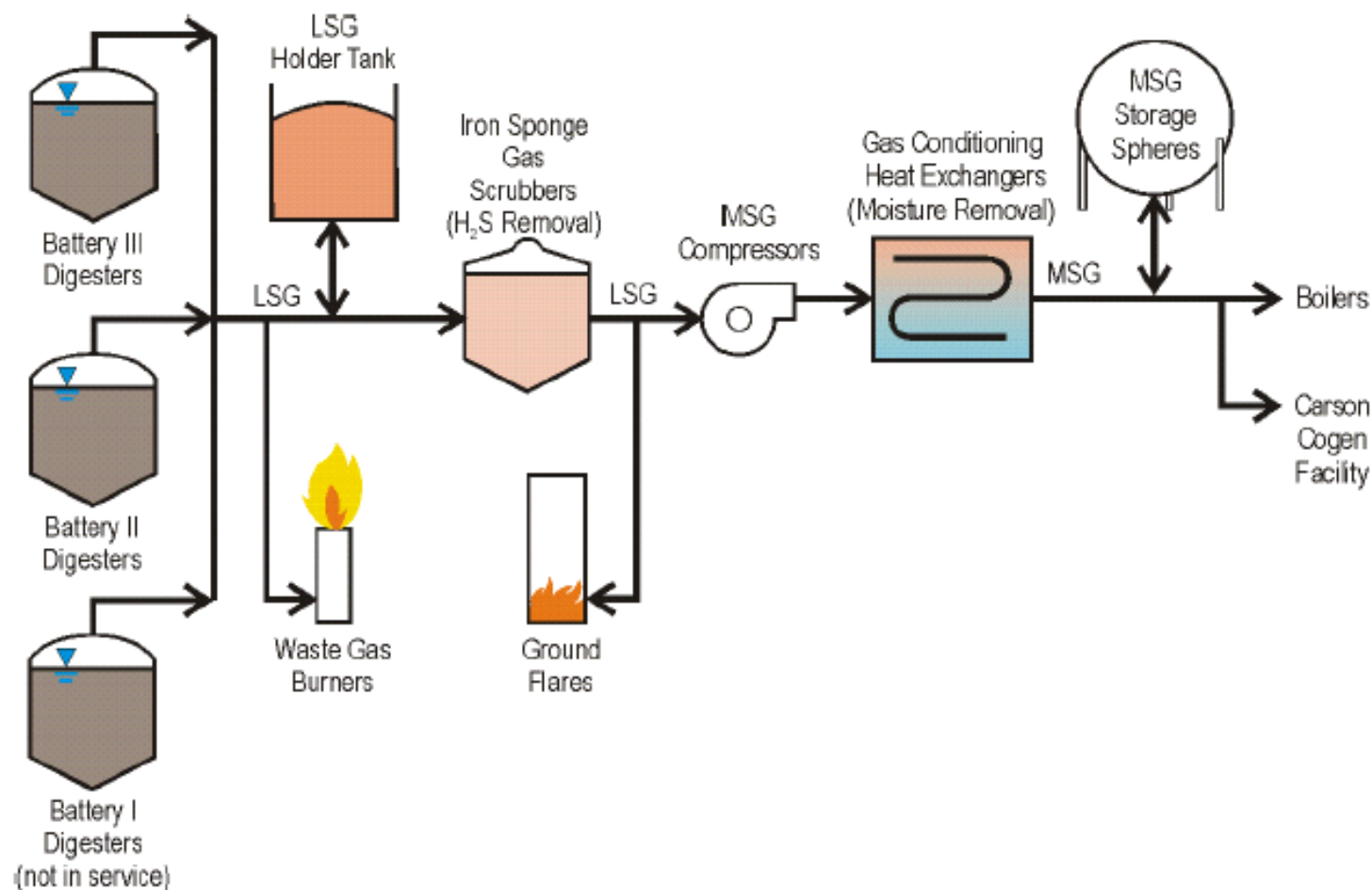


**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*

# SRWTP – Gas Management System



LSG = Low Pressure Sludge Gas  
MSG = Medium Pressure Sludge Gas

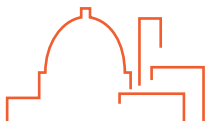
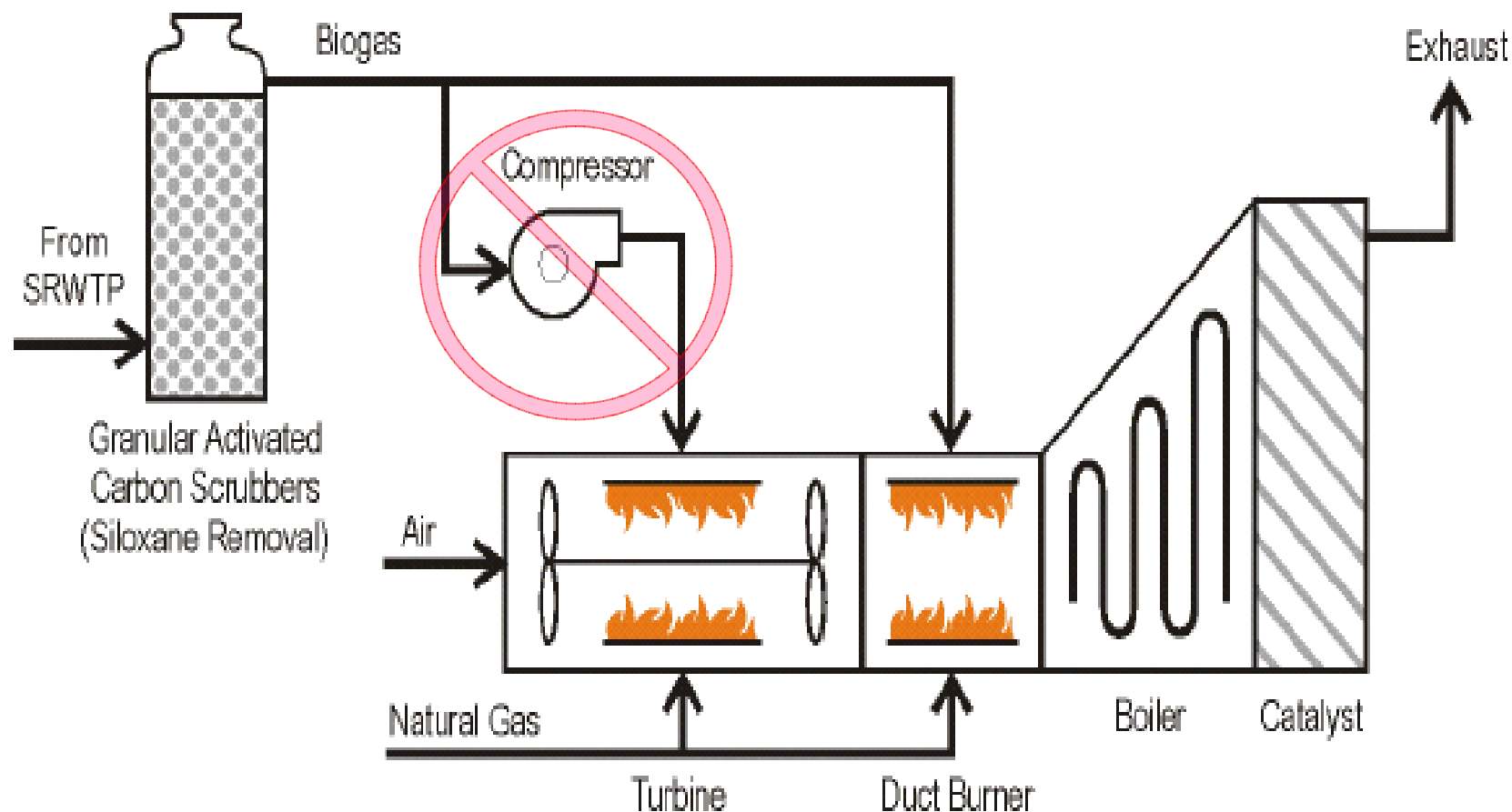


**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*

# Carson Energy Cogeneration Plant



**SMUD**

SACRAMENTO MUNICIPAL UTILITY DISTRICT

*The Power To Do More.*