The Metropolitan

Water Reclamation District

of Greater Chicago

WELCOME
TO THE OCTOBER EDITION
OF THE 2015
M&R SEMINAR SERIES

BEFORE WE BEGIN

- PLEASE SILENCE CELL PHONES OR SMART PHONES
- QUESTION AND ANSWER SESSION WILL FOLLOW PRESENTATION
- PLEASE FILL EVALUATION FORM
- SEMINAR SLIDES WILL BE POSTED ON MWRD WEBSITE (www. MWRD.org: Home Page ⇒ Reports ⇒ M&R Data and Reports ⇒ M&R Seminar Series ⇒ 2015 Seminar Series)
- STREAM VIDEO WILL BE AVAILABLE ON MWRD WEBSITE (www.MWRD.org: Home Page ⇒ MWRDGC RSS Feeds)

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Current: Assistant Director of Engineering , the Metropolitan Water Reclamation District of Greater Chicago

In charge of strategic engineering initiatives for the District

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Education: Graduate of the Water and Wastewater Leadership Center, Kenan-Flagler Business School, University of North Carolina
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Member of the Steering Committee for the WERF LIFT program
WEF (Water Environment Federation) Board of Trustees
Past Chair of the WEF Municipal Wastewater Treatment Symposium
WEF Fellow

Award: 2012 national recipient of the Charles Walter Nichols Award for Environmental Excellence from the American Public Works Association

MWRD Perspectives on Co-Digestion and Biogas Utilization

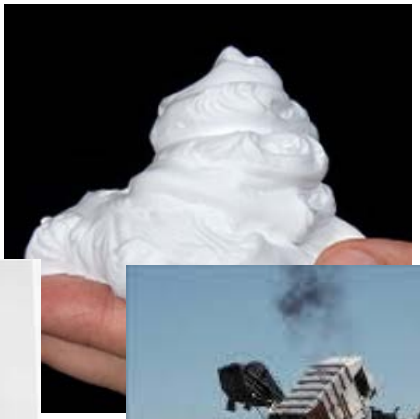
Thomas E. Kunetz, P.E., BCEE, WEF Fellow
Assistant Director of Engineering

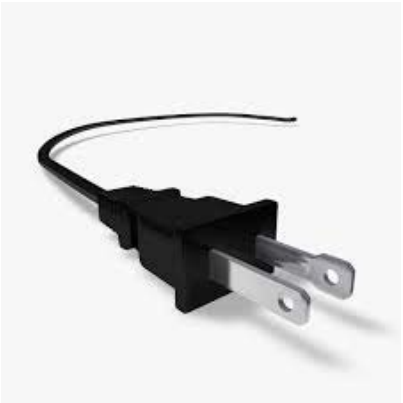
M&R Seminar Series

October 30, 2015

The Metropolitan Water Reclamation District of Greater Chicago
--Recovering Resources, Transforming Water

Vs.





VS.

Energy-Water Nexus

Image: World Bank

Energy Neutrality

On an annual average, to produce as much renewable energy as the energy that is imported

Energy Imported

- Electricity
- Natural Gas
- Diesel
- Gasoline
- Propane

Energy Produced

- Digester Gas
- Hydroelectricity

- Solar Thermal
- Sewer Thermal
- Photovoltaic
- Wind

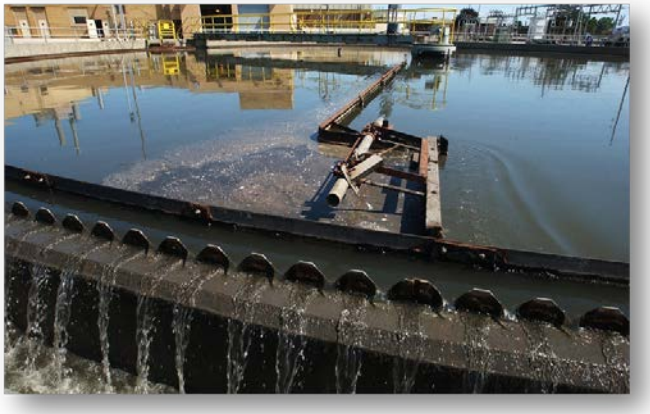
Energy Neutrality as of 2014

27%

UTILITIES OF THE FUTURE ENERGY FINDINGS

2014

WERF



Domestic wastewater contains 5 times the energy needed to treat it

- 80% Thermal energy
- 20% Chemical energy
- <1% Kinetic (hydraulic)

Anaerobic Digestion

- Biological process in which different groups of bacteria play a role to systematically break down organic matter into simpler compounds in the absence of oxygen (“anaerobic”)
- Reduces the volatile organic matter in the wastewater solids.
- Bacteria require heat to grow—"mesophilic”
- Byproduct is digester gas or “Biogas”

Biogas Composition

- 60-64% methane
- 35-39% carbon dioxide
- 5% VOC, sulfur compounds, siloxanes

- Heating value of ~600 BTU/cubic foot
- (Natural gas is ~1,000 BTU/cubic foot)

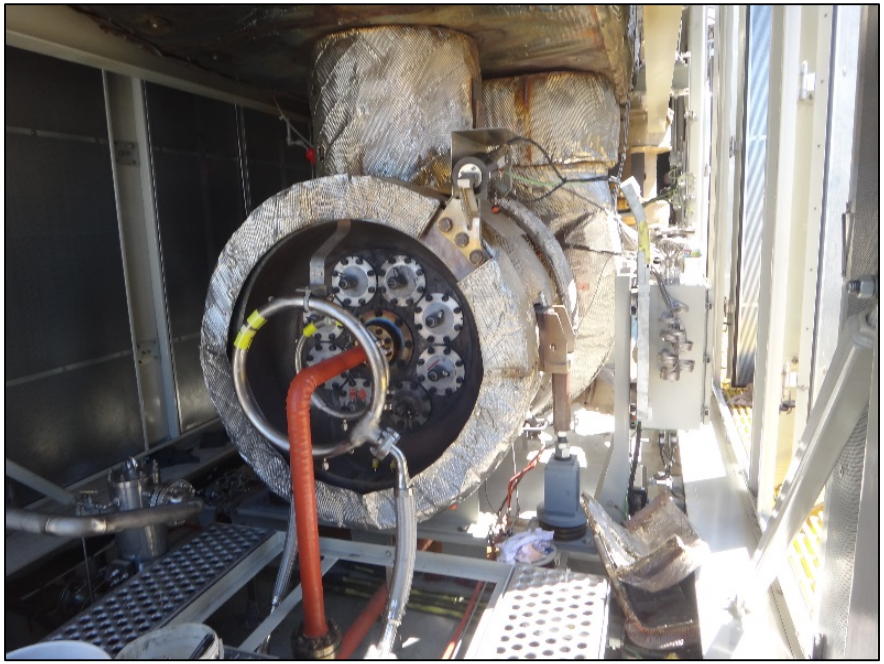
Biogas Utilization

- Boiler
- Electricity generation
- Pipeline gas
- CNG Fuel

Biogas Utilization—Boilers

- High pressure steam or hot water
- Digester heating
- Building heat
- Stickney, Calumet, Hanover Park, Egan

Biogas Utilization—Electricity Generation



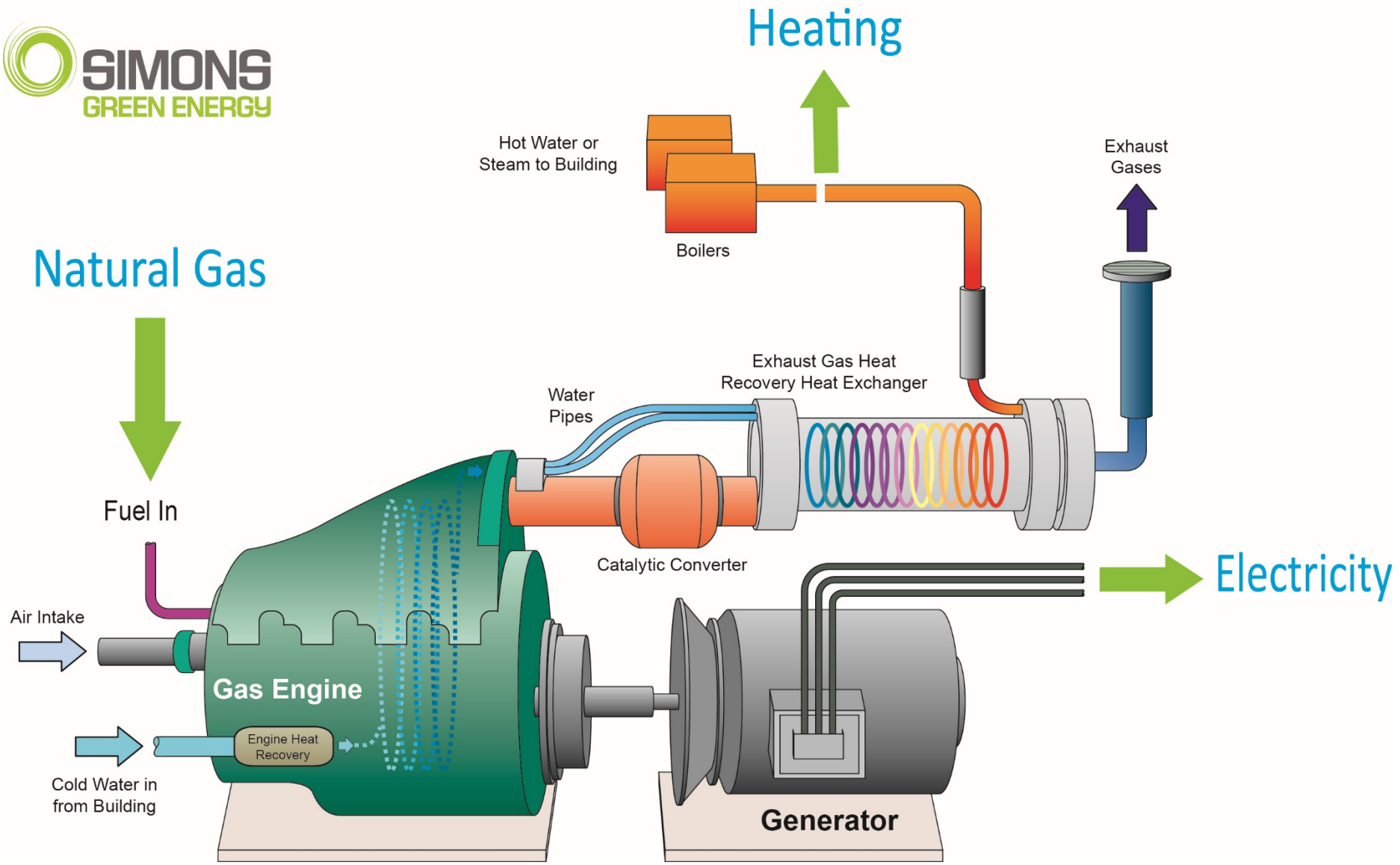
Gas Turbine

Engine Generators

Biogas Utilization—Electricity

- Digester gas cleaning
- Carbon dioxide
- Moisture
- Siloxanes

Combined Heat and Power (CHP)



Biogas Utilization—Pipeline Gas

- High BTU facility
- Cleans biogas using Pressure Swing Absorption (PSA) technology
- Recover 92% of methane from biogas
- Biomethane sold to natural gas pipeline for environmental attributes under Renewable Fuel Standards program

Image: Ameresco, Inc.

San Antonio Water System

Biogas Utilization—CNG

Janesville, WI WWTP

Biogas Utilization—CNG

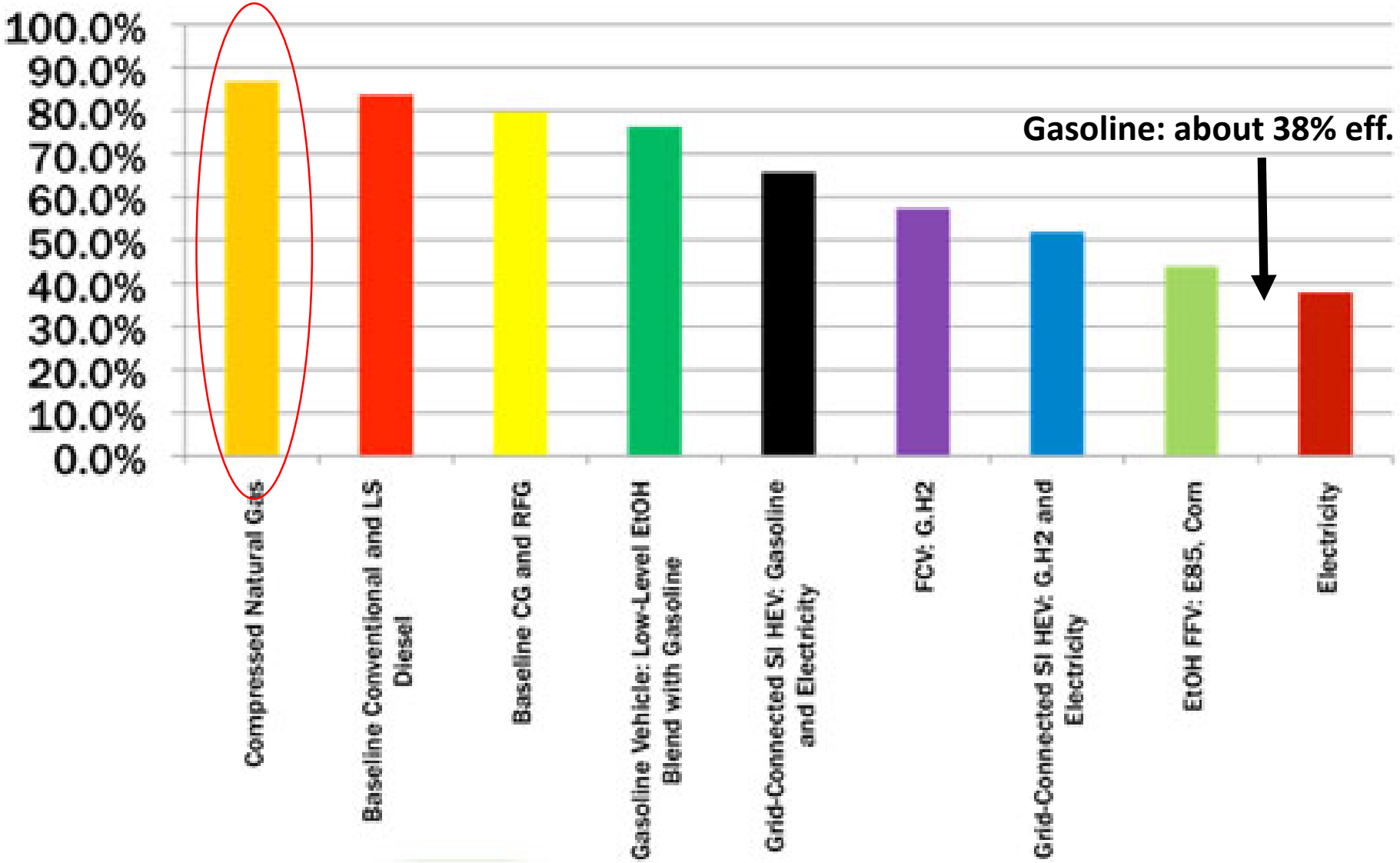
Image: Tenaris.com

CNG Vehicles improve air quality through dramatic reductions in emissions:

- Reducing carbon dioxide (CO_2) emissions by 20% to 30%
- Reducing carbon monoxide (CO) emissions up to 75%
- Reducing nitrogen oxide (NOx) emissions by approximately 50%
- Reducing up to 95% of particle matter (PM) emissions
- Reducing volatile organic compound (VOCs) emissions by 55%

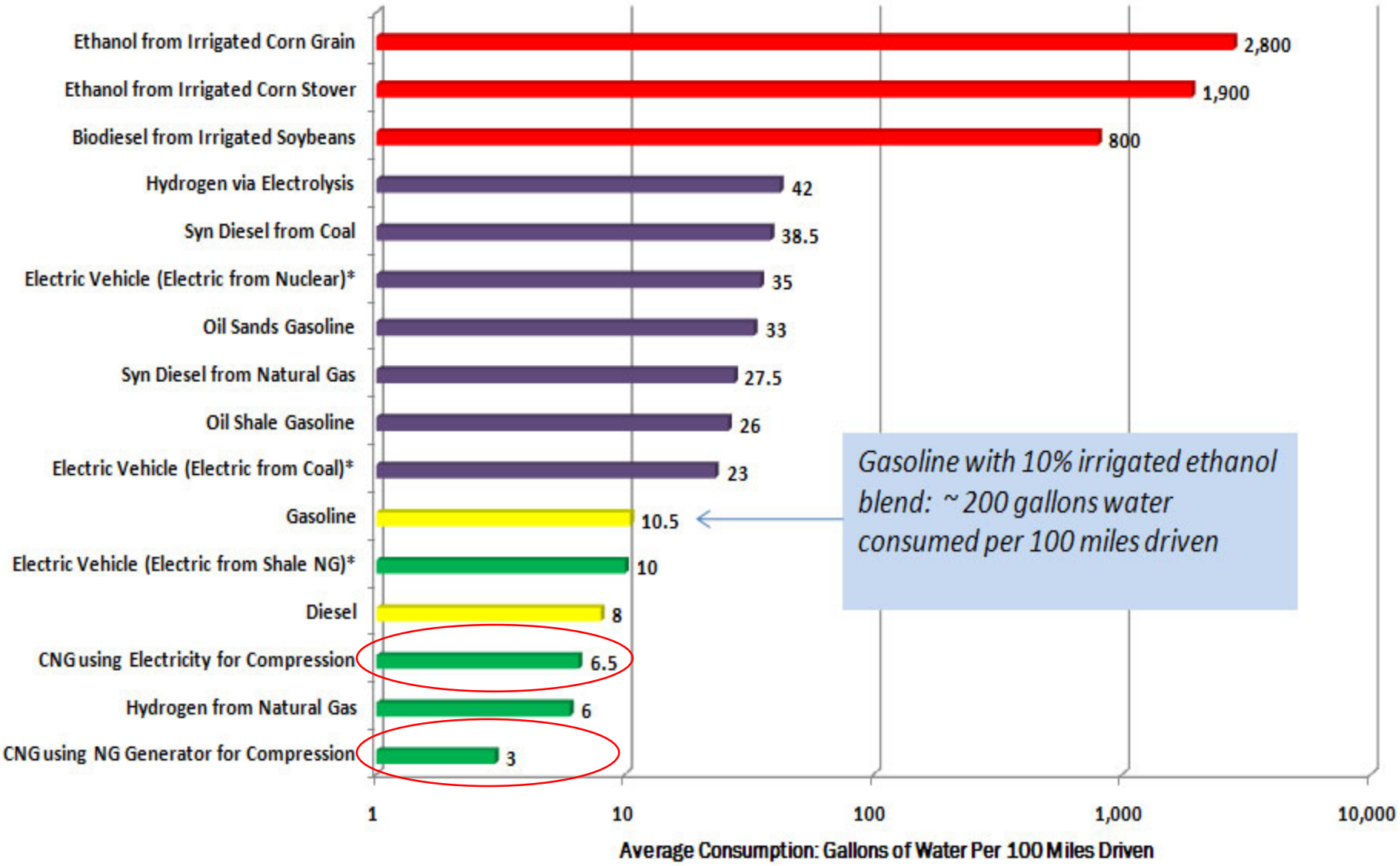
Source: TIAX Report - *Full Fuel Cycle Assessment: Well-To-Wheels Energy Inputs, Emiss*

Energy efficiency of various alternative fuels



Source: The Greenhouse Gases, Regulated Emissions and Energy Use in Transportation (GREET) Model 1.8b

Water intensity of transportation fuels



Source: NGVC.org: *Environmental Benefits of Natural Gas Vehicles.*

Renewable Fuel Standards

- USEPA Renewable Fuel Standards Program (2005)
- Establishes minimum volumes of renewable fuels that must be used for transportation fuel
- Volumes set by USEPA each year through Renewable Volume Obligations (RVO) for transportation fuel suppliers
- RVO compliance is measured by a unit called a Renewable Identification Number (RIN)
- Transportation fuel suppliers can meet the RVO by purchasing the credits for renewable fuels
- 1 RIN = 11.727 mmBTU

Renewable Fuel Standards

- Four categories of fuel:
  - Conventional Biofuels
  - Cellulosic Biofuels
  - Biomass-based Diesel
  - Advanced Biofuels
- USEPA sets RVO for each category
- RVO for Cellulosic Biofuels and Advanced Biofuels is required to increase each year

Low Carbon Fuel Standards (LCFS)

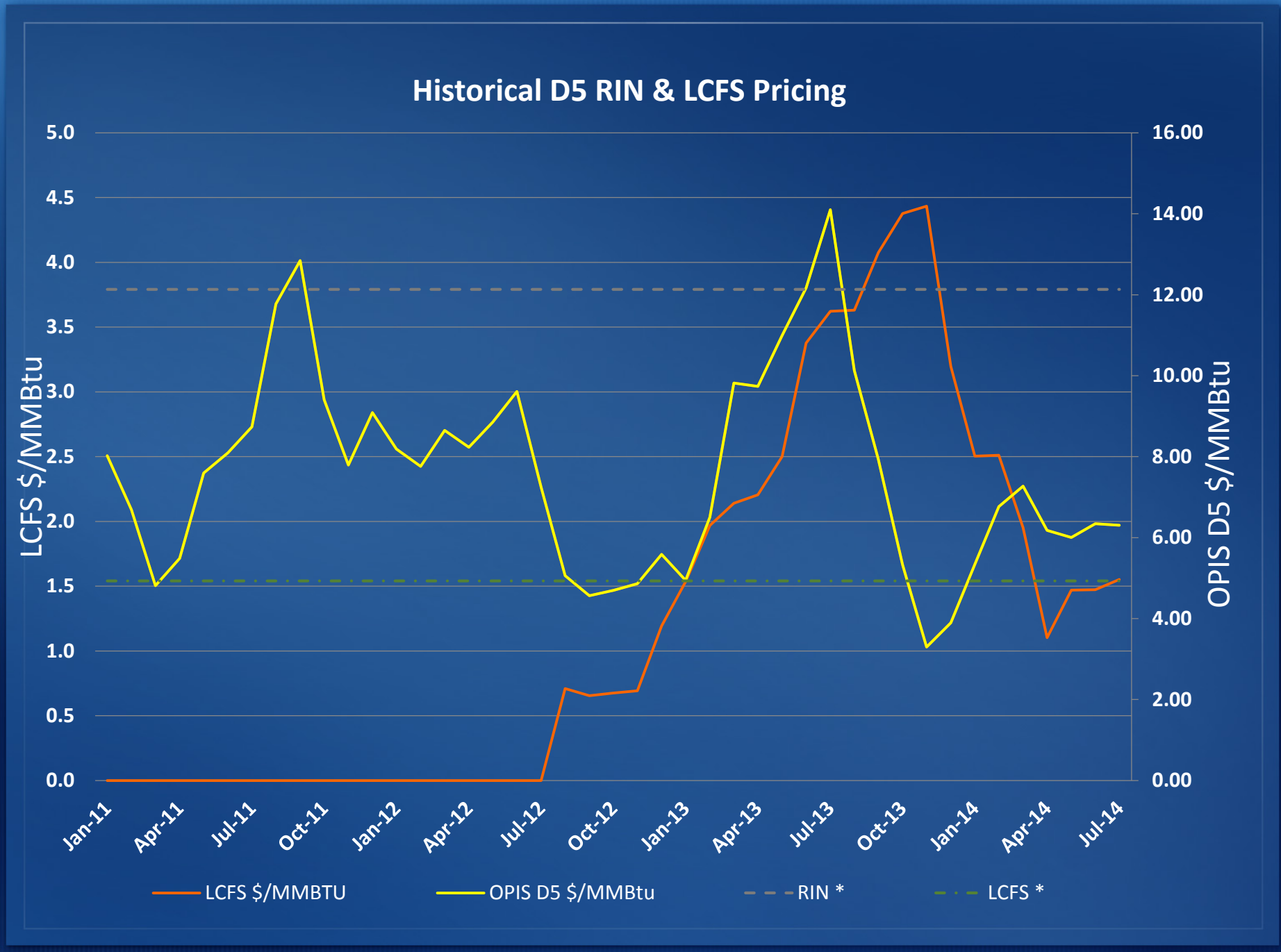
- Issued by California Air Resources Board
- Issues LCFS credits to reduce emission of carbon dioxide from vehicles through use of clean fuels.
- Measured in metric tonnes of carbon dioxide avoided through the use of clean fuels
- Regulated fuel producers must meet annual carbon intensity targets
- Can purchase LCFS credits to

  meet targets

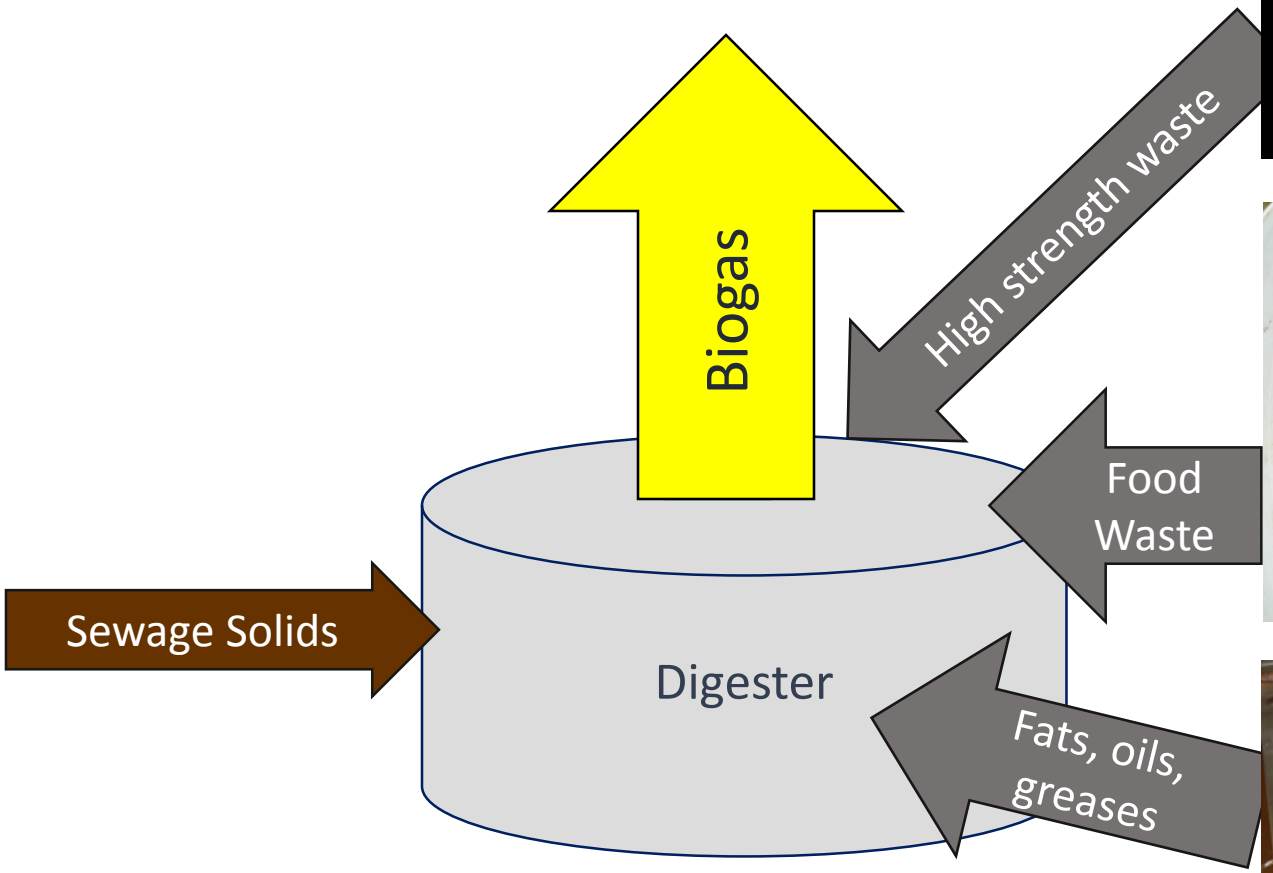
Biomethane Economics

Biomethane sale price made up of 3 components:

- Percent of Natural Gas market price (aka “Brown Gas”)
- Percent of RIN market price
- Percent of LCFS market price


Historical D5 RIN & LCFS Pricing
LCFS $/MMBtu
OPIS D5 $/MMBtu
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Jan-11
Apr-11
Jul-11
Oct-11
Jan-12
Apr-12
Jul-12
Oct-12
Jan-13
Apr-13
Jul-13
Oct-13
Jan-14
Apr-14
Jul-14
LCFS $/MMBTU
OPIS D5 $/MMBtu
RIN *
LCFS *

Co-Digestion



Resource Recovery Legislation

- ✓ Signed into law in July 2014
- ✓ Grants the District the authority to capture and sell recovered resources and produce renewable energy resources.
- ✓ “The District has the opportunity and the ability to change the approach to wastewater treatment from that of a waste material to be disposed of to one of a collection of resources to be recovered, reused, and sold, with the opportunity to provide the District with additional sources of revenue and reduce operating costs.”

Co-Digestion

GOAL:

- *Find a consistent , long term supply of organic waste to provide stability from both a process perspective and a financial perspective*

Feedstock Market--Analysis and Challenges

Organic Feedstock	Availability
FOG, Yellow Grease	Easily digestible. Competitive uses. Limited quantity.
High Strength Waste	Available, variable quality, variable availability.
Good quality industrial food waste	Available, often sold for animal feed.
Source separated organics (SSO) (pre-consumer food wastes)	Variable availability, variable quality. Potential for increasing availability if disposal options available
Wet Commercial Waste/ Municipal Solid Waste	Available in large quantities, but organic material co-mingled with non-organics.

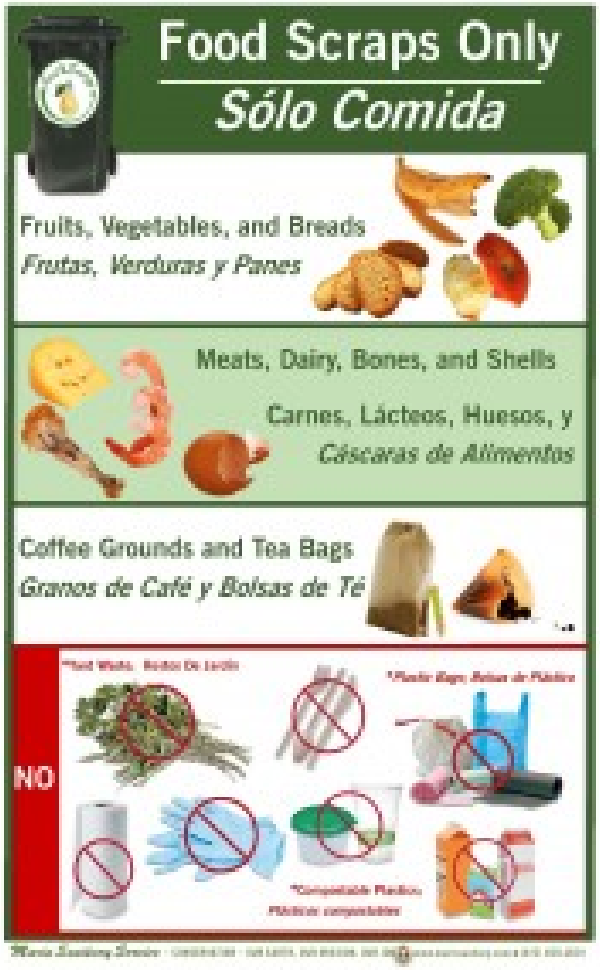
Liquid Organic Waste

Rock River Water Reclamation District

Fats, Oils and Greases (FOG)

West Lafayette, IN

Source Separated Organics (SSO)



Marin Sanitary Service

Source Separated Organics (SSO)

Source Separated Organics (SSO)

Source Separated Organics (SSO)

Marin Sanitary Service

Source Separated Organics (SSO)

Central Marin Sanitation Agency

Source Separated Organics (SSO)

Central Marin Sanitation Agency

Source Separated Organics (SSO)

Central Marin Sanitation Agency

Wet Commercial Waste

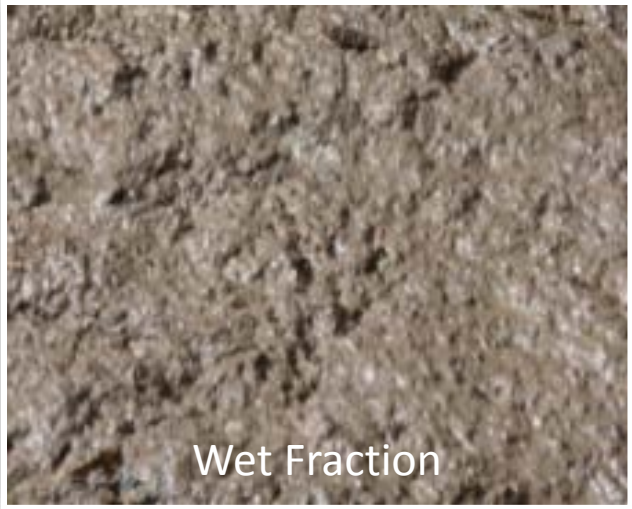
Wet Commercial Waste

Waste pulping/ screening

Digester Feed

Images: GE Monsal

Organics Extrusion Press (Anaergia)



Photos: Anaergia Services

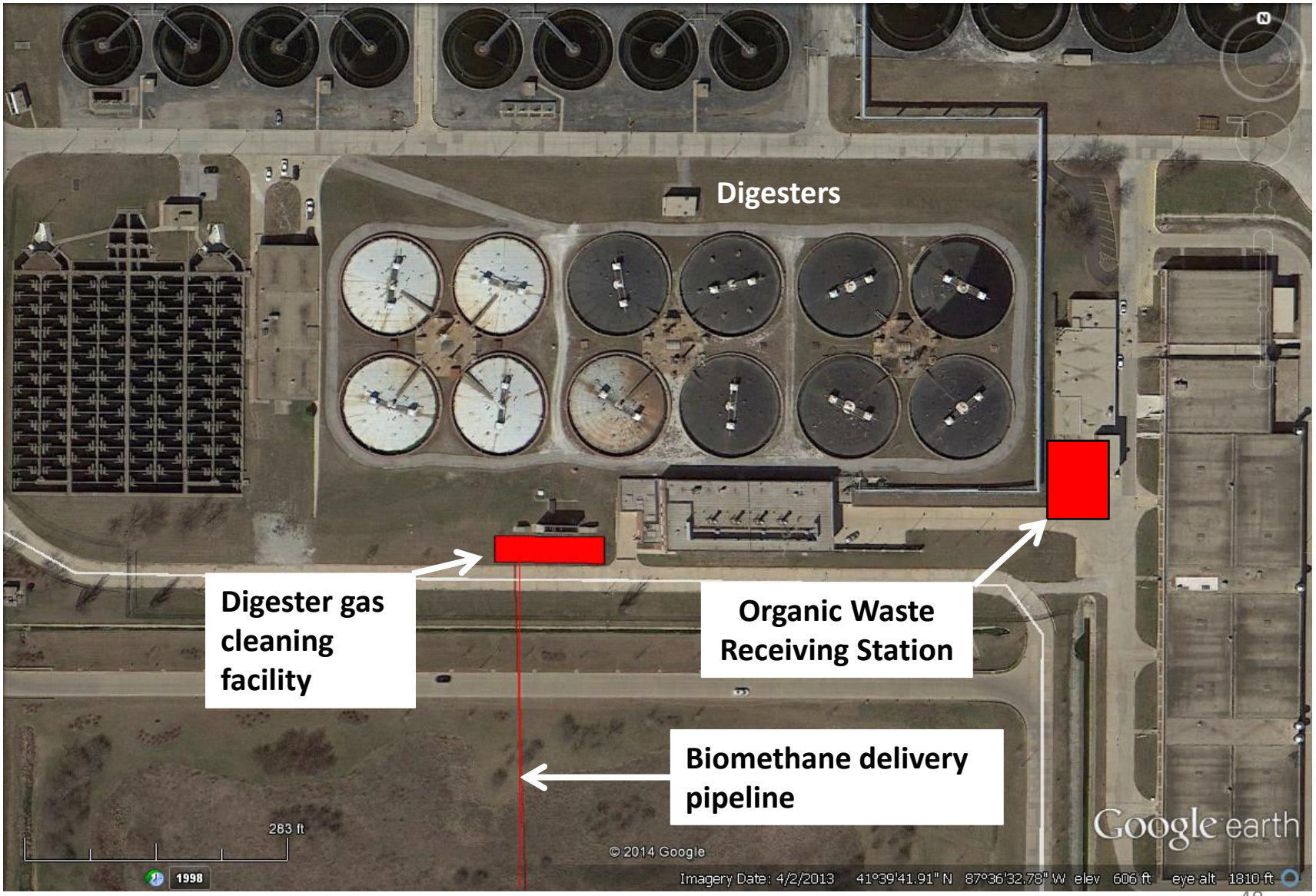
Calumet WRP
Co-Digestion and Biogas Utilization Plan

13-RFP-06 Biogas Renewable Energy Project at the Calumet Water Reclamation Plant--May 2013

CWRP Co-Digestion and Biogas Utilization Plan

Liquid Organic Waste (High Strength Waste) and FOG	Liquid Organic Waste Supply Chain Manager—15-RFP-27 (Dec. 2015)
Liquid Organics Receiving Station	Engineering Dept. Design (Summer 2016 award)
Digester Gas Cleaning Facility and Biomethane supply pipeline	Ameresco, Inc. Design/Build Contract (Nov. 2015 award)
Biomethane Offtake Agreement	BP (Jan. 2016 award)

CWRP Co-Digestion and Biogas Utilization Plan



Biogas Production--CWRP

Factor	Annual Average
Current Digester Gas Production	1,100 Mcf/d
Liquid Organics Gas Production	857 Mcf/d
Total Digester Gas Production	1,957 Mcf/d
Biomethane Production	1,026 mmBTU/d
Move Towards Energy Neutral	~40%

CWRP Biomethane Economics

Capital Costs	
Liquid Organic Waste Receiving Station	$7,400,000
Gas Cleaning Facility and Biomethane Delivery Pipeline	$14,300,000
Interest on loan	$1,800,000
Operations Costs	
Natural Gas	$1,680,000/yr
Electricity	$675,000/yr
Maintenance	$360,000/yr
Potential Revenue Source	
Liquid Organic Waste Tipping Fee	$2,500,000/yr
Sale of Biomethane	$4,500,000/yr*

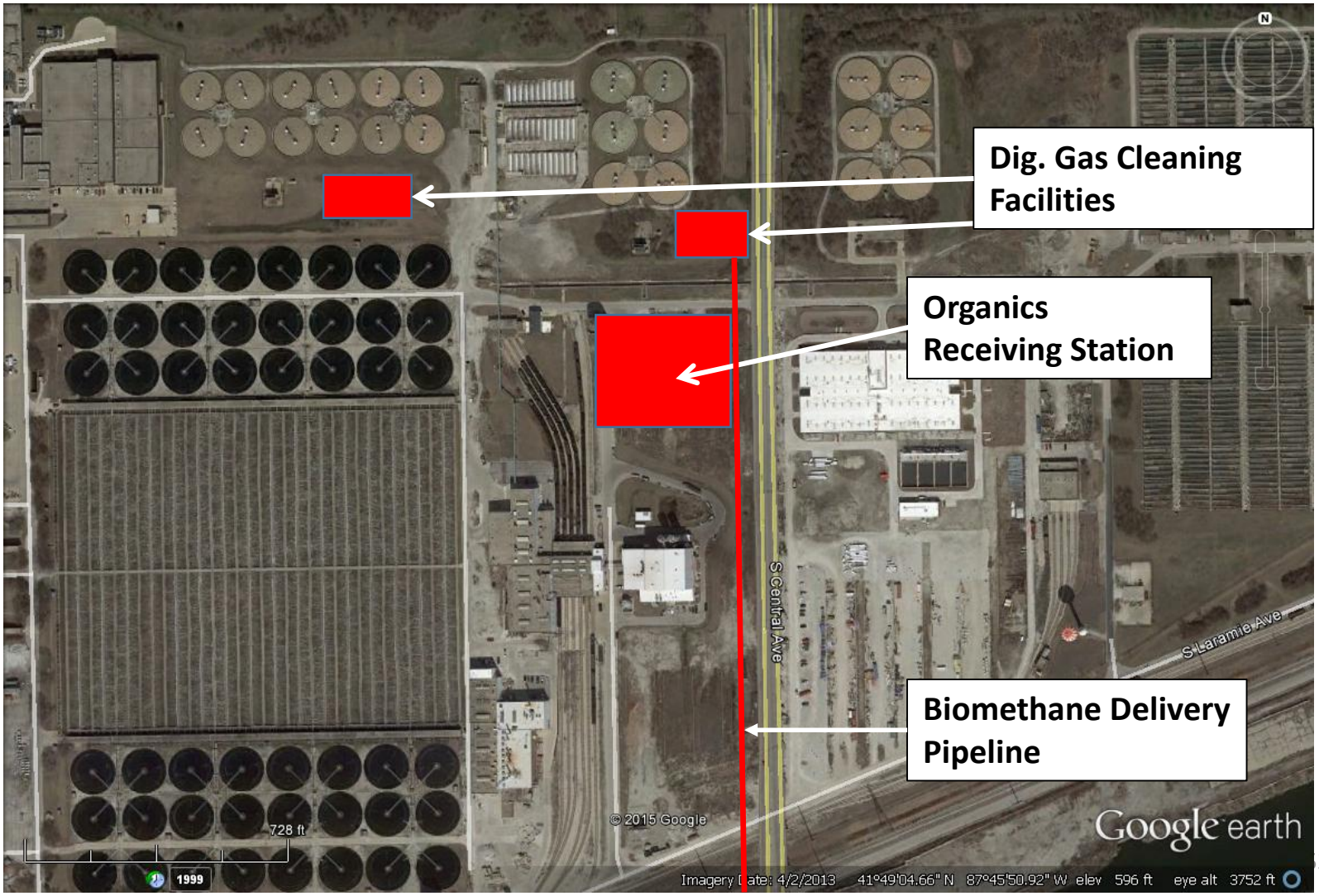
* Assumes $12/mmBTU for environmental attributes plus brown gas

Stickney WRP
Co-Digestion and Biogas Utilization Plan

SWRP Co-Digestion and Biogas Utilization Plan

SSO--Food Waste, Collected and Pre-processed offsite	RFP for Supply Contract (2016)
Organics Waste Receiving Station: • Food Waste Slurry • HSW • FOG	Engineering Dept. Design (2017 award)
Digester Gas Cleaning Facility (High BTU Plant) and Biomethane supply pipeline	RFP for Design/Build (2016)
Biomethane Offtake Agreement	RFP (2017)
Digester Gas Piping? Additional Flares?	Engineering Dept. Reviewing Options
Digester Mixers?	Engineering Dept. Reviewing Options

SWRP Co-Digestion and Biogas Utilization Plan



Digester Capacity Analysis Assumptions

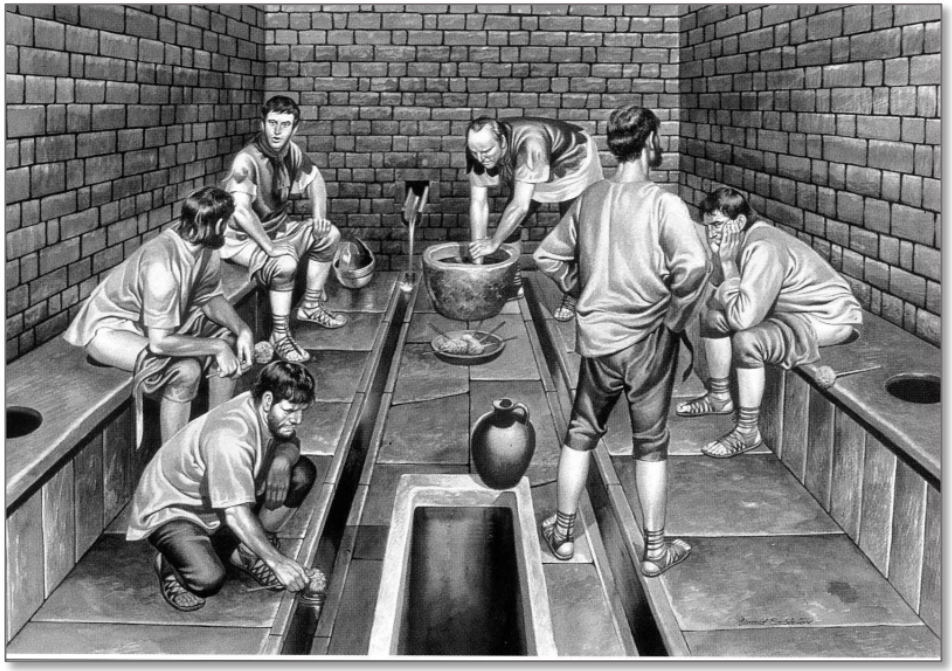
- Imhoff tanks replaced with West Side Primary Settling Tanks by year 2018
- New Gravity concentration facility and pre-digestion thickening centrifuges on-line: 5% solids to digesters
- Operational procedures to control solids loading to digesters to dampened peak loadings
- Reduce hydraulic retention time in digesters to 15 days from current 20 days (per PFRP)
- Result: Approximately 1,000,000 gal additional capacity available for outside organic wastes

Biogas Production --SWRP

Condition	Annual Average
Current Digester Gas Production	3,000 Mcf/d
WS Primary Settling Tanks	3,000 Mcf/d
1,000,000 gal/d high VS organic waste (eg. food waste)	6,000 – 11,000 Mcf/d
Total Projected Digester Gas:	12,000 – 17,000 Mcf/d
Biomethane Production	6,300 – 8,900 mmBTU/d
Organic Waste Trucks per day	150-200
Potential Biomethane Revenue	$27 - $39 million*
Potential GHG Reduction	500,000 MT CO_2e/yr
Move Towards Energy Neutral	100%

* Assumes $12/mmBTU for environmental attributes plus brown gas

Rome's sewers weren't built in a day…



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Transforming Water