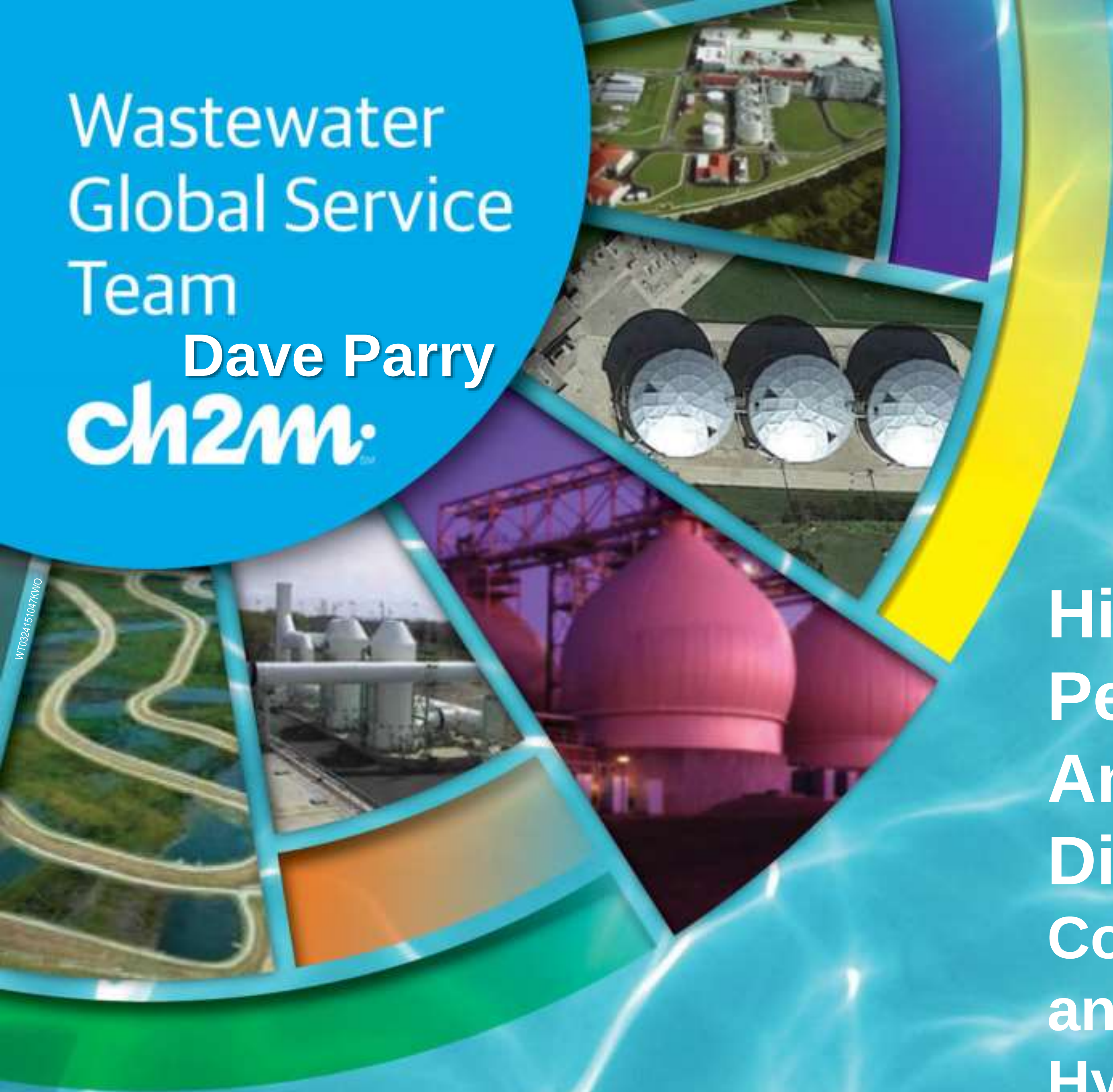


Wastewater Global Service Team

Dave Parry

ch2m

Ohio

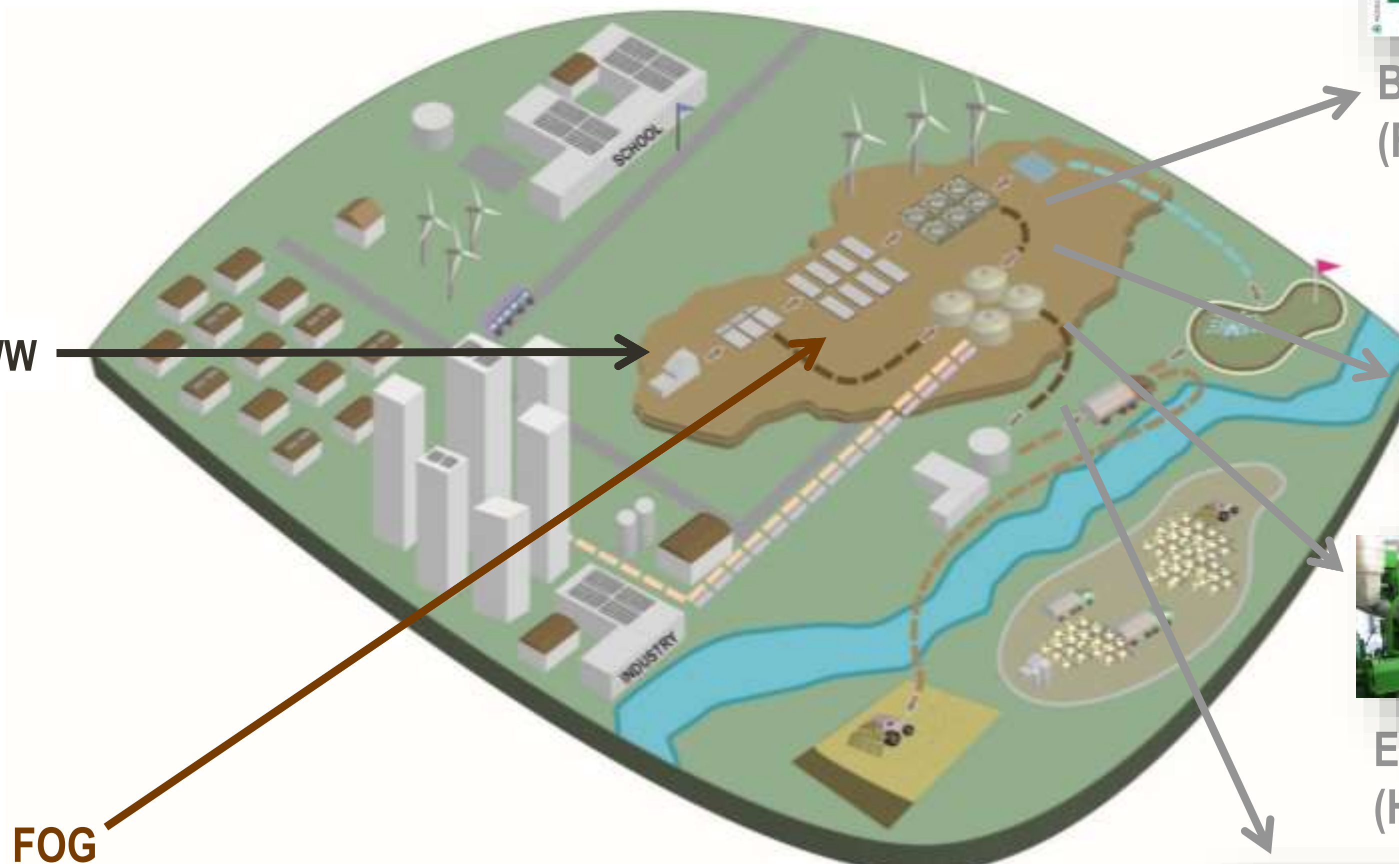
Water Environment Association

Biosolids Workshop

December 3, 2015

High Performance Anaerobic Digestion: Co-Digestion and Thermal Hydrolysis

Anaerobic Digestion is at the Heart of Resource Recovery from Wastewater



Biosolids
(Fertilizer, Fuel)

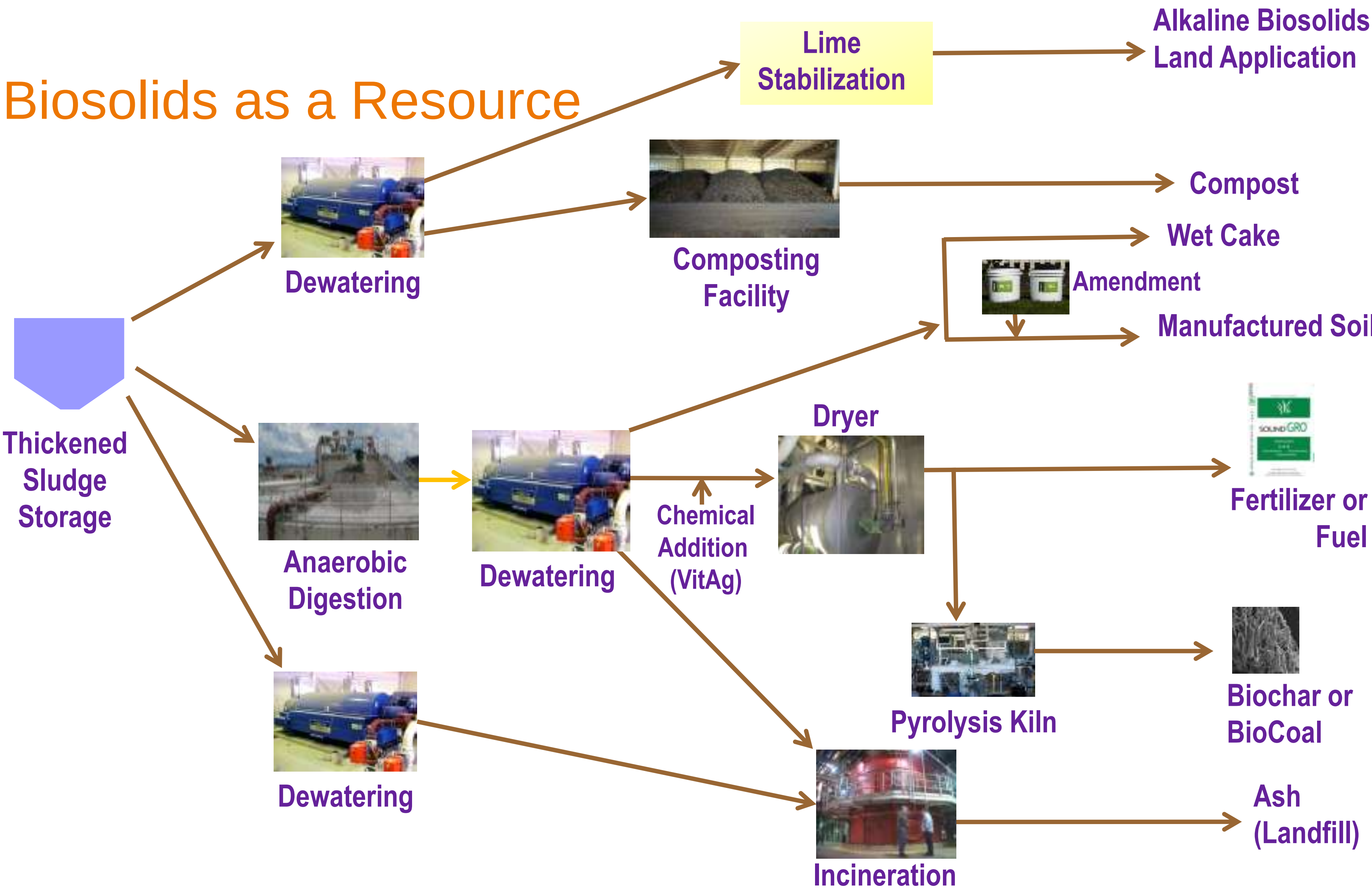
Nutrients
(Fertilizer)

Energy
(Heat, Power, Fuel)

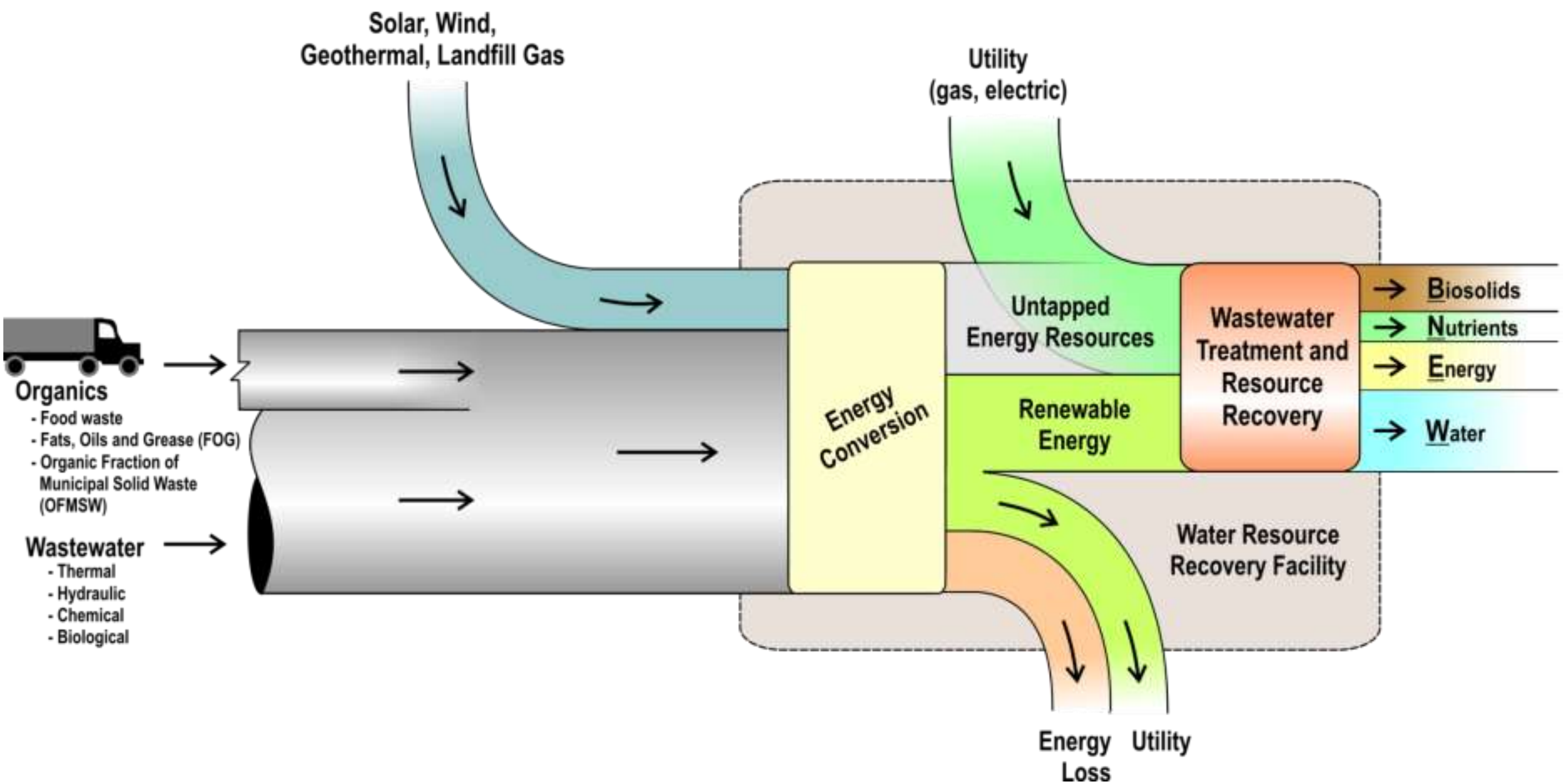
Water
(Reclaimed)

Biosolids, Nutrients, Energy, Water (BNEW) Recovery Center

Biosolids as a Resource



Energy Conversion and Resource Recovery Power Positive Resource Recovery P^2R^2 Goal



High Performance Anaerobic Digestion at the Heart of Energy Recovery

The Future is High Performance Anaerobic Digestion

High Performance Anaerobic Digestion Meets Multiple Objectives

- Achieve High Economic Value – low life cycle costs, adaptability to changing energy rates, recover valuable resource
- Be User Friendly – reliability, proven technology, ease of operation and maintenance
- Be Environmentally Sustainable – energy efficient, low carbon footprint, air quality, soil quality, water quality
- Socially Acceptable – good public relations for resource recovery, community friendly

Economic

Operational

Environmental

Social

Objectives of High Performance Anaerobic Digestion

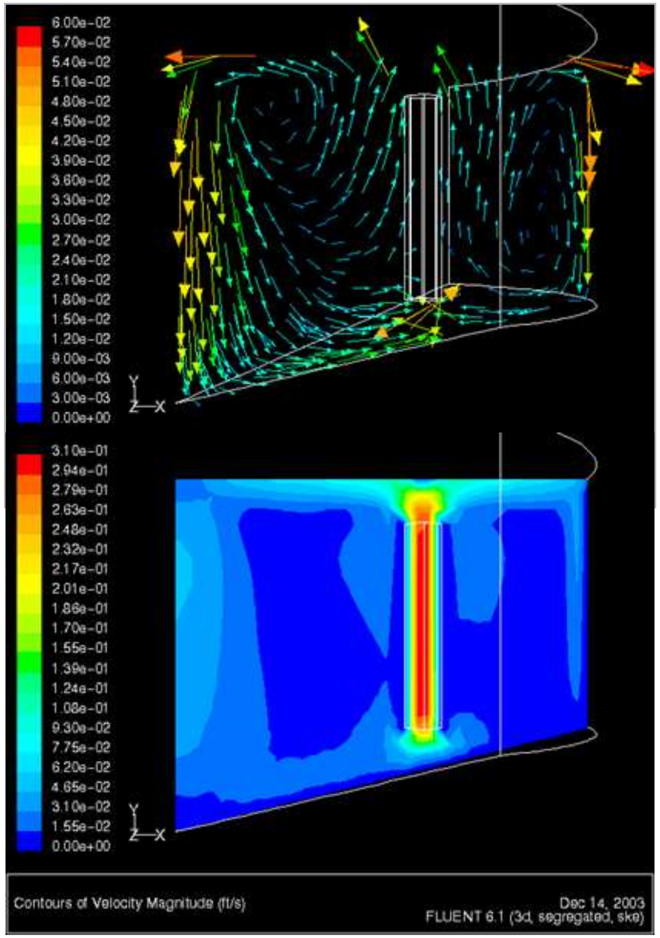
- Enhance operating characteristics
  - Increase stability
  - Reduce and manage foaming and volume change
  - Manage struvite and vivianite, hydrogen sulfide
- Improve biosolids quality
  - Reduce pathogens & odors
- Increase biomass conversion
  - More biogas, less biosolids
- Improve financial performance
  - Increase capacity
  - Produce and conserve energy

Methods to Achieve High Performance Anaerobic Digestion

- System: Best Solids Management Practice (feed, mix, heat, withdrawal)
- Engine: Enhance the Anaerobic Process
  - High temperature (thermophilic)
  - Separate phases (acid/gas)
  - Increase solids concentration and retention
- Fuel: Increase Solids Quantity and Quality
  - Co-Digestion
  - Thermal hydrolysis
- Handling: Optimize Beneficial Use of Biogas (Cogeneration, Biomethane)

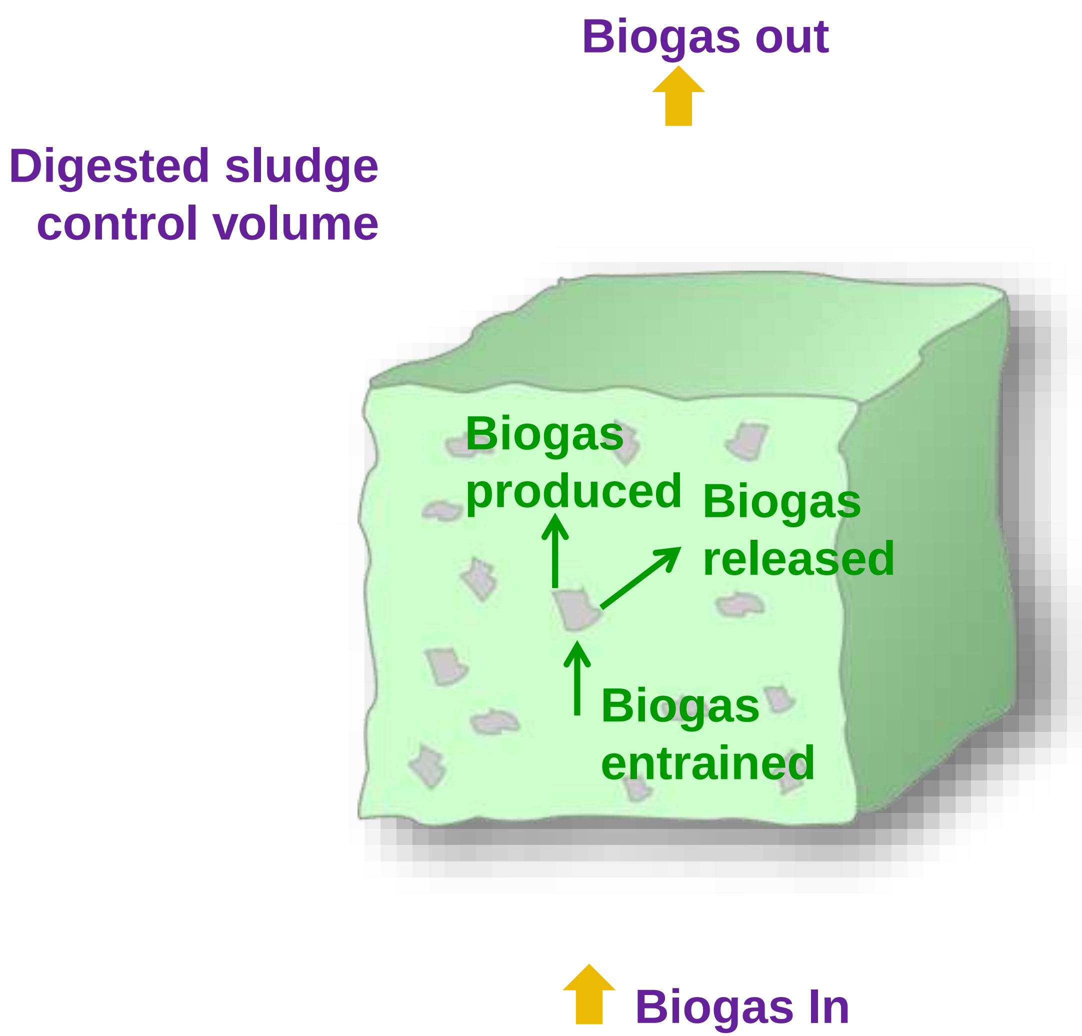
Effective Digester Mixing

- Assure effective use of entire digester
- Create uniform digester environment
- Promote contact between raw sludge and active biomass
- Evenly distribute metabolic waste products
- Reduce grit settling
- Reduce temperature stratification



Digested Sludge Density Fundamentals

More of an Issue with High Performance Anaerobic Digestion



Sludge density is inversely proportional to the amount of entrained biogas

Sludge density can change rapidly as well as the amount of biogas released

Biogas entrainment is proportional to apparent viscosity

Apparent viscosity increases with solids concentration and decreases with thermal hydrolysis and mixing

Sludge Withdrawal and Provisions for Volume Expansion

- Volume reserved for expansion
- Three overflows: normal, backup, and emergency

High Performance Biogas System

- Prevent sludge or foam from entering gas system
- Provide condensate removal
- Contain gas in digester during various operating levels
- Manage varying gas production rates
- Manage pressure
- Measure gas flow
- Clean gas for beneficial use
- Flare excess gas

High Performance Anaerobic Digestion Examples

Project and Process	**Biosolids Final Product**
Atotonilco: Modified Egg-Shaped Mesophilic	*Class B Biosolids Dewatered Cake* *Biogas fueled CHP*
Shafdan: Multi-Staged Thermophilic	*Class A Biosolids Dewatered Cake* *Biogas fueled CHP*
DC Water: Thermal Hydrolysis	*Class A Biosolids Dewatered Cake* *Biogas fueled CHP*
Des Moines: Codigestion	*Class B Biosolids* *Biogas fueled CHP and Biogas*
Encina: Biosolids Dryer and Pyrobiomethane	*Dried Biosolids Pellets and BioChar*

Atotonilco WWTP, Mexico City

1990 ML/day, 790 dtpd   Thirty 13 ML digesters   Twelve 2.8 MW CHP units

Shafdan Treatment Plant
Digestion and Cogeneration Facility
Tel Aviv, Israel

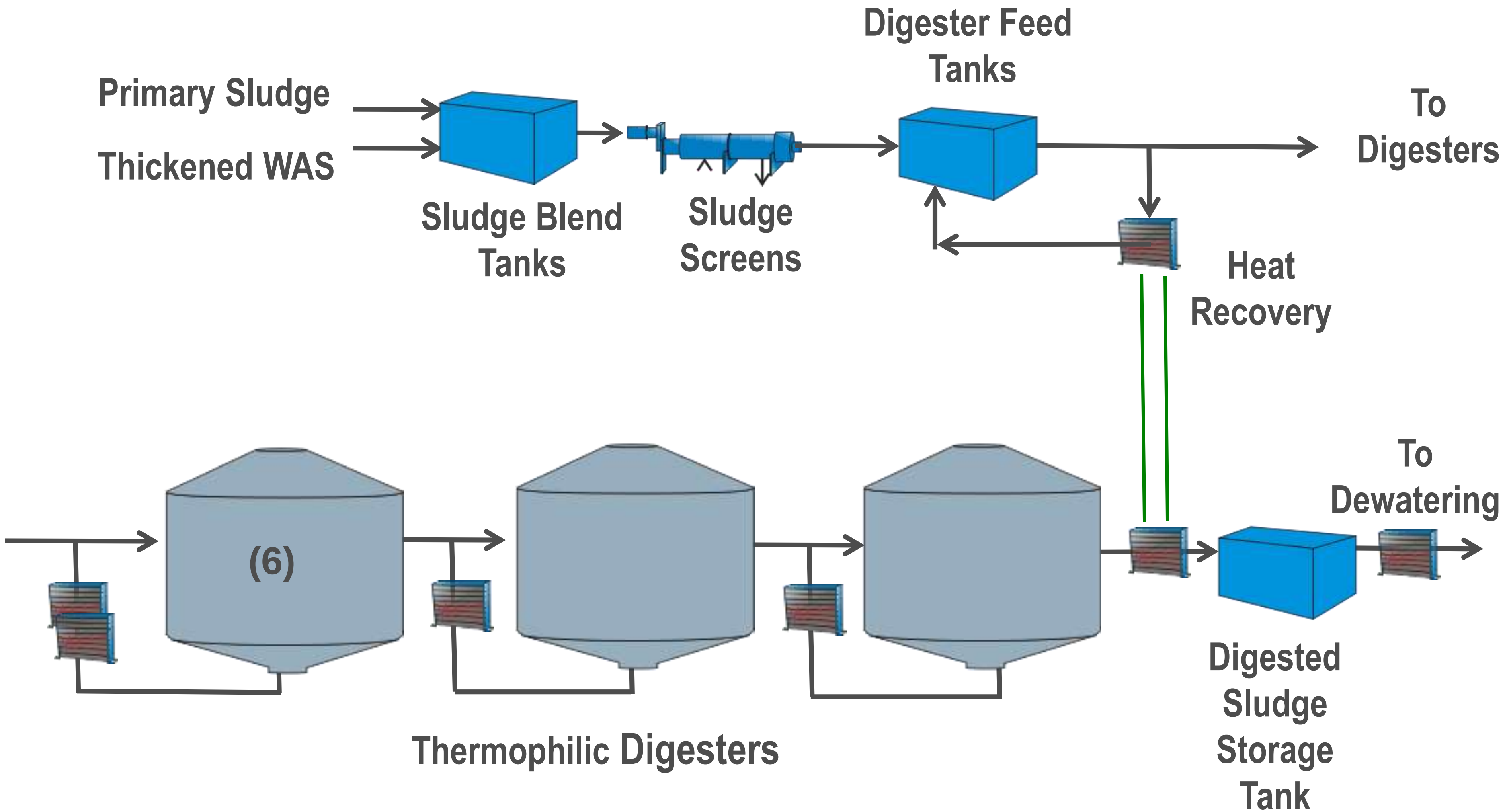

Renewable Energy

Reclaimed Water

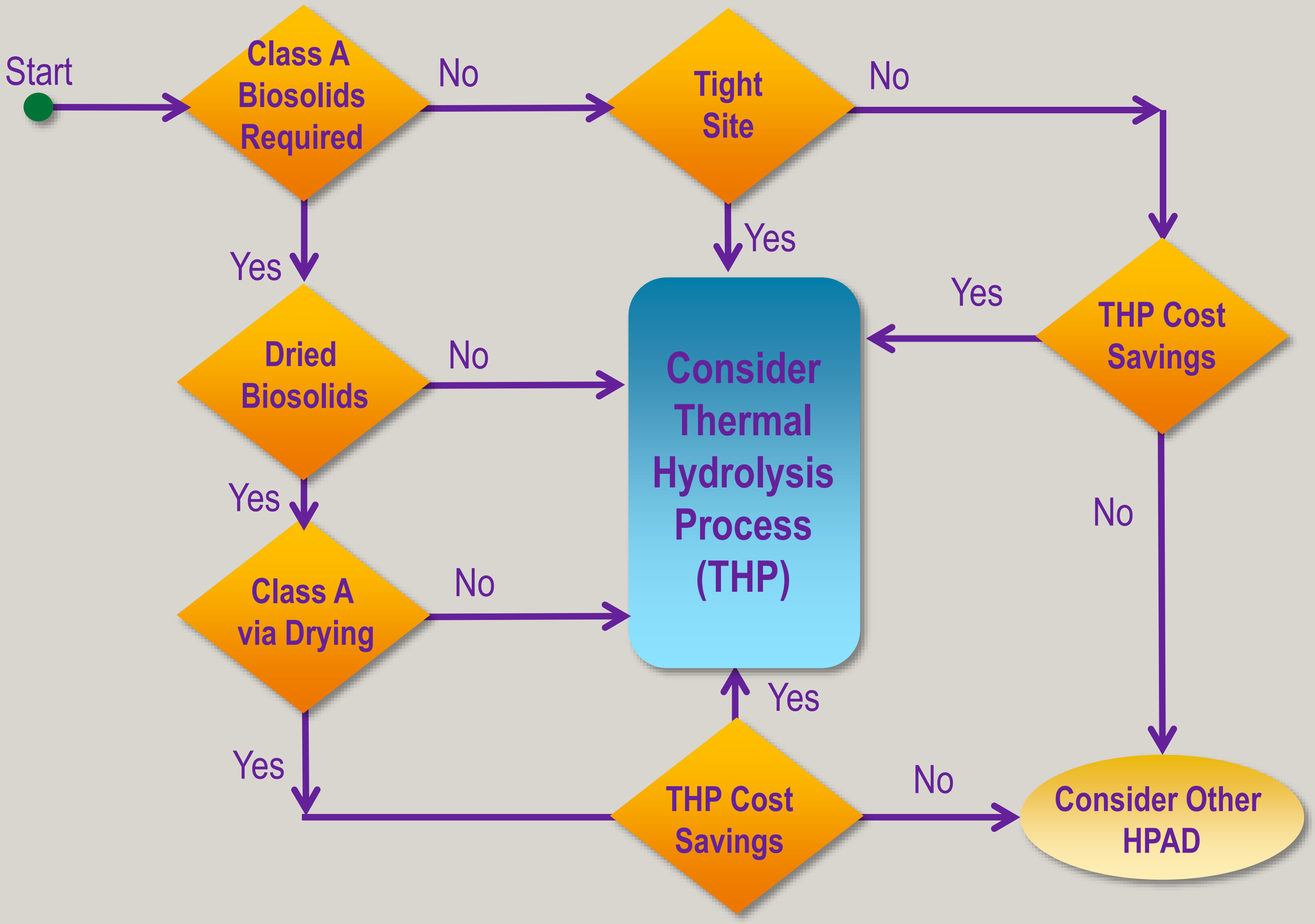
Class A Biosolids

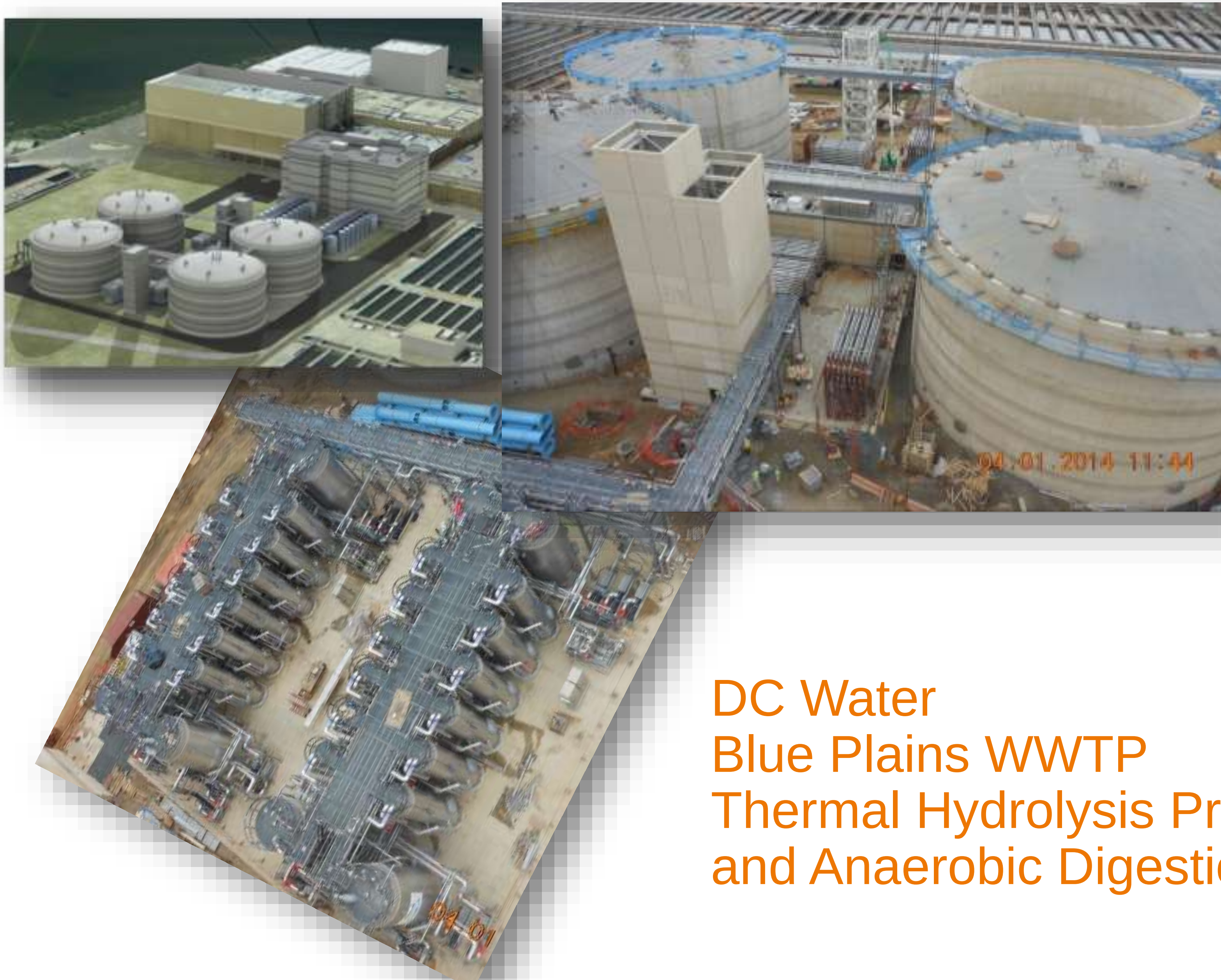
Bringing the Shafdan Digesters to Life with Jerusalem Seed

Multi-Staged Thermophilic Digestion



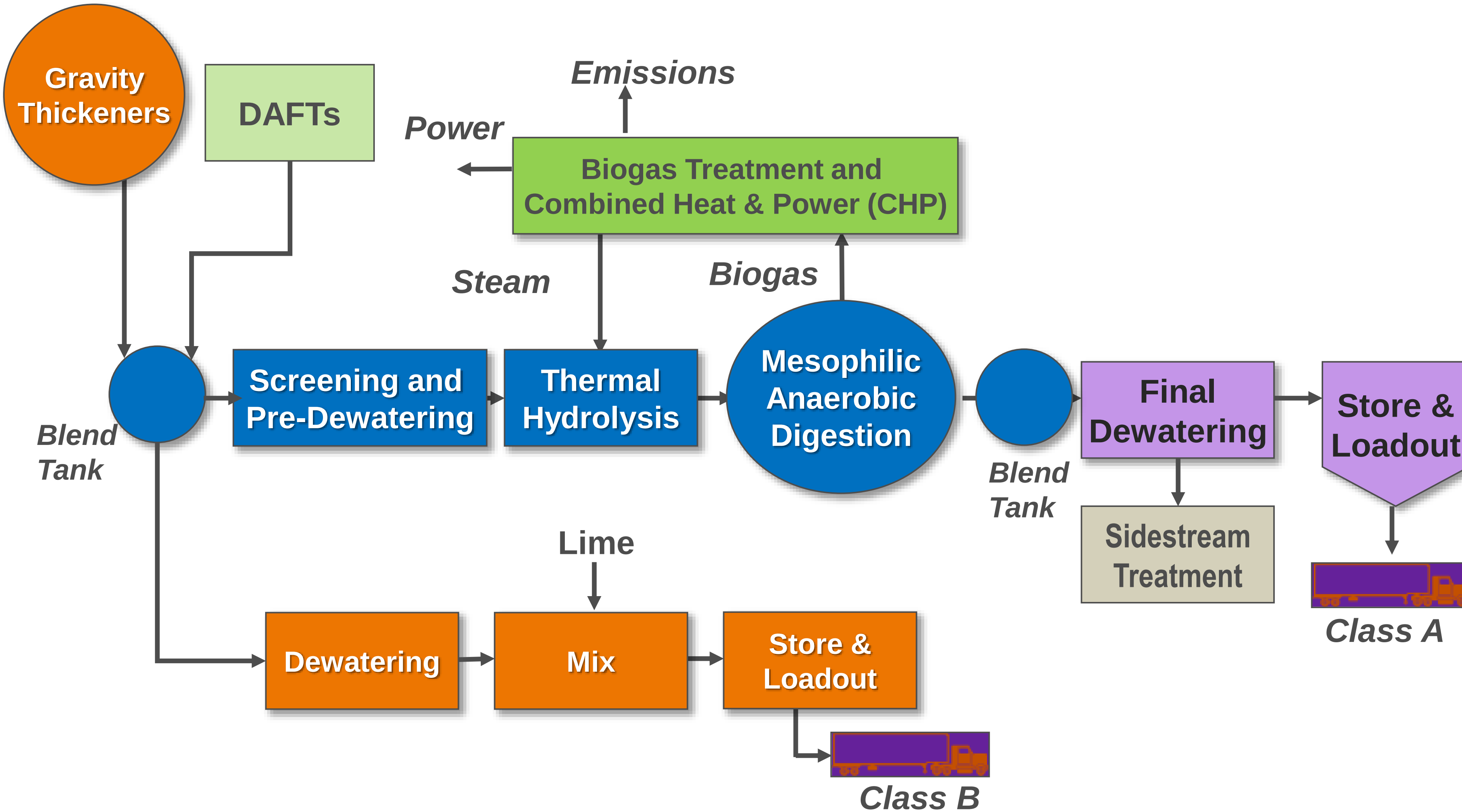
Thermal Hydrolysis Decision Guide





DC Water
Blue Plains WWTP
Thermal Hydrolysis Process
and Anaerobic Digestion

Process Schematic of DC Water's New Biosolids Program



Digester Loading Rates

	Feed Solids Concentration	Hydraulic Retention time	Volatile Solids Loading Rate	Specific Energy Loading Rate
	%	days	kgVS/day/m^3	kgCOD/day/kgVS
Atotonilco Mexico City	5.0	20	1.3	0.11
Shafdan Dan Region	5.5	13	3.1	0.29
Blue Plains DC Water	10.5	15	5.3	0.26

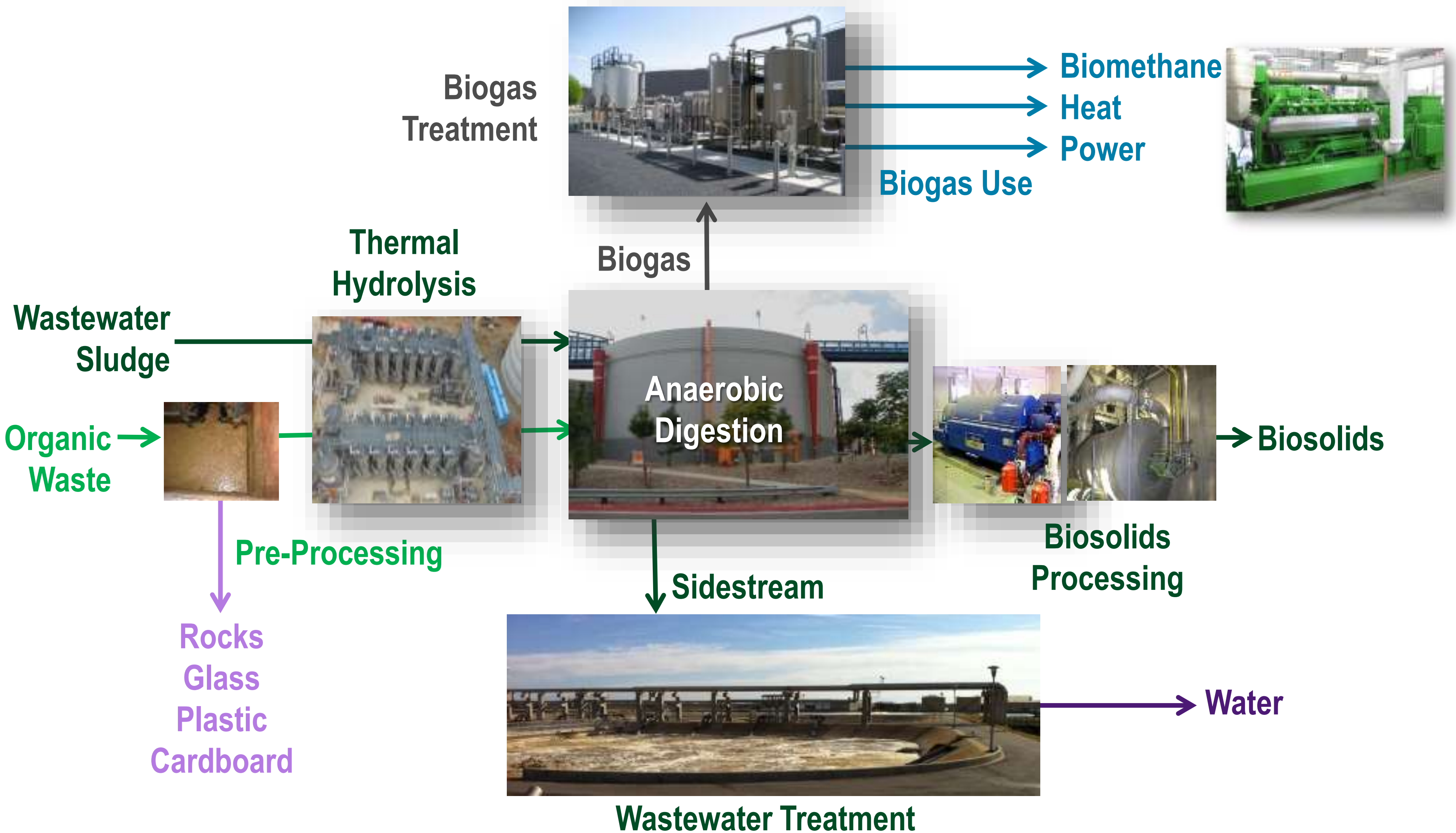
Codigestion Research WERF and ESTCP

- Bench: Waste Characterization & Biogas Production
- Lab: Acclimation
- Pilot: Organic loading rate
- Full scale: Demonstration of digester performance
- Economic analysis of codigestion

Des Moines Wastewater Reclamation Facility, Iowa Co-digestion Operation

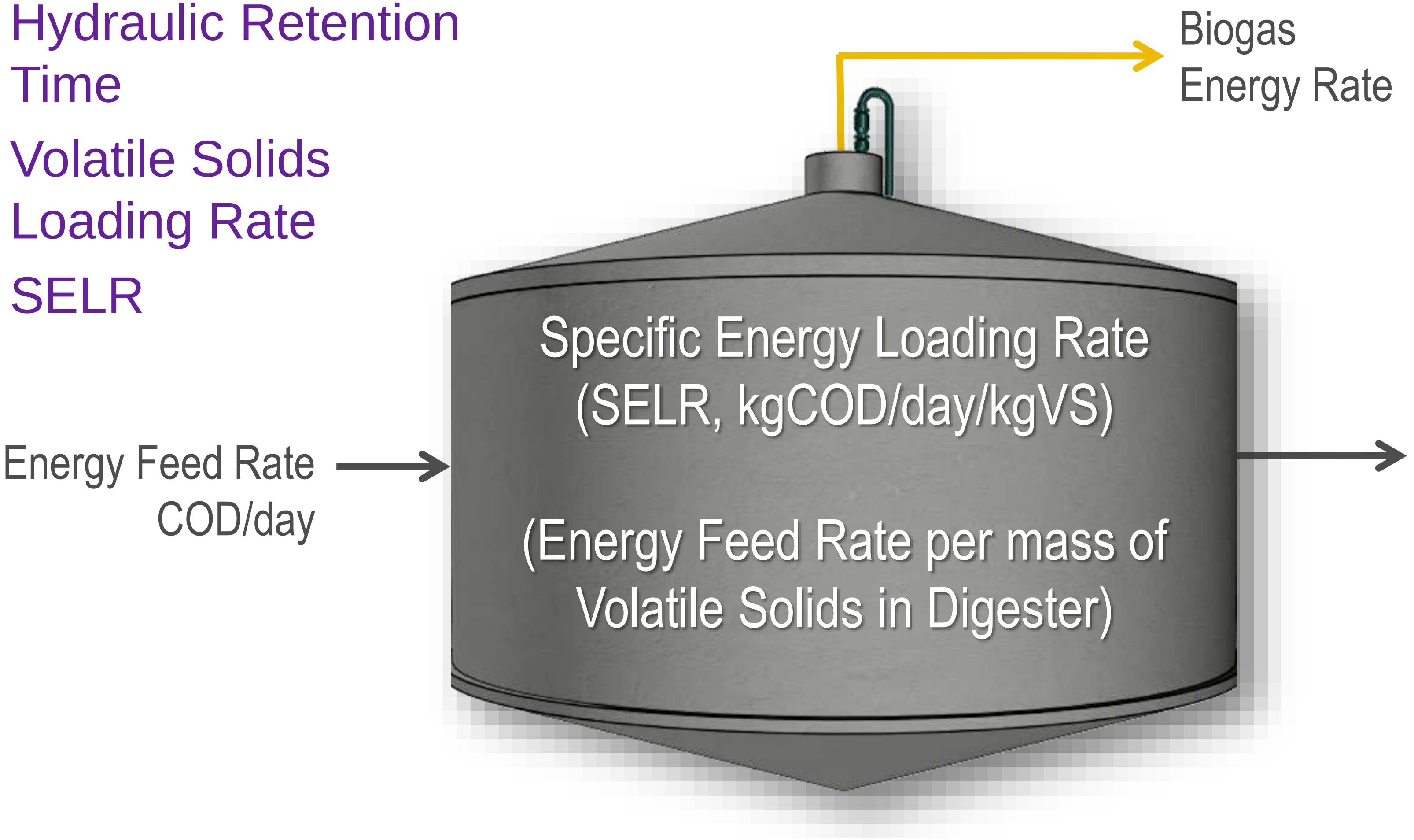
- Hauled organic wastes account for 40% of anaerobic digester feed
- Biogas sold to local industry
- Biogas Fueled CHP electrical savings
- Biogas conversion to Biomethane being considered

Co-Digestion Components



Organic Loading Rate for Codigestion, Digester Start-up, and Operation

- Hydraulic Retention Time
- Volatile Solids Loading Rate
- SELR



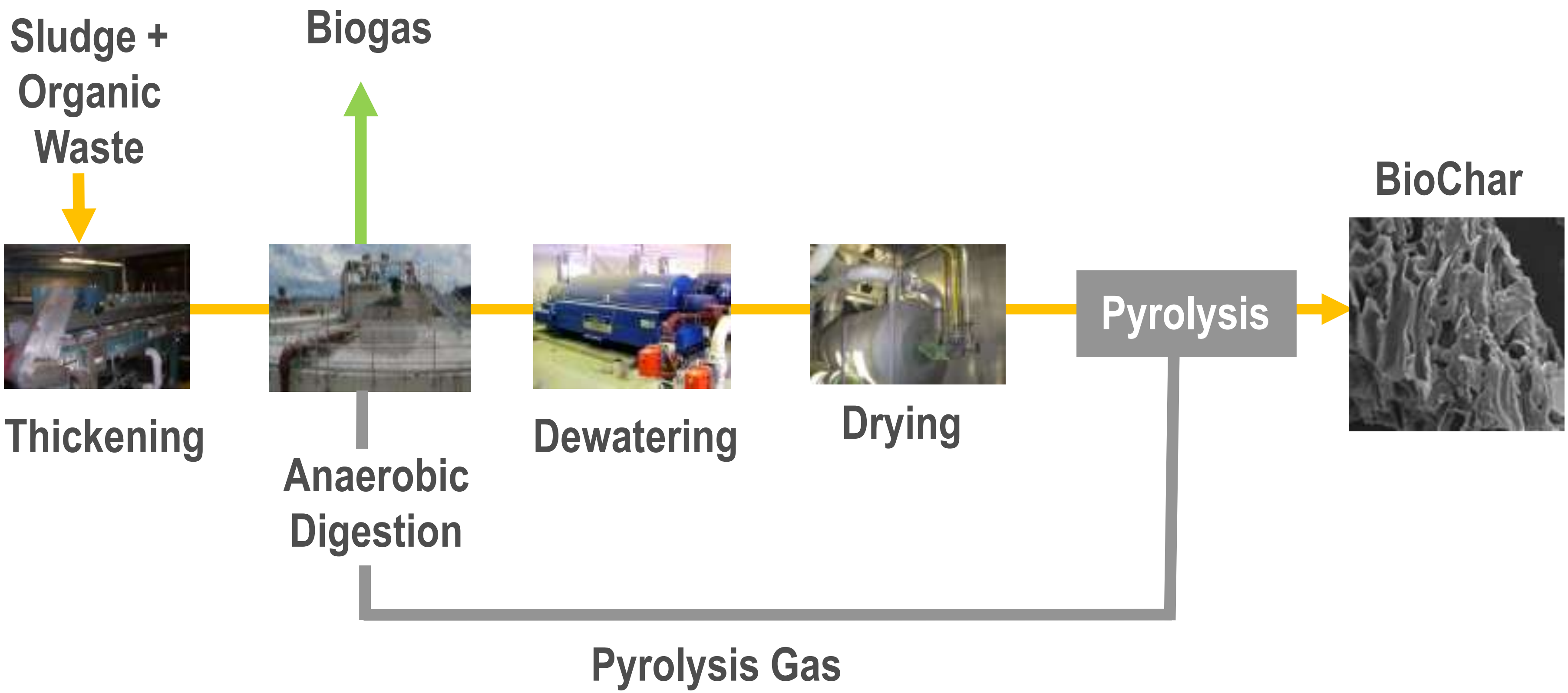
Food to Microorganism Ratio for Anaerobic Digestion

Biogas Fueled Cogeneration and Biosolids Drying, Encina Wastewater Authority, Carlsbad, CA

- Energy master planning, design, and services during construction of WWTP improvements
- 3.0 MW cogeneration system consisting of four 750 kW lean-burn engine driven generators
- Designed to strict California air quality standards

Four 750 kW Engine-Driven Generators,
Rotary Drum Dryer

Combined Digestion and Thermal Process



Full Scale PyroBioMethane in Startup Phase
Encina Water Pollution Control Facility, Carlsbad, CA

Arriving in California for Container Install

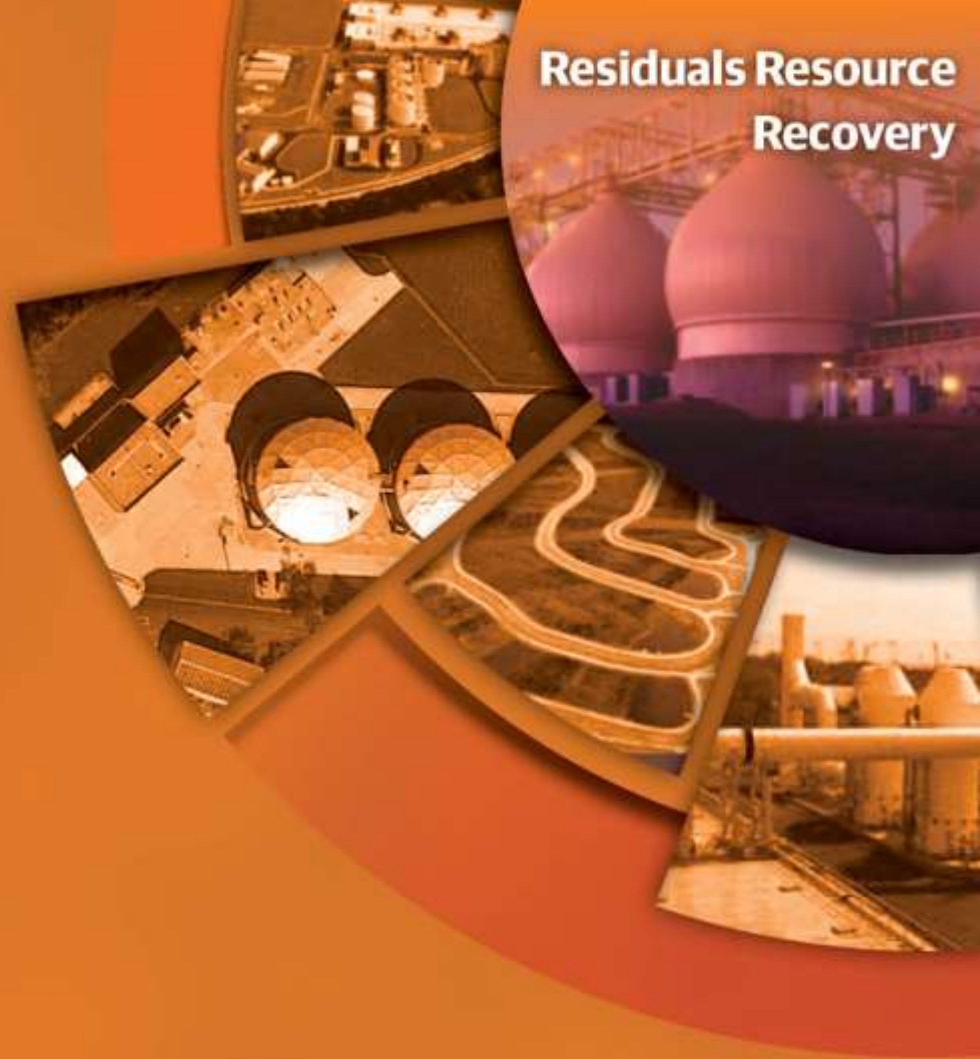
Pilot Digesters Awaiting Delivery to Encina

High Performance Anaerobic Digestion

- High Performance
- Conventional Mesophilic
- Thermophilic
- Thermal Hydrolysis
- Co-Digestion
- Digestion combined with thermal process

HPAD at the Heart of Resource Recovery from Wastewater: Biosolids, Nutrients, Energy, Water

High Performance Anaerobic Digestion



QUESTIONS?

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