

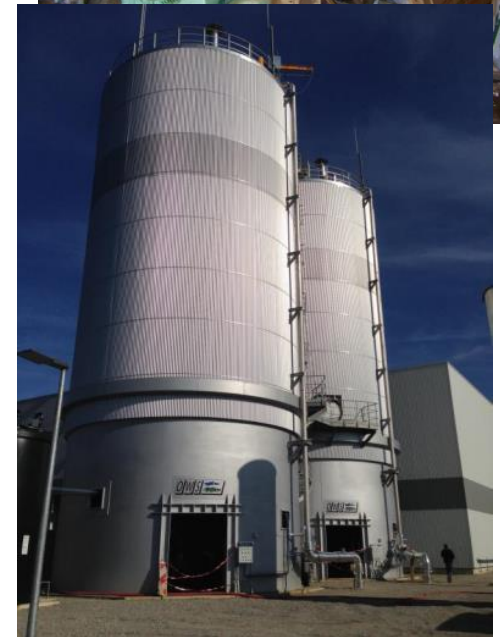
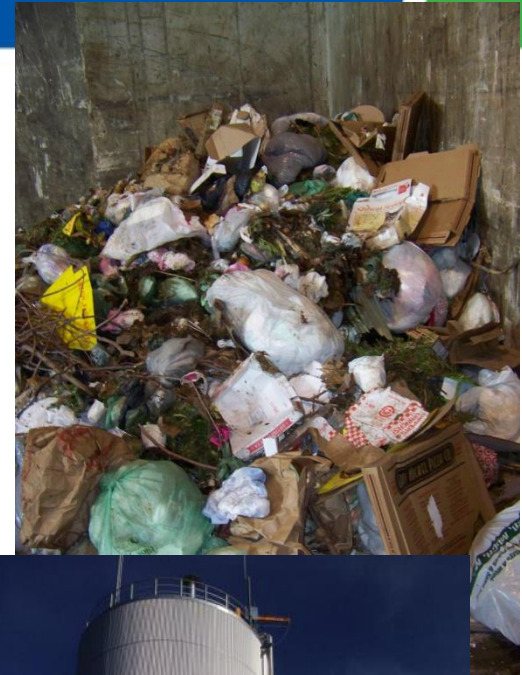


## RECOVERING ORGANICS AND ENERGY FROM MSW

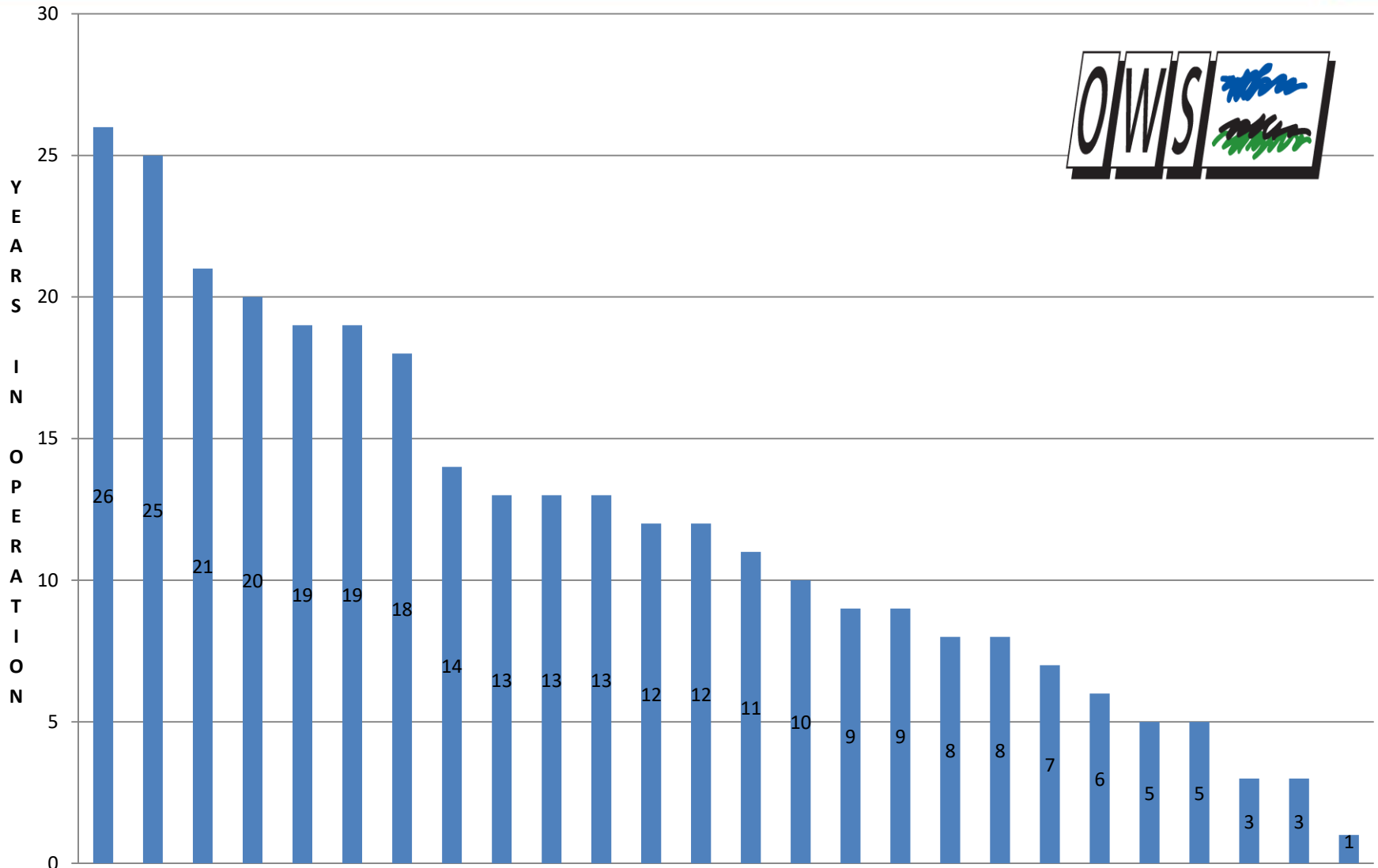
RAM/SWANA CONFERENCE – MINNEAPOLIS, OCTOBER 1018

# Brief CV of OWS

- Developer and owner of DRANCO technology: dry continuous digestion technology developed in early 80's
- OWS founded in 1988: >30 years experience in anaerobic digestion of household/municipal organic waste (SSO – OFMSW – Food Waste)
- 85 people
- 30 projects in 15 countries, >9 million tons processed to date
- HQ in Belgium; in Ohio since 1990

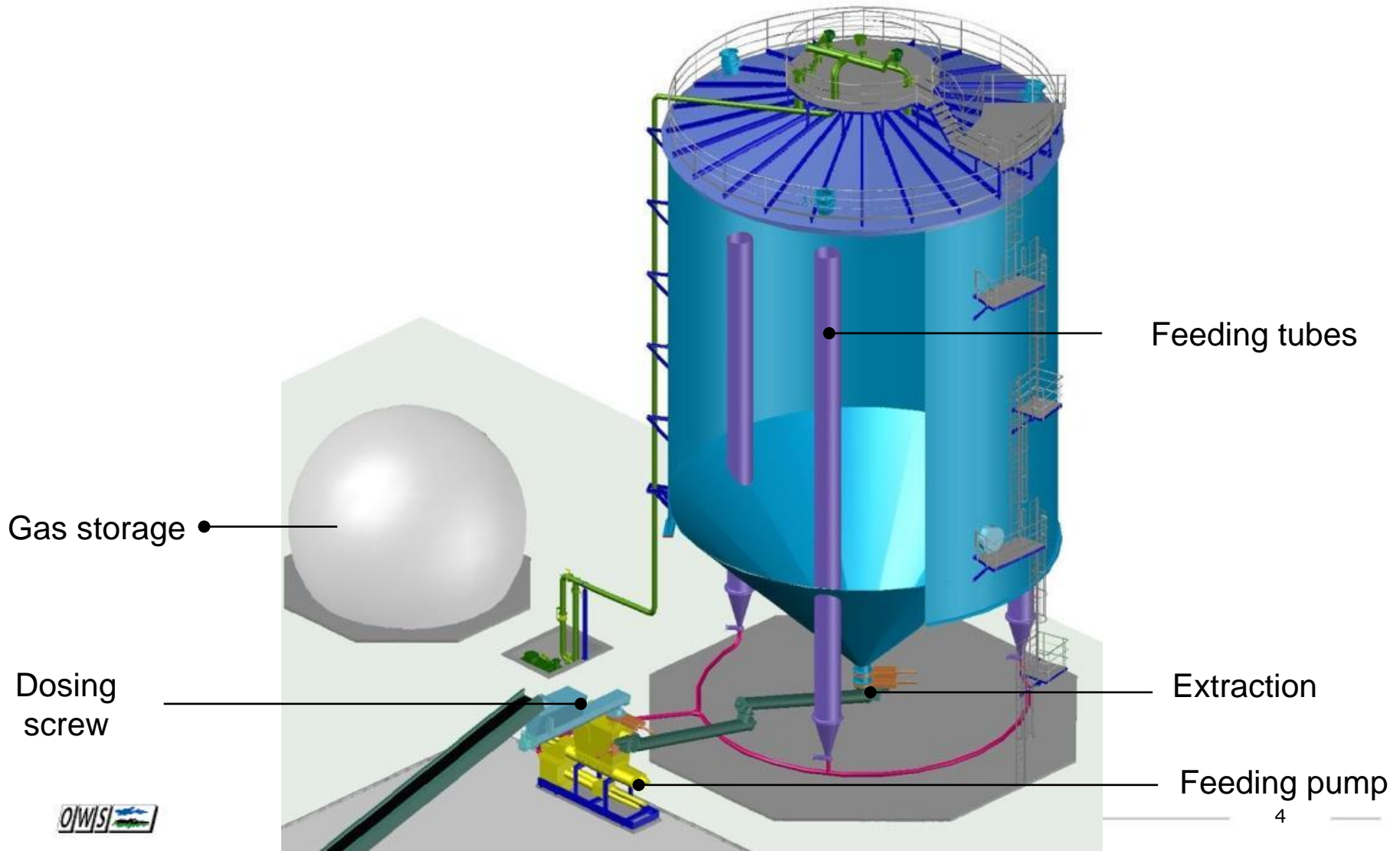


# COMMERCIALLY PROVEN TECHNOLOGY for OVER 25 YEARS



# THE DRANCO TECHNOLOGY

## DRANCO DIGESTER



- Organics in MSW represent the largest potential for increasing diversion and recycling – but how to separate them for reliable AD and clean compost? At the curb or at a facility?
- Inorganics/plastics in MSW represent thermal conversion opportunity – but how to eliminate the wet organics?
- Remaining recyclables in MSW represent potential added recovery – but how to separate a saleable fraction?



## Organic material is delivered to the digester system

This may include animal manure, food scraps, agricultural residues, or wastewater solids.

*Digested material may be returned for livestock, agricultural and gardening uses.*



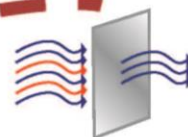
## Organic material is broken down in a digester

The digester uses a natural biological process under controlled conditions to break down organic material into products for beneficial use or disposal.

*Some biogas can be used to heat the digester.*

BIOGAS

DIGESTED MATERIAL



## Raw biogas is processed

Typically, water, carbon dioxide and other trace compounds are removed, depending on the end use, leaving mostly methane.



## Processed biogas is distributed and used

The gas may be used to produce heat, electricity, vehicle fuel or injected into natural gas pipelines.

SOLIDS

LIQUIDS



## Digested material is processed and distributed

Solids and liquids from the digester may be used to produce marketable products, like fertilizer, compost, soil amendments or animal bedding.

### organic material

Organic materials are the "input" or "feedstock" for a biogas system. Some organic materials will digest more readily than others. Restaurant fats, oils and grease; animal manures; wastewater solids; food scraps; and by-products from food and beverage production are some of the most commonly-digested materials. A single anaerobic digester may be built for a single material or a combination of them.

### the digester

An anaerobic digester is one or more airtight tanks that can be equipped for mixing and warming organic material. Naturally occurring microorganisms thrive in the zero-oxygen environment and break down (digest) organic matter into usable products such as biogas and digested materials. The system will continuously produce biogas and digested material as long as the supply of organic material is continuous, and the process remains inside the system.

### biogas processing

Biogas is mostly methane, the primary component of natural gas, and carbon dioxide, plus water vapor, and other trace compounds (e.g. siloxanes and hydrogen sulfide). Biogas can replace natural gas in almost any application, but first it must be processed to remove non-methane compounds. The level of processing varies depending on the final application.

### biogas distribution

Processed biogas, often called "biomethane" or "renewable natural gas," can be used the same way you use fossil natural gas: to produce heat, electricity, or vehicle fuel, or to inject into natural gas pipelines. The decision to choose one use over another is largely driven by local markets.

### digested material

In addition to biogas, digesters produce solid and liquid digested material, containing valuable nutrients (nitrogen, phosphorus and potassium) and organic carbon. Typically, raw digested material, or "digestate," is processed into a wide variety of products like fertilizer, compost, soil amendments, or animal bedding, depending on the initial feedstock and local markets. These "co-products" can be sold to agricultural, commercial and residential customers.

# BIOGAS – Uniquely flexible in feedstocks, process, products and revenue streams

## AGRICULTURAL

MANURE  
STOVER  
STUBBLE  
SPOILAGE  
COMPOSTED MORTALITY  
ENERGY CROP

## AG PROCESSING BYPRODUCTS

GLYCERIN  
SYRUP STILLAGE  
BLEACHING CLAY  
COBS AND HUSK LAGE  
SPOILAGE

## FOOD PROCESSING RESIDUALS

BAKERY  
FATS, OILS AND GREASES  
VEGETABLES  
WHEY  
OTHER DAIRY WASTE  
RUMEN CONTENTS  
ANIMAL RENDERING FATS

## PAPER WASTE

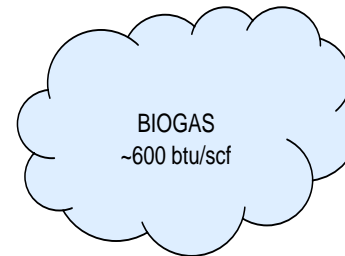
SHREDDED OFFICE PAPER  
SHREDDED CARDBOARD

## COMMUNITY

LEAVES  
GRASS CLIPPINGS  
RESTAURANT WASTE  
CAFETERIA WASTE

WET DIGESTION  
5-13% TOTAL SOLIDS  
1-10 SCF/GALLON BIOGAS  
Minimum Economical Size:  
25 million gpy

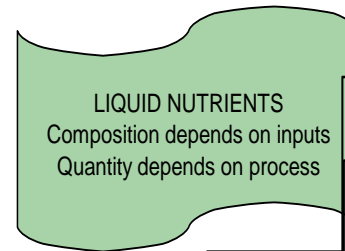
DRY DIGESTION  
20-45% TOTAL SOLIDS  
40-100 SCF/GALLON  
BIOGAS  
Minimum Economical Size:  
50,000 ton/yr



BIOGAS  
~600 btu/scf

MEDIUM BTU GAS SOLD TO LARGE USER
HIGH BTU GAS SOLD TO LARGE USER OR UTILITY
ELECTRICITY SOLD TO LARGE USER OR UTILITY
USE AS VEHICLE FUEL REPLACEMENT

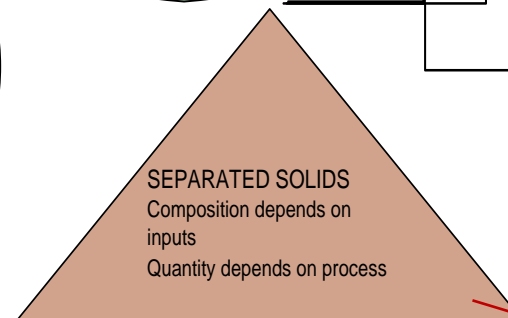
*Value of energy depends on market conditions  
and type of energy produced*



LIQUID NUTRIENTS  
Composition depends on inputs  
Quantity depends on process

DIRECT LAND APPLICATION
CONCENTRATION AND BULK SALES
ALGAE CULTIVATION
GREENHOUSE AQUACULTURE

*Use of effluents depends on local  
market conditions  
Opportunities for new business  
development*



SEPARATED SOLIDS  
Composition depends on  
inputs  
Quantity depends on process

CELLULOSIC  
ETHANOL  
PRODUCTION

*Need to know what is available  
where and at what cost*

*Choice of process dictated by feedstocks  
Both processes require carbon:nitrogen balancing  
Either process could be local or central*

*Biogas production is determined by feedstocks and process  
Quantity and composition of effluents depends on  
inputs and process*

# HOW DOES AD COMPARE?

140°F+

35°F - 85°F

Variable

COMPOST > SOIL > FRESH WATER > MARINE WATER > LANDFILL

---

ANAEROBIC DIGESTION

95°F or 135°F



# HOW DOES AD COMPARE?

Fungi + Bacteria  
+ Actinomycetes

Bacteria only (almost)

COMPOST > SOIL > FRESH WATER > MARINE WATER > LANDFILL

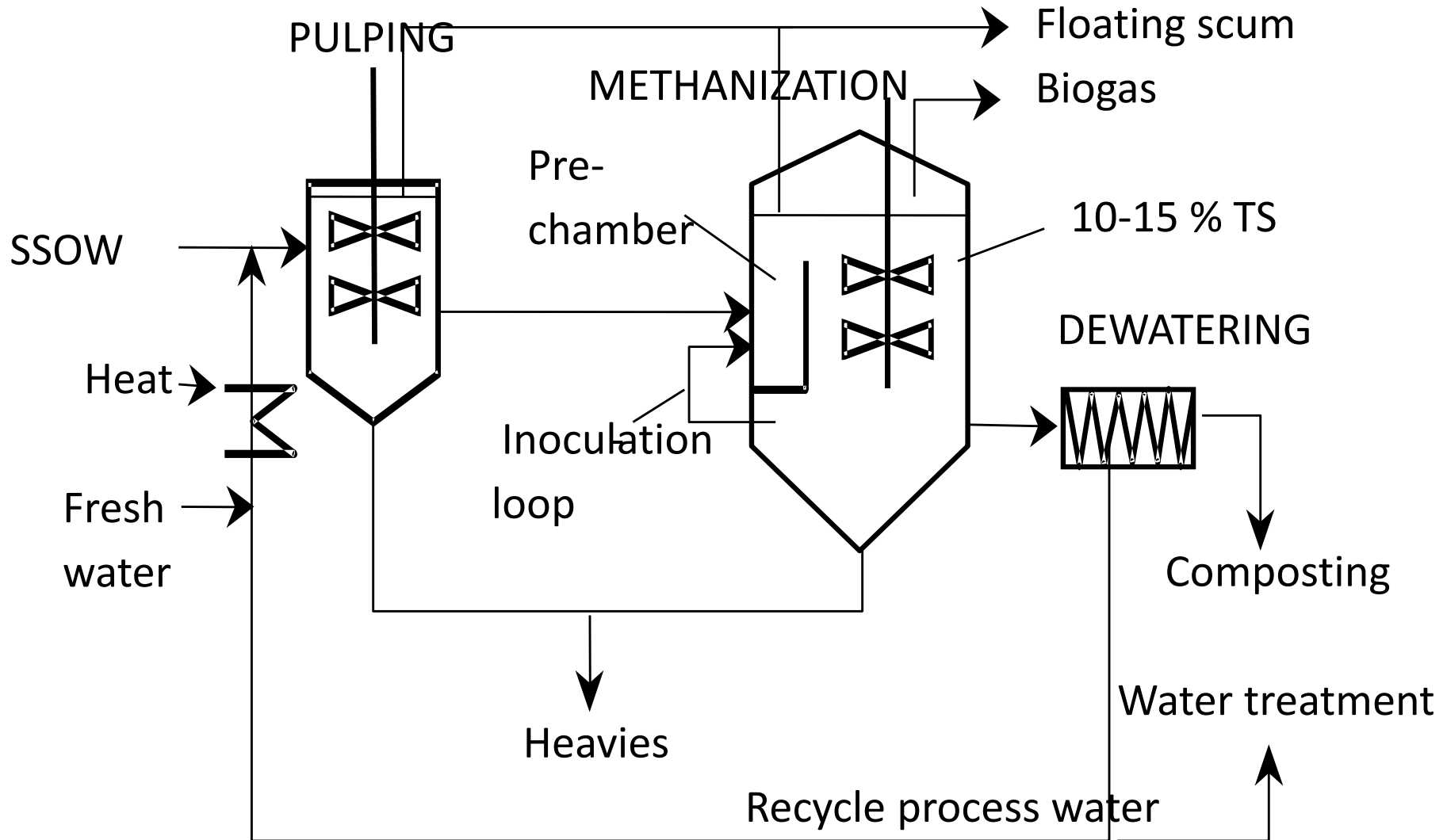
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## ANAEROBIC DIGESTION

Multiple Bacteria

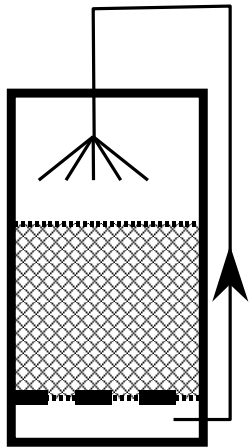


# WET SYSTEMS



# BATCH SYSTEMS

A. Single-stage

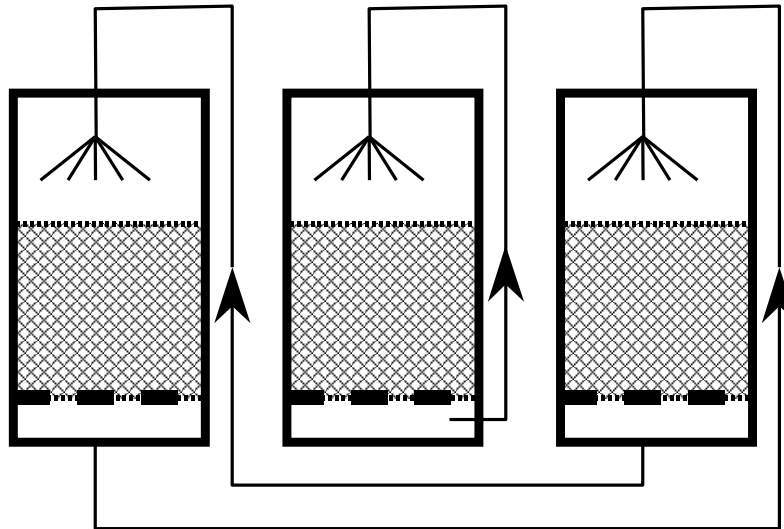


B. Sequential batch

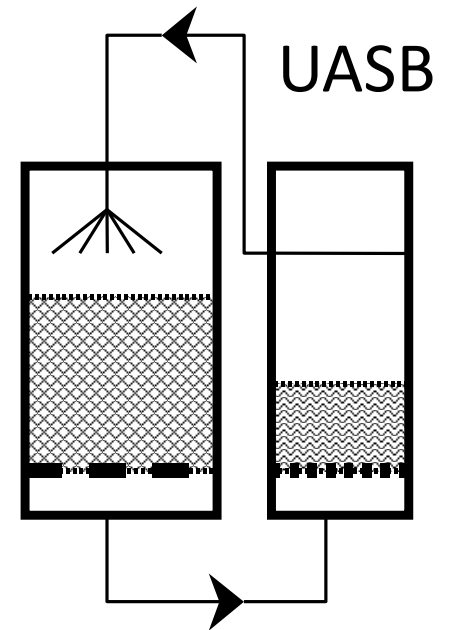
New

Mature

Old

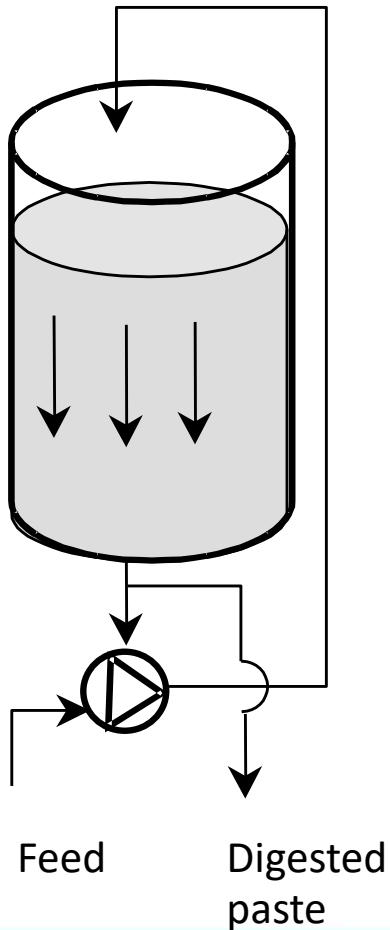


C. Hybrid batch-UASB

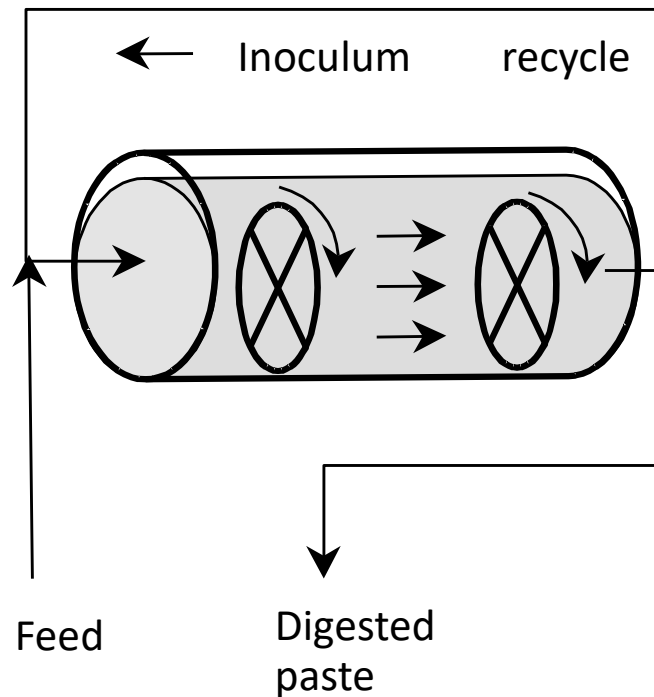


# DRY CONTINUOUS SYSTEMS

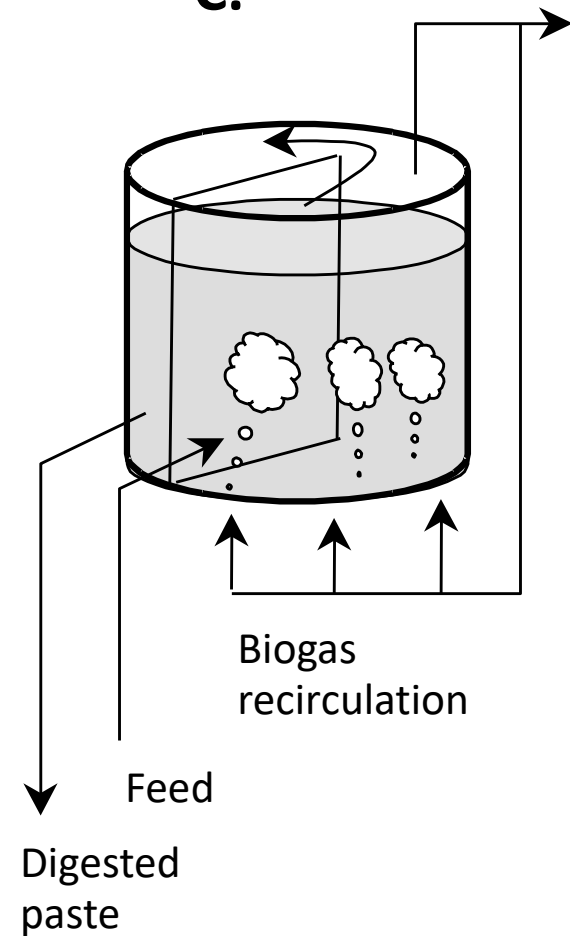
A.



B.



C.

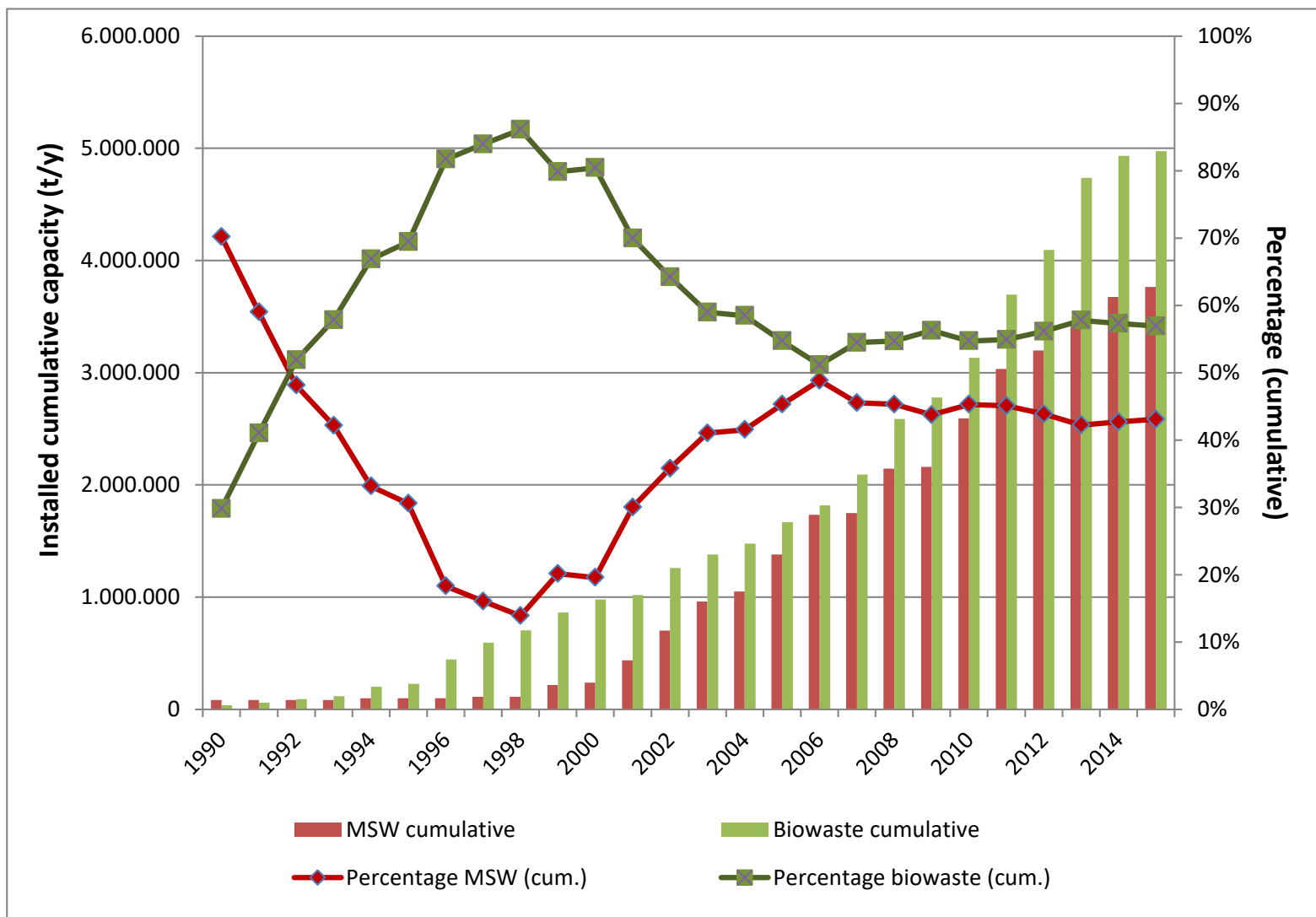


*Dry continuous systems design (A - Dranco, B - Kompogas and BRV, and C - Valorga)*

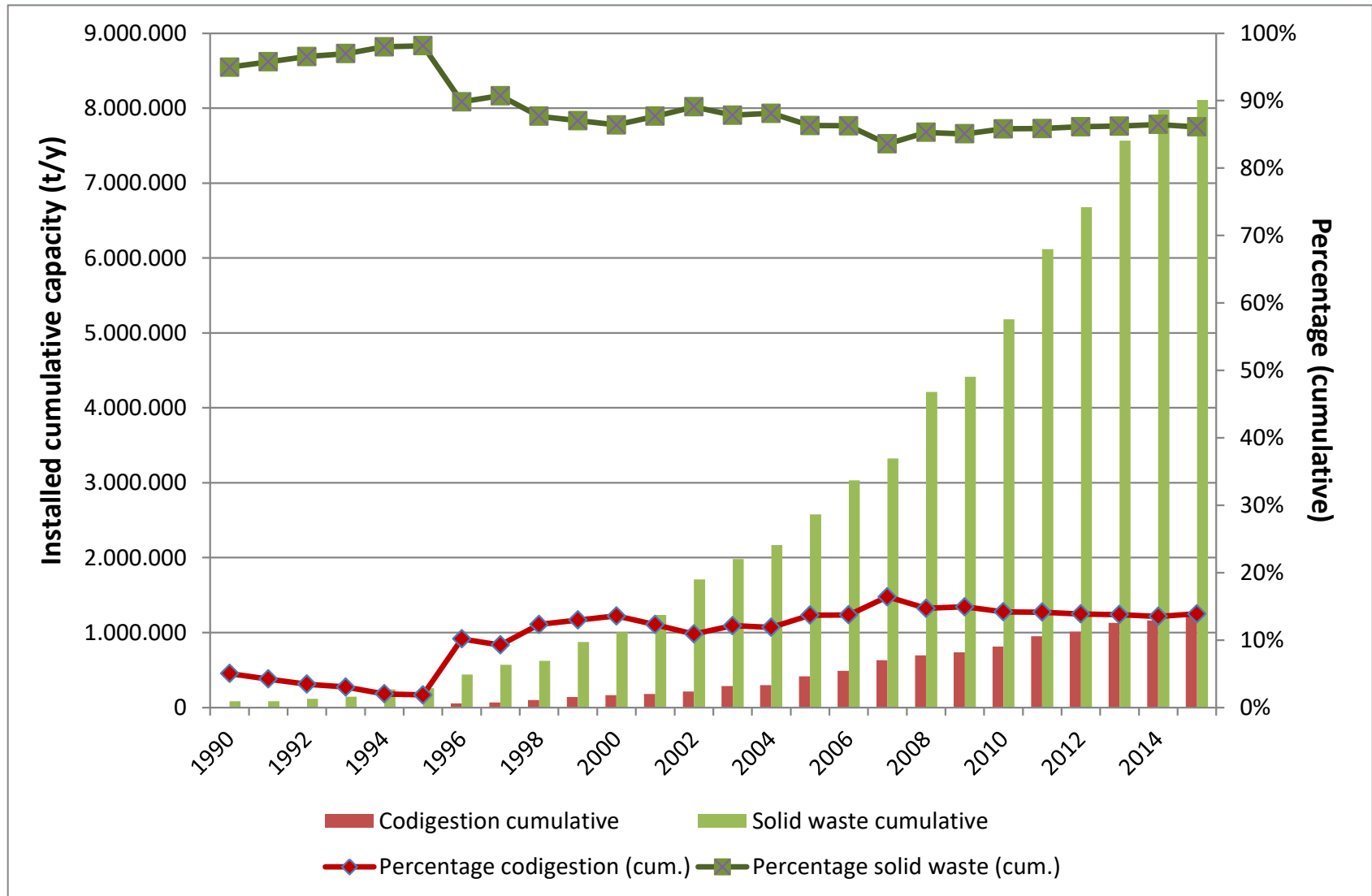
# Benefits of Anaerobic Digestion

Waste Management	Energy	Environmental	Economic
<ul style="list-style-type: none"> <li>•Biological process</li> <li>•Mature technology</li> <li>•Small footprint</li> <li>•Reduces waste volume</li> <li>•Very efficient and complete decomposition</li> <li>•Nutrient recovery</li> <li>•It's <u>recycling</u>, not disposal</li> </ul>	<ul style="list-style-type: none"> <li>•Net-energy producing</li> <li>•Multiple end-uses for biogas: <ul style="list-style-type: none"> <li>•Heat/electricity/both</li> <li>•Pipeline quality, renewable natural gas</li> <li>•Vehicle fuel</li> </ul> </li> <li>•Very reliable</li> <li>•Baseload renewable energy (not intermittent)</li> </ul>	<ul style="list-style-type: none"> <li>•Complete biogas/methane capture</li> <li>•Odor reduction</li> <li>•Reduced pathogens</li> <li>•Reduced greenhouse gases</li> <li>•Addresses nutrient run-off</li> <li>•Increased crop yield</li> </ul>	<ul style="list-style-type: none"> <li>•Reduced waste volume</li> <li>•Reduces costs</li> <li>•Jobs (temporary and permanent)</li> <li>•Balance sheet: changes an expense to revenue</li> <li>•Works well with composting (biogas first)</li> <li>•Marketing: A Greener Choice</li> </ul>

# AD is Equally relevant to SSO and OFMSW



# Co-digestion of Solid Organics at WWTPs has limits



# Develop both SSO and OFMSW pathways

## SSO

- Economics, logistics vary by community – do it where it makes sense
- Separate collection will get ~50%, composition will vary greatly between residential/ICI
- Tailor pretreatment for AD system requirements

## OFMSW

- Achieve >85% diversion
- Shift collection savings to pretreatment costs
- Can be sole route, or in addition to SSO
- Depending on primary goal (SLCP reduction or organics recovery), spend proportionately on compost or ADC production

# Integrate AD+Compost

- Achieve higher overall diversion by converting food/green waste, soiled, non-recyclable paper
- Maintain waste treatment fee paradigm, *but combine with organics recovery and recycling*
- Expedite permitting (?)
- Being “neighborly” by reducing open time, emissions, odors
- “Marry into” market expertise for compost production and sales
- Eliminate redundant capital expenses for pretreatment
- Manage seasonal volume/composition fluctuations

# **CASE STUDY:**

**Hengelo (The Netherlands)**

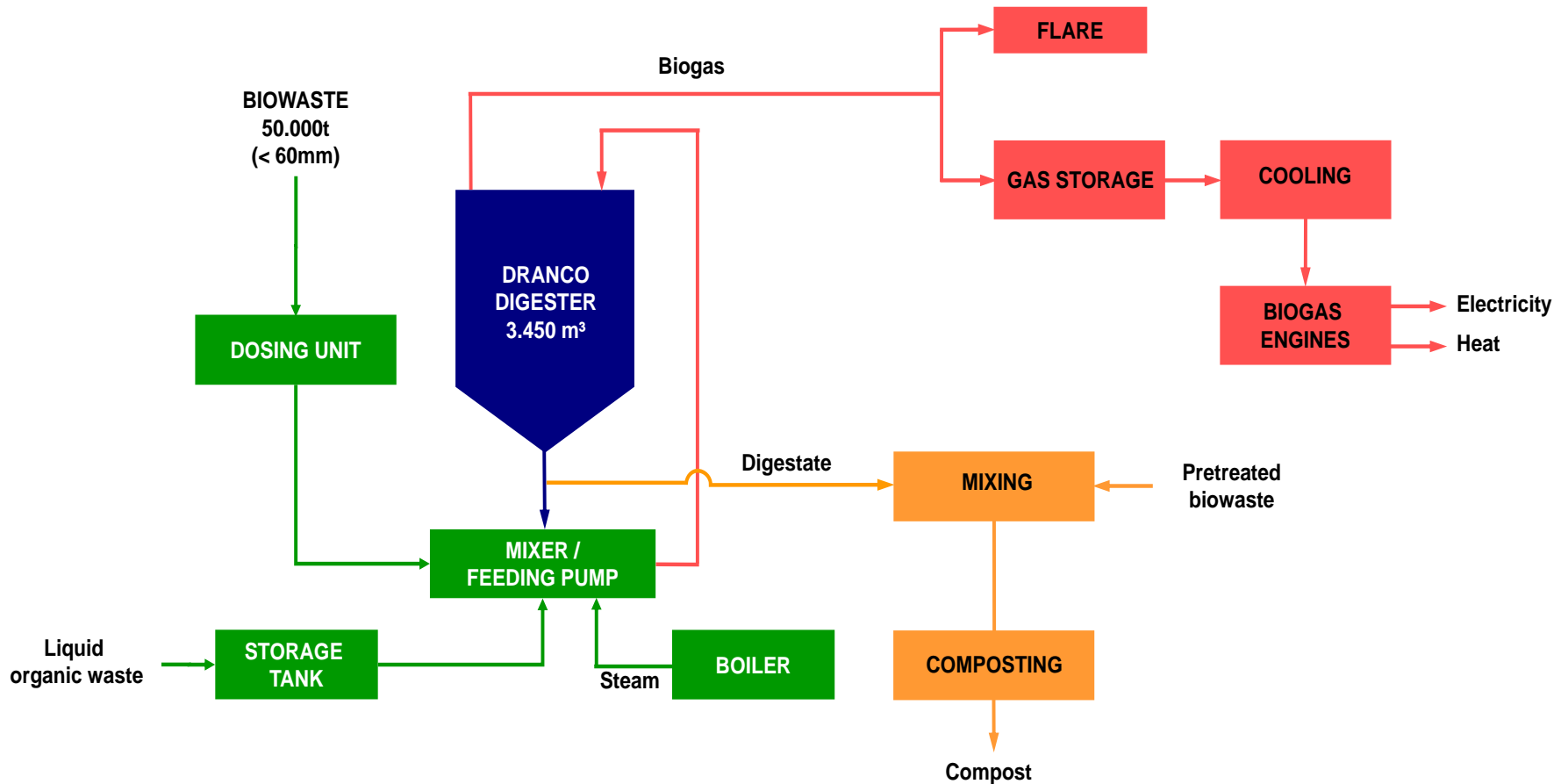
# ***HENGELO: DIGESTION OF BIOWASTE***



# ***HENGELO: DIGESTION OF BIOWASTE***



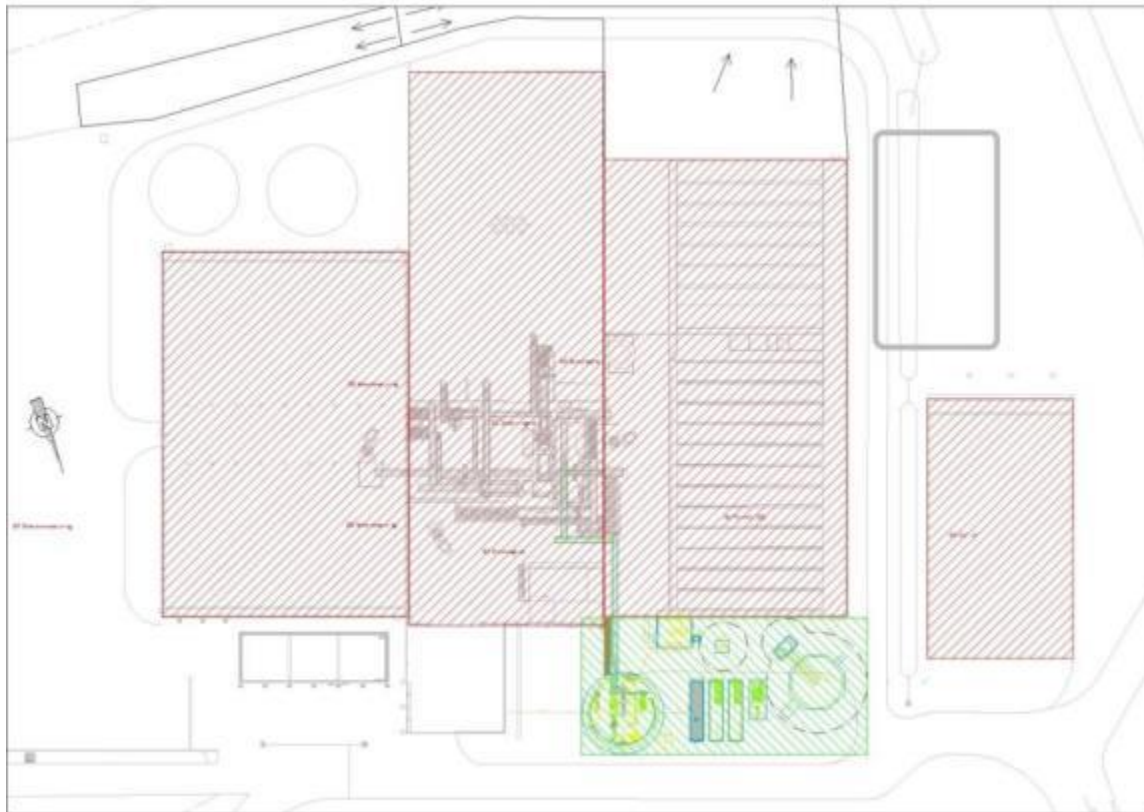
# HENGELO: DIGESTION OF BIOWASTE



# HENGELO: DIGESTION OF BIOWASTE

- Capacity:
  - 55,000 tpy
    - 44,000 tpy biowaste
    - 5,500 tpy overdue products
    - 5,500 tpy liquid products
- Digester volume: 121,835 ft<sup>3</sup>
- Start-up: 2011
- Digestate is mixed with 2.5''-6'' fraction
  - => dewatering is avoided
- Biogas production
  - 100% gas engines (2 x 1.2 MW)
  - Heat is used in district heating network

# HENGELO: DIGESTION OF BIOWASTE



**Existing aerobic  
composting: 3.7 acres**

**Anaerobic  
digestion: 0.4 acres**

## WHY LOOK AT MIXED WASTE?

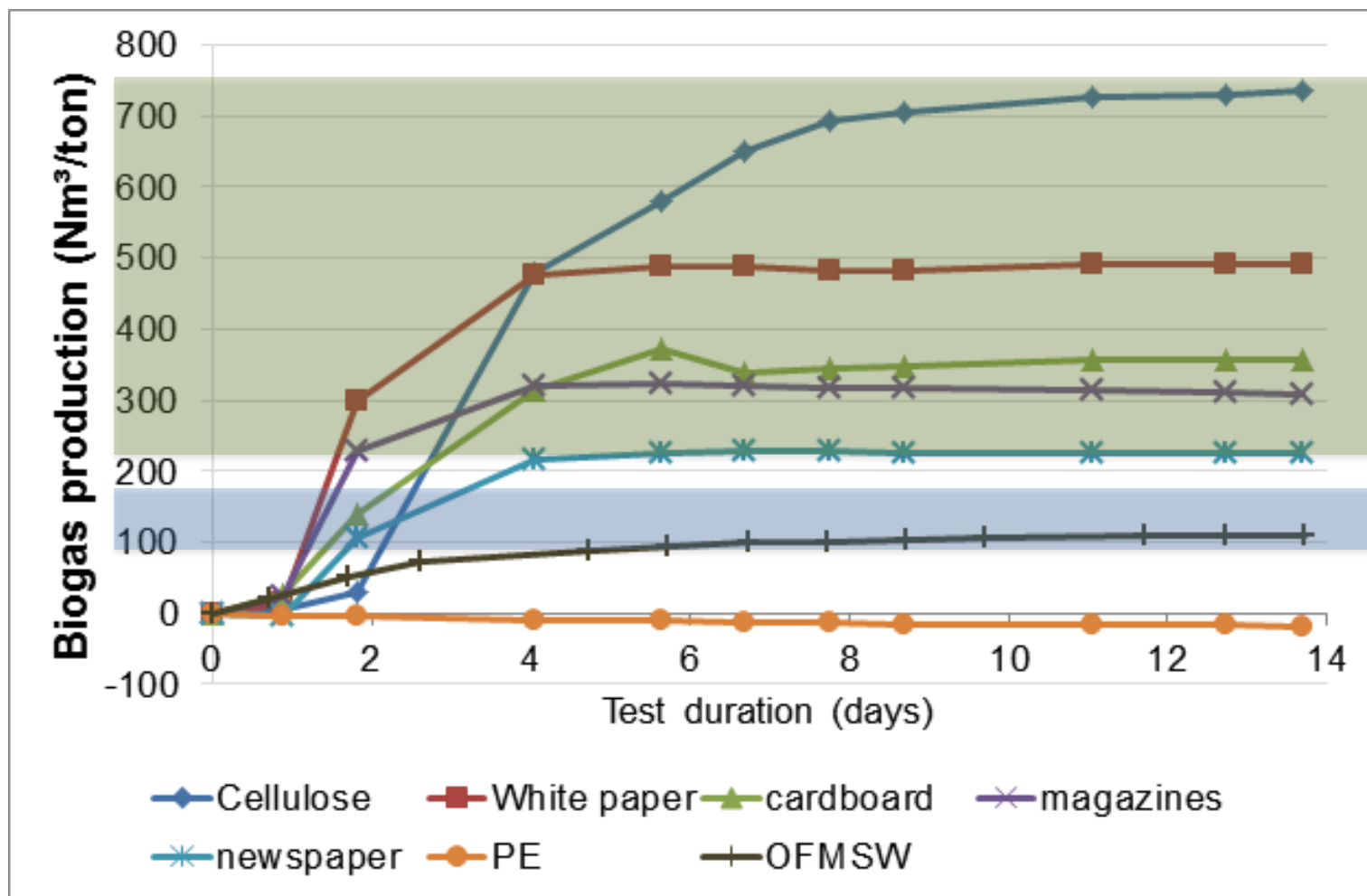
- Some communities find separate collection unaffordable
- Even with SSO collection, remaining organics in mixed MSW represent the largest potential for increasing diversion and recycling
- If we can produce a clean compost and recyclable fractions from mixed waste, then a significant increase in diversion: ZERO WASTE (>90% diversion) becomes attainable
- But so far mixed waste compost has been of low quality

HOW DO WE GO ABOUT IT?

# ***ADVANTAGES DRANCO DIGESTION for OFMSW***

- Less intensive pre-treatment
  - Sized to <2” diam. (e.g. corn cob) rather than <3/4” (e.g. thumbnail) as for wet digestion
  - No need to remove all grit and plastics
    - No floating layers
    - No settling/accumulation in the tank or percolate system
  - No need to remove paper
    - Soiled paper beneficial to C:N ratio and energy production
    - No mixing equipment inside the digester; increased viscosity OK
- Higher flexibility, more energy production
  - Total solids content in digester 15 – 40%
  - Intensive and reliable digestion
  - Nearly 100% of organics in MSW converted to biogas and compost

# MAXIMIZES VALUE OF SOILED PAPER



PAPER  
RANGE

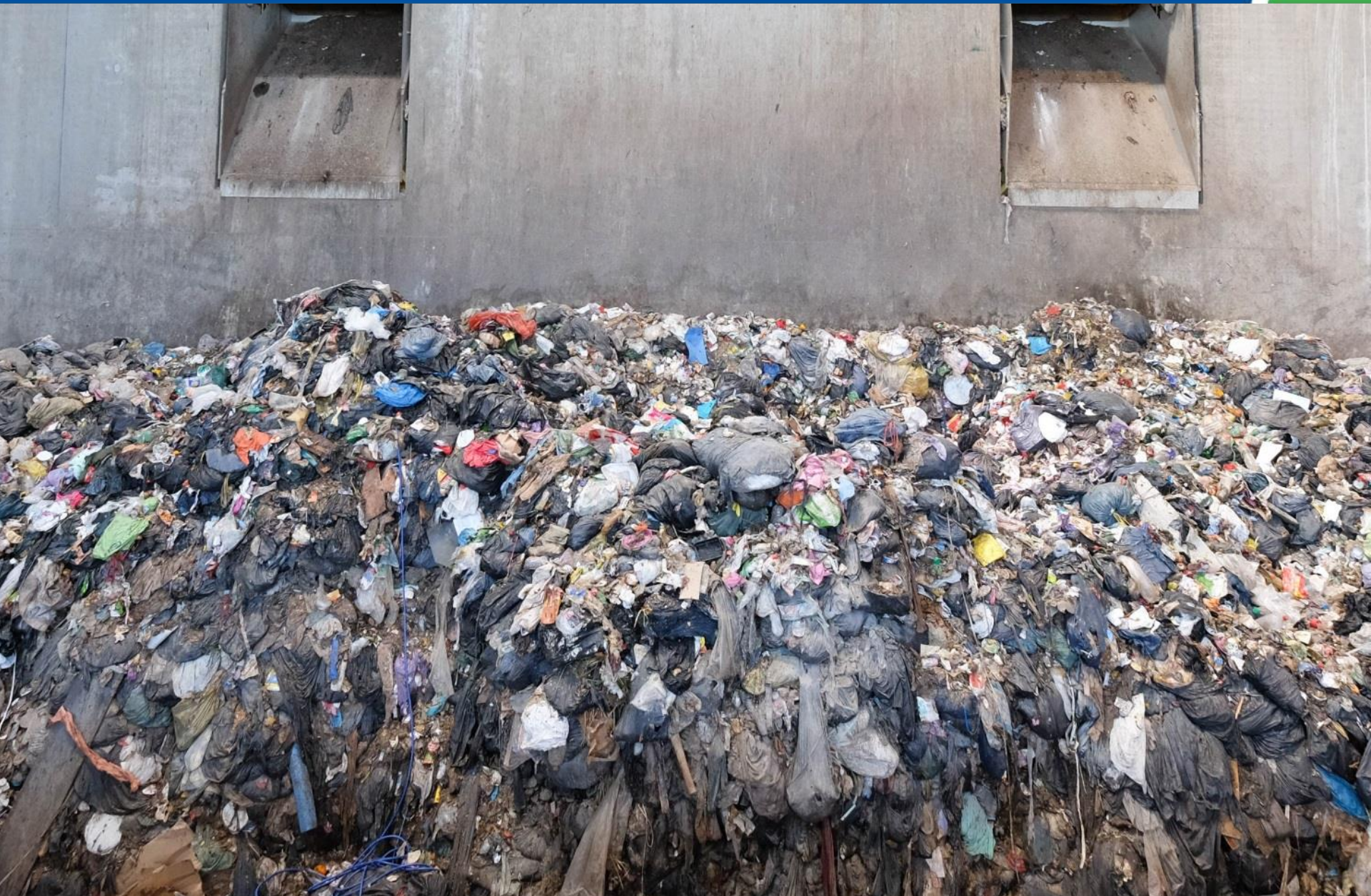
ORGANIC  
WASTE  
RANGE

RCNG+LCFS+D3 RIN VALUE  
EQUIVALENT OF >\$150/TON SOILED PAPER

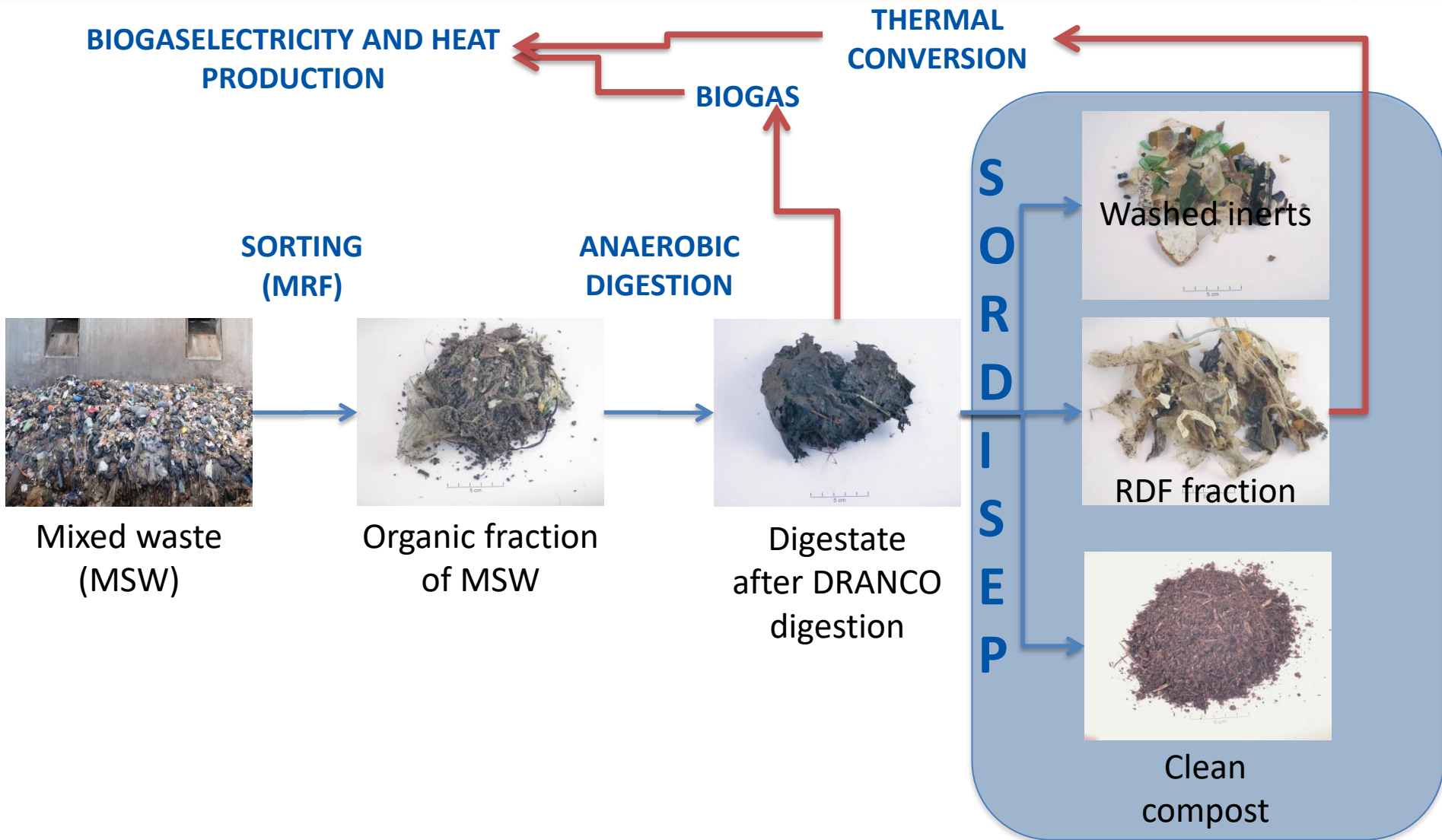
# BOURG-EN-BRESSE PLANT (FRANCE)



## ***FEEDSTOCK: BLACK BIN MIXED WASTE***



# PROCESS FLOW AT BOURG EN BRESSE



## BOURG-EN-BRESSE: INTEGRATION DRANCO-SORDISEP

- Capacity:
  - 72,700 sh t/y mixed waste
  - 8,200 t/y green waste
  - Capacity AD: 44,000 t/y
- Volume digester: 115,000 ft<sup>3</sup>
- Start-up: end of 2015
- 'Industrial operation' since May 1st, 2016
- Production of:
  - Compost: 23,000 sh t compost/y
  - Biogas: 4,800 scf/ton
  - Electricity from biogas: > 10,000,000 kWh/y



# ***SORDISEP – INITIAL MIXED WASTE DIGESTATE***

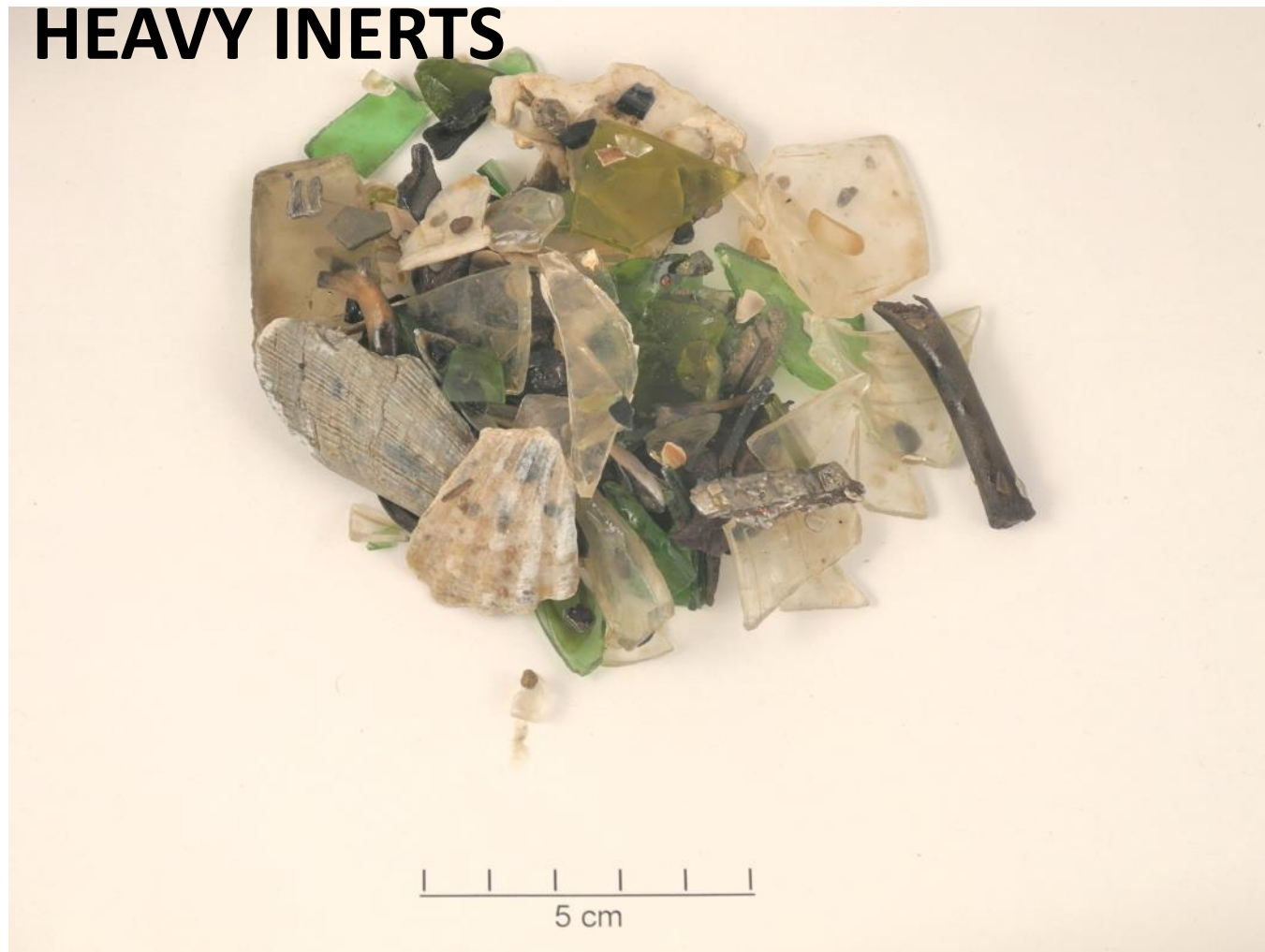
## **DIGESTATE**



## **LIGHT FRACTION**



## **HEAVY INERTS**



## **CENTRIFUGE CAKE**



## **COMPOST**



## OUTPUT: LIGHT FRACTION (FIBERS, PLASTICS,...)

- Particle size: <50 mm in 2 dimensions  
(after pretreatment and DRANCO AD)
- Composition
  - light plastics: 25-35%
  - hard plastics: 5-20%
  - textiles/fibers: 25-45%
  - Other (fraction <5 mm incl.): 15-25%
- Calorific value:
  - Lower combustion value: 5,100 BTU/lb
  - Higher combustion value: 6,000 BTU/lb (**brown coal** 8,000 BTU/lb)



## OUTPUT: HEAVY FRACTION (INERTS,...)

- Particle size: <50 mm (after pretreatment and DRANCO AD)
- Composition (on TS)
  - Glass: 70-85%
  - Stones: 5-20%
  - Others: 5-15%
- Quality meets the clients' demands (leachate test to determine soluble matter and TOC)



## ANALYSIS: HEAVY METALS IN SORDISEP COMPOST (1)

Results of press cake & compost in comparison to standards:

Metals <i>mg/kg TS</i>	Norm US EPA mg/kg TS	Norm France mg/kg TS	Compost BeB mg/kg TS	Norm Ontario CLASS AA	Norm Canada CLASS A	Norm Canada CLASS B
Arsenic	75	18	2.4	13	13	75
Cadmium	85	3	0.8	3	3	20
Chromium	3,000	120	67	210	210	1060
Copper	4,300	300	126	100	400	760
Lead	840	180	66	150	150	500
Mercury	57	2	0.2	0.8	0.8	5
Nickel	420	60	57	62	62	180
Zinc	7,500	600	402	500	700	1850

## ANALYSIS: HEAVY METALS IN SORDISEP COMPOST (2)

### Results of SORDISEP compost in comparison to SSO & green waste compost

Metals <i>mg/kg TS</i>	Norm US EPA mg/kg TS	Norm France mg/kg TS	Compost Mixed waste mg/kg TS	Compost SSO Brecht mg/kg TS	Green waste compost Brecht mg/kg TS
Arsenic	75	18	1,6	3,4	1,7
Cadmium	85	3	1,4	0,9	1,3
Chromium	3,000	120	39	21,0	35,1
Copper	4,300	300	151,2	64,4	143,9
Lead	840	180	64,6	73,7	65,4
Mercury	57	2	0.2	0,0	0,1
Nickel	420	60	36,7	13,8	46,3
Zinc	7,500	600	534,2	215,3	531,9

# ANALYSIS: IMPURITIES

## Results of press cake & compost in comparison to standards

=> Digested organics for compost production are screened over 3mm

California norm Jan 1, 2018:

Physical contaminants > 4 mm:  $\leq 0,5\%$  on TS  $\rightarrow < 5$  g/kg TS  
and  $< 20\%$  of these contaminants are film plastics  $\rightarrow < 1$  g/kg TS

**=> SO STANDARD WILL CERTAINLY BE MET!**

## CLEAN COMPOST PRODUCED

### COMPOST CHARACTERISTICS BOURG-EN-BRESSE

- *Digestate has been wetted to 5% solids (95% water) and is subsequently screened over a sieve of 3mm. The organics are recovered by centrifugation of the liquid containing the fine organics and composted*
- *Compost meets the future CA regulation of less than 0.5% contamination of which less than 20% can be film plastics*
- *Low heavy metals (similar to SSO) and other contamination way below standards (herbicides, PCB's, PAH'S,petroleum based mineral oils)*

Thank you!

For more information and videos, please visit our website, [www.ows.be](http://www.ows.be)

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