Enhancing Anaerobic Digestion Efficiency through Thermal Pressure Hydrolysis

ABC Sponsored Webinar
August 17, 2023

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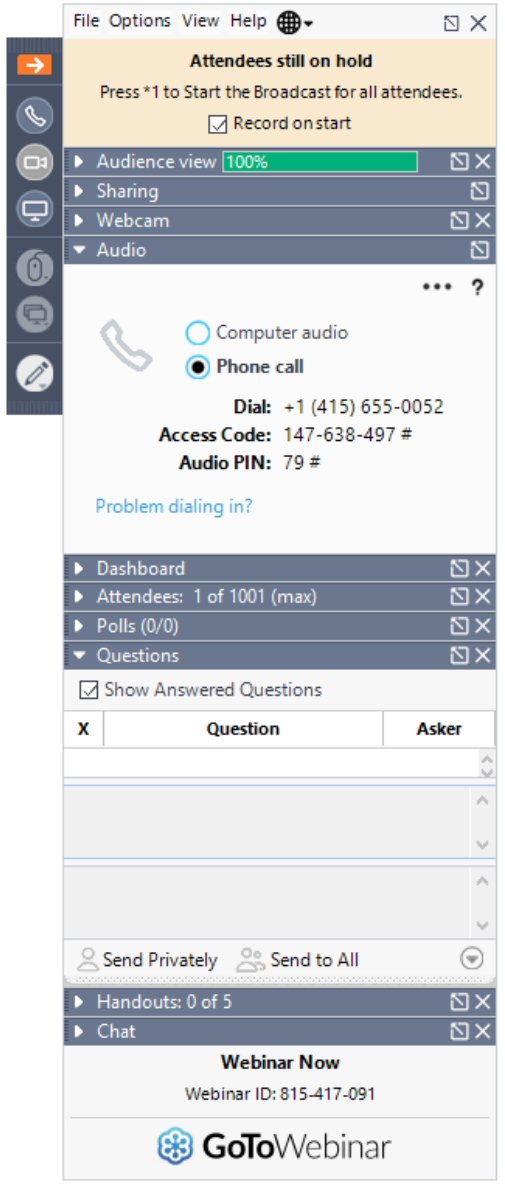


Audio

Questions

About the American Biogas Council

The voice of the biogas industry in the US

All sectors represented

- Project developers/owners
- Equipment retailers and dealers
- Waste management companies
- Waste water companies
- Farms
- Utilities
- Municipalities
- Consultants and EPCs
- Financiers, accountants, lawyers and engineers
- Non-profits, universities and government agencies

400 organizations

5,000 individuals

The US Biogas Market

Current

475 on Farm

1,269 Wastewater

97 Food Scrap

549 at Landfills

Potential

8,600 on Farm

4,000 Wastewater

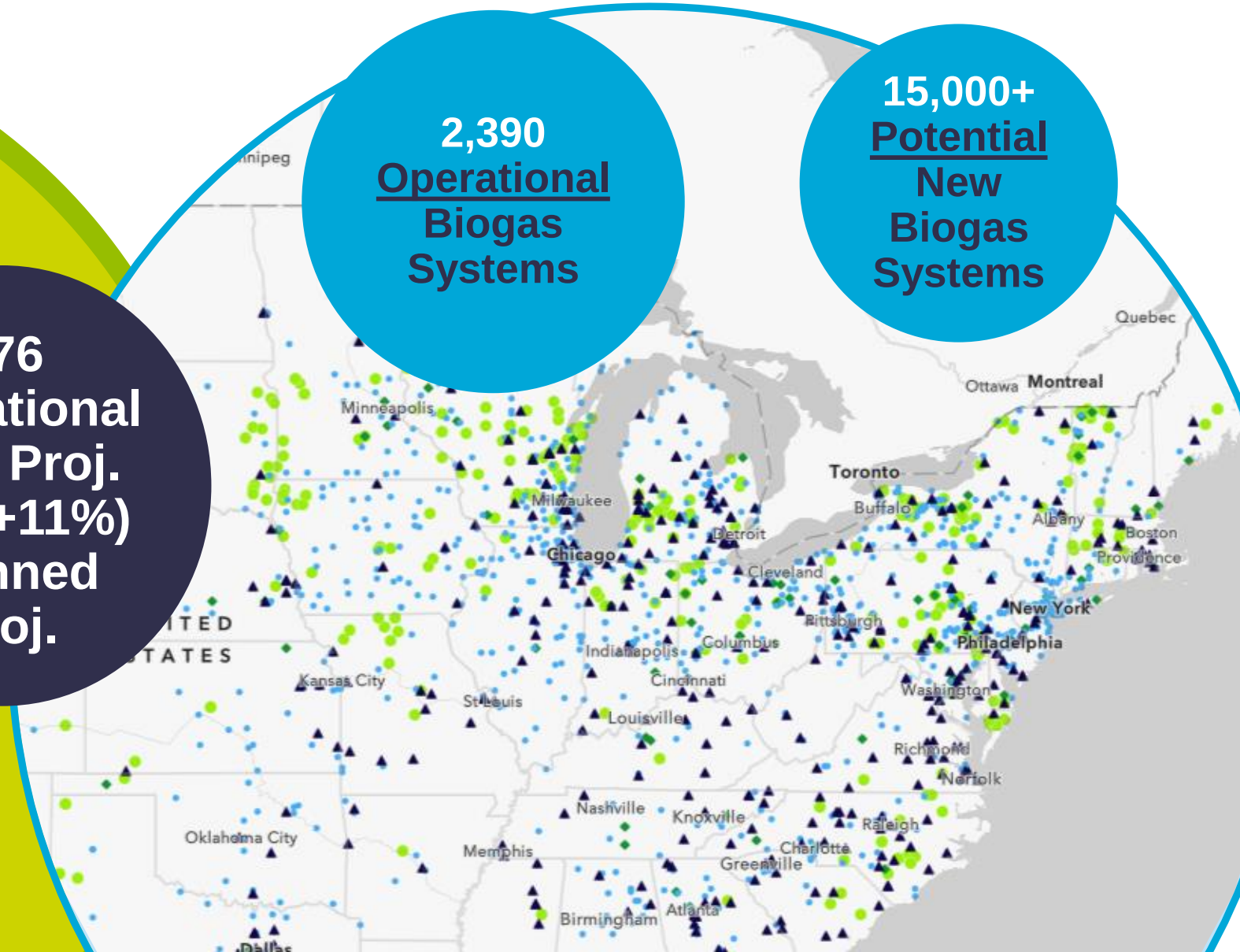
2,000 Food Scrap

470 at Landfills

276 Operational RNG Proj. 262 (+11%) Planned Proj.

2,390 Operational Biogas Systems

15,000+ Potential New Biogas Systems



Speakers

Joe Ayala
COO
ECONWARD

Patrick Serfass (Moderator)
Executive Director
American Biogas Council


ECONWARD
TECH
TRIPLE IMPACT TECHNOLOGY

WE ARE BACKED BY 14 YEARS OF EXPERIENCE IN R&D ACTIVITIES TO DELIVER INNOVATION TO THE ORGANIC WASTE MANAGEMENT AND RENEWABLE ENERGY PRODUCTION

2009

Start of **ECONWARD TECH**'s activities as a Spanish technology company

2010

Development of the **1st version of the BIOMAK®**

2011

Complation of the **Industrial Plant** at Rivas Vaciamadrid

2012

Development of the **2nd version of the BIOMAK®** (increased processing capacitiy)

2012-2016

Granting of **first patents**

2016

Change in the shareholder structure. Reinforcement of the executive, technical and scientist teams.

NOWON establishment in USA to introduce and market Econward's technology, with offices in California and Buenos Aires, Argentina

Development of the **3rd version of the BIOMAK®** (increased processing capacitiy)

2017

Beginning of **R&D activities**

2018

United Nations Sustainable Development Goals (SDGs) verification

- Development of 4,000 plans and 1,700 associated technical documents
- Experimental studies

2019

Granting of the following certifications:

ISO 9001 BUREAU VERITAS Certification | ISO 14001 BUREAU VERITAS Certification | ISO 45001 BUREAU VERITAS Certification

Filing of **two new patent applications**

2020

4th version of the BIOMAK® operating in Rivas at industrial scale

Filing of **four new patents**

2021

Biomethanation and Co-digestion Projects at industrial scale

Signing of **collaboration agreements** with leading companies in the metal-mechanic industry

Navantia

2022

National Energy Award

VICEPRESIDENCIA MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y RETO DEMOGRÁFICO

2023

Co-digestion Patent Pre-granted

ECONWARD TECH

Triple Impact Approach

1 Environmental

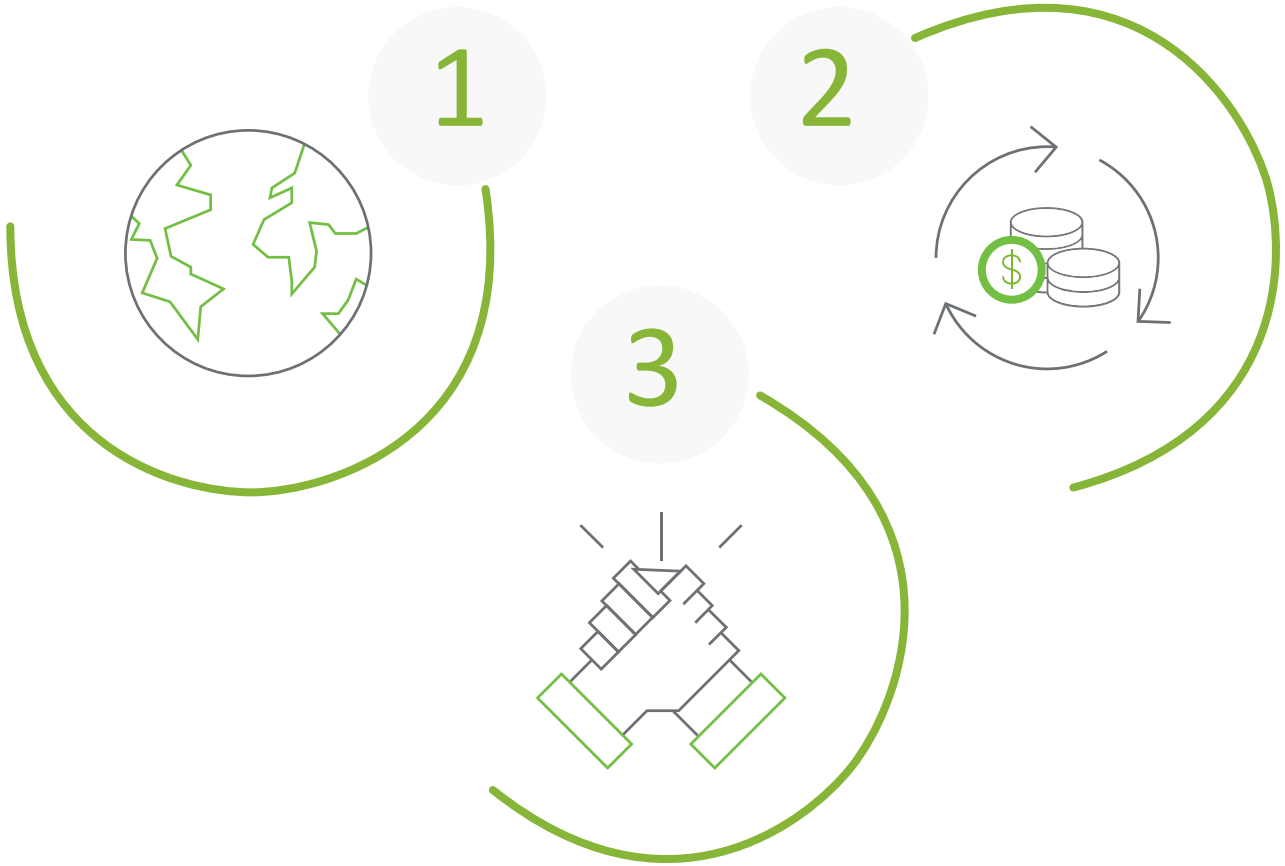
- Organics landfill diversion
- GHG reduction targets
- Decarbonization of the economy

2 Economic

- Increased biomethane potential
- Reduced retention times, smaller digesters
- Elimination of pathogens

3 Social

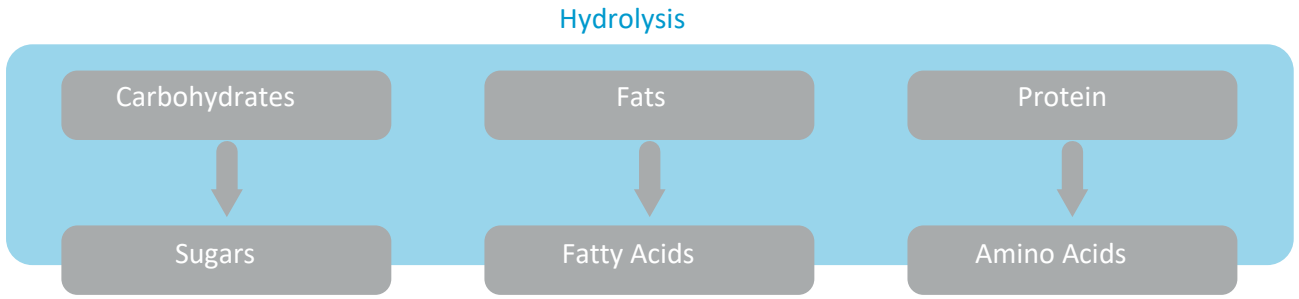
- Regulatory compliance
- Social engagement by reducing negative impacts
- Innovative technology to promote sustainability



ECONWARD TECH

Thermal hydrolysis as a pre-treatment for AD

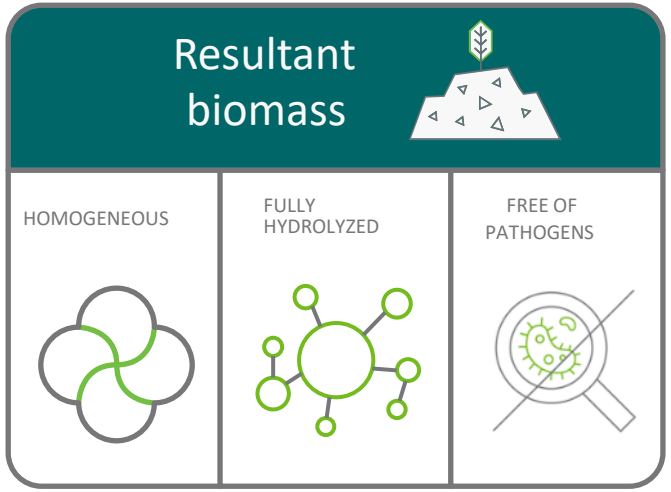
- **Thermal Hydrolysis** essentially acts as a pressure cooker by adding temperature and pressure through saturated water steam
- **Separation of hydrolysis** from the anaerobic digestion process improves digestion efficiency



Waste in

BIOMAK

Waste out



Creates an optimal substrate for AD out of the OFMSW

BIOMAK® process based experience

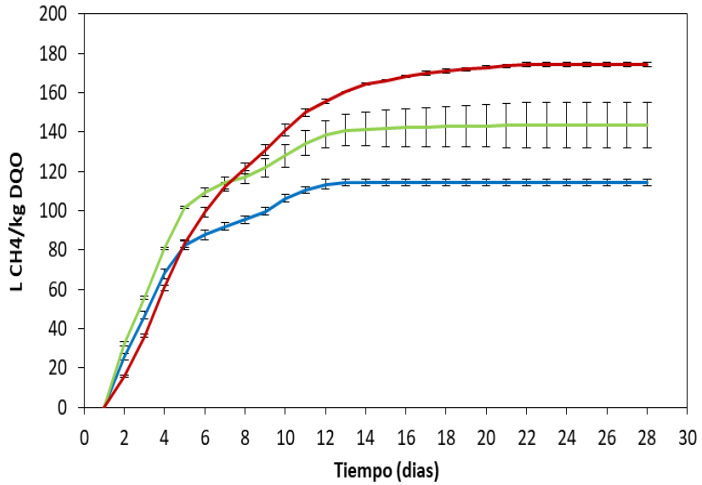
System Parameters

- 8.8 tons per hour/ 70,000 tons per year
- Treats high solid organic fraction of MSW (20% - 70% TS)
- Full facility footprint: 3,000 sq. ft.

Autoclave System

- 150 deg C / 305 deg F
- Pressure: 4 bar/ 58 psi / 400 kPa
- 4 autoclaves, total of 20 minutes residence time

More BMP + Less HRT = Higher ROI



Biomethane potential test (LCH_4/kg CDO_t) of OFMSW (●) OFMSW after treatment (●) and co-digestion mixture (●).

- **Methane production increase: 25,4 %**
- **Production rate increase: 28 %**

Waste input

Biomass produced in ECONWARD process

Experimental set-up for lab-scale continuous AD test. Reactor volume 6 liters.

Waste input

Waste output obtained in ECONWARD process

Demonstrated and validated results at industrial scale

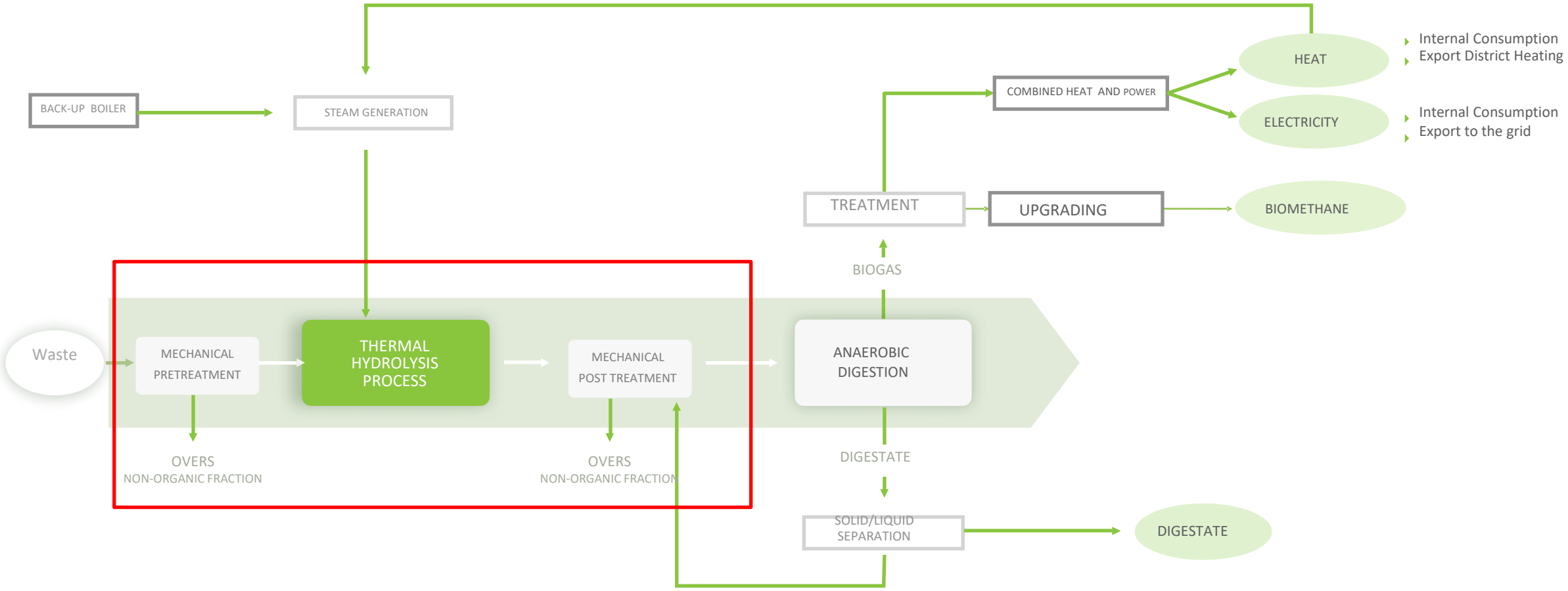
Demonstrated and validated results at industrial scale

BIOMAK - Industrial Thermal Hydrolysis unit.
ECONWARD's facilities (Rivas Vaciamadrid, Spain)

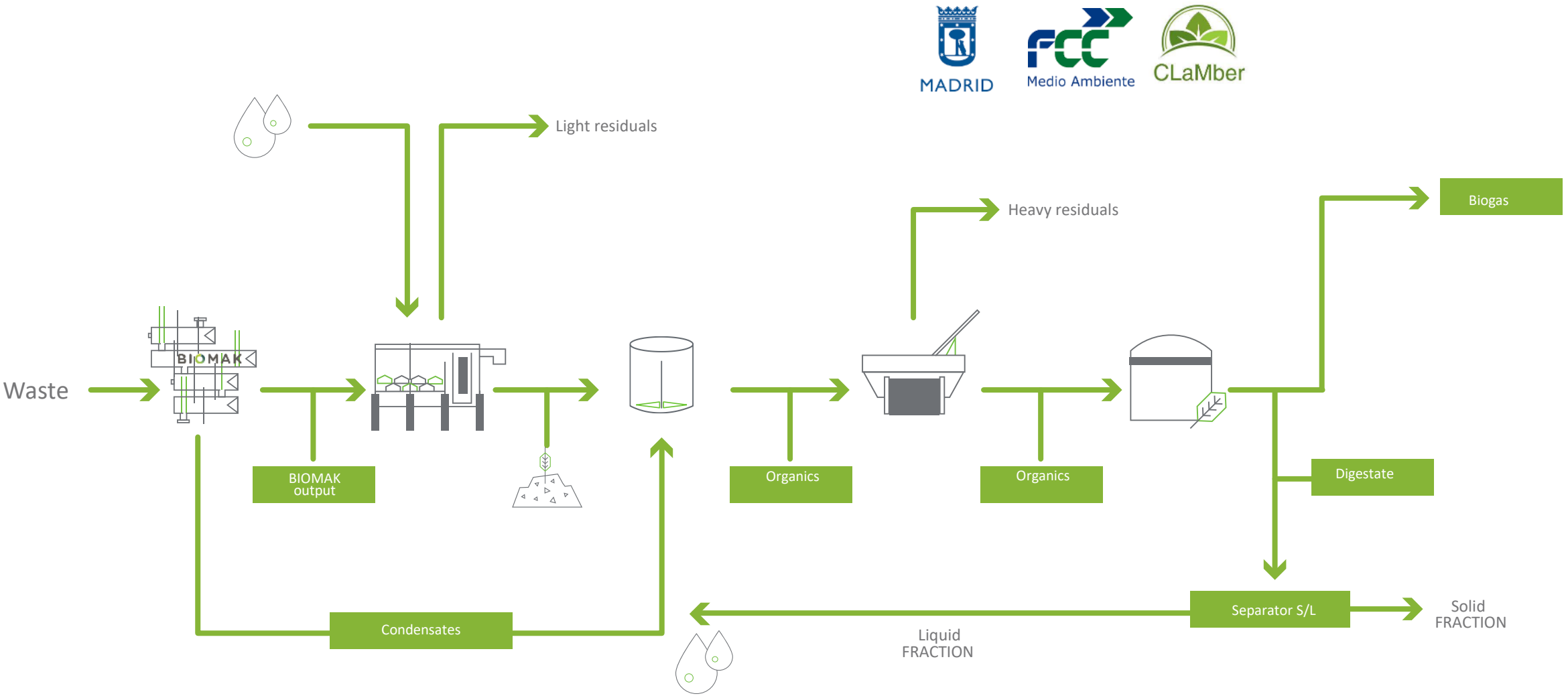
Industrial anaerobic digestion unit.
CLaMber facilities (Puertollano, Spain)

APPLICATION

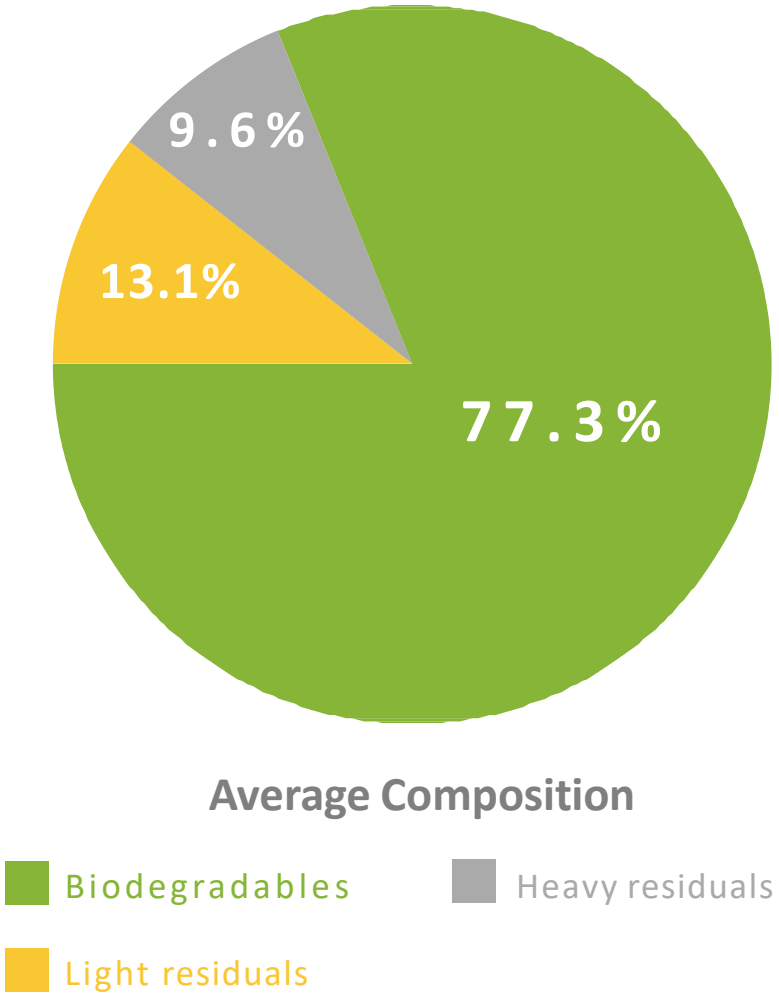
Organic Recovery Facility



ECONWARD industrial set-up



Source separated organic collection < 3-inch



Biodegradable organics	Light residuals	Heavy residuals
- Paper, cardboard and cellulose - Soft green waste - Fruit - Vegetable - Meat - Fish - Processed food	- Sanitary textile - Textiles - Plastics - Brick - Metals - Hard green waste - Wood and cork	- Glass - Inert - Other

ECONWARD TECH

Waste transformation – Thermal hydrolysis

Waste input

Hydrolyzed waste output

Waste transformation – Posttreatment stage 1

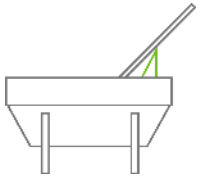
Hydrolyzed waste output

Clean light residuals

Hydrolyzed biomass

Waste transformation – Posttreatment stage 2

Hydrolyzed biomass



Clean heavy residuals

Anaerobic digestion feedstock

Summary of average operating parameters

- Thermal Hydrolysis

Parameters	Units	
Process pressure	psig	58
Treatment temperature	ºF	305

- Anaerobic digestion

Parameters	Units	Results
HRT	days	15
Process temperature	ºF	100 (Mesophilic)
pH	-	7.7-7.9
TS (Posttreatment outlet)	%	11-14
COD Degradation	%	86-91
VS Degradation	%	90-92
TS Degradation	%	87-91

Raw biogas characterization

- Average composition

Parameters	Units	Range
CH_4	%	65-68
CO_2	%	35-32
H_2S	ppm (mol)	120-1,500
NH_3	ppm (mol)	<0.25
Siloxanes	mg/Nm^3	0.5-1.6
Silicon	mg/Nm^3	0.2-0.4

- Physical and combustion characteristics

Parameters	Units	Range
Moisture	mg/l	5-30
Density	kg/m^3	1.1-1.2
LHV	$kcal/m^3$	5,770-5,780
Methane number (H/C)	-	99
Wobbe Index	$kcal/m^3$	6,600-6,900

Digestate quality

Microorganisms

Parameters(1)	ECW
Salmonella	Absence
Escherichia coli	Absence
Clostridium	Absence

Heavy metals (mg/kg dm)

	ECW
Cadmium	<DL(2)
Copper	<DL
Nickel	<DL
Lead	<DL
Zinc	<DL
Mercury	<DL
Chromium (total)	<DL
Chromium (VI)	<DL

(1) Colony-forming units

(2) Detection Limit

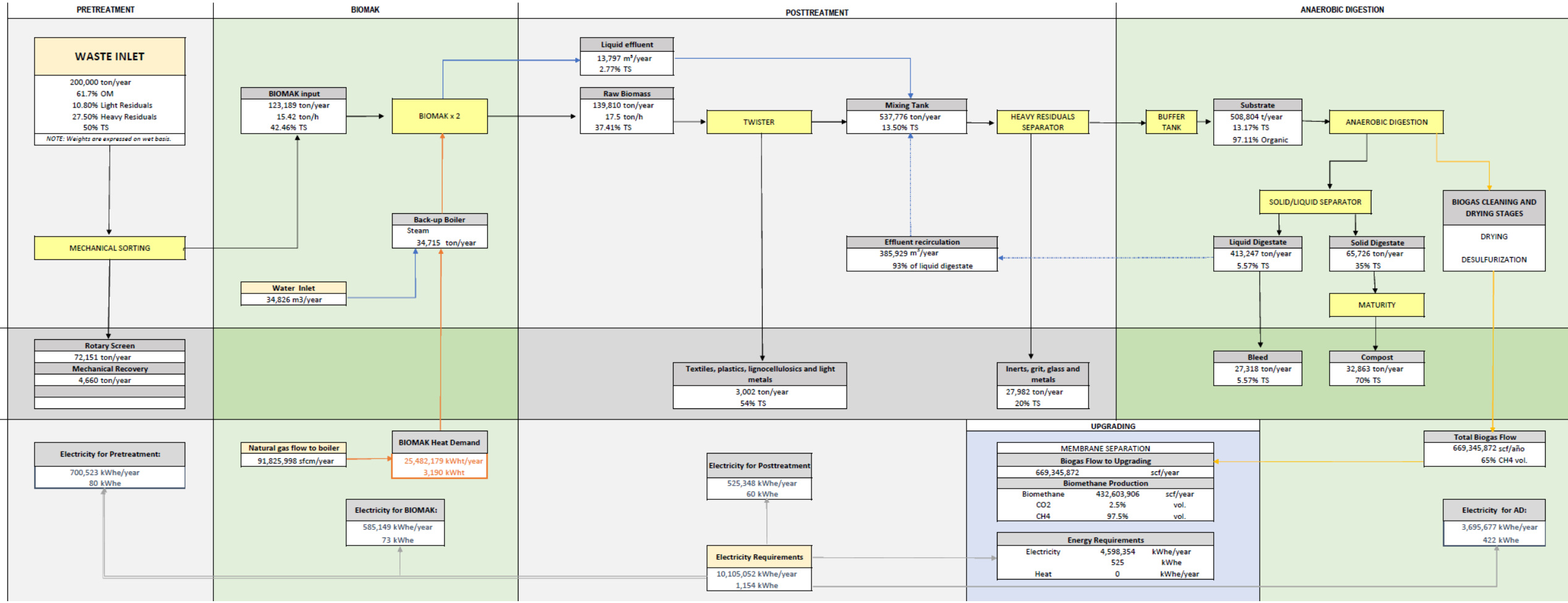
Summary of average production data

Parameters	Stage I (HRT = 20 days)	Stage II (HRT = 15 days)
% CH_4	67	67
scf biogas/ton of collected organics	4,870	4,709
scf biomethane/ton of collected organics	3,262	3,155
MMBTU biomethane/ton of collected organics	3.2	3.1

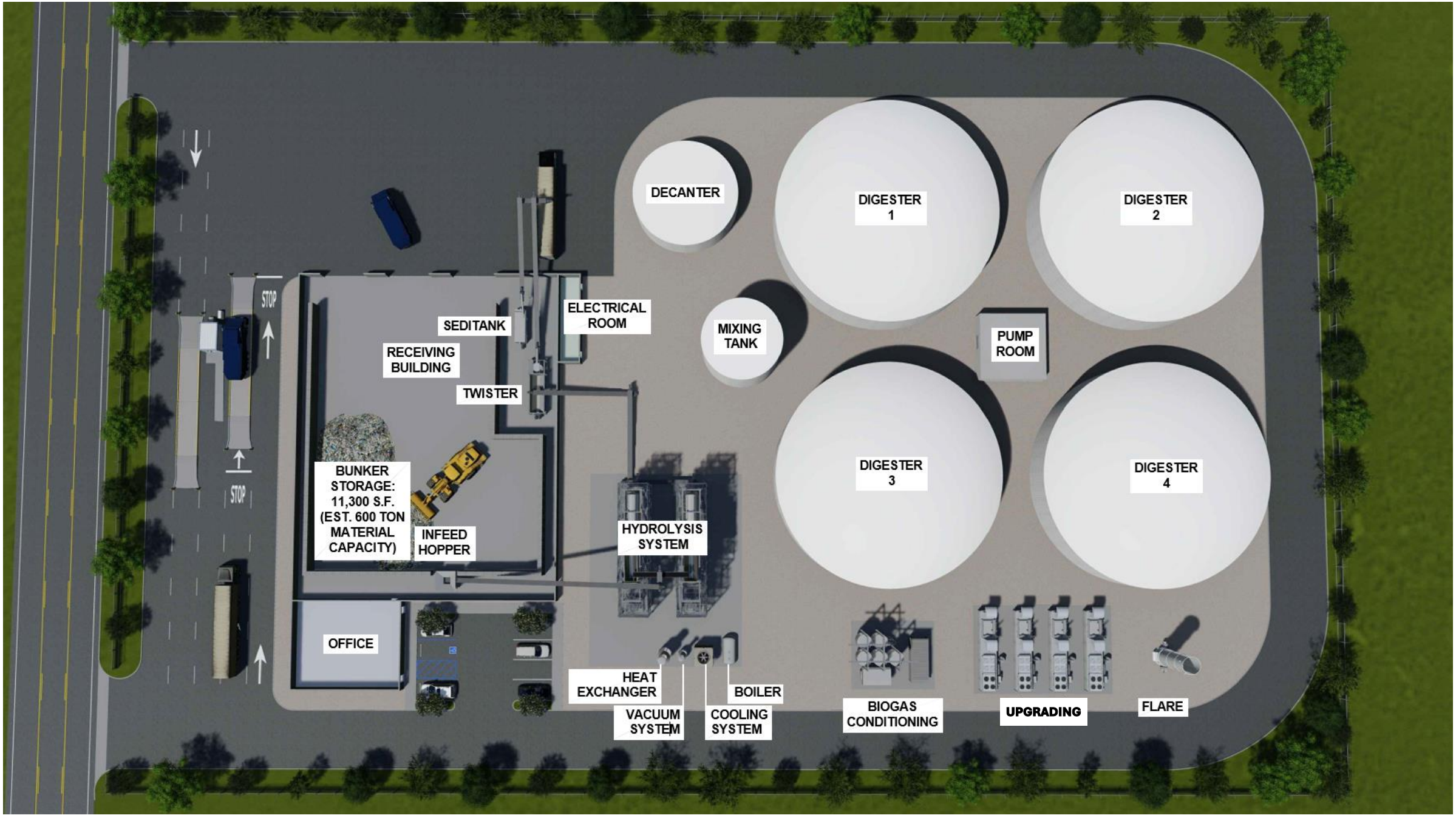
Summary of average revenue data

Parameters	Scenario I	Scenario II	Scenario III
Tons collected organics per year	50,000	60,000	70,000
MMBTU biomethane output per year	150,000	180,000	210,000
Additional revenue/ton of collected organics	$108	$108	$108
CAPEX + 10-year OPEX/ton collected organics	$38	$32	$27
Net profit/ton collected organics	$70	$76	$81

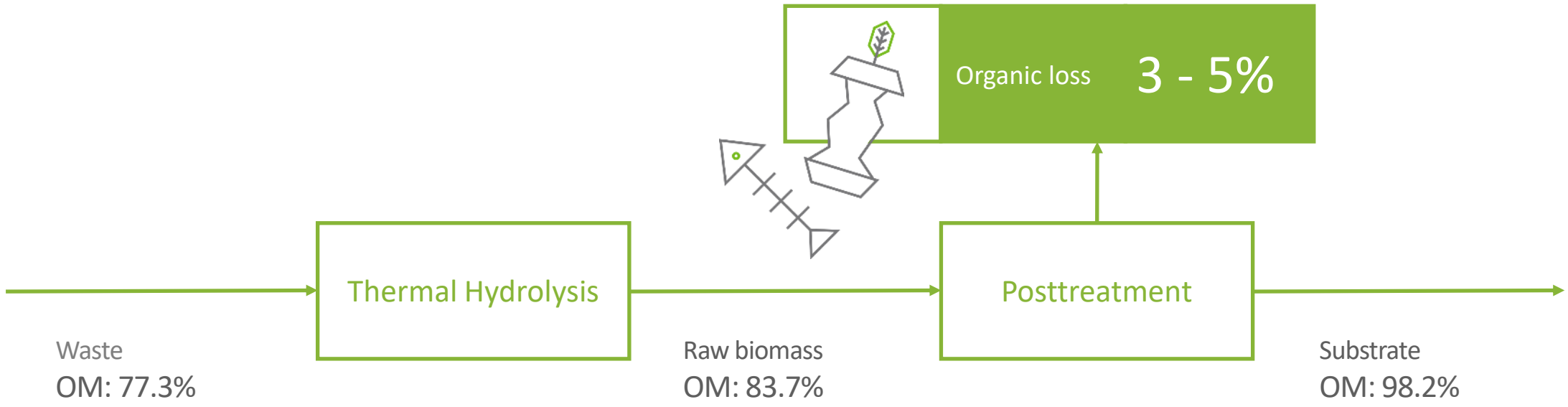
M&E Balances: Demonstrated success beyond concept design



Mass and Energy balance of facility with 2x BIOMAK.


DECANTER
DIGESTER 1
DIGESTER 2
STOP
STOP
ELECTRICAL ROOM
SEDITANK
RECEIVING BUILDING
TWISTER
MIXING TANK
PUMP ROOM
BUNKER STORAGE: 11,300 S.F. (EST. 600 TON MATERIAL CAPACITY)
INFEED HOPPER
DIGESTER 3
DIGESTER 4
HYDROLYSIS SYSTEM
OFFICE
HEAT EXCHANGER
VACUUM SYSTEM
COOLING SYSTEM
BOILER
BIOGAS CONDITIONING
UPGRADING
FLARE

High organic matter recovery



Thermal Hydrolysis improves AD performance

01 From 20% to 50% more biogas yield per ton of residue.

02 From 20% to 40% digester capacity increase due to the reduction of digesters' HRT. Able to increase OLRs

03 Over 10% higher CH4 concentration. Consistent reduction of pollutants in biogas.

04 Greater mechanical separation efficiency of residuals, and minimal organic loss. Additionally, hydrolysis removes ammoniacal nitrogen and pathogens from digestate improving its quality.

05 Achieving over 90% degradation of VS and COD.

06 Higher quality digestate, free of pathogens, easier for land application.

07 Doubled revenue by increasing capacity and energy production, reduction of operating cost per ton, energy-self consumption.

Adding BIOMAK® to an exiting AD facility generates a rapid return on capital

70k T/YEAR

BIOMAK CAPACITY

≈200k INHABITANTS

POPULATION

New BIOMAK®

ADDITIONAL CAPEX

11 MUSD

ADDITIONAL REVENUE

>3.7 MUSD/YEAR

ADDITIONAL OPEX

<1 MUSD/YEAR

PAYBACK

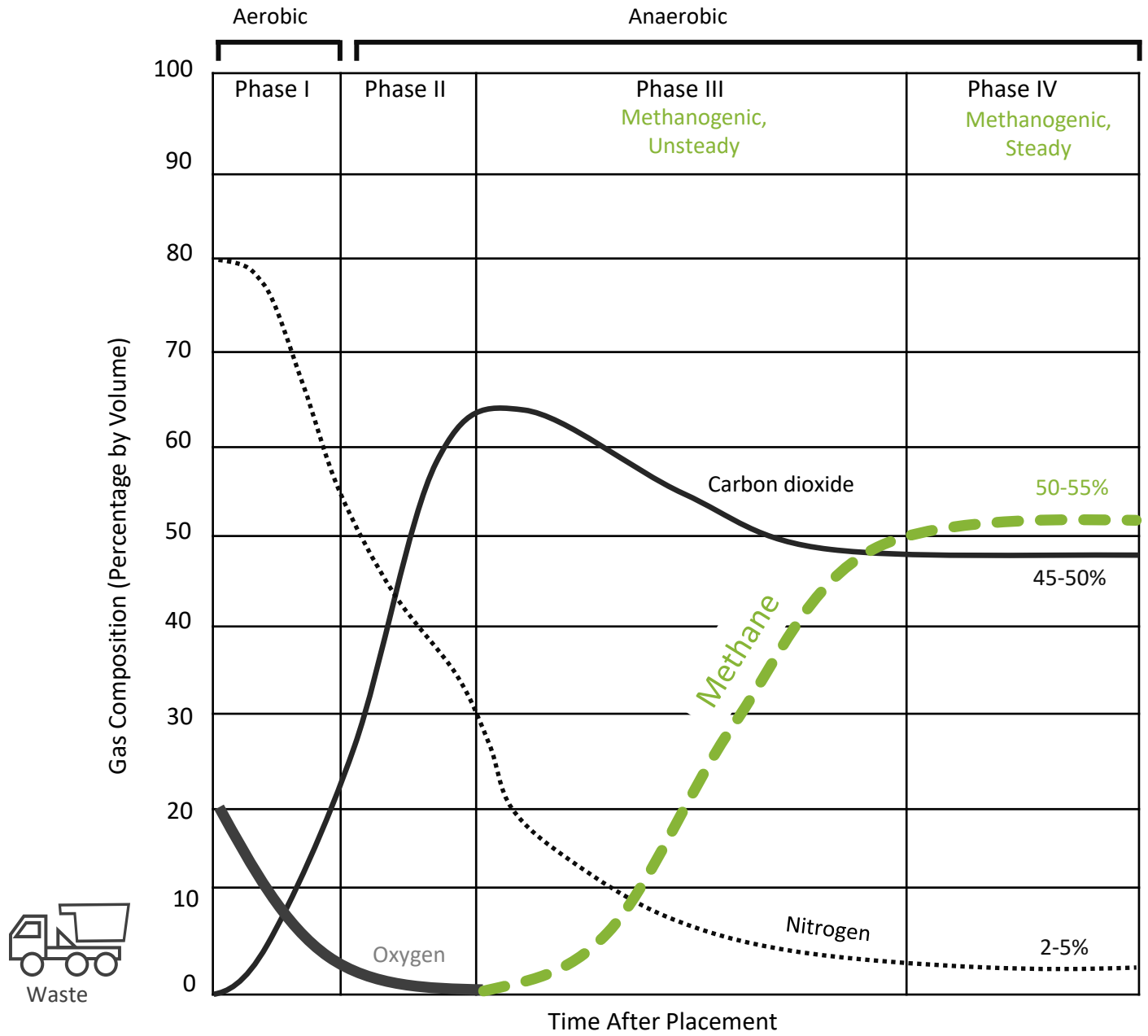
3 YEARS

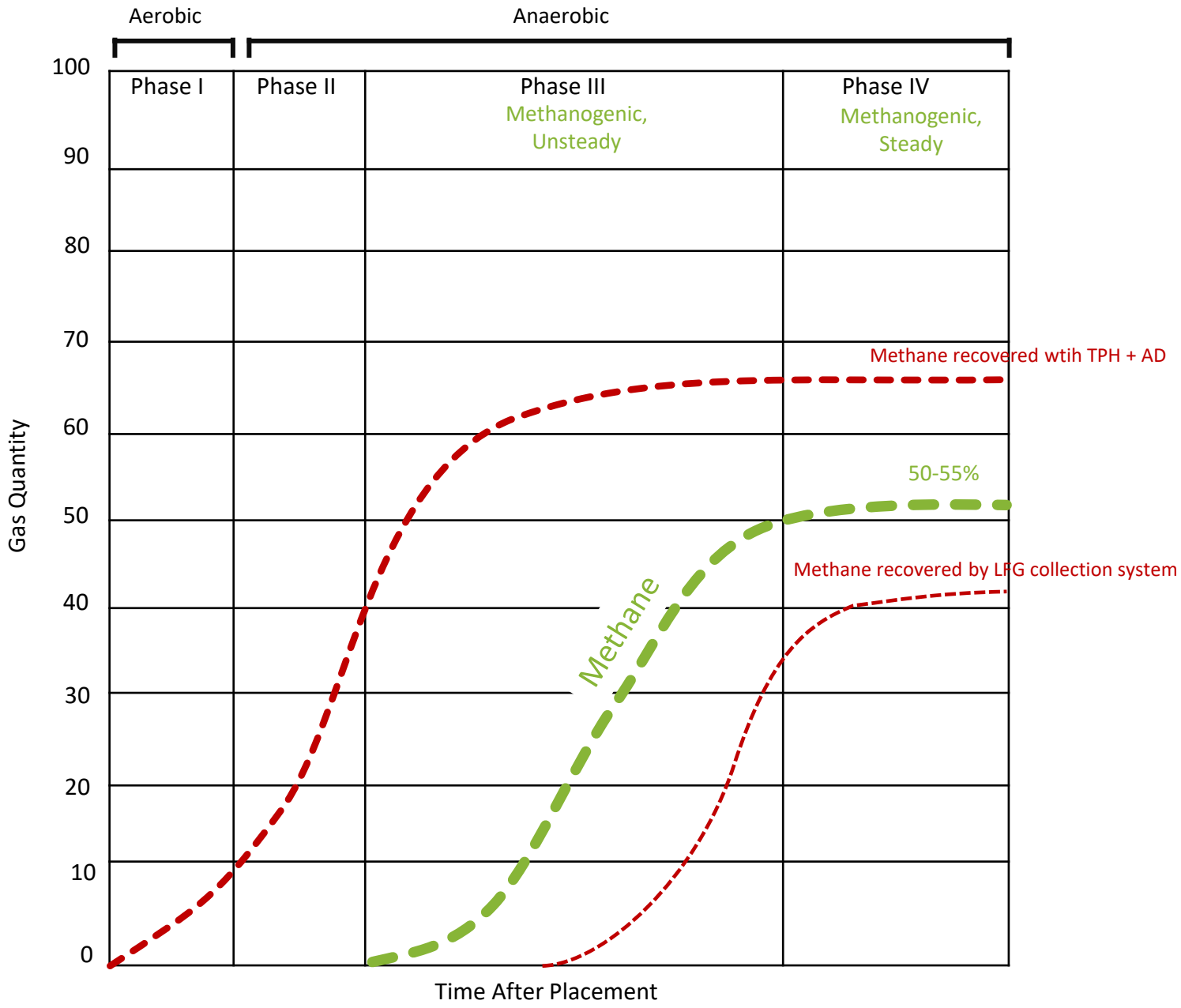
ECONWARD plant in Rivas-Madrid, Spain

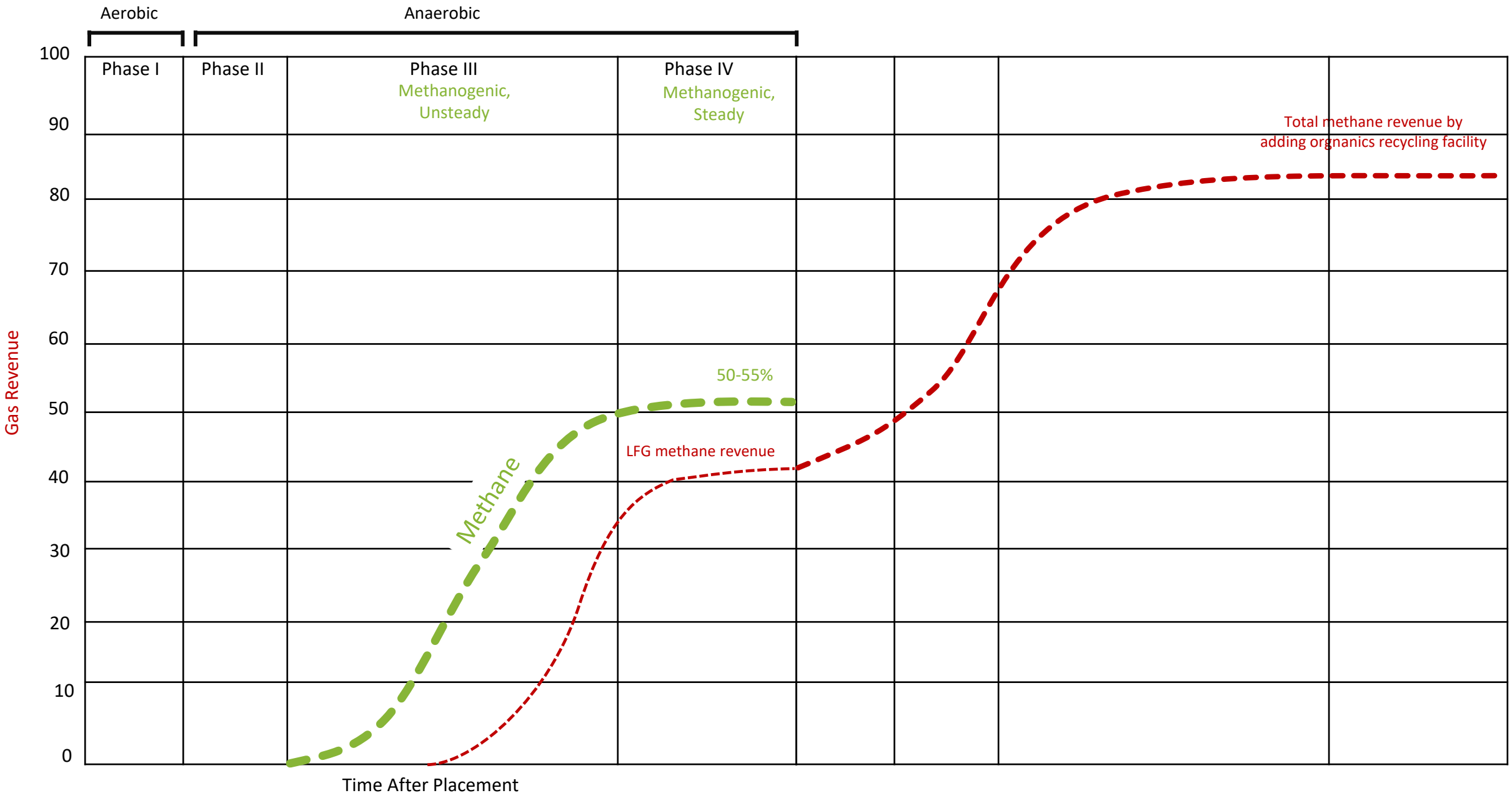
Link to video:

https://vimeo.com/798406419


NOWON
STOP


Aerobic
Anaerobic
Phase I
Phase II
Phase III
Methanogenic,
Unsteady
Phase IV
Methanogenic,
Steady
100
90
80
70
60
50
40
30
20
10
0
Gas Composition (Percentage by Volume)
Carbon dioxide
50-55%
45-50%
Methane
Nitrogen
2-5%
Oxygen
Waste
Time After Placement


Aerobic
Anaerobic
Phase I
Phase II
Phase III
Methanogenic,
Unsteady
Phase IV
Methanogenic,
Steady
100
90
80
70
60
50
40
30
20
10
0
Gas Quantity
Time After Placement
Methane recovered wtih TPH + AD
50-55%
Methane recovered by LFG collection system
Methane


Aerobic
Anaerobic
Phase I
Phase II
Phase III
Methanogenic,
Unsteady
Phase IV
Methanogenic,
Steady
Total methane revenue by
adding orgnanics recycling facility
50-55%
LFG methane revenue
Methane
Gas Revenue
100
90
80
70
60
50
40
30
20
10
0
Time After Placement

Let’s lead the change!

Joe Ayala
Chief Operating Officer
j.ayala@econward.com

ECONWARD TECH, LLC
401 Wilshire Blvd.
Santa Monica, CA 90401
USA

www.econward.com
info@econward.com

ECONWARD TECH, SLU
C/ Alcalá, 21
28014 – Madrid
Spain

www.econward.com
info@econward.com

Questions and Answers

Joe Ayala
COO
ECONWARD

Patrick Serfass (Moderator)
Executive Director
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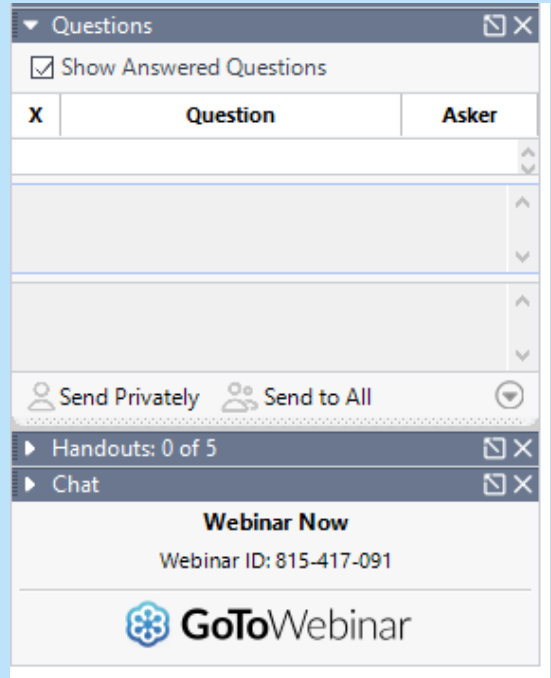

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-Connect with other biogas and anaerobic digestion leaders

-Support the industry’s growth and outreach

See you at BUSINESS OF BIOGAS in October!

Thanks for attending!