European Biomass Industry Association

Strategies for biogas production, upgrade and application in the context of EU bioeconomy

Bio Natural Gas Summit, Sino – EU 2016, Bejing, China

Who is speaking

EUBIA

The European Biomass Industry Association

Supporting Biomass Sector at all Levels

EUBREN

The European Biomass Research Network

Researching for Bioeconomy

A MULTI-FACETED SUPPORT

A business facilitator

- Identification of competitive projects
- Markets potentials evaluation
- Creator of Business opportunities
- Technical consultancy

International Projects developer

- More than 50 EC projects experience
- Coordinator/Partner in technical tasks, policy and market assessment,
- Supporting Dissemination

EUBIA

Information provider & diffuser

- Organizer of workshops, training events
- International conferences supporter
- Policy Measures Position papers
- Dissemination opportunities
- Legal framework barriers identification

State of Biogas production and upgrading in European countries

EU GHG emission reduction targets

2030

- ✓ a 40% cut in greenhouse gas emissions compared to 1990 levels
- ✓ at least a 27% share of renewable energy consumption
- ✓ at least 27% energy savings compared with the business-as-usual scenario
- ✓ A reformed EU emissions trading scheme (ETS)
- ✓ New indicators for the competitiveness and security of the energy system, such as price differences with major trading partners and interconnection capacity between EU countries

Waste streams processed in European AD plants

Sewage sludges from Municipalities & Industry

Sewadge sludge treatment

16%

Landifll and Municipal organic waste

Treatment of organic MSW

12%

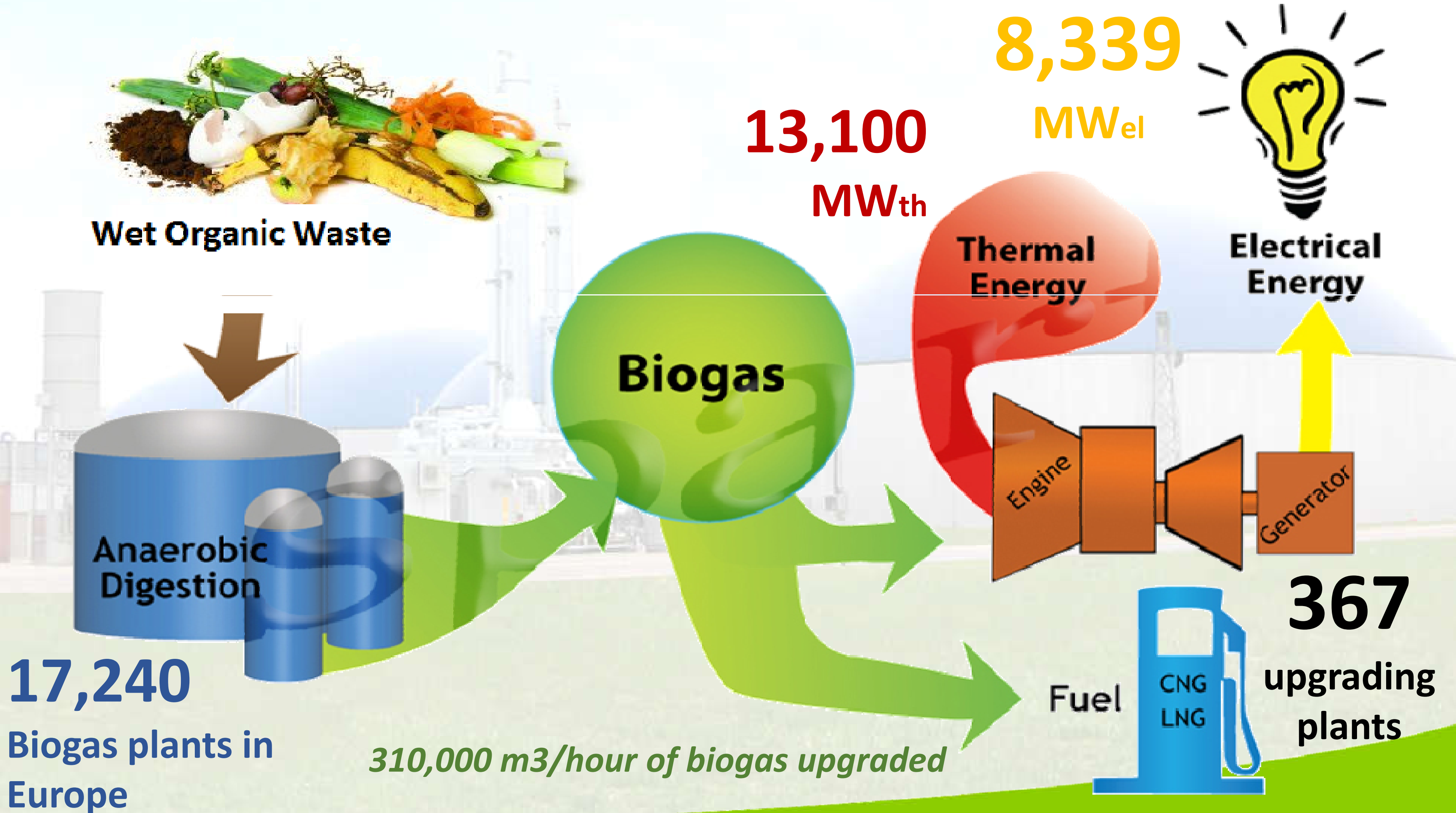
Valorization of Agricultural Residues

Animal manure, crops and straw treatment

72%

EU Anaerobic Digester

The European Biogas Sector at a glance



How Biogas is produced by Country

Germany

Italy

Czech Republic

Austria

Producers of biogas from agricultural sources: 87%, 80%, 69% and 46% of their biogas plants operated with agricultural feedstock

France

Produces biogas mainly from organic waste and on landfills

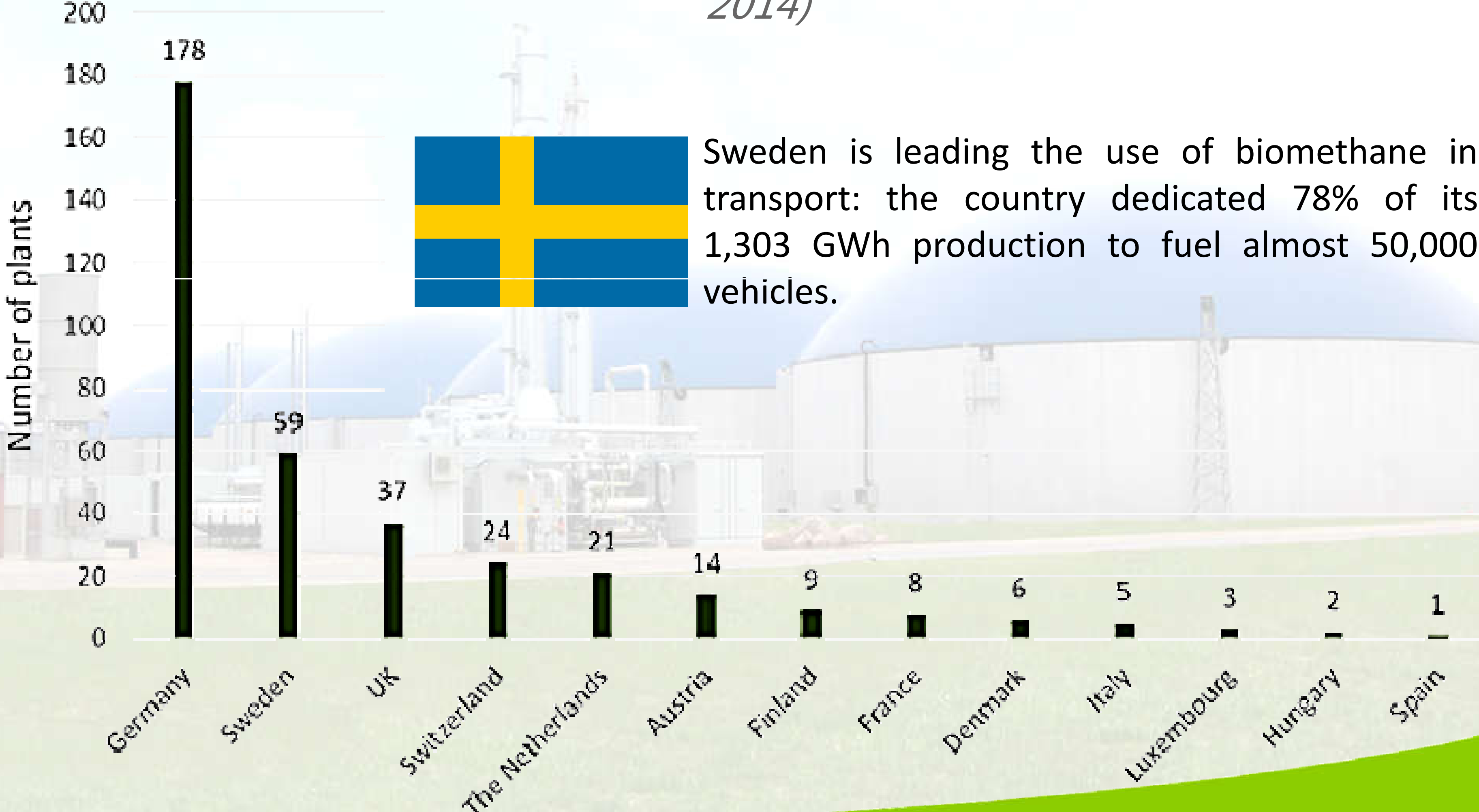
Switzerland

United kingdom

Switzerland and UK extracts biogas mainly from sewage sludge

Biogas upgrading to Biomethane in Europe

A steady increase can be appreciated in the biomethane sector (87 new biogas in 2014)



Sweden is leading the use of biomethane in transport: the country dedicated 78% of its 1,303 GWh production to fuel almost 50,000 vehicles.

Why upgrading Biogas into Biomethane

- Incomes obtained by biogas utilization in CHP engines for electricity production are uncertain and related to MS applied feed in tariffs
- Bio-electricity produced represents only the 35% of the energy contained in the biogas.
- Biogas upgrading recovers 95-98% of the total biogas energy content (incentives on biomethane can be higher)
- European commission is fostering the utilization of biomethane as vehicle fuel to reduce GHG emission in transportation sector
- Biomethane injection in national grids increases the energy efficiency
- Now Biogas upgrading technologies are more competitive an highly efficient
- Most of EU member states provide the biomethane injection to the national grid

Overview on different Biogas plants for energy production and upgrading to biomethane in EU

Sewage sludge treatment plant: Minworth STW - Sutton Coldfield, UK

Main Target: Water treatment and disposal

Treats sewage sludge of 1.7 million people

4,000 cubic meters/hour of biogas produced

Biogas utilisation strategy until 2011

9 CHP engines **20 Gwhel.** exported **56 GWhel**. produced

About 40 GWh of heat losses

New biogas upgrading solution adopted

1200 m³/h biogas upgraded -> **720 m³/h** of Bio Natural gas produced

2800 m³/h biogas processed in CHP engines

40 GWhel produced per year

65 GWh of Bio Natural gas injected to the grid

Water scrubbing columns for Malmberg biomethane upgrader

Maize and sugar beet pulp treatment plant: Rackwitz - Germany

Mai target: Gas production

12.2 million m3 of biogas produced/year

Gas upgrading capacity of 1,400 m3/h

6.7 million cubic metres of Bio Natural Gas produced per year

4 Primary Anaerobic digesters fermenters

2 secondary anaerobic fermenters

5 Digestate storage tanks

Sugar crops processing: Very quick digestion and very homogenous substrate

Food waste and sewage biomethane plant – Sweden

Main target: Waste treatment and energy efficiency

1,200 tons Food waste & 24,000 m^3 sewage (4% dry) per year

First plant built in Sweden which had to deal with methane leaks (3%).

600,000 Nm3 of Bio Natural gas produced annually (water wash upgraded)

1 Digester volume 1,300 m3

55°C process temperature

1600 t/year digestate

6 Million € total investment costs

Main issues: gas distribution, compression and transportation

Main issues related to Biogas upgrading to Bio-methane

Biogas upgrading to Bio methane: Most used technologies in EU

The most significant technologies in European region at present are:

1. water scrubbing - WATS
2. pressure swing adsorption - PSA
3. chemical scrubbing - CHEMS
4. physical scrubbing - PHYS
5. Membrane separation - MEMS

TECHNOLOGY	H2S removal	Pressure	CH_4 yield	CH_4 purity	gas flow capacity (m^3/h)
water scrubbing	Not needed	6 to 12 bar	94%	98%	500-2000
Pressure swing adsorption	Not needed	4 to 10 bar	91%	98%	> 2000
chemical scrubbing	Needed	1 atm	90%	99%	500-1000
physical scrubbing	Not Needed	7 to 8 bar	90%	94-98%	500-2000
membrane separation	Not needed	20 to 36 bar	78%	97-99.5%	<300

Energy consumption and costs of Biogas upgrading technologies

The most preferable technology is WATS with almost 40 % share, followed by PSA and CHEMS (both around 25 % share).

Technology	Energy requirements [kWh/Nm^3]				
	TUV (2012)	Beil (2010)	(Electrigaz, 2008)	Gunther (2007)	Berndt (2006)
WATS	0.46	0.2	0.3	0.391	0.28
CHEMS	0.27	0.56	n/a	0.126	0.42
PHYS	0.49-0.67	0.43	0.67	0.511	0.32
PSA	0.46	0.24	0.27	0.285	0.21
MEMS	0.25-0.43	0.19	n/a	n/a	0.5

Technology	Economic performance [relative values]				
	250 Nm^3/h – TUV (2012)		1000 Nm^3/h - Beil (2010)	250 Nm^3/h - de Hullu (2008)	
	Investments	Operating cost	Operating cost	Investments	Operating cost
WATS	1	1	1	1	1
CHEMS	0.91	1.16	3.93	1.98	1.50
PHYS	0.91	0.99	2.60	n/a	n/a
PSA	0.98	0.98	3.73	1.83	1.56
MEMS	0.87	0.93	1.67	1.70	1.1

A high investment

The economic bottleneck of Biogas upgrading facilities

Upgrading biogas in small scale biogas plants (150-300 Nm^3/h) doesn't give a valid payback time as both investment and operational costs are too high.

There is a large amount of small scale family farms in Europe

For a plant treating 2,000 Nm^3 biogas/h the costs are 1,500 €/Nm^3 and for a plant treating 500 Nm3 biogas/h the costs are on average 2,000 – 2300 €/Nm^3

According to AEBIOM (2013), CHP engine processing about 500 Nm^3/h biogas costs around 600-650 €/kWe, which means: **590-650,000 €**

According to Urban (2009) the investment costs for a biogas upgrading plant treating 500 Nm^3 biogas/h are on the average **1,000,000 €**

The economies of scale favour larger biogas plants where the desired scale should be between 500 and 1,400 Nm^3/h of raw biogas.

The great Bottleneck: Digestate disposal and reutilization

Digestate disposal & treatment costs

- Nitrate directives represent problem all around Europe. Digestate disposal is a bottleneck due to exceeding nitrogen (and ammonia) and heavy metals content.

- Digestate tratment requires high amount of energy and represents one of the most relevant costs.

Digestate treatment and disposal costs in Europe start from 15 €/ton

- the digestate treatment would allow to have a good biofertilizer to be also traded among other farmers for bio-food production.

- Digestate upgrading would be beneficial for:

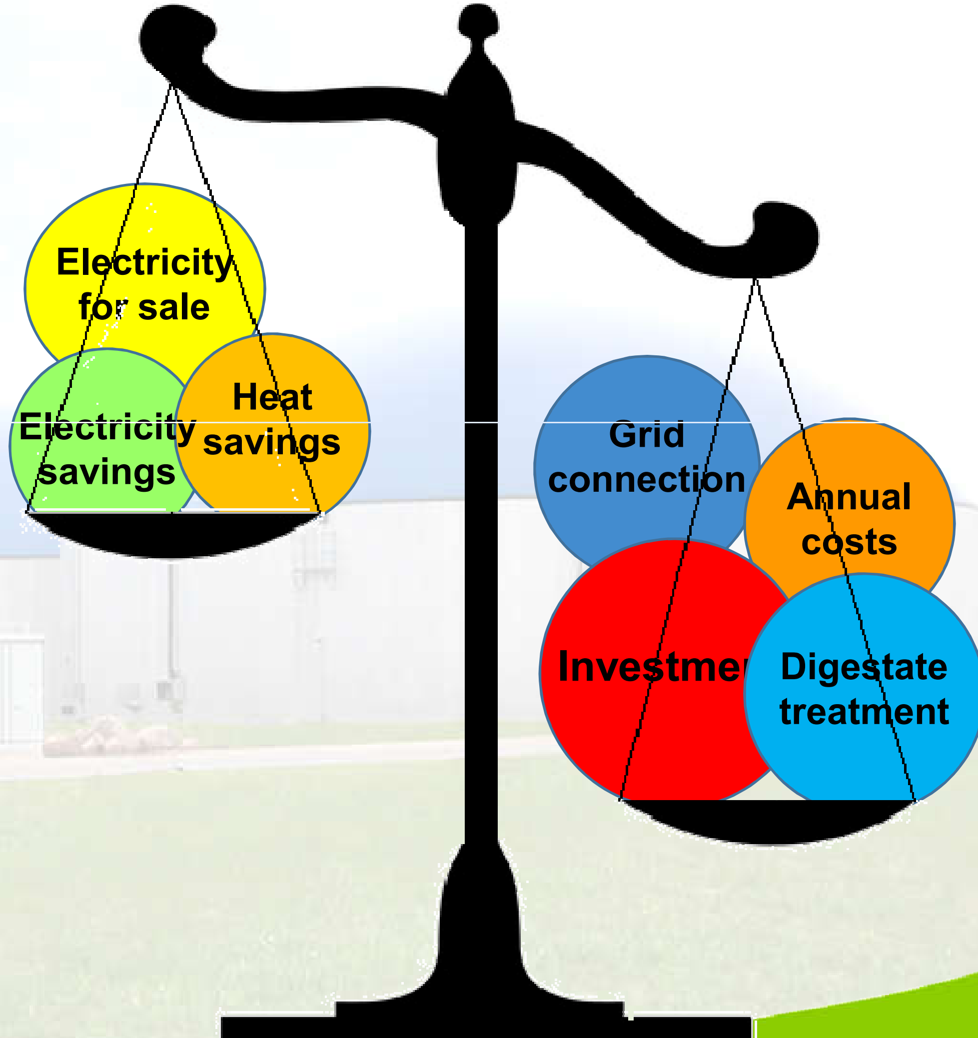
- Phosphorus recycling
- Organic Nitrogen input
- Avoid soil erosion
- Reduce synthetic fertilizers GHG emission

Digestate disposal & treatment costs

- Nitrate directives represent problem all around Europe.
- Digestate disposal is a bottleneck due to exceeding nitrogen content and heavy metals content.

High Disposal costs: More than 15 €/ton!

- Digestate tratment requires high amount of energy and represents one of the most relevant costs.
- Governments do not provides adequate laws or standards for biofertilizer from digestate substrate, still considered as waste.

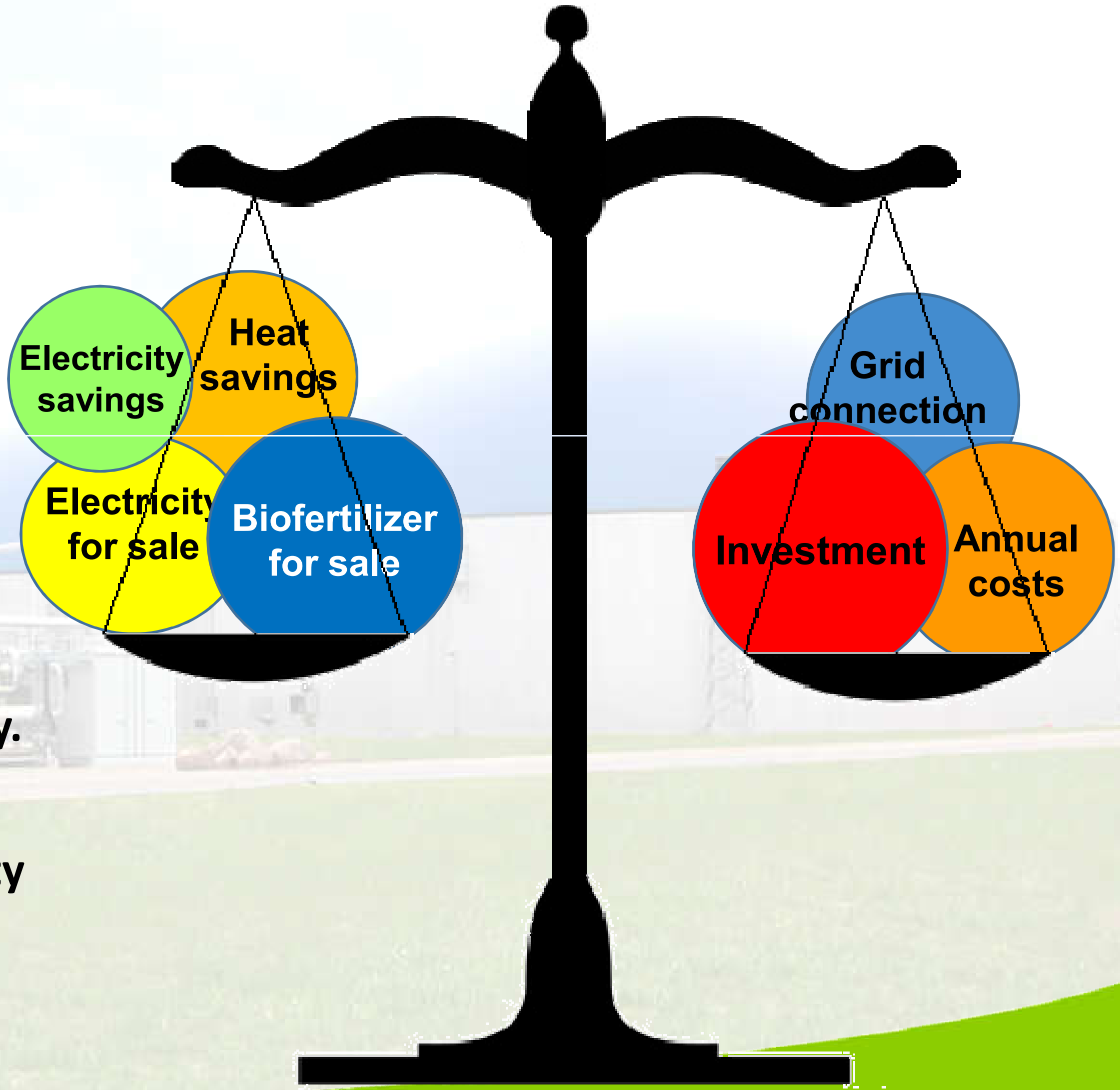


Digestate recycling for biofertilizer production

Digestate treatment would produce valuable biofertilizer (3-4% N_{db} content, 60-80 % Ammonia).

Biofertilizer low price: 100 €/ton!

1. **Supported as carbon saving product.**
2. **Promoted as valuable green fertilizer for increasing food quality.**
3. **Considered as co-product to increase biogas economic feasibility**
4. **Savings on digestate disposal and on artificial fertilizers**



Upgrading digestate into high value products: EUBIA European co-funded projects

AGROCYCLE
for a circular economy

Sustainable techno-economic solutions for the agricultural value chain

Agrocycle activity on digestate application as biofertilizer:

- ✓ Assess environmental impacts of agricultural waste materials and biofertilisers, especially on water quality
- ✓ Formulate farming practices recommendations and guidelines concerning the use of new biofertilisers
- ✓ Evaluate the effectiveness of anaerobic digestates from different waste materials
- ✓ Assess the agronomic performances and the soil fertility effects of anaerobic processed slurries in comparison with commercial fertilizers and composted municipal organic wastes from separate collection, on different crops
- ✓ Application of anaerobic digestate obtained from cattle slurry to organic vegetable crop rotations

SaltGae
algae to treat saline wastewater

SaltGae suite of technologies, combining aerobic and anaerobic processes for biogas production with ponds hosting synergistic mixtures of halotolerant bacteria and algae, will treat Waste water saline effluents resulting from three different production processes:

- Tannery: (~40 g/L salinity),
- Whey (~10 g/L salinity)
- Aquaculture (~3 g/L salinity),

Three different pilot plants operating:

- Slovenia,
- Italy
- Isreal

New technological applications for wet biomass waste stream products

Hydrothermal Carbonisation (HTC)

Organic substrate is milled and mixed with water, as the substrate is injected in liquid status, with moisture content from 60 to 85%.

Biomass is exposed to around 180-210 °C and 16-20 bars, converted into a main product a coal-water-slurry. After water separation, there main products are:

A coal-like product (HTC carbon) and a water phase rich in nutrients, sugars and organic acids (from 5 to 35%).

Thank you for your attention!

Andrea Salimbeni
EUBIA Project Manager
andrea.salimbeni@eubia.org
Skype: a_salimbeni