exergy

Engineering that inspires

Valorisation of Organic Fraction of Waste to Sustainable Bio-Fuels and Other Valuable Bio-Products

Dr. Yaying Chen

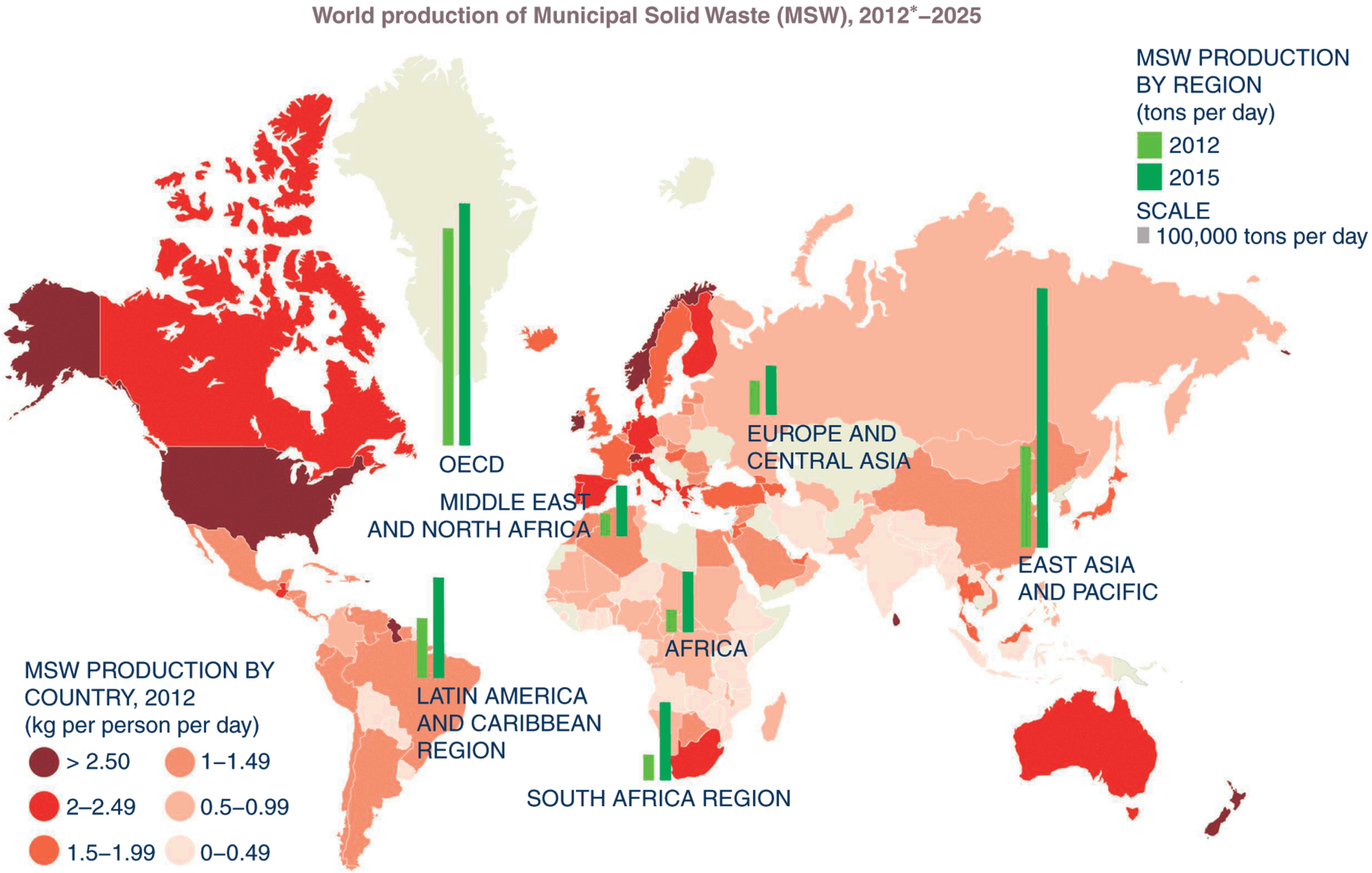
Contents page

Background – Municipal Solid Waste (MSW)

It is estimated that global municipal solid waste (MSW) generation is approximately ***1.3 billion t/yr*** and this amount is expected to increase to ***2.2 billion t/yr*** by 2025*

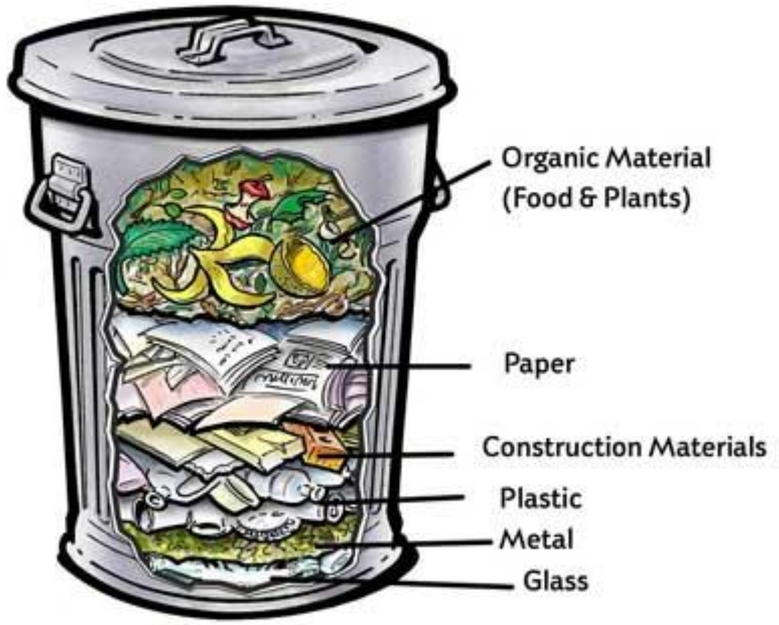
*World Bank/Hoornweg and Bhada-Tata, 2012

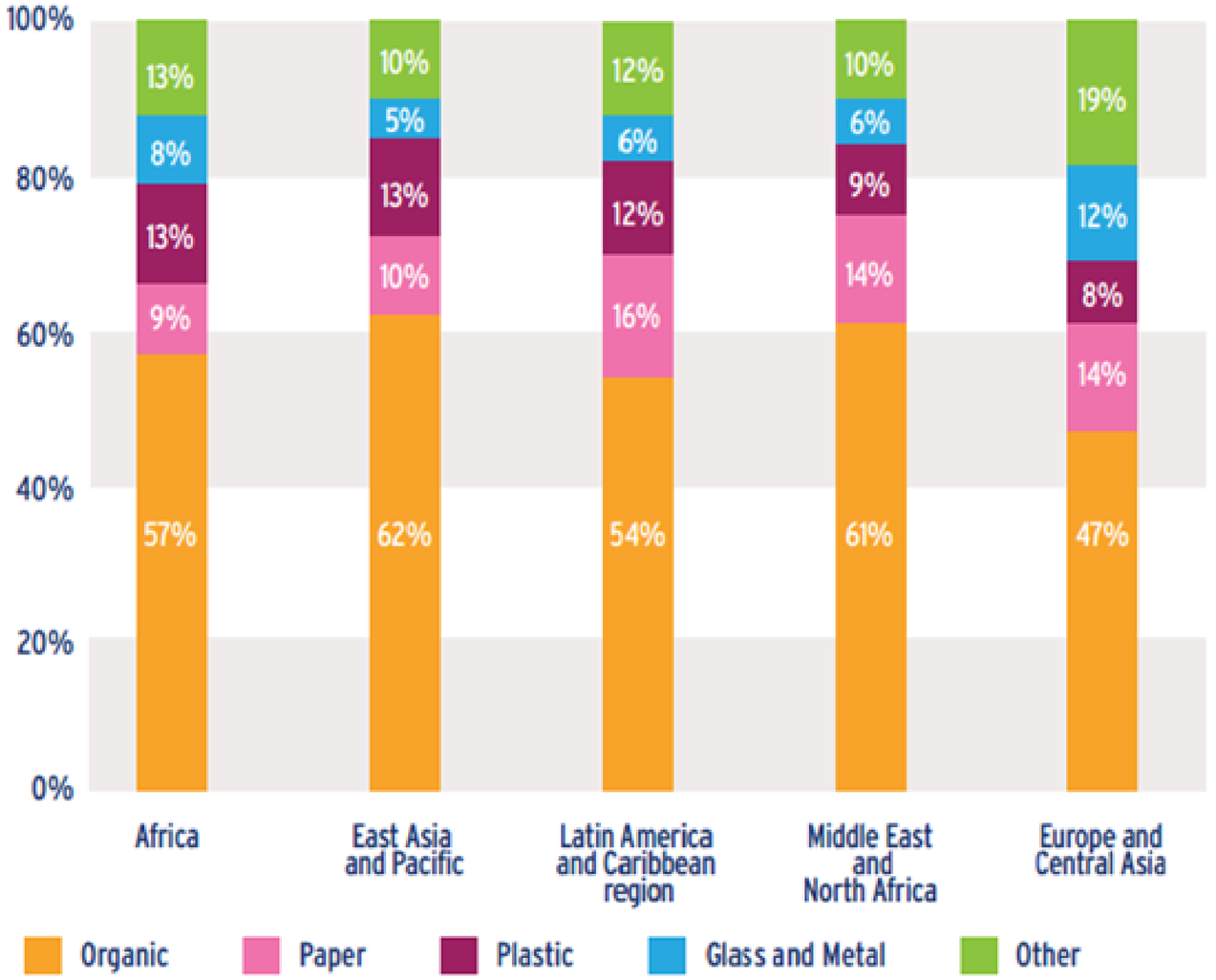
Background – Municipal Solid Waste (MSW)



*Municipal Solid Waste Disposal by Region, by The World Bank, 2012

Background – Municipal Solid Waste (MSW) in EU





Municipal Solid Waste Disposal by Region, by The World Bank, 2012

Background – Municipal Solid Waste (MSW) in EU

In Europe, about 240 million tonnes of Municipal Solid Waste (MSW) is produced every year:

- 25% - landfill,
- 75% - treated by composting, anaerobic digestion or combustion processes (incineration).

Landfilled is the least preferable option and should be limited to the necessary minimum (Directive 1999/31/EC).

UK government has already increased the landfilled tax again in 2018.

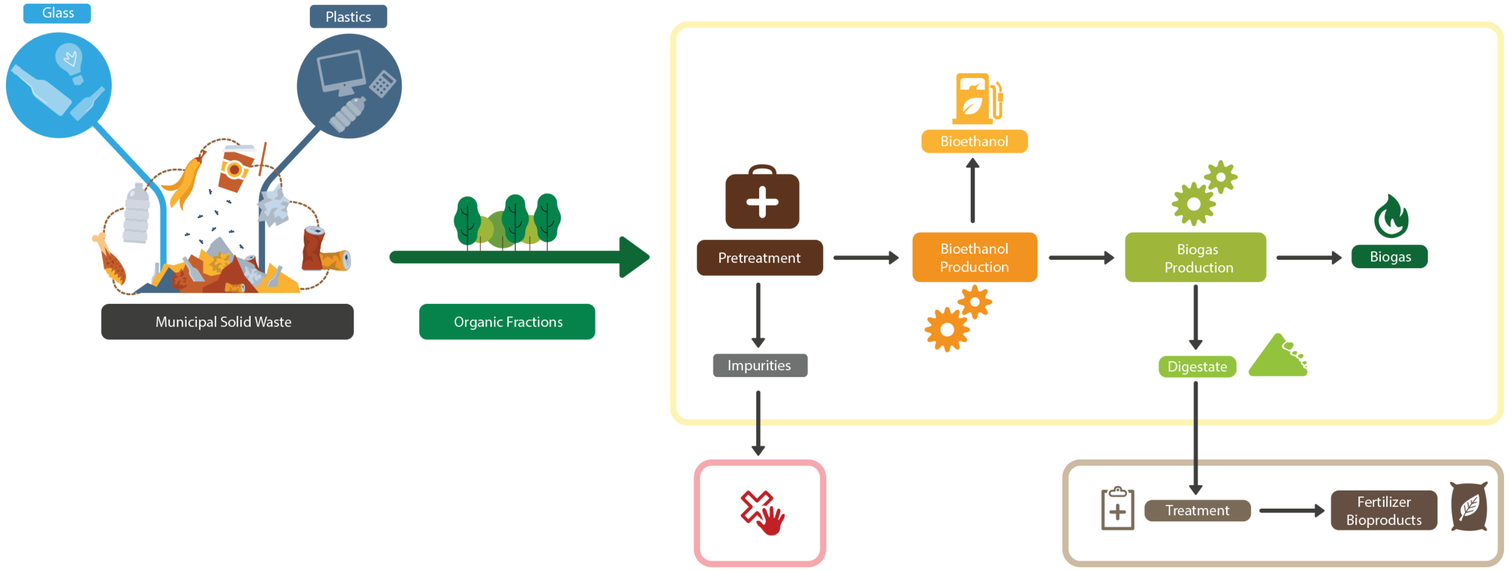
£ per tonne landfill tax	1 April 2016	1 April 2017	1 April 2018
Standard rate	£84.40 per tonne	£86.10 per tonne	£88.95 per tonne
Lower rate	£2.65 per tonne	£2.70 per tonne	£2.80 per tonne

Valorization of the MSW is a preferred route: improve the existing technologies; produce valuable products; and minimize the residue waste.

Waste2Bio Project Motivations

Waste2Bio project motivations:

- Maximization of MSW valorization to reduce landfill,
- Production of renewable fuels (bioethanol and biogas).



The most important innovation of the project is related to the integration of two bioprocesses for the MSW treatment, which allows maximum recovery of organic matter and quality upgrade.

Waste2Bio Project Motivations

Overview

The Renewable Energy Directive establishes an overall policy for the production and promotion of energy from renewable sources in the EU. It requires the EU to fulfil at least 20% of its total energy needs with renewables by 2020 – to be achieved through the attainment of individual national targets. All EU countries must also ensure that at least 10% of their transport fuels come from renewable sources by 2020.

On 30 November 2016, the Commission published a proposal for a revised Renewable Energy Directive to make the EU a global leader in renewable energy and ensure that the target of at least 27% renewables in the final energy consumption in the EU by 2030 is met.

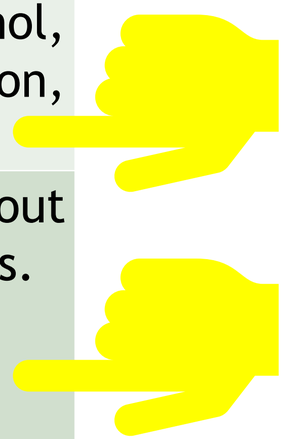
There are huge driving forces behind producing bio-energy. The Renewable Energy Directive (RED) 6 requires EU Members States to generate 20% of energy from renewable sources by 2020, and for 10% of transport fuels to be made up of renewable resources.

Since March 2013, a revised British Standard for petrol (EN228) has allowed oil companies to supply petrol containing up to 10% ethanol.

Normally, bioethanol can be produced by fermenting crops such as corn and sugar cane. However it has its own implications.

Waste2Bio Project Motivations

Advantages	Disadvantages
Unlike petroleum, ethanol is a renewable resource.	Ethanol has a lower heat of combustion (per mole, per unit of volume, and per unit of mass) than petroleum.
Ethanol burns more cleanly in air than petroleum, producing less carbon and carbon monoxide.	Large amounts of arable land are required to produce the crops required to obtain ethanol, leading to problems, such as soil erosion, deforestation, fertilizer run-off and salinity.
The use of ethanol as opposed to petroleum could reduce carbon dioxide emissions, provided that a renewable energy resource is used to obtain ethanol and distil the fermented ethanol.	Major environmental problems would arise out of the disposal of waste fermentation liquors.
	Typical current engines would require modification to use high concentrations of ethanol.



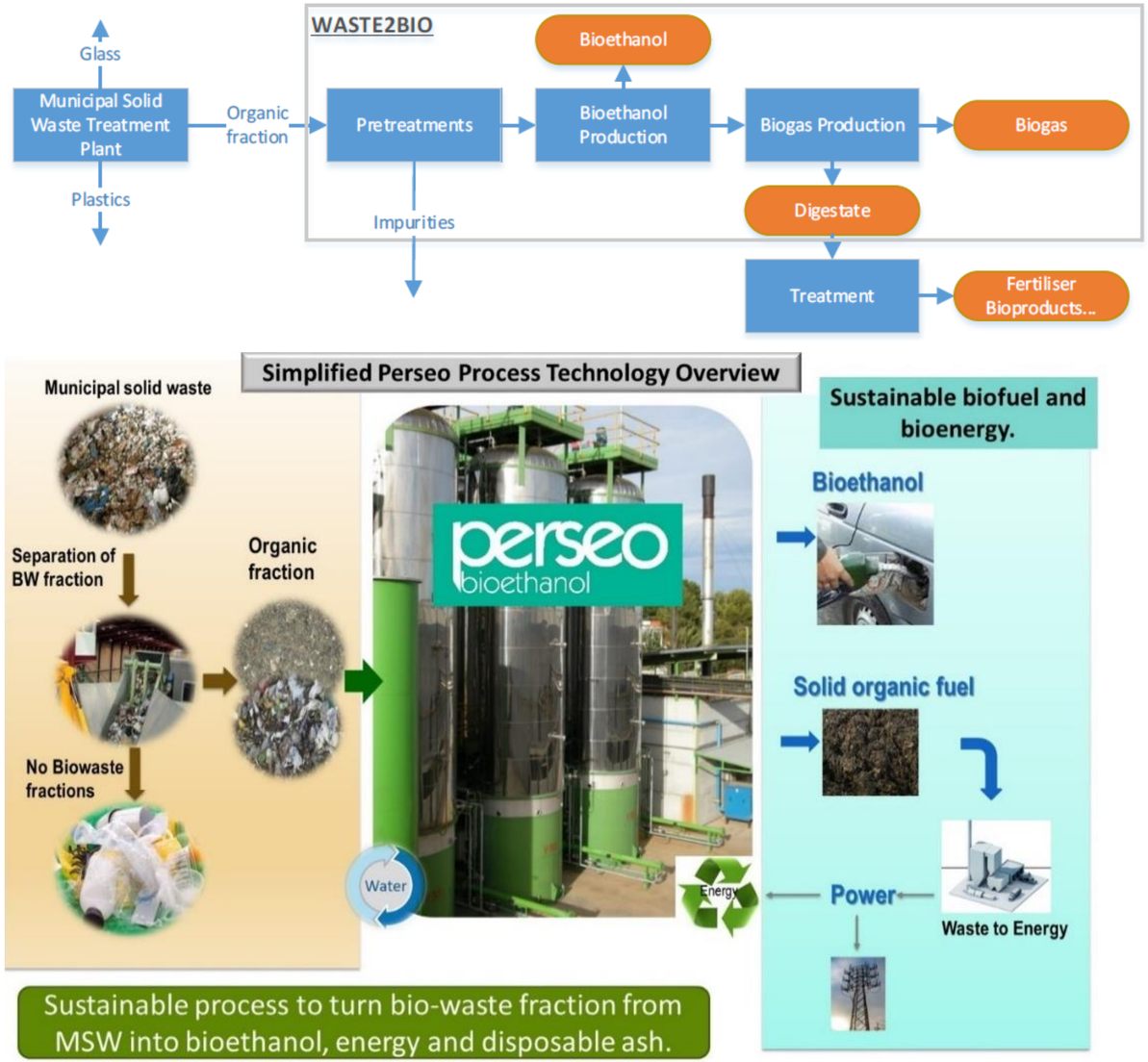
Waste2Bio Project Motivations

The principal idea of Waste2Bio is to develop a more sustainable and efficient alternative to the current methods by:

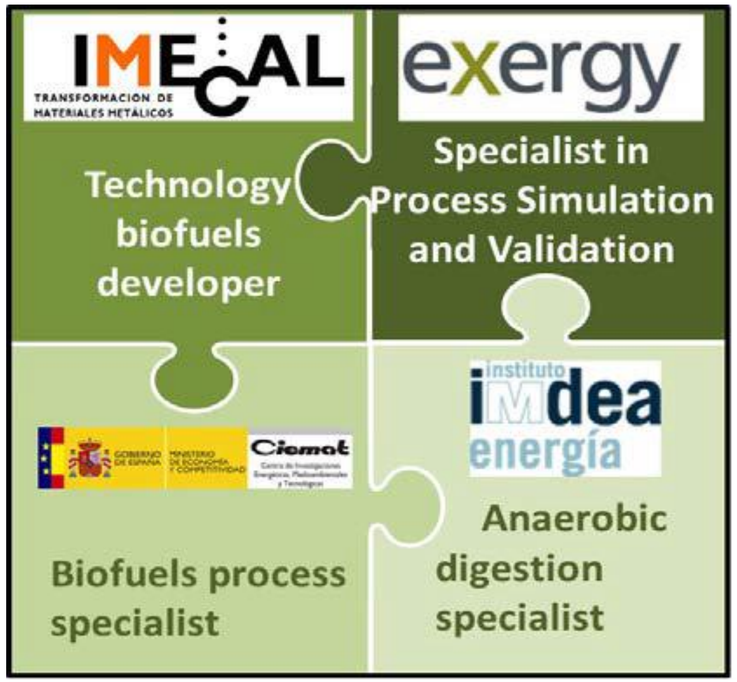
1. Producing bioethanol from biodegradable materials present in the MSW (by using patented PERSEO Bioethanol® process),

2. Processing the residual feedstock into biogas using anaerobic digestion,

3. Exploring the possibility of harvesting biofertilizers from the remaining solid waste.



Waste2Bio – Partners and Sponsors



Total project value: €1,752,700

UK Project Value: £428,991

BEIS Contribution: £257,395

Start Date: 31 March 2017 (1 March 2017 in UK)

Scheduled Completion Date: 31 January 2020

Department for Business, Energy & Industrial Strategy

This project has received funding from the ERA-NET BESTF3, and has been co-financed by CDTI and MINECO in Spain, BEIS (formerly DECC) in the UK, and by the H2020 Framework Programme of the European Union.

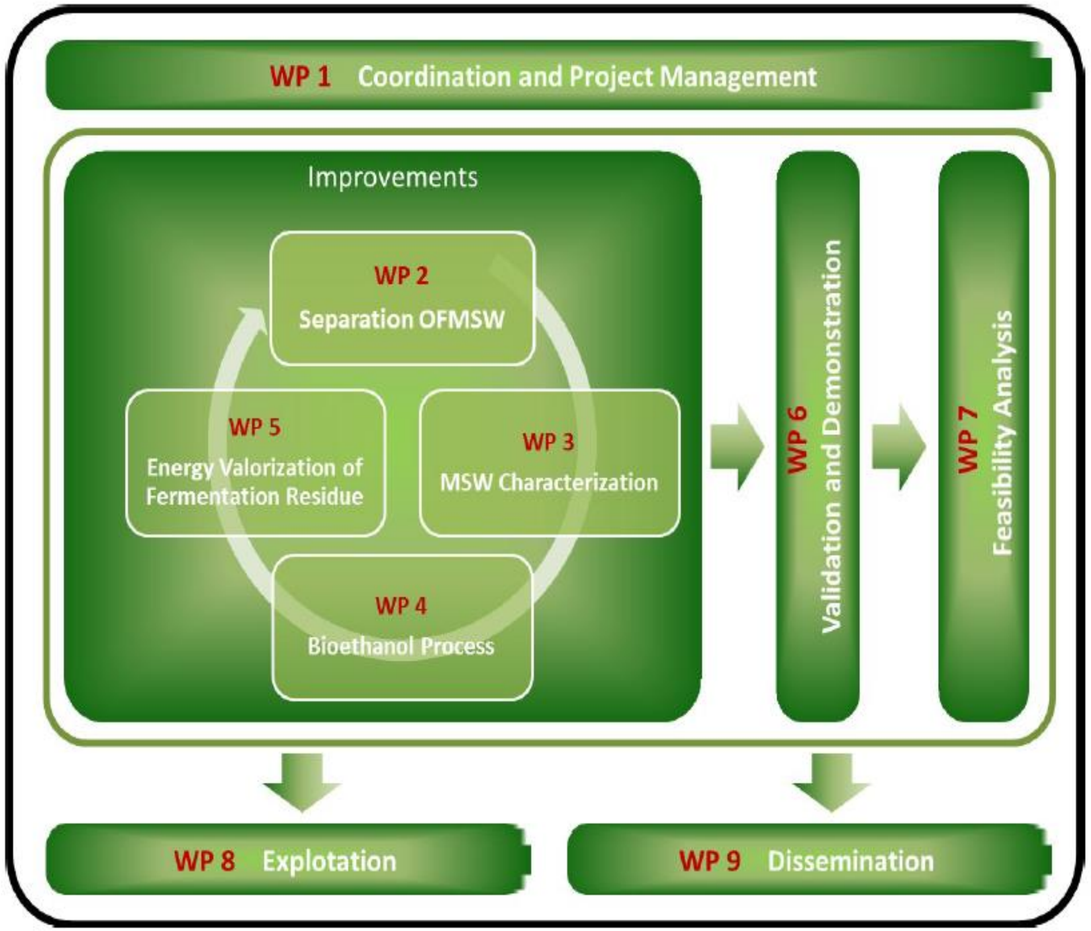
Waste2Bio - Working Lines

(1) <u>Improvement in the different processes</u>:

- ***Pre-treatment step*** (to obtain the most suitable organic fraction feedstock),
- ***Bioethanol production*** from the carbohydrates contained in the MSW involving the ***hydrolysis*** and ***simultaneous fermentation and saccharification***,
- ***Anaerobic digestion*** of the residue obtained from the fermentation process,
- ***Fertilizers production*** and raw material characterization.

(2) <u>Process validation and demonstration</u> at semi-industrial scale, including the process integration, process simulation, techno-economic assessment, and energy & sustainability analysis

(3) Integration of the project results in the new MSW treatment model defining the **<u>exploitation strategy and business models</u>**.



Waste2Bio – Progress

WP2 01

Improvement of the Processes for the Organic Fraction Separation from MSW (Municipal Solid Waste)

- Waste sorting reviews
- MSW(Municipal Solid Waste) Separation Techniques Selection

Biffa – West Sussex Waste Treatment Plant

Trommel Screening

Magnetic Separators

X-ray Separators

Optical Sensors

Waste2Bio – Progress

WP3 01

Municipal Solid Waste Characterization

Component	Content (% total solids)
Glucan	30.4 ± 7.4
Starch	14.5 ± 2.1
Protein	15.1 ± 4.7
Fat, oil, grease	14.9 ± 5.6
Free sugars	8.9 ± 5.1
Lignin	8.2 ± 4.5
Hemicellulose	7.3 ± 3.9

Average from China, Colombia, Denmark, France, India, Ireland, Italy, Mexico, Turkey, UK and USA

Campuzano *et al.*, Waste Management 56, 2016, 3-12

Olleco AD Facility – Westcott Business Park

Capacity: 48,000 tonnes/annum
Feedstock: Kerbside sorted organics & Supermarket Waste
Output: 3.1MW

Biffa West Sussex Waste Treatment Plant

Capacity: 310,000 tonnes/annum
Feedstock: 'Black-bag' household and commercial waste
Output: at full capacity, 4.5MW of electricity (powers the MBT facility and exported to the national grid)

Waste2Bio – Progress

WP3 02

Municipal Solid Waste Characterization

We has been focusing on studying the variability of Organic Fraction of Municipal Solid Waste (OFMSW) due to waste collection systems, geographical location and the seasonal variation.

Waste2Bio – Progress

WP4 01

Improvement of the Bioethanol Fermentation Process

1. An enzymatic cocktail, which is adopted to the fermentation process has been selected and optimised,

2. Evaluation of yeast strains is under process.

Waste2Bio – Progress

WP5 01

Energy Valorization of Fermentation Residue Through Anaerobic Digestion

The feasibility to produce biogas from the **bioethanol** production process residue has been studied.

1. Bio-chemical methane potential (BMP) assays,
2. Feed stream solid condition optimization.

The feasibility to produce fertilizer from the **biogas** production process residue will be studied.

1. Digestate analysis and characterization,
2. Evaluation of the product stability through storage.

Waste2Bio – Progress

WP6 01

Validation and Demonstration of the Integrated Process

Demonstration Tests

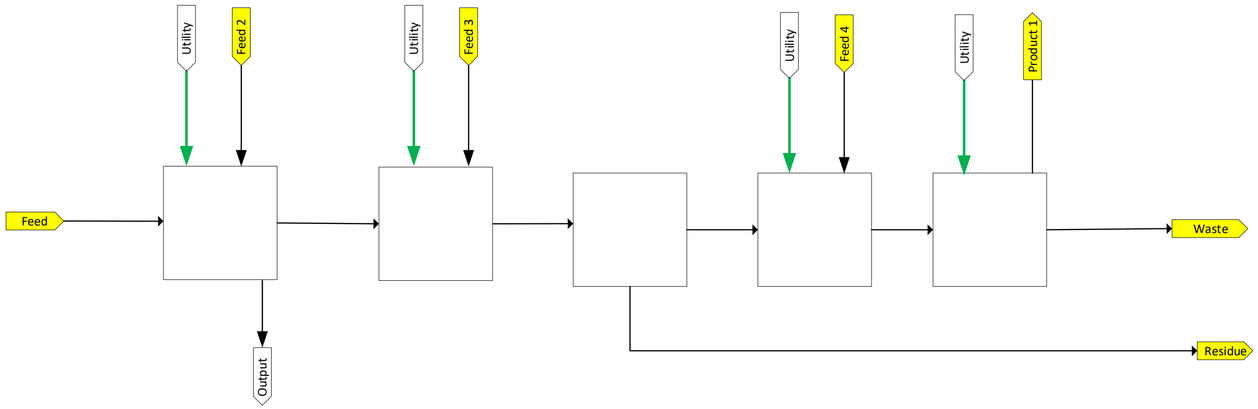
Pictures of PERSEO Bioethanol® plant

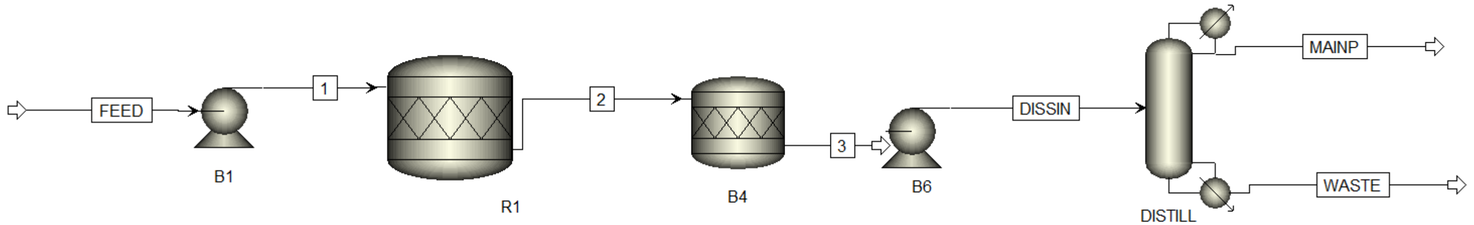
Waste2Bio – Progress

WP6 02

Validation and Demonstration of the Integrated Process

Process Simulations



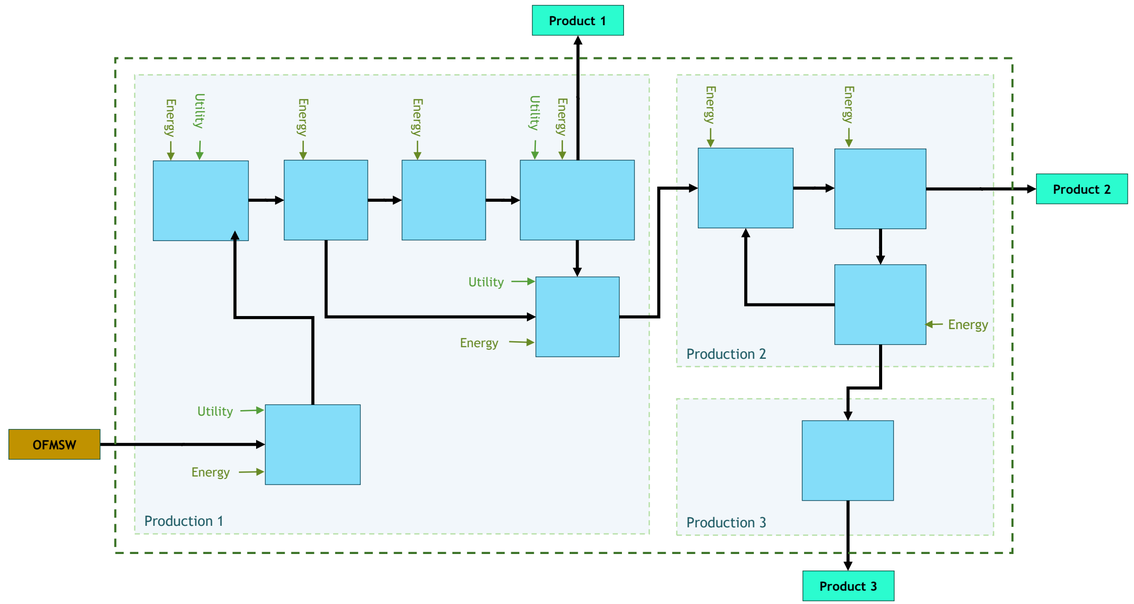


Waste2Bio – Progress

WP7 03

Environmental, Energy, LCA (Life Cycle Assessment), and Impact Analysis

- Techno-economic Assessment
- Life Cycle Cost Assessment
- Energy and Exergy Assessment
- Life Cycle Assessment
- Social Life Cycle Assessment



Waste2Bio – Progresses

WP 8 01

Exploitation

Establish the most appropriate exploitation routes for the technology developed in the Waste2Bio project, with the aim of bringing the technologies and products to the market with a low risks in the investment.

This will include:

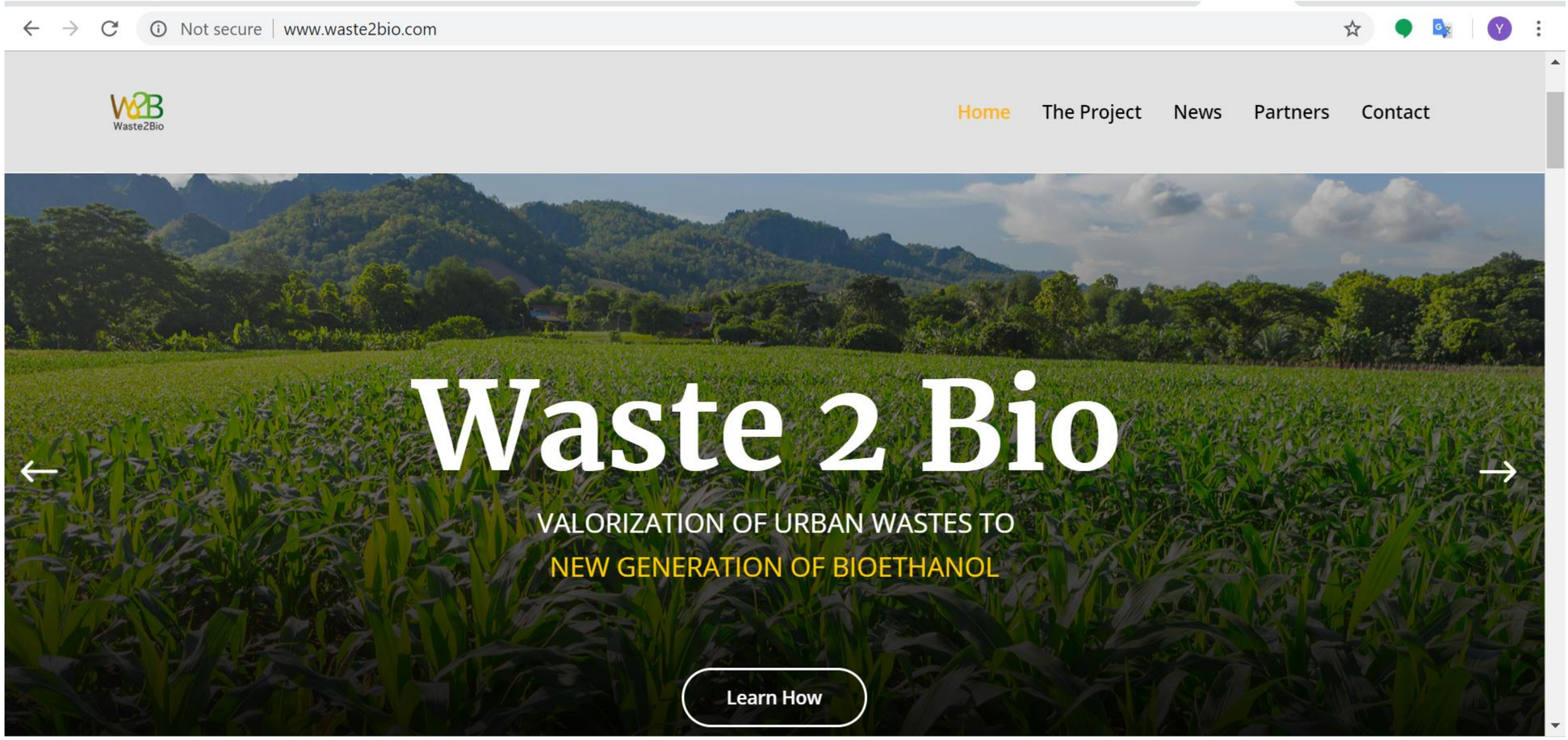
- Exploitation plan,
- Business plans and business models (from the most promising exploitable results),
- IPR (Intellectual Property Rights) protection,

Waste2Bio – Progress

WP 9 01

Communication and Dissemination - Website

http://www.waste2bio.com/

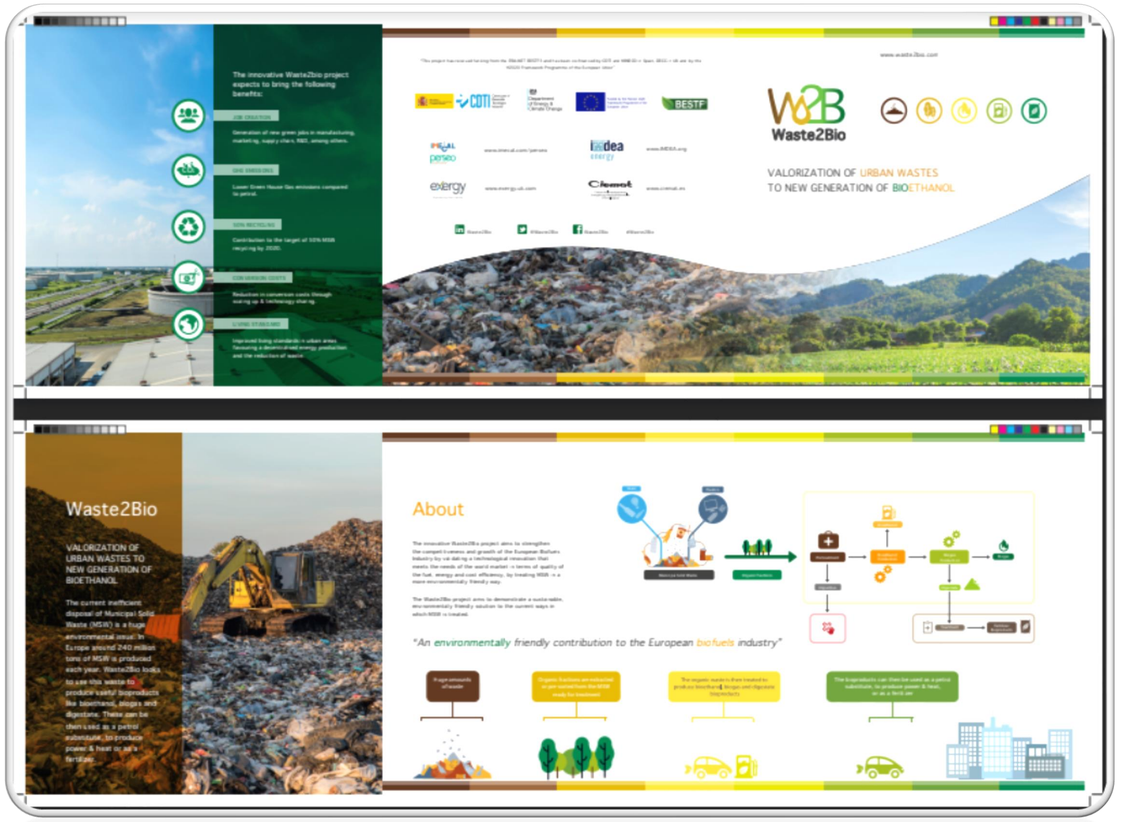


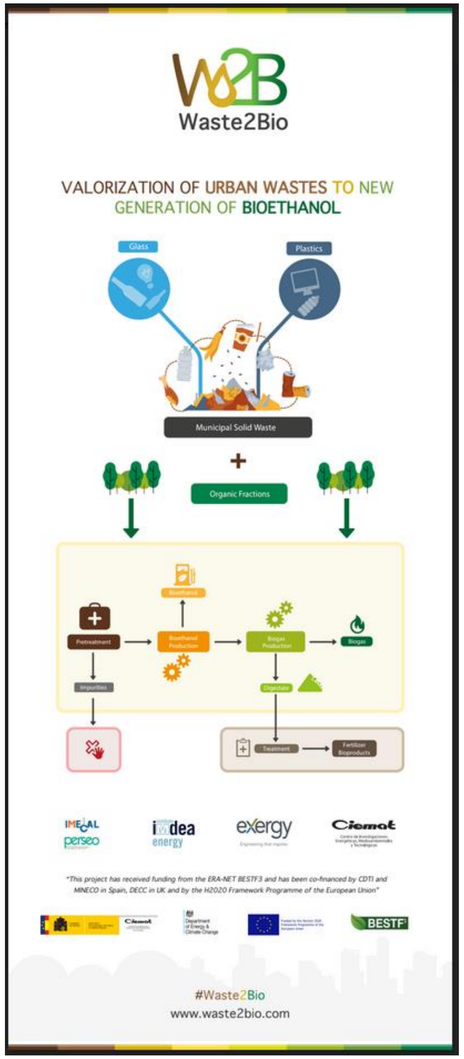
Waste2Bio – Progress

WP 9

02

Communication and Dissemination - Printed materials





Waste2Bio – Progress

WP 9 03

Communication and Dissemination - Twitter

Waste2Bio – Progress

WP 9 04 **Communication and Dissemination -** LinkedIn

Waste2Bio

34 followers

Manage page | See jobs

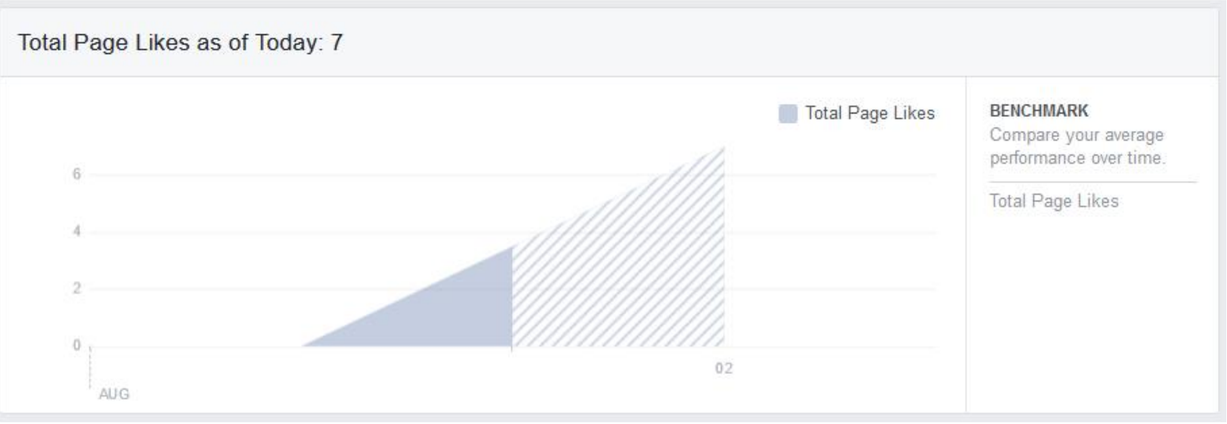
Update engagement

Viewing 1 - 6 of 6 Show: 10

Update name	Date	Impressions	Clicks	Video views	CTR	Social Actions	Engagement
Waste2Bio presented at the Biorefineries Seminar of ainia cent... All followers	6/29/2018	633	45	-	7.11%	5	7.9%
Waste2Bio partners met at the end of March to discuss the project pro... All followers	5/16/2018	120	8	-	6.67%	6	11.67%
WASTE2BIO project - From the organic fraction of the MSW to bi... All followers	5/4/2018	262	16	-	6.11%	4	7.63%
Learn more about the Waste2Bio project and updates on the 6 mont... All followers	10/24/2017	863	16	-	1.85%	3	2.2%
Connect with Waste2Bio on facebook to lean more about how ... All followers	9/18/2017	628	4	-	0.64%	6	1.59%

Waste2Bio – Progress

WP 9 05 **Communication and Dissemination** – Facebook



Posts

Twitter - https://twitter.com/ExergyLtd?lang=en
Facebook - https://www.facebook.com/exergyltd
Linkedin - https://www.linkedin.com/company/3478507/admin/updates/

OUR COMPANY - Exergy

We dream of a low carbon, sustainable future

OUR STORY

Exergy was founded in 2011 with the vision of empowering people, businesses and governments to make informed decisions about sustainability.

We have grown steadily due to our innovative solutions and participation in numerous initiatives in the built environment, sustainable process and circular economy sectors.

ABOUT US

https://exergy-global.com/

We are an engineering company who develop, engineer and undertake projects that contribute to our goal of a low carbon, sustainable future.

We excel at designing and implementing strategies and technologies that optimise the use of resources in buildings and industries.

OUR MISSION

To provide innovative engineering solutions across the globe that contribute to our goal of a low carbon, sustainable future.

OUR SERVICES – Sustainable Processes

We offer cost effective, sustainable and cutting-edge solutions in two main areas:

GREEN BUILDINGS & CITIES

- Sustainable Design & Certification
- Building Information Modelling - BIM
- Renewable Energy Solutions
- Resource Efficiency & Optimisation

SUSTAINABLE PROCESSES

- Process Development
- Process Modelling
- Scale-Up & Plant Design
- Techno-economic Evaluation

OUR SERVICES – Sustainable Processes

We offer cost effective, sustainable and cutting-edge solutions:

Sustainable Processes

PROCESS DEVELOPMENT

- Process Design
- Technology Integration
- Preparation of Process Flow Sheets
- Mass and Energy Balances

PROCESS MODELLING

- Process Simulation
- Process Optimisation
- Energy Optimisation (Exergy)
- Virtual Scale-Up

SCALE-UP & PLANT DESIGN

- Pilot Plant and Demonstration-Scale Design
- Equipment Sizing and Specifications
- Preparation and Tender Documentation
- Vendor/Contractor Selection

TECHNO-ECONOMIC ASSESSMENT

- Estimation
- Forecasting
- Economic Modelling
- Sensitivity Analysis

OUR SERVICES - Sustainable Processes

Technology – Economic – Environmental – Business for Real-Scale Projects