SEVENTH FRAMEWORK PROGRAMME
An ERA-NET financed by FP7

ERANET-LAC 2
JOINT CALL 2016
Full Proposal Form

Project acronym:	**Bowso**
Project Coordinator:	**Dr. William Camilo** Apec University, Dominican Republic
Ref.:	**Bowso 2016/BFV031016**

BIOECONOMY

Topic 3: Biorefinery - Fractionation and valorisation of residual biomass to intermediate and/or final high added value bioproducts.

Biorefineries for organic waste in municipal slaughterhouses for the sustainable biogas and compost production

Funded by the following EU CELAC R&I funding agencies:

EU Member States and Associated Countries:

Belgium: Belgian Science Policy Office (BELSPO)
Belgium: Scientific Research Funds (FNRS)
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France: Ministry of National Education, Higher Education and Research (MENESR) Ministry of Foreign Affairs (MAEDI)
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Argentina: Ministry for Science, Technology and Productive Innovation (MINCyT)
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INFORMATION RELATING TO THE COMPOSITION OF THE PROJECT CONSORTIUM

Project acronym:	Bowso		
Project full title:	Biorefineries for organic waste in municipal slaughterhouses for the sustainable production of biogas and compost		
Topics:	Topic 3: Biorefinery - Fractionation and valorisation of residual biomass to intermediate and/or final high added value bioproducts.		
Type of project:	**Research**		
Keywords:	Industrial biotechnology		
Total project costs:	1.368.995,00 €	Total requested funding	1.044.995,00 €
Project duration (months):	36	Expected start date (mm/yyyy):	
09/2016	474,00 PM		

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2. Consortium: Details of the Organizations involved

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University of Padua **Italy**	Dr. Andrea Marion andrea.marion@unipd.it	HE	CNR, Italy
ESPOL	Delgado Plaza, Emérita	HE	Secretariat of Higher Education, Science, Technology and Innovation (SENESCYT) (Ecuador)
Panama Techn. University, **Panama**	Dr. Humberto Alvarez (BGP) humberto.alvarez@utp.ac.pa http://humberto-r-alvarez-a.webs.com	HE	National Secretariat for Science and Technology and Innovation (SENACYT)
Åbo Akademi University	Dr. Dmtry Murzin (UAA) dmitry.murzin@abo.fi	HE	Academy of Finland (AKA) (Finland)
Istituto di Tecnologie Avanzate per l'Energia	Dr. Bonura, Giuseppe giuseppe.bonura@itae.cnr.it	HE	CNR, Italy
UNIVERSIDAD TÉCNICA DE AMBATO , ECUADOR	Paucar Samaniego, Mayra ma.paucar@uta.edu.ec	HE	Secretariat of Higher Education, Science, Technology and Innovation (SENESCYT) (Ecuador)

And others……..

Partners of the Project

Head/ Responsible	Organization/ Institution	Acronym	Type of partner	Funding Agency	Countr
Camilo, William	Universidad APEC	UNAPEC (coordinator)	Beneficiary	Ministry of Higher Education, Science and Technology (MESCyT) (Dominican Republic)	Repúbli Dominic
Álvarez, Humberto	Universidad Tecnológica de Panamá	BGP	Beneficiary	National Secretary of Science, Technology and Innovation (SENACYT) (Panama)	Panama
Delgado Plaza, Emérita	ESPOL	BIOLRE	Beneficiary	Secretariat of Higher Education, Science, Technology and Innovation (SENESCYT) (Ecuador)	ECUAD
Marion, Andrea	Università di Padova, Italy	Hywpu	Beneficiary	National Research Council (CNR) (Italy)	Italy
Bonura, Giuseppe	Istituto di Tecnologie Avanzate per l'Energia	ITAE	Beneficiary	National Research Council (CNR) (Italy)	ITALY
Murzin, Dmitry	Åbo Akademi University	UAA	Beneficiary	Academy of Finland (AKA) (Finland)	Finland
Paucar Samaniego, Mayra	UNIVERSIDAD TÉCNICA DE AMBATO , ECUADOR	UTA	Beneficiary	Secretariat of Higher Education, Science, Technology and Innovation (SENESCYT) (Ecuador)	ECUAD

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3.1. Overall Project Costs

3.2. Detailed Project Costs

3.2a. Personnel Costs

3.2b. Equipment

3.2c. Materials

3.2d. SubContracting

3.2e. Travel and Subsistence Costs

3.2f. Other Costs

3.2g. Overheads (Please, check specific national requirements)

3. Executive summary

A slaughterhouse is a State or private industrial plant in which slaughtered farm animals for further processing (desposted), storage and marketing as meat or other animal products. The location, operation and the processes used vary according to a number of factors such as the proximity of the producer, logistics, public health, the demand of the customer, and even religious or moral precepts. The problems of pollution by waste should also be avoided through proper planning and adequate equipment.

A clear and distintive feature of bioreactors used for waste treatment processes is the use of specialized microbial ecosystems as catalysts for the conversion processes. In particular, two important ideas behind this concept are its sustainable character and the possible diversification of feedstocks and products in order to optimize both bioenergy and biomolecules production. These ideas match with a novel concept called

"Environmental Biorefinery", in which the main objective is to minimize the pollution rejected to the environment while getting as much as possible high added value products. In this framework, this project combines several technologies used for the biological treatment of waste and wastewater for producing biogas (CH4 and BioH2) from agricultural residuals and makes the connection of these processes with the production of Biorefineries for organic waste in municipal slaughterhouses for the sustainable production of biogas and compost a by product of these bioprocess
as one of the main reagents. This project aims to combine these technological approaches for reducing the environmental impact of agricultural and urban wastes and to obtain valued energy, particularly in small scale biorefineries where all the substrates used for the different process come from only two unique sources of feedstock: solid organic waste and wastewater from the production of a distillery and waste grease from waste organic wate, rendered animal fats and organic residues. Whenever each technology working, either separately or in combination in a biodigestor as a biorefinery part, they present several scientific and technological challenges under a performance point of view, and claim for the implementation of optimization and process control techniques in order to guarantee their performance and to reach sustainability. The design and implementation of appropriate control and optimization strategies will be also be considered.

Applications and experiences of the subject in the various productive sectors

Publishable Summary

Part of CNR-ITAE, Italy

The supercritical water gasification (SCWG) process is an alternative to both conventional gasification as well as the anaerobic digestion processes for conversion of wet biomass. Such process consists in reacting biomass with supercritical water, that is water above its critical point; so avoiding the need for drying and taking place at very short residence times (*i.e.*, a few minutes at most). Supercritical water gasification is therefore a promising technology for the efficient conversion of wet biomass into a methane-enriched biogas that, after catalytic upgrading (methanation) can give a CO_X-free biomethane, useful for energetic purposes.

Scientific and technological challenge

CNR-ITAE

The proposed research intends to propose a biorefinery model based on the treatment of wastes from slaughterhouses. By an integrated approach of innovative technologies, the main challenge is to demonstrate the possibility to proof the "concept" of energy self-sufficiency in a modern slaughterhouse through the valorization of residual biomass, otherwise hard to dispose.

In the proposed research program, the expertise from Europe will allow to reinforce the competitiveness of LAC municipalities, providing a clean and efficient technology for dealing with biomass residues on a small-scale/short-chain way.

Technical and scientific description of the project

WP2.3 Catalytic production of biogas by supercritical gasification of organic wastes

Supercritical water gasification (SCWG) is a well-known technology for the efficient conversion of wet biomass (i.e., 60-95 wt% moisture) into burnable gases like hydrogen and methane without char formation [1]. The main advantage of using supercritical water (T>647K; P>22MPa) is that it acts both as a solvent capable of rapidly hydrolyze the biomass and as a reagent capable of degrading the polymer structure of the biomass. At relatively low temperatures (<400°C) and in the presence of a suitable catalyst, the gasification reaction leads preferably to the formation of methane-rich gas streams, whereas at higher temperature the hydrogen production is predominant [2]. Based on the experience gained by Bonura and coworkers about the technologies operating under supercritical fluids [3], this project task is aimed at developing a new SCW catalytic process for producing CH_4 from organic wastes, also allowing a strong reduction of char formation and increasing the reactor gasification efficiency. The main goal is to develop a robust catalyst, active at lower temperature, characterized by high selectivity to methane and resistant both to mechanical and chemical stresses.

A 500 cm^3 stirred tank reactor (Inconel special alloy) containing a basket to house the granular catalyst will be used. Reactor is equipped with a high pressure pumping system and a 1L tank (AISI 304L) for collecting, after reaction, the gas phase for analysis. Experiments will be carried out using an aqueosus solution of 10 vol.% of typical organic wastes coming from slaughterhouses into the reactor previously conditioned under supercritical conditions (22 MPa @ 375°C). The activity-selectivity pattern of “non noble” and “noble” metal based systems will be assessed to find the most promising system to maximize the CH_4 productivity. The effects of catalyst loading, its activation and regeneration, reaction time, as well as the presence of pollutants, like Cl or S precursors, will be investigated.

References

1. O. Yakaboylu, J. Harinck, K.G. Smit, W. de Jong. Energies 2015, 8, 859.

2. Y. Lu, S. Li, L. Guo in Near-critical and supercritical water and their applications for biorefineries; Fang, Z., Xu C. Eds.; Biofuels and Biorefineries Series 2; Springer, 2014, 343.

3. A. Narani, R.K. Chowdari, C. Cannilla, G. Bonura, F. Frusteri, H.J. Heeres, K. Barta, Green Chemistry 17 (2015), pp. 5046-5057.

WP3.3 CH_4-enrichment of streams from gasification

Depending on reaction conditions and technology used to treat biomass, different composition of syngas can be obtained. In particular, in certain conditions biomass can be treated under supercritical water conditions to produce methane employing a proper catalyst. In such processes, usually carried out at reaction temperature lower than 400°C, further to obtain methane and CO_2 as main products, also hydrogen forms. This represents a problem in case gasification of biomass is used to selective produce methane as fuel. A method to lower the content of hydrogen from such reaction stream could be the selective hydrogenation of CO_x into methane (*i.e.*, methanation) [4] in presence of a suitable catalyst. On this purpose, several metal-supported catalysts will be prepared and properly

characterized. Experiments will be performed using a plug flow reactor fed with reaction stream containing $CH_4/CO_x/H_2/N_2$ mixtures at variable composition, temperature ranging from 225 to 350°C and atmospheric pressure.
The structure-activity relationships should demonstrate that by using a proper catalyst the selective hydrogenation of CO_x is a valid approach to lower the hydrogen content of a biomass gasification stream containing CH_4 and CO_2 as main components. Metal supported catalysts, characterized by suitable metal dispersion and structural properties, may allow a singular performance in CO_x methanation reaction even in presence of high methane concentration in the outlet reaction stream.

References

4. Wei Wang, Jinlong Gong: Methanation of carbon dioxide: an overview, Front. Chem. Sci. Eng. 5(1), 2011, pp 2-10.

TECHNICAL DESCRIPTION

Publishable summary of the project

The agroindustry in many of our countries may not be sustainable due to the high level of affectation over the ecosystems located near from where this industry will develop. We are aiming to control the impact of these two high growing industries (sugar cane and cattle) by using biological and thermochemical methods meanwhile producing energy. The proposed methods are: 1) Anaerobic Digestion, 2) Gasification and 3) Pyrolysis. At the end the nutrients left behind after anaerobic digestion will return to the fields as fertilizer for sugar cane, the biogas, syngas and bio-oil obtained by the thermochemical methods will be used to satisfy the energy requirements of the cited industries, and the bio-char can be used to balance the pH of the soils or as water filtrating media in rural communities. Parallel studies will be run to determine the convenience of codigestion when studying the anaerobic digestion, and the usage of the solids left behind after anaerobic digestion as a material to make biopolymer composites.
The objective of this project is to implement the design of an experimental unit for bioprocessing residual biomass generating value-added products.

All organic waste can constitute potential danger of soil contamination, the courses of water surface and underground runoff and seepage, and the lower atmosphere by ammonia gas. These contaminations contribute to the process of eutrophication of aquatic ecosystems. If these wastes reach bodies of water without any treatment, increase the amount of nutrients to the producing organisms (algae), which increase their biomass. In moments of darkness, because of its metabolic activity consume dissolved oxygen in water, decreasing the availability of oxygen for aquatic life. (Also listed as contaminants air dust particles that can be erected, mainly in semi-arid areas or hot low precipitation and windy times. You can create areas of low visibility in adjacent, inconvenient routes in populations bordering and possible aggravate 8 respiratory diseases of cattle. Is also related with the area dedicated to each animal within the poultry for fattening. The issuance of gas ammonia from the nitrogen in manure is dissipated into the atmosphere, and In addition, the smell is unpleasant.

6. Scientific and technological challenge

Nowadays, the potential that anaerobic digestion has on the valorization of agro industrial and urban wastes trough methane production is
well known and one of the most attractive processes for the production of biofuels is the two stage anaerobic directly used in actual cogeneration systems due to the presence of undesirable gases like CO_2 and H_2S, and then, the biogas purification are required. However, the methods actually used to this end are expensive.
Under an operational point of view, this means that they are very susceptible to reach steady states with a poor performance or even to become completely unstable if appropriate control strategies are not applied.
Moreover from a control engineering point of view, this also means that classical control approaches may be applied only under local and restrictive operating conditions, which also results in a poor performance. Then Advanced Control and Optimization approaches must be implemented in order to guarantee stable conditions and the best performance for guaranteeing sustainability. This is the first scientific challenge, because it involves several stages, i.e., the

development of models that suitably represent the dynamics of processes by taking into account all the important aspects of the process (physical, chemical, biological) but with a minimum of complexity for the application of efficient control and optimization approaches, The parameter identification and validation of such models represent also a scientific and technical challenge because it involves an exhaustive experimental phase, and a continuous feedback. Besides the design of control and optimization approaches is another challenge since these have to be designed by considering intrinsic and key
mathematical properties that must hold by both model and control approaches. It turns out that most often the modelling and the control design have to be peformed in close combination.

Scientific and technological challenge

Our proposal aims to implement the design of an experimental unit that allows the evaluation of residual biomass or blends of it; and enables technological adaptation in agricultural areas of the country as a mechanism to generate added value products from residual biomass.Additionally, the residual solids will be dried before gasification, pyrolysis, or composting. The proposed system objective is to innovate in the evaluation and estimation of biogas, syngas, bio-oil and biochar production through the development of equipment that are able to work with an ample range of residual biomass or blend of it.

Technical and scientific description of the project

As a common problem for our countries this project relevance takes as example that in Ecuador the National Energy Institute in 2014, estimates that the country waste production (residual biomass) for that year was 2,875,810,670 t / year of livestock residual biomass, 4,323,14.73 t / year forestry residual biomass and 2,550,351, 672 t / year of agricultural residual biomass. This statistics does not take in consideration neither the addition of 36,000 hectares dedicated exclusively to sugar cane due to the official adoption of bioethanol as biofuel. Nor, the residual biomass due to animal husbandry, specifically bovine, where the government is investing considerable resources.

Description

We propose the design and installation of an experimental system for processing residual biomass or blends of it. This system is going to be installed at the Department of Mechanical Engineering and Production Sciences, specifically in the facilities of the Center for Sustainable Technological Development or another similar ones.

Objective General

Implement the design of an experimental unit for bioprocessing residual biomass generating value-added products.

Objetives Specifics:

1. Develop a protocol to handle, load and blend residual biomass at different stages of treatment.
2. Develop an experimental protocol for sampling residual biomass products at different stages of the biological or thermochemical treatment.
3. Characterize products and subproducts obtained from the various stages of the biological or thermochemical treatment

4. Estimate the correlation between methane production, syngas, bio-oil and biochar produced by residual biomass or blends of it fed to the digester, gasifier or pyrolyzer respectively.
5. Study the biogas, syngas, bio-oil and biochar production rates from each of the of residual biomass or blends of it fed to the digester, gasifier or pyrolizer respectively.
6. Identify the process that present better indicators of biogas, syngas, bio-oil and biochar production from residual biomass of blends of it.
7. Establish physical and chemical parameters affecting the biological or thermochemical process due to the blend residual biomass.
8. Feasibility of scaling up the designed process
9. Feasibility of use residual solids to make biomaterials (parallel study).
10. Slaughterhouse Biodigester infrastructure for Residual Biomas Collection

11. Pre-treatment effluents Sand and Activate Carbon filters with UV.
12. Co2 collections from fireplaces.
13. Hydraulic driving manure effluents heavy waste.
14. Dry reforming CH4 enrichment of streams from gasification.
15. Anaerobic biogas production by supercritical gasification from organic waste.
16. Separation S/L spoted bed drying.
17. Hi temperature biogas fuel cell installation and testing.
18. H2S remotion filters.
19. Sustainable agriculture facilities in greenhouse by CO2 feeding syntesis.
20. Clean water
21. Organic mineral granular fertilizer compost
22. Refrigeration system by Hi temp. fuel cell cogeneration
23. Biomethane Hi pressure compresing and storage system
24. Mathematic (Mat-lab, LabView) model
25. Combustion motors and cogeneration.

Methodology and work plan

The above objectives together (WP 1 THROW WP5 GENERAL BOWSO PROJECT) will be achieved through the following work plan:

Months 1-12.

As example for CNR-ITAE:

T2.3.1. Screening of granular catalysts in batch reactor under SCWG conditions for converting organic substrates into CH_4.

The screening of conventional granular catalysts will be performed in a batch reactor by feeding a solution containing representative organic wastes from slaughterhouses under SCW conditions. Both fresh and used catalysts will be characterized in terms of analytical, structural and morphological features by using the equipment already available at CNR-ITAE.

Months 13-24.

T2.2. Starting from the data obtained in (T2.3.1), a study will be carried out on the optimization of the reaction parameters (pressure, feedstock concentration, etc.), also evaluating how the presence of inorganic contaminants can affect catalyst stability, lifetime and CH_4 productivity.

T3.3.1. Comparing the activity-selectivity pattern of different metallic catalysts based either on “noble” or “non noble” elements.

Experiments will be performed using a plug flow reactor fed with typical $CH_4/CO_2/H_2/N_2$ reaction streams from SCWG (T2.1), at temperature ranging from 225 to 350°C and atmospheric pressure.

Months 25-36.

T3.3.2. To find out the best experimental conditions (H_2 partial pressure, space velocity, …) to minimize the $H_2/(H_2+CH_4)$ ratio in the outlet stream, without any significant evidence of catalyst deactivation (metal sintering, coke formation, …).

WP	**Task**	**Description at CNR-ITAE.**	**Year 1**	**Year 2**	**Year 3**
WP2.3		**Catalytic gasification of organic wastes under supercritical conditions to produce CH_4**			
	T2.3.1	*Screening of granular catalysts in batch reactor under SCWG conditions for converting representative organic substrates from slaughterhouses into CH_4.*			
	T2.3.2	*Evaluation of catalyst stability and lifetime in presence of inorganic contaminants*			
WP3.3		**Catalytic methanation of H_2-rich streams**			
	T3.3.1	*Catalytic behavior of "noble" and "non noble" metal catalysts in the methanation of H_2-enriched streams coming from SCWG, to meet the requirements of CH_4 as a fuel*			
	T3.3.2	*Influence of experimental conditions on the $H_2/(H_2+CH_4)$ ratio in the outlet stream*			

Work plan

Proposed processes for research for our twins anaerobic Biodigesters

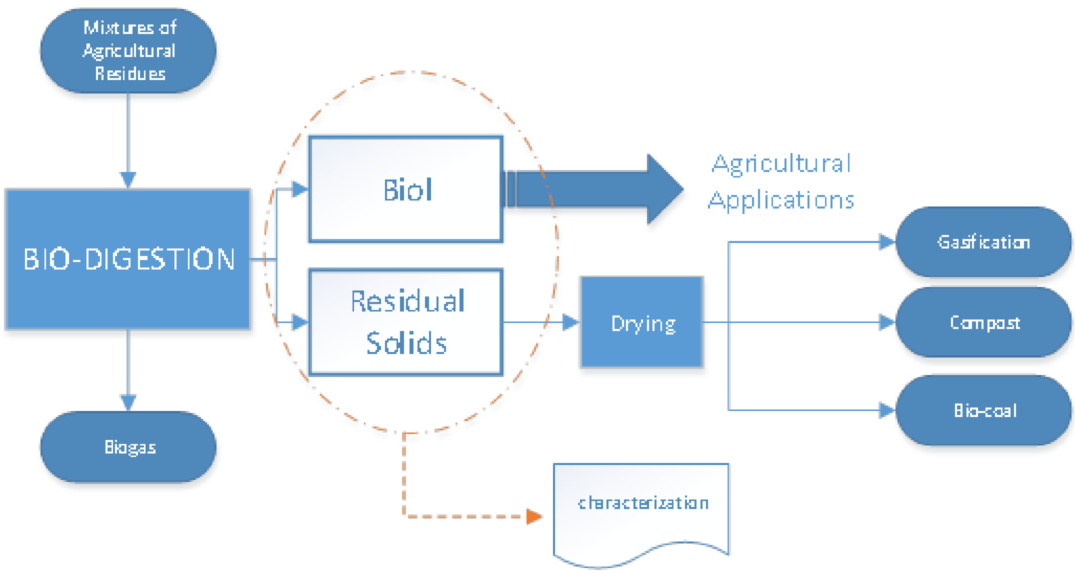

Figure 1. Principal phases for Biodigester proposal [Source: ESPOL Team 16]

The principal phases for proposal of project are:

Phase I: Gather information and process indicators: Identification of the residual agro-forestry biomass , characterization of the digestate obtained after anaerobic digestion of the selected residual agro-forestry biomass and estimate the amount of biogas produced using the adequate residual biomass or blends of it.
Phase II: Process equipment design: Design of the anaerobic digester, the gasifier and the pyrolyzer , design an adequate drying system for the residual solids after anaerobic digestion and develop standard methods to operate the anaerobic digestor, gasifier and pyrolyzer
Phase III: Build and start up of the designed equipment : Develop a Standard Operation Procedure for loading, unloading and manipulation of the residual biomass fed to the anaerobic digester, gasifier and pyrolyzer, develop Standard Methods to test the biogas generation, and determine the physical, chemical, and biological parameters of interest in the residual biomass or blends of it. And characterize the process subproducts.
Fase IV: Laboratory studies : Measure biogas composition and determine the amount of methane produced by a determined amount of residual biomass or blend of it fed into the digester.
Evaluation of biogas production depending on the feedstock fed to the digester.
Study the syngas, bio-oil and biochar production in the the gasifier and pirolyzer respectively using the dried residual solids, and, study the possibility of make biomaterials from the dried residual solids after anaerobic digestion.
Phase V: Scaling up and results diseminaton

Work plan continuing in Italy CNR-ITAE:

Objectives
The general objectives of this research unit can be summarized as follows:
2. To individuate a robust solid catalyst in suitable operative conditions for the production of CH4-enriched streams by processing organic wastes under supercritical water;

3. To demonstrate that the methanation of H2-containing streams can represent a valid catalytic approach to lower the hydrogen content of a biomass gasification stream, so to meet the requirements of CH4 as fuel.

Transnational/EU-CELAC related benefit & added value

The research program can constitute the basis for novel proposals, due to the exchange of personnel and sharing of “know-how” that can establish new future scientific collaborations.

This proposal is essential in the context of technical, scientific, social and environmental cooperation between Europe and Latin America. The results will directly contribute the Sustainable development of the countries and the reduction of the Green House gases.

Exploitation of results and (if applicable) economic impact

Project results may be expected to provide LAC municipalities with a clean and efficient technology for dealing with biomass residues on a small-scale/short-chain way, and to improve the international competitiveness of Caribbean industries in the field of biomass exploitation and disposal.

Results

- Prototype of system treatment of the biomass residuals
- Residual biomass and blends of it characterized
- Anaerobic digester, gasifier and pyrolyzer build and tested
- Productivity indicators determined
- Hi temperatura biogas fuel cell installation
- Sustainable agriculture facilities in greenhouse
- Clean water procedures.
- Organic mineral granular fertilizer compost source
- Refrigeration system by Hi temp. fuel cell cogeneration
- Mathematic (Mat-lab, LabView) model
- 3 journal articles

Testing system for municipal and agroforestal residual biomass standardized

Conclusion
Nowadays every country presents a high residual biomass potential generation. However, the lack of technical information and the low level of local development impedes the proper use of this natural resource. As a result, the presented proposal aims to make aware people about available technologies that can be used to obtain value added products from the residual biomass, and in this way contribute with a sustainable socio economic development

Experimental set-up for biogas upgrading (methanation), equipped with a continuous fixed bed reactor working at high temperature and pressure (up to 100 bar) and on-line connected to a three columns GC with two detectors for gas analysis.

Main facilities and Equipment

Lab-scale (500 cm3) stirred tank reactor (Inconel special alloy) for waste processing under supercritical conditions, equipped with a high pressure pumping system, a 1000 cm3 tank (AISI 304L) for collecting the gas phase and two GC (FID-TCD) for the analysis of both gas and liquid phases but for field more real application we pretend build Biodigester Twin Plants in Panamá and Dominican Republic including , a Biogas fuel cell for electricity production & an Absorption Refrigeration unit as cogeneration funcionality, between other as we can see in the general porpuse in annexes part, in this last (DR) country.

Experimental set-up for biogas upgrading (methanation), equipped with a continuous fixed bed reactor working at high temperature and pressure (up to 100 bar) and on-line connected to a three columns GC with two detectors for gas analysis.

Many of our universities as a research university counts with the following laboratories: Conversion System, Renewable Energy, Combustion Mechanical Design, as example: (CAMPRO) Center of Biotechnology of Ecuador Chemistry Deparment Research Labs, Heat Tranfers and Fluidics Lab, Computational Fluid Dynamics Lab.
In Adition, we have the space necessary to build and start up any equipment developed for this project. Including, administrative office with all the necessary utilities.

Status of consortium agreement

This project will be part of a consortium lead by Dr. William Camilo, and will be signed on June 2016.

Related proposals submitted to other funding agencies

No, this project has not been presented to any funding agency.

State of Art:

Photosynthesis, & Co2 recycles for greenhouses agriculture powering

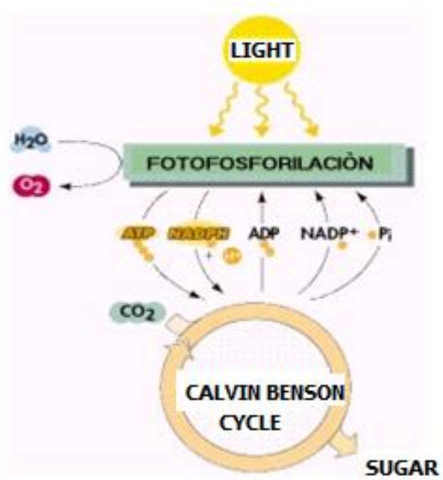

Figure 2. Diagram of photosynthesis

[Source: Calvin Benson 15]

In this reactions of light, capturing light energy by the pigments that absorb light into chemical energy (ATP) and power reducer (NADPH), requires a water molecule. As result, are free molecular O2. The general equation for this first stage of the photosynthesis is therefore as follows:

$$CO2 + NADPH + H^{+} + ATP \Longrightarrow GLUCOSE + P_{i} + NADP^{+} + ADP$$

CO2 reduction

In the second phase of photosynthesis, energy-rich products of the first phase, the NADPH, ATP, are used as energy sources for the reduction of CO2 and produce glucose. As a consequence will again produces ADP and NADP +.

This reaction takes place by conventional chemical reactions, catalyzed by enzymes that do not need light.

In the reactions of darkness, the CO2 from the atmosphere (or water in) aquatic/marine photosynthetic organisms) is captured and reduced by the addition of hydrogen (H +) for the formation of carbohydrates [(CH2O)]. The incorporation of the carbon dioxide in organic compounds, is known as fixation or assimilation of carbon. The energy used in the process it comes from the first phase of photosynthesis. Human beings cannot directly use luminous energy, however, through a series of photochemical reactions, it can be stored in the energy of the CC links carbohydrates, which, later, will be released through the processes respiratory or other metabolic processes.

The chemical composition of biogas is:

Methane (CH4), 50-70%

Carbon dioxide (CO2), 30-50%

Hydrogen sulfide (H2S), 0.1 - 1%

Nitrogen (N2), 0.5 - 3%

Their mashed and quality depend on the amount of methane that contains, the greater is the percentage of this element, more pure and more calorific value is the biogas.

PH (alkalinity or acidity)

The PH in the digester, is a function of the concentration of carbon dioxide (co2) in the gas, the concentration of volatile acids and own alkalinity or acides raw.

The bacteria involved in the process are highly sensitive to changes in PH. The strip of operation is between 6 and 8, taking as point optimum PH of 7.

[CVV-GTZ 15]

Acid digestion

Acids are converted by acetogenic bacteries to acetate, hydrogen and carbon dioxide. It is interesting to note that this process occurs hydrogen h2 which is an excellent fuel, which is not found in large quantities in the biogas, since it is used by the anaerobic bacteria (in the next stage) to produce methane.

Wastes and biogas production

Table 1. Wastes and biogas production

Kind of animal	Daily Production manure in % de L.W. (1)	Materials of fermentation %MST	%MSO	Production of biogas (lts/kg of wet manure)
Bovine	5	15-16	13	250
Pig	2	16	12	350
Caprine	3	30	20	200
Equine	5	25	15	280
Birds	15	25	17	400
Humans	1	20	15	300

(1) L.W. Animal Live Weight

[Source: SAT, GTZ 15].

FACTORS AFFECTING THE BIOGAS PRODUCTION PROCESS

The digestion process and its efficiency are determined by the following factors:

Temperature

Biogas production speed is a function of the operating temperature of the digester. Three ranges of temperature, in which anaerobic bacteria can operate are distinguished (1):

or Thermofilic temperatures higher than 35 ° C

or mesophilic between 15 - 25 ° C

or Psicrofilic between 0 - 15 ° C

Experience has shown that in the interval thermofilic occurs faster fermentation to the mesophilic, and this more than in the psicrofilic. This means that the retention time of the digester waste increases with decrease in temperature. **In the thermofilic range, the maximum performance is obtained at a temperature of 54 ° c**, and the mesophilic, close to 35 ° C.

There is the common tendency to use mesophilic, even if it is less efficient in terms of the time spent on the production of biogas, since costs are many minors, which does not require complex systems to increase the temperature [SAT, GTZ 15].

Annexes:

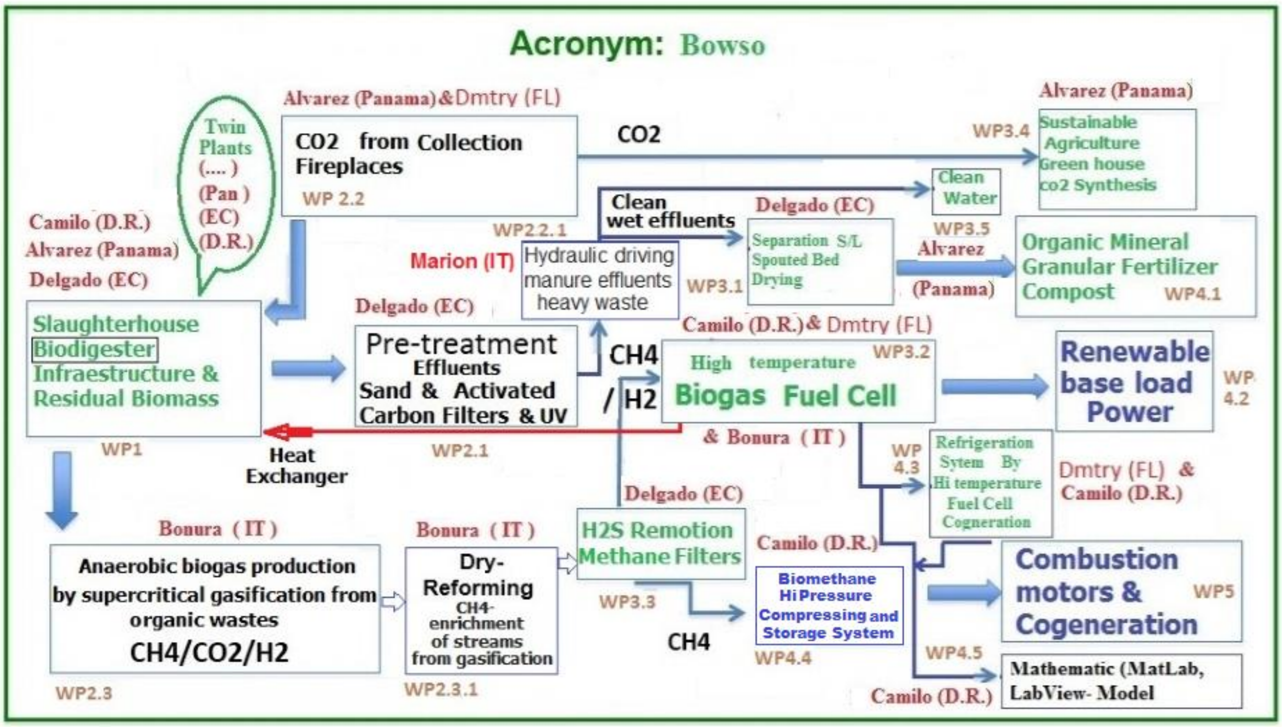

Figure 3. Municipal Slaughthouse Biorefinery Work Project Flux [Source CAMILO 16]

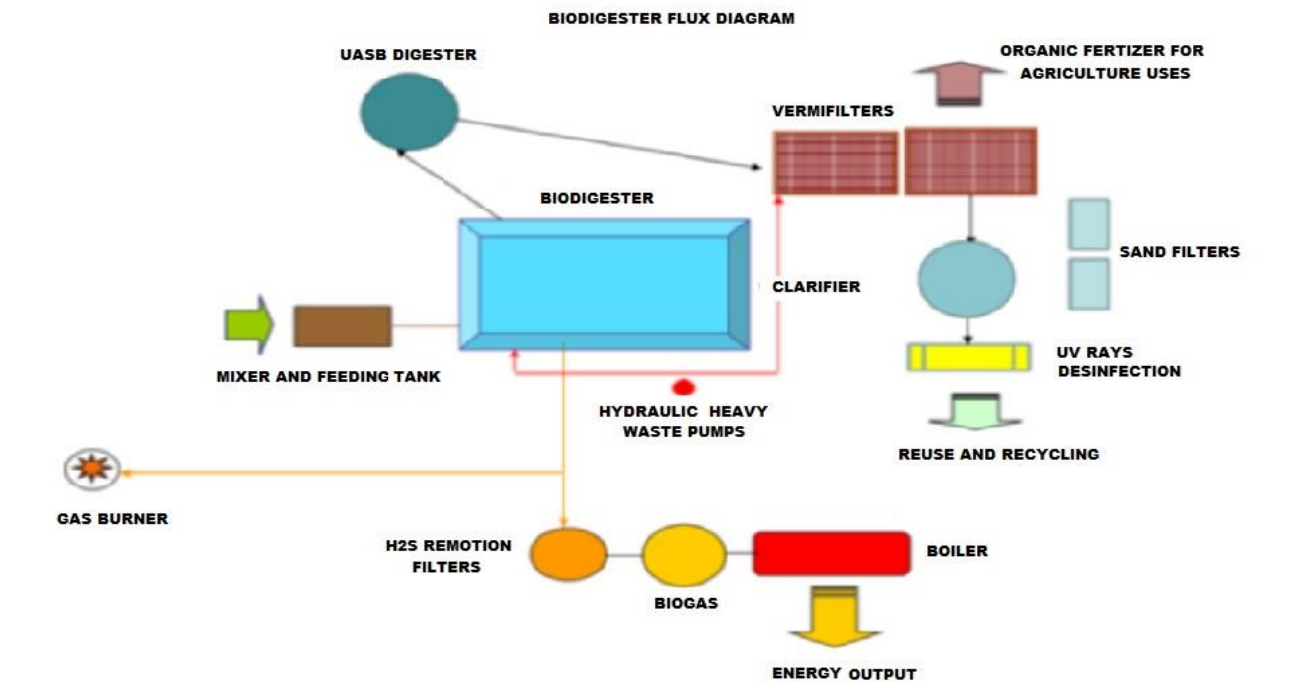

Figure 4. Flowchart of the Biorefineries proposed for production of biogas, compost, clean water and clean air emissions [Source CAMILO 16], Modified from

[AQUALIMPIA 15]

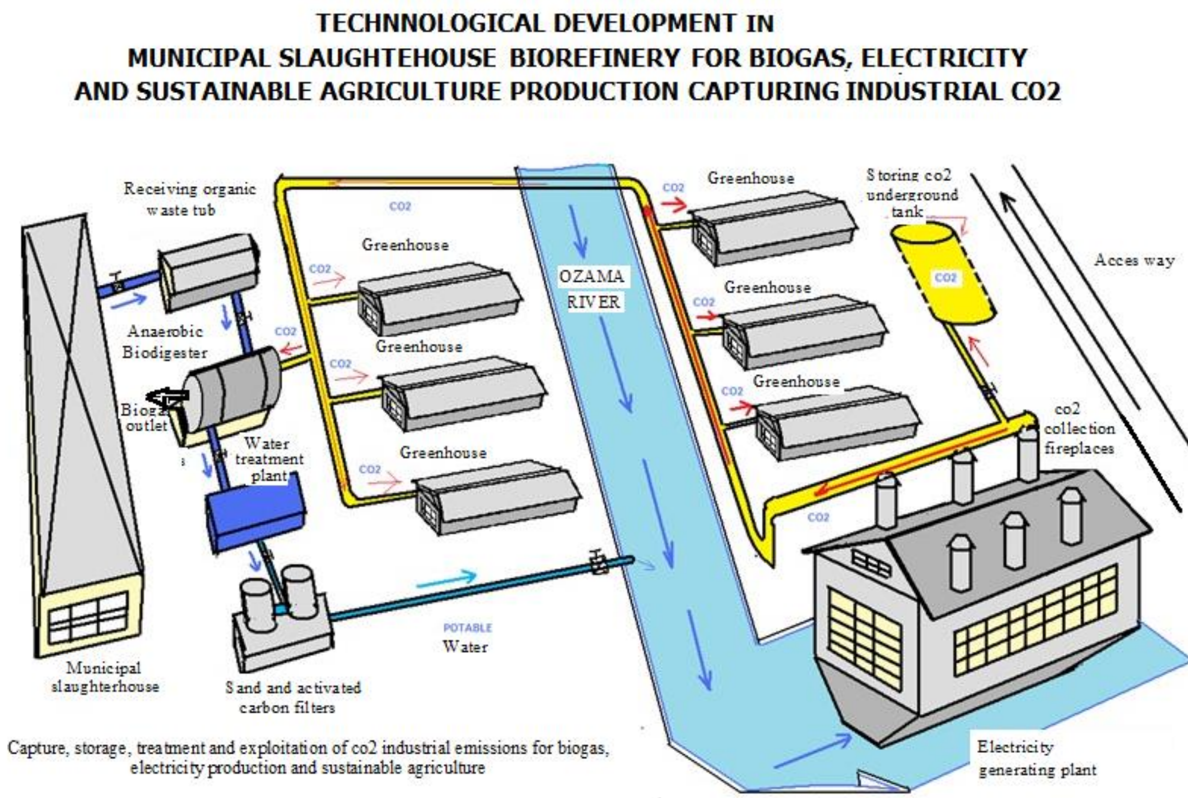

Figure 5. Municipal slaughthouse Biorefinery for (biogás-compost-greenhouse- Co2 recycle- potable water) Layout [Source: CAMILO 16]

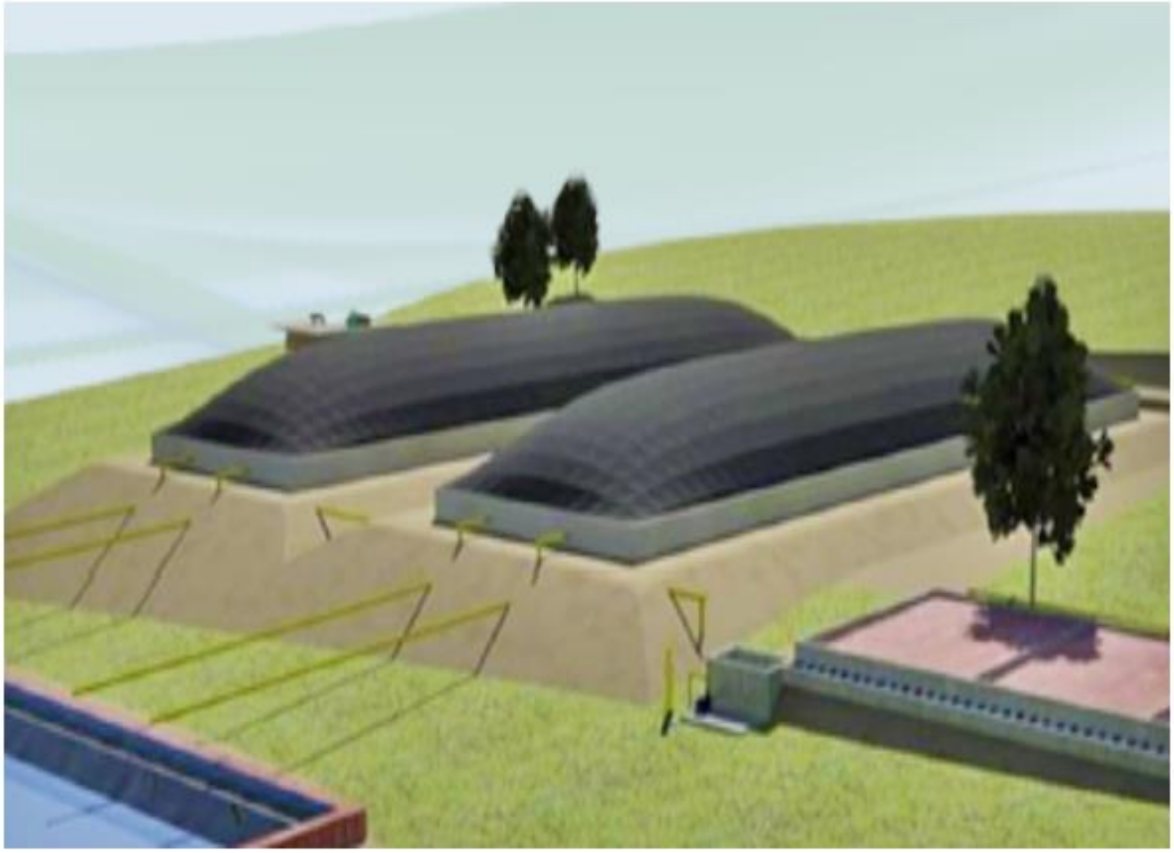

Figure 5. Biodigester Design [Source: AQUALIMPIA 15]

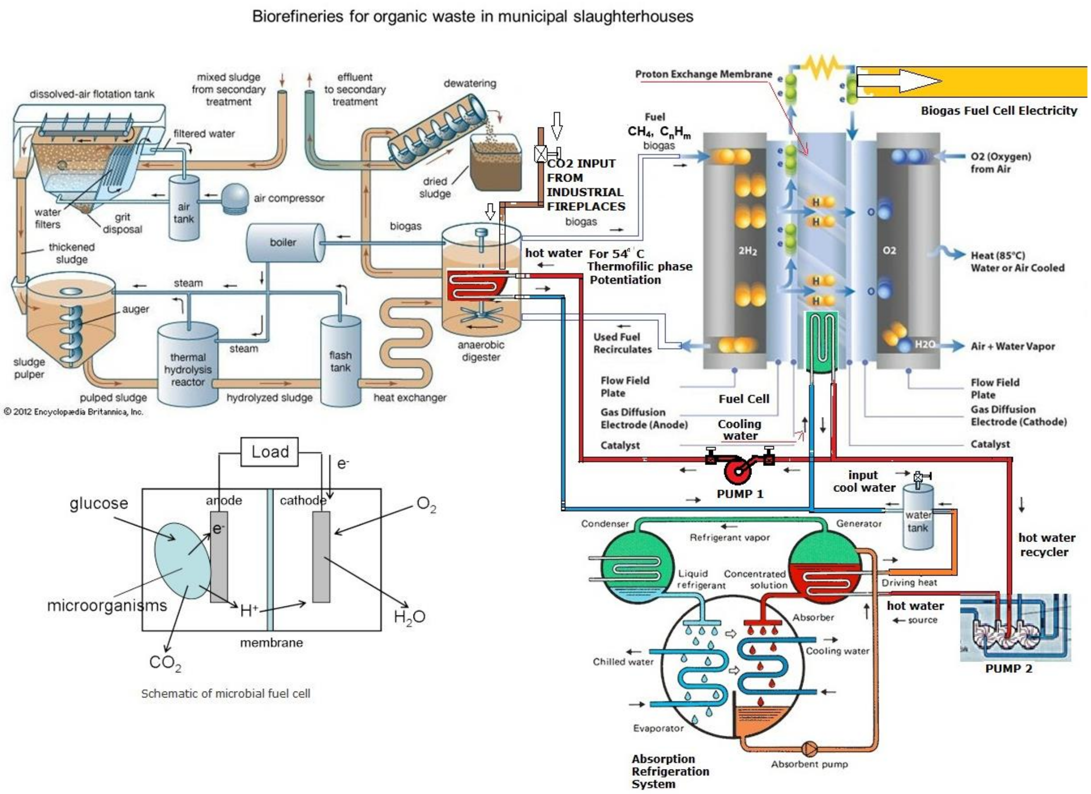

Figure 6. Municipal Slaughthouse Biorefinery Detail Work Project

[Source: CAMILO 16], Modified from

[AQUALIMPIA 15]

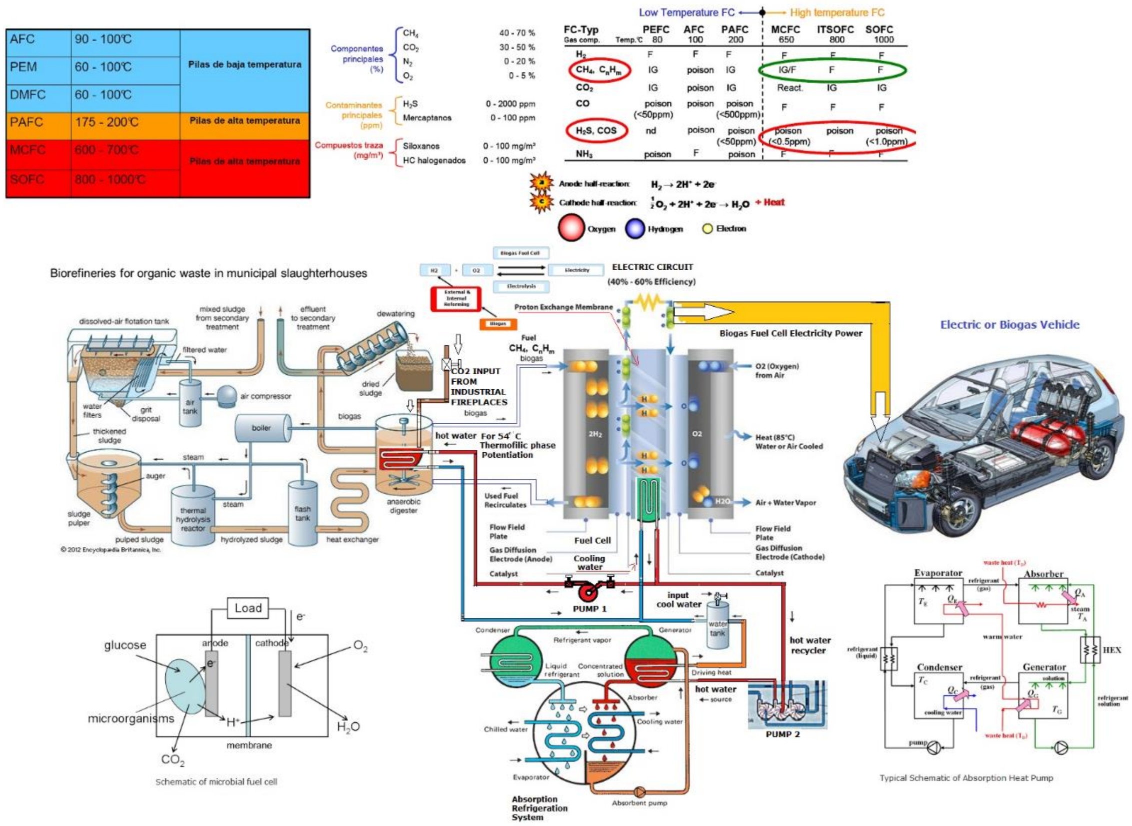

Figure 7. Municipal Slaughthouse Biorefinery Complete Work Project

[Source: CAMILO 16], Modified from

[AQUALIMPIA 15]

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7. Technical and scientific description of the project

Anaerobic Digestion. One of the most studied processes for wastewater treatment process (WWTP) is AD, whose main product is the socalled
biogas, which is a mixture of methane (CH4) and carbon dioxide (CO2).
However microbial ecosystems involved in anaerobic digesters can be also used to produce a whole range of anaerobic digestion (Azbar and Speece, 2001). During the first stage of this process (i.e.
acidogenesis), organic compounds are fermented to volatile fatty acids (VFAs), BioH2 and CO2; while in the second stage (i.e. methanogenesis), the VFAs are converted to CH4 (CotaNavarro et al., 2011; Xinyuan et al.,
Furthermore the subsequent production of methane, increases the overall energy yield.

Our pilot project for the municipal slaughterhouses process, and the way for providing basic material for the sustainable production of biogas and system of treatment and utilization of waste consists of a bio-digester and a wastewater treatment plant. In the bio-digester is an estimated 2300 m3 of waste water with high organic load.
The bio-digester for our project is type UASB effluent and sludge re-circulation.

BIODIGESTER Parts and Dimensions:

Volume: 15,000 m3
Area: 68 x 42 m

Material of construction:
Reinforced concrete with flexible cover
Cover: AQFlex
PLANT SEWAGE TREATMENT PLANT
Tank DAF: 20 m3
UASB tank: 1200 m3
Sand filters: 180 m3

Calcite filter: 180 m3
Clarifier: 80 m3
VERMIFILTROS
Volume: 1200 m3
safety accessories
-Blowers
-Water and biogas meters
-Sensors of pressure, pH, redox,
oxygen
-H2S filter
-Pumps
-Elimination of condensate
-Measurement and control equipment
FEEDING SYSTEM
THE BIO-DIGESTER FEED
IS THE CARRIED OUT THROUGH TWO PUMPS CENTRIFUGAL
18 kW.
CURRENTLY PUMP FLOW RATE
AVERAGE of 250 m3/h.

11. Experience of participants

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• Doctor in computer engineering concentration in systems (GIS) geographic information and geomatics, Universidad Pontificia de Salamanca (UPSA), Spain.

• Dean of engineering and computer science, Universidad APEC 2010-2015.

• Chair / VP of the Council of Deans of the Caribbean, and Board member of LACCEI, 2012-2015.

• Coordinator at the Centre for research in high-tech Crea of the Instituto Tecnológico de Las Américas ITLA, systems for geomatics, mechatronic systems, and systems for renewable energy, 2008-2010.

• Founder member and co-ordinator of the national group (GNEESER) and the International Consortium (CIEESEHR) for energy efficiency Solar, wind, hydro, biofuels, climate change and related.

• Evaluator of projects ERANet-LAC for the European Union.

• Researcher in Energia Termosolar, compressed air & fuel cells to Biogas.

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The magazine The American Scientific Research Journal for Engineering, Technology and Sciences (ASRJETS), ISSN 2313-4402, USA., 2015

The magazine MAPPING, scientific publication specializing in geomatics and Geosciences, Spain., 2015

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Universidad Politecnica de Cataluña, Spain, Energy and Climate Change, 2000

University of Ghent, Belgium, Energy and Climate Change,
2004

b. Publications

Quintana, C., (2015). Fracking and sustainable energy. UCE science. Vol. 3, no.2. www.uceciencia.edu.do

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Lopez, i., Quintana, C., Ruiz, J. Cross-Peragón, f., Golden, M., (2014). Effect of the use of olive-pomace oil biodiesel/diesel fuel blends in a compression ignition engine: Preliminary exergy analysis

ELSEVIER. Energy Conversion and Management 85 227-23.

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Iosvani Lopez Diaz; Candido E. Quintana Perez; Lizet Rodríguez Machin; María de el P. Dorado Perez; Jorgelina Pascualino, (2014) performance of an engine of compression ignition powered by sunflower and rape methyl ester in a comparative manner with diesel fuel. UCE science.Vol. 2, N.2. www.uceciencia.edu.do

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A degree in economics. Universidad Autónoma de Santo Domingo (UASD).1977
40 years of experience in planning, formulation and evaluation of projects, economy and agricultural marketing. Almost 10 in renewable energy
WORK CARRIED OUT
(a) installation of a bio-digester (1) in Don Juan, Monte Plata with my contribution and partnership on energy and environment (AEA)
(b) installation of twenty (20) biodigestors in Licey Al Medio, Santiago with contributions from USAID and APORLI, Inc.
(c) installation of a bio-digester (1) model in Licey Al Medio, Santiago with my contribution, of SEECyT (today MESCyT) and APORLI, Inc.
(d) more than one hundred fifty (150) feasibility studies for private industry and the Dominican agricultural and social projects.

PROFESSIONAL EXPERIENCE
Director Dept. Programmes and projects. Secretary of State for higher education, science and technology (SEESCYT). Feb. sep 2002. 2004.
e) President Center for counseling, support and promotion investment (COAPI). Consulting and advisory firm. 1992 to date.

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1990-current Director of the school of engineering, Universidad APEC RD

1997-1999 production manager, PRODASA. RD

1998-1999 Advisor to Director-General, Direction General of telecommunications RD

1990-1997 General Manager, Electromechanical services Rivera RD

1988-1989 Field Engineer., JOULE Engineering co. N.J., USA

1985-1988 Field Engineer.,STC Telecorp. N.J., USA

2009-2010 master in university management, University of Alcalá, Spain

2006-2009 master's degree in Education Sciences, University of Camagüey. CUBA

2003-2006 master's degree in electrical engineering, specializing in electronic communications

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• Coordinator at the Centre for research in high-tech Crea of the Instituto Tecnológico de Las Américas ITLA, systems for geomatics, mechatronic systems, and systems for renewable energy, 2008-2010.

• Founder member and co-ordinator of the national group (GNEESER) and the International Consortium (CIEESEHR) for energy efficiency Solar, wind, hydro, biofuels, climate change and related.

• CEO Biogeneración SRL Company, dedicate to study, design, construction, Assembly and operation of Anaerobic Biodigesters and Biorefineries for the Biogas and Biomethane production, Wind medium power and low speeds turbines, Hydraulic microturbines, Solar collectors power systems, Absorption cooling Systems, Hydrogen and/or Biogas Fuel Cells , Compressed air systems, other.

• Evaluator of projects ERANet-LAC for the European Union.

• Specialist in the approach to development of skills and professional competencies.

• Empreteco, Empretec, Unesco entrepreneurship skills.

• Ompi & Onapi, competences on patentas and intellectual property.

• Competences on management of forest resources and the environment, MIMARENA.

• More prominent professor at Unapec 2005-2008.

• Outstanding professor of Mechatronics in Itla 2009.

• Researcher in Energia Termosolar, compressed air & fuel cells to Biogas.

• Holder of a project successfully completed fondocyt.

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The magazine MAPPING, scientific publication specializing in geomatics and Geosciences, Spain.

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Edition: UNAPEC

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ISBN: 99934-812-7-0

URL http://repositorio.unapec.edu.do/handle/123456789/270

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1982-2010. Full Professor, Head of the Energy Department, Vice Dean for the research work, Head of the Environmental Study Group, Unidad Central de Las Villas, Cuba.

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Quintana, C., (2015). Climate ride between Lima and Paris. UCE science.Vol. 3, no. 1. www.uceciencia.edu.do

Lopez, i., Quintana, C., Ruiz, J. Cross-Peragón, f., Golden, M., (2014). Effect of the use of olive-pomace oil biodiesel/diesel fuel blends in a compression ignition engine: Preliminary exergy analysis

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Quintana, C., (2014). Sustainable energy development. UCE science. Vol. 2, no. 1. www.uceciencia.edu.do

Iosvani Lopez Diaz; Candido E. Quintana Perez; Lizet Rodríguez Machin; María de el P. Dorado Perez; Jorgelina Pascualino, (2014) performance of an engine of compression ignition powered by sunflower and rape methyl ester in a comparative manner with diesel fuel. UCE science.Vol. 2, N.2. www.uceciencia.edu.do

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Publications: Design of a hybrid kitchen for rural sectors. Magazine .INER- Ministry of Electricity and Renewable Energies. * Analysis of a system of low enthalpy geothermal energy for drying applications* Development of systems for the removal of pure vegetable oil of Jatropha Curcas for direct use as fuels or for manufacturing of biodiesel * Modeling and Analysis of driers with application to Alternative Energy Sources using Simulation Program* Experimental Study and Heat Transfer Process Modeling In The Solar Dryer With Agricultural and Marine Products.. Design and operation of a prototype for drying of biomass.

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SCIENTIFIC PUBLICATIONS

1 James, a., * W. Yuan, M. Cain, and D. Wang. "2015 The effect of air flow rate and biomass type on the performance of an updraft biomass gasifier," BioResources. 10 (2), 3615-3624

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2 James, a., * W. Yuan, M. Cain, D. Wang, and a. Kumar 2014. In-chamber thermocatalytic tar cracking in an updraft biomass gasifier. International Journal of Agricultural and Biological Engineering, 7 (6), 91-97.

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2015 James, a., and * W. Yuan. 2015 Top-lit updraft gasification - characterization of biochar from a low bulk density biomass. Accepted to be presented at the 2015 ASABE Annual International Meeting, 7/26 - 7/29, 2015, New Orleans, Louisiana. AKNOWETH paper No. 152187923.

2014 James, a., and * W. Yuan. 2014. a novel and efficient method to produce biochar from

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2013 James, a., and * W. Yuan. 2013 Evaluation of operating condition and type effects on an updraft biomass gasifier biomass. Presented in 2013 ASABE Annual International Meeting, 7/21 - 7/24, 2013, Kansas City, MO. AKNOWETH paper No. 1610317.

2012 * yuan, w., and Arthur James. 2012 In-situ thermo-catalytic cracking and reforming in an updraft gasifier biomass syngas tar. Presented at the 2012 ASABE Annual International Meeting. AKNOWETH paper No. 121336834. Dallas, TX

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http://www.ncsu.edu/bioresources/BioRes_10/BioRes_10_2_3615_James_YBW_Effect_Air_Flow_Rate_Biomass_Performance_Updraft_Gasifier.pdf
2. James, A., *W. Yuan, M. Boyette, D. Wang, and A. Kumar 2014. In-chamber thermocatalytic tar cracking in an updraft biomass gasifier. International Journal of Agricultural and Biological Engineering, 7(6), 91-97.
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2015 James, A., and *W. Yuan. 2015. Top-lit updraft gasification – characterization of biochar from a low bulk density biomass. Accepted for the 2015 ASABE Annual International Meeting, 7/26 - 7/29, 2015, New Orleans, Louisiana. ASABE paper No. 152187923.
2014 James, A., and *W. Yuan. 2014. A novel and efficient method to produce biochar from low-bulk density Biomass. Presented at the 2014 ASABE Annual International Meeting, 7/13 -7/16, 2014, Montreal, Canada. ASABE paper No. 1907902.
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Publications

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6. Corrosividad Atmosférica de Panamá, Proyecto MICAT-Panamá, ISBN: 9962-02-121-9, Panamá año 2000, Monografía, Coautor capítulo III: C. Hernández y J. de Bárcenas.
7. Study of the corrosion Products formed on carbón Steel in the tropical atmospheric of Panamá, J. Jaén, M.S. de Villalaz, L. de Araque, C. Hernández and A. de Bósquez, Scientia (Panamá), 2001, Vol.16, N°.1, 7-16.
8. Visión Actual del Tema de reciclaje, C. Hernández, Rev. El Tecnológico, N°13 enero-febrero 2008, 8-9, ISSN 1819-9623.
9. El Papel de la UTP en el diagnóstico de la Fibra de Vidrio, C. Hernández y J. de Bárcenas, Rev. El Tecnológico, N°14 marzo-abril 2008, 5, ISSN 1819-9623.
10. Charaterization of initial atmospheric corrosion of conventional weathering steels and a mild steel in a tropical atmosphere. Hyperfine Interactions 192 (2009). Juan A. Jaén, Alcides Muñoz, Jaime Justavino and Cecilio Hernandez.
11. Characterization weathering steels and a mild steel in a tropical atmosphere. Hyperfine Interactions (2009) 192, No. 1–2. J. A. Jaén, A. Muñoz, J. Justavino, and C. Hernández.
12. Analysis of Short-term steel corrosion Products formed in tropical marine environments of Panamá. Hindawi Publishing Corporation International Journal of Corrosion (2012). Juan A. Jaén, Josefina Iglesias and Cecilio Hernández
13. Microstructural and Mechanical Study of the Al-20Sn (mass%) Alloy processed by Equal-Channel Angular Pressing by Route C. Materials Transaction 54 (2013). C. Hernández, I.A. Figueroa, C. Braham, O. Novelo-Peralta, G.A. Lara and G. Gonzalez
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b. Appointments

2012- Abilitation to Full Professor.

2012-2014- Fellow of the Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin

2011- Associate Professor of Fluid Mechanics and Environmental Hydraulics, Univ. of Padova.

1998-2011- Lecturer, Univ. of Padova.

1999- Visiting Professor, Drexel University (USA)

c. Publications

Total publications: >100

Publications in ISI Journals: 46

Total citations (G. Scholar/SCOPUS): 1385 / 797

Bibliometric h-index (G. Scholar/SCOPUS): 21 / 18

Piper A.T., Manes C., Siniscalchi F., Marion A., Wright R.M.and Kemp P.S.“ Response of seaward-migrating European eel (Anguilla anguilla) to manipulated flow fields”, *Proceedings of the Royal Society B*, Vol.282, N. 1811, 2015.

Maggiolo D., Marion A. and Guarnieri M. “Lattice Boltzmann Modeling of Water Cumulation at the Gas Channel-Gas Diffusion Layer Interface in Polymer Electrolyte Membrane Fuel Cells”, *Journal of Fuel Cell Science and Technology*, Vol.11, Issue 6, doi: 10.1115/1.4028952, 2014

Marion A., Nikora V., PuijalonS., Bouma T., Koll K., Ballio F., Tait S., Zaramella M., Sukhodolov A., O'Hare M., Wharton G., Aberle J., Tregnaghi M., Davies P., Nepf H., Parker G., Statzner B. “Hydrodynamics and ecology: the critical role of interfaces in biophysical interaction”, *Journal of Hydraulic Research*, Vol. 52, Issue 6, doi:10.1080/00221686.2014.968887, 2014

Boano F., Harvey J.W.,Marion A., Packman A.I.,Revelli R., Ridolfi L. and Wörman A. “Hyporheic Flow and Transport Processes: Mechanisms, models, and biogeochemical implications”, *Review of Geophysics*, doi: 10.1002/2012RG000417, 2014

Marion A. Book Review “Fluid Mechanics of Environmental Interfcaes”, *Journal of Hydraulic Research*, Vol. 52, Issue 4, doi:10.1080/00221686.2014.945500, 201

Musner T., Bottacin Busolin A. and Marion A. “A contaminant transport model for wetlands accounting for distinct residence time bimodality”, *Journal of Hydrology*, vol. 515, 237-246, 2014

Maggiolo D., Manes C. and Marion A. “Momentum transport and laminar friction in rough-wall duct flows”, *Physics of Fluids*, Vol.25, Issue 9, doi: 10.1063/1.481845, 2013

Tregnaghi M., Bottacin-Busolin A., Marion A. and Tait S.J. “Stochastic determination of entrainment risk in uniformly sized sediment beds at low transport stages I: Theory”, *Journal of Geophysical Research - Earth Surface*, Vol. 117, doi:10.1029/2011JF002134, 2012.

d. Synergistic Activities

Coordinator of FP7-PEOPLE-2012-ITN HYTECH ‘Hydrodynamic Transport in Ecologically Critical Heterogeneous Interfaces’ (Approx. budget 3,7 M€)

Member of the List of Experts of the Italian Committee for Evaluation of Research (CIVR) by the Italian Ministery of University and Research, 2005.

Member of the list of Referees of GEV 07 and GEV 08, for the Evaluation of Quality of Research (VQR 2004-2010) by ANVUR (National Agency for the Evaluation of the University System and Research), 2012- 2013

National Coordinator, PRIN (Research Project of National Importance) on "Models and measurements of flow/sediment interaction at spatial and temporal scales of physical interest", 2007-2010..

Associate Editor of the Journal of Hydraulic Engineering, ASCE, 2008-2014

e. Collaborators & Other Affiliations

Heidi Nepf, MIT, USA; Gary Parker, Univ. Illinois, USA ; Bernhard Statzner, CNRS Lyon, France; Peter Davies, Univ. Dundee, UK; Vladimir Nikora, Univ. Aberdeen, UK; Simon Tait, Univ. Bradford, UK; Tjeerd Bouma, NIOZ, NL; Katinka Koll, Univ. Braunschweig, Germany; Sara Puijalon, CNRS Lyon, France; Francesco Ballio, Politechn. Milan, Italy.

(ii) Graduate and Postdoctoral Advisors

Prof. Norman H. Brooks, CalTech, USA.

(iii) Thesis Advisor and Postgraduate Sponsor

>90 Master Theses supervised

Doctoral Theses supervised:

Dr. Gianluca Giacometti, completed Ph.D. in 2000, with a thesis on the prediction of scouring at bed sills. (co-supervisor)

Dr. Francesco Comiti, completed Ph.D. in 2004, with a thesis on field validation of scouring at bed sills. (co-supervisor)

Dr. Mattia Zaramella, completed Ph.D. in 2005, with a thesis on hyporheic flow modelling.

Dr. Matteo Tregnaghi, completed Ph.D. in 2007, with a thesis on the development of scouring under unsteady flows.

Dr. Andrea Bottacin Busolin, completed Ph.D. in 2009, with a thesis on the vulnerability of riverine environments to pollution due to vegetation and hyporheic retention.

Dr. Tommaso Musner, completed Ph.D. in 2009, with a thesis on optimal design of constructed wetlands.

2 Marie-Curie Ph.D. candidates (ongoing).

Dr. Giuseppe Bonura, PhD

giuseppe.bonura@itae.cnr.it
BIOGRAPHICAL DATA
Born in Messina, Italy, October 4, 1978.

EDUCATION
2002 - Laurea in Industrial Chemistry, University of Messina, Italy.
2009 - Ph.D. in Chemical Technologies and Innovative Processes, University of Messina, Italy.

PROFESSIONAL EXPERIENCE
2008-Present: CNR-ITAE “Nicola Giordano”, Messina, Italy, Temporary Researcher (Lev. III).
Currently, Dr. Bonura is responsible for the research CNR module “Production of synthetic fuels from fossil sources and CO2”. He is also responsible for several WP activities in the frame of research programmes on National or International Commitments. He is a regular reviewer of manuscripts from international journals dealing with hot topics on industrial chemistry and catalytic processes.

MAIN SCIENTIFIC INTERESTS
Dr. BONURA’s research activity is mainly focused on the field of heterogeneous catalysis. The main topic of his studies concerns the development of catalytic systems for the production of synthetic fuels and clean alternative fuels, as well as the identification of relationships among chemical and physical properties of catalysts and their catalytic behaviour assessed in reactions of remarkable scientific and applicative interest, as follows:

- • Production of methanol and DME;
- • Production of synthetic fuels from CO2-rich syngas (GTL processes);
- • Production of hydrogen by reforming of oxygenated compounds;
- • Production of biodiesel by transesterification of vegetable oils;
- • Synthesis of oxygenated additives (acetals and glycerol ethers) for diesel fuels;
- • Upgrading of pyrolysis oils into biofuels for automotive;

- • Supercritical water gasification of waste biomass for methane production.

MOST RELEVANT PUBLICATION IN THE LAST FIVE YEARS

1. R.K. Chowdari, A. Narani, A. Kloekhorst, C. Cannilla, **G. Bonura**, F. Frusteri, K. Barta, H.J. Heeres. *Solvent free depolymerization of Kraft lignin to alkyl-phenolics using supported NiMo and CoMo catalysts. Green Chemistry 17 (2015), pp. 4921-4930 (Print ISSN: 1463-9262; Online ISSN: 1463-9270).*
2. F. Frusteri, M. Cordaro, C. Cannilla, **G. Bonura.** *Multifunctionality of Cu–ZnO–ZrO2/H-ZSM5 catalysts for the one-step CO2-to-DME hydrogenation reaction.* Applied Catalysis B: Environmental 162 (2015), pp. 57-65 (ISSN: 0926-3373).
3. A. Narani, R.K. Chowdari, C. Cannilla, **G. Bonura**, F. Frusteri, H.J. Heeres, K. Barta. *Efficient catalytic hydrotreatment of Kraft lignin to alkylphenolics using supported NiW and NiMo catalysts in supercritical methanol.* Green Chemistry 17 (2015), pp. 5046-5057 (Print ISSN: 1463-9262; Online ISSN: 1463-9270).
4. **G. Bonura**, M. Cordaro, C Cannilla, F. Arena and F. Frusteri. *The changing nature of the active site of Cu-Zn-Zr catalysts for the CO2 hydrogenation reaction to methanol.* Applied Catalysis B: Environmental 152-153 (2014), pp. 152-161 (ISSN: 0926-3373).
5. **G. Bonura**, M. Cordaro, L. Spadaro, C. Cannilla, F. Arena and F. Frusteri. *Hybrid Cu-ZnO-ZrO2/H-ZSM5 system for the direct synthesis of DME by CO2 hydrogenation.* Applied Catalysis B: Environmental 140–141 (2013), pp. 16–24 (ISSN: 0926-3373).

UNIVERSIDAD TÉCNICA DE AMBATO , Ecuador Team:

Mayra Alejandra Paucar Samaniego

M.Eng. Master in Energy Engineering. Pontifical Catholic University of Chile. Mechanical Engineer , Escuela Superior Politécnica de Chimborazo.

PROJECTS: *Characterization of solid waste from Ambato city and estimate of energy potential through thermo-physical analysis. *Estimate of carbon footprint in the development of bus type 1 bodywork.

Pablo Israel Amancha Proaño

M.Eng. Master in Energy Engineering. Pontifical Catholic University of Chile. Mechanical Engineer , Escuela Superior Politécnica de Chimborazo.

PROJECTS: *Characterization of solid waste from Ambato city and estimate of energy potential through thermo-physical analysis.

Partners of the Project

Head/ Responsible	Organization/ Institution	Acronym	Type of partner	Funding Agency	Countr
Camilo, William	Universidad APEC	UNAPEC (coordinator)	Beneficiary	Ministry of Higher Education, Science and Technology (MESCyT) (Dominican Republic)	Repúbli Dominic
Álvarez, Humberto	Universidad Tecnológica de Panamá	BGP	Beneficiary	National Secretary of Science, Technology and Innovation (SENACYT) (Panama)	Panama
Delgado Plaza, Emérita	ESPOL	BIOLRE	Beneficiary	Secretariat of Higher Education, Science, Technology and Innovation (SENESCYT) (Ecuador)	ECUAD
Marion, Andrea	Università di Padova, Italy	Hywpu	Beneficiary	National Research Council (CNR) (Italy)	Italy
Bonura, Giuseppe	Istituto di Tecnologie Avanzate per l’Energia	ITAE	Beneficiary	National Research Council (CNR) (Italy)	ITALY
Murzin, Dmitry	Åbo Akademi University	UAA	Beneficiary	Academy of Finland (AKA) (Finland)	Finland
Paucar Samaniego, Mayra	UNIVERSIDAD TÉCNICA DE AMBATO , ECUADOR	UTA	Beneficiary	Secretariat of Higher Education, Science, Technology and Innovation (SENESCYT) (Ecuador)	ECUAD

- The 'total requested funding' field on 'Project->Project data' and total sum of the 'total requested funding' field on each 'Partner->Financial Data' must be equals
- Publishable summary of the project is empty.
- Scientific and technological challenge is empty.
- Technical and scientific description of the project is empty.
- Work plan is empty.
- Status of Consortium Agreement is empty.
- Related proposals submitted to other funding agencies is empty.
- The 'total cost' field for partner BGP on 'Project->Financial Data' and total sum of the 'total cost' field of each one on 'Partner->Project Costs' must be equals
- The 'total cost' field for partner UAA on 'Project->Financial Data' and total sum of the 'total cost' field of each one on 'Partner->Project Costs' must be equals
- The 'total requested funding' field for partner UAA on 'Project->Financial Data' and total sum of the 'total requested funding' field of each one on 'Partner->Project Costs' must be equals

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http://calleranet-lac.cyted.org/Project/Indice?idconvocatoria=5WPGM4UR6XFCRS2GKEK2NLDGYXA9YV8C6VBWA5SM6XMAT8U96WUQ&idsolicitud=3BHJWJWHQFKEZ4PX69C8ZA8T9PLKDBJXU9DHSY6T5SYVQFS8KL9A