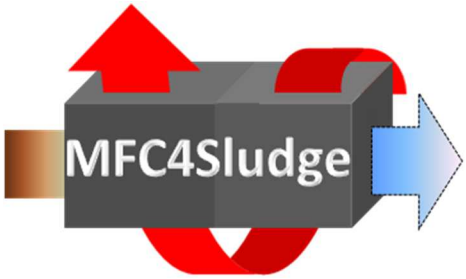
“MFC4Sludge”: Microbial fuel cell technologies for combined wastewater sludge treatment and energy production

FP7-SME-2013, Grant Agreement No. 605893



Deliverable 6.3

Press releases, publications and other communication activities during first reporting period

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Project details

Start date: 1st August, 2013 Duration: 24 months

Participant no.	Participant organization name	Participant short name	Country	Organisation type
1(Coord)	Ecotrend S.R.O.	ECO	Czech Republic	SME
2	Emefcy Ltd.	EMEFCY	Israel	SME
3	Automação e controle industrial, Lda	ACONTROL	Portugal	SME
4	Fraunhofer-Institute for Interfacial Engineering and Biotechnology IGB	FRAUNHOFER	Germany	RTD
5	Acondicionamiento Tarrasense Associacion	LEITAT	Spain	RTD
6	Optimización orientada a la sostenibilidad S.L.	IDENER	Spain	RTD
7	Gipuzkoako Urak, S.A.	GURAK	Spain	PUBLIC BODY

Deliverable information

PROJECT GA NUMBER	**605893**
PROJECT NAME	**MFC4Sludge**
DELIVERABLE NUMBER	6.3
DELIVERABLE NAME	Press releases, publications and other communication activities during first reporting period
DELIVERABLE VERSION	V1.0
DATE OF DELIVERY	30/04/2014
PERSONS-MONTH REQUIRED	4.73
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This project is funded under Capacities - 7th European Framework Programme

Abstract

This deliverable provides a cumulative overview of the undertaken Project's dissemination activities that have been carried out during the first nine months of the project. These activities have been executed as main consequence of the Dissemination Plan implementation (for further information about the Dissemination Plan, please check the deliverable D6.2 "Interim/Draft plan for use and dissemination of knowledge").

Firstly, information about MFC4Sludge project is provided in order to highlight main project objectives, research activities to be conducted and the S/T methodology behind the envisaged work to be performed. Information about project participants and main roles is also provided in this section.

Secondly, captions of the main dissemination tools such as project website, project brochure and project poster are included. Information about publications and events is also summarised, being possible to find the whole abstract of produced publications at the end of the document (see Annex I).

Finally, a table summarises all the aforementioned activities, providing information about the main partner involved, the target audience and the countries addressed by such a dissemination activity, being possible to have a quick idea of the dissemination activities carried out during the first reporting period of the project.

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1. Introduction

MFC4Sludge is a research project that aims to develop, according to participating SME needs, an innovative solution consisting of a MFC coupled to a hydrolytic-acidogenic anaerobic digestion (HA-AD) to treat sewage sludge from wastewater treatment plants (WWTPs). The technologies to be developed herein will not only improve existing sludge treatments in environmental terms (even avoiding sludge disposal) but also in cost-effectiveness terms (generating electricity in the MFC in order to power the sludge treatment). The objective is to develop a reliable, cost-effective and efficient alternative to existing wastewater sludge treatments with minimum environmental impacts and without increasing energy consumption of current wastewater treatment plants.

This project has received funding from the European Union's Seventh Framework Programme managed by REA – Research Executive Agency, http://ec.europa.eu/research/rea (FP7/2007_2013), under Grant Agreement N.605893, Capacities programme, call “Research for the benefit of SMEs”. The aim of this call is to strengthen the 'innovation capacity' of small and medium-sized enterprises (SMEs) in Europe and their contribution to the development of new technology based products and markets. This funding instrument helps them outsource research, increase their research efforts, extend their networks, better exploit research results and acquire technological knowhow, bridging the gap between research and innovation.

Wastewater sludge (also called sewage sludge or sludge hereinafter) is the main by-product of the most-widely employed biological treatment of wastewater with activated sludge. In such a technology, microorganisms metabolise the organic waste and produce the aforementioned sludge as a result. Its production varies between 10 and 30 kg per capita in most European countries being Germany, Spain and Poland the major producing countries with 2.048.500, 1.065.000 and 501.300 tonnes by 2006 and a total production for the EU of around 9.000.000 tons dry solids per year in 2010. The disposing of this sludge easily reach up to 60% of the total operation cost of a treatment plant and consume vast quantities of energy [1]. In addition, urban growth and the proliferation of wastewater treatment plants have sharply increased and will continue increasing the production of municipal sludge worldwide. It is therefore essential to develop handling and disposal technologies that enable maximum valorisation of this waste and, at the same time, minimum environmental impact [2].

However, sludge disposal is not a trivial issue due to its microbiological and chemical characteristics; in fact it tends to concentrate heavy metals (which may be toxic to plants and humans [3]) and poorly biodegradable organic compounds as well as potentially pathogenic organisms (viruses, bacteria, etc.). Sludge composition determines the type of treatment required and defines disposal options: sludge can be landfilled, incinerated or transformed into compost. When disposed in landfills, one tone of biodegradable waste produces around 300m3 of landfill biogas and its leachate is a cause of contamination from organic acids, ammonia and other hazardous substances [4]. Sludge incineration is traditionally applied when the sludge has been significantly contaminated with heavy metals and is therefore unsuitable for application to agricultural land. When sludge is incinerated, exhaust gas containing greenhouse gases (GHG) such as CO_2 and NO_x (around 1.240 g NO_x/tDS) is produced.

Sludge treatment not only being an environmentally sensitive problem, it is also a growing problem world-wide since sludge production will continue to increase as new sewage treatment works are built and environmental quality standards become more stringent. With some traditional disposal routes coming under pressure and others such as sea disposal having been phased out, the challenge facing sludge managers is to find cost-effective and innovative solutions whilst responding to environmental, regulatory and public pressures. Recycling and use of wastes are the preferred options for sustainable development rather than incineration or landfilling, but they are not straight-forward options as for sludge because of perceptions over contaminants, pathogens and its faecal origin, particularly by the food retailers [5].

Within this context, some key European SMEs got in contact in the framework of MFC4Sludge proposal in order to conduct a joint effort aimed to develop and scale up a low-cost, sustainable and competitive solution consisting of a microbial fuel cell (MFC) coupled to a hydrolytic-acidogenic anaerobic digestion (HA-AD) to treat sludge from wastewater treatment plants. The goal is to take advantage of the complementarities of both technologies in order to obtain a sustainable energy device with positive energy balance and ability to degrade more than 90% of chemical oxygen demand (COD). According to the several areas of knowledge and expertise required to reach such an objective, the participating SMEs have identified complementary research needs in three areas: sludge pre-treatment, MFC development and systems control and integration.

1.1 SMEs needs to be covered

MFC4Sludge project creates a framework where SMEs show their needs for advanced research in order to obtain a novel, cost-effective, efficient and integrated system to valorise the aforementioned sludge:

SME	Research need	Competitive position improvement
ECO	▪ HA-AD as MFC pre-treatment ▪ Enhance microbial community knowledge	▪ Development of a company new product aimed at sludge pre-treatment ▪ Enhancement of microbial community knowledge which can be extrapolated to other company's AD applications enhancement ▪ Know-how about HA-AD performance optimization
EMEFCY	▪ MFC design and architecture optimisation ▪ MFC biological community understanding	▪ Development of a new company's product by improving its existing portfolio with a solution suited for a broader MFC-based sludge management application range ▪ Consolidation of the company's market leading position in MFC and bioreactors by breaking the barriers that hinder its commercialization ▪ Increment of the company's know-how regarding MFC design and architecture
ACONTROL	▪ MFC mathematical model ▪ Advanced control design ▪ Optimal solution configuration	▪ Broadening of the company's portfolio of control solutions ▪ Introduction to wastewater and sludge management markets ▪ Creation of synergies with the other project participants, which are also new potential clients

1.2 Project objectives

In order to overcome the aforementioned SME needs and thus a marketable solution, some project objectives in each of the corresponding areas are expected to be achieved.

SME research needs	Corresponding project's S/T objectives
Sludge pre-treatment	
HA-AD as MFC pre-treatment	▪ Adapt hydrolytic-acidogenic anaerobic digestion (HA-AD) so it can be used as a pre-treatment of sludge to transform it to a suitable substrate for MFC ▪ Reduce the residence time of sludge to 7 days or less ▪ Keep the operating temperature below 30°C ▪ Avoid methane production and maximise concentrations of easily degradable volatile fatty acids (VFA) and other suitable substrates for the MFC
Enhance microbial community knowledge	▪ Research and document the microbial community to be selected as for an optimal partial HA-AD and MFC processes combination ▪ Produce start-up cultures for the partial HA-AD processes to be developed

	herein
MFC development and performance	
MFC design	▪ Obtain power output ratings of at least 250W/m^3 ▪ Reduce MFC carbon impact in electricity generation to 0.3 kg CO_2/kWh by an optimized design and usage of materials
MFC scaling-up process	▪ Develop novel fuel cell stack configurations in order to promote electrical contact between bacteria in suspension and the anode ▪ Increase the ratio of surface area of electrodes to volume by around 20%
MFC biological community understanding	▪ Research and document the correlation between MFC inlet, energy output and COD degradation
MFC control and integration	
Mathematical model of the overall system	▪ Non-linear, grey-box mathematical model combining first-principle physics with empirical data aimed to HA-AD-MFC process description (electrical performance, microbiology, mass and heat transfer, etc).
Advanced control design	▪ Develop a distributed control system (DCS) aimed to an optimal integration of HA-AD and MFC ▪ Implement a MPC controller in order to optimize HA-AD-MFC performance
Optimal plant configuration	▪ Research and document the scaling-up process of the HA-AD-MFC process for sludge treatment ▪ Perform an overall efficiency assessment from a plant-level point of view ▪ Construct a prototype with a 10L-volume MFC ▪ Achieve at least 90% of COD degradation ▪ Reduce sludge volumes at least 75% ▪ Generate a higher electricity output than required by the HA-AD. Initial estimations foresee a net energy generation of 140 W/m^3 or more

1.3 Participating RTD performers

According to the "Research for the Benefit of SMEs" program definition, achievement of the described project objectives requires performing research and development activities neither financially nor technically affordable by the participating SMEs at all. This is why first-level European RTD performers will be subcontracted by the SME participants during the project. Therefore, activities undertaken by the SMEs themselves will be essentially focused on initial specifications and, later, on validation and testing of the knowledge to be acquired. Specifically, next RTD performers are participating in MFC4Sludge project:

- **FRAUNHOFER**, Germany's leading non-profit organization for application-oriented research with research units in Europe, the USA and Asia, will be mainly focused on the development of the pre-treatment process, namely HA-AD. Given FRAUNHOFER's strong background in microbiological communities, this research organization will be also involved in MFC design tasks. Finally, FRAUNHOFER will collaborate with the other RTDs in integration-related tasks.
- **LEITAT,** a first-level Spanish technological centre which performs R&D activities in the areas of biotechnologies, environment, advanced materials science and energy among a number of other additional areas of knowledge such as surface treatments and new production processes. LEITAT will carry out tasks related to MFC architecture design (optimizing anode and cathode materials) and maximizing energy production. Moreover, characterisation of microbial communities and effluent properties will be also carried out in this centre. Finally LEITAT will cooperate with FRAUNHOFER in HA-AD development and with IDENER in overall system integration.
- **IDENER,** a spin-off company specialized in control and systems engineering and rooted in the University of Seville's Department of Systems and Automation, which has ranked among the world's top 150 research

groups under the category "Electrical Engineering" in the last *Performance Ranking of Scientific Papers for World Universities*. IDENER will conduct research related to mathematical modelling and optimal control both of the overall system and of each single process. Activities aimed to integration of processes will also be carried out in close cooperation with the other RTD performers.

1.4 S/T methodology

In order to accomplish the main objectives defined in section 1.2, a work plan broken down into seven work packages (WPs) has been established. The WPs also include management tasks and assessment of progress and exploitation of results:

WP1. Hydrolytic-acidogenic (HA-AD) process development as pre-treatment for microbial fuel cells (MFCs). This WP focuses on the research required to suit a HA-AD process as a MFC pre-treatment

WP2. Microbial fuel cell (MFC) design and optimization. The purpose of this WP is to provide improved MFC designs aimed to better system performance and cost-efficient up-scaling process.

Intensive interaction between WP1 and WP2 is envisaged, and information will be often exchanged during their execution in order to achieve a compact solution and, additionally, avoid divergences that could affect WP4.

WP3. Advanced modelling and control strategies development. The activity of this WP will be related to the design of an advance predictive controller accounting for HA-AD-MFC process optimization while explicitly taking process constraints into account. To that end, a comprehensive modelling effort will be also conducted in this WP as for HA-AD and MFC processes as well as their interactions.

WP4. Hydrolytic-acidogenic (HA-AD) and microbial fuel cells (MFCs) integration at lab scale. The objective of this WP is to develop optimal integration strategies as for the HA-AD and MFC solutions developed in WP1 and WP2 respectively.

WP5. Innovative prototype at pre-commercial scale production. The broad aim of this WP is to demonstrate and validate the technologies proposed therein through prototyping and comprehensive field testing.

WP6. Exploitation and dissemination. This WP will ensure the proper dissemination and exploitation of project results so that a right flow of knowledge can flow from RTD performers to SME.

WP7. Project management. The aim of this WP is to ensure the fulfilment of the project's goals and assure the success of the project by coordinating and managing the project activities in administrative, technical and financial terms; and to provide a pro-active relation and communication medium between the project partners and the EC.

Main interactions among WPs are depicted in the next Pert diagram:

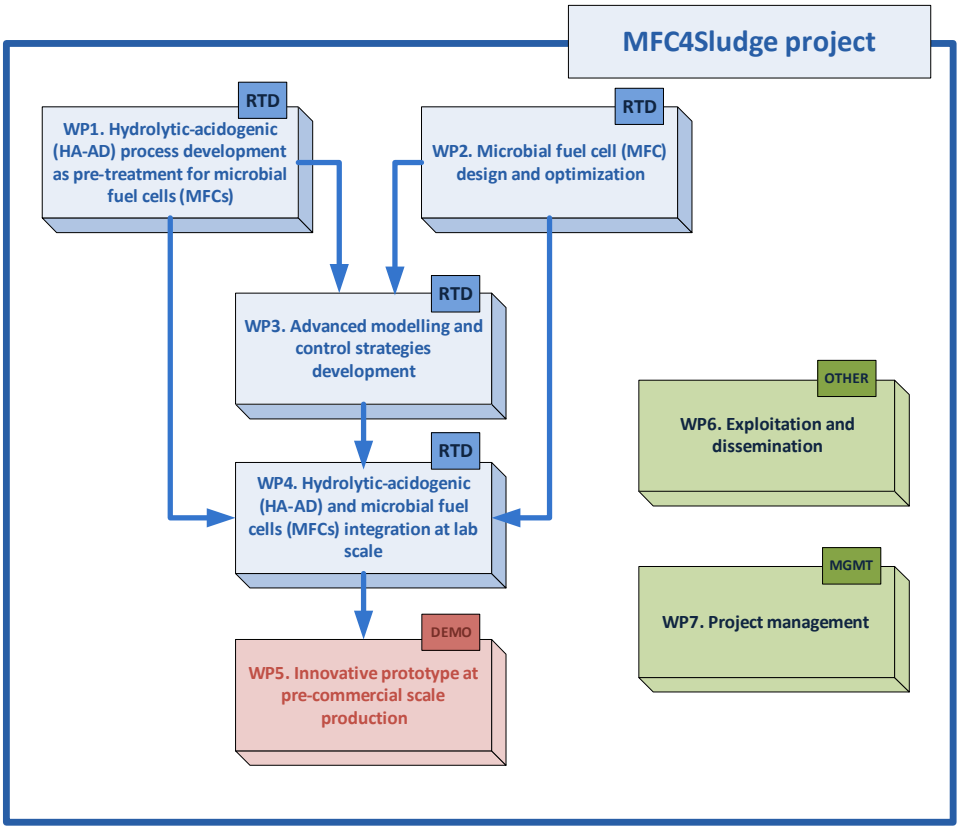

Figure 1. MFC4Sludge Pert diagram

Furthermore, the following figure shows the main areas where research will be conducted as well as the partners involved. The flow of knowledge exchange is also represented (from the RTD performers to the SMEs, adopting the "Research for the benefit of SMEs" approach).

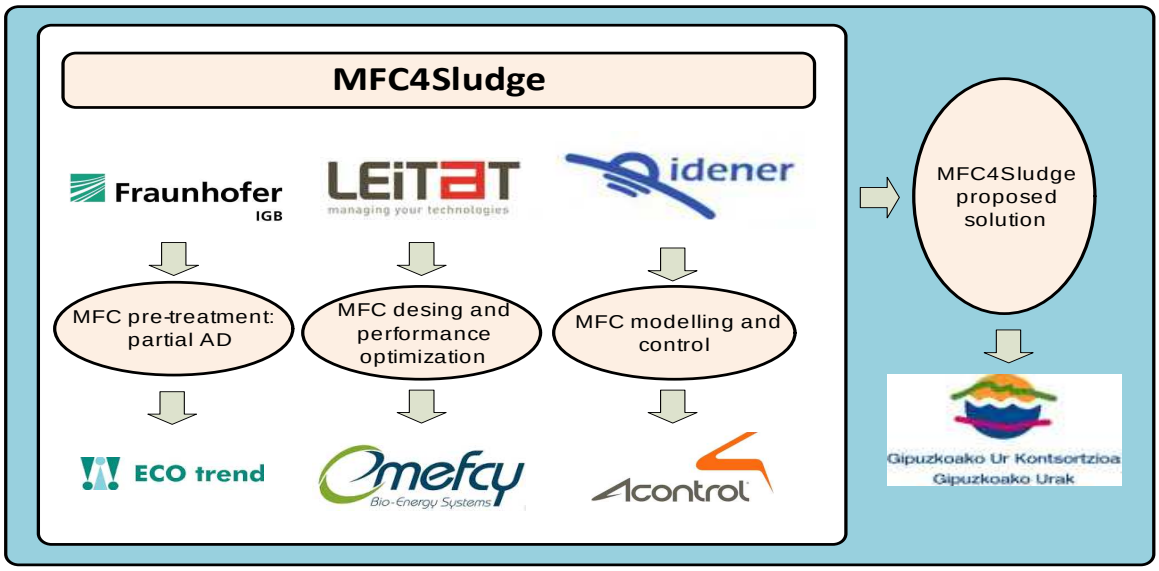

Figure 2. MFC4Sludge S/T methodology

2. Activities performed in the project's first nine months (August 2013 – April 2014)

The activities of the first nine months of the project have been consistent with the Dissemination Plan as well as with the originally planned dissemination activities of the project proposal. Further information and a detailed description of the aforementioned plan can be found in D6.2 "Interim/draft plan for use and dissemination of knowledge". The partners, as depicted in Table 1 from the Summary section, have used an array of mediums and tools in order to successfully disseminate the project to the relevant audience. Since at this early stage of the project the amount of generated project results and/or knowledge is limited, main dissemination activities have been related to spreading project main idea and the potential of the results to be obtained as an innovative way of valorising and manage olive mill waste.

In order to raise this public awareness of the proposed technology, the partners have performed pre-marketing activities, including publications, project website launching, presentations and conference papers and the distribution of project promotional material.

2.1 Project logo and graphical identity

The graphical identity is in line with the public website and the general brochure and poster. It is important to follow the graphical identity, since good use of it will help to consistently communicate and disseminate the project. Guidelines and templates will also save time and effort for the members of the consortium, since no further design work will be necessary.

An important item to establish the project's identity is the project's logo. This logo was created by project partners and is usually included in all presentations, reports, documents, etc., of the project. The logo is shown in the below figure.

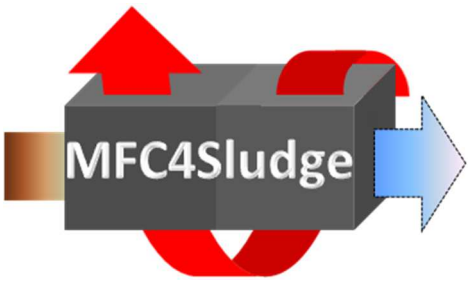

Figure 3. MFC4Sludge project logo

2.2 Project reports

Dissemination of projects results by making deliverables publicly available is regarded as one of the most important means to publish results. For that reason this project consortium team is considering to review the dissemination level of deliverables (after the end of the project) in order to have more public reports published on the project website. Additionally, it is under consideration the possibility to have, during the lifetime of the project, a public version of documents that contain confidential information. These documents will be published on the projects website.

As for the reports and deliverables, and in order to maintain the project graphical identity, a template was provided to the partners using the Alfresco share tool linked to the project website private area.

2.3. Project presentations

In line with aforementioned idea of keeping an identity in order to make easier for target audiences to identify the project and as well as to provide uniformity when presenting project ideas, results or facts in a meeting, a

template for a presentation has also been created and distributed to the partners through the above-mentioned internal sharing tool.

A caption of the main slides from the presentation template is included next.

Figure 4. MFC4Sludge presentation template

2.4 Brochures

For the purposes of effectively disseminating the project, a three-fold project brochure has been created. The brochure describes the main innovations that will be developed within the project and provides main contact details from project coordinator. In addition, all project participants logos are included as well as a reference to the EU funding. In order for the brochure to have a maximum effect on targeted audiences, one brochure per partner can be produced changing the partner profile, whereby a whole page is devoted to the description of that specific partner and their role within MFC4Sludge. In this way, it will prove much more efficient to attract local audiences and be particularly customized to be used nationally. The brochure is user-friendly, compact and easy to understand, being included as part of the Dissemination Plan. A caption of the aforementioned document can be found next.

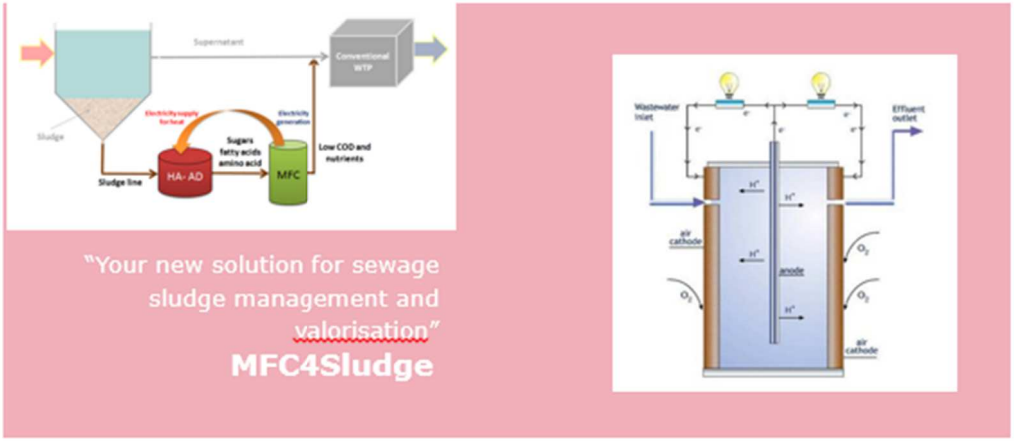

Figure 5. MFC4Sludge brochure (inside)

Sewage sludge valorisation

The originality and innovation of the project can be summarized through the following contributions to technological progress:

- Wastewater sludge pre-treatment using partial anaerobic digestion (HA-AD);
- Microbial Fuel Cell (MFC) system development aimed at improving system efficiency and cost-effectiveness;
- Microbial Fuel Cell (MFC) control strategies design in order to reach an optimal performance;
- Integration of the different elements which compose the final solution.
- Demonstration of techno-economical and environmental feasibility of developed technologies for their implementation in wastewater treatment plants.
- Promotion of proposed solution application for distributed power production.
- Testing of the technological competitiveness as renewable and integrated technological solution. By valorising sewage sludge the wastewater treatment process can become more sustainable.

FP7 – Capacities Programme

MFC4Sludge has received funding from the European Union's Seventh Framework Programme managed by REA – Research Executive Agency http://ec.europa.eu/research/rea (FP7/2007_2013) under Grant Agreement N. 605893.

CAPACITIES

NAME OF THE PARTNER

Partner description

PARTNER ROLE IN THE PROJECT

Main tasks to be carried out in the project by this partner are:

- ...
- ...
- ...

Contact Us

contact details from partner, website, etc...

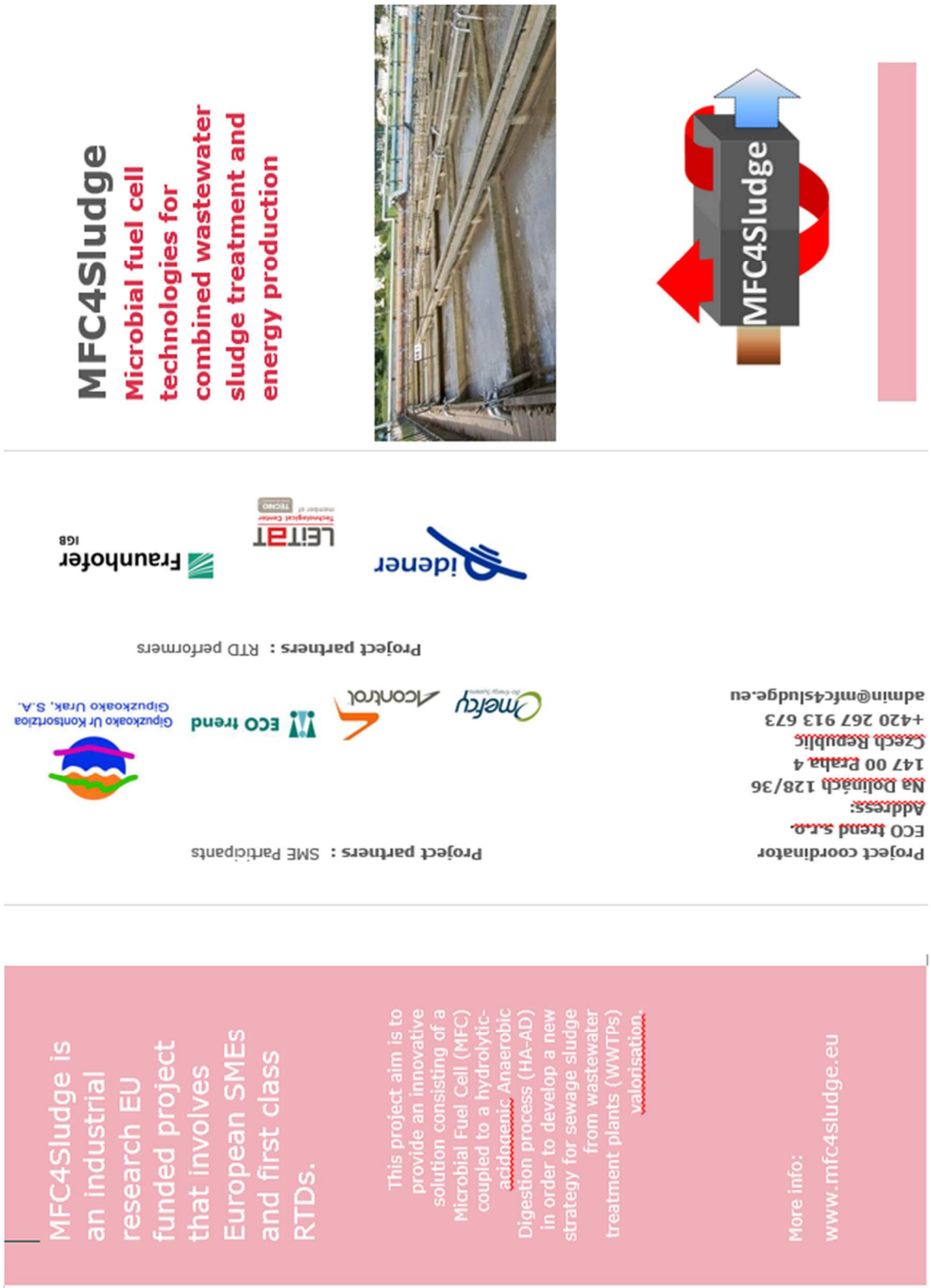

Figure 6. MFC4Sludge brochure (outside)

2.5 Poster

The project poster has been developed in order to provide basic information about the project main goals, the technical approach, the expected achievements and a list of project participants and the consortium. This will serve as the project's "business card" and will be distributed, by the project beneficiaries, as widely as possible in any appropriate occasion. This document is available on the public website so all the audiences as well as partners can have access to it. A caption of such a document can be found next.

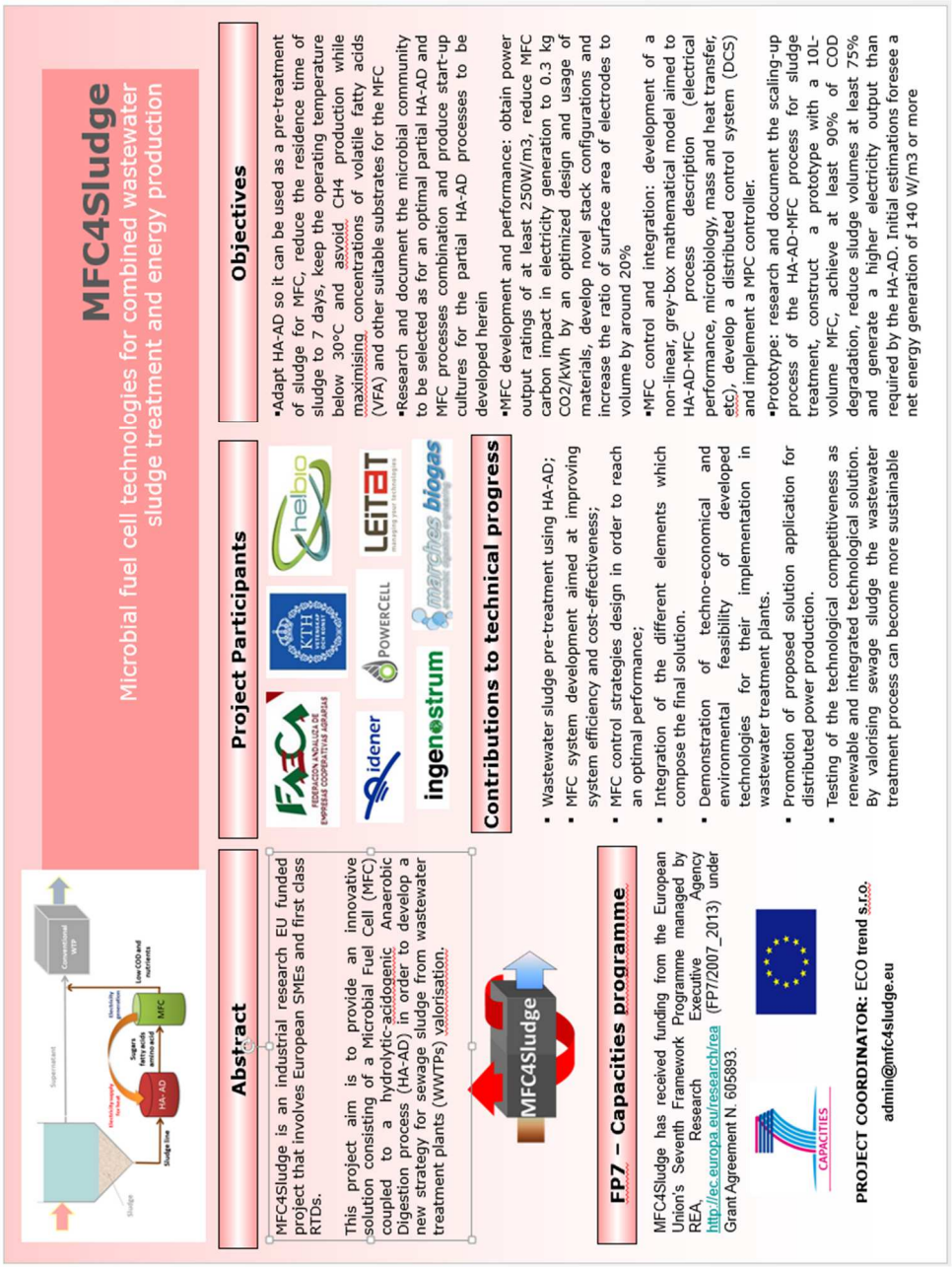

Figure 7. MFC4Sludge poster

2.6 Events

The first nine months of the project are noted with overall success in relation to the participation of the partners in conferences, since the partner LEITAT participated in the seminar "Energy efficiency of wastewater treatment plants: sources of savings" carried out in Gdansk (Poland) during 5-7th of November. The seminar was organized by the Gdańska Fundacja Wody in the framework of the EU-7th Framework Program project "WaterDiss 2.0. Dissemination and uptake of FP water research results" (EBV.2010.5.1.0-1, N 265167). The seminar was dedicated to energy efficiency of wastewater treatment plants. Eduard Borràs, in representation of the MFC4Sludge consortium, gave a presentation of the objectives of the project and the significance it may have for the management of wastewater treatment plants. The technology of the project was presented thoroughly and throughout this event, with the partners aiming at maximizing the visibility status of the project results foreseen. Besides, a representation of Leitat attended the Seminar "Applications of Bio-Electrochemical Systems in effluents", organised by Abengoa (14th February, Seville Spain) related to the project ValuefromUrine (FP7 308535). During this event, flyers of MFC4Sludge were spread among participants, mainly from industries and academia. Additionally, LEITAT hosted an event on 4th April 2014, the 3rd SME Pan-European Event where the project was also disseminated as part of LEITAT and IDENER presentation. Moreover, abstract have been sent to EU-ISMET 2014 conference (a copy of the aforementioned abstracts and documents can be found at the end of this deliverable, see Annex I). In addition, new events are often looked for, in order to boost the project impact.

Specific mention must be made in relation to the type of audience each event can be targeted, since the dissemination activities performed approached an array of interested parties, coming from different fields and areas of interest. Universities and academic institutions, technology institutes and potential end-users are some examples of the type of audience the dissemination activities aimed at.

As it can be depicted from Table 1 in next Summary section, all events had a wide geographic approach, targeting audiences in Europe. All events took place over the entire time span of the project's first nine months, thus maintaining a dynamic momentum of interest at a constant pace.

As far as project meetings are concerned, the partners met two times, as prescribed within the project proposal. The first meeting (kick off meeting) took place in Prague (Czech Republic), in September 2013, where the partners had the opportunity to present their organizations and further define and describe their involvement in the project. The second meeting (M6 meeting) was held online using Webex. The partners had the opportunity to comment on the work progress and establish internal deadlines. Several telephone conference and technical meetings between the partners served as a follow up to ensure that all aspects of dissemination and exploitation activities are carefully taken into consideration. The third meeting (M12 meeting) will took place in July 2014 where partners will have the opportunity to review the work progress during the first part of the project.

2. 7 Publications

Publications, either in the form of Press Releases or as scientific papers with the intention of being published and/or in the process of being published, play a significant role in the dissemination of the project during its first months and are elevated at an equal bearing as any other type of activities performed during this time.

The coordinator ECO plans to publish project information and preliminary results in the following publications:

- Odpady (Wastes), http://odpady.ihned.cz/

- Odpadové fórum (Waste forum), http://www.odpadoveforum.cz/cz/

- Alternativní energie (Alternative energy), http://www.tzb-info.cz/casopisy/alternativni-energie

- Energie 21, http://energie21.cz/

- Echo (Technology centre of Czech Republic magazine), http://www.tc.cz/en/publications/periodicals/periodicals-list/echo

2. 8 Website

The project website (www.mfc4sludge.eu) acts as a dissemination platform with the aim to establish an efficient and effective dissemination and communication tool for the MFC4Sludge consortium for the duration of the project. The website construction and management consists of one of the main dissemination tools of the project, which will ensure the successful use of project results and non-confidential information to the widest possible audience (including the industrial, academic community and potential end-users).

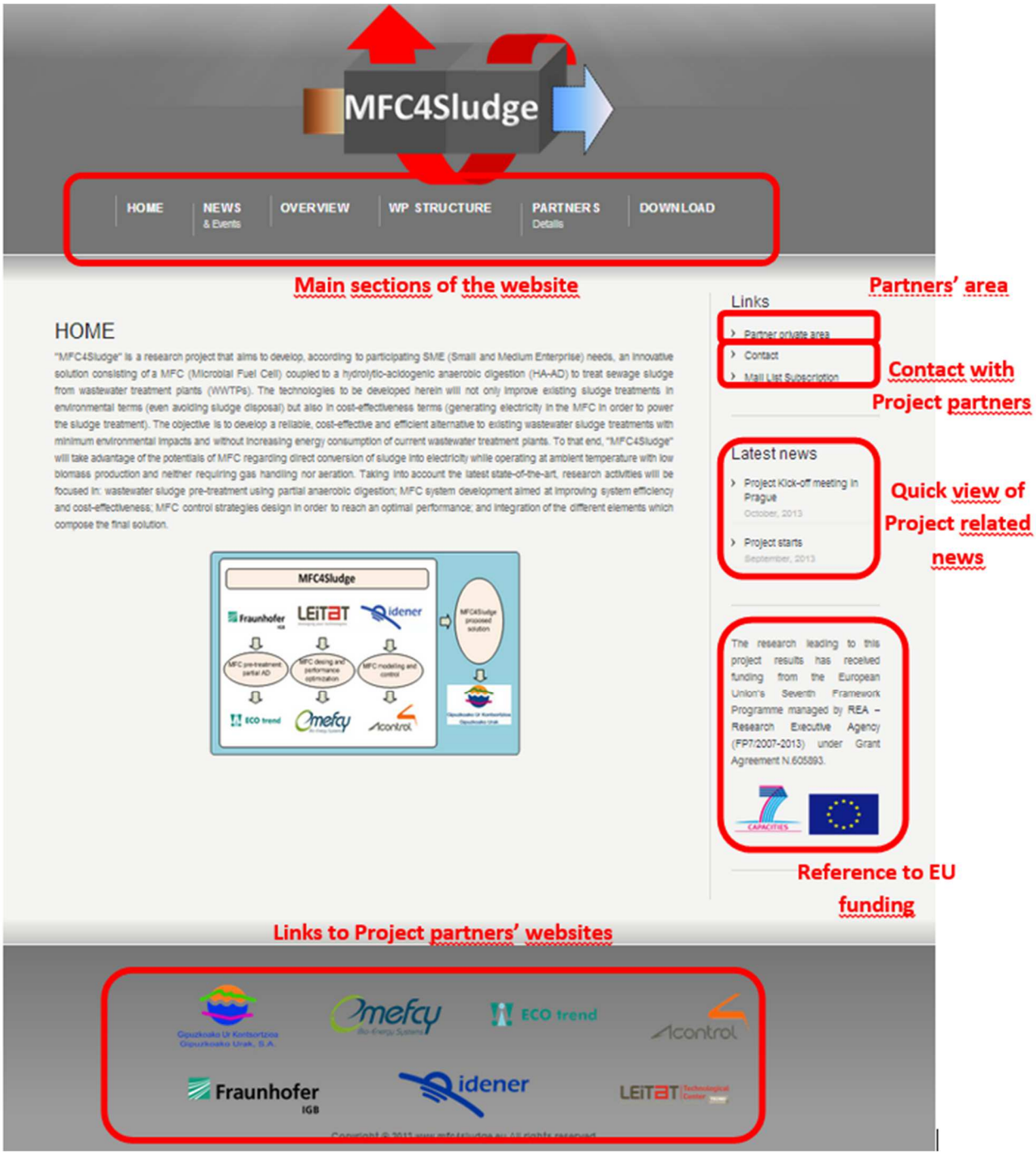

Figure 8. MFC4Sludge project website

The website has a clear structure with two types of webpage navigation depending on the type of user i.e. visitor (public) or Consortium member (private area). The potentials for navigation, document uploading and website

alterations differ for each type of user. The aim of the website is on one hand to inform general public about the project and on the other hand to constitute a tool to communicate and to exchange information on the project between partners. Project website is often updated through the insertion of news, new data and events and activities that are related to the project area and could be interesting for website visitors. More detailed description of the project website is given in D6.1 "Website".

Concerning project website updates, information has been added to the website often (a summary of website updates can be found in section 3 Summary).

In addition, some partners have also added a web link to the project on its organization's website.

3. Summary

The following table includes a detailed list of all dissemination activities (publications, conferences, web sites/applications, press releases, and flyers, articles published in the popular press, media briefings, presentations, and posters) that have been carried out during the first nine months of the project.

Type of activities	Main partner involved	Title	Date	Type of audience	Countries addressed
Project website	ACONTROL	www.mfc4sludge.eu	M3	All	Europe
Project website update	ACONTROL	MFC4Sludge project starts	M2	All	Europe
Brochure	GURAK	MFC4Sludge Brochure	M3	All	Europe
Poster	GURAK	MFC4Sludge Poster	M3	All	Europe
Logo	GURAK	MFC4Sludge Logo	M3	All	Europe
Project website update	ACONTROL	Project Kick-off meeting in Prague	M3	All	Europe
Event	LEITAT	WaterDiss	M4	Scientific and All	All
Project website update	ACONTROL	MFC4Sludge as part of WaterDiss activities	M4	All	Europe
Abstract sending	LEITAT, IDENER, FRAUNHOFER	EU ISMET 2014	M9	Scientific	All
Website publication	LEITAT	`Publication of MFC4Sludge participation and link to project website in LEITAT IPO website	---	All	All
Website publication	FRAUNHOFER	`Publication of MFC4Sludge participation and link to project website in FRAUNHOFER IGB website	---	All	All
Website publication	IDENER	`Publication of MFC4Sludge participation and link to project website in IDENER website	---	All	All
Website publication	ECO	`Publication of MFC4Sludge participation and link to project website in ECO website	---	All	All
Flyers disseminati	LEITAT	Flyers dissemination at the Event "Applications of Bio-Electrochemical Systems in effluents", organised Abengoa (Sevilla, 14 February) related to the project ValuefromUrine (FP7 308535)	M7	Scientific	All
Project	ACONTROL	First semester meeting	M7	All	All

website update					
Event	LEITAT and IDENER	3rd Pan-European SME event	M9	Scientific and All	All
Project website update	ACONTROL	Project dissemination at the 3rd Pan European SME Event	M9	All	All

The status of the MFC4Sludge project developed Dissemination Plan up to month 9 has been presented. Although at this early stage of the project there are not a lot of sounding results, dissemination is progressing well. The project website is up and running and partners have been provided with the required material as for starting their own dissemination activities.

ANNEX I. Abstracts and publications*

*All abstracts to EU-ISMET 2014 are not included since the deadline for the call for abstract has been extended until 12nd May.

A DYNAMIC 2D MATHEMATICAL MODEL FOR TUBULAR-AIR CATHODE MICROBIAL FUEL CELLS USING CONDUCTION-BASED APPROACH FOR ELECTRONS TRANSFER TO THE BIOFILM AND VOLATILE FATTY ACIDS AS SUBSTRATE

Macias Aragonés, Marta [1]; Leyva Guerrero, Carlos[1]; del Real Torres, Alejandro J. [1]

[1]: IDENER, C\Leonardo da Vinci 18, CP.41092, Sevilla, Spain.

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A mathematical model has been produced and is currently being validated for a tubular-air cathode microbial fuel cell (MFC). Such model is a 2D dynamic model, hence allowing to simulate the MFC operation through time and providing the chance of implementing further control strategies such as Model Predictive Control.

Main issues covered by the model are:

- MFC morphology: single chamber tubular air-cathode. Specifically, these cells have an anodic chamber which contains the anolyte and where the biofilm grows attached to the anode. The cathode is in direct contact with the anolyte on one side and with air flow on the other side, hence oxygen is the electron acceptor. The water produced through the cathodic reaction flows to the anolyte and is eliminated through the outlet of the MFC along with the treated substrate. Thus, the anode is modelled as a plug flow reactor while cathode is modelled using a CSTR approach. 2D are considered, namely the x-axis related to the length of the MFC and the z-axis related to the biofilm thickness
- Electron transference: a conduction-based approach is considered and, accordingly, the biofilm is characterised by a conductivity factor K_{bio}
- MFC substrate: a sludge pre-treated through a partial anaerobic digestion is considered as the influent of the MFC, i.e., a stream rich in volatile fatty acids (acetate, propionate and butyrate are included in the model as substrates)
- MFC microorganisms/biofilm: active and inactive biomass are considered in the model as well as the differentiation between Electrogenically active bacteria and Methanogenic bacteria

This first-principles based model has been discretised for x and z-axis dependent variables and implemented in Matlab using a Zero Order Hold approach. Validation using real data from an operating MFC is expected to be completed in the upcoming months.

Request: Oral communication

DEVELOPMENT OF ON-SITE POWER GENERATION MODULAR SYSTEM FOR WASTEWATER SLUDGE VALORISATION USING A COMBINATION OF PARTIALANAEROBIC DIGESTION AND MICROBIAL FUEL CELL TECHNOLOGIES

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Sludge is the main by-product of the activated sludge process for wastewater treatment (total EU production circa 9.000.000 tons-DS/year, 2010). Its disposal easily reach up to 60% of total operation cost of a treatment plant and consume vast quantities of energy, being not a trivial issue due to its microbiological-chemical characteristics.

In this context, "MFC4Sludge: Microbial fuel cell technologies for combined wastewater sludge treatment and energy production" project is being carried out under the EU Seventh Framework Programme aiming to develop an innovative solution for this problem consisting of a Microbial Fuel cell (MFC) coupled to a Hydrolytic-Acidogenic Anaerobic Digestion (HA-AD).

Specifically, technologies to be developed do not only improve existing treatments in environmental terms (even avoiding disposal) but also in cost-effectiveness terms (generating electricity in the MFC in order to power the sludge treatment). The objective is to develop a reliable, cost-effective and efficient alternative with minimum environmental impacts and without increasing energy consumption. Expected results are:

- Regarding HA-AD as pre-treatment: reduce HRT to maximum 7 days, keep operating temperature below 30°C, avoid methane production and maximise suitable substrates for the MFC (volatile fatty acids)
- Concerning the MFC system development: obtain power output ratings of minimum 250W/m^3, reduce impact in electricity generation to 0.3 kg CO_2/kWh by optimising the MFC design, develop novel stack configurations and increase the ratio "electrodes surface area/volume" circa 20%
- Research required microbial communities for an optimal HA-AD-MFC combination
- For MFC control and optimal performance: production of mathematical models combining first-principle physics with empirical data aimed to HA-AD-MFC process description, develop a distributed control system and implement a MPC controller
- For the scaled-up prototype of the integrated solution, achieve a 90% COD degradation while reducing sludge volume at least 75%. A net energy generation of minimum 140 W/m^3 is estimated.

Request: Oral communication

PROGRAM OF THE WATERDISS 2.0 SEMINAR

„ENERGY EFFICIENCY OF WASTEWATER TREATMENT PLANTS - SOURCES OF SAVINGS"

GDANSK, 05 – 07 NOVEMBER 2013

05.11. 2013 r. (Tuesday)

09.00 Welcoming words. Introduction to the seminar.
Zbigniew Sobociński, Gdansk Water Foundation

09.15 Knowledge and experience transfer regarding water and wastewater management as one of the factors determining energy efficiency of water supply companies.
Matthias Worst, Bavarian Environmental Protection Agency, Hof

09.30 Bavarian approach to increase the energy efficiency, data, tools, institutions in charge... -current founding of energetic optimizing at WWTP´s.
Claus Kumutat, Prezes Bawarskiej Agencji ds. Środowiska

10.30 Coffee break

10.45 Energy balance of a typical wastewater treatment plant as a basis for its energy efficiency.
Jan Surówka, Energy Engineering & Management Systems, Gliwice

11.30 Waste Water Treatment Plant energy balance - range, function, risk assessment of the exploiter.

12.15 Waste Water Treatment Plant - energy management.
Mirosław Włas, Energy Management Systems, Gdańsk

12:45 Quality of cogeneration devices and its service versus incomes.
Grzegorz Drabik, CES, Kraków

13.15 Lunch break

14.15 Energy Benchmarking of WWTP as a way to increase its energy efficiency
- Energy indicators of WWTP – European and American experiences
- From energy efficiency audit of wastewater treatment plant to its improvement

Jan Surówka, Energy Engineering & Management Systems, Gliwice

15.00 Analysis of energy use in the context of benchmarking on WWTP
Marius Wilke, Aquabench GmbH, Hamburg - Kolonia

16.00 Enhancing energy efficiency balance on WWTP
Tymoteusz Jaroszyński, Technical University of Poznań

16:30 Evaluation of the energy and ecological effects of disintegration implementation conducted with the use of hydrodynamic cavitation generator
Tomasz Rybicki, MVA Green Energy,

16:45 Energy efficiency on WWTP –"BARITECH" and FP7 „CarBala" projects
Ewa Zaborowska, Technical University of Gdansk

17.15 End of the I day of the seminar.

18.30 Common dinner.

06.11.2013 r. (Wednesday)

09.00 Introduction to the II day of the seminar.

09.10 Starting points for the design and implementation of efficient aeration systems
Martin Gräsl, Rudolf Messner Umwelttechnik, Areation Technology, Adelsdorf

10.05 Control and optimization of energy use in small and medium WWTP – Spanish experiences using FP7 OptimEDAR solutions
Małgorzata Steckiewicz, ADASA Sistemas, Warszawa

10:35 Microbial Fuel Cell technologies for combined wastewater sludge treatment and energy production- FP7 MFC4 Sludge project
Eduard Borras Camps, LEITAT Technological Center, Barcelona

11.05 Coffee break

11:15 Energy efficient Mixing Systems in the biological treatment steps/ Energy savings by use of an advanced aeration control
Peter Huber, **Invent Umwelt und Verfahrenstechnik GmbH, Erlangen**

12:00 Deammonification – energy efficient concentrate treatment .
Claus Lindenblatt, Environmental and Water Institute

13.00 Lunch break

14:00 DEMON+) Nitrogen removal – examples of efficiency enhancement on WWTP.
Robert Zarzycki, Stalbudom, Warszawa

14.45 Source of energy saving and generation during the processes of sludge treatment and removal.
Sebastian Kliemt, Huber SE, Berching

15.45 Optimal fermentation of sewage sludge- possibilities of improvement of WWTP energy balance. Can bio-refineries be treated as WWTP?
Andrzej Wójtowicz „Wodociągi Słupsk"

16.30 Model of dehydrated sewage sludge dryer – energy balance and economical effects.
Cezary Jędrzejewski, PEWIK Gdynia

16.45 Discussion

17.15 End of the II day of the seminar

07.11.2013 r. (Thursday)

09.00 Summary of the second day of the seminar

09.10 Energy consumption of sewage sludge incineration plant – experiences form international and national installations.
Leonard Szczepański, Gdańska Infrastruktura Wodno-Kanalizacyjna, Gdańsk

10.00 Experiences in the implementation of energy efficiency increase program in the group of Waste Water Treatment Plants.
Kinga Drensla, Erftverband, Bergheim

11.00 Coffee break

11.15 Energy efficiency technologies on waste water treatment and transport.
Marcin Fałdziński, Wilo Polska, Lesznowola

12.15 Quality of cogeneration equipment and its services versus the income.
CES, Kraków

12.45 The use of renewable energy sources to improve energy efficiency in the process of modernization of WWTP in "Dziarny" next to Iława.
Piotr Kowalski, Iławskie Wodociągi, Iława

13.30 Summary of the seminar. Lunch

Vision2020: The Horizon Network

Insights, organisation and networking for European research and innovation

3rd PAN EUROPEAN SME EVENT VISION 2020

4th April 2014
from 10:00 to 14:00

Casa Milà "La Pedrera"
Provença 261 - 265
Barcelona

POLICY PERSPECTIVE - OPPORTUNITIES WITHIN HORIZON 2020

10:00 - 10:10	**LEITAT - Technological Center - Opening.**
10:10 - 10:30	**Abdul Rahim, Director of Vision2020.** Presentation followed by Q&A session.
10:30 - 11:00	**Samuel Maenhout - European Commission - Policy Officer from DG Research & Innovation B3 – SMEs, Financial Instruments and State Aid.** Presentation followed by Q&A session.
11:00 - 11:30	**David Rovirosa, ACCIO – Government of Catalonia - Enterprise Europe Network.** Presentation followed by Q&A session.
11:30 - 12:00	Coffee & Networking.

EU FUNDED RESEARCH AND INNOVATION: COMMERCIAL CASE STUDIES + VISION 2020 RELEVANCE MEMBERS

12:00 - 12:15	**Emilie Mespoulhes, LEITAT as a Partner for Technology for SME's.** Presentation followed by Q&A session.
12:15 - 12:30	**Oonagh McNerney, SME Success story, IRIS (INNOVACIO I RECERCA INDUSTRIAL I SOSTENIBLE SL), SME on the 5th place on the 6th monitoring Report as a participation under FP7 with 28 participations last year.)** Presentation followed by Q&A session
12:30 - 12:45	**Marta Macias, SME Success story (IDENER). (SME Member of Vision 2020.)** Presentation followed by Q&A session.
12:45 - 13:00	**Michael Brown, University Success story (Head of European Project - University College London RTO Member of Vision 2020).** Presentation followed by Q&A session.

THE VISION2020 PLATFORM: CONNECTING SMES WITH RESEARCH & TECHNOLOGY ORGANISATIONS

13:00 - 14:00	**Networking reception with LEITAT International project Managers from various disciplines (Health, Food, Energy, Transport, Materials, ICT, Manufacturing, Nanotechnologies, Biotechnology, Production/processing), Vision2020 members and collaborators from across Europe.**

REGISTRATION LINK: http://v2020sme3.eventbrite.co.uk

Practical information

La Pedrera
Passeig de Gràcia 92 - 08008, Barcelona.

How to get there:
Bus: 7,16,17,22,24 and 28.
Underground: Lines 3 and 5,
Diagonal stop.
Train services: FGC: Provença station.
Train services: RENFE: Passeig de Gràcia station.
Nearest car park: Parking Saba Passeig de Gràcia.

Information:
LEITAT
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Organized by:

LEITAT Technological Center member of TECNIO

Collaborators:

European Commission · ACCIÓ Generalitat de Catalunya · enterprise europe network · iris Research | Engineering | Technology · UCL · idener · MFC4Sludge

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