Project Title	**Integrated management and exploitation of multi-dispersed agricultural residues – application to energy production - SYNAGRON**
Project Partners (Greece) 1. University of Patras, **UP** 2. University of Western Macedonia, **UWM** 3. Sirmet S.A., **SIRMET** **Other Collaborating Organizations** - Khalifa University of Science and Technology, **KUST**	**Project Partners (China)** 1. Beijing University of Chemical Technology, **BUCT** 2. Beijing United Pioneer Environmental Engineering Co. Ltd, **BUPEE** 3. Nanjing Benran Environmental Technology Co. Ltd, **BENRAN**

MINUTES OF KICK-OFF MEETING

The kick-off meeting of the project SYNAGRON took place via skype teleconference on Thursday, **14th November, 2019**, 17:00-19:00 Beijing time (11:00-13:00 Greek time).

Participants:

1. Prof. Vagelis G. Papadakis, University of Patras, Greece (Coordinator of Greek Consortium)
2. Assoc. Prof. Wen Wang, Beijing University of Chemical Technology, PR China (Coordinator of Chinese Consortium)
3. Prof. Guangqing Liu, Beijing University of Chemical Technology, PR China
4. Prof. Maria Goula, University of Western Macedonia, Greece
5. Assist. Prof. Savvas Douvartzides, University of Western Macedonia, Greece
6. Dr. Nikolaos Charisiou, University of Western Macedonia, Greece
7. Mr. Georgios Syriopoulos, Sirmet S.A., Greece

ADENDA:

1. Organization of the scientific work and task allocation between partners
2. Organization of managerial aspects (physical meetings/visits and skype meetings)
3. Enhancement of the collaboration activities, including: a) the organization of the ICB2021 conference, b) Erasmus proposal, c) common MSc, d) common research centre

The meeting was coordinated by Prof. Papadakis and started by introduction of each participant and giving general information about the project SYNAGRON. It was then announced that the project from the Greek side started officially on **October 14th 2019 and will last up to October 13th 2022** (36 months). The official project time from the Chinese part is **1/8/2019-31/7/2022** (36 months); therefore, the activities of both sides are almost simultaneous.

1. Organization of the scientific work and task allocation between partners

The main objective of the project SYNAGRON is to pave the way **for the environmentally friendly useful exploitation of the residues of the Chinese and Greek agricultural sectors for the generation of high value bio-products and/or energy**. This is to be accomplished by designing and developing an innovative pyrolysis - anaerobic digestion processing plant for the conversion of agricultural wastes initially into useful bio-products, such as bio-char, bio-oil, syngas and biogas, and then into hydrogen and/or electrical energy. Research will focus on the experimental and/or theoretical

design and optimization of each process, on the design and optimization of the overall processing plant, on the development of innovative catalytic systems for the pyrolysis and the biogas and bio-oil reforming for hydrogen production reactions, and on the utilization of the gaseous products of the processing plant for highly efficient generation of electricity in Solid Oxide Fuel Cells (SOFCs).

There are two separate **Technical Annexes** (TA), one for each participating country, describing the work packages (WPs) and tasks that have to be implemented during the project elaboration. Actually, the work described to each Technical Annex is similar; there some differences on labeling and presentation. Each participating part has communicated the Technical Annex to the other part so everyone is familiar with both TA.

Prof. Papadakis presented shortly the Technical Annex that is valid to the Greek side describing the WPs, tasks (T), deliverables (D) and the corresponding schedule (M: month).

WP1- MARKET UPTAKE, M1-M18 [GR: UP (Lead), SIRMET, UWM / CN: BUCT (Lead)]

WP1 includes a detailed survey of the most promising agricultural residues and an economic analysis for the outcomes expected by the introduction of each final product of the processing plant into the energy market. Both studies will specify the economic parameters and the commercialization prospects from the utilization of the proposed technologies in regional and national level, in both China and Greece.

UP has the leadership to perform this WP and agreed that BUCT will provide to the Greek partners all necessary information/data regarding the most promising agro residues in China as well as Chinese market data for the envisaged products (bio-char, bio-oil, biogas and hydrogen).

T1.1. Survey of the most promising agricultural residues (GR: UP, SIRMET, UWM / CN: BUCT)
T1.2. Market analysis for bio-char, bio-oil, biogas and hydrogen (GR: UP, SIRMET / CN: BUCT)

D1.1: Report on the most promising agro residues in CN & GR (M18)
D1.2: Report on market analysis in the two countries (M18).

WP2- BIODEGRADABLE WASTE FERMENTATION FOR BIOGAS PRODUCTION, M1-M24 [GR: UP (Lead), SIRMET, UWM / BUCT (Lead), BUPEE, BENRAN]

WP2 concerns the detailed experimental investigation and the theoretical modeling and optimization of the anaerobic digestion (AD) and solid/liquid separation processes. Experiments will provide insights on the parameters of operation and control which influence the performance of the relative equipment depending on the selected feedstock and its properties. Results will be used on the experimental optimization of the individual processes and will validate the subsequent theoretical modeling. The theoretical models will be formulated to rationally explain the observed processing phenomena as well as to widen the spectrum of the parametric analysis of the reactors and the auxiliary equipment.

T2.1. Experimental investigation of the anaerobic digestion process using various biodegradable agricultural residues (GR: UP, SIRMET / CN: BUCT, BUPEE, BENRAN)
T2.2. Theoretical modeling and optimization of the anaerobic digestion processes using various biodegradable agricultural residues (GR: UP, UWM / CN: BUCT)

D2.1 Mid-term project report (M18)
D2.2 Report on the experimental investigation of AD processes (M20)
D2.3 Report on the theoretical modeling and optimization of the AD processes (M24)
D2.4 Dissem Activ: 2 public in Int journals, 2 participations in Int confer (M24).

WP3- NON-BIODEGRADABLE WASTE CATALYTIC PYROLYSIS FOR THE PRODUCTION OF BIO-CHAR, BIO-OIL AND SYNGAS, M1-M24 [GR: UWM (Lead), UP, KUST / BUCT (Lead), BUPEE, BENRAN]

WP3 concerns the detailed experimental investigation, theoretical modeling and optimization of the catalytic pyrolysis process. *Design and development of innovative catalytic systems will be performed in order to improve the quality and/or the quantity of the produced bio-oil and chemicals. Efforts would be directed towards exploring the prospects of various catalysts from zeolites, as alkali ion-exchange zeolites, alkali ion-loaded zeolites and supported alkali metals, as alkaline metals on alumina or silica, alkali metals and alkaline metal hydroxides on alumina.* Experiments will provide insights on the parameters of operation and control that influence the behavior of the respective equipment depending on the selected feedstock and its properties. Results will be used on the experimental optimization of the specific process and will validate the subsequent theoretical model, which will allow the rational explanation of the observed reaction mechanisms. Modeling results will be validated by the accompanying experiments and optimization conditions will be recognized depending on the feedstock type and user needs for biogas, bio-char, bio-oil or uncondensed gases.

UWM has the leadership to perform this WP and agreed that it will provide BUCT with all necessary catalysts and substrates in order for the Chinese partners to perform the catalytic pyrolysis experiments.

BUCT agreed to perform the necessary experimental work and provide UWM with the information needed for T3.2, i.e., the Theoretical modeling and optimization of the catalytic pyrolysis processes

T3.1. Experimental investigation of the catalytic pyrolysis process using various non-biodegradable agricultural residues (GR: UWM, KUST / CN: BUCT, BUPEE, BENRAN)
T3.2. Theoretical modeling and optimization of the catalytic pyrolysis processes using various non-biodegradable agricultural residues (GR: UWM, UP)

D3.1: Report on the experimental investigation of the catalytic pyrolysis process (M20)
D3.2: Report on the theoretical modeling and optimization of the catalytic pyrolysis processes (M24)
D3.3: Dissem Activ: 2 public in Int journals, 2 participations in Int confer (M24).

WP4- BIOGAS AND BIO-OIL UTILIZATION FOR HYDROGEN PRODUCTION, M6-M30 [GR: UWM (Lead), UP, KUST]

WP4 concerns the detailed experimental investigation, theoretical modeling and optimization of the biogas and bio-oil catalytic reforming processes for hydrogen production. *Design and development of innovative catalytic systems will be performed in order to increase conversion, hydrogen yield, H_2/CO molar ratio and catalyst's life time. Effort would be focused in exploring the prospects of various catalysts that have active metals (transition metals like Ni or precious metals) incorporated in to the lattice of perovskite type oxides.* Experiments will provide insights on the parameters of operation and control that influence the behavior of the specific equipment depending on the feedstock and its properties. Results will be used on the experimental optimization of the specific processes and to validate the subsequent theoretical modeling of the reforming reactors.

T4.1. Experimental investigation through catalyst development and evaluation for the biogas and bio-oil reforming reaction to hydrogen production (GR: UWM, KUST)
T4.2. Theoretical modeling and optimization of the catalytic reforming processes for hydrogen production (GR: UWM, UP)

D4.1 Report on catalyst preparation and characterization results (M20)
D4.2 Report on catalytic performance evaluation (M28)

D4.3 Report on the theoretical modeling and optimization of the catalytic reforming processes (M30)
D4.4 Dissem Activ: 2 public in Int journals, 2 participations in Int confer (M30).

WP5- TECHNO – ECONOMICAL STUDY & OPTIMIZATION & ENVIRONMENTAL ASSESSMENT, M18-M36 [GR: SIRMET (Lead), UP, UWM / BUCT (Lead)]

WP5 aims at the cost-effective maximization of the final products of the plant according to the user needs. This includes the design and optimization of the overall processing plant depending on the user needs for bio-products and/or energy and the investigation of the utilization of the biogas or syngas products for highly efficient generation of electricity in Solid Oxide Fuel Cells (SOFC's).

T5.1. Theoretical modeling and optimization of the overall plant performance using various non-biodegradable agricultural residues (GR: UP, UWM)
T5.2. Theoretical modeling and optimization of the overall plant performance for generation of electricity in Solid Oxide Fuel Cells (GR: UP, UWM)
T5.3 Techno – Economical Study (GR: SIRMET, UP / CN: BUCT)
T5.4 Environmental Assessment (GR: UP, UWM / CN: BUCT)
T5.5 Feasibility project (GR: SIRMET, UP / CN: BUCT, BUPEE, BENRAN)

D5.1: Report on the theoretical model for the processing plant and SOFC integrated unit (M33)
D5.2: Report on the techno-economic study (M33)
D5.3: Environmental assessment (M33)
D5.4: Feasibility project (M36)
D5.5: Dissem Activ: 2 public in Int journals, 2 participations in Int confer (M36)
D5.6: Final project report (M36).

Mr. Syriopoulos explained how SIRMET can contribute especially on T5.5 by developing an appropriate pilot application and also he emphasized the necessity to cooperate with the Chinese companies towards the exploitation of scientific results deriving from the project elaboration.

From the Chinese part there is the following analysis on Topics and Sub-Topics according to TA:

Topic		**Sub-topic**
Topic 1	Efficient pyrolysis of un-biodegradable agricultural wastes	Task 1: Key Technologies for pretreatment of raw materials using less energy consumption and dense phase transmission device
		Task 2: Key technologies and complete equipment of external thermal pyrolysis reactor
		Task 3: Key Technologies for high-temperature dust removal and equipment for efficient purification of pyrolysis gas
		Task 4: Energy balance and process control of integrated system
Topic 2	Anaerobic digestion of biodegradable agricultural wastes coupled with pyrolysis gas biomethanation	Task 5: Parameter optimization and microbial analysis of the hybrid process
		Task 6: The effect of pyrolysis gas and trace components on conversion efficiency of anaerobic digestion reactor

		Task 7: Research and optimization of new figuration of the reactor
Topic 3	The match and integration for comprehensive utilization system	Task 8: Recognize and coordination of the key influencing factors in the whole process
		Task 9: LCA analysis, process integration and parameter optimization
		Task 10: Intelligent control system and system optimization

Then it became clear that, in general terms, Topic 1 corresponds to WP3, Topic 2 to WP2 and Topic 3 to WP5, whereas WP1 will feed all Topics. A detailed discussion was further performed in order to align both technical annexes and more importantly to follow all parts the same time schedule on similar task elaboration.

2. Organization of managerial aspects (physical meetings/visits and skype meetings)

Profs. **V.G. Papadakis** and **W. Wang,** as Principal Investigators from the Leading Partners (UP/Greece and BUCT/China, respectively), have the overall responsibility for the project, its coordination and management. They **apply a systematic management structure** for the overall administrative, financial and legal management of the project, and the different technological / scientific tasks that have been assigned to the participants. They manage the administrative and financial aspects of the award in accordance with the terms and conditions of each country.

For the purposes of SYNAGRON, the Leaders of the consortiums have to meet tri-monthly (via skype) to address the project updates (e.g. technical, development issues, report on progress updates, identify additional training or support requirements). Meetings (via skype) with the participation of both consortium members have to be organized on a six month basis. Budgetary provisions have also been made that allow the visitation of China and Greece by appropriate delegations from each side at the beginning and middle parts of the project.

Thus, it was agreed that beginning of February 2020 a 2nd skype meeting will be organized among all participants.

As regards the physical meetings, it was agreed a delegation of the Greek partners to visit BUCT/ China by the end of April – beginning of May 2020.

Then, possibly during September 2020, a delegation of the Chinese partners will visit Greece. This visit could be combined with the *International Conference on Advance Energy Materials*, organized by the University of Western Macedonia in Thessaloniki, Greece.

3. Enhancement of the collaboration activities

a) Organization of the ICB2021 conference

Biorefinery is a new industrial model that uses renewable biological resources as raw materials to produce green energy and chemical products, while reducing the consumption of fossil resources. It is also the most promising approach shifting from “the oil economy”, ensure the sustainable development of the global economy. At present, countries have been vigorously promoting research and development of the biological refining system, in order to facilitate the realization of a green economy.

The *International Conference of Biorefinery (ICB)* takes the development of biorefinery and bio-economy as its mission, and started to establish its reputation since 2007. The related themes including: bio-based chemicals, bioenergy, biomaterial, bio-raw material and products, application bioprocess & thermal processing technology, platform technologies (metabolic engineering, enzymatic engineering, separation and etc.), biotechnology policy, economical & environmental evaluation, and etc. More than 400 people from 30 countries and regions, both from the academy and industry, attended the first ICB in Beijing (2007). After the first success, the conference has been successfully held in Syracuse USA (2009), Brugge Belgium (2011), Xiamen China (2013), Christian Church City New Zealand (2017), Johannesburg South Africa (2019). BUCT, as the main and devoted co-organizer, has organized or assisted the local organizer with each organization. Every time more than 150 people attended the conference, and many collaborations have been established through the conference. Thanks to the fruitful outcomes, the conference has been developed into a well-known communication platform in the field of biorefinery and biotechnology, as well as an interdisciplinary forum. As a dedicated partner, Biotechnology Advances（IF >9.0）published three special issues for the congress.

As a suggestion of BUCT and President Prof. Tianwei Tan to the last ICB2019 it was discussed and decided the forthcoming **ICB2021 to be held in Heraklion Crete, Greece in July 2021**. Prof. Douvartzides who had participated in ICB2019 in Johannesburg gave more details about the Conference. In the local organizing committee UP and UWM will participate. With this conference, up-to-date development of the biotechnologies will be presented, bio-economy related issues will be profoundly discussed, and again knowledge will be spread, innovative ideas will be inspired, effective communication will be achieved for all the participants, and possible inspirations and solutions can be provided to overcome the challenges facing by the biotechnology industry.

All agreed to co-work towards a successful preparation and realization of ICB2021. Prof. Liu will undertake the responsibility to facilitate the bilateral communications among Greek partners and BUCT contributing on faster preparatory actions.

b) Erasmus proposal

BUCT, UP and UWM agreed to proceed with the submission of a common Erasmus+ international proposal (January 2020) in order to further strengthen their ties. If successful, the project will provide funding for academic staff visits and also for the exchange of PhD students. It was agreed that UWM will have responsibility for the submission of this proposal.

c) Common MSc

BUCT, UP and UWM agreed to work towards running a common MSc in the area of biomass-bioenergy. UWM will carry out the initial work (Title, curriculum development) and submit a draft of its proposal to all partners for comments and exchange of ideas. Further discussions on this topic will be held during the visit to BUCT by the Greek delegation.

d) Common research centre

A cooperation agreement was made on June 6th, 2018, under the framework of “Memorandum of Understanding Academic Cooperation between Beijing University of Chemical Technology, Beijing, China and University of Patras, Patras, Greece” and “Memorandum of Understanding Academic Cooperation between Beijing University of Chemical Technology, Beijing, China and Western Macedonia University of Applied Sciences, Hellenic republic”. With BUCT, UP and UWM as platform, focuses on the Belt and Road High-level Personnel Training Base and Innovative Technology Incubation, the purpose of this Cooperation Agreement is formally to record the mutual

interest of BUCT and UP, UWM in promoting and furthering the development of **The Joint International Lab of Biomass Energy and Environmental Engineering** between the three institutions from two nations, to comprehensively strengthen and deepen the cooperation in education, science and technology between universities in countries along the Belt and Road, promote cultural and educational exchanges, train and provide high-level personnel and high-tech.

During the meeting ideas and suggestions were discussed how to promote further the cooperation under this International Lab and what further actions needed in addition to the common project SYNAGRON.