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## Project BBChina: a new Master Program in three Chinese Universities on Bio-Based Circular Economy; from Fields to Bioenergy, Biofuel and Bioproducts

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### Abstract

Six Higher Education Institutions among China and Europe have agreed to work together in order to establish and implement a 120 ECTS equivalent Master Program on Bio-Based Circular economy in three Chinese Universities. The aim is to start the first edition of the Master in September 2019 in the following Universities: Tongji University and East China University of Science and Technology, both from Shanghai, and the Sichuan University of Chengdu. The Master will be implemented within the BBChina Project, supported by the Education, Audiovisual and Culture Executive Agency of the European Commission under the ERASMUS+ programme. The project BBChina, started in autumn 2017, aims to help People's Republic of China fully exploiting its wide bioenergy potential, thus strongly decreasing the present use of fossil fuels that dramatically increases the local pollution and that is strongly affecting the pollution at world level as well as global warming. To reach the aim, the newly established Master program will deeply analyse the complex chain that starts from the biomass production and collection until the output of biorefineries, to the bioenergy production, to the biofuel utilisation as well as to the always more important integration with other Renewable Energy Sources (RES). Furthermore, the program will include education and training activities such as technical laboratory, international mobility of teacher and students, seminars, and actions to trigger and encourage young entrepreneurship and innovation in the global green market scenario.

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## 1. Introduction

The project BBChina aims to help People's Republic of China fully exploiting its wide bioenergy and biobased products potential, through the implementation of a 120 ECTS equivalent Master Program on Bio-Based Circular economy in three Chinese Universities, Tongji University and East China University of Science and Technology, both from Shanghai, and the Sichuan University of Chengdu. The exploitation of this high potential could help strongly decreasing the present use of fossil fuels in China that dramatically increases the local pollution as well as the global warming at world level. In fact, declining fossil fuels availability and increasing environmental problems, including global warming and air pollution, are driving Chinese society to search for new sustainable sources of energy such as bioenergy and biofuels as well as biochemicals substituting petrochemical derived materials. Biomass provides an ideal alternative to fossil resources; indeed, biomass is the only sustainable source of interest organic compounds and has been proposed as the ideal equivalent to petroleum for the production of fuels and energy.

### Nomenclature

HEI Higher Education Institution

EACEA Education, Audiovisual and Culture Executive Agency of the European Commission

## 2. Project Objectives

The BBChina Project is focused on the development of a Master Program on Bio-Based Circular Economy devoted to the biomass chain from the field to bioenergy, biofuel and biochemicals.

The decision to implement a specific curriculum on bioenergy, biofuel and bioproducts designed for China has been undertaken following a request from Chinese head professors working in the related fields, so to help Chinese Universities train next generation of scientists and technicians to tackle this important environmental challenge.

China is a country rich in biomass resources, has great potential for energy utilization and, as of 2015, utilized biomass is already about 35 million tons of standard coal equivalent. Biomass power generation and liquid fuel industry are present and bio natural gas industry has started, showing a good development trend. Market for solid biomass (i.e. wood briquette) is also active.

Despite massive resources and increasing utilization, bioenergy and biochemicals are still in the early stage of development in China, and the following problems remain:

- a society not fully aware of biomass energy;
- the specialization degree of marketization is low, the technical level needs to be improved, and the standard system must be improved;
- related policies must be improved and there's a lack of mechanism to give utilization priority to the use of energy from biomass.

There are also several main limiting factors for biobased economy development in China:

- the market for organic fertilizer from bio-waste is still low;
- lack of standards and regulation regarding the quality of bio-based products and the pollution control of technologies;
- existing technologies/processes are not optimized or run stably;
- the benefits of Bioenergy, Biofuels and Biochemicals are underestimated and not comprehensively accounted from a life-cycle point of view (i.e. GHG and pollutants reduction, replacement of fossil energy/fertilizer etc.), but are only evaluated on the immediate economic gains.

In order to support the development of a biobased economy, the Chinese government, in March 2016, has then issued a series of “13th Five-Year Plan” [1] and strategic documents encouraging the development of biogas,

biofuel, bioenergy, organic fertilizer from bio-waste (food waste, manure, straw, etc) and biomass. These are the 13th Five-Year Plan on the:

- construction of Treatment Facilities for Urban Domestic Refuse in China,
- development of Biomass Energy (e.g. including the following 2020 targets: commercialization and large scale use of bioenergy; bioenergy per year 8 Mt coal eq.; installed gross biomass power generation 15GW, 90GWh/y energy output; 8 Gm<sup>3</sup> biogas, 6 Mt biofuel, 30 Mt briquette per year),
- development of Renewable Energy,
- formulation of National Environmental Protection Standards,

as well as the “Implementation Plan of Straw Comprehensive Utilization” and the “Plan to Promote the Resource Utilization of Agricultural Wastes.

There is indeed an increasing request of trained personnel in the field by the Industries asking for local expertise, presently scarcely available because Universities are not always able to fulfil the request; even if courses in the field are sometimes present in the involved Universities, there’s a strong lack of coordination and homogeneity.

### 3. Implementing the action

Regarding the Master implementation, since the “Biomass to Energy and Biobased Products Chain” is a highly interdisciplinary topic, it involves several independent Subject Areas including Chemistry, Biochemistry, Environmental Sciences, Ecology, Engineering, Agriculture, Forestry and Environmental protection. All these issues will be included within the course outline. The proposed Master will tackle this strong Education and Training Challenge, covering all the specific aspects related to the conversion of biomass into a sustainable and environmental friendly energy source or material.

The proposed action aims to fill the mentioned gaps, in order for the Chinese Universities to train a new generation of Master Graduates that will be able to drive China and East Asia towards a BioBased, low impact and low pollution new development model.

In parallel with the courses, several training activities and seminars will be held with the aim to trigger and encourage entrepreneurship and innovation. In particular, the action will aim to train students in the principles of entrepreneurship, with a special focus on how to set up a new activity/enterprise in the field of bioenergy in China and in Europe, and how to deal with the global green market.

#### 3.1. The partnership

The partnership is composed of three HEIs from European Union and three HEIs from People's Republic of China.

From EU:

- University of Florence, Italy,
- University of Rostock, Germany,
- Mälardalen University, Sweden,

and from PR of China:

- Tongji University from Shanghai,
- East China University of Science and Technology from Shanghai,
- Sichuan University, from Chengdu, Sichuan District.

About the development of a complete curriculum on Biomass to Energy and Bioproducts, the coordination among the HEIs is important to avoid overlap of contents. In particular, the EU HEIs can guarantee it:

- the expertise of the University of Florence is highly qualified in agroforestry, energy crops, thermochemical conversion and biofuels,
- the expertise of the University of Rostock is highly qualified in the field of Waste Management and Material Flow, of mechanical, biological and thermal treatment systems of waste and biomass, of bioenergy integration in renewable energy systems and of Land Management and Environmental Protection, and
- the expertise of Mälardalen University is highly qualified in the field of Advanced Energy Systems, of biomass, and biogas, thermodynamic properties of fluids, and technologies of CO<sub>2</sub> capture and storage (CCS) and of biorefineries.

Chinese HEIs are the core of the project since the need for new curriculum development comes directly from their request. They are actively involved in Master Course setting up, defining its final structure. Chinese HEIs expertise also has very few overlapping:

- Tongji University expertise is on biological, thermal treatment systems and sustainable landfilling of waste,
- the expertise of the East China University of Science and Technology is on gasification and carbon capture and storage (CCS) and on biofuels, while
- Sichuan University expertise is strong on agro forestry, energy crops, solid biomass and biofuel feedstock resource, biofuels, Green Chemistry.

For evaluating the quality of the project in progress, the partnership established an International Advisory Board, where representatives of scientific sectors of China and Europe have been invited to support decisions, dissemination actions and other activities, amongst which the assessment of the developed syllabus and course curriculum.

Over the HEIs partners, the seventh entity involved in the partnership is CESIE, a NGO that is entrusted to prepare the e-learning platform and to introduce to professors and students this useful tool. As well as European HEIs are responsible for the implementation of updated scientific contents, CESIE will act as a cultural broker, ensuring consistency of activities and facilitating learning process. CESIE will also coordinate the action to train students in the principles of entrepreneurship, based on its experience in the ERASMUS+ KA2 Project "SCIENT" and in the H2020 ENVISION project.

Associated partners operating in Bioenergy/Bioproducts sector are involved. EU Associated partners, in particular, are planned to support mobility, hosting visits to their plants/labs/premises, in order to show teachers and students a wide range of applied solutions according to available local resources, while Chinese Associated Partners will help connecting graduating students with labour market, establishing durable quality standards of proposed internships.

### *3.2. Implementation: from the syllabus to the running Master Program*

The implementation of the Master Program starts with the definition of the new Syllabus. The syllabus is under implementation to fully comply with the Chinese University structure, but efforts have been made to comply as much as possible also with the Bologna Process. A strong difference exists in between the Chinese and the European Master Program duration: the Chinese Master Program lasts 2 and a half year while the European one lasts two years. While defining the syllabus, the distribution of the education weight within it has been done taking into consideration the European target of 120 ECTS; this also meets the efforts that the three Chinese HEIs are presently implementing in order to adopt a conversion system from Chinese Credits to ECTS. In fact, all the Chinese HEIs are making efforts in this direction and at least conversion rules are under implementation, while some double degree programs exist with European Universities.

The syllabus is also the result of an Education and Training Needs Assessment previously performed, in order to support the definition of the Master Program structure and topics.

Based on the elaborated syllabus, the Master basis material will be implemented, ex-novo when necessary or integrating material and knowledges from other existing courses within the partnership HEIs when possible.

In parallel with the definition of the basis material, the e-learning platform will be implemented as well as the learning activity related to the promotion of the entrepreneurial spirit. This will focus on the development of the following skills: self-branding, team building, creative thinking/analytical thinking, resilience, leadership, market, gaining the customer perspective, lean start-up, economic and financial planning, design thinking for start-up, how to prepare a pitch, patent, market, value proposition, and understanding the mechanisms of investment of a venture capital and grants.

Mobility of the teaching staff before the Master start is also foreseen. Teachers will spend 10 days in one of the involved European Universities and mobility will be organised in order to obtain an equal scientific and didactic brokering to participants from each partner university so competencies and experiences delivered will roundly and completely reach Chinese University. During this activity, Chinese lecturers and professors will participate to seminars, lessons, laboratories, and visits in test fields and power plants.

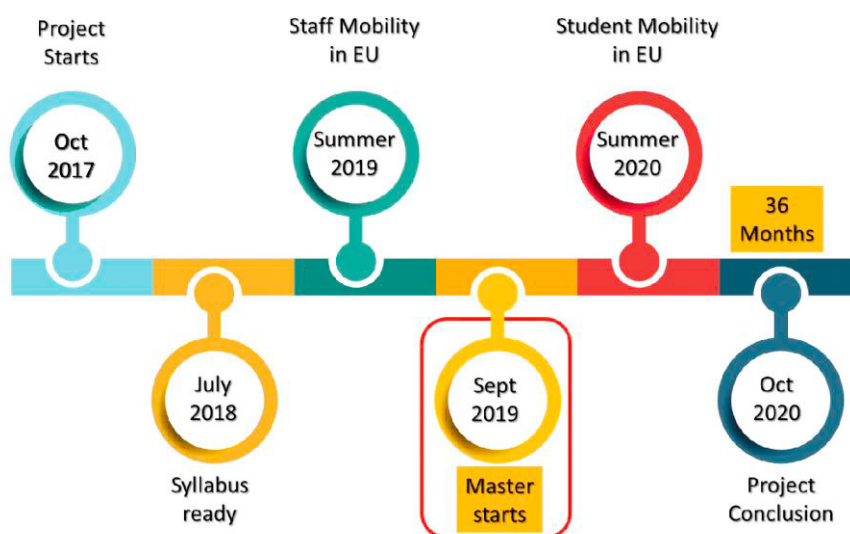


Fig. 1. Timeline of the BBChina Project implementation

The first edition of the Master Program is planned to start in September 2019.

The participation of 15 students per Chinese HEI at the first edition of the Master is the foreseen target. Student mobility in Europe is planned. Students will participate to seminars, lessons, e-learning activities. Each of this will be fit in order to develop problem-solving attitude in Biobased Economy Sector. A large set of case studies will be studied, examined and performed, with the following strengthening of concepts by performing visits and active workshops in field and power plants. Students will start their tour after the exam period. The tour will last two weeks and will be related to activities mentioned above, performed from each European HEI involved.

The complete timeline of the project is presented in Figure 1.

#### 4. Conclusions

Six Higher Education Institutions and a NGO between China and Europe are developing and implementing a 120 ECTS equivalent Master Program on Bio-Based Circular economy in three Chinese Universities.

The proposed program is designed to prepare highly-skilled engineers and managers in the biomass to energy and bioproducts chain, who will be able to coordinate the design and implement solutions to solve challenges with respect to technical, economic, environmental, and ecological constraints. Therefore, this master program will cover the topics, such as energy conversion technologies, including different biochemical routes, system design and optimization from both technical and economical perspectives, project management, legal restrictions and also aspects of climate change, pollution and the integration of renewable energies.

The Program will additionally be fostered through lectures oriented to the development of entrepreneurship skills for sustainable business growth.

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