

# Interdisciplinary Higher Education for a Resilient Circular Economy: the BBChina Project

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## ABSTRACT

The Net-Zero targets to 2050-2060 set by the major economies to face the global environmental challenges need a multi-disciplinary approach. Circular Economy is one of the main pillars to reach these targets, by redefining the growth models, moving towards a sustainable approach, and decoupling economic activities from the consumption of finite resources.

Higher Education Institutions have the responsibility to set-up capacity building paths with the primary role of providing the next generation of university students with the tools to develop and fully implement existing strategies, and to propose new ideas for new disrupting technologies.

The Project BBChina, funded by the European Commission under the ERASMUS+ CBHE program, dealt with this issue by establishing a Master Program on Bio-Based Circular Economy in three Chinese Universities, whose first edition started in September 2019, and presently starting with its third edition. This paper presents the path that led to the Program implementation, its structure and results, including the implementation of soft skills, represented by a specifically developed Entrepreneurship Course.

The topic will be further discussed by invited representatives from both the Academic and the Industrial world during the “Applied Energy Symposium 2021: Low carbon cities and urban energy systems” within the panel titled “Interdisciplinary Higher Education for a Resilient Circular Economy”.

**Keywords:** bioeconomy, circular economy, capacity building, education and training, higher education institution, bioenergy

## NOMENCLATURE

### Abbreviations

CBHE	Capacity Building in Higher Education
CESIE	CESIE
EACEA	Education, Audiovisual and Culture Executive Agency of the European Commission
ECUST	East China University of Science and Technology, China
HEI	Higher Education Institution
MDH	Mälardalen University, Sweden
SCU	Sichuan University, China
STEM	Science, Technology, Engineering and Mathematics
TJU	Tongji University, China
UNIFI	University of Florence, Italy
UROS	University of Rostock, Germany

## 1. INTRODUCTION

The global environmental challenges the world is facing need a multi-disciplinary approach. The Net-Zero targets and pledges to 2050-2060 set by the major economies, presently covering over two-thirds (68%) of the global economy, are ambitious and anything but easy [1]. The urgent need to meet these targets have been confirmed by the last IPCC Report, confirming the fact that global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in carbon dioxide (CO<sub>2</sub>) and other greenhouse gas emissions occur in the coming decades [2].

Young people are aware of being the first generation that could face the strongest effects of the climate crisis and, under the global movement “Fridays for Future”,

ask the politics to leave the old paths and stand united behind the science.

Greta Thunberg said, “*You don’t have to listen to us. But you do have to listen to the united science*” [3].

Apart from acting, rapidly, to start tackling the climate challenge, the “*United Science*” has the primary role of providing the young generations with the tools to give force to their ideas.

However, how to kindle the fire in the minds of those who will take the burning baton of the climate challenges of the next decades, a baton inherited by their parents?

Circular Economy redefines the growth models, moving towards a sustainable approach decoupling economic activities from the consumption of finite resources. Circular economy is one of the main pillars of the solution, and cities are the environment where it can be best applied.

With this aim, since 2017, under the BBChina Project, three European Universities, three Chinese Universities and an European NGO, worked together to set up a Master Program on Bio-Based Circular Economy in China, whose first edition started in September 2019 [4], [5].

The three Chinese Universities where the Program was implemented are Tongji University (TJU), East China University of Science and Technology (ECUST), and Sichuan University (SCU), while the three European Universities involved are University of Florence, Italy (UNIFI) that is the project Coordinator, University of Rostock, Germany (UROS), and Mälardalen University, Sweden (MDH). The European NGO is CESIE, based in Palermo (Italy), and it is specialised in supporting innovation in education.

	Chinese Credits / Hours	ECTS
Public Courses	6/126	<i>Not applicable</i>
Degree Courses	8~9 / 144~162	20
BBChina Obligatory Courses	5~6 / 90~108	10
BBChina Elective Courses	12/216	30

Tab 1 Integration with the Chinese System

## 2. THE BBCHINA MASTER PROGRAM

The objective of the developed program is to educate highly qualified engineers, managers, researchers and high-level operators in the field of biomass to energy and bioproducts, who will be able to

complexly apply the acquired knowledge to form, assess and make effective decisions on biomass-based projects, based on scientific argumentations. The graduate is able to follow the complex biomass to energy and bioproducts chain, to optimise each step of the chain and choose the adequate technology for every different step. The graduate is also able to select the best conversion route for each raw material considered as the starting point and will be able to deal with the technology, market and regulation issues and to operate within the green market.

### 2.1 Defining the syllabus

The development of the Syllabus of the new Master Program was the starting point for the implementation of the action. It was defined on the basis both of the results of an Education and Training Needs Assessment (ETNA) and of the expertise and existing courses already available within the EU and Chinese Higher Education Institutions (HEIs). The Syllabus was discussed together with the International Advisory Board (IAB) of the Project, in order to refine the structure before the final implementation.

Soft skills, in the form of a specifically developed Entrepreneurship Course, were assigned to be held during the second part of the study path.

### 2.2 Integration in the Chinese system

The structure of the Master Program had to be implemented to fully comply with the Chinese University structure, in order to make it possible the inclusion into the Chinese University System: 2.5 years total duration, where the first year is devoted to front lessons, while last one and half year is devoted to projects and thesis.

Regarding the front lessons, 1<sup>st</sup> Year of the Program, the Chinese Structure foresees the following distribution: Public Courses, Degree Courses, Obligatory Courses, and Elective Courses.

Regarding the single parts of the syllabus structure developed for the BBChina Master Program (Tab 1):

- **Public Courses;** courses such as “Foreign language”, “Dialectics of Nature” and “Theory and Practice of Socialism with Chinese Characteristics”. These courses are common all through the Chinese Universities and were not accounted for the total amount of ECTS of the Program, because these are side courses not directly related to the Degree.
- **Degree Courses;** these are the courses that are necessary to get the “Degree in”. These are the basis for the Master Title and may not necessarily be related to the BBChina Topic “Bio-Based Circular

Economy". As a matter of example, at TJU "College of Environmental Science and Engineering", these are the courses necessary to achieve the degree (M.Eng.) in "Environmental Engineering". In terms of credits, their weight is around 8~9 Chinese Credits that corresponds to 144~162 teaching hours. The amount varies all through the different Chinese Institutions. For the BBChina project, their amount has been evaluated as equivalent to 20 ECTS.

- **BBChina Obligatory Courses;** these are the obligatory courses of the BBChina; these courses are in strict correlation with the Title of the Degree and depend from it. As a matter of example, at the College of Environmental Science and Engineering of Tongji University, the Obligatory courses are "Integrated Solid Waste Management" and "Wastewater Treatment: Theory and Technology". These courses account for 10 ECTS, which is equivalent to 5~6 Chinese Credits and around 90~108 teaching hours.
- **BBChina Elective Courses;** these are the elective courses of the BBChina. These courses are, in general, not strictly correlated with the title of the Degree but linked to the topic BBChina Topic "Bio-Based Circular Economy". These courses account for 30 ECTS, estimated as equivalent to ~12 Chinese Credits and around 216 teaching hours.

### 2.3 The courses

Twelve courses related to the Topic "Bio-Based Circular Economy" are those characterising the BBChina Program. They pertain to five main areas:

- **Agriculture, Biology, and Chemistry**
- **Energy Engineering**
- **Waste Management**
- **Environment**
- **Economy and Market**

Some courses spans over two areas, such as the course "Thermal Waste management and WtE technologies" that spans over Energy Engineering and Waste Management. A scheme visualising the developed courses within their areas is presented in Fig 1.

Seven courses were already available in at least one Chinese University and, before sharing, have been updated and upgraded (with a new contribution accounting for up to 70% of newly developed material) to fit the BBChina Master Program. Five courses, that were not available in any of the Involved Chinese Universities, have been developed from scratch. These courses are characterised by the "N" bullet in Fig 1. In

both cases, they resulted from sharing the knowledge between the European and Chinese Universities.

#### 2.3.1 The content of the courses

A short summary of the courses and their content is presented here below:

- **Bioeconomy, Energy Market and Green Market**
  - New course coordinated by MDH. Focussed on bioeconomy/circular economy, provides the basis for Techno-economic analysis, financing, business models, market (also green market), and regulations and policies.

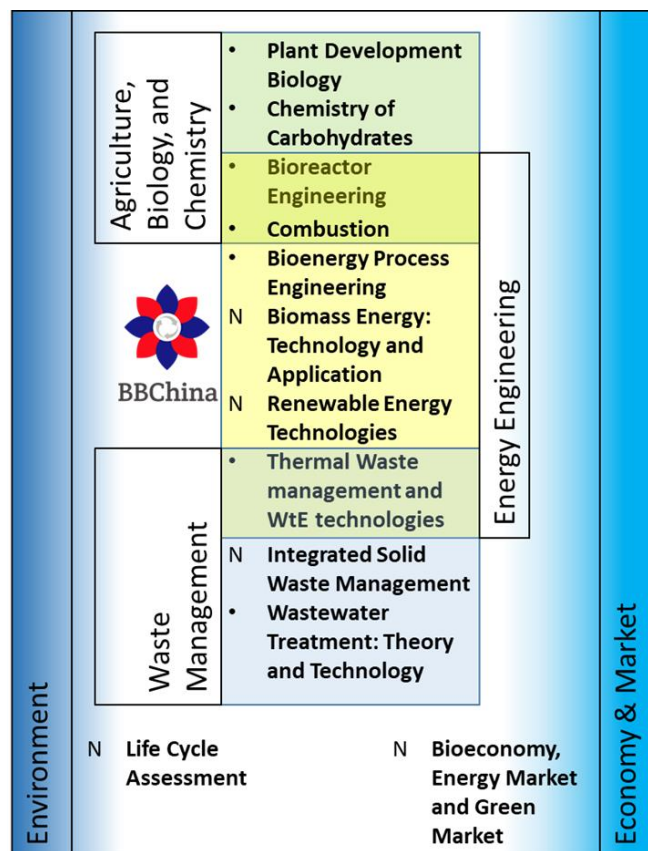


Fig 1 Structure of the Courses

- **Biomass Energy: Technology and Application**
  - New course coordinated by SCU. Focussed on the available routes for biomass to energy conversion, including thermochemical (e.g. pyrolysis), biological, biofuels, and hydrogen.
- **Biomass process engineering for Bioenergy Production (Bioenergy Process Engineering)**
  - Coordinated by ECUST. Deepens into bioenergy processes.
- **Bioreactor Engineering**
  - Coordinated by ECUST. Specifically targeting Bioprocesses for biomass treatment.

- **Chemistry of carbohydrates**
  - Coordinated by SCU. Deeply focussed on the chemistry of sugars, spans from theory to lab application of transformation processes.
- **Combustion**
  - Coordinated by TJU. Concerning combustion theory of solid, liquid, and gaseous fuels, including environmental issues.
- **Integrated Solid Waste Management**
  - New course coordinated by TJU. Waste management from characterisation to LCA, including basics of treatment and thermochemical conversion.
- **Life Cycle Assessment**
  - New course coordinated by SCU. Deepens into LCA and Environmental Impact Assessment, with a focus about Circular Economy.
- **Plant development biology**
  - Coordinated by SCU. Deepens into the biological mechanisms of plant growth, being the basis material of the Biobased economy.
- **Renewable Energy Technologies**
  - New course coordinated by UNIFI. Deep overview into all the “other from biomass” available Renewable Energy technologies.
- **Thermal Waste management and WtE technologies**
  - Coordinated by TJU. Deepens into Thermal Waste-to-Energy technologies and management.
- **Wastewater Treatment: Theory and Technology**
  - Coordinated by TJU. Deepens into wastewater treatment technologies and pollution.

### 3. SOFT SKILLS: ENTREPRENEURSHIP COURSE

An Entrepreneurship Course aimed at empowering entrepreneurship attitude in the master students has been developed by CESIE, based on their experience in the field. The program of the entrepreneurship course was fit to the students' target following a “learning needs assessment survey” focussing on the identification of specific students' knowledge/skill gaps in the field of entrepreneurship and soft skills.

Therefore, at the end of the Educational path, the graduate will also have the necessary entrepreneurship knowledge and skills to start-up their own activities in the field.

#### 3.1 Background

The initial idea to develop a basic entrepreneurship course for Chinese universities was based on two pillars:

1. Entrepreneurship has become an important tool to integrate within the STEM curriculum due to its target on the development of soft and collaborative skills, which spur innovations and employability. These skills make young STEM graduated more business-oriented and active resources, and risks management during the professional pathway.
2. Moreover, entrepreneurship correlates directly with the sustainable development goals. Therefore, it represents social, environmental and economic spheres between business processes, market transformations, and finally societal development.

#### 3.2 Preparatory actions

The course development was based on two main actions: common reflection regarding the soft skills development within study programmes of the Chinese university with the project's coordinators and self-analysis of the students, performed through a survey compiled by the students of the first edition of the Master Program. The results demonstrated that partner universities and consequently students of the STEM professions require upgrade of the study curricula. This modernisation is linked to integration of the specific courses, such as entrepreneurship for beginners, which would enrich students' knowledge with the skills linked to communication, presentation, time and risks management, etc., and professional competences linked to business plan development, business evaluation tools (PEST, SWOT, etc.). Based on this, the course was developed by CESIE, merging material of the best practices created within other EU initiatives.

#### 3.3 Structure and implementation of the course

The course has been developed, under the title “Entrepreneurship Training Course for Beginners”. It consists of eight different modules properly developed in collaboration with the Chinese Universities, in order to match the needs of the BBChina students based on the results from the learning needs assessment survey, and on the experience of CESIE from similar actions at European level.

A “train the trainers” activities involved six properly selected teachers of the Chinese Universities. They have been trained by means of specifically developed training material, and by participating to a series of lessons held online, because of the travel restrictions due to the COVID-19 pandemic, in June-July 2020. Furthermore, CESIE supported the lessons of the first edition of the course, held in spring 2021, by actively participating, as support, to the lessons given by the trained teachers.

Each module is presented here below:

- **Introduction to the concept of Entrepreneurship**
  - Aim: to provide integrated system of theoretical and practical knowledge of entrepreneurship basics, which would allow students to reflect on official European Commission definition of entrepreneurship and to start using entrepreneurial definitions and terminology.
  - Outcomes: the knowledge of the concept of entrepreneurship, applied seeking to evaluate complexly and with systematic approach the factors that determine it. To be familiar with the definition and terminology of entrepreneurship, and to develop critical thinking when analysing concepts.
- **Social Responsibility in Entrepreneurship**
  - Aim: to underline the importance of social responsibility amongst future entrepreneurs and prove how business ethics can strengthen the social cohesion of a society which is jeopardized nowadays, as well as to help learners to seize and shape opportunities to respond to environmental and societal challenges and create values for others by transforming ideas into solutions.
  - Outcomes: capability to identify and seize opportunities to create value by exploring the importance of social, cultural and economic landscape, to develop several ideas and opportunities to create value, including better solutions to existing and new challenges, to explore and experiment with innovative approaches, and to combine knowledge and resources to achieve valuable effects.
- **Entrepreneurial knowledge, skills, competencies and attitudes**
  - Aim: to share theoretical information about what attitude and knowledge is needed to endure the entrepreneurial world, along with the main skills and competences needed to help an individual adopt a more entrepreneurial attitude as well as to familiarize with tools which will help on becoming more entrepreneurial.
  - Outcomes: ability to recognize the key points which will help in advancing an entrepreneurial mind-set, knowledge of the necessary tools which will help in gaining a more entrepreneurial attitude, and familiarity with the main skills and competences needed to become more entrepreneurial.

- **Management skills**
  - Aim: to introduce, identify and the basic managerial skills, which can support the fulfilment of specific management activities or tasks.
  - Outcomes: to be familiar with the general ideas of management skills, and to be able to identify and analyse which are the managerial skills and how these skills can help an individual to fulfil specific managerial activities.
- **Intercultural, linguistic and ICT skills**
  - Aim: to present a variety of aspects by introducing intercultural and linguistic competences which have been identified as contributors and can affect the rise and viability of an enterprise, as well as to provide knowledge about the theoretical background of ICT competences by analysing the digital competences in the dimensions of information, communication content, creation safety, and problem solving.
  - Outcomes: to understand the importance of general linguistic competences, which can set a common basis for cooperation among people, ability to detect the benefits of a sufficient linguistic and cultural knowledge and to recognize the theoretical background of ICT competences, and competences connected to problem solving dimensions.
- **Conceptualizing the project: business concept and canvas**
  - Aim: to realise the significance of a clear entrepreneurial concept, to be acquainted with the 'Business Model Canvas' and 'Lean Innovation Canvas' methodologies, understand their similarities and differences, and to be able to use both Canvas tools.
  - Outcomes: ability to produce an entrepreneurial concept and to choose Business Model canvas or Lean Innovation canvas according to concrete needs and to use it, and knowledge of the importance of the business concept and business model and to know the tools to formalize a business model.
- **Business planning – Tools 4 entrepreneurs**
  - Aim: introduce to the step by step pathway for a business idea description, analyse the tools, which support business idea development, guide during the creation of a business plan.

- Outcomes: the in-depth comprehension of the application of the 'Business Plan' methodology and how its application can benefit the development of an enterprise, and the ability to prepare a business plan.
- **Entrepreneurship in Europe and China**
  - Aim: to share guidelines about academic entrepreneurship in Europe, so students to discover the entrepreneurial opportunities for innovation, job creation and economic growth between Europe and China while at the same time recognising the value of academic entrepreneurship.
  - Outcomes: ability to recognise the current entrepreneurial activity across Europe and China seeking to identify problems of business management and to form alternatives of problems solutions, to choose the ways of solving business management problems to accomplish raised tasks in different regions. Furthermore, recognise the current academic entrepreneurial activity around the globe as well as to discover opportunities, which would expand education and experience level.

At the course conclusion, the students are asked to develop a business plan applied to a case related to the topics of the BBChina, thus regarding Circular Economy, Bio Based solutions, and Renewable Energy issues in general.

#### 4. CONCLUSIONS

A joint effort between Europe and China, supported by the European Commission, led to the implementation of a Capacity Building action targeting the new generation of technics, managers, researchers, and scholars operating in the Bio-based circular economy field. Under the BBChina Project a Master Program on Bio-Based Circular Economy has been developed and implemented in three Chinese Universities. Furthermore, a particular attention has been devoted to capacity building of soft skills by setting-up and implementing an “Entrepreneurship Training Course for Beginners” based on experiences gained at European level further fit to the Chinese scenario.

The topic of how to deal with the Capacity Building in the field of the Bioeconomy/Circular Economy will be further discussed during the “Applied Energy Symposium 2021: Low carbon cities and urban energy systems”. Here a panel titled “Interdisciplinary Higher Education for a Resilient Circular Economy: Capacity Building for

bioproduct conversion, bioenergy, Waste Recovery, Reuse, Recycling and Conversion, low carbon solutions, and urban energy systems” will be the right place to open a discussion. Here, representatives from both the Academic and the Industrial world are invited as panellists to express their experiences, opinions, and points of view, and to propose new ideas and solutions.

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#### REFERENCES

- [1] R. Black et al., “Taking Stock: a global assessment of net zero targets.” London, 2021. [Online]. Available: <https://eciu.net/analysis/reports/2021/taking-stock-assessment-net-zero-targets>.
- [2] IPCC, “Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change,” 2021. [Online]. Available: <https://www.ipcc.ch/report/ar6/wg1/>.
- [3] G. Thunberg, “Greta Thunberg full speech at the National Assembly in Paris, July 23 2019,” Fridays for Future Youtube Channel, 2019. <https://www.youtube.com/watch?v=ESDpzwWrmGg> (accessed Aug. 04, 2021).
- [4] L. Nibbi, D. Chiaramonti, and E. Palchetti, “Project BBChina: A new master program in three Chinese universities on bio-based circular economy; from fields to bioenergy, biofuel and bioproducts,” in *Energy Procedia*, 2019, vol. 158, doi: 10.1016/j.egypro.2019.01.416.
- [5] BBChina, “Master Program on Bio-Based Circular Economy: From Fields to Bioenergy, Biofuel and Bioproducts in China (BBChina),” 2018. [www.bbchina.eu](http://www.bbchina.eu) (accessed Aug. 04, 2021).