

H2020 Work Programme

D1.2 - Best practice cases for Bio-based education Centres

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This document is the BIOBEC project (contract no. 101023381) corresponding to D1.2 (M9) led by University of Hohenheim. This report aims to identify the most relevant best practice cases for existing or evolving bio-based education hubs at different geographical and educational levels to obtain insights about education and infrastructure models, their core principles, characteristics, phases, learning outcomes, impacts and potential success as well as failure factors.

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1. Executive summary

This report is delivered as an output of the BIObec project. We present a compilation and analysis of the most relevant best practice cases across Europe that may serve as models for the six Bio-based Education Centres (BBEC) as targeted by the BIObec project. By shedding light on the stakeholders involved, educational formats, organisational and infrastructural models, as well as potential success and failure factors, we are able to develop guidelines for the design of the envisioned regional BBECs.

For the purpose of this report, we conducted a desk research for examples of what we define more broadly as bio-based education hubs. A bio-based education hub, here, is a regionally delimited construct designed to build and coordinate a community of actors who offer education and training in the bioeconomy and promote knowledge and innovation in the field. Following certain criteria, that we posed as identifying bio-based education hubs, we scanned a multitude of potential cases, thereby producing a list of 26 bio-based education hubs for further analysis. They are presented in table 1.

For a better understanding, we then categorize the identified education hubs along two different scales, namely by their scope and by their format. The scope is defined by the main target of the hub. According to the literature, we can distinguish here student hubs, talent or skilled workforce hubs, and knowledge and innovation hubs (see rows' caption to the left of table 1). The different formats have been defined rather inductively by considering the main types of organisational model that were observed (see columns' caption on top of table 1).

	Cooperative study programmes	Campus	Network/Cluster	Centre
Student hub	Biocirce Bioceb			
Talent hub		Bioeconomy Campus Straubing Science Campus plant-based Bioeconomy Halle Tarvaala Bioeconomy Campus	Association for European Life Science Universities (ICA) Forbioeconomy: Forest Bioeconomy Network	CBIO Aarhus University Centre for Circular Bioeconomy Centre for Bioeconomy (BOKU) European Centre for Biotechnology and Bioeconomy (CEBB)
Knowledge/innovation hub			BioEconomy Cluster (GER) Bioeconomy cluster (SLK) Bioeconomy for Change Biovale: Circular biobased delta Circular bioeconomy Cluster South-west European Bioeconomy Network European Bioeconomy University (EBU) Europe's bioeconomy intercluster Irish Bioeconomy Foundation (IBF) SUBMARINER Network	Bioeconomy knowledge centre BioSC Bioeconomy Science Centre Bio Base Europe Bioeast hubs: Bioest Hub CZ Biorbic ECO 3- Bio and circular business park

After a thorough analysis of the European cases, we conclude that for the design and implementation of a new BBEC the following guidelines should be followed:

1. Apply a long-term perspective

For developing the biobased education hubs or centres with a long-term perspective, models for saving the supply of required resources to run the future BBEC need to be considered from the beginning of the design process.

2. Involve a university

Universities have the experience and governance and administrative structure to manage education programs in the long term. Therefore, it is recommended to involve regional Universities in the design of BBEC.

3. Involve stakeholders early

The design of BBEC should involve all partners from the beginning, ideally already at the stage of developing a joint vision for the development of a BBEC.

4. Develop effective cooperation models and governance structures

For a harmonious and successful cooperation, from the beginning, a governance structure should be developed and formalised in a way that the interests of all involved stakeholders are adequately considered.

5. Create models and facilities for cooperative research

Demonstration or pilot plants and/or maker spaces, that allow for cooperative research of industry and academia partners is a strong incentive for the development of a biobased education hub.

6. Co-creation of suitable education programs and formats

It is recommended that study programs and educational formats offered by BBEC are co-created by involving stakeholders representing the employer and also involve them into education.

7. Seek political support

Strong models of existing biobased education hubs are those, that receive political support and regional/state funding. Therefore, it is recommended to include regional politicians into the design of BBEC from the beginning.

8. Support networking with dedication

The provision of a platform for networking and connecting with other stakeholders or biobased hubs has proven to be a crucial element of a biobased education hub. It is recommended that the design of BBEC develops a manageable model for a networking and exchange platform.

9. Keep stakeholders interested

The management of networks or clusters works well applying rather flat governance, employing an executive committee or general assembly and a management board. More important than the governance structure is the successful relationships management as the networks and clusters depend on the member's commitment. It is recommended to take this into consideration when designing BBEC.

10. Welcome diversity

It is recommended to involve a diverse group of stakeholders into the development of BBEC as this strengthens the hub from different perspectives and supports the development of results that are meaningful for practice and are usable or transferable outcomes.

2. Introduction

To unlock the full potential of the bioeconomy to contribute to the resolution of several grand global challenges such as climate change, resource depletion, malnutrition and our dependency on fossil energy, a systemic perspective and collaborative efforts are imperative. Accordingly, this holistic and concerted approach must be taken when defining the new skills and educational approaches required to build up a professional work force for the bioeconomy. This also affects the development and design of organisational solutions to provide education and training services that explicitly address skills and competences gaps. The aim of the BIObec project is to develop a holistic framework for multi-level Bio-Based Education Centers (BBEC) flexible enough to address the present and future needs of the industry and of the surrounding ecosystem at local, regional, national and/or international levels.

This report aims at exploring the conditions that are favourable for developing BBEC. Presumably, successful BBEC will operate like a knowledge or education hub that create dynamic ecosystems of interacting companies, education institutions, governmental organisations, and the civil society. To better understand how exactly such hubs can facilitate increased cooperation between the bio-based industry and the education system, we will specify success criteria for BBEC.

For this purpose, we select the most relevant best practice cases of existing or evolving bio-based education coalitions or hubs across Europe at different geographical and educational levels. The analysis of these cases provides insights about **education and infrastructure models**, their core principles, characteristics, phases, learning outcomes, impacts and potential **success as well as failure factors**.

These insights are then used to derive guidelines for the design of BBEC in the frame of this project.

3. Education Hubs

The term education hub denotes a dynamic connection between different actors that aims to generate and apply knowledge in a specific field. Knight (2014) defines it as a “planned effort to build a critical mass of local and international actors strategically engaged in cross border education, training, knowledge production and innovation initiatives”. This indicates that an education hub:

- is the product of intentional, strategic and deliberate activities based on strategies, policy frameworks and investments,
- includes a group of key actors and activities,
- could include local, regional, national and international stakeholders including providers, producers and users of the education offers (students, scholars, institutions, companies, organizations, research centres, knowledge industries),
- involves stakeholders or actors whose interaction or collaboration is planned and brings them an added value,
- facilitates a broad spectrum of activities,
- focuses its efforts on the connection between engaged stakeholders.

Each hub is different depending on the scope or topic focus, type of stakeholders involved and relationships among them, geographical level, impact, and priorities of the individual actors and also responds to the needs, drivers, approaches, expectations and in general, the respective context. According to Knight (2014), the key aspects to be considered when characterizing an educational hub are level, engagement and impact:

- Level: refers to the location where the hub, meaning the actors, is positioned.
- Engagement: refers to the actors and type of actors involved in the hub.
- Impact: refers to the focus topic of the hub as well as to the level of influence of the hub activities, where the benefits are evident.

An education hub could be developed and created for different reasons. The rationale behind an education hub could be economic, for example to boost the education industry or attract investment. It also can be motivated through for education and training requirements, for instance to align education with industry needs, improve access to education and/or improve the quality of education. Further reasoning is the knowledge generation and innovation to develop research or reinforce the innovation capacity and the development of human resources to train future labour force and retain talent. Lastly, another motivation could be to gain status and influence to promote the city, region, or country, increment attractiveness and/or establish networks for educational activities.

Knight (2014) proposed three models of education hubs:

3.1. Student hub:

The student hub is the most common type of education hub as it involves the traditional programs of higher education and the activities related to it: teaching and learning, especially through undergraduate programmes (Knight, 2014). It includes the recruitment and education offers of students and mobility programs, for example in the form of fieldwork, internships or exchange

programs, and the main stakeholders involved are High Education Institutions (HEI). It could include Massive Open Online Courses (MOOCs) or virtual education.

The student hubs aim at widening access for higher education students, modernizing and internationalizing HEIs, raising the profile of the education system and generating revenue from the influx of students as described by Knight (2014).

The development of these student hubs is mainly designed and created by the higher education sector (Knight, 2014) while governments directly or indirectly support the formation of the hubs through scholarships, regulations, programs and calls for projects.

3.2. Talent or skilled workforce hub:

A talent hub focuses on teaching and training with the overall goal of developing skilled workforce. It extends to different types of learning and professional development opportunities that are directed not only to students but also to professionals who seek to update their knowledge, gain new skills, continue education, and includes lifelong learning. The objectives of a talent hub are to increase the number of skilled workers, contribute to a service and/or knowledge economy, foster economic competitiveness, and improve the quality and relevance of the labour force.

The idea behind a talent hub is to respond quickly to the emerging and ever-growing societal needs. Therefore, the education practices used intend to approximate the efforts to tackle real-world problems.

According to Knight (2014) the main stakeholders leading the development of a talent hub are HEIs, local and international institutions, training companies, business councils, immigration offices; these could involve regulatory and licensing bodies and credential assessment agencies.

3.3. Knowledge/ innovation hub:

A knowledge/innovation hub focuses on the production and application of new knowledge which has the potential for commercial use. The knowledge hub integrates research from different sources: higher education institutions and also from public and private partnerships and the corporate sector. More specifically, a knowledge hub seeks to boost the research culture, capacity, and output for a country, zone, or city to become or to remain a prominent player in the global knowledge economy. In drawing on foreign expertise and financial resources, a knowledge hub recognizes that foreign involvement and investment are essential to its success. Some knowledge/innovation hubs have a notable emphasis on research in the areas of science, technology, engineering, and medicine (STEM).

A knowledge hub could follow different strategies:

- increase public funding for research and use publication records or patent applications to gauge success,
- direct investment to fund costly research and leverage intellectual property for commercial purposes,
- the construction of science and technology parks,
- expand graduate programs to increase the number of individuals with research training,

- formalize partnerships with research centres abroad to access expertise not locally available,
- multilateral linkages between higher education institutions and industry,
- regulations over intellectual property rights and the processing of patents.

The stakeholders leading the development of a knowledge/innovation hub are science and technology institutes, trade and industry companies, economic development organizations, and educational institutions. The synergy from these stakeholders and sectors working together positions the hub as a participatory knowledge-based hub rather than one based on specific topics such as manufacturing or natural resources. The potentially involved actors are local, regional, national and international HEIs and R&D centres, research grant agencies, local/foreign providers, research and development firms, patent offices, business councils and trade boards. The latter two are essential to support the commercial aims of a knowledge hub.

4. Types of biobased education hubs

As a first step to the identification and elaboration of best practices to be recommended to the design of future Biobased Education Centres (BBEC) a search for evolving or already existing biobased education hubs, that adhere to the above described criteria described for education hubs, was performed. This build on the findings of previous projects, including UrbBIOfuture, BioCannDO, Bioways, bloom, InnProBio, ABBEE, Biovoices, BLOOM, BE RURAL, literature search, website searches and reports of the BIObec consortia members.

A biobased education hub included for further analysis here is a regionally delimited construct designed to build and coordinate a community of actors who offer education and training in the bioeconomy and promote knowledge and innovation in the field. The biobased education hubs then:

1. integrate various stakeholders,
2. promote cooperation between those stakeholders,
3. include bioeconomy or biobased economy as an essential part of their mission,
4. have a leading role in the bioeconomy at regional, national or international level,
5. develop education, training, research and innovation strategies, actions and activities for any educational level,
6. are established or emerging hubs with a long-lasting vision and strategy.

The biobased education hubs show different educational formats and organisational models that have been developed to respond to the ever-growing number of stakeholders needs, demands and expectations within the bioeconomy and to take action on a wide variety of societal concerns. These hubs are more than a simply aggregation of stakeholders (Lupova-Henry, Blili & Dal Zotto, 2021), they could be seen as intermediaries between key actors, target groups and support groups. Being the key actors those who have a dominant position in the organisational model of the hub e.g. taking decisions that influence the hub activities, target groups those who benefit directly from the hub activities and support groups those related organisations that contribute additional resources to their cluster initiatives such as knowledge, financing and organisation-building capacity (Laur, Klofsten & Bienkowska, 2012).

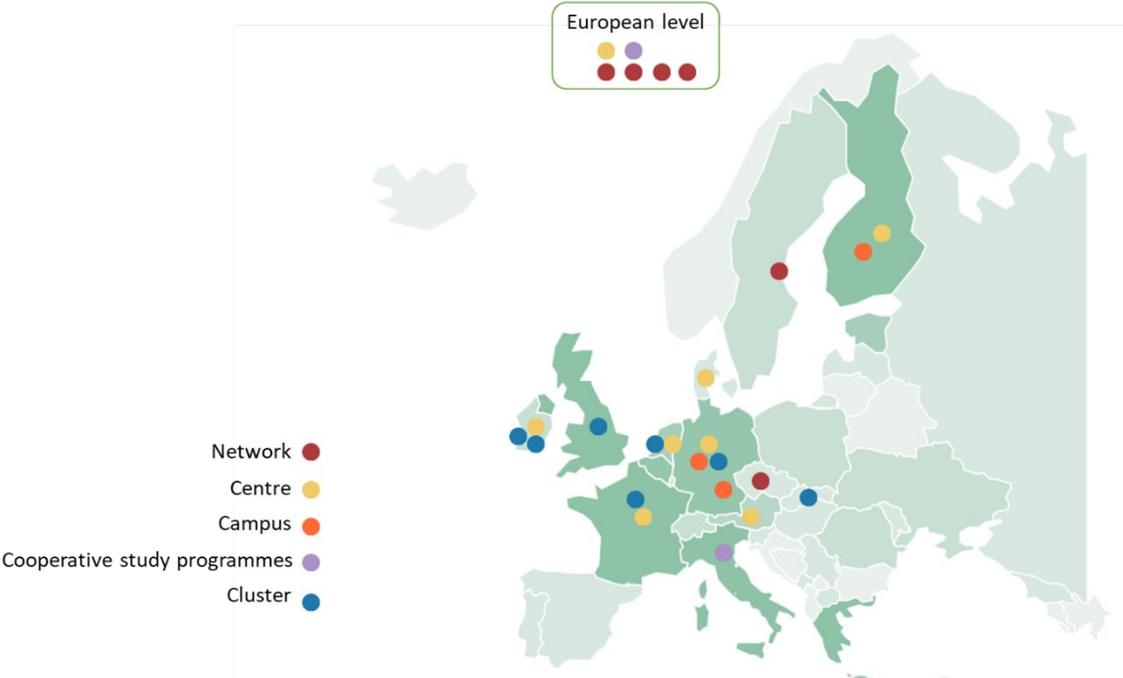
A final collection of 26 biobased European education hubs, that fit to the description, was selected for further analysis (Annex 1). Most of the selected biobased education hubs represent a joint effort between different types of actors where knowledge centres, meaning universities, research centres or training organisations, play an important role. The variety of training and education offers for different educational levels are an important characteristic of the hubs including formal, non-formal, or informal education.

Some of these selected 26 initiatives have concentrated on local needs and some have integrated European stakeholders creating cooperative programmes, centres, clusters or networks. These constitute consolidated or emerging biobased education hubs. From these, four types of hubs were identified:

4.1. Cooperative study programs

These are study programmes designed and delivered by an international partnership of higher education institutions. Cooperative study programmes may involve non-educational partners as well. Concerning the curriculum, this has to be jointly developed, including the definition of the professional profile to be created, the competences required for that particular professional profile, the definition of learning outcomes of the whole programme, the workload to be attributed to the single teaching units and modules for the achievement of the identified learning outcomes (Joiman, 2010).

Figure 1. European map with biobased education hubs



4.2. Campus

A campus is a thematically attuned physical area with an academic institution at its core. Study programmes, research facilities, and business activities are focused on a specific topic and attract

non-academic organisations working on the same topic to enhance knowledge exchange and increase innovative capacity.

4.3. Cluster or network

The term cluster refers to a geographically delimited concentration of interconnected companies and institutions in a particular field. Member organisations declare their will to collaborate within a cluster to improve competitiveness of the entire region (Porter, 1998). It usually integrates various types of actors including companies, research and educational institutions, government agencies and others. Thus, clusters are in a position to produce and exchange knowledge, bridge institutions and customers and create value (Sujová & Hajdúchová, 2015).

Generally, clusters are coordinated by a cluster manager or secretariat and receive financial incentives from the national and regional authorities (Lupova-Henry, Blili & Dal Zotto, 2021).

4.4. Centre

A centre is an interdisciplinary unit, usually a physical space, where different types of organisations work together and coordinate joint activities around a specific topic. The most common types of centres are technology, research and innovation centres. They capture and generate knowledge in a certain field of expertise. Ideally, they distribute and utilize this new knowledge in the form of new capacity in their field as research results, innovations, or talent (Hellström, 2017).

The following table provides an overview of the collected cases by classifying them according to the different types of education and biobased hubs as presented above:

Table 1: European biobased education hubs by hub type (for description see Annex 1)

	Cooperative study programmes	Campus	Network/Cluster	Centre
Student hub	Biocirce Bioceb			
Talent hub		Bioeconomy Campus Straubing Science Campus plant-based Bioeconomy Halle Tarvaala Bioeconomy Campus	Association for European Life Science Universities (ICA) Forbioeconomy: Forest Bioeconomy Network	CBIO Aarhus University Centre for Circular Bioeconomy Centre for Bioeconomy (BOKU) European Centre for Biotechnology and Bioeconomy (CEBB)
Knowledge/innovation hub			BioEconomy Cluster (GER) Bioeconomy cluster (SLK) Bioeconomy for Change Biovale: Circular biobased delta Circular bioeconomy Cluster South-west European Bioeconomy Network European Bioeconomy University (EBU) Europes's bioeconomy intercluster Irish Bioeconomy Foundation (IBF) SUBMARINER Network	Bioeconomy knowledge centre BioSC Bioeconomy Science Centre Bio Base Europe Bioeast hubs: Bioest Hub CZ Biorbic ECO 3- Bio and circular business park

5. Analysis of biobased education hubs

This chapter includes the description of the identified biobased education hubs along the different hub types elaborated. This description serves as basis for the analysis of best practice and the extraction of success factors and therefore mainly focuses on how the hubs are organised and the kind of educational formats they apply to provide skills relevant to the transformation to a biobased economy. Most of the identified bioeconomy education hubs are organised as clusters or networks (13), of which four have a European dimension (European Bioeconomy University (EBU), ICA, European Bioeconomy Network, Europes's bioeconomy intercluster). All eight centres identified are national, some of them with European level cooperation. There are three dedicated campuses identified, of which one is in Finland and two are in Germany, and two cooperative study programs, one in Italy and one in France (Table 1). For a detailed description of all 26 biobased education hubs see Annex 2. In the following chapters we compile the information extracted from this analysis per educational hub type.

5.1. Cooperative study programs

There are two cooperative study programmes, Biocirce and Bioceb, both of them being student hubs, focusing on the education of university students.

Types of stakeholders involved

Both cooperative study programmes encompass a collaboration of different universities, that are providing their specific expertise in the area of biobased economy to the hub. The Bioceb programme has a focus on the cooperation of universities from different regions in Europe, including France (lead), Finland and Estonia. The Biocirce programme is a cooperation between two Italian universities and an industry partner as well as companies and technological clusters.

Educational formats offered for skills in the biobased economy

Both cases are master study programmes that provide certain didactic elements and approaches that specifically support the conveyance of skills required in the biobased economy:

a) Educational formats offered in cooperation with industry partner

There are different formats applied for cooperation in education between the universities and the industry. These include for both cooperative study programmes the invitation of guest lectures from the industry, industry site visits as part of the curriculum, and a mandatory research internship (e.g., MSc thesis performed in cooperation with industry).

In the Bioceb programme there are joint graduation events, including opportunities to meet employers, to disseminate the results of thesis and projects through poster sessions and oral presentations, and to connect with Bioceb students from different cohorts.

b) Integration of mobility and obligatory stays at different locations

These educational formats include the study experience in different locations. In the Bioceb master, the students study at different European countries universities, enabled through the cooperation of Universities, while in the Biocirce program, the students move to take courses where the Italian universities are located.

c) Project work and integration of horizontal skills training

Horizontal skills are trained through education in project management, interculturality, adaptability, team work and leadership. In both programs described here, this is offered through working on concrete case studies or projects within or inspired by the business partners.

d) Practical education elements in both programmes include the provision of access to experimental facilities and (biorefinery) site visits.

Organisational and infrastructural models

Both cooperative study programmes are managed by one lead university, who offers the programme as integral part of their overall study portfolio.

The Bioceb programme originates from an Erasmus Mundus Programme funded by the European Commission. Fees must be paid by students for both programmes.

The Biocirce has established a scientific advisory board formed by members from the technological clusters, the University of Milano and associated partners that support the development of the program structure. The cooperation with other partners associated to the program is regulated by a Memorandum of Understanding.

Success and failure factors reported

The success of cooperative study programmes depends on the commitment of the leading university. This host institution should fully integrate the programme into its educational structure.

The development and introduction of a cooperative study programme is certainly strongly supported by external funding. It is, however, essential that resources are secured for running the programme on a longer term.

The involvement of an industry partner into a study programme will only be successful if this partner considers his or her engagement sufficiently beneficial for the company. Therefore, the design of cooperative study programmes should involve all partners from the beginning and the governance structure of the study programme should be formalised in a way that all interests are considered.

5.2. Campus hubs

All three campus initiatives identified (Bioeconomy Campus Straubing, Science Campus plant-based Bioeconomy Halle, Tarvaala Bioeconomy Campus) can be characterized as talent hubs because they focus on teaching and training with the overall goal of developing a skilled workforce. This educational offer is directed to students enrolled at the respective Universities at both bachelor as well as master level, but also provides educational opportunities for professionals.

Types of stakeholders involved

The nucleus and driving force of all three campuses is a university. However, the structures differ strongly.

The Bioeconomy Campus Straubing was developed from scratch following a decision of the German state of Bavaria, as a satellite campus of the Technische Universität München (TUM). It was established in the vicinity of a state funded research centre for biobased resources and bioenergy, the Nawareum, which has existed there since 2011 and was integrated into the campus dedicated to the bioeconomy.

The Science Campus plant-based Bioeconomy Halle developed around the traditional agricultural University of Halle, which initiated cooperation with state and federal funded research institutions in a specific area, the plant-based bioeconomy.

The Tarvaala Bioeconomy Campus is a University campus which has been equipped with facilities where entrepreneurs, investors, researchers, developers, and students. It is based on a business park which encourages the set-up of demonstration facilities on the campus. The facilities can be utilized by the educational institutions and other companies in the region.

Educational formats offered for skills in the biobased economy

All three campus hubs offer the full suite of bachelor- and master study programmes related to the bioeconomy - in the case of the Science Campus Halle, these are mainly focused on the plant-based bioeconomy.

An important element of education for future professionals in the biobased industry is the integration of research platforms, infrastructures or pilot plants, which are also used as education facilities.

Organisational and infrastructural models

The universities manage the campus hubs through their regular governance and administration system. Resources for additional facilities, e.g. demonstration and R&D facilities, are provided by state or federal funds. Additional financial resources are acquired through EU projects.

The cooperation models differ depending on the specific regional conditions. The cooperation between the Bioeconomy Campus Straubing and the **Nawareum** is based on the spatial vicinity as well on the fact that both are funded by the Bavarian State. The cooperation between the University of Halle and the public research institutions is facilitated by so-called “joint” professorships - a model that provides scientists who are employed and work at the state research institute an academic chair at the university.

Success and failure factors reported

Universities strongly depend on public money and therefore on the support of the respective ministry or state policies in their thematic focus. Even in times of internet and distance learning the spatial vicinity of thematically close organisations obviously creates a positive effect on the quality of collaboration and the visibility of the topic.

5.3. Cluster and Network hubs

Two of the cluster and network initiatives, ICA - Association for European Life Science Universities and Forbioeconomy: Forest Bioeconomy Network, are talent hubs focussing on teaching and training with the overall goal of developing skilled workforce. Their educational offer is directed to students enrolled at the respective universities at both bachelor as well as master and PhD level, but also includes offers for professionals.

Another eight cluster or network initiatives are characterized here as knowledge and/or innovation hub as they focus on innovation and scale-up. Therefore, they cooperate in research (e.g. EBU, SUBMARINER Network, Irish Bioeconomy Foundation (IBF)/ Bioeconomy campus), have PhD graduate or Postdoc networks (Forbioeconomy: Forest Bioeconomy Network, EBU), offer and/or share research infrastructure (EBU, BioEconomy Cluster (Germany), circular bioeconomy Cluster South-west) or focus on educational offers to companies and start-ups (Biovale, Circular biobased delta, Irish Bioeconomy Foundation (IBF)/ Bioeconomy campus).

Types of stakeholders involved

Most of the clusters and networks involve a variety of stakeholders. Educative and/or research institutes are part of all the biobased networks and hubs. Only one of these hubs (Biovale) involves

community groups and non-profit organisations as part of their stakeholders including bioeconomy-related research and innovation centres, while seven networks and clusters involve governmental actors (Bioeconomy for Change (former IAR), BIOEAST Hub, Biovale, Circular biobased delta, Circular bioeconomy Cluster South-west, SUBMARINER Network, Irish Bioeconomy Foundation (IBF)/ Bioeconomy campus).

It is important to highlight that the core of each of these types of biobased hubs is usually formed by industry members as they intend to innovate and scale up research to a practical level. All the clusters have more members from the industry than other type of stakeholders.

Educational formats offered for skills in the biobased economy

Cluster and network hubs mainly offer educational formats that deviate from the traditional formal education, but rather focus on vocational and on-the-job training level. Only two of the networks make an exception, the European Bioeconomy University and the Circular biobased delta.

Generally, these hubs offer educational tools and didactic material on specific bioeconomy topics such as bioenergy, innovations in agriculture, food waste, processing technologies and biotechnology, among others. Additionally, many of them offer training for the conveyance of soft-skills and other cross-cutting skills including creative thinking, networking, human resources management, finance, business creation or resource efficiency. These topics are conveyed through workshops, clubs, masterclass, courses, MOOCs, individual mentoring, biocamps, and peer-to-peer learning.

As part of their information or dissemination activities, these clusters and networks publish research results, tools and resources. These materials are addressed to the internal stakeholders or to external stakeholders such as the general public through open libraries or catalogues. For dissemination, some hubs organize conferences or seminars and are actively participating in bioeconomy-relevant events at national and European level.

This type of hubs serves as platform for networking and connection through dissemination activities as well as other initiatives such as match making events or workshops aiming to attract investors or find cooperation with different types of stakeholders. As many of these hubs focus on the connection of research outcomes with the industry, they tend to offer or are intermediaries to access to infrastructure, facilities or laboratories, pilot plants, demonstration plants that support prototyping and upscaling.

Many of the hubs support entrepreneurship through:

- Events as workshops, courses, events
- Access to specialized intelligence tools
- Personalised support
- Relevant Information e.g. resources, publications, tools, funding opportunities
- Accelerator programmes e.g. Biocamps offered by Biovale

Interestingly, only few hubs advertise open innovation platforms such as the BioEconomy Cluster (Germany).

Organisational and infrastructural models

It is common that the clusters use membership fees as part of their funding strategies. Some of them rely on regional or national budget. Usually, the amount of the fee depends on the type of member.

Cluster or network hubs are not necessarily located in a physical space as the members already have an affiliation and use that facility to work for the hub. However, some of the clusters or networks offer physical facilities and infrastructure, which is either provided by an extra space by one of the participating stakeholders that hosts it.

Most of these hubs are governed in a flat hierarchy with an executive committee or general assembly. The governance structure usually involves a general assembly by the members of the different founding partners and a decisive board, staffed by a team that reflects the diversity of the members. Most of these kinds of hubs are open for new membership, meaning any external stakeholder is allowed to join under certain conditions such as paying fees, sending a letter of intent, or else.

Success and failure factors reported

The management of the relations is really important as the networks and clusters depend on the members' commitment. For this same reason, it is expected to be beneficial to keep the formal and non-formal educational offers updated, to specifically select them and even personalise them to maintain the interest of the members, especially for the clusters.

The inclusion of a diverse group of stakeholders strengthens the hub in various ways: research and innovation results are meaningful for practical use and outcomes are transferable; it increases the capacity of the hub as each stakeholder can potentially offer different "assets" to the hub in terms of skills, legitimization, individual network, infrastructure and capacity for example for joint projects.

5.4. Centres

Three of the centres identified can be categorized as talent hubs: The Aarhus University Centre for Circular Bioeconomy (CBIO), the Centre for Bioeconomy at the University of Natural Resources and Life Sciences (BOKU), and the European Centre for Biotechnology and Bioeconomy (CEBB). These centres offer educational services to their affiliated researchers. Five centres rather fulfil the tasks of knowledge and/or innovation hubs as they additionally provide research facilities or combine science and innovation by operating industry-research parks. These are: The Bioeconomy knowledge centre Biorbic, the BioSC Bioeconomy Science Centre, the Centre of Expertise Biobased Economy (CoE BBE) ECO 3-Bio and circular business park, the European Centre for Biotechnology and Bioeconomy (CEBB).

Types of stakeholders involved

All biobased education centres identified here are research-centred hubs with the main stakeholders being universities and research institutes. Two of the hubs additionally include companies as stakeholder (ECO 3-Bio and circular business park and Biorbic). The aim of ECO 3 is to develop bioeconomy and circular economy businesses and innovations on an industrial scale with a strong support from research. The centre Biorbic, instead, aims to create new products, processes and markets from renewable biological resources and associated waste streams. All eight centre-like hubs

cover a broad range of topics within the bioeconomy with the exception of CEBB that focuses on biotechnology.

Educational formats offered for imparting skills in the biobased economy

The main focus of the centres is put on research. That is why these kind of hubs provide strong infrastructural and transfer support through the set-up of research facilities, demonstration and pilot plants, support in project consortia building and information services.

Five out of eight centres offer pilot or demonstration plants for innovative biobased processes (ECO 3-Bio and circular business park, Centre of Expertise Biobased Economy (CoE BBE), CBIO Aarhus University Centre for Circular Bioeconomy, BioSC Bioeconomy Science Centre, and European Centre for Biotechnology and Bioeconomy (CEBB)). These include biorefinery plants for investigating the engineering bases for the use of renewable resources or an application laboratory for biopolymers for the development of prototypes and pilot series.

Some of the centres offer information services, e.g. by offering support in finding an expert on a certain bioeconomy related topic, in the case of CBIO. Furthermore, they pursue knowledge and skills transfer activities through courses, MOOCs, tools, training, workshops and innovation support.

A particularly interesting case is Blorbic, which has developed activities for knowledge transfer towards the general public with activities such as the bioeconomy day.

Organisational and infrastructural models

The coordination of networking activities is a key task of all the centres identified. Activities are tailored to stimulating the cooperation among the affiliated members internally as well as to facilitating collaboration with external stakeholders. Building, strengthening and tightening research and knowledge networks therefore determines the ways the centres are organised and governed. At the same time, funding models vary strongly. As a centre requires a physical location or office, an important financial lot is usually needed especially for this position. They obtain financing from regional development funds, national or European funds. Another important source of funding is often acquired by successful third-party proposals for joint projects. This especially holds for those centres that are not affiliated to a previously established institution.

Success as well as failure factors reported

For an education centre that is established within a previously existing institution, a very clear mandate and a broad agreement on a shared vision is essential. The affiliated researchers need to understand the added value of the centre in order to use its full potential.

Although most of the centres connect internal actors of a university or similar actors between universities and research centres, additional connections to other types of stakeholders is mandatory for safeguarding a profound knowledge transfer process. Especially in the case of a dynamic and applied field like the bioeconomy, the risk of losing touch with the outside world must be minimised.

As the focus of the centres is usually research and innovation, there is no evidence of connection with students – a fact that may potentially lead to recruitment problems.

Finally, financial support and staff for the set-up and maintenance of the centre is a critical success factor, without which the centre cannot survive.

6. Guidelines

For anyone assigned with the task of designing and running a new bio-based education hub, such as one of the regional BBECs in the frame of the BIObec project, it is essential to learn from previous experiences. The following guidelines have been derived from the analysis of the cases presented above and shall provide support and practical advice for such task.

1. Apply a long-term perspective

Several biobased education hubs are supported by project money. This can be helpful especially for the design of new or adapted educational formats and also for starting an educational program that is based on the cooperation of several universities and between academia and industry. However, for developing the biobased education hubs or centres with a long-term perspective, models for saving the supply of required resources to run the future BBEC need to be considered from the beginning of the design process.

2. Involve a university

Most biobased education hubs are evolving from or are at least involving the support of Universities, who are not only the experts in developing and performing education programs, but are also equipped with the governance and administrative structure to manage education programs on the long-term. Therefore, it is recommended to involve regional Universities into the design of BBEC.

3. Involve stakeholders early

The involvement of industry partner into study program or BBECs will only be successful if the industry partner sees enough benefit for them to take the effort. Therefore, the design of BBEC should involve all partners from the beginning, ideally already at the stage of developing a joint vision for the development of a BBEC.

4. Develop effective cooperation models and governance structures

The motivation of companies to get involve get into and support BBEC includes access to young experts, specifically educated for their skills demand, but also the access to R&D facilities and results that enables the development of new products and business areas. For a harmonious and successful cooperation, from the beginning a governance structure should be developed and formalised in a way that the interests of all involved stakeholders are adequately considered (e.g. through MoU or cooperation agreements).

5. Create models and facilities for cooperative research

The availability of demonstration or pilot plants and/or maker spaces, that allow for cooperative research of industry and academia partner is a strong incentive for the development of a biobased education hub. Also, models and support provided for cooperative research, especially the opportunity for performing student's thesis research in cooperative supervision of University and industry partner, enhances the cooperation of different stakeholder in education. Therefore, it is recommended to involve such facilities and (student) research cooperation models into the design of BBEC.

6. Co-creation of suitable education programs and formats

Biobased education hubs apply different educational formats that go beyond the classical lecture format, including practical elements that are often performed in cooperation with industry, and also horizontal skills training. It is recommended that study programs and educational formats offered by BBEC are co-created by involving stakeholder representing employer and to also involve them into education, for example through guest lectures, in supervision of project work or co-supervision of student thesis.

7. Seek political support

All existing biobased education hubs are directly or at least indirectly supported and funded by public money. Strong models are especially those, that receive political support and regional/state funding. Therefore, it is recommended to include regional politicians into the design of BBEC from the beginning.

8. Support networking with dedication

The provision of a platform for networking and connecting with other stakeholder or biobased hubs has proven to be a crucial element of a biobased education hub. However, most of the existing biobased hubs are only informally organized on this matter. It is recommended that the design of BBEC develops a manageable model for a networking and exchange platform. This can be virtually supported, but requires a personal manager and person dedicated to networking activities.

9. Keep stakeholders interested

The management of networks or clusters works well applying a rather flat governance, employing an executive committee or general assembly and a management board. More important than the governance structure is the successful relationships management as the networks and clusters depend on the member's commitment. It is recommended to take this into consideration when designing BBEC. Communication and dissemination activities should be a key strategical activity for the hub. This allows to attract more stakeholders and also have a higher impact and visibility. The communication and dissemination should be clearly directed to the intended group of stakeholders and therefore this intentional activity should be well planned and be an essential part of the organisational model of the hub. Offers that can ensure the members' commitment include for example the provision of updated, specific selected and even personalised information to maintain the interest from the members, especially for the clusters.

10. Welcome diversity

It is recommended to involve a diverse group of stakeholders into the development of BBEC as this strengthens the hub from different perspectives: results are meaningful for practice and are mainly usable or transferable outcomes; increases the capacity of the hub as each stakeholder could potentially offer different “assets” to the hub in terms of skills, legitimization, individual network, infrastructure and capacity for example for joint projects.



Annex 1. Description of identified and analysed biobased education hubs in alphabetical order

Name	Description	Link	Year of establishment	Regional level	Type
Association for European Life Science Universities and ICA Community of Practice for Bioeconomy Education in Europe (ICA CoP Bio-Edu)	<p>ICA, Association for European Life Science Universities, is a network of more than 50 universities from the EU and neighbouring countries (European Higher Education Area, EHEA). The life science universities relate to the circular bioeconomy (agriculture, forestry, food value chain & biobased economy), the sustainable use of natural resources, biodiversity, the protection of the environment and rural development.</p> <p>The CoP Bio-Edu is an ICA board committee that aims to enhance the quality, offer and diversity of education for the sustainable circular Bioeconomy in Europe, by bringing together educational actors to engage with each other to share experiences and good practices among educational actors, consult with industry and stakeholders about skills demands and educational outcomes, and develop educational projects to develop and evaluate new educational materials, strategies and innovative training concepts</p>	https://www.ica-europe.info/ica-board-committees/ica-community-of-practice-for-bioeconomy-education-in-europe	2019	Europe	Network
Bioceb	<p>Bioceb- European Master in Biological and Chemical Engineering for a Sustainable Bioeconomy is a 2-year joint master programme training future research and innovation managers to tackle the challenges related to the deployment of the bioeconomy across the world. Bioceb offer to the students a study experience in at least 2 European countries and allows the integration of students with</p>	http://www.bioceb.eu/	2019	Europe	Cooperative study programme

	different backgrounds and regions through a modular set of courses that permit to choose between 5 different tracks.				
Biocire	It is an interdisciplinary program jointly offered by 4 Universities (University of Bologna, University of Milano-Bicocca, University of Naples Federico II, and University of Turin), by 4 non-academic partners (Intesa Sanpaolo, Novamont SpA, GFBiochemicals SpA, and PTP Science Park di Lodi), and 2 Italian Technological Cluster (Cluster SPRING and Cluster CLAN agrifood) this MS degree program provides skills and expertise necessary to deal with the full range of issues in this complex field.	https://masterbiocirce.com/	2016	Italy	Cooperative study programme
Bioeast hubs: Bioest Hub CZ	First Bioeast Hub established to gather stakeholders and support their engagement in bioeconomy. The goals of this hub are: - to support the engagement of national stakeholders in bioeconomy and to enhance and promote long-term sustainable growth in Central and Eastern Europe - to facilitate the dialog with policy members and to provide a concept paper for the national bioeconomy strategy and support the Czech presidency of the EU in the second half of 2022 - to support applied research, technology transfer and join projects of SMEs and research organizations in the bioeconomy field - transfer good practice of bioeconomy innovations to the BIOEAST region	http://www.bio-hub.cz/	2020	Czech Republic	Network

BioEconomy Cluster	The BioEconomy Cluster is a network of companies, research institutes and educational institutions that work closely together on the fundamentals of a bio-based economy. It focuses on the integrated material and energetic use of non-food biomass to generate materials, chemicals, innovative products and sources of energy. A unique feature of the cluster is the cross-sector formation of value chains (e.g. timber and forestry industry, chemical and plastics industry, plant manufacturing and energy sector) and the integration of an established chemical region. This Cluster together with Fraunhofer Center for Chemical-Biological Processes CBP intend to establish a BioEconomy HUB.	https://www.bioeconomy.de/en/	2012	Germany	Cluster
Bioeconomy cluster	Bioeconomy Cluster is an association of legal entities with the aim to promote cooperation, networking, innovation and mutual exchange of information between cluster members and other stakeholders in agri-food and bio-based sectors. The members and partners of Bioeconomy Cluster are research centers, agricultural university and SMEs operating in the sector of agriculture, food, forestry and other areas representing wide bioeconomy spectrum. Therefore, the Bioeconomy Cluster has national coverage.	https://bioeconomy.sk/en/	2015	Slovakia	Cluster
Bioeconomy for Change (former IAR)	This cluster brings together more than 360 stakeholders from Research, Higher Education, Industry (SMEs and Large Companies) and Agriculture, around a common goal: the optimal valorisation of renewable resources focusing particularly on integrated biorefineries, biofuels, biomaterials, biochemicals and bio-ingredients. The objectives of IAR are to develop, support and strengthen the French bioeconomy, boost the competitiveness of biobased industries and support job creation by leveraging innovation, training and partnership opportunities. It brings together students, training organisations and bioeconomy companies to help meet Cluster members' HR needs by offering: <ul style="list-style-type: none"> - Pinpointing future and current industry needs; - Accreditation for training delivered by their members; - Sharing job vacancies, internship and thesis opportunities 	https://en.iar-pole.com/services/academy/	2006	France	Cluster

<p>Bioeconomy knowledge centre</p>	<p>The European Commission’s Knowledge Centre for Bioeconomy is a central knowledge hub that helps develop a common and robust knowledge base for a sustainable and circular bioeconomy to improve knowledge management for policymaking on the bioeconomy by:</p> <ul style="list-style-type: none"> - Identifying and filtering relevant information and making it accessible - Bringing together researchers, policymakers and other experts in the field. - Analysing, synthesising and communicating available evidence. - Enhancing the knowledge base for policymaking. <p>The Centre counts with a Bioeconomy community of practice, a workspace to pool expertise on bioeconomy, promote the exchange of knowledge by facilitating lively discussions in order to create synergies and cooperation between the CoP members.</p>	<p>https://knowledge4policy.ec.europa.eu</p>	<p>2018</p>	<p>Europe</p>	<p>Centre</p>
<p>Bioökonomie Campus Straubing</p>	<p>TUM Campus Straubing brings together the “Integrative Research Center” of the Technical University of Munich. This requires scientifically and technically trained specialists, chemists, biotechnologists and engineers who also have a broad understanding of the economic and social interrelationships, or economists who understand the language of the technicians. Based on this approach, research and teaching capacities in Straubing are being systematically expanded with bachelor, master and doctorate courses and research.</p>	<p>https://www.cs.tum.de/campus-straubing/campus/?lang=en</p>	<p>2017</p>	<p>Germany</p>	<p>Campus</p>

Biorbic	<p>Ireland's national bioeconomy research centre, established to promote and develop Ireland's bioeconomy through excellent research and innovation. BiOrbic is at the forefront of technological development and knowledge creation in Ireland's new bioeconomy. BiOrbic harnesses the wealth of Ireland's natural resources on land and in the sea for the development of a sustainable circular Irish bioeconomy that will contribute to the creation of vibrant sustainable communities in rural Ireland and Europe. It is an inter institutional collaboration between University College Dublin, TEAGASC, Trinity College Dublin, National University of Ireland Galway and University of Limerick.</p>	https://biorbic.com/	2017	Ireland	Centre
BioSC Bioeconomy Science Centre	<p>Competence centre based on an integrative structure consisting of basic research, applied and industry-oriented research including the natural, engineering and economic sciences and is focused on the mission of sustainable bioeconomy on the pillars of the science system. It was formed by RWTH Aachen University, the Heinrich Heine University in Düsseldorf, the Friedrich Wilhelms University in Bonn and the Forschungszentrum Jülich</p>	https://www.biosc.de/eng	2013	Germany	Centre
Biovale	<p>BioVale is a cluster that brings together around 600 members that strengthens Yorkshire and the Humber's circular bioeconomy through the support for bio-based innovation and business.</p> <p>The aim of the cluster is to establish the region as a world-leading centre for bioeconomy innovation which focuses on renewable raw materials and low-carbon agriculture by facilitating networking, dialogue, supporting the entrepreneurial ecosystem and promoting the region. It works together with The Biorenewables Development Centre (BDC), an open-access R&D biorefinery centre, working at</p>	https://www.biovale.org/	2013	United Kingdom	Cluster

	the interface between academia and industry to convert plants, microbes and biowastes into profitable biorenewable products.				
<u>CBIO Aarhus University</u> <u>Centre for Circular Bioeconomy</u>	The aim of the centre is to carry out research and develop bioeconomy production systems and recirculation concepts; e.g. bio refining methods and high-value products based on green crops, marine biomasses as well as residual and by-products from the agricultural and food sectors. CBIO activities include research within the entire production chain ranging from cultivating and procuring biomasses, logistics, management, refining, product development and tests, recirculation, impact on nature and environment as well as research in relation to society and economy. In addition, more basic research activities are carried out, e.g. in relation to the understanding of biomass conversion at molecular level, supported by advanced chemical analyses.	https://cbio.au.dk/en/	2017	Denmark	Centre
Centre for Bioeconomy (BOKU)	Centre created to coordinate the comprehensive activities within the university, to promote internal and external cooperation and collaboration as well as communication. The aim of the Centre is to initiate and support bioeconomy-relevant activities in the field of research, education and innovation.	https://boku.ac.at/en/zentrum-fuer-biooekonomie	2019	Austria	Centre
Centre of Expertise Biobased Economy (CoE BBE)	The CoE BBE is a partnership between Avans University of Applied Sciences and HZ University of Applied Sciences. The Centre of Expertise Biobased Economy (CoE BBE) is central to the transition to a biobased economy as a knowledge partner of many companies and organizations. We conduct applied research that matters, help companies with their biobased ambitions and ensure that biobased gets a place in all levels of education.	https://www.coebbe.nl/en/	2020	Netherlands	Centre
Circular biobased delta	Biobased Delta is an alliance of Dutch provinces, businesses and knowledge centres in the delta region of North Brabant, Zeeland and South Holland. The cluster supports initiatives to use biomass as a raw material in the chemical, construction and packaging industries. The cluster: - links up innovative start-ups with established companies;	https://biobaseddelta.com	2012	Netherlands	Cluster

	<ul style="list-style-type: none"> - helps sustainable investors develop cast-iron business cases; - attracts investors; - strengthens cooperation between the authorities, businesses and knowledge centres; - lobbies at local authorities, the government and Brussels; - organises events to put partners inside and outside the region in touch with each other. 				
Circular bioeconomy Cluster South-west	The cluster has a focus on marine, agriculture and waste-to-value thematic areas. The goal is to develop and promote the circular bioeconomy in the South-West region. The cluster brings together industry, enterprises, government and research centres to deliver unique and co-created initiatives to benefit member companies.	https://cbcs.wie/	2021	Ireland	Cluster
ECO 3- Bio and circular business park	<p>An innovative, industrial-scale, multidisciplinary bio- and circular economy business area located at the Kolmenkulma Eco-Industrial Park in Nokia where bio and circular economy businesses and innovations are being developed on an industrial scale.</p> <p>Based on the needs and ideas of cooperating companies, universities and public organizations, a new circular innovation ecosystem has been created and continuously developed. A waste recycling plant 'digests' materials from both sewage water and biowaste. This material is then turned into biological nutrients for food production, material for green infrastructure, biogas for vehicles and CHP production, and CO2 for agricultural production in green houses. With thermal treatment, the waste-water sludge mixed with wood ash is refined as raw material for earthworks.</p>	https://eco3.fi/en/	2018	Finland	Centre
European Bioeconomy University (EBU)	The EBU is an alliance of six leading European universities in the bioeconomy field. It will act as a think tank for knowledge generation, and as a creative hub for knowledge transfer to transform diversity into creativity, support the European approach of democratic, transparent and participative processes and foster actual change in an innovative and sustainable way. The vision of the EBU is the creation of Europe's leading intellectual institution for tackling the enormous environmental, economic and societal challenges.	https://european-bioeconomy-university.eu/	2019	France, Austria, Finland, Germany, Italy, the Netherlands	Network

<p>European Centre for Biotechnology and Bioeconomy (CEBB)</p>	<p>The Center for Biotechnology and Bioeconomy (CEBB) is a multidisciplinary research academic center, with a technological hall and a chemistry scale-up zone, at the heart of the biorefinery to the value of biomass and industrial by-products.</p> <p>Supported by Grand Reims, the Department of Marine and the Grand Est Region, it brings together the complementary scientific and technical expertise of about 60 researchers from four entities: AgroParisTech, Centrale Supélec, NEOMA Business School and the University of Reims.</p> <p>The complementary scientific expertise brought by each chair or unit covers the entire knowledge and competencies needed to create innovation and new technologies and turn them into industrial reality: white biotechnologies, green chemistry, process engineering, multi-scale modelling and studies of promising market tracks.</p>	<p>https://cebb-innovation.eu/Home?lang=en</p>	<p>2015</p>	<p>France</p>	<p>Centre</p>
<p>Europe's bioeconomy intercluster</p>	<p>3BI is a strategic European partnership that builds on the complementary strengths of five regional innovation clusters. All five clusters use biorefining to convert biological resources into materials, chemicals and fuels.</p>	<p>http://www.3bi-intercluster.org/home/</p>	<p>2005</p>	<p>Europe: France, United Kingdom, Germany, the Netherlands</p>	<p>Network</p>
<p>Forbioeconomy: Forest Bioeconomy Network</p>	<p>ForBioeconomy is a newly research network that primarily focus on the forest-based bioeconomy in the context of northern Europe, addressing both regional diversity as well as emerging challenges and opportunities.</p> <p>ForBioeconomy will establish strong cooperation with the Bioeconomy programme coordinated from Joensuu, with a specific focus on sustainable and efficient production and use of biomass, securing sustainable provision of forest ecosystem services and, promotion of supply and demand for bio-based products.</p>	<p>https://forbioeconomy.com/</p>	<p>2019</p>	<p>Sweden</p>	<p>Network</p>

	The Network mainly conduct activities in the field of research and knowledge networking (e.g., scientific seminar, research development and policy analysis), capacity building (e.g., summer schools, PhD seminars, collaboration policy-research organizations) and building bridges through scientific cooperation (e.g., between northern European countries, and/or between forest stakeholders).				
Irish Bioeconomy Foundation (IBF)	IBF is Ireland's national bioeconomy association and innovation cluster. mission is to promote the conversion of Ireland's natural land & sea resources to high value products for the development of a sustainable bioeconomy that is globally competitive and creates local development. IBF helps its members by: <ul style="list-style-type: none"> - Facilitating relations among innovative agribusiness, forestry, marine, energy and bioeconomy champions; - Generating synergies between different sustainable initiatives; - Creating an integrated ecosystem of converging assets and ambitions - Enabling innovative projects to reach their next level; 	https://bioeconomyfoundation.com/	2017	Ireland	Cluster
Science Campus plant-based Bioeconomy Halle	The Science Campus Halle - plant-based bioeconomy (WCH) aims to strengthen the teaching and training of undergraduate and graduate students in the field of plant-based bioeconomy by uniting leading experts in the field of plant science, agricultural, economic and social sciences in order to meet the social challenges of our time. Synergies shall be created between the members of the SCH enabling the combination of strengths in teaching and research in order to initiate new joint projects. Expertise and existing structures at the university shall be linked to strategic priorities in research and teaching at the four Leibniz-Institutions in the region of Halle.	https://www2.sciencecampus-halle.de/homepage.html	2012	Germany	Campus
SUBMARINER-Network	The SUBMARINER network is a platform that brings together actors from the Baltic Sea Region to promote innovative and sustainable uses of marine resources. The network is a hub for projects, initiatives and activities at all levels.	https://www.submariner-network.eu/	2012	Europe	Network

<p>Tarvaala Bioeconomy Campus</p>	<p>The campus in Tarvaala, Saarijärvi, has provided agricultural education for over 150 years. The Tarvaala Campus is home to two bioeconomy training and research and development education institutions: the natural resources department of the Vocational Institute of Northern Central Finland (POKE) and the Jyväskylä University of Applied Sciences, Institute of Bioeconomy. In the campus work and study almost 600 people: 500 students and 100 professionals.</p> <p>The Bioeconomy Campus can serve as a concrete meeting place for industry entrepreneurs, investors, researchers, developers and students. Company and education requirements form the starting point of the area development – the goals are to illustrate the structures and functions of a future bioeconomy society and to offer the opportunity to test new solutions.</p>	<p>https://biotalouskampus.fi/en/</p>	<p>-</p>	<p>Finland</p>	<p>Campus</p>
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Annex 2. Detailed description of identified education hubs per hub type

A. Cooperative study programmes:

	<i>Biocirce</i>	<i>Bioceb</i>
Engagement	<ul style="list-style-type: none"> • HEIs: University of Bologna; University of Milano-Bicocca; University of Naples Federico II; University of Turin • Companies: Intesa Sanpaolo, Novamont SpA, GFBiochemicals SpA, and PTP Science Park di Lodi • Two technological Cluster: Cluster SPRING and Cluster CLAN agrifood 	<p>Universities: AgroParisTech – France; University of Reims-Champagne-Ardenne (URCA) – France; Aalto University – Finland; Tallinn University of Technology (TalTech) – Estonia; University of Liège (ULiège) – Belgium</p> <p>Strategic partners from academic, research and industrial sector:</p> <ul style="list-style-type: none"> • socio-economic partners from France, Belgium, Estonia and Italy such as Bioeconomy for Change, Lesaffre International Sarl, Global bioenergies, Pole Greenwin, AS Estonian Cell, TFTAk- Center f Food and Fermentation Technologies and Arterra Bioscience; • research associated partners from Finland, France and Portugal such as Teknologian tutkimuskeskus VTT Oy, Inrae, Neoma Business School, Lneg • international academic partners from USA, Australia, Canada, Thailand, Egypt, Brazil, Hong Kong and United Kingdom
Educational format	<ul style="list-style-type: none"> • Courses at different locations • Case studies • Six-month Internship • Project • Industry visits 	<ul style="list-style-type: none"> • Guest lectures • Study experience in at least 2 European countries • Joint transversal project along three semesters • Mandatory research internship (MSc Thesis) • Integration of horizontal skills training: project management, interculturality, adaptability, team work, leadership • Access to experimental facilities and (biorefinery) site visits

		<ul style="list-style-type: none"> • Joint graduation event, including opportunities to meet employers, disseminate the results of thesis and projects through poster sessions and oral presentations and to connect with Bioceb students from different cohorts.
Organisational model	<ul style="list-style-type: none"> • Administration: Università degli Studi di Milano-Bicocca (admissions) • Coordination: A coordinating committee formed by representatives from the universities and companies partners • Scientific supervision: A scientific advisory board formed by members from the technological clusters, the University of Milano and associated partners • Funding: Admission fees; Scholarships for the most deserving students of the master by the Raul Gardini Foundation; Scholarships for international students from the Virginia Tech students by Garnet Services and Peritas; two additional scholarships by Parco Tecnologico Padano • Associated partners: Memorandum of understanding for cooperation with international associations such as the Irish Bioeconomy Foundation • Stakeholders involvement: Apart from the administration, coordination and scientific supervision, each university delivers one of the four compulsory modules covering relevant scientific topics while the members of participating companies and associations cover specific case studies and/or visits. The partner companies and institutions offer internships as well as associated regional partners. • Beneficiaries: 15 students per year from different backgrounds: professionals with either scientific or legal/economic background or persons already working in biotechnology fields. If students have degrees and/or expertise in biotechnology, economics, chemistry, industrial chemistry, biology, pharmacy, agricultural sciences, engineering, this is considered a plus for the admission process 	<ul style="list-style-type: none"> • Administration: AgroParisTech (admissions, secretariat) • Funding: funded by the European Commission through Erasmus Mundus Programme; differentiated fees for EU and non-EU students • Associated partners: Memorandum of understanding for cooperation with associated partners, invited professors and companies • Stakeholders involvement: Apart of the administrative tasks that each partner should perform, each university offers a set of courses on a specific focus topic. Associated partners act in training, promoting, sponsoring and advisory activities. • Beneficiaries: 30 students per year from different backgrounds: engineering or science including a strong background in at least one discipline related to biology: biotechnology, biochemistry, microbiology, biophysics, bioprocess engineering, molecular biology with a preferred but non-mandatory background in chemistry, physics or environmental sciences;

B. Campus:

	Bioeconomy Campus Straubing	Science Campus plant-based Bioeconomy Halle	Tarvaala Bioeconomy Campus
Engagement	Technische Universität München, more than 100 international partners, around 80 national partners and four regional partners (C.A.R.M.E.N., Hafen Straubing-Sand, Gründerzentrum und BioCubator Straubing-Sand; KoNaRo – Kompetenzzentrum für Nachwachsende Rohstoffe and Technologie- und Förderzentrum im Kompetenzzentrum für Nachwachsende Rohstoffe)- research and teaching institutions, industry, authorities and associations.	Leibniz Institute of Agricultural Development in Transition Economies (IAMO), the Leibniz Institute of Plant Biochemistry (IPB), the Leibniz Institute of Plant Genetics and Crop Plant Research (IPK) and the Halle Institute for Economy Research (IWH) in an interdisciplinary manner with the thematically corresponding departments of the Martin Luther University Halle-Wittenberg (MLU), the Agrochemical Institute Piesteritz (AIP), the Julius Kühn-Institute Federal Research Centre for Cultivated Plants (JKI), the Fraunhofer Center for Chemical-Biotechnological Processes (CBP), the Helmholtz Centre for Environmental Research (UFZ) and the Anhalt University of Applied Sciences.	the natural resources department of the Vocational Institute of Northern Central Finland (POKE) and the Jyvaskyla University of Applied Sciences, Institute of Bioeconomy
Educational formats	<ul style="list-style-type: none"> • The academic training at the TUM Campus Straubing takes place within the framework of the study courses Bioeconomics (B.Sc. & M.Sc.), Chemical Biotechnology (B.Sc. & M.Sc.), Technology of Biogenic Resources (B.Sc. & M.Sc.), Sustainable Management and Technology (B.Sc. & M.Sc.), Biomass Technology (M.Sc.) as well as Bachelor's and Master's theses and doctorates. • Modules in different bioeconomy related topics: economics and sustainability, biotechnology, social sciences • For the master programme on Bioeconomy, two specialisation options are offered: social sciences and Biotechnology • Mandatory Master Thesis 	<ul style="list-style-type: none"> • The ScienceCampus Halle has set the goal to strengthen the teaching and training of undergraduate and graduate students in the field of plant-based bioeconomy. It offers courses of studies in different bachelor and master degree programs touching the field of plant-based bioeconomy e.g. biology, chemistry, biochemistry, pure economics, Agricultural Sciences, Management of Natural Resources and Crop Plant Sciences • Junior research groups on Economics and Institutions of the Bioeconomy and Protein Recognition and Degradation 	<ul style="list-style-type: none"> • The University offers a bachelor programme in Logistics, bioeconomy and a master degree programme in bioeconomy development as well as in other bioeconomy-related topics • For the bioeconomy master, the university offers flexible options so the students can complete a large part of the studies through online learning and remote assignments with regular face-to-face learning. • For the bachelor program on bioeconomy, the students take modules on multiple fields such as natural sciences, technology,

	<ul style="list-style-type: none"> For research: SynBiofoundry@TUM – the Biofoundry of the TUM Campus Straubing – high throughput technology platform to develop and optimize biotechnological production processes. <p>The Green Fuel Center (GFC): developing new fuel production pathways for the sustainable mobility of tomorrow. The GFC integrates all development steps from basic scientific research to process engineering piloting and sustainability assessment. Through its networking with industrial partners and within the TUM network, the GFC ensures practicality and rapid implementation.</p>	<ul style="list-style-type: none"> It has a demonstration platform on plant genome editing intended to support the platform and transfer function 	<p>finance and economics, logistics, entrepreneurship and bioeconomy. The students should work on a project related to an area of logistics for the company where the student is working.</p>
Organisational model	<p>Administration: Rector, pro-rector, dean of studies and managing director and administrative departments for the management of the campus</p> <p>Stakeholder involvement: The Campus Straubing is linked at international national and local level and is constantly working to expand its network with research and teaching institutions, industry, authorities and associations. The University develops agreements on cooperation with partners for joint projects, cooperative studies or professorships exchange</p> <p>Funding: through European, national and regional funds through different projects and programmes</p>	<p>Funding: Funded by the state and the European Union fund for regional development (EFRE) and the Leibniz Association through programmes and projects</p>	<p>Funding: state, European projects and programmes</p> <p>Stakeholders involvement: the stakeholders are involved in the campus as a community of practice that develops and promotes new business based on renewable natural resources. It supports experiments in the commercialisation of bioeconomic solutions. Bioeconomy campus connects with bioeconomy developers via biobord.eu to solve challenges at global and local level through innovations.</p>

C. Cluster or network:

Name	Engagement	Educational format	Organisational model	Success factors
ICA Community of Practice for Bioeconomy Education in Europe (ICA CoP Bio-Edu)	Universities, Educators, existing networks and consortia, institutions related to Bioeconomy education	Conferences and networking activities	ICA General Assembly: representatives from each ICA member institution. ICA Board: senior members in the life science community. ICA Council: ICA Standing Committees- forum to support networking and the initiation of new ventures Full Membership open to all higher education institutions in Europe with a focus on the circular bioeconomy (agriculture, forestry, food value chain & biobased economy), the sustainable use of natural resources, biodiversity, the protection of the environment and rural development Associate Membership is open to universities outside of the EHEA. For the community of practice, there are full members (educators) and associate members (existing network and consortia)	Broad geographical scope Council as connector of internal committees Participation in bioeconomy education events at European level
BIOEAST hubs: BIOEAST Hub CZ	Association of Research organisations representing applied research (AVO has more than 75 members; the Czech-Moravian Breeding and Seed Association; the Czech Technological Platform Plants for Future. Non-profit organisation: Technology Centre of the	Training on topics such as energy, creative thinking and management Networking activities such as the "Science coffee event" Provision of training and dissemination materials through case studies for secondary school students on bioenergy, food processing and agriculture innovations Online materials for secondary	Thematic working groups from BIOEAST thematic working groups (bottom-down), and needs of its stakeholders (bottom-up). Funding: initial funding through project BIOEASTsUP	Guideline/model to build other regional hubs Supported by a greater network: Bioeast Networking activities

	<p>Czech Academy of Sciences</p> <p>Business units AgriKomp Bohemia</p>	<p>school focused on composting, biogas and biomass</p>		
BioEconomy Cluster (Germany)	<p>4 universities; 7 R&D-Institutes; 10 Partners; 22 SMEs; 10 Industry members</p>	<p>Networking and Formation consortia</p> <p>Funding and financial support: laboratory, pilot scale to demonstrator and industrial production</p> <p>Infrastructure access</p> <p>Business development and project management</p> <p>Knowledge transfer and innovation: matching events, open innovation platform</p> <p>Prototyping, upscaling support or connection</p>	<p>BioEconomy e.V.--> legal platform for the organization and financing of joint activities</p> <p>The board: central control body and makes the fundamental decisions for the design of the R&D project portfolio of the leading-edge cluster and the implementation of the strategy</p> <p>Application for membership and Member-dependent admission fee</p>	<p>Clear organisational structure</p> <p>Clear benefits to the members</p> <p>Different types of stakeholders involved</p>
Bioeconomy cluster	<p>Research centers, agricultural university and SMEs operating in the sector of agriculture, food, forestry and other areas representing wide bioeconomy spectrum from the Danube Region countries</p>	<p>Bioeconomy Cluster connects the entities of knowledge triangle, promotes knowledge transfer and cooperation of R&D with agri-business.</p> <p>Implementation and participation in joint projects which can help to the development of its members, to promotion of innovation, knowledge and technology transfer and finding solutions to the problems of individual cluster members.</p> <p>Virtual emerging library with relevant links such as the catalogue of bioeconomy</p>	<p>General Assembly</p> <p>Governing Board (executive body of the cluster and it is composed of the representatives of the founding members)</p> <p>Board of Supervisors (supervisory body)</p>	<p>Implementation of R&D through joint projects</p>

		solutions and the bioeconomy strategy accelerator toolkit		
Bioeconomy for Change (former IAR)	The cluster has more than 600 members: Companies, research and transfer institutes, education and training organisations, state and local authorities, financial institutes, consulting firms, network and economic organisations	Connection to strategic partners through different events Support on decisions: studies, access to intelligence tools Business development support Accreditation for the bioeconomy training Human resources Club and workshops	Decision-making bodies: Executive Committee, Board of Directors, and the Scientific Council Funding: Annual membership fees deepening on type of organisation and regional, national or European funding bodies.	Clear benefits for members Personalized offer depending on member's need
Biovale	BioVale has around 600 members from private companies, research organisations, higher education, community groups, agricultural and horticultural groups, local government, non-profit organisations and other innovation clusters.	It offers a set of resources: case studies, reports, information maps MOOC on bioeconomy Training programmes: BioCamps Support for entrepreneurship Networking: BioVale roundtable	BioVale is a non-profit company associated with the University of York. BioVale operates as a team of the Biorenewables Development Centre Funding: BioVale is a grant-funded initiative by the European Regional Development Fund (ERDF), the Connecting Capability Fund of Research England has funded the THYME project (Teesside, Hull and York – Mobilising Bioeconomy Knowledge Exchange) with BioVale as a delivery partner, BBI-JU as BioVale is a partner in the Agrimax project.	Support to entrepreneurship Big engaged community

Circular biobased delta	Alliance of Dutch provinces, businesses and knowledge centres in the delta region of North Brabant, Zeeland and South Holland	Networking and strengthening cooperation: match making; attract investors; cooperation between authorities, businesses and knowledge centres; Business cases development Cooperative development of demand-driven education and refresher courses at secondary, higher and university levels.	Managing: The cluster is managed by a chairman and vice chairman with the support of the acceleration team Funding: projects supported by Interreg Flanders-The Netherlands and European funds	Successful networking Cooperative development of demand-driven education
European Bioeconomy University (EBU)	Universities of Hohenheim, Bologna, and Eastern Finland, AgroParisTech, BOKU Vienna, and Wageningen University and Research	- Each university provides a range of educational offers covering all thematic areas of the bioeconomy. - Joint education offers have been created such as: a common qualification certificate for master students; bioeconomy entrepreneurship programme; and a post-doctoral network. - Research projects on different topics that have also been developed by the members of the alliance	EBU presidents board Scientific coordinators group and operational coordinators group. The EBU general meeting of all representatives is held biennially and includes a scientific forum.	Complementation of capacities Knowledge-based network
Forbioeconomy: Forest Bioeconomy Network	University: Swedish University of Agricultural Sciences (SLU); Research Centres: Natural Resources Institute Finland (LUKE) and Nordic Forest Research (SNS) and European Forest Institute (EFI)	The Network mainly conduct activities in the field of research and knowledge networking (e.g., scientific seminar, research development and policy analysis), capacity building (e.g., summer schools, PhD seminars, collaboration policy-research organizations) and building bridges through scientific cooperation (e.g., between	Managed by the Department of Forest Economics at the Swedish University of Agricultural Sciences (SLU).	Communication and dissemination of research

		northern European countries, and/or between forest stakeholders).		
Irish Bioeconomy Foundation (IBF)/ Bioeconomy campus	21 members- Private and corporate members, SMEs, and public members and 8 partners-companies, research centres	Access to financing, bioprocess design and scale up, promotion activities. Resources such as a biomap, a digital innovation hub, and funding opportunities	Funding: funds from Ministry of Business, Enterprise and Innovation and joint projects	Strengthen industry capacity
SUBMARINER Network	Research institutions, public administrations, business parks and private companies across the Baltic Sea Region	Networking: SUMBARINER Network Working groups on different topics: career, youth and training opportunities SUMBARINER Accelerator: mentoring and accelerator program for start-ups and SMEs Communication: Publications	The SUBMARINER Network is a not-for-profit European Economic Interest Grouping (EEIG) managed by a professional secretariat based in Berlin and hosted by the network members. There are full and associate members. Funding: European funds from the European regional development fund, flagship project under the priority area "Innovation" of the EU Strategy for the Baltic Sea Region (EUSBSR)	Dissemination of results
Circular bioeconomy Cluster South-west	University, industry, enterprises, government and research centres	- Project collaboration: events and workshops, site visits, project matchmaking, joint projects - Applied R&D: product and process innovation and development, link to facilities and research centres - Training and upskilling: link to bioeconomy courses, access to master classes, link to training programmes - Communication: Promotion of	The cluster has an advisory group and it is managed by an education and outreach manager Funding: Fees: except on the establishment period	Networking events Applied knowledge and communication and dissemination of results

		members and cases studies, access to research - Funding opportunities: Grant funding, referrals to venture funders and fundraising programmes		
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D. Centre

Name	Engagement	Educational format	Organisational model	Success factors
Bioeconomy knowledge centre	Directorates and units from the Joint Research Centre and the European Commission	Communication and disseminations strategies: - Reports on specific topics of the bioeconomy - Online library of external documents, events, news, datasets, resources for the bioeconomy - Visualizations e.g. European policy strategies, Bioeconomy Monitoring system, projects	The Bioeconomy Knowledge centre is an initiative of the Joint Research Centre to develop a common and robust knowledge base for a sustainable and circular bioeconomy. The team is under the unit Bio-economy of the Directorate D- sustainable Resources.	High capacity for dissemination

Biorbic	More than 100 researchers focused on the development of a sustainable circular bioeconomy Cluster, associations, research institutes	<ul style="list-style-type: none"> - Own and partners research activities communication - Work with industry partners to create new products, processes and markets (Access to R&D infrastructure) - Resources: Bioeconomy map, games, information - Events: Bioeconomy Ireland Week to raise awareness of Ireland's bioeconomy 	<p>Management: the centre counts with governance, scientific advisory, industry advisory, executive, research programme and industry committees</p> <p>Funding: Science Foundation Ireland and industry</p>	Big community of researchers supporting the hub
BioSC Bioeconomy Science Centre	Research Centre and Universities	<ul style="list-style-type: none"> - Research group work on Smart management for plant performance, Integrated biorefineries for sustainable production and processing, modular biotransformation for high-value chemicals, and economy, strategies and concepts. - Training offers for doctoral students and young scientists - Internal and external events such as the BioSC Forum, workshops, integration forum, BioSC Symposium, BioSc Spotlight and BioSC Lecture to discuss about the projects, learn from external actors and share results with the community 	<p>Management: The Centre is managed by scientific managers of the institutes (directorate) and an executive board. In addition, and advisory board is appointed</p> <p>Funding: State</p>	Training for stakeholders (scientists)
CBIO Aarhus University Centre for Circular Bioeconomy	Departments of the University	<ul style="list-style-type: none"> - Research activities - Facilities: biogas plant, biofuel laboratory, HTL pilot plant and extraction of protein - Cases catalogue, find an expert, list of publications 	<p>Management: The Centre is managed by a steering committee and a board</p> <p>Funding: University funds and Europe and funds through projects</p>	Offer of facilities and open information base

Centre for Bioeconomy (BOKU)	Departments of the University	-Stimulation of cooperation with Austrian and international actors; coordination of networking activities within BOKU; collaboration and communication	The Centre is managed by a coordinator and scientific and non-scientific staff	
Centre of Expertise Biobased Economy (CoE BBE)	Universities	<ul style="list-style-type: none"> - Support on the search for knowledge, talent, funding facilities to entrepreneurs - Research projects that are translated into teaching content for the needs of biobased professional practice - Teaching materials for primary and secondary education - MOOCs - 1 biobased major and 8 minor and specialisations - Facilities: biobased building, energy, chemistry, agri-food business, engineering, mycelium labs - Joint projects within the universities - Internships and projects for students with companies and other external organisations 	Centres of Expertise are established by the Dutch Ministry of Education, Culture and Science (OCW) to link higher education with regional economic focal points such as the bio-based economy.	- Practical approach of research
ECO 3- Bio and circular business park	38 organisations: companies, research centres and universities	<ul style="list-style-type: none"> - Communication: Share cases - Collaboration activities - Development of businesses and innovations on an industrial scale - Demonstration and pilot environment 	An innovative, industrial-scale, multidisciplinary bio- and circular economy business area, ECO3, is being built on the excellently located Kolmenkulma Eco-Industrial Park, situated in the Finnish growth corridor. This nationally important competence centre is also a demonstration and piloting environment, developed by the City of Nokia and Verte Ltd., the City of Nokia's development company, in cooperation with companies and universities.	Diverse group of stakeholders together in one location

European Centre for Biotechnology and Bioeconomy (CEBB)	Researchers from universities	The complementary scientific expertise brought by each chair or unit covers the entire knowledge and competencies needed to create innovation and new technologies and turn them into industrial reality: white biotechnologies, green chemistry, process engineering, multi-scale modelling and studies of promising market tracks.	Funding: local funds (Grand Est, Grand Reims, Marne), European Funds (European Regional Development Fund)	Cover a broad spectrum of knowledge
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