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Part 1 – Theoretical framework

Consortium:



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Partners short names

ZSI	Zentrum Fur Soziale Innovation Gmbh
WR	Stichting Wageningen Research
APRE	Agenzia per la Promozione della Ricerca Europea
BZN	Bay Zoltan Alkalmazott Kutatasi Kozhasznu Nonprofit Kft.
EAEA	European Association For The Education Of Adults
MOME	Moholy-Nagy Muveszeti Egyetem
artEZ	Stichting Artez
CLIC	Clic Innovation Oy
TMG	Business Upper Austria – Oo Irtschaftsagentur Gmbh
MET	Metropolia Ammattikorkeakoulu Oy
UNIPA	Università Degli Studi Di Palermo

Abbreviations

COR	Committee of the Regions
EGD	European Green Deal
NGO	Non Governmental Organization
RIS3	Regional Innovation Strategies Smart Specializations
SME	Small and Medium Sized Enterprise
TRL	Technological Readiness Level

1 Introduction – Part 1

Background

Providing an analytical framework will ensure that the co-creation processes and implementation materials as well as activities will comply with the objectives of this project. The framework includes four approaches; (1) the technological approach of bioeconomy covering the biobased value chain (resources biomass crop (components) or waste, extraction / refineries, and applications (materials and products)) paying attention to economic, ecological as social aspects; (2) the concept of regional development; activities will take place within the smart specialization of every region and built on Quadruple Helix interplay involving public, private, knowledge and societal partners; and (3) bring in the citizens perspective through art and design from the very beginning through the use of 2d and 3d visualizations and materials and to go beyond by approaching domains/networks/facilities with high outreach (ie. Arts and Design); (4) education and learning; skill and capabilities development; human capital and collaboration.

Problem

The transition towards a circular bioeconomy is complex and enhances many different aspects, domains and perspectives. The framework will help the project partners to understand and overcome complexity of societal transformation and the various underlying challenges:

- How to manage transformative change within European regions?
- Creating a new economy with sustainable value adding activities and new products; from fossil based to nature based.
- To understand regional potentials, needs, barriers and facilitators, and to enable pathways towards socially and environmentally responsible behaviour of consumers, industries and public bodies.
- To define needs and long-term approaches by primary producers, citizens, innovators, educators, SMEs, industry, national authorities and other actors
- Alignment and engagement of all domains of society: public, private, knowledge and societal
- From policy frameworks and theoretical concepts to operationalization and implementation
- From innovative ideas to full scale investments and implementation
- Education and skills development for new and emerging bioeconomy approaches and new value chains.
- Optimal utilization of means for productivity and innovation for better informed decision making and for changing behaviours: knowledge, finance and human capital, the up-take of creativity (arts and design) as a means.

2 Conceptual Framework

2.1. Working with concepts

A framework of concepts underlies the approach taken in Engage4Bio. This framework of concepts has been developed in order to be able to deal with Mission driven innovation and the challenges on circular bioeconomies on regional level. We choose to work with a variety of relevant concepts for the following reasons:

- Knowing the concepts helps the formulation and the implementation of Missions
- Different concepts are relevant at the same time, interlinked and integrated approaches are needed
- Working with concepts helps with designing the processes, defining next steps; creation of conditions and incentives for initiatives, implementation, investments and changing behaviors; developing support infrastructure and services
- Governance of regional development and creating regional circular bio-economies should take into account and need to be aware of the different overarching and underlying concepts. Which is relevant to organizations and networks playing a role within the transformational approaches: quadruple helix networks, boundary organizations, and/or intermediate organizations.

2.2. Overarching Concepts

The core challenge in Engage4Bio is to cope with grand challenges in regional development and specifically in direct relation to the bioeconomy.

- European Green Deal
- Mission driven innovation
- Transformative change

European Green Deal

The *Green Deal* (2019)¹ is an integral part of this Commission's strategy to implement the United Nation's 2030 Agenda and the sustainable development goals. (Climate, biodiversity loss) The European Green Deal is a response to climate and environmental-related challenges. It is a new **growth strategy** that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use. The European Green Deal will be a driver of new economic opportunities. Many European firms are cutting their carbon footprint and discovering the clean technologies. They understand that there are planetary boundaries. They also know that if they discover the sustainable solutions of tomorrow, this will give them first mover advantage.

The European Commission has adopted a ***Circular Economy Action Plan***² (2018) - one of the main blocks of the European Green Deal, Europe's new agenda for sustainable growth. The new

¹ Europese Commissie 2019. Mededeling. Brussel.

² https://ec.europa.eu/environment/circular-economy/pdf/new_circular_economy_action_plan.pdf

Action Plan announces initiatives along the entire life cycle of products, targeting for example their design, promoting circular economy processes, fostering sustainable consumption, and aiming to ensure that the resources used are kept in the EU economy for as long as possible.

Achieving a climate neutral and circular economy requires the full mobilization of industry. **It takes 25 years** – a generation – **to transform an industrial sector and all the value chains**. The circular economy action plan will include a ‘sustainable products’ policy to support the circular design of all products based, on a common methodology and principles. It will prioritize reducing and reusing materials before recycling them. It will foster new business models and set minimum requirements to prevent environmentally harmful products from being placed on the EU market. The circular economy action plan will focus in particular on resource-intensive sectors such as textiles, construction, electronics and plastics. Promoting new forms of **collaboration with industry** and **investments in strategic value chains** are essential.

The 2018 update of the **Bioeconomy Strategy**³ aims to accelerate the deployment of a sustainable European bioeconomy with 14 concrete measures based on three key priorities:

1. Strengthen and scale up the bio-based sectors, unlock investments and markets
2. Deploy local bio-economies rapidly across the whole of Europe
3. Understand the ecological boundaries of the bioeconomy

Regarding the **regional bio economies**, EU favors a systemic approach, which will address Bio-based innovations including in farming, **to develop new chemicals, products, processes and value chains** for bio-based-markets **in rural areas**, with involvement and **increased benefits for primary producers**. And, new opportunities arising for the forestry sector in view of replacing non-sustainable raw materials in construction, packaging with bio-based materials and for providing more sustainable innovations in sectors such as forestry-based textiles, furniture and chemicals, and new business models based on the valuation of forestry ecosystem services.

Mission Driven Innovation

The European Green Deal is based on Mission Driven Innovation concepts. From a regional development perspective, a shift is occurring from sector-based approaches to challenge-based ones, or mission driven regional development in which public values are no longer seen as peripheral, but as central (Kattel & Mazzucato, 2018). In this perspective, the bioeconomy and the applications of biomass and waste in new materials and uses in different sectors, are part of a mix of solutions for missions around the European Green Deal, the New European Bauhaus and the Sustainable Development Goals. Innovation is a central process, which focuses on “market-shaping and creating” (Kattel & Mazzucato, 2018). In line with smart specialization thinking this innovation process has an element of entrepreneurial discovery (Foray, 2015; Virkkala & Mariussen, 2018; Mazzucato et al, 2021), which takes place in a quadruple helix setting, in which especially public policies are influential in exploring new directions and aligning with business (Kattel & Mazzucato, 2018). By specific learning environments, such as Living Labs, clusters or Communities of Practice new directions are discussed and new activities are initiated (Gerritsen et al, 2019). These are knowledge intensive processes of collaboration, experimentation, exploring and learning.

3

Transformative Change

The European Green Deal (EGD) identifies two main sets of methods to generate transformational change. These can be considered as pillars of the EGD, and have major implications for its implementation at the local and regional levels (Committee of the Regions, 2022):

(1) Profoundly renewed modes of public action. The EGD helps to overcome the challenges of environmental transition. It encourages public authorities to *work across sectors*, as part of partnerships *involving public, private and 'third sector' organizations*, with the active participation of the broadest possible range of stakeholders susceptible of contributing to the transition processes or affected by them.

(2) Fairness when it comes to sharing the economic and social burden of this transition process. This presupposes a *strengthening of dialogues, cooperation and collaboration* between e.g., actors at different institutional levels, regional and local authorities governing territories with higher or lower levels of resilience in the face of green transition, social groups, public and private actors.

2.3. Underlying concepts

In this chapter the underlying concepts are described in more detail in terms of the four perspectives that underly Engage4Bio: technology, regional development, arts and design and learning.

Perspectives: Technological concepts of the bioeconomy

This chapter gives an overview of the resources, processes and products that are produced in the bioeconomy. It aims to be generic and fully inclusive in terms of possible technologies underlying the bioeconomy. For each European region, and the regional hubs as defined in the Engage4Bio project, different aspects of this overview will be relevant. In the Engage4Bio project, the bioeconomy overview for each hub will be defined in further detail, to facilitate tailor-made dissemination per hub. This gives Engage4Bio a tool to show where the hubs strength lies, what and how to communicate to stakeholders, and where they may develop their bioeconomy further.

In the Figure 'Carbon Based Products' (Figure 1) the carbon flows through the bioeconomy are described. The full explanation of the processes is presented in the table at the bottom of the graph. Reading of the graph starts in the center with photosynthesis. Then follow the first and follow up processing steps after harvest (in the yellow blocks), either biorefineries, where incoming streams are separated into multiple other streams, or mechanical processing, where incoming streams are processed into smaller parts. After that follow the next factories where incoming streams are converted to (intermediate) products (purple blocks). In the grey blocks, intermediate and end products are presented (see also the table). The arrows describe streams of feedstocks, intermediate products, products and residues. The figure is an abstracted representation of the complete value chain and each block and arrow can be made specific to the activities in each Engage4Bio hub.

Carbon Based Products

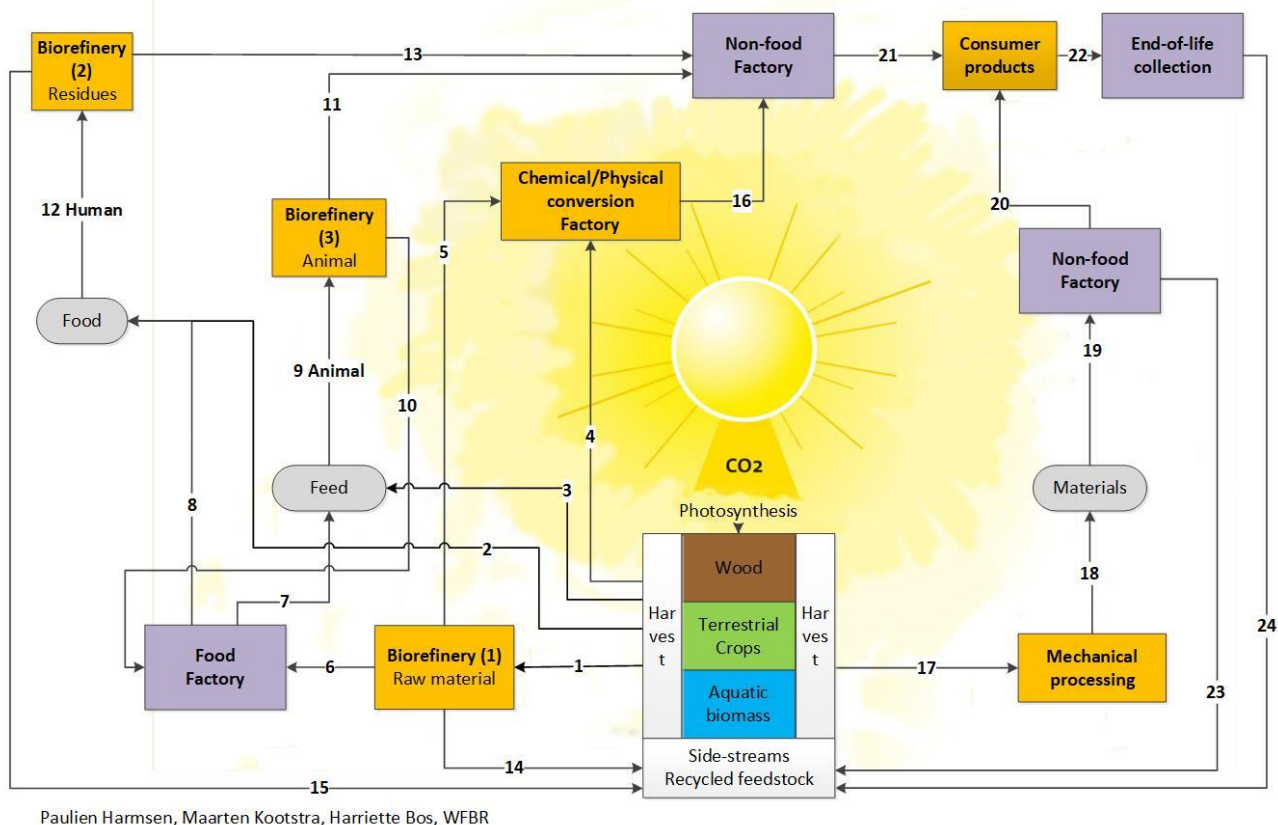


Figure 1: Carbon based products

Description of processes

In next table the streams between the processing steps that occur in the biobased value chains (shown as the arrows between the yellow, purple and grey blocks in Figure 1 'Carbon Based Products') are presented. Descriptions are short and general, to include the entire bioeconomy, and need to be made specific for each hub in the hub analysis phase. Each hub will presumably only cover part of these streams

Table 1: Explanation of streams in Figure Carbon Based Products, describing the bioeconomy

Arrow nr.	Description
1	Feedstock transported to 'Biorefinery (1) raw material' for further processing.
2	Harvested crops for food, ready to eat such as vegetables or fruit.
3	Harvested crops for feed (e.g., maize).
4	Harvested biomass, side streams and recycled feedstock for chemical & physical conversion as feedstock for non-food factory.
5	Biomass components (e.g., starch, oil, cellulose (pulp), lignin, sugars) from 'Biorefinery (1) raw

	material' to be converted to intermediates for non-food products (chemicals and materials).
6	Biomass components (e.g., flours, starch, oil, sugars) for food from 'Biorefinery (1) raw material' to Food Factory.
7	Residual streams coming from the food industry for feed applications (e.g., brewer's spent grain, beet pulp).
8	Processed food products for human consumption.
9	Animal products (e.g., milk, meat, bones, skins, manure) as input for Biorefinery (3) animal.
10	Animal based products (milk, meat, eggs, fats) for food-to-food Factory.
11	Animal-based feedstocks (tallow, skins, bone meal) to Non-food Factory
13	Oils and fats left over from human consumption after Biorefinery (2) to Non-food factory.
14	Residual streams from 'Biorefinery (1) raw material' going back to the land as soil improver or fertilizer.
15	Residual streams from Biorefinery (2) going back to the land as soil improver or fertilizer.
16	Intermediates from chemical/physical conversion (chemicals and materials) to the non-food factory.
17	Biomass (e.g., wood from forestry, fibres from crops) to Mechanical processing.
18	Intermediates from Mechanical processing (e.g., beams, particleboards and planks, textile yarns).
19	Materials to non-food factory intermediary products (building materials, textiles).
20	Intermediates produced in non-food factory for product production (furniture, houses, textiles).
21	Green chemicals and polymeric materials produced in Non-food Factory for consumer product production (packaging, textiles).
22	Used materials to End-of life collection.
23	Side stream from non-food factory back to recycled feedstock.
24	Material from end-of-life collection to recycled feedstock.

Perspectives: regional development

Many European regions are in search for the most optimal valorization routes for their regional resources and biomass, and try to discover which incentives and support are needed for the uptake, and which kind of processing facilities investments should take place. In the execution of new strategies and policies, gaps between current practices and biobased solutions are being identified which hamper the uptake of the bioeconomy in Europe. The main gap is between the technological development and the awareness of the potential value thereof, from the value chain partners to the general public. The current situation is characterized by small-scale pilots and demonstrations. Transitions face lock-in problems such as resistance, current business practices, conflicting interests, (institutional) learning effects, economies of scale, network externalities, technological interrelatedness, collective action and the differentiation of power (Unruh, 2000).

To bridge these gaps and to deal with such lock-in situations, Wageningen Research’s vision – based on the bioeconomy approach – is built upon the so-called *framework of concepts*. This framework identifies interacting concepts that need to be addressed during the implementation of the bioeconomy and offer instruments to support the transition to well performing regional innovation systems. These concepts offer information about patterns of and phases in the transitional process and offer organizational basics about conditions for innovation. They have to be made operational in order to bridge and manage the complex organizational, economic and societal challenges that come with this transition. The following concepts are being described.

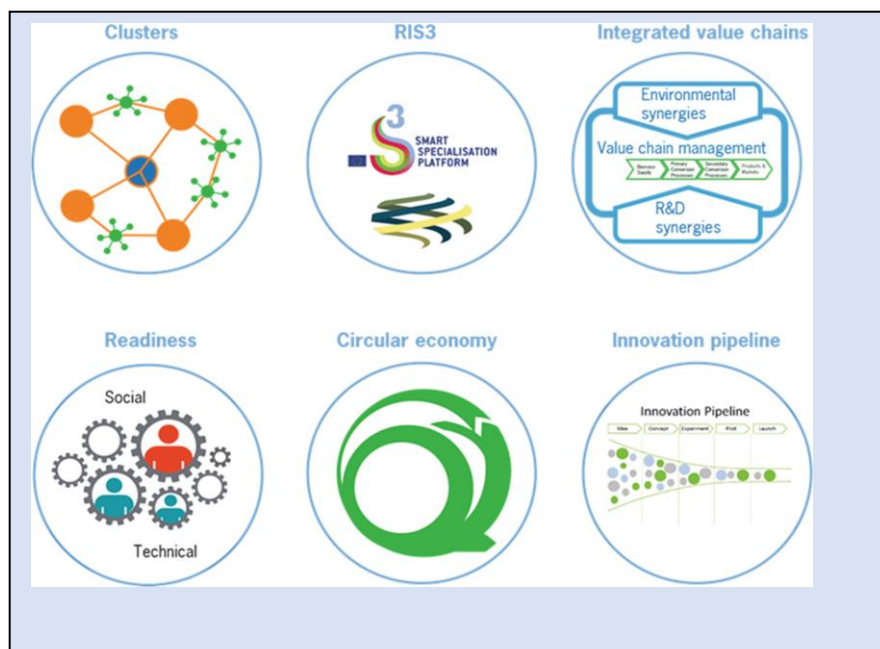


Figure 2: Regional Governance - transition management

Smart Specialization Strategies RIS3

Each region or locality has a unique combination of assets and challenges when it comes to implementing the EGD. From European regional policies and funds (ERDF), European regions

are challenged to make strategic choices to invest in specific sectors or challenges that fit with the characteristics, qualities and advantages of their economies and environment – also compared to other regions. The concept of RIS3 emerged due to insights from mission-driven innovation moving towards RIS4, with cross-sectoral challenges around public values / public purpose. Mission formulation and implementation is a collective and iterative process. Gerritsen et al (2019), consisting of (CoR, 2022) preparation, elaboration, strategy renewal and implementation.

Many European regions have mentioned the bioeconomy as one of the main drivers for regional innovation and growth. Within the bioeconomy different routes are possible, depending on the combination of availability and components of the regional biomass and the existing industries for valorization. Quadruple helix partners are challenged to discover the unique regional profile and collaboratively come to smart strategic specializations as well as make these operational in developing pathways. Quadruple helix partners commit themselves to these strategies and align their own objectives and resources with these strategies. By doing so, they create broadly supported conditions for innovation and regional growth.

Quadruple helix interplay

The idea behind transitioning towards a regional bioeconomy is the necessity of interplay between the domains of the private sector, knowledge and research, government and the civil society. The perspectives and resources from all domains are relevant to arrive to implementation, alignment and acceptance that is needed in order for an innovation to be successful. The triple helix model of innovation was firstly suggested by Etzkowitz and Leydesdorff (2000) and emphasizes networks and hybrid organizations of university-industry-government relations to provide the necessary infrastructure for innovation and economic development. The quadruple helix adds as a fourth helix the general public and civil society emphasizing societal and sociological concepts (Cavallini et al, 2016).

Innovation pipeline

The innovation pipeline represents a logical order in which innovations usually evolve from fundamental knowledge to applied knowledge, piloting and demonstrations as well as investments, business case development and upscaling. Transitions from one phase to the next do not always run smoothly. The innovation process can be supported by management, facilities and instruments. Innovations start with (1) ideation. Promising ideas need to be (2) explored and (3) tested or demonstrated. The so-called valley of death often occurs when innovations have successfully reached the demonstration phase. Then, the most difficult part is for an innovation to reach maturity (4) by implementation and full investment in a new business case. It is important to recognize these phases, characteristics and potential hurdles in advance and be prepared in order to create optimal conditions, support services, resources, incentives and facilities for the innovation process.

Readiness

Connected with the 4 phases of the Innovation pipeline are the Technological Readiness Levels (TRL). Nine TRL's are recognized and adapted by the European Commission in the Horizon 2020 program:

- TRL 1. Basic principles observed;
- TRL 2. Technology concept formulated;
- TRL 3. Experimental proof of concept;
- TRL 4. Technology validated in lab;

TRL 5. Technology validated in relevant environment

TRL 6. Technology demonstrated in relevant environment

TRL 7. System prototype demonstration in operational environment;

TRL 8. System complete and qualified;

TRL 9. Actual system proven in operational environment

These nine levels primarily focus on the development of technological aspects – or artifacts – within one innovation and on the status regarding implementation. The uptake of new technology in society, however, also depends on social aspects and acceptance, i.e., **social readiness**. Often there are innovations hampering due to lack of social conditions or acceptance. Smooth uptake involves topics and issues such as awareness raising, knowledge transfer, coalition building, addressing and coping with resistance – by compensating for real losses instead of just enforcing new realities, trust building and institutionalizing new practices.

Integrated Value Chains - Circular Economy

All regions have specific biomass from their natural resources, from their specific agricultural production, from arable farming or from biowaste streams. From this regional biomass, specific components such as sugars, fibers and proteins can be extracted or be processed by refineries in order to produce the building blocks for industries. Within regions the bio-chemical building blocks can be processed into regional specific applications that can subsequently be found in textiles, packaging, paper, bioplastics, construction and different other sectors. Another option is to connect regions with biomass availability to regions with processing facilities, industries, knowledge centers, capacities and investments. In other words, the primary sector – covering biomass producers – can be linked with industries. The value chain can thus be formed across regions. A circular economy is based on the principles of designing out waste and pollution, keeping products and materials in use and regenerating natural systems. The principles behind circular economy and the routes to (re-)use and valorize waste streams.

Regional governance - Transition management

To overcome the complexity of different partners, cultures, perspectives, disciplines, domains and phases in the development processes, suitable management concepts and techniques are needed. Transition management is a responsibility of the partners from different domains. This transition cannot be steered or managed from a specific domain or actor, but needs contributions from all domains, with their resources as budgets, capacities, knowledge, networks and initiatives. Often, an intermediate organization is being shaped, by the quadruple helix partners, as a regional service organization to support the integrated approach leading to transformative change. A cluster organization is an example of such an intermediate organization, which can support the implementation of new policies, strategies and innovations in circular bio economy, carbon neutrality, regional innovations and specializations.

Transition management should take into account strategy development (definition of a common Mission, with cross-sectoral challenges around public values / public purpose), collaboration among quadruple helix partners, innovation processes, strengthening the regional profiling of smart specialization, bringing together and attracting resources such as knowledge, human capital (capacities and capabilities), financial means (subsidies, funding and investments) and creativity. The services which are needed should be based on different aspects of change (economic, technological, environmental and social), on the phases of innovation (ideation, exploration, demonstration and implementation), and on the means for action (financial, knowledge, capacities and capabilities, creativity).

Clusters

Relevant players in regional innovation ecosystems are so-called Boundary organizations: organizations which are set up to connect different domains with each other, which are able to overcome differences (cultural, content, task orientations, competences). Boundary organizations can function as change agents. A cluster organization is a common form for strengthening the regional economies and innovations, within the European Union. "Cluster initiatives are organized efforts to support the increase and competitiveness of the regional economy, involving cluster firms, government, the research community." Certain cluster organizations are to be promoted – in terms of their forms, strategies and activities or services. Clusters play a critical role in innovation processes among firms and in regions (Lindqvist, Ketels & Sölvell, 2013). Among clusters, there is a growing attention for sustainability and green growth.

Perspectives: Art & Design Approaches for Bioeconomy

Next to the importance of mobilizing and involving financial means, different forms of knowledge and capacities, there has been growing insight within European Union that also creativity is an important mean for change and transitions, which can also be applied and used within the domain of circular bioeconomies and within European regions. Therefore the involvement of Arts and Design sector, instruments, skills and capabilities becomes increasingly relevant.

Looking at various reports of the EU about knowledge and skills related to the Green Deal (including the New European Bauhaus-program) and the bioeconomy, there are some important concepts to address in the framework.⁴ The most prominent and urgent concepts are:

- Embodying sustainable values (valuing sustainability, supporting fairness, promoting for an connecting with nature, concepts like climate change, biodiversity, circularity and zero harmful emissions), related to ethical aspects of using biological resources = Values & ethics for the bioeconomy.
- Embracing complexity in sustainability (systems thinking, critical thinking, problem framing, global versus local) = Understanding complexity of the bioeconomy.
- Envision sustainable futures (futures literacy, adaptability, exploratory thinking), related to technological, digital, social, cultural and economic opportunities (holistic, transdisciplinary approaches) = Exploring holistic future scenarios for the bioeconomy.
- Acting for sustainability (political agency, collective action, individual initiative) related to transdisciplinary collaboration (between quadruple helix actors) = Multi-stakeholder co-creation and co-development.
- Developing skills to act according to concepts, mentioned above, for understanding values & ethics, complexity, future scenarios and multi-stakeholder collaboration = Skills development and learning activities for the bioeconomy.
- Aesthetic values (the aesthetical experiences by all human senses to create positive emotions and cultural benefits) = Aesthetics.
- Inclusive values (diversity of people, accessible and affordable for all with a priority to minority groups) = Inclusivity.
- Regaining a sense of belonging (with the community, history, culture and nature), related to participatory and empowering approaches = Belonging & Empowering.

⁴ Final Report *Promoting education, training and skills across the bioeconomy*, European Commission, August 2022; Y. Punis & M. Bacigalup (eds.), *GreenComp. The European sustainability competence framework*, Joint Research Centre, European Commission, 2022; *Report on the co-design phase*, annex to the New European Bauhaus: Beautiful, Sustainable, Together, European Commission, 15-09-2021; *The New European Bauhaus policy ecosystem*, annex to the New European Bauhaus: Beautiful, Sustainable, Together, European Commission, 15-09-2021.

Art and design is a wide field of expertise with approaches which touch upon concepts, mentioned above. Artistic and design research contribute to (critical) (re)framing, potential future alternatives and concrete solution for social, ecological and economic sustainable and bio-based design (Ehrenfeld 2008; Walker & Giard 2013; Bakker et. al. 2015, Dunne & Raby 2013, Benyus 1997, Myers 2014). Within the wide concept of sustainable design, there is a number of different design disciplines, methods and tools that are useful (circular design, ecodesign, participatory and co-design, UX-design, etc.). A design approach can support in development processes especially in interdisciplinary collaborations not only by exploring applications for new technologies, materials or consumer behavior, but also by contributing the creation of new knowledge from a more holistic point of view and can contribute to ensure the integration of circularity and environmental sustainability requirements.

CLICKNL, the Dutch knowledge and innovation network of the top sector creative industry, has developed a framework for methods used by creative professionals for research and innovation processes.⁵ Key methodologies, also known as Key Enabling Methodologies (KEMs), are important groups of methods and tools with which the creative professional can tackle transition issues. They are the tools of the 'change professional', such as the consultant, designer or architect who works to bring about change. KEMs tell us how we can formulate a common goal, how we can achieve that goal and how we can develop impact for change and transitions. CLICKNL distinguishes eight groups of KEMs:

1. Vision & Imagination (methods for mapping the current world, imagining new worlds, and seeing problems differently. In this way they give direction to the change).
2. Participation & Co-creation (Methods to involve players with different interests in the change process. In this way involvement and support is achieved).
3. Behavior & Empowerment (Methods to direct behavioral change and to offer people a perspective for action when making choices).
4. Experimental Environments (Methods for experimenting with innovation directions and for testing and adjusting interventions in real-life contexts).
5. Value Creation & Upscaling (Methods for issues related to the creation of new value for society, upscaling, ownership and management).
6. Institutional Change (Methods to organize the behavior of institutions through structures and procedures).
7. System Change (Methods to work forward-looking and system-oriented when shaping transformations).
8. Monitoring & Impact Measurement (Methods for monitoring, evaluation and adjustment of the effects of interventions).

The role of art(ists) and design(ers) in the transition towards a bioeconomy

Engage4BIO is strongly focused on to bring in the citizens perspective and to use creativity as a mean for productivity and innovation for better informed decision-making and for changing behaviours. Based on the various mentioned concepts and expertise of the creative and cultural sector we've distinguished 4 categories in which art(ists) and design(ers) could play a main role in the Engage4BIO project, especially to engage civil society:

- 1. Best practices of artists and designers related to the bioeconomy (vision & imagination, creating awareness)**

⁵ <https://kems-en.clicknl.nl>

Artists and designers are most of the time frontrunners in new and urgent social, cultural and technological developments. Many of them are experimenting with new materials, production technologies and alternative ways of (re)use and ownership for the bioeconomy and address critically the pro's and con's, for instance in more utopian or dystopian future scenarios. Despite the low TRLs of these concepts, they offer different stakeholders, involved in the bioeconomy, new perspectives and future scenarios and create understanding and awareness for the challenges which they stand for. Most of the time they showcase these experiments at design weeks, art events, exhibitions at museums and galleries. Often little connection is made to all the relevant stakeholders within the ecosystems for the bioeconomy.

2. Understanding of complex (scientific) data and systems (participation & co-development, creating understanding and awareness)

Collaboration between different stakeholders means also sharing different kind of knowledge, from scientific data, complex systems and specialist (academic) language to practical experiences and a common understanding of main concepts for the bioeconomy. A special knowledge domain within the art and design disciplines is (data) visualization and prototyping to understand abstract data and complex systems in a more sensorial way. Design artefacts (for debate) will support public understanding as well.

3. Awareness campaigns and interventions by artistic and design events (*participation & co-creating/co-developing, creating awareness*)

Beside exploring existing best practices, artists and designers could be involved actively in developing awareness campaigns and events for stakeholders in very different forms of online and offline campaigns, in specific (social) art and design events or critical fashion shows and art performances. Especially campaigns for governments, business organizations and educational settings to inform consumers and users seems to be relevant as a honest, transparent and more interactive way of communication about the necessity of a bioeconomy.

4. Multi-stakeholder collaboration by art and design methods (*Participation & Co-creating*)

Many designers are trained to work with different stakeholders within design processes and to balance their many and various requirements and conditions for a common goal. Based on these skills, the role of design(ers) could be placed at the core in transdisciplinary collaboration. Specific skills to visualize and materialize concepts (prototyping in the broadest sense of this concept) will support the common understanding in multi-stakeholder collaboration (Houde & Hill 1997; Lim et. al. 2008).

Perspectives: education and learning

This section aims at providing an overview of the key concepts related to education systems and lifelong learning. For the present exercise (map analysis), we consider all type of learning activities (formal and non-formal) and also the links with existing competences frameworks of relevance (Greencomp, Lifecomp, Entrecomp for example).

A more extensive overview of the key concepts related to education and learning systems are available in this presentation: Engage4Bio Lifelong Learning Concepts

In terms of describing education activities, we can consider four main education types:

- Formal education (for example secondary school or VET (Vocational and Educational Training) programmes leading to a recognised qualification)
- Non formal education (for example short professional development courses offered by a professional association, literacy courses offered by the Municipality etc.)
- Informal education (for example, experiential learning or peer learning during a job or leisure activity)
- Awareness raising activities (activities aiming at providing general understanding of a matter and encourage learners to further their learning).

Within formal education, we can also distinguish the level, such primary and secondary education, higher education and VET

Learning activities can be delivered in a variety of formats (for example online, face to face, blended) and be short courses (few hours, days) or long educational activities (developed over weeks, months or years).

An important aspect for this exercise is also to analyze and describe a skills/competence mapping that are needed to support the uptake of bioeconomics practices. We would organize these skills/competence mapping as following:

- Transversal/systemic skills for example, system thinking and critical thinking
- Transversal/technical skills (while not specific to the sectors): economics, business management, policy, ethics, biology, technology
- Skills related to a specific sector and/or specific bioeconomics applications, for example waste disposal, recycling and storage processes, use of biomass in various industries, reconversion of industrial plants etc.

Finally, we apply a very broad concept of learners. Learners can be for example: employees, trainers, industry, SME's, business owners, training institutes and educational organizations, EU bioeconomy partner projects (in specific those ones connected to training and skill development), citizens at large, civil servants, local/regional authorities and policy makers.

2.4. Conclusions – Part 1

This deliverable gives an overview of the theoretical concepts that will be used within Engage4Bio, which will be made operational for mapping the state of the art within the regional hubs and for finding gaps within current regional innovation ecosystems and current strategies and approaches. This gap analysis will be used for defining the pathways and next steps for the transition towards the regional bioeconomies.

The canvases that will serve as the basis for the Map and Gap analysis are presented in section 2 of this deliverable.

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