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## Expert Survey: Identification of criteria that influence the success of a circular bioeconomy transition

**Background:** In the context of a publication that shall support a structured and justified selection of technologies in regional circular bioeconomy (CBE)<sup>1</sup> scenarios we conducted a literature review in order to identify criteria that influence the success of a CBE transition or of the implementation of CBE technologies. We used the search terms SWOT, driver and barrier in combination with terms referring to the CBE. We identified 24 studies and extracted from them drivers, barriers, challenges, opportunities, threats, weaknesses, etc. for CBE transition/ technology implementation, which we clustered into the seven criteria categories: biomass resource, technological, environmental, economic, political, social and methodological. We derived one to five main criteria per category and for each main criterion several sub-criteria. We documented the number of studies (given in brackets) that refer to each main and sub-criterion and ordered them based on this by relevance.

**Expert survey:** the goal of this survey is to validate/improve the criteria selection and their sorting by relevance that we derived from the literature review. With the survey we hope to identify further important main and/or sub-criteria that we could not find in the literature. We are furthermore interested in feedback on the ordering of the criteria by relevance that we derived from the review. Therefore, we ask the experts either to agree with the selection/sorting of main /sub-criteria (tick box) or to propose changes by adding main/ sub-criteria and/or by giving feedback/making different suggestions on the criteria sorting (write into boxes).

We will integrate the results from the survey into the criteria list that will be part of the envisaged publication.

**Timing:** We expect the survey not to take longer than 30 minutes.

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<sup>1</sup> circular bioeconomy - we apply a definition by Stegmann et al (2020), however the publications reviewed for criteria identification might use different definitions:

“The circular bioeconomy focuses on the sustainable, resource-efficient valorization of biomass in integrated, multi-output production chains (e.g. biorefineries) while also making use of residues and wastes and optimizing the value of biomass over time via cascading. Such an optimization can focus on economic, environmental or social aspects and ideally considers all three pillars of sustainability. The cascading steps aim at retaining the resource quality by adhering to the biobased value pyramid and the waste hierarchy where possible and adequate.”

**Stegmann**, Paul; Londo, Marc; Junginger, Martin (2020): The circular bioeconomy: Its elements and role in European bioeconomy clusters. In: *Resources, Conservation & Recycling: X* 6, S. 100029. DOI: 10.1016/j.rcrx.2019.100029.

| CRITERIA<br>CATEGORY | main criteria (no. of publications mentioning the main criterion)<br>- sub-criteria (no. of publications mentioning the sub-criterion)   | <div>I agree with the selectin of main criteria</div> <div>I agree with the order of sorting (by relevance): main criteria</div> <div>I cannot make a choice, because I am no expert in this sub-field</div> <div>I agree with the selection of sub-criteria</div> <div>I agree with the order of sorting (by relevance): sub-criteria</div> |  |  |  |  | I want to add one or more main criteria | I want to add one or more sub-criteria | I want to change the order of sorting (by relevance) of main or sub-criteria |
|----------------------|--|--|--|--|--|--|---|--|--|
|                      |  |  |  |  |  |  |   |  |  |
| BIOMASS<br>RESOURCE  | <b>biomass availability (20)</b><br>- temporal fluctuation in biomass availability (7)<br>- competing biomass uses   security of biomass supply in long term (7)<br>- sustainably available biomass (5)<br>- distribution of biomass availability (point vs. non-point sources*) (1)<br>- local biomass availability (1) |  |  |  |  |  |   |  |  |
|                      | <b>biomass quality (6)</b><br>- no standardization of inputs (1)<br>- changes in composition and qualities (1)<br>- toxicant sensitivity (1)   |  |  |  |  |  |   |  |  |
| TECHNO-<br>LOGICAL   | <b>logistic &amp; supply chain (17)</b><br>- storage and transportation (5)<br>- space for/ position of facility (4)<br>- waste collection systems (3)<br>- waste separation (1)<br>- high demands: electricity, water... (1)  |  |  |  |  |  |   |  |  |
|                      | <b>availability of technology (17)</b><br>- maturity of technology   need for scale up (7)<br>- technology efficiency   conversion rates (5)<br>- successful technology showcases (3)<br>- complexity of technology   ease of adoption (1)   |  |  |  |  |  |   |  |  |
|                      | <b>availability of knowledge/expertise   R&amp;D (11)</b><br>- locally based scientific institutions (2)<br>- local tradition of knowledge (1)<br>- advances in sciences (e.g. biological and CIT) (1)   |  |  |  |  |  |   |  |  |
| ENVIRON-<br>MENTAL   | <b>potential to mitigate/increase environmental issues** (14)</b><br>- climate change (6)<br>- biodiversity   ecosystems (6)<br>- resource efficiency   circularity (6)<br>- land use (change) (3)<br>- soil- and water quality (2)<br>- waste generation (1)  |  |  |  |  |  |   |  |  |
|                      | <b>sensitivity towards environmental changes/ issues*** (14)</b><br>- climate change (3)<br>- soil conditions (2)<br>- water scarcity (1)  |  |  |  |  |  |   |  |  |

\* e.g. beet pulp from a big sugar factory as point source vs. biowaste from households as non-point source

\*\* e.g. a CBE product has the potential to replace a fossil-based product and thereby to reduce climate change impacts

\*\*\* e.g. the production of a CBE product is threatened by climate change, as the crops whose residues are valorised can no longer be cultivated under changing climate conditions

| CRITERIA<br>CATEGORY | main criteria (no. of publications mentioning the main criterion)<br>- sub-criteria (no. of publications mentioning the sub-criterion)  | <div>I agree with the selectin of main criteria</div> <div>I agree with the order of sorting (by relevance): main criteria</div> <div>I cannot make a choice, because I am no expert in this sub-field</div> <div>I agree with the selection of sub-criteria</div> <div>I agree with the order of sorting (by relevance): sub-criteria</div> |  |  |  |  | I want to add one or more main criteria | I want to add one or more sub-criteria | I want to change the order of sorting (by relevance) of main or sub-criteria |
|----------------------|---|--|--|--|--|--|---|--|--|
|                      |   |  |  |  |  |  |   |  |  |
| ECO-NOMIC            | <b>profitability &amp; markets (18)</b><br>- competitiveness (with fossil counterparts) (7)<br>- fluctuations in fossil fuel's prices (1)<br>- cost-effectiveness (6)<br>- market demand   unfavourable markets (6)<br>- value creation from waste/ by-products (4)<br>- immature markets   need to develop new market (4)<br>- economic benefits due to multiple product output (3)<br>- knowledge of customer's needs (3)<br>- business diversification (3) |  |  |  |  |  |   |  |  |
|                      | <b>investment (15)</b><br>- need for financial investment (9)<br>- public incentives and subsidies (8)<br>- private investor's interest (5)<br>- lack of financial resources (2)  |  |  |  |  |  |   |  |  |
|                      | <b>operational costs (9)</b><br>- costs of biomass (6)<br>- logistic costs (4)  |  |  |  |  |  |   |  |  |
|                      | <b>general socio-economic development (3)</b><br>- population development (2)<br>- economic crises (1)  |  |  |  |  |  |   |  |  |
| POLITICAL            | <b>policies, legislation &amp; standards (18)</b><br>- supporting policies and legislation (10)<br>- unfavourable   inadequate policies and legislation (9)<br>- missing policies and legislation (5)<br>- inconsistent policies and legislation (1)<br>- normative tools such as technical standards and certifications (1)<br>- availability and direction of regional policies and legislation (1)   |  |  |  |  |  |   |  |  |
|                      | <b>policy implementation (8)</b><br>- ineffectual execution (4)<br>- uncertainties in future legislation (predictable, less turbulent) (3)<br>- excessive bureaucracy (2)   |  |  |  |  |  |   |  |  |

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|----------------------|--|---|--|---|--|---|--|--|--|
| SOCIAL               | <b>cooperation (16)</b><br>- stakeholder involvement (7)<br>- clusters & networks (7)  |   |  |   |  |   |  |  |  |
|                      | <b>jobs &amp; labour (15)</b><br>- availability of skilled labour (10)<br>- job creation (in rural areas) (6)<br>- labour conditions (1)   |   |  |   |  |   |  |  |  |
|                      | <b>consumer awareness (product) (14)</b><br>- green consumerism (bio-based and waste valorisation) (9)<br>- awareness of CBE products (6)<br>- consumer's perception of product quality (e.g. non-primary cycle) (4)<br>- regionality of products (2)<br>- consumer reluctance to change (1)                         |   |  |   |  |   |  |  |  |
|                      | <b>social acceptance (production) (12)</b><br>- public acceptance (7)<br>- competition for biomass with food production (5)<br>- interfering civil society   promotion to increase acceptance (5)<br>- impacts on human health (1)   |   |  |   |  |   |  |  |  |
|                      | <b>company culture   regional culture (11)</b><br>- commitment to sustainability, esp. environ. protection (4)<br>- vision-driven culture   willingness to change (4)<br>- willingness to cooperate (2)<br>- closed-loop thinking (2)<br>- innovative, agile, imaginative and creative (1)<br>- non-hierarchical (1) |   |  |   |  |   |  |  |  |
| METHODO-<br>LOGICAL  | <b>uncertainties in environmental &amp; economic assessment (3)</b><br>- availability of (standardized) methodologies (3)<br>- availability of data for econ./ environ. evaluation (2)<br>- availability of results (1)  |   |  |   |  |   |  |  |  |

I am an expert in the field of:

My name and affiliation are:

**Acknowledgement:**

I would appreciate if my contribution could be acknowledged in the publication, with my name mentioned.

I would prefer to remain anonymous.

I am fine with both options.