SCALE UP
community-driven
bioeconomy development

SCALE-UP Information Package

T2.4 Review and preparation of existing scientific and technological information supporting bio-based solutions

Region:	Upper Austria
Organization:	TMG
Biomass stream/value chains:	Food waste
Bio-based solutions:	Spent brewery grains, bakery waste products

This information package aims at reviewing and collecting information relevant to the SCALE-UP project and for the regional platforms. Relevant studies should aim at supporting the bio-economy rollout in the SCALE-UP regions and of the specific bio-based solutions.

Information on the following topics will be gathered:

1. EU Policies and legislation
2. Research projects
3. Local policies
4. Technical Information on specific biobased solutions
5. Biomass availability & Nutrient recycling

1. EU Policies & Legislation

EU policies and legislation relevant to the SCALE-UP project and bio-based solution.

Other sources of interest: JRC Knowledge Centre for Bioeconomy (English) JRC Knowledge Centre for Bioeconomy (German)

List of important EU policies and legislation

	Date	Name	Link	Translation link (English → German)	Summary of contents	Relevance to the SCALE-UP project	Relevance to the specific bio-based solutions
1	02-2012	**EU bioeconomy strategy**	https://op.europa.eu/en/publication-detail/-/publication/edace3e3-e189-11e8-b690-01aa75ed71a1/language-en/format-PDF/source-149755478	https://op-europa-eu.translate.goog/en/publication-detail/-/publication/edace3e3-e189-11e8-b690-01aa75ed71a1/language-en/format-PDF/source-149755478?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp	The 2012 European Bioeconomy Strategy paved the way for a more innovative, resource-efficient and competitive society that reconciles food security with the sustainable use of renewable resources for industrial purposes, while ensuring environmental protection. A comprehensive review concluded that it has been a success, notably at mobilising research and innovation, boosting private investments, developing new value chains, promoting the uptake of national bioeconomy strategies and involving stakeholders.	The EU bioeconomy strategy aims at strenghtening and scaling-up bio-based sectors, as well as deploying local bioeconomies across Europe. Through: -The deployment of the bioeconomy will lead to the creation of jobs, especially in rural areas through the growing participation of primary producers in local bioeconomies. -The bioeconomy strategy sets as one of its main goals to support research and innovation and deployment of innovative solutions for the production of new and sustainable bio-based products. -A Strategic Deployment Agenda will be developed, which will provide a long-term vision on pathways to deploy and scale up the bioeconomy in a sustainable and circular manner. -Enhance synergies between existing EU instruments to support local activities. -CAP to support bioeconomies in rural areas.	Relevant to the specific bio-based solutions: -It aims at increasing the availability of secondary materials (such as feed and biowaste) for further exploitation through conventional technologies (e.g. composting and anaerobic digestion) and innovative ways of extracting valuable substances. Innovation is expected to support markets for bio-based products, where one industry's waste becomes the starting material for another. -It addresses new opportunities for the forestry sector, where non-sustainable raw materials in various sectors are replaced with forestry-based materials and chemicals. -Biowaste and residues can be used as valuable resources and can help reduce food waste by 50% by 2030.
2	2019	**European Green Deal**	https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en	https://commission-europa-eu.translate.goog/strategy-and-policy/priorities-2019-2024/european-green-deal_en?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp	European Green Deal is a set of comprehensive and integrated to transform the EU into a modern, resource-efficient and competitive economy, ensuring no net emissions of green house gases by 2050 and economic growth decoupled from reseource use.	The Green Deal includes measures in agriculture on the reduction of environmental and climate foodprint and increase of competative sustainablility from farm to fork (see below). In the energy sector the Green Deal includes measures to promote eco design of products en renewable energy from sustainable biomass resources.	
3		**European Digital Strategy**	https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age_en	https://commission-europa-eu.translate.goog/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age_en?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wa	The EU's digital strategy aims to make this transformation work for people and businesses, while helping to achieve its target of a climate-neutral Europe by 2050.	EU's digital strategy recognises that digital technologies are profoundly changing our world, and generate an ever-increasing amount of data, which if pooled and used properly, can lead to completely new means and levels of value creation, leading towards more sustainable solutions which are resource-efficient, circular and climate-neutral.	Real time tracking, new, added-value creations, interconnections, boosting bio-based solutions driven by new, high and/or deep technologies
4	02-2020	**European data strategy**	https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy_en	https://commission-europa-eu.translate.goog/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy_en?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp	The European data strategy aims to make the EU a leader in a data-driven society. Creating a single market for data will allow it to flow freely within the EU and across sectors for the benefit of businesses, researchers and public administrations.	The EU is creating a single market for data where data can flow within the EU and across sectors, for the benefit of all European rules, in particular privacy and data protection, as well as competition law, are fully respected the rules for access and use of data are fair, practical and clear	By having more information, consumers and users such as farmers, airlines or construction companies will be in a position to take better decisions such as buying higher quality or more sustainable products and services, thereby contributing for example to the Green Deal objectives.

5	01-2023	**Common Agricultural Policy (CAP) CAP 2023-27**	https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/cap-glance_en#cap2023-27	https://agriculture-ec-europa-eu.translate.goog/common-agricultural-policy/cap-overview/cap-glance_en?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=en-US&_x_tr_pto=wapp#cap2023-27	The CAP 2023-2027 must be oriented more than ever to respond to the specific needs of the agricultural sector and rural areas in terms of equity, distribution of support, instruments and characteristics, after the serious health crisis caused by COVID. To achieve these objectives, the CAP is focusing on innovation, CAP Strategic Plans (in line with the objectives and targets of the "Green Deal"), giving the EU a greener and fairer CAP.	The CAP 2023-2027 includes "support for rural development" as one of its focal points through the development of a wide range of tools including: Funding for investment, knowledge creation, innovation and cooperation will in many cases be targeted at environmental and climate-related needs, but will also serve other CAP objectives.	Within the CAP 2023-2027, it is indicated that the improvement of existing requirements is also a necessary condition for the improvement of agricultural sustainability, for this purpose, measures are proposed to improve soil health in the long term, so farmers are required to carry out beneficial crop rotations (among other measures). On the other hand, a wide range of types of action are proposed, including ecosystems that support voluntary actions related to better nutrient management, agroecology, agroforestry, carbon farming or animal welfare (among others).
6	05-2020	**Farm to Fork strategy**	https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en	https://food-ec-europa-eu.translate.goog/horizontal-topics/farm-fork-strategy_en?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=en-US&_x_tr_pto=wapp	The Farm to Fork Strategy is a set of measures to accelerate the transition to a sustainable food system that should have a neutral or positive environmental impact help to mitigate climate change and adapt to its impacts, reverse the loss of biodiversity ensure food security, nutrition and public health, making sure that everyone has access to sufficient, safe, nutritious, sustainable food preserve affordability of food while generating fairer economic returns, fostering competitiveness of the EU supply sector and promoting fair trade.	The Farm to Fork Strategy includes measures to promote sustainable food production and processing (including nutrient recycling). This includes measures on the compatativeness of the EU food supply sector including use of residues for bioproducts	

2. Research Projects

Please add Interreg, Horizon 2020, Horizon Europe projects, and other projects that you find relevant to the SCALE-UP project and for your bio-based solutions.

Other sources of interest:	JRC Knowledge Centre for Bioeconomy (English)	JRC Knowledge Centre for Bioeconomy (German)

List of relevant projects

	Start month	End month	Name	Project website	Translation link (English to German)	Project summary	Relevance to the SCALE-UP project	Relevance to the specific bio-based solutions	Activities of interest	Comments
1	1-9-2022	1-8-2025	**MainstreamBIO**	https://mainstreambio-project.eu/	https://mainstreambio--project-eu.translate.goog/?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp	MainstreamBIO sets out to get small-scale bio-based solutions into mainstream practice across rural Europe, providing a broader range of rural actors with the opportunity to engage in and speed up the development of the bioeconomy. Regional Multi-actor Innovation Platforms (MIPs) will be established in 7 EU countries (PL, DK, SE, BG, ES, IE and NL) to enhance cooperation among key rural players towards co-creating sustainable business model pathways in line with regional potentials and policy initiatives.	Innovation support services,Decision Support System, Multi-actor Innovation Platforms, Digitalisation and Practice abstracts.	Some cases related with our 12 bio-based solutions (potential exchange of good practices and Knowledge)	WP4, WP5	SCALE-UP sister project
2	1-10-2022	1-9-2025	**RuralBioUp**	https://www.ruralbioup.eu/	https://www-ruralbioup-eu.translate.goog/?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp	RuralBioUp will strengthen the cooperation among regional key actors and knowledge holders, empowering them to establish an inclusive and long-lasting ecosystem (the RuralBioUp Regional Hubs) to support the mainstreaming of bio-based business models in rural areas. In particular, RuralBioUp will establish 9 Regional Hubs in 6 EU countries, that will co-design and implement 9 Action Plans on 18 value chains.	9 regional hubs (one multi-stakeholder hub) are established in 6 EU countries (France, Romania, Czech Republic, Ireland, Latvia and Italy). 9 Action Plans will be implemented in 18 value chains.	Biomass value chain development: Biomass logistic, Valorisation, Communities. Lessons learnt	WP4, WP5	SCALE-UP sister project
3	1-9-2022	1-8-2025	**BioRural**	https://biorural.eu/	https://biorural-eu.translate.goog/?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp	BioRural's goal is to create a European Rural Bioeconomy Network to promote small-scale bio-based solutions in rural areas and support the transition towards a sustainable, regenerative, inclusive and just circular Bioeconomy across all Europe at local and regional scale.	BioRural focusses on EU-level developments, it does not feature any regional case studies.	Rural Bioeconomy Alliance. Network. Cooperate to promote the currently available small-scale bio-based solutions		SCALE-UP sister project
4	1-4-2019	1-7-2022	**BE-Rural**	https://be-rural.eu/	https://1-be--rural-eu.translate.goog/?_x_tr_enc=1&_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp	BE-Rural aimed at exploring the potential of regional and local bio-based economies and support the development of bioeconomy strategies, roadmaps and business models. To this end, the project focused on establishing Open Innovation Platforms (OIPs) within selected regions in five countries: Bulgaria, Latvia, North Macedonia, Poland and Romania.		Case study in North Macedonia (focussing on Mycelium-based packaging and insulation material); Case study in Latvia (foussing on wood wool)	D5.1 "Briefing paper: Analysing market conditions and designing business models within BE-Rural's OIPs"; D5.2 "Summary report on small-scale bio-based business models and their market potentials"; D5.4 "Note on the development of a sustainability screening for regional bioeconomy strategies"	Power4Bio sister project
5	1-10-2018	1-3-2021	**POWER4BIO**	https://power4bio.eu/	https://power4bio-eu.translate.goog/?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp	POWER4BIO project aimed at empowering regional stakeholders to boost the transition towards bioeconomy regions in Europe by providing them with the necessary tools, instruments and guidance to develop and implement sound sustainable bioeconomy strategies. POWER4BIO targeted 10 regions with a focus on regions in Central and Eastern Europe.		Case study in Andalusia (focussing on Bioeconomy Strategy and Available Biomass Sources At Regional Level (Olive Biomass, Intensive Horticulture and Seaweed production)) and Mazovia (agricultural residues)	D3.3 "Catalogue with bio-based solutions"; D6.4 "Training design and materials for increasing the bioeconomy capacity of regional stakeholders"	BE-Rural sister project; certain outputs related to the development of bio-based solutions were classified as confidential and are thus not publicly available.

Other projects

	Start month	End month	Name	Project website	Translation link (English to German)	Project summary	Relevance to SCALE-UP	Comments
1	09-2022	08-2025	**ShapingBio**	https://www.shapingbio.eu/	https://www-shapingbio-eu.translate.goog/?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp	The overall aim of ShapingBio is to support and accelerate bioeconomy innovation and the deployment of new knowledge in the EU and its member states. ShapingBio aims to provide evidence-based and concrete information and recommendations for better policy alignment and stakeholder actions to realize the cross-sectoral potential of the bioeconomy and to reduce the fragmentation across bio-based sectors and food system and policies across regions, domains and governance levels.	Promote innovation in the EU bioeconomy.	ShapingBio focusses on EU macro-regions, it does not feature any rural case studies.
2	07-2022	06-2025	**BioModel4Regions**	https://www.biomodel4regions.eu/	https://www-biomodel4regions-eu.translate.goog/?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp	BIOMODEL4REGIONS aims to support the establishment of the innovative governance models at local/regional level to achieve better-informed decision-making processes, social engagement and innovation to support and strengthen EU and international science-policy interfaces to achieve the Sustainable Development Goals.	Support regional bioeconomies.	
3	09-2022	08-2025	**CEE2ACT**	https://www.cee2act.eu/	https://www-cee2act-eu.translate.goog/?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp	CEE2ACT will empower countries in Central Eastern Europe and beyond to develop circular bioeconomy strategies and action plans through knowledge transfer and innovative governance models enabling sustainability and resilience to achieve better informed decision-making processes, societal engagement and innovation, building on the practice of experienced countries serving as role models.	Development of bioeconomy strategies.	CEE2ACT focusses on national-level developments, it does not feature any regional/rural case studies.
4	09-2022	08-2025	**ROBIN**	https://robin-project.eu/	https://robin--project-eu.translate.goog/?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp	ROBIN aims to empower Europe's regions to adapt their governance models and structures in ways that accelerate the achievement of their circular bioeconomy targets while promoting social innovation and accounting for different territorial contexts. In this context, ROBIN will support 5 regional authorities across Europe (Southern Region of Ireland, Central Macedonia, Andalusia, Baden-Wuerttemberg, Zilina) to adapt their governance models to support the scaling up of the bio-based value chains of their ecosystem.	Regional bioeconomy development, as well as social innovation in the bioeconomy, which is covered in WP5 of SCALE-UP.	
5	06-2022	05-2025	**RELIEF**	https://relief.uop.gr/	https://relief-uop-gr.translate.goog/?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp	RELIEF aims to develop and deliver an innovative approach for teaching bio-economy in farming, by developing specific learning resources addressing HEIs students and farming practitioners. RELIEF will deliver a training needs analysis and develop two curricula in bio-economy, for HE students, farming practitioners and farmers exploring the key areas that are critical for the implementation of business models and strategies towards bio-economy in farming.	Training courses on bioeconomy, also covered in WP3 of SCALE-UP.	
6	01-2021	06-2023	**COOPID**	https://coopid.eu/	https://coopid-eu.translate.goog/?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp	Wtin COOPID, a network of bioeconomy clusters from 10 European countries has been created, involving a range of stakeholders: primary producers, in cooperatives or associations, within agriculture, forestry and aquaculture; industry; public sector; research and academia. So-called COOPID ambassadors showcased success stories, organised workshops and conducted interactive dissemination and communication campaigns. The focus was on the uptake of sustainable bio-based business models in the primary production sector.	Development of bioeconomy clusters.	D4.2 "Success story factors for biobased Business models"
7	12-2022	11-2026	**P2GreeN**	https://p2green.eu/	https://p2green-eu.translate.goog/?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp	P2GreeN will implement and demonstrate innovative N & P recovery solutions based on human sanitary waste from urban settlements and its conversion into safe bio-based fertilisers for agricultural production. The project will test the solutions in three pilot regions on a north-south trajectory.	Nutrient recovery is a part of SCALE-UP.	

3. Regional, National & Local policies

Please add the local policies (including strategies, roadmaps, incentives, subsidy schemes and regulatory information) that you find relevant to the SCALE-UP project and to your bio-based solutions.

List of relevant policies

	Year	Regional/Provincial/National	Title	Link	Translation link	Author/Publisher:	Policies	Relevance to the SCALE-UP project	Relevance to the specific bio-based solutions
1	2019	National	**Bioeconomy Strategy for Austria**	https://www.bmk.gv.at/en/topics/climate-environment/climate-protection/bioeconomy/strategy.html	https://www-bmk-gv-at.translate.goog/en/topics/climate-environment/climate-protection/bioeconomy/strategy.html?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=en-US&_x_tr_pto=wapp	Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology	The long-term goal of the bioeconomy is to reduce fossil material and energy consumption and at the same time substitute it with renewable raw materials. The basis for action here is formed by European and international objectives and commitments such as the Paris Climate Agreement or the United Nations Sustainable Development Goals (SDGs) made binding in the 2030 Agenda. In the Austrian strategy, these goals were placed in front in the form of guidelines, which thus form the framework for the further design of future bioeconomy measures.	The strategy sets concrete measures for the bioeconomy rollout in Austria..... (Please try to be specific)	The strategy aims at promoting innovative bio-economy related concepts, services and goods. This is done through increased patents and scientific publications that can be relevant as they.... (Please try to be specific)
2	2023	Regional	**UpperVision#2030**	uppervision.at	https://www.uppervision.at/	: Business Upper Austria – OÖ Wirtschaftsagentur GmbH und Amt der Oö. Landesregierung	In order to secure Upper Austria as a business, industrial and research location and to maintain its international competitiveness, it must be our aim to drive forward the development of products, services and technologies and to generate more start-up research, technology-oriented and exporting companies in Upper Austria. We are relying on Smart Specialization and the rapid transfer of research results to economic to bring Upper Austria to the forefront of technological developments.	#upperVISION2030 tracks not only economic but also socio-political trends with a view to sustainability goals and thus creates synergies with the UN Agenda 2030	One goal in this vision is to develop technological processes that increase flexibility with regard to the use of raw materials, enable the cascading or combined use of raw and residual materials, and thus generate additional value added. and thus generate additional value added.
3	2012	National	**Rückstände aus der Nahrungs- und Genussmittelproduktion**	untitled (umweltbundesamt.at)	-	Umweltbundesamt - Environment Agency Austria	The annual generation of residues from plant based food and feed production industries is estimated to be 1.26 million tonnes in Austria. This is about 10 times the amount of waste from plant based food and feed production reported to be treated. The main reason for the difference is that by far the biggest majority of these residues is used as feed and thus classified as by-product. On the whole the Austrian food and feed industry in cooperation with the Austrian waste management sector follows the waste hierarchy as specified by the waste framework directive (2008/98/EC): 1. Waste is prevented by optimising the production processes; 2. If possible residues from food and feed industry are used as food and feed in secondary applications; 3. Residues which cannot be used as food or feed are composted, 4. or used as input for biogas generation. (Thermal treatment plays only a small part, but if applied, the energy is recovered.) 5. There is no depositing of food and feed waste in Austria as these are reac tive, biodegradable waste types.	Bakery production waste products	The report contains information on valorization options of food waste (including bakery products) and which valorization option of food waste would be considered as up-scaling or downscaling
4	2018	local, based on EU	**Guidelines for the use of food that is no longer intended for human consumption as animal feed**	https://eur-lex.europa.eu/legal-content/DE/TXT/PDF/?uri=CELEX:52018XC0416(01)&from=EN	-		As an integral part of the Communication on a Circular Economy (1), the Commission has developed an Action Plan to reduce food waste. One of the initiatives is about, recovering the nutrients in foods that are no longer fit for human consumption for economic reasons, or because of problems in production or because of certain deficiencies, by using them safely in animal feed.	food waste used as feed	the report contains information on usage of food/food waste as feed.

4. Technical information on specific bio-based solutions

Please add technical information, including scientific information, peer-reviewed articles, reports, and other data or research that you find relevant to the bio-based solutions.

List of relevant technical information

Solution 1: Spent brewery grains

Solution 2: Bakery production waste products

Solution 3:

	Date	Author(s)	Title	Link	Translation link (English -> German)	Organizations	Summary of contents	Relevant to which solution?	Why is it relevant?	Comments
1	2005	Winfried Russ. Heinrich Mörtel. Roland Meyer-Pittroff	**Application of spent grains to increase porosity in bricks**	Application of spent grains to increase porosity in bricks - ScienceDirect	https://www-sciencedirect-com.translate.goog/science/article/abs/pii/S0950061804001187?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp		The dumping of spent grains is going to be more difficult because of the increasing number of cattle. That means new ways of dumping must be developed. The goal of the work was to test the technical properties of bricks produced with spent grains added to increase porosity. The flexural strength of the fired samples remained at 8.5 MPa; the air-dried samples exhibited a small increase in flexural strength. The shrinkage and true density were almost identical, while the raw density, capacity for water absorption and open porosity showed minor differences. In the large-scale experiment no problems were observed during the production. The bricks produced with spent grains possessed a comparable or higher strength, a higher porosity and a reduced density after firing than those from a standard production clay. Because of the lower sintering temperatures the fired clay product was more strongly sintered, exhibiting both greater strength and higher porosity.	Spent brewery grains	The study describes a way how to valorize spent grains from brewery in a cross-sectoral application.	
2	2022	Zeinab Qazanfarzadeh. Abirami Ramu Ganesan. Loredana Mariniello. Lorenza Conterno. Lorenza Conterno	**Valorization of brewer's spent grain for sustainable food packaging**	Valorization of brewer's spent grain for sustainable food packaging - ScienceDirect	https://www-sciencedirect-com.translate.goog/science/article/abs/pii/S0959652622053008?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp		The accumulation of petroleum-based plastics causes economic and environmental concerns which necessitate a comprehensive search for biodegradable packaging materials. Brewer's spent grain (BSG) is an interesting by-product, which is one of the main wastes of beer production in Europe. BSG could offer added value in the food packaging sector owing to the significant amount generated annually, high biomaterials content, and low market value. Herein, the significance of various biorefinery techniques (physical, chemical, and biological) for the extraction of high-value products (such as protein, cellulose, hemicellulose, lignin, and phenolic compounds) from the BSG are comprehensively examined. BSG-derived biodegradable films and coatings for food packaging are critically evaluated. Finally, techno-economics, environmental impacts, energy consumption, regulations, challenges, and prospects are also critically evaluated. The best biorefinery system necessitates a balance between extraction efficiency, energy consumption, environmental impact, tangible upscaling, and operating cost. The mechanical dewatering of BSG before extraction, including the physical pretreatments, utilization of green solvents, the integration of the solvent recovery system, and the combination of two or more biorefinery techniques could reduce the energy requirements, greenhouse gas emissions, and increase the recovery yield of biomaterials. Cellulose, lignin, xylitol, and arabinoxylan are recommended as the most promising components from BSG for food packaging	Spent brewery grains	This review describes different ways how spent brewery grains could potentially be used as a film and coating material for food packaging as well as ways on how to improve the environmental impact of BSG.	
3	2022	Anđela Zeko-Pivač. Marina Tišma. Polona Žnidaršič-Plazl. Biljana Kulisic. George Sakellaris. Jian Hao. Mirela Planinić.	**The Potential of Brewer's Spent Grain in the Circular Bioeconomy: State of the Art and Future Perspectives**	Frontiers | The Potential of Brewer's Spent Grain in the Circular Bioeconomy: State of the Art and Future Perspectives (frontiersin.org)	https://www-frontiersin-org.translate.goog/articles/10.3389/fbioe.2022.870744/full?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp	Josip Juraj Strossmayer University of Osijek	Brewer's spent grain (BSG) accounts for approximately 85% of the total mass of solid by-products in the brewing industry and represents an important secondary raw material of future biorefineries. Currently, the main application of BSG is limited to the feed and food industry. There is a strong need to develop sustainable pretreatment and fractionation processes to obtain BSG hydrolysates that enable efficient biotransformation into biofuels, biomaterials, or biochemicals. This paper aims to provide a comprehensive insight into the availability of BSG, chemical properties, and current and potential applications juxtaposed with the existing and emerging markets of the pyramid of bio-based products in the context of sustainable and circular bioeconomy. An economic evaluation of BSG for the production of highly valuable products is presented in the context of sustainable and circular bioeconomy targeting the market of Central and Eastern European countries (BIOEAST region).	Spent brewery grains	This review describes the state of the art of how brewer's spent grain (BSG) is used in circular bioeconomy at the moment at what potential uses in the future could be.	

4	2021	Samuel Vinícius Bonato. Diego Pacheco. Carla Schwengber ten Caten. Dario Caro.	**Circularity in small breweries' value chains: Unveiling strategies for waste management and biomass valorization**	(PDF) Circularity in small breweries' value chains: Unveiling strategies for waste management and biomass valorization (researchgate.net)	https://www-researchgate-net.translate.goog/publication/357446700_Circularity_in_small_breweries'_value_chains_Unveiling_strategies_for_waste_management_and_biomass_valorization?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp&_x_tr_hist=true	Universidade Federal do Rio Grande (FURG)	Despite the large quantities and possibilities of reuse of the by-products (solids and liquids) generated by the brewing industry, the proper disposal of these by-products has imposed severe problems for circular and cleaner production transitions worldwide. These challenges are still more salient for the small breweries due to the recognized lack of resources, such as knowledge, finances, and skilled staff. To address this problem, this article aims to identify sustainable strategies for waste management and biomass valorization that can be implemented in the value chain of small breweries. A mixed-method approach was implemented for the data collection and analysis to expand the evidence of the findings, including interviews with 18 small breweries and six specialists in the sector. We found that breweries mainly dispose of the by-products for animal feeding, although industry experts and the specialized literature indicate that at least 21 reuse and recycling alternatives have not been implemented in the value chain. Findings add to the literature five new alternatives informed by companies and six informed by experts for circular and cleaner production realization in small breweries' value chains. Furthermore, the article proposes a novel conceptual model to facilitate waste management and biomass valorization realization in small breweries value chains. Findings provide new insights that complement previous studies to overcome the challenges for waste management and biomass valorization in the sector. The article offers implications for theory, policymakers and managerial practice with repercussions on the production, environmental and financial issues.	Spent brewery grains	In this study different options of BSG valorization for small breweries were described as well as alternatives to using BSG as spent grains.	Particularly interesting could be the table with the valorization options on page 3.
5	2022	Philimon D. Nganyira. Godlisten N. Shao. Jovine K. Emmanuel	**Evaluating the potential applications of brewers' spent grain in biogas generation, food and biotechnology industry: A review**	(PDF) Evaluating the potential applications of brewers' spent grain in biogas generation, food and biotechnology industry: A review (researchgate.net)	https://www-researchgate-net.translate.goog/publication/364429146_Evaluating_the_potential_applications_of_brewers'_spent_grain_in_biogas_generation_food_and_biotechnology_industry_A_review?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp&_x_tr_hist=true	University of Dar Es Salaam, Mkwawa University College of Education	Breweries, as the major users of fossil fuels, are constantly under economic and environmental pressure to minimize energy consumption and residual management costs. Biogas generation from brewing wastes is a realistic solution for significantly reducing fossil fuel use. Brewers' spent grain (BSG) forms about eighty per cent of the total wastes from a brewing plant. BSG has a high cellulose and non-cellulosic polysaccharides content which makes it potential for biogas production. This paper reviews the potential applications of BSG as an alternative substrate for production of biogas and the recent achievements which have been attained in anaerobic digestion (AD) technology. The usability of BSG in diverse technologies including production of animal and human food and as a medium for growing microorganisms and enzymes is reviewed. The chemical processes involved in producing biogas from BSG are discussed.	Spent brewery grains	A review of potential applications of BSG in different technologies.	
6	2022	Ines Ben Rejeb. Ichrak Charfi. Safa Baraketi. Hanine Hached. Mohamed Gargouri.	**Bread Surplus: A Cumulative Waste or a Staple Material for High-Value Products?**	Molecules | Free Full-Text | Bread Surplus: A Cumulative Waste or a Staple Material for High-Value Products? (mdpi.com)	https://www-mdpi-com.translate.goog/1420-3049/27/23/8410?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp	University of Carthage, Université Libre de Tunis	Food waste has been widely valorized in the past years in order to develop eco-friendly materials. Among others, bread waste is currently of increasing interest, as it is considered a huge global issue with serious environmental impacts and significant economic losses that have become even greater in the post-pandemic years due to an increase in cereal prices, which has led to higher production costs and bread prices. Owing to its richness in polysaccharides, bread waste has been previously studied for its physico-chemical characteristics and its numerous biotechnological applications. The present review highlights the re-use of bread waste and its valorization as a valuable resource by making value-added products through numerous technological processes to increase efficiency at all stages. Many research studies reporting several transformation methods of surplus bread into ethanol, lactic acid, succinic acid, biohydrogen, hydroxymethylfurfural, proteins and pigments, glucose–fructose syrup, aroma compounds, and enzymes are widely discussed. The wide variety of suggested applications for recycling bread waste provides significant insights into the role of technology development in potentially maximizing resource recovery and consequently contributing to environmental performance by reducing the amount of bread waste in landfills.	Bakery production waste products	This review gives an overview of potential valorization products from reprocessing bread waste.	
7	2022	Claudio Cacace. Carlo Giuseppe Rizzello. Gennaro Brunetti. Michela Verniö Claudio Cocozza.	**Reuse of Wasted Bread as Soil Amendment: Bioprocessing, Effects on Alkaline Soil and Escarole (Cichorium endivia) production**	Foods | Free Full-Text | Reuse of Wasted Bread as Soil Amendment: Bioprocessing, Effects on Alkaline Soil and Escarole (Cichorium endivia) Production (mdpi.com)	https://www-mdpi-com.translate.goog/2304-8158/11/2/189?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp	University of Bari, University of Rome	In an era characterized by land degradation, climate change, and a growing population, ensuring high-yield productions with limited resources is of utmost importance. In this context, the use of novel soil amendments and the exploitation of plant growth-promoting microorganisms potential are considered promising tools for developing a more sustainable primary production. This study aimed at investigating the potential of bread, which represents a large portion of the global food waste, to be used as an organic soil amendment. A bioprocessed wasted bread, obtained by an enzymatic treatment coupled with fermentation, together with unprocessed wasted bread were used as amendments in a pot trial. An integrated analytical plan aimed at assessing (i) the modification of the physicochemical properties of a typical Mediterranean alkaline agricultural soil, and (ii) the plant growth-promoting effect on escarole (Cicharium endivia var. Cuartana), used as indicator crop was carried out. Compared to the unamended soils, the use of biomasses raised the soil organic carbon content (up to 37%) and total nitrogen content (up to 40%). Moreover, the lower pH and the higher organic acid content, especially in bioprocessed wasted bread, determined a major availability of Mn, Fe, and Cu in amended soils. The escaroles from pots amended with raw and bioprocessed bread had a number of leaves, 1.7- and 1.4-fold higher than plants cultivated on unamended pots, respectively, showing no apparent phytotoxicity and thus confirming the possible re-utilization of such residual biomasses as agriculture amendments.	Bakery production waste products	This study describes the possibility of enzymatically transforming wasted bread into a soil amendment as a valorization option for balery product waste.	

8	2021	Anna Lissel (PR)	**Old bakery products as a basis for bioplastics and the chemical industry**	Press release 2021/02: Old bakery products as a basis for bioplastics and the chemical industry - Fraunhofer WKI	https://www-wki-fraunhofer-de.translate.goog/en/press-media/2021/PI_2021-02_old-bakery-products-as-a-basis-for-bioplastics-and-the-chemical-industry.html?_x_tr_sl=en&_x_tr_tl=de&_x_tr_hl=nl&_x_tr_pto=wapp	Fraunhofer Institute for Wood Research Wilhelm-Klauditz-Institute (WKI), University of Hohenheim	Plastics from unsold baked goods: Researchers have succeeded in extracting the basic chemical hydroxymethylfurfural (HMF) from old bakery products. HMF provides a starting material that can replace, for example, formaldehyde in bio-based adhesives. Furthermore, HMF can be used to produce bio-based plastics. The Fraunhofer WKI and the University of Hohenheim were successful in preparing HMF for further processing on a semi-industrial scale.	Bakery production waste products	This press release gives an overview of the process on how stale bakery products could be used as a raw material for the production of HMF, which is a monomer used for different polymer applications.	No original publication found, but could be interesting for further investigation.

5. Biomass availability studies and nutrient recycling

Please add biomass availability and nutrient recycling studies that you find of interest to the deployment of your bio-based solutions.

List of relevant studies

Solution 1: Spent brewery grains

Solution 2: Bakery production waste products

	Year	Author(s)	Title	Link	Translation link (German -> English)	Summary of contents	Relevant to which solution?	Why is it relevant?
1	2019	Christian Pladerer Philipp Hietier	Abfallvermeidung in der österreichischen Lebensmittelproduktion, Österreichisches Ökologie-Institut. Wien, 2017	https://united-against-waste.at/wp-content/uploads/2019/08/20190703_MMO_%C3%96sterr.Wasser-undAbfallwirtschaft_S.22-29_Studie_Pladerer_Hietler.pdf	-	In total, 121,800 tonnes (+/- 6%) of avoidable food waste are generated in food production in Upper Austria every year. This value was collected in a survey of large-scale productions, which turn over between 90% and 95% of all goods. This value is calculated on the basis of the member statistics of the Chamber of Commerce Food Industry Association. Almost half of all avoidable food waste is generated in the bakery sector (51,700 tonnes +/- 12%). 35,000 tonnes of this is bread and bakery products that food retailers return to producers as part of free returns. In beer breweries, 5,700 t of avoidable food waste is generated, according to this study	Spent brewery grains	generell overview about food wast and food production in Upper Austria. Information about food waste in different branches
2	2018	DI Philipp Hietler DI Christian Pladerer	Endbericht Lebensmittelabfälle in Österreich Aktualisierung des Lageberichts mit neuen Daten, rechtlichen Rahmenbedingungen und konkreten Handlungsempfehlungen. Pulswerk. Wien. 2018	https://www.pulswerk.at/download.php?f=532	-	The distinction between avoidable food waste and non-avoidable organic materials is very important and can be defined as follows: - Non-avoidable organic by-products/residues/wastes that are generated in the course of food production and are not suitable for human consumption (e.g. bones, blood, slaughterhouse waste, sour whey, pomace, ...). These must be disposed of, recycled or further processed accordingly. - Preventable food waste such as pre-packaged products, overstocked food, returned goods or edible raw products that are waste and must be disposed of. Returned goods are products that are transported back to the producer by the retailer when they are not sold and are offset. The reasons and causes for food losses in production are manifold and range from the manufacturing process, cleaning, quality assurance measures to overstocking and overproduction as well as returns, transport damage or foreign bodies in the product.	Spent brewery grains	generell overview about food wast and food production in Upper Austria. Reasons for the generation about avoidable food waste
3	2008	J. Bärnthaler, H. Bergmann, B. Drosg, D. Hornbachner, R. Kirchmayr, G. Konrad, Ch. Resch	Energiesysteme der Zukunft: Technologie, Logistik und Wirtschaftlichkeit von Biogas-Großanlagen auf Basis industrieller biogener Abfälle		-	A questionnaire cover around 82% of the Austiran beer market. It shows that around 17.4 kg of spent malt is produced per hectoliter of beer. In 2009, 8.7 million hectoliters of beer were produced in Austria. Different tables provide an overview of the quantities of biogenic residues. In 2004, a total of about 150,000 t of spent malt, malt kernels and malt dust were produced, yeast and yeast-like residues about 12,000 t.	Spent brewery grains	The study gives an overview about amount and current utilization of biogenic residues in beer production using the data of a questionnaire survey

4	2012	Hubert Reisinger Manfred Domenig Peter Thaler Christoph Lampert	Rückstände aus der Nahrungs und Genussmittelproduktion	https://www.umweltbundesamt.at/fileadmin/site/publikationen/rep0403.pdf	-	In this sector, 90% of the market is shared by commercial bakers and 10% by industrial companies. It also includes the flour milling, baking agent and pasta industries. In production, a surplus of 1.5% to 2% is common in order to meet certain deliveries. A distinction must be made here between by-products that are generated in the manufacturing process during production and finished bakery products that are left over in sales as scrap goods. By-products of production are mainly dough types. Weather and seasonal factors influence the quantity of returned goods. Based on the reports of a well-known bakery producer, the waste dough production amounts to 3.5% of the bakery production. If this percentage is applied to the total baked goods produced in Austria of about 599,000 tons (STATISTIK AUSTRIA 2010), this results in an annual generation for SN 11111 "Dough" of about 21,000 tons.	Bakery production waste products	Gives a good overview on waste production in bakery branch deviding between returned goods and waste dough production
5	2022	Rudolf BRAUN Arthur WELLINGER	Potential of Co-digestion	https://task37.ieabioenergy.com/wp-content/uploads/sites/32/2022/02/Potential_of_Codigestion_short_Brosch221203.pdf	-	400 - 800 t yeast and yeast like products and sludge from breweries, wine making, distilleries,	Spent brewery grains	Information on waste from brewery industry
6	2023	suedtreber	Biertreber	https://cms.dextermedia.de/dcmpro/documents/05778008451/Biertreber_Infoblatt.pdf	-	nutrient content of brewers grains	Spent brewery grains	nutrient content of brewers grains
7	2023	suedtreber	Bierhefe	https://cms.dextermedia.de/dcmpro/documents/05778008451/Bierhefe.pdf	-	nutrient content of brewers yeast	Spent brewery grains	nutrient content of brewers yeast
8	2023	Deutsches Ernährungsberatungs- und Informationsnetz	Nährstofftabellen und Inhaltsstoffe verschiedener Brottypen	https://www.ernaehrung.de/lebensmittel/	https://www-ernaehrung-de.translate.goog/lebensmittel/?_x_tr_sl=de&_x_tr_tl=en&_x_tr_hl=nl&_x_tr_pto=wapp	nutrient content of all different kind of bread	Bakery production waste products	nutrient content of all different kind of bread
9	2021	Philipp Hietler, Carla Hopfner, Christian Pladerer	Brot ist kostbar! Ohne Mist! Handlungsanleitung zur Reduktion von vermeidbaren Brot- und Backwarenabfällen entlang der Wertschöpfungskette	https://www.bmk.gv.at/themen/klima_umwelt/abfall/abfallvermeidung/publikationen/brot-ist-kostbar.html	https://www-bmk-gv-at.translate.goog/themen/klima_umwelt/abfall/abfallvermeidung/publikationen/brot-ist-kostbar.html?_x_tr_sl=de&_x_tr_tl=en&_x_tr_hl=nl&_x_tr_pto=wapp	amount of backery production waste products and innovative ideas against food waste in the baking industry	Bakery production waste products	Innovative ideas against food waste in the baking industry
10	2012	Hubert Reisinger Manfred Domenig Peter Thaler Christoph Lampert	Rückstände aus der Nahrungsund Genussmittelproduktion	https://www.umweltbundesamt.at/fileadmin/site/publikationen/rep0403.pdf		Estimated waste generation and best practice examples, Recycling and techniques of waste treatment	Bakery production waste products	Waste prevention in the bakery sector

11	2016	Urs Baier Lona Mosberger Dominik Gröbly Jürg Buchli Claudia Müller	ORGANISCHE VERLUSTE AUS DER LEBENSMITTELINDUSTRIE IN DER SCHWEIZ. Massenflussanalyse nach Branchen Ursachen / Verwertung	https://www.bafu.admin.ch/dam/bafu/de/dokumente/abfall/externe-studien-berichte/organische-verlusteausderlebensmittelindustrie.pdf.download.pdf/organische-verlusteausderlebensmittelindustrie.pdf		Cereals and bakery products: Branch bakeries have to reckon with up to 50 m3/a bread losses. It is also known that this value can be reduced by up to 20 % with better planning (Meteolytix presentation). The losses in the production of small rolls (gate to gate) in very large baking plants amount to an annual average of 4 %, based on the final product dry matter (confidential). In biscuit production, losses of 6.1 % to 16 % occur, depending on the product and the process used, in relation to the quantity produced. The greatest losses are generated by the cutting process for biscuits, where a large bar is first produced and then cut up (confidential information from a large manufacturer). Finished products: The losses incurred in the production of fresh pasta also depend on the type of product and range from 3.75 % to a maximum of 34 % (confidential information from an SME).	Bakery production waste products	Study based on a survey conducted in Switzerland on food losses/waste in manufacturing companies. Mainly conducted in the baking industry.