

STAR-ProBio

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Potential links to BE monitoring activities and their support by STAR-ProBio results

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Abstract

The STAR-ProBio project aims to assist stakeholders of the European Bioeconomy with tools, appropriate for the sustainability assessment of biobased products. In that sense, products from STAR-ProBio can be integrated into different activities, supporting for example sustainability certification and standardisation.

The growth of the EU Bioeconomy is closely and critically observed by civil society. Concerns about sustainability and “bad examples” from previous projects in different sectors of the Bioeconomy (e.g. from the Biofuels sector) have raised the awareness, that strategies for a growing bioeconomy have to be monitored and accompanied by appropriate instruments. Thus, several institutions on EU level have started activities to monitor the development of the bioeconomy or single bioeconomy sectors as well as the potential impacts of Bioeconomy policies. While this general development is progressing, it might be necessary to combine elements from the different sectors of the Bioeconomy in order to develop efficient structures for effective monitoring instruments, which can help to understand the impact of Bioeconomy policies and their future development. An obvious example, which will be the main object of investigation in this report, is the combination of data and information from sustainability certification with Bioeconomy monitoring activities.

We have analysed current activities for a monitoring of the Bioeconomy and its sectors and discussed the potential contribution with data from sustainability certification, which can be considered a growing activity in the EU Bioeconomy. This analysis has revealed a huge potential of useful data from certification activities, which could potentially support Bioeconomy monitoring in the future, when the overall share of certified biomass has increased and more, centralistic database structures would be established.

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2 Introduction

The STAR-ProBio project aims to assist stakeholders of the European Bioeconomy with tools, appropriate for the sustainability assessment of biobased products. This can support the development of a sustainable Bioeconomy in the EU and the development of an appropriate and ambitious overarching sustainability framework, which integrates the manifold challenges deriving from existing targets such as the Sustainable Development Goals or the Paris Agreement to limit global warming to a level of well below 2°C. In that sense, products from STAR-ProBio can be integrated into different activities, supporting for example the assessment and benchmarking of biobased products in the context of life cycle thinking, eco-design applications as well as sustainability certification and standardisation.

One of the main targets of STAR-ProBio is the development of a certification blueprint for biobased products. In that regard, the main objectives of the project are in line with general developments in the EU Bioeconomy, which include increasing activities related to sustainability certification (compare STAR-ProBio WP1).

The growth of the EU Bioeconomy is closely and critically observed by civil society. Concerns about sustainability and “bad examples” from previous projects in different sectors of the Bioeconomy (e.g. from the Biofuels sector) have raised the awareness, that strategies for a growing bioeconomy have to be monitored and accompanied by appropriate instruments. Thus, several institutions on EU level have started activities to monitor the development of the bioeconomy or single bioeconomy sectors as well as the potential impacts of Bioeconomy policies.

While this general development is progressing, it might be necessary to combine elements from the different sectors of the Bioeconomy in order to develop efficient structures for effective monitoring instruments, which can help to understand the impact of Bioeconomy policies and their future development. An obvious example, which will be the main object of investigation in this report, is the combination of data and information from sustainability certification with Bioeconomy monitoring activities.

2.1 Objective of this report

This report is part of STAR-ProBio WP9, which analysis policy elements in the context of the EU Bioeconomy. Consequently, WP9 discusses potential options for the future implementation of STAR-ProBio results into the policy framework of the EU Bioeconomy or elements associated with the implementation of this framework. Throughout the course of STAR-ProBio, WP9 has analysed:

- Links between the existing policy framework of the EU Bioeconomy and tools for sustainability assessment and verification (T9.1);
- The current status of (eco) labels and their applicability to the STAR-ProBio case studies and (T9.2);
- Co-regulation instruments, suitable for the implementation of the STAR-ProBio blueprint into the existing and future EU policy frameworks for the Bioeconomy (T9.3).

In this context, Task 9.4 focusses on the potential connection of sustainability certification and standardisation with EU Bioeconomy monitoring activities.



The general idea behind this work is to explore the question, how both activities, which do currently experience increasing attention in the EU can benefit from one another in order to use synergies and reduce costs and effort for stakeholders.

In this sense, T9.4 has analysed recent activities in the EU to develop and establish monitoring instruments and procedures for the Bioeconomy or economic sectors.

Furthermore, we analysed existing sustainability certification schemes concerning the data, which is collected during the process of certification, their reporting procedures and the general possibilities to feed data from sustainability certification into Bioeconomy monitoring activities.

Following this objective, this report encompasses two main parts.

The first part (chapter 2) describes current activities for the monitoring of different aspects related to the Bioeconomy or Bioeconomy sectors in the EU and its member states.

The second part (chapter 3) discusses the potential contribution of data flows from existing sustainability certification activities in the EU to developing monitoring approaches.

3 Bioeconomy Monitoring in the EU – recent activities

Following the above-described objectives, STAR-ProBio T9.4 has identified and analysed different activities from various stakeholders in the EU, aiming to monitor aspects related to the development of the Bioeconomy or single sectors of the Bioeconomy.

3.1 Method for the analysis of monitoring activities

In order to identify potential links between BE monitoring activities and STAR ProBio results, current activities for the monitoring of the bioeconomy were screened with the aim to build an inventory serving as an overview and a starting point for the task. This was done conducting desktop research. From previous tasks in the project, the inconsistent use of the “BE-terminologies”¹ was well-known. Taking this into account, search terms for “bioeconomy” were varied accordingly. To identify as many relevant activities as possible, “green economy”, “biobased economy”, “biobased industry” were used besides “bioeconomy”, which is the most commonly, used term in this project and on EU policy level. For conducting the research, we focussed primarily on specific activities dealing with the bioeconomy in a comprehensive way. Additionally, further activities focussing on the resource base and resource efficiency were regarded as potentially relevant as well as activities focussing on single BE sectors, e.g. the energy sector.

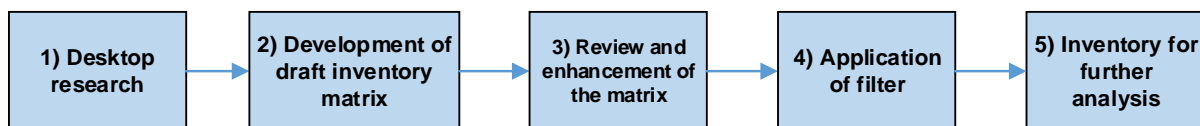


Figure 1: Methodological approach for the generation of an overview of existing BE monitoring activities.

The initial desktop research resulted in a list of 28 items (see Annex for the initial research results). Based on this list, a table was generated. For each activity, the following data was collected, which allowed for a brief characterisation and the possibility to further analyse the table applying different filters:

- Name of monitoring system/activity/project;
- Geographical scope (national, EU);
- Year (in case of non-continuous system);
- Sustainability dimension;
- Economic sectors included;
- Publisher;
- General purpose of system;
- Reporting interval;
- Definition of used terminology;

In order to produce a comprehensive inventory, intermediate results were shared among the project partners involved in the task. Within a defined feedback period, comments and proposals for further entries were collected, processed and considered in the final inventory matrix.

¹ In the sources and references analysed, the term “bioeconomy” is not used consistently. Other terminologies (e.g. biobased industry, biobased economy) are used in parallel, while sometimes not defined appropriately.

3.2 Results from the analysis of monitoring activities

From the desktop research 28 monitoring activities were obtained and added to the inventory. There are some approaches referring to Europe as well as others with a geographic scope limited to EU member states as indicated in Figure 2.

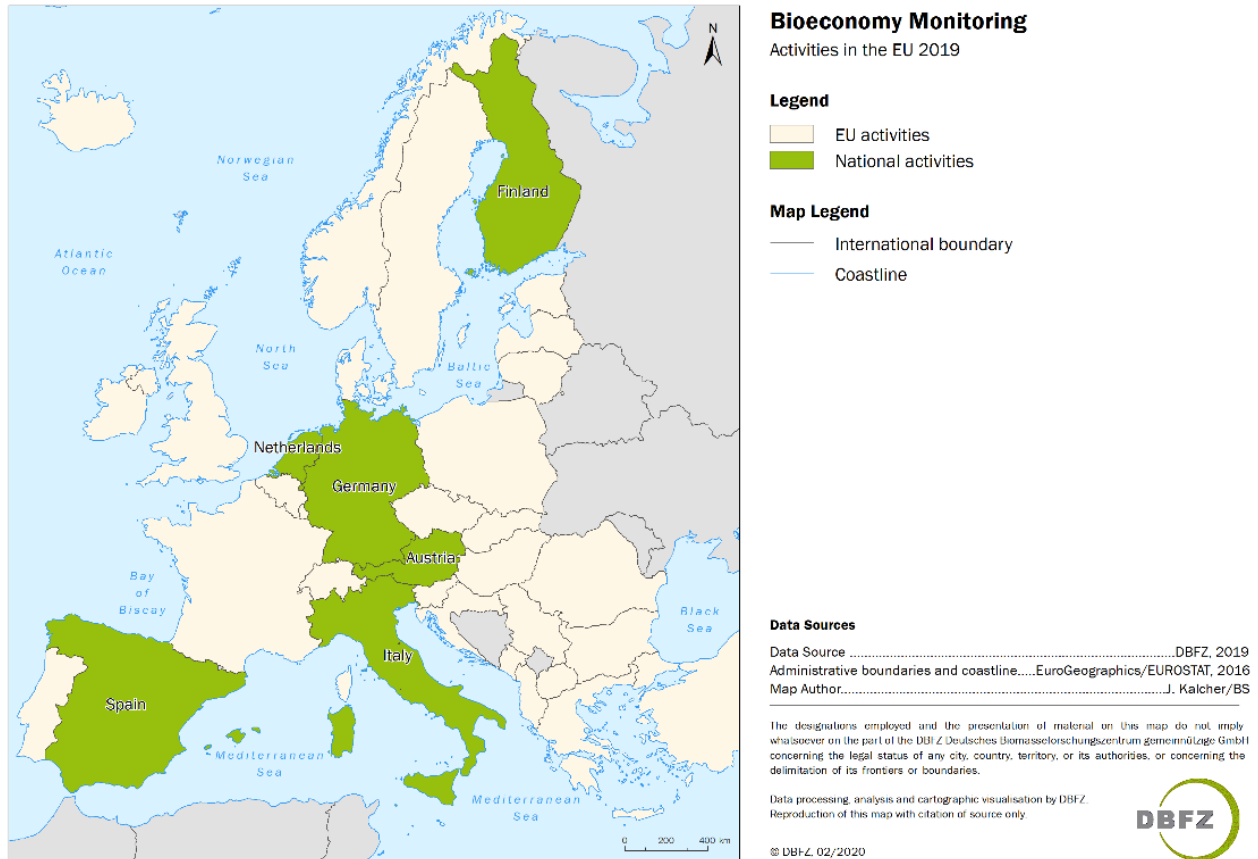


Figure 2: Distribution of the current activities for the monitoring of the Bioeconomy across Europe.

Besides the different geographical foci, the identified existing approaches differ mostly in terms of their general purpose, the applied monitoring criteria, the reporting frequency and the presentation/reporting of the monitored data.



Table 1: Inventory of bioeconomy monitoring activities

Name/Title of the activity	Country of investigation	Regional focus	Year	Terminus (Bioeconomy, biobased economy etc.)	Dimension of sustainability (Parameters)	Included sectors	Publisher	Reporting
SAT BBE	Project consortium: EU (NL, FIN, GER, AUT) and USA		2012 - 2015	Bioeconomy, Bio-Based Economy	Economic, Environmental, Social		Research	Unknown
MontBioeco	Germany		2017 - 2018	Bioeconomy			Research	
Bioeconomy Observatory	EU		2016 - 2017	Bioeconomy	Economic, Social (public perception)	Agriculture, forestry, fishery, food, pulp and paper production, plastics, parts of chemical, biotechnological and energy industries	Government	(Unknown)
Monitoring Biobased Economy	NL	Global	2017	Biobased Economy (embedded in Bioeconomy)	Economic		Government	Annually
Finnish Bioeconomy in numbers"	Finnland		2016	Bioeconomy	Economic, Environmental, Social (Employment)		Government	Annually
Inter-Ministerial Working Group on Bioeconomy	Germany		2014	Bioeconomy	Economic (sectors of German BE)		Government	
Spanish Bioeconomy Observatory	Spain	Global	2017	Bioeconomy	Economic, Social (Employees)	Agrofood production, forestry, marine	Government	



						and maritime, waste and residues, water		
BIT Bioeconomy in Italy	Italy		2017	Bioeconomy	Economic, Environmental, Social	Products, commodities, intermediate goods and technologies	Government	
Towards Green Growth Monitoring Progress OECD Indicators	OECD	Global	2011	Green Growth, Green Economy	Economic, Environmental	Government	n.a.	
vTI Analysis for 2007	Germany		2007;2002-2010	biobased economy (biobasierte Wirtschaft)/bioeconomy	Economic		Research	n.a.
Bioeconomy knowledge center	EU	EU	2008-2015	Bioeconomy	Economic		EC	
Bio-economy Monitoring	Germany		2016-2019	Bioeconomy	Economic		Research	n.a.
Ermittlung wirtschaftlicher Kennzahlen und Indikatoren für ein Monitoring des Voranschreitens der Bioökonomie	Germany		2016-2019	Bioeconomy	Economic		Research	n.a.
Bioeconomy Market Reports (nova-Institute)	Germany		1994-present	Bioeconomy, bio-based economy	Economic		Research and Consultancy	Several times/year
SYMOBIO	Germany	Global	2017-2020	Bioeconomy	Economic, Environmental, Social	Entire BE	Research	n.a.



Biomonitor - Monitoring the Bioeconomy	EU	Europe	2018-2022	Bioeconomy	Economic, Environmental, Social	Entire BE	Research	n.a.
European BE in figures 2008-2015	EU	Europe	2008-2015	Bioeconomy	Economic	Agriculture, forestry, fishery, food, beverages, tobacco, paper and paper products, textile and textile products, forest-based industry, chemicals and plastics, pharmaceuticals, forest based industry	Private	Regular updates are done. The precise interval of updates is not clear
SUMINISTRO (Sustainability monitoring Index for assessing regional bio-based industry networks)	Germany		2015	Bioeconomy (Bioökonomie)			Research	n.a.
DataBio (Data-Driven Bioeconomy)	EU	Europe	2017-2019			Agriculture, forestry and fishery/aquaculture	Research	
DIABOLO (Distributed, integrated and harmonised forest information for bioeconomy outlooks)	EU		2015-2019			Forestry	Research	



Employing social accounting matrix multipliers to profile the bioeconomy in the EU member states: is there a structural pattern?	EU		2014				Research	n.a.
EEG Monitoring Stromerzeugung aus Biomasse(Vorhaben Ila Biomasse)	Germany		2015	Bioenergy	Economic	Energy	Research	Annual (untill 2015?)
Solid biomass barometer; Biogas barometer; Biofuels barometer			2010 – present	Focus on bioenergy	Economic	Energy	Research and private	Annually
Resource use in Austria	Austria		2012, 2015, (2019)	Focus on resources			Government	3-4 years interval
More from less - material resource efficiency in Europe	Europe		2016	Resource efficiency			Government agency (EEA)	
EU Resource Efficiency Scoreboard	EU		2014	Resource efficiency		Cross-sectoral	EC	Annual update of indicators
The JRC Biomass Assessment Study	EU		2015	Biomass	Economic and Environmental	EC		
Renewable Energy Mapping and Monitoring in Europe and Africa (REMEA)	Europe and Africa			Bioenergy	mostly Economic	Energy	EC	n.a.

To further study the differences in our selection of existing activities, we classified the items in the matrix according to four different categories (compare Figure 3). We thereby distinguished between research projects and studies, compilations of indicators, monitoring systems and others. Each category will be further described in the following.

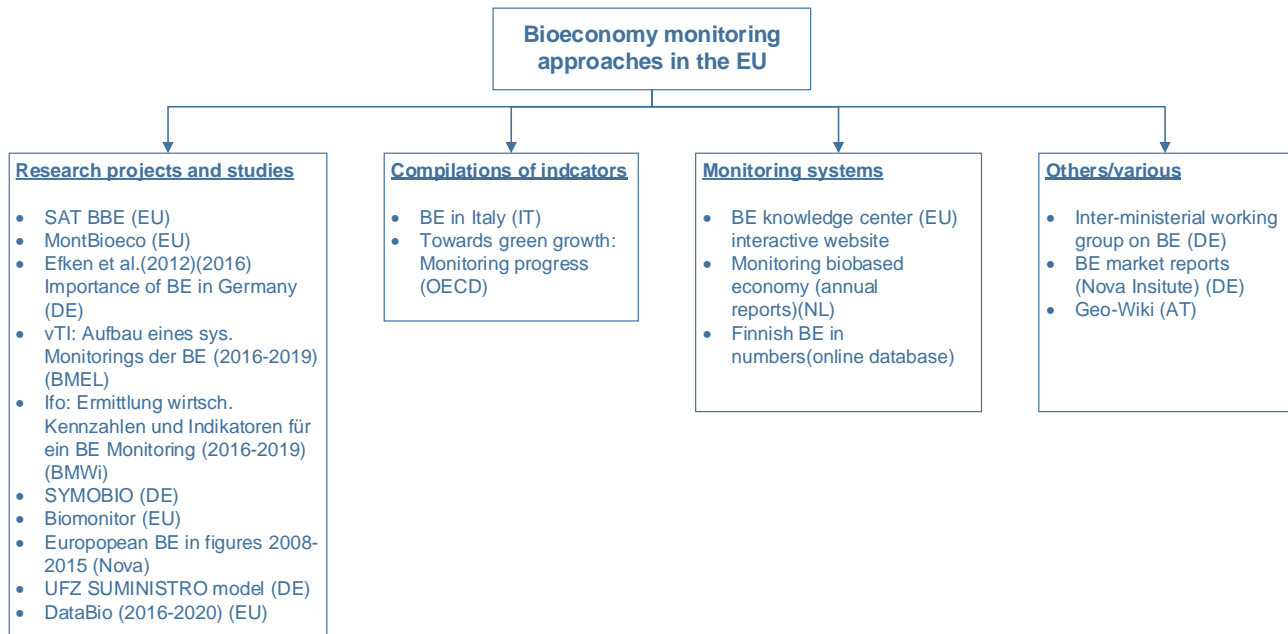


Figure 3: Classification of desktop research results in categories.

Research project and studies

As there is limited experience available, both conceptual and operational, research demand for the monitoring of the bioeconomy seems to be considerable. Moreover, the Bioeconomy with its various value chains, sectors and products is a complex concept, which makes a comprehensive monitoring a challenging assignment. Hence, it is not surprising, that the bigger part of the analysed approaches and activities was assigned to the category “research activities and studies”.

Research activities took place mainly in Germany and on EU level. These are mostly about government-funded research projects, preparing the introduction of respective monitoring systems and aiming at answering specific technical questions.

The nova Institute contributed to the development of the EU BE monitoring. In the report “European Bioeconomy in Figures 2008-2016”, the BE is analysed using two economic indicators: turnover and employment. This report exists since 2016 and has been updated as data availability allowed to cover a longer period. The analysis is based on the Eurostat database.

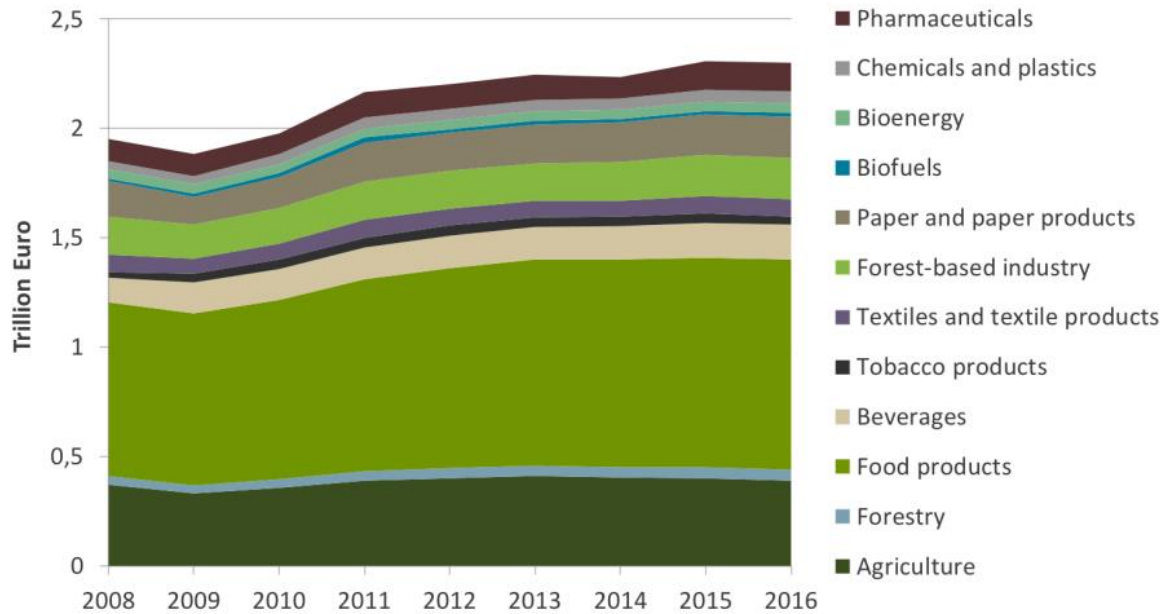


Figure 4: Turnover in EU bioeconomy sectors 2008-2016. Source: (Piotrowski et al. 2019)

The “SYMOBIO project” is a research project funded by the German government, aiming at the development of the scientific fundamentals for a systemic monitoring of the BE. It has a comprehensive sustainability approach and considers sustainability aspects on national and international level. As a result there will be aggregated indicators in form of footprints informing about the impact of the BE on land, greenhouse gas emissions, water and material. The project plan foresees a prototype monitoring report for Germany as well as an interactive website for the examination of BE data as final product (Center for Environmental Systems Research 2020).

Another good example for research on the essentials of monitoring is the “DataBio project”. It has a focus on data and studies innovative concepts, e.g. big data and earth observation. The aim is to develop a data platform which is fed by various data sources like satellites and sensors. It focusses on the production of raw materials for BE products, taking amongst others sustainability issues into account (Habyarimana 2020).

Compilations of indicators

The results in this category focus on documents which do not describe how a monitoring system should be shaped with all necessary components, but state indicators, which are foreseen to be included. Indicators can be regarded a core element of a monitoring system. The set of indicators, a monitoring system is based on, is determined by different factors, especially by the general goal and purpose. In the Italian BE strategy, for instance, a set of monitoring criteria is briefly mentioned as preliminary selection. This selection is stated to become aligned to the criteria on EU level, once these will be specified (BIT Bioeconomy in Italy 2019). In comparison, OCED proposes monitoring criteria providing a multitude of details and explanations to every single criterion (OECD 2011).

Monitoring systems

We found three monitoring systems, considered to be operational. There is an existing and running system, developed by the Joint Research Centre and established by the European Commission. It is an online, browser based dashboard (Figure below), presenting data for the entire European Union. It is possible to select year, biobased activity and country. This enables to quantify the market size. It follows the method described in (Ronzon und M'Barek 2018). Data is available for all EU member states for the period 2008-2015. However, monitoring indicators are very limited to turnover, value added and employment. It is moreover not quite clear, why the monitoring stopped in 2015.

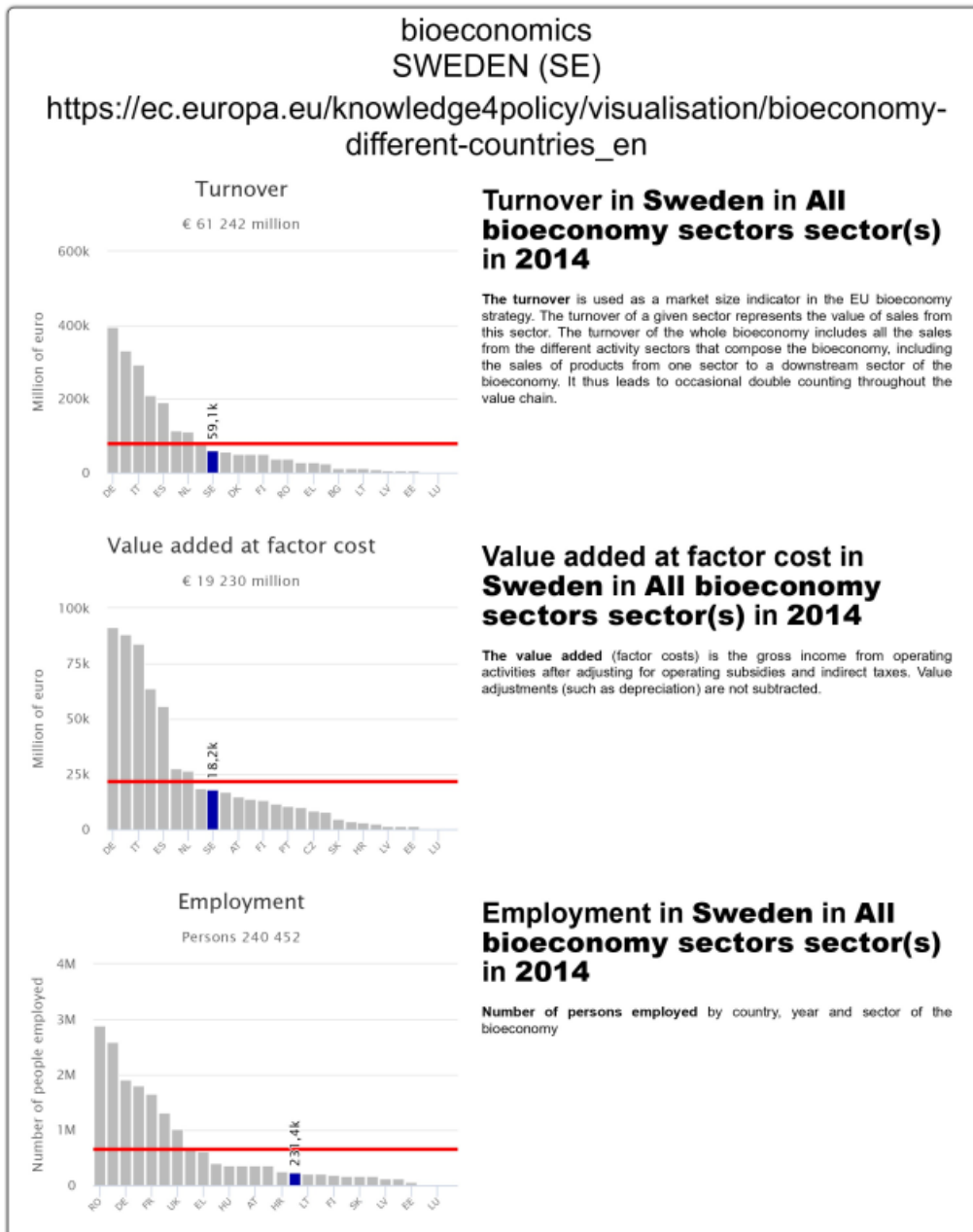


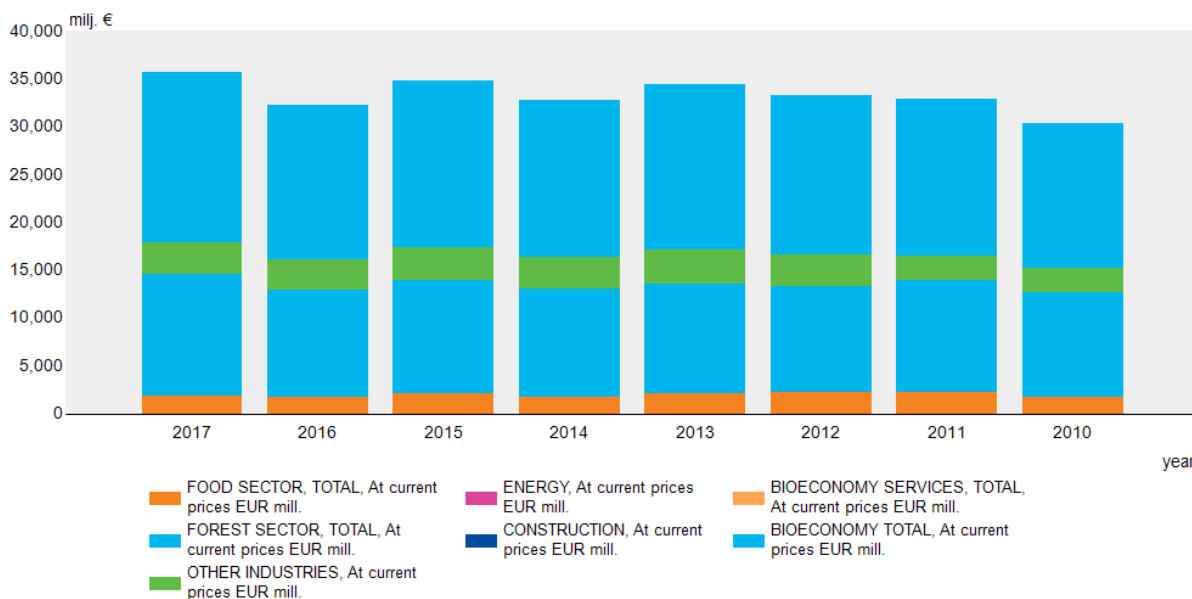
Figure 5: EU bioeconomy monitoring system visualisation. This example shows a exported dataset for the BE in Sweden in 2014 (European Commission 2020).



Another relatively advanced example stems from Finland and is called “finnish BE in numbers”. It is prepared by the National Resource Institute Finland (Luke) and Statistics Finland. The presentation of the results is similar to the system for monitoring the EU BE – a web browser based application. In contrast, the application offers more possibilities. There are different templates for tables and graphs selectable. Graphs are adjustable and the export of individual results in different formats is possible (Figure 5).

The underlying data is based on the national accounts. Finland’s BE is monitored by means of four criteria: Output, value added (gross), number of people employed and Investments (gross fixed capital formation). The calculations cover the period from 2010 to 2018. Where the data quality is insufficient to produce reliable results, expert estimations are used (“The principles for monitoring the bioeconomy”).

Exports of bioeconomy goods



Source: Statistics Finland and Natural Resources Institute Finland

Figure 6: Reporting example of the Finnish bioeconomy monitoring system "Finnish bioeconomy in numbers". The example shows the export figures of bioeconomy goods differentiated by sector for 2010-2017 (Natural Resources Institute Finland (Luke) 2020b).

Others/various

In this category, we assorted approaches, which do not fit in the previous three categories. Activities presented in here are not primarily related to the BE, but still have potentially valuable aspects worth to highlight. The Austrian “International Institute for Applied Systems Analysis” (IIASA) develops different applications linking earth observation with citizen science. Their application “Geowiki” provides various maps presenting information on land cover and land use. The innovative approach includes a citizen science component, in which citizens are participated by validating specific data in order to enhance the original dataset derived from databases.

Recent development of BE monitoring on EU level

There is significant effort for the monitoring of the BE on an EU level, as revealed in our analysis of the status quo. The Commission is establishing a system which is already operational, but works with very limited criteria only. The system is not completed and still under development. The Joint Research Centre recently reported on the current status in 2020 and the planned further development (Giuntoli 2020). The advancement approach is strongly aligned to the EU BE strategy. In its current state, the concept includes a distinction of the monitoring criteria between different levels.

Figure 7 illustrates the proposed further development on EU level. The criteria are central in the concept and mirror the strategy objectives. The following can be considered key aspects for the compilation of the set of monitoring criteria. Adequate reflection of sustainability aspects seems to be crucial. To assure a sustainable BE, the criteria set shall take the social, economic and environmental sustainability pillar into account and shall be assessed against the Sustainable Development Goals. The system shall facilitate to identify sectoral contributions of agriculture, forestry, fisheries and aquacultures, as they represent the resource base. The possibility to link monitoring results to value chain elements shall be implemented to make hot spot analysis feasible. A stakeholder consultation process will complement consensual agreement for the monitoring criteria.

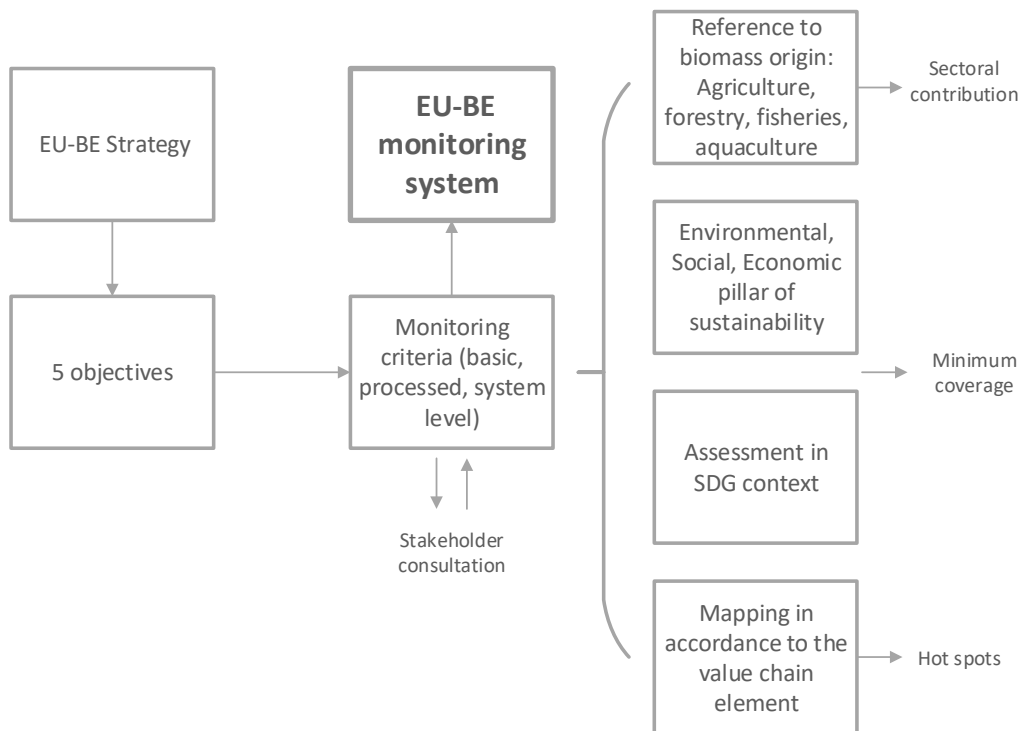


Figure 7: Concept for the EU bioeconomy monitoring system. Preliminary results based on (Giuntoli 2020).

4 Links between Bioeconomy monitoring and sustainability certification and standards

Sustainability certification has become an important instrument, addressing different purposes in various sectors of the Bioeconomy. As shown in STAR-ProBio T1.1, certification is currently being used to ensure safeguards for a number of specific sustainability criteria associated with the production of biomass or biobased products (e.g. in the bioenergy sector). Furthermore, in certain sectors (e.g. the food sector) it has also become an instrument, which can support market differentiations and orientation for consumers, demanding certain products or product characteristics. Consequently, T1.1 has shown that a wide range of certification schemes, addressing different biomasses, regions and niches within the Bioeconomy, has been developed throughout the recent years. (Majer et al. 2018; STAR-ProBio 2017) With increasing activities in sustainability certification and monitoring of the Bioeconomy, the question arises, to which extend both activities might benefit from one another in the future.

For this purpose, we will build on the analysis done in STAR-ProBio T1.1, where we have analysed several sustainability certification schemes in the EU Bioeconomy according to their sustainability criteria and indicators. (Majer et al. 2018; STAR-ProBio 2017) We will analyse and describe “typical” data flows that are relevant in sustainability certification and discuss the suitability of this data for current and future monitoring activities. A brief description on the methodological approach for the general selection of sustainability certification activities and their subsequent in depth assessment is included in the following paragraph.

4.1 Our approach to analyse sustainability certification

In order to discuss the data and information, which is collected, processed and produced by certification frameworks, we followed a stepwise approach for the analysis. Firstly, sustainability frameworks², relevant for our analysis have been identified. Secondly, the selected relevant frameworks have been analysed with regards to their data structure criteria and indicators used in current sustainability certification.

To picture the sustainability frameworks presently available for application within the bio-based economy, firstly an overview was generated. This process followed a three-stage course of action, which is illustrated in Figure 8. Primarily, a desktop research using web databases (e.g. ITC standards map (International Trade Centre 2020), label online (Bundesverband Die Verbraucher Initiative e.V. 2020)) was used to identify frameworks relevant for the Bioeconomy in the EU.

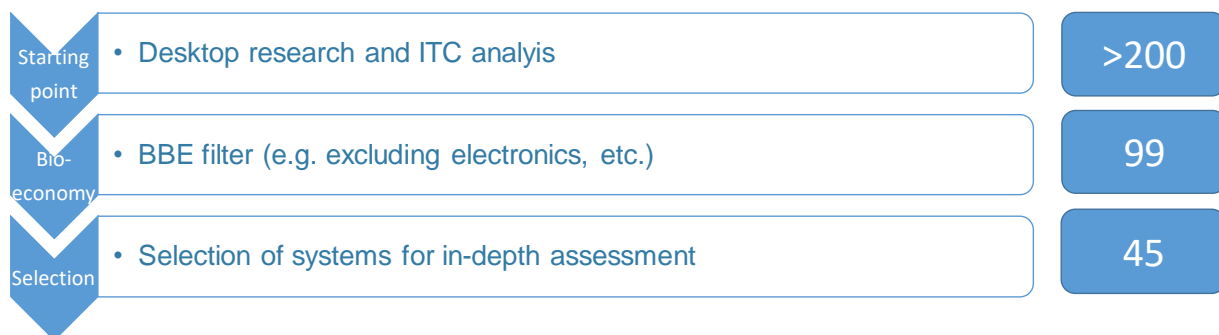


Figure 8 Analysis of relevant frameworks currently available for application in EU BBE - procedure



The resulting list of frameworks was supplemented by further desktop research as well as the review of the additional scientific literature. An internal database has been produced (see Figure 9) to allow the introduction of additional filters to reduce the number of frameworks in a stepwise approach. The filters applied represent different Bioeconomy sectors which have been determined based on definitions by (Adler et al. 2015). Thanks to this step, systems dealing with non-bio-based products and products originating in branches beyond the scope “Bioeconomy” could be excluded. The resulting selection of frameworks was enriched by further systems proposed by experts from the project consortium. In the final step, the sample was reduced by half, according to a set of criteria in order to make an in-depth analysis of the initiative possible. The following criteria were determined by all involved partners (mainly from WP1):

- Scope of the certification framework,
- Quality of system documents and overall transparency of the system,
- Comprehensiveness relating to the three sustainability dimensions,
- The relevance of the framework.

This procedure resulted in a list of sustainability frameworks for further elaboration. The frameworks were arranged within a table (Figure 9), allowing first evaluations, due to the comprehensive coverage of the Bioeconomy. The table lists frameworks with information on:

- Kind of framework (label, initiative, scheme),
- Bioeconomy sector,
- Supply chain coverage (single supply chain elements/full supply chain/...),
- Geographic scope (national, global),
- Feedstock scope (single/multiple),
- Sustainability dimension (social, environmental, economic) addressed.



Sector	Label	Initiative	Certification scheme	Name	Scope			Criteria			
					geographic	feedstock	Supply Chain	Social	Environment	Economic	Good Governance
Bioenergy	liquid biofuels	x	x	International Sustainability & Carbon Certification (ISCC)	global	multiple	full	x	x	x	x
		x	x	RED cert EU	Europe (+Ukraine, Belarus)	multiple	full		x		
		x	x	Roundtable on Sustainable Biomaterials EU RED (RSB EU RED)	global	multiple	full	x	x		x
		x	x	Red Tractor Farm Assurance Combinable Crops & Sugar Beet (Red Tractor)	UK	cereals, oilseeds, sugar beet	until first feedstock delivery point		x		
		x	x	Roundtable on Sustainable Palm Oil RED (RSPO)	global	multiple	full	x	x	x	x
	solid biofuels		x	Certification System addressing Indirect Impacts of Biofuel (CIIB)	EU+	multiple	farm gate to first processor		x		
		x	x	Sustainable Biomass Partnership (SBP)	global	woody biomass	from cultivation to energy production	x	x	x	
		x	x	DINplus Short rotation coppice sustainably grown according to DIN EN16214-3	global	SRC wood	cultivation	x	x		
	Biogas		x	Nordic Ecolabeling (SWAN)	Denmark, Finland, Iceland	woody biomass		x	x	x	x
		x	x	CIIB- Biogasdoneright	Italy	multiple	production process, product		x	x	
Heat/Power			x	Green Gas Certification Scheme (GGCS)	UK	multiple	production to use		x		
		x	x	Global Bioenergy Partnership (GBEP)	global	multiple	full	x	x	x	
		x	x	nature made star	CH	multiple	energy production and delivery		x		
		x	x	OK-Power	Germany	multiple	power production		x		
		x	x	Grüner-Strom-Label (Green-Power-Label)	Germany	multiple	power production to distribution		x		
		x	x	Green-e	global	multiple	full	x	x	x	x
		x	x	Forest Stewardship Council (FSC) CoC	global	woody biomass	full	x	x	x	x
		x	x	Eco-Certified Composite (ECC) Sustainability Standard	USA	wood fiber	full		x		x
	Construction	x	x	DGNB System			from cradle to grave	x	x	x	
		x	x	Green Building Rating System BREEAM	global		design and procurement stage, post	x	x	x	
		x	x	Assessment System for Sustainable Building (BNB)	Germany		from cradle to grave	x	x	x	
		x	x	Minergie	Switzerland, Lichtenstein				x		
		x	x	Leadership in Energy and Environmental Design (LEED)	global			x	x		
Food	Fair Trade Certification Systems	x	x	Fairtrade-Label - Fairtrade Labelling Organizations International (FLO)	global	crops	full	x	x	x	
		x	x	NATURLAND fair	global	multiple	full	x	x	x	
		x	x	Rapunzel Hand in Hand	global	multiple	full	x	x	x	x
	Fish Certification Systems Agricultural Products	x	x	Marine Stewardship Council (MSC)	global	fish	from fisheries to retailers	x	x	x	
		x	x	GlobalGAP crops certification	global	crops	pre-farm-gate		x	x	
		x	x	demeter	global	multiple	cultivation to processing		x		
		x	x	Ecovin	Germany	grapes	cultivation to processing		x		
		x	x	Sustainable Agriculture Network/ Rainforest Alliance Certified (SAN)	global	crops	cultivation	x	x		
		x	x	Roundtable on sustainable palm oil (RSPO)	global	palm oil	full	x	x	x	
		x	x	UTZ certified	global	coffee, cacao, tea, hazelnut	full	x	x	x	
Feed		x	x	GMP+ Feed Responsibility Assurance	global	soy, fish meal	feed production and trade		x	x	
		x	x	DLG certificate sustainable agriculture	Germany	multiple	agricultural production	x	x	x	
Textiles	Fair Trade Certification Systems	x	x	Fairtrade Textile Standard - Fairtrade Labelling Organizations International (FLO)	global	certified cotton, other resp	full	x	x	x	x
		x	x	NATURLAND Textil (natureland textile)	global	natural fibre	production		x		
		x	x	EU Ecolabel - fabrics	EU, CH, NOR, ISL, TUR	multiple	products	x	x		
		x	x	Textile Exchange Organic 100% content standard	global	organic fibres	product				x
Minerals and Plastics		x	x	ISCC PLUS	global	multiple	full	x	x	x	x
			x	Bioplastic Feedstock alliance	global	multiple	full	x	x	x	x
Pharmaceuticals/Products	Cosmetics	x	x	COSMOS Standard - Cosmetics organic and natural standard	global	multiple	production process, product		x		x
		x	x	CRADLE TO CRADLE CERTIFIED PRODUCT STANDARD	global	multiple	production process, product	x	x		
			x	INRO Nachhaltigkeitskriterien für die stoffliche Biomassenutzung (sustainability)	global	agricultural biomass	cultivation	x	x	x	
		x	x	Nature Care Products Standard	global	multiple	products		x	x	

Figure 9 Matrix with overview of existing certification frameworks (Majer et al. 2018)



Throughout this analysis, it also became obvious that there is a wide range of categories for the existing sustainability frameworks. Existing frameworks can differ significantly with regards to their operability, stakeholder involvement, scope, etc. To allow for a differentiation, we have distinguished three types of sustainability frameworks. Our definitions for the sustainability certification labels (1), initiatives (2) and labels (3) are included in Table 2.

Table 2 Considered types sustainability frameworks and their particular definition (Majer et al. 2018)

Frame- work/ system	Definition
Labels	Labels are tags on products, which communicate the guarantee of certain product characteristic to the consumer, which ideally is described in an adequate level of transparency. A certification process can be a precondition for the labeling of a product. However, there are products self-labeled by the producer. Further types are labels of testing organisations, testing same products from different manufacturers and label the ones with the best test results.
Sustain- ability initiatives	Sustainability initiatives are herein referred to as initiatives compiling sets of sustainability criteria and indicators for a particular purpose, e.g. the analysis of the sustainability of liquid biofuels. They might be organised as a heterogeneous group of people with different background and with different interests. The goal of this type of initiative is to reach a consensus between the different parties. In the resulting set of criteria, the different interests are covered equally. This type of initiative is often called "multi-stakeholder initiative" or "roundtable". The second type of initiative included in this context shall be an initiative consisting of a group of people belonging to one party. They can have a background in science and academics, governmental agencies, enterprises or NGOs. The one object, quality sustainability initiatives have in common is the outcome/product, which is a set of criteria for further unspecified or specified use. The outcome can be used internally, e.g. for the sustainability strategy of an organisation or may be picked up by other organizations in case the outcome is open source.
Certificatio n schemes	Certification schemes are based on a normative framework, e.g. a standard or a set of criteria and indicators. The output of initiatives may be used as the basis for a certification scheme. Sustainability initiatives therefore sometimes turn into a certification scheme holder over time as it happened with different roundtables. The most important characteristic of a certification scheme, as it is understood in this context, is that it includes a third party verification of the sustainability criteria, stipulated in the system documents. Also, the whole certification process is usually based on accreditation standards (e.g. ISO 19011 or ISO 17065), in which the separation of evaluation and certification is to mention an important feature. As a result of the certification process, a label on a product shows compliance with the respective certification scheme. Certificate holders mostly participate voluntarily in a certification scheme. However, there are industries, in which holding certificate facilitates market access, which is, for instance, the case with liquid biofuels within the European Union.



Further definitions could include differentiations regarding the market (Business-to-Business: certification schemes; Business-to-Customer: Certification systems and labels) and target groups that are relevant for the frameworks under analysis.

Finally, we excluded those systems from the analysis, which have been intransparent regarding a minimum of information made available to public stakeholders. Consequently, the remaining frameworks include a publically available database containing at least the following information:

- Certification number
- Name and address of the certificate holder
- Country
- Type of certification
- Valid from/to
- Certified products

Certificate	Certificate Holder	Scope*	Raw Material	Add-Ons**	Valid From	Valid Until	Issuing CB	Map	Certi...	Audit Report
EU-ISCC-Cert-DK220-688021012020	Vesttec Aps, Vestes, Denmark	CP, TR	AF 3, Sewage		19.02.20	18.02.21	Baltic Control			
EU-ISCC-Cert-DE100-11142020	Ambrion Energy GmbH, Hamburg, Germany	TRS			19.02.20	18.02.21	SGS			
EU-ISCC-Cert-IT206-330	KL Agri Sdn Bhd, Shah Alam, Selangor, Malaysia	CP, TRS			19.02.20	18.02.21	RINA			
EU-ISCC-Cert-NL220-2243551001	Landbouwwerfening A. van der Krift B.V., Zeewolde, Netherlands	CP, BG, BM	Crude glycerine, Food ...		19.02.20	18.02.21	Deira NL			
EU-ISCC-Cert-NL220-2243552001	Schoongas Sint Nicolaasga B.V., Sint Nicolaasga, Netherlands	CP, BG, BM	Crude glycerine, Food ...		19.02.20	18.02.21	Deira NL			
EU-ISCC-Cert-DE100-39482020	JH Agrocom, spol. s r.o., Pilsy, Czech Republic	FG, TR	Corn, Rape/canola		18.02.20	17.02.21	SGS			
EU-ISCC-Cert-DE100-11802020	ADM Spyck GmbH, Kleeve, Germany	OM, RE, TR	Rape/canola, Soybean ...		18.02.20	17.02.21	SGS			
ISCC-PLUS-Cert-DE100-11802020	ADM Spyck GmbH, Kleeve, Germany	OM, RE	Rape/canola, Soybean ...	GHG	18.02.20	17.02.21	SGS			
EU-ISCC-Cert-DE100-11952020	ADM Spyck GmbH, Straubing, Germany	OM, RE, TR	Rape/canola, Soybean		18.02.20	17.02.21	SGS			
ISCC-PLUS-Cert-DE100-11952020	ADM Spyck GmbH, Straubing, Germany	OM, RE	Rape/canola, Soybean	GHG	18.02.20	17.02.21	SGS			

Figure 10 Screenshot of the ISCC certificate database (ISCC 2020a)

4.2 Data from sustainability certification

This sub-chapter gives an overview of bio-based supply chain examples and shows, at which stages and for which elements of the supply chain the relevant information on certified biomass and bio-based products is gathered. In general, for the analysis and assessment of data availability from certification, a differentiation between markets with mandatory certification and voluntary certification is essential.

For example, in the biofuels market, certification according to the requirements of a recognized, voluntary certification system is mandatory in order to count the certified amount of biofuel against the national quota (mandatory market). For all other markets, certification is voluntary and data on certified biomass being consumed can only be gathered via market analysis and/ or information from certification systems being used.

Based on the certification system or the element of the supply chain or the kind of final bio-based product etc. this gathered data is transmitted through the supply chain and provided to the certification system.

Supply chains for biobased products are diverse and can include different international and regional trade-flows and set-ups. As shown in STAR-ProBio T1.1. (STAR-ProBio 2017), supply chains under certification consist of different supply chain elements, starting with the production/cultivation of the biomass and ending with the processing of the biomass (one to multiple processing steps) into a bio-based product. Additionally, also traders and/or warehouses or storage facilities can be included.

According to the specific systematic of the certification framework, a certification system may verify a whole supply chain or each single element of the supply chain. In most of the certification frameworks analysed, sustainable (i.e. certified) input material is a prerequisite for producing a sustainable (certified) product. In that sense, throughout the supply chain, specific requirements and criteria are being verified in an audit process, which is part of the certification procedure.



Due to this close cooperation between auditors and the stakeholders of the supply chain, a huge number of different datasets being potentially relevant for a monitoring of the BE is verified during auditing. However, most of this information is currently not documented by the auditor and/or neither transmitted to the certification scheme. Furthermore, as concluded in STAR-ProBio D1.1 (compare (Majer et al. 2018)) the existing certification frameworks in the EU Bioeconomy do differ significantly according to, not only the sustainability criteria covered, but also regarding the practical implementation of these criteria as well as additional rules for the certification process. Consequently, also the quality and quantity of data documented by the auditor during an audit depends on the requirements of the certification system and differs between all certification systems analysed.

The following figure shows a simplified supply chain for a biobased product, as well as the types of documents that are potentially being issued and collected for the different supply chain elements and transferred throughout the supply chain as part of the certification process.

Due to the significant differences between certification activities in the various sectors of the Bioeconomy, the development of a general systematic for the types of documents and data from the certification of biobased products seems not feasible at this point in time. However, as shown in STAR-ProBio WP1, we can differentiate between certification activities in different sectors of the EU Bioeconomy.

Some sectors are already fully covered by certification (currently biofuels, bioenergy from 2021 onwards) as a result of existing legislation. In these sectors, we can observe common structures regarding the documentation of data from the auditing process as well as the procedures for internal and external reporting of audit information. Furthermore, we can observe voluntary certification activities in sectors with a high market penetration of a few certification schemes (e.g. the forestry sector) and finally, sectors with a low market penetration of certification and a huge variety of existing schemes (e.g. business to customer markets such as the food sector).

So, in order to demonstrate the general potential for the sourcing of data for Bioeconomy monitoring activities, we focus on those sectors of the Bioeconomy, in which we can observe already a high market penetration of certification as well as some established general structures for the documentation and reporting of information from the process of certification.

During auditing and while transferring certified biomass and bio-based products through the supply chain, different certification and auditing documents are being generated. These documents contain relevant information on certified biomass (e.g. feedstock type and origin)

In general, four types of documents are can be relevant in the generalised, typical supply chain, pictured in the figure below (Figure 11). Along this supply chain, relevant information are included in the following documents:

Those documents are:

- The self-declaration: relevant for the interface biomass production, statement to declare general compliance with the relevant criteria for the agricultural/forestry production;
- The audit documentation or report;
- The sustainability declaration;
- The sustainability certificate or the proof of sustainability.

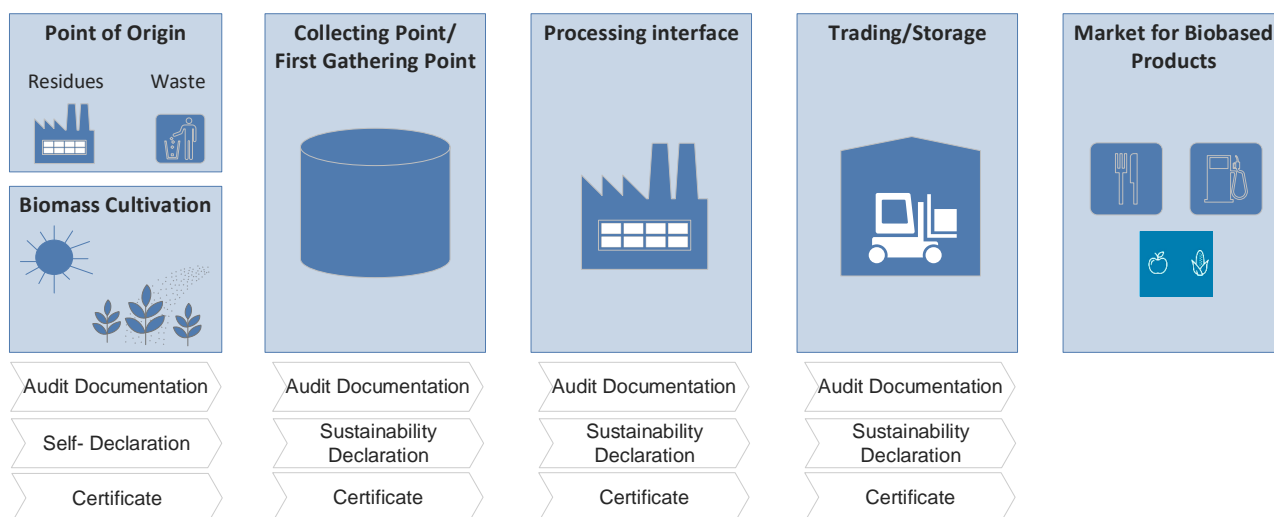


Figure 11 Typical elements of a biobased supply chain with relevant certification and auditing documents

The type of information, potentially to be included in the self-declaration documentation is shown in the following table (example from the ISCC framework).

Table 3 Typical data from self-declaration in the context of sustainability certification under the RED(2) framework (example from the ISCC framework) (Henke 2018; ISCC 2020b)

Type of information collected with the self-declaration
Name of the producer/grower of the biomass
Name of the farm
Address
Crops produced
Total size of Farm
Geo-coordinates of the farm
NUTS II region
Documentation and information available for compliance and confirmation
GHG calculation methodology
Allowance for audits (based on sample)

This information is usually not publically available, but it is collected and managed by the respective certification scheme.

Supply chains for biobased products are complex and can involve various different stakeholder, but also different certification bodies and certification schemes, at the different stages of the supply chain. Thus, a general element, which allows for a transfer of the relevant information through the supply chain, is needed. One of these tools, under the EU RED framework is the sustainability declaration. This declaration includes a number of information, which could also be relevant for monitoring activities. The information included are shown in the following table. Information included in the sustainability declaration are typically not publically available.



Table 4 Typical data from sustainability declarations under the RED(2) framework (example from the ISCC framework), transferring relevant data through the supply chain (example from the ISCC framework; based on (Henke 2018; ISCC 2020b))

Type of information collected and transferred through the supply chain with the sustainability declaration
Contract number
Certification scheme and certificate number of issuing party
Name and address of recipient
Date of dispatch of the sustainable material
Type and quantity of sustainable material
Type of sustainability of material, GHG information and If applicable – add-on information
Country of origin of raw material
Unique number of SD or alternatively unique batch
Identification number
Chain of Custody information
Statement that the sustainability criteria according to RED Art. 17 (3) to (5) were not taken into account

Finally, the sustainability certificate, which also confirms that a company is allowed to receive, handle and forward sustainable material, includes relevant information shown in the following table. The data on the certificate, as well as the whole of the sustainability certificates filed under a specific certification scheme operating under the EU RED framework are publically available, usually in online databases hosted by the schemes.

Table 5 Information included on the sustainability certificate in the context of sustainability certification under the RED(2) framework (example from the ISCC framework; based on (Henke 2018; ISCC 2020b))

Type of information included on the sustainability certificate
Name of system user
Address
Certificate number
Name and address of certification body
Validity period (from-to)
Type of operation
Sustainable materials handled (input and output material, GHG values)

Additionally, some of the existing schemes, such as for example RSPO, RSB, ISCC an, REDcert and others release further information on a voluntary basis (e.g. summary audit reports giving additional information on certified units). The information provided in these reports is diverse. Further, for some certification systems, the information published is based solely on company information and is not being verified by an auditor or other third party verifiers. However, there are also examples from ISCC and others, which publish reports for all of their certified system users summarizing relevant information on certified biomass and bio-based products. These audit reports are written by the respective auditor and based on information verified during the audit.

The following table shows an example from the ISCC framework, containing publically available information.

Table 6 Additional information included in summary audit reports (example from the ISCC framework; based on (Henke 2018; ISCC 2020b))

Type of information reported in the ISCC summary audit report
Information about the certification system itself
Information on the Certification Body (name, relevant accreditations, E-Mail, website)
Information about the system user (name, address, country, contact details, audit date, type of certification, first certification, certification number, other systems used, validation, scope)
Information on the CB Audit Team (name of lead auditor and further auditors, name of GHG expert, date of issuance of this report)
Risk assessment data (risk level, risk indicators, tools used, sampling applied, scope, size, number of audits)
Summary of activities (type of sustainable input material, amount of input material, supply base smallholders/farms/plantations, type of GHG emission value)
Summary of audit results (number of requirements assessed, number of improvement measures, audit results per system chapter, status of improvement measures, remarks/ observations)
Description of scope/ different system users

On a more general, system level, some certification schemes do publish information regarding the activities of the scheme. For example, the RSPO publishes annual reports with information on its system users.

Table 7 Information included in the RSPO Annual Communications of Progress

Type of information included in the RSPO annual communications of progress
Main activity within supply chain
Main markets (country)
System for mass balancing available?
Information on certified units (country)
Information on volumes of palm oil, palm kernel oil and its processed, handled and used
Information on GHG emission reporting (voluntary)
Information on future company-owned aims for sustainability and planned actions
Information on trademark use
Information on smallholder support



Figure 12 Example sectoral reports from the RSPO (Roundtable on Sustainable Palm Oil 2017a, 2017c, 2017d, 2017b)



Finally, several certification schemes, from various sectors of the EU Bioeconomy do host database structures, which also include partly publically available data regarding the certificates and general activities of the scheme.

Figure 13 Examples for certification scheme online database structures (above left: FSC (Forest Stewardship Council 2020); above right: ISCC (ISCC 2020a); below left: RSPO (Roundtable on Sustainable Palm Oil 2020) ; below right: REDcert (REDcert 2020))

Therefore, depending on the specific rules of the respective certification scheme and the individual supply chain under certification, different types of data and information are being collected, documented and processed throughout the certification procedure. Data is being collected, as part of one of the above mentioned documents for each of the relevant supply chain elements. Furthermore, parts of this information is processed and combined in order to describe the sustainability characteristics of the whole supply chain and the main product to be certified.

Since, supply chains for biobased products can involve both, various stakeholders but also different certification schemes (e.g. combinations of certificates from different schemes are possible in reality, for example a FSC certification for the wood production and an ISCC certification for the processing unit), a certain harmonisation regarding the documentation of the audit information is necessary. Furthermore, this example underlines the importance of overarching database solutions, which are suitable to combine the different data from the documents for each supply chain element and to link them in order to create draw meaningful conclusions for the whole supply chain and the final product.

The following two figures illustrate examples of more complex and diverse supply chains of biobased products and show the documents and, thus the data being collected, documented and transferred throughout the certification process.

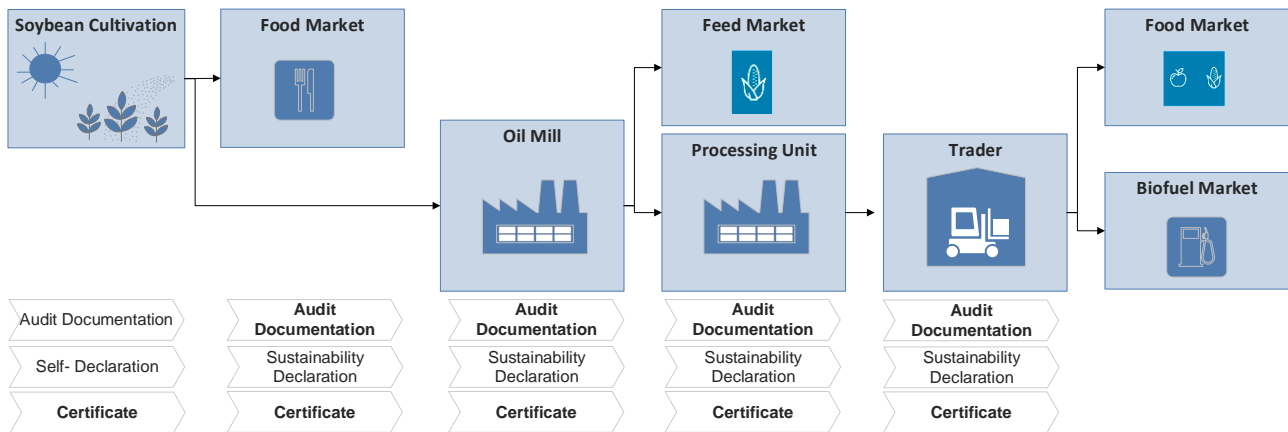


Figure 14 Simplified, exemplary supply chain based on soybean as feedstock for fodder, food and biofuel production (own figure, based on (Henke 2018))

The next figure shows a more complex example of a wood based supply chain, involving several supply chain elements, stakeholders and potentially several certification schemes. Again, various documents and information can be collected for each supply chain element throughout the process of certification. The type of information relevant for each of these documents is shown in Tables 3-6.

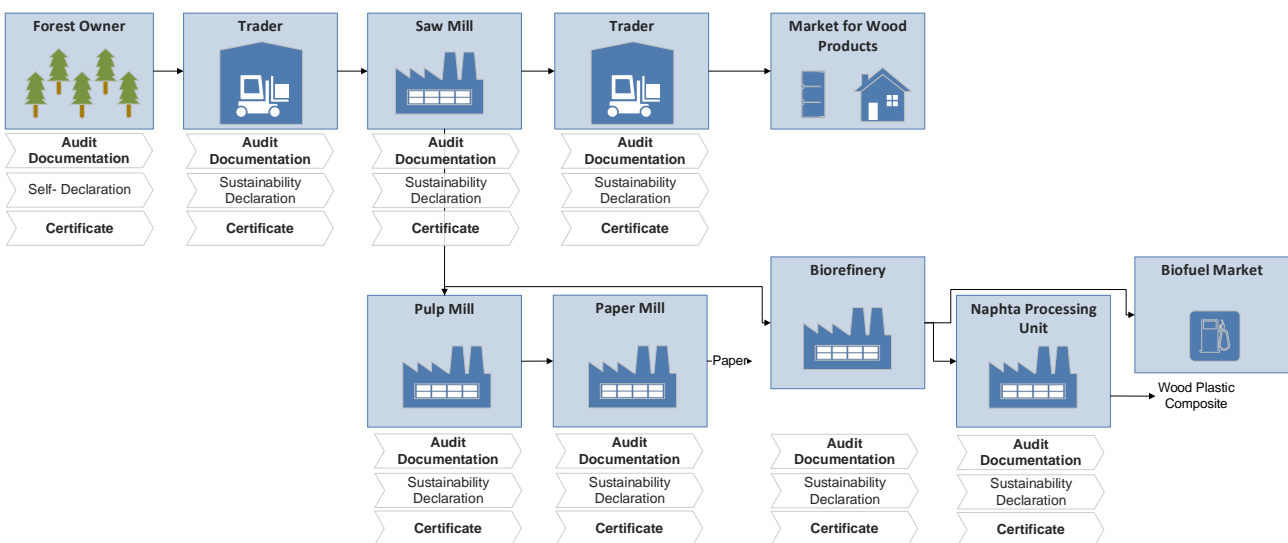


Figure 15 Simplified, exemplary supply chain based on wood as feedstock for the production of paper and biofuel (own figure, based on (Henke 2018))



4.3 Some first examples for the use of data from certification to monitor the Bioeconomy

Some of the data from sustainability certification, discussed in the previous section is already been used to monitor certain aspects related to the development of the Bioeconomy (or single sectors), mostly on a member state level. In this section, we will briefly discuss two examples, which could also be relevant for a Bioeconomy monitoring on EU level.

4.3.1 NABISY – “sustainable biomass system” and the national Evaluation report

The first example is the national database Nabisy (Nachhaltige Biomasse System), which is a governmental web application for sustainable biomass operated by the German Federal Office for Agriculture and Food (BLE). The purpose of Nabisy is to prove the sustainability of bioliquids and/ or liquid or gaseous fuels from biomass, pursuant to EU Directive 2009/28/EC and in future the recast of the RED. For this purpose, Nabisy collects information regarding the sustainability characteristics, the market volume of certified materials as well as feedstocks, associated regions for feedstock productions and technologies involved for the production of the certified products. National authorities, such as the German main customs offices, the biofuel quota body, the German Emissions Trading Authority, network operators as well as the competent authorities of other member states of the European Union have direct access to the web application Nabisy. Additionally, Nabisy also serves as a source for the Experiences and Evaluation Report regarding EU Directive 2009/28/EC, to be drafted annually for the German government and the EU Commission (Bundesanstalt für Landwirtschaft und Ernährung 2020).

The information, which is collected via sustainability certification and which is transferred to and processed in Nabisy is currently being used by national and by EU authorities to support a number of monitoring and reporting procedures. The information categories included in Nabisy, which are being collected with the sustainability certificates, are shown on the template for the proof of sustainability in the following Figure.

This information include data related to the:

- Producers and supply chain stakeholders,
- Country of origin of the biomass used,
- Type and quantity of biomass and biobased products,
- Greenhouse Gas savings (in relation to a defined comparator value),
- Mass balancing system, etc.

Proof of Sustainability

For bioliquids pursuant to Arts. 15 et seqq. of the Biomass electricity sustainability ordinance (Biomassestrom-Nachhaltigkeitsverordnung (BioSt-NachV)), or for biofuels pursuant to Arts. 15 et seqq. of the biofuels sustainability ordinance (Biokraftstoff-Nachhaltigkeitsverordnung (Biokraft-NachV))

Number of the proof:

Interface:	Recipient:	Certification system:
(name, address, number of certificate)	(name, address)	(name, website, registration number)

1. General information on biomass / biofuels:

Type, potential parts (e.g. 80% rapeseed oil, 20% palm oil)*:	Country of cultivation*:
Quantity (t oder m ³):	Energy content (MJ):

The bioliquids / biofuels have been produced from residues or by-products, with by-products not arising from agriculture, forestry, fisheries or aquaculture. ☐ yes ☐ no

Advice: If Yes has been indicated, no further particulars are required for 2.

2. Sustainable production of biomass and / or sustainable production of biofuels pursuant to Arts. 4 – 7 BioSt-NachV/Biokraft-NachV:

The biomass complies with the requirements pursuant to Arts. 4 – 7 BioSt-NachV / Biokraft-NachV. ☐ yes ☐ no

3. Greenhouse gas savings pursuant to Art. 8 BioSt-NachV / Biokraft-NachV:

☐ The greenhouse gas emissions savings potential has been complied with as follows:

- Greenhouse gas emissions (g CO ₂ eq/MJ):	Comparator for fossil fuels (g CO ₂ eq/MJ):
- Compliance with the savings potential when used	<input type="checkbox"/> for electricity generation <input type="checkbox"/> as fuels
- Compliance with the greenhouse gas savings when used in the following countries (e.g. Germany, EU):	<input type="checkbox"/> for combined electricity / heat generation <input type="checkbox"/> for heat generation

Calculation of the greenhouse gas savings has been carried out wholly or partially on the basis of standard values according to Annex 2 BioSt-NachV / Biokraft-NachV. ☐ yes ☐ no

☐ The biomass originates from an exemption granted interface pursuant to Art. 8 para. 2 BioSt-NachV and Art. 8 para. 2 Biokraft-NachV respectively.

The proof of sustainability is valid without signature. The interface is responsible for accuracy of the proof. Identification of the proof takes place by means of ist non-recurring number.

Place and Date of issuance:

Delivery / shipment based on a mass balance system pursuant to Art. 17 BioSt-NachV / Biokraft-NachV:**

☐ Delivery / shipment has been documented in a mass balance system.

☐ Documentation has been carried out according to the requirements of the following certification system:

☐ Documentation is carried out pursuant to Art. 17 para. 3 Biokraft-NachV.

☐ Documentation has been carried out by means of the following electronic database:

☐ Documentation has been carried out in the following different way:

Last supplier (name, address):

* **Advice:** When blending different quantities of biofuels, indication of the two major parts of the blend will be sufficient.

****Advice:** to be completed by the last supplier

Blank by the Federal Office for Agriculture and Food

Figure 16 Template for the Proof of sustainability and the respective information categories in the NABISY database (Bundesanstalt für Landwirtschaft und Ernährung 2020)

Based on the information included in Nabisy, German national authorities publish annual reports related to the development of the German Biofuel Market.

This reporting includes information regarding:

The total amount of sustainable biofuels and biomass used

- Percentages and amount of the various feedstocks for all biofuels
- Origins of the feedstocks and biofuels used
- GHG emissions associated with the used biofuels and GHG avoidance due to biofuel use
- Total number of certificates issued



Figure 17 Annual Evaluation report of the BLE (Bundesanstalt für Landwirtschaft und Ernährung 2019)

4.3.2 Spatial monitoring of certified forestry biomass

The second example focusses on an application which results from a research activity coordinated by the IIASA. This application, the IIASA Geo-Wiki Tool (Kraxner et al. 2017) involved a participatory and collaborative approach to collect information regarding the sustainability certification of forestry biomass and their spatial location.

Besides several services, which the application can provide, users can access Geo-Wiki information in order to understand the relevance of sustainability certification in the forestry sector on a global level. The tool provides information regarding the percentage and the spatial location of certified forests and links it with data related to the consumption (based on the issued final certificates) of forestry biomass. This allows a general discussion regarding the risk related to the sourcing of forestry biomass from different regions in the world, as well as the general development in the demand for certified biomass and its supply.

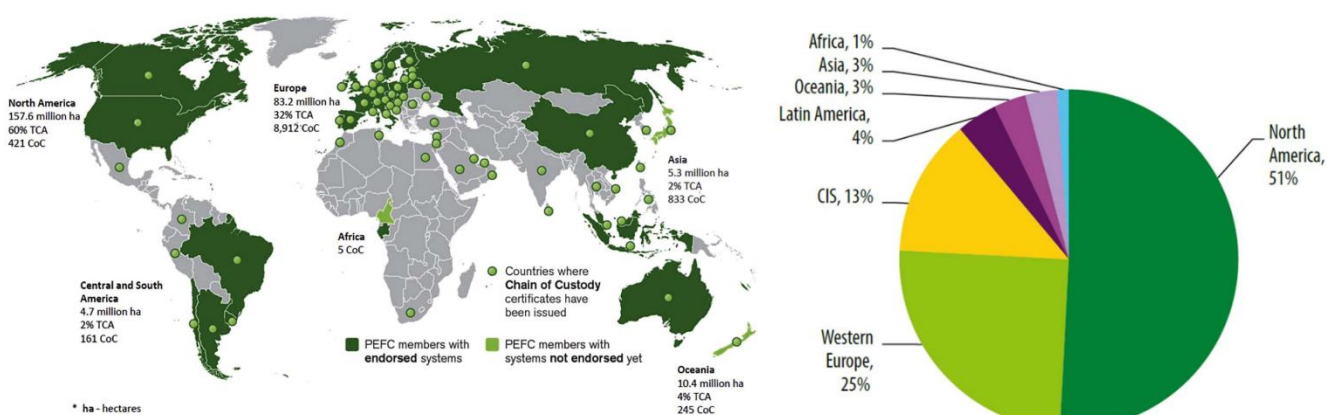


Figure 18 Mapping of certified forestry areas based on the Geo-Wiki application (Kraxner et al. 2017)

Information in the Geo-Wiki application is sourced from the official statistics and data published by the certification schemes and by national authorities (as described above). However, Geo-Wiki also entertains a participatory approach which involves users and allows them to validate information and datasets.



5 Summary and conclusions

With a growing interest in the concept of the Bioeconomy in the EU, also activities regarding the monitoring of Bioeconomy sectors and the impacts of the Bioeconomy development have increased. As a result, of the policy framework in some Bioeconomy sectors and an increasing awareness of consumers and the civil society regarding sustainability risks associated with an intensified use of natural resources, also sustainability certification activities have increased significantly throughout the recent years.

In our analysis, we reviewed current BE monitoring activities and found a huge variety, ranging from conceptual works to complete operational monitoring systems. However, only a few of these activities can be considered a comprehensive monitoring, considering all relevant aspects of data collection, processing and reporting.

To support the development of the BE in a sustainable way, it seems necessary to apply a balanced monitoring indicator set consisting of environmental, social and economic criteria. So far, economic monitoring criteria were implemented on EU level, enabling the quantification of the size of the BE in all member states by measuring the turnover, for instance.

Social and environmental monitoring indicators are so far poorly implemented in monitoring activities. One reason for that might be a lack of appropriate of data. To improve this situation, alternative ways of data collection might offer a way forward in some cases. Citizen science campaigns, to name one example, could be considered a cost efficient way for data gathering. Furthermore, specific data could be derived from certification processes. The potential role certification could play to close gaps will be further discussed in the next section.

Summing up, the monitoring of the BE in the EU as a whole as well as in the EU member states is currently still in its infancy. Monitoring indicators in place are not suitable to evaluate the sustainability of the BE without including additional social and environmental indicators. On EU level, this seems to be considered by the foreseen further development. There is a lot of research ongoing and already many results available. This research focuses amongst other extensively on monitoring indicators. This can be considered a good groundwork for the upcoming development work.

Our analysis of existing certification framework revealed a significant number of schemes, with different foci on specific regions, feedstocks and products. In most of the currently operating sustainability certification schemes in the EU Bioeconomy, all elements of the supply chain that are producing, processing and handling certified biomass and bio-based products must be certified. Throughout this process, various information about the stakeholders involved, the types and volumes of used biomass and produced biobased products, as well as their sustainability characteristics are being collected.

The type of information being documented is very diverse and mainly depends on the certification system being used, the type of biomass and the type of certified element. Only few information (e.g. information on the certified unit) is being document by all certification systems. In addition, some certification systems also publish public (summary) audit reports on a voluntary basis. The information provided in these reports is diverse. Further, for some certification systems, the information published is based solely on company information and is not being verified by an auditor or other third party verifiers.



In theory, the activities of currently operating certification schemes and thus, the data involved in this process cover all relevant feedstocks of the EU Bioeconomy (e.g. main commodities such as for example: woody biomass, domestic and imported agricultural crops and residues such as for example used cooking oils). Furthermore, operating certification schemes do cover a wide geographical scope and a wide range of products (most of the relevant schemes from the bioenergy sector have started to expand their activities also to non-energy related markets; compare D1.1). So, an inclusion and use of this data from sustainability certification for monitoring purposes could provide valuable insight regarding the number of certified volumes of biomass and biobased products, the number of certified areas for biomass production as well as the respective sustainability characteristics of these goods and resources. With a growing relevance of certification, also the potential importance and meaningfulness of this data for a BE Monitoring would increase. Therefore, even though the possible contribution of data from existing certification to a regular monitoring of the EU Bioeconomy is still limited, it has a very high potential when certification activities do further increase in the future.

In markets with mandatory certification (e.g. the biofuel market), some member states collect and publish relevant information on the consumption of certified biomass in centralised database structures (e.g. the Nabisy database). For non-mandatory markets (e.g. food, feed) the documentation of information on certified biomass being consumed is mandatory.

However, the centralised collection and organisation of information from certification processes could be an interesting approach for the future. This could contribute to both, more harmonisation regarding the documentation of relevant data across the existing schemes and the subsequent use of the relevant information for purposes such as the monitoring of certification activities in different sectors of the Bioeconomy, but also the development of the Bioeconomy itself.

With the recast of the renewable energy directive, the EU Commission has already foreseen the development of a more centralised database structure, which shall “enable the tracing of liquid and gaseous transport fuel...” Furthermore, this database structure shall be suitable to collect information on “the sustainability characteristics of those fuels, including their life-cycle greenhouse gas emissions, starting from their point of production to the fuel supplier that places the fuel on the market.” (European Commission 2018)

Purely speaking from a technical perspective, this would mean that in theory such a centralised database structure could be connected to the existing database structures implemented in currently operating certification schemes.



6 References

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7 Annex

Table 8 Inventory matrix of bioeconomy monitoring activities

Name of System/activity	Country	Year	Terminus (Bioeconomy, biobased economy etc.)	Sustainability dimension	Included sectors	Published by	Purpose of monitoring system or project	Details	Reporting	Source
SAT BBE	Project consortium: EU	2012-2015	Bioeconomy, Bio-Based Economy	Economic, Environmental, Social		Research	Inputs into EU BE Observatory; describe, monitor and model the BE part of the economic system; assess and address short and long term challenges, for effective and sustainable EU strategy; inform BE policy development and decision-making by stakeholders within EU	Project name: Systems Analysis Tools Framework for the EU Bio-Based Economy Strategy; focus lies on primary production of biomass in the EU (agriculture, forestry, residues, fisheries, waste), import of biomass to the EU (agriculture, forestry, residues, waste) and global land use for biomass based consumption in the EU	unknown	(O'Brien et al. 2013)



MontBioeco	GER	2017-2018	Bio-economy	Economic, Environmental, Social	entire BE	Research	Support for policy makers and technicians that want to measure BE in local context	Project name: Monitoring Bioeconomy-current approaches in EU member states and at EU level; screening and comparing different approaches within EU comission and MS to monitor progress of BE; Provide overview of monitoring actions; Analyze differences between monitoring actions; Suggest consistent approach of BE monitoring	n.a.	(Lier 2020)
Bio-economy Observatory	EU	2016-2017	Bioeconomy	Economic, Social (public perception)	agriculture, forestry, fishery, food, pulp and paper production, plastics, parts of chemical, biotechnological and energy industries	Government	Monitoring instrument of EC Bioeconomy Strategy	Activities to monitor development of BE in Europe; collects and analyses data about BE; led by JRC performed comprehensive, independent and evidence-based environmental sustainability assessment of bio-based products and supply chains using life cycle perspective; Project: Bioeconomy Information System and Observatory Project (BISO) – Set up of the Bioeconomy Observatory. Deliverable 1.3: Methodology Report for the Bioeconomy Observatory.	unknown	(European Commission 2013; Viorel Nita, Lorenzo Benini, Constantin Ciupagea, Boyan Kavalov, Nathan Pelletier)



Moni-toring Biobased Economy	NL	2017	Biobased economy	Economic		Government	The 'Netherlands enterprise agency' is developing a methodology to monitor bio- based economy in NL Aims at the quantification of the size of the industry and the monitoring of its development over time.	Annual reports on the state of the biobased economy in the Netherlands. Details on the different Dutch regions and on some best practice cases.	annually	(Bracco et al. 2018; Meesters et al.; Rijksdienst voor Ondernemend Nederland 2020)
Finnish bio- economy in numbers"	FIN	2016	Bio-economy	Economic, Environmental, Social		Government	Providing statistical data on the Finnish Bioeconomy (online database)	The Finnish Bioeconomy is monitored using five indicators: output, value added, investments, employment and exports. The main source is the annual national accounts, produced by Statistics Finland	annually	(Natural Resources Institute Finland (Luke) 2020b)



Inter-Ministerial Working Group on Bio-economy	GER	2014	Bio-economy	Economic		Government	Strengthen interaction between BE Council and other consultative committees set up by Federal Governments on Bioeconomy-related issues; to be integrated in coordination of public-relations work relating to BE	Support exchange of information and coordination of policies adopted by various governmental departments with regard to BE; monitoring and implementation of impact assessment		Federal Ministry of Food and Agriculture (2014)
Spanish Bio-economy Observatory	ES	2017	Bio-economy	Economic, Social (Employees)	Agrofood production, forestry, marine and maritime, waste and residues, water	Government	Creation of new value chains; new economic activities, competitiveness of spanish companies, knowledge generation, technological, organisational and management innovation	Consists of (1) monitoring group for Spanish BE strategy (representatives of ministries and autonomous communities) and (2) Spanish BE Strategy Committee (tasks: foster implementation as part of strategy and annual action plans)		(Ministerio de economía y competitividad 2016)



BIT Bio-economy in Italy	IT	2017	Bio-economy	Economic, Environmental, Social	Products, commodities, intermediate goods and technologies	Government	Construction of monitoring tools is subjected to an evolutionary process of data availability to meet public awareness and assessment needs	Proposed key performance criteria (which all include 2-5 indicators): biomass availability, production structure, employment structure, human capacity, innovation, investment, demographics, markets. Proposed sustainability objectives (which all include 2-6 indicators): ensuring food security, managing natural resources sustainably, reducing dependence on non-renewable resources, coping with climate change, enhancing economic growth		(BIT Bioeconomy in Italy 2019)
Towards Green Growth Monitoring Progress OECD Indicators	OECD	2011	Green Growth, Green Economy	Economic, Environmental		Government	Keep natural and economic asset's base intact. Develop a conceptual framework, green growth indicators and present results for selected indicators- balanced coverage of the two dimensions green and growth	conceptual framework and statistical accounting framework - select indicators that reflect the major trends (key principles in the selection: policy relevance, analytical soundness, measurability)	n.a.	(OECD 2011)



vTI Analysis for 2007	GER	2007;2002-2010	biobased economy /bio-economy	Economic		Research	One study analysed the importance of the Bioeconomy for the entire economy in Germany for the year 2007. Based on the methodology the development from 2002-2010 was analysed in a second study.	vTI analysed the importance of the Bioeconomy within the national economy in 2007 by means of measuring the economic indicators number of companies, employment, turnover and gross value added using mainly official statistics. Result: 5 mio employees (12,5% of all employees), 165 billion € = 7.6% of German gross national product	n.a.	(Efken et al. 2016; Efken J., Banse M., Rothe A., Dieter M., Dirksmeyer W., Ebeling M., Fluck K., Hansen H., Kreins P., Seintsch B., Schweinle J., Strohm K., Weimar H. 2012)
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Bio-economy knowledge center	EU	2008-2015	Bioeconomy	Economic		EC	initiative on better knowledge management for bioeconomy-related policy making aim to become a central knowledge hub supporting the work of Commission services and other stakeholders Economic indicators turnover, value added and employment can be displayed for the EU member states for the years 2008-2015	Project includes *visualisations of data and background information on bioeconomy – by topic and by country the Bioeconomy Library with relevant publications * the Bioeconomy Data Catalogue, a central repository for metadata describing bioeconomy-related datasets from both the European Commission and other organisations * bioeconomy-relevant news and events		(European Commission 2020)
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Bio-economy Monitoring	GER	2016-2019	Bioeconomy	Economic		Research	Develop the basics for a national monitoring system of present and future flows of biomass. (Resource base as focus); fill knowledge and data gaps about bio-based supply chains and enable assessment of BE	Thünen-Institut; financed by German ministry BMEL; to provide a solid database of the de facto development; to develop manageable and summarizing balance sheets and indicators, which aggregate multitude data to informative key ratios.	n.a.	(Banse 2020)
Ermittlung wirtschaftlicher Kennzahlen und Indikatoren für ein Monitoring des Voranschreitens der Bioökonomie	GER	2016-2019	Bioeconomy (Bioökonomie)	Economic		Research	Support development of scientific basis for long-term monitoring of BE; create knowledge base for continuous monitoring to support political action and public debate about BE	in collaboration with Leibniz-Institut für Agrartechnik und Bioökonomie, Fraunhofer-Institut für System- und Innovationsforschung ISI und der nova-institut GmbH; financed by BMWI	n.a.	(Wackerbauer et al. 2019)
Bio-economy Market Reports (nova-Institute)	GER	1994-present	Bioeconomy, bio-based economy	Economic		Research and Consultancy	exchange of knowledge and communication as key to success is bio-based economy	Commercial Reports on bio-based economy; nova-institute is partner of projects i.e. BEPASO,	Several times/year	(Piotrowski et al. 2019)



SYMOBIO	GER	2017-2020	Bioeconomy	Economic, Environmental, Social	Entire BE	Research	Developing the scientific basis for a systematic modelling and monitoring of the German bioeconomy	A result of the project will be an interactive website showing information on the German bioeconomy by means of different footprints and the consideration of all three sustainability dimensions, in particular there will be the following footprints: Land, GHG, Water, Material	n.a.	(Center for Environmental Systems Research 2020)
Bio-monitor - Monitoring the Bio-economy	EU	2018-2022	Bioeconomy	Economic, Environmental, Social	Entire BE	Research	The project aims to resolve the lack of indicators needed to quantify the bioeconomy's economic, environmental and social impacts in the EU and its Member States.	Three-fold approach: * Enhancing existing modelling tools that guide industries and policymakers in defining long-term strategies * creating a stakeholder engagement platform and training modules to validate and disseminate the data and modelling framework developed by the project * Closing the data gaps observed when measuring the bioeconomy by using new and improved datasets	n.a.	(BioMonitor 2020)



European BE in figures 2008-2015	EU	2008-2015	Bio-economy	Economic	Entire BE	Private	A report was worked out by ova Insitute on behalf of Bio-based Industries Consortium (BIC). This report shows turnover and employment of the EU BE. It is the second report, as reports shall be updated regularly.	Eurostat is used as main data source. Methodology has been developed in collaboration with JRC (see Ronzon et al.). Therefore published data from EU (BE knowledge center) seem to be identical. Due to slight differences in details, figures are not exactly the same. Harmonization is planned for the future.	Regular updates are done. The precise interval of updates is not clear	(Piotrowski et al. 2018, 2019)
SUMINISTRO	GER	2015	Bio-economy			Research	The UFZ Bioenergy Department is working on the development of a Sustainability Index for ex-post assessment of regional bioeconomy industry networks and Multi-Criteria Decision Analysis (MCDA) for ex-ante evaluation of emerging bio-based value chains.	Interesting from a methological point of view. The approach combines LCA with MCDA (Sustainability monitoring Index for assessing regional bio-based industry networks)	n.a.	(Hildebrandt et al. 2018)



DataBio	EU	2017-2019			agriculture, forestry and fishery/aquaculture	Research	Support the development of EU BE with collection and handling of large amounts of data, mostly from sensors and satellites	The data intensive target sector selected for the DataBio project is the Data-Driven Bioeconomy, focusing in production of best possible raw materials from agriculture, forestry and fishery/aquaculture for the bioeconomy industry to produce food, energy and biomaterials taking into account also various responsibility and sustainability issues. DataBio proposes to deploy a state of the art, big data platform “on top of the existing partners’ infrastructure and solutions - the Big DATABIO Platform.		(Habyarimana 2020)
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DIA-BOLO	EU	2015-2019			Forestry	Research		<p>DIABOLO aims to:</p> <ul style="list-style-type: none"> i) strengthen the methodological framework towards more accurate, harmonised and timely forest information; ii) support EU policy processes, international reporting obligations, forest administration and forest planning entities with new methodologies and EU-wide consistent forest information; iii) make innovative use of existing field-collected data and EC space-based applications of EO and satellite positioning systems with reference to INSPIRE and GEOSS, and global monitoring systems such as REDD+, FLEGT and UNFF. 		(Natural Resources Institute Finland (Luke) 2020a)
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Philippidis et al. (2014)	EU	2014				Research	identify certain bioeconomic activities with greater than average wealth generating properties as "key sectors"	"This research represents a first step by employing social accounting matrices (SAMs) for each EU27 member encompassing a highly disaggregated treatment of traditional 'bio-based' agricultural and food activities, as well as additional identifiable bioeconomicactivities from the national accounts data.	n.a.	(Philippidis et al. 2014)
EEG Monitoring Stromerzeugung aus Biomasse	GER	2015	Bioenergy	Economic	Energy	Research	Research funded by German Ministry of Economy and Energy to assess the impact of renewable energy legislation on bioenergy	General assessment of bioenergy plants in Germany. Reduction of subsidies led to the desired effect that fewer new bioenergy plants have been built.	Annual (until 2015)	(Daniel-Gromke et al. 2014)



REMEA	EU		Bioenergy	mostly economic	Energy	EC	Activity by Joint Research Center of the European Commission to map renewable energy raw resources, monitor their deployment and foster international scientific cooperation	Develop databases on renewable resources availability. Integrate exploitability and sustainability constraints. Monitor actual deployment of renewable energies. Analyze deployment opportunities, perhaps in connection to key threats. Involve in relevant activities of international scientific networking.	n.a.	
Solid biomass barometer; Biogas barometer;	EU	2010–now	Focus on bioenergy	Economic	Energy	Research and private	Monitoring of various sectors of renewable energy in the EU	Reports published each year for several sectors, among them three with relevance to the bioeconomy: solid biomass, biogas and biofuels. These reports ("barometers") summarize the state of the sector in the EU Member States. There is an online database available as well.	Annually	(EurObserv'ER 2020)
Resource use in Austria	AUT	2012, 2015, (2019)	Focus on resources			Government	Analysis of resource extraction, trade and use in Austria, biomass represents around 1/4 of total resource use	Report by Austrian ministry of economy and ministry of environment; separate focus chapter on biomass (which represents 23% of all resources used). Focus mostly on quantities, e.g. a flow chart of biomass use in Austria	3-4 years interval	(Kazmierczyk 2015)(Institute of social ecology (sec) und statistics Austria 2015)



More from less - material resource efficiency in Europe	Europe	2016	Resource efficiency			Government agency (EEA)	overview of approaches to material resource efficiency and to circular economy in thirty two European countries	It explores similarities and differences in national policy responses, with respect to policy objectives, priority resources and sectors, driving forces, targets and indicators, and the institutional setup. The report also reviews the EU policy framework for resource efficiency and analyses trends in material use and resource productivity between 2000 and 2014.		(Kazmierczyk 2015)
EU Resource Efficiency Scoreboard	EU	2000-2019	Resource efficiency		Cross-sectoral	EC	The EU Resource Efficiency Scoreboard indicators illustrate the progress towards increased resource efficiency of individual Member States and the European Union as a whole	Published by Eurostat since December 2013, it is regularly updated based on the best available indicators and most recent statistics from Eurostat, the European Environment Agency and other internationally recognised sources.. 2014 + 2015: Full analytical reports assessing progress towards a resource efficient EU	Annual update of indicators	(Eurostat 2020)



The JRC Biomass Assessment Study	EU	2015	Biomass	economic and environmental		EC	providing the EC services, on a long-term basis, with data, models and analyses of EU and global biomass potential, supply, demand and related sustainability	A number of European Commission (EC) services have given the Joint Research Centre (JRC) a mandate to provide data, models and analyses on EU and global biomass supply and demand and its sustainability (environmental, social and economic), on a long-term basis		(Camia et al. 2018)