Work Package 1 – Shared modelling framework and learnings

D1.2 – Description of scientific methods

Task 1.5- Framework for socio-economic assessment

Social indicator quantification for bio-based sectors

Lead Contractor: University of Antwerp (ANTW), Belgium.
Author(s): Dr. Maxim Tschulkow

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DELIVERABLE CONTRIBUTORS			
	Name	**Organisation**	**Job title**
Deliverable leader	Steven Van Passel	ANTW	Prof.
Contributing Author(s)	Maxim Tschulkow	ANTW	Postdoc
Reviewer(s)	Massimo Pizzol	AAU	Prof.
	Kira Lancz	AAU	Res. Assist.
	Bas Davidis	BTG	Consultant
Final review and quality approval	Massimo Pizzol Kíra Lancz Dalia Stakenaite	AAU AAU AAU	Prof. Res. Assist. Project manager

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Acronyms and abbreviations

ABBREVIATIONS	Description
EU	European Union
FWP	Fair wage potential
ISO	International organization for standardization
LCA	Life cycle assessment

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Executive summary

This task consists of coordinating a consistent implementation of socio-economic assessment within the ALIGNED project. It consists of three building blocks; (i) economic evaluation (techno-economic assessment), social evaluation (social indicator quantification), and (iii) multi-criteria decision analysis. In this particular description, the developer focuses on the social indicator quantification and evaluation based on the work of Van Schoubroeck et al. (2021) covering the social dimension of the ALIGNED project.

1. The need for sustainability in the bio-based sectors

The 2030 Agenda for Sustainable Development expresses a dedication to realize sustainable development across economic, social, and environmental domains in a harmonized and cohesive manner (United Nations, 2015). Hence, the European Commission introduced the strategy " European Green Deal". This initiative aims to transform the European Union (EU) into a society that is both fair and prosperous, characterized by a modern, resource-efficient, and competitive economy (European Commission, 2019). In addition to governmental policies and environmental regulations, sustainability is also stimulated by customers' demand and increasing societal and environmental awareness (Leal-Millan et al., 2018). Consequently, companies are faced with the challenge of adopting new strategies, products, and technologies that prioritize sustainability.

Achieving sustainability is closely tied to the implementation of existing and novel innovative technologies and products, ideally with reduced environmental impacts and positive social and economic outcomes. In a world of population growth and increasing environmental challenges (e.g. climate change), the bioeconomy is gaining prominence as it provides an avenue to harmonize economic expansion with environmentally responsible practices, presenting the prospect of a low-carbon economy and the creation of new jobs (Eickhout, 2012). The advancement of the bioeconomy is a key element of the 2020 strategy (Fritsche and Iriarte, 2014). Consequently, the European Commission formulated the Bioeconomy Strategy in 2012 to serve as a guide for research and innovation agendas (European Commission, 2012). An updated version of this strategy was released in 2018, aligning more effectively with contemporary policy priorities (European Commission, 2018).

The development of new or enhanced industrial processes is essential for converting biomass into various energy applications and other products. However, the utilization of organic matter (i.e., biomass) for food, feed, biobased products, and bioenergy carries potential negative impacts, such as land use changes due to deforestation and unsustainable farming practices, as well as increased water use. Consequently, it is crucial to measure and monitor these sustainability-related impacts, preferably already during the developmental phase of new biobased technologies (Van Schoubroeck et al., 2018).

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2. Method for social indicator quantification

The social dimension of sustainability gets more and more attention. This can be seen by the increased effort of the EU towards social improvement and protection (European Commission, 2022). The previous Europe 2020 strategy underlines the effort to fight poverty and social inclusion targets supported by the recent European Pillar of Social Rights and its Action plan to implement and monitor the process of poverty and social inclusion towards the year 2030 (European Commission, 2022).

To align with the EU's overall goals to reduce poverty and social inclusion, it is expected that companies, projects, or technologies within the companies make their fair contribution. Hence, indicators of the social impact performance of companies throughout the life cycle of the products are crucial. Social indicators have the purpose of measuring and evaluating several aspects of social well-being, progress, and life quality within society (Van Schoubroeck et al., 2018).

However, only a few studies developed models that transform life cycle inputs/outputs into quantitative measures of social impact. However, choosing the right impact pathways, impact categories and indicators to effectively express and measure social impacts at different stages of assessment remains a significant challenge because of subjectivity and their qualitative or semi-qualitative measurement manner (Van Schoubroeck et al., 2021).

The following social indicators are considered in the ALIGNED project:

2.1. Faire wages potential (FWP)

Neugebauer et al. (2017) developed a quantified fair wages potential (FWP) indicator that has been validated on a case study about German tomato production. Equations (1) and (2) are used to calculate the fair wage potential:

$$FWP_n = \frac{RW_n}{RWT_n} * CF_{FW,n} \qquad (1)$$

$$CF_{FW,n} = \frac{1}{MLW_n} * CWT_n * (1 - IEF_n^2) \qquad (2)$$

where

FWP_n: Fair wage potential (in FWeq.) representing (production) process n within a product's life cycle taking place at a defined location,

RW_n: Real (average) wages (€ per month calculated over one year), which are paid to the worker(s) employed in (production) process n,

RWT_n: Real working time (hours per week) of workers performing (production) process n (including vacation days and unpaid overtime),

$CF_{FW,n}$: Fair wage related characterization factor (month per €) for (production) process n representing the country, region, or sector specific conditions,

MLW_n: Minimum living wages (€ per month), which has to be paid to the worker to enable an adequate living standard for an individual and/or family in the respective country or region, where (production) process n is performed,

CWT_n: contracted working time per country or sector (hours per week) for workers performing (production) process n (including vacation days), and

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IEF_n: (squared) inequality factor (in %) of the organization, region, or country, where (production) process n is performed.

Note, that value ‘1’ is the turning point. Values greater than 1 are considered superior over values below 1. Values below 1 indicate an underpayment in those countries, regions, or sectors.

In addition, it must be emphasized that the method considers the recommendation of ISO (2006) regarding the characterization models. Thus, Equations (1) and (2) are designed to represent the midpoint-related consequences of wages, present a numerical category indicator result by means of ‘fair wage equivalents’ (FW_{eq}), and offer a robust approach to conducting social impact assessments.

For more detailed information, user should refer to the work of Neugebauer et al. (2017).

2.2 Product transparency

The measurement of product transparency typically involves *qualitative or semi-quantitative methods*. According to Social life cycle assessment (LCA) methodological sheets established by UNEP and SETAC in 2013, transparency aims to empower consumers to make informed decisions without misleading or concealment. Two indicators are provided that can be utilized for assessing technologies/projects: 'existence of a law or regulation concerning transparency (by country and/or industry)' and 'sector transparency rating: the count of organizations within a sector that has released a sustainability report' (UNEP SETAC, 2013).

The following approach is used to calculate the proxy transparency value:

- the number of country and sector-specific enterprises divided by the number of sustainability reports for this particular sector within the country.

A higher value equals to a higher level of transparency.

In case the value chain lies completely in one single country, the value is weighted with one. However, if the value chain lies within multiple countries, it is advised to calculate the transparency value for each country and allocate accordingly. The same allocation method as for LCA can be applied such as mass allocation or economic (revenue) allocation. Note, this allocation method have not been validated yet and need further research.

3. Challenge of social indicators

Most of the social indicators are considered to be subjective and are measured in a qualitative or semi-qualitative manner (Van Schoubroeck et al., 2021), whereas the environmental indicators for the LCA’s are quantitatively measured and validated. As indicated above, the transparency indicator is semi-qualitatively assessed. On the other hand, FWP follows the recommendation of ISO (2006) and is quantitatively assessed. FWP has been peer-reviewed and validated by a case study about German tomato production (Neugebauer et al., 2017).

Still, for most of the social indicators the challenge of being subjective and qualitatively measured remains which calls for further research.

In this work, some pre-defined values for transparency and FWP are considered based on the work of Van Schoubroeck et al. (2021). These values are based on a case study of microalgae replacing potential products in the food and chemical market. While these values can be used as

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proxies for certain bio-based sectors, other sectors might need to identify and quantify the indicator's values according to the sector/project-specific needs.

There are three ways of doing so:

- **Literature review** for sector-specific data: the user is advised to conduct a literature review on existing social indicators and their values in the sector in which the project/technology/ product is currently situated.
- **Proxies**: In case sector-specific data is not (or partially) existing, the user is advised to look for sectors that have strong linkages to the sector in which the project is currently situated.
- **Delphi study**: The most precise and correct way is to conduct its own study accruing to the project and sector-specific needs. The user is advised to use the approach of Van Schoubroeck et al. (2019). Depending on the complexity of the indicators, the user can go solely for a Delphi study or a Delphi study combined with a multi-criteria decision analysis. Note, that these studies and associated surveys to evaluate stakeholders' perceptions can be extensive and lengthy.

An additional challenge with the chosen indicators is that they refer to the country, region, sector, or company but not necessarily to the product itself. A company can have multiple products that can account differently to the overall contribution of a social indicator of the company and hence mislead the interpretation of the real social impact of that particular product. Hence, it is advised to conduct additional splitting of the social impact among the products based on weighting schemes defined by the user.

4. Guideline to use the tool 'Quantification model for social indicators_ALIGNED'

To conduct a social indicator quantification, the University of Antwerp (ANTW) provides an Excel-based tool 'Quantification model for social indicators_ALIGNED' that has been developed by Van Schoubroeck et al. (2018). It consists of the following worksheets:

- **ReadMe**
- **Social indicators**

This guide provides an explanatory tutorial on how to conduct the quantification of the social indicators, fair wages potential (FWP) and product transparency.

4.1 ReadMe

This sheet provides a general overview of all worksheets and their purposes within the Excel file 'Quantification model for social indicators'. Moreover, it describes the utilization of the different sources within the datasheets.

4.2 Social indicators

The worksheet 'Social indicators' represents two social indicators ; (i) product transparency, (ii) and fair wages potential. On the top of the worksheet, the user can find the summary of all two indicators.

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Before using the social indicator tool 'Quantification model for social indicators' the user is advised to pay attention to the legend which indicates which values need to be (i) inserted, (ii) calculated automatically, or (iii) represent the results:

LEGEND (color indication)
Value to be inserted by the user
Value calculated authomatically
Results

Figure 1: Color-based legend.

4.1 Transparency (proxy)

In Table 1: Sustainability reporting as a proxy for transparency the following columns are defined as follows:

- **Column B** defines the European countries.
- **Column C** defines the number of sustainability reporting instruments.
- **Columns D and E** define the number of companies that produce products that are linked to/target specific sectors. Note, that the sector might refer to other sectors that have strong linkages/interference with the bio-based sector.
- **Column F** is the sum of the number of companies within the targeted sectors.
- **Column G** defines the number of sustainability reports in the particular sectors.
- **Column H** defines the total number of all sustainability report in the country.
- **Column I** defines the employees in the particular sector.
- **Column J** calculates the '**transparency proxy'** by dividing the sum of the number of companies within the targeted sectors (column F) by the number of sustainability reports in the particular sectors (column G) and multiplying by 100.

Action required: Once all green-marked sections (column C-I) are filled out, the user can select the automatically calculated results in blue (column J), see Table 1:

Table 1: Sustainability reporting as a proxy for transparency

Table 1: Sustainability reporting as a proxy for transparency								Transparency proxy
Country	Number of sustainability reporting instruments	Manufacture of chemicals and chemical products (number of companies)	Manufacture of food products	# companies food and chemicals	Number of sustainability reports food and chemicals	Number of sust	250 or more persons employed	Sust. Reports relative to large companies
Belgium	3	614	6720	7334	6	58	218849	0.0818

4.2 Fair wage potential (FWP)

In Table 2: Calculations fair wage potential (can be company-specific) the following columns are defined as follows:

- **Column B** defines the European countries.

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- **Columns C - G** define the real wages. Column G defines the real (average) wages (€ per month), which are paid to the worker(s).
- **Column H** defines the real working time (hours per week) of workers (including vacation days and unpaid overtime).
- **Column I** defines the minimum living wages (€ per month), which have to be paid to the worker to enable an adequate living standard for an individual and/or family.
- **Column J** defines the contracted working time per country or sector (hours per week) for workers performing (production) process n (including vacation days).
- **Column K** defines the inequality factor (in %) of the organization, region, or country.
- **Column L** calculates the **fair wage potential** (FWP) (in FWeq.) within a product's life cycle taking place at a defined location.

Action required: Once all green-marked sections (column C-K) are filled out, the user can select the automatically calculated results in blue (column L), see Table 2:

Table 2: Calculations of fair wage potential (can be company specific).

Table 2: Calculations fair wage potential (can be company specific)										
Country	Real (average) wage (**RW$_n$**)					Real working time (**RWT$_n$**)	Min. living wage (**MLW$_n$**)	Contracted working time (**CWT$_n$**)	Inequality factor (**IEF$_n$**)	**Fair wage potential (FWP)**
	€/month					hours/week	€/month	hours/week	%	
	Chemicals, plastics and life sciences	Manufacturing	Average	Wage in dollar/yr (OECD)	OECD number					
Belgium	4154	3510	3445.00	52,080.00	3,677.97	41.00	1,330.00	38	0.277	2.37

Bio-based products that are linked to the chemical and food products:

In case the bio-based products are connected to the chemical and food products/industry (e.g. algae production for the food and chemical industry (see example of Van Schoubroeck et al. (2021)), then the user can use the pre-defined indicator values for the indicators 'product transparency' and 'FWP'. Note, that not all European countries are covered in this tool. In case, other countries are needed the user is advised to conduct his/her own research.

Important:

It is highly recommended to double-check the pre-defined numbers since they specifically apply to the case study of Van Schoubroeck et al. (2021) based on the year 2021.

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