Bio-FlexGen

5.4 Selection of Social Impact Indicators and Methodology for Measurement

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Summary

Summary of Deliverable

This document summarises the Deliverable D5.4. "Selection of social impact indicators and methodology for measurement".

Disclaimer

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1 Introduction

Energy is essential for development with negative and positive social and environmental effects. Because energy is central to development, and its related social and environmental effects are often irreversible, it is crucial that the effects produced by introducing or expanding any given energy source be fully evaluated at each stage, thereby enabling an evaluation of actual benefits.
For the sake of sustainability, a precautionary approach is essential for ensuring awareness of biofuel development and its early performance; bringing a nuanced understanding of what works, what does not and why; and exploring what can be done to improve outcomes and mitigate risks, while analysing broader implications for energy transitions and the role of biofuels.

The ex-ante social impact assessment will provide the baseline information of the social contexts where the Bio-FlexGen business cases will be carried out and it will contribute to the identification, assessment and mitigation of the socio-economic impacts. This deliverable aims at explaining the relevance of carrying out social impact assessments to identify the positive and negative impacts that the Bio-FlexGen technology might have.
Social data has been gathered from both quantitative and qualitative sources. Quantitative information serves to understand the scale and the effects of the implementation of the new technology and to transparently weigh the positive and negative aspects of bioenergy implementation. Qualitative data will help assess the potential social acceptance of Bio-FlexGen technology. The result of these assessments is key to inform and guide in the decision-making process.

Ex ante knowledge of the project's potential positive and negative impacts and the balance between the two enables decision makers to minimise undesirable impacts. However, there is no consensus on the key socio-economic areas of concern regarding a bioenergy project nor agreement on the indicators that could and should be used to measure the social performance of a bioenergy project throughout its development. Ex-ante assessment of the socio-economic impacts of bioenergy requires using methods and models that translate scenarios and assumptions of bioenergy implementation to effects on the various indicators.[1] It will help understand how political, economic and ecological systems will influence Bio-FlexGen development and implementation and these, in turn, will influence the wider economic, social and ecological systems, is needed to improve policy and governance, as well as modelling and forecasting.

Energy typically has a two-way relationship with the factors. For instance, education influences our involvement in the energy transition, but the availability of energy influences our ability to learn as well. As a result, some factors exhibit reverse causality, or two-way causality. Creating social impact ecosystems in emerging technological marketplaces, it is critical to attract funding as to strengthen both the supply and demand sides. Ex ante social impact assessment help us to ensure a specific level of acceptance of our technology when we are innovating in a product or service. This process is crucial for gaining knowledge about the different social issues that might impact or influence the project, prioritise the action areas, and identify expected and unforeseen consequences. It is also important to acknowledge that when it comes to energy transition and power transformation context it is critical and there is "no one size fits all". Thus, the results areas of impact and indicators chosen for this deliverable are fitted for Bio-FlexGen business cases and they might vary if applied in other contexts. However, the methodology developed in this deliverable should reduce research bias and increase the reliability and replicability of the ex-antes social analysis results. Mindful of the key role of stakeholders' perception ensure a relevant social impact assessment approach, Bio-FlexGen will validate the list of pre-selected indicators with different groups of stakeholders, as well as define the weights for composite indicators together with them.

[1]Brinkman, Marnix L.J.; Wicke, Birka; Faaij, André P.C.; Van der Hilst, Floor (2019): "Projecting socio-economic impacts of bioenergy. Current status and limitations of ex-ante quantification methods"

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2 Selection criteria and methodology

The approach for this study consists of three parts. The first part is the desk review of the state of the art of ex-ante social impact assessments in energy projects. The second part is the selection of relevant indicators for Bio-FlexGen. While the last part is the use of the selection of techniques for normalisation, weighting, and aggregation to create consensus based composite indicators.

The literature review has allowed us to have a general overview of the main socio-economic impacts that will be later addressed by different indicators. On its behalf, the review of the main international standards (both public and private) has allowed us to identify the most relevant areas of impact when it comes to the energy transition to later choose the most relevant ones to our project.

Then, a pre-selection of multiple social indicators has been made in order to account for the various dimensions of each social impact. This will allow us to later analyse the various spatial scales and to be able to comprehensively capture the socioeconomic impacts of bioenergy. After having the overall list of indicators, a list of the most relevant for the Bio-FlexGen project has been made.

Finally, the pre-selected, in order to create an overall composite indicator to measure the social impact of bioenergy projects, normalisation, weighting and aggregation techniques have been selected and explained for each social impact category and subcategory.

3 Description of the social environment of the business cases

Swedish and Spanish energy markets will undergo large changes in the upcoming years. New markets have recently been introduced and more will come. Therefore, a deeper coupling between the district heating and electricity systems entail a need for district heating companies to better understand the current and future markets in the electricity side in which they can participate.[2] Both Sweden and Spain have been ranked among the overall top ten performers for the 2021 Trilemma Index[3] that ranks countries on their ability to provide sustainable energy through 3 dimensions: energy security, energy equity (accessibility and affordability) and environmental sustainability.[4]

In this part, we thoroughly assess Spain and Sweden's social contexts providing more specific details of the business cases sites. This part of the document has been made through a review of existing data of Spain and Sweden and in collaboration with project partners.[5]

3.1 SPAIN

The biomass energy sector in Spain it is a valuable industry strongly linked to the rural environment and with a significant tractor potential in terms of economic activity and job creation.[6] Currently, the most widespread fuel for district heating is natural gas, which covers almost 60% of the demand, the rest being covered by biomass.
Combined heat and power generation -- which optimizes output by producing both electricity and thermal energy -- accounted for 10% of the country's energy mix in 2021[7]

[2] D3.3. Review of current and future heat-and electricity-related products and their relevance for DHC
[3] World Energy Council (2021): World Energy Trilemma Index | 2021 | World Energy Council
[4] WEC Energy Trilemma Index Tool (worldenergy.org)
[5] Information on this section has been gathered through consultation with involved stakeholders (CEMEX and SULQUISA) and web search of relevant information. Note that this section of the deliverable will be actualized for the D5.5 – Potential social impact report (M36) when more information about the uses cases is gathered in M18 from the uses cases analysis that COMILLAS and RISE will carry out for both locations
[6] De Gregorio, Margarita (2020): "El potencial de la biomasa en España. Condiciones para su desarrollo y viabilidad económica" en Cuadernos de Energía.
[7] Las renovables alcanzan en 2021 su nivel de producción más alto de la historia: ya son el 46,6% del mix (elespanol.com)

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The Spanish energy market counts with very different business models with public, private, or mixed ownership covering one third of the market each. However, only 22% of Spanish heating networks serve industrial premises, making commercial (46%) and residential (32%) the two sectors with the highest participation. There is no comprehensive regulatory framework for district heating in Spain but there are expected some market modifications [see D3.3.] in the coming years that will most likely have strong social implications.[8] According to the research made by RISE for the Bio-FlexGen project, the main modifications that are expected in the Spanish market design will be:

1. Opening of most market segments for flexibility services to demand response and distributed energy resources
2. Introduction of new services and markets, in terms of voltage control and local markets for solving local technical constraints
3. Harmonisation of balancing services with the rest of European markets
4. Introduction of a capacity remuneration mechanism if a reliability assessment identifies the need for it

The biomass sector has a strong socio-economic potential in Spain due to its relation to the rural environment and its implications in employment and population.[9] The biomass industry needs continuous supply of biomass material that must be processed before or after installation and start the recovery process. It also requires operation and qualified maintenance that guarantees the efficiency and success of the process. Hence, it directly impacts on employment numbers in collection, processing, and transport of biomass prior to the recovery of the same, as in the management of these and the facility itself. Impact on rural employment that, in the case of Spain, is an important step for rural socioeconomic dynamisation and contribution to the revitalisation of the rural areas.[10] The depopulation of Spanish rural areas goes beyond the loss of economic activity in these areas, it also implies the abandonment of crops and agroforestry resources that can potentially burn at high intensity.

Every hectare that burns in high-intensity forest fires is a lost opportunity to protect biodiversity, to try to stop the advancement of desertification, to stop soil and water loss and to have resilient landscape that can accept social and economic again while trying to mitigate the effects of climate change. Spain is the second country with the largest forest area in the EU right behind Sweden.[11] The depopulation of the countryside and the reduction of agricultural and livestock activity have left spaces full of highly flammable thickets aggravating the risks of spreading fire.[12] A sustainable management of Spanish forests means, among other things, is cleaning them. These agricultural, forest and livestock wastes could be re-valorised in biomass as the alternative to having them burned every summer causes irreparable losses both for the environment and the population and enormous costs for the Spanish Government.[13] Nowadays, rural population in Spain represents 17,2% of the total population while urban population accounts for the other 82,8%. The abandonment of the rural environment and the traditional use of forests has increased the area of young vegetables masses, with an excess of density,

[8] D3.3. Review of current and future heat-and electricity-related products and their relevance for DHC
[9] Greenpeace Spain. Proteger el medio rural es protegernos del fuego. Hacia paisajes y población resilientes frente a la crisis climática.
[10] De Gregorio, Margarita (2020): "El potencial de la biomasa en España. Condiciones para su desarrollo y viabilidad económica" en Cuadernos de Energía.
[11] Greenpeace Spain. Proteger el medio rural es protegernos del fuego. Hacia paisajes y población resilientes frente a la crisis climática.
[12] Ibid.
[13] De Gregorio, Margarita (2020): "El potencial de la biomasa en España. Condiciones para su desarrollo y viabilidad económica" en Cuadernos de Energía.

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aggravated by the lack of faunal diversity and, on the other hand, the "urbanisation" and recreational use of the mountains has resulted in increased risk of ignition and higher gravity.[14]

3.1.1 CEMEX

CEMEX is a vertically integrated heavy building material company focused on four core businesses – Cement, Ready-Mix Concrete, Aggregates and Urbanisation Solutions. It is a leading company in its sector. CEMEX is focused on fighting climate change and developing low carbon products, solutions, and production processes. CEMEX is part of the United Nations "Race to Zero" campaign and the Business Ambition for 1.5ºC coalition. The company has already reduced its specific net CO2 emissions by 26.2% compared with the 1990 baseline, on track to achieve more than the 40% reduction goal by 2030. CEMEX has a plant-by-plant roadmap and a climate action 2030 goal that are setting the company's pathway to achieve its climate goals.[15]

In 2021, alternative fuels constituted 29,2% of its fuel mix, a record substitution rate for CEMEX. The most common alternative fuels are biomass fuels (crop residues, nut hulls, wood waste), refuse-derived fuel (shredded or pelletised municipal solid waste), tire-derived fuel (tire waste, processed tire chips), and alternative liquids (waste oils). While there are many types of alternative fuels, they are not all equal. Biomass waste has already removed and absorbed CO2 from the atmosphere, so when it is later used as a fuel, it has a neutral impact on our gross emissions. CEMEX gives priority to the use of alternative fuels with high biomass content.[16]

According to CEMEX[17] the implementation of **Bio-FlexGen would mean even less dependence on electricity supply from the grid** which, although not quantified, will be self-consumed electricity from renewable sources, **which could either be self-consumer or used to allow CEMEX to participate in the balancing market** [depending on the volume generated] contributing to the stability of the electricity system. Both applications of Bio-FlexGen technology entail a cost reduction, on the one hand by minimising the company's exposure to the electricity market and on the other hand, the company's participation in the energy market with its associated economic retribution.

[14] Greenpeace Spain. Proteger el medio rural es protegernos del fuego. Hacia paisajes y población resilientes frente a la crisis climática.
[15] CEMEX Spain (2021) "Building a better future: Integrated report"
[16] Ibid.
[17] Information obtained through consultation

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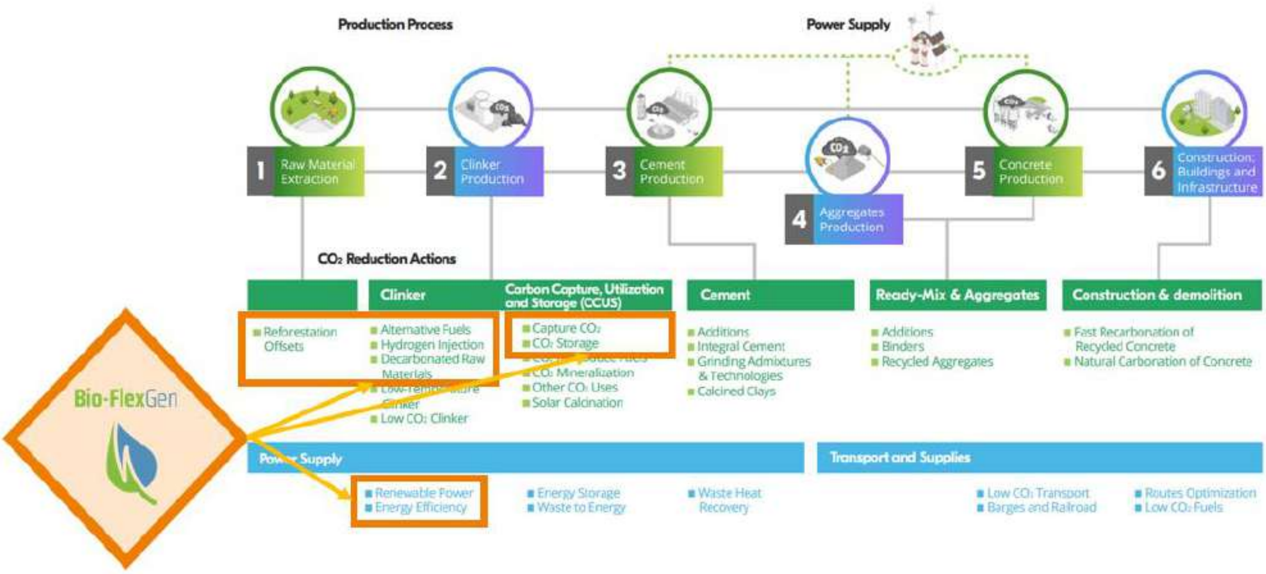

Figure 1: Bio-FlexGen contribution to CEMEX supply chain

3.1.2 SULQUISA

SULQUISA is one of the leading mining companies in the production and trade of Anhydrous Sodium Sulphate of natural origin, obtained through the exploitation of deposits of sodium salts used in many different industrial applications (detergent, glass, cellulose pulp, textile) and in animal feed (monogastric and multigastric animals). Since its foundation in 1978, SULQUISA has become a leading company in the Natural Anhydrous Sodium Sulfate market, currently being the third largest European producer, with a capacity of 300,000 tons/year of finished product and exporting to more than 30 countries on 5 continents.

SULQUISA is intensive, both in natural gas and electricity consumption. Additionally, it participates in the CO2 market. Given the current volatile international context and the increase in energy prices (both gas and electricity) and CO2 emissions, **Bio-FlexGen could have a powerful impact on the company's results while leading the company's reduction of GHG emissions**.[18]
Moreover, SULQUISA is starting to articulate its commitment with sustainability and the implementation of Bio-FlexGen would promote the company's involvement in environmental sustainability using renewable energies, competitiveness, and alignment with the energy transition.

It will also help the company to establish a framework for measuring and deciding different social measures related to the project. Currently, SULQUISA does not count with a Sustainability Strategy so implementing the **Bio-FlexGen project would help the company analyse and map their stakeholders and contribute to the company's social and environmental positive impact**.

3.2 SWEDEN

The introduction and expansion of district heating in Sweden have never been driven by a specific governmental policy or parliament decision advocating district heating. Instead, the growth of district heating in Sweden can be explained by its ability to contribute to the fulfilment of a number of societal goals. These goals include energy efficient thermal power production by cogeneration of electricity

[18] Information obtained through consultation

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and district heat, reduced oil consumption for individual heating, improved local air quality and climate change mitigation.[19] The supply of district heat is expected to remain at the current level in the near future and then to decrease somewhat after 2030 due to saturated markets and decreasing heat demands.[20] Due to the steady growth in the demand for bio-based products, Sweden has significantly invested in biomass availability and supply security. Domestically produced wood fuels dominate the biomass supply to the district heating sector, but it also includes imported biomass. The Swedish Forest ownership is distributed into six classes. Almost half of the forest is owned by individual farmers, another 25% is privately owned by limited companies, and the rest 25% forest is distributed between state-owned limited companies (14%), other private owners (6%), the state (3%) and other public owners (2%). These categories of landowners are relevant for the project's social impact as it will imply developing different engagement strategies depending on the type of owner involved in the process.

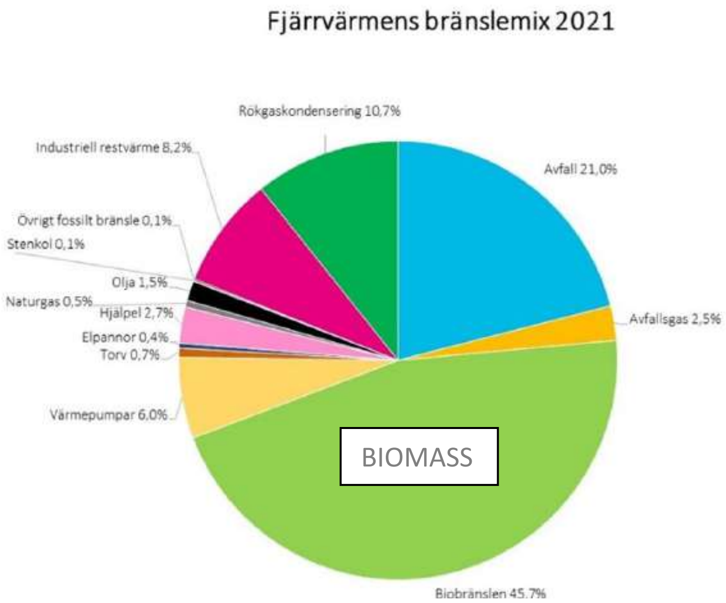

Figure 2: District heating fuel mix 2021 via Energi Företagen

Sweden has implemented a forest strategy with the following priorities:

- Maintaining the competitiveness of existing production facilities to maintain profitability, and to finance the **development of new bio-based products and processes**.
- Increasing the availability of forest raw materials whilst maintaining sustainable forestry.
- Developing new bio-based products to replace today's fossil-based materials and products.
- Stimulating an increase in industrial timber constructions to achieve more sustainable buildings.
- Increasing international research cooperation, since the market is international.[21]

The Swedish heat market produces 100 TWh heat, half of which comes from district heating. District heating systems in Sweden enable utilisation of energy resources that would otherwise be wasted.

[19] Ericsson, Karin and Werner, Sven (2016): "The introduction and expansion of biomass use in Swedish district heating systems"
[20] Kumar, Anuj; Adamapoulos, Stergios, Jones, Dennis; Amiandamhen, Stephen O. (2020): "Forest Biomass Availability and Utilization Potential in Sweden: A Review"
[21] Ibid.

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This is related to the waste heat from industry and energy from the recycling of waste.[22]

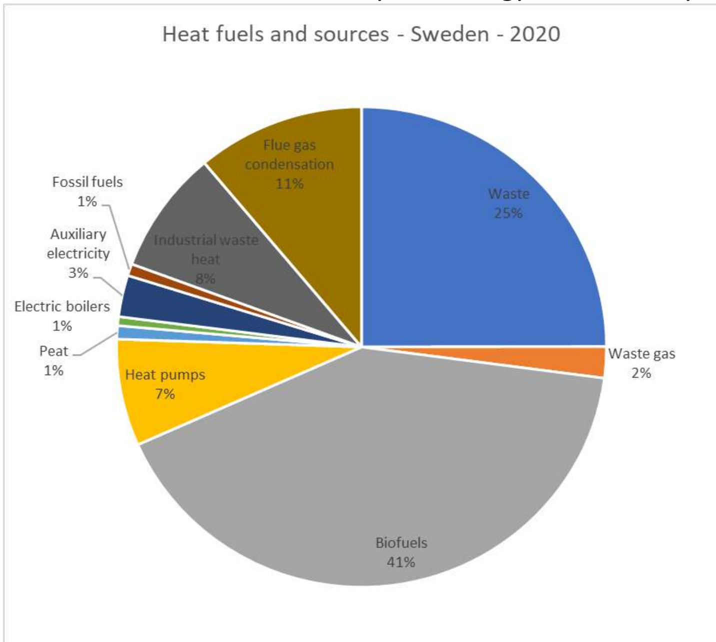

Figure 3: Heat fuels and sources in Sweden for 2020

The pricing on the heat market in Sweden is not regulated,[23] which enables companies to effectively manage dynamic challenges to remain competitive. Theory suggests that business change is difficult when the current model still works.[24] **Customers are free to choose their preferred heat solutions among district heating and other competing technologies such as direct electricity, heat pumps, pellet boilers etc.** The district heating companies dialogue with the major customers and explain and motivate the heat price to keep their customers as they act on a non-regulated market. There is currently no common pool for trade heat in Sweden. The heat market is always local, and heat cannot be traded between separate cities except in a few cases where district companies in neighbouring communes share the same heat network. Deregulated, municipal energy companies were urged to operate in a "business-like" fashion. Misconduct about the price development post-deregulation resulted in a district heating law in 2008. It has since become evident that the law is so that a distinction is made between personal trust and trust for the district heating system, which created a negative bias towards the district heating system. [25] This bias is a challenge that reinforces the negative perceptions surrounding the natural monopoly status of district heating companies. This lack of trust erodes the competitiveness of district heating compared to other heating alternatives.[26]

In response to this challenging discussion, the district heating industry has initiated a voluntary dialogue with their largest customers. This process is called "the price dialogue" and is one way to proactively engage in a dialogue with customers on the topic of district heating prices. Currently, 37 district heating companies are members of the dialogue including the three largest district heating providers in Sweden.[27] "*Another aspect that characterises the Swedish district heating market is the Price Dialogue, a self-regulation platform instituted by district heating and real estate companies where these parties meet and discuss future prices.*"[28]

[22] D3.3. Review of current and future heat-and electricity-related products and their relevance for DHC
[23] Ibid.
[24] Lygnerud, Kristina (2018) "Challenges for business change in district heating"
[25] Ibid.
[26] Ibid.
[27] Celsius Initiative (2021): Ownership and district heating prices: The case of an unregulated natural monopoly - Celsius Initiative (celsiuscity.eu)
[28] Ibid.

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Sweden is the country with the largest proportion of industrial heat recovery in its district heating systems in the world. In Sweden, financing of new district heating is predominantly undertaken by municipalities. The case of the Swedish district heating could be considered a successful transition to a low-carbon energy system. However, energy transition is not enough to remain competitive. Attention needs to be given to the management of business challenges beyond the vision of being fossil-free. The example of the Swedish heat sector should be useful to decision-makers desiring to keep the low-carbon district heating system competitive.[29]

Biofuels and waste are the most common fuels used in district heating in Sweden.[30] Sweden is a successful example of well-developed district heating systems that is primarily adjusted to incineration of waste and biofuels. **There is thus a risk that companies are locked-in to the current technology.** Taking into account that there are alternative uses for biofuels other than incineration, and that the amounts of wastes are to be reduced in Europe, identifying alternative heat sources is relevant in the long-term.[31]

Sweden wants to become a world leader in creating and utilising innovation to satisfy the demand for sustainable fossil-fuel products and services while preserving the forest industry. Moreover, within this strategy, Sweden aims to contribute to global sustainable development and the implementation of the 2030 Agenda through the synergies between forests issues and international cooperation. Also, Sweden aims to contribute to rural development by taking into account the social values of forests, harnessing the skills of both women and men, including those of newly arrived immigrants, to enhance more jobs and sustainable growth throughout the country.[32]

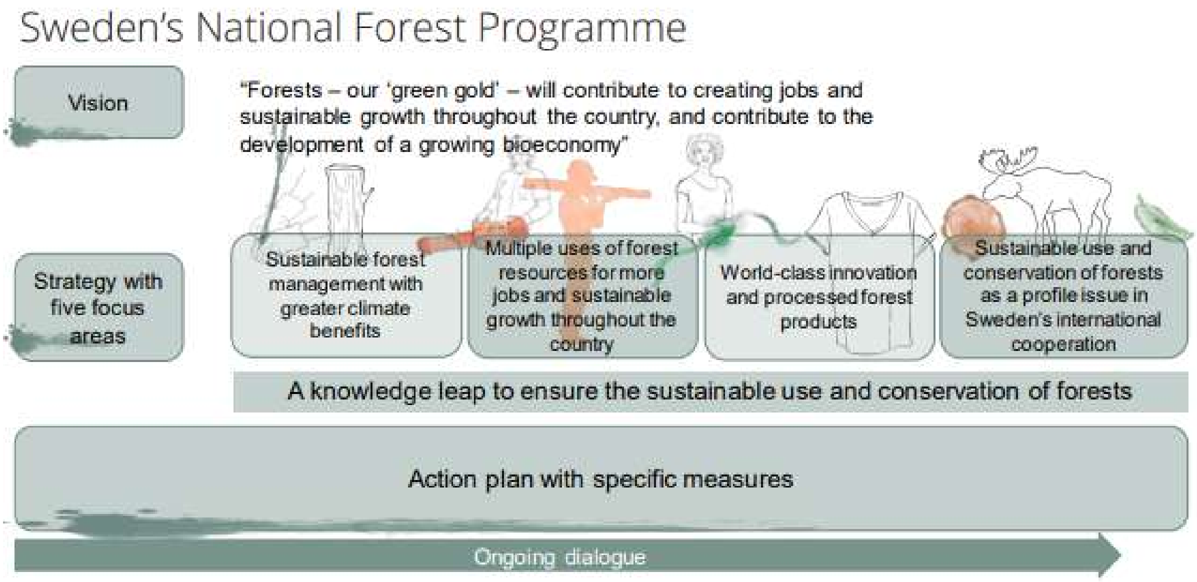

Figure 4: Sweden's National Forest Programme

Sweden estimates that 43% of its rural population will benefit from improved services or infrastructure through local development actions. Under LEADER, 50 Local Action Groups (LAGs) will implement Local Development Strategies (LDS) that are supposed to face the key challenges that Sweden is experiencing regarding Rural Development. With changes in the agricultural and forestry sectors, other

[29] Lygnerud, Kristina (2018) "Challenges for business change in district heating"
[30] Ibid.
[31] Ibid.
[32] Government Offices of Sweden (2018): Sweden's National Forest Programme. Fact Sheet.

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business opportunities in rural areas have become increasingly important in employment. The rural economy is, however, still largely dependent on agriculture, forestry and related businesses.[33]

* Information on this section has been gathered through consultation with involved stakeholders (CEMEX and SULQUISA) and web search of relevant information. *Please note, that this section of the deliverable will be updated for the D5.5 – Potential social impact report (M36) when more information about the uses cases is gathered in M18 from the uses cases analysis that COMILLAS and RISE will carry out for both locations*

4 Stakeholder Map

After analysing the social context of the business cases, a preliminary map of stakeholders has been made. This analysis allows us to identify those individuals and organizations that are relevant for Bio-FlexGen. The analysis of stakeholders helps to understand the perspectives, viewpoints, needs and demands and helps to build trust, thus, making the project more likely to succeed both economically and socially.

At this time of the project, prioritisation of stakeholders cannot be made [see D.5.3 Analysis of local stakeholders and engagement plan] but the analysis that has been made for this deliverable allows us to have an overview of the main stakeholders and thus, to pre-identify impact dimensions and indicators that might be relevant for them.

Figure 6: Residential business case stakeholder map

Figure 5: Industrial business case stakeholder map

5 Impact dimension identification

Four socio-economic impact categories for bioenergy projects were identified:
- Employment
- Economic dimension
- People and communities

[33] The European Network for Rural Development (2015): Rural Development Programme: Key Facts and Figures.

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- Social Acceptance

These impacts are selected based on previous studies on the topic and the review of international standards.

To ensure sustainability and long-term viability of the Bio-FlexGen project, it is crucial to find criteria that covers the whole spectrum of social impacts that a biomass project might have. The location of any new future infrastructure in Spain and Sweden will have many different social impacts at different scales. Social impacts of energy transition projects are difficult to quantify, but the social part of the sustainability dimension, or the absence of it, will have a global impact and it is important to establish limits on what is and what is not sustainable.

The decision has been taken to focus on four impact categories in the Bio-FlexGen project (employment, economic dimension, people and communities and local acceptance), as the rest of the categories are relevant mainly in social contexts in which conflicts related to land management arise more frequently than in the EU context.

Impact dimensions for this study have been selected aiming at covering the broadest possible spectrum of areas that might be affected by the project, but it is important to keep in mind that social impacts might vary with climate, culture region, time, age, and sex.

Impact dimensions have been adapted to the business cases' countries where Bio-FlexGen will be hypothetically implemented. There are no basic social needs to be covered such as minimum of food, shelter and/or protection of fatal diseases. Thus, impact dimensions represent higher-level needs such as employment or income. As was reflected in the proposal stage, social assessment needs to be carried out in parallel with environmental and economic evaluations of the long-term viability of biomass development projects and their projected impacts on all key stakeholders.

The selection of impact dimensions have been carried out by analysing international standards for the energy transition and by evaluating the current state of the art of ex ante social impact analysis in biomass projects.

5.1 International Standards Review

The international sustainability system is a combination of binding legal frameworks and set of private sector-driven voluntary sustainability schemes. In recent years, there has been an increasing number of sustainability initiatives, many of which are implemented through certification schemes. The main international certification schemes for bioenergy sustainability have been reviewed for this report to be able to choose specific indicators for each of the selected impact dimensions. Indicators from international institutions and those that are only used for the private sector have been considered to cover the full spectrum of social indicators that might affect the business cases of this project.

5.1.1 Sustainable Development Goals (SDGs)

Energy is central to Sustainable Development. From access to electricity, to improving clean cooking fuels, from reducing wasteful energy subsidies to reduce air pollution. Sustainable development goal 7 stands for ensuring access to affordable, reliable, sustainable, and modern energy for all. The adoption of energy specific sustainable development goals was a milestone in moving the world towards a more sustainable and equitable system.[34]

In addition, the energy industry is also pivotal to the achievement of other goals such as, SDG 13 on **urgent action to combat climate change**; SDG 1 on **alleviating poverty**, SDG 2 on **fighting hunger**, SDG

[34] IEA, IRENA, UN Statistic Division, The World Bank, World Health Organization (2022): The energy progress report

3 **promote health**, SDG 4 to **promote education**, SDG 6 to **increase access to clean water** or SDG 14 and 15 to **protect life in land and in water**.

Implementing the 2030 Agenda requires a more holistic, coherent and integrated approach at the national, regional and global levels. Policies, projects and initiatives to implement the 2030 Agenda need to address the **inter-linkages within the social sector and other dimensions of sustainability**[35]

5.1.2 Global Bioenergy Partnership (GBEP)

The Global Bioenergy Partnership 's goal is to provide a mechanism for partners to organise, coordinate, and carry out targeted international research, development, demonstration, and commercial activities related to production, delivery, conversion, and use of biomass for energy with a special emphasis on developing countries.[36] GBEP also provides a forum for implementing effective policy frameworks, identifying ways and means to support investments, and removing barriers to collaborative project development and implementation.

The Partnership's main objectives are to:

1. Create a global high-level policy dialogue on bioenergy, support national and regional bioenergy policymaking and market development, and facilitate international cooperation.
2. Favour more efficient and sustainable uses of biomass and develop project activities in the bioenergy field.
3. Foster the exchange of information, knowledge skills and technologies by identifying and promote potential areas of bilateral and multilateral collaboration.
4. Facilitate bioenergy integration into energy markets by tackling specific barriers in the supply chain.
5. Act as a cross-cutting initiative, working in synergy with other relevant activities, avoiding duplications.[37]

5.1.3 Roundtable on Sustainable Biofuels

These principles were developed by private initiative on biofuel sustainability, established by the École polytechnique fédérale (EPLF) Energy Center in 2006. It is based on a management and risk-oriented approach. The Rountable on Sustainable Biofuels Principles & Criteria help operators identify and manage sustainability issues in a specific context, reducing risks for operators, brand owners and investors. They identify the following impact dimensions: **Economic, resettlement, food security, immigration, population growth and concentration, social, cultural heritage sites and resources, health and welfare, and governance impacts.**[38]

5.1.4 Inter-American Development Bank (IDB) Sustainability Scorecard

The Sustainable Energy and Climate Change Initiative (SECCI) and the Structured and Corporate Finance Department (SCF) of the Inter-American Development Bank (IDB) created in 2009 the IDB Biofuels Sustainability Scorecard based on the sustainability criteria of the Roundtable on Sustainable Biofuels (RSB).
The Scorecard's primary goal is to provide a framework for thinking through the numerous difficulties related with biofuels from the field to the tank, supporting better levels of sustainability in such initiatives. While the Scorecard tackles many concerns related to sustainability, it should not be used in place of certification schemes and/or life-cycle assessment tools, but rather to inform these procedures.[39] In the social category it identifies 8 areas: **labor rights, land ownership, change in access**

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[35] United Nations Department of Economic and Social Affairs. Social Inclusion. Social Development for Sustainable Development | DISD (un.org)
[36] Global Bioenergy Partnership (GBEP) | Department of Economic and Social Affairs (un.org)
[37] Global Bioenergy Partnership (GBEP) | Department of Economic and Social Affairs (un.org)
[38] The Roundtable on Sustainable Biofuels: plant scientist input needed - ScienceDirect
[39] Interamerican Development Bank. IDB Biofuels Sustainability Scorecard | Publications (iadb.org)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grand agreement N° 101037085.

to resources, impact on food security, consultation and transparency, capacity building, local income generation, impacts on indigenous peoples.[40]

[40] Interamerican Development Bank. IDB Biofuels Sustainability Scorecard | Publications (iadb.org)

This project has received funding from the European Union's Horizon 2020
research and innovation programme under grand agreement N° 101037085.

5.2 Social Measurement Initiatives linked to the Private Sector

As a result of the increased demand for transparency on environmental, social and governance issues, many private certification schemes have emerged to improve the process of measuring and reporting on sustainable practices. We have chosen three reporting initiatives for corporations and analysed how social impact is measured in their guidelines.

5.2.1 Global Reporting Initiative (GRI)

GRI is one of the pioneers in providing a standard guide to unify non-financial Information and present it according to criteria widely accepted by institutions and organisations worldwide. The Global Reporting Initiative is an independent institution with a worldwide presence that aims to help organisations to be more transparent and take responsibility for their economic, environmental, and social impacts. To achieve this, GRI has been working for years to provide a Sustainability framework, a common language so that organisations around the world can standardise their triple bottom line information and present it in a way that is understood and accepted globally.

The social dimension of GRI is focused on the impacts a company has in its supply chain ad how they are managed. The impact areas identified in GRI for measuring social impact are employment, health and safety, child labor and forced and compulsory labor.[41]

5.2.2 Social Return of Investment (SROI)

There is no formal list of SROI indicators. It begins with the organisation's objectives and involves the selection of suitable indicators, similar to the theory of change or cost benefit analysis, both of which inspired the creation of the SROI technique. Commonly used proxies may be found in several industries that employ SROI indicators and can be implemented and/or altered for individual enterprises. Others are more broadly relevant across industries. In terms of analysing social value, SROI is a very prominent technique.

SROI has also been the target of numerous criticisms, notably because the chosen monetary values are frequently based on subjective estimates and, at a more fundamental level, the method assumes that social benefits that are not traded on the market should be given a monetary.[42]

Table 1: Ovo Foundation. A Forecast Social Return on Investment.[43]

SROI principle
Involve stakeholders **– Inform what gets measured and how this is measured and valued in an account of social value by involving stakeholders**
Understand what changes **– Articulate how change is created and evaluate this through evidence gathered, recognising positive and negative changes as well as those that are intended and unintended.**
Value the things that matter **– Making decisions about allocating resources between different options needs to recognise the values of stakeholders. Value refers to the relative importance of different outcomes. It is informed by stakeholders' preferences.**

[41] GRI Standards (2016): Supplier Social Assessment.
[42] Salathé-Beaulieu, Gabriel (2019): Sustainable Development Performance Indicators for Social and Solidarity Economy: State of the Art.

[43] Ovo Foundation (2021) A Forecast Social Return on Investment.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grand agreement N° 101037085.

Only include what is material **- Determine what information and evidence must be included in the accounts to give a true and fair picture, such that stakeholders can draw reasonable conclusions about impact.**	
Do not over-claim **– Only claim the value that activities are responsible for creating.**	
Be transparent **– Demonstrate the basis on which the analysis may be considered accurate and honest, and show that it will be reported to and discussed with stakeholders**	
Verify the result **– Ensure appropriate independent assurance.**	
Be responsive **– Pursue optimum Social Value based on decision making that is timely and supported by appropriate accounting and reporting**	

5.2.3 B LAB/ B IMPACT ASSESSMENT

Although this evaluation system uses a different branding focused on impact and "doing business for good", the methodology is very similar to corporate social responsibility assessments. This means the questionnaire every Business Corporation has to complete covers **governance, workers, community, environment and customer areas** that rarely focus on the ultimate impact of the organisation's activities, but rather on the way it operates.
As a comprehensive impact management tool, the B Impact Assessment is categorised into five distinct impact areas representing the company's Governance and four key stakeholder groups: Governance, Workers, Community, Environment, and Customers.

- **"Governance** evaluates a company's overall mission, engagement around its social/environmental impact, ethics, and transparency. This section also evaluates the ability of a company to protect its mission and formally consider stakeholders in decision making through its corporate structure (e.g. benefit corporation) or corporate governing documents.

- **Workers** evaluates a company's contributions to its employees' financial security, health & safety, wellness, career development, and engagement & satisfaction. In addition, this section recognizes business models designed to benefit workers, such as companies that are at least 40% owned by non-executive employees and those with workforce development programs to support individuals with barriers to employment.

- **Community** evaluates a company's engagement with and impact on the communities it operates, hires from, and sources from. Topics include diversity, equity & inclusion, economic impact, civic engagement, charitable giving, and supply chain management. In addition, this section recognises business models that are designed to address specific community-oriented problems, such as poverty alleviation through fair trade sourcing or distribution via microenterprises, producer cooperative models, locally focused economic development, and formal charitable giving commitments.

- **Environment** evaluates a company's overall environmental management practices and its impact on the air, climate, water, land, and biodiversity. This includes the direct impact of a company's operations and, when appropriate, its supply chain and distribution channels. This section also recognises companies with environmentally innovative production processes and those selling products or services that have a positive environmental impact. Some examples might include products and services that create renewable energy, reduce consumption or waste, conserve land or wildlife, provide less toxic alternatives to the market, or educate people about environmental problems.

- **Customers** evaluates a company's stewardship of its customers through the quality of its products and services, ethical marketing, data privacy and security, and feedback channels. In addition, this section recognises products or services that are designed to address a particular social problem for or through its customers, such as health or educational products, arts & media products, serving underserved customers/clients, and services that improve the social impact of other businesses or organisations". [44]

5.2.4 Impact Management Project (IMP)

The Impact Management Project (IMP) is an initiative promoted by Bridges Funds Management in partnership with several major impact investors around the world such as: Omidyar Network, Ford Foundation, UKAid, MacArthur Foundation, Barclay's, Big Society Capital, BlackRock, UBS and many more.[45] They identify five dimensions of impact:

[44] B Lab Impact Assessment (2020): Impact Areas: Governance, Workers, Community, Environment and Customers : B Impact Assessment Knowledge Base

[45] Impact Management Project (2020): Building Consensus on Impact Management Topics. A Summary of recent engagement with the IMP's Practitioner Community

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Table 2:Impact Frontiers. A Shared Logic for Managing Impacts on People and the Planet.[46]

Impact dimension	Impact data category	Description
What	Outcome level in period	The level of outcome experienced by the stakeholder when engaging with the enterprise. The outcome can be positive or negative, intended or unintended.
	Outcome threshold	The level of outcome that the stakeholder considers to be a positive outcome. Anything below this level is considered a negative outcome. The outcome threshold can be a nationally or internationally-agreed standard.
	Importance of outcome to stakeholder	The stakeholder's view of whether the outcome they experience is important (relevant to other outcomes). Where possible, the people experiencing the outcome provides this data, although third party research may also be considered. For the environment, scientific research provides this view.
	SDG or other global goal	The Sustainable Development Goal target or other global goal that the outcome relates to. An outcome might relate to more than one goal.
Who	Stakeholder	The type of stakeholder experiencing the outcome.
	Geographical boundary	The geographical location where the stakeholder experiences the social and/or environmental outcome.
	Outcome level at baseline	The level of outcome being experienced by the stakeholder prior to engaging with, or otherwise being affected by the enterprise.
	Stakeholder characteristics	Socio-demographic and/or behavioral characteristics and/or ecosystem characteristics of the stakeholder to enable segmentation.
How Much	Scale	The number of individuals experiencing the outcome. When the planet is the stakeholder, this category is not relevant.
	Depth	The degree of change experienced by the stakeholder. Depth is calculated by analyzing the change that has occured between the "Outcome level at baseline" (Who) and the "Outcome level in period" (What).
	Duration	The time period for which the stakeholder experiences the outcome.
Contribution	Outcome level counterfactual	The difference between the outcome level that occurred and the level that would have occured in the absence of the enterprise.
Risk	Risk type	The type of risk that may undermine the delivery of the expected impact for people and/or the planet. There are nine types of impact risk.
	Risk level	The level of risk, assessed by combining the likelihood of the risk occuring, and the severity of the consequences for people and/or the planet if it does.

Source: Impact Management Project

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5.3 Literature Review

The current literature on social sustainability studies is limited. There is no clear definition of social sustainability which difficults its to measurement.
For this deliverable, we have gathered relevant literature and identified relevant social indicators for the energy sector. A special focus has been given to the biomass industry, but indicators used for renewable energy projects have been also considered.

According to Afshari et al. (2022) [47] the social sustainability pillar indicates an organisation's ability to measure issues important to stakeholders. Promoting energy efficiency and using renewable energy sources requires the inclusion of stakeholders, including their understanding of the extent of such initiatives. The successful management of ESCs requires making decisions at different levels concerning the efficient flow of information, product/service, and funds.

The same paper[48], presented a literature review on existing social indicators through a four-step methodology and choose those that could be translated to the energy sector. They identified 420 indicators relevant to energy-related SSIs that are a mix of indicators that uniquely relevant to the energy sectors and indicators that were generally relevant were also considered. They investigated and classified existing SSIs in the literature to be applied in the energy sector; the role of SSIs in promoting the energy sector; and the key challenges and implications of applying SSIs in the energy sector.[49] They concluded that classifiying social sustainability indicators based on their position in the energy supply chain stages revealed that the majority of the indicators address the production and demand stages. They also highlighted that the reason behind the limited studies on social sustainability compared to the other two sustainability pillars is that social sustainability indicators might potentially conflict with indicators in the other two dimensions.

Table 2
A summary of the proposed classification of SSIs and related sub-groups.

	Main Categories			
	A1 (Human rights and social life)	A2 (Occupational)	A3 (Business-related)	A4 (Legal, political, and Government)
Sub-categories	Basic needs Education Equity & social justice Health & quality of life Rights of minorities Social & cultural capitals Social communication & interaction Social development Social involvement & inclusion Social security & safety	Benefits & well-being Communication & discipline Fair & ethical behavior Governance Health & safety Personal development Employee Satisfaction Security & mental health	Ethics in business Innovation Knowledge management Local community support Social responsibility Social security & safety Stakeholders' relationship	Compliance with regulations Political contribution Public resources management Supportive regulations

Figure 7: Afshari, H. ; Agnihotri, S, ; Searcy, C. et al.

Yawar and Seuring (2017)[50] identified seven categories: **child labor, labor conditions, health and safety, human rights, minority development, gender, and disabled/marginalized people inclusion**.

[46] Ibid.
[47] H. Afshari, S. Agnihotri, C. Searcy, M.Y. Jaber, Social sustainability indicators: A comprehensive review with application in the energy sector
[48] H. Afshari, S. Agnihotri, C. Searcy, M.Y. Jaber, Social sustainability indicators: A comprehensive review with application in the energy sector.
[49] Ibid.
[50] Yawar, S.A., Seuring, S. (2017) Management of Social Issues in Supply Chains: A Literature Review Exploring Social Issues, Actions and Performance Outcomes.

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Mani et al. (2020)[51] addressed in their paper social sustainability in the supply chain in small and medium manufacturing enterprises using empirical evidence from an emerging Asian economy. They did it through a life cycle perspective and introduced dimensions like **philanthropy, safety and well-being, health, ethics and human rights, and equity** as categories. That same author, presented in 2016 another paper[52] on social sustainability in the supply chain based on the relationship with suppliers, internal departments, consumers, and the society within which it operated. The categories used there were: **human rights and social life**; **occupational indicators; business-related indicators, and legal, political, and government-related indicators**.

Brinkman et al. (2019) identified 13 socio-economic impact categories for bioenergy in their paper "Projecting socio-economic impacts of bioenergy: Current status and limitations of ex-ante quantification methods": **employment and income, food security, macroeconomic development, rural economic development, energy access, energy independence, economic feasibility, health and safety, land rights, working conditions, social acceptability, equal opportunities, and community impacts.** They identified 236 indicators that were mentioned in reviews, certification schemes, and guides of good practice. Of those 236 only 46 were considered relevant based on their suitability to *ex-ante* quantify the socio-economic impacts of bioenergy.[53]

Two approaches have been considered for this deliverable based on previous research on social indicators for energy projects: measuring social impact in supply chain and measuring social impact in stakeholders.

5.3.1 SLCA approach

Energy sustainability indicators are expected to measure and manage the performance of sustainable supply chains. Whether energy is generated from fossil fuels or renewable sources, SSIs must monitor efficiency and optimise the usage of those energy sources. Adopting a supply chain perspective to measure social impact ensures the integration and coordination of the phases to meet the demands of stakeholders.

CSR in supply chain research rarely provides insights into the interaction of social challenges, supply chain activities, and performance consequences. Because of the involvement of multiple suppliers and actors who directly impact or are directly affected by a project, social concerns become significant in supply chains. The desk review of social sustainability indicators based on their position in the energy supply chain, shows that most of the indicators address the production and demand stages.[54]

[51] V. Mani, Rajat Agarwal, Angappa Gunasekaran, Thanos Papadopoulos, Rameshwar Dubey, Stephen J. Childe (2016) Social sustainability in the supply chain: Construct development and measurement validation.
[52] Venkatesh Mani, Charbel Jose Chiappetta Jabbour, Kavitha T.N. Mani (2020): Supply chain social sustainability in small and medium manufacturing enterprises and firms' performance: Empirical evidence from an emerging Asian economy.
[53] Brinkman, Marnix L.J.; Wicke, Birka; Faaij, André P.C.; Van der Hilst, Floor (2019): Projecting socio-economic impacts of bioenergy. Current status and limitations of ex-ante quantification methods
[54] H. Afshari, S. Agnihotri, C. Searcy, M.Y. Jaber (2022): Social sustainability indicators: A comprehensive review with application in the energy sector

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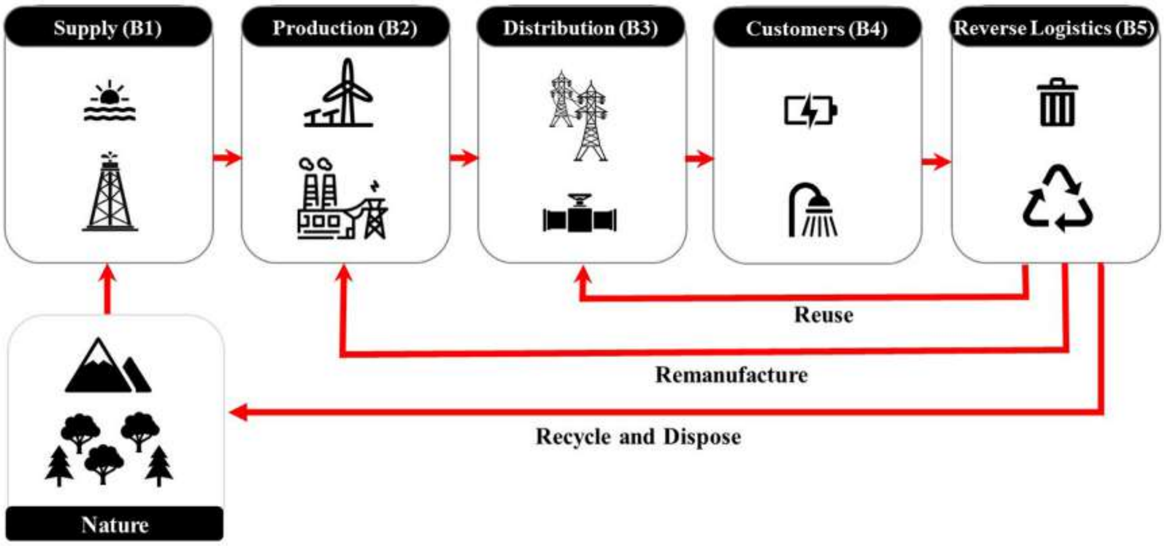

Fig. 5. Energy supply chains.

Table 3
A set of common SSIs based on their role in ESCs.

Supply	Production	Distribution	Customers	Reverse logistics
Fair sourcing	Health and safety of employees	Energy coverage	Societal impact of technology	Appropriate land use for landfill sites
Avoid child labor	Equity in hiring	Logistics traceability	Social mixing and cohesion/identity	End-of-life responsibility
Relationship with suppliers	Fair wages	Network with local companies	Quality of life	Legislation for recycling
Sourcing from marginalized groups	Commitment to the stakeholders needs	Reliability of distribution system	Community Engagement/ Involvement	Waste consumption rate
Compliant with culture of sourcing origin	Average distance travelled by employees to the company	Provision abroad for the crew	Complaints or feedback system	Legal waste disposal
Investing in workplace improvement of suppliers	Displacing local communities		Community improvement	Legal demolition
	Minimize noise annoyance/exposure		Local preference	
	Safety of animals/birds/species		Affordability	

Figure 8: Afshari, H. ; Agnihotri, S, ; Searcy, C. et al.

Awaysheh and Klassen[55] highlight that the difficulty in measuring the social performance can be attributed to the challenges in understanding the dynamic and complex nature of most of the relevant social and societal issues in supply chains. Some indicators like employment of minority groups, reduction in pollution, improved health and safety are suggested across the literature but there are no comprehensive indicators that can measure social performance in supply chains. As a result, the author maintains that it remains open to interpretation which indicators are key for each context.[56]

Yawar and Seuring[57] present the following table summarising the main social issues in supply chains identified through a literature review:

[55] Awaysheh and Klassen (2010): The impact of supply chain structure on the use of supplier socially responsible practices.
[56] Yawar, S.A., Seuring, S. (2017): Management of Social Issues in Supply Chains: A Literature Review Exploring Social Issues, Actions and Performance Outcomes.
[57] Ibid.

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Table 3 Social issues in supply chains identified through a literature review

Social issue	Number of papers (N = 142)
Labour conditions	117 (82 %)
Health and safety	96 (68 %)
Human rights	84 (59 %)
Child labour	73 (51 %)
Gender	55 (39 %)
Disabled and marginalised people inclusion	22 (15 %)
Minority development	21 (15 %)

Figure 9: Yawar, S.A. and Seuring, S. (2017)

5.3.2 Stakeholder approach

The stakeholder approach is relevant because it determines what is expected from firms in terms of performance and affects their types of strategies to meet stakeholder's demands. From Wood and Jones[58] in Yawar and Seuring[59] it is extracted that analysing the project's social impact on the stakeholders is essential because the goal of a project is to satisfy the needs of the stakeholders. Maignan et al.[60] Elaborate this concept by claiming that stakeholders are agents of social change because they wield various types of power and are the ones who expose social concerns in a supply chain, putting them at the center of the social responsibility discussion. According to Klassen and Vereecke[61], the social regions of a supply chain include any product or procedure that impacts human safety, welfare, or community development. The development of external stakeholders such as the media, NGOs, and civil society has highlighted projects' unethical behaviour, prompting them to implement effective ways to combat societal problems. The importance of such social concerns stems from research that has revealed social obstacles that enterprises and projects may confront. Various scholars agree on socioeconomic issues such as **labour conditions, which include pay, working hours, health and safety, and child labour.**[62] Other topics such as **human rights, minority development, gender and the inclusion of disabled and marginalized people** are highlighted in other social science papers and articles[63] as important areas to consider when analysing the social impact of a project.

[58] Wood and Jones (1995): Stakeholder mismatching: A theoretical problem in empirical research on corporate social performance.
[59] Yawar, S.A., Seuring, S. (2017): Management of Social Issues in Supply Chains: A Literature Review Exploring Social Issues, Actions and Performance Outcomes.
[60] Maignan et al. (2002): Managing socially responsible buying: How to integrate non-economic criteria into the purchasing process.
[61] Klassen and vereecke (2012): Social issues in supply chains: Capabilities link responsibility, risk (opportunity), and performance.
[62] See pag. 624 of Yawar, S.A., Seuring, S. (2017): Management of Social Issues in Supply Chains: A Literature Review Exploring Social Issues, Actions and Performance Outcomes.
[63] See pag. 624 (Welford and Frost 2006; Zutshi et al. 2009; Preuss 2009) in Yawar, S.A., Seuring, S. (2017): Management of Social Issues in Supply Chains: A Literature Review Exploring Social Issues, Actions and Performance Outcomes.

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5.4 Social Categories

Employment

- Job losses
- Job Creation
- Job Quality
- Quality of Employment
- Working conditions and rights
- Health and Safety
- Gender
- Re-skilling and up-skilling

Economic Dimension

- Economic Feasibility
- Energy poverty
- Energy efficiency
- Energy security
- Macroeconomics
- Rural Development

People and Communities

- Impact on traditional livelihoods and cultural heritage sites
- Food security
- Interaction with community
- Energy communities and civic energy

Social Acceptance

- Level of knowledge
- Public Concerns
- Local/Global advocacy for development of bioenergy industry
- Trust and credibility in stakeholders
- Participation of society
- Attitudes towards financial support/ funding

Figure 10: List of identified social areas for Bio-FlexGen

6 Selection of Indicators

6.1 Pre-selection of Indicators

Based on the literature review explained in the previous sections, several social impact indicators have been pre-selected, as a main tool assessing any potential social impact of the implementation of the technology developed in Bio-FlexGen.
Annex 1 includes the complete list of indicators pre-selected at this project stage, which will be co-selected with the main stakeholders belonging of the business cases identified in the project.

6.2 Selection of final indicators

Social impact indicators must be meaningful and adapted to each social context in which the technology is implemented. Thus, the final list of indicators needs to be selected in the light of the specific socio-economic characteristics.
In order to adapt to different business cases, Bio-FlexGen project will co-select the final list of indicators per each scenario together in collaboration with the main stakeholders, as follows:

1. FOCUS GROUP: project partners, as experts in the sector and the technology, will participate in a "focus group" activity to elaborate ranking of the most relevant indicators.
2. Questionnaire to local stakeholders linked to business cases: the project will handle a set of questionnaires to stakeholders linked to both business cases to identify the impact areas that are more relevant for them or those they are more concerned about. For instance, workers from the industrial business cases may be asked to answer the questionnaire. In contrast, in the case of the residential business case, the project will try to gather the feedback from local public authorities, neighbour associations and/or consumer associations.

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7 Interrelation of social indicators with other sustainability dimensions

7.1 Economic dimension

Economic profitability, and hence long term-viability for biofuels is a moving target. It depends on cost-reducing technological improvements and relative price competitiveness (with alternative uses of feedstocks). Competition with alternative uses of feedstocks may also be localised and highly determined by the presence or absence of policy incentives or disincentives.

Economic equity (intragenerational and intergenerational) implies social and economic justice, quality of life, democracy, public participation and empowerment; the incidence and magnitude of unsustainable practices originate from power inequality. The growing global demand for liquid biofuels and the attendant environmental and socio-economic transformation might have different impacts on men and women in the same households as well as male- and female- headed households, as regards their access to and control of land and other productive assets, their level of participation in decision-making, employment opportunities and conditions, and their food security.
The potential high-land use requirement for biofuels might put pressure on the so-called "marginal" lands (perceived as less critical for food production), prompting their conversion to biofuels production.

7.2 Environmental Dimension

The environmental impact of the Bio-FlexGen technology will be addressed by Geonardo in Task 5.1. The task will assess the environmental impacts of the flexible CHP solution, introducing various alternative supply chains and special attention will be brought to the environmental impacts of hydrogen and biomass syngas generation. An additional objective of this task is to assess the environmental sustainability and the associated costs of the integrated BIO-FLEXGEN prototype combustion system, emphasizing on switching from hydrogen-firing to bio-syngas-firing, emissions compliancy and mapping of system boundaries on biomass raw material feedstock and hydrogen production quantities and qualities.
Geonardo will develop complementary approaches for this purpose:

- A full Life Cycle Analysis (LCA): to quantify the environmental impacts of the conversion of raw materials to heat and power. Both "Cradle–to-gate" and "Cradle-to-grave" LCA studies will be investigated to be performed on the defined prototype demo case in order to evaluate environmental impacts of the combustion prototype while including the development of functional bio-based components and their respective manufacturing processes.
- A Life Cycle Cost Analysis (LCCA) will be also performed to determine cost associated with BIO-FLEXGEN biomass and hydrogen origin materials and the technology to be developed. This task will identify clear performance indicators relating to life cycle costs, environmental impact and risk profiles in consultation with stakeholders.

8 Measurement Methodology

8.1 The process of building composite indicators

To measure the impact of Bio-FlexGen we propose the construction of a composite indicator. Composite indicators, defined by authors such as [64] are constructed from multiple individual indicators (hereafter referred to as component indicators) and used for measuring multidimensional variables or

[64] Freudenberg, M. (2003) 'Composite Indicators of Country Performance: A Critical Assessment'

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realities that are difficult to delimit with a single indicator. This is the case of Bio-FlexGen, where using a high number of individual indicators applied independently may impede the holistic and global analysis required in such a multidisciplinary project. Besides, the hierarchical aggregation procedure proposed for the construction of the composite indicator ensures the availability of more granular measures if they are required for further analysis (indeed, all the component indicators and the intermediate composite indicators are always available with this architecture).

Composite indicators are of growing importance in the academic and professional world, as they allow monitoring qualitative, quantitative, and complex aspects. Their incipient use is documented by numerous authors, especially in the public and media sphere[65]. However, although the use of these measures is widespread -the paradigm being the Human Development Index (HDI)[66], there has also been much academic discussion about them. Some academics criticise them for lacking statistical significance and for the arbitrariness present in their elaboration[67]. On the other hand, those in favour of composite indicators emphasise how they attract public attention, facilitate the understanding of complex realities, and energise the decision-making of public and private entities[68]. In fact, these arguments led Amartya Sen, winner of the Nobel Prize in Economics in 1998, to change his critical stance on composite indicators.

Therefore, composite indicators present an enormous potential for social transformation, but they can also be misleading if they are not carefully developed. Several organisms provide guidelines and manuals to minimize the risks associated with indexes' incorrect construction. In particular, we use the manual proposed by the Organization for Economic Development (OECD, 2008) as our main reference for this document.

When constructing a composite indicator, the steps to follow are:

- Definition of the theoretical framework and data collection: the component indicators to be selected for the construction of the index must be aligned and coherent with the objective. Besides, the indicators must be selected according to certain quality criteria, such as relevance, usefulness, and consistency. Sections 2, 3, and 4 have already given the details concerning the selection of the component indicators, while data collection is out of the project's scope.
- Imputation of missing data: once the data has been obtained, it is very likely that some values are missing. In these cases, there is a large number of techniques that can be applied depending on the behavior pattern of the missing data: missing completely at random (MCAR), missing at random (MAR), or not missing at random (NMAR). Since data is not available yet, this step will not be observed in the project.
- Multivariate analysis: it provides relevant information about the data structure. This analysis is essential to understanding the correlations between indicators[69]. It is impossible to delve into this stage until the data is available. Nevertheless, we recommend starting this analysis with the study of the correlation matrices and applying the Principal Component Analysis (PCA).
- Normalisation: it is used to avoid adding up indicators with different measurement units[70]. More details about this stage and our proposal for the Bio-FlexGen composite indicator are given in the next sections.

[65] Saltelli, A. (2007) 'Composite Indicators between Analysis and Advocacy'
[66] Anand, S. and Sen, A. (2003) 'Human Development Index: Methodology and Measurement'
[67] Grupp, H. and Mogee, M.E. (2004) 'Indicators for national science and technology policy: how robust are composite indicators?'
[68] Greco, S., Ishizaka, A., Tasiou, M. and Torrisi, G. (2019) 'On the Methodological Framework of Composite Indices: A Review of the Issues of Weighting, Aggregation, and Robustness'
[69] OECD (2008) 'Handbook on constructing composite indicators: methodology and user guide'
[70] Capelle-Blancard, G. and Petit, A. (2017) 'The Weighting of CSR Dimensions: One Size Does Not Fit All'

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- Aggregation and weighting: although these two stages can be separated (each one has different associated techniques and objectives), we prefer to merge them in this initial description of stages due to their high interrelationship. Indeed, the aggregation stage needs the weights for its implementation, and, on the other hand, the weights must be selected considering the type of aggregation to be implemented. In our opinion, weighting and aggregation is the crucial stage in constructing a composite indicator since it is when the multiple component indicators are mixed into a single one. Therefore, the next sections will explain the different possibilities regarding weighting and aggregation and provide our proposal for constructing the Bioflex composite indicator.
- Robustness analyses: according to Saisana, Saltelli and Tarantola[71], this is the 'quality assurance' stage, used to study the sensitivity of the index to changes in decisions taken in the previous stages. It is aimed to reduce the probability of the composite indicator conveying a misleading message. Since Bio-FlexGen data is not available yet and the indicator cannot be obtained, this step will not be observed in the project.

Once introduced to the reasons for selecting a composite indicator for measuring the impact of BioflexGen and to the stages for the construction of the index, the following sections will provide the theoretical framework for the normalisation, weighting, and aggregation. These stages are more conceptual and, therefore, can be studied without available data. The remainder stages have either already been addressed -this is the case for the theoretical framework- or cannot be properly addressed without data -such as the imputation of missing data, the multivariate analysis and the robustness analysis-.

8.2 Normalisation, weighting and aggregation

8.2.1 Normalisation

Normalisation is used to avoiding theadding up of indicators with different measurement units[72] [73]. We propose to homogenise our component indicators at a normalised value in the 0-100 interval, 0 meaning the worst possible result and 100 the best one.
There is a big set of available normalisation techniques: standardisation, distance to a reference, min-max method, etc.[74] [75] [76]. Among all of them, we have opted for the Min-Max method due to its simplicity, efficiency, and widespread use. For example, Min-Max has been used for the HDI (Anand and Sen, 1994) or the SDG index and dashboards[77] [78]. The normalisation process is performed according to (1) in cases where a higher value of the component indicator implies a better performance in the field evaluated.

$$\overline{idx_k} = \begin{cases} \dfrac{idx_k - LB_k}{UB_k - LB_k} \cdot 100 & if\ LB_k \leq idx_k \leq UB_k \\ 0 & if\ idx_k < LB_k \\ 100 & if\ idx_k > UB_k \end{cases} \qquad (1)$$

where:

- idx_k is the component indicator k.

[71] Saisana, M., Saltelli, A. and Tarantola, S. (2005) 'Uncertainty and sensitivity analysis techniques as tools for the quality assessment of composite indicators'
[72] OECD (2008) 'Handbook on constructing composite indicators: methodology and user guide'
[73] Capelle-Blancard, G. and Petit, A. (2017) 'The Weighting of CSR Dimensions: One Size Does Not Fit All'
[74] OECD (2008) 'Handbook on constructing composite indicators: methodology and user guide'
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[76] Jacobs, R., Smith, P., Goddard, M.K. and University of York Centre for, Health Economics (2004) 'Measuring performance: an examination of composite performance indicators : a report for the Department of Health'
[77] Lafortune, G., Fuller, G., Moreno, J., Schmidt-Traub, G. and Kroll, C. (2018) 'SDG index and dashboards detailed methodological paper'
[78] Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G. and Fuller, G. (2017) 'SDG index and dashboards report 2018'

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- $\overline{idx_k}$ is the component indicator k after normalisation.
- LB_k is the lower bound for the indicator k.
- UB_k is the upper bound for the indicator k.

The upper bounds must be determined by technical optimums[79] which allows us to interpret the value of 100 as an aspirational goal. These aspirational goals must be determined after dialogue and sharing of the different stakeholders involved in Bio-FlexGen. So, the composite indicator will engage them since they have participated actively in the construction of the index. The values for the lower bounds must be obtained in the same participatory way but giving them the interpretation of the worst acceptable value for the indicator.

In contrast, in cases where a higher value of the component indicator implies a worse performance, the normalisation is applied according to (2).

$$\overline{idx_k} = \begin{cases} 100 \cdot \left(1 - \dfrac{idx_k - LB_k}{UB_k - LB_k}\right) & if\ LB_k \leq idx_k \leq UB_k \\ 100 & if\ idx_k < LB_k \\ 0 & if\ idx_k > UB_k \end{cases} \quad (2)$$

8.2.2 Weighting

There is also a large number of weighting methods. According to[80], four of the main approaches to design weighting factors are: a) equal weights, b) expert criteria/Budget Allocation process (BAP), c) mathematical weights, and d) subjective/flexible weights. Other methods, such as the Data Envelopment Analysis (DEA), do not require setting the weights because they are generated automatically through an optimisation procedure [81] [82]. However, we dismiss the DEA method since it can be difficult for non-specialists to grasp[83] . Thus, it is not aligned with the easy-to-interpret principle under which we want to construct the Bio-FlexGen composite indicator.

For most aggregation levels, we have opted for the BAP[84] [85]. BAP is a participatory weighting method (OECD, 2008) where experts are asked to allocate a "budget" of one hundred points to the indicator set, for which they have to take into account the relative importance of the indicators within the set [i]. Then, weights are calculated as average budgets[86]. We have selected this method for its participatory nature (once again, the experts can be the stakeholders involved in Bio-FlexGen). Besides, according to OECD[87], one of the main disadvantages of this method is that it can produce inconsistencies for a number of indicators higher than 10, due to the serious cognitive stress that experts can suffer in the decision-making of allocating the budget. Nevertheless, we have checked that this project's biggest indicator set to be aggregated is made out of 69 indicators, so this problem does not apply[ii].

In those aggregation levels where the number of indicators increases, we propose the Analytic Hierarchy Process (AHP)[88], which is another participatory method that fits better for cases with heterogeneous and/or multiple indicators. This is because the AHP, instead of comparing the whole

[79] Lafortune, G., Fuller, G., Moreno, J., Schmidt-Traub, G. and Kroll, C. (2018) 'SDG index and dashboards detailed methodological paper'
[80] Ibid.
[81] Chen, C. and Delmas, M. (2011) 'Measuring Corporate Social Performance: An Efficiency Perspective'
[82] Capelle-Blancard, G. and Petit, A. (2017) 'The Weighting of CSR Dimensions: One Size Does Not Fit All'
[83] Capelle-Blancard, G. and Petit, A. (2017) 'The Weighting of CSR Dimensions: One Size Does Not Fit All'
[84] Moreira, R., Malheiros, T.F., Alfaro, J.F., Cetrulo, T.B. and Ávila, L.V. (2018) 'Solid waste management index for Brazilian Higher Education Institutions'
[85] Zhou, P., Ang, B.W. and Zhou, D.Q. (2010) 'Weighting and Aggregation in Composite Indicator Construction: a Multiplicative Optimization Approach'
[86] OECD (2008) 'Handbook on constructing composite indicators: methodology and user guide'
[87] Ibid.
[88] Saaty, R.W. (1987) 'The analytic hierarchy process—what it is and how it is used'

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set of indicators to be aggregated at a time (as in the BAP), establishes an ordinal pairwise comparison to obtain the weights (which makes the comparison easier).
The use of flexible weights can also be considered at any aggregation level, especially to undertake sensitivity analyses.

8.2.3 Aggregation

Deciding the level of substitutability among the different aggregation levels is crucial to choosing the most appropriate aggregation technique. The standard constant-elasticity-of-substitution (CES) function[89] [90] shown in (3) is the basis for any aggregation technique to be applied.

$$I = \left(\sum_{k=1}^{N} (\alpha_k \cdot \overline{\imath dx_k}^{\,\rho}) \right)^{1/\rho} \qquad (4)$$

where:

- $\overline{\imath dx}_k$ is the component indicator k after normalisation.
- α_i is the weighting factor associated with dimension i.
- N is the number of indicators to be aggregated in a certain aggregation level.
- I is the aggregated indicator.
- ρ is the substitution parameter, whose relationship with the elasticity of substitution, σ, is determined by (4). It must be noted that ρ can vary in the interval $[1, -\infty]$ and, therefore, σ can vary in the interval $[0, \infty]$.

$$\sigma = \frac{1}{1-\rho} \qquad (4)$$

Depending on the value of σ (and, consequently, of ρ), different levels of substitutability can be observed, two of them being the selected ones for this project:

- **Absolute substitutability ($\sigma = \infty$ and $\rho = 1$).** As explained in Lafortune *et al.*[91], a regress on one indicator can be offset by progress on another indicator, which turns the CES function into a weighted mean, which is the most widespread linear aggregation method (OECD, 2008) and can be computed according to (5).

$$I = \sum_{k=1}^{N} (\alpha_k \cdot \overline{\imath dx_k}) \qquad (5)$$

- **Intermediate/moderate substitutability ($\sigma = 1$ and $\rho = 0$).** In these cases, the CES function transforms into the Cobb-Douglas production function, which gives rise to a geometric aggregation, whose formula is given by (6). Having intermediate substitutability means that the trade-off among indices in the same aggregation level is not fully permitted. As stated by Lafortune *et al.*[92]"(geometric aggregation) is often used to aggregate heterogeneous variables with limited substitutability and in cases where the focus of the analysis is on percentage changes instead of absolute changes".

[89] Arrow, K.J., Chenery, H.B., Minhas, B.S. and Solow, R.M. (1961) 'Capital-Labor Substitution and Economic Efficiency'
[90] Lafortune, G., Fuller, G., Moreno, J., Schmidt-Traub, G. and Kroll, C. (2018) 'SDG index and dashboards detailed methodological paper'
[91] Lafortune, G., Fuller, G., Moreno, J., Schmidt-Traub, G. and Kroll, C. (2018) 'SDG index and dashboards detailed methodological paper'
[92] Ibid.

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$$I = \prod_{k=1}^{N} \left(\overline{\iota d x}_k{}^{\alpha_k}\right) \quad (6)$$

The decision about the aggregation method to be applied to each aggregation level depends on several factors. The OECD[93] establishes two interesting considerations regarding the relationship between linear aggregation ($\rho = 1$) and geometric aggregation ($\rho = 0$): *i)* countries or entities "with low scores in some individual indicators would prefer a linear rather than a geometric aggregation" (p.104); *ii)* a country or entity "would have a greater incentive to address those sectors with low scores if the aggregation were geometric rather than linear" since "the marginal utility of an increase in the score would be much higher when the absolute value of the score is low" (p.104).

8.3 Development of the Bio-FlexGen composite indicator

The aggregation system that we propose is based on a hierarchical structure composed by component indicator indicators, subcategories, categories, and a final aggregated score: the Bio-FlexGen composite indicator. Each category is denoted with a letter (e.g.: A), each subcategory is denoted with the category letter and a number (e.g.: A1) and, finally, each component indicator is denoted with the category letter, the subcategory number and an additional number preceded by a point (.) used to differentiate each component indicator from the rest of component indicators within the same subcategory (e.g.: A1.1). In addition, and to enhance readability, we use a different color code per category.
We discuss firstly the normalisation, weighting, and aggregation techniques on a subcategory basis, this is followed by the same exercise on a category level, and finally, we disclose the aforementioned techniques to construct the final composite indicator.

As explained in previous sections (section 3), Bio-FlexGen project will consider two main business cases to assess the potential application of the technology in a real environment: industrial application (industrial business case) and residential application (residential business case). Each scenario differs in terms of main stakeholders and potential effect of the technology application. Also, different stages of the biomass energy production value chain will have different socioeconomic impacts:

- A: Biomass extraction
- B: Energy production
- C: CO2 capture and storage

For this reason, the following list of indicators also states its adequacy for each business case and stage of the value chain, resulting in six different scenarios:

1. IA: Biomass extraction in the industrial business case
2. IB: Energy production in the industrial business case
3. IC: CO2 capture and storage in the industrial business case
4. RA: Biomass extraction in the residential business case
5. RB: Energy production in the residential business case
6. RC: CO2 capture and storage in the residential business case

8.3.1 CATEGORY A: IMPACT ON EMPLOYMENT

Subcategory A1: Job losses

[93] OECD (2008) 'Handbook on constructing composite indicators: methodology and user guide'

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		SCENARIOS					
Component indicators (Number of component indicators)	Normalization formula	IA (1)	IB (1)	IC (1)	RA (1)	RB (1)	RC (1)
A1.1 total number of job losses as a consequence of replacing: - the current biomass extraction technology - current fossil fuel energy plants - or adapting the current BTC technology as well as job losses for other existing livelihood activities (due to the expansion of biomass extraction)	(2)	X	X		X	X	

Weighting and aggregation techniques: In this case, weighting and aggregation are not needed since there is only one indicator. In turn, the normalisation process will focus on net figures and against a consensus target.

Subcategory A2: Job creation

Component indicators (Number of component indicators)	Normalization formula	IA (4)	IB (4)	IC (4)	RA (4)	RB (4)	RC (4)
A2.1 Total number of annual direct jobs created to operate: - the new biomass extraction technology - the new bioenergy plant/technology - the new CO2 capture and storage technology"	(1)	x	x	x	x	x	x
A2.2 % of jobs for unemployed people from the closure/adaptation of the current biomass extraction technology	(1)	X	X	X	X	X	X
A2.3 % of jobs for unemployed vulnerable groups	(1)	X	X	X	X	X	X

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A2.4 % of local workers employed	(1)	X	X	X	X	X	X

Normalisation technique: Normalisation will be carried out against consensus targets emanated from stakeholder consultation. Every indicator can be interpreted as an improvement with a mathematical increase of its value, hence, inversion is not required.

Weighting technique: Due to the limited number of indicators in this subcategory (three), BAP or flexible weightings are suitable as weighting techniques.

Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not. At this stage, however, geometric aggregation method seems to be more appropriate, as the global creation of jobs cannot compensate discrimination against vulnerable groups, like long term unemployed or creation of job opportunities for local people.

Subcategory A3: Job quality

Component indicators (Number of component indicators)	Normalization formula	IA (3)	IB (3)	IC (3)	RA (3)	RB (3)	RC (3)
A3.1 Ratio (%) skilled/unskilled jobs	(1)	X	X	X	X	X	X
A3.2 Ratio (%) permanent/temporary (casual/daily)	(1)	X	X	X	X	X	X
A3.3 Provision of worker training (average hours for training per year)	(1)	X	X	X	X	X	X

Normalisation technique: Normalisation will be carried out against consensus targets emanated from stakeholder consultation. All the indicators can be interpreted as an improvement with a mathematical increase of its value, hence, inversion is not required.

Weighting technique: Due to the limited number of indicators in this subcategory (four), BAP is a suitable weighting technique.

Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not, although, at this stage, geometric aggregation is preferred.

Subcategory A4: WORKING CONDITIONS AND RIGHTS

Component indicators (Number of component indicators)	Normalization formula	IA (4)	IB (4)	IC (4)	RA (4)	RB (4)	RC (4)

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A4.1 Employee income (Annual average income per employment category compared to minimum or median wage)	(1)	X	X	X	X	X	X
A4.2 Employment benefits (housing, transport, health care, holydays – in monetary value)	(1)	X	X	X	X	X	X
A4.3 Hours of work (extra hours – Yes/No)		X	X	X	X	X	X
A4.4 Freedom of association (existence of labour unions and right to join them: YES/NO)		X	X	X	X	X	X

Normalisation technique: Normalisation will be carried out against consensus targets emanated from stakeholder consultation. All the indicators can be interpreted as an improvement with a mathematical increase of its value, hence, inversion is not required. In the case of indicator A4.3 "YES" will be interpreted as 0 and "NO" as 100, considering that the necessity of doing extra hours damages work/life balance. In the case of indicator A4.4 "YES" will be given 100 value and "NO" 0 value.

Weighting technique: Due to the limited number of indicators in this subcategory (four), BAP is a suitable weighting technique.

Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not.

Subcategory A5: HEALTH AND SAFETY

Component indicators (Number of component indicators)	Normalization formula	IA (7)	IB (7)	IC (7)	RA (7)	RB (7)	RC (7)
A5.1 Number of work-related deaths	(2)	X	X	X	X	X	X
A5.2 Number of work-related accidents	(2)	X	X	X	X	X	X
A5.3 Number of work-related diseases	(2)	X	X	X	X	X	X
A5.4 Number of retirements due to working accidents	(2)	X	X	X	X	X	X

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A5.5 Benefits for disability and fatalities in the operation of the biomass extraction technology (YES/NO)		X	X	X	X	X	X
A5.6 OSH training: Percentage of employees that have received OSH (Occupational Safety & Health) training per year	(1)	X	X	X	X	X	X
A5.7 OSH management policies and strategies established in the company (YES/NO)		X	X	X	X	X	X

Normalisation technique: Normalisation will be carried out against consensus targets emanated from stakeholder consultation. All indicators, except A5.4 and A5.7, can be interpreted as an improvement with a mathematical decrease of its value, hence, normalization is inverted. In the case of indicator A5.5 and A5.7 "YES" will be interpreted as 100 and "NO" as 0, considering the existence of benefits and policies and strategies as best value.

Weighting technique: Due to the limited number of indicators in this subcategory (four), BAP is a suitable weighting technique.

Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not.

Subcategory A6: GENDER

Component indicators (Number of component indicators)	Normalization formula	IA (4)	IB (4)	IC (4)	RA (4)	RB (4)	RC (4)
A6.1 Ratio of men to women in workforce (difference in percentage points and in absolute value)	(2)	X	X	X	X	X	X
A6.2 Ratio of men to women in leadership and management positions (difference in percentage points and in absolute value)	(2)	X	X	X	X	X	X
A6.3 Average salary gap between female and male employees (and in absolute value)	(2)	X	X	X	X	X	X
A6.4 Gender Equality Plan (YES/NO)		X	X	X	X	X	X

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Normalisation technique: Normalisation will be carried out against consensus targets emanated from stakeholder consultation. All indicators, except A6.4 can be interpreted as an improvement with a mathematical decrease of its value, hence, normalization is inverted. In the case of indicator A6.4 "YES" will be interpreted as 100 and "NO" as 0, considering the existence of a Gender Equality Plan as best value.

Weighting technique: Due to the limited number of indicators in this subcategory (four), BAP is a suitable weighting technique.

Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not.

COMPOSITE INDICATOR CATEGORY A: IMPACT ON EMPLOYMENT

Subcategories indicators (Number of subcategories)	IA (7)	IB (7)	IC (7)	RA (7)	RB (7)	RC (7)
A1: Job losses	x	x	x	x	x	x
A2: Job creation	X	X	X	X	X	X
A3: Job quality	X	X	X	X	X	X
A3: Quality of employment	X	X	X	X	X	X
A4: Working conditions and rights	X	X	X	X	X	X
A5: Health and Safety	X	X	X	X	X	X
A6: Gender	X	X	X	X	X	X

Weighting technique: Due to the limited number of indicators in this subcategory (four), BAP is suitable as a weighting technique.

Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not. However, as subcategories are measuring the impact in very diverse dimensions, geometric aggregation is preferred.

8.3.2 CATEGORY B: IMPACT ON ECONOMIC DIMENSION

Subcategory B1: Economic feasibility

Component Indicator (Number of component indicators)	Normalization formula	IA (0)	IB (4)	IC (0)	RA (0)	RB (4)	RC (0)
B1.1 Productivity/efficiency	(1)		x			X	

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B1.2 Net energy balance surplus	(1)		X			X	
B1.3 Gross value added	(1)		X			X	
B1.4 Profitability: **- Annual net present value,** **- Annual return on investment** **- Payback period** **- Internal rate of return**			x			x	

Normalisation technique: Normalisation technique: Indicators will be inverted and normalized against consensus targets and maximum threshold (for instance, equivalent to a historic maximum). This means deducting the value of the indicator from the historical maximum and calculate the proportion (divide) versus the maximum. All the indicators can be interpreted as an improvement with a mathematical increase of its value, hence, inversion is not required.

Weighting technique: Due to the limited number of indicators in this subcategory (four), BAP is a suitable weighting technique.

Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not.

Subcategory B2: Energy Poverty

Component indicators (Number of component indicators)	Normalization formula	IA (0)	IB (1)	IC	RA (1)	RB (2)	RC
B2.1 Decrease of energy prices due to energy efficiency	(1)		x			x	
B2.2 Decrease of energy cost share in disposable households' income due to energy efficiency	(1)					X	

Normalsation technique: Indicators will be inverted and normalised against consensus targets and maximum threshold (for instance, equivalent to a historic maximum). This means deducting the value of the indicator from the historical maximum and calculate the proportion (divide) versus the maximum. Normalisation will be carried out against consensus targets emanated from stakeholder consultation. All the indicators can be interpreted as an improvement with a mathematical increase of its value, hence, inversion is not required.

Weighting technique: Due to the limited number of indicators in this subcategory, BAP is a suitable weighting technique. (Only for RB scenario)

Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not. (Only for RB scenario)

Subcategory B3: Energy Efficiency

Component indicators (Number of component indicators)	Normalization formula	IA (1)	IB (2)	IC (1)	RA (1)	RB (2)	RC (1)
B3.1 Increase of energy efficiency	(1)	x	x	x	x	x	x

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B3.2 Decrease of energy production cost	(1)		X			X	

Normalisation technique: Indicators will be inverted and normalized against consensus targets and maximum threshold (for instance, equivalent to a historic maximum). This means deducting the value of the indicator from the historical maximum and calculate the proportion (divide) versus the maximum. Normalisation will be carried out against consensus targets emanated from stakeholder consultation. All the indicators can be interpreted as an improvement with a mathematical increase of its value, hence, inversion is not required.
Weighting technique: Due to the limited number of indicators in this subcategory, BAP is a suitable weighting technique. (Only for IB and RB scenarios)
Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not. (Only for IB and RB scenarios)

Subcategory B4: Energy Security

Component indicators (Number of component indicators)	Normalization formula	IA (0)	IB (2)	IC (0)	RA (0)	RB (2)	RC (0)
B4.1 Decrease of fossil fuel imports	(1)		x			x	
B4.2 Energy diversity/diversification of the energy mix	(1)		X			X	

Normalization technique: Indicators will be inverted and normalized against consensus targets and maximum threshold (for instance, equivalent to a historic maximum). This means deducting the value of the indicator from the historical maximum and calculate the proportion (divide) versus the maximum. All the indicators can be interpreted as an improvement with a mathematical increase of its value, hence, inversion is not required.

Weighting technique: Due to the limited number of indicators in this subcategory, BAP is a suitable weighting technique. (Only for IB and RB scenarios)

Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not. (Only for IB and RB scenarios)

Subcategory B5: Macroeconomics

Component indicators (Number of component indicators)	Normalization formula	IA (6)	IB (6)	IC (6)	RA (6)	RB (6)	RC (6)
B5.1 GDP/capita (€ or $)	(1)	x	x	x	x	x	x
B5.2 Sector contribution to GDP (%)	(1)	x	x	x	x	x	x
B5.3 GRDP (€ or $)	(1)	x	x	x	x	x	x
B5.4 Unemployment ratio (%)	(2)	x	x	x	x	x	x
B5.5 Average minimum wage (€ or $/day or month)	(1)	x	x	x	x	x	x
B5.6 Price of national food basket (€ or $)	(2)	x	x	x	x	x	x

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Normalisation technique: Normalisation will be carried out against consensus targets emanated from stakeholder consultation. B5.1, B5.2 and B5.4 indicators can be interpreted as an improvement with a mathematical increase of its value, hence, inversion is not required. Concerning indicators B5.3 and B5.5 improvement is interpreted as a mathematical decrease of its value, hence inversion is required for normalisation.
Weighting technique: Due to the limited number of indicators in this subcategory, BAP is a suitable weighting technique.
Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not.

Subcategory B6: Rural development

Component indicators (Number of component indicators)	Normalization formula	IA (2)	IB (2)	IC (2)	RA (2)	RB (2)	RC (2)
B6.1 Contribution to local industries in the local economy: (Percentage of total production cost paid annually to local contractors and suppliers)	(1)	x	x	x	x	x	x
B6.2 Taxes/royalties paid to the local government	(2)	x	X	x	x	X	x

Normalization technique: Normalisation will be carried out against consensus targets emanated from stakeholder consultation. All the indicators can be interpreted as an improvement with a mathematical increase of its value, hence, inversion is not required.

Weighting technique: Due to the limited number of indicators in this subcategory, BAP is a suitable weighting technique.
Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not.

COMPOSITE INDICATOR FOR CATEGORY B: IMPACT ON ECONOMIC DIMENSION

Subcategories indicators (Number of subcategories)	IA (3)	IB (6)	IC (3)	RA (3)	RB (6)	RC (3)
B1 : Economic Feasibility		X			X	
B2: Energy poverty		X			X	
B3: Energy efficiency	X	X	X	X	X	X
B4: Energy security		X			X	
B5: Macroeconomics	X	X	X	X	X	X
B6: Rural development	X	X	X	X	X	X

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<u>Weighting technique:</u> Due to the limited number of indicators in this subcategory (four), BAP is suitable as a weighting technique.
<u>Aggregation technique:</u> Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not. However, as subcategories are measuring the impact in very diverse dimensions, geometric aggregation is preferred.

8.3.3 CATEGORY C*:* PEOPLE AND COMMUNITIES

Subcategory C1: IMPACT ON TRADITIONAL LIVELIHOODS AND CULTURAL HERITAGE SITES

Component indicators (Number of component indicators)	Normalization formula	IA (2)	IB (0)	IC (0)	RA (2)	RB (0)	RC (0)
C1.1 Limitation in access to traditional livelihoods practices (hunting and fishing, harvesting of traditional food and medicines, …) as a consequence of deforestation for biomass extraction (Decrease of % of land dedicated to these activities over the years)	(2)	x			x		
C1.2 Limitation in access to areas or resources of cultural value such as sacred and recreational sites as a consequence of deforestation for biomass extraction (Decrease of % of land dedicated to these activities over the years)	(2)	x			x		

<u>Normalisation technique:</u> Indicators will be inverted and normalised against consensus targets and maximum threshold (for instance, equivalent to a historic maximum). This means deducting the value of the indicator from the historical maximum and calculate the proportion (divide) versus the maximum.
<u>Weighting technique</u>: Due to the limited number of indicators in this subcategory (three), BAP is a suitable as a weighting technique. (Only for scenarios IA and RA)
<u>Aggregation technique:</u> Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not. (Only for scenarios IA and RA)
Subcategory C2: FOOD SECURITY

Component indicators (Number of component indicators)	Normalization	IA (1)	IB (0)	IC (0)	RA (1)	RB (0)	RC (0)

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C2.1 Edible feedstock diverted from food chain to bioenergy	(2)	x			x		

Normalisation technique: Normalisation shall be done against a consensus target emanated from stakeholder consultation. A mathematical decrease of its value can be interpreted as an improvement, hence, inversion is required.
This subcategory is composed of one indicator, hence, **aggregation and weighting** are not required.

Subcategory C3: LAND USE AND LAND USE CHANGE

Component indicators (Number of component indicators)	Normalization formula	IA (3)	IB (0)	IC (0)	RA (3)	RB (0)	RC (0)
C3.1 Total area of land for feedstock production	(2)	x			x		
C3.2 Net annual rates of conversion between land-use types caused directly by bioenergy feedstock production	(2)	x			x		
C3.3 Land conflicts (YES/NO)		X			X		

Normalisation technique: Indicators will be inverted and normalized against consensus targets and maximum threshold (for instance, equivalent to a historic maximum). This means deducting the value of the indicator from the historical maximum and calculate the proportion (divide) versus the maximum. All the indicators can be interpreted as an improvement with a mathematical decrease of its value, hence, inversion is required.
Weighting technique: Due to the limited number of indicators in this subcategory, BAP is a suitable weighting technique. (Only for IA and RA scenarios)
Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not. (Only for IA and RA scenarios)

Subcategory C4: INTERACTION WITH COMMUNITY

Component indicators (Number of component indicators)	Normalization formula	IA (2)	IB (0)	IC (0)	RA (2)	RB (0)	RC (0)

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C4.1 Community Engagement (Existence of engagement plans/strategies: YES/NO)		x	X	X	x	X	X
C4.2 Community investment in education and awareness (Description of company's activities and projects in environmental awareness and educating about sustainability conducted in and for local communities.)	(1)	x	X	X	x	X	X

<u>Normalisation technique:</u> Normalization will be carried out against consensus targets emanated from stakeholder consultation. Every indicator can be interpreted as an improvement with a mathematical decrease of its value, hence, inversion is required.
<u>Weighting technique:</u> Due to the limited number of indicators in this subcategory, BAP is a suitable weighting technique.
<u>Aggregation technique:</u> Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not.
Subcategory C5: ENERGY COMMUNITIES AND CIVIC ENERGY

Component indicators (Number of component indicators)	Normalization formula	IA (0)	IB (4)	IC (0)	RA (0)	RB (4)	RC (0)
C5.1 Development of energy communities (Increase energy supply by energy communities)	(1)		X			X	
C5.2 Public promotion of energy communities (Public incentives)	(1)		x			x	
C5.3 Private promotion of energy communities (Private incentives)	(1)		x			x	
C5.4 Cooperative culture: Energy communities composed by private persons members	(1)		x			x	

<u>Normalisation technique:</u> Normalization will be carried out against consensus targets emanated from stakeholder consultation. Every indicator can be interpreted as an improvement with a mathematical increase of its value, hence, inversion is not required.
<u>Weighting technique:</u> Due to the limited number of indicators in this subcategory, BAP is a suitable weighting technique. (Only for IB and RB scenarios)

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Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not. (Only for IB and RB scenarios)

COMPOSITE INDICATOR FOR CATEGORY C: PEOPLE AND COMMUNITIES

Subcategories indicators (Number of subcategories)	IA (4)	IB (2)	IC (1)	RA (4)	RB (2)	RC (1)
C1: Impact on traditional livelihoods and cultural heritage sites	X			X		
C2: Food security	X			X		
C3: Land use and land use change	X			X		
C4: Interaction with community	X	X	X	X	X	X
C5: energy communities and civic energy		X			X	

Weighting technique: Due to the limited number of indicators in this subcategory (five), BAP is suitable as a weighting technique.
Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not. However, as subcategories are measuring the impact in very diverse dimensions, geometric aggregation is preferred.

8.3.4 Category D*:* SOCIAL ACCEPTANCE

Subcategory D1: LEVEL OF KNOWLEDGE

Component indicators (Number of component indicators)	Normalization formula	IA (1)	IB (1)	IC (1)	RA (1)	RB (1)	RC (1)
D1.1 Level of knowledge on bioenergy (Likert scale 1-5)	(1)	x	x	x	x	x	x

Normalization technique: Qualitative indicators' normalization require a 0-100 scale, assuming an improvement along with an increase in their respective values.

This subcategory is composed of one indicator, hence, **aggregation and weighting** are not required.

Subcategory D2: PUBLIC CONCERNS

Component indicators	Normalization formula	IA (3)	IB (3)	IC (3)	RA (3)	RB (3)	RC (3)

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(Number of component indicators)							
D2.1: Environmental concerns (Likert scale 1-5)	(1)	x	X	X	x	X	X
D2.2: Safety and social concerns (Likert scale 1-5)	(1)	x	X	X	x	X	X
D2.3: Impact on traditional livelihoods and cultural concerns (Likert scale 1-5)	(1)	x	X	X	x	X	X

Normalisation technique: Qualitative indicators' normalisation require a 0-100 scale, assuming an improvement along with a decrease in their respective values, hence, inversion is required.

Weighting technique: Due to the limited number of indicators in this subcategory (three), BAP is suitable as a weighting technique.

Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not

Subcategory D3: LOCAL/GLOBAL ADVOCACY FOR DEVELOPMENT OF BIOENERGY INDUSTRY

Component indicators (Number of component indicators)	Normalization formula	IA (2)	IB (2)	IC (2)	RA (2)	RB (2)	RC (2)
D3.1: Global support: **- Climate protection** **- Environmental protection** **- Distributive justice** **- Import dependency** **- Contribution to national economic development (Likert scale 1-5)**	(1)	x	X	X	x	X	X
D3.2: Local support and relevance of proximity (Likert scale 1-5)	(1)	x	X	X	x	X	X

Normalisation technique: Qualitative indicators' normalisation require a 0-100 scale, assuming an improvement along with a decrease in their respective values, hence, inversion is required.
Weighting technique: Due to the limited number of indicators in this subcategory (two), BAP is suitable as a weighting technique.
Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not

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Subcategory D4: TRUST AND CREDIBILITY IN STAKEHOLDERS

Component indicators (Number of component indicators)	Normalization formula	IA (2)	IB (2)	IC (2)	RA (2)	RB (2)	RC (2)
D4.1: Trust in industry (Likert scale 1-5)	(1)	x	X	X	x	X	X
D4.2: Trust in municipality (Likert scale 1-5)	(1)	x	X	X	x	X	X

Normalization technique: Qualitative indicators' normalisation require a 0-100 scale, assuming an improvement along with an increase in their respective values, hence, inversion is not required.
Weighting technique: Due to the limited number of indicators in this subcategory (two), BAP is suitable as a weighting technique.
Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not

Subcategory D5: PARTICIPATION OF SOCIETY

Component indicators (Number of component indicators)	Normalization formula	IA (4)	IB (4)	IC (4)	RA (4)	RB (4)	RC (4)
D 5.1: Desired information (Likert scale 1-5)	(1)	x	X	X	x	X	X
D5.2: Desired consultation (Likert scale 1-5)	(1)	x	X	X	x	X	X
D5.3: Desired cooperation (Likert scale 1-5)	(1)	x	X	X	x	X	X
D5.4: Desired assumption of responsibility (Likert scale 1-5)	(1)	x	X	X	x	X	X

Normalization technique: Qualitative indicators' normalization require a 0-100 scale, assuming an improvement along with an increase in their respective values, hence, inversion is not required.
Weighting technique: Due to the limited number of indicators in this subcategory (two), BAP is suitable as a weighting technique.
Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not

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Subcategory D6: ATTITUDES TOWARDS FINANCIAL SUPPORT/ FUNDING

Component indicators (Number of component indicators)	Normalization formula	IA (1)	IB (1)	IC (1)	RA (1)	RB (1)	RC (1)
D6.1 Desired level of involvement of funding actors (Likert scale 1-5)	(1)	x	x	x	x	x	x

Normalisation technique: Qualitative indicators' normalisation require a 0-100 scale, assuming an improvement along with an increase in their respective values.

This subcategory is composed of one indicator; hence, **aggregation and weighting** are not required.

COMPOSITE INDICATOR FOR CATEGORY D: SOCIAL ACCEPTANCE

Subcategories indicators (Number of subcategories)	IA (5)	IB (5)	IC (4)	RA (5)	RB (5)	RC (4)
D1: Level of knowledge	X	x	x	X	x	x
D2: Public concerns	X	x	x	X	x	x
D3: Local/global advocacy for development of bioenergy industry	X			X		
D4: Trust and credibility in stakeholders	X	X	X	X	X	X
D5: Participation of society		X			X	
D6: Attitudes towards financial support/ funding	X	X	X	X	X	X

Weighting technique: Due to the limited number of indicators in this subcategory (six), BAP is suitable as a weighting technique.

Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not. However, as subcategories are measuring the impact in very diverse dimensions, geometric aggregation is preferred.

FINAL AGGREGATED INDICATORS

Once the component indicators have been aggregated into subcategories, and subcategories have been aggregated into categories, we proceed to aggregate categories into a final, aggregated indicator, as follows:

Categories (Number of categories)	IA (4)	IB (4)	IC (4)	RA (4)	RB (4)	RC (4)

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A: IMPACT ON EMPLOYMENT	X	X	X	X	X	X
B: IMPACT ON ECONOMIC DIMENSION	X	X	X	X	X	X
C: PEOPLE AND COMMUNITIES	X	X	X	X	X	X
D: SOCIAL ACCEPTANCE	X	X	X	X	X	X

Weighting technique: Due to the limited number of indicators in this subcategory (four), BAP is suitable as a weighting technique.

Aggregation technique: Arithmetic or geometric aggregation methods can be applied, depending on whether compensation among indicators is allowed or not. Nonetheless, we suggest geometric aggregation to build the final indicator.

9 Limitations

In the process of identifying the main methodologies, processes and indicators for an ex-ante and ex-post social impact assessment (SIAs) in the bioenergy sector, we have encountered the following limitations:

1. Lack of universally recognised social standards might SIAs be perceived as propaganda
2. Possibly conflicting links of SIAs with the decision-making process
3. Most indicators of previous research are quantified using a regional or national method
4. Considerations of spatial integration
5. Whether the net impact will be positive or negative will depend on the country, the region, and ultimately the household and individual position
6. The social assessment of bioenergy can touch upon many potentially interlinked causes. This raises a number of methodological difficulties including the challenge of distinguishing between direct and indirect social issues.
7. Most of the already implemented standards have been intended for the food or forest sector. Accordingly, the focus has been on local management rather than global impacts such as the greenhouse effect and food security.

10 Conclusions

The bioenergy sector is crucial for current and future energy scenarios as it has an enormous potential to improve European growth, wellbeing and energy independence. However, along its value chain it presents a considerable impact in the communities and societies where the production activity is set, but also in the locations from which raw materials for energy production are extracted. It is, in consequence, crucial important to assess the potential negative and positive impacts of bioenergy production before any bioenergy production project.

Ex-ante social impact assessment, which is closely linked to environmental and economic impacts, is still a methodological challenge, as there is a general lack of consensus on the assessment techniques to be used (qualitative/quantitative) and lack of widely accepted or used indicators or standards.

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The Bio-FlexGen project tries to shed some light on the main social impact categories are and corresponding indicators that companies, public authorities or other stakeholder need to consider before the launching of a Bioenergy production initiative.

This deliverable offers a preselection of 69 indicators, described and organised under four main impact categories (employment, economic dimension, people and communities and social acceptance) that gather together the main social impacts that may arise as a consequence of a bioenergy production project, considering the whole value chain (extraction of raw materials, energy production and CO2 capture technologies).

Aiming to offer a useful tool for any project in the sector, Bio-FlexGen also suggests the elaboration or composite indicators, which will allow comparability among different initiatives, technologies and projects in the sector and facilitate the interpretation of impact assessment results.

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[i] Equal weights have been discarded due to the heterogeneous relevance of the different indicators.

[ii] Mathematical weights are very useful when there is a large number of indicators to be aggregated. On the one hand, this large number makes it difficult to implement other methods such as the BAP and, on the other hand, makes it very likely to have strong correlations among indicators. Nevertheless, we discard it due to the small number of indicators within each indicator set to be aggregated and, over all, because it is not a participatory method.

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ANNEX 1: LIST OF SOCIAL IMPACT INDICATORS

CATEGORIES	SUBCATEGORY	No	INDICATORS	GUIDANCE	BUSINESS CASE CATEGORY	UNIT Qn: quantitative Ql: qualitative	POSITIVE/NEGATIVE IMPACT	SCOPE	TRL/RSL (At which stage of the project could these be measured?)	SOURCE	STAKEHOLDER	ASSESSMENT OF INDICATORS S (specific)	M (measurable)	A (achievable)	R (relevant)	T (time bound)
CATEGORY A: IMPACT ON EMPLOYMENT	A1: JOB LOSSES	**A1.1**	total number of job losses as a consequence of replacing: - the current biomass extraction technology - current fossil fuel energy plants - or adapting the current BTC technology as well as job lossess for other existing livelihood activities (due to the expansion of biomass extraction)	Sum of the four situations. Annual number of job losses	BOTH	Qn: number of jobs	NEGATIVE	EX ANTE To be measured in Year 0	7 to 9	Local statistics	LOCAL AUTHORITIES					
	A2: JOB CREATION	**A2.1**	total number of annual direct jobs created to operate: - the new biomass extraction technology - the new bioenergy plant/technology - the new CO2 capture and storage technology	Sum of the three situations. Total number of people employed per year. Breakdown should be given for categories of employment (management, technician…) and desagregated by sex	BOTH	Qn: number of jobs	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Company records	PLANT OPERATOR BIOMASS EXTRACTION COMPANY					
		A2.2	% of jobs for unemployed people from the closure/adaptation of: - the current biomass extraction technology - the fossil fuel energy plants - the adaptation of the BTC plant	Percentage of indicator I.2	BOTH	Qn: %	POSITIVE	EX ANTE To be measured in Year 0	7 to 9	Company records	PLANT OPERATOR BIOMASS EXTRACTION COMPANY					
		A2.3	% of jobs for unemployed vulnerable groups	% of jobs for unemployed vulnerable groups (long-term unemployed over 45 years old, people with disabilities, ...)	BOTH	Qn: %	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company records	PLANT OPERATOR BIOMASS EXTRACTION COMPANY					
		A2.4	% of local/migrant workers employed	Annual percentage of employment from local area/outside local area per category of employment (management, technician…). Local area is defined as state or province (ADAPT THIS IF NECESSARY)	BOTH	Qn: %	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company records	PLANT OPERATOR BIOMASS EXTRACTION COMPANY					
	A3: JOB QUALITY	**A3.1**	% skilled/unskilled jobs	Annual percentage of skilled/unskilled jobs per category of employment (management, technician…).	BOTH	Qn: %	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company records	PLANT OPERATOR BIOMASS EXTRACTION COMPANY					
		A3.2	% permanent/temporary (casual/daily)	Annual percentage of permanent/temporary jobs created. Percentage of workers that have a fixed contract employment per category of employment (management, technician…).	BOTH	Qn: %	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company records	PLANT OPERATOR BIOMASS EXTRACTION COMPANY					
		A3.3	Provision of worker training	Average hours of training per year per employee and type of training (excluding OHS training)	BOTH	Qn: number of hours	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company records	PLANT OPERATOR BIOMASS EXTRACTION COMPANY					
	A4: WORKING CONDITIONS AND RIGHTS	**A4.1**	Employee income	Annual average income per employment category compared to minimum or median wage	BOTH	Qn: € / $ per year	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Company records	PLANT OPERATOR BIOMASS EXTRACTION COMPANY					
		A4.2	Employment benefits	Breakdown of average employment benefits (housing, transport, health care, holidays) given per employment category. Distinction should be made between the benefits that are mandated by law and those that are not	BOTH	Ql: list of benefits	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company records Survey with employees	PLANT OPERATOR BIOMASS EXTRACTION COMPANY EMPLOYEES					
		A4.3	Hours of work	Average daily working hours of work per employee per employment category. This should be verified from employment records and worker surveys with questions addressing number of working hours/day: **SURVEY ITEM**: *Do workers work extra work hours? (average additional hours worked); Are they given days off for the extra hours worked?*	BOTH	Qn: number of hours Ql: survey results	NEGATIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company records Survey with employees	PLANT OPERATOR BIOMASS EXTRACTION COMPANY EMPLOYEES					
		A4.4	Freedom of association	Existance of labour unions and whether workers have the right to join them. This should be verified by surveys with workers: **SURVEY ITEM:** *Do you belong to a trade union or other type of working associations?*	BOTH	Qn: % of employees belonging to a trade union	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company records Survey with employees	PLANT OPERATOR BIOMASS EXTRACTION COMPANY EMPLOYEES					
	A5: HEALTH AND SAFETY	**A5.1**	Number of work related deaths	Number of work related deaths per year	BOTH	Qn: Number of deaths per year	NEGATIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Company/health clinic records Survey with employees	PLANT OPERATOR BIOMASS EXTRACTION COMPANY EMPLOYEES					
		A5.2	Number of work related accidents	Number of work related accidents per year f	BOTH	Qn: Number of accidents per year	NEGATIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company/health clinic records Survey with employees	PLANT OPERATOR BIOMASS EXTRACTION COMPANY EMPLOYEES					
		A5.3	Number of work related diseases	Number of work related diseases per person per year	BOTH	Qn: Number of diseases per year	NEGATIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company/health clinic records Survey with employees	PLANT OPERATOR BIOMASS EXTRACTION COMPANY EMPLOYEES					
		A5.4	Number of retirements due to working accidents	Number of retirements due to working accidents, as proportional to the total number of workers per year	BOTH	Qn: Number of retirements per year	NEGATIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company/health clinic records Survey with employees	PLANT OPERATOR BIOMASS EXTRACTION COMPANY EMPLOYEES					
		A5.5	Benefits for disability and fatalities in the operation of the biomass extraction technology	List of benefits for disability and fatalities in the operation (e.g., paid sick leave benefits, short-term disability insurance, long-term disability insurance, …)	BOTH	Ql: list of benefits	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Company/health clinic records Survey with employees	PLANT OPERATOR BIOMASS EXTRACTION COMPANY EMPLOYEES					
		A5.6	OSH training	Percentage of employees that have received OSH (Occupational Safety & Health) training per year	BOTH	Qn: %	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company records	PLANT OPERATOR BIOMASS EXTRACTION COMPANY					
		A5.7	OSH management policies and strategies established in the company	The plant operator counts with a OSH management policy and/or strategy at company level. Qualitative description of the main aspects of the policy and whether it includes a monitoring plan	BOTH	Ql: yes/no and qualitative description of policy	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company records	PLANT OPERATOR BIOMASS EXTRACTION COMPANY					
	A6: GENDER	**A6.1**	Ratio of men to women in workforce		BOTH	Qn: %	NEGATIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company records	PLANT OPERATOR BIOMASS EXTRACTION COMPANY					
		A6.2	Ratio of men to women in leadership and management positions		BOTH	Qn: %	NEGATIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company records	PLANT OPERATOR BIOMASS EXTRACTION COMPANY					
		A6.3	Average salary gap between female and male employees		BOTH	Qn: %	NEGATIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company records	PLANT OPERATOR BIOMASS EXTRACTION COMPANY					
		A6.4	Gender Equality Plan	**Survey item:** *Does the company have a Gender Equality Plan?*	BOTH	Ql: yes/no	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company records	PLANT OPERATOR BIOMASS EXTRACTION COMPANY					

CATEGORY B: IMPACT ON ECONOMIC DIMENSION	B1: ECONOMIC FEASIBILITY	**B1.1**	Productivity/efficiency	Indicator broken down into: - Productivity of bioenergy feedstocks by feedstock or by farm/plantation - Processing efficiencies by technology and feedstock - Amount of bioenergy end product by mass, volume or energy content per hectare per year - Production cost per unit of bioenergy	INDUSTRIAL	Qn	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company records	PLANT OPERATOR BIOMASS EXTRACTION COMPANY					
		B1.2	Net energy balance	Energy ratio of the bioenergy value chain with comparison with other energy sources, including energy ratios of feedstock production,, processing of feedstock into bioenergy, bioenergy use; and/or lifecycle analysis	INDUSTRIAL	Qn: !!!!	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company records	PLANT OPERATOR BIOMASS EXTRACTION COMPANY					
		B1.3	Gross value added	Gross value added per unit of bioenergy produced and as a percentage of gross domestic product	INDUSTRIAL	Qn	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company records	PLANT OPERATOR BIOMASS EXTRACTION COMPANY					
		B1.4	Profitability	Indicator broken down into: - Annual net present value, - Annual return on investment - Payback period - Internal rate of return	INDUSTRIAL	Qn	POSITIVE	EX ANTE To be measured in Year 0	4 to 6	Company records	PLANT OPERATOR BIOMASS EXTRACTION COMPANY					
	B2: ENERGY POVERTY	**B2.1**	Increase/decrease of energy prices due to energy efficiency	Increase/decrease of energy prices due to energy efficiency	BOTH	Qn: %	NEGATIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	National/Local Statistics	LOCAL/REGIONAL/NATIONAL AUTHORITIES LOCAL COMMUNITY					
		B2.2	Increase/decrease of energy cost share in disposable households income due to energy efficiency	Annual percentage expenditure for energy	BOTH	Qn: %	NEGATIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Survey with local communities	LOCAL COMMUNITY					
	B3: ENERGY EFFICIENCY	**B3.1**	Increase/decrease of energy efficiency	Annual increase/decrease of energy efficiency from: - biomass extraction technology - biopower production - CO2 capture technology	BOTH	Qn: %	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	National/Local Statistics	LOCAL/REGIONAL/NATIONAL AUTHORITIES LOCAL COMMUNITY					
		B3.2	Increase/decrease of energy production cost	Increase/decrease of energy production cost	INDUSTRIAL	Qn: €-$/year	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	National/Local Statistics	LOCAL/REGIONAL/NATIONAL AUTHORITIES LOCAL COMMUNITY					
	B4: ENERGY SECURITY	**B4.1**	Increase/decrease of fossil fuel imports		INDUSTRIAL	Qn: % of fossil fuel imports	NEGATIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	National/Local Statistics	LOCAL/REGIONAL/NATIONAL AUTHORITIES LOCAL COMMUNITY					
		B4.2	Energy diversity/diversification of the energy mix		BOTH	Qn: % distribution of energy mix	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	National/Local Statistics	LOCAL/REGIONAL/NATIONAL AUTHORITIES LOCAL COMMUNITY					
	B5: MACROECONOMICS	**B5.1**	GDP/capita (€ or $)		BOTH	Qn	POSITIVE	EX ANTE To be measured in Year 0 AFTER IMPLEMENTATION	4 to 6	National/Local Statistics	LOCAL/REGIONAL/NATIONAL AUTHORITIES LOCAL COMMUNITY					
		B5.2	Sectore contribution to GDP (%)		BOTH	Qn	POSITIVE	EX ANTE To be measured in Year 0	4 to 6	National/Local Statistics	LOCAL/REGIONAL/NATIONAL AUTHORITIES					
		B5.3	GDPR (€ or $)		BOTH	Qn	POSITIVE	EX ANTE To be measured in Year 0 AFTER IMPLEMENTATION	4 to 6	National/Local Statistics	LOCAL/REGIONAL/NATIONAL AUTHORITIES LOCAL COMMUNITY					
		B5.4	Unemployment ratio (%)		BOTH	Qn	NEGATIVE	EX ANTE To be measured in Year 0	4 to 6	National/Local Statistics	LOCAL/REGIONAL/NATIONAL AUTHORITIES					
		B5.5	Average minimun wage (€ or $/day or month)		BOTH	Qn	POSITIVE	EX ANTE To be measured in Year 0 AFTER IMPLEMENTATION To be measured annually from Y_1	4 to 6	National/Local Statistics	LOCAL/REGIONAL/NATIONAL AUTHORITIES LOCAL COMMUNITY					
		B5.6	Price of national food basket (€ or $)		BOTH	Qn	POSITIVE	EX ANTE To be measured in Year 0 AFTER IMPLEMENTATION	4 to 6	National/Local Statistics	LOCAL/REGIONAL/NATIONAL AUTHORITIES LOCAL COMMUNITY					
	B6: RURAL DEVELOPMENT	**B6.1**	Contribution to local industries in the local economy	Percentage of total production cost paid annually to local contractors and suppliers: - biomass suppliers - other raw materials and goods	BOTH	Qn: %	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	4 to 6	Company records Local authorities' records Survey with Industry associations	PLANT OPERATOR BIOMASS EXTRACTION COMPANY LOCAL AUTHORITIES INDUSTRY ASSOCIATIONS					
		B6.2	Taxes/royalties paid to the local government	Breakdown of payments made to the local government per year	RESIDENTIAL	Qn: € / $ per year	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Company records Local authorities' records	PLANT OPERATOR BIOMASS EXTRACTION COMPANY LOCAL AUTHORITIES					
CATEGORY C:	C1: IMPACT ON TRADITIONAL LIVELIHOODS AND CULTURAL HERITAGE SITES	C1.1	Limitation in access to traditional livelihoods practices (hunting and fishing, harvesting of traditional food and medicines, …) as a consequence of deforestation for biomass extraction	Percentage of lands, territories and natural resources used traditionally by Indigenous Peoples for subsistance and food production (farming, fishing, hunting, gathering, herding) which are now damaged, diminished, contaminated, etc. due to the expansion of biomass extraction compared to benchmarks established in the past (5, 10, or 20 years etc.).	BOTH	Qn: % of land	NEGATIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Company records Interviews/surveys with local/national authorities and cultural (inc. Indigenous) environmental NGOs	BIOMASS EXTRACTION COMPANY LOCAL/NATIONAL AUTHORITIES CULTURAL (INC. INDIGENOUS) AND ENVIRONMENTAL NGOs					
		C1.2	Limitation in access to areas or resources of cultural value such as sacred and recreational sites as a consequence of deforestation for biomass extraction	Percentage of lands, territories and resources of cultural value such as sacred and recreational sites which are now damaged, diminished, contaminated, etc. due to the expansion of biomass extraction compared to benchmarks established in the past (5, 10, or 20 years etc.).	BOTH	Qn: % of land	NEGATIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Company records Interviews/surveys with local/national authorities and cultural (inc. Indigenous) environmental NGOs	BIOMASS EXTRACTION COMPANY LOCAL/NATIONAL AUTHORITIES CULTURAL (INC. INDIGENOUS) AND ENVIRONMENTAL NGOs					
	C2: FOOD SECURITY	C2.1	Edible feedstock diverted from food chain to bioenergy	Annual amount of edible raw material diverted into bioenergy production. This can be checked with the operation and cross checked with local or national authorities or environmental NGOs.	BOTH	Qn: Kilograms or Tons / year	NEGATIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Company records Interviews/surveys with local/national authorities and environmental NGO	BIOMASS EXTRACTION COMPANY LOCAL/NATIONAL AUTHORITIES ENVIRONMENTAL NGOs					
	C3: LAND USE AND LAND USE CHANGE	C3.1	Total area of land for feedstock production	Total area of land for bioenergy feedstock production, and as compared to national surface and agricultural and managed foest land area. This can be checked with the operation and cross checked with local or national authorities or environmental NGOs.	BOTH	Qn: ha	NEGATIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Company records Interviews/surveys with local/national authorities and environmental NGO	BIOMASS EXTRACTION COMPANY LOCAL/NATIONAL AUTHORITIES ENVIRONMENTAL NGOs					
		C3.2	Net annual rates of conversion between land-use types caused directly by bioenergy feedstock production	Net annual rates of conversion between land-use types caused directly by bioenergy feedstock production, including the following: - arable land and permanent crops, permanent meadoows and pastures, and managed forest - natural forest and grasslands, peatlands, and wetlands This can be checked with the operation and cross checked with local or national authorities or environmental NGOs.	BOTH	Qn: %	NEGATIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Company records Interviews/surveys with local/national authorities and environmental NGO	BIOMASS EXTRACTION COMPANY LOCAL/NATIONAL AUTHORITIES ENVIRONMENTAL NGOs					

PEOPLE AND COMMUNITIES		C3.3	Land conflicts	Area of land currently under dispute, land conflict. Quantitative number (ha) and qualitative description of any current or previous land use conflicts. Survey items: - *Has the operation had any land use conflics?* - *If so, what caused them? How were they resolved ?* This can be checked with the operation and cross checked with local or national authorities or environmental NGOs.	BOTH	Qn: ha Ql: list of land conflicts and description	NEGATIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Company records Interviews/surveys with local/national authorities and environmental NGO	BIOMASS EXTRACTION COMPANY LOCAL/NATIONAL AUTHORITIES ENVIRONMENTAL NGOs					
	C4: INTERACTION WITH COMMUNITY	C4.1	Community Engagement	Engagement strategies/mechanisms in place to enable public's contribution to influence decision-making process in which they are affected by or interested in and to receive, manage and resolve formal claims and complaints. This can be checked with the operation and cross checked with local communities and authorities and NGOs.	BOTH	Ql: description of engagement strategies/mechanisms	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0		Company records Interviews/surveys with local communities and authorities, and NGOs	PLANT OPERATOR BIOMASS EXTRACTION COMPANY LOCAL COMMUNITIES LOCAL AUTHORITIES NGOs					
		C4.2	Community investment in education and awareness	Description of company's activities and projects in environmental awareness and educating about sustainability conducted in and for local communities.	BOTH	Qn: % of annual revenue Ql: qualitative description of in-kind contributions	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Company records Interviews/surveys with local communities and authorities, and NGOs	PLANT OPERATOR BIOMASS EXTRACTION COMPANY LOCAL COMMUNITIES LOCAL AUTHORITIES NGOs					
		C5.1	Development of energy communities	Energy communities are developing in different ways in EU Member States but their contribution to the energy supply is still minimal.	RESIDENTIAL	Qn: % of energy communities' owned distributed of installed capacity	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y_1	7 to 9	Interviews/surveys with local communities and authorities, and NGOs	LOCAL COMMUNITIES LOCAL AUTHORITIES NGOs					
	C5: ENERGY COMMUNITIES AND CIVIC ENERGY	C5.2	Public promotion of energy communities	Public incentives to promote energy communities	RESIDENTIAL	Qn: n° of public initiatives for financially promote energy communities	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y1	7 to 9	Interviews/surveys with local communities and authorities, and NGOs	LOCAL COMMUNITIES LOCAL AUTHORITIES NGOs					
		C5.3	Private promotion of energy communities	private incentives to promote energy communities	RESIDENTIAL	Qn: n° of private initiatives for financially promote energy communities	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y1	7 to 9	Interviews/surveys with local communities and authorities, and NGOs	LOCAL COMMUNITIES LOCAL AUTHORITIES NGOs					
		C5.4	Cooperative culture	Energy communities composed by private persons members	RESIDENTIAL	Qn: n° of energy communities with more than 95% of private persons members	POSITIVE	AFTER IMPLEMENTATION To be measured annually from Y1	7 to 9	Interviews/surveys with local communities and authorities, and NGOs	LOCAL COMMUNITIES LOCAL AUTHORITIES NGOs					
	D1: LEVEL OF KNOWLEDGE	D1.1	Level of knowledge on bioenergy	**Survey items (Likert scale: 1-5):** - *How would you rate your general knowledge of biomasss and bioenergy technologies?* - *Are you aware of the types of resources that are used for bioenergy and are you familiar with types of energy that are produced?*	BOTH	Ql: survey	POSITIVE	EX ANTE To be measured in Year 0	7 to 9	Survey with local communities and NGOs	LOCAL COMMUNITIES LOCAL NGOs					
	D2: PUBLIC CONCERNS	D2.1	Environmental concerns	**Survey items (Likert scale: 1-5):** - *Biomass/bioenergy plants cause air pollution and odor nuisances for residents* - *The operation of Biomass/bioenergy plants jeopardizes groundwater or surface water* - *Biomass/bioenergy plants cause soil degradation* - *Biomass/bioenergy plants cause noise and dust derived from traffic for feedstock delivery* - *Biomass/bioenergy plants cause destruction of roads by the traffic for feedstock delivery* - *Biomass/bioenergy plants spoil the natural landscape*	BOTH	Ql: survey	NEGATIVE	EX ANTE To be measured in Year 0 AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Survey with local communities and NGOs	LOCAL COMMUNITIES LOCAL NGOs					
		D2.2	Safety and social concerns	**Survey items (Likert scale: 1-5):** - *The operation of a biomass/bioenergy plant entails an increased risk of accidents for residents (e.g., risk of fires and explosions through gas leakage or the leakage of a container)* - *The increased usage of biomass will increase the price of energy* - *The production of biomass competes with the production of food* - *The production of biomass can reduce local communities' access to food* - *As a result of the increased use of bioenergy, monocultures (such as plantations of pines and eucalyptus) will increase excessively* - *The biomass/bioenergy plant has a negative impact on the property values in our community* - *The biomass/bioenergy plant hurts me financially (e.g., reduced property values, less tourists)* - *People negatively affected by power generation projects should be compensated*	BOTH	Ql: survey	NEGATIVE	EX ANTE To be measured in Year 0 AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Survey with local communities and NGOs	LOCAL COMMUNITIES LOCAL NGOs					
		D2.3	Impact on traditional livelihoods and cultural concerns	**Survey items (Likert scale: 1-5):** - *Biomass extraction can reduce local communities' access to traditional livelihoods practices (hunting and fishing, harvesting of traditional food and medicines, …)* - *Biomass extraction can reduce local communities' access to cultural services such as sacred and recreational sites*	BOTH	Ql: survey	NEGATIVE	EX ANTE To be measured in Year 0 AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Survey with local communities and NGOs	LOCAL COMMUNITIES LOCAL NGOs					
		D3.1	Global support: - Climate protection - Environmental protection - Distributive justice - Import dependancy - Contribution to national economic development	**Survey items (Likert scale: 1-5):** - *Bioenergy plants are a suitable form of energy generation* - *Bioenergy should play an important role in Germany/Canada's future energy generation* - *Bioenergy protects the climate* - *Bioenergy is a clean electricity source* - *The ratio of costs (e.g., odors) and benefits (e.g., financial gains) of biomass/bioeenergy plants is distributed fairly* - *Biomass combustion and bioenergy plants help to reduce the dependency on imported energy* - *Biomass/bioenergy plants can contribute to the economic development of Germany/Canada*	BOTH	Ql: survey	POSITIVE	EX ANTE To be measured in Year 0 AFTER IMPLEMENTATION To be measured in Y0 and every 5 years (Y5, Y10, …)	7 to 9	Survey with local communities and NGOs	LOCAL COMMUNITIES LOCAL NGOs					
	D3: LOCAL/GLOBAL ADVOCACY FOR DEVELOPMENT OF BIOENERGY INDUSTRY	D3.2	Local support and relevance of proximity	**Survey items (Likert scale: 1-5):** - *The biomass/bioenergy plant has a positive effect on our municipality as a business location* - *I support biomass/bioenergy plants in my neighborhood* - *Biomass/bioenergy plants can contribute to the economic development of my municipality and region* **Survey items (Single choice):** - *To what extent is the distance between your house/ apartment and biomass or bioenergy plant important to you? (Single choice)* *a) I do not accept the plant, independent of the distance.* *b) The distance of the plant to my home is not relevant for me.* *c) The distance is not relevant but the plant should not be visible from my home.* *d) The plants should keep a minimal distance to my home.* - *What should be the minimum distance of a biomass/bioenergy plant to your home for you to accept the plant? (Single choice)* *1 kilometer (km), 1 km, 2 km, 3 km, 4 km, 5 km, 6 km, 7 km, 8 km, > 9 km*	BOTH	Ql: survey	POSITIVE	EX ANTE To be measured in Year 0 AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Survey with local communities and NGOs	LOCAL COMMUNITIES LOCAL NGOs					
CATEGORY D: SOCIAL ACCEPTANCE	D4: TRUST AND CREDIBILITY IN STAKEHOLDERS	D4.1	Trust in industry	**Survey items (Likert scale: 1-5):** **EX ANTE:** - *I trust that the industry will ensure that safe technology plants will be built* - *I trust that the industry will take into account the neighborhood's concerns* - *I trust that the industry will operate the plant safely* **AFTER IMPLEMENTATION:** - *I can rely on the information provided by the plant operator* - *The plant operator appreciates the neighborhood's concerns* - *The plant operator has the relevant expertise to operate the plant safely*	BOTH	Ql: survey	POSITIVE	EX ANTE To be measured in Year 0 AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Survey with local communities and NGOs	LOCAL COMMUNITIES LOCAL NGOs					

		D4.2	Trust in municipality	**Survey items (Likert scale: 1-5):** **EX ANTE:** *- I trust that the municipality will take the concerns of residents into account* *- I trust that the municipalitys will make a responsible decision on whether or not to build the technology* *- I trust that the municipality will ensure that safe technology plants will be built* *- I trust that the municipality will execute safety checks to ensure the safe operation of the plant* **AFTER IMPLEMENTATION:** *- I think that the municipality takes the concerns of residents into account* *- think that the municipality executes safety checks to ensure the safe operation of the plant*	BOTH	QI: survey	POSITIVE	EX ANTE To be measured in Year 0 AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Survey with local communities and NGOs	LOCAL COMMUNITIES LOCAL NGOs					
	D5: PARTICIPATION OF SOCIETY	D5.1	Desired information	**Survey item (Likert scale: 1-5):** **EX ANTE:** *- It's important for me to be informed in advance about planned biomass/bioenergy plants* **AFTER IMPLEMENTATION:** *- During the planning process of the local plant, sufficient information was available*	BOTH	QI: survey	POSITIVE	EX ANTE To be measured in Year 0 AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Survey with local communities and NGOs	LOCAL COMMUNITIES LOCAL NGOs					
		D5.2	Desired consultation	**Survey item (Likert scale: 1-5):** **EX ANTE:** *- In the realization of a biomass/bioenergy plant the population's opinion should be asked for* **AFTER IMPLEMENTATION:** *- The opinion of the population regarding the local biomass/bioenergy plant was asked for and respected*	BOTH	QI: survey	POSITIVE	EX ANTE To be measured in Year 0 AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Survey with local communities and NGOs	LOCAL COMMUNITIES LOCAL NGOs					
		D5.3	Desired cooperation	**Survey item (Likert scale: 1-5):** **EX ANTE:** *- The population should have a say in the implementation processes of biomass/bioenergy plants* **AFTER IMPLEMENTATION:** *- The decisions with regard to the realization of the local biomass/bioenergy plant were taken jointly with the population*	BOTH	QI: survey	POSITIVE	EX ANTE To be measured in Year 0 AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Survey with local communities and NGOs	LOCAL COMMUNITIES LOCAL NGOs					
		D5.4	Desired assumption of responsibility	**Survey item (Likert scale: 1-5):** **EX ANTE:** *The decisions with regard to the realization of a local biomass/bioenergy plant have to be taken jointly with the population* **AFTER IMPLEMENTATION:** *- The population contributed decisively to the realization of the local biomass/bioenergy plant*	BOTH	QI: survey	POSITIVE	EX ANTE To be measured in Year 0 AFTER IMPLEMENTATION To be measured annually from Y_0	7 to 9	Survey with local communities and NGOs	LOCAL COMMUNITIES LOCAL NGOs					
	D6: ATTITUDES TOWARDS FINANCIAL SUPPORT/ FUNDING	D6.1	Desired level of involvement of funding actors	**Survey item (Likert scale: 1-5):** **EX ANTE:** *The decisions with regard to the realization of a local biomass/bioenergy plant have to be taken jointly with the financial actors that will support the project* **AFTER IMPLEMENTATION:** *- The financial actors contributed decisively to the realization of the local biomass/bioenergy plant*	BOTH	QI: survey	POSITIVE	EX ANTE To be measured in Year 0 AFTER IMPLEMENTATION To be measured annually from Y0	7 to 9	Survey with public authorities and private actors such as investment funds, banks and other financial entities	PUBLIC AUTHORITIES FINANCIAL ENTITIES					