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Deliverable D2.2
Report on selected evaluation indicators

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Abbreviations

KPI	Key Performance Indicator
CAPEX	Capital expenditures
CCU	CO2 capture and use
OPEX	Operational expenditures
LHV	Lower Heating Value
ROI	Return on investment
GHG	Greenhouse gases
DFB	Dual fluidized bed
LCC	Life Cycle Costing
LCA	Life Cycle Assessment
s-LCA	Social Life Cycle Assessment
Tn	Tonne

Contents

Executive summary

Deliverable 2.2 “Report on selected evaluation indicators” is a public document of the BioSFerA project, delivered in the context of WP2 “Definition of full value chain” and it is an output of the Task 2.2 “KPIs definition”.

Task 2.2 refers to the definition of relevant Key Performance Indicators (KPIs) for the overall BioSFerA value chain.

Thus, this report establishes a list of indicators to assess the benefit of the overall concept proposed by the project. It is important to note that scope of this deliverable is the definition of the KPIs that will orient the project implementation and not to establish a calculation and a target value for each KPI, since it’s impossible to set each of the target values for the new technology in this early stage. However, when possible an expected value will be detailed in those KPIs that can be preliminarily established.

In the first part, the required inputs to calculate KPIs are identified and listed. These inputs are to be supplied by technology providers, innovation and research centers/institutes, refineries and fuel traders. These data characterize the state of reference of the process proposed by the project.

To facilitate their understanding, they are split into four different categories related to technical, economic, environmental and social aspects. When necessary, a calculation method is proposed.

The set of KPIs selected during this analysis will enable the assessment of impacts related to the implementation of BioSFerA overall concept. All the KPIs and their characteristics are to be validated by the consortium of BioSFerA to have a common basis of evaluation for the project.

Introduction

The overall goal of the H2020 funded-EU project **BioSFerA** is to develop a cost-effective interdisciplinary technology to produce sustainable aviation and maritime fuels. The process, combining thermochemical, biological and thermocatalytic parts is based on the gasification of biomass and other biogenic waste in a DFB gasifier and the two-stage fermentation of the produced syngas.

The **WP2** of the project has several main objectives such as the definition of KPIs, the definition of the overall process value chain or the selection of case studies. Within this WP, **T2.2** deals with the identification of KPIs for the demonstration of the BioSFerA overall concept. Based on these KPIs, data will be collected during the lab scale demonstrations and several assessments will be done at a later stage in the project: the technical energy analysis, the scalability, and replicability analysis. The main output of T2.2 is the **D2.2 – *Report on selected evaluation indicators***. The objective of this deliverable is to establish a list, as exhaustive as possible, of objective criteria to evaluate the benefits of the BioSFerA concept implementation.

The KPIs are selected, whenever possible, following the principles below.

- **Specific** - The KPIs are clearly defined. There is one widely-accepted definition of the KPI to make sure the different users interpret it the same way and, as a result, come to the same and right conclusions which they can act on.
- **Measurable** - The KPI is measurable to make it possible to measure the progress.
- **Achievable** - The KPI is defined in a way that it is achievable. Thus, the set norms are realisable.
- **Relevant** - The KPI aims to give more insight in the performance of the project.
- **Time-specific** - It is important to express the value of the KPI in relation to time-scale. Every KPI has a meaning only if its time dimension, in which it is realised, is known. The KPI therefore has to be time-specific. There are, however, KPIs that don't always follow these principles. In some cases, itis not possible to quantify and/or measure the progress as the KPI is set for information purposes.

The establishment of the list of KPIs has mainly involved the partners involved in the development and optimisation of the overall BioSFerA process as well as external stakeholders. The list of KPIs were enriched from valuable information provided within Task 2.1 'Elicitation of stakeholders requirements and market needs'. The partners contributing to T2.2 were a core group composed of: BBEPP, CERTH, CSIC, VTT and RINA.

The list of criteria to be determined and then regarded as KPIs, is split into four categories:

- **Technical**
- **Economical**
- **Environmental**
- **Social**

As mentioned before, a number of criteria will be regarded as KPIs. When possible, each KPI is described by characteristics listed hereafter:

- **KPI title and description**.
- **Unit**: indicator unit is not always trivial, especially when defining specific quantities. Basis of normalization must be clearly defined.
- **Means of verification**: Indication of where and how the information can be obtained, including the corresponding project task(s).
- **Expected value**: In some cases, taking into consideration the experience of the consortium as well as the targets set within the proposal phase, some preliminary estimations regarding specific KPIs (mainly technical) expected value threshold were performed. However, in most cases, it is too early for estimations and the identified KPIs will be calculated within the dedicated project Tasks, as mentioned in the means of verification.

1 Technical indicators

This section includes a list of different KPIs related to the technical aspects that define the performance of the main BioSFerA processes. These processes include feedstock handling (KPI 1.1), DFB gasification and syngas treatment (KPIs 1.2-1.7), fuel synthesis through syngas and liquid fermentations (KPIs 1.8-1.14) and fuel upgrading and final production (KPIs 1.15-1.23).

1.1 Feedstock flexibility

Definition: Number of different types of biogenic residues/biomass (such as such as agricultural wastes, biogenic wastes from ports and/or airports) that is effectively tested for gasification.
Means of verification: bench/pilot tests with different biomass feedstock. **[Tasks 2.3, 3.1]**
Expected value: 4

1.2 Biomass gasified

Definition: Percentage of biomass effectively gasified in order to obtain the subsequent syngas.
Unit: %
Means of verification: Mass balance calculation after bench and pilot scale gasification tests. **[Tasks 3.1, 4.3]**
Expected value: >90%

1.3 Carbon conversion in the DFB gasifier

Definition: Fraction of carbon in initial feedstock that is converted to gas (syngas and flue gas) in the gasifier.
Unit: %
Means of verification: Material balance calculation after pilot gasification tests. **[Task 4.3]**
Expected value: 99.5%

1.4 Cold gas efficiency

Definition: Fraction of the chemical energy in the initial feedstock that is transferred to syngas in the gasifier.
Unit: % (LHV based).
Means of verification: Mass and energy balance calculation after pilot gasification tests. **[Task 4.3]**
Expected value: >80% based on the assumption that some of gases are recycled back to the oxidiser to provide part of the required heat - if not, then the target should be 75 % as more feedstock must be combusted in the oxidiser.

1.5 Tars conversion

Definition: Percentage of efficient tars reforming.
Unit: %

Means of verification: Mass balance calculation after bench and pilot scale gasification tests. **[Tasks 3.1, 4.3]**
Expected value: >99% tars and C2-C5 conversion.

1.6 Concentration of syngas impurities

Definition: Maximum fraction of impurities in initial syngas (i.e. tars, H2S, HCN, etc.) that are acceptable for the effective syngas fermentation or do not affect the bacteria and yeast performance
Unit: mg/m^3n (tars), ppm-v (HCN, H2S, COS, NH_3)
Means of verification: Contaminant measurements from the slip stream gas cleaning unit after pilot gasification tests. **[Task 3.1]**
Expected value: required level of gas cleaning and required gas purification stages to be defined during the project. Preliminary targets:
- no condensable tars at the inlet conditions of the fermentation.
- concentration of water soluble tars < 5 mg/m^3n.
- in addition to tars, the following impurities are present: H_2S, COS, NH_3, HCN.

1.7 Gas cleaning steps

Definition: Number of minimum gas cleaning steps after gasification of feedstock needed for obtaining syngas acceptable for the subsequent gas fermentation stage.
Means of verification: fermentation trials at lab scale using water samples collected after the filtration and reforming steps of the gasification process. **[Task 3.3**, **Task 4.3]**
Expected value: solids filtering, tars, NH_3 and COS/HCN removal.

1.8 Acetate productivity

Definition: Amount of acetate that is produced per L reactor volume and per hour.
Unit: g/L/h
Means of verification: Mass balance calculation after gas fermentation tests. **[Tasks 3.3, 4.3]**
Expected value: 0.55

1.9 Acetate production yield

Definition: Fraction of $CO/CO_2/H_2$ that is converted to acetate in the first bioreactor.
Unit: %
Means of verification: Mass balance calculation after gas fermentation tests. **[Tasks 3.3, 4.3]**
Expected value: 90

1.10 CO/CO_2 abatement potential

Definition: Amount of CO/CO_2 that is incorporated per amount of final product (lipids).
Unit: tnCO_2/tn lipids
Means of verification: Mass balance calculation based on pilot tests **[Tasks 4.3, 4.4, 6.2]**
Expected value: 2.83

1.11 H_2 requirement

Definition: Amount of additional H_2 that is required to build in the final product (lipids).
Unit: tn/tn lipids
Means of verification: Mass balance calculation after gas fermentation tests. **[Tasks 3.3, 4.3]**
Expected value: 0.9

1.12 Lipid productivity

Definition: Amount of lipids that are produced per L reactor volume and per hour.
Unit: g/L/h
Means of verification: Mass balance calculation after acetate fermentation tests. **[Tasks 3.4, 4.4, 6.2]**
Expected value: 0.26

1.13 Lipid production yield

Definition: Fraction of acetate that is converted to lipids in the second bioreactor.
Unit: %
Means of verification: Mass balance calculation after acetate fermentation tests. **[Tasks 3.4, 4.4]**
Expected value: >90

1.14 Total lipid content

Definition: Fraction of all fatty acids present in the dry cell weight.
Unit: %
Means of verification: Lipid extraction and measurement after bench and pilot scale fermentation tests. [**Tasks 3.4, 3.5, 4.4, 4.5]**
Expected value: 60

1.15 Biofuel conversion efficiency

Definition: Conversion ratio from the initial feedstock to the final biofuel produced.
Unit: %
Means of verification: Mass balance calculation after pilot gasification and fermentation tests. **[Tasks 3.4, 3.5, 4.4, 4.5, 6.2]**
Expected value: 17.4

1.16 Total C utilization factor

Definition: Fraction of carbon in initial feedstock (biogenic residues and wastes) that is converted to the final biofuels.
Unit: %
Means of verification: Material balance calculation based on process simulation. **[Tasks 4.3, 4.4, 6.2]**
Expected value: >37%

1.17 Drop-in fuel to feed energy ratio

Definition: Fraction of the chemical energy in the initial feedstock to be transferred to the final fuel.
Unit: % LHV basis
Means of verification: Energy balance calculation based on process simulation results. **[Tasks 4.3, 4.4, 6.2]**
Expected value: >40%

1.18 Quality of final jet biofuel

Definition: Definition and measurement of key parameters (Density, Flash Point, Distillation, Freezing Point, Acidity, Aromatics, Thermal stability and Sulfur content) present in the produced final jet biofuel
Unit: density (kg/L), flash point, distillation, freezing point, thermal stability (°C), sulphur content (% wt).
Means of verification: Laboratory analytics. **[Task 5.3, 5.4]**
Expected value: To meet Jet-A1 specifications. Sulphur content < 1000 ppm, freezing point between -40 and -50 °C, flash point 38 °C and density near to 800 kg/m^3.

1.19 Quality of final marine biofuel

Definition: Definition and measurement of key parameters (Density, Flash Point, Viscosity, Carbon Residue and Sulfur content) present in the produced final marine biofuel
Unit: density (kg/L), flash point (°C), viscosity (m^2/s), carbon residue (%), sulphur content (% wt).
Means of verification: Laboratory analytics. **[Task 5.3, 5.4]**
Expected value: There is wide spectrum of marine biofuel choices, therefore different sets of specifications that correspond to drop-in marine fuels. Specific target values will be defined during the project.

1.20 Total electricity consumption

Definition: Electricity consumed during the entire industrial process in order to produce 1 tn of final biofuel.
Unit: KWh/tn biofuel
Means of verification: Energy balance calculation based on process simulation results. **[Tasks 4.3, 4.4, 4.5, 6.2]**
Expected value: 0.168

1.21 Total water consumption

Definition: Water consumed during the entire industrial process in order to produce 1 tn of final biofuel.
Unit: tn water/tn biofuel
Means of verification: LCA analysis. **[Tasks 4.3, 4.4, 4.5, 6.2]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

1.22 Reduction of energy consumption

Definition: Difference of KWh of energy not consumed by making use of the BioSFerA process instead of the state of the art (fossil fuels).
Unit: %
Means of verification: LCA of the entire value chain **[Task 7.3]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

1.23 Potential productivity

Definition: Potential production of biofuels in the BioSFerA biorefinery plant at industrial scale.
Unit: kWh (or L)/year
Means of verification: Development of an integrated model based on design and operation of the biorefinery plan. **[Tasks 4.3, 4.4, 4.5, 6.2, 6.4]**
Expected value: 30-100.

2 Economic indicators

This section includes those KPIs related with the main economic aspects that define the expected profitability of the BioSFerA demonstrated processes, such as system capital costs (KPIs 2.1-2.5), variable costs (KPI 2.6) and other parameters including biofuel production costs (KPIs 2.7-2.10).

2.1 Specific capital costs

Definition: Costs associated with the main operations of the processes of BioSFerA including gasifier, fermenters, other reactors and peripheral units, etc. Members will evaluate the techno-economics of the full-scale operation of BioSFerA process analysing the full Value Chain and cost/competitor/potential supplier of each value chain step from a technical (performances) and economic (Cost) point of view. The operational parameters, whole process lay-out and system management (discontinues or continues operations) will be considered and compared in order to evaluate the system specific capital costs**.**
Unit: €/kW (or L of biofuel)
Means of verification: Techno-economic assessment of the BioSFerA process. **[Task 6.2, 7.1]**
Expected value: <3900.

2.2 Specific investment cost reduction

Definition: Cost reduction associated with gasification plant compared to the state-of-the-art gasification routes for biofuels synthesis.
Unit: %
Means of verification: Techno-economic assessment of the BioSFerA process. **[Task 6.1, 7.1]**
Expected value: <30.

2.3 Gasifier specific energy costs

Definition: Cost of the energy consumption of the gasifier unit used for the biomass gasification process.
Unit: €/ KWh
Means of verification: Techno-economic assessment of gasification process. **[Task 6.1, 7.1]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

2.4 Gas fermentation specific energy costs

Definition: Cost of the energy consumption of the gas fermentation unit used for the syngas fermentation process.
Unit: €/Nm^3/h
Means of verification: Techno-economic assessment of gas fermentation process. **[Task 6.2, 7.1]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

2.5 Liquid fermentation specific energy costs

Definition: Cost of the energy consumption of the liquid fermentation unit used for the acetate fermentation process.
Unit: €/m^3/h
Means of verification: Techno-economic assessment of liquid fermentation process. **[Task 6.2, 7.1]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

2.6 Total operational costs (OPEX)

Definition: Total expenses for operations of the BioSFerA processes including labor, maintenance, electricity and consumables per unit of final fuel.
Unit: €/ L of biofuel
Means of verification: Techno-economic assessment of the entire value chain. **[Task 6.2, 6.3, 7.1]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

2.7 Total intended costs

Definition: Total intended costs (CAPEX+OPEX) per L of biofuel produced.
Unit: €/ L of biofuel
Means of verification: Development of a techno-economic assessment of the full-scale operation of BioSFerA process **[Task 6.2, 6.3, 7.1]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

2.8 Expected cost difference

Definition: Reduction of production cost compared to other similar (reference) fuels.
Unit: %
Means of verification: Techno-economic assessment of the entire value chain. **[Task 6.3, 7.1]**
Expected value: <26-60

2.9 Cost of GHG emissions saving

Definition: Final cost correlation to the amount of GHG emissions saved while the new bio-fuels are used by the marine and air industries.

Unit: €/CO_2 equivalent

Means of verification: LCA of the entire value chain **[Task 7.3]**

Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

2.10 Minimum biofuel selling price

Definition: Cost of drop in biofuels production considering revenues from sale of power, heat, CO_2, side products, etc.

Unit: €/L

Means of verification: Techno-economic assessment of the entire value chain. **[Task 6.2, 7.1, 7.3]**

Expected value: <0.8 €/L and <0.7 €/L for biojet fuel and bunker biofuel, respectively.

3 Environmental indicators

This section includes a list of common environmental indicators identified in the literature review to monitor and evaluate the performance of biofuel sustainable production process within BioSFerA. Most of them can be classified as emissions to air (KPI 3.1- 3.10), to water (KPI 3.11) and to land (KPI 3.12). Furthermore other KPIs considered, including resource use (3.13-3.18). Values not estimated yet will be set according to European limits for the emissions and trying to lower them as much as possible.

3.1 GHG emissions reduction

Definition: Net GHG emissions reduction of overall BioSFerA process compared to conventional routes linked to fossil-derived fuels.

Unit: %

Means of verification: LCA of the entire value chain. **[Task 6.2, 7.3]**

Expected value: 44-120[1]

3.2 CO_2 carbon footprint

Definition: Net CO_2 emissions per produced fuel without considering CO_2 storage.

Unit: gCO_2/KWh of produced biofuel

[1] The GHG emission savings from biomass fuels used as transport fuels, in conformity with REDII directive (Directive (EU) 2018/2001), have been calculated from the part C.3 (a) of Annex V, taking into account the emissions derived from the cultivation and transport of feedstock, the biomass processing, the final biofuel distribution and use. The calculations were based on using grid electricity for the coverage of the electricity needs. The results show a high reduction of at least 120 % of GHG emissions in the first scenario (with CCU considerations) and at least 44% in the second scenario (without CCU considerations) compared to fossil fuels. If RES electricity is considered, the targeted KPI will overcome the minimum threshold established by REDII (65%).

Means of verification: LCA of the entire value chain. **[Task 6.2, 7.3]**
Expected value: <58

3.3 Global warming potential

Definition: Relative measure of how much heat can be trapped by a given GHG, compared to a reference gas, usually CO_2.
Unit: kg CO_2/ kg emission from biofuel production
Means of verification: LCA of the entire value chain. **[Task 7.3]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

3.4 SOx emissions

Definition: Measure of the emitted mass of SOx during the entire BioSFerA process.
Unit: kg/tn biofuel
Means of verification: LCA of the entire value chain. **[Task 7.3]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

3.5 Damage of human health

Definition: Potential impact on the human environment of toxic substances released by the BioSFerA processes. This is expressed as the number of year life lost and the number of years lived disabled. The KPI "damage of human health" includes: human toxicity, respiratory effects, ionizing radiation, ozone layer depletion, photochemical oxidation.
Unit: DALY/kg
Means of verification: LCA of the entire value chain. **[Task 7.3]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

3.6 Abiotic depletion resources

Definition: Depletion of non-living (abiotic) resources such as fossil fuels, minerals, clay, and peat caused by the BioSFerA processes.
Unit: kg Sb/ kg emission from biofuel production
Means of verification: LCA of the entire value chain. **[Task 7.3]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

3.7 Acidification

Definition: Reduction in the pH due to spillage to the environment of produced reactives and side-products. Acidification Potentials (AP) classification factors are mainly based on the contributions of SO_2, NO_x, HCl, NH_3 and HF. AP for emissions to air are calculated with the adapted RAINS 10 model, describing the fate and deposition of acidifying substances.
Unit: kg SO_2 equivalents/ kg emission from biofuel production
Means of verification: LCA of the entire value chain. **[Task 7.3]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

3.8 Eutrophication

Definition: Impact due to excessive levels of macro-nutrients in the environment caused by emissions of nutrients to air, water and soil. Eutrophication is calculated in kg based on a weighted sum of the emission of nitrogen and phosphorus derivatives such as N_2, NO_x, NH_4^+, PO_4^{3-}, P and chemical oxygen demand.

Unit: kg PO_4 equivalents/ kg emission from biofuel production

Means of verification: LCA of the entire value chain. **[Task 7.3]**

Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

3.9 Ecotoxicity-fresh water, marine and terrestrial

Definition: Impact on fresh water, marine and terrestrial ecosystems, as a result of emissions of toxic substances to air, water and soil produced during BioSFerA. Ecotoxicity potentials are calculated with USES-LCA, describing fate, exposure and effects of toxic substances.

Unit: kg 1,4 – Dichlorobenzene/kg of biofuel

Means of verification: LCA of the entire value chain. **[Tasks 6.2, 7.3]**

Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

3.10 Acid and organic emissions to land

Definition: Acids and organic chemicals that are emitted to land –(e.g. solvents such as formaldehyde and alcohols, long chain hydrocarbons) during the BioSFerA processes. These emissions are usually caused by accidental spillage.

Unit: total mass of product spilled.

Means of verification: Absolute number of spills during the pilot scale tests. **[Tasks 4.3, 4.4, 4.5, 5.4]**

Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

3.11 Fossil depletion

Definition: Measurement of the fossil fuel depletion that takes place when the biofuel is implemented in the final fuel mixture, in comparison to state of art biofuels utilised in this task.

Unit: MJ/kg of biofuel

Means of verification: LCA of the entire value chain. **[Tasks 6.2, 7.3]**

Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

3.12 Infrastructure impact

Definition: Infrastructure impact associated to the land utilized and required infrastructure for the new facilities.

Unit: m^2

Means of verification: LCA of the entire value chain. **[Task 7.3]**

Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

3.13 Management of biogenic wastes and residues

Definition: Total amount of biodegradable waste that will be managed during the plant lifetime.
Unit: kg
Means of verification: LCA of the entire value chain. **[Task 2.4, 2.5, 7.3]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

3.14 Cumulative energy demand

Definition: The energy harvested approach 'CED standard' is a consistent approach, which quantifies the energy content of all different (renewable and non-renewable) energy resources taking part in BioSFerA. It would be interesting to make a comparison of the renewable and not renewable share of CED with a reference fuel.
Unit: MJ/kg of biofuel
Means of verification: LCA of the entire value chain. **[Tasks 6.2, 7.3]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

3.15 Reduction in land use

Definition: Difference in land use existing when comparing this process to the state of the art (fossil fuels) and other renewable biofuels technologies.
Unit: %
Means of verification: LCA of the entire value chain **[Task 7.3]**
Expected value: <22-34%

4 Social indicators

In order to evaluate the social impact of BioSFerA, three main impact categories are examined (Workers, Consumers and Other value chain actors). For each impact category identified, a set of KPIs will be defined and quantified, which will facilitate the effective monitoring and quantification of this type of social impacts.

- Workers

4.1 Direct/indirect jobs creation

Definition: Number of direct and indirect jobs created thanks to the different stages of the project. The construction, operation and maintenance of the proposed technology will allow the creation of jobs. Some of these jobs will be located at the feedstock collection and transport sector.
Unit: Number of new employees hired per year.
Means of verification: s-LCA **[Task 7.4]**
Expected value: 100-450

4.2 Local employment

Definition: A part of the jobs will be created locally, for example within a 100 km distance around the company; it should be interesting to give the share of the local job creation to the total job creation (%).This indicator will be used for communication purposes: website, involvement of public authorities, etc. Jobs will be related to plantations, working on collecting and harvesting the required feedstock and more high skilled jobs on biomass logistics and on the biomass processing at the biorefinery.
Unit: Number of local employees hired per year.
Means of verification: s-LCA **[Task 7.4]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

4.3 Gender equity

Definition: This indicator is related to personnel involved in the BioSFerA activities with respect to those associated to fossil-based facilities.
Unit: Number of female employees hired per year.
Means of verification: s-LCA **[Task 7.4]**
Expected value: 50%

4.4 Work-life balance

Definition: Work-life balance concerns workers having choices over when, where and how they work. The balance between the commitments of work and those of private life is central to workers' well-being. Work-life balance is achieved when the worker's right to a fulfilled life at and outside work is accepted and respected, for the benefit of both the worker and the employer.
Unit: Cumulative number of absent days
Means of verification: Employee surveys **[Task 7.4]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

4.5 Job satisfaction and engagement

Definition: Job satisfaction is the extent to which workers are satisfied with their job, their employer; intend to stay and to be loyal to their employers. Many factors influence the job satisfaction levels of the workers of an organisation, for example, work content, responsibilities and career opportunities.
Unit: Average number of employee satisfaction levels.
Means of verification: Employee surveys **[Task 7.4]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

4.6 Number of incidents

Definition: Number of Health and Safety incidents reported per year.
Unit: Number of Verifications for Injuries Prevention done in one year
Means of verification: Health and Safety Evaluation Risk assessment **[Task 7.5]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

4.7 Health and Safety

Definition: Facilities at the production stages must include any safety facilities workers may need in order to develop their work correctly minimizing the risk of sustaining an injury.
Unit: Number of non-conformities issued during safety Audit in one year, Number of awareness initiatives about Health and Safety organized in one year, and Number of employees who have attended to awareness initiatives about Health and Safety.
Means of verification: Health and Safety Evaluation Risk assessment **[Task 7.5]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

- Consumers

4.8 Health and safety

Definition: Products are expected to perform their intended functions satisfactorily and not pose a risk to consumers' health and safety. This social topic addresses both risks and the positive impacts that products may have on the health and safety of the end-users of products.
Unit: Average number of positive feedback.
Means of verification: Health and Safety Evaluation Risk assessment **[Task 7.5]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

4.9 Experienced well-being

Definition: Experienced well-being is the self-evaluation of positive and negative feelings or emotional states, with reference to a particular experience. This social topic measures the well-being the consumer experiences associated with the use of BioSFerA biofuels.
Unit: Average number of positive feedback.
Means of verification: Survey template **[Task 7.4]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

4.10 Feedback mechanism

Definition: A feedback mechanism is a loop system wherein the consumers respond to the products obtained. The response may be in the same direction (as in positive feedback) or in the opposite direction (as in negative feedback). In this case, the main consumers would be the air and marine companies that would utilize the BioSFerA products as sustainable biofuel.
Unit: Average number of positive feedback.
Means of verification: Survey template **[Task 7.4]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

- Other value chain actors

4.11 Supplier relationships

Definition: Discipline of strategically planning for, and managing, all interactions with potential third party organizations that supply goods and/or services to BioSFerA in order to maximize the value of those interactions.
Unit: Number of potential third party organizations interested.
Means of verification: Market assessment and exploitation **[Task 7.2]**
Expected value: To be calculated in the above mentioned Tasks (too early for an estimation).

4.12 Promoting social responsibility

Definition: Social responsibility within the topics the project relates must be prompted by the consortium members by the implementation of conferences and meetings from professionals of the field, directed to all different stakeholder groups.
Unit: Number of events and conferences attended per year
Means of verification: Communication plan **[Task 8.1, 8.2]**
Expected value: 19

5 Conclusions

This report sets the monitoring framework using a set of Key Performance indicators (KPIs). The defined KPIs herein are differentiated and grouped according to their purpose of the analysis (technical, economic, environmental and social).

Within BioSFerA, a set of exemplary KPIs were selected and defined in order to provide a general overview of the concept, based on the production of sustainable clean biofuels at industrial level. In total, **23 technical KPIs, 10 economic KPIs, 15 environmental KPIs and 12 social KPIs** were selected.

In most cases, expected value will be present when it's available, however in other cases is impossible to set a target since the KPIs will be calculated for the first time in the dedicated Tasks presented in the means of verification.

The KPI selection has been carried out through a survey on the relevant technology centres and external stakeholders approached within T2.1, who rated the relevance of each pre-defined indicator. Accordingly, the selection and definition of the most relevant indicators has been carried out, as a reference for the activities within the project and for providing interesting benchmarks on the overall process features, performances and costs.

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