



Promoting sustainable use of underutilized lands for bioenergy production through a web-based Platform for Europe

D3.3

User Manual for STEN Tool



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STEN

USER MANUAL 1.0

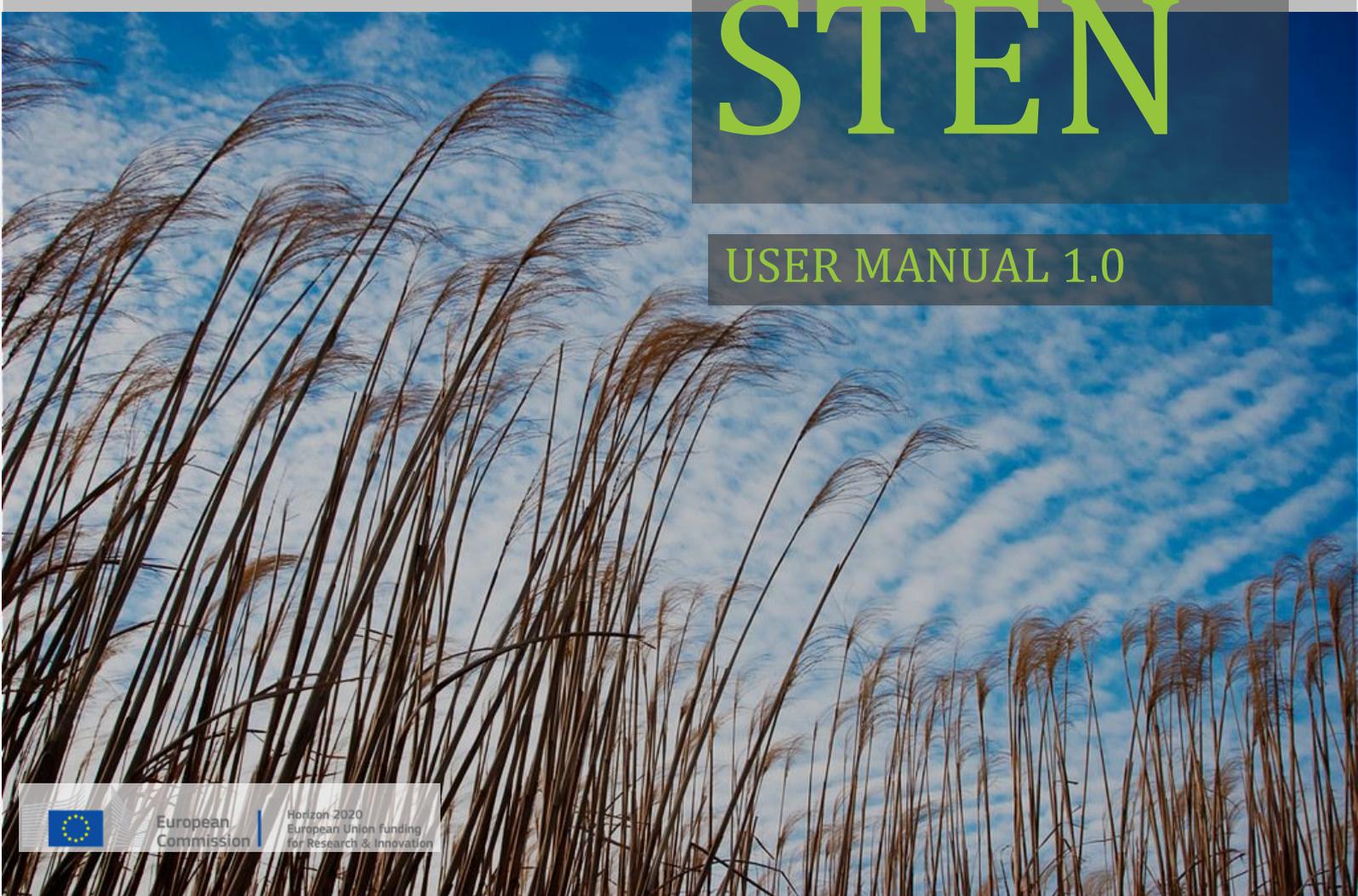


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Sustainability Tool for Europe
and Neighbouring Countries



STEN

USER MANUAL 1.0

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Executive Summary

According to [IEA 2020](#), Global energy-related CO₂ emissions grew 1.7% in 2018 to reach a historic high of 33.1 Gt CO₂. It was the highest rate of growth since 2013, and 70% higher than the average increase since 2010. Last year's growth of 560 Mt was equivalent to the total emissions from international aviation. The increase in emissions was driven by higher energy consumption resulting from a robust global economy, as well as from weather conditions in some parts of the world that led to increased energy demand for heating and cooling.

According to the [High-Level Panel of the European Decarbonisation Pathways Initiative](#) in the next year bioenergy will continue to play an important role in the decarbonisation of certain activities such as aviation or shipping, where currently no other decarbonisation options seem economically deployable at large scale. R&I should thus focus on finding synergies with agriculture and forestry and on removing potential trade-offs.

In this context, a constant assessment of the sustainability of the bioenergy production needs to integrate economic, social, environmental and institutional considerations. And on the basis of this principle, a tailored set of sustainability indicators can be applied by countries when planning investments in bioenergy sector. Concerted efforts to improve access to reliable, affordable, efficient and clean energy services, preferably from renewable sources, are essential for sustainable development. The goal is to foster economic growth through more efficient use of energy and wider utilization of renewable energy resources, including bioenergy. Effective choices of energy solutions that take into account national circumstances are important and can benefit from the creation and application of tools to guide decision-makers. The BIOPLAT-EU project looks at closing this gap through the provision of the Sustainability Tool for Europe and Neighbouring countries (STEN).

This manual illustrates how to carry out sustainability assessments of bioenergy investment projects using the STEN.

This manual explains, by means of a step-by-step procedure, how to: a) fill out the required information for the analysis; b) edit user's own data in the database; c) understand the structure of the sustainability indicators and their variables; and e) interpret and understand the results of the sustainability assessments.

1 General

The STEN tool is part of the BIOPLAT-EU Web Platform. The tool, in parallel with the Geographic Information System (GIS) maps, completes the WebGIS tool to assess the sustainability of selected bioenergy investments on marginal and underutilized lands in Europe and Ukraine. Its indicators have been created starting from the methodologies of the Global Bioenergy Partnership (GBEP) [Sustainability Indicators](#) (GSI).

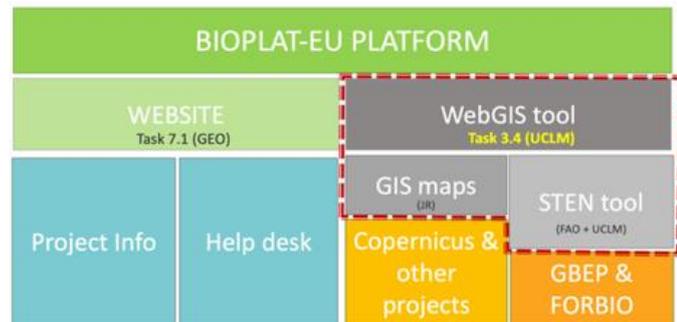


Figure 1. Structure of the BIOPLAT-EU Platform

The STEN provides for two levels of analysis. A standard level of analysis is performed by standard users where most of the analysis runs in automatic with minimal user inputs, and an Advanced level of analysis where the user can interact directly with the system modifying pre-selected values and activating and measuring additional sustainability indicators.

Standard User: The standard user is the basic form of user who is granted access to the system. This user type can search for marginal, underutilized and contaminated (MUC) land plots, view layers and MUC areas with the webGIS tool, add plots to their list of favourites to perform biomass sustainability simulations with STEN, display the available layers of the viewer and generate reports on screen with the results of the sustainability simulation.

Advanced (AD) user: The Advanced users are registered users who, in addition to the functionalities of the standard users, have the ability to edit values listed by default in the value chain DATABOX, where Standard users can only use default values for their simulations. Moreover, advanced users have the possibility to unlock the measurement of additional indicators for which Europe-wide representative data was not found in the context of BIOPLAT-EU and include those indicators provided that they can retrieve the necessary data.

2 Start-up

2.1 Why the STEN tool?

Concerted efforts to improve access to reliable, affordable, efficient, and clean energy services, preferably from renewable sources, are essential for sustainable development. The goal is to foster economic growth through more efficient use of energy and wider utilization of renewable energy resources, including bioenergy. Effective choices of energy solutions that consider national circumstances are important and can benefit from the creation and application of tools to guide decision-makers. Furthermore, the need for developing new methodologies and tools for assessing the impact of bioenergy at local (regional or sub-regional) and site-specific (municipality) level, paved the way for the development of a user-

friendly and tailored set of sustainability indicators to be used in the context of the BIOPLAT-EU Project for measuring the impacts of the advanced bioenergy value chains studied.

In this context, the STEN has been developed with the aim to provide a public user-friendly tool that will assess sustainability aspects of bioenergy value chains and scenarios with respect to specific economic and non-economic conditions (technical feasibility of RES project) on MUC land. The tool allows any stakeholder to search for MUC lands in Europe at a sub-national level. It gives the user some specifications about these lands such as agronomic and climatic specifications and consequently what type of biomass can be grown on these lands. The tool then allows assessing selected environmental, social, and techno-economic sustainability aspects of the defined value chain if the user enters the required data specified in the tool.

2.2 MUC lands and Sustainable bioenergy production in Europe

MUC lands are considered lands that cannot be used for agricultural and recreational purposes but can still be productive to grow biomass for bioenergy purposes. The challenge to issue biomass production on underutilized land in Europe raises agronomic, technological and environmental consideration on top of economic considerations. Land with potential use for production of additional bioenergy must be statistically and technically assessed taking into account sustainability considerations. Furthermore, since biomass supply chains and bioenergy pathways vary depending on the type of feedstock, the establishment of bioenergy value chains and the evaluation of their sustainability is a complex task. The STEN tool enables users to conduct sustainability assessments on defined value chains on MUC lands destined for bioenergy production.

The following definitions of underutilized and contaminated lands come from the official project deliverable D3.1 of BIOPLAT-EU made by FAO and are available at [this link](#).

Marginal and Underutilized land: According to the FAO), there are two different aspects for an area to be considered as marginal: 1) biophysical constraints: Soil constraints (low fertility, poor drainage, shallowness, salinity), steepness of terrain, unfavourable climatic conditions; or 2) socio-economic constraints: Absence of markets, difficult accessibility, restrictive land tenure, small holdings, poor infrastructure, unfavourable output/input ratios. In the context of BIOPLAT-EU, a surface of land is considered marginal only when satellite images time series show that such condition of marginality is supported by the lack of intensive utilization of the land for a period of more than 5 years. In the context of our project then, if an area is considered marginal because it has poor soil performances but there is some form of land use (e.g. agriculture, even if low productivity) this is not considered marginal. Similarly, if an area is classified as agricultural land but satellite images time series show no sign of utilization over the last 5+ years, the area is considered underutilized and therefore in a condition of having low or null impact on iLUC risk when turned into cultivation.

Contaminated land: According to the EU [2], contaminated land is defined by EU regulation as any land which appears to be in such a condition - by reasons of substances in, on or under the land - that significant harm is being caused or there is a significant possibility of such harm being caused; or pollution of controlled waters is being, or is likely to be caused. iLUC:

According to the EU [3], when biofuels are produced on existing agricultural land, the demand for food and feed crops remains, and may lead to someone producing more food and feed somewhere else. This can imply land use change (by changing e.g. forest into agricultural land), which implies that a substantial amount of GHGs are released into the atmosphere. The best available science indicates that iLUC is an issue that needs to be tackled and the BIOPLAT- EU project, through its webGIS platform is pursuing this objective aiming to prioritise the production of bioenergy which takes place on marginal and underutilized lands with low or null iLUC risk.

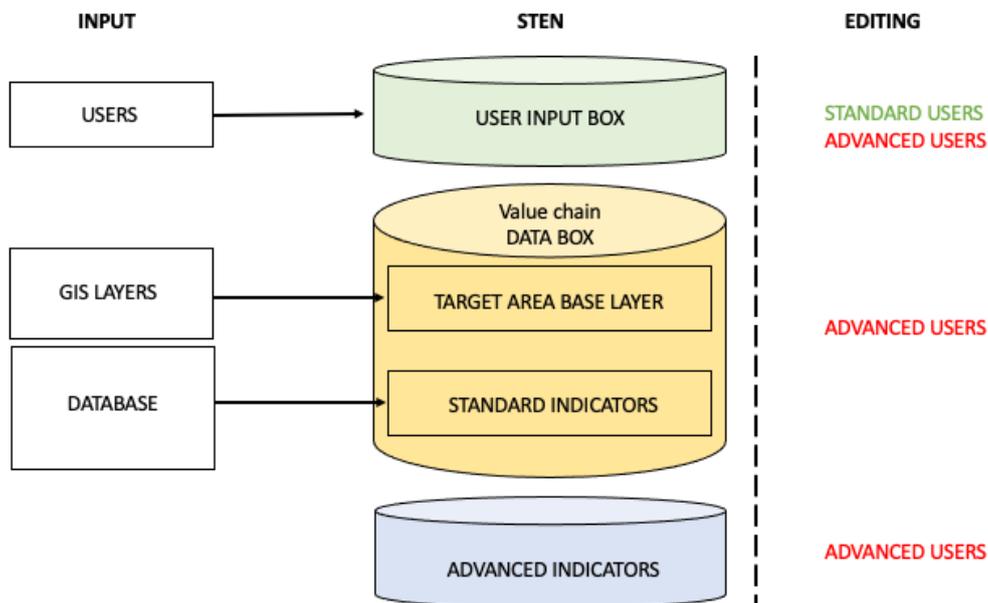
2.3 Constructing STEN sustainability indicators

In order to ensure comprehensiveness and reliability of the operations, the starting point for the production of the BIOPLAT-EU set of indicators was the most broadly accepted tool for bioenergy sustainability analyses: the [GBEP](#) sustainability indicators for bioenergy. Specifically, the set of indicators developed in the context of BIOPLAT-EU is thought to support the assessment of bioenergy value chains' sustainability. It was clear from the inception of BIOPLAT-EU then, that a solid starting point was represented by the GBEP Indicators that though needed a specific adaptation to produce valuable results.

With the aim to develop and offer an ad-hoc sustainability assessment and monitoring tools and methodologies, FAO was able to bring into play its sustainability approach starting from the GSI, allowed to assess the environmental, social and economic sustainability of a list of common and/or promising bioenergy value chains in Europe.

The GSIs and their sub-components are meant to describe all possible sustainability features of any bioenergy product globally and therefore several indicators are developed to address specific potential sustainability challenges found in developing countries in Africa or Latin America (e.g. the time spent by women and children collecting biomass or the assessment of indoor pollution attributable to bioenergy use, etc). Although these indicators are considered crucial in the bioenergy sustainability assessments of many developing countries, this is not the case for the BIOPLAT-EU context. In fact, being its predominant focus the European context (plus Ukraine), those indicators were considered not applicable and therefore discarded. Moreover, some indicators are expressly designed to work as ex-post (e.g. injuries and fatalities in the bioenergy sector) and it does not make sense to attempt to adapt them for an ex-ante assessment.

2.4 Organisation and workflow of STEN



2.5 Building a baseline scenario: the Target Area Base Layer

A specific sub-section of the value chain DATABOX, based on data that come from the GIS map layers, that characterizes the baseline scenario is the Target Area Base Layer (TABL). To understand the concept of the TABL it is important to refer to the *target area* concept. The FORBIO project, first introduced the concept of *target area*, which is also at the heart of the delimitation of the reference system for the simulations in BIOPLAT-EU. This novel concept stepped away from the assessments performed using the GBEP Sustainability Indicators before FORBIO and towards the analysis of a single value chain at the sub-national level. The definition of the reference system in the sub-national realm was originally devised in FORBIO as the area delimited by those municipalities or watersheds touched upon by the production of the biomass and the related processing plant. In terms of area then, the *target area* of FORBIO was the minimum surface (delimited by existing physical or political borders) that was relevant to the bioenergy value chain simulated. The same approach has been kept for the BIOPLAT-EU project, although for the purpose of this project only municipality boundaries were taken into consideration rather than watershed limits, where the TABL's variables allow automatic characterization of the *target area* (baseline scenario). Figure 9 shows the variables that compose the TABL, their origin and editability. Environmental, social and economic variables are present. All variables are based on data that comes from the GIS map layers and are editable only by an advanced user.

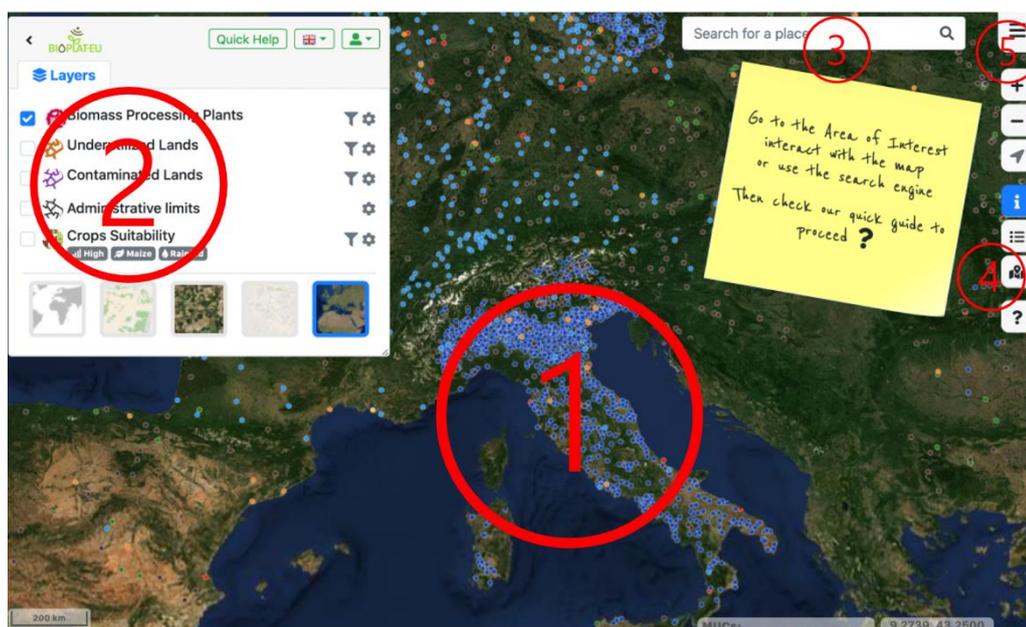
3 WebGIS tool

The BIOPLATEU webGIS tool is formed by integrating and combining geospatial data (a set of basic layers including the GIS maps of MUC lands) and the STEN tool to perform European-wide sustainability assessments of bioenergy production. Its development was carried out in three phases. In the first phase, the conceptual design was defined. This included the identification of user requirements, user profiles, and the use cases. The main variables and the algorithms to compute the set of sustainability indicators were identified. The webGIS system interaction with users were defined using the wireframe technique to visualize how the user would interact with the maps and the STEN. Then, during the second phase, the prototype was developed while in the third phase, the webGIS prototype integrated all the GIS layers and the data required for its full operation and was tested and fine-tuned before making it available for public use.

3.1 Main interface

The system revolves a map viewer where the user can perform the main functionalities of the system. The user would have a geographic representation base map of the reference countries and layers with the information which is related to the BIOPLATEU project where the user can view and search for interesting areas for performing simulations.

Once the user opens the WebGIS link, he will be directed to the main interface where one can navigate the map, visualize a number of different layers and decide to start a new project simulation. The main interface includes 5 sections: **1) the 2D viewer;** **2) the action panel;** **3) the search for a place bar;** **4) convenient buttons;** **5) information panel.**



3.1.1 The 2D Viewer

In STEN, Users can see Europe and its terrain in the 2D viewer. Furthermore, users can navigate through this 2D view of the EU by moving the mouse while pressing one of the buttons, you can:

- Drag the view in any direction
- Zoom in or out
- Tilt the view (requires middle button or scroll wheel)

3.1.2 The Action panel

The action panel is composed by a series of items which characterise the visualisation of the 2D viewer. The following picture lists them in numerical order.

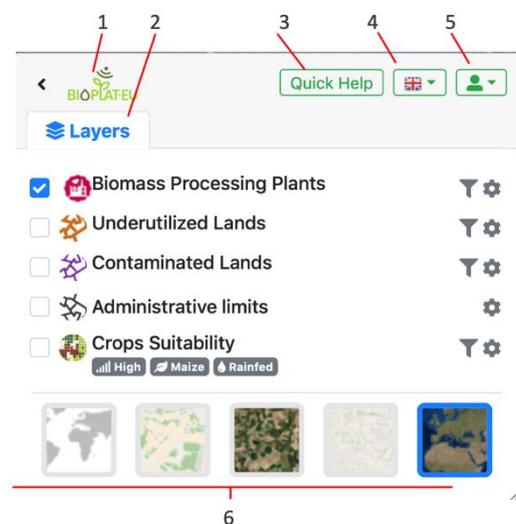
1 Hide-show button – Users can use this button to hide and show the action panel.

2 Layers tab – Users can use this window to interact with the STEN’s layers. Further information on the layers is provided in a specific paragraph below (2.2).

3 Quick help – User can use this window to visualise and interact with the quick help.

4 Language – User can use this button to select one of the languages provided for the interface

5 Login – By accessing the BIOPLAT-EU webGIS platform, the anonymous users can get access to the login page by pressing the login button in the top-right part of the webpage. Once the button has been pressed, the screen to the right is displayed. If the user is already registered, he only has to type his email address and his password and press login, and the webGIS tool comes up again with the enabled functionalities considering the user role. If the user is not registered and he wants to login, he has to press “register”, so the user can create a new account by completing all the required shown information. Adding a “sign up” button next to the “log in” button is also considered.



REGISTER

EMAIL ADDRESS

YOUR EMAIL ADDRESS

PASSWORD

YOUR PASSWORD

CONFIRM YOUR PASSWORD

YOUR PASSWORD

FULL NAME

YOUR NAME

ORGANIZATION

YOUR ORGANIZATION

BY CLICKING REGISTER YOU ACCEPT OUR [TERMS OF SERVICE](#)

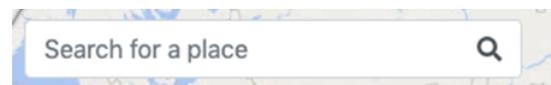
REGISTER

6 Map visualization:

- **Empty Map**
- **Layers /no background** – This setting only shows the layers selected in the layers window
- **Layers/OpenStreetMap** – Using OSM, the user can visualize roads and directions, official names and labels of places, etc for better orientation in the viewer
- **Layers/Bing aerial**– Using this option, the user can visualize the selected layers on a satellite image
- **Layers/Bing roads** – Using this option, the user can visualize the selected layers on a detailed maps which contains administrative and natural borders, roads, names, terrains.

3.1.3 Search for a place

Users can search for specific locations using the search for a place bar. To do this, enter the location in the input box and click on the Search button.



STEN recognizes the following types of search terms, which you can enter with or without commas.

Format	Example
City, State	Rome, IT
City Country	Rome Italy
Number Street City State	Viale delle Terme di Caracalla, 00153 Roma RM
Zip code or Postal Code	00153

3.1.4 Convenient buttons

These buttons, situated on the right side of the page, provides the following options:

- + **Zoom in** – The user can use this button to zoom in
- **Zoom out** – The user can use this button to zoom out
- 📍 **Your position** – The user can center the map over his current location
- ℹ️ **Information** – This allows the visualization of the information popup
- ☰ **Legend** – The user can use this button to open the legend
- 📄 **Summary** – The user can use this button to access a summary
- ❓ **Quick help** – The user can use this button to access the quick help

3.1.5 Information panel

This button allows to hide and show the information panel connected with the convenient buttons.

View information in popup

(9.6114, 51.2387)

Bioenergy Processing Plants WMS	
Id	DE00000336
Name	KFS Biodiesel GmbH & Co. KG 2 (Kassel)
Postcode	0
Biopathways	Biodiesel
Country	Germany
Municipality	Kaufungen

3.2 GIS layers

As described above, the viewer is composed by a set of layers with which the user can interact. Some of the actions the user can perform include: enable or disable the visualization of a specific layer, visualize the map key and consult the layer information available in the system. These functionalities are described in the following paragraph.

List of available layers:

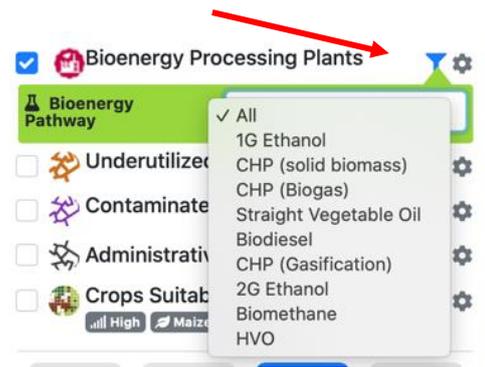
- Bioenergy plants layer
 - Underutilized lands layer
 - Contaminated lands layer
 - Administrative limits layer
 - Crop suitability layer
- | | | | | |
|--------------------------|-------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <input type="checkbox"/> |  | Bioenergy Processing Plants |  |  |
| <input type="checkbox"/> |  | Underutilized Lands |  |  |
| <input type="checkbox"/> |  | Contaminated Lands |  |  |
| <input type="checkbox"/> |  | Administrative limits | |  |
| <input type="checkbox"/> |  | Crops Suitability |  |  |
- High Maize Rainfed

In addition, the funnel  and opacity  icons can be selected to improve the detail level of the analysis and modify the transparency of the layer on the map. This is especially useful when the user is looking for a suitable crop in a given area. By interacting with the funnel and opacity keys, the user can select a specific crop and see its suitability values at screen, and by adjusting the opacity slider can make a choice without losing track or reference points on the map.

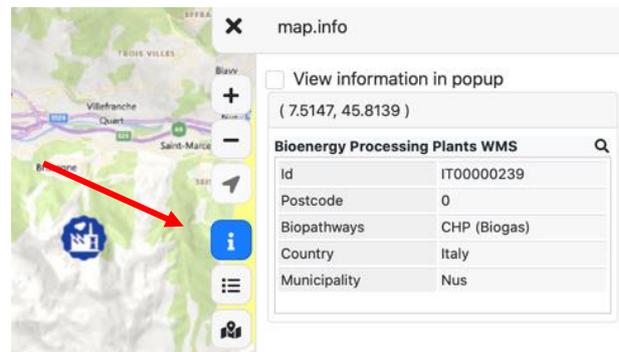
3.2.1 Bioenergy processing plants layer

By enabling the Bioenergy processing Plants layer, bioenergy plants mapped in BIOPLAT-EU are displayed on the map. The plants are grouped by different bioenergy pathways which can be selected using the funnel button. Using the setting button, the opacity of the layer is defined.

- All
- 1G Ethanol
- CHP (solid biomass)
- CHP (Biogas)
- Straight Vegetable Oil
- Biodiesel
- CHP (Gasification)
- 2G Ethanol
- Biomethane
- HVO



With a left-click on the mouse, the user selects a bioenergy processing plant on the map. The information panel on the right-hand side of the screen will provide information on the selected plant.



3.2.2 Underutilized and contaminated land layers

Warning about Contaminated & Underutilized Lands Map

Potentially Contaminated Lands

Please note that this layer was developed based on maps of heavy metal concentration in soil and national and EU thresholds for heavy metals in soils and was complemented by additional national data sets for Italy and the district Spree-Neiße (Germany). The heavy metal concentration maps were produced by the Joint Research Centre (JRC) and are available [here](#). BIOPLAT-EU did not produce any of the contamination data and does not take responsibilities for any results. More information on the procedure for the generation of this layer is available under **chapter 2.2 (Contaminated Land Mapping) of Deliverable 2.3 (Report on Tier-1 Map)** available at [this link](#).

Potentially Underutilized lands

The pan-European layer of potentially underutilized lands was produced specifically for the context of BIOPLAT-EU using an ad-hoc methodology based on Landsat 8 and Sentinel-2 satellite image time series from 2015-2019. Additionally, existing data sets from related projects as well as data provided by public and private stakeholders are integrated. All details on the methodology are available under chapter 2.3 (Underutilized Land Mapping) of Deliverable 2.3 (Report on Tier-1 Map) available at [this link](#). Additional information is available [here](#).

When the underutilized lands layer is enabled, underutilized lands are visualized as orange polygons in the viewer.



When the contaminated lands layer is enabled, contaminated lands are visualized as purple polygons in the viewer.



By using the funnel key the user can select the size limit of the polygons that appear in the map; By using the  slider the opacity of the MUC land layer can be set.



3.2.3 Administrative limits layer

The user can visualize border information by enabling the administrative limits layer in the Action panel. The layer shows all available borders, including:

- Country borders
- Regional borders
- Municipality borders

3.2.4 Crop suitability layer

Crop suitability and productivity maps from the Global Agro-Ecological Zoning (GAEZ) produced by FAO and the International Institute for Applied Systems Analysis (IIASA), and ad-hoc layer maps developed with the same methodology have been applied to the STEN to define crop suitability. The GAEZ methodologies utilize a land resources inventory to assess all feasible agricultural land-use options and to quantify expected production of cropping activities, for a selected number of crops, relevant in a particular agro-ecological context, for specified management conditions and different input levels (e.g. high, low).

The characterization of land resources includes all relevant components of climate, soils and landforms, which are basic for the supply of water, energy, nutrients and physical support to plants. The availability of the GAEZ methodology is an important added value for the BIOPLAT-EU project. It represents an impressive source of data which, coming from a single FAO tool, is applied

to the STEN engine. The following images show the 5 suitability categories adopted by the STEN tool and their representation as GIS layer into the STEN webGIS tool.

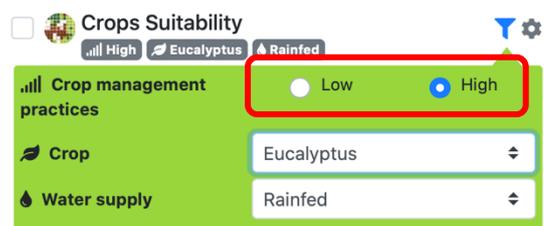


- Very High (> 75%)
- High (63% - 75%)
- Good (50% - 63%)
- Moderate (30% - 50%)
- No Suitability (< 30%)

Input level selection:

The user can select between Low and High Input management. This will reflect in different application rates of:

- Fertilizers
- Mechanization
- Pesticides



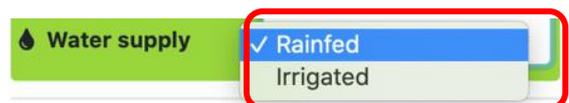
Crop selection:

The user can select any crop from the suitability list. Please note that if a specific MUC is already selected, the drop down menu does not allow the user to visualize the crops that are not suitable for the area (0 suitability) into the list.



Water management:

Certain crops (e.g. maize, sugarbeet, giant reed) are often grown in irrigated conditions in Europe and irrigation infrastructures do exist near or on MUC lands. However, the BIOPLAT-EU project was not able to map and georeferenced existing irrigation infrastructures. As a consequence, the option to select irrigation water supply to a specific MUC patch is left to the user for those crops commonly grown under irrigated conditions.



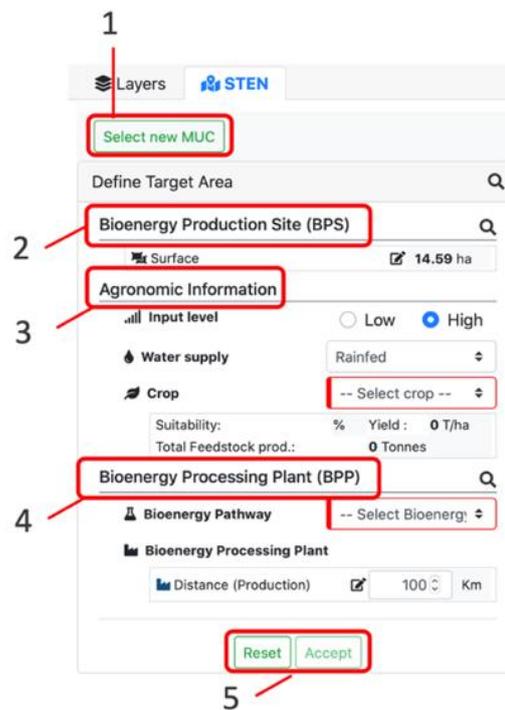
4 STEN Standard

When a MUC has been selected, the user input section is composed of the essential steps required by the system to identify the foundation of the analysis: Where is the potential production site located? What type of crop have we selected? What bioenergy product are we going to produce? In other words, these initial steps are indispensable to characterize the scenario the user has in mind, and at the same time, to inform the system about what type of value chain has been chosen and how it is characterized. Subsequently, the information is read by the system, which provides all necessary default data for the automatic measurement of the standard indicators.

4.1 The STEN Action panel

The action panel is composed by a series of items which characterise the bioenergy value chain. The following picture lists them in numerical order.

1 Select new MUC button – Use this button to change MUC selection and select a new MUC;



The screenshot shows the STEN Action panel interface. It includes a 'Layers' tab and a 'STEN' logo. The main section is titled 'Define Target Area' and contains several input fields and buttons. The interface is annotated with red boxes and numbers 1 through 5:

- 1**: Points to the 'Select new MUC' button.
- 2**: Points to the 'Bioenergy Production Site (BPS)' section, which shows a 'Surface' of 14.59 ha.
- 3**: Points to the 'Agronomic Information' section, which includes 'Input level' (Low/High), 'Water supply' (Rainfed), and 'Crop' (Select crop).
- 4**: Points to the 'Bioenergy Processing Plant (BPP)' section, which includes 'Bioenergy Pathway' (Select Bioenergy) and 'Bioenergy Processing Plant' (Distance (Production) 100 Km).
- 5**: Points to the 'Reset' and 'Accept' buttons at the bottom.

2 Biomass Production Site (BPS) – Use this window to interact with the bioenergy production site (BPS):

After selecting a MUC, its total area in hectares is provided by the system.

1_ The user can proceed with the analysis considering the entire surface



The screenshot shows a single input field for 'Surface' with a value of 60.47 ha.

2_ Alternatively, the user can draw a polygon inside the MUC patch mapped by BIOPLAT-EU and that will be considered as Biomass Production Site (BPS) for the analysis. A farmer whose own field

is within a certain MUC patch (some MUC patches reach several thousand hectares) can select only the area of interest to perform all STEN analyses.

The polygon is drawn by clicking on the specific drawing icons



Once the icon is selected, at the top of the map a series of buttons appear. These buttons are provided to draw the polygon with the following functions: Select, draw, go back, go ahead, and save the BPS.



Using the above buttons, the user can easily draw a polygon and save it for the sustainability analysis.



If the user saves the wrong BPS, can revert the process by resetting the STEN tool (5) or selecting a different MUC land (1) and restarting the operation.

3 Agronomic information – Use this window to change the agronomic information.

Input level selection:

The user can select between Low and High Input management. This will reflect in different application of:

- Fertilizers
- Mechanization
- Pesticides



Low input management systems usually rely on minimal inputs for the given crop, lowest value in the range for fertilizers, mechanization usually reduced to the minimum (e.g. only for harvesting), no application of pesticides. The high input management systems usually rely on highest values of fertilizers, pesticides and mechanization in each agronomic phase for that specific crop and for

some crops, irrigation. Advanced users can see and modify every single input value to a custom input level specific for the crop and the given BPS. Please note that the choice of the input level has repercussions on crop suitability for that specific input level and consequently expected yields and all related sustainability indicators.

Once the input level is selected, the user can select the option for irrigation application. The tool provides two options: a rainfed management (no irrigation) and an irrigated management.



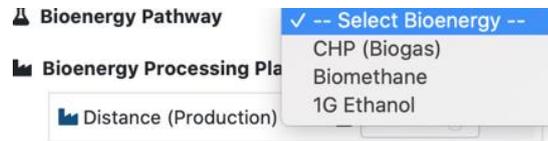
When selecting the water supply regime, please remember that although the crops grown in rainfed conditions can be grown in both low and high input levels crop management practices for fertilizers, mechanization and pesticides application, irrigated crops are automatically associated with a high input level for all inputs.



Crops:	Input Level: LOW	Input Level: HIGH
Black locust	Rainfed	Rainfed
Camelina	Rainfed	Rainfed
Eucalyptus	Rainfed	Rainfed
Giant reed	Rainfed	IRRIGATED
Maize	Rainfed	IRRIGATED
Miscanthus	Rainfed	Rainfed
Poplar	Rainfed	Rainfed
Rapeseed	Rainfed	Rainfed
Sorghum	Rainfed	Rainfed
Soybean	Rainfed	IRRIGATED
Sugar beet	Rainfed	IRRIGATED
Sunflower	Rainfed	Rainfed
Switchgrass	Rainfed	Rainfed
Wheat	Rainfed	Rainfed
Straw	Rainfed	Rainfed
Willow	Rainfed	Rainfed

4 Bioenergy Processing Plant (BPP) – Use this window to insert information concerning the bioenergy processing plant, the plant where the transformation of the biomass into bioenergy intermediate carrier or final product takes place. The pathways available from the list are related

to the typology of crop selected (e.g. giant reed is linked to 2G ethanol as well as to biogas/biomethane pathways, but not to biodiesel, etc). By changing the crop selection, a different pathway could appear in the list. Please refer to chapter 1 of this manual for the entire list of available bioenergy pathways.

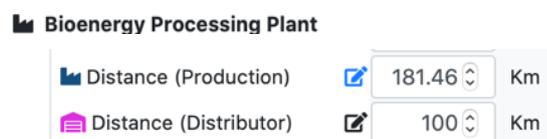


To select the BBP the following options are available to the user:

- The nearest existing suitable BPP is automatically provided and selected by the tool. In this case the distance from the BPS and the BPP is automatically calculated by the system and appears in the Distance (Production) cell.
- The suitable plant provided by the tool are not accepted by the user because it is located too far from the BPS. The User can insert the distance from the BPS and a hypothetical or existing BPP by typing the arbitrary distance (in km) into the dedicated cell.
- The suitable plant provided by the tool are not accepted by the user because it is located too far from the BPS. The user, through the drawing icon, can select a point in the map and the system will automatically calculate the distance.



For all liquid biofuels, the transportation to distributors is automatically calculated as a default distance of 100 km. The User can change it by inserting a different number in the call or draw a point into the map.

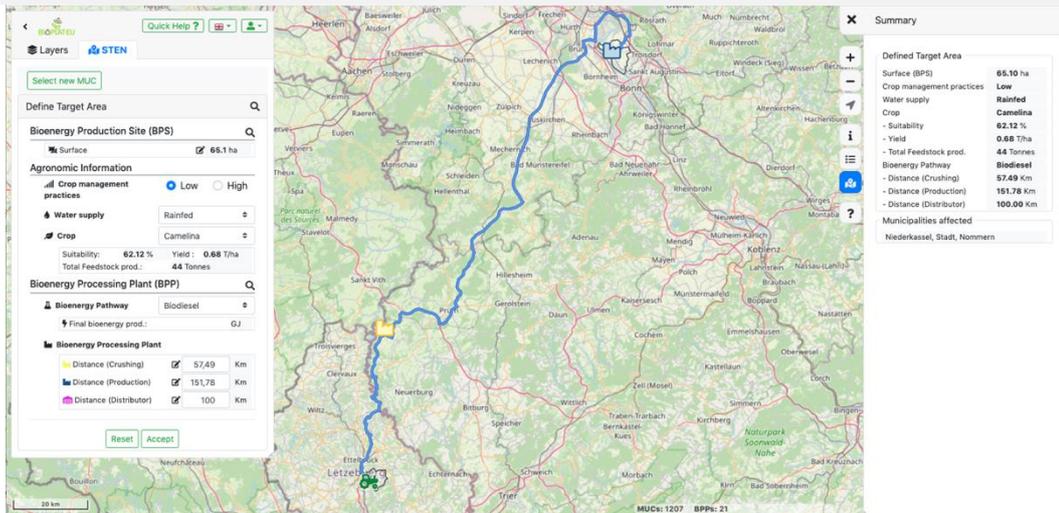


In addition, when Biodiesel or HVO are selected, the user can provide information on an intermediate facility (crushing) for the production of the vegetable oil. In case this intermediate step is not necessary/envisaged the User can insert the value 0 in the cell next to the “crushing” distance.

Bioenergy Processing Plant

Distance (Crushing)		<input type="text" value="100"/>	Km
Distance (Production)		<input type="text" value="181.46"/>	Km
Distance (Distributor)		<input type="text" value="100"/>	Km

	Bioenergy Pathways	Technology generation	Transport sections
	1G Ethanol	I° generation	BPS BPP DISTRIBUTOR
	2G Ethanol	II° generation	BPS BPP DISTRIBUTOR
	CHP (solid biomass)	I° generation	BPS BPP
	CHP (Biogas)	I° generation	BPS BPP
	CHP (Gasification)	I° generation	BPS BPP
	Biomethane	II° generation	BPS BPP
	Straight Vegetable Oil	I° generation	BPS BPP
	Biodiesel	I° generation	BPS BPP BPP DISTRIBUTOR
	HVO	II° generation	BPS BPP BPP DISTRIBUTOR

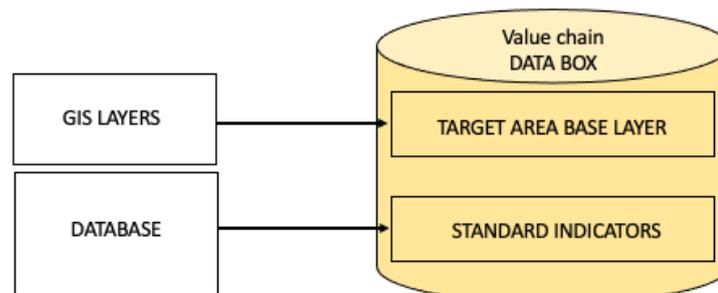


5 Reset and accept button – Use these buttons to reset all the information and restart with a new analysis, or to accept the information provided and proceed with the sustainability assessment.



4.2 The Value Chain DATA BOX

All information needed to measure the standard indicators is directed to the value chain DATABOX. This component of the STEN is organized into different sub-sections based on the typology of data that come from both the internal database and the platform map repository. Only advanced users can access the user input BOX and edit the data. The sections are: i) target area base layer (TABL); ii) Crop information; iii) Agronomic information and input level; iv) Bioenergy production; v) Transport of feedstock; and vi) Transport of bioenergy products. Figure 8 graphically presents the scheme of the DATABOX and its sub-components. For a standard user who runs an analysis this section can only be visualized. The information provided by the system cannot be modified. Advanced user can edit any data entry used by the STEN as they wish, though taking responsibility for the outcomes of the simulation. By clicking on the reset button of STEN, even advanced users can reset to default values any change made in the value chain DATA BOX.



The Value chain DATA BOX is divided as follow:



- Target Area
- Crop Information
- Agronomic Information
- Bioenergy Production
- Transport of Feedstock
- Transport of SVO
- Transport of Bioenergy Products

By clicking on the name, each subcategory menu can be expanded, and a list of values used by the system is provided. Advanced users can edit this information.

Target Area	
Municipalities affected: Bioenergy Production Site: Orbetello Bioenergy Processing Plant: Magliano in Toscana	
Annual Crops	25,917.16 ha
Permanent Crops	2,965.31 ha
Permanent Meadows and Pastures	947.13 ha
Industrial Sites	35.15 ha
Forest	10,070.77 ha
Urban Areas	737.31 ha
Water & Wetlands	3,196.48 ha
Others	4,206.10 ha
Population (year 2016)	18,282
Gross Domestic Product (year 2016)	442,424,400 €

After checking the values provided by the tool in the DATA BOX, the user can review the data and proceed with the measurement of the indicators by clicking on the “Simulate” button, or reject the scenario composed by the STEN and go back to the map to modify the selected data. Advanced users can modify value directly in the DATA BOX (see chapter 5).

[Back to the map](#)

Value Chain Data Box

[Simulate](#)

By clicking on the “Simulate” button, the tool runs the analysis and the result of the sustainability indicators are provided.

This section is described in the specific section of the STEN indicator results.



5 STEN Advanced Indicators

The indicator modules of the STEN are specific sections that can be filled out only by advanced users. To understand these modules, it is important to know that there is a list of additional indicators (advanced indicators) that are not shown at the very start of the analysis, but which can be activated by the advanced user as far as he/she provides all essential information (data) required to measure these additional indicators.

The data used by these modules does not flow in from the pre-existing databases or other repository (GIS maps, etc.) internal to the STEN, but is entirely provided by the users. The STEN, however, provides the algorithms that link the data provided with the indicator’s value.

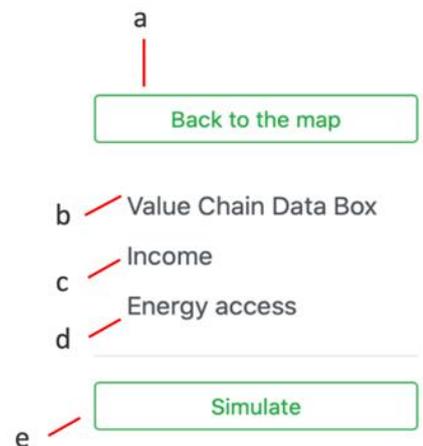
The list of additional indicators includes:

- Change in Income
- Change in Energy Access

5.1 The advanced user options

Once the advanced user accepts the inputs inserted into the Action panel, the system provides a window at the left side of the page, which allows the following actions:

- a) The advanced user can pause the assessment and go back to the Map and the Action panel by using the green button at the top of the window;
- b) The advanced user can open the Value Chain DATA BOX and modify the value;
- c) The advanced user can open the Income indicator data entry;
- d) The advanced user can open the Energy access data entry;
- e) Using the simulate button the advanced user can run the measurement of the indicators.



5.1.1 The value chain DATA BOX

Advice

If you have an account in BIOPLAT-EU, you can edit the values for a customized parameterization of the target area. Registered users have advanced options in the webGIS Tool. You can edit the parameters of the value chain and obtain advanced analysis indicators.

All the numbers presented by default into the value chain DATA BOX can be modified by the advanced user with the aim to improve the accuracy and realism of the analysis.

It is therefore in the user's interest to provide reliable and verified information to the analysis in order to obtain accurate and trustworthy sustainability assessments. Once the values of the DATA BOX are altered, the system reports that into the results sheets downloadable at the end of the assessment.

5.1.2 The Income advanced indicator

The Income sustainability indicator is an advanced indicator that the advanced user can use to measure the Net Annual Benefit of the biomass production. This simple analysis can inform about the profitability of the agricultural production phase of the value chain, and it is particularly thought for farmers and biomass producers. The results are also useful for processors who want to characterize the value chain.

The user can insert the required information by typing directly into the cells. Only if all cells have been filled out the analysis can be considered correct, and the model will complete the assessment of this indicator successfully.

Operating inputs	Unit	Year 1	Year 2-20	Unit	Market price
Seeds/Plants	Kg/ha	15.00	0.00	€/Kg	2.00

The results of the indicator are provided in the results sheet created by the system.

5.1.3 The Energy Access advanced indicator

Energy services from bioenergy can be intended as new energy services originated from biomass and converted through advanced processing technologies. The impact of new bioenergy services can be assessed at different levels:

- **local level:** at this level, the contribution of the energy production is assessed considering the direct impact, on the area, that new bioenergy can provide in terms of supply of district heating and/or district cooling;
- **country level:** the improvement in energy access at national level.
- **EU level:** at this level, the contribution of the energy production is assessed considering the impact of the new bioenergy production on the total European consumption (EU27).

The indicator allows the advanced user to directly type into the cells and provide numbers that characterise the baseline condition in terms of energy access.

Baseline amount of energy access	Unit	
Electricity for lighting, communication, healthcare, education and other uses	GWh/yr	<input type="text" value="800000"/>
Liquid biofuels for transport	GJ/yr	600,000
Gaseous biofuels for transport	MJ/yr	400,000
Thermal Energy (district heating and cooling)	MJ/yr	400,000

The required information is divided into sub-sections:

- **Baseline amount of energy access:**
- **Number of Households (HH) benefiting from electricity**
- **Number of HH benefiting from heat**

The results of the indicator are provided in the results sheet created by the system.

6 STEN Results

After the simulation, the system generates two different outputs for the sustainability assessment: 1) A summary of the values considered into the Value Chain Data Box for the measurement of the indicators; 2) A final report which presents, for each sustainability indicators, a series of tables and charts containing the final results.

The following paragraph provides an overview of the indicators and their results.

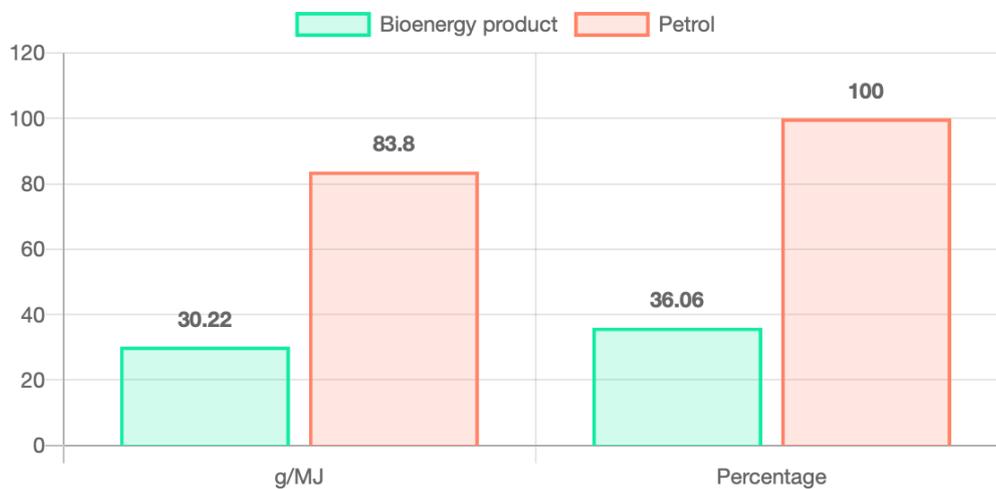
6.1 The standard indicators

AIR QUALITY INDICATOR

The GHG emission intensity is expressed in grams of carbon dioxide equivalent per megajoule of bioenergy produced (gCO₂eq/MJ)

Emission Factor	Total (tonnes of CO ₂ eq)	Allocated (tonnes of CO ₂ eq)	g/MJ of bioenergy prod.
CO ₂ -eq	33.87	16.83	30.2217
CO	0.05	0.01	0.0188
NO _x	0.15	0.03	0.0614
SO _x	0.02	0.00	0.0088
PM _x	0.01	0.00	0.0029

Comparison with Fossil Fuel (Petrol) g/MJ CO₂eq



The air quality indicator presented is based upon the GBEP Common Methodological Framework and relies on the methodology employed by BioGrace for assessing the contribution of the various components of the value chain to total GHG and non-GHG air pollutant's emissions. The framework includes all main stages of bioenergy production value chains including emissions due to land-use change, biomass production, input (e.g. fertilizers) manufacturing, transport and use of fertilizers, co-products and by-products, transport of biomass, processing into fuel and transport of fuel. The results are presented as total amount of GHG emitted in tonnes of CO₂ and non-GHG pollutants emitted without and with allocation (on energy basis), and in grams per unit (MJ) of bioenergy produced.

WATER USER AND EFFICIENCY INDICATOR

Water withdrawn from watersheds within the target area for the production and processing of bioenergy feedstock

Unit	W _{bioenergy} /E _{total}	Production
m ³ /MJ	0.29	
l/MJ	291.07	
m ³ /t _{feedstock}		972.50

Evaluating this indicator will provide basic information on the role that bioenergy production and use plays in water management at the watershed level and beyond. Water withdrawn from watersheds within the target area for the production and processing of bioenergy feedstock; expressed as the unitary water requirement for the production of a unit of bioenergy product (either m³ of water per MJ of bioenergy product, or litre of water per MJ of bioenergy product) as well as the water footprint of feedstock production expressed in m³ of water per ton of feedstock produced.

LAND USE AND COVER CHANGE INDICATOR

Change in surface of land under annual and perennial crop cultivation

Unit	Annual crop	Perennial crop
Absolute value hectares	13.29	0.00
Percentage	0.01	0.00

Net annual rates and absolute values of conversion between land-use types caused directly by bioenergy feedstock production on underutilized lands in the **target area**. The indicator considers both annual and perennial crop cultivated surfaces (ha) increased or decreased by the potential scenarios developed in STEN.

EMPLOYMENT IN BIOENERGY SECTOR

Change in job position along the whole value chain

Unit	Permanent job positions	Temporary job positions
Absolute value positions	0	1
Percentage	0.00	0.00

Net job creation, with a high percentage of skilled, secure and decent jobs, can have a significant positive impact on sustainable development at the national, local and regional level. In order to inform national and sub-national decision-making, particular attention can be given to net job creation from bioenergy production and use in areas of high unemployment where a growing bioenergy sector can promote the transition over time towards a greater proportion of both temporary and permanent jobs. The indicator measures

the net job creation as result of bioenergy production and use, in both percentage and absolute values and disaggregates as follows:

- Permanent job positions
- Temporary job positions

NET ENERGY BALANCE

Energy efficiency of the value chain

Unit	Parameter	Cultivation	Processing	Value Chain
MJ/ton FSTK	TFI	2,435.22	0.00	
MJ/ton FSTK	TFO	6,000.00	3,360.00	
MJ/ton FSTK	Net Energy Value	3,564.78	2.46	
Ratio	Net Energy Ratio	3,360.00	N/A	1.38

As in the case of the lifecycle assessments under the Environmental set of indicators, the energy balance is calculated as the difference between the outputs of the value chain and all its inputs, in energy terms rather than in terms of GHG and/or non-GHG pollutants. In order to do so therefore, the same data list used for the aforementioned indicator is used, this time with the attribution of the respective LHV for each component rather than their emission factor. The net energy ratio (i.e. ratio of energy output to total energy input) is a useful indicator of the relative energy efficiency of a given pathway of bioenergy production and use. The more energy consumed during the bioenergy lifecycle, the less energy is available to meet other energy needs. Efficient use of energy is essential for improving energy security and for optimizing the use of available natural resources. Energy input to the bioenergy production process sometimes come from hydrocarbons; therefore, a high net energy ratio will indicate efficient, reduced use of these non-renewable resources.

GROSS VALUE ADDED

Gross value added per unit of bioenergy produced and as a percentage of gross domestic product

Unit	GVA	Contribution to GDP
€/year	5,358.53	
Percentage		0.00

The indicator measures the gross value added per unit of bioenergy produced and as a percentage of gross domestic product. GVA provides a monetary value for the amount of goods and services that have been produced, less the cost of all inputs and raw materials that are directly attributable to that production. This indicator will also inform the theme of economic viability and competitiveness of bioenergy.

INFRASTRUCTURES

Number and capacity of routes for critical distribution systems

TOTAL hours travelled	0.12
------------------------------	------

This indicator is primarily related to the theme of Energy security/Infrastructure and logistics for distribution and use of biomass and bioenergy products. Understanding the quality of infrastructures through the required time to transport biomass and bioenergy products to complete the supply chain is a relevant parameter for stakeholders to guide decision making on bioenergy investments and project development.

The indicator makes an estimation of the time spent to transport the biomass and bioenergy product along the value chain considering the number and capacity of routes for critical distribution systems.

CAPACITY

Ratio of capacity for using advanced biofuels compared with actual use for each significant utilization route

Unit	Level	
	National	EU
Change in %	0.00	0.00000

Unused or flexible capacity in using bioenergy contributes to overall energy security and can be considered as an aim for infrastructure development for bioenergy use. A flexible bioenergy system helps to reduce the risks and further bring down operating costs.

The indicator measures the ratio of capacity for using new bioenergy productions compared with actual use for each significant utilization route. In other words, it can show the contribution of the simulated bioenergy value chain to meeting the available quotas that the national as well as the EU-level market could accept of that specific bioenergy product. In the case of liquid biofuels, the said market space is defined as the difference between mandated blending thresholds for ethanol and biodiesel with effective liquid biofuel consumption as of 2020 in each Member State (plus Ukraine). This indicator will show relatively less significant results in the case electricity is considered as bioenergy product since the capacity of the grid to uptake additional energy generated from biomass is usually several orders of magnitude larger than the additional generation capacity itself.

6.2 The advanced indicators

INCOME

Yearly Gross and Net margin at farm gate for the production of bioenergy feedstock

Unit	Annual Gross Profit	Annual Net Profit
€	41,477.97	37,997.55
€ ha ⁻¹ yr	1,717.36	1,693.36

The Income sustainability indicator is an advanced indicator that measures the Net Annual Benefit of the biomass production. This simple analysis can inform about the profitability of the agricultural production phase of the value chain, and it is particularly thought for farmers and biomass producers. Therefore, this indicator provides the basis for evaluating and comparing the relative profitability of alternative investments with different productive scenarios.

Particularly, the gross output is a preliminary measure of income. It assesses the performance of the biomass producer purely in terms of the benefits it yields and only considering the operative costs (inputs). On the other hand, the net output provides a basis for comparing the use of land on biomass farms with different crop options. Net output includes the expenses of fixed costs (salaries) into the analysis and therefore provides a better measure for comparing the productive capacity of land devoted to biomass production than the gross output.

ENERGY ACCESS

Change in energy access

Parameter	Unit	Value
Electricity for lighting, communication, healthcare, education and other uses	GWh/yr	0.00
Liquid biofuels for transport	GJ/yr	0.00
Gaseous biofuels for transport	GJ/yr	0.00
Thermal Energy (district heating and cooling)	BTU/yr	513.94
Target area		
Electricity	Percentage	0.00
Thermal	Percentage	513.94
National		
Electricity	Percentage	0.00
Thermal	Percentage	0.00
EU		
Electricity	Percentage	0.00
Thermal	Percentage	0.00

Energy services from new bioenergy productions can be assessed at different levels:

- local level: at this level, the contribution of the energy production is assessed considering the direct impact, on the area, that new bioenergy can provide in terms of supply of district heating and/or district cooling.
- country level: the improvement in energy access at national level.
- EU level: the improvement in energy access at EU level

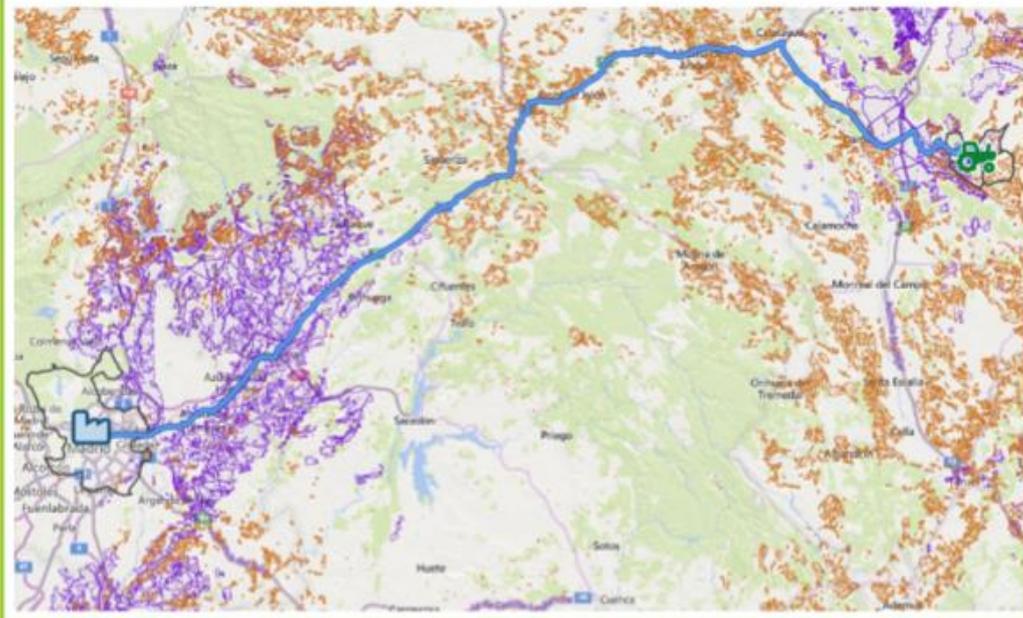
The additional amount of bioenergy produced in the STEN simulation is reported as percentage of change in comparison with the baseline information inserted by the user.

6.3 The downloadable report

The generation of reports is also possible after the simulation in the operational webGIS Tool. The results of the sustainability indicators and the summary of the Value Chain Data Box are shown in practical tables. These reports are downloadable in pdf format. The following images are one example of a sustainability report downloaded from the operational webGIS Tool.

Results

Summary



Defined Target Area

Biomass Production Site (BPS)	1,342.51	ha
Crop management practices	High	
Water supply	Rainfed	
Crop	Sorghum	
- Suitability	48.34	%
- Yield	2.68	T/ha
- Total Feedstock prod.	3,598	Tonnes
Bioenergy Pathway	biomethane	
- Final bioenergy prod.	37,395	GJ
- Distance (Crushing)	0.00	Km
- Distance (Production)	306.06	Km
- Distance (Distributor)	0.00	Km

Legend

- Municipalities affected
- Biomass Production Site (BPS)
- Transport route
- Pick up point
- Biomass Production Site

Municipalities affected

Biomass Production Site	Bádénas, Loscos, Monforte de Moyuela
Biomass Processing Plant	Madrid
Population	3,223,548
Gross Domestic Product	106,052,888,800 €
Number of PERMANENT jobs position	1,212,793
Number of TEMPORARY job position	421,149

Value Chain Data Box

Target Area

Annual Crops	9,846.52	ha	Forest	13,720.37	ha
Permanent Crops	7,145.79	ha	Urban Areas	29,039.81	ha
Permanent Meadows and Pastures	3,144.50	ha	Water & Wetlands	431.88	ha
Industrial Sites	4,404.39	ha	Others	9,043.59	ha

Crop Information

Bioenergy crop ET	550.00	mm/year
Market price	130.00	€/ton
Unitary water requirement	4,260.0	m ³ /ha/year

Agronomic Information

Level of mechanization	69.6	Kg/ha	Amount of applied pesticides	3	Kg/ha
Amount of fertilization: N NITRATE	100	Kg/ha	Amount of organic fertilizers	0	Kg/ha
Field emission N ₂ O	2	Kg/ha	Number of PERMANENT job position	0.003684211	N°Job/Ha
Amount of fertilization: P	13	Kg/ha	Number of TEMPORARY job position	0.036842105	N°Job/Ha
Amount of fertilization (chemical) K	100	Kg/ha			

Bioenergy Production

MJ of Bioenergy product(s)/MJ FSTK	0.64	%
MJ of co-products / MJ of bioenergy production	0.00	%
LHV of FSTK	16,240	MJ/ton
Water consumption for feedstock processing	5.5	m ³ /feedstock
MJ of energy input per unit of feedstock processed	1.00	MJ/ton
Number of PERMANENT job positions	0.000000	N°Job/MJ
Number of TEMPORARY job positions	0.000000	N°Job/MJ
EU market price of bioenergy product	0.01	€/MJ
Market price of co- product	0.00	€/MJ
Cost of raw material	0.00	€/MJ

Transport of Feedstock

Distance to BPP	306	Km
Number of PERMANENT job positions	0.000000000	N°Job/Ton/Km
Number of TEMPORARY job positions	4e-7.000000000	N°Job/Ton/Km

Value Chain Data Box (Advanced Indicators)

Income

Yearly Gross and Net margin at farm gate for the production of bioenergy feedstock

Operating inputs	Year 1	Year 2-20	Unit	Market price	Unit
Seeds/Plants	15.00	0.00	Kg/ha	2.00	€/Kg
Top Dress Fertilizer	0.0	0.00	Kg/ha	1.00	€/Kg
Basal Fertilizer	150.00	0.00	Kg/ha	1.00	€/Kg
Herbicides	0.00	0.00	Kg/ha	2.00	€/Kg
Pesticides (Pre-harvest)	0.00	0.00	Kg/ha	2.00	€/Kg
Pesticides (Post-harvest)	0.00	0.00	Kg/ha	0.00	€/Kg
Manure	0.00	0.00	Kg/ha	0.0	€/Kg
Hiring/usage tractor (Diesel consumption)	10.00	10.00	hr/ha	5.00	€/hr/ha
Transport cost	2.00		t/ha	2.00	€/t
Irrigation	0.00	0.00	m3/ha	0.00	€/m3
Labour					
Land preparation	0.50	0.00	person-day/ha	70.00	€/man-day
Planting	0.50	0.00	person-day/ha	70.00	€/man-day
Weeding	0.50	0.00	person-day/ha	70.00	€/man-day
Applying fertilizer/manure	0.00	0.00	person-day/ha	70.00	€/man-day
Spraying pesticides	0.00	0.00	person-day/ha	70.00	€/man-day
Harvesting	0.20	0.20	person-day/ha	70.00	€/man-day
Transport	0.20	0.20	person-day/ha	50.00	€/man-day

Energy access

Change in energy access

Baseline amount of energy access		Unit
Electricity for lighting, communication, healthcare, education and other uses	800,000	GWh/yr
Liquid biofuels for transport	600,000	GJ/yr
Gaseous biofuels for transport	400,000	GJ/yr
Thermal Energy (district heating and cooling)	400,000	BTU/yr
Number of HH benefiting from electricity		
Target area	54,638	
National	25,775,000	
EU	195,000,000	
Number of HH benefiting from heat		
Target area	1,000	
National	500,000	
EU	2,000,000	

Standard Indicators

Air Quality Indicator

The GHG emission intensity is expressed in grams of carbon dioxide equivalent per megajoule of bioenergy produced (gCO₂eq/MJ)

Emission Factor	Total (tonnes of CO ₂ eq)	Allocated (tonnes of CO ₂ eq)	g/MJ of bioenergy prod.
CO ₂ -eq	3,122.18	3,122.18	83.4910
CO	1.35	1.35	0.0362
NO _x	4.38	4.38	0.1171
SO _x	0.60	0.60	0.0162
PM _x	0.20	0.20	0.0054

Water User and Efficiency Indicator

Water withdrawn from watersheds within the target area for the production and processing of bioenergy feedstock

Unit	Wbioenergy/Etotal	Production
m ³ /MJ	0.15	
l/MJ	153.46	
m ³ /tfeedstock		1,589.55

Land Use and Cover Change Indicator

Change in surface of land under annual and perennial crop cultivation

Unit	Annual crop	Perennial crop
Absolute value hectares	1,342.51	0.00
Percentage	13.63	0.00

Employment in Bioenergy Sector

Change in job position along the whole value chain

Unit	Permanent job positions	Temporary job positions
Absolute value positions	5	50
Percentage	0.00	0.00

Net Energy Balance

Energy efficiency of the value chain

Unit	Parameter	Cultivation	Processing	Value Chain
MJ/ton FSTK	TFI	4,197.57	1.00	
MJ/ton FSTK	TFO	16,240.00	10,393.60	
MJ/ton FSTK	Net Energy Value	12,042.43	3.87	
Ratio	Net Energy Ratio	10,392.60	10,393.60	2.34

GROSS VALUE ADDED

Gross value added per unit of bioenergy produced and as a percentage of gross domestic product

Unit	GVA	Contribution to GDP
€/year	373,954.12	
Percentage		0.00

Infrastructures

Number and capacity of routes for critical distribution systems

TOTAL hours travelled	5.10
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Capacity

Ratio of capacity for using advanced biofuels compared with actual use for each significant utilization route

Unit	National	EU	Level
Change in %	0.00	0.00000	

Advanced Indicators

Income

Yearly Gross and Net margin at farm gate for the production of bioenergy feedstock

Unit	Annual Gross Profit	Annual Net Profit
€	151,757.33	-21,426.46
€ ha-1 yr	293.04	269.04

Energy access

Change in energy access

Parameter	Unit	Value
Electricity for lighting, communication, healthcare, education and other uses	GWh/yr	0.00
Liquid biofuels for transport	GJ/yr	0.00
Gaseous biofuels for transport	GJ/yr	0.09
Thermal Energy (district heating and cooling)	BTU/yr	0.00
Target area		
Electricity	Percentage	0.00
Thermal	Percentage	0.00
National		
Electricity	Percentage	0.00
Thermal	Percentage	0.00
EU		
Electricity	Percentage	0.00
Thermal	Percentage	0.00

6.4 HelpDesk

BIOPLAT-EU provides further guidance to users of the platform through the dedicated  Helpdesk.

You can reach out to our experts and send them your questions regarding any project's topic of your interest. Here below a link to the website!

[HELPDESK](#) 

