Smart Light Concepts

Decision Support Tool Final Version V2.0: USER MANUAL

A support document for Deliverable D1.7.3 – Decision Support Tool Final Version V2.0

View Video Manual: https://www.youtube.com/watch?v=mZtn2e3kORw

Visit SLIC DST: http://dst.smartlightconcepts.eu

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Revision history

REVISION	DATE	AUTHOR	ORGANISATION	DESCRIPTION
1	04/11/20	Ramazan Esmeli	University of Portsmouth	Manual preparation
2	04/11/20	Hassana Abdullahi	University of Portsmouth	Manual preparation
3	14/11/20	Professor Djamila Ouelhadj	University of Portsmouth	Manual review
4	17/05/22	Ramazan Esmeli	University of Portsmouth	The Manual Update for the final version of the tool (DST 2.0)
5		Hassana Abdullahi	University of Portsmouth	Manual review
6	18/05/2022	Professor Djamila Ouelhadj	University of Portsmouth	Manual review

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1. INTRODUCTION

The adoption of energy efficient lighting technologies by municipalities has been undergoing technological transformation as a way to reduce harmful emissions and energy consumption as well as a facilitator of sustainable smart city goals. Currently, energy efficient lighting systems that reduce energy consumption also meet these important features are hindered by several barriers such as initial setup cost, policies and regulations, knowledge about the technologies and the lack of an established minimum quality standard.

This document describes the user manual for the last version of the Decision Support Tool (DST) developed as a part of the SLIC project. The SLIC project is a European research project that involves two knowledge institutions (Avans University of Applied Sciences and the University of Portsmouth), six local authorities (Amiens Metropole, City of Bruges, Municipality of Etten-Leur, Province of West Flanders, Suffolk County Council, and West Flanders Intermunicipal Association) and one grid operator (Fluvius) to investigate in practice what investment in sustainable public lighting can contribute to reducing carbon emissions. The remaining part of the report consists of the following sections: The aim of the SLIC DST (section 2), Web-Based DST: User Manual (section 3), and Contact Information (section 4).

2. AIM OF THE SLIC DST

The SLIC Decision Support Tool (DST) is a web-based application designed to support users in making decisions on the adoption of innovative technologies and techniques for energy savings, low-carbon technologies, and renewable energy use in smart cities. The tool integrates the economic, environmental, social, and technical sustainability aspects (Figure 1) of public lighting in different surroundings. The tool consists of a user interface that allows for computational analysis that combines these sustainability dimensions along with the preference of each individual user. The analysis provides outputs (lighting options) highlighting the cost and impact of each dimension. According to the score of each option, the best solution is selected. This tool can also be useful for calculating the expected energy use, light performance, and lifecycle cost of street lighting upgrades for the areas that are defined in the SLIC project.
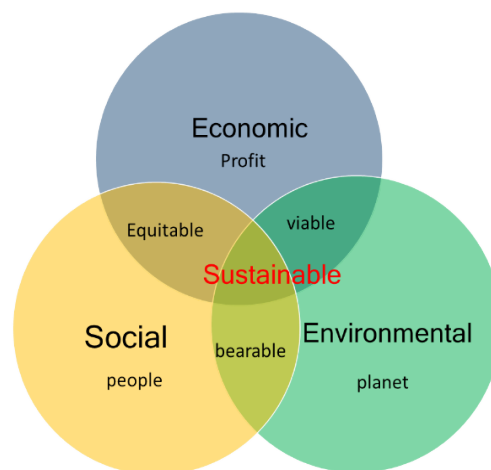

Figure 1: Sustainability dimensions dimensions

3. WEB–BASED DST: USER MANUAL

The SLIC Decision Support Tool (DST) is a web-based application that allows users to use the tool with a browser by accessing it via its web address: http://dst.smartlightconcepts.eu

This is the user manual for the final version of the tool (DST V 2.0). It is important to read this technical manual before using the tool. The user interface contains a series of drop-down menus and toolbars to allow the user to implement several tasks. These tasks are:

- Input and modify parameter values
- Define baseline, upgrade and alternative scenarios
- Modify inputs
- Save inputs
- Run the impact analysis
- View and save the results

The rest of this document describes the DST interface and dependencies required to run the tool and the general menu navigation, input requirements of the tool and how to enter the inputs, a description of how to run the tool, and how to extract the results in readable formats. This manual is organised as follows:

3.1. General information about the web–based DST

- **Software requirements:** As the tool is a web based application, the user only needs an up-to-date web browser to run the DST.

- **Web-based requirements:** To use the tool, the user does not need to install any software or libraries as the tool is web-based and accessible through its web address.

- **Browser recommendations:** The recommended browser to use for the best user experience is Google Chrome.

- **Required inputs:** Downloadable excel files containing the formats for the DST inputs are provided in Tool Information, step 6-lighting system, and step 7-design lighting scenarios. These files can be downloaded, filled, and uploaded into the tool in the step 6-lighting system or step 7-design lighting scenarios of the DST. A description of how the tool works and information about the downloadable templates can be found in the Tool Information and is available in the sidebar under Technical Information.

- **Save or Print results:** To view, save, or print the calculation result in PDF format, you need to have a PDF viewer installed.

- **Save the inputs and continue later:** The tool supports saving the inputs and continuing later, so that users can use previously saved data and do not need to start from the beginning next time.

3.2.   DST overview

Figure 2 shows a general flow of SLIC DST. After entering the URL address of the web application, the user can access the dashboard. In the dashboard, if a user wants to proceed to the main application page, then he needs to provide user information (name, email, and organisation). After successfully submitting the required user information, the main tool window with input requirements opens (tool version, location specification, system inputs, and designing scenarios). Note that if the inputs are not given properly, the scenario and calculation will not work, thereby prompting an error. The system will notify the user to enter the missing inputs.
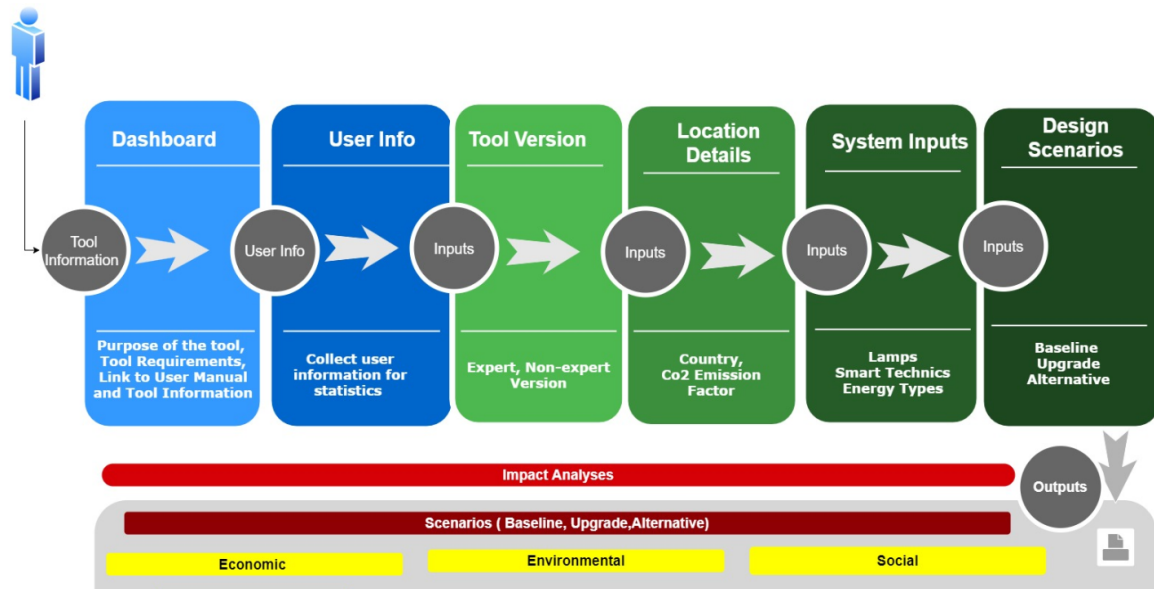

Figure 2: DST overview

Once input collection is complete, the user can go to step 7 designing lighting scenarios—to build the scenarios. In the scenario population step, the user will define the specific inputs for each scenario accordingly. The user can leave empty the options in this part (e.g. no dimming option in baseline scenarios or different lamp specification in baseline and upgrade scenarios). In this case, the system will assume empty lighting techniques or specifications will not be applied in the selected scenario. After scenario specifications are selected and scenarios are built, the user can proceed to impact analysis for the defined scenarios. Once impact analysis is finished, the results will be shown. Also, the results can be saved as a pdf or printed out. The steps for using this tool have been described in detail in the steps for system functions.

3.3.   DST functions

The DST functions are described in the following steps:

1. Dashboard
2. User information
3. End User specification
4. Location specification
5. General inputs
6. Lighting system inputs
7. Designing lighting scenarios
8. Sustainability impact analysis
9. Outputs

3.3.1. Step 1: Dashboard

The SLIC DST Dashboard shown in Figure 3 provides an overview of the DST, including information about the browser information, required inputs, and technical terms used in the tool. The technical terms used in this tool can be found in the sidebar of the knowledge library. For an optimal user experience, please use Google Chrome. Information on how to run the tool and the type of inputs required to run the tool are all provided in the tool information under technical information. The tool information page provides a detailed description of how to run the tool and the type of inputs required.
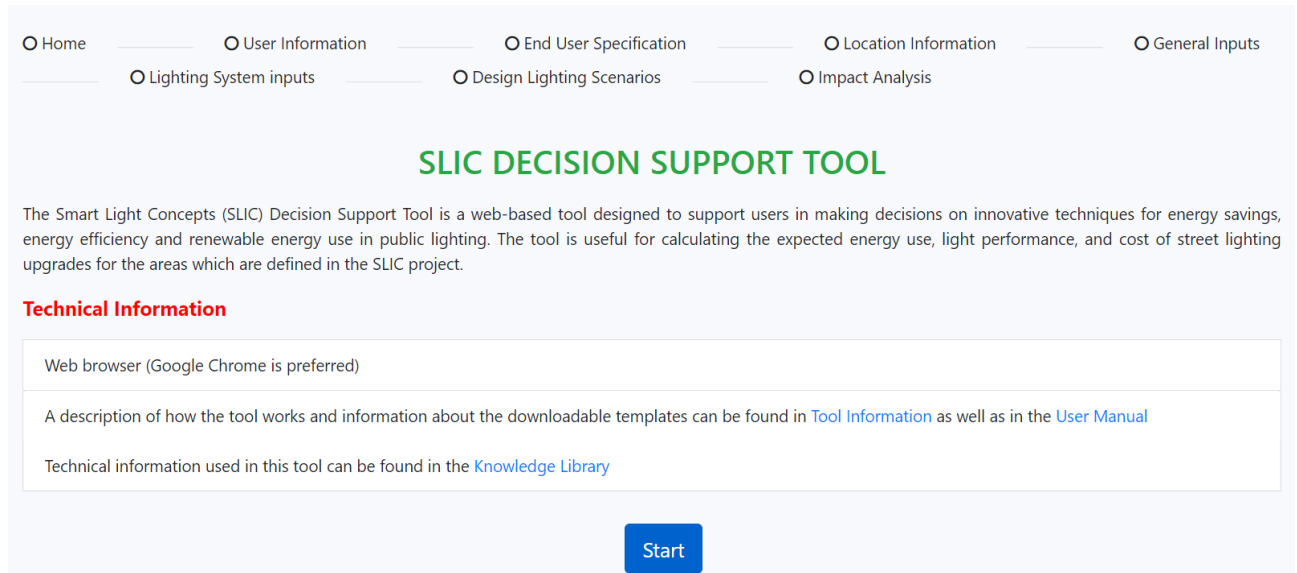

Figure 3: Dashboard

Sidebar

In the sidebar, you will find the steps and functionalities of this tool. This has been divided into categories, which are Home, Interface, and Extras.

1. Home shown in Figure 4, contains the Dashboard and the page where User Information is collected.
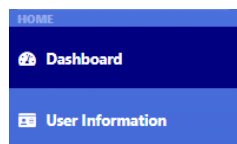

Figure 4: Home

2. The interface in Figure 5 is divided into Inputs, Building Scenarios, and Outputs.

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Figure 5: Interface

a. Inputs collect data about a lighting system and end-user specification (tool version). These inputs are used to build the scenarios previously described and to determine the user category, which is divided into expert and non-expert.

b. In the building scenario, the 3 scenarios are designed based on the inputs collected or by importing data.

c. In the outputs, impact analysis of the 3 scenarios is presented in both tabular and graphical forms.

3. Extras (Figure 6) provides the technical information and a how-to-use guide for the DST. Feedback contains the pilot partner validation questionnaire, and lastly, contact us, FAQs and the user manual are in Help.
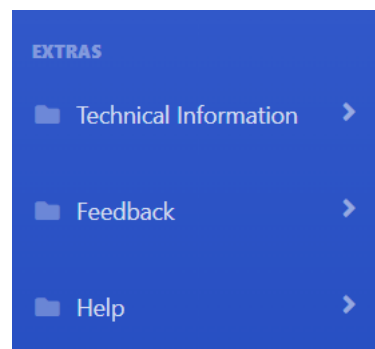

Figure 6: Extras

3.3.2.   Step 2: User information

The START button on the DST initialises the tool. This takes you to the page where user information is collected (Figure 7). Information collected includes the category of user accessing the tool. The predefined user categories are: Technology Expert, Policy Maker, Project Owner and Sustainability Expert. If you could not find the category that defines you then you can add it by input it into the textbox. If you do not wish for your information to be saved and/or if you do not wish to be contacted for feedback, please leave this box unchecked.

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Figure 7: User information

3.3.3. Step 3: End User specification

This information will be used to classify the user based on lighting expertise and direct the tool to the most suitable version.

Available tool versions are Non-expert and Expert versions (Figure 8).

1. The non-expert version of the tool is primarily dependent on publicly available data, such as lamp information available on lighting manufacturers' websites. We also collect data from SLIC pilot partners.
2. The expert version assumes that the user has adequate technical knowledge and can provide the technical data required to run the tool.
3. The user type is required to get a comparison of scenarios.

Figure 8: End User Specification

3.3.4. Step 4: Location specification

The tool requires the user's lighting location information to collect country-specific emission conversion factors. This can also be edited if the default value is not up-to-date. Also, based on the selected location, the lighting level requirement is determined. The location details page looks different based on the selected user category. A non-expert

user only needs to select a country from options and location type and edit the conversion factor if it is required (Figure 9).

Figure 9: Location specification for non–expert users

On the other hand, expert users need to provide more inputs, including road-related information and required lighting levels, in addition to non-expert users (Figure 10).

Figure 10: Location specification for expert users

3.3.5.   Step 5: General Inputs

This tab gathers inputs specific to the road geometry, light geometry, and required lighting levels (minimum illuminance and luminance standard). These inputs are used to provide the tool with the basic road layout to be analysed. If any of the parameter values are blank, the tool will be unable to perform the calculations. Expert users can update the inputs in this section if needed (Figure 11). A non-expert user does not need to provide any information in this step.
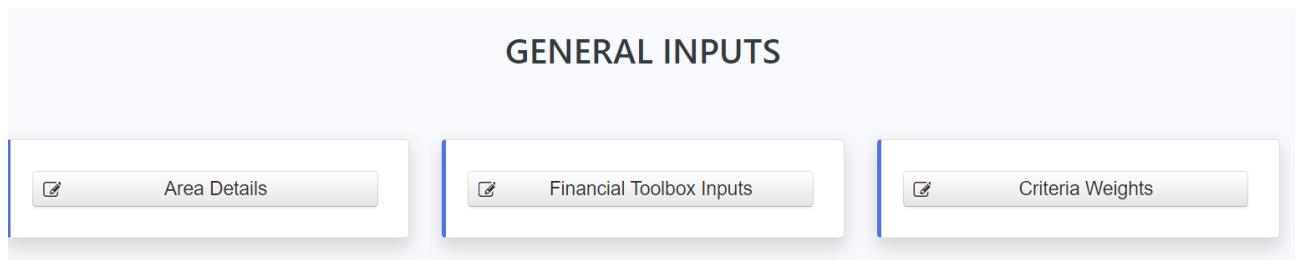
GENERAL INPUTS

☑ Area Details	☑ Financial Toolbox Inputs	☑ Criteria Weights

Figure 11: Lighting system inputs

The input collection in this step is divided into three stages:

- **Area Details:** Figure 12 shows the collected inputs for area details. These inputs are required to calculate the required lighting level based on the given area specifications. Figure 12 shows the default given values for these inputs; users can update those inputs according to their requirements.

General Area Specification   ✖

Please provide the area details for lighting level calculation

No of Lanes	3
No of Poles	24
Lane Width(m)	12.0
Median Width(m)	3.0
Pole Placement	single_sided ▾
Luminaire Mounting Height(m)	6.0
Pole Spacing(m)	10.0
Pole Setback(m)	2.0
Arm Length(m)	1.0
CU	1.0
Pole Height(m)	6.0
Target Illuminance	7.0
Target luminance	2.0
Target Uniformity	1.0

💾

Figure 12: General Area Specification inputs

- **Financial Toolbox Inputs:** In this input section, expert users can provide inputs for the financial calculation of designed scenarios (Figure 13). Non-expert users do not need to provide these inputs.

Financial Toolbox Inputs

Investment	1000.0
Projected Energy Saving (%)	60.0
Projected Maintenance Saving (%)	3.0
Energy price	4.0
Inflation Rate for Energy	0.1
Energy Tax	4.0
Interest Rate	0.02
Duration of Project	12
Discount Rate %	0.02

Figure 13: Financial inputs

● **Criteria Weights:** In this input section, expert users can provide inputs to indicate which cost is more important for the designed scenario. By default, the weights are assigned equally to each criterion (Figure 14).

Weight Parameters

Economic(%)	33.34
Environmental(%)	33.33
Social(%)	33.33

Figure 14: Weight parameters inputs

3.3.6.   Step 6: Lighting System inputs

The tool collects information about lamp details, technical details such as dimming or sensor equipment costs (in the case of new installation), and maintenance costs. This step is optional and contains downloadable excel templates that can be used to collect data and upload to the tool. To upload to the tool, the excel file needs to be converted to a txt file. The other option for providing data will be explained in step 7—designing scenarios.

For this step, default information already existing in the tool can be used, and this can be updated or deleted (Figure 15).

The data provided has to be correct to have accurate cost, savings, and impact calculations. Also, provided inputs are validated, so providing the wrong type of data as an input will not be allowed by default.
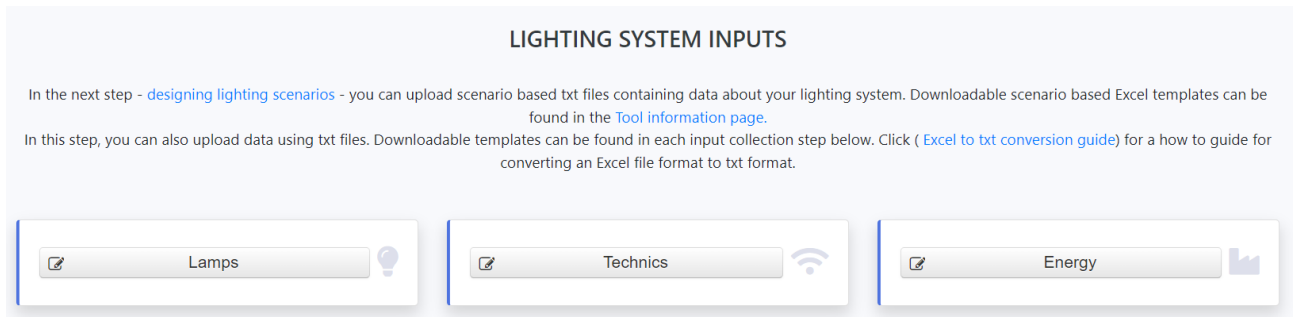
LIGHTING SYSTEM INPUTS

In the next step - designing lighting scenarios - you can upload scenario based txt files containing data about your lighting system. Downloadable scenario based Excel templates can be found in the Tool information page.

In this step, you can also upload data using txt files. Downloadable templates can be found in each input collection step below. Click (Excel to txt conversion guide) for a how to guide for converting an Excel file format to txt format.

Lamps	Technics	Energy

Figure 15: Lighting system inputs

The input collection in this step is divided into three stages:

- **Lamps:** Figure 16 shows information collected about the luminaire operating cost and investment cost, as well as luminaire power. The current version of the tool contains generic lamps which can be updated or deleted. Note that a lamp's power includes fixture and luminaire power. If you prefer to add more lamps to the existing list, users should use the "add" button. Alternatively, you can download the excel template and gather the required inputs and upload it back into the tool in txt file format (you can upload up to a maximum of 10 files). Note that the format of the template must not be changed or altered. Additional text must not be entered.

Please select lamps to build scenarios
*Note that Power(W) includes both the fixture and luminaire. Fixture details can also be imported as a csv file

	Type	Manufacturer	Power (W)	Equipment Cost (€)	Installation Cost (€)	Maintenance Cost (€)	Update
☐	HPS	Generic	70.0	150.0	50.0	16	update
☐	HPS	Generic	115.0	150.0	50.0	16	update
☐	HPS	Generic	130.0	150.0	50.0	16	update
☐	HPS	Generic	189.0	150.0	50.0	16	update
☐	HPS	Generic	150.0	150.0	50.0	16	update
☐	HPS	Generic	183.0	150.0	50.0	16	update
☐	HPS	Generic	188.0	150.0	50.0	16	update
☐	HPS	Generic	310.0	150.0	50.0	16	update
☐	HPS	Generic	289.0	150.0	50.0	16	update
☐	HPS	Generic	250.0	150.0	50.0	16	update
☐	HPS	Generic	297.0	150.0	50.0	16	update
☐	HPS	Generic	400.0	150.0	50.0	16	update
☐	HPS	Generic	465.0	150.0	50.0	16	update

|◄ ◄◄ 1 2 3 ►► ►|

Figure 16: Lamp details for configuring scenarios

- **Technics:** The tool collects data about the costs of the smart techniques used in the lighting system (Figure 17). You can download the excel template and gather the required inputs and upload it back into the tool in txt format (maximum of 10 files). Note that the format of the template must not be changed or altered. Additional text must not be entered.

Please select technics to build scenarios.
*Technic details can be uploaded as a txt file using downloadable Excel as a template.

	Type	Name	Equipment Cost (€)	Installation Cost (€)	Maintenance Cost (€)	Update
☑	Sensor	Motion Sensor	0.0	0.0	0.0	✎ update
☐	Dimmer	Dimmer	0.0	0.0	0.0	✎ update

Figure 17: Technics details for configuring scenarios

- **Energy:** Here, data about the cost of the energy equipment used in the lighting system and the price of energy (Kwh) is collected (Figure 18). Data collected includes costs of procuring and installing energy harvesting modules for solar energy or other equipment associated with energy provision for the lighting system. You can download the excel template and gather the required inputs and upload it back into the tool in txt format (maximum of 10 files). Note that the format of the template must not be changed or altered. Additional text must not be entered.

Please select energy source to add to scenarios.
*Energy source details can be uploaded as a txt file using downloadable Excel as a template.

	Type	Name	Battery Cost (€)	Energy Cost (€/kwh)	Equipment Cost (€/l)	Installation Cost (€/l)	Maintenance Cost (€/l)	Inflation Rate (%)	Update
☑	Solar	British gas	10.0	12.0	30.0	10.0	60.0	0.0	✎ update
☐	Gas	SSE	30.0	20.0	90.0	10.0	20.0	0.0	✎ update

Figure 18: Energy details for configuring scenarios

In this step, saved inputs from previous tool usage can be uploaded, or users can save the inputs given until this step (Figure 19).

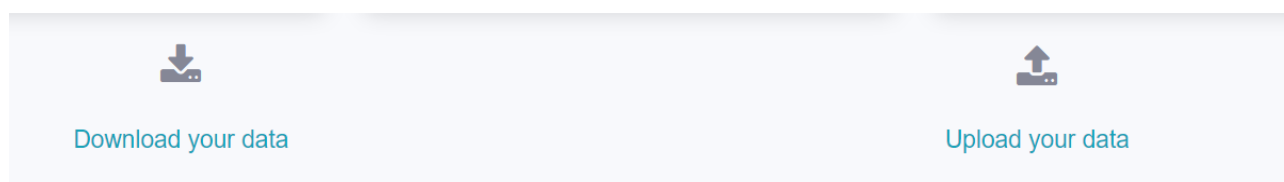Download your data   Upload your data

Figure 19: Energy details for configuring scenarios

This step needs to be provided for both user types. However, non-expert users can choose the default given lamps, techniques, and energy sources in the system.

3.3.7.   Step 7: Designing Lighting Scenarios

The design of the scenarios is based on the information obtained from the pilot partners and the existing literature and documents on low-carbon public lighting. The scenarios aim to select the best-performing combination of fixtures and components to meet the needs of the pilot partners. To develop an initial set of possible scenarios, a combination of strategies and actions have been considered, along with additional information provided by the pilot partners.

1. **Description of the Scenarios considered in the DST**

The tool considers three scenarios: baseline, upgrade, and alternative scenarios. The **Baseline scenario** describes the current situation. The **Upgrade scenario** describes the situation after the implementation of energy-saving lighting technologies. The **Alternative scenario** provides an alternative lighting scenario based on optimisation. This scenario is generated based on an optimisation algorithm that takes into account the importance level of each sustainability dimension (economic, environmental, and social). Computational analysis provides a set of options (lighting options) with their costs and impacts on each dimension. A key feature of this tool is the ability to compare the scenarios.

In this step, you can build your lighting scenarios with input saved from the previous step. Alternatively, you can upload scenario-based TXT files.

If step 6—lighting system inputs—is skipped, lighting system data must be provided in step 7—design lighting scenarios. The inputs collected in step 6 are used in this step. To provide the data for building the scenarios, Excel templates can be downloaded for each scenario.

2. **Building scenarios using data saved from lighting system inputs in step 6**

To start building the scenarios, you must define the number of lamps, energy details, and applicable techniques required for each scenario (Figure 20). These steps are described below.

- **Fixtures:** Here, you can set the total number of lamps for all the scenarios. This is now sent to each scenario, and you will see it under the required lamps. The lamps required are calculated based on the given inputs in the Fixture details screen. On this screen, for each scenario, the number of fixtures and number of lamps for each fixture are collected. Consequently, required lamps are calculated as the multiplication of the number of fixtures and the number of lamps per fixture, which will be shown in Required Lamps in Figure 23.
- **Technics:** Techniques that have previously been saved can be selected and added to the scenarios. The techniques are divided into two categories, which are existing and new. Existing shows already exist in the system, while new shows are planned for new technical installations.
- **Lamps:** Here, lamps required for each scenario can be built and specific lamp details can be defined. All the lamps sent to the scenarios will be listed in the lamps table. From this list, the user can pick relevant lamps for the scenarios, and the total number of lamps selected and added for each scenario is shown in Total lamps in Figure 22.
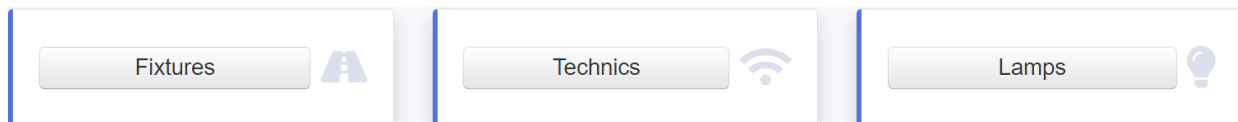

Figure 20: Building scenarios

Figure 21: Lamp list from Step 6

Figure 21 shows the list of lamps selected that can be added to scenarios. When the user selects a lamp from the list, the Lamp Info screen (Figure 22) will be shown. On this screen, the user can specify the lamp features for each scenario. For example, if the user prefers not to have a lamp in the baseline, the number of lamps for the baseline can be set to '0'.

Lamp Info ✕

Baseline	
Type and Watt	HPS 130.0
Energy Type:	British gas
Dimming %	0.0
Dimming Hours(Per year)	0
Number of the Lamps	0
Operating Hours(per year)	0.0

Upgrade	
Type and Watt	HPS 130.0
Energy Type:	British gas
Dimming %	0.0
Dimming Hours(Per year)	0
Number of the Lamps	0
Operating Hours(per year)	0.0

Alternative	
Type and Watt	HPS 130.0
Energy Type:	British gas
Dimming (Min %)	0
Dimming (Max %)	0
Dimming Hours(Per year)	0
Number of the Lamps	0
Operating Hours(per year)	0.0

Add to Scenario

Figure 22: Add lamps to the scenarios

Baseline

Required lamps	10	Total lamps	10
Dimming factor	0.0	Sensor factor	0.0
Use factor?	No	Use factor?	No

Technics

Name	Update
Motion Sensor	✎

Lamps

Info	N	DR	DH	D	S	
Generic HPS 130.0W	10	0.0	0	No	No	✎

Upload files   **remove all**

N: Number of Lamps
DR: Dimming Rate
DH: Dimming Hour
D: Is Dimming enabled?
S: Is Sensor enabled?

Upgrade

Required lamps	10	Total lamps	10
Dimming factor	0.0	Sensor factor	0.0
Use factor?	No	Use factor?	No

Technics

Name	Update
Motion Sensor	✎

Lamps

Info	N	DR	DH	D	S	
Generic HPS 130.0W	10	0.0	0	No	No	✎

Upload files   **remove all**

N: Number of Lamps
DR: Dimming Rate
DH: Dimming Hour
D: Is Dimming enabled?
S: Is Sensor enabled?

Figure 23: Overview of designed scenarios

In Figure 23, the configuration for each scenario can be viewed. The selected lamps from the lamps list and techniques will be shown for each scenario. These can be updated using the update button.

- **Dimming and sensor correction factors:** These factors are used when you do not provide a dimming rate, which is the percentage of dimming per lamp. These factors are reduction factors for energy consumption when using dimming or sensors or a combination of both. This is highly customisable according to the lamp. Non-expert user does not need to provide these inputs.

3. **Building scenarios by uploading scenario specific text files**

Excel templates for the scenarios can be downloaded at the top of this page or in the tool information. These templates cannot be altered otherwise; they cannot be read. Additionally, after collecting the inputs, each text file will need to be uploaded under its specific scenario. In addition, you can remove all the lamps in a scenario and upload new ones.

- **Using saved data to build scenarios:** Users can upload previously saved data, and if it is required, the user can update related inputs and then create scenarios (Figure 24). When the impact analysis button is clicked, if there are any missing inputs, the user will be informed.
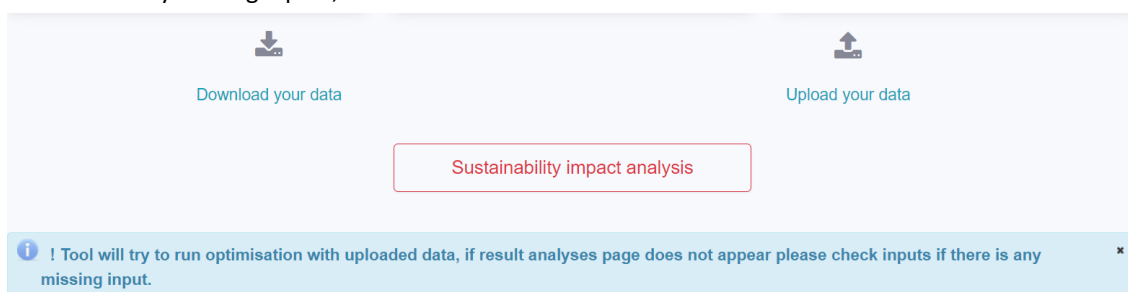
Figure 24: Using the 'Upload your data' function to build scenarios

3.3.8. Step 8: Sustainability Impact Analysis

Once all inputs have been provided, the impact analysis for these scenarios is calculated by pressing the IMPACT ANALYSIS button (Figure 25). Note that for this version, only data for the lighting systems in the defined scenarios is included in the calculations. If any input is missing, the tool will not run and you will be prompted with an error message.
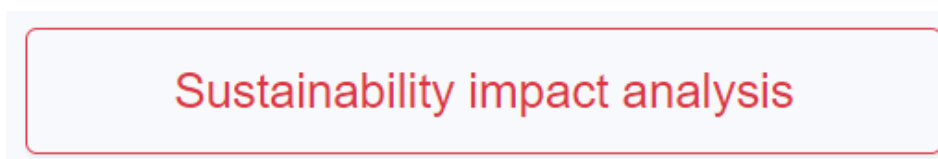

Figure 25: Sustainability impact analysis

3.3.9. Step 9: Outputs

In this step, the tool provides the results for the scenarios. The results provided in this tool provide a high-level overview of the costs and impacts of the scenarios with respect to the lighting systems. The output addresses three sustainability dimensions—economic, environmental, and social (Figure 26). The outputs can be printed for each dimension using the print button.

Figure 26: Sustainability impact analysis categories

The tool uses the inputs related to the fixture's light output, energy use, and costs to perform analysis of how each fixture will perform on a specific road type. In this step, calculation results are divided into sub-costs in the well formatted table. In addition, this tool has the added functionality to allow the user to view the details of the created scenarios by clicking the "see details" button for the corresponding scenario.

The scenario results are shown in a table comparing the costs and savings between the scenarios (see Figure 27). Additionally, the cost saving comparisons are visualised in a bar chart (results summary) for a comparison of the costs and the impacts of the scenarios. Also, the results can be printed or saved in PDF format (print-figure 27). To update the Input details to create or change a new scenario, click the "back" button (back) to go to the previous screen to update the scenario details. Lastly, the details of the created scenarios can be viewed by using the "See Details" (Pop-up to see scenario input details) button for the corresponding scenario, which opens a pop-up screen. The financial toolbox is also printed under the economic results tab (financial toolbox).

The financial toolbox is only available for expert users.
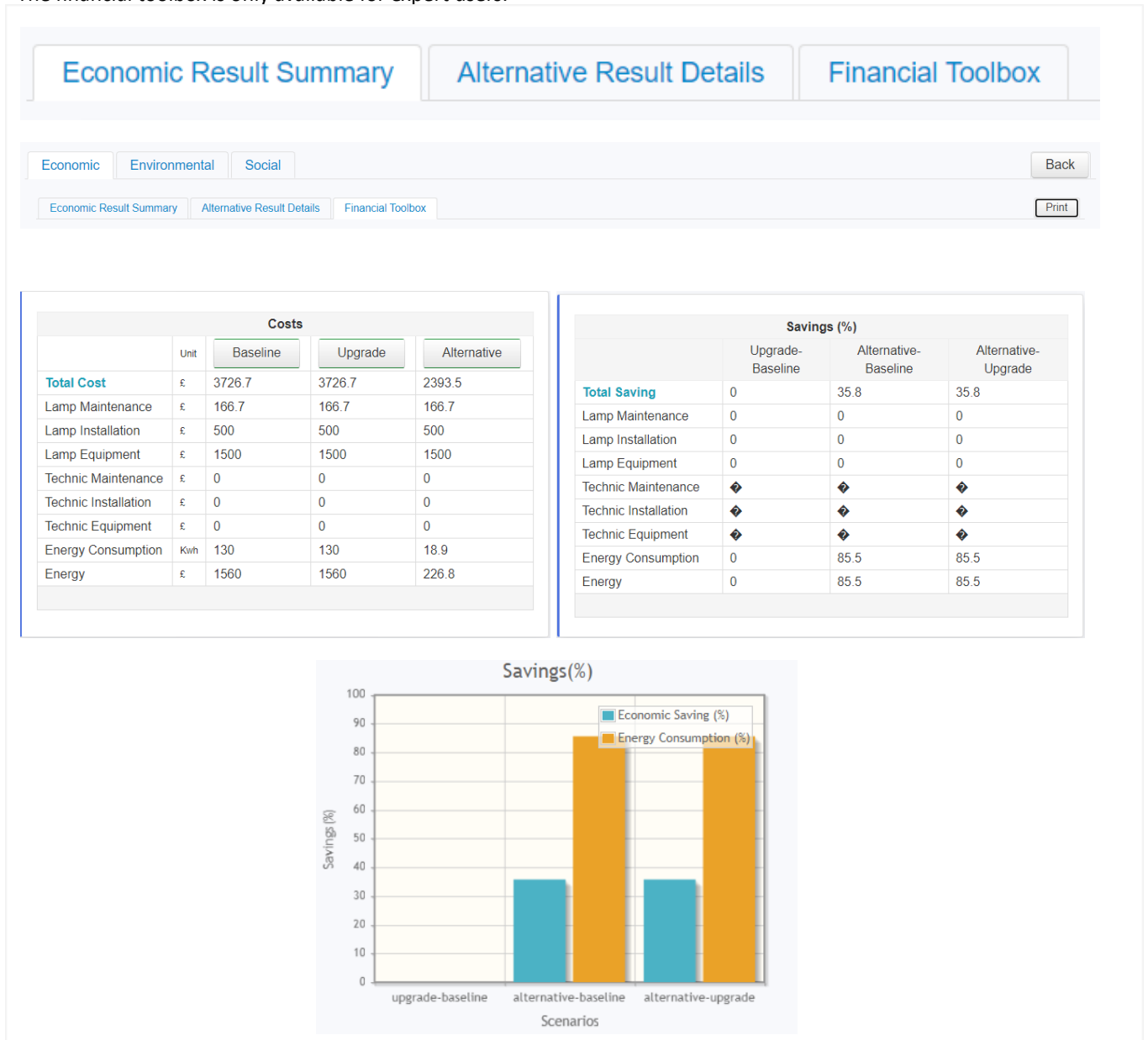
Figure 27: Sustainability impact summary

For further analysis of the scenario, users can click the "show more analysis" button (Figure 28). Users can also download the result of the impact analysis.

show more analysis   Download your data

Figure 28: Detailed sustainability impact analysis and data download

On the further analysis page, more detailed cost analysis of base, upgrade, and alternative scenarios can be investigated. Also, the best three alternative scenarios can be viewed in detail (Figure 29).

Alternative scenarios sustainability impact analysis (%)
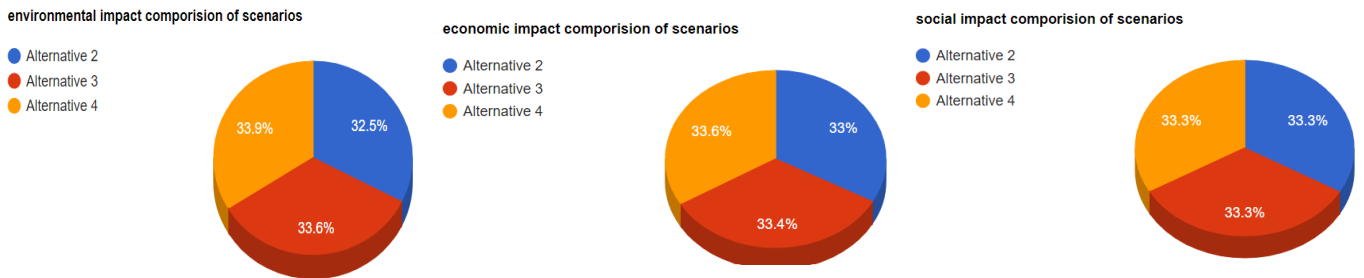
Alternative scenarios selected lamp(s) analysis

	Scenario	Lamp Info	Number Of Lamps	Watt	Dimming
1	Alternative 2	HPS L8	96	140	39
2	Alternative 2	LED L1	4	300	0
3	Alternative 3	HPS L8	96	140	36
4	Alternative 3	LED L1	4	300	23
5	Alternative 4	HPS L8	99	140	30
6	Alternative 4	LED L1	1	300	16

Alternative scenarios sustainability impact analysis (cost)

	Scenario	Environmental cost	Economic cost	Social cost
1	Alternative 2	605.047	22,503.04	10
2	Alternative 3	608.248	22,579.36	10
3	Alternative 4	606.949	22,638.4	10

Figure 29: Detailed sustainability impact analysis for alternative scenarios

4. CONTACT INFORMATION

For any queries about the SLIC Decision Support Tool or this User Manual, please visit the project website https://www.smartlightconcepts.eu/ to contact us.

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