

ArtemideTCO[®]

User manual

Table of contents

1. Introduction		4
	System requirements	4
	Overview of the application	5
	Access to the application	6
	User interface	6
	Sample projects (Template)	7
	User profile	8
	User manual	8
2. Job folders (projects)		9
	Managing the job folders	9
	Details	10
	Managing the areas	11
	Creating a project from Dialux	12
	Managing proposals for aggregate solutions (Proposals)	12
	Energy and economic evaluations of the aggregate proposals	14
	Reporting the proposals	14
3. AREAS section		15
	City and intended use of the system	16
	Surface area of the room, maintenance factor and period of operation	16
	Area occupancy	18
	Contribution of natural light	18
4. SOLUTION section		19
	Power consumption	20
	Costs of the solution	20
	Lighting fixtures	21
	Control systems	23
	Room plan	24
5. ENERGY section		24
	EN15193 Benchmark	25
6. TCO section		26
7. REPORT section		27
8. Annex		28
	European Standard UNI EN 15193	28
	Calculation of the LENI (Lighting Energy Numeric Indicator)	29
	Calculation of the TCO and Payback Time	30
	Compatibility with Dialux projects	31

The application is used to calculate the consumption of lighting systems using the LENI (Lighting Energy Numeric Indicator) in accordance with European standard EN 15193. In just a few simple steps the energy efficiency of the system can be estimated, taking both the fixtures and the lighting control systems into consideration. This indicator makes it possible to estimate the TCO, or the Total Cost of Ownership, of the system.

Design choices can be suggested to customers by comparing various lighting solutions and the related procedures to control the fixtures. The application can be used to calculate all the information on the initial energy and maintenance costs of the systems and allows a fast and accurate evaluation as to whether one design solution is better than other options. It is therefore possible to evaluate any product that is available on the market, such as the new LED fixtures and the Building Automation control solutions.

System requirements

Il computer utilizzato dall'utente per accedere all'applicazione deve avere le seguenti caratteristiche:

- Windows, Linux or OSX operating system
- At least 512MB RAM
- Minimum video resolution of 1024x768 pixel
- Web browser: Internet Explorer 9, Firefox 16, Chrome 25, Safari 5.1.7 (or subsequent versions)
- Acrobat Reader 10 or subsequent version
- Internet/intranet connection with the server hosting the application.

Overview of the application

The web-based architecture allows the application to be accessed from any browser that can connect via intranet/internet to the server hosting the software and the projects/products database. The workspace is organised into project folders which contain the areas:

- **Project folder:** set of documents dedicated to the same business, for example a building.
- **Area:** always represents a single room inside a building.

One or more **Solutions**, that is, design variations made up of different fixtures, possibly managed with different control systems and/or procedures, can be specified for each area.

Thus the type of fixtures used (of which there may of course be more than one) can be specified for each solution. The mode of management must be specified for each type of fixture, selecting from options that may be manual (traditional) or automatic control (via control systems).

Data relating to the energy and economic parameters of fixtures and systems can be entered in various ways:

- all the parameters are entered by the user, for example for third-party fixtures.
- the products in the company database are entered by the user; in this case the user only has to select the type of product and all the parameters will be filled in automatically.

Even in the second case, the user can still edit and therefore personalise the parameters, since these have just been copied into the area from the database. Thus, if the data of a fixture are modified in the database, for example a price in a price list or an energy parameter, this will not modify any of the areas in which this fixture may have been used.

After entering the data, the application will automatically carry out the energy and economic evaluations, the results of which will be displayed in the relevant sections and can be exported into a PDF document. The information produced by the application regard the following:

- **Energy consumption**
- **Amount of CO2 produced**
- **LENI**
- **Energy comparison of solutions**
- **Initial investment costs**
- **Energy consumption costs**
- **System maintenance costs**
- **TCO**
- **Investment payback time.**

The maintenance costs include bulb replacement, the labour needed for replacement activities and any extra costs that may be required, such as the hiring of machinery to change bulbs at great heights or the costs of cleaning fixtures in critical applications. Besides evaluating a single room (area) it is also possible to perform an overall evaluation of the building (project folder). One or more **Proposals** can therefore be carried out, in which a solution is selected for each area contained in the project folder. After the Proposal data have all been entered, the application will automatically carry out the overall energy and economic evaluations, the results of which will be displayed in the relevant sections and can be exported into a summary PDF document. It is important to remember that all the data relating to projects and products are saved on the server whereas the PDF documents that are generated must be filed by the user in his/her PC.

Access to the application

The application can be accessed from the Artemide intranet and is only available to users who are authorised for the service. To access ArtemideTCO, follow Home > Applications and select TCO as shown in figure 1.1.

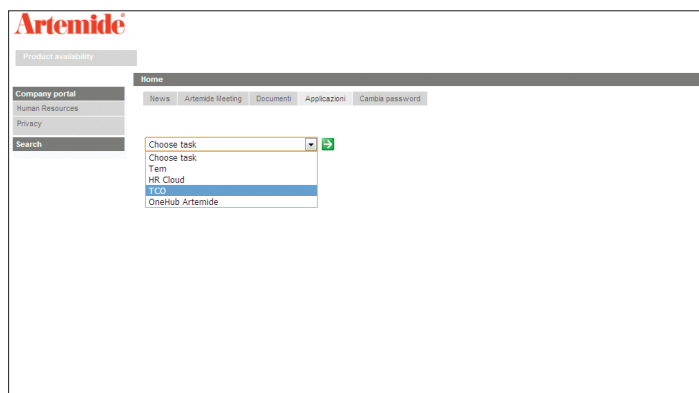


Figure 1.1 – Access to ArtemideTCO from the Artemide intranet

User interface

The home page (*Home*), shown in figure 1.2, provides access to the main sections of the application:

- **My projects:** management of project folders.
- **Sample projects:** management of samples (*Templates*) that can be used to generate new areas.
- **User profile:** management of the data of the user's account.
- **User manual:** displays this manual in electronic format.

To exit the application (*Logout*), just click on the button in the top right-hand corner, next to the username.

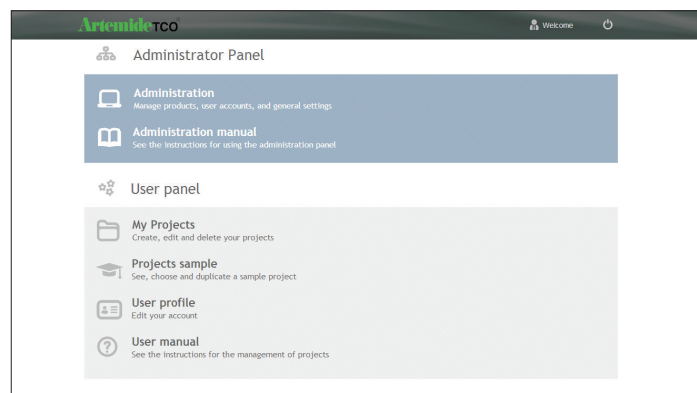


Figure 1.2 – Home page of the application

Sample projects (Template)

In this section (figure 1.3) projects relating to the areas prepared by the administrator can be displayed; these can be taken as examples in order to understand how the application works, the potential of certain fixtures and the advantages that can be obtained from using control systems. These areas are organised into subject folders, for example by type of building. The summary, shown as a pop-up on pressing the *Print Report* command, can be displayed for each area.

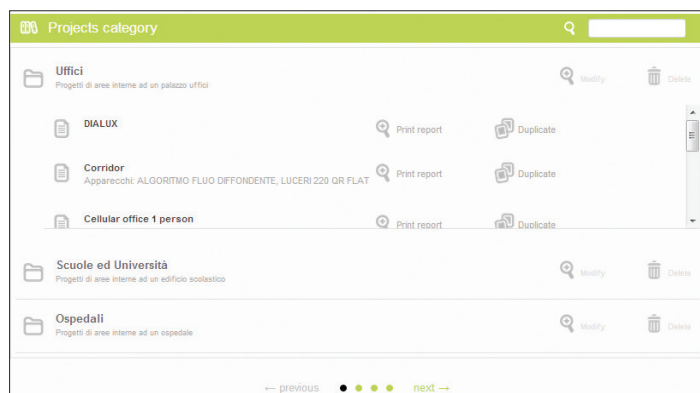


Figure 1.3 – Sample projects (Templates)

After identifying the required project, the *Duplicate* command can be used to create a new job from the selected sample. The name of the new area and the project folder in which it is to be filed can be entered in the window shown in figure 1.4. Thus, if a new folder is to be created, the procedure described in the following chapter must be followed before duplicating a project.

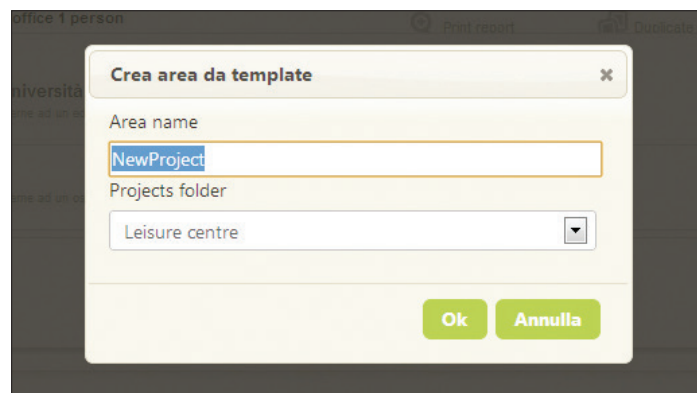


Figure 1.4 – Duplicating a Template project

User profile

The data relating to the user can be displayed and modified in the section shown in figure 1.5. This information may be used, if required, in the project PDF reports. In addition to the user's general information, the language used for the display of the application's user interface is required, as well as the language and the price list used for the description and the economic evaluation of the products in the projects that are carried out:

User manual

Using the User manual command on the home page of the application (figure 1.2), a new window can be opened to display the electronic version of this manual.

The screenshot shows a web application interface for 'Arconide TCO'. At the top, there is a navigation bar with 'Arconide TCO' on the left and 'Web.com' with a home icon on the right. Below this, a 'User data' form is displayed. The form has a light gray border and contains the following fields:

- Name: Text input field with 'Marco' entered.
- Surname: Text input field with 'Rossi' entered.
- Company: Text input field with 'Arconide spa' entered.
- Job description: Text input field with 'Lighting designer' entered.
- E-mail: Text input field with 'marco@arconide.com' entered.
- Web site: Text input field.
- Telephone: Text input field with '+39 3337654562' entered.
- Mobile: Text input field with '+39 3337654562' entered.
- Address: Text input field.
- Post code: Text input field.
- Country: Text input field with 'Italy' entered.
- Language: Dropdown menu with 'en' selected.
- Report language: Dropdown menu with 'en' selected.

At the bottom right of the form, there are two green buttons: 'Annulla' and 'Apply'.

Figure 1.5 – Modifying personal data

Job folders (projects)

The workspace is arranged in project folders containing the Areas. A project folder is a set of documents dedicated to the same business, for example a building, while an Area always represents a single room inside a building.

Managing the job folders

The window shown in figure 2.1 can be used to manage the various project folders. Each project folder is given a name and description. Click on the name of the folder to access the areas. To add a new folder, use the New folder command located in the menu, which can be accessed by clicking on the icon in the top right-hand corner (next to the username). The menu also has the Home command, which is used to return to the main page of the application, and the Logout command, to exit from the application. To delete a project folder, use the Delete command located on the right-hand side of each row; the user will be asked to confirm before proceeding, since all the data in the folder will be deleted.

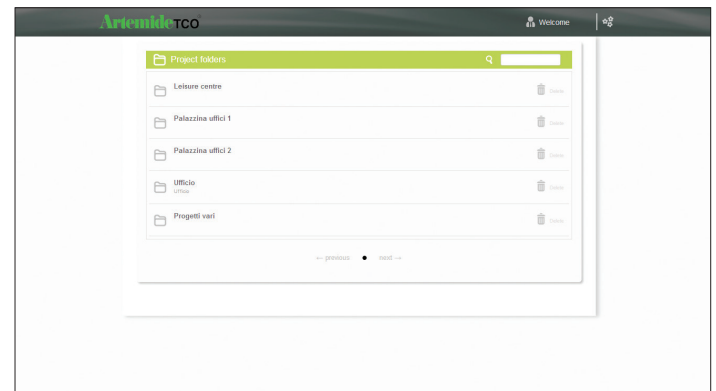


Figure 2.1 – Project folders

Figure 2.2 shows the workspace inside a project folder. The left-hand column is used to manage the folder and contains the following sections:

- **Details:** to set the general data of the folder (figure 2.3).
- **Areas:** to display and manage all the areas contained in the folder.
- **Proposals:** to display and manage all the aggregations of the various solutions of each area.
- **Energy:** to display the energy evaluations of the Proposals.
- **TCO:** to display the economic evaluations of the Proposals.
- **Report:** to display the settings to print the summary PDF document.

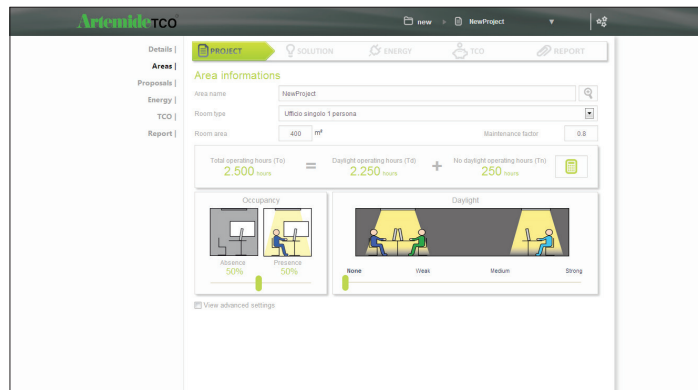


Figure 2.2 – Contents of a project folder

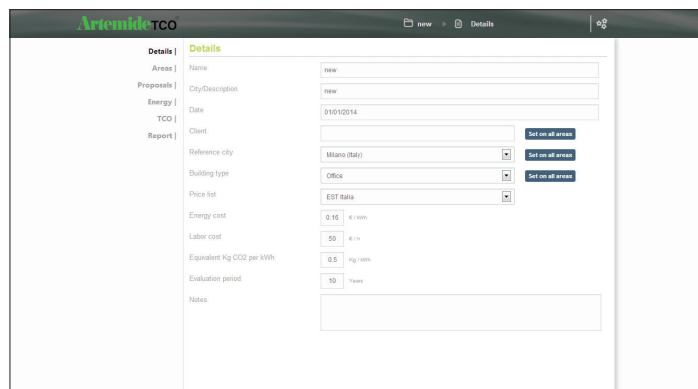


Figure 2.3 – Details: setting the general data of the project folder

Details

In this section you can set the general data of the project folder, such as the name, the date of creation, the customer or other fields. For some of these, the setting of the parameter can be extended to all the areas contained in the current project.

The values relating to energy and labour costs are used to evaluate the energy costs and to calculate the costs required for the replacement of bulbs throughout the period of use of the system. The costs refer to the geographical area in which the system has been set up.

The parameter Kg CO₂ equivalent for kWh is used to calculate the amount of CO₂ produced, corresponding to the energy consumption of the system.

The application automatically performs the energy and economic evaluations considering an evaluation period which may, for example, be the same as the expected lifetime of the system. This parameter must be specified by the user and is expressed in years.

Managing the areas

In the Areas section you can create, manage or delete an area (room). There are two ways of creating a new area, which can be found in the menu by clicking on the icon in the top right-hand corner (figure 2.4):

- **New empty area:** creates an empty area to be completed in all its parts.
- **New template area:** creates an area by duplicating all the information from a sample area (Template) selected by the user, who in this case can only modify the data in question.
- **New area from Dialux:** imports a file (with the extension .stf) from Dialux and creates an area from the information contained in this.

It should be noted that when a new project is created from a template with the above-mentioned command, the user will not be asked for the destination folder as the one currently in use will be used.
Besides those described above, the following operations can also be performed:

- **Duplicate current area:** creates an area that is identical to the current one in the same project folder, and assigns it the same name with the addition of the suffix "(copy)".
- **Delete current area:** deletes the current area and all the corresponding solutions.

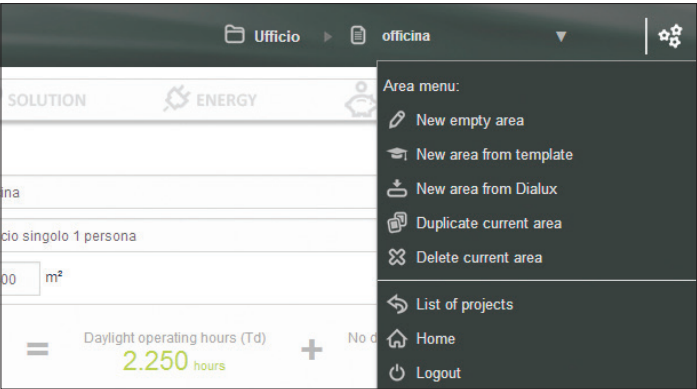


Figura 2.4 – Menu Areas

To work on the various Areas, just select one from the dropdown menu on the top bar, next to the name of the project folder (figure 2.5).

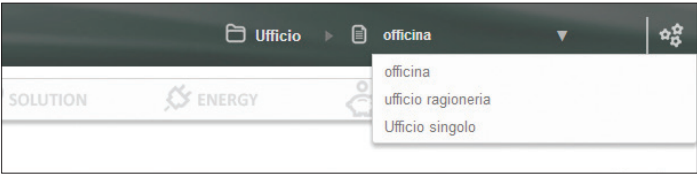


Figure 2.5 – Dropdown menu to select an area

Figure 2.6 shows the project management bar. The five sections will be dealt with in detail in the following chapters. Click on the name of the section to go into the project and the bar will show the current work position.

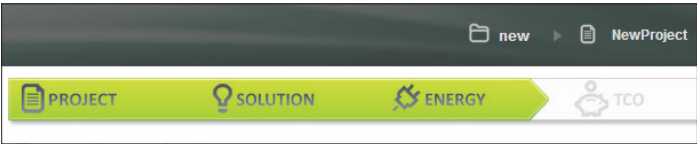


Figure 2.6 – Project management bar

Creating a project from Dialux

A file in *.stf* format generated by Dialux can be imported in order to create a new project. For more information on preparing a project in Dialux, please see the paragraph *Compatibility with Dialux projects* in the annex.

After selecting the *New area from Dialux* command (menu in figure 2.4), the user is asked to select the *.stf* file to be imported (figure 2.7). Press *Upload* and follow the progress of the import shown in the window.

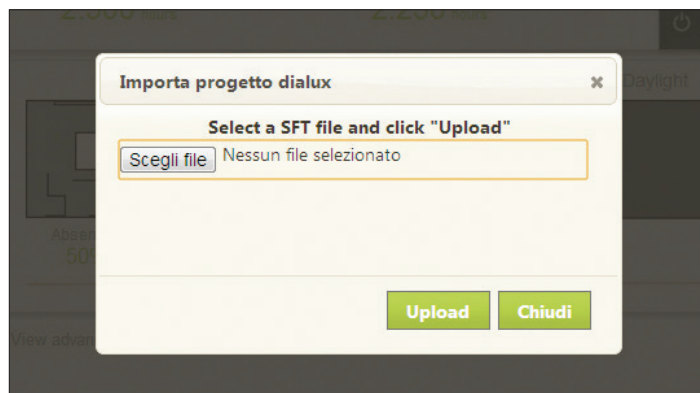


Figure 2.7 – Selecting the .stf file exported from Dialux

When the file has been imported into the application, the information it contains will be verified. The user is notified of any inconsistencies or possible errors, such as when the fixtures used in the Dialux project are not also stored in the products database of the application.

Managing proposals for aggregate solutions (Proposals)

While a single room is analysed in the *Areas* section, an overall evaluation of the building can be performed in *Proposals*, by taking one or more of the proposals and selecting a solution in each of them for each area contained in the folder. Figure 2.8 shows the window used to add, modify or delete a proposal.

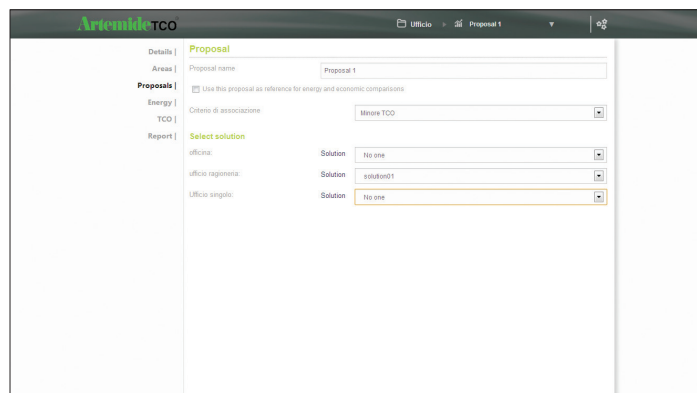


Figure 2.8 – Managing proposals

Click on the *New proposal* item in the menu shown in figure 2.9 to enter a new proposal. An existing proposal can also be duplicated or deleted, by clicking on the items *Duplicate current proposal* or *Delete current proposal* respectively.

For each **Proposal** a name can be specified and a solution selected for each area contained in the folder. In the event that an area is not to be included in a particular proposal, the option *None* can be selected from the dropdown menu, as shown in figure 2.10.

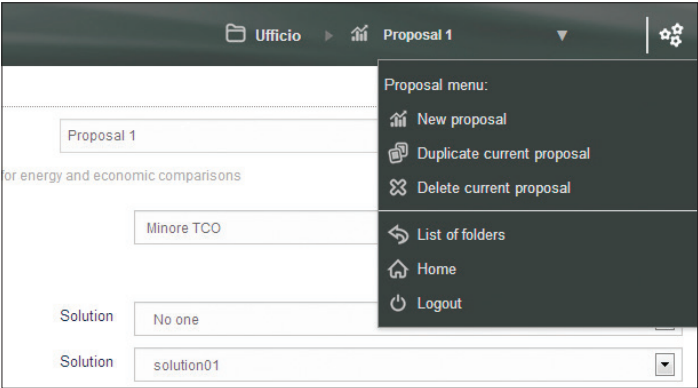


Figure 2.9 – Creating a new proposal



Figure 2.10 – Excluding a project from a proposal

In the energy and economic evaluations, the energy saving and investment payback time values are always calculated by considering one of the proposals as reference and comparing the other proposals one by one. To select which of the proposals is to be considered as reference, use the option *Use this proposal as reference for the energy and economic comparisons* (figure 2.8). Obviously, only one of the proposals can be selected as the reference.

Energy and economic evaluations of the aggregate proposals

In the **Energy** and **TCO** sections, the energy and economic evaluations can be displayed for each *Proposal*, with the related energy comparison and investment payback time indicators (figures 2.11 and 2.12).

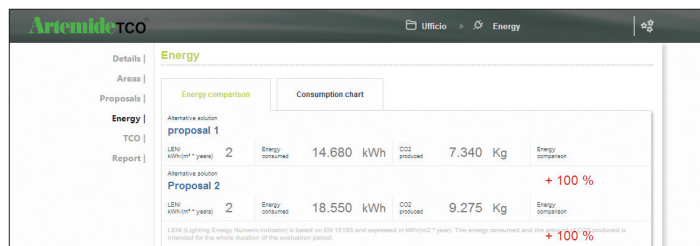


Figure 2.11 – Energy section for the energy evaluation of proposals

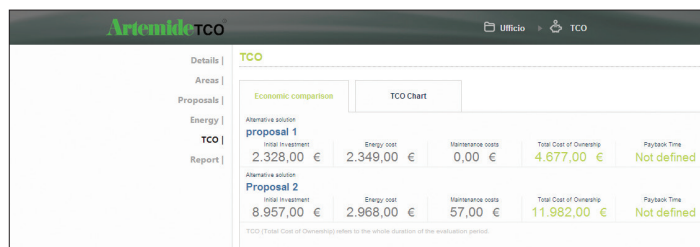


Figure 2.12 – TCO section for the economic evaluation of proposals

Reporting the proposals

In the **Report** section (figure 2.13), all the options can be set to generate the summary PDF document of the aggregation of the various rooms.

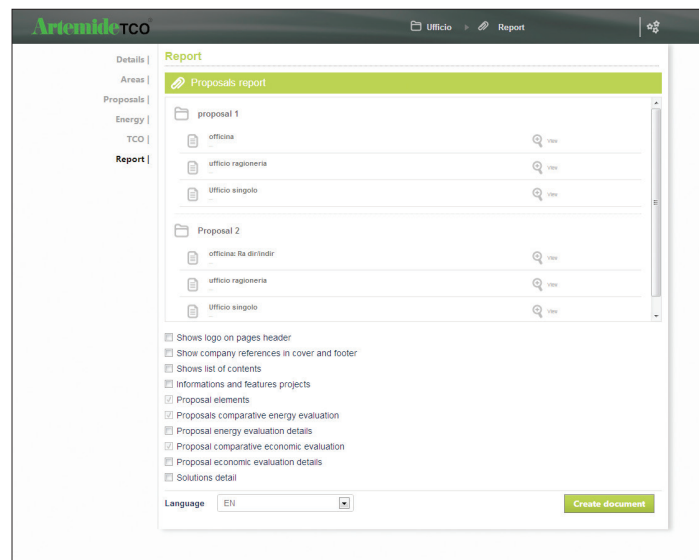


Figure 2.13 –Report section for the generation of the PDF document

AREAS section

After selecting the required area via the dropdown menu in the **Areas** section (fig. 2.5), you can move around in the workspace by means of the management bar located at the top of the middle section of the window (fig. 2.6). The first section is **PROJECT**, where the window shown in figure 3.1 can be displayed, and where all the general information of the area can be entered. For some types of parameters the user can decide whether to use the settings suggested by the application, generally relating to standard EN 15193. The checkbox *Display advanced settings*, which can be used to configure all the parameters of the area, such as those specific to calculation of the LENI, is located at the bottom of the window.

To modify the name and the other references of the area, click on the icon next to the name field to display the window shown in figure 3.2. If required, these references can be reported in the PDF document generated as a report on the project (see the **REPORT** chapter).

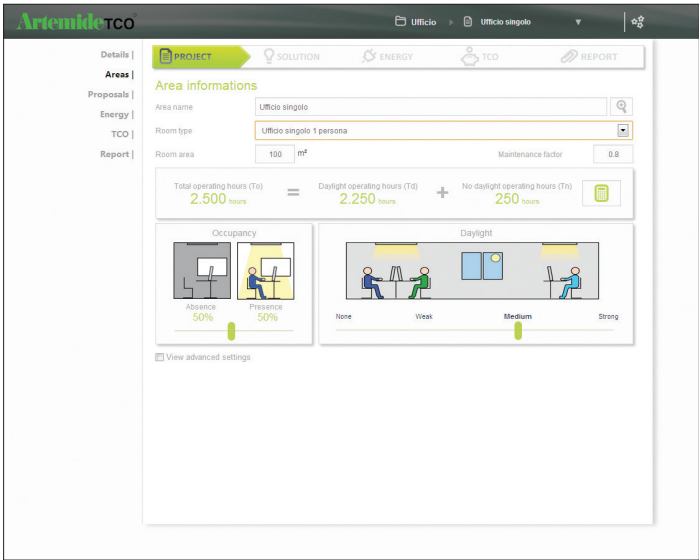


Figure 3.1 – PROJECT section

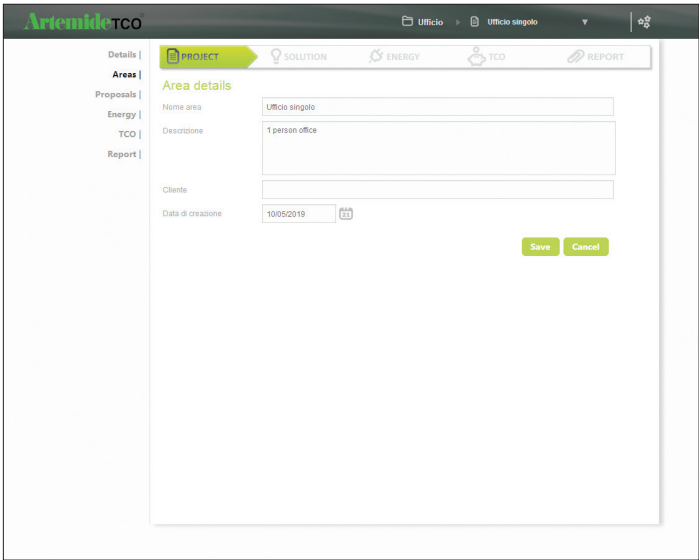


Figure 3.2 – Name and other references of the area

City and intended use of the system

In order to estimate the contribution of any natural light that there may be in the area, the geographical position of the system needs to be specified by setting the City parameter as the nearest main city to the locality.

The parameters *Type of building* and *Type of room* refer to the classification of the areas described in standard EN 15193. Various room types are suggested for each type of building. Each choice determines the setting of reference values for the parameter *Operating hours (To)* of the system.

Besides the operating hours, the standard also specifies reference values for the *Required lighting level* and for the *Absence factor (Fa)*, which indicates for how long the room is occupied by the end users during the operating hours.

Surface area of the room, maintenance factor and period of operation

The PROJECT section can be used to specify the surface area of the room expressed in m² and the maintenance factor (*MF*). It should be noted that the *Evaluation period* in the energy and economic evaluations is the one specified by the user for each project folder in the *Details* section seen earlier.

The choice of type of area determines the setting of the reference values defined in standard EN 15193 for the parameter *Operating hours (To)* of the system. This value is given by the sum of the hours in which there is natural light (*Td*) and those in which there is none (*Tn*), always with reference to one year. It is nevertheless possible to specify the period of operation using the window shown in figure 3.3, by clicking on the icon to the right of the values *To*, *Td* and *Tn*.

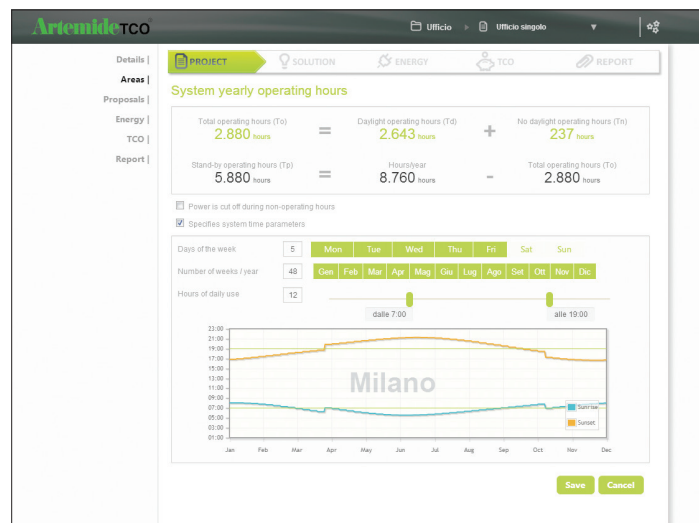


Figure 3.3 – Setting the annual operating hours of the system

The checkbox *The power is switched off in the hours in which the system is not in use* allows an evaluation of the consumption of energy during the hours in which the system is “off” (lighting level nil) but is nevertheless powered. This situation would involve consumption of energy, for example when DALI fixtures are used and/or when the system has control systems which remain active even when the area is not being used. By selecting the checkbox, the number of hours of stand-by T_p are considered as nil; otherwise T_p is obtained by considering the number of hours in one year less total operating hours T_o .

The checkbox *Specify the time parameters of use of the system can be used to calculate T_d and T_n automatically by setting simple parameters for the operation of the system*. Besides the number of days in a week and the number of weeks in a year, the weeks of use can be specified for each month of use. To select, click on the name of a month and then select (green) or deselect (grey) the required week of the month (see figure 3.3).

Place the mouse cursor over the name of a month to also display the tooltip showing the number of weeks selected (figure 3.4).

The number of hours T_d , T_n , T_o and T_p is calculated automatically by considering the *Hours of daily use* and the sunrise and sunset times for the selected locality. The graph displayed in the lower part of the window provides a graphical interpretation of the calculation, showing the progress of the various parameters during the year.

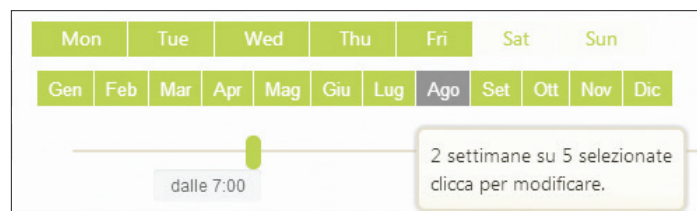


Figure 3.4 – Setting the weeks of operation for a specific month

Area occupancy

The choice of the type of area determines the setting of the reference value defined in standard EN 15193 for the parameter F_a (Absence), in addition to the percentage indicator of room occupancy (Presence). This parameter can also be personalised by the user as shown in figure 3.5.

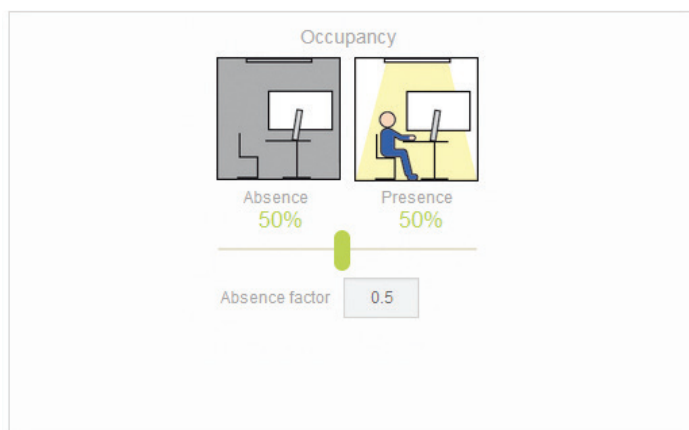


Figure 3.5 – Personalising the room occupancy indicator

Contribution of natural light

The evaluation of the contribution of natural light is the most critical stage in the calculation of the LENI, as the user does not typically know all the construction parameters needed to determine it exactly. These parameters may, for example, refer to the reflectance indices of the walls and the floor, the construction features of the windows and so on. Thus the application allows qualitative operation, where you can select the index of the contribution of natural light from the hypothetical situations illustrated by the image (Nil, Poor, Good, Excellent). If the user wishes, operation can also be detailed, with all the technical parameters specified (D_c , E_m , F_d s – see Annex), as shown in figure 3.6.

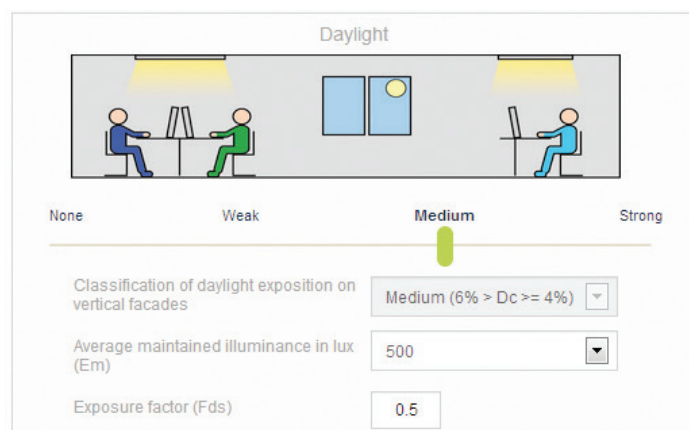


Figure 3.6 – Personalising the contribution of natural light indicator

The **SOLUTION** section shown in figure 4.1 is used to manage all the various design hypotheses that need to be considered in the energy and economic evaluations. Each solution consists of one or more groups of fixtures managed by traditional means (for example manual turning on and off by means of a switch) or by control systems (for example automatic turning on and off and regulation according to occupancy and the contribution of natural light).

A new solution can be added by using the *New solution* command in the top right-hand corner of the solution selection bar. To delete a solution use the command located next to the Name field. The user is required to confirm before it is deleted.

In the energy and economic evaluations, the energy saving and investment payback time values are always calculated by considering one of the solutions as reference and comparing the other solutions one by one. Up to five solutions per area can be created.

To select which of the solutions is to be considered as reference, use the option *Set as reference* in the solution menu that is displayed by clicking on the icon next to the name of the solution (figure 4.2). Obviously, only one of the solutions can be selected as the reference.

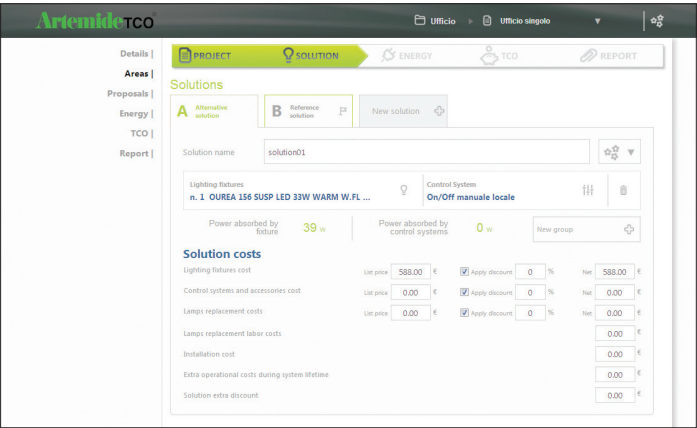


Figure 4.1 – SOLUTION section

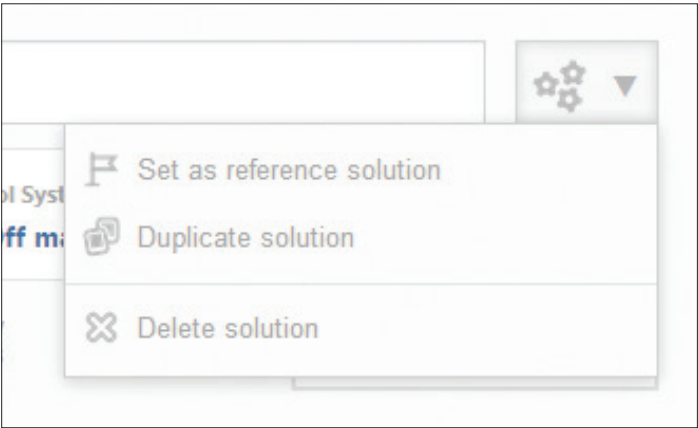


Figure 4.2 – Solution menu

Power consumption

The total power consumed by the components of the solution, that is, by the lighting fixtures and control systems, is calculated automatically by considering the choices made in the sections for entering the data described in the paragraphs below.

Costs of the solution

The costs of the solution can be calculated automatically by considering the price list costs of the components, to which a discount can be applied, or they can be entered directly by the user. The latter option is useful when the retail prices of the individual components are not known, such as for third-party products.

The labour costs for the replacement of sources are calculated automatically by considering their useful life, the evaluation period of the system and the ensuing number of *relamping* cycles.

The installation costs, any extra management costs incurred during the life of the system (for example for hiring platforms for the maintenance of fixtures installed at critical heights) and any extra discount on the total amount can also be specified.

Lighting fixtures

The various commands shown in figure 4.3 are used to add, modify or delete a group of fixtures. A group of fixtures can be added with the New group command. To modify an existing group, use the command icon next to the description. Both operations will display the window shown in figure 4.4.

The data can be entered in the following ways:

- Manual entry of all the values.
- Selection of a fixture from the products database using the Search in the database command next to the *Description* field. Using the window shown in figure 4.6, you can search for the required product by entering the first letters of the description (or product code) and selecting it from the table, or you can navigate manually in the table to select the required product.
- When a product has been selected, its data are shown (figure 4.7). At this point you can confirm the choice of the product (*Copy*), return to the table and select another product (*Cancel*), or return to the initial table (*New search*).
- If necessary, data copied from the Products database can also be modified. Such modifications will be stored exclusively in the project and will not have any effect on the data saved in the Database.

The *Quantity* field, that is, the number of fixtures of the group to be considered in the solution, can be set as required by the user or calculated automatically by the application. In this case the parameters of the project and the *Standard installed power* field (expressed in W/m2/100Lux) are considered as shown in the window in figure 4.5, and can be displayed by selecting the option *Display advanced specifications*. To enable automatic evaluation, select the option *Calculate automatically according to the standard installed power (W/m²/100lx)*, select the option *Calculation plan* and complete the field *Required lighting level* (see figure 4.5).

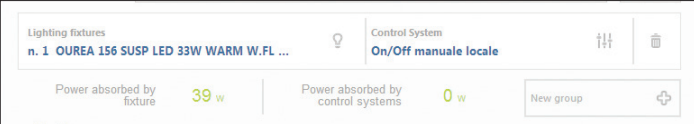


Figure 4.3 – Managing groups of fixtures in a Solution

The following are some comments on the parameters shown in the windows of figures 4.5 and 4.7:

- *Regulation technology*: if a fixture is dimmable, this indicates the control technology with which it is compatible (Leading/Trailing Edge dimmer (THE/TE), 1/10V, DSI, DALI, DMX).
- *Power consumption in standby*: indicates the power consumed by the fixture when its light level is nil but the power supply is connected. This parameter is important for DSI, DALI and DMX dimmable fixtures. Other types of fixtures cannot be powered if they are off.
- *Standard installed power*: laboratory-calculated parameter to estimate qualitatively the number of fixtures needed to light a room of a given surface area when a particular lighting level is required. This value is expressed in W/m2/100Lux.
- Some fixtures may have two separate types of light sources and the parameters can be defined for each type.
- *Time needed for bulb replacement*: this is the time, expressed in *minutes*, needed to replace all the bulbs of that type in the fixture. This parameter is used to calculate the number of relamping cycles during the whole evaluation period of the system.

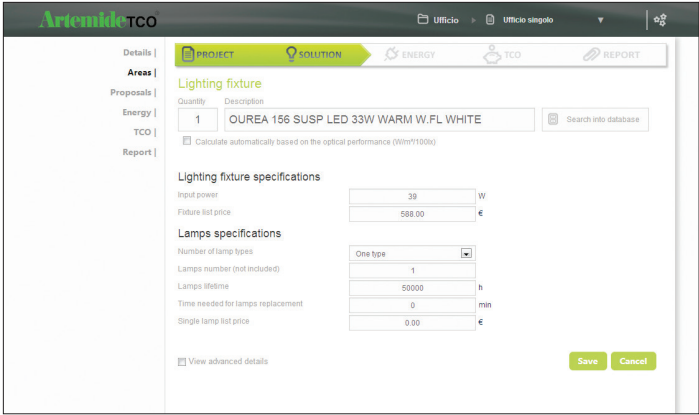


Figure 4.4 – Managing data relating to a group of fixtures in a Solution

Figure 4.5 – Advanced specifications of a group of fixtures in a Solution

code	family	description	price	power
L564200	RA SYSTEM	RA OTTECA 28W DIR-SCREEN L	294	0.00
L564300	RA SYSTEM	RA OTTECA 35W DIR-SCREEN L	332	0.00
L565000	RA SYSTEM	RA OTTECA 35W DIR-IND-SCREEN	282	0.00
L565100	RA SYSTEM	RA OTTECA 35W DIR-IND-SCREEN	321	0.00
L563000	RA SYSTEM	RA OTTECA 28W DIR-DIFF.	232	0.00
L563900	RA SYSTEM	RA OTTECA 35W DIR-DIFF.	252	0.00
L566600	RA SYSTEM	RA OTTECA 28W DIR-IND-DIFF.	220	0.00
L566700	RA SYSTEM	RA OTTECA 35W DIR-IND-DIFF.	248	0.00
L567800	RA SYSTEM	RA OTTECA 28W IND-ADIMM SX-DX	711	0.00
L567900	RA SYSTEM	RA OTTECA 35W IND-ADIMM SX-DX	784	0.00
L570100	RA SYSTEM	RA PANNELLO TERMINAL MICROF.	66	0.00
L570200	RA SYSTEM	RA PANNELLO INTERNAL MICROF.	105	0.00
L570900	RA SYSTEM	RA QUANTO INTERNAL MICROF.	34	0.00
L571000	RA SYSTEM	RA TESTATA TERMINALE	45	0.00
L571110	RA SYSTEM	RA CANALINA PASSACAVI 14W ESTREMITA'	113	0.00
L571140	RA SYSTEM	RA CANALINA PASSACAVI 28W INTERNAL	183	0.00
L571150	RA SYSTEM	RA CANALINA PASSACAVI 35W INTERNAL	178	0.00
L571210	RA SYSTEM	RA COPERCHIO CANALINA 14W ESTREMITA'	74	0.00

Figure 4.6 – View of the products database

Figure 4.7 – Selecting a fixture in the products database

Control systems

After adding a group of fixtures to the Solution, the control mode must be specified using the command icon next to the description, which will provide access to the window shown in figure 4.8. Select the mode with which the fixtures are managed from the dropdown menu System description. Various options are possible:

- *Manual control*: switching on and off, and possibly also regulation via local command, that is a control located inside the room and therefore managed by the end users, or via centralised command.
- *Automatic control*: switching on and off, and possibly also regulation via automation systems based on presence and light sensors.
- *Control via a particular family of control systems*: these modes are the same as the previous ones, except that the family of products used is stored in the products database and therefore all the related evaluation parameters are available.
- *User defined*: the user can enter manually all the parameters of the window shown in figure 4.8.

The total power consumed by the system and the total price list cost are calculated automatically by considering any components of the system that may be entered with the *System modification* command. If required, the user can personalise these values by deselecting the relevant checkboxes next to the insertion fields.

In the window shown in figure 4.9, which is accessed via the *System modification* command, you can set the control solution for the group of fixtures selected. Click on a record in the table to enter the component in the list below, the number of units of which must be specified in the Qty column.

The parameters for *Presence control* and *Light intensity control* (see figure 4.8) are based on standard EN 15193. For more information please see the Annex.

Figure 4.8 – Managing data relating to the control of a group of fixtures in a Solution

Figure 4.9 – Managing the components of the control system

Room plan

If the project was created by importing a .stf file generated by Dialux, the menu shown in figure 4.2 will contain the item Display room plan. Select this command to display the window shown in figure 4.10 in which the room plan will be displayed with the layout of the lighting fixtures used, including a key.

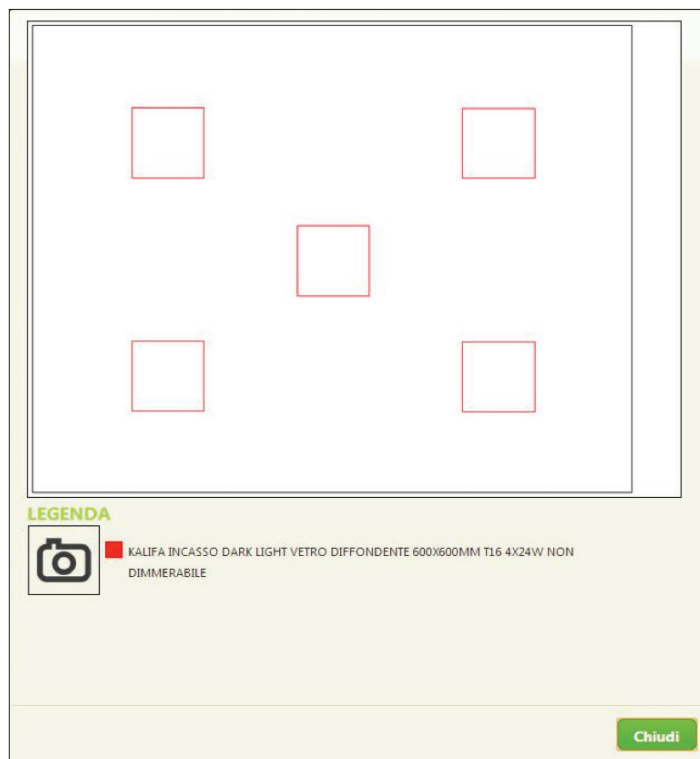


Figure 4.10 – Plan of the Solution (available only for projects created by Dialux)

The **ENERGY** section shown in figure 5.1 is used to display the results of the energy evaluations of the solutions. The LENI (Lighting Energy Numeric Indicator) is calculated in accordance with the procedures described in standard EN 15193 and is expressed in $kWh/(year \times m^2)$. The energy consumed and the amount of CO₂ produced refer to the entire duration of the evaluation period of the system. The energy comparison is calculated using the solution indicated with the “flag” icon as reference.

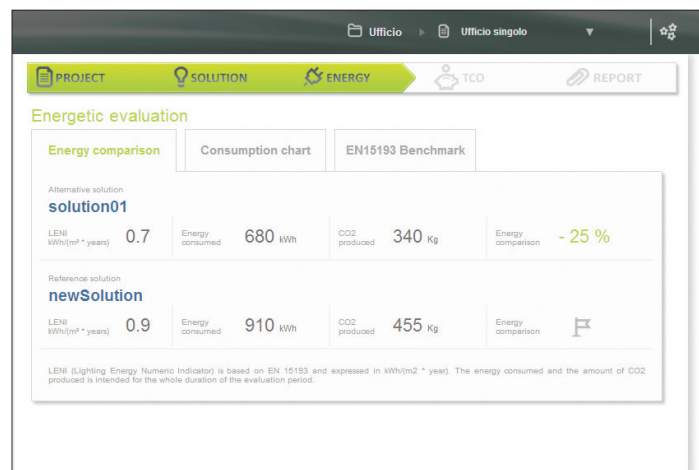


Figure 5.1 – ENERGY section: Energy comparison

If a solution has a greater consumption than the reference solution, the percentage value reported in the *Energy comparison* column will be positive, if not it will be negative.

Click on the *Consumption graph* tab to display the window that shows the energy comparison between the solutions as a graph.

The red bars show the solutions with the highest energy consumption, while the green bars indicate the solutions that provide energy savings, always in comparison with the reference solution, which is shown in grey (figure 5.2).

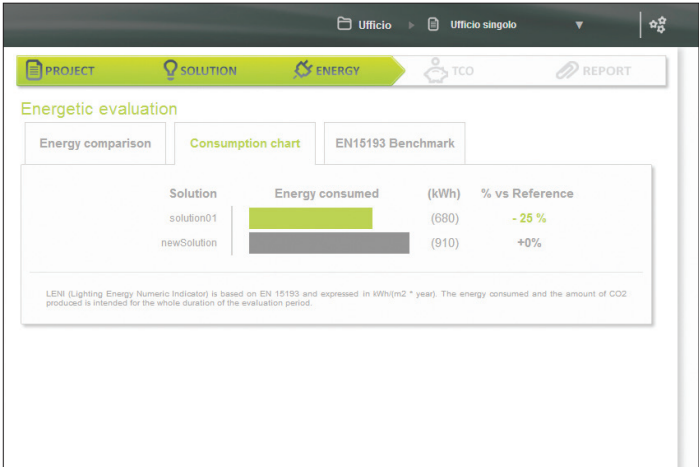


Figure 5.2 – ENERGY section: Consumption graph

EN15193 Benchmark

Click on the *EN15193 Benchmark* tab to compare all the solutions with the maximum LENI values specified in standard EN 15193 (figure 5.3). These values depend on the following parameters (set by the user):

- Criteria adopted for the lighting project.
- Presence of a control system to keep the lighting constant.
- Type of occupancy and daylight control system.

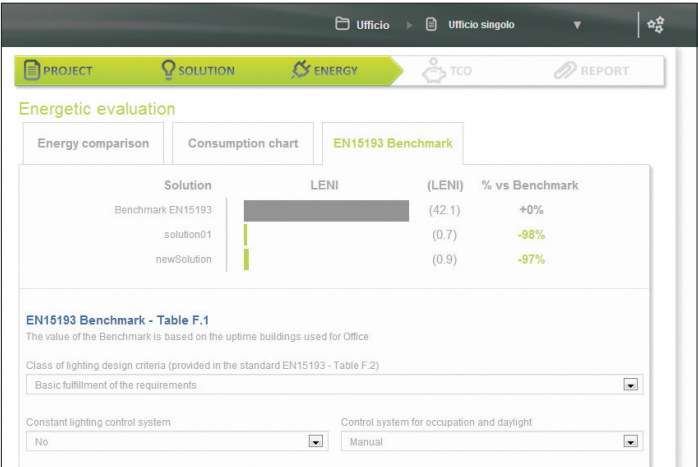


Figure 5.3 – ENERGY section: EN15193 Benchmark

6 TCO section

The **TCO** section shown in figure 6.1 is used to display the results of the economic evaluations of the solutions. The TCO (Total Cost of Ownership) indicator is the sum of the initial investment, the energy costs and the maintenance costs for the entire duration of the evaluation period. The *Payback Time* indicator, which shows the time needed to pay back the investment, is expressed in years and is calculated using as reference the solution indicated with the “flag” icon.

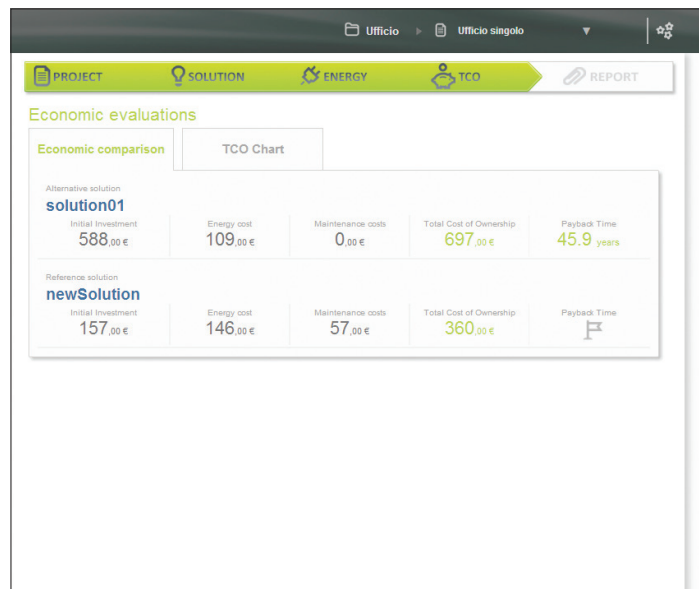


Figure 6.1 – TCO section: Economic comparison

If the *Payback Time* is not significant, for example when the reference solution has a higher initial cost or when the management costs are lower, the text *Not defined* is displayed in the table (figure 6.1).

Click on the *TCO Graph* tab to compare in graphic form the progress over time of the costs of the various solutions throughout the entire duration of the evaluation period (figure 6.2).

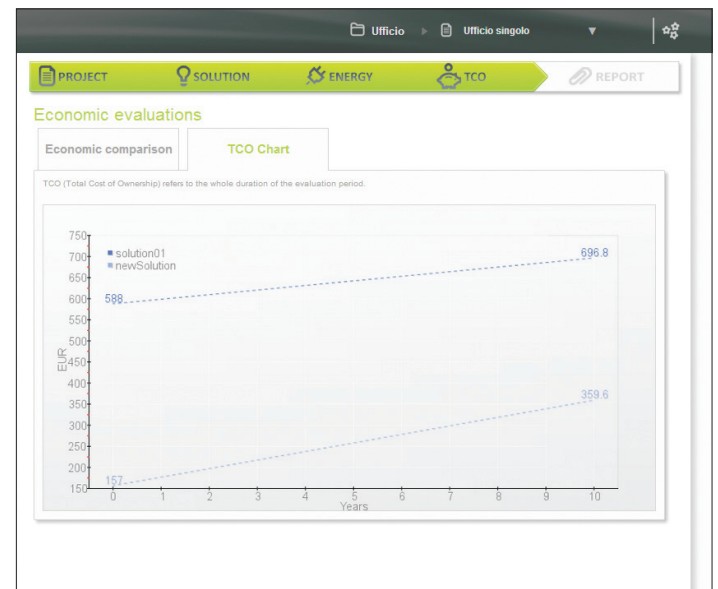


Figure 6.2 – TCO section: TCO graph

REPORT section

The **REPORT** section shown in figure 7.1 is used to display in advance the information of the summary PDF document of the entire project. Print options can be selected for each category of information. Use the *Generate document* command to create the PDF document and wait a few seconds (figure 7.2).

A new window will then open in which the PDF document that has been generated will be displayed (figure 7.3). To file the document, it must be saved on the user's PC as only the data relating to the project are saved on the server.

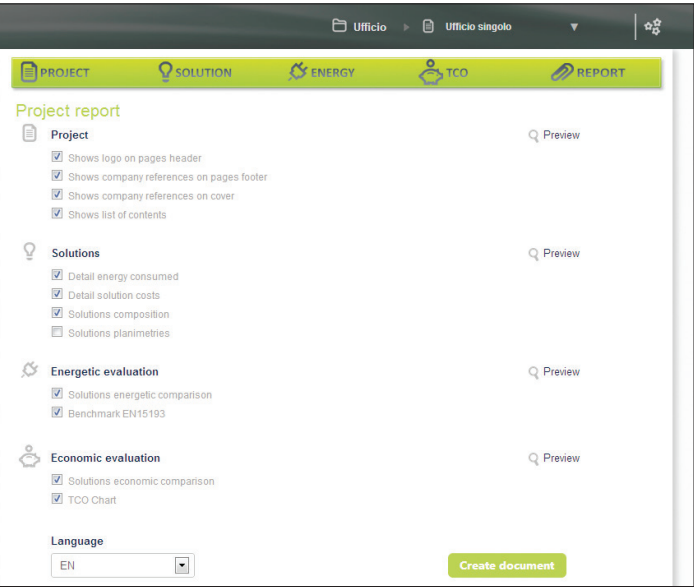


Figure 7.1 – REPORT section



Figure 7.2 – Wait message during generation of the PDF document

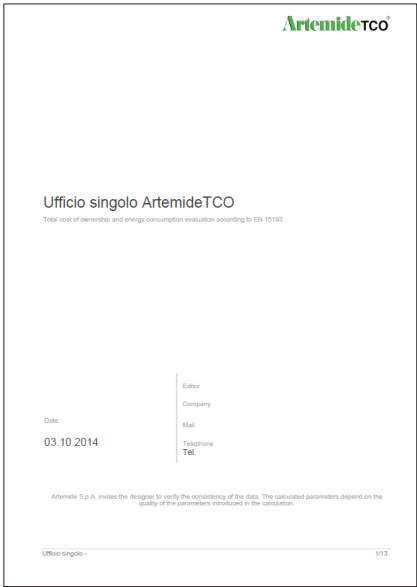


Figure 7.3 – PDF document with project report

This section of the user manual covers some technical subjects related to standard EN 15193, the calculation methods contained in the standard for the evaluation of the LENI and the methods for calculating the economic indicators used by the application.

European Standard UNI EN 15193

Since the technologies available in the field of Home & Building Automation have made it possible to get significant benefits in the energy consumption, comfort and safety of buildings, in 2002 the European Union issued the directive known as “EPBD – Energy Performance of Buildings Directive”. The matter of energy consumption relating to buildings was then taken up by the CEN (European Committee for Standardisation) for the purpose of drawing up precise calculation standards which would allow evaluation of the effect of automation and technical management on the energy consumption of buildings.

Thus standard EN 15232 “Energy performance of buildings – Impact of building automation, controls and building management on the energy consumption of buildings” was issued in 2007. This regulatory process is set to continue, since the EPBD directive must be transposed into national and regional legislation by the responsible bodies: it will be compulsory in the future to adopt automation and control systems, especially with regard to the management of lighting.

Standard EN 15232 evaluates the effects of BACS (Building Automation and Control Systems) and TBM (Technical Building Management) technologies on consumption and provides two methods to calculate their impact on energy performance. While the “BAC factors method” is statistical, the second method is detailed and allows exact results to be calculated, using reference regulations specific to each type of system (e.g. lighting, heating, ventilation, etc.).

Specific European legislation UNI EN **15193** was then defined for lighting systems, including the LENI (Lighting Energy Numeric Indicator) to express the energy consumed in a building based on a given m² in one year.

Calculation of the LENI (Lighting Energy Numeric Indicator)

The UNI EN 15193 standard specifies the methods to calculate the energy consumption of lighting systems inside buildings. By using a numeric indicator, which can also be used for energy certification, the consumption can be estimated both for existing buildings and for new constructions or buildings under renovation. The standard also provides the maximum energy values envisaged for the lighting of various types of buildings and enables the calculation of instantaneous energy consumed, which can be used to estimate the overall energy efficiency of the building.

The indicator in question is the **LENI (Lighting Energy Numeric Indicator)** which expresses the energy consumed for lighting in a building, based on a given m² in one year and is expressed in kWh/(m² x year).

$$\text{LENI} = \frac{\{(P_n \times F_c) \times [(T_d \times F_o \times F_d) + (T_n \times F_o)]\}}{\text{Area}} \quad [\text{kWh} / (\text{m}^2 \times \text{year})]$$

The variables that determine the value of the LENI in turn depend on various factors:

- **Pn** – expresses the nominal power of the lighting system
- **Fc** – depends on the overrating of the power of the system
- **Fo** – depends on the degree of the occupancy of the lit area
- **Fd** – depends on how the control system takes advantage of the natural light
- **Td** – expresses the number of hours per year in which the system works when there is natural light
- **Tn** – expresses the number of hours per year in which the system works when there is no natural light
- **Area** – expresses the surface area of the lit area.

The parameter Fc (Constant illuminance factor) is used to evaluate the energy savings resulting from the introduction of fixtures that can be regulated in combination with systems to control the luminous flux. The overrating of the system, expressed by the parameter MF (Maintenance Factor), means that the light level required from the fixtures can be lowered in order to maintain the required brightness. Though this contribution to energy saving drops as the light sources diminish, it is still present even when there is no natural light.

When the area is occupied irregularly and there is an automatic presence control system, Fo (Occupancy dependency factor) values are obtained; these are better the lower than 1 they are. This parameter determines the time in which the lighting fixtures are off, with the ensuing reduction in consumption and increase in the lifetime of the sources, which therefore also leads to a saving in maintenance and relamping costs.

The parameter Fo depends in turn on the following parameters:

- **Fa** (Absence Factor) – indicates the degree of occupancy of the area during the period of operation of the system.
- **Foc** (Occupancy dependent lighting control system factor) – indicates the effectiveness of the control system in managing the system according to the presence/absence of people in the area.

If the lighting system has fixtures that can be regulated and a system that allows the automatic management of the brightness in relation to the contribution of natural light, the parameter Fd (Daylight dependency factor) is less than 1. The reduction in consumption due to the ability to use the natural light clearly depends on the location of the building (latitude) and its construction characteristics, such as the geometric indices of the windows and the reflection coefficients of the walls and floor.

The parameter Fd depends in turn on the following parameters:

- **Dc** (Daylight factor for façade opening) – factor depending on the construction parameters of the building which determine the index of penetration of natural light inside the room (for vertical façades).
- **Fds** (Daylight supply factor) – factor of the availability of daylight which depends on the geographical location of the building, the maintenance light level and the index of penetration of natural light inside the room;
- **Fdc** (Daylight dependent artificial lighting control factor) – effectiveness of the control system in managing the contribution of artificial light in relation to that of natural light.

Calculation of the TCO and Payback Time

The Total Cost of Ownership (TCO) of a lighting system includes all the costs of various kinds incurred during the entire lifecycle of the system relating to materials, energy consumption and installation and maintenance activities. The following are the main factors to be considered:

- **Initial investment**

- Costs relating to the light fixtures, control system and accessories
- Costs relating to the installation and commissioning of the system

- **Maintenance costs**

- Costs for consumables
- Costs for maintenance activities

- **Costs relating to the consumption of energy.**

Energy consumption can be estimated by following the instructions provided by European Standard EN 15193, which describes a very detailed calculation method using the LENI (Lighting Energy Numeric Indicator) to evaluate the efficiency of a lighting system that may also have an automatic control system for presence and natural light detection.

Thus, to evaluate an investment, two or more design solutions are compared, each of which will involve different initial costs and management costs. The investment payback time can be calculated using the **Payback Time** indicator, a parameter that indicates how many years it will take to pay back a solution with a higher initial cost but which is more efficient in terms of management costs. The Payback Time is obtained by dividing the difference of the initial investment by the annual saving in energy and maintenance costs and is expressed in years.

Figure 8.1 shows the comparative analysis of two solutions in graph form by considering the TCO (on the right) and the annual cumulative costs of the system (on the left). The intersection between the two lines shows the *Payback Time*.

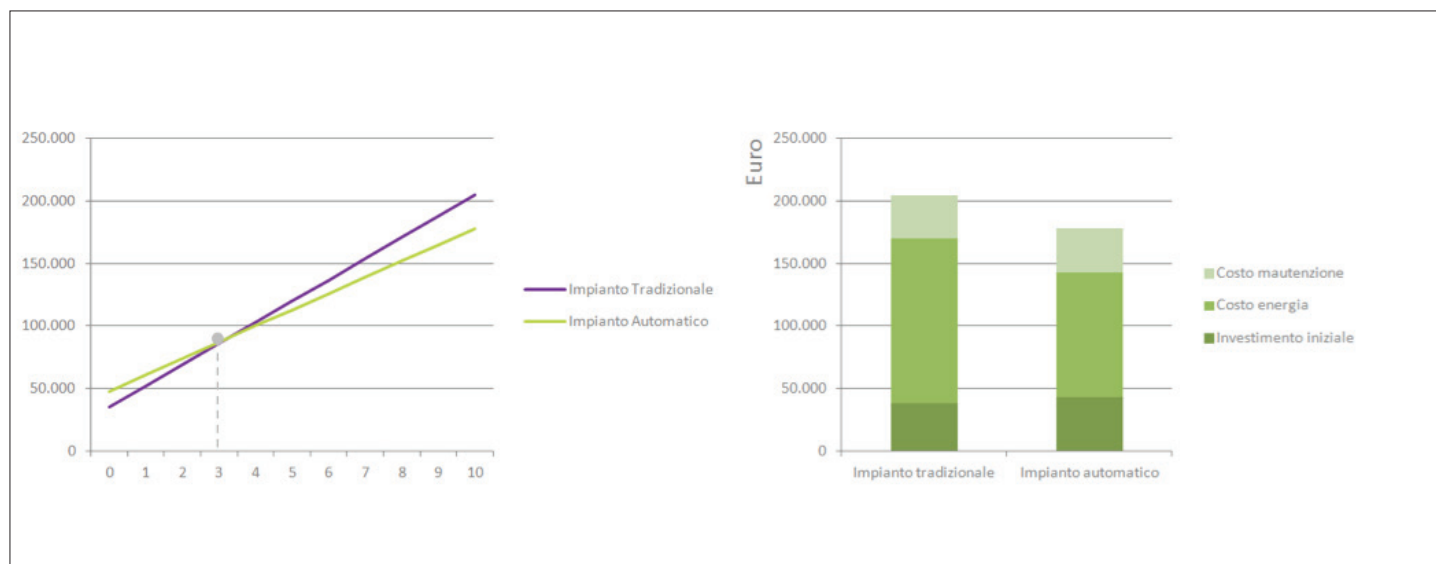


Figure 8.1 – Graphical representation of TCO and Payback Time

Compatibility with Dialux projects

The application can be used to create new projects from files generated by Dialux. Figure 8.2 shows the command of the menu *File>Export>Save STF file...* in Dialux which is used to export the STF file which will then be imported into the application.

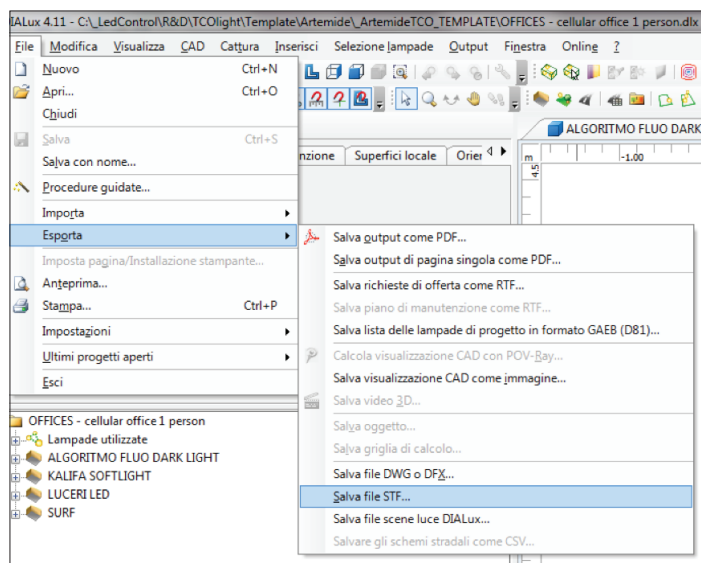


Figure 8.2 – Exporting the project in STF format from Dialux

However, it is essential to follow the guidelines set out below when creating projects in Dialux:

- The name of the project in the application will be the same as the one used in Dialux. For example in the figure 8.2 the name is "OFFICES – cellular office 1 person".
- Each room in the project will correspond to a solution in the application (*Solution*) and must therefore have identical geometric properties. To this end, it is recommended to use the *Duplicate room* command as shown in figure 8.3. The name of the *Solution* will be the same as the name of the room, for example "LUCERI LED".
- If a room project uses Artemide fixtures whose data are stored in the Database, the application will automatically copy all the information into the *Solution*. Alternatively, for example when using third-party products, all the energy and economic data of the fixtures used will have to be entered manually.

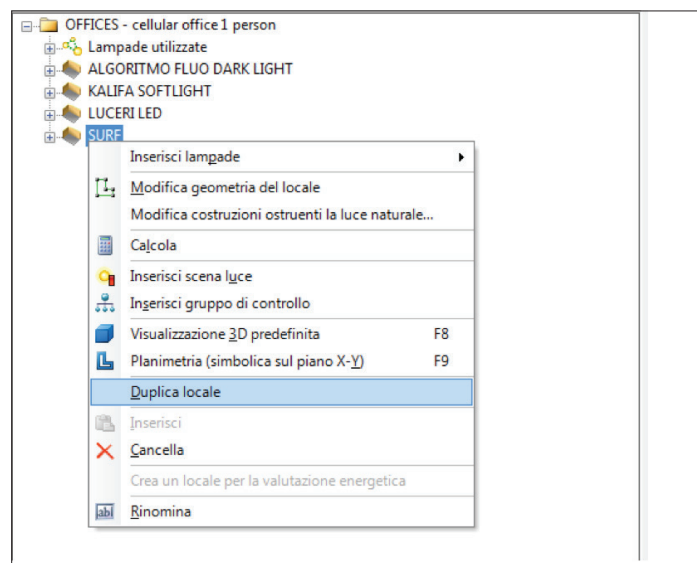


Figure 8.3 – Use of the Duplicate room command to create different Solutions

