Overview

This **Reference Guide** represents the complete guide of the program. It is addressed to all users whether they are using the program for the first time and hence need basic information or have already acquired a certain familiarity and need quick information on the functioning of a command or deepened information on particular characteristics and facilities of the program.

The program allows contextual use of these guidelines. **Pressing F1** opens the Help topic on which you are working.

System requirements

Before installation of BlueSol it is good practice to perform some procedures and tests.

Make sure that the computer on which you are going to install BlueSol meets the following requirements:

- **Operating systems:** Windows 7, Windows 8, Windows 8.1, Windows 10 each with latest Service Packs, MAC OS X (supported through the use of a virtual machine running Windows).
- **Internet connection:** Internet access is mandatory
- **RAM:** 4 GB
- **Free hard disk space:** 1 GB
- **Screen resolution:** min. 1024 x 768 pixels
- **Software:** .NET-Framework 4.52 (*)

User rights

To install the program you must have full access (admin rights) for its installation directory.

Country Settings: currency, numbers, time and date

The program adopts the currency formats, numbers, time and date established in the country setting on the control panel of Windows. These formats also appear on prints. Note that the thousands separator and the comma are different.

(*) The .NET framework 4.52 is installed automatically, if not present.

General description of the program

BlueSol is a software product that allows you to create the design of the following types of photovoltaic systems:

- Systems connected to the grid with or without energy storage on batteries in DC area or in a AC area.
- Systems standalone with energy storage on batteries in DC area or in a AC area.

This program helps the designer in all phases of project development, from the simulation of energy production to the production of documentation. Allows you to simulate the energy production of a PV system, and perform the economic analysis on the return on investment. Also checks the compatibility of connections string-inverter and generates the documentation of the project. In addition it incorporates a 2D/3D CAD engine that allows the insertion of system layout and generation of the electrical scheme. It also allows the dimensioning of the electrical components and cables.

BlueSol handles the following aspects of design:

Locations and irradiations: Defines the location and the irradiations, read from the database or specified by the user. It estimates the losses for far shadings being able detect the horizon line also from digital photos, and for near shadings recognized in Layout by the presence of obstacles next to the system.

System: Represents the scheme of the PV system and simulates its behavior by calculating the energy produced. In addition, the program sizes the grid of photovoltaic field checking the compatibility of the coupling between strings and inverters.

Layout: Allows you to enter the planimetry and the components that make up the system, to do this you are working on a map accessed directly from Internet. The modules and other PV system components are included in the planimetry in assisted mode using the program's tools and can then be modified and exported in DWG format.

In addition, the layout can be displayed in a 3D view that presents the arrangement of all elements of the system. In this 3D view are also displayed the shadows of obstacles close to the system and the distribution of irradiations on the areas of the PV system.

Electrical scheme: The single-line scheme is generated automatically based on the layout of the system and the electrical components. The design obtained can then be modified using the CAD functionality and exported in DWG format.

Electrical components: specifies the electrical components used in the electric panels DC and AC system. The program performs the electrical verification of all components and manages the storage in the archive of the models used most frequently.

Economic analysis: Provides the tools to analyze the convenience of the realization of the photovoltaic system, evaluating costs of realization and management and simulating the profitability during the period of observation. The program then produces graphs and summary tables exportable in xls format.

Energy consumption: Evaluates consumption and self-consumption of the user connected to the PV system. The program provides the tools to define the power consumption of individual electrical devices with which to create a database of reusable information. The combination of the consumption of the devices realizes a consumption profile that identifies the energy consumption of a user.

Print documentation: Creates and prints the project documentation, the program provides the templates for the technical and economic report. But also provides to user all the tools to create new custom reports.

Product features

Operating system	
Windows 7 (32/64 bit), Windows 8, Windows 8.1, Windows 10	
MAC OS X is supported through the use of a virtual machine running Windows	
Projects	
Grid connected systems	
Stand-Alone systems	New
Grid connected systems with AC-coupled battery storage	New
Grid connected systems with DC-coupled battery storage	New
Creating a new project using the wizard for the dimensioning of the photovoltaic system	Improved
Archives	
Archive of photovoltaic modules, modifiable and expandable	
Archive of the inverters, editable and expandable	
Archive of batteries, editable and expandable	New
Archive of inverter-chargers, editable and expandable	New
Archive of cables and other electrical components managed by the user	
Archive for consumption of electrical devices	
Archive consumption profiles	
Update of modules, inverters, batteries and inverter-chargers archives	New

Project properties	
No limit to the power of the system	
Data input: system, designer, customer	
Project Settings: system temperatures, sizing on power of the inverters, dispersions	
Location	
Data tables for the average irradiation of most important locations	
Insertion of new data of irradiation by the user	
Importing of the irradiations from PVGIS	
NASA-SSE world wide irradiations	
Choice of locations and geographical coordinates with the aid of maps (requires internet connection)	
Automatically adjust the radiation data based on the location on the map	New
Analysis of azimuth and tilt optimal. Possibility of differentiating the period of the year	
Automatic insertion of far shading diagram from digital images	
Import of SunEye obstruction elevations file	New
Editing far shading diagram	
Far shading loss calculation	
Near shading loss calculation	Improved
System	
Representation of the schema of the system in all its parts	
Calculation of the irradiation on the plane of the panels	
Calculation of the producibility of the photovoltaic system	

Checks on the coupling between strings and inverters	
Checks on the coupling between strings and charge controller	New
Checks on the coupling between battery bank and inverter-charger	New
Determination of the voltage drops and the flow rates of the cables	
List of the electrical components of the system	
MPPT management	
Microinverter management	New
Commands to cut, copy and paste the elements of the schema within the system schema	
Selection commands by type of the elements of the system	
Management of AC Panels connected to the main panel	
Ability to explicitly specify the cable lengths	
Verifications of the electrical components	
Management of the electrical protection groups in the panels	
Scheme of producibility of the sections of the system	
Automatic rename of the system components	
Wizard for the dimensioning of the photovoltaic system	
Wizard for the definition of cables	
Wizard for the dimensioning of electrical components	
Layout	All New
Interactive design of layout over map and 3D view	
PV systems on roof or on ground	

Automatic insertion of strings

Optimal filling of areas

Clear path management on area of strings insertion

Automatic insertion of inverters, panels and batteries

Edit of arrangement of inserted devices

Cables arrangement with measurement of the lengths

Management and edit of obstacles in the scene around the system

Points of shade evaluation

Shade diagram on point

Shadowing due to obstacles next to the system

Animation of shadings on the PV system

Calculation of map of distribution of radiations on areas with automatic mesh refinement

Calculation of map of distribution of shading frequency on areas with automatic mesh refinement

Management of preview of system layout

Preview 2D and 3D of system layout with or without realistic textures

Exporting system layout to DWG

Exporting system layout to image

Results

Verifications on the inverter: limits on the voltage, limits on the current, limits on the power

Verifications on the inverter: calculation of the input voltage to the inverter calculated by reference to MPPT trackers

Verifications on the battery: limits of voltage incoming on charge controller New

Verifications on the battery: limits of current incoming on charge controller	New
Verifications on the battery: limits of power incoming on charge controller	New
Verifications on the inverter/charger: limits on the battery charging voltage	New
Verifications on the cables: voltage drop, capacity, calculation of the maximum voltage drop in the system	
Verifications of electrical components	
Use of PV energy	New
Consumpion coverage	New
Days of autonomy for stand-alone system	New
Economic analysis	
Analysis of profitability of the system with assessment of financing	
Cash flow over the life of the system	
Management of taxation	
Management of incentive rates	
Energy sales	
Tools of analysis of the consumption and self-consumption of the system	
Export in xls format of the summary tables	
Electrical scheme	
Automatic generation of single-line electrical scheme	
Schema creation options: choice of layout. paper size. height of the character of the texts. display full or partial of modules and strings. The options for creating the schema are saved in the project	
In the regeneration of the electrical scheme the user	

can keep the primitives he had created

Editing and printing of the electrical scheme with advanced CAD capabilities

Exporting to DWG and DXF

Print Documentation

The technical documentation of the project is produced as editable Word documents obtained from customizable templates

Technical report

Economic report

Bill of cables

Bill of electrical components

User-created documents

Integrated RTF editor Improved

Support

To get support using your product, you will need to enter the Support section of our website www.bluesolpv.com. Here you can open a ticket to get answers from technical support or you can try in the Knowledge Base area if the topic has already been discussed.

Also provided is a **free service of maintenance** of software that allows you to work with the latest version of our programs and have the most recent data available of components

The following services are included in the maintenance:

- Software updates to the purchased version
- Database updates
- Response to e-mails by technical support

Maintenance does not include:

- Purchase of upgrades to new major versions
- Personal telephone support

Evaluation mode

Until the product is not registered it will operate for 15 days from the date of installation in evaluation mode. The evaluation mode of this program has no restrictions and you can try the product with the same functionalities as the commercial version.

☞Also notice that the projects carried out and the data inserted in the database using the evaluation version can still be used when you will decide to buy the licence of the commercial version.

Licensing

Licensing Terms

The program can be installed on multiple computers, but can be used on a number of computer equal to the number of licenses purchased..

If you need to use the license on another computer, such as a notebook, you can easily transfer the license on this computer.

Activation key

When you purchase the program, you will receive an Activation Key

This consists of a combination of 24 digits, that must be entered entirely, including the characters hyphens.

You will receive the activation key by e-mail when purchasing the product..

The activation key uniquely identifies the license holding by the user.

Registration ID

The Registration ID uniquely identifies your computer on which will be installed the program. This is automatically generated by the program and is displayed in the license activation window

The Registration ID is automatically communicated to CadWare during the automatic activation of the product or, in the case of manual activation, sent by e-mail with the Activation key.

You cannot enter the Registration ID alone.

License activation

Before using the program, it must be activated. This can be done automatically or manually.

After the installation completes you can run BlueSol, then a window will appear requiring activation of the product:

Automatic activation: The Activation key, inserted during installation, will be proposed in the window, then click *Auto activate* and the program will be immediately activated through the Internet connection to the CadWare activation service of software

> ☞ To perform this procedure **you must have an Internet connection** on the computer where you installed the program. ATTENTION, the internet connection is only necessary during activation, then the program can also be run without Internet connection.

Manual activation: You send an email to support@cadwaresoft.com in which you specify the Activation key and Registration ID proposed in the Product activation window. You will receive a reply via email containing the License key to be inserted, then click *Manual Activate.*

> ☞ We recommend using the manual activation only in the absence of an Internet connection on your computer.

Completing the activation of the license the program will be run.

License deactivation

The license deactivation of the program is a necessary procedure to use the program on multiple machines while being in possession of a single license, or in general to transfer the use of the program on another computer.

From the Main Menu of BlueSol you run the command *Deactivate license* that opens a window that allows you to deactivate the license:

Automatic deactivation: Enter the activation key and click *Deactivate*. The program automatically connects to the activation server to deactivate your license. The license that you have disabled can then be re-activated on this or another computer.

Activation key proposal is that with which you activated the product.

> ☞ To perform this procedure, **you must have an Internet connection on the computer** where you installed the program.

Manual deactivation: You send an email to support@cadwaresoft.com in which you specify the Activation key. You will receive a reply via email containing the Registration ID to be entered in the appropriate field. Then, click *Deactivate manually*, so you will get the license key. Transmit this key to the producer that will disable the license.

> ☞ This deactivation procedure should only be used in the absence of an Internet connection on your computer.

This operation, if successful, requires the closure of the program.

The license so deactivated is available to be used on another computer, always using the same Activation Key in the Activation window that will be proposed.

Transfer license to another computer

In some instances it is necessary to use the software on more than one computer, such as a desktop computer and a notebook, and you have only one license of the program.

Because you cannot use the same license at the same time on more than one computer, you must disable the license from the computer on which it is active. At this point, when you run the program on a new computer will be requested the activation by proposing the activation key used when installing or in the last activation. Just click *Auto activate* and the program will start.

This operation, if done on a computer with an Internet connection, is very fast.

Updates

The program automatically checks, for each execution, if an update is available. If you have a newer version informs the user. This service only works if the computer on which the program operates has an Internet connection.

However, you can check at the www.bluesolpv.com site , in Download/Updates area, the presence of updates. On the main page is always reported the number of currently available version. You can know the version number of your BlueSol opening the window About BlueSol.

If there is a software version newer than you have, download the update and do the installation by executing the file you downloaded.

The installer does not need to uninstall the version you are currently using.

User license

CADWARE SOFTWARE LICENSE AGREEMENT

THE USER MUST READ THE CONDITIONS OF THE LICENSE AGREEMENT CAREFULLY BEFORE USING THIS SOFTWARE.

USING THE SOFTWARE, USER AGREES TO THE TERMS OF THE LICENSE.

Under the terms and conditions that follow, CadWare S.r.L. is required to provide under license, for a fee, the User the enclosed software with its user documentation.

Any previous verbal or written agreement between the parties is canceled by this contract.

1 Using the license

1.1 CadWare S.r.L. grants the User the non-exclusive use of the software reserving any other rights arising from the ownership of the software and user documentation.

1.2 The software is protected by an activation key that allows the activation of the license on a single computer. User can transfer the license from one computer to another at any time without limitation. The activation can be either automatic (it requires an internet connection) or manually.

CadWare S.r.L. provides an activation key different for each license purchased.

If the User wishes to transfer the license to another computer, he should deactivate the license on the source computer and then follow the normal procedure to reactivate the target computer. The User cannot use again this same license on the source computer.

1.3 The User must not modify, translate, engineer, decompile, disassemble, create applications, or anything else that may cause deviations from the original software based on the software itself. The User may not alter or modify the installer or create a new installer for the software.

1.4 The User may not modify, translate, adapt, create applications, or anything

else based on the documentation submitted in support of use of the software by CadWare S.r.L.

2 Sub licenses

Are prohibited.

3 Transfer of rights

The software and related user documentation may not be transferred, assigned, leased, or given in use to third parties without a prior written consent of CadWare S.r.L. that may, at its discretion, refuse.

4 Ownership

4.1 The software is owned by CadWare SrL and is protected by copyright under national legislation Italian, EC legislation and the provisions of international treaties to which Italy is a party.

4.2 The license confers no title or ownership of the software and should not be construed as a sale of any right in the software.

5 User’s obligations

5.1 The user undertakes to satisfy the conditions set out in this license and to consider the software and related documentation for use strictly personal. To this end, he will allow access to the software only to qualified personnel that will be required to comply with this license. In any case, the User shall be responsible for his own behavior and that of those who access the software, authorized by him, for any use and misuse of the software used under license.

5.2 The User is responsible for protecting its activation key(s) from being used by a third party that may access the software.

5.3 The User should not communicate his customer ID to a third party, neither give the license rights or the activation keys.

5.4 Non-compliance by the User with this obligations will lead to legal sanctions.

In this case, if the payment has been made or if the activation key has already been delivered to the User, CadWare S.r.L. has the right to block the access to the software without returning the amount already paid by the User.

6 Trial

This software is not free. When User first obtains a copy of the software, an evaluation period is granted.

During this evaluation period, the software has some functionality limitations that preclude its productive use, but allow a complete evaluation of the product, supported by the documentation provided. If the User desires to use the software after this period, he must buy it.

User is expected to use the software thoroughly evaluating its usefulness and functionality before making a purchase. This "try before you buy" approach is the ultimate guarantee that the software will perform to User’s satisfaction; therefore, User understands and agrees that there is no refund for any purchase of the software.

7 Limited warranty

All warranties, statements regarding the performance, quality, suitability for the use of the software and the user documentation are excluded from this license.

8 Unforeseeable circumstances

The occurrence of unforeseeable events and facts, such as natural or accidental disasters, offenses committed against the User, improper use of the software, functioning of the software in an operating environment not compatible or different from the one indicated are not chargeable to CadWare S.r.L. and therefore CadWare S.r.L. will not respond.

9 Liability

9.1 The software takes into account as far as possible the current state of the technology.

CadWare S.r.L. does not guarantee the results of the software, which depend to a large extent on the parameters determined by the user. The validity of the content of meteorological databases and the validity of components databases cannot be guaranteed.

Under no circumstances CadWare S.r.L. shall endorse or be responsible or liable for the consequences of a difference between an estimate of the software and a real situation.

9.2 CadWare S.r.L. shall not be liable for damages caused to the user by original defects or supervening in the software supplied, even if CadWare S.r.L. has been advised of the possibility of such damage.

9.3 CadWare shall not be liable for any direct or indirect damage suffered by the User or third parties caused by the use or non-use of the software.

9.4 USING THE SOFTWARE, USER ACKNOWLEDGES AND AGREES THAT HE IS THE EXCLUSIVE RESPONSIBLE FOR PROPER USE OF THE SOFTWARE, OF THE VERIFICATION OF DATA USED, OF THE CORRECT INTERPRETATION, AND OF THE NEED TO CONTROL THE RESULTS OF ELABORATIONS.

10. Technical support

10.1 CadWare S.r.L. has no obligation to provide maintenance, support, updates, enhancements, or modification.

10.2 As far as possible, CadWare S.r.L. will provide technical support to the User for the current version, however without a guarantee of success. Technical service is provided by e-mail.

10.3 If a dysfunction occurs, CadWare S.r.L. will try to correct the error as quickly as possible.

11 Express termination clause

Apart from the cases of resolution expressly provided for by Italian law, this License shall be deemed terminated in law in case of violation of art.1 (Using the license), art.2 (Sub licenses), art.3 (Transfer of rights), art.4 (Ownership), art.5 (User’s obligations), art.6 (Trial) as these are essential conditions for CadWare S.r.L.

12 Applicable Law

This License is governed by the laws of Italy.

13 Competent jurisdiction

For any dispute which may arise from this license, jurisdiction is that of Padua, Italy.

14 Invalidity

The invalidity of any of the provisions of such license does not make it totally invalid.

User Interface

This section explains how to access the commands BlueSol and how to get familiar with its interface elements.

The interface means the main window; it consists of:

The Title bar with the name of the project.
The Menu bar for the entering of commands.
The Status bar for information.

Title bar

Placed along the upper part of the window contains the name of the program and the current project. The project name when the program is Untitled.bsp.

In the title bar also appear very common commands using the program:

- Open a project
- Save a project
- Dimensioning wizard
- Verifying system

Menu bar

Located below the title bar along the upper part of the window contains all of the BlueSol commands.

Each menu indicates a homogeneous category of features that realize some aspects of the design of the photovoltaic system:

Home; project management and utilities as general maintenance of databases.

Properties; general data of the project and the PV system, of the customer and of the designer.

Location; choice of locations of the photovoltaic system, determination of its irradiation and definition of shadings.

System; definition of the photovoltaic system and its constituent components.

Layout; Planimetry and placement of the system, insertion of modules and cabling, evaluation of shadings due to objects near the system. 3D simulation of shading and distribution of radiations on the scene.

Economic analysis; costs, financing, consumptions, incentives, profitability of system.

Electrical scheme; creation of single line electrical scheme of system.

Results; analysis of the final features of the photovoltaic system.

Reports: when the project has been completed it will be possible to automatically generate the documentation and then print or export in PDF format.

Each menu opens a page containing data, charts, diagrams or drawings of its design aspect.

Status bar

This is the area of information provided by the program, from left to right, the information displayed is:

Peak power [kW] of the system that you are designing, updated in real time to changing system requirements.

Estimated annual energy production [kWh] of the system that you are designing, updated in real time to changing system requirements.

Alert for recalculation of Near Shades losses

In addition, the right area of the status bar displays a progress indicator during operations in which the program requires waiting times.

Home page

This page contains the main commands for managing the program and projects, as well as tools for consulting and maintenance of the database used by the program:

Project management:

- New project
- Open an existing project
- Saving a project

Program tools:

- General settings of the application
- Import and export functionality
- Settings of application
- Reference guide

Database maintenance

Open an existing project

The *Open* command allows you to load in memory a previously saved project.

In addition, the reading of a project can be done by clicking on the name of one of the projects recently read, displayed in the list at the center the opened page from the Home menu.

Save a project

The *Save* and *Save As* commands allows you to save on disk the project currently in memory.

The files saved by the program have the extension .bsp.

New project

The *New Project* command creates an empty project named Untitled.pvp, and automatically run the Sizing Wizard.

This wizard will guide the designer in sizing the PV system.

Settings of the application

The *Settings* command on the Home menu opens the window that manages the program settings.

Many of the parameters that are set are present, with the same meaning, even among the project properties. Difference between them is that the program settings are the default values that are assigned to the project properties when you create a new project. Note that changing the setting parameters of the program does not change the properties of the current project.

General

General Settings on the functioning of the program. These parameters configure some features of th operation of BlueSol Design.

Verifications

Defining the parameters of the verifications on the system. These are the default values that the program uses when you create a new project, then these settings can be changed separately for each project in the project properties.

Losses

Definition of the parameters of loss of power of the system. These are the default values that the program uses when you create a new project, then these settings can be changed separately for each project.

System

Definition of default parameters for the design of the system. These values are automatically assigned to the corresponding project properties when you create a new project.

Economic analysys

Parameters relative to economic analysis features, like the currency text

Language

Set the language of BlueSol's user interface. To make active this option you must close and reopen the program.

Conventions

Setting the convention used by BlueSol for azimuth angles in the orientation of the PV modules, you can use two conventions:

- The angle 0° is always to the north for both hemispheres
- The angle 0° is to the south or north depending if the location is on northern or southern hemisphere

Designer

Data of designer of the photovoltaic system. These values are automatically assigned to the corresponding project properties when you create a new project.

Updates

Setting parameters for automatic update of the program.

With this option, the update is not installed but it is reported that there is an update.

Photovoltaic project

Creating a new project takes place with the Wizard of the photovoltaic system, this tool guides the designer at all stages of the project and simplifies the learning of the program's capabilities.

This is the set of all the information which characterize the photovoltaic system.

- Properties: General information on the project
- Location and shadings: Location systems installation and shadings
- System: Definition of the composition of the photovoltaic system
- Layout: Planimetric arrangement of the photovoltaic system
- Economic analysis: Economic evaluation of the convenience of the realization of the system
- Electrical scheme: Circuit diagram generated automatically by the program

Wizard of photovoltaic system

This tool allows you to create, quickly, a scheme of system. The procedure does not control all the parameters of the photovoltaic system that the program is able to manage, but covers the design requirements of the most common situations.

These are the sections in the wizard:

- Choice of type of photovoltaic system
- Properties of project
- Location of system
- Users consumption
- Project settings
- Sizing batteries on Grid Connected
- Sizing batteries on Stand Alone
- Select photovoltaic module
- Placement areas of system
- Modules arrangement
- Inverter sizing
- Electrical panel DC and AC
- Electrical Components sizing

Using the Wizard it is very important to have an Internet connection.

In the event of a connection you will be able to use the program geo map features, so you can locate the installation site of the plant and immediately implant the layout, this latest functionality increases the possibilities of choice in sizing.

If the Internet connection is not available, you can still use the wizard, but the location of the system can be defined by nominally locating the location and the layout can not be realized at this stage.

☞ Each page of the Wizard has a contextual help that can be clicked on the Help

button or by pressing F1

The wizard can be used to make a guided sizing, accepting however some simplifications in the composition of the system. In this way you get to quickly implement a first schema that can then be anyway completely modified and completed with the normal modeling tools of the system.

Wizard - Choice of type of photovoltaic system

You choose the type of photovoltaic system you want to design:

- **Grid connected system**, the system is connected to utility grid with which it can exchange energy in bidirectional way. For this type of system is also possible the energy storage with batteries.
- **Standalone system**, the system is completely isolated from the utility grid and can only use a backup system different from the power supply.

☞ Note that this choice cannot be modified in the continuation of wizard

Wizard - Properties of photovoltaic system

This section defines some of the major system properties, the rest can be completed after running the wizard on the Properties page.

If the internet connection is active, it is important to note that the Country field is mandatory, as well as at least one between City and Zip Code must be mandatory. This is important because it allows immediate identification, on the map, of the site of the system. If the address is also entered, the positioning is even more accurate.

Wizard - Location of system

You can choose the location by specifying the Country, Location, and/or Zip Code, then the user can move the map to look for the installation site. The Climatic data selection chooses the data source, this can be different by changing the Country. All countries have at least NASA-SSE data available.

The *Irradiances* button shows the climatic data for the location currently displayed on the map.

👉 In the Location field you can also enter the full address

 **If there is no internet connection:**

You make the choice of location of the PV system, the button Select location... opens a window where you can choose one of the locations in the database, or enter data of irradiation specified from user.

Wizard - Users consumption

If you design a stand alone system or grid-connected system with energy storage, it is necessary to evaluate the electrical consumption of the user connected to the system.

The most accurate way to evaluate user consumption is to use an electrical consumption profile. This allows you to obtain more accurate results in simulating self-consumption, in the days of autonomy calculation in a stand alone system and in the energy coverage calculation in grid-connected systems with storage. In this case, for simulation, the program distributes the average daily consumption throughout the day for all days of the year.

> The results improve if the precision of the electric load profile approaches as much as possible to the actual situation, but rather than simply using average daily consumption it is best to create a simple load profile with a dummy device that roughly reproduces the distribution of consumption.

By clicking the check mark *Specifies the details of electricity consumption* you will be able to use an electrical consumption profile. On this profile will be calculated the average daily consumption which can also be calculated in the most unfavorable conditions by clicking on the check mark *Search the most unfavorable consumption period.* Where the period is the number of days on which the most unfavorable load conditions are assessed.

Project settings

In this section of the Wizard, the designer defines the settings in order to decide the power or the producibility of the photovoltaic system. In addition, some general parameters are defined as to how the system will be realized.

Power of system:

The power or the energy produced can be defined or by working directly on the layout of the system or through the explicit choice of designer

In first case the power of system is calculated by the program based on the arrangement of the modules on the areas available for the placement of photovoltaic modules. This operation is carried out by drawing the system layout directly on the map.

In second case the power of the system is chosen by the designer, the wizard will create a system with equal length strings and equal inverters.The layout of the system and any changes to the system scheme may be executed by the program outside the wizard.

In this case, the designer must specify the orientation of the photovoltaic field setting the angle of inclination (tilt) and the angle of orientation (azimuth) of the photovoltaic field. Assumes the simplification of having a unique arrangement of strings for the entire system photovoltaics. Once you have completed the wizard, you can change the orientation of the strings, if necessary, using standard modeling tools.

Arrangement:

If the system power is defined by the layout, the arrangement of the modules can be:

- Free, the program optimizes the arrangement of the modules in the sectors present in the layout areas to try to get the greatest possible power.
- Constrained by target power, the user specifies the desired power for the system, so the program arranges the modules in the layout so as to achieve this target. Note that the program may warn you that there is not

enough space in the layout to reach that power.

- Constrained by energy to be produced, the user specifies the desired energy production for the system, so the program arranges the modules in the layout so as to achieve this target. Note that the program may warn you that there is not enough space in the layout to reach that energy production.

If the system power is defined by designer, the power or the energy to be produced can be specified, but the goal is always to know the power of the system, which means that the power of the system will be calculated as the power which will be able to produce the specified energy based on orientation of photovoltaic field (Tilt and Azimuth).

Settings:

Definition of general parameters for the realization of the system:

- Maximum DC voltage from photovoltaic field, sets the maximum DC voltage output from the photovoltaic field, this limits the length of the strings.
- System built using micro inverter, the system will be designed using only micro inverters. This choice affects certain features of the wizard that no longer provides a DC section.
- Storage layout, decides between two accumulation design approaches: DC-coupled battery storage or AC-coupled battery storage.

 If the batteries are inserted in the DC section and if the arrangement of the modules is performed directly on the layout, the wizard runs a sizing of system with a only exposure of the photovoltaic field, a single charge controller and only one inverter. This limitation can however be overcome by operating changes in the schema of system after the completion of the wizard.

- Tracking system of strings, specifies the type of strings tracking and its configuration. This is applied to all strings in the system.
- System placement, chooses whether the system is made on a roof or on the ground.

Sequence of choice:

You can decide the sequence of choice between modules and inverters, but this option is only useful if the power of the system is chosen by the designer, in fact if the power is defined by the layout of the system, the designer always chooses the module first.

If you want to choose primarily the photovoltaic module, after the choice of the model, the program offers a number of possible compositions of the grid to obtain the required power for the system. You can also choose the number of the inverter on which divide the grid of photovoltaic system. The division is carried out as far as possible uniformly on the inverters.

If you want to choose primarily the inverter, the program requires the definition of the number of inverters you want to use. The power of the system will still be equally divided on the number of inverters. The window also displays the list of inverters compatible with the request power, the search is performed within the database of inverter of the program.

 **If there is no internet connection:**

You cannot use the layout features of the program, so the designer can only explicitly choose the power of the system and only the *Power or energy production defined by designer* option is enabled.

Wizard - Sizing batteries on Grid Connected system

A suitable sizing of the battery bank for a grid connected photovoltaic system allows to storage the energy produced and not self-consumed by the user. Energy that in the absence of the battery storage would be fed into the grid.

There is no unique battery sizing criteria in this case as the designer can search for different targets for energy storage. Depending on battery choice and battery bank size, the program will be able to simulate how the user's energy consumption will be covered between self-consumed energy, from battery and utility grid.

The *Consumption distribution* explains what is the source, on annual basis, of the percentage of energy needed by the system user. In addition, the values of the energy produced and consumed by the user and the amount of energy exchanged with the utility grid are shown in *Result of storage*.

If you are not using a profile of electrical consumption for defining the annual consumption, but you are simply assigning the Average Daily Consumption, the calculation of Consumption distribution must be considered as indicative and its reliability is low. It is recommended to use a profile of electrical consumption to have a more accurate result.

If the system is **DC-coupled battery** storage, it will be necessary to size a charge controller compatible with battery bank and PV field. Compatibility between battery bank and charge controller is verified by:

- Open circuit Voltage < Maximum voltage of charge controller
- Maximum current from PV (short circuit current) < Maximum current capabilities of charge controller
- Maximum power from PV < Maximum operative power of charge controller
- The nominal operative voltage of charge controller = Nominal voltage of battery bank

furthermore if charge controller is Mppt:

- Minimum Mppt voltage from PV > Minimum voltage MPP allowed by charge controller
- Maximum Mppt voltage from PV < Maximum voltage MPP allowed by charge controller

The program will propose a list of compatible charge controllers among those present in the archive

If the system is **AC-coupled battery** storage, you need to insert an inverter/charger in the AC section, the compatibility battery bank and inverter/charger is verified by:

- Power of inverter/charger >= Peak power of users consumption
- Battery voltage <= Maximum charging voltage of inverter/charger
- Battery voltage >= Minimum charging voltage of inverter/charger

Wizard - Sizing batteries on Stand Alone system

The goal of sizing a battery bank in a stand alone photovoltaic system is to provide the user with a number of days of autonomy. *Days of autonomy* are the number of days the battery bank can support the project load without the solar contribution.

After making the choice of the battery type, the *Days of autonomy* can be modified by the designer along with the *Depth of discharge (DOD)* and the battery *Voltage*, the program calculates the size of the batteries bank to achieve the desired autonomy.

Depending on the user consumption setting, average daily consumption is considered to start sizing the battery bank. The Parameters section has the options that the designer can modify for sizing.

- Days of autonomy
- Depth of discharge (DOD)
- Voltage of battery bank

The *Suggested capacity* that the battery bank needs to have is calculated as:

Capacity = (Average daily consumption * Days of autonomy) / (Depth of discharge * Voltage of battery bank)

The battery bank should have a higher capacity than the Suggested capacity. By combining in series and in parallel the model of the chosen battery, the program realizes the sizing to achieve the required autonomy.

The size of the PV array must be able to provide the energy consumed on average in a day. The amount of energy needed to be produced by the photovoltaic field will be reported in Project settings in *Constrained arrangement by energy to be produced* so that the wizard continues to design the system with the goal of producing that amount of energy.

If the system is **DC-coupled battery** storage, it will be necessary to size a charge controller compatible with battery bank and PV field. Compatibility between battery bank and charge controller is verified by:

- Open circuit Voltage < Maximum voltage of charge controller
- Maximum current from PV (short circuit current) < Maximum current capabilities of charge controller
- Maximum power from PV < Maximum operative power of charge controller
- The nominal operative voltage of charge controller = Nominal voltage of battery bank

furthermore if charge controller is Mppt:

- Minimum Mppt voltage from PV > Minimum voltage MPP allowed by charge controller
- Maximum Mppt voltage from PV < Maximum voltage MPP allowed by charge controller

The program will propose a list of compatible charge controllers among those present in the archive

If the system is **AC-coupled battery** storage, you need to insert an inverter/charger in the AC section, the compatibility battery bank and inverter/charger is verified by:

- Power of inverter/charger >= Peak power of users consumption
- Battery voltage <= Maximum charging voltage of inverter/charger
- Battery voltage >= Minimum charging voltage of inverter/charger

Wizard - Select photovoltaic module

The wizard offers several ways to choose the photovoltaic modules of the system depending on the settings selected in the Project settings.

- **If the choice of the module is primary with respect to the inverter**

If the power is defined by the layout of the system you can only choose primarily the module and also in this case you do not have to choose the grid composition because it will be chosen according to the layout of the strings in the areas.

Otherwise, if the power is defined by designer, after the choice of the model the program offers a number of possible compositions of the grid to obtain the required power for the system. You can also choose the number of the inverter on which divide the grid of photovoltaic system. The division is carried out as far as possible uniformly on the inverters.

> ☞ In this phase the user can also decide to choose a different composition of grid, different from those proposed; the power generated could however not be what is desired.

- **If the choice of the inverter is primary with respect to the module**

This sequence is only possible if the power is defined by the designer. The inverter has already been selected, the button Select module... opens the choice of modules within the database. Specified in the module, the program proposes all possible compositions of the grid photovoltaic field in terms of the number of modules for number of strings. All the solutions proposed are verified and compatible with the previous choice of the inverter.

> ☞ In this phase the user can also decide to choose a composition of any grid, different from those proposed in this case there is no guarantee that this is compatible with the inverter.

Even at this stage the program highlights the exploitation of the inverter, those

with optimal exploitation are represented with the color green, the solutions who exploit shortly the inverter are shown in yellow, and those who exploit the overly inverter are shown in red.

☞ Unlike the inverter choice, the exploitation of the inverter is now calculated on the power grid has been chosen and not on the required power

💡In any situation where it is required the choice of a photovoltaic module in the archive, you can choose in the most recently used list.

Wizard - Inverter sizing

The wizard offers several ways to choose the inverters of the system depending on the settings selected in the Project settings.

- **If the choice of the module is primary with respect to the inverter**

The module has already been selected, if the power is defined by designer is showing the result of research into the database, the inverters are compatible with the grid of the PV system chosen. All models proposed creates a solution verified of the system. Among the proposed solutions, those with optimal utilization are represented by the color green solutions, those who exploit shortly the inverter are represented in yellow and those who exploit overly the inverter are represented in red.

If the power is defined by the layout of the system It will be possible to have an arrangement of strings of the system with different orientations and string lengths, so the program will seek the best arrangement of strings on the inverters based on the *Number of inverters* in the system. The distribution of strings on inverters requires that each MPPT will have a homogenous PV array for string length.

The designer should therefore individually choose each inverter of the system between those that are compatible with the photovoltaic field in input to each inverter. If the photovoltaic fields are equal to each other, it will be possible to specify the *Same inverter model for each fields*

☞ Research in database can be made by searching among the favorites or by specifying an inverter manufacturer.

☞ The double click on a row containing the model of the inverter, opens a window that displays all of the technical data of the inverter.

- **If the choice of the inverter is primary with respect to the module**

If you want to choose primarily the inverter, the program requires the definition of the number of inverters you want to use. The power of the system will still be

equally divided on the number of inverters. The window also displays the list of inverters compatible with the request power, the search is performed within the database of inverter of the program.

Among the proposed solutions, those with optimal utilization of the inverter are shown with the green solutions, the solutions who under-uses the inverter are shown in yellow and those who exploit overly the inverter are represented in red.

- Research in database can be made by searching among the favorites or by specifying an inverter manufacturer.
- The double click on a row containing the model of the inverter, opens a window that displays all of the technical data of the inverter.
- The limits of sizing on power of inverter can be configured in the project properties.

Electrical panel DC and AC

Sets the criteria that the wizard should be used in the insertion of panels DC and AC in the composition of the scheme of system.

> ☞ These criteria are used exclusively by the wizard, in the process of modeling manual these settings are not binding.

Panels AC: You can specify the presence of the main electrical panel and an isolation transformer. The wizard can enter a single panel AC in the system (the main panel), the possibility to introduce other panels AC is delegated to the manual modeling.

Panels DC: You choose the criterion of insertion of panels DC on input to the inverter:

- Inserting a electrical DC panel on each inverter input, the strings are divided among all panels.
- Inserting a single electrical DC panel on inverter input.
- Inserting of electrical DC panels only if the inverter inputs are insufficient.
- Limitation on the number of inputs for each electrical DC panel.

> ☞ The possibility of limiting the maximum number of inputs on panels DC allows the wizard to split the inputs on several panels within the limit imposed.

Furthermore, both for AC panels that for those DC is possible to choose a protection scheme to be used in the composition and optionally in the dimensioning of the electrical components of electrical panels of the system.

Wizard - Electrical Components sizing

Allows you to manage the configuration and automatic sizing of the electrical components of the system. This can be prevented by disabling the check mark in the *Automatic configuration of electrical components in a photovoltaic system*.

Properties

The Properties menu of BlueSol allows the insertion of data on the personal data of the designer and the client, as well as specify the settings of the system and project:

- General properties
- System info
- Customer
- Designer
- Settings

General properties

General information on the project, are used in the technical documentation of the project generated by BlueSol

System info

You specify the location data of the system, the data of the electrical grid and the contract for the supply of electricity, then indicate the characteristics of electricity delivery.

Customer

Data of the customer

Designer

Data of the designer of the PV system. When you create a new project, the fields in this section are automatically filled with the data of designer that have been set in the program settings (Menu: Home | Settings).

Modification of these fields affects only the current project.

Settings

This section provides the settings of specific parameters of the project on:

- **System**:

  Annual loss of system efficiency, this fall is mainly due to the decrease of efficiency of the photovoltaic modules. The system decreases over time the ability to produce energy.

  Maximum voltage drop in DC area of system: is the maximum voltage drop in the cables achievable in the DC area of the system, this value should not be exceeded.

  Maximum voltage drop in AC area of system: is the maximum voltage drop in the cables achievable in the AC area of the system, this value should not be exceeded.

  Number of bypass diodes per module: is the number of bypass diodes present in the photovoltaic modules of the system. This value is used in the simulation for loss calculation for near shade .

  Recognition of micro -nverter: It allows you to automatically treat the strings of a single module as part of the combination module + micro-inverter.

- **Verifications**:

  System verification with minimum and maximum temperatures specified by the user, the system temperature, used in verification, can be defined explicitly by the user enabling this check and specifying the minimum and maximum temperatures. If this check is not activated the system temperature is calculated based on the minimum and maximum temperatures of the location.

  *System Temperature*s, these are the minimum and maximum temperature reached by the photovoltaic modules. These values are used to calculate maximum and minimum voltage output from the PV array. The temperature reached by the modules is calculated by program when there are the maximum and minimum temperatures of the location of the system. These values are used in the absence of climate data on temperature or if the user chooses to directly set the

temperature of the modules by selecting the previous check

Sizing on power of inverter, expresses, in terms of power, the exploitation of an inverter. This parameter is used by the program in the search of the inverter during the phase of sizing the system.

- **Losses**:

  Specifies the percentage values of system loss. For losses due to shading can be specified if this value is calculated automatically by the program or if it is assigned by the user.

- **Cables**:

  Maximum voltage drop in the cables, defines the maximum allowable of voltage drop percentage on each cable of system.

- **Positioning**:

  It specifies whether the system is placed on the *roof* or on the *ground*.

- **Economic analysis**:

  Inflation:: Is a percentual rise in the general level of prices in a period of one year. The program uses this index to increase yearly maintenance costs of the system.

  Discount rate: The program uses this index to calculate the Net present value (NPV)

  Currency text, is the text that the program will use for the currency currently set. The currency setting is done by the operating system.

When you create a new project, setting values are automatically assigned to those that have been set in the program settings (Menu: Home | Settings).

☞ Modification of these fields affects only the current project.

Location and shadings

The electrical energy that the photovoltaic system can produce depends on the amount of solar irradiance which, the site where the system is made, it can receive.

The shadings of a photovoltaic system limit the time of irradiation of the modules that constitute the system, lower the production capacity of electricity and generate inhomogeneities in behavior between the various modules generating mismatch losses.

So you need to evaluate the degree of shading of the generator due to buildings, vegetation, land elevations or otherwise, that might prevent, even partially, the direct solar radiation to reach the photovoltaic modules at certain times of day and / or for a longer or shorter periods of the year.

BlueSol provides the tools for the definition of the incident radiation on the system through the choice of locations and the definition of shades that affect the photovoltaic system.

Location

The choice of location is performed within the Sizing Wizard. Upon completion of the wizard that choice can not be changed, this because we assume that the change of location involves the remaking of project.

See also:

- Database of climate data

Irradiance

The irradiance is the amount of solar energy incident on the photovoltaic modules, which can be converted into electrical energy.

The location of installation of the system allows to obtain the data of irradiance, obtained on a statistical basis, on a horizontal plane; the orientation of the modules and the shadings allow the program to calculate the average irradiance monthly on the plane of the modules and then the calculation of the electricity produced by the system.

Since BlueSol is able to manage systems with multiple orientations of the modules, it will be possible to choose, among the various orientations provided inside the system, that for which you want to know the irradiance on the plane of the modules.

Upon variation of:

Location,

Orientation of the modules,

Shadings.

BlueSol calculates:

- **Radiation annual**, amount of solar energy, expressed in kWh/m² per year, incident on the plane of oriented modules, regardless of the presence of shade.
- **Radiation annual net**, amount of solar energy, expressed in kWh/m² per year, incident on the plane of oriented modules, considering the presence of shade.
- **Loss shading**, percentage of loss of sun irradiance on the module plane, due to shading.
- **Distribution of losses due to shading**, charts that represent the monthly distribution of the absolute values and the percentage of losses due to shadows caused by near objects and horizon profile (far shadows).

Far shading

Is defined as "Far shading" the shadows produced by objects distant from the system, typically this is the horizon line which in some cases can present obstacles (such as mountains) that limit the irradiation time on the system. The loss resulting therefrom can be calculated by defining a diagram representing the horizon line.

The definition of the diagram is done with the command Far shading  in Location menu

> ☞ The calculation of loss due to the far shading assumes that the entire system undergoes simultaneously the shadow presence. But this approximation is admissible only if the diagram of the horizon line does not consider neighboring objects to the system.

Diagram of far shading

To take account of the effect of far shadows we must be pointed out a mapping of the obstacles on the horizon, seen by an observer located at a point of the PV system, bringing on a diagram that represents the projection of the celestial hemisphere seen by the observer on a flat surface, so as to obtain a graph in which the abscissa shows the orientation East-West (or West-East for the southern hemisphere) and the ordinate the elevation above the horizon.

BlueSol provides the user with the tools for the realization of the diagram of shading that can be realized:

- Defining a series of points that represent the values of solar height of the obstacles detected on the field with the aid of a compass and a clinometer.
- Putting the panoramic around the PV system through the use of digital photographs.

The commands available to allow the definition of diagrams:

 **Add shadows**: Allows you to draw a diagram of shading by the insertion of a polyline, the Enter key ends the data entry and opens a window that summarizes the values that have been entered.

 **Cut shadows**: Allows you to cut a part of the diagram shading. The inclusion of two or more points allows you to define the area of the diagram that will be cut, the Enter key ends the data enter and opens a window that summarizes the values that have been entered.

 **Clear shadows**: Used to delete a section of the diagram shading. The inclusion of two or more points identifies the area in which the plot is canceled, the Enter key ends up entry and opens a window that summarizes the values that have been entered.

 **Clear all shadows**: Delete all diagram shading.

 **Import shading**: Allows you to import from a file with the extension .shd, a diagram of shading.

 **Export shading**: Export to a file with the extension .shd the current diagram shading.

 **Shading from panoramic image**: Opens a window that allows you to compose the panoramic image from which is derived the diagram shade.

 In all commands that require the insertion of points, if you want to cancel the entered points simply click the right mouse button to go backwards in order of entry.

Panoramic image

BlueSol is able to automatically detect the diagram of shading, starting from a sequence of digital photographs made at the site of installation of the photovoltaic system.

The individual images are assembled by the program to realize a single image that covers the horizontal visual field up to 360°.

To achieve correctly every single image you should follow some simple precautions:

1. Perform photos trying to keep horizontal the camera, the use of an easel would simplify this operation.
2. Make all the photos maintaining the same focal length on the camera.
3. The photographs must submit areas of overlapping with adjacent ones.

- Once done with digital images, these will be assembled by the program reading them and placing them in sequence with the command to insert a new image. Then you will need to place each image by overlapping them to the previous by exploring the common points effect by the transparency of the image.
- Place the horizon line, dragging the horizontal blue line marked by the word Horizon.
- Locate the South (North), dragging the vertical yellow line marked by the word south (or north if in the southern hemisphere), the point of the image that identifies the south (north).
- Identify the limits east and west, dragging the green vertical lines marked by the words East and West at the points that identify the limits of the panoramic image to the east and west.
- Specify angle of panoramic which is the opening angle of the panoramic image from the east and west limits already specified.

The program highlights, on the panoramic image, the line of separation between the sky and the obstacles surrounding the photovoltaic plant. Using that line the

program generates the diagram of shading.

Multiple shading

Since the detection of far shadows is done in one place, it is assumed that the approximation to be valid for the entire system.

This approximation is definitely acceptable if the system is realized on a limited extension.

BlueSol allows multiple measurements to be made of the diagram shade in most places on the site of the photovoltaic installation will create more than one diagram of shading.

For each shading is assigned a name to be referenced in the definition of strings of the system, so as to specify that the string is applied to a particular shading.

Near Shading

The photovoltaic system is normally affected to shadows cast by objects close to the PV array. These shadows on modules generate losses in energy production that can be assessed by the program. To do this it is necessary that in the project is present the system layout and the arrangement of the obstructions that generate shadows.

The calculation of loss is influenced by:

- The geometry of the system layout.
- The arrangement of the obstructions that generate the shadows.
- The number of bypass diodes and their arrangement in the PV modules.

When these parameters are correctly defined the program can apply the calculation model for the evaluation of losses.

The calculation of Near shading loss is done with the command Near Shading  in Location menu

☞ This command must be run explicitly by the user and the calculation result is stored with the project data. This is needed for this calculation because it can be time consuming and must be performed when the user has completed the project schema.

However, the program will notify the user through an alert in the status bar when there are conditions that require a recalculation of the loss for near shading.

System

The system section of BlueSol provides the tools to define the composition of the PV system in all its aspects in order to carry out design and verification. BlueSol implements a software simulator of a photovoltaic system and therefore each element of the system will be defined and present within the simulator.

Scheme of system

The scheme of the photovoltaic system is represented by a tree structure, where each node identifies a component of the system:

-  Electricity grid
-  Electrical AC panel
-  Inverter
-  Electrical DC panel
-  String
-  Battery
-  Inverter/Charger

The tree diagram, which represents the system, starts from the electricity grid and expands to the strings. Selecting tree nodes are displayed, within the panel next to the diagram, all the information related to the component allowing the consultation and editing. Moreover, for each component of the system are visible electrical parameters specific.

Electricity grid

Defines the part of the system that connects to the grid. The parameters that can be set differs depending on whether the delivery of electricity occurs in low or medium voltage and that the connection is single phase or three phase.

Electrical AC panel

Defines the configuration of the electrical panel in AC current and the

components with which it is made.
In this section you can set:

- Electrical protection group on AC
- Isolation Transformer

Inverter

Conversion device from direct current to alternating current, the system may contain multiple inverters of different models.
In this section you can set:

- MPPT of inverter
- Change the inverter model

Electrical DC panel

Defines the configuration of the electrical panel in DC current and the components with which it is made.
In this section you can set:

- Electrical protection group on DC

String

Sequence of photovoltaic modules wired in series; each string is characterized by:

- Type of photovoltaic module (same for the whole string)
- Number of PV modules
- Angle of inclination of the modules (tilt)
- Angle of orientation (azimuth)
- Far shading

👉 Each string of the system can have its own orientation (tilt and azimuth) different from that of the other strings of the system.

In this section you can set:

- Model of the photovoltaic module with which the string is composed
- Number of modules with which the string is composed
- Orientation
- Far shading

The scheme of system which is realized, using the dimensioning wizard or modeling of the system, it can be modified using the tools provided by BlueSol:

- Modify the schema of the system
- Changing the parameters of system elements
- Resizing the system
- Rename the names of system elements
- Analize the producibility of system
- Verify the system

Battery

Defines the composition of a battery bank as a sequence of batteries in series and in parallel. It can be present in both DC section and AC section.

In this section you can set:

- Type of battery
- Number of batteries in series
- Number of batteries in parallel

Inverter/Charger

It defines the Inverter/Charger that recharges the batteries in one direction and transforms the charge in alternating current in the other direction. This device is only used when the system is AC-coupled battery storage.

In this section you can set:

- Type of inverter/charger

Electricity grid

Defines the part of the system that connects to the electricity grid, so this section is never present in standalone systems. The parameters that can be set differs depending on whether the delivery of electricity occurs in low or medium voltage and that the connection is single phase or three phase (property modified in the section Properties|System).

This section allows you to define the components that make the connection to the electrical grid. Since this part of the design of the PV system can be influenced by normatives of each country, the program offers a general solution that can be configured to adapt to the needs of the designer. If the designer considers it necessary, you can also delete everything related to the connection of the PV system to the grid.

This can be achieved by clicking the check mark *Unmanaged configuration of connection to the grid.*

All these settings modify the electrical scheme created by the program, you can set:

- **Panel parallel grid**: It is the panel for the distribution of energy to the consumers connected to the PV system.
- **Panel detachment grid**: Make the detaching of the PV system from the grid.
- **Interface group**: The interface is a protection device of the grid involved in case of faults in the electrical grid. The interface inhibits the release of electric current of the photovoltaic system in the network, in the case where is no voltage on the national grid or in the case in which the parameters of the network found to incorrect. It is therefore a measure of protection placed to grid security, of the system and who should be working. It is composed by *Interface relay* which opens the *Interface protection* both in case of fault internal to the protections both for fault of the network. Some types of inverters, mostly of small power, have the function of the network interface already integrated within them.
- **Transformer group**: Inserts a transformer for adapting the output voltage of the system with that of the electricity network.
- **Energy meter**: Inserts the meter for energy fed / drawn from the grid.

☞ The creation, of each of these sections, can be disabled using the appropriate check marks on the page *General*

See also:

- Electrical scheme

Orientation of strings

The orientation of the strings can be fixed or variable for the presence of a solar tracker. BlueSol allows you to specify on each string, the type of orientation, which can be:

- *Fixed inclined plane*: The string is in a fixed position and angles of *Tilt* and *Azimuth* cannot never change.
- *Two-axis tracker: Two* axis trackers have two degrees of freedom that act as axes of rotation, this solution allow for optimum solar energy levels due to their ability to follow the sun vertically and horizontally. Therefore the angles of *Tilt* and *Azimuth* vary according to the position of the sun and the sun's rays are always perpendicular to the surface of the modules.
- *Single-axis vertical tracker:* The axis of rotation for vertical single axis trackers is vertical with respect to the ground. These trackers rotate from East to West over the course of the day, the angle of *Tilt* is fixed and the *Azimuth* angle varies. The tracker will change the angle of azimuth in order to minimize the angle of incidence between the sun's rays and the plane of the modules.
- *Single-axis horizontal tracker:* The axis of rotation for horizontal single axis tracker is horizontal with respect to the ground. In this case the angle of *Azimuth* is fixed and varies the angle of *Tilt*. The tracker will change the angle of tilt in order to minimize the angle of incidence between the sun's rays and the plane of the modules.

The Tracker configuration allows you to set the maximum and minimum limits of the angles that the tracker may vary.

☞ Note that the angles of tilt and azimuth assigned to strings (and used in the drawing of the layout), they are still used by the program. In the single-axis trackers is the angle remains fixed, the software also assumes that the string takes this orientation before sunrise and after sunset when there is no sun to govern the movement of the tracker.

MPPT of inverter

Maximum Power Point Tracking, often referred to as MPPT, is an electronic system that manages the photovoltaic modules so as to allow maximum power production. MPPT is an electronic system that varies the electrical operating point of the modules so that they are capable of delivering the maximum power available.

The inverters can embed one or more of these electronic devices, and on each of them there may be one or more inputs in parallel from the photovoltaic field. The manufacturer shall provide these data and the fields within inverters archive of the program with these data are *Number of MPPT trackers* and *Number of DC inputs*.

> ☞ Note that even if the number of MPPT and the number of DC inputs are defined in the database, the program allows you to modify this data in the *Scheme of system* in the properties of the inverter.

In the case in which there are more than one MPPT tracker is possible to distribute the input current on each tracker by clicking the check mark *Shares current from a single input to all MPPT*. This can be achieved by exploiting a characteristic of the inverter or by inserting an *External device of current splitting*.

MPPT Properties

By clicking on *MPPT Properties* button, you open window that allows you to edit the properties of the MPPT, adding or deleting of trackers and determine the characteristics of each.

In the *MPPT page* you can modify the characteristics of each MPPT tracker, the data are derived from the data sheet of inverter, where it distributes the *Maximum current from PV* over the trackers.

- Max. current from PV: Maximum possible current input on the single MPPT tracker from the photovoltaic field.
- Min. MPPT voltage: Minimum value of voltage operating range of MPPT tracker.

- Max. MPPT voltage: Maximum value of voltage operating range of MPPT tracker.
- Max. voltage from PV: Maximum possible voltage input on the single MPPT tracker from the photovoltaic field.
- No. DC inputs: Number of inputs for the selected tracker.

In the *Inputs page* is shown a scheme of the inputs in MPPT, using the drag&drop you can change the connections between input and trackers. Normally, the program assigns these links by distributing the input lines over all MPPT.

Note that a different distribution of the inputs changes the results of the verification of compatibility between the PV array and inverter.

Modeling the system

BlueSol is a software simulator of a photovoltaic system, so you have to define the system model incorporating all the elements defining features, and links. The program provides the tools to create and modify the schema of the photovoltaic system and to specify the electrical components which it is composed the system.

With these features the user is able to perform the following operations:

- Insert an element in the system
- Modify the schema of the system
- Changing the parameters of system elements
- Resizing the system
- Rename the names of system elements
- Analize the producibility of system

Insert an element in the system

Selecting a node of the schema of the system, with the right mouse button you can have the context menu that offers items which you can add to the node. Only displays features that you can apply to the element of the system represented by the node, if for example, you select an inverter, you can only connect panels or strings.

Once you select an element to add is displayed window that allows you to:

- Give a name to the element, each element of the system must have a different name
- Choose the amount
- Choose the appropriate model

If you accept the operation by the Ok button the program will insert the elements chosen in the scheme of system.

For DC and AC electrical panels, the program offers two modes of input: The command Add panel and the command Insert panel. These commands are different because the first connects the panel to the element of the system and is placed in parallel to any other elements already present. In the second case, the panel is still connected to the element from which is created, but all the existing elements are going to connect to the new panel just created.

In the insertion of elements in the system is necessary to be aware of some controls that the program makes to maintain the accuracy and consistency of the scheme.

- Control on inputs of the element, if you are connecting an element to an inverter (panel or string) This operation is allowed only if the inverter will have a sufficient number of DC inputs free.
- To the electricity grid can be connected or a single inverter or an electrical AC panel, if you try to connect more than one inverter to the grid will be automatically entered a main electrical panel AC (of course you can have a single inverter and a main electrical panel).

Modify the schema of the system

To modify the schema of the system you can use the drag&drop of elements, working both in the selection of a single item or in multiple selection. In this way, the selected items can be moved or copied to the new location, in fact when you release the mouse button at the end of drag&drop operation, the program proposes the menu to choose between copying or moving.

- ☞ The multiple selection of elements of the system is done with the left mouse button and the ctrl key or shift, or the context menu of the diagram of the system with the feature selection by category (all strings, all inverters, etc ...).
- ☞ In the drag&drop the program checks the correctness of the changes that are taking place and prevents those introducing errors or inconsistencies in the system.

The same operations carried out with drag&drop can be made, acting on the elements of the system, selected with the *Cut*, *Copy* and *Paste* in the menu *System* and in the context menu. To delete an item from the scheme of the system use the *Delete* button in the *System* menu or the context menu.

If you delete an element of the system, the program, before performing the operation, propose a list of all the elements connected to the selected and these will be deleted.

Changing the parameters of system elements

The selection of an element of system displays all its properties, some of them can not be modified because the results of calculations (eg nominal current). Other parameters can be changed and in any case, is valid the principle that can be modified individually or in groups, that is, you select multiple homogeneous elements in the scheme of the system and make the change that is so marked on all elements.

With this method, for example, you change the disposition of all or part of the strings of the system. The button *Select all strings* in the context menu of scheme of system selects strings, then you can change Tilt and Azimuth.

Resizing the system

When designing a PV system, you may need to change the size of the PV array or a part of it. In a situation like this the *Resize* command allows you to change the size of a photovoltaic field connected to inverter choosing between solutions already verified.

This feature refers to the element of the system currently selected, selectable items can only be inverters and DC panels. In the case of panels, these must be connected to inverter with more than one MPP, if the inverter has a single MPP you must select directly the inverter to perform the resize. However this command is enabled only if the selected node corresponds to an element of the system with the characteristics necessary to use this feature.

> ☞ The resizing of the photovoltaic field that goes to a panel DC allows for sizing separately the inputs MPPT of an inverter, as in the case of an inverter with 2 MPPT used to connect the photovoltaic fields placed on two different slopes of a roof.

If the selected item is an inverter you can change the model, in the case of selection of a framework DC this feature is disabled.

The solutions that are proposed are always solutions verified and compatible between the PV array and inverter.

Rename system elements

This tool allows you to automatically change the names of the elements of the system. This feature is useful when making a large system and when it is operated on the scheme of system with many editing operations.

It can operate in two modes:

- *Auto-setting* of the parameters, in this case is the program to change the names of the elements of the system using its default parameters.
- Choice of parameters made by the user, in this case it is possible to choose on which category of elements operate, the base name and the base numbering for each category.

Clicking the Next> button you can see a preview of the scheme of system with the new denomination of the elements.

System producibility

This tool allows you to analyze the producibility of each element of the system. The window shows the scheme of system with all its elements, next to each item are shown:

- Annual production
- Power
- Number of modules
- Production rate, that is the value of percentage of the total energy of the system.

Each value refers to the corresponding element of the system.

Electrical components

In the realization of the project of a photovoltaic system, BlueSol allows you to define the electrical components which make up the DC and AC electrical panels. The component data can be read, edited and stored in an archive that you can reuse the data. On each component, the program is able to perform the electrical verification so that it can propose the right components with which to make the electrical panel. The program handles the following electrical components:

Cable	Surge arrester	Disconnecting switch	Switch	Fuse	Diode	Transformer
						

To specify an electrical component you need to use the button with the image of the electrical symbol, that appears in the page *Electrical protection group* of the electrical panels DC and AC and of the *Electricity grid*. Then you opens the dialog definition of the electrical component where you can specify the characteristic data, which can also be read from the archive, if any, or manually entered and then saved in the database to be used later.

> ☞ The archives of the electrical components, as well as are provided at the time of installation of the program, contain a limited number of products. The purpose of these archives is not to provide a complete set of these components, which would be difficult to keep up to date. The aim is to provide a powerful and integrated tool to manage the data of the electrical components that the designer most commonly uses, then the user will enter the data in the design phase and store them in the database to be used by future projects.

The reading window of the data of the electrical components in the archive has a field called *Verification* that indicates with the coloring green or red if the component is verified whether or not inserted in the specified position of the electrical panel.

See also:

- Cables
- Wizard sizing of electrical components
- Protection schemes
- Electrical components list
- Database electrical components

Wizard sizing of electrical components

With this tool, the program is able to search within the archives, the electrical components to be used in the system, checking that they are always verified and meet the search criteria defined by the designer. In this way it is possible to automatically dial the electric panels of the system. Obviously then the user can freely change the configurations made with the standard tools of modeling the system.

The user has the ability to set the standard by which the program chooses the electrical components, these options are available:

- **System sections to be sized**: Specifies which section of the system, electrical panels AC or DC and grid connection, must be carried out search operation and sizing.
- **Electrical components and choice of producers**: You choose in which category of electrical components is performed the sizing. Furthermore, for each category, you can make the choice of the producer or *All manufacturers* in the archive. In the event that you choose to search *All manufacturers* it is possible specify *Preferences* about which manufacturers will be used and in what order will appear in the search of electrical components. In the dialog of choice of manufacturers a column contains all the producers in the archive for the specified component, a second column contains the manufacturers with which you want to search. The and buttons are used to change the search order.
- **Protection schemes of electrical panels**: You can make the choice of a protection scheme to be applied to panels DC and AC
- **Options**: Allow you to set the search criteria of the electrical component:

  Gives priority to the optimization of the electrical verification, performs the choice of the electrical component that best fits the verification regardless of the preferences on the manufacturer.

  Gives priority to the preferences on the manufacturer, in this case chose the first element is verified that a manufacturer makes available respecting the search order of the producers.

  Clears the contents of electrical component not verified, if there isn't a verified solution the electrical component in question is not assigned.

Sizing the electrical components verified, the sizing is also made on the electrical components that have already been verified.

Sizing the electrical components not verified, the search is performed also on the electrical components that are unverified.

Sizing the electrical components not assigned, the search is performed also on the electrical components that are not assigned.

Cables

BlueSol allows you to define and verify all the wiring of the PV system. Each element of the system must be considered connected with a cable coming out, which is connected to the next. The cable connected to the element of the system can be modified by accessing the properties of the element.

The modify of the cable opens a window that has access to all its characteristic data:

- **Length** [m]: total length of the cable. The cable length is a property that the user can edit only if the cable has not been drawn in Layout, in this case the length is calculated automatically by the program according to the path that follows the cable to connect the devices.

  ☞ The designer can define in the preliminary draft of the approximate lengths that allow an initial verification on the cables. Only at a later stage by inserting the cables in the Layout will be calculated the exact lengths and make any final verifications.

  ☞ When you insert a cable into the Layout any cable length specified by the user is replaced by the calculated length by the program. At this point, the length can not be changed except by deleting the cable from the Layout.

- **Cross-section** [mm ²]: cross-section of the conductors. For cables in DC are selectable sections for positive, negative and protective earth (PE). For AC cables are selectable sections for phase, neutral and protective earth (PE).
- **Material**: material of construction of the cable conductor.

In the section **Electrical data** are reported electric parameters:

- **Nominal voltage** [V]: It is the nominal voltage.
- **Current** [A]: It is the operating current of the cable, is obtained from the nominal current of the PV module (declared by the manufacturer) and the combination of the strings in the scheme of system.
- **Short circuit current** [A]: Present in the DC side, is taken as the

maximum current that can circulate in the cable.

And the calculated values on the basis of the composition of the system and definition of the cable:

- **Power dissipation** [W]: Describes the power lost for resistance of the cable conductor. Calculated as: *Power dissipation = Nominal voltage * Voltage drop * Current*. / 100
- **Voltage drop** [%]: Describes the percentage loss of energy, compared to the *Nominal voltage* applied to the cable, due to the resistance of the conductor of the cable.

See also:

Insertion of electrical cables

Voltage drop

Short circuit current

Wizard of cables definition

This tool allows the definition of cables dividing them by classes of connections:

- String cables,
- Connecting cable string - panel DC,
- Connecting cable panel DC - panel DC,
- Connecting cable panel DC - inverter,
- Connecting cable inverter - panel AC,
- Connecting cable panel AC - panel AC,
- Connecting cable panel AC - grid.

The dimensioning of the connection class is applied to all the cables belonging to the class. This operation can be carried out either before or after insertion of the cables in the Layout, if it is made after it has the advantage of being able to perform a verification using the calculated lengths of the cables. In fact, to field *Length* is assigned the highest value among those measured in the class of connection, this can only happen if you have already inserted the cables in the Layout. In the case in which the cables have not been inserted, the field *Length* may be assigned by the designer to be able to however obtain the calculation of the Voltage drop.

The wizard can be used to make a default sizing for each category of connection, having then the opportunity to make any changes to the sizing of individual cable with modeling tools of the system.

The first page of the wizard is on the choice of the PV field on which it operates cable sizing, choosing the inverter to which they are connected. Subsequent pages performing the dimensioning of the cable relatively to each class of connection in the system.

See also:

Cables

Layout

Insertion of electrical cables

Components list

The lists of the electrical components are tables that are supplied with all electrical components of each category. For each component, the program specifies the information to recognize it within the system:

- **Device**: Specifies the device that owns the electrical component.
- **Code**: Is the univocal code with which the electrical component is stored in the database, this encoding is handled freely by the user, of course the program will not allow the same two codes in the same archive.
- **Label**: This label allows to recognize each component within the electrical scheme, it is generated automatically by the program with the following code: single character representing category of component + incremental number. The label on the component is visible near the bottom of definition of each electrical component.

The tables can be displayed in two different views:

List of all elements, shows the detailed list of all the components.

Bill of material, shows the amount of each type of electrical component.

See also:

Electrical components

Database electrical components

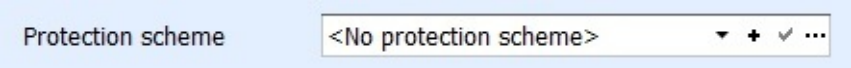
Electrical scheme

Protection schemes

The protection scheme of a electrical panel DC or AC allows the user to store one or more configurations of a panel to be able to then be applied quickly to other panel of the current or other project.

Note that a protection scheme is a template and does not store the model of electrical component but only the type (switch, fuse...), the sizing of the component is performed after the definition of the protection scheme.

The control that allows to manage the protection scheme is located in various parts of the program: in the *Electrical protection group* of the panels DC and AC, in wizard *Sizing of system* and in the *Sizing electrical components*.



You choose from the list a protection scheme previously stored, after selecting an item the key **+** implements the scheme, instead the **V** key allows to store the protection scheme of the electrical panel in the works. The button **...** opens the dialog to manage the stored *protection schemes*.

☞ Protection scheme can also be applied in multiple selection of electrical panels.

Users consumption

If you design a stand alone system or grid-connected system with energy storage, it is necessary to evaluate the electrical consumption of the user connected to the system.

The most accurate way to evaluate user consumption is to use an electrical consumption profile. This allows you to obtain more accurate results in simulating self-consumption, in the days of autonomy calculation in a stand alone system and in the energy coverage calculation in grid-connected systems with storage. In this case, for simulation, the program distributes the average daily consumption throughout the day for all days of the year.

> The results improve if the precision of the electric load profile approaches as much as possible to the actual situation, but rather than simply using average daily consumption it is best to create a simple load profile with a dummy device that roughly reproduces the distribution of consumption.

By clicking the check mark *Specifies the details of electricity consumption* you will be able to use an electrical consumption profile. On this profile will be calculated the average daily consumption which can also be calculated in the most unfavorable conditions by clicking on the check mark *Search the most unfavorable consumption period.* Where the period is the number of days on which the most unfavorable load conditions are assessed.

Electric consumption profile

To enable the program to evaluate the consumption and self-consumption must indicate which are the individual electrical devices that realize the consumption user. For this BlueSol creates consumption profiles which group the consumption of individual electrical devices. Each profile can be stored in database and reused in projects with similar characteristics.

These are the commands that allow you to perform these operations:

 Adds a consumption of electrical device, opens a window with which you specify the characteristics of the consumption both in terms of power used that of temporal distribution.

 Adds a consumption of electrical device from the data of the selected one, in this way the consumption thus created can then be modified.

 Edit the consumption of selected electrical device, opens a window where you can change the consumption data of the device.

 Delete the consumption of selected electrical device.

 Reads from file a consumption profile.

 Save the current consumption profile, stores it on user database the configuration of consumption currently specified so as to create a profile that the designer can edit and reuse in other projects.

If you read from archive a consumption profile, this can be modified and adapted to the new requirements without, for this reason, the original profile on archive is affected by changes.

Consumption of electrical device

To create or modify the consumption of an electric device, BlueSol proposes a window to manage parameters that identify consumptions.

We must give a name to the consumption, the name must be unique within the profile of consumption, then specify the number of devices (consumption will be multiplied by this number) and the power needed the electrical device.

Hourly consumption:

For each hour of the day is indicated which is the estimated consumption of the electrical device. We must choose the unit of measure by which you specify the hourly consumption:

- *Min*, in each hourly interval daily you specify the number of minutes (0 to 60), the device is running at the specified power.
- *kWh*, in each hourly interval daily is indicated consumption in kWh of electrical device.

To simplify the insertion of consumption schedules there are some commands that allow rapid insertion of common situations:

Apply throughout the day the consumption to the power of the device.

Inserts the consumption in a time period to specify the power of the device.

Reset all hourly consumptions.

Weekly distribution:

You specify which days of the week can be activated the daily distribution of consumption. The green color indicates that it is active, the red is not active. To change the activation status simply click on the colored box.

Monthly distribution:

You specify in which months of the year can be activated consumption. The green color indicates that it is active, the red is not active. To change the

activation status simply click on the colored box.

Verifications

The system verification performs a check on various aspects of the design of the photovoltaic system. The verifications are divided into groups and each group is populated with the results of the verification on the element of the system to which it is applied.

The icons in the window indicate the status of the verification:

- Verification exceeded:
- Alert condition occurs in verify:
- Error verifying:

The program performs the following verifications:

- Verifications on inverters
- Verifications on batteries
- Verifications on cables
- Verifications on electrical components
- Verifications on system

Verifications on inverters

Performs the following verifications on all inverters in the system in order to check the correct compatibility between the inverter and the photovoltaic field which flows into:

- **Limits on the voltage**: The minimum and maximum values of the output voltage of the photovoltaic generator under the operating conditions must be contained in the range of MPP of inverter, also the maximum voltage produced by the generator must be less than the maximum voltage allowable from the inverter. The maximum voltage of the generator is the string voltage at the minimum operating temperature of the photovoltaic module.
- **Limits on the current**: The short-circuit current of the photovoltaic generator must be less than the maximum current permissible by the inverter.
- **Limits on power**: The sizing factor of power must be between the minimum and maximum allowable (see Properties|Settings).

Verifications on batteries

Performs the following verifications on all batteries in the system in order to check the correct compatibility with the charge controller, if the battery is in the DC section or with the inverter/charger, if the battery is in the AC section.

Battery in DC section:

- **Limits of voltage incoming on charge controlle**r: The open circuit voltage, at the module temperature, of the photovoltaic field connected to the charge controller must be less than the maximum voltage allowed by the charging controller. Also, if the charge controller has a Mppt then the minimum Mppt voltage from photovoltaic field must be greater than the minimum Mppt voltage allowed by the charge controller, and similarly the maximum Mppt voltage from photovoltaic field must be lower than the maximum Mppt voltage allowed by the charge controller. Finally the maximum power from photovoltaic field must be lower that the maximum operating power of charge controller and the charge controller voltage output must be equal to nominal voltage of battery bank.
- **Limits of current incoming on charge controlle**r: TThe short-circuit current of the photovoltaic field must be lower than the maximum current capabilities of charge controller.
- **Limits of power incoming on charge controller**: The power of photovoltaic field must be lower than the permissible power incoming to the charge controller.

Battery in AC section:

- **Limits on the battery charging voltage**: The battery voltage must be between the minimum and maximum charging voltage for the inverter/charger.

Verifications on cables

Performs the following verifications on all the cables in the system:

- **Voltage drop**: The voltage drop percentage (percentage ratio of the voltage drop on the cable and the nominal voltage) must be less than the maximum allowable value (see Properties | Settings).
- **Ampacity**: The value of short-circuit current must be less than the permissible current of the cable.

Verifications on electrical components

Verifications on system

Performs the following verifications on the system:

- **Maximum voltage drop**: Calculate the maximum voltage drop in the system, distinguishing between the DC and AC side.
- **Electrical loads**: It is checked whether the photovoltaic system is suitable for the electrical loads, in particular:

  If it is AC-coupled energy storage system, It checks whether the power of the inverter/charger is adequate to the maximum demand for power by the electric loads.

  If it is DC-coupled energy storage system, It checks that the system is capable of producing enough energy in the most disadvantaged conditions so as to cover the most onerous demands of daily loads.

Layout

The Layout menu allows you to enter the planimetry and the components that make up the system. It also allows you to place obstacles around the PV system, necessary for the calculation of losses for near shades.

When you design the layout, BlueSol allows you to navigate on a map that will become your reference in the system design. Navigation for the search of the location is only possible if you have an Internet connection,

The work area for designing the layout is divided into two views:

- **Map view**: It proposes the plan view map of the location where the system is sited. In this view the user always works with a map in the background, and it can detect the map of any location worldwide. In this view you can perform all the construction operations and editing of layouts.
- **3D view**: It proposes the 3D view of the currently visible content in your map view. Note that in this view are not allowed all construction tasks and edit available in the map view.

To simplify the operation of the program when designing the Layout, the commands of edit and creation are only accessible within the context in which they can work.

Contexts

To simplify the operation of the program when designing the Layout, the commands of edit and creation are only accessible within the context in which they can work. Also within each context it will be displayed only the elements of the layout that have meaning for the context.

These contexts are present:

- Area
- Modules
- Devices and Cables
- Shadows
- Radiactions
- Preview

👉 To switch from a context to another, simply click on the tab that contains the name of context.

👉 In some situations you will notice that some contexts are disabled and his commands are not accessible. This happens when you must perform before some operations in other contexts enabled. For example, if you don't complete the tasks of Area context, all other contexts will be disabled.

Area context

This section of the Layout functions is dedicated to the definition of the areas in which they are inserted the modules of PV system. These areas can be roofs in case of rooftop systems, or areas of terrain in the case of ground systems.

The context of the area is always enabled because the user should always be able to add or edit areas of the Layout. When you start designing a new layout this is the only open context as it is not possible to proceed with the definition of the layout if it is not inserted at least one area in which to insert the modules.

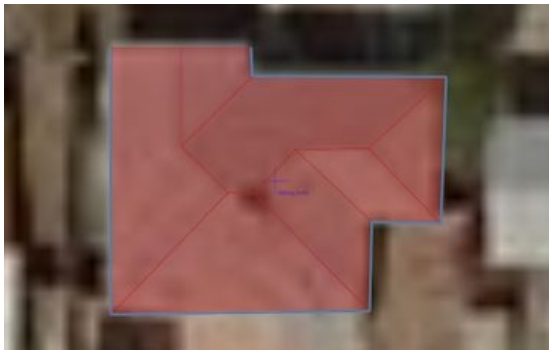
The command *Add Area* inserts a new area in layout. The command requires the entry of the vertices that delimit the area, can be used for an unlimited number of points, but the area should be closed, then the last point must coincide with the first.

When you have entered an area you must specify its inclination and the height from the ground of its lower edge. To do this you need to know what is the lower edge. This edge is drawn in blue color and in many cases it is automatically identified by the program, but in the event that his position was wrong, the user can change it by clicking on the arrows that appear at the edge doing so slide the lower edge up to the correct position. Note that the lower edge identifies the azimuth of the area


When designing the system layout you can limit inclusion only in the areas in which the modules are to be inserted, but you can also add areas where they will not be included modules. Until for example, to have a complete representation of the roof.

When adding new areas is necessary that vertices in common between areas overlap. This is done by inserting points with the automatic snap (showed with a red box) that the program makes it active in the phase of insertion of the area vertices. This will link the nodes of the different areas and when you move a node you will change all areas that includes that node.

Note that when the areas are connected by nodes, any changes in *Tilt angle* and *Height roof* of a single area affect those connected since the software recalculates the geometry for the respect of the links.

☞ You cannot change the *Tilt angle* and *Height roof* of an area if in this area the modules are already been included, to do this you must enter into the Modules context and delete them from the area so you can make your

changes

In the **3D View** you cannot change the geometry of the areas, but you can change the height and tilt of the area.

Modules

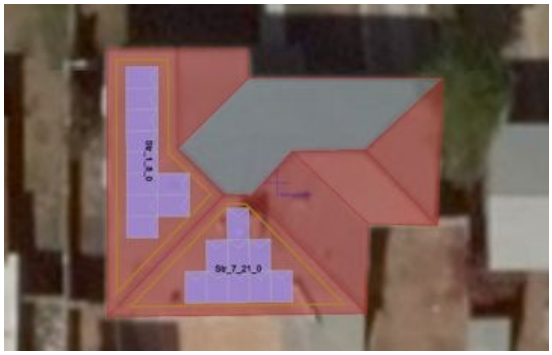
This context of the Layout functions is dedicated to the arrangement of modules and strings within areas already defined in the Area context. In this case you can see all the already defined areas, but these can not be changed in this context, but only in that of the areas. The modules can only be inserted within the areas already defined.

When selecting an area, you can decide whether you want to enter modules in this area, you can do this with the check mark on *Insert modules on this area*.

☞ It is possible to insert modules on more that one area.

When you enable an area to the insertion of the modules, the program shows the sectors in the area and the properties that configure the arrangement of the modules within the sectors of the area. Note that these properties are applied to all sectors of the area.

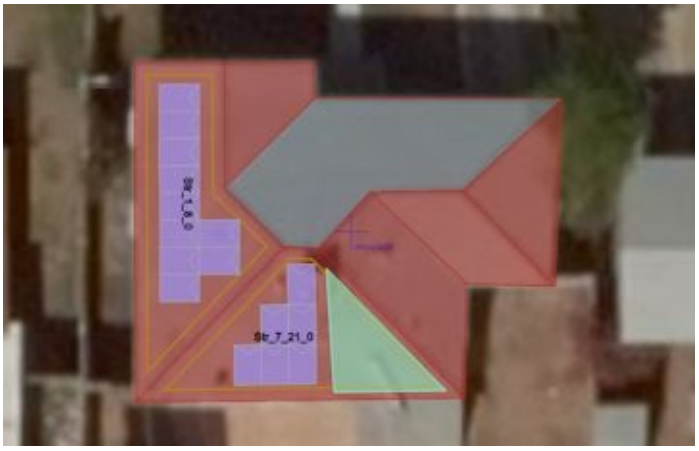
The first time you enter in the Context of the modules, the program tries to automatically enable certain areas, but the user can immediately change this choice if is not correct. Also in each area a sector that has the same geometry of the area, less than an offset, is automatically built. The default sector can be edited by the user or even deleted and replaced by a more sectors completely different from the initial one.



The modules can be arranged exclusively within sectors. and the user can insert any number of sectors in the area using command *Add Sector*. The areas belong to each area and must be fully designed within their area.

☞ The command *Add Sector* in some situations can be disabled, this may be if there is no adequate space available in the area for the insertion of a new sector.

Within each area you can define zones in which the modules cannot be positioned, these areas are named "Clear Path" and it is possible define them using the command *Add Clear Path*. It is a closed polygon built by inserting the the vertices, the last vertex it must overlay the first. Each Clear Path must be internal to the area but may overlap with other sectors or Clear Path.



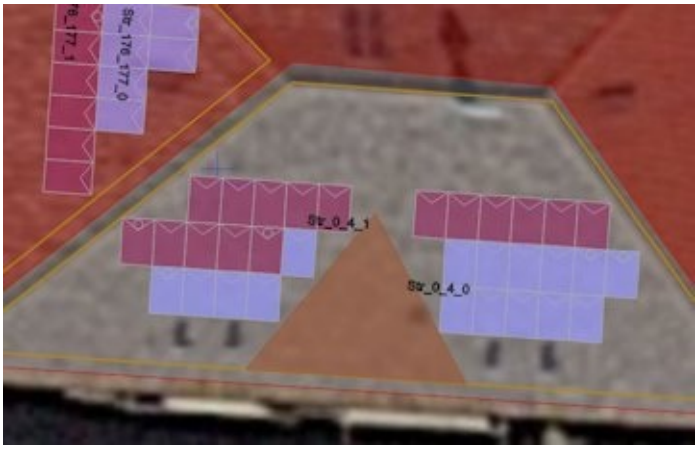
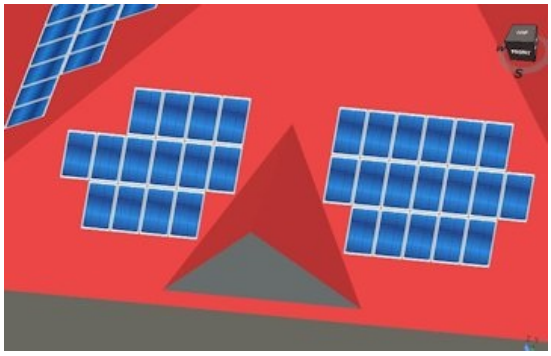
Be careful that the Clear Path is drawn within the currently selected area.

Similar to the ClearPath, over an area can be defined other areas where you cannot place the modules, these are *Chimney* and *Dormer*. But unlike to ClearPath these are also considered as obstacles and are therefore considered in the calculation of losses for shading and in analysis of the radiation of the area.

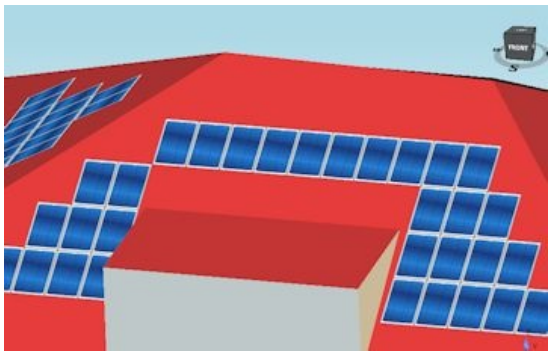
Using *Add Chimney* it is possible to add a chimney to an area, It is a closed polygon built by inserting the the vertices, the last vertex it must overlay the first. Chimney must be internal to the area but may overlap with other sectors. Selecting the Chimney it is possible to specify its height, which is calculated from the lower intersection with the area.

Similarly for Dormer with *Add Dormer* it is possible to add a dormer to an area, it is a closed polygon with 3, 4 or 5 vertices to represent three types of Dormer. Dormer must be internal to the area but may overlap with other sectors.

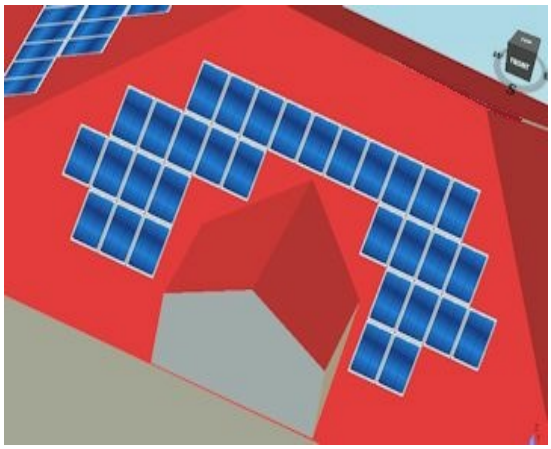
3 vertex Dormer:

4 vertex dormer:

5 vertex Dormer:

If you select any type of dormer you can set its *Height*. If you set the check mark on *Height automatically computed*, the height will be calculated by the program so that the top of the dormer is horizontal.

☞ The modules cannot be positioned on the roofs of dormers.

The user can select and freely move the modules within the sector they belong to. By double-clicking a single module you bring in selection all modules of the string so that the string can be moved uniformly.

☞ When moving a layout entities, pressing the shift key is enabled the snap on vertices of entities.

The arrangement of the modules within the sectors is performed automatically by the program, on the basis of the properties of arrangement defined for the area. At each modification of the geometry of the sectors or of the Clear Path, or of the arrangement properties, the program calculates the new modules arrangement.

When making the required arrangement, you can lock any modification on area with the check mark on *Lock the modules arrangement*.

In the **3D View** you cannot change the geometry of the objects inserted in this section, but selecting the objects it is possible to modify any associated property, seeing the result of modification instantly in 3D.

Devices and Cables

In this context, you can manage the arrangement of cables and devices in your photovoltaic system. Using the command Positioning Devices and Cables, the program makes a standard arrangement of the system components on the basis of how these are related to each other in the system scheme.

The arrangement made by the program can then be modified by the user by moving the devices and changing the path of the cables. To do this, the user can edit both in Map view well as in 3D view.

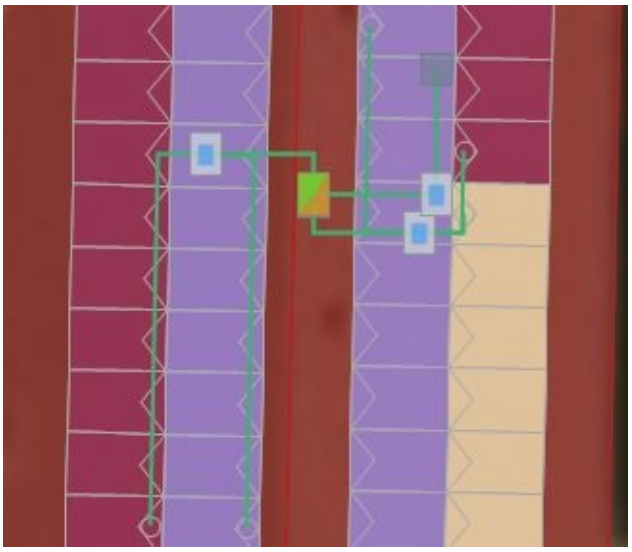
> Displacements, parallel to the xy plane, of devices must be made within the Map view. And displacements in z direction will be made in 3D view by specifying the height from the ground.

The devices managed in this context are:

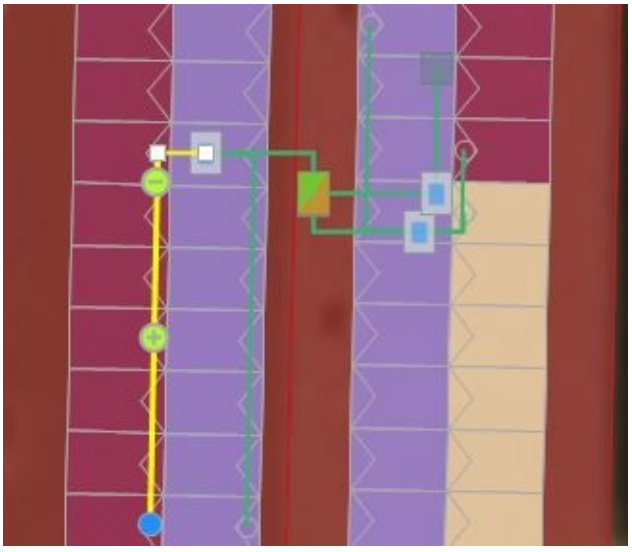
- Inverters
- Panels
- Batteries
- User
- Grid

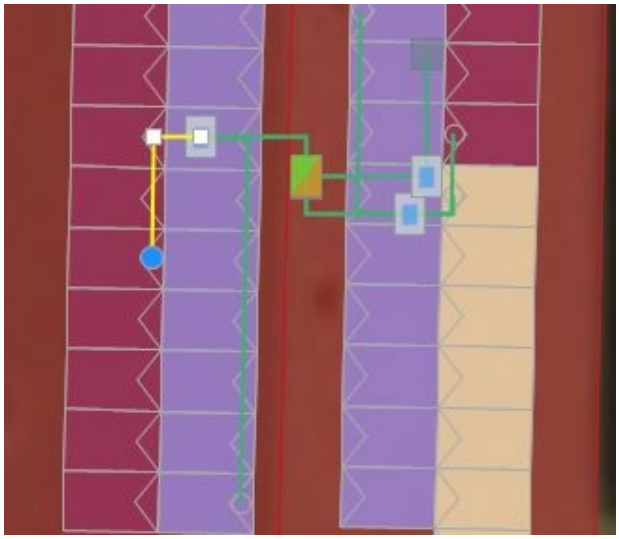
When it opens for the first time this context, the program shows an arrangement of devices in the PV system. The command *Positioning Devices and Cables* performs a re-arrangement of the devices.

> This must be made by the user when the system scheme changes.



Selecting any device you can change its *Height* from the ground, dragging it all attached cables follow new position parallel on the ground.





When selecting a cable it is possible to move nodes and, for each node, you can set the *Height*. Also you can add or remove nodes to path of cable. If cable starts from a string, the connection node is marked blue and can be dragged on a different module of the string. In 3D view you can also set the *Height* of any selected node.

Shadows

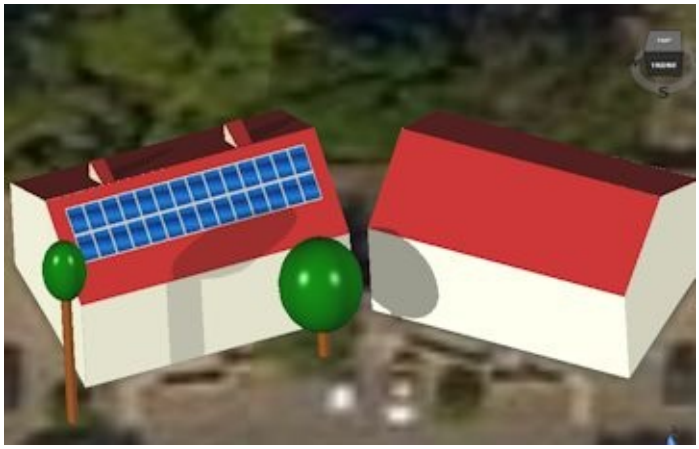
This context of Layout is in charge of analyzing the shadows generated by obstacles near the system. This is possible by inserting in the scene the objects that can be obstacles able to shade the strings of the system.

The objects that can be added are:

Trees: The *Add Tree* command creates a circle by entering the center and a point on it, in this way is summarized the tree shape. For each tree it is possible to specify the *Height tree*, the *Height treetop* that specifies the height of the tree covered by foliage and the *Tree type* that indicates the shape of the tree foliage, spherical or conical.

Buildings: The *Add Building* command creates a closed polygon that is extruded upward to a height *Height building*. With these simple objects it is possible to simulate the presence of buildings around the system.

You may also analyze the shading with more sophisticated scenes with buildings with pitched roofs. Simply add other roofs as indicated in the context Area, making sure that for these areas the inclusion of modules id disabled unchecking the check mark *Insert modules on this area* in the context Modules.



This section contains the tools to study the interference between the shadows of nearby objects to the system and the photovoltaic modules.

The *Shadows* command opens a window that allows you to set the position of the sun by:

- *Position*, specifies azimuth and elevation of the sun position
- *Day of the year*, specifies the date and time in which to realize the shading, the program automatically displays relative azimuth and elevation.

You can also make the animation of shadings by the move of the sun along its trajectory daily specifying the *Start date* and *End date* of simulation. The buttons *Start*, *Stop* and *Pause* managing the execution of the animation. The track-control *Speed* allows you to change the speed of execution of the animation.

You can also define the points of the shadows evaluation on the areas using the command *Add Shade Point.* In this way it defines a point on the area to which to plot a Shade diagram.

☞ The shade point must be inserted on the area, and it is positioned over the plane of the area.

Selecting a shade point the command *Show Shade Diagram of point* it is enabled, this command shows the Shade diagram on the point.

In the **3D View** you cannot change the geometry of the obstacles inserted in this section, but selecting the objects it is possible to modify any associated property, seeing the result of modification instantly in 3D.

Radiactions

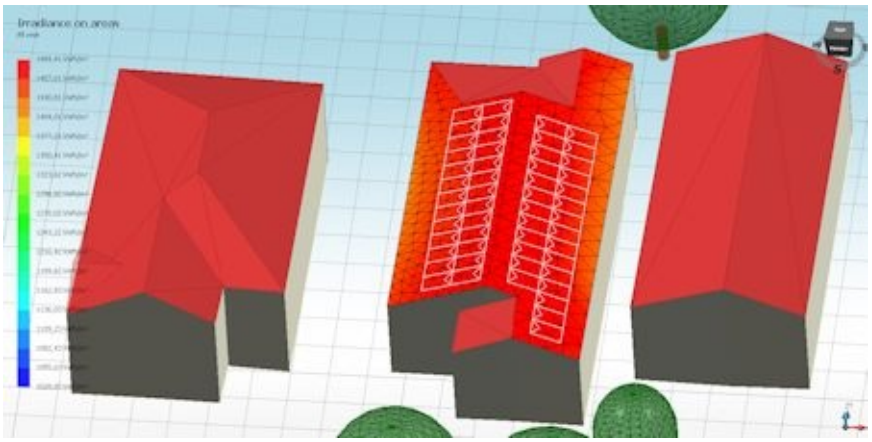
The calculation of the radiation distribution allows for an evaluation, on the areas in the layout of the PV system, of how the radiation of the sun is lost due to the presence of near obstacles. The areas will be colored differently depending on irradiance received throughout the year. The areas that receive always the irradiation will be red while those who are always in a shaded area of the obstacles will be colored blue.

The assessment of irradiation will be made only on the areas that are enabled to the arrangement of modules.

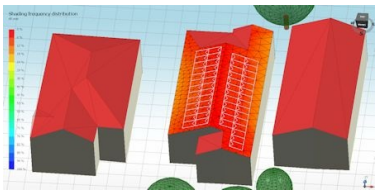
☞ This context it is available only in **3D View**

The evaluation is made by:

- *Irradiance on areas*, global irradiation received on the area, expressed in kWh/m²
- *Shading frequency distribution*, frequency with which the area is in the shade, expressed as a percentage. 100% indicates that the area is always in the shade, the 0% that the area has always irradiated.



Irradiance on areas



Shading frequency distribution

The command *Radiation distribution* opens a windows to manage options involved in the calculation of the irradiations on areas.

The track-control *Calculation precision* improves the accuracy with which you calculate the distribution of radiation near areas, the program thickens the mesh of points on which you want to calculate the radiation. Increase the accuracy of calculation can require more time of computation.

It is possible decide to apply the calculation on a specific period of the year with settings *Start date* and *End date* or over *All year*.

With Advanced options it is possible to apply an algorithm of *Mesh refinement* for calculation, in this way the software generate a non uniform mesh for the definition of points of radiation evaluation, but it will make more refined mesh in areas in which the variations of radiation due to shades are larger.

This allows to obtain a calculation with less point of evaluation, but better distributed. With *Number of steps of mesh refinement* you can improve the result precision.This options it is strongly recommended expecially for large area with shades limited only in a little area.

Clicking on *Run* button the calculation it is performed and the map of radiations it is updated.

Preview

This context lets you set the preview of the layout, both in 3D and Map view, which will be included in the documentation reports.

These options allow the user to customize the design of the layout that the program places in the reports. In addition to these options, you are using the point of view of the scene used for viewing this context.

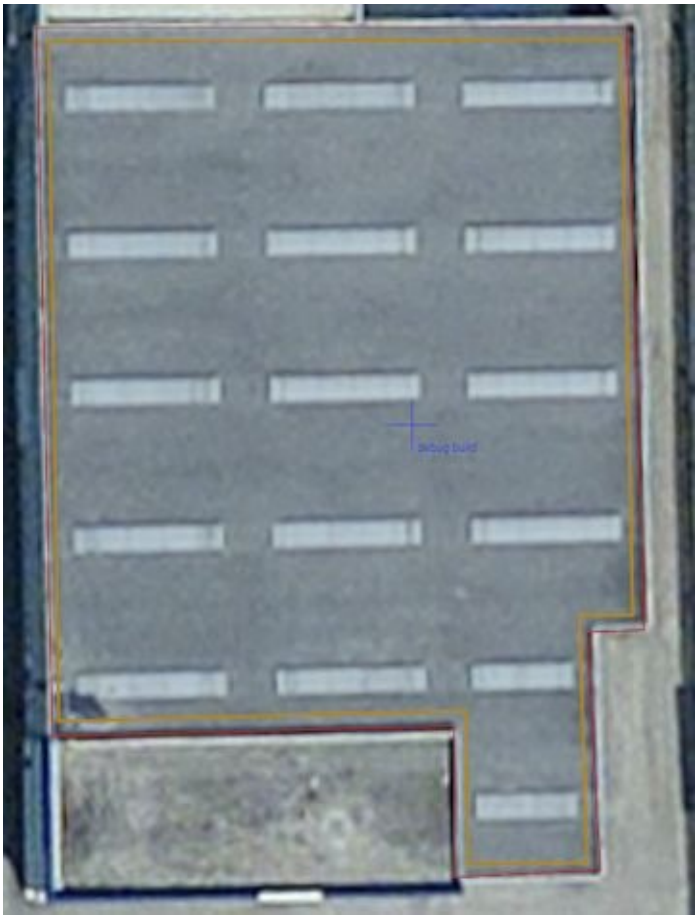
Clicking the *Apply* button, it will display the changes due to the display options.

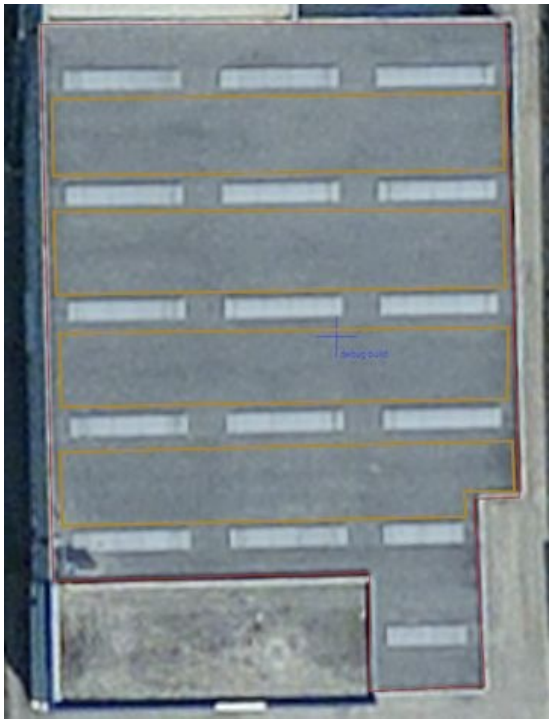
> ☞ Note that these options are specified for the individual project, and not as the program's options.

Sectors

We have introduced the *Sector* concept to simplify the insertion of modules within the areas and to allow the designer to realize all the different strings of the strings.

A Sector is a portion of the area bounded by a closed polyline, each area can contain multiple Sectors. To make a Sector use the *Add Sector* command. When you create an area a standard sector is automatically created, this Sector has the same geometry of the area minus than an offset. In many situations, this sector is sufficient for positioning strings. But often it is not possible, or you do not want, to include strings regularly in the Sector, in this case it is appropriate to create a different set of Sectors. Each sector can be edited and moved, but it must always remain completely within a single area.





The program make module placement only within the Sectors and the

positioning parameters refer to the Sectors where the strings are inserted. For this reason, the user of the program must properly learn the use of the Sectors because it is a tool that simplifies and enhances the positioning capabilities of the modules

- The program does not allows overlay Sectors in an area
- Note that the length of the strings can be different for each Sector

Modules arrangement

With these settings, the program performs the arrangement of the modules within the sectors of the areas. Note that these properties are applied to all sectors of the area.

Orientation:

These values represent the orientation of the strings in the area, they are automatically calculated by the program based on the disposition of the areas in the Layout.

Azimuth	Azimuth of strings, it is editable only while the system is in the ground, if the system is on the roof this value is given by the orientation of the lower edge of the area.
Tilt	Tilt of strings, it is editable only when the *Coplanar modules* parameter is set to false or when the system is in the ground.

Arrangement:

These values affect the way in which the program has strings within the sectors of the areas.

Horizontal alignement	Alignment of the modules respect to the sector along the horizontal direction, can be Left, Center or Right. The horizontal direction is defined by the direction of the lower edge of the area.
Vertical alignement	Alignment of the modules respect to the sector along the vertical direction, can be Left, Center or Right. The vertical direction is defined by the direction perpendicular to the lower edge of the area.
Strings direction	Direction in which the strings are arranged, can be Vertical or Horizontal. The vertical direction is defined by the direction perpendicular to the lower edge of the area. The horizontal direction is defined by the direction of the lower edge of the area.
Start point	Corner of the sector from which to begin the module

	arrangement.
Module disposition	Disposition of the arrangement of the modules, can be Vertical or Horizontal. The vertical disposition is defined when the side of major size of the module is perpendicular to the lower edge of the area. The horizontal disposition is defined when the side of major size of the module is parallel of the lower edge of the area.
Arrangement verso	Verso wherein arrange the modules in the lines subsequent to the first, can be Alternating or Unique. If Alternating, the order of numbering of each module of the string changes direction when the modules are starting to be placed on a new line. If Unique, the order of numbering of each module of the string has always the same direction also when it change the line. The direction is determined by the choice of *Start point* parameter.
String on multiline	Enables a string to be placed on multiple lines, if false a string can be arranged only along a straight line. Using multiline optimizes the exploitation of available space.
Modules alligned	Enables module arrangement aligning each module with those of the other rows of strings.

Spacing:

Module distance	Distance between modules expressed in cm. This distance is in the direction of the lower edge of the area.
Line distance	Distance between lines expressed in cm. This distance is in the direction perpendicular to the lower edge of the area.
Optimal distance	Enable the distances between the lines of modules calculated so that the modules do not shading between them. In this case, the *Line Distance* parameter is not changeable and its value is calculated by the program. This parameter is disabled if the modules are coplanar to the area.

Various:

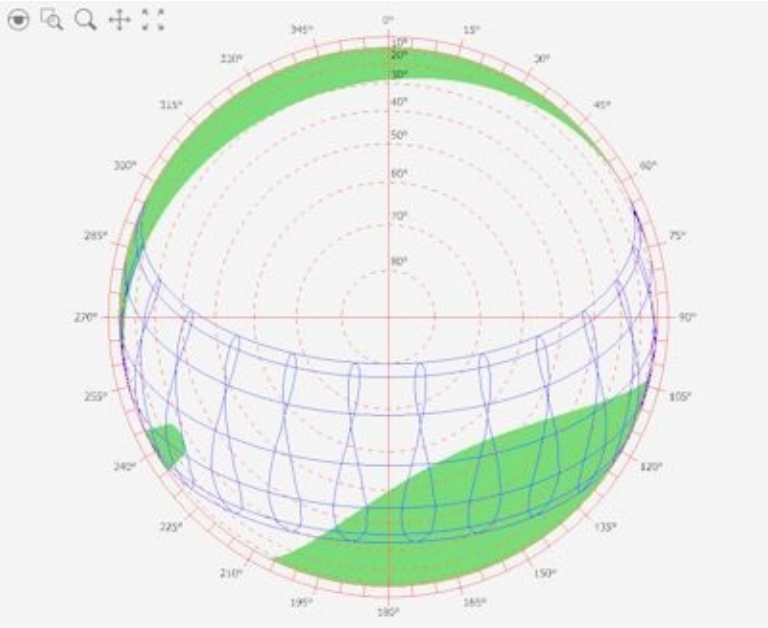
Coplanar modules	Enable the modules to be coplanar and integrated to the area, in this case the *Tilt* parameter of the string is not editable.
Height from area	Distance in height between the area and the lower edge of modules of the strings, this distance is expressed in cm. This parameter is disabled if the modules are coplanar to the area.

Shade diagrams

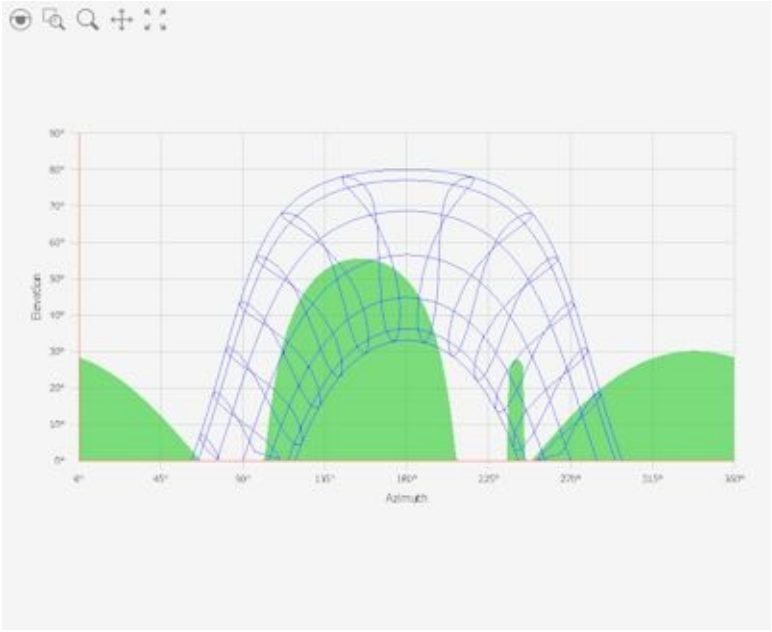
This graph shows the surrounding skyline viewed from a point and the path of the sun, being so able to observe the interference of these charts will help you understand the solar access at that point.

Looking at the diagrams, the lines in blue are the path of the sun between the summer solstice and the winter solstice, the areas in green are the obstacles around the point where it is conducting the evaluation.

Polar diagram:

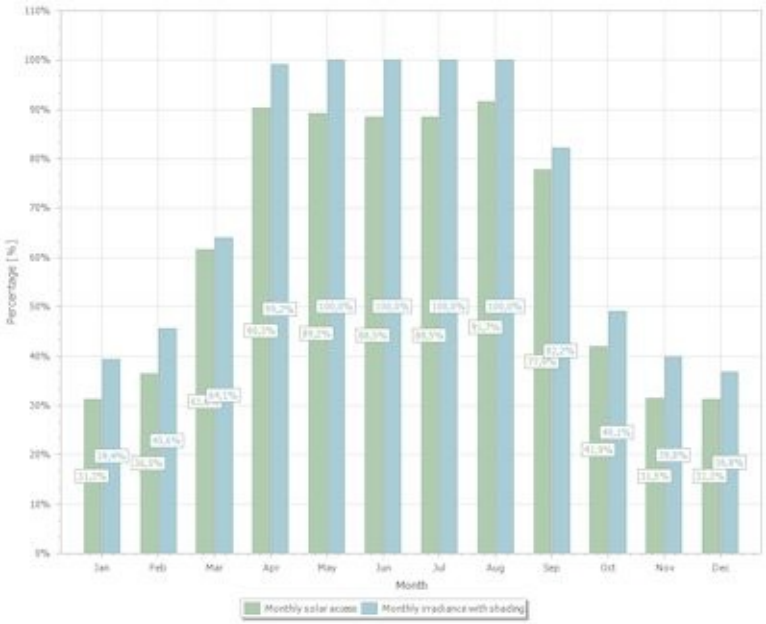


XY diagram:



Azimuth and *Elevation* identify the position of the sun, so that the green areas that overlap the path of the sun indicate the times of year when the point is not reached by the sun's rays.

The Monthly solar access diagram explains the amount of available solar energy or insolation in a particular location.



The reported solar access percentages are the amount of site-specific solar insolation available at the location where access was evaluated given the shade-

causing obstructions, divided by the solar insolation if there were no shading.

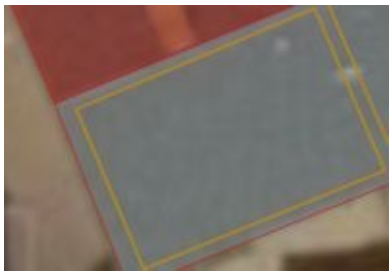
☞ Note that *Monthly solar access* explains the frequency with which the point is shaded, and the *Monthly irradiance with shading* is the percentage of solar energy that the point receives in presence of shadows generated by obstacles compared to the situation in the absence of shadows.

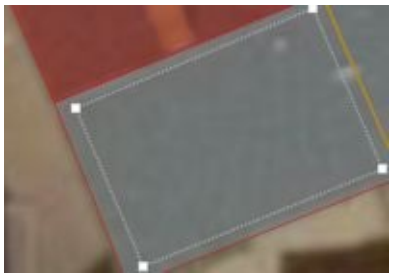
Edit of Layout entities

All the graphic entities in the layout can be edited, these are the rules for doing this:

Selection:

By clicking on a graphic entity this is enabled to be edited, this is highlighted by squares on editable nodes and changing the contour line style. You can also make multiple selection of graphic entities, keeping the uppercase key pressed while selecting, or you can select all entities that intersect a rectangle traced by the cursor.





Move entity:

All selected entities can be moved by moving the mouse while holding the left key pressed. Note that some layout entities cannot be moved or can only be moved within certain zones.

Moving entities by holding down the uppercase key, nodes of entity will trigger the snap on other nodes.

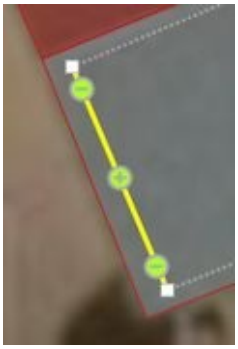
Edit node:

Clicking on a node this can be moved by holding down the left mouse button. Moving node by holding down the uppercase key, the node will trigger the snap on other nodes. Note that some node of layout entities cannot be moved or can only be moved within certain zones.

Edit edge:

Moving the mouse cursor over the edges of the graphics entity, the edge is highlighted in yellow and appears the markers to add and remove the nodes.

The cursor picture changes according to the operation that you can activate by clicking.



Remove node:

By clicking on the marker , the node near the marker is removed and the two edges connected to the node are deleted and replaced by a new edge.

Add node:

By clicking on the marker creates a new node at the middle point of the edge, this point can then be moved to a new position.

Map modes

The Map view of system layout proposes the plan view of the location where the system is sited. The program can work in two map mode:

- Dynamic map mode
- Static map mode

Dynamic map mode: this mode is possible only with the internet connection, dynamically getting images of the site map.

Static map mode: in this mode the program stores a static image, read by internet, of the site. This image has a limited extension but after being read can also be shown without the active internet connection.

When running the Wizard design, the map display mode is always dynamic and can not be changed by the user, so it requires access to the Internet. When the wizard ends, a sufficiently extensive image is generated to fit the photovoltaic plant area and the program is set to work in static mode.

In this way the user can continue to work on the project even without an internet connection. But also out of the wizard the user can swap the static and dynamic mode, or change the image of the static mode.

In the lower left of the layout area, you will found a menu that allow to modify the map mode.

Economic analysis

The production of electricity through a photovoltaic system allows to obtain economic benefits as a result of:

- Sale of energy
- Savings due to a lower purchase of energy from the utility grid
- Obtaining the incentives
- Tax benefits

However, the construction of a photovoltaic system comes at a relevant cost which must be compared with future revenues to be able to evaluate the cost-effectiveness.

BlueSol provides the tools to be able to analyze the advantages of the realization of the photovoltaic system, evaluating costs of realization and management and simulating the profitability during the assessment period, considering variable aspects as the falling of the annual production, the cost impact of financing, the changes in energy costs due to inflation.

The economic evaluation involves a lot of data to be processed, concerning:

- Costs: Specifies the costs of realization of the PV system in addition to periodic and the maintenance
- Financing: Sets the details of a possible partial or total financing of the realization of the system
- Energy consumption: Estimates the consumption and the self-consumption of system
- Energy sales: Rates of electricity sales
- Incentives: Incentives, on the energy produced, that may be available in the country in which it operates the system
- Taxes: Defines the fees charged to earnings procured by the photovoltaic
- Table: Detailed table of profitability, for each year during the assessment period of the system

The *Profitability* page summarizes the main results of the economic analysis.

More details can be found in the pages Table and *Charts*, where it is presented a detailed table for years and the graphs of the trend of economic parameters over time. Tables and graphs can then be exported in XLS format and as images.

👉 **Please note that all amounts included in the economic analysis should be entered either with or without sales tax. As a rule, all amounts should be entered as net sums. However, if you enter a gross amount, you should make sure that all entries are gross.**

👉 The currency symbol used by the program ($ or € ...) is taken from the settings of your computer, but the currency text is set in the settings of the application.

Costs

In this section you specify the costs of construction and maintenance of the PV system.

The initial costs total (net) of the PV system (material, structure, assembly ...) necessary for the realization of the system can be specified as an absolute amount or specific to kWp power of the system.

The maintenance costs of the system are divided, over time in *Periodic costs* and *Extraordinary costs.*

The designer can add any number of items to these lists by specifying the following parameters:

- **Periodic costs:** specifies the period and duration in terms of years and the annual ammount.
- **Extraordinary costs**: specifies the year of issue and the amount.

Alternatively, or in parallel, to this definition of costs, you can specify an *Annual maintenance as a percentage* of the system realization cost that is applied to each year of the assessment period.

Financing

In the event that the manufacturer decides to apply for funding to build the pV system you must enable the check mark *Allow financing*. Then you will specify the terms of the loan:

- *Capital to finance*: The loan amount can be entered as an absolute value or as a percentage of the investment
- *Loan interest*:: Nominal interest rate to be paid on remaining debt
- *Term:* The time period after which the loan has been repaid
- *Frequency installment:* Deadlines to which the payment of installments are made

The program then calculates the *Installment amount* and the *Global financing* amount including the interests.

Energy consumption

In the design of a photovoltaic system is important to be able to evaluate the consumption of users with respect to the production of system. In particular, it is necessary to quantify the *self-consumption*.

The self-consumption [kWh] is the amount of energy produced by the system and at the same time consumed by the user. The program indicates this amount as share of self-consumption as the percentage of production of system self-consumed by the user.

> ☞ Please pay attention to the fact that consumption and self-consumption are amount different.

The self-consumption may not exceed the consumption and normally self-consumption is less than the consumption, this implies that a part of the consumption must be fetched from the network or from batteries if availables, in fact:

Energy taken by electricity grid + Energy taken from the batteries = consumption - self-consumption

A precise evaluation of the self-consumption requires to know the energy production and consumption as a function of time to compare the trend of these data. The software allows you to define the self-consumption by manually setting the share of self-consumption, or to make perform the evaluation to the program, in this case is on the check mark on *Calculate Total annual consumption and Share of consumption based on the profile of electricity consumption*.

> ☞ The designer can manually define the share of self-consumption based on own experience, or if is already in possession of the data of self-consumption design situation similar to the one under study.

If a grid-connected system provides for energy storage and If you do not use a profile of electricity consumption to define annual consumption, but you simply define the *Total annual consumption*, the calculation of *Share of Self-consumption* and the simulation of the use of photovoltaic energy must be considered as indicative and their reliability is low. So it is recommended that you use a profile of electricity consumption.

The program provides the tools to define the power consumption of individual electrical devices with which to create a database of reusable information. The combination of the consumption of the devices realizes a consumption profile that identifies the energy consumption of a user.

Energy sales

The electricity produced by the photovoltaic system, but that is not self-consumed by system users or stored in batteries, can be sold to the grid operator. There are two types of contracts for the sale of electricity fed into the grid:

Sale: The energy fed into the grid is sold or on the basis of an *Average price* or *Variable price based on production*. In the first case all the energy is sold on the basis of the average price. In the second case the tariff is set based on the amount of energy annually fed into the grid.The price ranges can be edited using the *Add* and *Delete* buttons, and any value changed within the grid.

Net metering: With this contract for the sale of energy, the owner of the PV system receives a credit for the energy they feed into the grid. Since for each country can be different interpretations of this sales policy, the program offers a generic approach where you need to set some parameters.

The credit that is granted is based on the valorization of energy fed into the grid. If this value is the same as the purchase price of the energy, then the grid behaves as an energy storage: that which has not been used can then be withdrawn in a deferred way without additional costs. If the energy that feeds into the grid is greater than that which is taken, it creates a credit which can be possibly used in subsequent years.

Note that, in the economic evaluation, the net metering is considered a revenue even though there may not be a bill, and you may see as a savings.

With these parameters you configure the net metering:

- *Managing credit balances*: In the case in which there is a credit, this can be used in the subsequent years (with a limit of *Credit energy period*) or paid annually.

- *Credit energy period*: Number of years within which can be taken the credit.

- *Price of energy valorization exchanged different from the cost of electricity withdrawn*: Specifies whether the value of the energy fed into the grid is different from that taken, in this case you must specify

the *Price of energy valorization.*

- *Price of energy valorization*: Amount by which valorizes the energy fed into the grid.

The economic value of net metering is calculated as follows:

Revenue from net metering = Min (*Price of energy valorization* * *Energy fed to grid*, Cost of energy withdrawn from the grid)

Incentives

Incentives for photovoltaics are offered to producers of electricity from photovoltaic systems. A government can offer incentives for the PV industry to promote the economies of scale necessary to make the cost of photovoltaic electricity competitive with the cost of the existing grid. These policies are carried to promote national or territorial energy independence and reduce carbon dioxide emissions that cause global warming.

Enabling the check mark *Allow incentive to photovoltaic production* you can enter the revenue from incentives in the economic analysis. Because each country may decide different methods of incentives, the program proposes a method for evaluating generic and simplified to the definition of incentives.

- **Feed in tariff**: Are the tariffs, related to the production of electricity, expressed in [currency/kWp] with which the program evaluates the revenue from incentives. You can define different tariffs for different use of energy produced:

1. *Feed-in tariff for the produced energy*: All the energy produced gets the incentive specified
2. *Feed-in tariff for energy fed to the grid*: The incentive is applied only to the energy fed into the grid
3. *Feed-in tariff for self-consumed energy*: The incentive is applied only to the energy self-consumed by users of PV system

Tariffs may be cumulated enabling its check marks. But tariffs may also decrease over the years, in this case must be assigned parameter *Annual variation of feed-in tariff* as a percentage of annual reduction of tariffs set.

- **Payout duration**: It is the period of time in years as they are granted the incentives.

In addition to revenues due to incentives, the energy that is not self-consumed can be sold to the grid operator. But not always the rules that manage the incentives that allow the sale or net metering are compatible with the incentives. Therefore, if these revenues are compatible, you must use the check mark

Additional remuneration for sale/net metering

Taxes

If you want to activate the assessment of taxes in economic analysis you must enable the check mark *Allow taxes.* The program allows a general and simplified assessment of taxes since each country adopts different rules. These are the parameters that can be configured:

- *Tax rate for income*: In a tax system, the tax rate describes the burden ratio (expressed as a percentage) at which a business or person is taxed. In this way the tax to apply is *Taxable income* * *Tax rate for income.*
- *Tax on feed-in tariff:* In the event that the energy production of the PV system receives incentives, income that follows may be subject to taxes. Each country may have different rules, so you can specify which part of the PV production is subject to tax by clicking the corresponding check mark.
- *Taxes on electricity: sale/net metering*: Allows to enable/disable the taxation of energy sold or the net metering.
- *Depreciation:* It is the allocation of the cost of assets to periods in which the assets are used. They can be considered in the economic evaluation by selecting the check mark *System depreciation*, then you can determine the percentage of the investment that is subject to depreciation. The *Annual depreciation* parameter sets the percentage of value subject yearly to depreciation. If, for example, the depreciation will be in 20 years then the *Annual depreciation* will be of 5%.

Another way of encouraging the realization of photovoltaic systems is to allow the tax detraction of the cost of the system. In some countries this is possible, if this is the case, you must enable the check mark *Enable tax detraction of system cost*.

- *Percentage of system cost:* Percentage of total system cost that can be detracted from taxes.
- *Detraction period:* Number of years on which shall be distributed, in equal parts, the percentage of the cost of the system that can be detracted from taxes.

Table of profitability

BlueSol generates a detailed table of all parameters of economic evaluation, detailed per year for the assessment period of the system:

- **Year**: Year of PV system life
- **Energy production** [kWh]: Energy production estimated by the program. Also matches the *Energy fed to grid + Self-consumption*
- **Energy fed to grid** [kWh]: Energy produced by the system and fed into the grid because not consumed by users of the PV system.
- **Energy consumption** [kWh]: Annual energy consumption, including any increases in consumption. Also matches *Self-consumption + Energy taken from the grid*
- **Self-consumption** [kWh]: The amount of energy produced by the system and at the same time consumed by the users of system
- **Energy taken from the grid** [kWh]: Energy consumed by the user and coming from the grid
- **Total revenue** [currency]: [Revenu of feed-in tariff] + Revenue from energy sale or Revenue from net metering
- **Revenue of feed-in tariff on energy produced** [currency]: Energy produced * Feed-in tariff for the produced energy
- **Revenue of feed-in tariff on energy fed into grid** [currency]: Energy fed into grid * Feed-in tariff for energy fed to the grid
- **Revenue of feed-in tariff on energy self-consumed** [currency]: Energy self-consumed * Feed-in tariff for self-consumed energy
- **Revenue from energy sale** [currency]: Energy fed into grid * sale price
- **Revenue from net metering** [currency]: Valorization of energy escanged into the grid
- **Energy purchase tariff** [currency/ kWh]: Energy purchase tariff (see *Average cost of electricity withdrawn* in Energy consumption section) revalued annually by the *Energy price inflation*
- **Saving on energy bill** [currency]: Savings due to non-purchase of energy. Calculated as *Self-consumption * Energy purchase tariff*
- **Maintenance costs** [currency]: Cost of maintenance periodic and

extraordinary

- **Financing** [currency]: Amount of annual installment with financing. The amount is calculated by the program based on the capital to be financed. Also matches *Loan capital amount* + *Loan interest amount*
- **Loan capital amount** [currency]: Principal portion of the installment loan
- **Loan interest amount** [currency]: Interest portion of the installment loan
- **Gross profit** [currency]: *Total revenue* + *Saving on energy bill* - *Maintenance costs* - *Depreciation* - *Loan interest amount*
- **Total tax** [currency]: *Taxable income* * *Tax rate for income* (see Taxes)
- **Taxable income** [currency]: Refers to the basis upon which an income tax system imposes the taxes, calculated for each year as *Income subject to tax* - *Maintenance costs* - *Depreciation*. Note that the program does not handle tax credits, so if *Taxable income* is negative then *Total tax* will be forced to zero.
- **Income subject to tax** [currency]: Part of the *Total revenue* subject to tax
- **Depreciation** [currency]: Depreciation of the system, calculated for each year as the *Realization cost* * *System depreciation* * *Annual Depreciation* (see Taxes)
- **Net profit** [currency]: *Gross profit* - *Total tax*
- **Cash flow** [currency]: *Net profit* + *Depreciation* - *Loan capital amount*
- **Cumulative cash flow** [currency]: cash flow of year + cash flow of previous year. The first year is calculated as: cash flow of year - system cost + amount to be financed.
- **Net present value (NPV)** [currency]: By calculating the NPV is established the convenience expected of investment, by discounting the future cash flows in order to detect the present value of the investment.

Note: The *currency* symbol used by the program ($ or € ...) is taken from the settings of your computer

Electrical scheme

The menu Electrical scheme allows you to generate the single-line electrical diagram of the system.

The scheme is generated fully automatically using the Create electrical scheme command and can subsequently be modified using the CAD functionality.

Electrical scheme generation

The command *Create electrical scheme*  opens the *Electrical scheme* window, which allows you to define some characteristics of the scheme.

Electrical scheme window

Arrangement

Allows you to set how the electrical scheme should be drawn between four predefined arrangements.

Paper format

Allows you to define the format of the paper on which the electrical scheme will be printed.

> ☞ When printing, you must set the printer paper to the same size you set here.

Optimize

If there is a check mark, the schema is drawn even in areas under the legend and to the left of the title block.

> ☞ There is no check to see if the scheme overlaps the legend or title block, so when that happens, disable the option.

Character height

Used to define the height you want for the character of the text on the printed sheet. The height is calculated in such a way as to be correct in the paper size that has been set.

Default

Resets the character height to its default value.

Groups of modules

A group of modules is formed by the modules components a string. Depending on the structure of the system and the number of modules of the strings, and in order to have the best readability of the diagram, you can choose between two options:

Show all modules

Displays all the modules.

Show a maximum N modules

Displays all the modules if their number is less than or equal to the number set N, otherwise displays N modules.

Groups of strings

A group of strings is formed by the strings connected to a single electrical panel or to a single inverter.

As for the modules, you can choose between two options:

Display all strings

Displays all the strings.

Display a maximum N strings

Displays all the strings if their number is less than or equal to the number N set, otherwise displays N strings.

Insert button

The drawing if present is erased and is generated the electrical scheme according to the current system composition.

☞ If there are primitive created by the user will be asked whether should be kept or deleted. A primitive scheme changed by the user is considered a primitive user.

Cancel button

Closes the window canceling the command. The drawing is not changed.

☞ *Electrical scheme window* settings are saved with the project, so each time you give the command *Create electrical scheme* are proposed settings previously used for that project. If the command is given for the first time for that project are proposed settings used for the last scheme generated by the program.

☞ The various components of the electric diagram are inserted on different layers, in order to make easier the change of dwg if the drawing is exported. The layers are: Draft, Texts, Legend and Frame. These levels are not visible in the Layers dialog and then can not be changed by the user.

CAD capabilities

In the page Electrical scheme, there are CAD commands that allow the insertion of new graphic primitives and the modification of existing ones.These allow you to change the schema after it has been generated automatically.

☞ To modify a graphical entity you can select it and then edit it interactively in the manner described in Interactive editing.

☞ In any situation by pressing the right mouse button opens the context menu that puts at your disposal the most useful commands in that context.

More information:

- CAD commands : description ot the commands grouped by categories of functionality.
- CAD windows : description of the main windows used by CAD.

Interactive editing

At the beginning of every work session and after the termination of the execution of a main command the base command *Select* is activated that lets the user select entities of the drawing in order to operate with them. Obviously, the *Select* command can be recalled at any moment cancelling as the other main commands do the former active command.

When the *Select* command is active you can select any graphic entity by a simple mouse click on it. The selected entity can now interactively be modified, it is in **editing.**

When an entity is in editing the use of modifying and transformation commands is inverted: instead of first entering the command and then selecting the entity or entities to apply the operation on in editing you first select the entity you want to modify and then the command that shall be applied. The commands are applied to all entities that are in editing, after their execution they are automatically disabled; the selected entities continue to be in editing, other modifications can be made.

The commands mainly used in editing are available in the context menu.

When the *Select* command is active and you select a graphic entity it is in editing: you will see it within a dashed rectangle that encloses it perfectly, the so-called *box*; further you will see markers on the entity's snap points and other markers on the box: on its center and its vertices as well as on the middle points of its sides.

If the box is too small and cannot be displayed the only thing to be displayed is the marker on its center. You have to enlarge the view to see the box with all of its markers. See Zoom commands.

The selection of another entity de-selects the entity that is in editing.

If you want to select several entities you have to press the *Shift* key while

selecting the entities: this way selected entities are not de-selected by the selection of other entities. If you select an already selected entity with the *Shift* key pressed a second time it will be de-selected and lose the editing state. This use of the *Shift* key is active only when the *Select* command is activated.

When the cursor is brought onto a marker of whatever type the cursor appears in another shape; this shape indicates the action you can perform if you select the marker by left mouse clicking. The editing operation can be still modified opening the contextual menu by right mouse clicking. The available operations are:

- **Modify** the geometric position of the selected point. This action can be performed on the snap points only.
- **Move** the entities that are in editing according to the transformation type you choose in the menu. The transformation of the entities is executed by moving the selected point according to one of the following types:
    - **Translation**: translates the all the entities the same way as the selected point is translated.
    - **Rotation**: rotates the entities round the center of the box by an angle that equals the angle defined by the translation of the selected point.
    - **Mirror**: mirrors the entities at the axis that passes through the center of the box and the selected point.
    - **Scale**: resets the size of the entities according to the increase or decrease of the distance of the selected point from the center of the box.
- **Copy** the entities that are in editing. The available transformation operations are the same as in **Move**, the only difference is that the original entities are not deleted, but continue being part of the drawing; they also continue being in editing. Copying is therefore not actually an interactive modifying operation than a handy interactive way of copying. The transformations are:
    - **Translation**
    - **Rotation**
    - **Mirror**
    - **Scale**

Selecting the marker and moving it to a new position you modify the entity. The modifying is interactively displayed by the echo.

The available operations are memorized separately for each marker type. When you perform an operation through a marker as described above the next time you select a marker of the same type the same operation will be reproposed.

In case of the *Rotation* the *Ortho mode* is active respectively to the center of the box, i.e. to the point the rotation axis passes through. This way performing a rotation at one of the markers positioned at the middle points of the box sides you can - when pressing the *Ctrl* key - perform rotations of 90, 180 or 270°.

👉 If you have selected an entity that does not allow some of the editing, these are disabled. In particular, the devices of the system can be moved or deleted, but you can not change its size.

👉 If you select an electrical cable, you can move, add or delete a node. To move a node, simply select it and move it; to add or delete a node, you must use the commands available from the context menu when selecting a cable.

👉 If a single module is selected, the snap points of the box coincide with the corners of the module even if it is rotated. This feature allows you to move a module by hooking a corner, allowing a precise repositioning.

Context menus

Pressing the right mouse button when the cursor is in the drawing area you open a menu that offers various sets of commands according to the command which is active, therefore the name *contex menu*. The commands here listed are the commands that usually are the most useful in the given situation.

Selection contextual commands

When the selection of an entity is requested and the command requires the selection of several entities the contextual menu places at your disposal various selection commands.

All

Select all entities that are entirely or partly visible on the screen.

Zone

Select all visible entities located within a zone that is defined by two given vertices.

> ☞ When is require a selection you can use an alternative method to this command:
>
> - press the left mouse button on one end of the selection area
> - holding down the left mouse button, drag the cursor to the second end, you will see the echo of the selected area
> - once you reach the second end point, release the mouse button

Complementary zone

Select all visible entities that are located outside a zone defined by two given vertices.

String

Select the entire string by the selection of its own module or text.

Chain

Select the “course” of consecutive entities, i.e. entities that have each one vertex in common with its predecessor.

Requires the selection of one entity of the course. The course finishes where the outer vertex of an entity doesn’t coincide with the vertex of another entity.

Intersection

Select all entities that intersect the line defined by two given points.

Last

This subcommand selects the entity you have worked on last.

Entity selection commands

Commands to filter the selection of entities on the base of their type. These commands can be used in combination with the other selection commands.

Attribute selection commands

Commands to filter the selection of entities on the base of their attributes. These commands can be used in combination with the other selection commands.

End selection

Finishes an entering sequence of operands for the execution of a command that requires an undefined number of operands.

> ☞ Some commands require a variable number of selected entities. In these cases the program continues requesting operand-inputs (points or selections) until the user finishes the data input by use of this command.

Attributes...

Opens the Attributes window in *Define attributes* mode.

Snap point contextual commands.

Snap point commands are commands that help you select points when the program requests the input of points. Use one of these commands to insert as point a snap point of an existing entity.

You can also snap to snap points through the *Automatic snap* (see *Snap points page* in CAD options window).

Extreme

Select the vertex of the entity which is the nearest to the selection point.

Selectable entities are: lines, arcs, circles and splines.

☞ If a line is visible only partly the visible part only will be considered.

☞ In case of arcs besides the actual vertices are also considered eventual intersection points with the horizontal and the vertical diameter.

☞ In case of circles only the four intersection points with the horizontal and the vertical diameter are considered (actual vertices don’t exist in a closed curve).

Middle

Select the middle point of the entity.

Selectable entities are: lines, arcs and splines.

Centre

Select the center of the entity.

Selectable entities are: arcs, circles and points.

Intersection

Select the intersection point of the two selected entities which is the nearest to the selection point.

Selectable entities are: lines, arcs, circles and splines.

☞ If the entities intersect more times the intersection point will be selected which is the closest to the selection point.

Near

Select the point of entity which is the nearest to the selection point.

Selectable entities are: lines, arcs, circles and splines.

Grid

Select the point on the grid which is the nearest to the selection point.

☞ When this command is active the cursor is displayed doubled: first at its real position, second as echo at the respective nearest grid point.

Origin

Select the origin of the entity.

Selectable entities are: texts, blocks, hatchings and dimensions.

☞ The origin of texts and blocks is their positioning point.

☞ The origin of a hatching is its barycenter.

☞ The origin of a dimension is the positioning point of the dimension text.

Point

Select an entity of the point type.

☞ Corresponds to the *Center* command applied to a point with the only difference that this command only allows the selection of entities of the point type.

End Selection

Finishes an entering sequence of operands for the execution of a command that requires an undefined number of operands.

☞ Some commands require a variable number of selected entities. In these cases the program continues requesting operand-inputs (points or selections) until the user finishes the data input by use of this command.

Coordinates...

Opens the Coordinates window.

Interactive editing contextual commands.

When the *Select* command is active (see Modify commands) and you select one or more graphic entities, the selected entities are in editing**.**

In editing mode the contextual menu provides several commands, some depending on selected entity type. The commands are applied to all entities that are in editing.

Delete

Delete the selected entities.

Entities information

Opens the *Information window* that displays the information on the selected entity. If more than one entity are selected it displays the information about all entities.

Copy and Move

Commands that operate transformations on entities in editing. The transformations are the same for both the copy commands and the move commands. In both cases, you create a new entity by applying the transformation to the selected entity. The difference is that the copy commands maintain the original entity while the move commands erase it

➞ Translation

The command requires two points and applies a transformation of translation along the vector that goes from the first to the second point inserted.

↻ Rotation

The command requires a point and an angle, then applies a rotation transformation equal to the angle around the point inserted. The angle is in sexagesimal degrees and a positive value means an anticlockwise angle.

Mirror

The command requires two points and applies a transformation of reflection relative to the line passing through the two points inserted.

Scale

The command requires a point and a number, and then applies a scale transformation with respect to the inserted point, with a scale factor equal to the number entered. The factor can be negative, it cannot be zero.

Last

Performs on the selected entities the last transformation that has been made. If you have not yet made any transformation the command does nothing.

Attributes...

Opens the Attributes window in mode *Modify attributes* of the selected entities

Interactive editing commands depending on selected entity type

Layout device commands

Go to the system

Open the page *System* on the properties of the selected device.

Properties...

Opens the Properties window for the selected device.

☞ Double-clicking on a device automatically run the *Properties* command on that device.

Electrical cable commands

Add node

Requires the selection of a stroke of the electrical cable and the insertion of a point, then inserts a new node at the point inserted; the node splits the selected stroke in two new sections.

Delete node

Requires the selection of an internal node of the electrical cable. The node is deleted and the two adjacent sections are replaced by a single stroke between the two adjacent nodes.

☞ To move a node of an electric cable you must select the cable, which then is in Interactive editing, and then use the functionality of changing the geometrical position of the node.

Circle and Arc commands

Modify radius

The command requires a number, then changes the circle (or arc) selected so that its radius is equal to the number entered.

Text commands

Modify text

The command asks for the input of a new text through the *Strings* window; it initially offers the currently selected text in order to be modified.

Dimension commands

Move

The command requires a point, then changes the position of the text of the selected dimension and moves it to the point inserted.

☞ The position of the dimension text depends on the *Optimum dimensioning* setting: if active the dimension is automatically

centered, otherwise it is positioned at the inserted point. The *Optimum dimensioning* can be set in the *General page* of the CAD Options window.

Move parallel

The command requires a point, then changes the position of the text of the selected dimension and moves it to the point inserted, with the constraint that the new positioning point is on the dimension line passing through the old point.

Move perpendicular

The command requires a point, then changes the position of the text of the selected dimension and moves it to the point inserted, with the constraint that the new positioning point is on a line perpendicular to the dimension line passing through the old point.

Detach

The dimensions are associative, that is memorize which are the entities that measure. This associativeness enables the dimension to immediately adapt itself to a new geometric situation that may be caused by the transformation or the modification of an entity.

This command deletes the association of selected dimension and measured entity (or entities), the dimension becomes independent.

Modify text

The command asks for the input of a new text through the *Strings* window; it initially offers the text of the currently selected dimension in order to be modified.

☞ The position of '#' character in a dimension text indicates the effective value of the dimension. The '#' character can be followed and preceded by other characters; it can be missing as well.

Block commands

Explode

Disaggregates the selected block into its components.

There are no commands for the insertion of blocks, but the blocks may have been inserted with the planimetry in DWG format.

CAD commands

The CAD commands are grouped into categories of functionality:

File : commands for printing and export of drawing.

Modify : commands for selecting and deleting of graphics entities.

View : commands for changing the view on the drawing.

Insert : commands for inserting new entities.

Edit : commands for editing the graphic entities.

There are also options for the behavior of CAD commands:

CAD Options

Automatic Snap

If for a point input you want to use a snap point of a graphic entity you can use snap commands (see Context menus).

You can also head for a snap point just pressing the *Shift* key while the cursor is approaching to an existing graphic entity. When the cursor has come close to it the nearest snap point of the graphic entity is highlighted by a little square. If you then press the left mouse button the highlighted point is inserted.

The heading for the nearest snap point can be set as permanent by activating the option *Automatic snap* in the *Snap point page* of the *CAD Options window*. In this case you don't have to press the *Shift* key to use the automatic snap.

Ortho Mode

If during a point input you press the *Ctrl* key the inserted point will be perpendicular in regard to the previously inserted point whatever movements the cursor performs. This situation is highlighted by the creation echo.

The ortho mode can be set as permanent by activating the option *Ortho Mode* in the *Snap point page* of the *CAD Options window*.

In this case you don't have to press the *Ctrl* key to use the ortho mode.

File

Commands for printing and export of drawing.

 *Print*

Starts the printing of the drawing using the current print settings.

 *Print Preview*

Opens the preview window of the print with the current print settings.

 *Print settings*

Opens the Print settings window.

 *Export DWG*

Export the drawing in DWG format.

> ☞ The *Print* command only asks the print confirmation. The command *Print settings* must be called explicitly.

Modify

Commands for selecting and deleting of graphics entities.

Select

Allows you to select entities in the drawing to make changes to the geometry or attributes, to obtain information or delete them. We say that the entity thus selected are in *editing*.

Extensive information can be found in Interactive editing.

☞ You can activate the command *Select* also by pressing the *Esc* key.

☞ When the command *Select* is active (and whenever it is require a selection) to select the primitives contained in an area you can use an alternative method to the *Zone* command available from the context menu:

- press the left mouse button on one end of the selection area
- holding down the left mouse button, drag the cursor to the second end, you will see the echo of the selected area
- once you reach the second end point, release the mouse button

Delete

Delete the selected entities.

Delete part

When an entity is selected that intersects one or more times other entities the command deletes the portion of the selected entity between two points of intersection or a point of intersection and one adjacent extreme.

Undo

Undoes the last executed operation. You can repeat this command until all executed operations are canceled.

Redo

Resets the last undone operation. You can repeat this command until all undone operations are reset.

View

Commands for changing the view on the drawing.

 *Zoom window*

Requires the selection of two points and displays as whole window the zone of the drawing that has been determined by the rectangle selected through these two points. In case the view is on more than one window is asked the selection of the window on which to perform the operation.

 *Redraw*

Clear the screen and redraw the current drawing. Is performed automatically by all the view commands, and can be used to clear the screen after editing operations to the drawing.

 *Zoom fit*

View the entire drawing in maximum scale compatible with the size of the window on the screen. This enables you to view all parts of drawing. In case the view is on more than one window is asked the selection of the window on which to perform the operation.

 *Previous view*

Lets you reset the previous view situation of the drawing. You can step back like this for one step only. Re-entering the same command you reset the current view situation.

 *1 Window*

 *2 Horizontal Windows*

 *2 Vertical Windows*

 *4 Windows*

The program places at the user’s disposal multiple-windows views. Each window is independent of the others, in each window you can work independently and perform view, selecting and creating operations.

When you change the multiple windows view, if you start from a view more than one window, you are prompted to select the window you want to copy the view in new windows.

Attributes

Opens the Attributes window.

Layers

Opens the Layers window.

Coordinates

Opens the Coordinates window.

Grid

Enables / disables the display of the grid.

The grid is similar to a squared sheet that lets you move the cursor in discrete steps.

> ☞ The visibility of the grid and snapping the cursor to the grid are independent and can be controlled separately.

Insert

Commands for inserting new entities.

Line 2 points

Creates a line that passes through two given points.

Broken line

Creates a broken line (sequence of consecutive lines). The broken line itself is not a single entity, the lines it is formed by are single entities; as such they can be used and modified.

Parallel through a point

Creates a parallel line to a selected existing line that passes through the given point.

Sloped

Creates a new line that is inclined to the selected (existing) line by an angle and that starts from the entered point (its first vertex).

> ☞ The pick point determines direction and orientation of the new line: it will be created rotated for the given angle towards the side of the pick point with respect to the selected line. The angle is measured from the line itself towards the vertex that is closest to the pick point. If the line is visible only partly the visible part is considered only. The length of the new line equals the length of the selected line in case the entered is a point on the line, otherwise the line passes from the entered point to the selected line.

Arc

Creates an arc that passes through three points.

The first and last point input define the initial and the final vertex of the arc; the second point input determines the arc defining a common point on the arc.

The three points cannot be aligned.

Circle center point

Creates a circle with center at the first point and passing through the second.

Circle 3 points

Creates a circle that passes through 3 given points.

The three points cannot be aligned.

Text

Opens a window in which it is possible to enter a text without limitations in size, and which can be disposed on one or more lines. Then asks you to select the point where to insert the text.

Point

Creates an entity of the point type.

Rectangle

Creates a rectangle whose diagonal has the two selected point as vertices. A rectangle is formed by a single polyline which consists of several lines.

Polyline

Generates a polyline composed of linear stretches that connect the input points. The *End Selection* command, available from the context menu, finishes the insertion of the points forming the entity.

Spline

Creates a spline as interpolation of the inserted points. The *End Selection* command, available from the context menu, finishes the insertion of the points forming the entity. The maximum of points for the construction of a spline is 100.

Hatching

Lets you execute the hatching of a closed perimeter requiring the input of only

one side of the perimeter.

Selectable entities are lines, circles, arcs and ellipses.

The command doesn’t consider eventual perimeters inside the selected perimeter. The perimeter can be formed by a maximum of 5000 entities.

If the selected entity belongs to only one closed perimeter is uninfluential the position of the center of the trap selection.

> ☞ If the selected on primitive belongs to more of a closed perimeter the position of the center of the trap selection becomes important, as the search for the closed perimeter is "resting the right hand" on primitive selected on the side of the center of the trap selection and advancing until to return to the starting point. In practice, you search the drawing area in which is the selection point.
> If the center of the trap selection is within a closed perimeter internal to others, this will be identified, if it is outside the perimeter closed outermost of all, the latter will be identified.

 *Hatching with Lakes*

Creates a hatching of a closed perimeter by the selection of one entity that belongs to it excluding the “lakes”, i.e. the closed perimeters inside the perimeter.

Selectable entities are lines, circles, arcs and conics.

> ☞ The entity has to be selected holding the selection cursor towards the inside of the perimeter you want to hatch.

 *2 points dimension*

Creates a dimension that measures the distance between the two points positioning it in the third point inserted.

 *Angle dimension*

Creates a dimension that measures the angle formed by two lines positioning it in the third point inserted.

> ☞ Two intersecting each other lines form four angles. Which of these

angles will be dimensioned depends on the pick points of the selection. In the first selection the exact position of the pick point defines in which of the two half planes of the first line the angle shall be; in the second selection the exact position of the pick point defines in which of the two half planes of the second line the angle shall be, this way you unequivocally determine the angle.

Diameter dimension

Creates a dimension that measures the diameter of the circle (or of arc) is selected positioning it in the point inserted.

☞ If inserted point is inside the circle the dimension line will be the diameter that passes through the point, if it is outside the dimension line will be horizontal or vertical according to the position of point.

Radius dimension

Creates a dimension that measures the radius of the circle (or of arc) is selected positioning it in the point inserted.

☞ The dimension line is on the the line passing through the center of the circle (or of arc) and passing through the point inserted.

More about dimensions

The position of the dimension text depends on the *Optimum dimensioning* setting: if active the dimension is automatically centered, otherwise it is positioned at the inserted point. The *Optimum dimensioning* can be set in the *General page* of the CAD Options window.

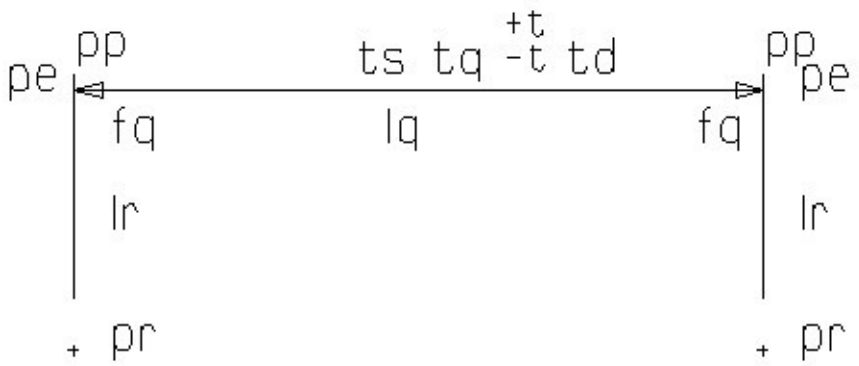
The dimensions are associative, that is memorize which are the entities that measure. This associativeness enables the dimension to immediately adapt itself to a new geometric situation that may be caused by the transformation or the modification of an entity.

You can delete this associativity with context command *Detach*.

Dimensions except for angle dimensions can be supplemented by tolerances. **Tolerances** indicate the maximum margin that the measured dimension is allowed to have with regard to the nominal dimension. Tolerances can be set in *Dimensions page* of Attributes window.

You can set tolerances as well by inserting their **ISO code**. In this case the values of the upper and lower tolerances are calculated automatically by the program that bases its calculation on the ISO code and the size of the dimension.

The following schema illustrates a typical dimension:



abbr. description**:**

fq arrow

lq dimension line

lr reference line

pe extension point

pp projection point

pr reference point

t+ upper tolerance

t- lower tolerance

td text on the right

tq dimension text

ts text on the left

☞ The texts on the right and on the left can be inserted during the

modifying of the dimension (see context command *Modify text* for dimensions).

Edit

Commands for editing the graphic entities.

 *Trim*

Lets you make coincide the vertices of two graphic entities by shortening or prolonging them, depending on whether the selected entities have an intersection point.

 *Fillet*

Creates an arc that links the two selected entities. You are prompted the radius of curvature. The graphic entities are shortened or prolonged, depending on whether they have an intersection point or not.

In the subsequent executions the radius is not requested again, it remains the same; the only input requested is the selection of two other entities.

 *Chamfer*

Creates a chamfer between two selected entities inserting a line that cuts them at a distance from their intersection point equal to the required value.

The segments that remain outside the chamfer are deleted.

CAD Options

Pressing the symbol  at the bottom right in the menu of CAD commands opens the CAD options window, .where you can set options related to the functionality of CAD.

CAD windows

This section describes the main windows used by CAD, which are:

Print settings window

Attributes window

Layers window

Coordinates window

CAD options window

Print settings window

This windows lets you set the print parameters. It has some pages that group settings:

- **Printer page**
- **Page page**
- **Drawing page**
- **Options page**
- **View page**
- **Pens page**

In the *Printer page* in particular you set the size of the printer page whereas in the *Drawing page* you set the size of the drawing sheet you want to produce in the end. Initially the two sizes are equal (Default setting of the Size of the *Drawing page*), but they can be separately modified: this way you can produce a drawing in a larger format than the largest format of your printer. This means that the printer will print several pages that have to be cut and united in order to form the required format. In this case you are recommended to activate the *Cropmarks* option in the *View page*: the printer will print little marks at the edges of the print area of each page that will help you afterwards cut the pages when composing the whole drawing.

Preview

In this field the effect of the settings is displayed immediately and updated at every modifying:

- A white square shows the drawing sheet that will be printed (independently of the paper format); a dashed line represents the margins of the page. The size of the drawing sheet is set in the *Drawing page*.
- A blue square shows the drawing area that contains the entities of the drawing that are to be printed; if there is nothing to print there won’t be any blue square. In case of a multiple window view the blue squares represent the windows instead of the graphic entities box.

- One or more red squares show the order of the pages that are to be printed; each page has its number and corresponds to one print page displayed without the margins. The print pages are more than one if the drawing is larger than the printer paper. The size of the printer paper is set in the *Page page*.

Print preview...

Clicking on this button you open the *Print preview window* that displays an exact preview of the drawing as it would be printed (the whole drawing, not only one page of it) with the current setup that is not necessarily saved. You can have a print preview without opening the *Page setup window*, too: just using the Print preview command.

Open settings...

Read a page setup file that was previously saved.

Save setup...

Saves the current page setup as file in order to reuse it subsequently.

Default setup

Resets the settings made in all pages at their default values.

☞ The general page setup (*Printer page* and *Page page*) are saved separately from the page setup of other programs and are set for every new drawing.

☞ All settings are always saved together with the drawing and are read automatically when the drawing is loaded.

☞ In case of a multiple windows view the view and scale settings in the *View page* are disabled: the drawing will be printed the way it is displayed on the screen, not being defined the window where the settings should be applied.

☞ Pay attention to the fact that there are different concepts of *printer paper* and *drawing paper*. The *printer paper* is physically the single sheet of paper where draws the printer. Instead, the *drawing paper* is the sheet on which we consider to print our drawing. The two may coincide (Default setting for *Size* in the *Drawing page*), but not necessarily, because you can also print drawings on paper sizes not supported by the printer. For example you can print on an A0 size while having available a printer capable of printing only on A4 size, in this case the drawing A0 is printed on multiple sheets A4, to be precise 18.

Printer page

This page lets you set the printer you want to use.

It has to be reminded that besides printers you can use plotters as well which are managed by the program the same way as printers.

Printer

In this field you choose the printer you want to use:

Name

Displays the printer chosen. The pull-down menu offers a list of all installed printers.

Beneath some information on the selected printer is displayed.

Printer properties...

Lets you modify the settings of the selected printer according to the modes of the printer driver. Eventual modifications are valid for the drawing program only, they don’t interfere with the system settings.

Print unit

Lets you define the unit of measure for all settings: metric or English.

Color of printer paper

This setting corresponds to the *Desktop color* setting in the *View page* of the *CAD Options window*. If the check box of *Colored paper* is checked the printer will consider the color of the print sheet set in the input field aside. E.g. a white segment on white paper is printed black. The available colors are the same as the color attributes of graphic entities.

Page page

This page lets you set the printer paper. The drawing sheet is set in the *Drawing page*.

In the *Preview* the print sheet is displayed as red square. If the size of the drawing sheet is bigger than the printer paper you will need more print sheets for printing the whole drawing: in the *Preview* you then can see several numbered red squares, one for each print sheet

Printer paper

In this field you set the print page:

Size

In this field you set the format of the printer paper that can be selected from the list of the available paper formats in the pull-down menus. The available formats depend on the printer driver.

Feed

The feed can be selected from the list of the available feed modes in the pull-down menu.

Portrait

With this option the print page will be put vertically.

Landscape

With this option the print page will be put horizontally.

Print range

In case the drawing needs more print pages (i.e. if the format of the drawing sheet is bigger than the printer page format set in this sheet) in this field you can decide what pages are to be printed:

All

All pages will be printed.

Pages

Only those pages are printed that are indicated in the input field on the right (e.g. 1,3, 5-8: prints pages 1, 3, 5, 6, 7 and 8). The page numbers correspond to those in the Preview field.

Margins of the printer paper

In this field you set the margins of the print page. Remember that printers usually have a minimum margin outside of which they cannot print. If in this page you set margins that are under the minimum margins the program when closing the *Print settings window* asks whether the margins shall be corrected. If you deny, in the print phase outer parts of the drawing might not be considered and not printed, thus. The print area of the print page is displayed in the *Preview* as dashed box.

Drawing page

This page lets you set the drawing sheet. The print page can be set in the *Page page*.

The drawing sheet is displayed as white square in the *Preview*.

Initially the drawing sheet is set equivalent to the print page, but it can be modified separately. You can print a drawing in a larger format than the largest format of the printer: that means that the printer will print several pages that you will have to cut and unite in order to obtain the one drawing in the format you set. In this case in the *Preview* you will see several numbered red squares representing each one print page on the white drawing sheet square.

Drawing sheet

Here you set the drawing sheet:

Size

In this field you can set the format of the drawing sheet, in the pull-down

menu you can select one of the available formats: standard ISO and ANSI formats as well as several special formats:

Default: with this format the size of the drawing sheet always corresponds to the printer paper as set in the *Page page*, margins included; this way the print area will always correspond to the occupied drawing area.

Customized: this format lets you set the format of the drawing sheet as you like it: use the two input fields under the *Size* field that is enabled when you click here.

Multiple pages: with this format the size of the drawing sheet is set to make sure that the number of print pages is a multiple of the format set in the *Page page*. To get the correct size you have to define the number of *Rows* and *Columns* in the corresponding input fields under the *Size* field that is enabled when you click here. The size of the drawing sheet as well as the print page, margins included, is then calculated.

Portrait

The print page will be vertical.

Landscape

The print page will be horizontal.

Margins of the drawing sheet

Here you can set the margins of the drawing sheet. In case under *Size* you have selected *Default* the input fields are disabled: in that case the margins of the drawing sheet equal the margins of the print page set in the *Page page*.

Options page

This page lets you scale graphic entities or display only part of them for the printing.

Scale

Usually, the scale settings for the graphic entities made in the *View page* are

valid for the printing, too. In this field, though, you can set a different scale, that can be absolute or relative, for certain types of entities or attributes; for the specific meaning see below.

In the column on the left you find a list of the entities and attributes a different scale can be set for. If you don't check the check box the respective input field is disabled and the scale is the general scale of the drawing. If the check box is checked the input field is enabled and you can define the scale for the respective entity or attribute. Two scale types are available:

Absolute scale

Is enabled when the *Absolute* check box is checked. In this case the first input box is locked, its value is 1, the other input box is enabled: you have to insert the absolute value in the unit of measure displayed beside the box that shall correspond to drawing unit 1 in the printing.

Relative scale

Is enabled when the *Absolute* check box is not checked. In this case both input boxes are enabled; in the first you insert a value in the drawing unit (usually 1), in the other (on the right) you have to insert the value in the unit of measure displayed beside the box that shall correspond to the value in drawing unit in the printing.

The meaning of the values set in the input boxes is specific:

Hatchings: Spacing of the hatching

Points: Point size

Text height: Character height

Dimension height: Character height of the dimension text

Line types: Multiplication factor of the pieces of a dashed line. The option doesn't concern continuous lines.

Width: General multiplication factor of the widths that are set in the Pens sheet.

View

Lets you select the entity types to be printed. If the option *All* is checked all entities are printed, and the other check boxes are disabled. Otherwise they are enabled and let you select one by one (by checking the respective check boxes)

the entities you want to print.

View page

Here you can define the view settings.

Fit

If the check box is checked the drawing scale is selected automatically in order to adapt the drawing to the printer paper. With this option the drawing is automatically centered.

Optimum scale

Shows the value of the optimum scale in case the *Fit* option has been enabled.

Drawing scale

Checking the check box you can set the drawing scale inserting a value in the input field. Besides the *Unit of Measure* input field at the bottom of the sheet is activated: it lets you define the unit of measure that shall correspond to the non-dimensional drawing unit.

Current view

If the check box is checked the center of the drawing sheet (set in the *Drawing page*) will correspond to the center of the current view of the drawing.

Centered

If the check box is checked the center of the drawing sheet will correspond to the center of the box of the printed entities.

Origin

If the check box is checked the origin of the drawing sheet will correspond to the origin of the box of the printed entities.

Print selected entities

If the check box is checked selected entities are printed only; otherwise all entities will be printed.

Rotated

If the check box is checked the drawing is printed rotated by the value inserted in the input field aside.

Crop marks

If the check box is checked crop marks are printed at the corners of the print area of the printer paper, i.e. at the corners of the margins set in the *Page page*. This option helps you unite the pages in case you are printing a drawing on several pages.

Margins

If the check box is checked the margins of the print area are printed.

Monochrome

If the check box is checked the drawing is printed in black and white.

Unit of Measure

This field is enabled when the printing is set to be scaled (*Drawing scale* check box). Here you can define the unit of measure that shall correspond to the non-dimensional drawing unit, e.g. if cm is selected and the scaling factor is 3 a line with length 1 in the print will be 3 cm long.

Pens page

This page lets you set the respective correspondence between the various screen colors and the print colors as well as the correspondence between the widths of the graphic entities on the screen and in printing.

Colors

This field contains the lists of both screen colors and print colors with aside their respective attribute value. On the right there is a list of the widths besides. Selecting a color from the list you have the following possibilities:

Color

Selects the screen color. By selecting another color from the pull-down menu you move the list to the respective color.

Pen color

Sets the print color of the entities with the screen color selected under Color. The print color can be selected from the pull-down menu.

Pen width

Sets the width the entities with the screen color selected under Color are

printed with. The width can be selected from the pull-down menu. If the option *Activate width* in the *Width* field is checked the width of an entity doesn’t depend on its color, but on its width attribute.

Width

Here you can set the correspondence between width on the screen and width in print.

Activate width

If the check box is checked the width of an entity depends on its width on the screen, otherwise the screen width is ignored: the width then depends on the entity color as set in the Color field.

Width

Selects the width on the screen. It can be selected from the pull-down menu.

Pen width

Sets the print width of the entities with the screen width selected under Width.

☞ Remember that if the *Width* checkbox in the *Scale* field of the *Options page* is checked the factor that is defined there multiplies all widths set here.

Attributes window

This window allows you to manage the attributes. It can be opened and closed by use of the *Attributes* command. The window can remain open during the work session.

Beneath the title bar of the window there are two buttons that let you define the mode of the attributes:

 Sets the **Define attributes** mode.

In this mode, the value set for a given attribute becomes the current value for that attribute in the sense that it is automatically applied to all the graphics entities that are created and admit it as an attribute.

 Sets the **Modify attributes** mode.

In this mode you can change the attributes of a graphical entity without modifying the current values of the attributes themselves.

In *Modify attributes* mode you can select more primitive simultaneously, for the generic attributes also primitives of a different type. The attempt to assign an entity an attribute that does not handle has no effect.

> ☞ In the case where one or more entities are selected, these two buttons are disabled. In this case you see the attributes of the primitive selected (or those common to the primitives selected), which can then be modified.

Next to these two buttons there are two other buttons that let you insert an angle value getting it from the drawing. These buttons are enabled when an angle input field is selected.

 **Angle 3 points**

Requires entering three points, and inserts an angle with point 2 as vertex and defined by two half-lines that pass through point 1 and respectively point 3.

 **Angle =**

Requires the selection of an entity and inserts an angle equal to that which the entity forms with the X axis.

The window consists of several pages that assemble each a type of attributes corresponding to an entity type:

- **General page**
- **Texts page**
- **Dimensions page**
- **Dimension text page**
- **Hatching page**
- **Units of measure page**

General page

This page lets you manage the attributes that are common to all types of graphic entities. The general attributes are:

Color

Sets the value of the color attribute that can be selected from the pull-down menu. Available color options:

- **256 default colors**: these colors cannot be modified.
- **Color by block**: the entity is displayed in the color of the block it belongs to. If it doesn't belong to any block it is displayed in white.
- **Color by layer**: the entity is displayed in the color of the layer it belongs to. The color can be modified through the Layers window.

In the *Pens page* of the Print setting window you can assign a print color to each color on the screen.

Width

Sets the value of the width attribute that can be selected from the pull-down menu.

The display of the width in the drawing area can be set in the *View page* of the CAD options window.

The width that is visible on the screen depends on the resolution of the graphic card of your computer; it doesn't necessarily correspond to the width that will be printed by use of the Print command. In the *Pens page* of the Print settings

window you can assign print width to each width on the screen.

Point type

Sets the value of the point type attribute that can be selected from the pull-down menu.

The size of the point in the Drawing area depends on the resolution of the graphic card of your computer. In the print phase it depends on the resolution of your printer. It can also be set as scaled in the *Options page* of the Print settings window.

Line type

Sets the value of the line type attribute that can be selected from the pull-down menu.

The display of the discontinuous line types in the drawing area depends on the resolution of the graphic card of your computer. It can also be set as scaled in the *Options page* of the Print settings window.

Fill

All entities, lines and points excluded, have the fill attribute. If the check box is checked the area enclosed by the entity is filled by the color of the entity itself. In case the entity is an open form, such as arcs , polylines and splines, the part to be filled is closed by the virtual line that joins one vertex of the entity to the other.

Layer

Sets the value of the layer attribute that can be selected from the pull-down menu. The active layer can also be defined by setting the Work property for the layer selected in the Layers window.

Through the *Layers window* you can create, modify and delete layers.

Texts page

This page lets you manage the attributes that are common to Text entities. The specific text attributes are:

Font

Sets the font that can be selected from the pull-down menu. All available TrueType fonts are available and 5 own fonts of the program.

Style

Sets the font style that can be selected from the pull-down menu. Styles are available for TrueType fonts only, not for the program fonts.

Height

Sets the value of the height attribute that can be selected from the pull-down menu or by use of the keyboard entering directly the value in the input field. The height refers to the capitals, such as 'A'.

Effects Field

Underlined The text is underlined on its whole length.

Crossed The text is crossed on its whole length.

Box Draws a rectangle around the text..

Capital The text is entirely displayed in capitals. Small letters remain saved as small, though; this option concerns the view only, not the text itself.

Hidden The text is not displayed. When this setting is active the *Box* setting is automatically enabled in order to make sure that the text remains available for further operations; otherwise it even wouldn’t be selectable any more.

Proportional The characters of a proportional font have a variable breadth; that increases their legibility. The characters of a non-proportional font instead occupy all the same space. This quality is useful e.g. for the construction of a table with numbers which is a lot more legible when the numbers are aligned. This attribute doesn’t concern TrueType fonts, but only the fonts of the program.

Justification Field

Origin Sets the origin of the text, i.e. its postition with respect to the inserting point.

Justification Is used in case of multiline texts; it sets the justification of the text lines with respect to the box that is occupied by the text:

Left The lines begin at the left border of the box.

Right The lines end at the right border of the box.

Centered The lines are centered with respect to the box.

Justified Blank spaces are added between the words of a line in order to make each line of the text touch both borders of the box: the breadth

of the text will correspond to the breadth of the box.

Spacing Field

The entered values are defined as the ratio with the height of the text (entered in *Height*).

Line spacing Sets the vertical distance between the origin of two lines. Line spacing value 0 means superimposing lines.

Spacing Sets the horizontal distance between the characters. A positive value means an increase of space between the characters, a negative value means a decrease of space.

Other attributes Field

Slant Sets the slant of the character within the character cell. The value indicates the inclination angle, expressed as centesimal degrees, of the character with respect to the straight position. A positive value lets the character incline forward, a negative value lets it incline back. This option is enabled for the program fonts only.

Base/height ratio The value defines the ratio base : height of the character cell.

Angle Indicates as degrees the inclination of the whole text with respect to the horizontal axis. A positive value makes the text rotate anticlockwise round the application point.

Dimensions page

This page lets you manage the attributes that are common to Dimension entities. Attributes of dimension texts are managed separately through the *Dimension text page*. The units of measure for the display of the dimensions, instead, are managed through the *Units of measure page*.

The attributes of dimension are:

Colors Field

This field lets you separately set the colors of the various parts a dimension is made of:

Dimensions dimension line and arrows

Extensions reference lines

Text dimension text, eventual texts on the left or the right included

Tolerances dimension tolerances

☞ To assign one single color to all parts of the dimension you are recommended to set the *Color* attribute through the *General page*.

Arrows Field

Type Sets the arrow type; value 0 indicates the absence of an arrow.

Ratio Sets the ratio between the arrow size and the character height of the dimension text.

Tolerances Field

Upper Sets the value of the upper tolerance; a blank input field indicates the absence of an upper tolerance.

Lower Sets the value of the lower tolerance; a blank input field indicates the absence of a lower tolerance.

ISO Sets the ISO code for the tolerances. In this case the values inserted under Upper and Lower are ignored; upper and lower tolerance are calculated according to the code.

Various Field

Factor Sets the multiplication factor for dimensions. Value 1 means the dimension text displays the value of the dimension in drawing unit. Inserting here another value you can scale the dimension value by the respective factor.

Ref. Dist. Sets the value of the Reference distance, i.e. the distance between the measured point and the extension line. If you want to detach the extension from the measured entity insert a value different from 0.

A **positive** value defines the distance between the reference points and the reference lines of the dimension.

A **negative** value defines in its absolute value the length of the

reference lines; they start from the dimension line and are detached from the reference points.

Dimension text page

This page lets you manage the attributes that are common to dimension entities . The other dimension attributes are managed through the *Dimensions page* and the *Units of measure page*.

In general the attributes of dimension texts are the same as the attributes of normal texts - that are managed through the *Texts page* – with the following differences:

- The attributes are saved separately.
- Dimension texts have a fixed inclination and a fixed origin, they are aligned to the dimension line.
- Dimension texts can consist of one single line only.

The attributes of dimension texts are:

Font

Sets the font that can be selected from the pull-down menu. All available TrueType fonts are available and 5 own fonts of the program.

Style

Sets the font style that can be selected from the pull-down menu. Styles are available for TrueType fonts only, not for the program fonts.

Height

Sets the value of the height attribute that can be selected from the pull-down menu or by use of the keyboard entering directly the value in the input field. The height refers to the capitals, such as 'A'.

Effects Field

Underlined The text is underlined on its whole length.

Crossed The text is crossed on its whole length.

Box Draws a rectangle around the text..

Capital The text is entirely displayed in capitals. Small letters remain saved

as small, though; this option concerns the view only, not the text itself.

Hidden The text is not displayed. When this setting is active the *Box* setting is automatically enabled in order to make sure that the text remains available for further operations; otherwise it even wouldn't be selectable any more.

Proportional The characters of a proportional font have a variable breadth; that increases their legibility. The characters of a non-proportional font instead occupy all the same space. This quality is useful e.g. for the construction of a table with numbers which is a lot more legible when the numbers are aligned. This attribute doesn't concern TrueType fonts, but only the fonts of the program.

Other attributes Field

The values inserted for *Ratio b/h* and *Spacing* refer to the text height (selected under *Height*).

Slant Sets the slant of the character within the character cell. The value indicates the inclination angle, expressed as centesimal degrees, of the character with respect to the straight position. A positive value lets the character incline forward, a negative value lets it incline back. This option is enabled for the program fonts only.

Ratio base/height The value defines the ratio base : height of the character cell.

Spacing Sets the horizontal distance between the characters. A positive value means an increase of space between the characters, a negative value means a decrease of space.

Hatching page

This page lets you manage the attributes that are common to the Hatching entities. The attributes of hatchings are:

Angle

Inclination of the hatching lines in sexagesimal degrees (full angle = 360°).

Step

Distance between two hatching lines. Step 0 means the densest hatching step

ever possible (equals fill).

Type

Lets you select the type for the display of the hatching.

Units of measure page

This page lets you manage the attributes that are common to the units of measure for the display of the texts of the Dimension entities. The other dimension attributes are managed through the *Dimensions page* and the *Dimension text page*.

The unit of measure can be set separately in the *Space units field*, for linear dimensions, and the *Angular units field*, for angular dimensions.

Space units field

Here you can set the format of the numbers that express the linear dimensions. Two units of measure formats, *Engineering* and *Architectural*, use the English system (inch), the others use the metric system. The formats are:

Decimal decimal notation (ex. 15.50)

Engineering measures in feet and decimal inches (ex. 1’-3.5”)

Architectural measures in feet, inches and fractional inches (ex. 1’-3 ½”)

Fractional integers and fractionals (ex. 15 ½)

Scientific scientific notation: numbers with mobile point and powers of ten (ex. 1.55 E+01)

Angular units field

Here you can set the format of the numbers that express the angular dimensions:

Decimal degrees the circle describes an angle of 360°, degree fractions are expressed in decimals (ex. 30.500°)

Degrees/min/sec the circle describes an angle of 360°, degree fractions are expressed in minutes and seconds (ex. 30°30’0”)

Centesimal degrees the circle describes an angle of 400°, degree fractions are expressed in decimals (ex. 30.889g)

Radians the circle describes an angle of 2¶ (number pi), degree fractions are expressed in decimals (ex. 0.532r)

Decimal precision field

Here you can set the number of decimal places, i.e. the precision the measuring values shall be displayed in. These settings don’t modify the precision of the values in memory that remains on the maximum level.

Dimensions Number of decimal places that will be displayed in the dimension text. If the check box **Delete unused zeroes** is checked the last digit after the decimal point that doesn’t equal zero will be rounded

Tolerances Number of decimal places that will be displayed in the texts of eventual tolerances. If the check box **Delete unused zeroes** is checked the last digit after the decimal point that doesn’t equal zero will be rounded.

> ☞ The units of measure set in this sheet are the same that are set in the *Units of measure page* of the CAD options window. Whereas here you set the display of the dimensions in the drawing area in the Options you set the units of measure for the display of the dimensions in the *Information window*.

Layers window

This window lets you manage the Layers and can remain open during the work session.

The window shows the list of the defined layers that contains the following information about each layer:

Status

The icons displayed in the status column indicate the status of the layer:

- Work layer. There is always one work layer only.
- Visible layer.
- Invisible layer.

  ☞ If a layer is visible are visible all entities that have as their attribute level, the number corresponding to that level. The active layer is always visible. The level 0 is always visible, even if it is not active. The characteristic of visibility is useful to be able to control different levels of detail of our drawing, both in construction phase of the drawing and during printing.

- Locked layer, protected from writing.
- Unlocked layer, not protected.

  ☞ If a layer is protected you can not delete or modify entities that belong to him, and it is not possible to create new entities. This is useful in order to avoid unwanted changes to a part of the drawing consolidated. The active layer can not be protected. The layer 0 can never be protected, even if it is not active.

Number

Indicates the layer number, i.e. the value of the layer attribute.

☞ At the start of the program are defined layers 0 and 1. Layer 0 is a particular layer, which can never be erased, is always visible and can not be protected.

Color

Shows the color that is assigned to the layer.

- ☞ If an entity has as *Color* attribute equal to *By layer* is displayed with the color associated with the layer to which it belongs.
- ☞ If in the *General page* of the CAD options window is activated *Layer color*, when a layer becomes the work layer, the color associated with the the layer becomes the current one.

Description

Shows the layer description.

Selecting a layer in the list and right clicking you can open a contextual menu that offers several options for the selected layer:

Work

If the check box is checked the selected layer is work layer (the active layer). Otherwise you can make it work layer selecting here.

Visible

If the check box is checked the layer is visible. Selecting here you can modify the visibility status of the layer: a visible layer becomes invisible and vice versa. Remember that work layer and layer 0 are always visible.

Lock

If the check box is checked the layer is locked. Selecting here you can modify the protection status of the layer: a locked layer becomes unlocked and vice versa. Remember that work layer and layer 0 are always unlocked.

Create...

Calls the *Create / Modify layers window* for the creation of a new layer.

Modify...

Calls the *Create / Modify layers window* for the modification of the selected layer.

Delete

Deletes the selected layer. A layer can only be deleted if it is blank, i.e. if it doesn’t function as layer attribute for any graphic entity, block components included. Work layer and layer 0 cannot be deleted.

Select all

Selects all layers from the list in order to modify them all together.

You can select multiple layers at once as follows:

1. Select the first level of the group.
2. Holding down the shift key, select the last level of the group.

At this point, you can perform the same action on all selected layers. Some actions are disabled. For example, you can make it work layer or modify only one layer at a time. Also, if is made not visible a group that contains the work layer or layer 0, this action has no effect on the work layer and layer 0. Similarly, if is made protected a group of layers.

☞ BlueSol inserts the entities it creates (modules, devices, cables, etc... on the Layout page, and the Electric scheme) in particular layers that are not visible in the *Layers window* and then can not be modified by the user.

Coordinates window

This window allows you to enter a point by inserting its coordinates. The window can stay open during the work session.

The window consists of several pages that let you insert the coordinates in various ways:

- **Absolute coordinates page**
- **Incremental coordinates page**
- **Polar coordinates page**

Absolute coordinates page

This page lets you insert a point by the immediate entering of its coordinates. The coordinates values are inserted separately in the **X** and **Y** input fields.

Checkboxes of the X and Y input fields

If the check box is checked the corresponding coordinate is locked; the inserted point will have the inserted value for the corresponding coordinate; in interactive inserting the echo displays the situation.

X and Y input fields

Contain the values for the x and y coordinates. With the input of a new point (input by mouse included) the fields are automatically updated by the new coordinates values. The values can then be reused for the input of the subsequent point. In the fields you can insert expressions that use the same syntax as the Calculator window.

By use of the arrow keys you can recall the last 10 inputs made in the respective input field.

X= and Y= buttons

Call *X* = and *Y* = commands respectively that let you set the x coordinate (by use of *X*=) or the y coordinate (by use of *Y*=) equivalent to the coordinate value of the selected point. The commands lock the respective coordinate.

Ix= e Iy= buttons

Call *Increase in X* and *Increase in Y* commands respectively that let you define an increase of the x coordinate (by use of *lx=)* or the y coordinate (by use of *ly*=) with regard to the last selected point, i.e. with regard to the value displayed in the respective *X* or *Y* input field. The commands lock the respective coordinate.

Dx= e Dy= buttons

Call respectively the *Distance in X* and *Distance in Y* commands that let you define an increase of the x coordinate (*Dx*=) or the y coordinate (*Dy*=) in relation to the next point to be inserted. In interactive inserting the echo displays the situation.

Insert

Inserts the point with the coordinates values that are defined in the X and Y input fields.

Incremental coordinates page

This page lets you insert a point by the definition of the increase of its coordinates with regard to the last inserted point.

Dx and Dy input fields

Contain the increase values for the x and y coordinates. By use of the arrow keys you can recall the last 10 inputs made in the respective input field.

Insert

Inserts the point with the coordinates values that equal the coordinates of the last inserted point plus the increases defined in the *Dx* and *Dy* input fields.

Polar coordinates page

This page lets you insert a point by the definition of a distance to the last inserted point and an angle with respect to the X axis.

Distance

Is the value that defines the distance of the next point to be inserted from the last inserted point.

By use of the arrow keys you can recall the last 10 inputs made in the input field.

Angle

Is the inclination of the next point to be inserted with respect to the X axis in relation to the last inserted point. A positive value means an angle in anticlockwise direction.

By use of the arrow keys you can recall the last 10 inputs made in the input field

D= button

Calls the *Length* = command that retrieves a length from the selected entity. The value is inserted in the *Distance* field.

A= button

Calls the *Angle* = command that requires the selection of an entity to calculate the angle the entity forms with respect to the X axis. The value is inserted in the *Angle* field.

A3pt= button

Calls the *Angle 3 points* command that requires the selection of 3 points to retrieve the angle formed by these three points with the second point as vertex. The value is inserted in the *Angle* field.

Insert

Inserts the point with x and y coordinates obtained from the last inserted point at a distance and at an angle equal to the values inserted in the *Distance* and the *Angle* input fields.

CAD options window

This windowlets you manage the CAD settings of the program.

The window consists of several sheets that correspond each to one type of program components that can be set:

- **General page**: General settings of the program.
- **View page**: View mode of the drawing area.
- **Grid page**: Some grid settings. Further settings are available using the grid commands of the View menu.
- **Snap points page**: Automatic snap and Ortho mode
- **Units of measure page**: Format of the numbers displayed in the Information window.
- **Dwg - Dxf page**: Writing version of DWG and DXF formats.

General page

This page lets you perform the general settings.

Copy onto active layer

If the check box is checked, in moving and copying operations the moved entities are copied onto the work layer, i.e. they change layer attribute; otherwise layer attributes are left intact.

ISO text orientation for text

If the check box is checked, texts, dimension texts included, are displayed according to the ISO norms, i.e. the orientation of texts eventually turned upside down is automatically corrected in order to ensure an easy reading.

Optimum dimensioning

If the check box is checked, the program activates the optimum positioning of the dimension text, i.e. the text is above the dimension line centered at its middle point.

Layer color

If the check box is checked, when the respective layer becomes work layer, the color assigned to the layer becomes the current color.

Lock color by layer

If the check box is checked, when an entity has color *By layer*, if the layer is changed the color does not remain *By layer* (visually could change if the two layers do not have the same color), but is replaced with the actual color of the starting level.

View page

This page lets you set the view mode of the drawing area.

Colors

In this field you set the color attribute for:

Desktop

The background of the drawing area.

Selection

The selection echo of the entities.

Feedback

In this field you can set the echo of the operations on the screen.

Entity selection

If the check box is checked, the entity the cursor is approaching to changes its color when the program requires the selection of an entity. The selection color can be set under *Selection* in the Colors field.

Creating entities

If the check box is checked, the program - during the interactive creation of an entity when the input of operands such as points or the selection of an entity is required - displays a dynamic preview of the entity in creation that changes with the movements of the cursor in the drawing area. Otherwise the only thing to be displayed is the cursor itself.

Complete echo

If the check box is checked, the echo of complex entities such as blocks or texts is a complete reproduction of the entity itself; otherwise the only thing

to be displayed in the echo is the entity box. You are recommended to disable this option in case you want to insert a complex block in your drawing because the calculating of the echo can slow down the actual operation.

Tooltip

If the check box is checked, if you move the mouse close to an entity while a selection is required, after a few seconds displays a box with some information on the entity.

View

In this field you can set the width and bitmap view. Their display can be disabled in order to increase the drawing speed or for view necessities.

Width

If the check box is checked, entities are displayed in their width, otherwise they are always displayed in width 1. This setting doesn’t act on printing: entities are always printed in their specific width.

Images

If the check box is checked, background pictures are displayed. This setting acts on printing, too.

☞ A planimetry inserted as an image is a background image.

Quick width

This option can be activated only if the *Width* option is active. In that case, if this check box is checked, all line widths that exceed width 1 are displayed as width 2.

Undefined blocks

If the check box is checked, undefined blocks are displayed, otherwise they are invisible.

Grid page

This page lets you define the view mode of the grid.

Show grid

If the check box is checked, the grid is visible in the drawing area .

☞ The visibility of the grid and snapping the cursor to the grid are independent and can be controlled separately.

Spacing

Lets you set the spacing of the grid.

X=

Grid spacing along the X axis.

Y=

Grid spacing along the Y axis.

Same spacing for x and y directions

If the check box is checked, the *Y=* input field is disabled; the value of the *X=* input field is assigned to both directions.

View type

Lets you choose the view mode of the grid.

Points

Grid made of points.

Lines

Grid made of lines like a squared sheet.

Grid color

From the pull-down menu you can select the display color of the grid.

Snap points page

This page lets you set the automatic snap points and the permanent automatic snap as well as the ortho mode.

Automatic snap field

Defines the point types that are enabled for the automatic snap . If the check box is checked, the correspondent point type becomes a snap point for the automatic snap mode, i.e. it will be among the points the cursor will snap to.

Ortho mode

Enables the permanent ortho mode. If the check box is checked, you don't need to press the *Ctrl* key to insert a point perpendicularly with regard to the previously inserted point.

Permanent automatic snap

Enables the permanent automatic snap. If the check box is checked, you don't need to press the *Shift* key to use the automatic snap.

Units of measure page

This page lets you set the format of the numbers showed in the Information on graphical entities window.

Space units and *Angular units* can be set separately.

The number of decimal places can be set under *Decimal numbers*.

Space units field

Here you can set the format of the numbers that express the linear dimensions. Two units of measure formats, *Engineering* and *Architectural*, use the English system (inch), the others use the metric system. The formats are:

Decimal decimal notation (e.g. 15.50)

Engineering measures in feet and decimal inches (e.g. 1'-3.5")

Architectural measures in feet, inches and fractional inches (e.g. 1'-3 ½")

Fractional integers and fractionals (e.g. 15 ½)

Scientific scientific notation: numbers with mobile point and powers of ten (e.g. 1.55 E+01)

Angular units field

Here you can set the format of the numbers that express the angular dimensions:

Decimal degrees the circle describes an angle of 360°, degree fractions are expressed in decimals (e.g. 30.500°)

Degrees/min/sec the circle describes an angle of 360°, degree fractions are expressed in minutes and seconds (e.g. 30°30'0")

Centesimal degrees the circle describes an angle of 400°, degree fractions

are expressed in decimals (e.g. 30.889g)

Radians the circle describes an angle of 2p, degree fractions are expressed in decimals (e.g. 0.532r)

Decimal numbers field

Here you can set the number of decimal places, i.e. the precision the measuring values shall be displayed in.

Input field number of decimal places to which the number is displayed.

Cancel redundant zeros If the check box is checked the last digit after the decimal point that doesn't equal zero will be rounded.

☞ The units of measure settings you perform in this sheet are the same as in the *Units of measure page* of the *Attributes window*. But instead of setting the display of the numbers in the drawing area as the Attributes settings do, in this page you set the units of measure for the display of the numbers in the *Information window*.

The display of the dimension of a dimension entity within the Information window is an exception: here unit of measure and decimal precision are the same as are defined for the dimension entity; so that in this case the screen attribute settings and the settings for the Information window are identical.

Dwg - Dxf page

In this page you can set the saving mode for DWG and DXF formats.

You can read and write drawings in DWG and DXF formats, both in various versions. Whereas in reading the version of the file is automatically recognized for saving you have to set the version by use of this sheet.

Save as version field

DWG Choose from the pull-down menu the version you want to write the DXF formatted drawing in. All formats are available, i.e. 2.5, 2.6, 9, 10, 11, 12, 13, 14, 2000.

DXF Choose from the pull-down menu the version you want to write the DWG formatted drawing in. All formats are available, see DWG.

Binary DXF

If the check box is checked, drawings saved in DXF format are saved in binary DXF format.

Databases

In the implementation of projects of photovoltaic systems, BlueSol uses archives of components and data:

- Photovoltaic modules
- Inverters
- Batteries
- Inverter/Chargers
- Electrical components
- Climate data
- Consumption of electrical devices
- Profiles of electricity consumption

For all these databases BlueSol provides the tools for the insertion of new products and data, or for the modification of those already present. The management tools are all executable from the *Home* page of the program.

> ☞ The contents of the archive can be edited and updated by the user, without these changes to be lost by subsequent program updates and of archives standard.

WARNING - BlueSol archives are updated individually when the manufacturer makes a new version available with new devices. The program checks for the existence of updates each time the software is launched.

We emphasizes that it is the responsibility of the designer to verify that the data on the components used in the project correspond as declared by the manufacturer in the technical specifications of the product.

If there is no internet connection:

You can not check the availability of updates and download them

Database of photovoltaic modules

The archive of the photovoltaic modules contains the module data that can be used by BlueSol in project implementation.This archive is composed of a part of data modules supplied with the program. This section of the database is regularly updated. In addition to the module data provided by the program, the user can enter others or edit existing ones.

To use the tool of management of the PV modules you must click on *PV modules*  on the *Home* page.

The left side of the window contains a list of models of photovoltaic modules grouped by manufacturer, with the ability to display all modules or modules favorites. The area to the right shows the data of photovoltaic module selected.

Once you have selected a model you can do the following:

-  Add the current module to the favorites
-  Modify the data of the current module,
-  Delete from the archive the module (only if it is a module entered by the user),
-  Print description of the current module,
-  Preview card of the current module,
-  Inserts a new PV module in archive

☞ The user can also change the module data in the archive provided by the program. In this case it will be created in the user database a copy of the module data with the user's changes. In the event that the same module (same name of manufacturer and model) be present in the standard and in the user archive, the program displays the module data in the user archive. You can delete only the data of the modules in the user archive.

Database inverters

The archive of the inverters contains the inverters data that can be used by BlueSol in project implementation.This archive is composed of a part of data inverters supplied with the program. This section of the database is regularly updated. In addition to the inverter data provided by the program, the user can enter others or edit existing ones.

To use the tool of management of the inverters you must click on *Inverters* on the *Home* page.

The left side of the window contains a list of models of inverters grouped by manufacturer, with the ability to display all inverters or inverters favorites. The area to the right shows the data of inverter selected.

Once you have selected a model you can do the following:

- Add the current inverter to the favorites
- Modify the data of the current inverter,
- Delete from the archive the inverter (only if it is a inverter entered by the user),
- Print description of the current inverter,
- Preview card of the current inverter,
- Inserts a new inverter in archive

☞ The user can also change the inverter data in the archive provided by the program. In this case it will be created in the user database a copy of the inverter data with the user's changes. In the event that the same inverter (same name of manufacturer and model) be present in the standard and in the user archive, the program displays the inverter data in the user archive. You can delete only the data of the inverters in the user archive.

Database of batteries

The archive of the batteries contains the batteries data that can be used by BlueSol in project implementation.This archive is composed of a part of data batteries supplied with the program. This section of the database is regularly updated. In addition to the battery data provided by the program, the user can enter others or edit existing ones.

To use the tool of management of the batteries you must click on *Batteries* on the *Home* page.

The left side of the window contains a list of models of batteries grouped by manufacturer, with the ability to display all batteries or batteries favorites. The area to the right shows the data of battery selected.

Once you have selected a model you can do the following:

- Add the current battery to the favorites,
- Modify the data of the current battery,
- Delete from the archive the battery (only if it is a battery entered by the user),
- Print description of the current battery,
- Preview card of the current battery,
- Inserts a new battery in archive

☞ The user can also change the battery data in the archive provided by the program. In this case it will be created in the user database a copy of the battery data with the user's changes. In the event that the same battery (same name of manufacturer and model) be present in the standard and in the user archive, the program displays the battery data in the user archive. You can delete only the data of the batteries in the user archive.

Database of Inverter/Chargers

The archive of the inverter/chargers contains the inverter/chargers data that can be used by BlueSol in project implementation.This archive is composed of a part of data inverter/chargers supplied with the program. This section of the database is regularly updated. In addition to the inverter/charger data provided by the program, the user can enter others or edit existing ones.

To use the tool of management of the inverter/chargers you must click on Inverter/chargers on the *Home* page.

The left side of the window contains a list of models of inverter/chargers grouped by manufacturer, with the ability to display all inverter/chargers or inverter/chargers favorites. The area to the right shows the data of inverter/charger selected.

Once you have selected a model you can do the following:

- Add the current inverter/charger to the favorites,
- Modify the data of the current inverter/charger,
- Delete from the archive the inverter/charger (only if it is a inverter/charger entered by the user),
- Print description of the current inverter/charger,
- Preview card of the current inverter/charger,
- Inserts a new inverter/charger in archive

☞ The user can also change the inverter/charger data in the archive provided by the program. In this case it will be created in the user database a copy of the inverter/charger data with the user's changes. In the event that the same inverter/charger (same name of manufacturer and model) be present in the standard and in the user archive, the program displays the inverter/charger data in the user archive. You can delete only the data of the inverter/chargers in the user archive.

Database electrical components

The electrical components used by BlueSol to implementation of projects, are handled and stored in archives that contain information relating to:

- Cables
- Surge arresters
- Disconnecting switchs
- Switchs
- Fuses
- Diodes
- Transformers
- Charge controllers

☞ **The archives of the electrical components, as well as are provided at the time of installation of the program, contain a limited number of products. The purpose of these archives is not to provide a complete set of these components, which would be difficult to keep up to date. The aim is to provide a powerful and integrated tool to manage the data of the electrical components that the designer most commonly uses, then the user will enter the data in the design phase and store them in the database to be used by future projects.**

To use the management tools of the archives of the electrical components you must use the buttons in the group box *Electrical components databases* of the Home page.

The management operations of the archive are:

- Insertion of a new product in the database,
- Deleting the selected product,
- Edit the selected product,
- Acceptance of the changes made,
- Cancel any changes made.

To each product in the archives is assigned a field *Code*, alphanumeric of 20 characters that uniquely identifies the product. The encoding is handled freely by the user, of course, the program will not allow the same two codes in the same archive.

See also:

- Electrical components

Database climate data

The archive of climate data contains information, used by the program, which are related to the location of the photovoltaic system: irradiance, temperature, geographic coordinates, time zones. BlueSol comes with a default archive of climate data which includes:

- Data NASA-SSE for about 1400 locations worldwide
- Data ENEA for Italy
- Data UNI 10349 for Italy

This database can however be extended by the user, adding new locations and sources of climate data.

The *Search* location command allows you to select the location places depending on the choice the country and the data source of radiation.

The toolbar proposes a list of countries for the sources of climatic data currently selected. The first step is the selection of the source of climatic data, then appears the countries for which the data are available. All locations, available for the selected country, will be displayed.

The location can be selected by scrolling through the list of locations, or entering the name in the search box location. Writing the *Location*, the list scrolls proposing the location that is closer to the text that you are typing. Usually just type a few characters to see displayed the name you search.

Once you have selected the location, the window proposes the values of irradiance per day (average monthly) on a horizontal plane, with respect to diffuse and global irradiance. In addition, values are proposed average annual total irradiance, measured on a horizontal plane, the components of direct, diffuse and global.

☞ If the maximum and minimum temperatures of the locations were not known, these values must be left zero. In this case the program assumes, in the calculations of the verifications on the tensions produced by photovoltaic modules, that the minimum and maximum values reached by

photovoltaic modules are defined in project settings (default values are -10° and +70° C).

See also:

Location

Database of consumption of electrical devices

An archive containing the characteristics of energy consumption of electrical devices, allows to realize a faster consumption profile of a user. The management tool of these archive displays the devices offered by the program and those created by user.

> The archives of electrical equipment supplied with the program may not be editable and can be updated by the manufacturer with program updates.

The functionality available to work on electrical devices are:

- Insertion of a new device in the archive
- Edit the currently selected device
- Copy creates a new device using the data of the selected
- Delete of the selected device

The electrical devices supplied with the program can be used as starting points for creating new ones making changes, this can be done with the *Copy* command.

Database of profiles of electricity consumption

The archive of consumption profiles allows you to store information about when and how much electricity consumes a certain type of user. Each consumption profile can be modified or used as a template to create similar to store in the database and use in future projects.

In the left area of window of the management of consumption profiles you choose the profile by name within groups *Program database* or *User database*. In the area of the right displays the details of the profile consisting of all their electrical devices.

The functions available to operate on the profiles are:

- Insertion of a new consumption profile in the database
- Changing consumption profile currently selected
- Copy, create a new profile of consumption using data from the selected one
- Clearing from database the consumption profile selected

The archives of consumption profiles, supplied with the program, should be considered as indicative and references is the responsibility of the designer to assess the applicability in each design situation.

Import and export user database

BlueSol manages an archive of user data. This archive is particularly important in that it stores all the information specified by the user using the program as:

- Program settings
- Photovoltaic modules favorites
- Inverters favorites
- Batteries favorites
- Inverter/Chargers favorites
- Photovoltaic modules entered by the user
- Inverters entered by the user
- Batteries entered by the user
- Inverter/Chargers entered by the user
- Recently opened projects
- Electrical Components
- Configuring user documents
- Electrical consumption entered by the user
- Irradiance data entered by the user
- User properties
- Protection schemes of electrical panels

This database is created the first time that the computer runs BlueSol and it is never uninstalled or modified by subsequent updates of the program.Given its relevance, it is advised to carry out regular backups of this database. In some cases, then the user can request to share some of these data with other users who work on the same projects.

For these reasons, the data contained in the user archives can be imported or exported via read/write a file in a proprietary format with the extension .dxp. To do this you use the wizard management functionality to import / export and backup (Menu: *Home* | *Import and export*)

Import - export user databases

During export, you can choose which files you want to include in the export file. Similarly, on import, you can choose which database to import among those that you are importing, also you can set options to define how import the data:

- Option to delete the data in the database before importing
- If some items are already in the archive, you can replace them with those that you are importing or keeping the ones currently present

💡 The use of import / export is a good way to maintain parity between the user data in case you have multiple installations of the program.

Backup - restore user databases

The program is able to make a backup of all user data by creating a file with the extension .bck that can be used to restore user data.

☞ When you perform a restore of the user archives the entire archive is replaced with the backup

☞ In case you change your computer after you install the product on the new machine you should use a backup file to restore on the new machine the same user data.

Make project documentation

When the project has been realized it will be possible to automatically generate the documentation. BlueSol uses the document templates that the program completes by entering the project data, some standard models are provided with the program, but the user has the option to edit or create new ones.

The report functions management is available in *Reports* menu. This window shows the available documents by categories:

- Project documentation
- Tabs
- User documents

On each document it will be possible: print, print preview, export to RTF or viewing. Each document is created by the program from a RTF template file.

☞ For some documents you can only export to RTF format and viewing, in this case, you will enable only the buttons *Export report in RTF* and *View report*. After the export the program executes the application that, in the operating system setup, can read the RTF file you just created.

In the User documents section, clicking on a document's text using the right mouse button opens a menu that allows you to manage the functionality of user documents:

- *Modify definition*: change the description and the name of files of the user document.

- *Modify text:of template* change the contents of template of the user document.

- *Delete*: deletes the definition of the user document, however the template file is not deleted.

☞ The command *View report* or the double click on the selected document or the double click on the selected document allows to show the content of report.

The visualization of a document is made by a word processor integrated into the

program, this tool provides all the functionality for document management: the editing, the printing or saving in various standard formats.

Standard documents

BlueSol generates the following standard documentation:
Project documentation

- Technical reportt
- Bill of cables
- Bill of electrical components
- Economic report

Tabs

- Data sheets of photovoltaic modules
- Data sheets of inverters

These documents are generated by the program from the template file in RTF format delivered with the the program and installed in the directory *<Installation path>\Templates.*

👉 We do not recommend the user to modify these files because during the software update, the template files will be overwritten by the predefined of BlueSol. If you want to change a standard document suggest you to create a new user document importing an existing template.

User documents

In addition to the standard documents, the program can create documents that are user defined. To achieve this the user must realize the document template. The template is an RTF file that contains the text (as well as images, tables, etc..) of the document and the references to the data of the photovoltaic project. When generating the report the references to the project data are replaced with the data itself in the current project.

Use the *New user document* command to create a user document, in the window that will open now the first step is to define the *Description* of the document, so the definition of the template:

- *Import an existing template*: the creation of the template starts from a template already exists, it will be used as a starting point. Note that the starting template will not be changed in any way.
- *File name of the user document*: explicitly specify the name of the file in RTF format of the template, note that the file must exist.
- *Empty document*: you start with a blank template.

After choosing these parameters will be displayed the word-processor integrated with which to modify or write the contents of the template. The text of the model obviously has to be saved at the end of work.

👉 The templates created by the user are stored on files, it will be up of user to perform the backup or copy if you moved the installation of the program on another computer.

Labels of project data

To make the template file of user documentation is necessary to know the labels of data BlueSol. The inclusion of these labels in the template, allows to the program to replace the data in the generation of the final document. The label data is made with the following syntax:

\Category.Name

Where Category is the category of data and Name is a mnemonic name of the project data in the specified category. These are the categories of data:

Customer: data of customer

Designer: data of designer

Results: results of the analysis the system

Properties: project properties

System: data of the system

Site: site data

Net: connecting to the electrical grid

Graph: some graphics created by the program

Draw: drawings of layout and electrical scheme

PanoramicShade: Far shading diagrams

User: user-defined properties

☞ To simplify the insertion of these labels the program has a tool be used with the integrated word-processor. When you edit the template text, clicking the right mouse button you display a menu that contains the command *Insert label...* You will see a window that contains all the available labels, their descriptions and the relative value for the current project.

Tables of project data

In addition to the labels of project data, each project contains tables of data that can be included in the documentation templates. To extract the data in these tables is to use the scan cycles of the tables in the macro language for templates. The following are the names of the data tables of BlueSol projects:

(CATEGORY_INVERTER) InverterFeature: Characteristics of inverter installed in the system

(CATEGORY_MODULE) ModuleFeature: Features of the modules used in the system

(CATEGORY_MODULESYS) Module: Module features present in the system

(CATEGORY_INVERTERSYS) Inverter: Data on inverters installed

(CATEGORY_HORIZONSHADE) HShades: Shadings of the horizon line

(CATEGORY_ORIENTATIONS) Orientations: Orientation of the strings (PV fields)

(CATEGORY_STRINGS) Strings: Composition of strings (list and characteristics of the different strings)

(CATEGORY_PANELSDC) PanelsDC: Composition of DC electrical panels (list and features of the panels with different characteristics)

(CATEGORY_CABLES) Cables: Table data for all individual cables

(CATEGORY_CABLESSUMMARY) CablesSummary: Table summary of data relating to different types of cables used

(CATEGORY_CABLESPESUMMARY) CablesPESummary: Table summary of data relating to different types of cables (PE) used

(CATEGORY_CABLESNEUTRALSUMMARY) CablesNeutralSummary: Table summary of data relating to different types of neutral cables

(CATEGORY_SWITCHSPARTLIST) SwitchsPartList: Table data relating to the list of the switches

(CATEGORY_BREAKERSPARTLIST) BreakersPartList: Table data list of disconnecting switches

(CATEGORY_DIODESPARTLIST) DiodesPartList: Table data on the list of diodes

(CATEGORY_FUSESSPARTLIST) FusesPartList: Table data with the list of fuses

(CATEGORY_DISCHARGERSPARTLIST) DischargersPartList: Table data to the bill of surges

(CATEGORY_ECONOMICTABLE) EcoTab: Table of economic data

(CATEGORY_PERIODCOST) PCost: Table of periodic costs of maintenance

(CATEGORY_FIXCOST) FCost: Table-off costs of maintenance

Macro language for template

In the template file of documentation can be inserted control words that allow you to make calculations based on data from the PV system project, before they are included into the final document.

In a report template all controlling words, variables and data fields must be comprised between symbols "\" (back slash),

for example: \date\ or \Query1:CustNo\

Reference to a field name may be created, using its number. For example: \Query1:(0)\, \Table1:(5)\

Report generator ignores spaces in field names and keywords. However, if you want to use name with spaces, you may write it between the chars "[" and "]"

for example: \Table1:[Field name with spaces]\

All labels of project data are part of this macro language and can be used with all its keywords.

☞ Attention, every key word of macro language should be used in capital letters.

IF-ENDIF construction in report

Format of IF-ENDIF construction is:

\IF(<boolean value>)

.....

\ELSEIF(<boolean value>)

.....

\ELSEIF(<boolean value>)

.....

\ELSE

.....

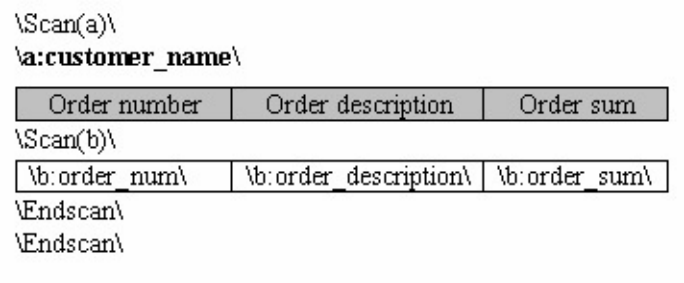
\ENDIF

\ELSEIF and **\ELSE** are optional.

<boolean value> may be a variable, data field or user defined function.

Cycle SCAN-ENDSCAN construction in report

All records of a data table, attached to the Table of project data collection, may be inserted in a document as a table rows or in any free form. For this use keywords **\SCAN(DataTable)** and **\ENDSCAN**. Inside cycle scan-endscan may be located a block of text with data fields, variables and constants, for example:


\Scan(a)\
\a:customer_name

Order number	Order description	Order sum

\Scan(b)\

\b:order_num\	\b:order_description\	\b:order_sum\

\Endscan\
\Endscan\

Lines with words "SCAN", "ENDSCAN" are excluded from the result document. However, if in step of designing a report you want to see as will look a result, you may set an attribute "hidden font" for words "SCAN", "ENDSCAN".

Full format of scan block is:

\SCAN(DataTable) [, WHILE(<boolean value>)] [,page] [,noeof] [,function1,...,functionN]

.....

\Scanentry [,function1,...,functionN]

.....

\Scanfooter [,function1,...,functionN]

.....

\ENDSCAN [,function1,...,functionN]

If keyword "**WHILE**" defined in a scan expression, scan block will be terminated when **<boolean value>** returns **false** result. "WHILE" is often used with records grouped by some data field. <boolean value> may be a report variable, data field or user defined function.

Option "**page**" forces to begin every record of scanned DataTable (besides first) from a new page.

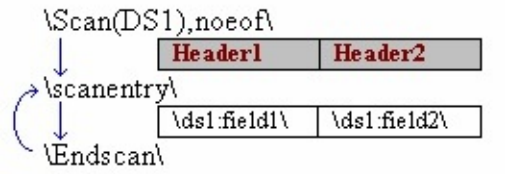
If you use option "**noeof**" report generator will skip entire scan block if scanned

DataTable have no any records. This option is useful when making master-details reports.

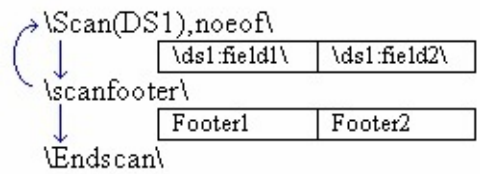
Attention: with option "**noeof**" scan block will start from the current record. DataTable will not be moved to the first record.

Words "**Scanentry**" and "**Scanfooter**" are optional. You may add them when using option "noeof" in "scan" keyword, or if you want to develop some special functionality, calling optional scan block functions.

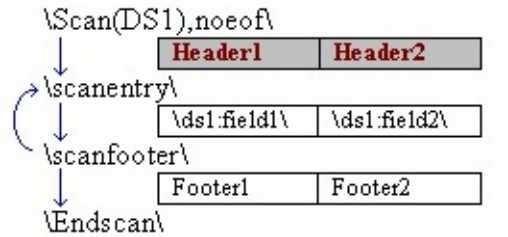
Use option "noeof" with keyword \Scanentry\ to manage scan block with some header section. Every new record of DataTable will return control to the position of \Scanentry\ keyword. However, if DataTable has no any records, entire block from "scan" to the "endscan" will be missed. For example:



Keyword \Scanfooter\ may be used to manage scan block with some footer section. Every time when report generator gets "Scanfooter", it returns control to the position of \Scanentry\ or \Scan\ keyword. If DataTable has no any records, entire block from "Scan" to the "Endscan" will be missed. For example:



\Scanentry\ and \Scanfooter\ may be used simultaneously:



NOTE: You must type keywords \scan(...)\, \scanentry\ and \endscan\ all with the same format attributes, for example with font Arial, 10, regular (or other that you like). It guarantees that format attributes inside block scan-endscan will be correct in output document.

If you use "page" option and a table immediately after "scan" keyword in report

template, keep in mind that you should have at least one paragraph (empty line) before the table in the RTF document, otherwise, RTF editor such as MS Word ignores "new page" control.

Recommended technique:

When editing report template, place keywords \scan(...)\, \endscan\ outside of table or in the same cell to prevent corrupting of RTF table structure.

Operators and functions in report

Different arithmetical and logical expressions may be used in report template.
Arithmetical operations:
>, <, =, <=, >=, <>, != (not equal), +, -, *, /, % (mod)
Logical operations:
&& (and), || (or), ! (not)
For example:

```
\IF( (table1:field1>b+1) || (table1:field1=0) )\
.....
\ENDIF\
```

The next built-in functions are supported by report language:

- Variables and conditions: VAR, SET, IIF, :=
- String functions: STR, VAL, UPPER, LOWER, COPY, MID, SUBSTR, POS, TRIM, FORMATFLOAT
- Data tables navigation: EOF, BOF, LAST, FIRST, NEXT, PRIOR
- Numeric functions: ROUND, INT, FRAC, POWER, INTPOWER
- Date/time functions: NOW, DATE, TIME, DATETOSTR, DATETIMETOSTR, TIMETOSTR, STRTODATE, STRTODATETIME, STRTOTIME, YEAR, MONTH, DAY, SYEAR, SMONTH, SDAY, DTOS, STOD

Variables and conditions

VAR(VAR1, ... , VAR N) - Creates variables VAR1, ... VAR N if they don't exist.

VarName := Value - Assigns Value to variable VarName, for example \a:=4\

SET(VarName, Value) - Assigns Value to variable VarName.

IIF(Logical_expr, Value1, Value2) - Returns one of two values depending on the value of a logical expression. This function, also known as Immediate IF, evaluates a logical expression and then returns one of two expressions. If the logical expression evaluates to True, IIF( ) returns the first expression. If the logical expression evaluates to False, IIF( ) returns the second expression.

String functions

COPY(S,StartPos,[Optional count])

MID(S,StartPos,[Optional count])

SUBSTR(S,Startpos,[Optional count])

These functions return a characters from the given source string *s*. Parameter *s* specifies the character expression from which the character string is returned. *StartPos* specifies the position in the character expression from where the character string is returned. The first character of s is position 1. If *StartPos* is greater than the number of characters in source string, the empty string is returned. *Optional count* specifies the number of characters to return from string. If you omit count, characters are returned until the end of the source string is reached.

STR(Number,[Length, Decimals])

Returns the character equivalent of a specified numeric expression. Number specifies the numeric expression STR( ) evaluates. *Length* specifies the length of the character string STR( ) returns. The length includes one character for the decimal point and one character for each digit to the right of the decimal point.

STR( ) pads the character string it returns with leading spaces if you specify a length larger than the number of digits to the left of the decimal point. STR( ) doesn,t cut a string, if you specify a length less than the number of digits. If Length isn't included, the length of the character string is number of actual digits in source numeric expression.

Decimals specifies the number of decimal places in the character string STR( ) returns. If you specify fewer decimal places than are in numeric expression, the return value is rounded up. If Decimals isn't included, the number of decimal places defaults to zero.

If Length set to 0, but the same time decimals is not zero, result string is trimmed with trim() function.

POS(Substr, S)

Pos searches for *Substr* within *S* and returns an integer value that is the index of the first character of Substr within S. Pos is case-sensitive. If Substr is not found, Pos returns zero.

VAL(s) - Converts the string value *s* to its numeric representation. If s is not a valid number, exception is raised.

UPPER(s) - Returns the specified character expression in uppercase.

LOWER(s) - Returns the specified character expression in lowercase.

TRIM(s) - Returns the specified character expression with all trailing blanks removed.

Data navigation

In the data tables you can control and navigation functions. These functions are described below

EOF(Table) - Indicates whether or not a cursor is positioned at the last record in a Table.

BOF(Table) - Indicates whether or not a cursor is positioned at the first record in a Table.

LAST(Table) - Positions the cursor on the last record in the Table.

FIRST(Table) - Positions the cursor on the first record in the Table.

NEXT(Table) - Positions the cursor on the next record in the Table.

PRIOR(Table) - Positions the cursor on the previous record in the Table.

For example

\EOF(a)\, \NEXT(table1)\

NOTE: You should not use these functions at the same time with SCAN having data table name. You may use these functions in SCAN with no name mentioned, for example:

\SCAN(), WHILE(! EOF(table1))\
.....
\ENDSCAN, NEXT(table1)\

Numeric functions

ROUND(n,decimals) - The Round function rounds a real-type value to an integer-type value. 0.5 is always processed to largest integer number. This is NOT banker rounding.

INT(number) - Returns the integer part of a real number.

FRAC(number) - Returns the fractional part of a real number.

POWER(base, exponent) - Raises Base to any power. For fractional exponents or exponents greater than MaxInt, Base must be greater than 0.

INTPOWER(base, exponent) - Calculates the integral power of a base value. IntPower raises Base to the power specified by Exponent.

Date time functions

NOW() - Returns the current date and time.

DATE() - Returns the current date.

TIME() - Returns the current time.

DATETOSTR(date) - Converts a date constituent of DateTime value to a string.

DATETIMETOSTR(datetime) - Converts a DateTime value to a string.

TIMETOSTR(time) - Converts a time constituent of DateTime value to a string.

STRTODATE(string) - Converts a string to a DateTime value. Time part is set to 0.

STRTODATETIME(string) - Converts a string to a DateTime value.

STRTOTIME(string) - Converts a time string to a DateTime value.

YEAR(date) - Returns the year of specified date.

MONTH(date) - Returns the month of specified date.

DAY(date) - Returns the day of specified date.

SYEAR(date) - Returns the year of date in string representation.

SMONTH(date) - Returns the month of date in string representation. Month

which is less than 10 have zero in place of first symbol - "01", "02" and so on ...

SDAY(date) - Returns the day of date in string representation. Day which is less than 10 have zero in place of first symbol - "01", "02" and so on ...

DTOS(date) - Converts date to the string formatted as yyyymmdd.

STOD(string) - Converts string formatted as yyyymmdd to date value.

Definitions

Interface group: The interface is a protection device of the grid involved in case of faults in the electrical grid. The interface inhibits the release of electric current of the photovoltaic system in the network, in the case where is no voltage on the national grid or in the case in which the parameters of the network found to incorrect. It is therefore a measure of protection placed to grid security, of the system and who should be working. It is composed by *Interface relay* which opens the *Interface protection* both in case of fault internal to the protections both for fault of the network.

Sizing on power of inverter (Sizing factor): Represents the degree of exploitation of the inverter in terms of power, it is the ratio between the nominal power of the PV array input and the DC power of inverter

System temperature calculated by the temperature of location: The program calculates the temperature of the photovoltaic modules starting from the value of the ambient temperature and the NOCT (Nominal Operating Cell Temperature) of the cells of the modules. In the event that this value is not present between the data of the PV module it assumes NOCT = 50. The temperature of the module is calculated as follows: TModule = T + (NOCT - 20.0) * 1000.0 / 800.0.

Net metering, is an electricity policy for consumers who own renewable energy facilities such as photovoltaic. In this context, it is used with the meaning what remains after deductions", in this case the deduction of any energy outflows from metered energy inflows. Under net metering, a system owner receives retail credit for at least a portion of the electricity they generate.

Net present value (NPV), establishes the convenience of investment envisaged, by discounting the future cash flows, in order to detect the current value of the investment.

Self-consumption [kWh], is the amount of energy produced by the plant and at the same time consumed by the user. The program indicates this amount as share of self-consumption as the percentage of production of system self-consumed by

the user.

Voltage drop

In the cases in which the conductors of the circuit runs through long distances, the voltage drop must be calculated in fact, if the voltage drop is too large, the section of the conductor of the circuit must be increased to maintain the current between the points. The calculations for a single-phase circuit and a phase differ slightly.

Single-phase calculating voltage drop:

Voltage drop [V] = 2 * Cable length * Resistance factor * Current

Three-phase voltage drop calculation:

Voltage drop [V] = (2 * Cable length * Resistance factor * Current) * 0.866

and in both cases:

Voltage drop percentage [%] = (Voltage drop / Voltage) * 100

The **Resistance factor** depends on whether you are in AC or DC:

In DC: Resistance factor = R / 1000

In AC: Resistance factor = Sqrt (R^2 + X^2) / 1000

where:

R = the resistance of the line per km at a temperature of 80° C

X= the reactance of the line per km at a temperature of 80° C

These values are tabulated as a function of the type and section of the cable:

	Single-core cables		Multi-core cables	
Cross-section [mm²]	Resistance at km [Ohm / km]	Reactance at km [Ohm / km]	Resistance at km [Ohm / km]	Reactance at km [Ohm / km]
1	22.1	0.176	22.5	0.125
1.5	14.8	0.168	15.1	0.118
2.5	8.91	0.155	9.08	0.109
4	5.57	0.143	5.68	0.101
6	3.71	0.135	3.78	0.0955
10	2.24	0.119	2.27	0.086
16	1.41	0.112	1.43	0.0817
25	0.889	0.106	0.907	0.0813
35	0.641	0.101	0.654	0.0783
50	0.473	0.101	0.483	0.0779
70	0.328	0.0965	0.334	0.075
95	0.236	0.0975	0.241	0.0762
120	0.188	0.0939	0.191	0.074
150	0.153	0.0928	0.157	0.0745
185	0.123	0.0908	0.125	0.0742
240	0.0943	0.0902	0.0966	0.0752
300	0.076	0.0895	0.078	0.075
400	0.0607	0.0876	0.0625	0.0742
500	0.0496	0.0867	0.0512	0.0744
630	0.0402	0.0865	0.0417	0.0749

Short circuit current

It is calculated only the DC side, is taken as the maximum current that can circulate in the cable. The calculation is different depending on the connection that performs the cable:

Isc in string cable: It is the short circuit current of a single PV module (declared by the manufacturer).

Isc in connection from string to electrical panel: It is equal to the short circuit current of the single module only if the cable itself is protected by a fuse incoming to the electrical panel. In the case of cable is not protected, the short circuit current is the sum of the short circuit current of all strings in parallel minus one.

Isc in connection from electrical panel to electrical panel: You are using the same process of connecting cables between strings and electrical panels.

Isc in connection from electrical panel to Inverter: Consider the MPP tracker to which the cable is connected, the short-circuit current on the cable is the sum of current Isc from the parallel inputs to what is considered.

Producibility

The producibility of the system is calculated on the basis of data, derivates from source of specified climate data, of the installation site relative to the average monthly global of solar radiation incident on horizontal surface.

The procedure for the calculation of the energy produced by the plant takes into account the rated power, the angle of inclination and azimuth of the PV generator, the losses on the PV generator (resistive losses, losses due to the difference in temperature of the modules, reflection and mismatching between strings), the efficiency of the inverter, as well as the reflection coefficient of the ground in front of the modules (albedo).

Therefore, the energy produced by the system on an annual basis (Ep, y) is calculated as follows:

$$Ep,y\ [kWh] = Pnom * Irr * (1\text{-}Losses)$$

Where:

- Pnom [kW] = Nominal power of system
- Irr [kWh/m²] = Annual irradiation on the surface of the modules
- Losses [%] = Power losses

The power losses are due to various factors. The following table lists the loss factors used by the procedure for the calculation of system producibility.

- Temperature losses
- Mismatching losses
- Resistive losses
- Losses for DC/AC conversion
- Other losses
- Shading losses

Irradiances data sources

In addition to the database of the data irradiances included in BlueSol, There are many sources of meteorological data available from the Web or by other means. BlueSol includes some tools to easily import some of these sources.

NASA SSE (Surface Meteorology and Solar Energy programme) are monthly data, average of 1983-2005 satellite measurements, provided for any cell in a grid of 1°x1° over the world (1° latitude is 111 km). See the site of the Nasa for further information.

Also available from this database, but direct import not implemented in PVsyst: irradiances or temperatures in daily values for any period in the 1983-2005 range.

Although the SSE data within a particular grid cell are not necessarily representative of a particular microclimate, or point, within the cell, the data are considered to be the average over the entire area of the cell. For this reason, the SSE data set is not intended to replace quality ground measurement data. Its purpose is to fill the gap where ground measurements are missing, and to augment areas where ground measurements do exist.

PVGIS (Photovoltaiv Geographical Information System) is a research project of the European Communities.

The PVGIS databases encompass the following regions:

- European Subcontinent

  - Geographical data: digital elevation model (1 km x 1 km for horizon evaluation).

  - Spatially Continuous Climatic data: monthly global irradiation (from 566 ground meteorological stations, 1981-1990 averages from the ESRA project), diffuse/global ratio, air temperature..

- Mediterranean Basin, Africa and South-West Asia

  - Geographical data: elevation model (1 km x 1 km or 2 km x 2 km), administrative boundaries, Global land cover, cities, etc.

- Spatially Continuous Climatic data: monthly global irradiation, from Helioclim-1 database (Ecole des Mines de Paris/Armines), based on METEOSAT images (1985-2004), with resolution of about 30x30 km^2.
Air temperature.

See also:

Irradiance data provided by the user

Near Shading model calculation

Let us consider a PV array affected by shading. At any instant, we can state

$$Ps = Pns\ (1-Fes) \qquad \text{Eq. (2)}$$

where Ps and Pns represent the power delivered by the PV array with and without shading, respectively, and Fes so-called here as effective shading factor, whose value determines the power decrease.

A first possible Fes estimation consists of assuming that the power reduction is just equal to shaded array fraction. This is the

geometrical shading factor Fgs:

$$Fes = Fgs \qquad \text{Eq. (3)}$$

Obviously, this approximation represents a minimum limit for power reduction. Hence, it is always optimistic.

A second approximation, this time pessimistic, is to assume that any shadow fully cancels power:

$$Fgs > 0 \text{ then } Fes = 1 \qquad \text{Eq. (4)}$$

A better approximation is obtained by taking into account the

shaded blocks. A "block" is here defined as a group of cells protected by one bypass diode. A block is shaded when at least one of its cells is shaded. A first possibility is to consider that the power of a block is fully cancelled when the block is shaded.

Hence

$$(1-Fes) = (1- Nsb/Ntb) \qquad \text{Eq. (5)}$$

where Ntb is the total number of blocks inside the concerned array and Nsb is the number of shaded blocks. A priori, Eq. (5) tends to be optimistic because the power losses are usually greater than the power of the shaded blocks. For example, when a block is shaded and its bypass diode is ON the output power of the block is cancelled.

Besides, if there are other unshaded strings connected in parallel their operating

voltage will be reduced, causing additional power losses.

Another example: if a block is shaded and its bypass diode is OFF the string current is limited by this block, which reduces the power of the remaining unshaded blocks connected in series. Later in this paper we will show that Eq. (5) actually leads to an optimistic estimate.

(1-Fes) = (1-Fgs)(1-Nsb/(Ntb+1)) Eq. (6)

The number " 1 " added in the denominator has not direct physical sense: it is a mathematical trick to avoid fully cancel power when a shadow affects all the array blocks (Nsb=Ntb\ but still keeps a significant illuminated area (low Fgs). It is worth stressing that Eq. (6) is purely experimental and its physical interpretation may lack sense.For example, for a large value of Ntb the ratio Nsb/(Ntb+1) tends toward Fgs. Hence (1-Fes) ~ $(1-Fgs)^2$.

Another example: when all blocks are shaded (Nsb=Ntb) the ratio Nsb/(Ntb+1) varies between 0.5 (Ntb=1) and 1 (Ntb >> 1), which is unreal because it implies that the power losses caused by the same shadow repeated on several PV modules increase as the number of PV modules increases (actually, the power losses could be equal).

The simplicity of this model does not allow taking into consideration the electrical characteristics of the PV array, which would require the simulation of the I-V curve. However, and despite its limitations, the model performs well and better than the others.

Reference:

"Experimental model to estimate shading losses on PV arrays"

F. Martinez-Moreno, J. Muñoz, E. Lorenzo

Instituto de Energía Solar—Universidad Politécnica de Madrid (IES-UPM), E.T.S.I. Telecomunicación, Ciudad Universitaria, s/n 28040, Madrid, Spain

Irradiance data provided by the user

The command of new data irradiance permits the insertion in database the irradiation values specified by the user. We must then enter all the required data, including the source of these data.

The program allows you the ability to search a new location directly from a map, choosing the *Country* and the *Location*, the program will identify the place and display it in the map, the presence of a red marker on the map indicates that the location is found. If you select the check mark *Free selection of location* you can freely choose the geographical coordinates clicking the mouse position on the map.

To take on the geographical coordinates of the selected location is necessary to click the button *Select location*. This operation enters the data taken from the map in the irradiance data table: geographical coordinates, country and location. All other data in the table can be specified by the user or imported from other sources of climate data as explained below.

👉 The use of the map it is possible only if there is an internet connection, otherwise the user will need to enter, including the data of the new location, explicitly geographic coordinates latitude and longitude.

It is also possible to import data radiation in the following way:

- Set NASA-SSE irradiances: Inserts data irradiance relative to the location with geographic coordinates specified in the data table irradiance. So before you use this tool, you need to identify the location.
- Import PVGIS irradiances: Reads data from the radiation portal Web PVGIS, note that as the imported data contain the location and the geographical coordinates, these will overwrite those that may be present in the data table. At the end of the operation the map will move to the location for which you are importing the data.

See also:

Irradiances data sources