Version 8

Pumping Systems
My first project

PVsyst SA
www.pvsyst.com

Contents

1 Basic Approach - My First Project

1.1 First Contact with PVsyst

The "Pumping Systems" in PVsyst refer exclusively to standalone pumping systems that operate based on the availability of sunlight, without using electrical storage or being connected to the grid. These systems typically consist of:

- **One or more pumps,**
- **A photovoltaic array,**
- **A controller or power conditioning unit**, sometimes accompanied by a small backup battery (very rarely).

To successfully implement such systems, it is essential to precisely define:

- **The hydraulic circuit** (whether it is a well, a borehole, pumping from a lake, or a pressurization system),
- **The water requirements,**
- **The total head**, depending on the flow rate and other potential parameters,
- **A storage tank.**

Other constraints may also need to be considered, such as the maximum drawdown in a deep well or managing a full reservoir.

System Operation: The system works by adjusting the power of the pump according to the power available from the photovoltaic generator at any given time. The total head (or fall) is determined by external conditions, such as the difference in level, the head loss in the pipes, or the drawdown in a deep well. Therefore, the water flow rate will be directly linked to the instantaneous power provided by the PV generator.

Modeling in the Simulation: The simulation requires a complete model of the pump to determine the flow rate based on power and head conditions. Since the total head varies with the flow rate (mainly due to head losses in the pipes or drawdown), the operating point is evaluated through successive approximations.

Advantages of Standalone Systems: One of the main advantages of these systems is the absence of a battery, which reduces maintenance costs related to battery replacement. Storage is achieved by accumulating water in a tank, avoiding the use of batteries. However, this requires a pump capable of operating over a wide range of power levels.

1.2 Pumping Tests

Before Drilling a Well, Key Questions to Ask:

It is essential to ask a few key questions, such as: "What quantity of water can I pump in the short and medium term, and what will be its quality?"
To answer these questions, a pumping test must be conducted.

What is a Pumping Test?

The principle is simple: water is extracted from a well or borehole, which causes the water level to drop. During this process, the water level and flow rate are measured over a given period, while other parameters are also observed. The analysis of variations in the water level allows us to determine the performance of the well and the hydraulic properties of the aquifer.

There are different types of tests, whether intermittent or continuous, short-term or long-term, with low or high flow rates.
One major challenge of studying groundwater is that the aquifer cannot be directly seen. Information about the well and the aquifer can only be inferred by observing how the water level responds to pumping.

Objectives of Pumping Tests

Pumping tests are used for various purposes, including:

- **Assessing the long-term performance of a well:** This helps determine whether the well is effective and how many people it can serve.
- **Evaluating the hydraulic performance of the well**: Characteristics such as flow rate and drawdown are analyzed to better understand its operation.
- **Determining the hydraulic properties of the aquifer:** Pumping tests are the primary method to assess the transmissivity and storage coefficient of the aquifer, or to detect potential hydraulic boundaries.
- **Testing the equipment:** Ensuring that the pumping and observation equipment is functioning properly to ensure safe and efficient operation.
- **Analyzing the effects on neighboring wells:** The test helps evaluate the impacts of pumping on other wells, particularly possible interferences.
- **Assessing the impact of extraction on the environment.**
- **Obtaining information on water quality.**
- **Anticipating potential issues,** such as the pumping of saline or polluted water after extended periods.
- **Determine optimal operating conditions:** Choose the most suitable pumping station for long-term use, and estimate potential pumping or treatment costs.
- **Decide on the ideal depth to install the pump in the well.**

Different Types of Tests

- **Step Drawdown Test:** This test aims to establish the short-term relationship between flow rate and drawdown of the well. It involves pumping in successive stages, gradually increasing the flow rate at each step, until the estimated maximum yield of the well is reached.
- **Constant Rate Test:** This test involves pumping at a constant flow rate for a longer period compared to a step test. Its main objective is to provide data on the hydraulic properties of the aquifer. Information on the storage coefficient can only be obtained if appropriate wells are used for observations.
- **Recovery Test:** After pumping is stopped, this test measures the recovery of water levels. It is often performed after a constant rate or step drawdown test and serves to validate the characteristics of the observed aquifer. However, it is only valid if a check valve is installed to prevent water from flowing back into the well.

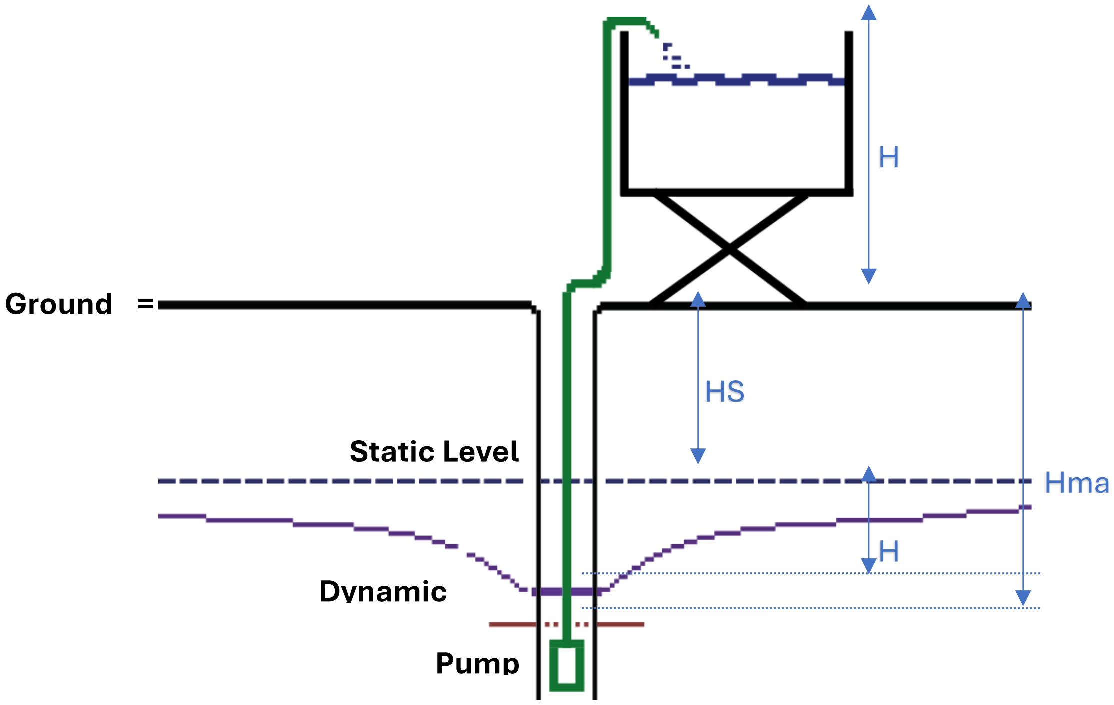
These tests can be performed individually or in combination. In general, a complete series starts with a step drawdown test to define the flow rate for the constant rate test and ends with a recovery test. The process can be adapted based on the size of the wells, with variations in pumping rates, test duration, and the complexity of the observation systems.

In PVsyst, the reference is taken at ground level, as shown in the figure (cf. fig):

$$\boxed{HT = HG + HS + HD + HF}$$

where:

- **HG** = Height of the water column between the ground and the filling level of the reservoir.
- **HS** = Static head due to the depth of the water level in the well, in the absence of any pumping.
- **HD** = Dynamic drawdown head: in a borehole, the effective water level is dynamically lowered by the extraction of water flow (see below). It depends on the flow rate at each moment.
- **HF** = Friction losses in the piping system, which depend on the flow rate.



1.3 Pumping Systems from a Lake or River

Pumping systems from a lake or river operate similarly to those from boreholes or wells, but with certain technical simplifications:

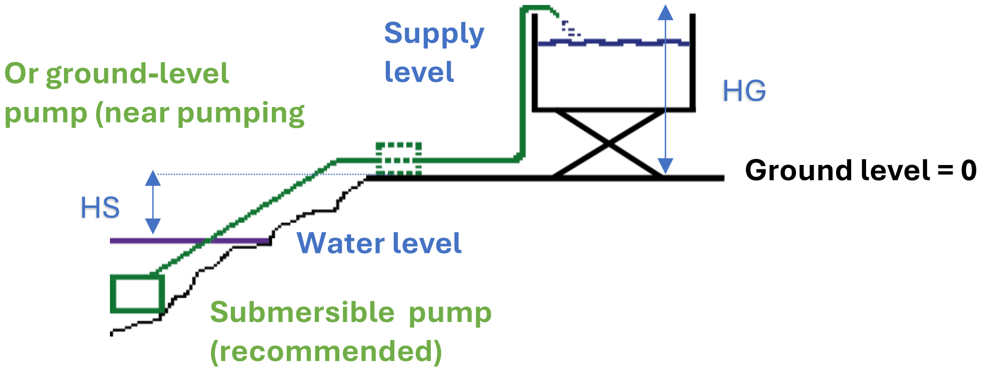
- The pump can be installed close to the source, at a maximum distance of 5 meters above the water surface. This distance should be further reduced at higher altitudes to avoid cavitation issues.
- There is no need to use a submersible pump, which makes the system less expensive and easier to maintain.
- It is important to note that the pressure or total head primarily depends on the difference between the inlet and outlet water levels. The pump must be able to provide a total head that results from several combined factors.

In PVsyst, we take the reference at ground level, as shown in the figure (cf. fig):

$$\boxed{HT = HG + HS + HF}$$

where:

- **HG** = Total head due to the height of the outlet pipe above the ground (assuming that the outlet pressure is negligible).
- **HS** = Static head due to the depth of the water level, relative to the ground.
- **HF** = Friction losses in the piping system, which depend on the flow rate.



For this system, in the "Pumping Hydraulic Definitions" dialog box, you will be asked to specify:

- **The level of the lake or river,** relative to ground level. It can also be given in seasonal or monthly values, in the "Water Needs" dialog box.

- **The depth of the pump.** It must be strictly less than 5 meters above the depth of the source, but it can also be submerged.

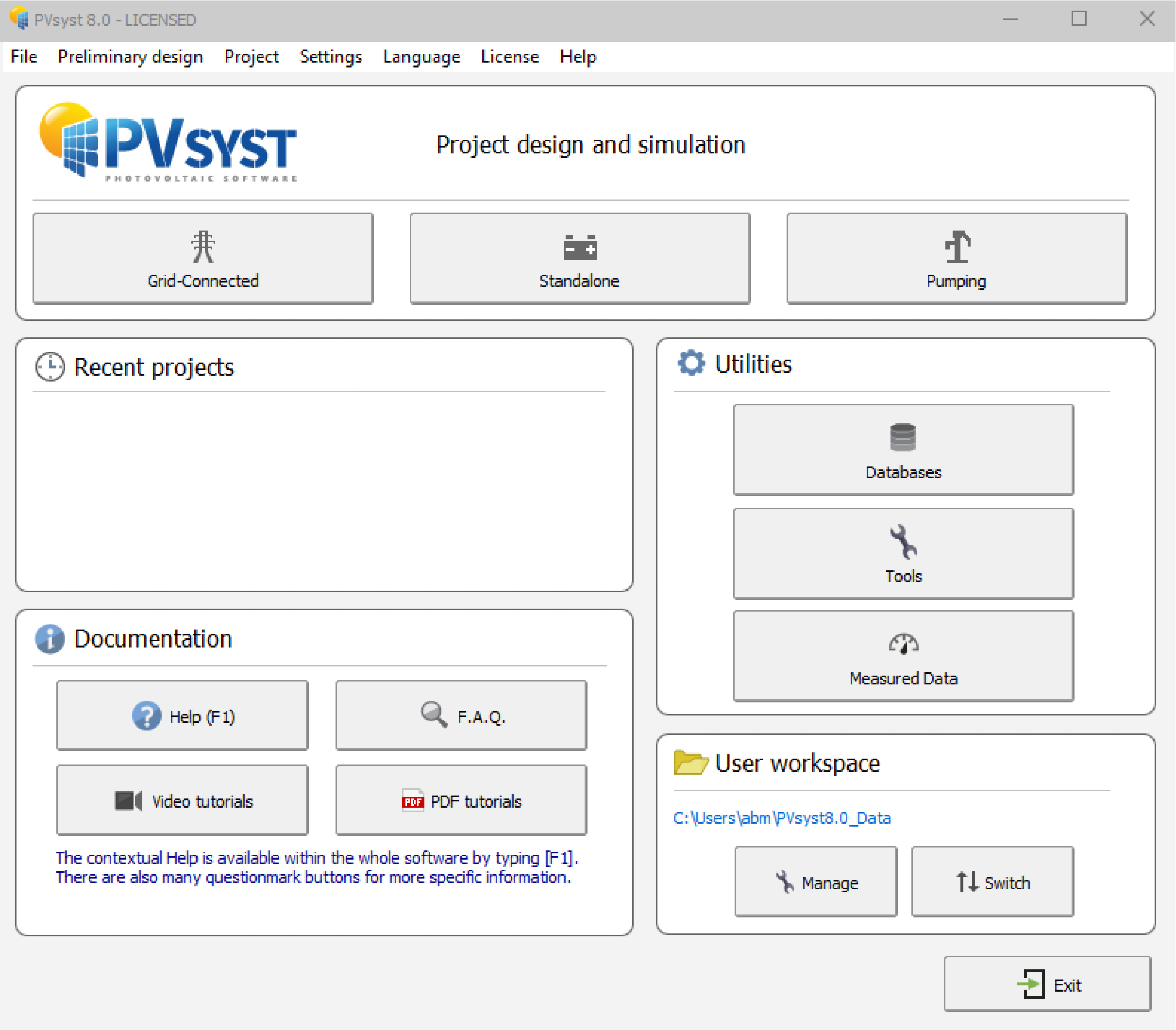
Conventional Pumping Systems

Conventional pumping systems, powered by an electrical grid (or potentially by a larger standalone system, such as a village mini-grid), operate at the specified grid voltage. The operating power is fixed and assumed to be available at all times. The system operates in an "ON/OFF" mode, based on water needs and the control system. Intelligent energy management can encourage pumping during sunny hours when solar energy is available.

However, these conventional pumping systems are not explicitly implemented in PVsyst. They are treated as a load, just like any other electrical consumption.

Therefore, a pumping system defined in PVsyst cannot be integrated into another PV system, even if it is standalone. It must remain independent from any other electrical system.

2 Procedure for Developing a Pumping System



The contextual Help is available within the whole software by typing [F1].
There are also many questionmark buttons for more specific information.

C:\Users\abm\PVsyst8.0_Data

1.Orientation

Configure the orientation of the sensor array.

2.Pumping Circuit

Choose from the following three systems:

- Pumping from a well/borehole to a storage tank.
- Pumping from a lake or river to a storage tank.

3.Water Needs

Specify the water needs (in m^3/day), with the option to define them annually, seasonally, or monthly. Also, specify the static pumping depth if it varies throughout the year.

4.Pre-Dimensioning

Go to the "System" page to access the "Pre-Dimensioning Suggestions," which estimate parameters like reservoir volume, pump power, and PV generator power. Adjust these suggestions to better refine the simulation.

5.Pump
Choose a pump model on the "Pump Definition" page. Suitable pumps are marked in green, less optimal ones in orange, and unsuitable ones in red. You can also evaluate the selected pump's capabilities.

6.PV Module
Select a PV module and configure the subfield accordingly. The modules are also color-coded (green, orange, red) to indicate their suitability for the system.

7.Regulation Strategy
Define the regulation mode. The green, orange, and red colors indicate the most suitable or unsuitable choices based on the system type and selected pump model.

8.Control
Set up the control device, adjusting the operating limits, such as a full reservoir, dry running, or power and voltage limits.

9.PV Field Design
Adjust the number of modules in series and parallel according to the pump's power requirement, considering the constraints related to the MPPT controllers.

10.Launch Simulation
If no errors appear in red, launch the first simulation of the system.

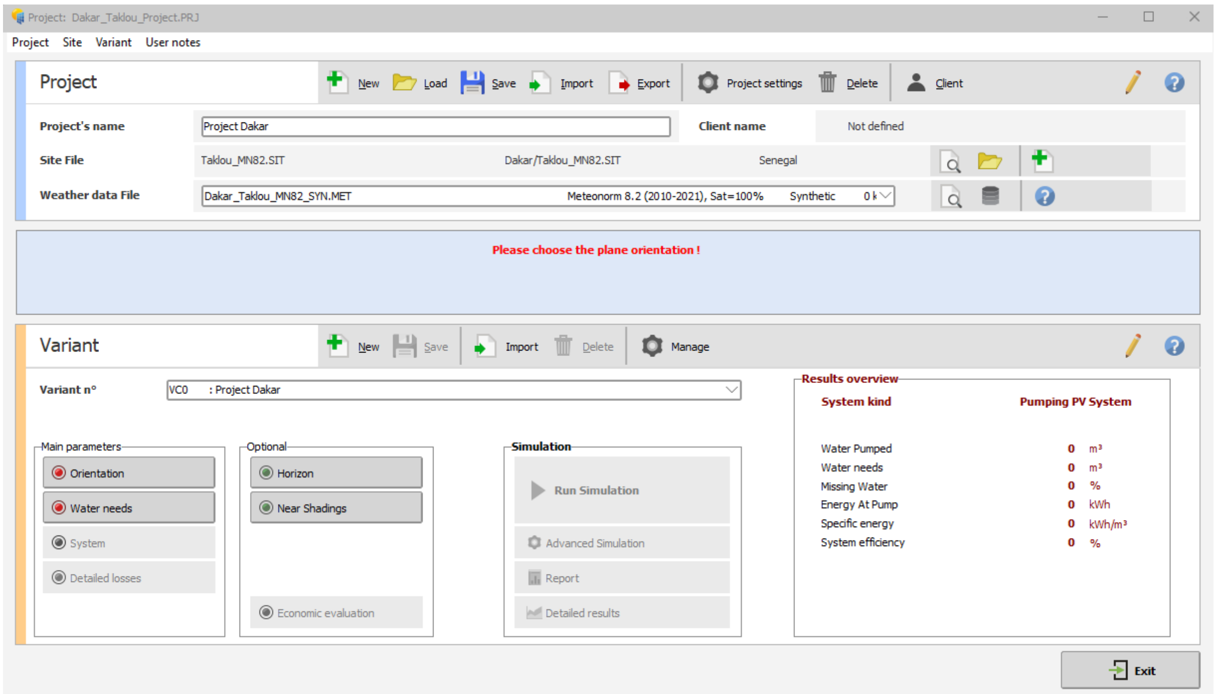
2.1 Creating the First Variant for Your Project

After defining the project site and meteorological data, you can proceed to create the first variant. At the beginning, on the left side of the interface, two buttons labeled "Orientation" and "Water Needs" appear in red. The red color indicates that this project variant is not yet ready for simulation and that additional information is required.

The basic parameters to be defined for all variants are:

- The orientation of the solar panels,
- The water needs,
- The type and number of PV modules,
- The type and number of pumps used.

These steps are essential for ensuring that the project is complete and ready for proper simulation.



Project's name: Project Dakar

Client name: Not defined

Site File: Taklou_MN82.SIT Dakar/Taklou_MN82.SIT Senegal

Weather data File: Dakar_Taklou_MN82_SYN.MET Meteonorm 8.2 (2010-2021), Sat=100% Synthetic 0 k

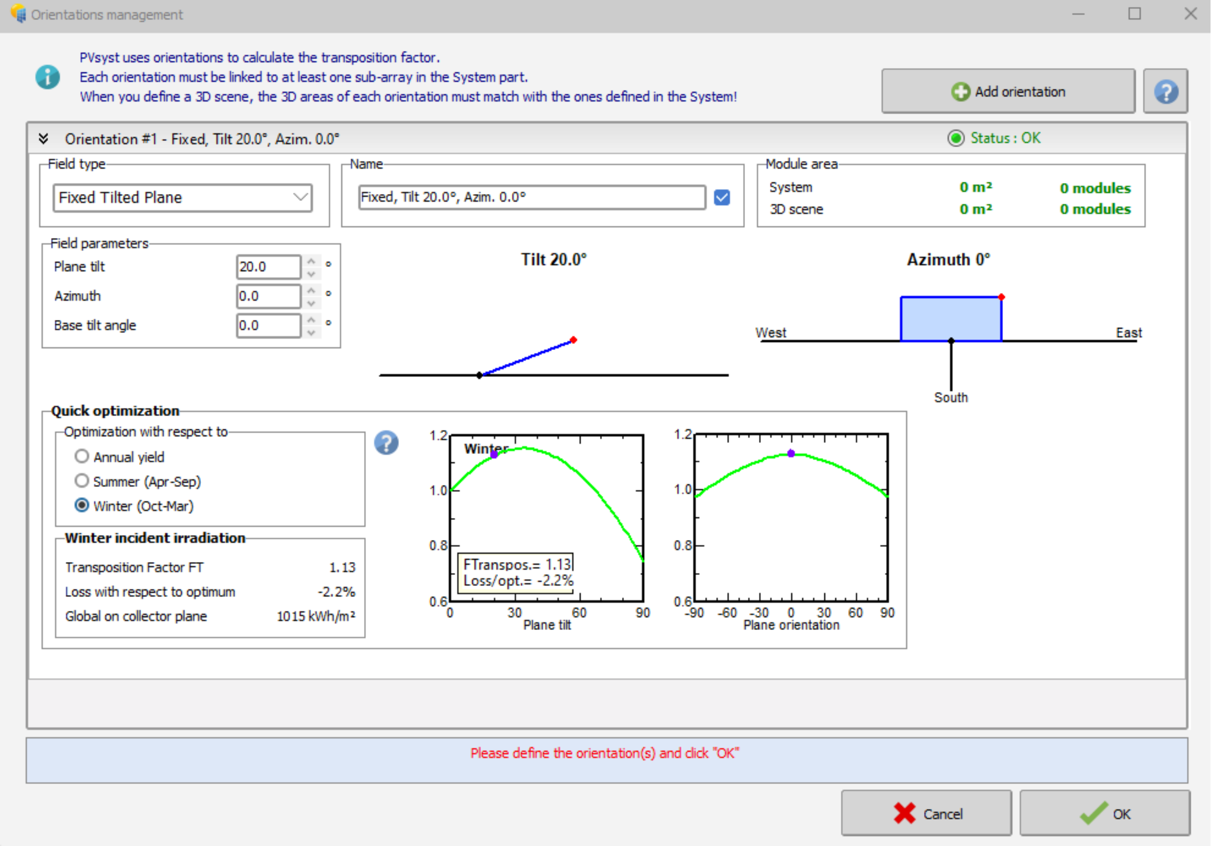
Please choose the plane orientation !

Variant n°: VC0 : Project Dakar

Results overview

System kind	Pumping PV System	
Water Pumped	0	m³
Water needs	0	m³
Missing Water	0	%
Energy At Pump	0	kWh
Specific energy	0	kWh/m³
System efficiency	0	%

Define the Orientation



PVsyst uses orientations to calculate the transposition factor.
Each orientation must be linked to at least one sub-array in the System part.
When you define a 3D scene, the 3D areas of each orientation must match with the ones defined in the System!

Orientation #1 - Fixed, Tilt 20.0°, Azim. 0.0° Status : OK

Field type: Fixed Tilted Plane

Name: Fixed, Tilt 20.0°, Azim. 0.0° ☑

Module area

System	0 m²	0 modules
3D scene	0 m²	0 modules

Field parameters

Plane tilt	20.0 °
Azimuth	0.0 °
Base tilt angle	0.0 °

Quick optimization

Optimization with respect to
- ○ Annual yield
- ○ Summer (Apr-Sep)
- ● Winter (Oct-Mar)

Winter incident irradiation

Transposition Factor FT	1.13
Loss with respect to optimum	-2.2%
Global on collector plane	1015 kWh/m²

FTranspos.= 1.13
Loss/opt.= -2.2%

Please define the orientation(s) and click "OK"

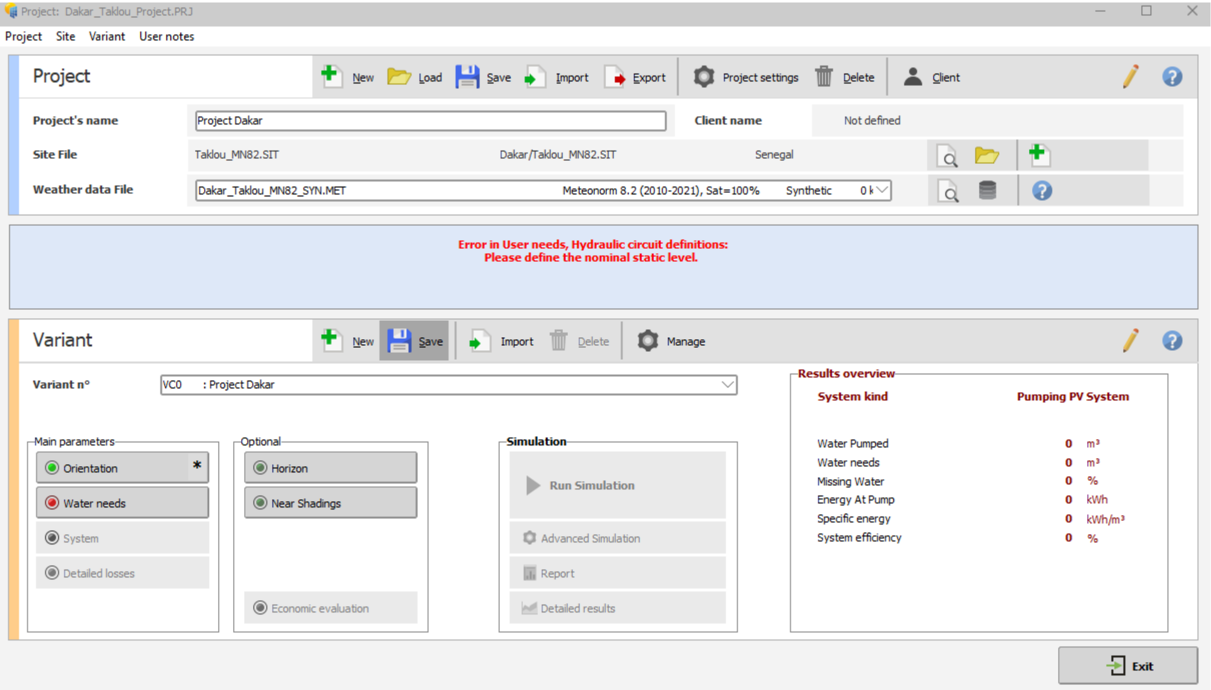
This tool allows you to determine the most suitable orientation for a photovoltaic system. The transposition factor is defined as the ratio between the irradiation incident on the inclined plane and the horizontal irradiation. In other words, it measures what you gain or lose by tilting the collector plane.

In **version 8 of PVsyst**, a new feature allows for defining **multiple orientations** within a single project. This provides greater flexibility to model complex systems with different tilt angles and photovoltaic field orientations. This option optimizes energy production for surfaces with varied inclinations.

The tool also allows you to select the optimization period: year, winter, or summer. Additionally, the optimization may depend on specific conditions related to distant obstacles such as mountains, which create distant shading. In such cases, you can define a horizon line, which will generally adjust the azimuth to maximize energy production.

2.2 Water Needs Definition

To complete the information related to your water needs, it is necessary to click on the "Water Needs" tab.



Project's name: Project Dakar

Client name: Not defined

Site File: Taklou_MN82.SIT Dakar/Taklou_MN82.SIT Senegal

Weather data File: Dakar_Taklou_MN82_SYN.MET Meteonorm 8.2 (2010-2021), Sat=100% Synthetic 0 k

Error in User needs, Hydraulic circuit definitions:
Please define the nominal static level.

Variant n°: VC0 : Project Dakar

Results overview

System kind	Pumping PV System	
Water Pumped	0	m³
Water needs	0	m³
Missing Water	0	%
Energy At Pump	0	kWh
Specific energy	0	kWh/m³
System efficiency	0	%

Once you have opened the "Water Needs" menu, you will need to define the following elements:

Type of Pumping System:

- Well/borehole to storage tank,
- Lake or river to storage tank,
- Pressurization system.

Characteristics of the Well/Borehole:

- **Static level,**
- **Drawdown or maximum flow rate** (only one of these two values is required, the other will be calculated automatically by the software using the following formula):

$$Drawdown = \frac{Lower\ Dynamic\ Level - Static\ Level}{Max\ Flow\ Rate}$$

- **Minimum dynamic level** (calculated by the software; if you modify this value, it will automatically adjust the drawdown or maximum flow rate. The minimum dynamic level must always be higher than the static level),
- **Pump level,**
- **Borehole diameter** (not used in calculations or simulations).

Reservoir:

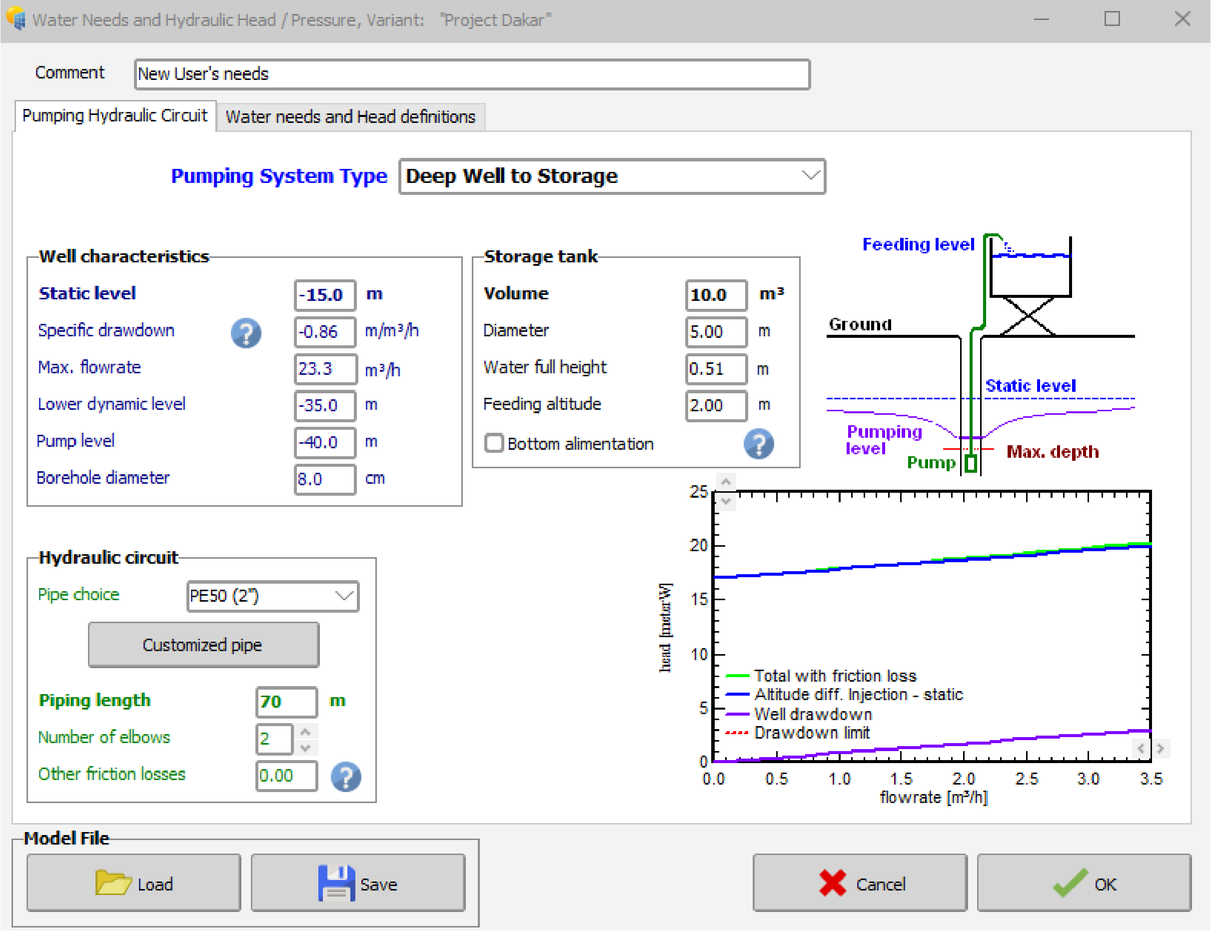
- **Volume,**
- **Diameter,**
- **Maximum height (full):** This value is measured from the bottom of the tank and not from natural ground level,
- **Injection altitude** (particularly important if the reservoir is elevated, as it influences the pressure for distribution).

Hydraulic Circuit:

- **Type of piping,**
- **Piping length,**
- **Number of bends** (can be set to "0" for the simulation),
- **Other friction losses** (can also be set to "0" for the simulation).

Water Needs (next window).

In PVsyst, levels and distances are always indicated relative to natural ground level (TG)


Water Needs and Hydraulic Head / Pressure, Variant: "Project Dakar"

Comment: New User's needs

Pumping Hydraulic Circuit | Water needs and Head definitions

Pumping System Type: **Deep Well to Storage**

Well characteristics

Static level: **-15.0** **m**
Specific drawdown: -0.86 m/m³/h
Max. flowrate: 23.3 m³/h
Lower dynamic level: -35.0 m
Pump level: -40.0 m
Borehole diameter: 8.0 cm

Storage tank

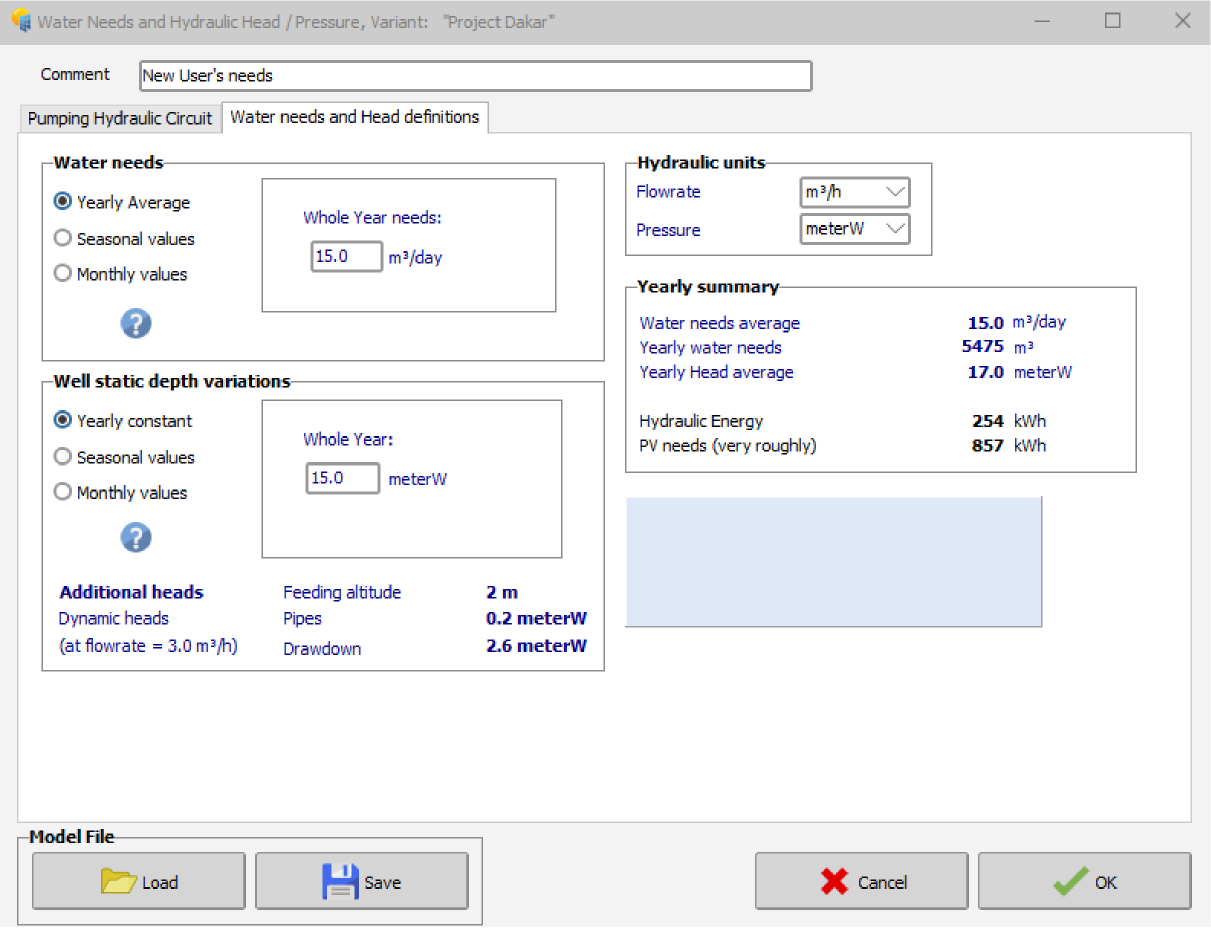
Volume: **10.0** **m³**
Diameter: 5.00 m
Water full height: 0.51 m
Feeding altitude: 2.00 m
☐ Bottom alimentation

Hydraulic circuit

Pipe choice: PE50 (2")
Piping length: **70** **m**
Number of elbows: 2
Other friction losses: 0.00

Model File

Now, you need to define the water needs. To do this, click on the "Water Needs and Pressure" tab.



Water Needs and Hydraulic Head / Pressure, Variant: "Project Dakar"

Comment: New User's needs

Water needs

● Yearly Average
○ Seasonal values
○ Monthly values

Whole Year needs: 15.0 m^3/day

Well static depth variations

● Yearly constant
○ Seasonal values
○ Monthly values

Whole Year: 15.0 meterW

Additional heads	Feeding altitude	**2 m**
Dynamic heads	Pipes	**0.2 meterW**
(at flowrate = 3.0 m^3/h)	Drawdown	**2.6 meterW**

Hydraulic units

Flowrate: m^3/h
Pressure: meterW

Yearly summary

Water needs average	**15.0**	m^3/day
Yearly water needs	**5475**	m^3
Yearly Head average	**17.0**	meterW
Hydraulic Energy	**254**	kWh
PV needs (very roughly)	**857**	kWh

Water Needs (volume of pumped water) can be defined annually (as a constant value) or based on monthly or seasonal values. It is not relevant to specify needs in hourly terms (daily distribution), as the pumping system usually includes sufficient storage for at least one day's consumption.

Note: The pre-dimensioning cannot account for these variations and will be based on the annual average.

The static level in the borehole can be specified in different ways:

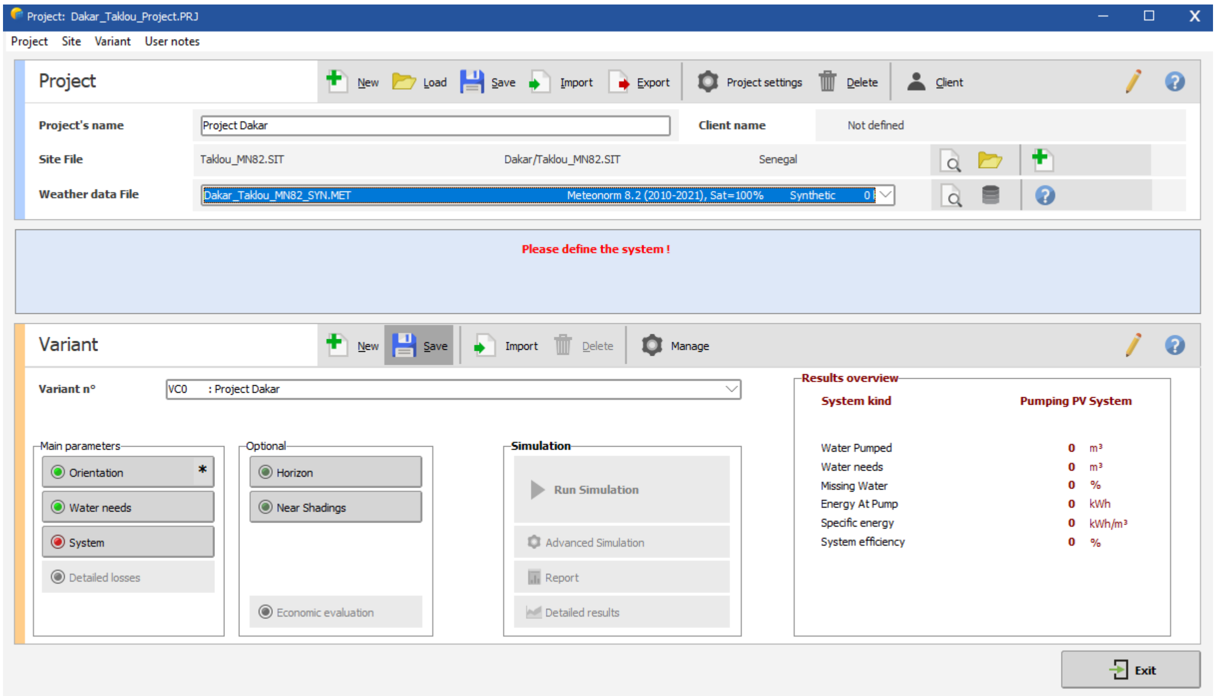
- **Constant throughout the year,**
- **Seasonal values,**
- **Monthly values.**

Any adjustment of this value in the window will influence the calculation of the drawdown and the dynamic level.

3 System Definition

You can now click on the "System" tab to define the following elements:

- **The pump:** select the technology, brand, and model.
- **The photovoltaic array:** choose the technology, brand, and model.
- **The pumping control system:** select the technology, brand, and model.



Project: Dakar_Taklou_Project.PRJ

Project's name Project Dakar

Client name Not defined

Site File Taklou_MN82.SIT Dakar/Taklou_MN82.SIT Senegal

Weather data File Dakar_Taklou_MN82_SYN.MET Meteonorm 8.2 (2010-2021), Sat=100% Synthetic 0

Please define the system !

Variant n° VC0 : Project Dakar

Results overview

System kind	Pumping PV System	
Water Pumped	0	m³
Water needs	0	m³
Missing Water	0	%
Energy At Pump	0	kWh
Specific energy	0	kWh/m³
System efficiency	0	%

3.1 The pump

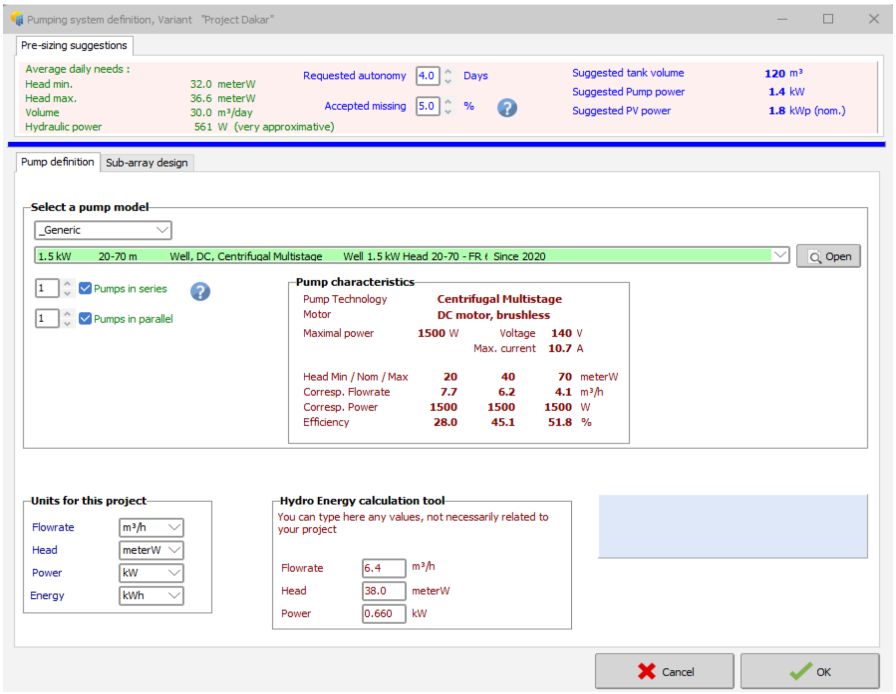
In this first window, you will need to select the model and the number of pumps for your circuit. Several pump manufacturers are already listed, providing you with a choice among:

- **Surface pumps,**
- **Submersible pumps,**
- **AC pumps,**
- **DC pumps,**
- **Etc.**

The pre-dimensioning tool provides recommendations based on your choices. However, its results are not automatically integrated into the definition of your system. You have the option to modify them without interfering with your system configuration. It calculates three key pieces of information:

1. **Recommended reservoir volume**, based on the expected consumption and desired autonomy,
2. **Recommended pump power,**
3. **Recommended PV power.**

You can adjust the autonomy and the "Accepted Shortfall" value according to the needs of your simulation. Any changes to these parameters will automatically recalculate the three values suggested by the software.



Average daily needs :
Head min. 32.0 meterW
Head max. 36.6 meterW
Volume 30.0 m³/day
Hydraulic power 561 W (very approximative)

Requested autonomy 4.0 Days
Accepted missing 5.0 %

Suggested tank volume 120 m³
Suggested Pump power 1.4 kW
Suggested PV power 1.8 kWp (nom.)

Select a pump model

_Generic

1.5 kW 20-70 m Well, DC, Centrifugal Multistage Well 1.5 kW Head 20-70 - FR (Since 2020

1 ☑ Pumps in series

1 ☑ Pumps in parallel

Pump characteristics

Pump Technology **Centrifugal Multistage**
Motor **DC motor, brushless**
Maximal power **1500** W Voltage **140** V
Max. current **10.7** A

Head Min / Nom / Max	**20**	**40**	**70**	meterW
Corresp. Flowrate	**7.7**	**6.2**	**4.1**	m³/h
Corresp. Power	**1500**	**1500**	**1500**	W
Efficiency	**28.0**	**45.1**	**51.8**	%

Units for this project

Flowrate m³/h
Head meterW
Power kW
Energy kWh

Hydro Energy calculation tool

You can type here any values, not necessarily related to your project

Flowrate 6.4 m³/h
Head 38.0 meterW
Power 0.660 kW

Selection of a Pump Model

To select the pump that best suits the characteristics of your system, the software performs a pre-selection based on the following criteria:

- **Total head (HMT), minimum and maximum,**
- **Flow rate,**
- **Power.**

As with other elements of the system, a green/orange/red color code is used to indicate whether the pump is optimal (green), compatible (orange), or incompatible (red) with your configuration.

Pumps in Parallel and Series

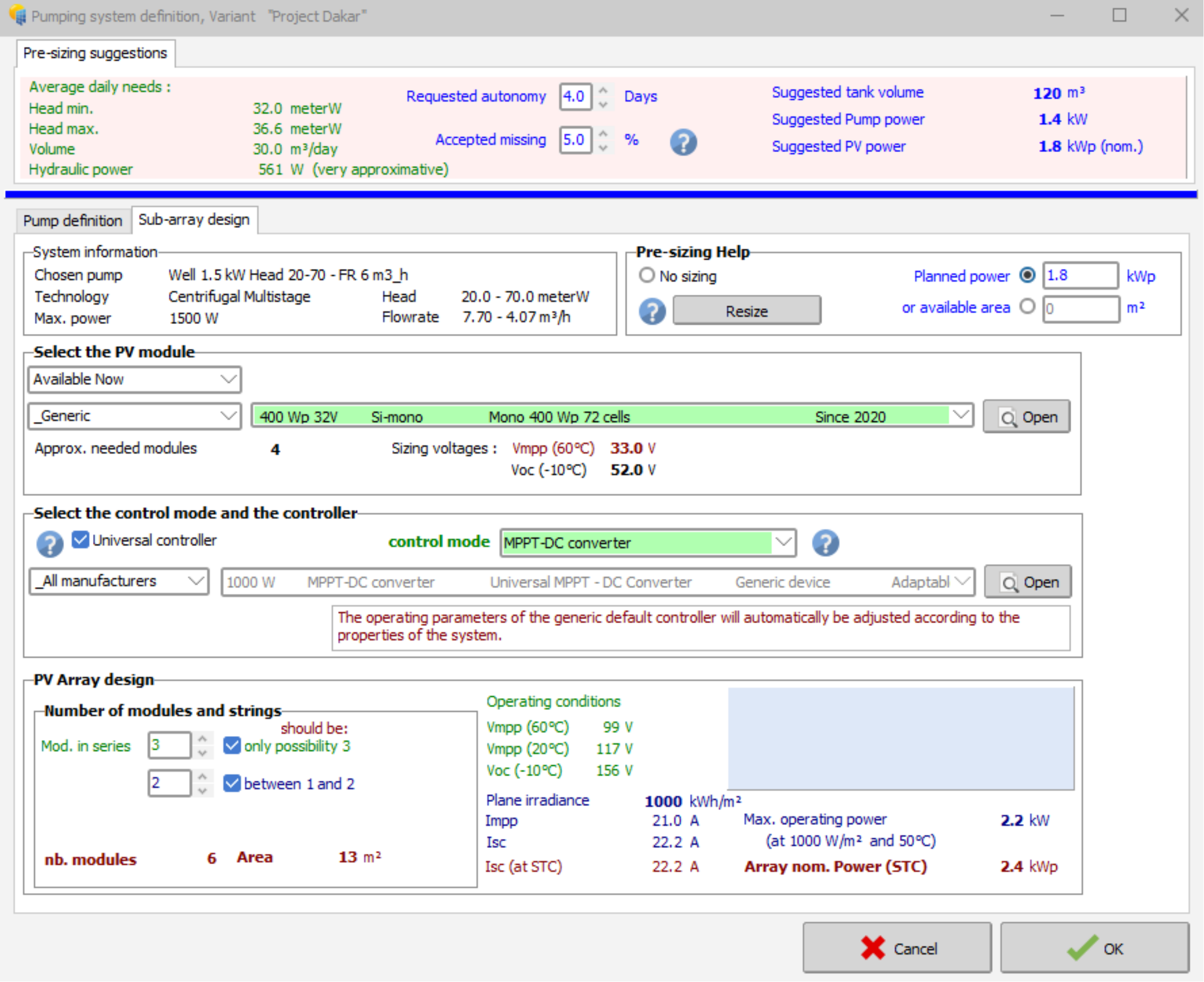
Whether for the electrical or hydraulic part, it is recommended to connect all pumps in parallel. Currently, PVsyst only supports series connections for centrifugal pumps with DC motors, as other configurations are not suitable. Here is why:

- **From an electrical perspective:**
  Connecting two positive displacement pumps in series creates startup problems. After the first pump starts, once the peak startup current is exceeded, the current drops abruptly to its operating value. This total current may then be too low for the second pump to reach its own startup threshold, preventing it from functioning properly.
- **From a hydraulic perspective:**
  It is not recommended to connect two pumps in cascade to increase the head at a constant flow rate. Non-linearities in pump behavior, as well as potential differences in electrical supply, can cause significant imbalances in head, particularly for positive displacement pumps.

Therefore, it is better to choose a pump that directly supports the required nominal pressure, rather than combining multiple pumps in an attempt to achieve this pressure.

3.2 The Photovoltaic Array

With this tool, you have the option to define either an area or a maximum power to be installed. Once one of these values is entered, the software suggests a wiring configuration using the photovoltaic design tool.



Average daily needs :
Head min. 32.0 meterW
Head max. 36.6 meterW
Volume 30.0 m^3/day
Hydraulic power 561 W (very approximative)

Requested autonomy 4.0 Days
Accepted missing 5.0 %

Suggested tank volume **120** m^3
Suggested Pump power **1.4** kW
Suggested PV power **1.8** kWp (nom.)

System information
Chosen pump Well 1.5 kW Head 20-70 - FR 6 m3_h
Technology Centrifugal Multistage
Max. power 1500 W
Head 20.0 - 70.0 meterW
Flowrate 7.70 - 4.07 m^3/h

Pre-sizing Help
○ No sizing
Planned power ● 1.8 kWp
or available area ○ 0 m^2

Select the PV module
Available Now
_Generic
400 Wp 32V Si-mono Mono 400 Wp 72 cells Since 2020
Approx. needed modules **4**
Sizing voltages : Vmpp (60°C) **33.0** V
Voc (-10°C) **52.0** V

Select the control mode and the controller
☑ Universal controller
control mode MPPT-DC converter
_All manufacturers
1000 W MPPT-DC converter Universal MPPT - DC Converter Generic device Adaptabl
The operating parameters of the generic default controller will automatically be adjusted according to the properties of the system.

PV Array design
Number of modules and strings
should be:
Mod. in series 3 ☑ only possibility 3
2 ☑ between 1 and 2
nb. modules **6** **Area** **13** m^2

Operating conditions
Vmpp (60°C) 99 V
Vmpp (20°C) 117 V
Voc (-10°C) 156 V
Plane irradiance **1000** kWh/m^2
Impp 21.0 A
Isc 22.2 A
Isc (at STC) 22.2 A
Max. operating power **2.2** kW
(at 1000 W/m^2 and 50°C)
Array nom. Power (STC) **2.4** kWp

3.3 System Configurations and Possible Coupling Strategies

Direct Coupling

Between the PV generator and the pump(s), no power conversion is used. This type of configuration is only possible with pumps powered by a DC motor. Despite its simplicity, this solution requires very precise electrical optimization and does not guarantee optimal efficiency under all operating conditions.

The direct coupling mode can be optimized using several specific regulation modes, although they are rarely used:

- **Booster:** An electronic device that helps overcome the high starting current, which is particularly important due to friction losses.
- **Cascade for multiple pumps:** A cascade operation mode when multiple pumps are used.
- **PV field reconfiguration:** A fairly simple, although uncommon, method that uses a control device with relays to modify the configuration of the panels.
- **Buffer battery systems**: These systems use a battery to regulate the operation of the pump over a certain period. The battery works as in a standard standalone system, allowing the pump to always operate under optimal conditions at the battery's nominal voltage.

PowerConditioning
This refers to a device that adapts the voltage/current characteristics of the PV generator to meet the specific requirements of the pumps. This type of conditioning is essential, particularly for AC pumps, which require the use of an inverter. For DC motors, power conditioning allows for more precise management of the current, which is a crucial operating parameter.

It is possible to consult the simulation results to compare the performances of these different regulation strategies.

Current Practice
Today, the direct coupling mode is largely abandoned. It is now common to use an electronic device to adapt the power provided by the photovoltaic array to the power required by the pump, whether it is alternating current (AC) or direct current (DC).

3.4 Controller + Power Conditioning

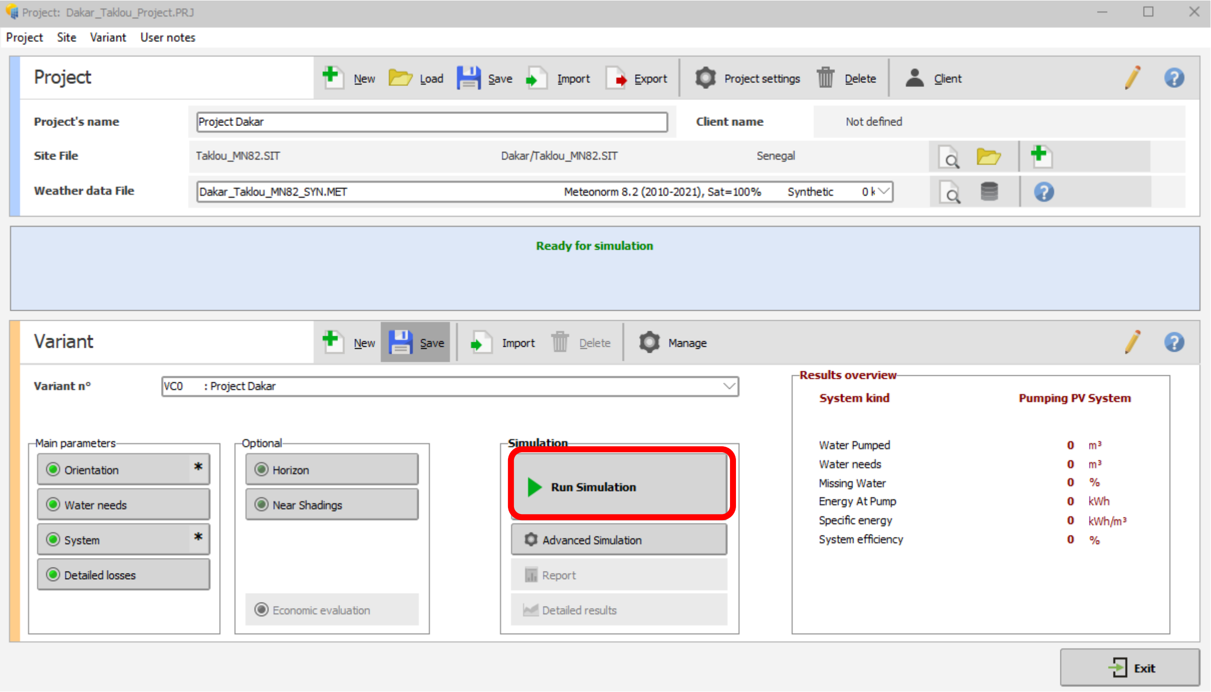
Even for the simplest configurations, such as direct coupling, it is essential to have a control device to ensure the following functions:

- **Manual On/Off,**
- **Automatic pump shutdown when the reservoir is full,**
- **Pump shutdown if the water level drops below the suction threshold (to avoid dry running),**
- **Thermal protection for the motor if the temperature exceeds allowable limits,**
- **Protection against overloads of power, current, or voltage exceeding the specified limits for the pump.**

These sizing constraints are closely related to the specific system configuration.

4 Running the first simulation

On the project dashboard, all the buttons are now green (possibly orange) or turned off. The "Simulation" button is active, and you can click on it.



Project's name Project Dakar

Client name Not defined

Site File Taklou_MN82.SIT Dakar/Taklou_MN82.SIT Senegal

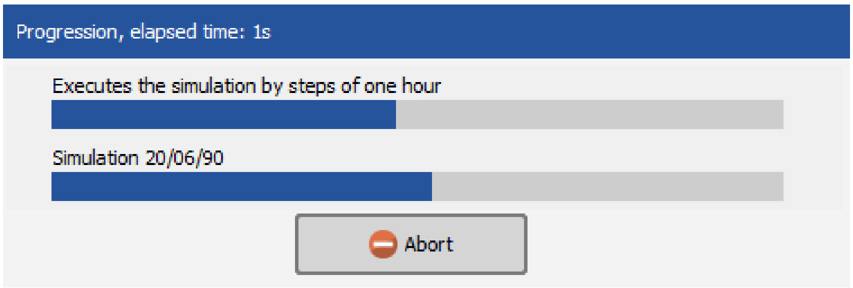
Weather data File Dakar_Taklou_MN82_SYN.MET Meteonorm 8.2 (2010-2021), Sat=100% Synthetic 0 k

Ready for simulation

Variant n° VC0 : Project Dakar

Results overview

System kind	Pumping PV System	
Water Pumped	0	m³
Water needs	0	m³
Missing Water	0	%
Energy At Pump	0	kWh
Specific energy	0	kWh/m³
System efficiency	0	%

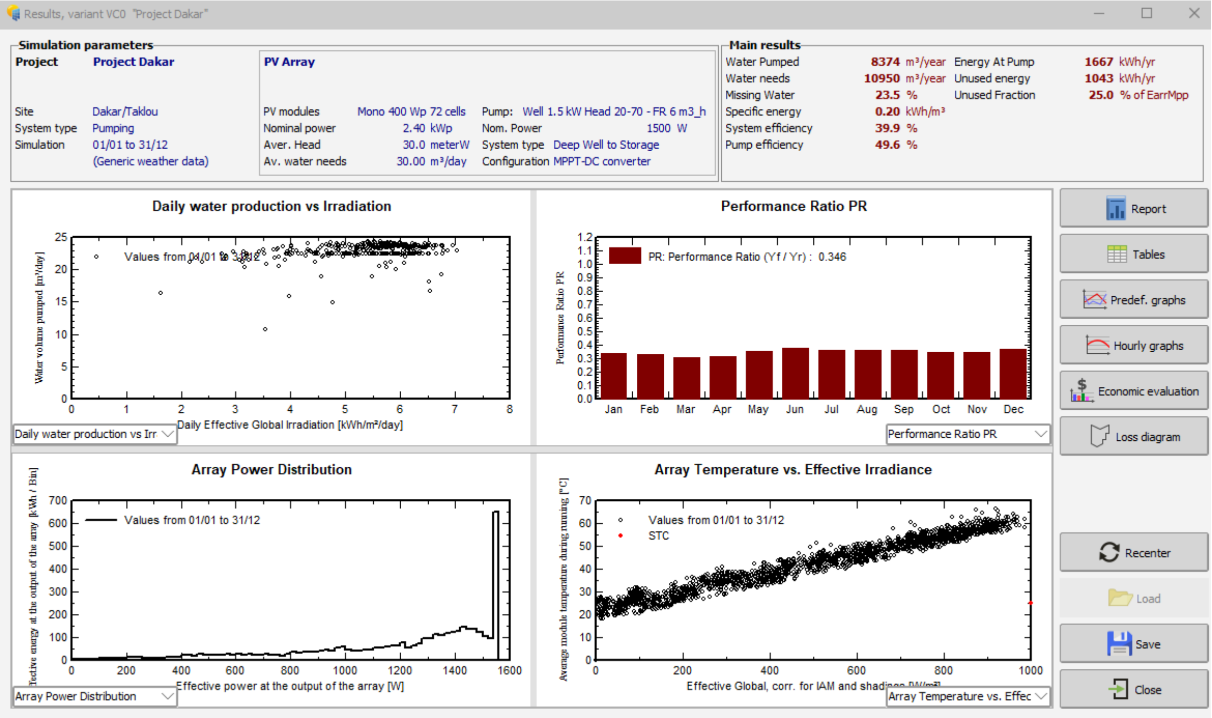


Progression, elapsed time: 1s

Executes the simulation by steps of one hour

Simulation 20/06/90

A progress bar appears to indicate the remaining part of the simulation to be completed. Once the simulation is finished, the "OK" button becomes active. By clicking on it, you are redirected directly to the "Results" dialog box.


Results, variant VC0 "Project Dakar"

Simulation parameters

Project	**Project Dakar**
Site	Dakar/Taklou
System type	Pumping
Simulation	01/01 to 31/12 (Generic weather data)

PV Array

PV modules	Mono 400 Wp 72 cells	Pump:	Well 1.5 kW Head 20-70 - FR 6 m3_h
Nominal power	2.40 kWp	Nom. Power	1500 W
Aver. Head	30.0 meterW	System type	Deep Well to Storage
Av. water needs	30.00 m³/day	Configuration	MPPT-DC converter

Main results

Water Pumped	8374	m³/year	Energy At Pump	1667	kWh/yr
Water needs	10950	m³/year	Unused energy	1043	kWh/yr
Missing Water	23.5	%	Unused Fraction	25.0	% of EarrMpp
Specific energy	0.20	kWh/m³			
System efficiency	39.9	%			
Pump efficiency	49.6	%			

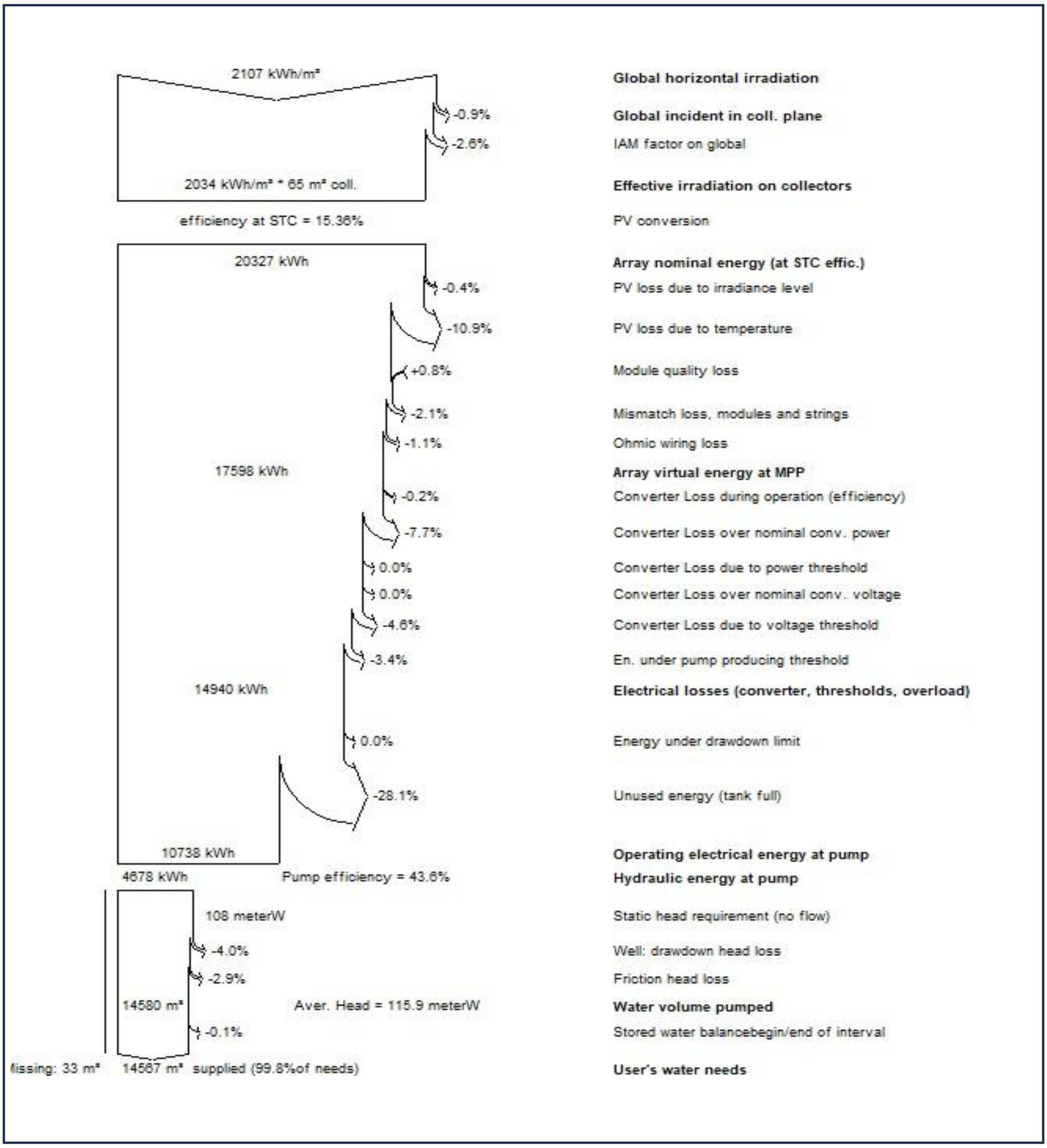
PR: Performance Ratio (Yf / Yr) : 0.346

This dialog box presents, at the top left, a summary of the main simulation parameters. It is important to check them to ensure that no errors have been made in the input parameters.

At the top right, a box displays nine values that summarize the main results of the simulation. These pieces of information provide a simplified overview and allow you to quickly detect any obvious errors or get a first impression of changes or comparisons between different project variants.

For a complete description of your system, including all the parameters used and detailed results, you can refer to the simulation report.

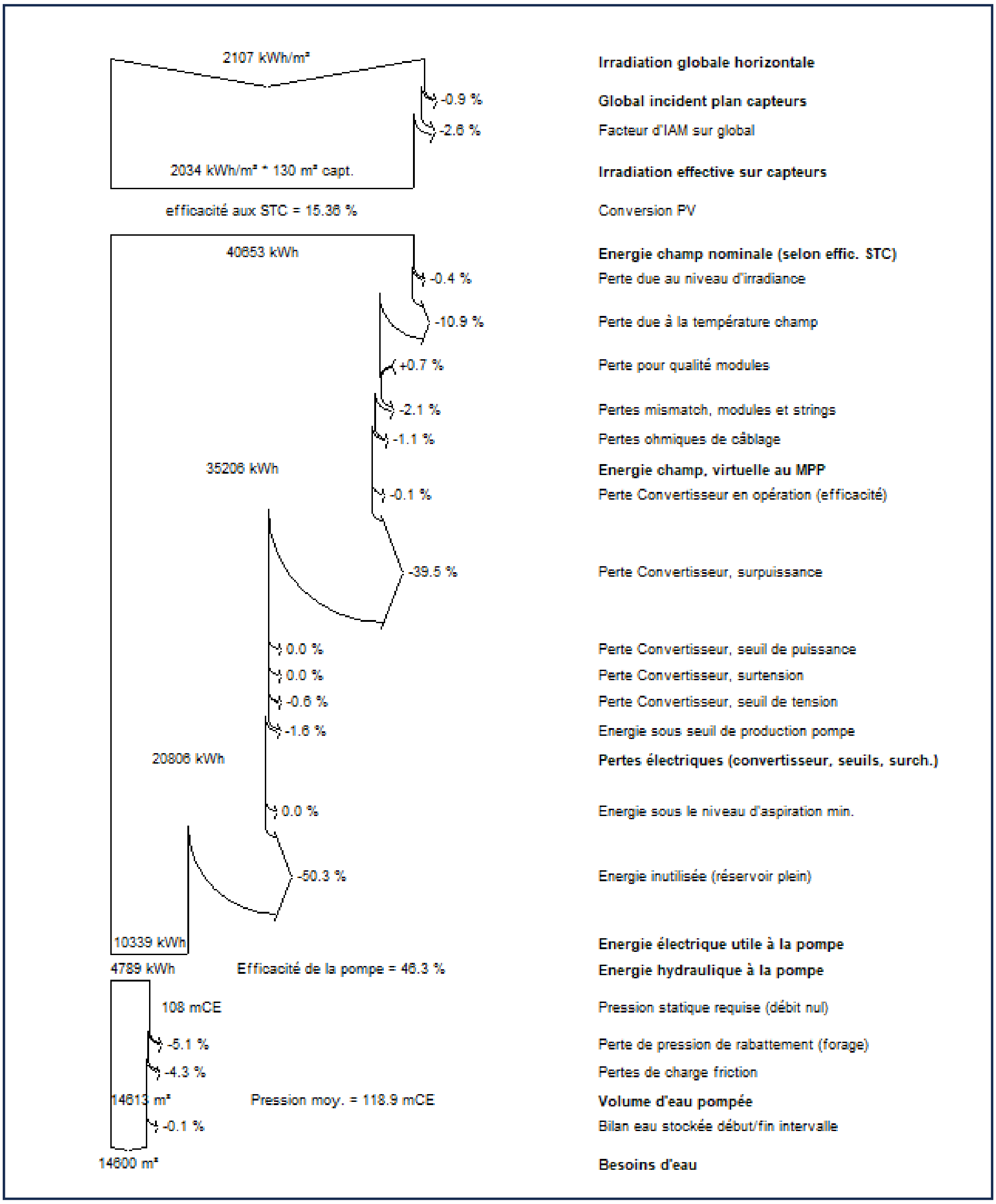
The "loss diagram" presented at the end of the report provides a detailed analysis of the system's actual performance throughout the year and allows for an in-depth verification of its sizing.
Here are some examples of loss diagrams:



In this loss diagram, we observe an energy loss of 28.1%, labeled as "Unused Energy (full reservoir)."
This loss occurs in the following situations:

- When the water reservoir is undersized,
- When the PV array is oversized,
- When the water needs are low compared to the system's simulated capacity.

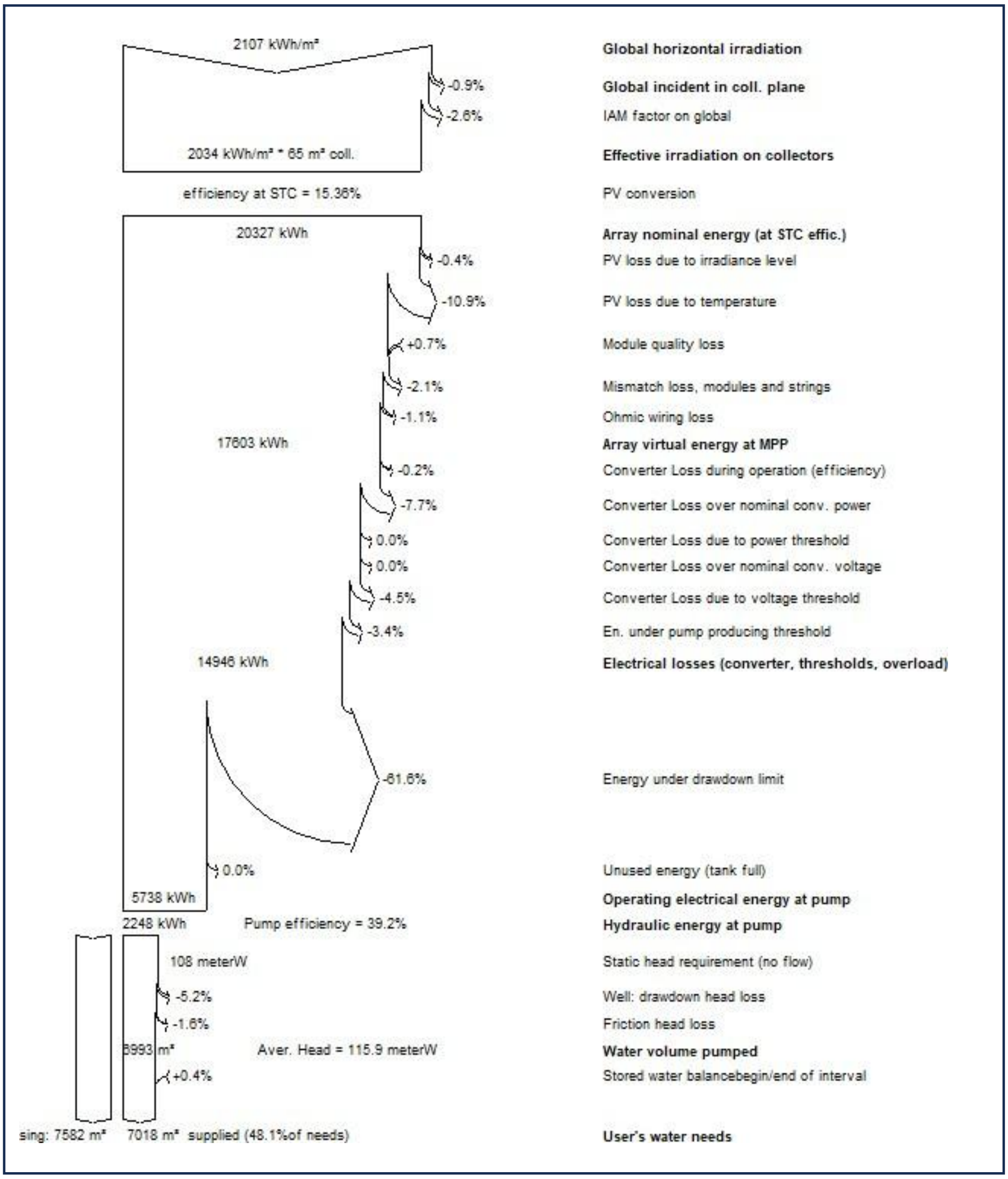
This loss is considered normal, as sunlight conditions and water needs can vary throughout the year. To fully meet the user's needs, the system must be sized for conditions less favorable than full sun. Inevitably, there will be periods during the year when production exceeds demand, leading to some unused energy.



In this loss diagram, we observe an energy loss of 39.5%, identified as "Converter Loss, Overpower."

This loss occurs when:

- The power of the PV array exceeds, at certain times of the day, the maximum power that the pump regulator can handle. This usually happens when the PV array is oversized compared to the converter's capacity.


2107 kWh/m^2
Global horizontal irradiation
-0.9%
Global incident in coll. plane
-2.6%
IAM factor on global
2034 kWh/m^2 * 65 m^2 coll.
Effective irradiation on collectors
efficiency at STC = 15.36%
PV conversion
20327 kWh
Array nominal energy (at STC effic.)
-0.4%
PV loss due to irradiance level
-10.9%
PV loss due to temperature
+0.7%
Module quality loss
-2.1%
Mismatch loss, modules and strings
-1.1%
Ohmic wiring loss
17603 kWh
Array virtual energy at MPP
-0.2%
Converter Loss during operation (efficiency)
-7.7%
Converter Loss over nominal conv. power
0.0%
Converter Loss due to power threshold
0.0%
Converter Loss over nominal conv. voltage
-4.5%
Converter Loss due to voltage threshold
-3.4%
En. under pump producing threshold
14946 kWh
Electrical losses (converter, thresholds, overload)
-61.6%
Energy under drawdown limit
0.0%
Unused energy (tank full)
5738 kWh
Operating electrical energy at pump
2248 kWh
Pump efficiency = 39.2%
Hydraulic energy at pump
108 meterW
Static head requirement (no flow)
-5.2%
Well: drawdown head loss
-1.6%
Friction head loss
8993 m^3
Aver. Head = 115.9 meterW
Water volume pumped
+0.4%
Stored water balancebegin/end of interval
sing: 7582 m^3
7018 m^3 supplied (48.1%of needs)
User's water needs