

PV-Wind[®] SOFTWARE
for Windows[®]
User's Guide

Contents

1. Overview

1.1. General description of the PV-Wind Software

2. Inputting Parameters

2.1. System type

2.2. Location

2.3. Loads

2.4. PV modules

2.5. Inverters

2.6. Batteries

2.7. Charge controllers

2.8. Wind turbines

3. Obtained results

3.1. PV-Wind hybrid system parameters

3.2. PV modules parameters

3.3. Battery parameters

3.4. Inverter parameters

3.5. Charge controller parameters

3.6. Wind turbine parameters

3.7. Cost optimization

3.8. Pie chart of the system

4. Economical assessment

1. Overview

1.1. General description of the PV-Wind(Photovoltaic-Wind) software

The main goal of “PV-Wind” software is to optimize and design the cost effective photovoltaic-wind (PV-Wind) different types of systems. This software is developed to support and help users to design photovoltaic-wind hybrid power systems having minimal price and supplying the required electricity. It has a user friendly interface.

The software has an accurate geographical location database with solar irradiations and wind speeds data. It has the databases for components as the PV modules, wind turbines, batteries, inverters and charge controllers as well. The user can add the new items to existing lists of components very easily.

During the design, the user inputs the parameters of AC (alternative current) and DC (direct current) loads. The user can select the desired types of components from the databases. During optimization, the program selects the optimal combination of components which is providing the minimal price for a photovoltaic-wind hybrid system.

The economical assessment tool of program allows to evaluate the efficiency of the hybrid system by getting the total price of system, price per Watt, annual electricity to be produced, income per year and payback time. The related charts and graphs are shown in a clear approach.

Thus the “PV-Wind” software is an efficient and user friendly program which allows to design the cost effective photovoltaic-wind hybrid systems.



The “PV-Wind” software can be used by designers, engineers and researchers. It can be used for educational purposes at Universities as well.

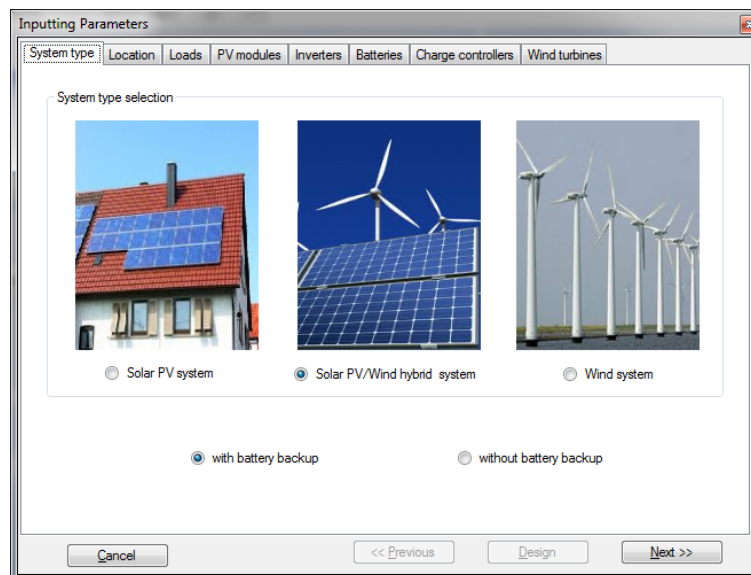
2. Inputting Parameters

2.1 System type

In the “**System type**” section three, different systems are available for optimal design. These systems are:

- Solar PV (only solar)
- Solar PV/wind hybrid
- Wind (only wind)

At the beginning the system type is selected. Then the program will run in accordance with the selected system type. By default the system type is the Solar PV/wind hybrid system with battery backup.



2.2. Location

In the “**Location**” section, the geographical location is selected by inputting the country and city. According to selected location, the program selects from the data base the longitude and latitude, solar irradiation and the wind speed on the elevation of 10 meters above the ground by default and displays on the right side of the window. The user can input the other necessary elevation for the wind turbine in the range from 5 to 60 meter above the ground. The program will determine and present the wind speed for that elevation which will be used further in optimal design process.

Inputting Parameters

System type | Location | Loads | PV modules | Inverters | Batteries | Charge controllers | Wind turbines

Input data

Select location

Country
Armenia

City/Village (nearest to the plant)
Yerevan (Lat.40.18; Lon.44.51)

Selected location parameters

Site geographical coordinates

Longitude 44.51

Latitude 40.18

Solar irradiation

Solar annual average direct irradiation
4.53 kWh / m² / day

Wind speed

60 m elevation 10 m

wind speed 5.55 m / sec

5 m

Cancel << Previous Design Next >>

2.3. Loads

In the “**Loads**” section, the user inputs the parameters of AC (Alternative Current) and DC (Direct Current) loads which will operate by electricity generated by “Solar PV”, “Solar PV/wind hybrid” or “Wind” system. The input parameters for loads are the load’s name, the power, the quantity, the working hours per day, week or month. According to these input parameters the program calculates the daily energy demand which is used further for optimal system design.

Inputting Parameters

System type | Location | Loads | PV modules | Inverters | Batteries | Charge controllers | Wind turbines

AC loads

Name	Power (Watt)	Quantity	Working hour	Per
TV	60	12	4	day
Lamp	50	2	4	day
Refrigerator	70	1	10	month
Oven	800	1	7	week
*				

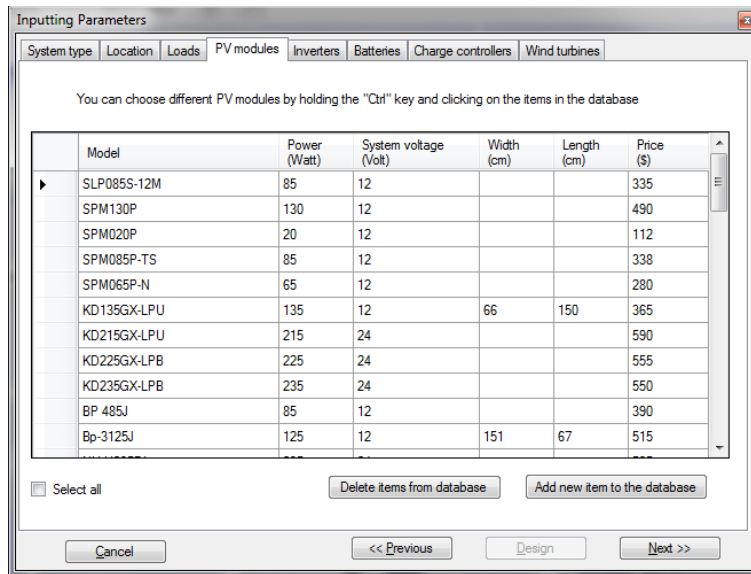
DC loads

Name	Power (Watt)	Quantity	Working hour	Per
Pump	120	1	20	month
Control block	50	1	10	day
*				

Cancel << Previous Design Next >>

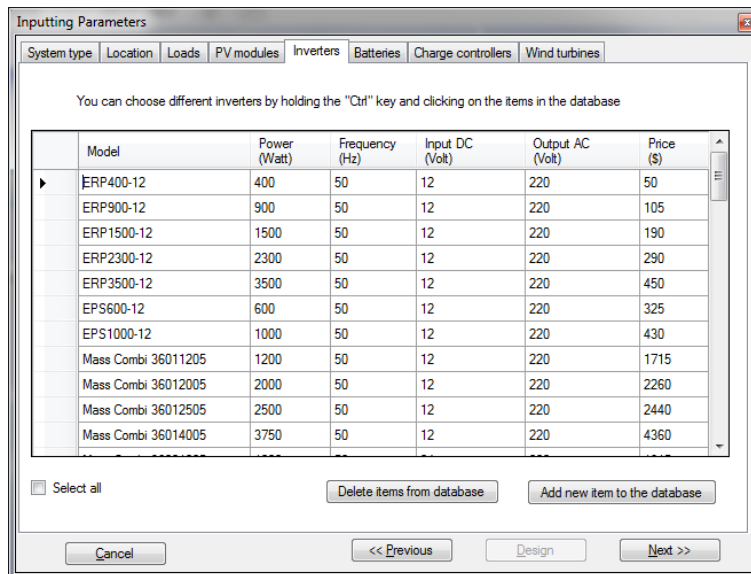
2.4. PV modules

In the “**PV modules**” section all available PV modules are listed. The user selects the desired types or all types of PV modules from the list. It is possible to add new modules by clicking the button “**Add new item to the database**”. During optimization, the program selects the optimal model of PV module which provides the required electric energy and the minimal price of the system.



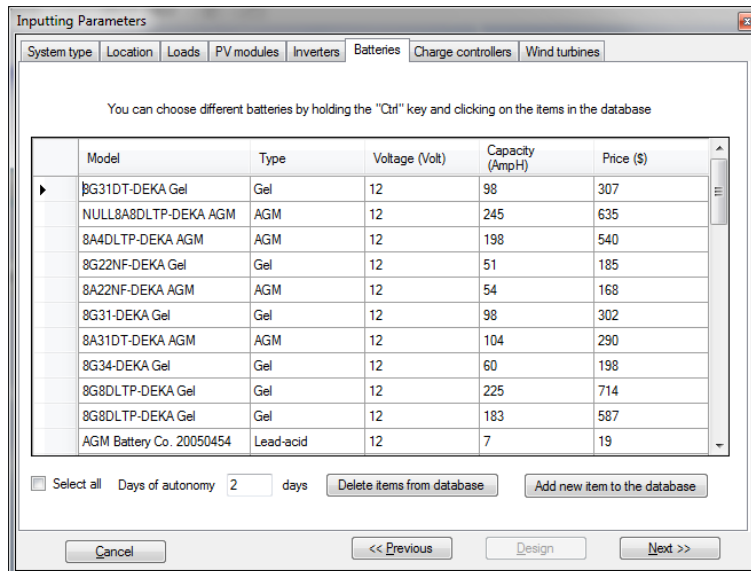
2.5. Inverters

For AC loads the inverter is necessary to convert the generated DC into AC. In the “**Inverters**” section all available inverters are listed. The user selects the desired types or all types of inverters from the list. It is possible to add new inverters by clicking the button “**Add new item to the database**”. During optimization, the program selects the optimal model of the inverter which provides the minimal price of the photovoltaic-wind hybrid system.



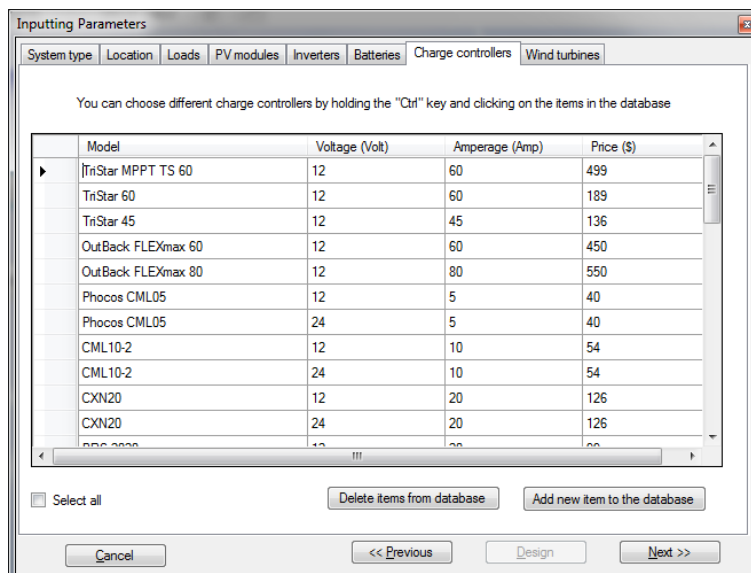
2.6. Batteries

Batteries are required for the system autonomy operation. In the “**Batteries**” section all available batteries are listed. The user selects the desired types or all types of batteries from the list. In this section, the user must input the needed autonomy days as well. It is possible to add new batteries by clicking the button “**Add new item to the database**”. During optimization, the program selects the optimal model of battery which provides the minimal price of the system.



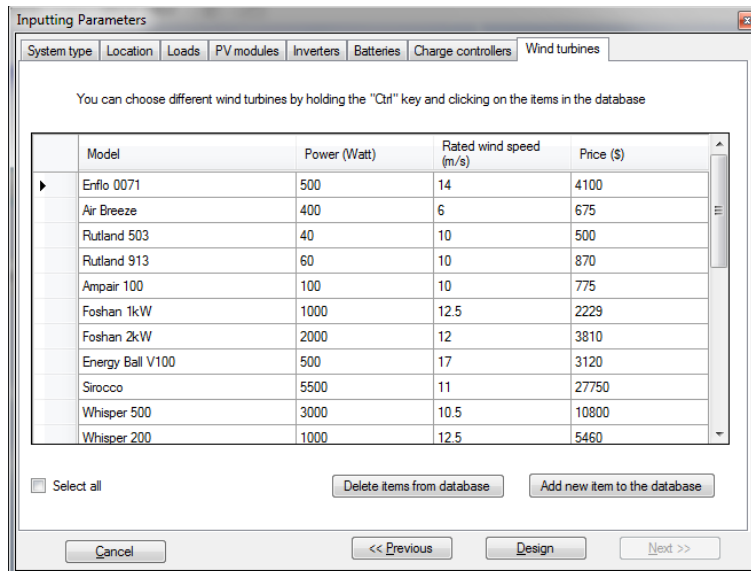
2.7. Charge controllers

The charge controller adjusts the charging process of batteries. In the “**Charge controllers**” section all available charge controllers are listed. The user is selecting the desired types or all types of charge controllers from the list. It is possible to add new charge controllers by clicking the button “**Add new item to the database**”. During optimization, the program selects the optimal model of charge controller which provides the minimal price of photovoltaic-wind hybrid system.



2.8. Wind turbines

In the “**Wind turbines**” section all available wind turbines are listed. The user selects the desired types or all types of wind turbines from the list. It is possible to add new wind turbines by clicking the button “**Add new item to the database**”. During optimization, the program selects the optimal model of wind turbine which provides the required electric energy and minimal price of photovoltaic-wind hybrid system.



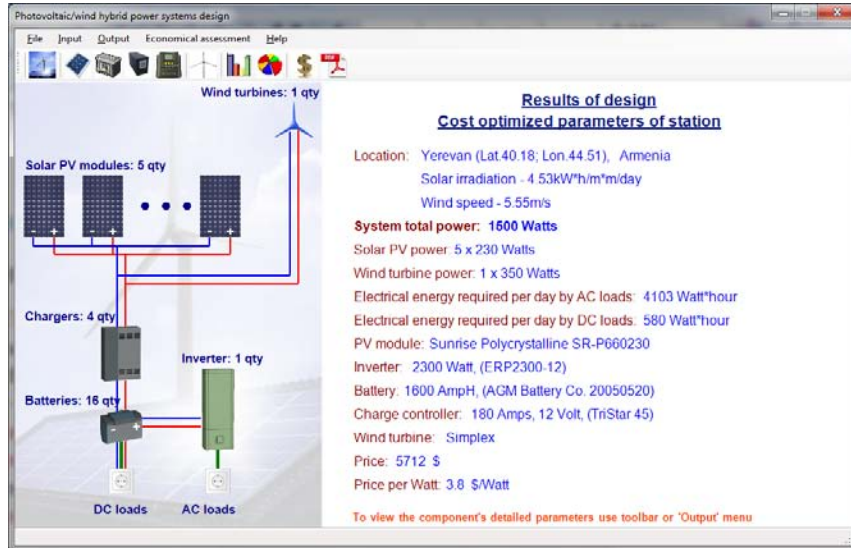
3. Obtained results

3.1. PV-Wind hybrid system parameters

On the left side of this page the diagram with components and connection chart of optimized PV-Wind hybrid system is presented. The determined quantities of PV modules and wind turbines are shown also on the diagram.

On the right side of this window the parameters of the optimized hybrid system are presented. These parameters are:

- **Location** – geographical location with solar irradiation and wind speed data;
- **Total hybrid power** – total power of PV- wind hybrid system;
- **Solar PV power** – the total power of PV modules;
- **Wind turbine power** – the power of wind turbine or turbines;
- **Electrical energy required per day by AC loads** – daily energy needed for AC loads;
- **Electrical energy required per day by DC loads** – daily energy needed for DC loads;
- **PV module** – the optimal model of PV modules;
- **Inverter** – the optimal Inverter model;
- **Battery** – the optimal battery model;
- **Charge controller** – the model of optimal charge controller;
- **Wind turbine** – the model of optimal wind turbine;
- **Price** – the total price of optimized hybrid system;
- **Price per Watt** – the price of one Watt power.



3.2. PV modules parameters

In this page the optimal PV module parameters are presented. The parameters are:

- **Model of PV module** – model of optimal PV module;
- **Price** – the price of the one PV module;
- **Power** – the power of the one PV module;
- **Voltage** – system operating voltage;
- **Amperage**- amperage of PV modules
- **Dimension** – the length and width of PV module;
- **Area**- area of the one PV module;
- **Number of modules** – the required quantity of PV modules.



3.3. Battery parameters

In this page the parameters of optimal battery are presented. The parameters are:

- **Model of battery** – the optimal of model battery;
- **Price** – the price of battery;
- **Amperage hour** – the capacity of battery given on amperage hours;
- **Voltage** – the voltage of battery;
- **Days of autonomy** – the days that batteries can supply electrical energy to the loads;
- **Number of batteries** – the optimal quantity of batteries;
- **Life cycles chart** – the type of battery and appropriate dependence of life cycle from the depth of discharge.



3.4. Inverter parameters

In this page the parameters of optimal inverter are presented. The parameters are:

- **Model of inverter** – the model of optimal inverter;
- **Price** – the price of inverter;
- **Power** – the power of inverter;
- **Input DC voltage** – input voltage of inverter;
- **Output AC voltage** – output voltage of inverter
- **Frequency** - frequency of output AC voltage.



3.5. Charge controller parameters

In this page the parameters of optimal charge controller are presented. The parameters are:

- **Model of charge controller** – the model of optimal charge controller;
- **Price** – the price of charge controller;
- **Amperage**– the amperage of charge controller;
- **Voltage** – the voltage of charge controller;
- **Number of charge controllers** – the optimal number of charge controllers that needed for charging the batteries.



3.6. Wind turbine parameters

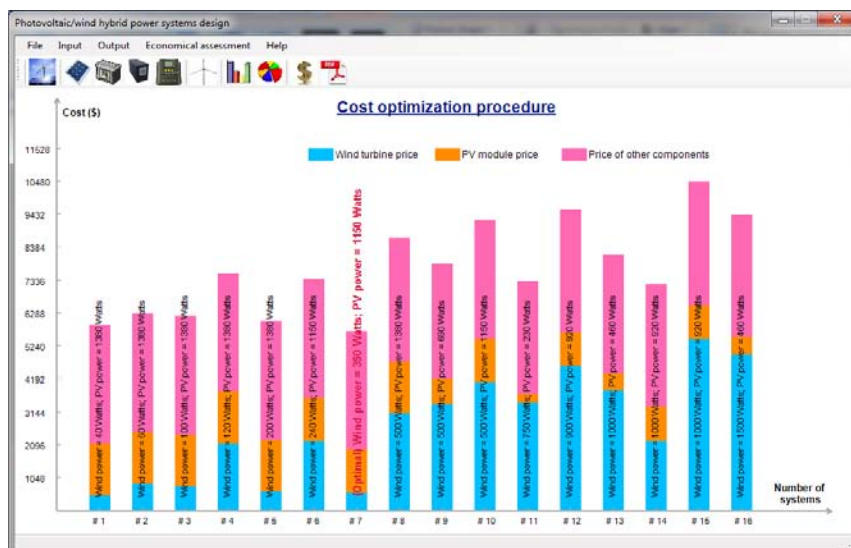
In this page the parameters of optimal wind turbine are presented. The parameters are:

- **Model of wind turbine** – the model of optimal wind turbine;
- **Price** – the price of wind turbine;
- **Power** – the power of wind turbine;
- **Rated speed** – nominal wind speed for which the turbine power is calculated;
- **Number of wind turbines** – the required quantity of wind turbines.



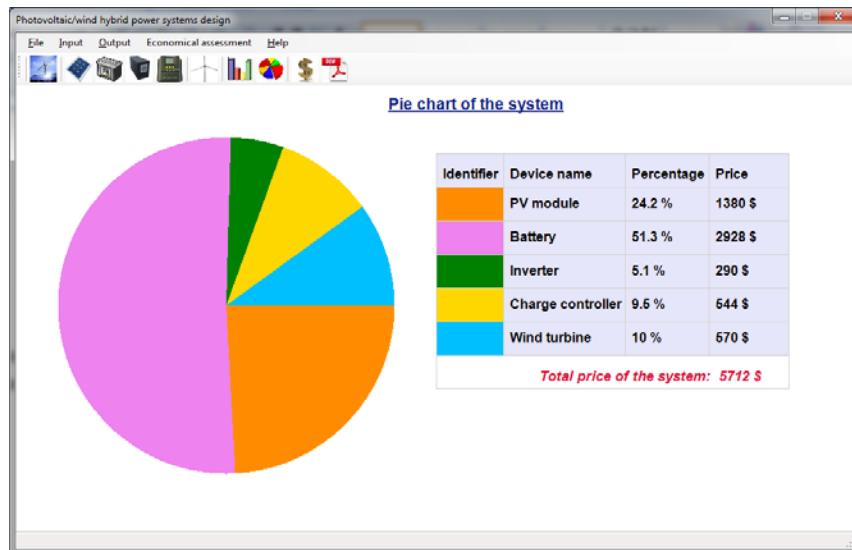
3.7. Cost optimization

In this diagram the systems' costs versus different systems are presented. During optimization, all possible combinations of different components are considered and the system with the minimal price is chosen as optimal. The graph is divided into wind part (mentioned with sky blue), PV (mentioned with orange) part and other components (batteries, inverters, charge controllers mentioned with pink) part. The parameters of optimal system are mentioned in a red text.



3.7. Pie chart of the system

In this page the cost distribution among different components is presented. On the left side the pie chart form is presented and on the right side each component's name, percentage and price are presented. This distribution is useful for comparative analysis of the system's components' prices.



4. Economical assessment

The economical assessment is an important part of designed system. In this form the main economical parameters such as the price of the system, the income per year, the payback time and etc. are presented.

Inputting parameters

Working period: 20 year

Cost of 1 kWh for sale: 20 cent

Maintenance cost per year: 0 \$/year

Include battery replacement

Battery lifespan: 4 year

Calculation

Main parameters obtained

Peak power of system: 1500 Watt

Price of system: 5712 \$

Price per Watt: 3.8 \$/Watt

Cost of 1 kWh to be produced: 5.7 cent

Electricity produced per year: 4967 kWh

Income per year: 993 \$

Income per year: 17.4 %

Payback time: 5.8 year

Close

The input parameters for economical assessment of the system designed are the working period, the cost for 1 kWh electricity for sale and the maintenance cost per year. The battery replacement also can be taken into account during economical assessment by checking the “**Include battery replacement**” box. After calculation the following results are obtained:

- **Peak power of system** – this is the peak power of hybrid system in Watts;

- **Price of system** – the optimized price of hybrid system;
- **Price per Watt** – price per watt power of designed hybrid system;
- **Cost of 1kWh to be produced**– the average cost of 1 kWh electricity that the system will produce during the inputted working period;
- **Electricity production per year** – the annual amount of electricity to be produced by hybrid system;
- **Income per year** – the amount of money obtained from selling the produced electricity. The value is represented in percent and currency;
- **Pay backtime** – the period when the money will back to the owner.