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Creating a computer program to measure standalone Hybrid photovoltaic-wind power generation

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Abstract

New options for power production based on renewable energy, such as photovoltaic energy systems, wind energy systems, and their combination in a hybrid photovoltaic-wind system, have emerged as a result of the depletion and all the downsides of fossil fuels. In this research, we suggested a method for determining the ideal technical and economic configuration of standalone Photovoltaic-Wind systems via the evaluation of a computer program built primarily on the Loss of Power Supply Probability (LPSP) algorithm. Sizing a combined photovoltaic and wind power facility is shown and discussed.

Keywords:

Introducing Software, Size, PV, Wind, LPSP Algorithms, and a Hybrid System

Introduction

Two or more renewable sources, such as wind turbines and solar generators, and/or one or more conventional sources, such as diesel generators, are combined to form a Hybrid Energy System (HES) [1]. Since renewable energy is naturally intermittent, it is necessary to complement it with traditional power sources to ensure steady electricity production. A common component of hybrid systems is a means of storing energy [2].Electrochemical batteries, inertial storage, and hydrogen fuel cells are only some of the storage options available. The latter has a low storage capacity and a hefty price tag. Optimizing the output power quality, making the most of available renewable resources, and maximizing the efficiency with which the hybrid system uses its resources are the three primary concerns when designing a hybrid system [3]. Hybrid systems may take numerous forms. DC-bus and DC/AC hybrid bus configurations dominate the market. We provide a quick overview of these frameworks below.

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Organization of DC Buses

Figure.1 shows how all of the different power sources feed into a single DC-bus, which makes it easy to use a DC-AC converter to match the DC-bus with the AC loads. This architecture's simplified control system is a major perk [4].

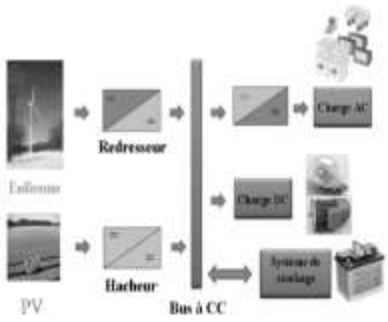

Fig.1. DC Bus architecture

Parallel AC and DC Bus Structure

This design outperforms the DC bus design in terms of efficiency. In this instance, the AC load may be directly fed with power from the wind generator's output, significantly boosting the system's efficiency. It seems to reason that when there is an abundance of energy, battery charging will begin. Second, a single bidirectional converter between the two buses may replace the conventional two unidirectional converters [2, 4]. Typical DC/AC Bus Design

Business Plan

It's a set of instructions for controlling how power is distributed across the system.

Based on the load profile, the system characteristics, and the power quality requirements [2, 3].

Load profile, diurnal changes, seasonal variations, peak troughs, etc. all affect how a hybrid system functions.

Renewable materials:

mean, standard deviation, frequency, extremes, daily and annual swings, and other metrics

The set-up of the system, including the number and kind of components, and x Power quality regulations.

Managing Data Storage

Filtering out variations in renewable energy and/or load is made possible by the "Shaving pecker Strategy" of short-term storage.

In order to maintain load supply for an extended length of time, the "Cycle Charge Strategy" is used [4].

Managing Demands

Short-term and long-term costs might be grouped together or separated depending on importance:

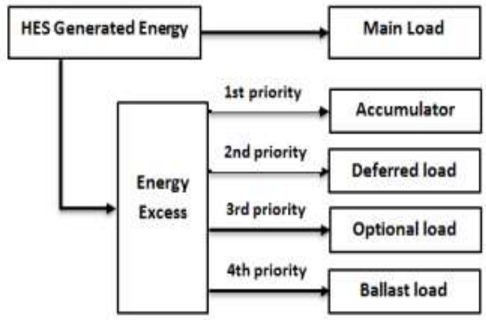

Fig.2. Load management

A Hybrid System Was Analysed

The hybrid setup is shown in Figure 4. The foundation of this setup is an asynchronous machine wind turbine and solar cells. A shopper links the battery pack to the DC bus. The DC/DC chopper connects directly to the DC-bus to provide DC loads, while the DC/AC inverter provides power to AC loads. The wind generator is linked to both the DC and AC buses, whereas the solar generator is only connected to the DC bus through a DC/DC chopper managed by an MPPT controller. Ep = EPV + EW is how we write the amount of energy generated over the course of a day, and Ec is how we write the amount of energy used up. Ec. Figure 5 depicts the movement of energy.

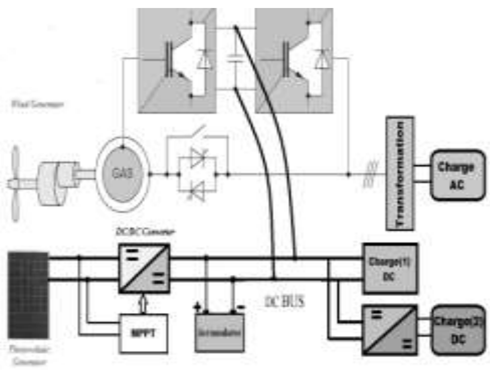

Fig.3.Configuration of the standalone studied PV-Wind hybrid system.

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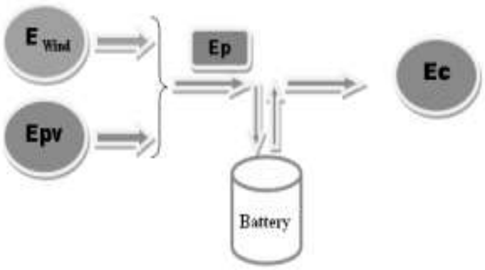

Fig.4. Energy flow diagram

Assuming the bus voltage is still constant, it can resonate in current such as:

$$i_p = \frac{E_p}{24hU_c}$$

$$i_c = \frac{E_c}{24hU}$$

We can establish the nodes equation:

$$i_p = i_c + i_b \,,$$

where bi is the equivalent battery current. If there is an imbalance between production and consumption, this difference will vary the DC-bus voltage for a period of time ΔT, the timewhen the battery is working: either to charge or to discharge, we can write:

$$i_c = C\left(\frac{\Delta U}{\Delta T}\right) = \left|I_p - I_c\right| \Rightarrow C = \frac{\Delta T\left|I_p - I_c\right|}{\Delta U}$$

In this way we can estimate a priori the value of the battery capacity

Explanation of the developed interface:

In this section we have developed a software code for sizing PV-Wind hybrid system which is based on the loss of power supply probability (LPSP) method [5,9]. The design of a facility window for LPSP sizing appears with five buttons in order to carry the different tasks in the sizing procedure, figure 7.

Fig.5. LPSP based window

The user may set the numerous values and constants that determine his system size in a new window that displays upon clicking a button. Below, we'll talk more about these intervals.

Meetings at Locations: If we click this link, we'll be sent to a new screen where we can:

The user may choose the site where the installation will be built in this menu; the data for this comes from a NASA database and includes information like the average annual temperature, the number of hours of sunshine per day, the average annual rainfall, the average annual wind speed, and more. After making a careful selection, you may verify it by clicking the OK button; if everything checks out, the formerly red indicator will now be green. The window is now minimized and we're on to the next option.

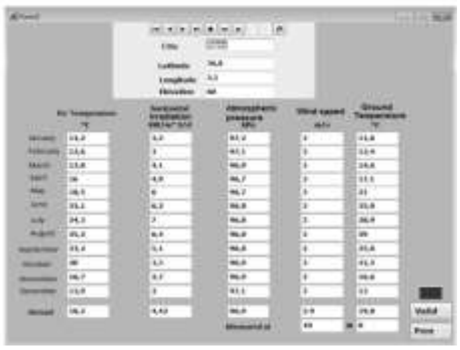

Fig.6. Site characterizations

Load characteristics

This step is crucial, the user must specify the load profile [6, 12]; this can be done in two ways: x Daily average load: where the user should provide the load values during 24 hours within a typical day in each month. x Monthly average load: where the user is prompted to enter the daily average load value of his load. For the daily average load whenever the user entered a value, he must increment time by clicking the increment button. At the end user must provide the rated values: number of days of autonomy, to be able to operate the system using the storage and the probability of dissatisfaction LPSP in the load [7, 13]. The validation is done by a click on the submit button, the icon red becomes green for the confirmation of validation.

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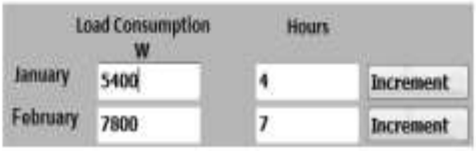
Fig.7. Load profile window

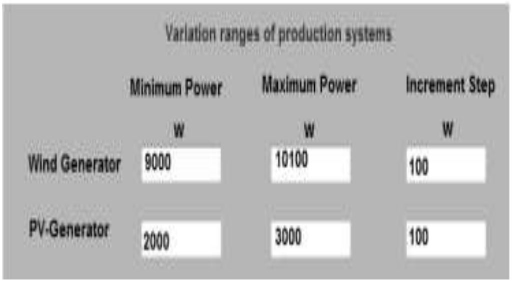


	Load Consumption W	Hours	
January	5400	4	Increment
February	7800	7	Increment

Fig.8. monthly Average consumption

Technical parameters

When clicking the technical parameters button, a new window appears, which bring together all the parameters characterizing the system, it is unscrewed in four fields: x Adjustment of the range of system production: the user must specify the maximum power, the power and the minimum increment step for each PV system and wind, figure8.

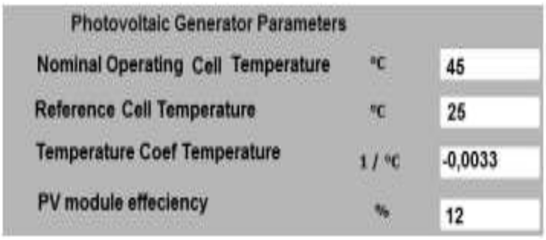


Variation ranges of production systems

	Minimum Power W	Maximum Power W	Increment Step W
Wind Generator	9000	10100	100
PV-Generator	2000	3000	100

Fig.9. Variation interval of production sources

Parameters of the photovoltaic generators: to calculate the power of PV generator, the user is prompted for this field: the performance of the panel, NOTC temperature, reference temperature (usually it is equal to 25°C), the temperature coefficient β (generally between 0.004 and 0.006) [8], figure.10.

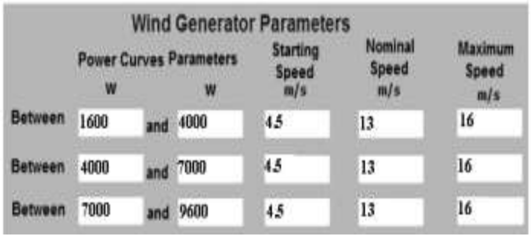


Photovoltaic Generator Parameters

Nominal Operating Cell Temperature	°C	45
Reference Cell Temperature	°C	25
Temperature Coef Temperature	1 / °C	-0,0033
PV module effeciency	%	12

Fig.10. PV Generator parameters

Parameters of wind generators: in this field the user must specify the ranges of variation of the used wind turbines. There are three tracks to complete, and every power range of wind turbine must enter their speed characteristics: Release, Nominal, and Maximal (that according to Power (speed) turbines gives by manufacturers) [9].



Wind Generator Parameters

	Power Curves Parameters W		W	Starting Speed m/s	Nominal Speed m/s	Maximum Speed m/s
Between	1600	and	4000	4.5	13	16
Between	4000	and	7000	4.5	13	16
Between	7000	and	9600	4.5	13	16

Fig.11. Wind generator parameters

Technical parameters

The parameters that define the system are grouped into four fields in a new window that opens when you click the technical parameters button. Figure 11 demonstrates how to modify the system's output range by entering the maximum power, the power, and the minimum increment step for each PV and wind system.

Conclusion:

For this project, we used the LPSP technique to calculate the optimal size of a PV-Wind hybrid system. This technique relies on a cost analysis that factors in the various equipment's, the load profile, and the climatological parameters of each installation location. This approach enables the definition of many configuration outcomes that meet the profile load. Next, we do an economic analysis to establish the best possible setup. The next stage of this project is to build and implement tools that can facilitate this analytical investigation. In order to clarify the LPSP sizing method of PV-Wind hybrid systems, a thorough presentation of this program has been produced. Our program is now functional, interactive, and simple to use. An autonomous PV wind hybrid energy system's battery bank and PV array sizes may be optimized for a given load and a desired loss of power supply probability using this sophisticated modelling tool. In addition to internal factors like the cost of batteries (subject to legislation affecting the cost of new materials and the cost of disposal), the potential downward trend of equipment costs with rising volumes, etc., the total cost also depends on external trends like these. Market demand for renewable energy and the price of fossil fuels are two factors that determine a hybrid system's cost-effectiveness. Market demand for renewable energy

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and the price of fossil fuels are two factors that determine a hybrid system's cost-effectiveness.

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