ARTICLE IN PRESS

Renewable and Sustainable Energy Reviews xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Comparative study of photovoltaic system optimization techniques: Contribution to the improvement and development of new approaches

Wassila Issaadi[a,*], Salim Issaadi[b,a], Abdelkrim Khireddine[a]

[a] Electrical Engineering Laboratory, Faculty of Technology, University of Bejaia, 06000 Bejaia, Algeria
[b] 1022 Rue de Louvain Est, Montréal, Québec, Canada H2M 2E8

ARTICLE INFO

Keywords:
New Techniques
Optimization
Improvement
Command MPPT
Power
Maximum Power Output

ABSTRACT

During a few years, the photovoltaic (PV) market has shown unprecedented growth and wide-spread use of this environmentally friendly and distributed source of power generation. On a global basis, new PV installations approximately varies between 78 GW and 82 GW in 2016 and estimates for 2017 are in the 80–85 GW range.

For the 6th year in a row, solar power with 56% of total investment representing USD 161 billion (EUR 146 billion) took the largest share of new investments in renewable energies. These investments were almost evenly shared between large scale solar power and distributed solar energy systems.

The most impressive result is however the number of installations and therefore of individuals, companies, and public entities participating in this development: nearly 2 million single PV installations produce photovoltaic power already today.

The strong growth in PV installations is currently driven in particular by Asian countries, accounting for some 70% of the global market, and accompanied by the promising key markets of North America, Japan and Australia. Europe contributed with a share of 5%. At the same time, the PV arena has importantly widened its number of participating countries and also increased their specific weight. Major new areas for development lie also in the Sunbelt region, with Africa, Middle East and South America just starting to create new growth opportunities, almost always dedicated to covering local demand.

In this topic, the proposed study involves a comparison between the delivered power optimization techniques. Among all, there is the technique of Truly Maximum Power Point Tracking method and the optimization techniques With and Without Sunshine Compensation. The last two techniques are less efficient than the first one, but easier in their implementation.

In order to increase their performance, an improvement has been proposed. The obtained results are promising, very satisfactorily and remain to be practically validated.

1. Introduction

The major competitive advantages of PV technology lie in its versatility, i.e. the wide range of sizes and sites, resulting into proximity to electricity demand, in the value of its production profile concentrated during peak-load hours and in its enormous potential for further cost reduction.

PV technology has reduced its unit costs to roughly one third of where it stood 5 years ago, thanks to continuous technological progress, production efficiency and to its wide implementation. The trend of decreasing unit cost will continue also in the future, just like in comparable industries such as semiconductors and TV screens.

Adding the important feature of integrated PV solutions in particular in building architecture, the potential of further growth is simply enormous.

This solar generation report combines different growth scenarios for global PV development and electricity demand until 2050. It is built on the results of several reference market studies in order to accurately forecast PV growth in the coming decades. In addition, the economic and social benefits of PV, such as employment and CO2 emissions reduction, are also worked out. With PV becoming a cost competitive solution for producing power, it will open up an increasing variety of new markets and contribute more and more significantly to cover our future energy needs.

Abbreviations: MPPT, Maximum Power Point Tracking.; P & O, Perturb and Observe.; MPP, Maximum Power Point.; pn, pn junction.; PV, Photovoltaic.; GPV, Generator Photovoltaic.; DC, Direct Current.; CS, Static Converter

* Corresponding author.
E-mail addresses: milissa_eln@rocketmail.com (W. Issaadi), salim_issaadi@yahoo.ca (S. Issaadi), abdelkrim.khired@gmail.com (A. Khireddine).

http://dx.doi.org/10.1016/j.rser.2017.08.041
Received 14 February 2016; Received in revised form 25 June 2017; Accepted 12 August 2017
1364-0321/ © 2017 Elsevier Ltd. All rights reserved.

Nomenclature

I	Current of the generator PV [A]
V	Voltage at the output of a solar module or cell [V]
I_{ph}	Photocurrent generated by the PV module or cell [A]
I_{S1}, I_{S2}	Diodes saturation currents
n_1, n_2	Ideality factor of the diode
R_S , R_p	Series resistance and parallel resistance, respectively (Ω)
T	Temperature of the junction of the cells PV [K]
q	Elementary charge ($q = 1.602*10^{-19}$ C)
KB	Constant of Boltzmann ($KB = 1.380*10^{-23}$ J/K)
I_{dr}, I_{dd}	Currents flowing through a diode [A]
E_g	Energy gap [eV]
V_{oc}	Open-circuit voltage [V]
I_{cell}	Current delivered by the cell [A]
V_{cell}	Terminal voltage at the cell [V]
I_{SC}, I_{CC}	Short-circuit current [A]
Z	Number of photovoltaic cells connected in series
I_{OP}	Optimal current of generator PV in MPP point [A]
V_{OP}	Maximum voltage of generator PV in MPP point [V]
S, E, Φ (W/m^2)	Sunshine [W/m²]
P	Power from a generator PV [W]
R_i, R_S	Variable load (Ω)
V_b	Battery voltage (V)
d	Duty cycle
I_S	Output current of the converter [A]
V_S	Output voltage of the converter [V]
R_{op}	Optimal resistance of the generator (Ω)
T	Cells temperature (K)
V_{ref}	Output voltage of PV at moment (k) [V]
Ppv(k)	Output power of PV at moment (k) [W]
I(V)	Current-Voltage characteristic
P(V)	Power-Voltage characteristic
m_1	Proportion of short circuit current (I_{CC})

PV technology has all the potential to satisfy a double digit percentage of the electricity supply needs in all major regions of the world. Going forward, a share of over 20% of the world electricity demand in 2050 appears feasible, and opens a bright, clean and sunny future to all of us.

In order to improve it efficiency, in other words, maximize the power delivered to the load connected to the generator bounds, several criteria of the photovoltaic system efficiency optimization were applied [1–3] and techniques were surveyed for obtaining good adaptation and high productivity. Among these techniques, there are the technique of Maximum Power Point Tracking "MPPT" called True MPPT or P & O command [4] and the techniques of optimal power points research With and Without Sunshine Variation or Compensation (WSC and WOSC).

The comparison between these techniques is fixed as a goal in the first step, then a contribution to the improvement is proposed. Throughout this study, we use the "Matlab/Simulink" software to model the different parts of the system and simulate the proposed and even the improved commands.

Through this work, we found that improving the method With Sunshine Variation is very succeeded and this improvement provides very high power and maximum performance system that are equal to that given by the True MPPT. By using the enhanced version of this method, the replacement of the True MPPT method in some applications requiring precise powers can be envisaged.

The second step consists of a contribution to the improvement of the functioning powers of these two last commands, therefore more improved yields have been developed in this article.

Indeed, the method of P & O is a widespread approach in the field of MPPT technologies [1–3,5,7], because it is simple. It only requires measurements, on the panel output voltage V_{pv} and its output current I_{pv}, thus it can immediately detect the maximum power point by generating at its output a voltage V_{ref}. As its name indicates, the P & O method works by the V_{pv} perturbation and the observation of its impact on the change of the output power of the PV panel [1–3,5,7].

This latter reveal a really higher yield, compared with the two other MPPT commands treated in this article, however, this command is used as a reference in the calculation of powers and returns all over this work.

On the other hand, in face to the poor values of the photovoltaic system productivity, especially for the optimal power point research Without Sunshine Variation technique, which is characterized by a yield value that decreases to 48.15% and for the complexity of implementation of the True MPPT technique, then improvements in optimization techniques With and Without Sunshine Variation are proposed.

Indeed, the MPPT control Without Sunshine Variation presents a very simple control and only requires cyclic measurement of the current I of PV panel. The measurements made across this article present a very low yield, however a contribution to the improvement has been proposed: in this case, instead of using a constant reference, an adjustment of this value is carried out by adding a value proportional to the voltage at the generator bound, the proportionality factor may be a shunt conductance in bounds that the measurement is carried out.

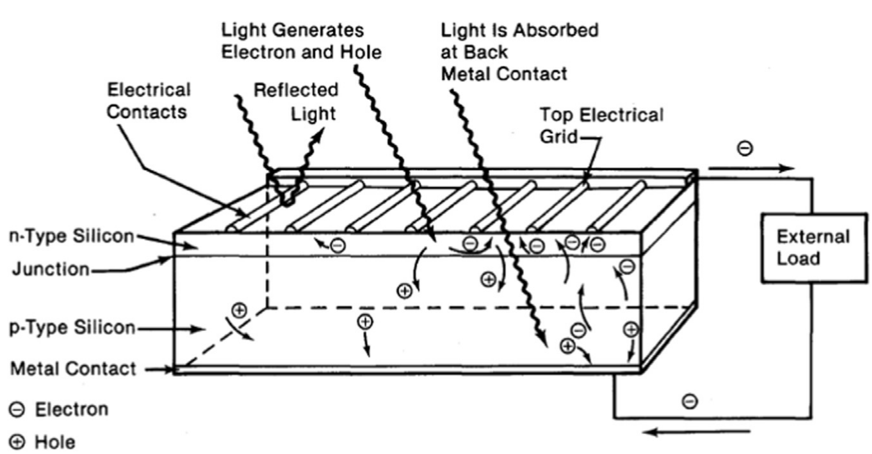

Fig. 1. Schematic representation of a solar cell.

Download English Version:

https://daneshyari.com/en/article/8111750

Download Persian Version:

https://daneshyari.com/article/8111750

Daneshyari.com