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Comparative Study of Maximum Power Point Techniques

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Abstract - *This paper aimed to study the behavior of different maximum power point tracking (MPPT) techniques applied to PV systems. In this work, techniques such as incremental conductance (INC), perturb-and-observe (P&O), and fuzzy logic controller (FLC) are assessed. The response of the different MPPT techniques is evaluated in rapidly changing weather conditions. The results indicate that, INC performed best among compared MPPT techniques followed by P&O, FLC and HC MPPT techniques in both dynamic response and steady-state in most of the normal operating range.*

Keywords: photovoltaic (PV), Incremental conductance (INC), perturb-and-observe (P&O), and fuzzy logic controller (FLC)

1. INTRODUCTION

Solar PV array has many advantages and disadvantages such as Solar PV systems operate differently than solar thermal ones. Solar PV system actually generates free electricity while solar thermal systems heat up your water. Though the feed-in tariff has changed quite a bit since it was introduced, solar PV systems are still a great investment because they substantially lower your electric bill .The price of solar panels has gone down by 45 percent or more, which makes the entire system much more affordable. Solar photovoltaic systems require daylight and so will work in days when the sun is not shining. All you need is light to create energy, so although the effectiveness of the solar PV array will be less when the sun is covered by clouds, it will still generate some electricity. Utilizing solar power helps lower your electric bills because you are generating some of the electricity you use. Some systems can generate as much as 40 percent of the electricity you use on an annual basis. There is very little maintenance involved in owning a solar PV system. Just make sure that you purchase the system from a company with a solid reputation so that you know you are buying quality panels and a good aftercare service .The feed-in tariff is designed to increase the amount of solar power being utilized in the UK, but it also makes the installation of solar PV systems look even more attractive to home and business owners .By using green energy instead of fossil fuels, you are doing what you can to protect the environment. Our world's fossil fuel reserves are rapidly decreasing, so we will have to find alternative fuels soon. Solar PV panels provide a green way to produce electricity. The disadvantages are such as Solar PV panels are more expensive than panels designed for solar thermal energy. However, they do a lot more for your home or business than solar thermal panels do, and there are some incentives and grants to help pay for them .You need an adequate roof space to display your solar PV panels. The larger the panel covering the more the electricity generated .Solar PV panels may not be a viable green energy option for be used. Other font types may be used if needed for special purposes.

Your home or business if you have a predominantly north or east facing roof or if tall buildings and/or trees place your roof in the shade during the day.

2. STUDY OF MAXIMUM POWER POINT TRACKING TECHNIQUES

For a long term and sustainable supply of energy, it is essential to exploit and utilize the renewable sources at a much larger scale. Among the renewables, the solar photovoltaic (PV) is expected to be among the most prominent due to its abundance, ease of installation and almost maintenance free. In addition, it is considered as green energy and thus addresses the concerns over the environment Photovoltaic (PV) array is usually an essential part of PV systems. In general, PV generation systems have two major Problems: the conversion efficiency of electric power generation is low (in general less than 17%, especially under low irradiation conditions) and the amount of electric power generated by solar arrays changes continuously with weather conditions. Moreover, the solar cell (current-voltage) characteristic is non-linear and varies with irradiation and temperature. There is a unique point on the I-V or (power-voltage) curve of the solar array called MPP, at which the entire PV system operates with maximum efficiency and produces its maximum output power. The location of the MPP is not known, but can be located, either through calculation models, or by search algorithms. Therefore MPPT techniques are needed to maintain the PV array's operating point at its MPP. However, due to the low conversion efficiency of the PV modules, the cost of solar power is still higher relative to the fossil fuel. One effective way to increase the efficiency is to improve its maximum power point tracking (MPPT) algorithm. Since the MPPT comprises of software codes, this approach appears to be the most economical way to enhance the energy throughput. The function of MPPT is to ensure that the operating voltage and current always stay at the maximum power point (MPP) on the *P-V* characteristic curve. To date, numerous MPPT techniques are reported, they are broadly classified into two categories, namely the conventional and soft computing approach. The most popular conventional MPPT are the perturb and observe (P&O), hill climbing and incremental conductance. These algorithms are widely used in

commercial products—mainly due to their simplicity and robustness. On the other hand, soft computing based MPPT such as artificial neural network, fuzzy logic, differential evolution, particle swarm optimization and cuckoo search tend to be more versatile and flexible. Despite exhibiting better steady state performance, they are much slower and in practice, are not as acceptable.

Among the conventional MPPT, P&O is the simplest and exhibits very good convergence. However, the algorithm suffers from two serious drawbacks. First is the continuous oscillation that occurs around the MPP. Second, the P&O is prone to lose its tracking direction when the irradiance (G) increases rapidly. Both problems contributes to the loss of power and hence reduced tracking efficiency. Although there exists several works that address the oscillation issue using the adaptive P&O schemes, none has comprehensively address the loss of tracking direction. Notwithstanding have introduced several solutions to address these two problems. However, the methods are limited for specific conditions as shall be discussed in Section II. With this hindsight, this work proposes a more comprehensive modification to the P&O, with the aim to solve both problems simultaneously. The modified algorithm maintains a similar structure to the conventional P&O, but it incorporates a unique dynamic perturbation to decrease the oscillation, while maintaining a reasonable convergence time. In addition, the method introduces boundary conditions on the *P-V* curve that prevents the operating point from being diverged (uncontrollably) from the MPP.

Another issue that has been neglected is the performance benchmarking of the MPPT algorithms. In almost all publications, the P&O are tested against very simple irradiance profiles—which in most cases do not reflect the Conditions that occur in the real environment. Consequently, the margin of improvement between the conventional and adaptive P&O is not very significant. In this work, the conventional as well as the modified P&O is comprehensively benchmarked using the EN 50530 dynamic MPPT efficiency test. This test is very rigorous as it demands the algorithm to track a set of irradiance ramps with variable rate of change. The results for the conventional and modified P&O is compared side by side and the performance enhancement due to the proposed method is clarified.

3. FUTURE SCOPE

As well know that distributed computing is the latest trend in all the fields. They are more widely used all over the world. As there are many positives from this, there are also certain aspects that might make distributed computing a menace to the world. The main issues regarding this menace will be the security issue. Which is to be implemented very strongly such that, the systems are protected from whatever the attack, it might get even in the upcoming future.

4. CONCLUSIONS

The use of solar energy is essential for providing solutions to the environmental problems and also energy demand. The vast development to improve the efficiency by the MPPT algorithms encouraged the domestic generation of power using solar panels. The available MPPT techniques based on the number of control variables involved, types of control strategies, circuitry, and applications are possibly useful for selecting an MPPT technique for a particular application for grid tied or standalone mode of operations. This review has included many recent hybrid MPPT techniques along with their benefits for mismatched conditions such as partial shading, nonuniformity of PV panel temperatures, and dust effects.

It is observed that Perturbation and Observation and Incremental Conductance methods are simple and used by many researches, but they have the slow tracking and low utilization efficiency. To overcome the drawbacks, fuzzy and neural network techniques are used in the present days by which the efficiency is increased. To boost up the voltage various DC-DC converters are used along with battery storage systems in order to store the excessive energy from solar PV panel. The DC link voltage oscillations in the grid connected PV system can be obtained by using Cuk converters, SEPIC converters, and Zeta converters with reducing current ripple injected in the PV array and load. The harmonic content is reduced from the output of DC-DC converters using the filter circuits. The passive filters as LC, LCL, and LLCC are used for harmonic distortion as well as to improve the power quality. Filter capacitors are used to reduce high frequency current ripple.

This DC is again fed to the inverter for converting the DC to AC with various PWM techniques. These PWM inverter techniques yield the better AC outputs which are used to connect the grid interconnections and standalone AC loads. Multilevel inverters with sinusoidal PWM and SVM are used to reduce the harmonics in the load voltage even in low switching frequency. Grid tied inverters with battery backup are preferred in hybrid systems for backup even if the grid goes down for both grid tied and off grid systems.

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