Optimization Technique for PV Cell through MPPT Technique

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***Abstract* -** Maximum Power Point Tracking (MPPT) methods are used in photovoltaic (PV) systems to continually maximize the PV array output power which generally depends on solar radiation and cell temperature. MPPT methods can be roughly classified into two categories: there are conventional methods, like the Perturbation and Observation (P&O) method and the Incremental Conductance method and advanced methods, such as, fuzzy logic (FL) based MPPT method. It is necessary to track the maximum power point (MPP) of the PV array rapidly and accurately and it can increase the output power of photovoltaic array. This paper divides a number of different techniques for MPPT of PV arrays into four groups by the control theory and development process of MPPT, analyses their merits and demerits and compares methods with others.

***Keywords* -** PV Array, MPPT, fuzzy logic, Optimization of Energy

I. INTRODUCTION

The recent sharp increases in the prices of oil, natural gas, uranium and coal underline the importance for all countries to focus on development of alternative energy resources. For developing countries, these price increases can have ruinous economic consequences; for many countries already plagued by poverty this means a choice between fuel and food, health care, education and other essentials. Renewable energy resources need priority because: 1) the overwhelming scientific evidence that anthropological emissions of greenhouse gases from carbon combustion threaten catastrophic results from rapid climate change; 2) the severe health and environmental consequences from fossil fuel combustion being experienced in every major developing country city; and 3) the high cost, environmental damages and security threats of nuclear power. The world already is responding to these imperatives. "Annual investment in renewable energy was an estimated $17 billion worldwide in 2019, up from $6 billion in 1995. And cumulative investment of at least $80 billion was made in renewable energy during the period 1995 – 20019." Virtually all those who have addressed the energy aspects of sustainable development have concluded that renewable resources should play a major role. Thus in the latest international pronouncement of the Plan of Implementation of The World Summit on Sustainable Development, Article 20 (e) states: "With a sense of urgency, substantially increase the global share of renewable energy sources with the objective of increasing its contribution to total energy supply, recognizing the role of national and voluntary regional targets as well as initiatives, where they exist, and ensuring that energy policies are supportive to developing countries' efforts to eradicate poverty, and regularly evaluate available data to review progress to this end;" Yet, in both developed and developing countries, renewable resources, while they are the most rapidly growing energy resource, still have not reached anywhere near their technical and economic potential. Indeed, world-wide, the share of renewable resources accounts for only about 3% of total global energy supply. There are a host of economic, social and legal barriers that account for the failure of renewable resources to reach their potential. Those barriers can be overcome. They have been overcome successfully in many jurisdictions. There are successful examples in many developing countries. Legislation can remove these barriers, get the price signals right, and encourage successful utilization of renewable resources anywhere. This paper explores mechanisms that can be used and that have been used successfully in developing countries in various parts of the world to remove those barriers and to promote greater use of renewable resources, particularly in rural areas of developing countries.

II. INDIA'S RENEWABLE ENERGY

India's renewable energy program is exemplary, demonstrating many measures that can make programs successful. As a result, India today is a world leader in use of renewable energy. It has pioneered in renewable energy applications research through its internationally renowned Tata Energy Research Institute. India is the only country in the world to have created a cabinet-level department for promotion of renewable energy technology, the Ministry of Non-Conventional Energy Sources (MNES).

Technology support centers have been created in India's universities to provide renewable technology support to manufacturers and to certify the quality of technology procured by the government. India has embarked on manufacturing itself a number or renewable technologies. India also created as far back as 1987 a Renewable Energy Development Agency (IREDA) to fund renewable energy projects.

Wind - Wind energy for electricity production today is a mature, competitive and virtually pollution-free technology widely used in many areas of the world. Wind also still is used to some extent for pumping water. Wind electric systems have some siting problems involving their aesthetics, and some wind machines have problems with killing raptor birds that fly into the blades, though this problem has been minimized with more modern slower-rotating blades and the siting of wind farms outside raptor flying zones. Wind power is the fastest growing energy technology in the world. Total world-wide capacity was 18,000 MW in 2000, about 10% of it in developing countries. India is the world leader with 1,300 MOW of installed capacity. Chine is second with over 350 MW.

Solar - Solar energy presents great development opportunities in developing countries, particularly since most of them are in the Sun Belt. Solar photovoltaic energy is uniquely useful in rural areas unserved by electric grids to provide basic services such as refrigeration, irrigation, communications and lighting. An estimated 1.1 million solar photovoltaic home systems and solar lanterns existed in rural areas of developing countries as of 2000. Solar thermal energy is particularly suited to the large demand for heat and hot water in the domestic, agricultural, industrial and commercial sectors of the economy. It is applied successfully for water heating, industrial process heating, drying, refrigeration and air conditioning, cooking, water desalination and purification (through use of solar ponds), pumping and power generation. "Hot water for residential and commercial uses, both in rural and urban areas, can be provided cost-effectively by solar hot water heaters in many regions. An estimated 15 million domestic solar hot water collectors are installed worldwide, about two thirds of them in developing countries. China's solar hot water industry has mushroomed in the 1990s, with growth rates of 10%–20% and up to 10 million households now served with solar hot water. Markets with hundreds of thousands of households served include Egypt, Israel, India, and Turkey." Solar energy often is far more efficient than existing energy uses. For lighting, a photovoltaic compact fluorescent light system is 100 times more efficient than kerosene, used in the rural areas of many developing countries to provide night lighting. Photovoltaic systems also avoid the high costs and pollution problems of standard fossil-fueled power plants.

Biomass - Utilization of biomass is a very attractive energy resource, particularly for developing countries since biomass uses local feed stocks and labor. Crop wastes, cellulosic biomass and crops raised to provide energy feed stocks on otherwise barren lands are good energy sources for industry, electricity production and home heating and cooking if used in efficient modern stoves or gasified. Technologies for efficient biomass cookstoves in developing countries have developed rapidly, with close to 220 million improved biomass stoves in use in 2000. The largest program is in China, where between 1982 and 1999, the Chinese National Improved Stoves Program disseminated 180 million improved biomass stoves. This program established local energy offices to provide training, service, installation support, and program monitoring. It also fostered self-sustaining rural energy enterprises that manufacture, install, and service the stoves. Users pay the full direct costs of the stoves (about $10), and government subsidies are limited to the indirect costs of supporting the enterprises. In Africa in the 1990s, over 3 million improved biomass stoves were disseminated.

Geothermal - Geothermal power is a relatively pollution-free energy resource derived from naturally occurring reservoirs of hot water or steam that occur below the earth's surface and is tapped to drive a turbine to create electricity. It is an established and economic energy source used in many parts of the world. Its use is expanding in Indonesia, the Philippines, Mexico, Kenya and Central America. Global electricity generating capacity is about 8,500 MW as of 2000, about 45% of it in developing countries. A more experimental pollution-free geothermal energy resource, requiring further research to become economic, hot rock energy is obtained by drilling intersecting holes deep into the center of the earth, pouring water down one of the holes and obtaining steam to drive a turbine up the other hole.

Hydroelectricity - Hydroelectricity is the largest renewable resource in use today, but mostly utilizing large dams with their environmental problems described above. Adding power to existing dams, however, does not create these problems. Also, the placement of generating equipment at existing dams has great worldwide potential and no environmental consequences. Run of the river hydro systems are technologically more complex but also have minimal environmental consequences. Lastly, small dams can reduce the environmental harms of large dam hydroelectric power production. Small hydropower uses the flow of water in small rivers and streams to run electricity-producing turbines. Plants classified as small hydropower generally produced less than 10MW.World-wide small hydropower production is about 43,000 MW as of 2000, about 60% in developing countries. China alone accounted for 21,000 MW of that capacity.

Hydrogen - Hydrogen, while not an energy resource in itself, is the most promising alternative fuel for the future. It currently is produced from natural gas in a process less polluting than oil or coal-fired power plants. With improved and more economic technology, hydrogen can be produced from photovoltaic or wind-powered electrolysis, separating hydrogen from water – the focus of current EU research. Most hydrogen utilization research in the U.S. is centered on fuel cells that are pollution-free, involving no combustion. Fuel cells can power vehicles or stationary electric generators, but they still require substantial research to bring down their costs and are not expected to be available commercially for approximately twenty years.

III. AN OVERVIEW OF MAXIMUM POWER POINT TRACKING

A typical solar panel converts only 30 to 40 percent of the incident solar irradiation into electrical energy. Maximum power point tracking technique is used to improve the efficiency of the solar panel. According to Maximum Power Transfer theorem, the power output of a circuit is maximum when the Thevenin impedance of the circuit (source impedance) matches with the load impedance. Hence our problem of tracking the maximum power point reduces to an impedance matching problem.

In the source side we are using a boost convertor connected to a solar panel in order to enhance the output voltage so that it can be used for different applications like motor load. By changing the duty cycle of the boost converter appropriately we can match the source impedance with that of the load impedance.

IV. DIFFERENT MPPT TECHNIQUES

There are different techniques used to track the maximum power point. Few of the most popular techniques are:

1) Perturb and Observe (hill climbing method)
2) Incremental Conductance method
3) Fractional short circuit current
4) Fractional open circuit voltage
5) Neural networks
6) Fuzzy logic

The choice of the algorithm depends on the time complexity the algorithm takes to track the MPP, implementation cost and the ease of implementation.

V. SIMULATION WORK

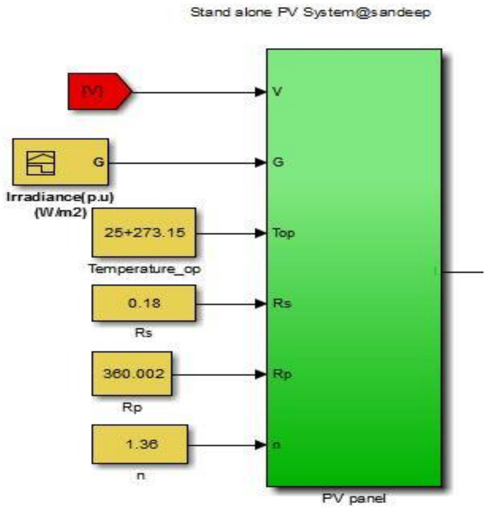

Figure 1: Comparison Model

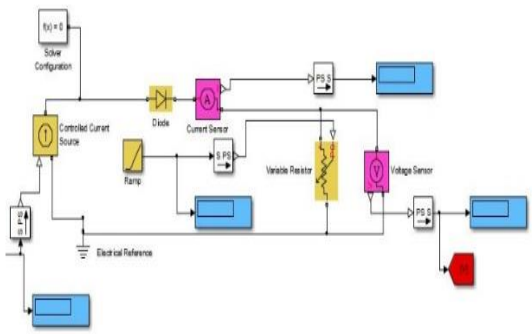

Figure 2: pv1

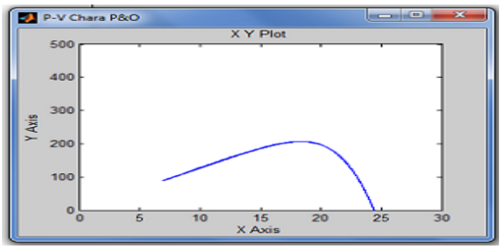

Figure 3: P-V Characteristics P& O

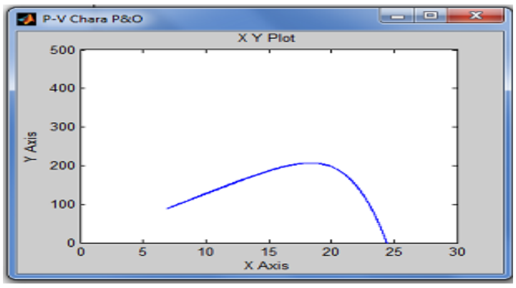

Figure 4: P-V Characteristics P& O

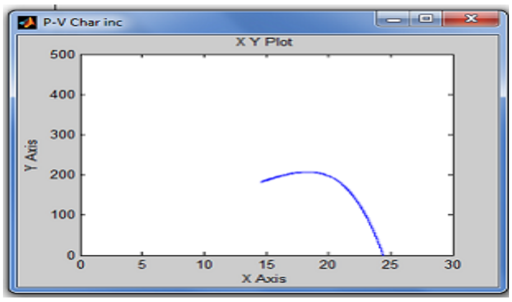

Figure 5: P-V Characteristics inc

Table 1: Comparison of different MPPT techniques

MPPT technique	Convergence	Implementation complexity	Periodic Tuning	Sensed Parameters
Perturb & Observe	Varies	Low	No	Voltage
Incremental Conductance	Varies	Medium	No	Voltage, current
Fractional V_{oc}	Medium	Low	Yes	Voltage
Fractional I_{sc}	Medium	Medium	Yes	Current
Fuzzy Logic Control	Fast	High	Yes	Varies
Neural Network	Fast	High	Yes	Varies

As shown in graph this research found very improve the efficiency of the solar panel as well eliminate the error due to change in irradiance. Here use of Perturb and Observe and Incremental Conductance method reduces the complexity and cost of implementation. As figure above shows the graphs come out after proposed simulation is so improved and the quotient point is very good.

VI. CONCLUSION AND FUTURE WORK

The model is simulated using SIMULINK and MATLAB. The plots obtained in the different scopes have been analyzed. The simulation was first run with the switch on no MPPT mode, bypassing the MPPT algorithm block in the circuit. It was seen that when we do not use an MPPT algorithm, the power obtained at the load side was around 95 watts for a solar irradiation value of 85 Watts per sq. cm. It must be noted that the PV panel generated around 250 Watts power for this level of solar irradiation. Therefore, the conversion efficiency came out to be very low. The simulation was then run with the switch on MPPT mode. This included the MPPT block in the circuit and the PI controller was fed the V_{ref} as calculated by the P&O algorithm. Under the same irradiation conditions, the PV panel continued to generate around 250 Watts power. In this case, however, the power obtained at the load side was found to be around 215 Watt, thus increasing the conversion efficiency of the photovoltaic system as a whole. The loss of power from the available 250 Watts generated by the PV panel can be explained by switching losses in the high frequency PWM switching circuit and the inductive and capacitive losses in the Boost Converter circuit. Therefore, it was seen that using the Perturb & Observe MPPT technique increased the efficiency of the photovoltaic system by approximately 126% from an earlier output power of around 95 Watts to an obtained output power of around 215 Watts. Finally this research concludes as below.

1. Several MPPT techniques taken from the literature are discussed and analyzed herein, with their pros and cons. It is shown that there are several other MPPT techniques than those commonly included in literature reviews. The concluding discussion and table should serve as a useful guide in choosing the right MPPT method for specific PV systems.

2. Since perturb and observe algorithm is quite simple and easy to implement but this is slow as compared to Incremental conductance. Implementation complexity of P&O low as compared to IncCond algorithm. Because we have to use complex circuitry like.-Comparator, integrator, differentiator etc.

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