Performance Degradation Issues of PV Solar Power Plant

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Abstract:- **P V solar power plants are planned to work for long time , monitoring of plant will ensure a safety and longterm operation.The photovoltaic system degradation of 10% per year in the year 1991 has reduced to 12% for 25 years due to modules manufactured after 2000. Some of the common and basic degradation issues in pv solar plants are discussed in this paper. The adequate maintenance is required for long term operations and increasing performance.**

Keywords- PV solar plant; degradation; failures.

I. INTRODUCTION

Solar photovoltaic is an alternate electricity source. The countries which receivehuge solar energy from the sun have sunny weather nearly throughout a year. In such places the annual radiation ranges between 1600 to 2200kWh per square meter. Solar energy has become important as it is environmental friendly, noiseless and abundant. We find more advantages of solar energy in PV solar plants, due to system the modularity, the reliability, and less maintenance cost. They are adequate for stand-alone applications, where the regular solutions are expensive to implement [2].

A. SOLAR PV PLANT BLOCKS

The main purpose of PV plants is to convert light into electricity. This conversion is done using photoelectric effect. Basically, a PV plant consists of [2]:

- Photo Voltaic generators,
- The mounting structure,
- The Inverters,
- The Cables for connection,
- Electrical connections,
- Equipment's to measure voltage,
- Meters to measure energy.

The energy is captured from solar radiation using photovoltaic panels, which in turn depend on photovoltaic plants. Almost allof the solar cells are made of sometype of silicon. Solar panels are of two types: crystalline or amorphous [1].

Semiconductors are main part of the PV cells.To Increase the efficiency of a cell Puresilicon is used. Monocrystalline cells are manufactured using silicon, these cells are the more efficient.The titan oxide anti reflective coating gives it dark blue color and this helps in collecting photoelectrons. Mono crystalline cells last longer and hence usually 25 years of warranty is offered by manufacturers on such cells.

Monocrystalline panels are the more expensive compared to other solar cells [1]. Polycrystalline and amorphoussolar panels are less expensive compared to the monocrystalline panels. The thin film panels (amorphous panels) technology is limited (below 10%), and in future this couldreach 30% to 40%[7]. PV arrays contain the solar modules which are attached to ground where the plant situated by using frames. The mechanical component acts as the main support structure.

The sun's rays which are normal to the surface of solar cell will give best performance. The ground mounted PVsystems or free-field solar power plants, will have a fixed tilt for stationary systems or an axis solartracker for non-stationary systems. The dual model can be used, depending on the motion of sun every year, or a single hybrid model can be used, which will include features of fixed tilt and tracking. Tracking improves the performance, at the same timeincreasing the system installation cost as well as its maintenance cost. PV DC power is converted to AC by Solar inverters. The PV plant uses Cables, and electrical converters which are connected to the grid [1].

II. DEGRADATION

The output degradation of solar modules depends on temperature and time. The total energy generated is affected by degradation of solar modules and arrays. For first 10 years the panels produce 90% of power, and 80% of power till 25 years. That's the reason usually power plants have a warranty of 25 years.

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A. CAUSES OF DEGRADAION

The real-time exposures are needed to test the module degradation. The tests demonstrate the module degradation of nearly 1% per year. The increase in temperature causes the breakdown of a module's encapsulant back sheet. An encapsulant is usually ethylene vinyl acetate usually called EVA. The back sheet usually made of polyvinyl fluoride films [3].

The encapsulant protects internal electrical connections and the cells from entry of moisture. The little moisture that enters is pushed out daily, when module temperature increases. The ultra violet rays slowly break down the encapsulant material, making it less elastic. As the time moves, the ability to pushout the moisture reduces. The resistance increases due to the corrosion, which is caused due to the moisture inside the cell reducing the module operating voltage.

Next cause of degradation is UV light which breaks the EVA layer causing the degradation. The EVA layer is between module's front glass and the silicon cells. The long-term performance of modules depends on properties of the encapsulant. The encapsulant is used to protect silicon against breaking and cracking. The breakdown of the material will not be visible, but over breakdown starts the amount of sunlight that reaches the cell will be limited.As a result there is a reduced output current in a cell.

The discoloration of the EVA layer is the main reason for reduced output. Discoloration occurs due to two main reasons:

1. Interactions between cross-linking peroxides and stabilizing additives,
2. Due tooxidation of the EVA layer.

The next cause of degradation is due to Meta stable dangling bonds. Meta stable dangling bonds result due to the exposure of silicon cells to sunlight [3].The solution to Meta stable dangling bonds is removing them, but removing them needs the silicon cells to be heatedto a high temperature. The idea of heating cells to remove Meta stable dangling bonds is not practical.

The dangling bonds capture electrons, and hence reduce the electrical output and in turn the efficiency of the cell. The photovoltaic components life expectancy are shown below:

- Solar Modules: up to 30 years.
- Inverters: up to 15 years for small plants; 30 years with 10% of part replacement for every 10years.
- Structure: roof-top structures 30 years and ground mount structures between 30 to 60 years.
- Cables: 30 years.

III. FAILURES OF ASOLAR PLANT

As per data of 1991[2] around 10% degradation per year was recorded. The advances in the solar technology show 12% degradation for 25 years. The main component failure values are shown in Table [2] below.

TABLE I. Important component failure rate of pv plant

PV plant components	1st year degradation	Degradation Between 1st and 3rd year	Degradation After 3rd year
PV panels	25%	15%	15%
Mounting structure	3%	1%	1%
Cables, Protections electrical connectors	10%	20%	30%
Inverters	55%	60%	50%
Less voltage equipment	5%	3%	3%
Energy meters	2%	1%	1%

The failure rate is more in inverters due to inverters technological complexity, sensitivity of equipment's and long hours of service. The components other than inverter show less failure in a solar plant.

The failures in the inverters are reduced due to improved quality of inverters in the last decades, due to experienced manufacturers [11]. The problems related to inverters are important for the inverter behavior and keep track of failure incident rate.

Apart from the periodic and adequate preventive maintenance, these type of equipment'sare often subjectto corrective high complexity actions. Such systems are implementedby specialized technicians and they consists of the following:

- Assembling the replacement parts;
- the repair of components;
- Actions to be taken at the programming machine and automata levels in code and appropriate language.

The advantage of distributed generation can be obtained, instead of centralized generation by using grid connected plants.The MVcontrol equipment cells consists of circuit breakers and other protection equipment. Transformers are needed in the interface between inverters and medium voltage (MV) distribution. [12-16], due to low voltage from inverter.

IV. CONCLUSION

In this work an analysis of the mostcommondegradation issues for the solar power plants has been done. Malfunctioning of any parts of the pv plant may affect the output supply from a plant. Monitoring of the solar power plants to check the malfunctioning or degradation of any part of the solar power plant will increase the performance of the solar power plant.

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