SOLAR POWER LATEST INNOVATIONS AND DEVELOPMENTS IN SOLAR ENERGY SYSTEMS

As technology transcends beyond current capabilities, AI will become a key component in the functioning of solar plants. It will be used increasingly to regulate frequency, optimize project performance, forecast weather, and predict maintenance. With an increased focus on EV infrastructure, solar carports are being developed across the country, to ensure vehicles are being powered by renewable energy, and boost the sector in the years to come.

Since 2011, when the renewable energy movement gained momentum, it was characterized by attractive subsidies and incentives from the Government, availability of land, and low cost of layout. The industry quickly scaled up and soon started presenting itself as a viable option to traditional sources of energy. Today, India is spearheading the RE evolution, and has seen a large number of corporates adopt renewable energy to achieve both profitability, and meet their sustainability targets. India has now become one of the world's fastest adopter of solar energy and the fifth largest installer of solar energy in the world. From a high of Rs. 17-18 per unit in the 2010's, the price now stands at almost Rs. 2.5-3.5per unit, discovered through competitive bidding, demonstrating that at such low prices, there are takers, who are rapidly evolving and innovating at their end. Back in the 1960s when solar technologies first emerged, solar photovoltaics (PV) were seen as futuristic. Today, they are at the center of all technological advancements. In fact, today, polycrystalline solar panels have an efficiency range of 16 to 18%, which seemed a challenge in earlier days. This efficiency could be increased to as much as 24% through the help of monocrystalline infused with PERC technique. Through this in-crease in efficiency, modules are now seeing an improvement in their power rating to 430Wp, and higher, allowing them to harvest more energy. The same PV modules are also seeing a shift in technology among other components such as frames, EVA, and backsheets. PolyvinylideneDifluoride (PVDF) and PVF tedlar type technologies are being used in backsheet production. Also, back sheets are now coming in transparent type and EVA is being developed as white EVA, in turn to replace back-sheet and use glass instead. These are the innovations leading to penetration of bifacial modules to harness even more energy than ever before. The other innovations like solar skin, solar road and wearable solar panels could soon be seen dominating the residential solar market. The new type of solar farm installations is floating type so-lar plants. Floating solar farms can generate huge amounts of electricity without using valuable land or real estate. The special equipment's required for this kind of installations such as compatible structures have evolved a lot. Also, research showed that the power production of floating solar panels is greater by up to 10% due to the cooling effect of water. Furthermore, as energy storage gains momentum, developments in inverter technologies keeping pace with increased power ratings from 500kW to 5MW that is aiding in accelerating the construction timeline. Additionally, inverters are the prime subject of intensive innovation to help meet the incremental roles within a PV power plant. Being a

key component of a PV system, the power range, efficiency, and reliability of solar power generation from a project are based on the properties of an inverter. These machines are today equipped with inbuilt monitoring, and communication protocols. They can also now supply reactive power throughout the night, to provide to highly inductive loads of the plant, such as transformers. Newer generation inverters have become more reliable, and play a vital role in cost optimization, and machine intelligence of a solar plant. The string inverter technology adoption in ground mounted large scale plants has taken reliability and redundancy of solar energy to newer heights. In order to meet the requirements of these inverters, transformer designs have evolved, in terms of dv/dt withstand, galvanic isolation, and impedances. Nowadays, two Core Coil Assembly (CCA) transformers are the preferred choice, and are extensively used to reduce the Balance of System (BOS) cost without compromising on galvanic isolation and impendence. Furthermore, the introduction of 1500V DC systems has greatly aided developers to construct and operate plants in an energy efficient manner. The introduction of self-adjusting tracker control systems too has boosted the energy outputs from a solar plant by almost 20 per cent. They not only continuously analyse and optimize tracking algorithms of each individual row, but are also able to monitor and predict weather conditions of a particular region. These smart systems are able to combine weather forecasting with advanced machine learning technologies and sensors to maximize the energy yield. This development has come about after it has been successfully proven that an increase in power production is directly proportionate to improved performance of the plant and subsequently lowers operating costs. In addition to this, remote monitoring of the solar PV system has been found to be particularly useful in monitoring its health. Given that most solar plants are located in industrial zones and hinterlands, it is imperative that the provider has access to in-formation concerning the functioning of the plant on a daily ba-sis. As O&M providers will have limited access to local weather conditions and their impact on the plant's performance, remote monitoring plays a key role here. It has also helped bridge the information gap, as clients too are provided access to these systems, and can avail real time updates of the plant, and maximizes their investments. Drones are being explored as a feasible solution to support the Operations & Maintenance of the solar plant. To start at the be-ginning of a project where they play a key role to survey the land required to develop large scale solar farms, they can also be harnessed to identify PV modules or parts which are not working, through the use of thermal sensing. Data analytics too have penetrated the solar space with the help of specialized SCADA systems. One can now monitor plants and identify potential problems before they become severe and in event monitor projects that are miles away from the solar farm. Today, the best in class technology is being employed to not just identify O&M requirements, but also for cleaning. Environ-mentally friendly methods are practiced in the pressure cleaning tools, dry cleaning methods and robotic cleaning systems, as they use minimal water. Going forward, corporates who are looking to adopt solar power have much to be gained. As technology transcends beyond current capabilities, AI will become a key component in the functioning of solar plants. It will be used increasingly to regulate frequency, optimize project performance, forecast weather, and predict maintenance. Battery technologies too are being developed to make solar and storage a scalable option. With an increased focus on EV infrastructure, solar carports are being developed across the country, to ensure vehicles are being powered by renewable energy, and boost the sector in the years to come.

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