Solar Module DML Test Machine

Client: NCPRE IIT Bombay

Objective:

- This project aimed to develop a Dynamic Mechanical Loading (DML) machine to simulate the static and dynamic stresses solar panels experience during adverse weather conditions like snowstorms and strong winds, and verify IEC compliance.
- This machine is designed to study the effects of mechanical stresses on solar panel performance and evaluate the resilience of new solar panel designs against snow and wind loads, in line with the latest IEC standards. Additionally, it incorporates capabilities for Electroluminescence (EL) imaging and flash I-V testing of the photovoltaic (PV) module.

Approach:

- Various sizes of solar panels are manufactured for different applications, so decided to design a machine that could test all size variations. Special units with centrifugal pumps will provide both pressurized air and vacuum to apply the required load on the panel.
- A camera setup will be positioned opposite the Dynamic Mechanical Loading (DML) machine to capture Electroluminescence (EL) images of the PV module.

Solution:

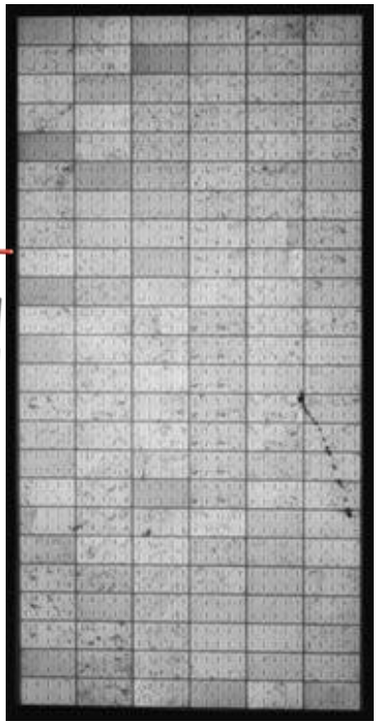
- Engineered an adaptive mechanism for testing module sizes from 0.9×0.7 to 2.1×1.1 m, reducing cost 18% and ensuring 100% adaptability to future variants.
- The pressurized air and vacuum system is designed to apply static loads up to 8000 Pa and dynamic loads up to 2500 Pa, exceeding IEC standards. The tool can administer stress cycles on solar panels as per IEC standards, with full control through a PLC and HMI interface, ensuring precise testing and adjustments.
- The camera setup, positioned opposite the DML tool, is programmed via PLC to capture Electroluminescence (EL) images of the PV module during specified testing phases. These images allow for assessing damages and performance before, during, and after testing. Interconnect ribbons between cells, vulnerable to breakage from mechanical stresses, can be thoroughly evaluated using EL and flash I-V images. This method enables a comprehensive study of damage to the solar panel and its performance, ensuring accurate analysis of stress-induced failures.

My Role (Freelancing Project):

- Conceptualized the design, created CAD models, and developed production drawings with GD&T while coordinating closely with the professor at IIT Bombay.
- Applied Design for Manufacturing & Assembly (DFMA) principles to streamline manufacturing and assembly.
- Manufacturing from vendors and procurement of off-the-shelf parts.
- Assembly and Testing of the prototype at a rented workshop.
- Installation at IIT Bombay.

- **DML Tool Installed at IIT Bombay :**

- **Sample of EL Picture :**



- **Deflection of the solar panel due to stress induced by creating a vacuum on the backside of the panel:**

- **Deflection of the solar panel due to stress induced by applying compressed air to the backside of the panel.:**