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National Physical Laboratory

Advancing Solar Innovation: How NPL Helped Power Roll Improve Efficiency and Market Readiness

Power Roll Limited is a pioneering company focused on developing scalable, lightweight solar modules. Unlike traditional silicon-based solar panels, Power Roll's unique architecture uses microgrooves within a flexible plastic film, enabling high-throughput roll-to-roll manufacturing. This unique approach allows the production of ultra-lightweight solar modules suitable for applications where conventional solar technologies are not viable, such as non-load-bearing rooftops and curved surfaces.

The technology is particularly relevant given the increasing global demand for sustainable energy solutions and the limitations of traditional solar installations. Power Roll's approach offers an efficient alternative that can be adapted to a broader range of environments, making solar energy more accessible and versatile for the future of both industrial and domestic energy requirements.

Challenge

Despite the advantages of Power Roll's technology, the company faced a challenge measuring and validating the performance of its solar architecture. Unlike conventional solar technologies, Power Roll's microgroove-based design required a new combination of electrical characterisation and performance assessment that were outside industry standard approaches.

Existing standards do not sufficiently address both microscopic and macroscopic characterisation – in Power Roll's case, the ability to analyse both the performance of individual grooves and the efficiency of whole modules. Both were required to ensure consistency and yield in large-scale production.

They also do not cover bifaciality and angular response. Power Roll's technology allows for light absorption from both the front and back, so techniques were needed that could accurately measure energy generation potential in both circumstances.

Lastly, common characterisation techniques usually applied to conventional solar technologies fail to address defect identification and performance consistency, making it difficult to determine if small defects within microgrooves significantly impact overall module efficiency.

Solution

Power Roll collaborated with the National Physical Laboratory (NPL) through the Measurement for Business (M4B) programme over two consecutive projects to create a robust method for measuring product performance. NPL's expertise in both emerging PV technologies and advanced characterisation techniques played a crucial role in achieving a successful outcome.

The first project focused on developing a validated approach to microscopic characterisation. It aimed to understand Power Roll's architecture at a fundamental level. This involved blending together:

- **Electrical photocurrent mapping techniques** to visualise electrical responses across microgrooves at the core of the Power Roll technology.
- **Photoluminescence imaging** to assess uniformity and identify defects not visible through conventional microscopy.
- **Electrical characterisation** at the 'microgroove level' to determine how individual components of modules contribute to overall efficiency.
- **Validation of defect tolerance** – demonstrating that damaged or underperforming microgrooves did not significantly impact entire modules, unlike conventional series-connected PV cells.

The second project addressed broader commercialisation challenges, focusing on large-scale performance assessment and standardisation. This project involved assessing and combining a different set of techniques to the first piece of work:

- **Spectral response measurements** were used to identify the best calibration methods for improving accuracy in efficiency testing.
- **Bifaciality characterisation** helped the project team understanding how Power Roll's modules absorb light from both sides and how this impacts real-world energy generation.
- **Angular response analysis** demonstrated that Power Roll's devices maintain efficiency at oblique angles, making them suitable for diverse applications such as greenhouse installations and building-integrated photovoltaics (BIPV).

Impact

The collaboration with NPL provided Power Roll with critical insights about how its technology works in real environments, and validated performance claims, directly benefiting its ability to engage new customers and sell its technology to industry.

The most important outcome was immediate product performance improvements. Correcting calibration methods led to a measurable 15% increase in rated power, improving investor confidence and strengthening Power Roll's market position.

The work also offers a route to more diverse applications for Power Roll's products. The ability to optimise bifacial performance and angular response opens new market opportunities beyond traditional rooftop solar, including lightweight installations and agricultural applications.

Power Roll's engagement with NPL is set to continue, evolving into a long-term research partnership. Not only does this offer the promise of ongoing access to world-leading expertise in PV measurement and characterisation, but it suggests Power Roll will now be at the forefront of industry engagement in standards development. Contributing to international efforts to establish measurement protocols for emerging PV technologies means that Power Roll can ensure its architecture is accommodated in future regulations.

"The partnership between Power Roll and NPL has been instrumental in advancing the commercial viability of our unique PV technology," explains Nathan Hill, Senior Scientist at Power Roll. "By overcoming critical measurement challenges and contributing to the development of industry standards, Power Roll is now well-positioned to bring its scalable, high-efficiency solar solutions to market."

"This collaboration exemplifies how UK innovation, supported by national research institutions such as NPL, can drive the future of sustainable energy technologies, ensuring robust, reliable, and market-ready solutions for the global transition to renewable energy," suggests George Koutsourakis, Senior Scientist at NPL.

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