International Arbitration of Solar Photovoltaic Belt and Road Projects

How multi-disciplinary teams can support complex failure analyses

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Renewable energy installations are an integral part of Belt and Road Initiative (BRI) efforts to "go green." Approximately 12.6 gigawatts of wind and solar power generation capacity has been installed in BRI countries in the last 5 years. While the majority of that capacity is in Southeast Asia, research indicates that a further potential 7.8 terawatts of solar capacity exists in other Belt and Road countries across the globe.

Like all construction projects, solar photovoltaic installations can be subject to various defects or performance issues that develop long after commissioning. Installation failures in Korea, Africa, Vietnam, and China highlight the variety and complexity of potential failure mechanisms, as well as the extent to which environmental conditions can influence failures in the field. When vetting international arbitration claims for solar photovoltaic failures, it is important to combine legal and technical expertise wherever possible. By embracing a multi-disciplinary approach to root-cause analysis early in the claim development or claim vetting process, international arbitrators can identify why a failure occurred and what the failure means within the context of a dispute.

Failure Mechanisms for Solar Photovoltaics Can Be Varied and Complex

Solar photovoltaic installations can be subject to various defects or performance issues, including inefficiency in operation, degradation over time, or latent failures that develop long after installation. While the majority of failures result from improper installation techniques or methods, including improper component selection, failures can and do occur for other reasons.

In some cases, failures are due to component defects arising from the manufacturing process as opposed to installation methods or techniques employed on site. According to one European study[1], about 60% of defects arise from poor thermal management of certain electrical components (i.e., diodes), while 24% arise from poor cable management strategies. Bypass diodes, devices used to provide alternative paths for the flow of electrical current from sunlit panels, can also contribute to field failures. A Korean study conducted in 2018[2] showed that the failure rates of bypass diodes installed outdoors are approximately 47%.

Additional failure mechanisms involve power converter failures, improper electrical grounding, and degradation or failure of the photovoltaic module. The latter may result from a variety of causes, including cracking from mechanical stresses during shipping or installation, the formation of "snail trails"—streaks of silver acetate—on module surfaces, and failures of the "backsheet" found on the underside of modules.

[1] https://ec.europa.eu/energy/intelligent/projects/sites/iee-projects/files/projects/documents/pvtrin_common_failures_on_pv_installations_en.pdf
[2] https://www.mdpi.com/1996-1073/11/9/2416

Environmental Conditions Can Influence Field Failures

140 countries[3] across the globe have joined the Belt and Road Initiative (BRI) with China. Belt and Road countries span all seven continents and experience varied environmental conditions. This is notable, as photovoltaic installations in different climates are prone to different failure mechanisms. Photovoltaic modules in hot and humid climates tend to exhibit considerably different failure and degradation modes[4] from those in desert and moderate climates. Corrosion is more likely to occur in a facility built in Vietnam's seacoast atmosphere than a facility in Eastern Europe. In contrast, overheating bypass diodes are more likely to be an issue in the deserts of Africa.

We recommend that root-cause analyses of photovoltaic failures be performed by investigators who have experience with failure analysis in the specific environmental conditions in which the failure occurred. Our team at Exponent has significant experience in assessing the root cause of field failures in connection with a range of BRI projects across the globe.

Importance of Investigating Failures Across Disciplines

Because photovoltaic failure analyses often cross technical specialty lines, we also recommend that investigatory teams be multi-disciplinary in nature. Our team at Exponent typically enlists electrical engineers to investigate photovoltaic failures at the macroscopic level first. These engineers understand both system and component level design and can leverage additional subdisciplines (e.g., semiconductors) if needed. If a failure is determined to have occurred at the component level, materials engineers, polymer scientists, and other specialists can perform more detailed analyses. For example, materials engineers and polymer scientists are particularly valuable in identifying the root cause of component corrosion and backsheet failures, respectively.

By embracing a multi-disciplinary approach to root-cause analysis early in the claim development or claim vetting process, we can help solicitors in international arbitration identify why a failure occurred and what the failure means in the context of a particular dispute. For example, we can help solicitors determine 1) whether a failure is the result of having deviated from project requirements; 2) whether an opposing party is dismissing a technical claim that has merit; or 3) to what extent a technical concern may also be a contractual issue.

How Exponent Can Help

Exponent has over 50 years of experience in the investigation of field failures and has assisted BRI contractors and their counsel in assessing the technical merits of claims in connection with international arbitrations across the globe. We can help international arbitrators identify why a failure occurred and what the failure means within the context of a dispute.

[3] https://green-bri.org/countries-of-the-belt-and-road-initiative-bri/
[4] https://onlinelibrary.wiley.com/doi/abs/10.1002/pip.2866

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