

# Performance and Reliability Test Methodology

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## → Abstract

Product Quality Assurance is one of the main focuses of REC Solar aimed to ensure solar modules quality and safety over 25 years of lifetime. In this work, good understanding of modules performance and materials degradation is very important. Therefore, internal REC test methodology has been developed based on existing test from standards (IEC, UL) with further investigation on system functioning, material characterization, etc. Example of reverse current load test will be shown to illustrate our way of working in Product Development and Quality Assurance

## Standard tests

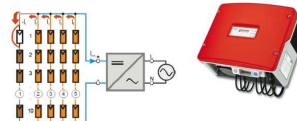
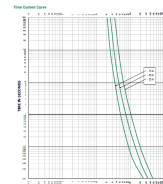
### Highly Accelerated Life Testing (HALT)

- Active in short notice failure modes and predict module 's capacity to withstand stress
- Provide baseline of degradation rate for module design/ quality benchmark
- REC's Qualification/ Certification Process ensure Product quality meeting and beyond standard requirement with high product design margin

## Field risk analysis

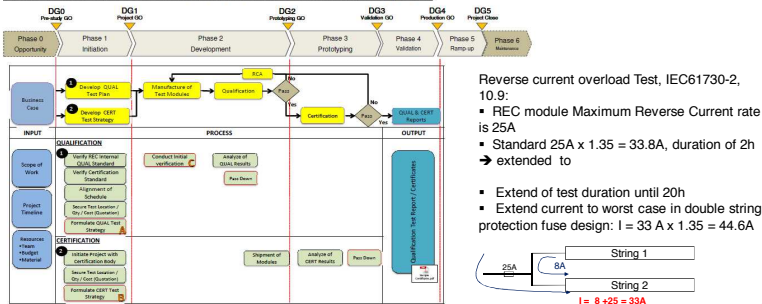
Investigation of failure probability caused by system and environment factors => FMEA establishment

- Use external partner and customer feedback
- Use REC monitoring systems data
- Outputs will be used for building test plan



- High reverse current failure:
- Survey of possible failure modes causing in sites: ground fault, shading, inverter fault, wrong polarity
  - Function analysis of system components function: inverter, fuse in each case
  - Building hypothesis of most severe case for testing

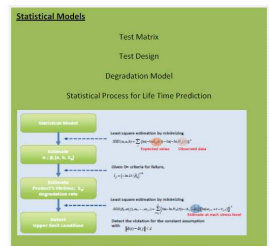
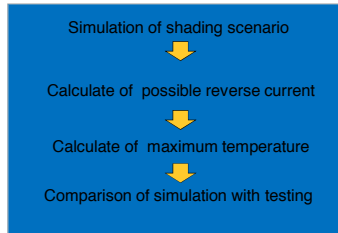
## Process Flow Chart for Qualification (QUAL) & Certification (CERT)



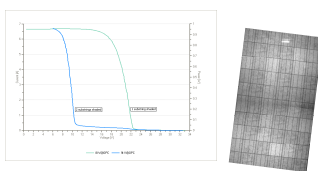
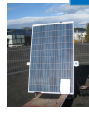
## Modeling

1. Statistical model describing failure rate based on customer feedback and monitoring data to predict future failure rate

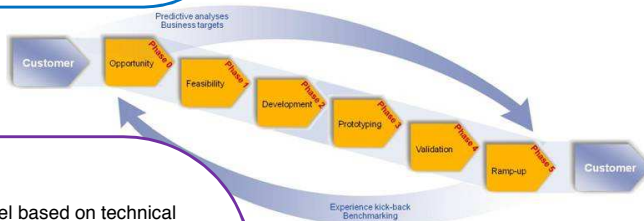
2. Physical model based on technical understanding of failure mechanism to predict effects on modules



3. System modeling



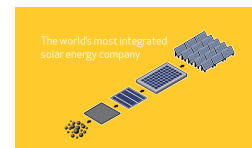
- Predict system performance
- Compare with monitoring data → analysis of possible degradation causes



## Component material test

Testing data for material characterizing from provided by:

- Component test data by suppliers according to REC's material specification
- In-house test on component material and final product
- As solar integrated manufacture, REC is able to control wafers and cells quality



## About REC

REC is a leading vertically integrated player in the solar energy industry. Ranked among the world's largest producers of polysilicon and wafers for solar applications and a rapidly growing manufacturer of solar cells and modules, REC also engages in project development activities in selected PV segments.

Founded in Norway in 1996, REC is an international solar company, employing about 3,700 people worldwide with revenues of more than NOK 13 billion in 2011. Please visit [www.recgroup.com](http://www.recgroup.com) to learn more about REC.

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## Discussion

REC test methodology has been developed in order to ensure product quality over 25 year. This long term work needs to be enriched continuously with our growing knowledge in PV technology, process improvement and field data.