

Recycling and Repair of PV modules – requirements and testing

12th SOPHIA PV-Module
Reliability Workshop,
30.06.2022
Neuchâtel



VDE RENEWABLES

Overview

- “End of life” scenario
- Logistic and handling
- Repair option
- Requirements / regulation / testing

“End of life” scenario

- If PV modules are dismantled from the site of installation, they are called end of life modules.
- Depending on the reason of dismantling (defects, repowering.....) it may be desirable to think about a second life.
- The decision has to be made according ecological and economical points:
 - Optical and electrical conditions
 - If failure occurs, are the repairable?
 - Exist a market for these modules?
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Logistic and handling

- An important issue for the second life of modules is, thinking before the first steps about logistic and handling during dismantling and transport.
- First of all, do not declare the modules as waste, otherwise the modules have to be handled from this time according the WEEE (Waste Electrical and Electronic Equipment) directive. To bring it back to a commercial product is not so easy.
- To reduce time and working load, a first sorting direct on the dismantling site make sense.

Logistic and handling

- In the event the Installation site was affected by environmental impacts like storm or hailstorm a lot of modules are heavy damaged like deformation, broken glass and so on. These modules can easily sort to waste.
- In other cases, a minimum optical sorting should be done, preferable direct on the installation site.
- It could make sense, for very tall module plants, to do electrical measurements like IV and insulation measurements directly on site. Also monitoring protocols can help to separate bad parts.

Repair option

- Several repair options are possible. Easy to do repair actions are:
 - Plugs: Trained operator can connect fast new certified PV plugs. Important issue! Only plugs from the same type are allowed to connect. So-called compatible plugs are not allowed and have a high fire risk.
 - Diodes: For not potted j-boxes, diodes are easily to exchange by the same type. This must be done on a disconnected module, otherwise the contacts carry high DC voltage.
- The complete j-box can also be exchanged. But this procedure can only be performed in a factory, and the method must be verified before by several accelerated tests.

Repair option

- Due to the current situation with cracked back sheets after 5 to 8 years outdoor installation, repair methods are one of the most discussed question.
- Just a few repair methods are currently on the market, several have passed accelerated test procedures.
- The project PVRe² has shown, that liquid coatings, which can be done onsite, is one of the best solution. Depending on the kind of failure, a 2-step method could be necessary. First step filling deep cracks, second step cover the whole rear side.
- Repair option for deep cracks with only one “layer”, independent whether it is liquid or a foil, hold the risk of hollow spaces, which could be filled with humidity during the subsequent period outdoor.

Repair option



Repair option



Requirements / regulation / testing

- The European Union pointed out in the waste directive that ReUse should be preferred.
- The IT business set an example.
- Refurbished computer and mobile phones can be bought anywhere.
- Why is it so complex in case of PV modules?
- What can we do to simplify the process?

Requirements / regulation / testing

- No question – safety has high priority!
- Within the EU the low voltage regulation is necessary for electrical equipment.
- This must be verified for PV modules with the IEC EN 61730 test sequences.
- What does this mean for “refurbished” modules?

Requirements / regulation / testing

- For safety reason, insolation test is in any case necessary!
- But what else?

Requirements / regulation / testing

- For safety reason, insolation test is necessary!
- But what else?
- As mentioned before, for new modules IEC EN 61730 is necessary, a type test, not for each module!
- Should we do a few of these tests also for ReUse Modules?

Requirements / regulation / testing

- My opinion

No!

Requirements / regulation / testing

- My opinion

No!

Why?

Requirements / regulation / testing

- Who knows how do modules conduct during these test sequences, which are without failures and 5 or 10 years outdoor? Would they pass the tests?
- I did not know any study with statistical data about outdoor modules with additional 61215 or 61730 tests.
- And have in mind, the accelerated test should show the behavior after a few years lifetime, why should we do accelerated tests again?
- For sure, repair solution should be verified with tests. Currently discussions in standardization bodies are in progress.
- Some of repaired modules did pass accelerated tests. Results of liquid back sheet repair are available in several papers of the PVRe² project. **VDE** Renewables

Requirements / regulation / testing

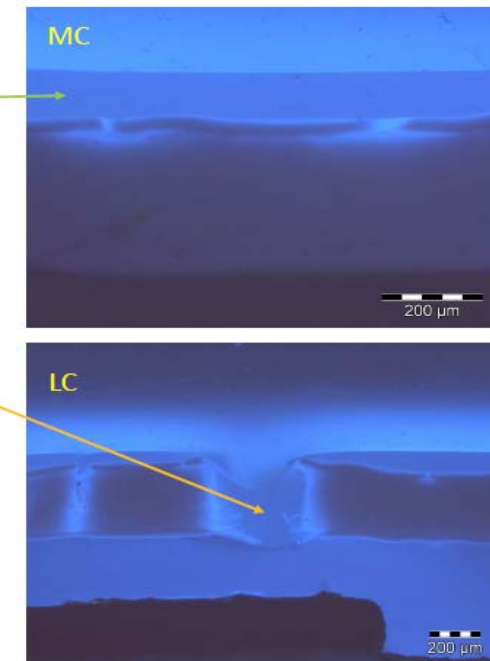
- Insolation test before and after liquid coating
- Cross-section liquid coating

R_{ISO} wet before coating	R_{ISO} wet after coating
0 M Ω	800 M Ω
0 M Ω	740 M Ω
0 M Ω	800 M Ω
0 M Ω	900 M Ω
0 M Ω	1000 M Ω
0 M Ω	900 M Ω

MICROSCOPIC IMAGES:
CROSS-SECTIONS

Sealing; protection /
barrier layer

Crack filling (no voids)



Thank you for your attention

Questions?

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WIPANO

ReSi-Norm

Gefördert durch:



Bundesministerium
für Wirtschaft
und Energie

aufgrund eines Beschlusses
des Deutschen Bundestages



Energy Research 4th call
Topic 5.5 Photovoltaics
Project Nr.: 867267



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