SUPER PV PROJECT – SUPPORT COST-REDUCTION OF THE PV SYSTEM THROUGH INNOVATIVE TECHNOLOGIES ON PV MODULE LEVEL

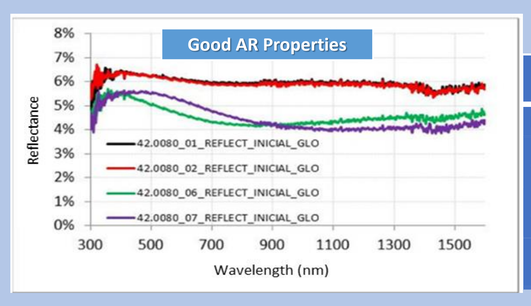
Julius Denafas, „Soli Tek R&D“ UAB

Intermediate SUPER PV project results have been already achieved in WP3, which is focusing on the development and demonstration of the following PV module innovations:

- low cost and easy to apply multifunctional nano-coatings with antisoiling and antireflective properties in one layer.
- light management in bifacial c-Si modules to increase the power output up to 7 Wp.
- laminated diode innovations produced by solar cell production
- low-cost encapsulation innovation with a low-cost humidity barrier leading to 45% cost reduction of flexible CIGS modules
- inline inspection system of encapsulation process for CIGS modules
- recycling approaches and their demonstration to all types of modules under consideration in SuperPV project
- Cost and performance evaluation (Eur/Wp, Eur/kWh).

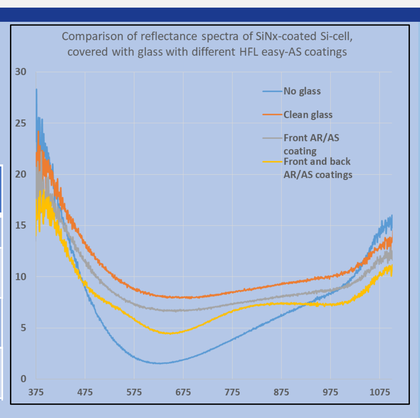
PV module innovations
introducing and combining five PV module innovations applied to c-Si based bifacial modules and CIGS modules.

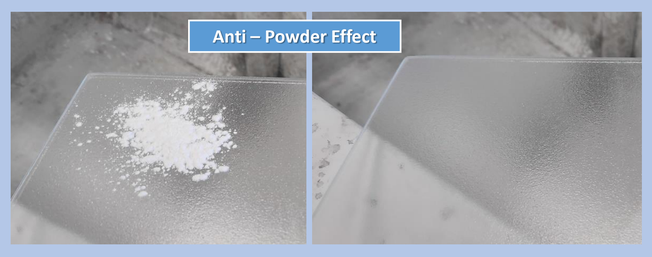
MULTIFUNCTIONAL COATINGS



HFB Performance

	Time between layers	Transmittance (visible light)	Water Effect (Contact angle)	Anti – Soiling
Non Treated	---	89	---	---
AR + AS HFB	0 minutes	89	HFB 105.03°	AS: √√ EtC: ≈
AR + AS HFB	5 minutes	90	HFB 121.57°	AS: √≈ EtC: √√
AR + AS HFB	30 minutes	90	HFB 121.80°	AS: √≈ EtC: √√

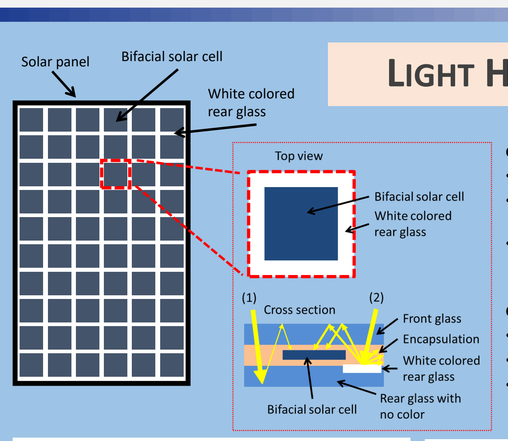




- ✓ Estimated gain due to antireflectivity was:
  - ✓ 1,4% for single coating
  - ✓ 2,8% for double coating

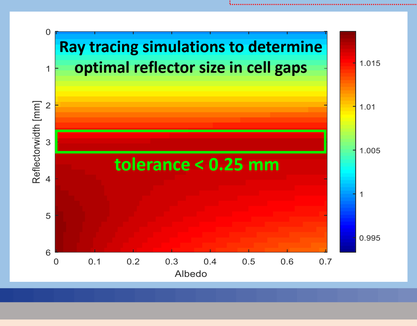
  Laboratory results of real PV modules
- ✓ Produced and in-house coated six 60-cell modules
  - ✓ Gain for AR + HFB easy coatings was 1.8-2.0%
  - ✓ Gain for AR + HFL easy coatings was 0.6-1.0%

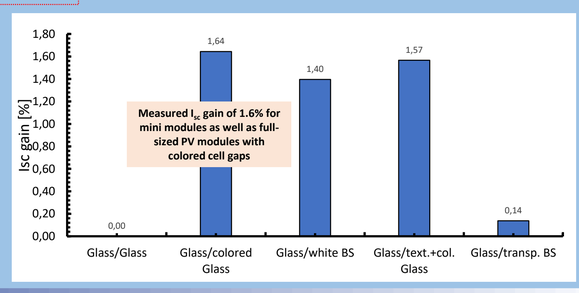
LIGHT HARVESTING



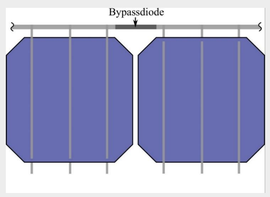
Concept
- Majority of Light impinging the cell gaps lost in bifacial solar modules (1)
- Enhance light harvesting of module with white reflector in the cell gaps (2)
- Increased light harvesting from cell gaps improves module power and annual yield

Challenges:
- Find suitable printing technique and color
- Test reliability of colors in climate chamber tests
- Optimize color pattern and position for annual yield by experiment and optical modeling



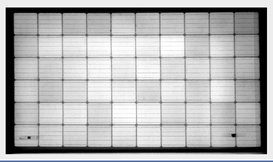


Laminated By-Pass Diodes



Concept:
- Cell processing line to produce bypass diodes on mono crystalline cell wafer material ⍰ lower diode costs
- Reduce size of module by 0.6%
- Junction box replaced by two cable connectors

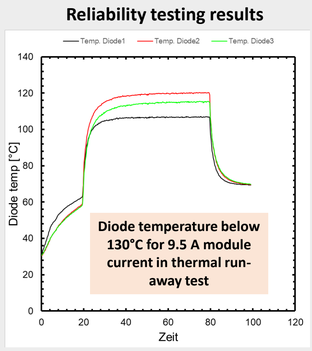
Challenges:
- Reliability of diodes during humidity freeze and thermal run-away test
- No module power reduction due to in-laminate bypass diodes
- Low diode temperature when diodes conduct full module current

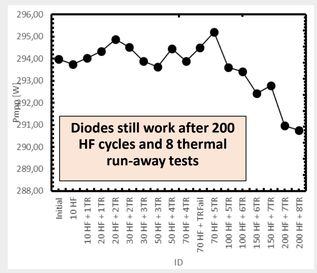


IV characteristics of 60-cell monofacial modules: with and without soldered Si bypass diodes					
Configuration	I_{sc} [A]	I_{mp} [A]	V_{oc} [V]	V_{mp} [V]	P_{mp} [W]
with diodes	8.75	8.36	38.66	31.84	266.24
without diodes	8.74	8.38	38.62	31.81	266.42

No power reduction due to in-laminate bypass diodes in full size PV module

Reliability testing results

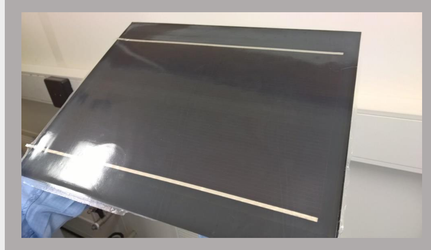




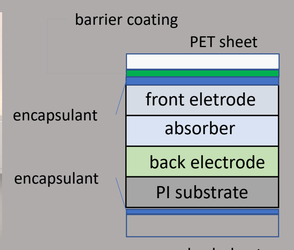
COST EFFECTIVE BARRIER LAYER FOR FLEXIBLE THIN FILM SOLAR MODULES

Problem description:
The encapsulation costs are the main drawback for current flexible light weight applications of thin film modules. This innovation will open new market segments for building integrated PV where typical PV system cannot be applied because of their high additional weight.

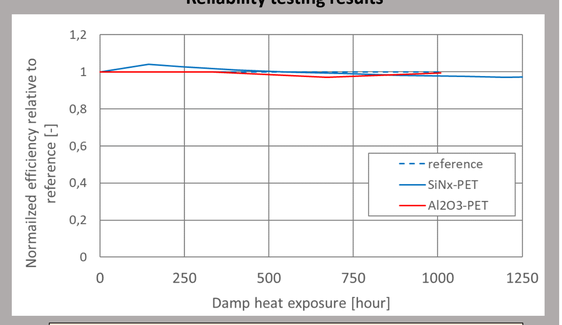
Concept:



CIGS module on poly-imide substrate, laminated on back sheet, bonded to PET foil with Al_2O_3 coating.



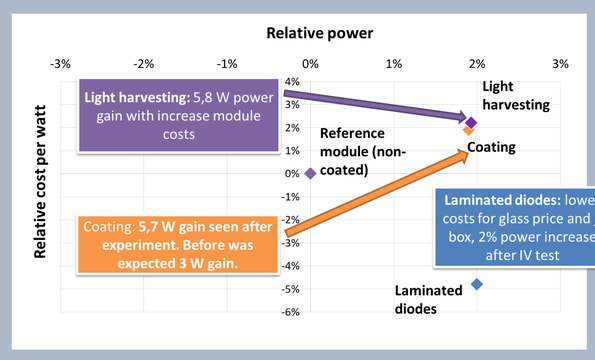
Reliability testing results

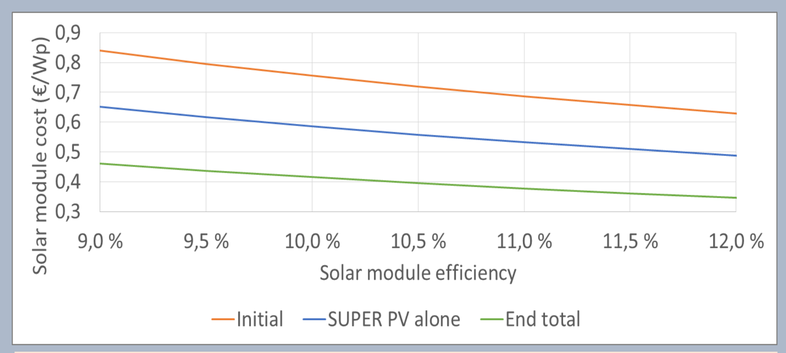


Modules laminated with a PET foil with nanometric Al_2O_3 or SiNx barrier had a similar output at 1000 hour of 85°C/85 % RH damp heat exposure as with a reference (high grade) front sheet.

PV module innovation transfer and costs: intermediate assessment

c-Si modules (Solitek)





- By combining the cost reduction of 34 €/m2 with the targeted 45% overall module cost reduction, we obtain a module cost of 75.6 €/m2 initially, 58.6 €/m2 intermediate (SUPER PV alone) and 41.6 €/m2 end cost.
- At 9.5 % module efficiency the end FLISOM module cost is below 0.45 €/Wp, which was the original ambition for FLISOM module cost at the SUPER PV proposal stage

Construction of the SUPER PV demosites and outdoor performance monitoring has started. Data collection for LCOE and PR (Performacen Ratio) evaluations will be done during next 12 months of the project in various climate zones: Norway, Lithuania, Spain, Morocco and Tunisia.

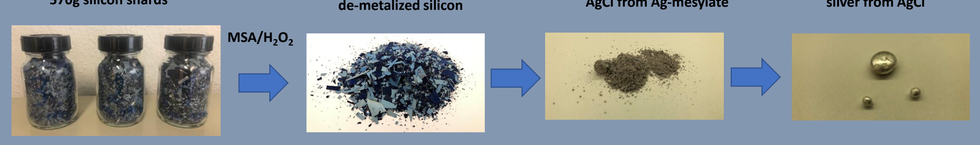
Assessment of PV recycling for module level innovations

Pyrolysis: Rapid (~5 min) thermal heat treatment (~ 500- 600 °C) – intensive gas formation, flame – burning of gas, burning of EVA

recovery rate above 85% (glass) is possible

Sample	Size (mm)	Weight 0 (g)	Weight 1 (g)	Weight loss (g)	Weight loss (%)
Sample 1	49*28*6.5	22.13	21.35	0.78	3.52
Sample 2	38*32*7	19.91	18.98	0.93	4.85

Recovery of silver: Treatment of the silicon shardes from Apollon N.I.C.E. solar modules



570g silicon fragments were obtained from one module. These fragments were desilvered -> 7.563g AgCl. 5.68 g of silver were produced from these AgCl, which corresponds to a yield of 99.84%.

Contact details of Project Coordinators
Mr. Juras Ulbikas (juras.ulbikas@protechnology.lt)
& Mr. Julius Denafas (Julius.Denafas@solitek.eu)

Find us on
#SuperPV
@SUPERPV_H2020
www.superpv.eu

This project has received findings from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 792245. The sole responsibility for the content of this material lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither INEA nor the European Commission are responsible for any use that may be made of the information contained therein.