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SOLAR —
EUROPE 2024**

Session 9: Prolonging Solar Lifetime Through PV Module Reuse

12 December 2024

Session 9: Prolonging Solar Lifetime Through PV Module Re-use



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Prolonging the Lifetime of Solar PV through Module Reuse – a business model and policy view

12.12.2024 – Roger Nyffenegger, Brian Baldassarre & Nancy Bocken



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**Maastricht
University**

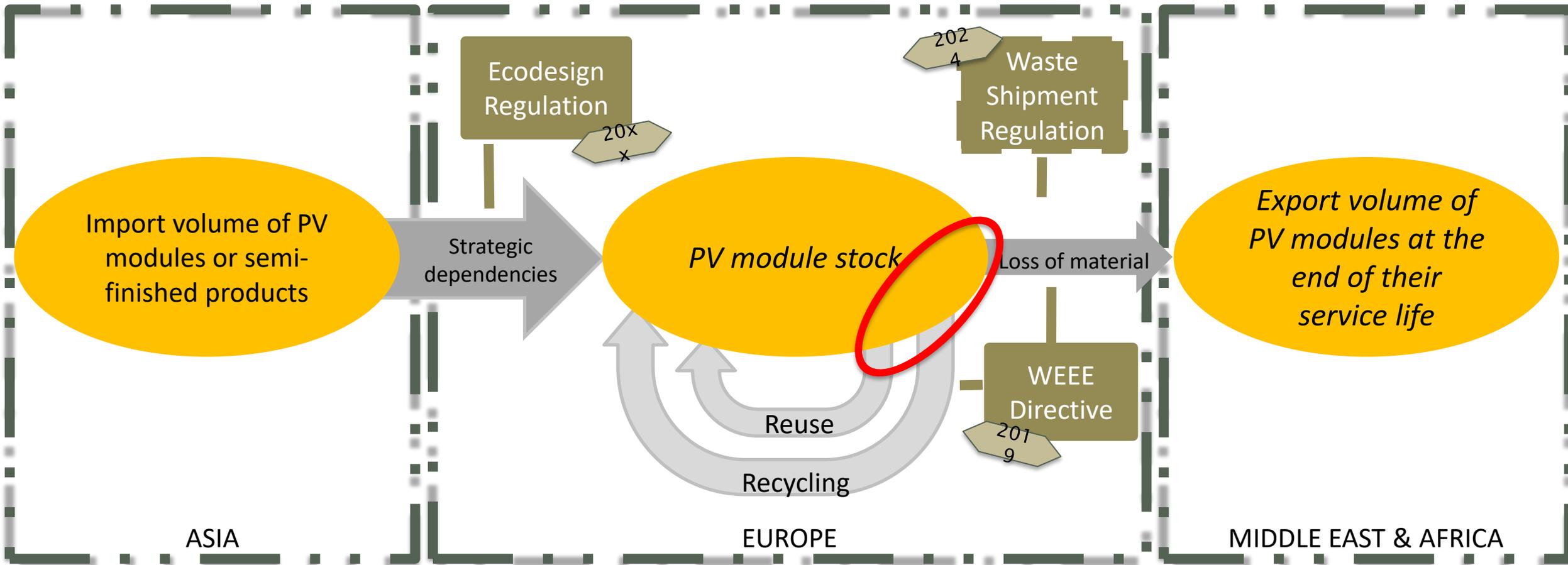


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European dependencies in PV industry

And efforts by the EU to reduce import and export dependencies by means of circular strategies

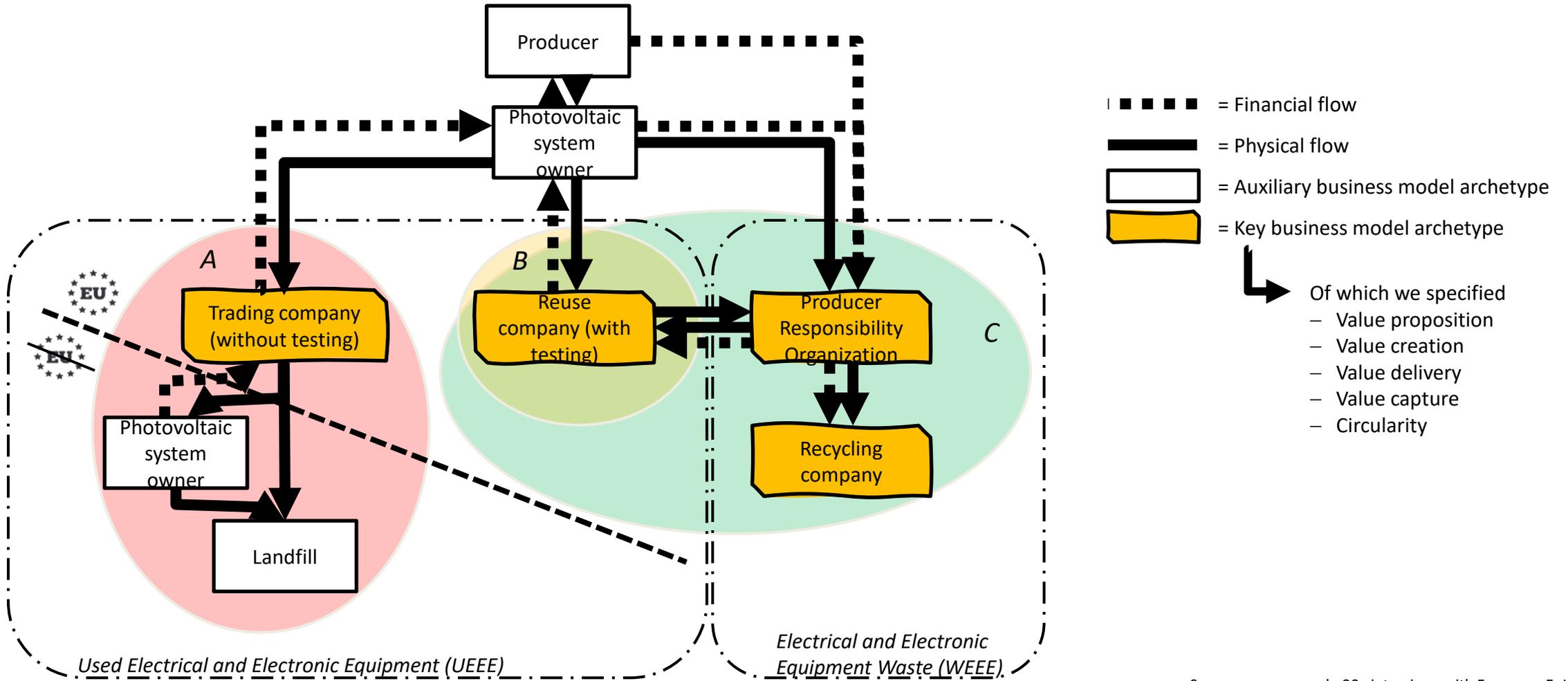


Source: Nyffenegger et al., 2023



PV system end-of-first-life scenarios in Europe

Politically intended vs. actual routes and the involved business models



Source: own research, 30+ interviews with European EoL actors



Two key challenges for Reuse in Europe

And how industry and policy interventions can mitigate those challenges

Challenge	Export	Recycling prioritization by policy
Challenge explanation	<ul style="list-style-type: none">Export of end-of-life PV modules as used products (UEEE) bypassing WEEE DirectiveLimited business case for reuse operationalization	<ul style="list-style-type: none">Prioritization of recycling over reuse in EU policy, contradicting the European waste hierarchyLimited business case for reuse operationalization
Affected area	A	C
Industry intervention	<ul style="list-style-type: none">Establishing collaborations as Producer Responsibility Organizations (PRO) with (large) PV system owner and Operation & Maintenance companies	<ul style="list-style-type: none">Developing standards for preparing PV modules for reuseBuilding alliances to advocate for a more supportive political framework
Policy intervention	<ul style="list-style-type: none">Tighten the rules and their enforcement in the shipment regulationEstablish clearer distinction between UEEE and WEEE in the forthcoming WEEE Directive	<ul style="list-style-type: none">Specific PV product category in forthcoming WEEE DirectiveAlign forthcoming WEEE Directive with waste hierarchy by favouring reuse over recycling



Swiss Reuse Project «Swiss PV Circle»

Setting the basis for reuse business models in Switzerland

Feasibility



No unsolvable technical or organizational obstacles

- Good degradation results (0.24% per year)
- High reusability rate (fail rate below 3%)

Desirability



- Interesting niche markets such as spare part for single modules or public procurement
- Too little volume demand for scaled reuse business models

Viability

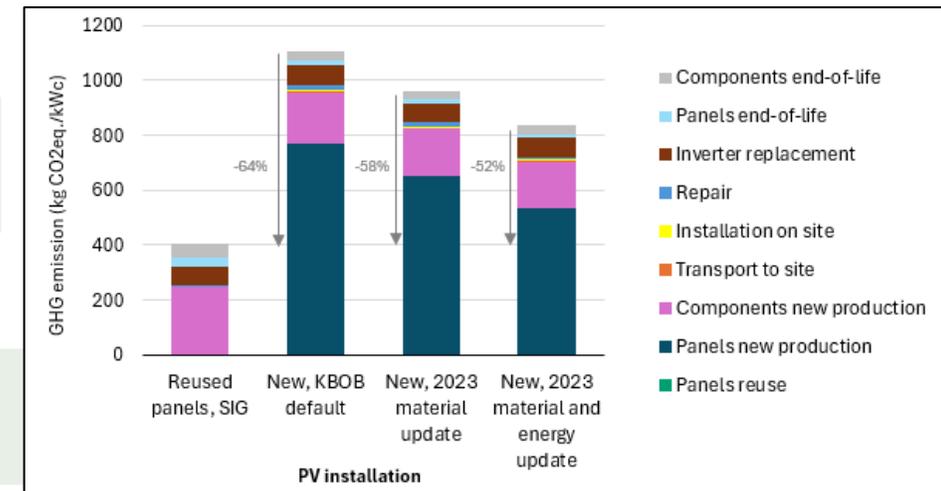


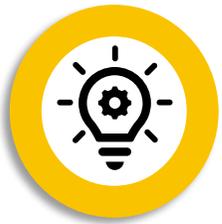
- Testing costs of € 0.24 per Wp → € 38 per module
- Economic efficiency mainly depending on new module prices (€ 0.26-0.36 per Wp)

Circularity



- Total GHG emission of reused PV installation 66% lower compared to new, but more space needed
- Main reason is panel production emissions

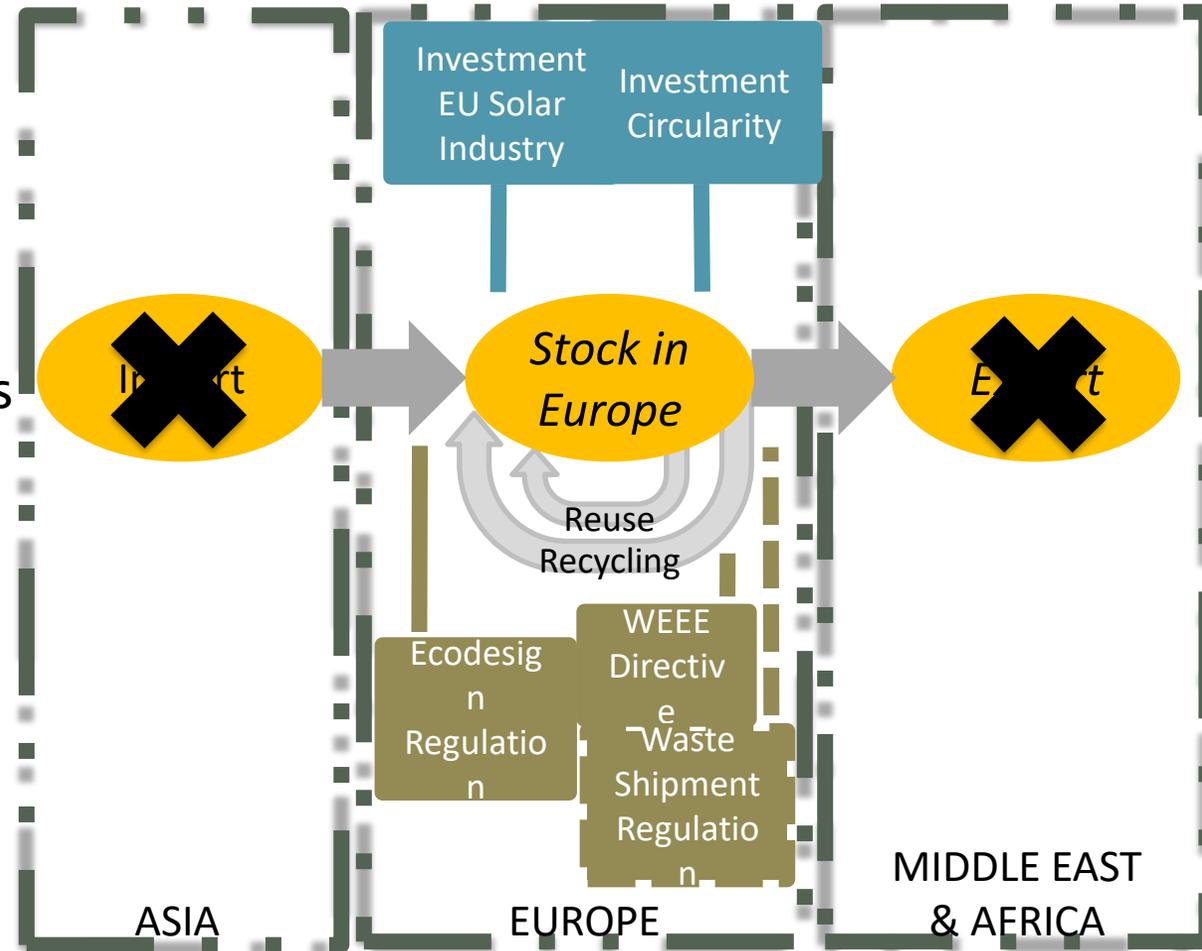


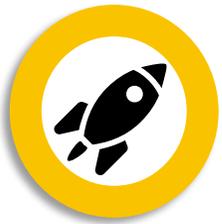


Key points for discussion

What can we say from a business model and policy perspective

- Solar industry was designed in a linear way
- Circularity effort were introduced later to fix end-of-life challenges by regulation
- Regulatory efforts for circularity come with limits
 - Waste shipment regulation <> free trade
 - Ecodesign <> production in Asia
- To avoid export industrial basis is needed, which would also limit import
- Should we invest in an EU solar industry basis in a circular way?





Call to action: Solar Reuse Europe consortium

Contact me for more information: roger.nyffenegger@bfh.ch

- A diverse network of reuse partners is driving *preparation for a reuse of PV systems*, mainly modules, across Europe.
- *Regional disparities* in solar energy production between northwestern and southeastern Europe shall be addressed.
- *Reuse of PV systems presents an opportunity* to simultaneously reduce CO2 emissions, decrease the use of critical materials, and expand solar energy capacity.
- The project focuses on *strengthening the European solar reuse value chain* by
 - advancing standardization and industrialization of testing processes,
 - fostering ecosystem and business model innovation,
 - analyzing the policy framework,
 - and improving selling platforms through data collection and harmonization.



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ENERGYCITIES

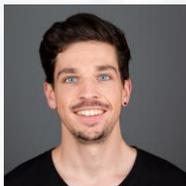
ZONNEXT



ACR+



Local Governments
for Sustainability



Roger Nyffenegger

Bern University of Applied Science, Switzerland & Maastricht Sustainability Institute, The Netherlands



Brian Baldassarre

Joint Research Centre of the European Commission, Spain & Maastricht Sustainability Institute, The Netherlands



Nancy Bocken

Maastricht Sustainability Institute, The Netherlands

Thank you!



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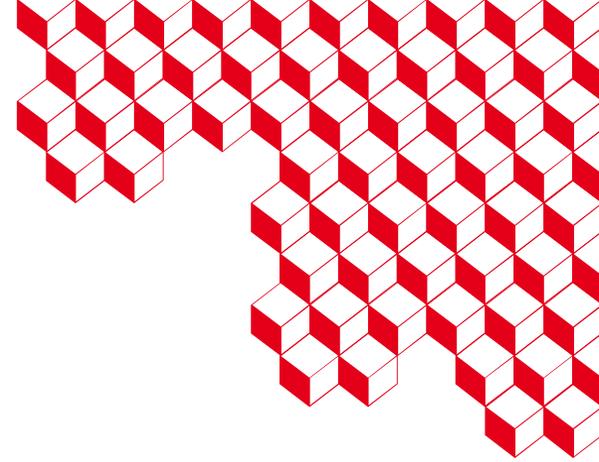
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‘Prolonging Solar Lifetime Through PV Module Reuse’

Challenges & Solutions

Jérémie Aimé

Head of Applied Systems laboratory



22 000 sqm
120 M€ Equipment
500 employees
50 M€ Annual Budget

Premium PV Cells and modules | Process & equipment | X-IPV | Power electronics | Plants Architectures

Hardware ...

for **Solar Energy**

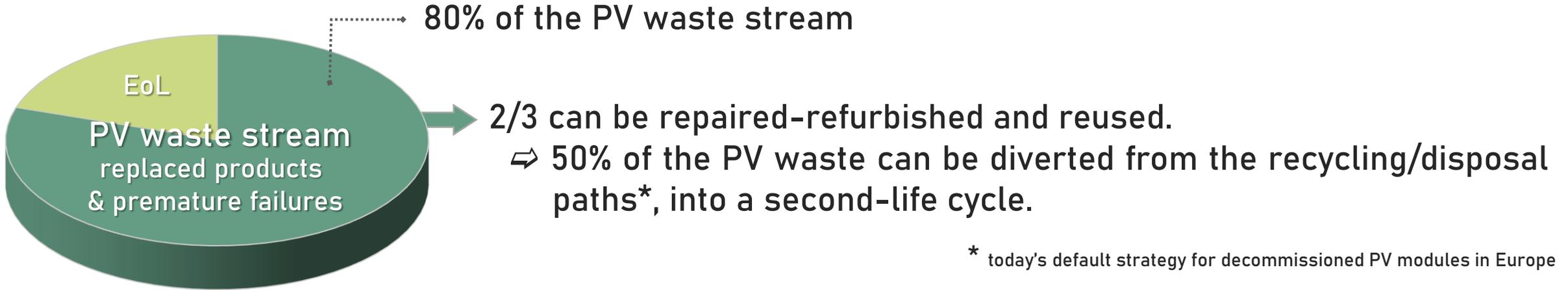
... & software

Grid integration | Diagnosis & Data | Energy management systems | Storage | **Smart grids & Smart cities**

Expected volumes



PV fleets installed during the boom of FIT schemes, have now passed mid-life (10+yr old)
⇒ unprecedented wave of revamping and repowering
⇒ well-functioning 10-15yr old PV modules being replaced in utility-scale PV plants.



Need to optimize EoL management strategies in the PV industry from design to O&M level

▶ Higher reuse readiness of PV

Outlook towards PV reuse: Regulatory framework



To justify the bankability of PV reuse, considering the very low prices of new PV modules.

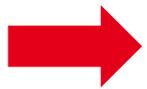
Key point: Avoiding that healthy modules are prematurely sent to waste (very short financial life).



Enforce state-of-health (SOH) analysis in case of PV modules reaching the end of their first life ten years earlier than their warranty period end.

For example, for modules with 30 years warranty, SOH check is enforced if owners want to perform repowering/revamping before 20 years of lifetime.

Such policy could become relevant and come into action as early as by 2030.



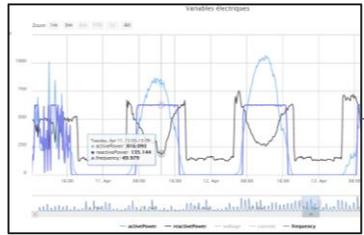
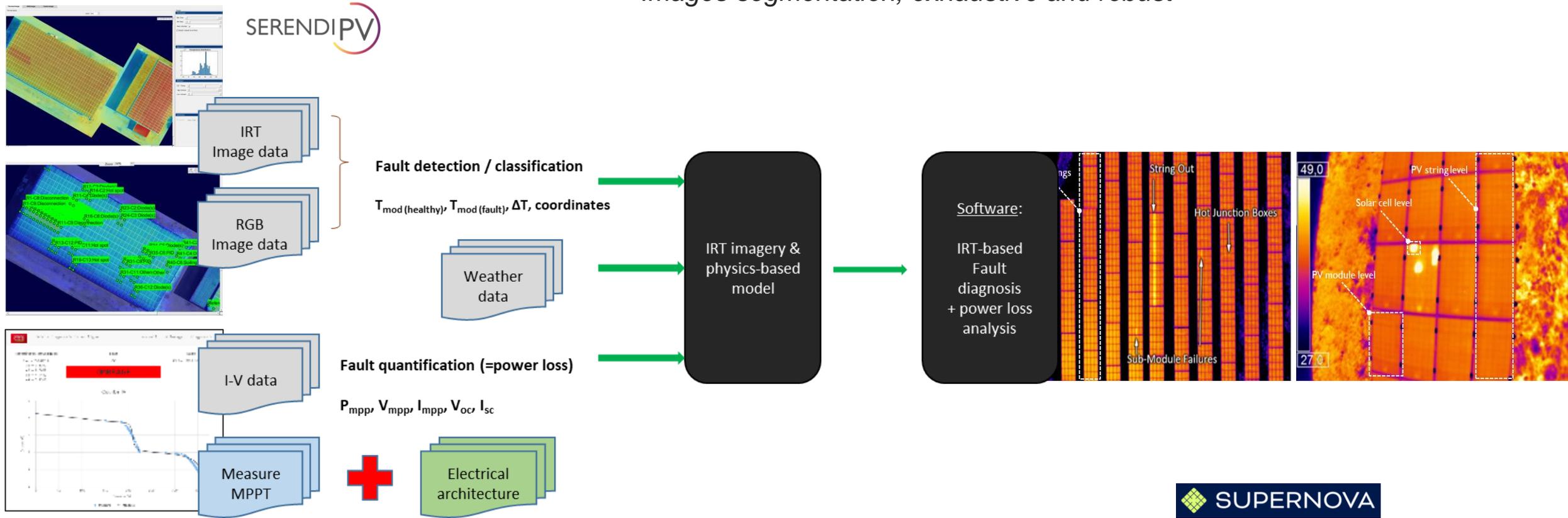
Policy needs to have a science/technology based foundation

Critical building blocks

- 1) PV failure diagnosis
- 2) Understanding failure mechanisms
- 3) Database, use cases

Diagnosis tools

Diagnosis tool using thermal images and cross-linked analysis
Images segmentation, exhaustive and robust

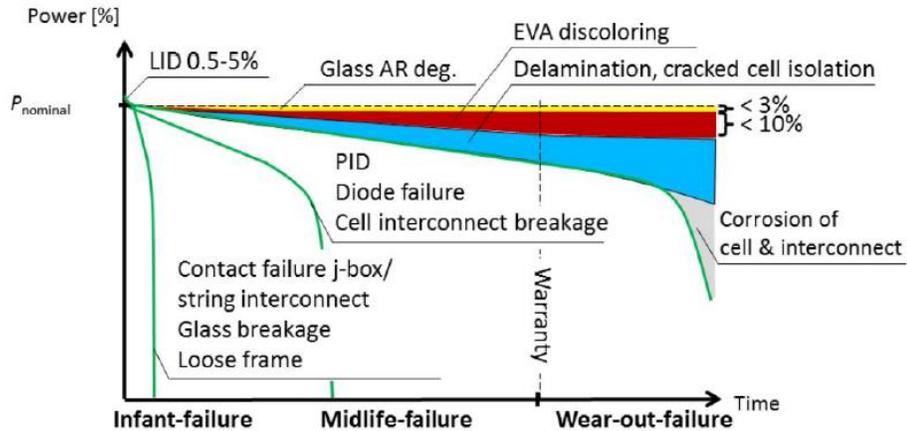
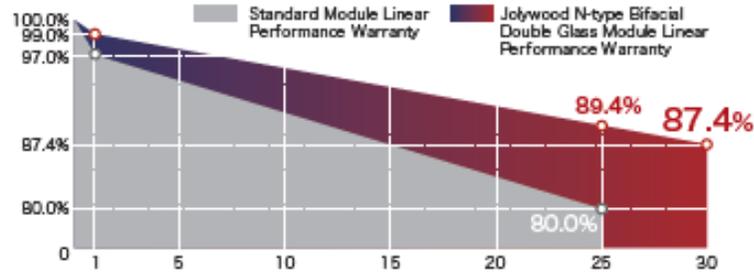


SERENDI-PV has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement no. 953016.
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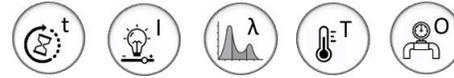


Reliability, durability

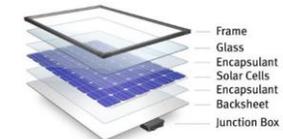
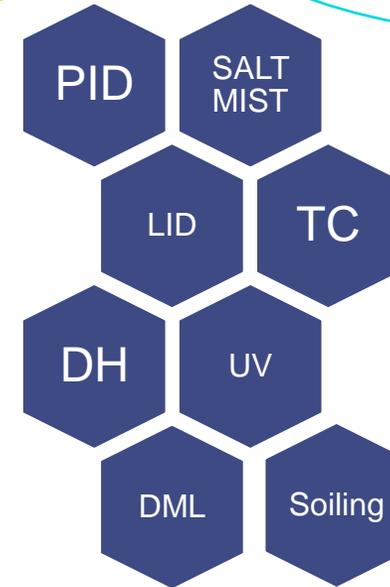
-1.00% 1st-year Degradation | 15 Years Product Material & Workmanship
 -0.40% Annual Degradation | 30 Years Linear Performance Warranty



Floating Desert



Conditions

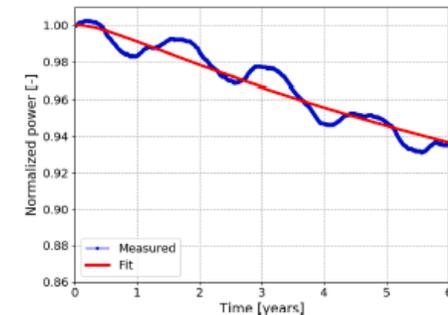


BOM

CHALLENGE

➤ Modelling of modules degradation in real conditions

Prediction of performances



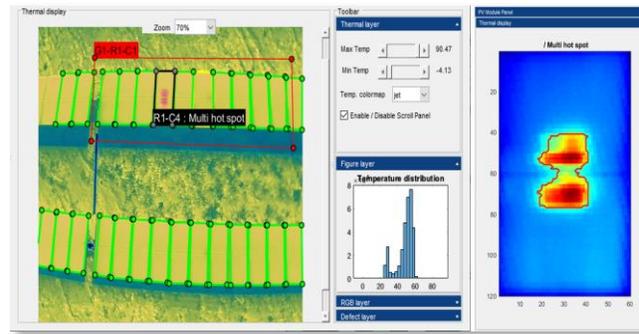
Data base generation, controlled environment



Data generation, diagnosis of modules/systems:

- No defect
- With known defect
- Repaired

Test sequences using mobile test lab
Creation of database (min 400 ref), guidelines
Durability using accelerating ageing sequences



Multi-spectral images
End of life management dashboard



Funded by the European Union

SUPERNOVA has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement no. 101146883.

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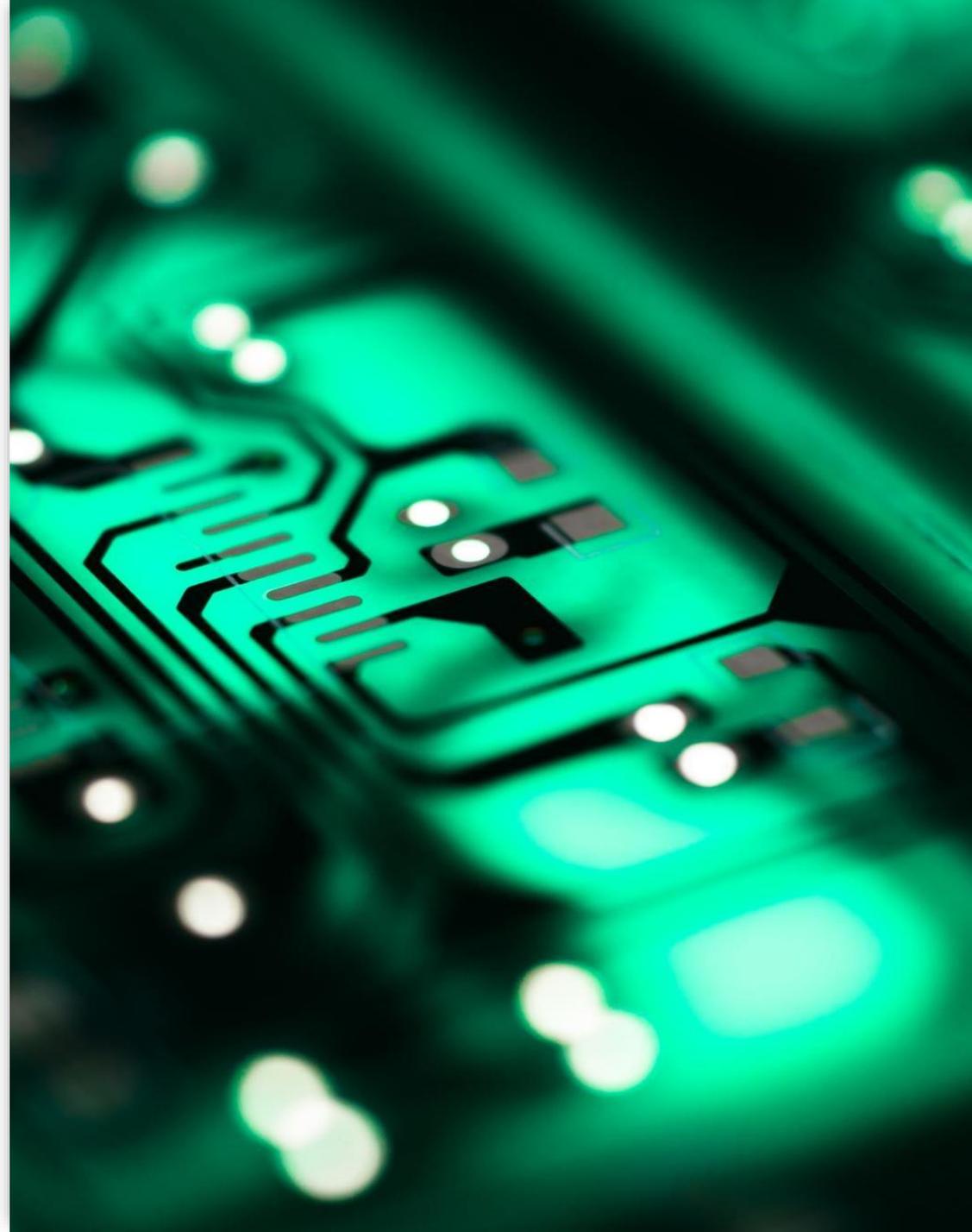
Technology and innovation

Innovations from CEA:

We use technological advances in the field of photovoltaic module monitoring and diagnostics to detect problems early and accurately.

SolReed expertise:

We have developed exclusive repair techniques that enable us to maximise the reuse of these modules, thereby reducing waste and enhancing sustainable development.





Contact information :

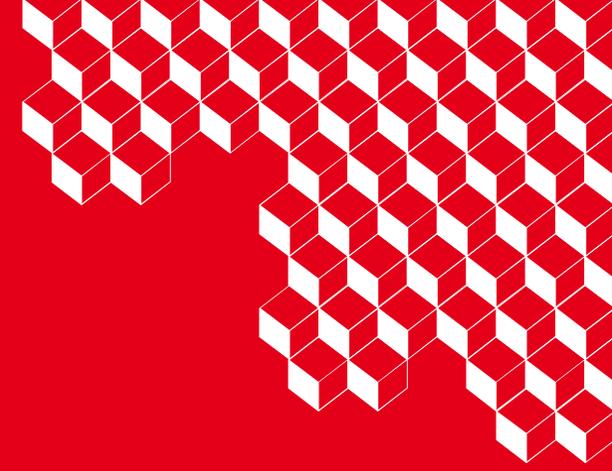
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Thank you



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 **SECONDSOL™**
THE PHOTOVOLTAIC MARKETPLACE



**SolarPower
Europe**

Sustainable

Solar Europe 2024

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SecondSol GmbH

Business units



Online Marketplace

60k users across Europe
2 million items online (new, used, repaired)



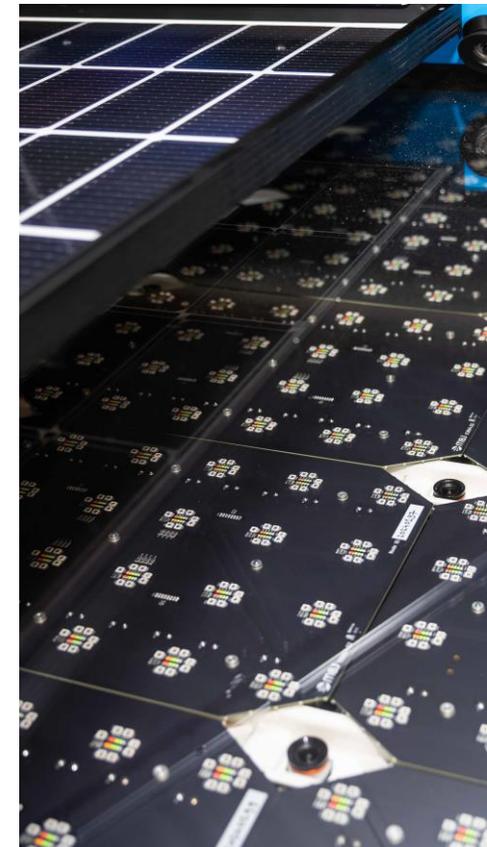
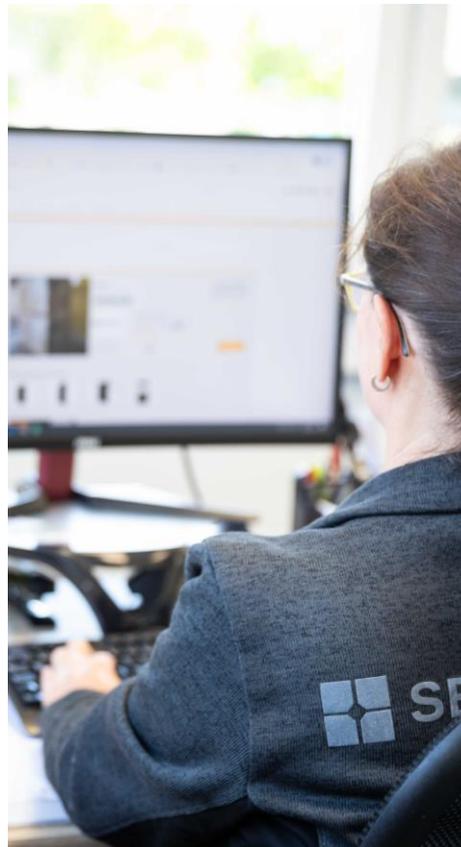
Parts and Spare Parts

250k spare parts (modules) in stock
We deal with new and used products



PV Testcenter

Electroluminescence
Power measurement



Recycle or reuse?

We believe in a marketplace



Source: ENERGYBIN

- Functionality
- Age
- Degradation
- Free of defects

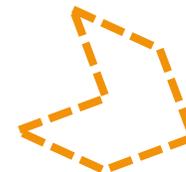
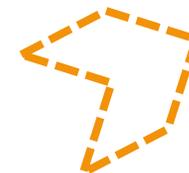


IMPORTANT QUALITY !!!



SecondSol Marketplace

Supply and demand will drive the price and the channel.



Reuse



Source: United Nations

Recycling



PV Circular economy – what we need for reuse

Get more quality with data analysis



Standardization

We need a product data standard that allows us to track products across the entire value chain.



Collect product data

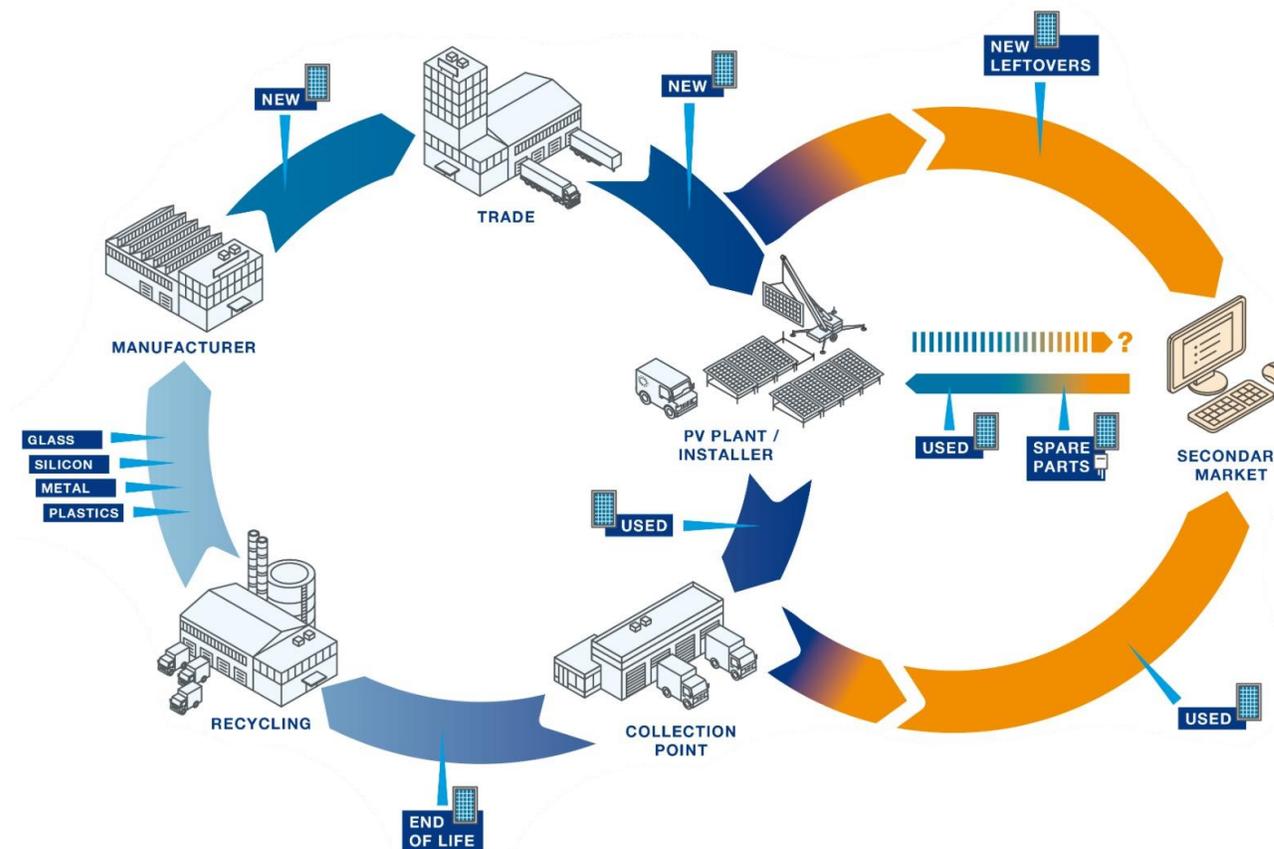
Data collection along the entire value chain in the operating time.



Data analysis

Analyze data at the point of sale. Decision on general reuse potential.

➤ No waste to Africa



At end...

We need to recycle.



If we reuse...

- we have to make sure that the goods are in good condition.
- the goods are also recycled at the end.
- we may have to help set up a collection system in the destination countries.



Source: Reiling



Source: ZDF/Juan Solera

Contact



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Panel discussion



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THANK YOU

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solar**
connecting solar business | EUROPE

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