

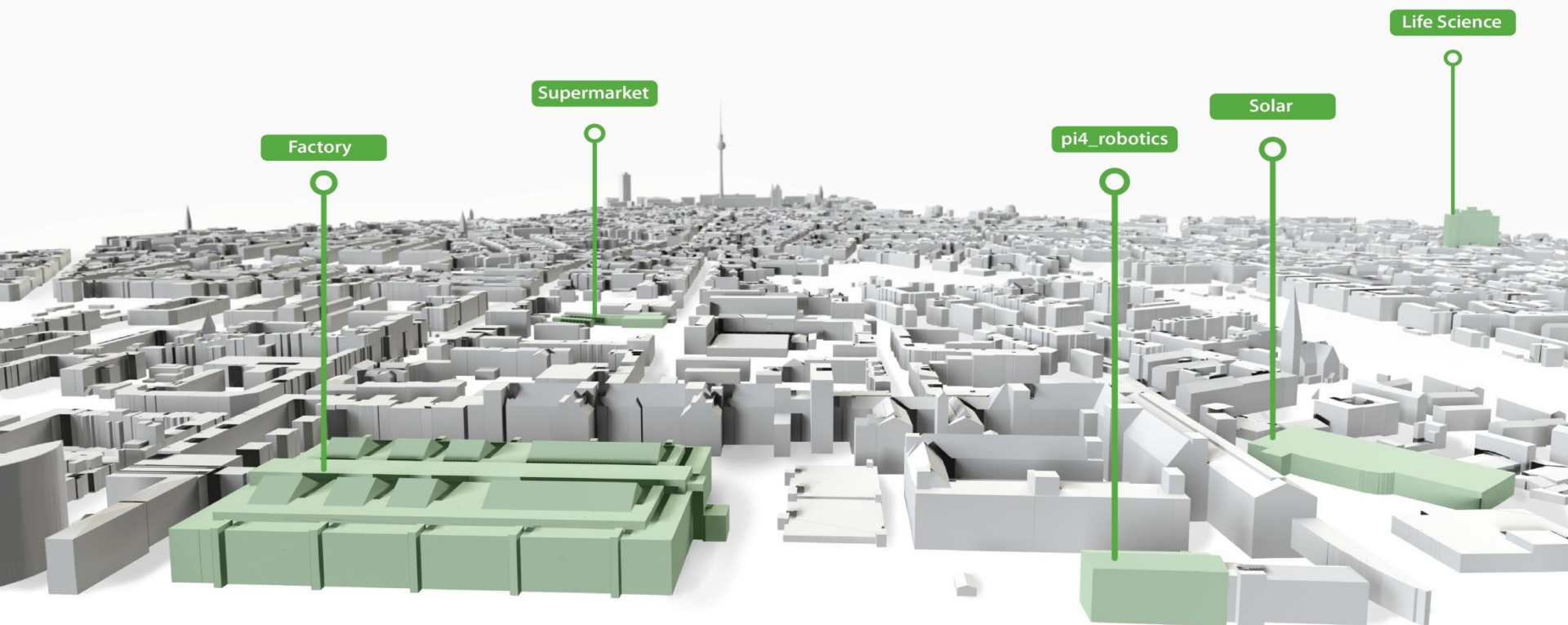


## PV-IDent™ The fingerprint of your pv-modules

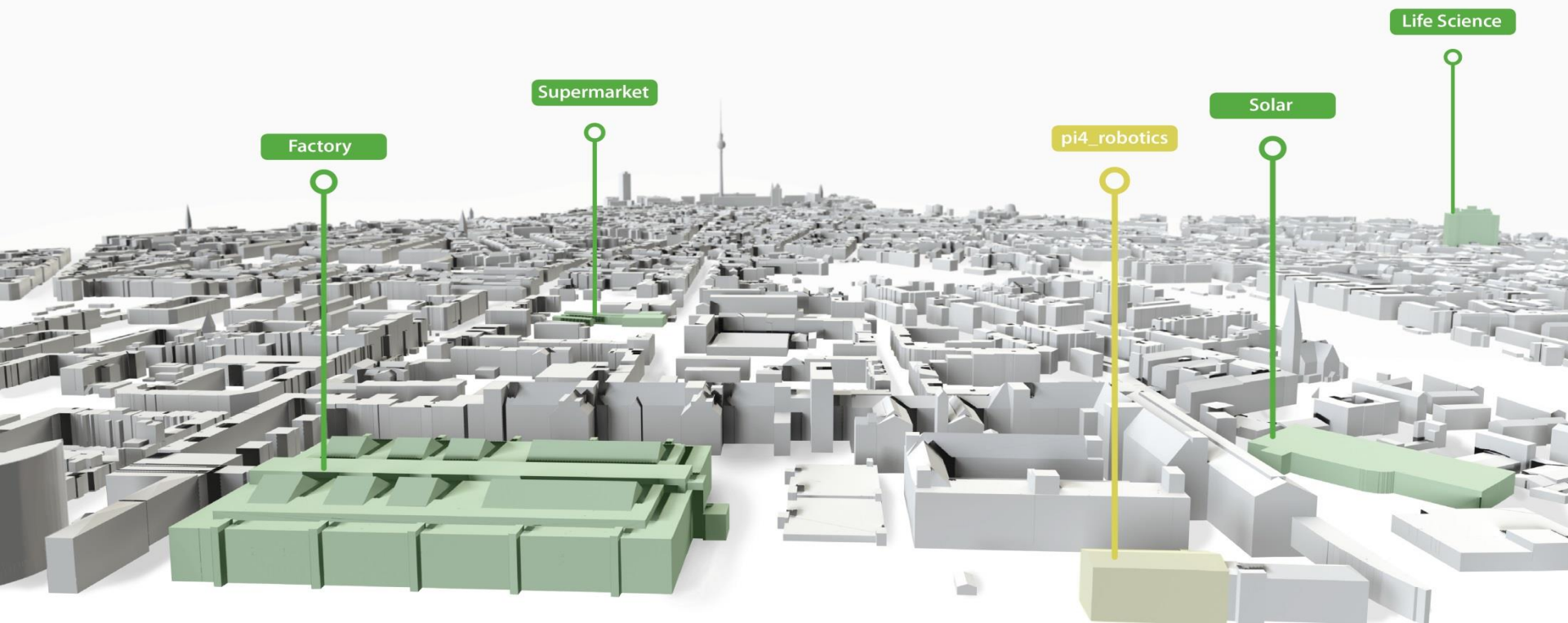


**pi4** never sleeps – we offer 24/7 service and support





**Four business units** serve more than 500 active customers all over the world<sup>3</sup>

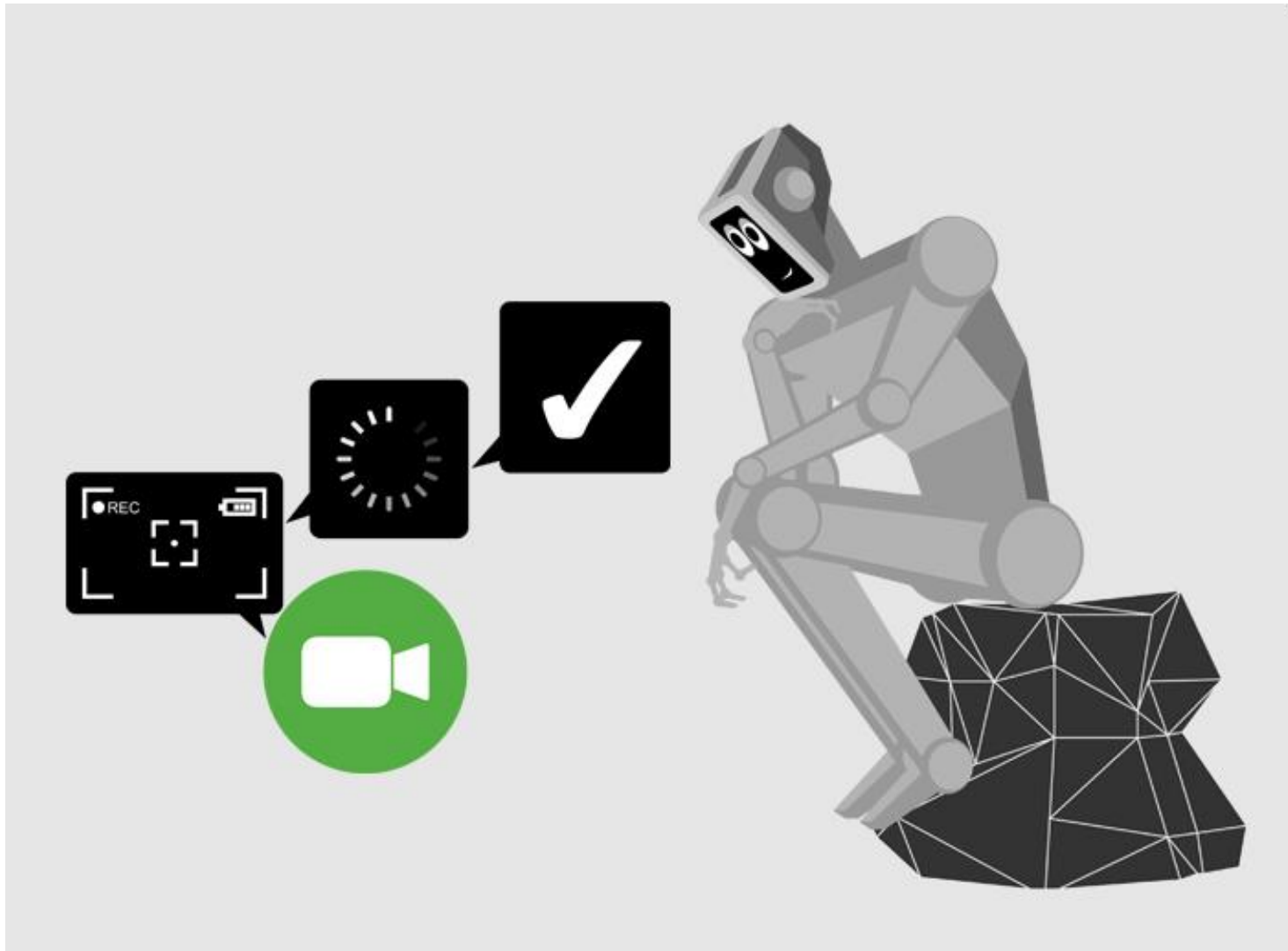




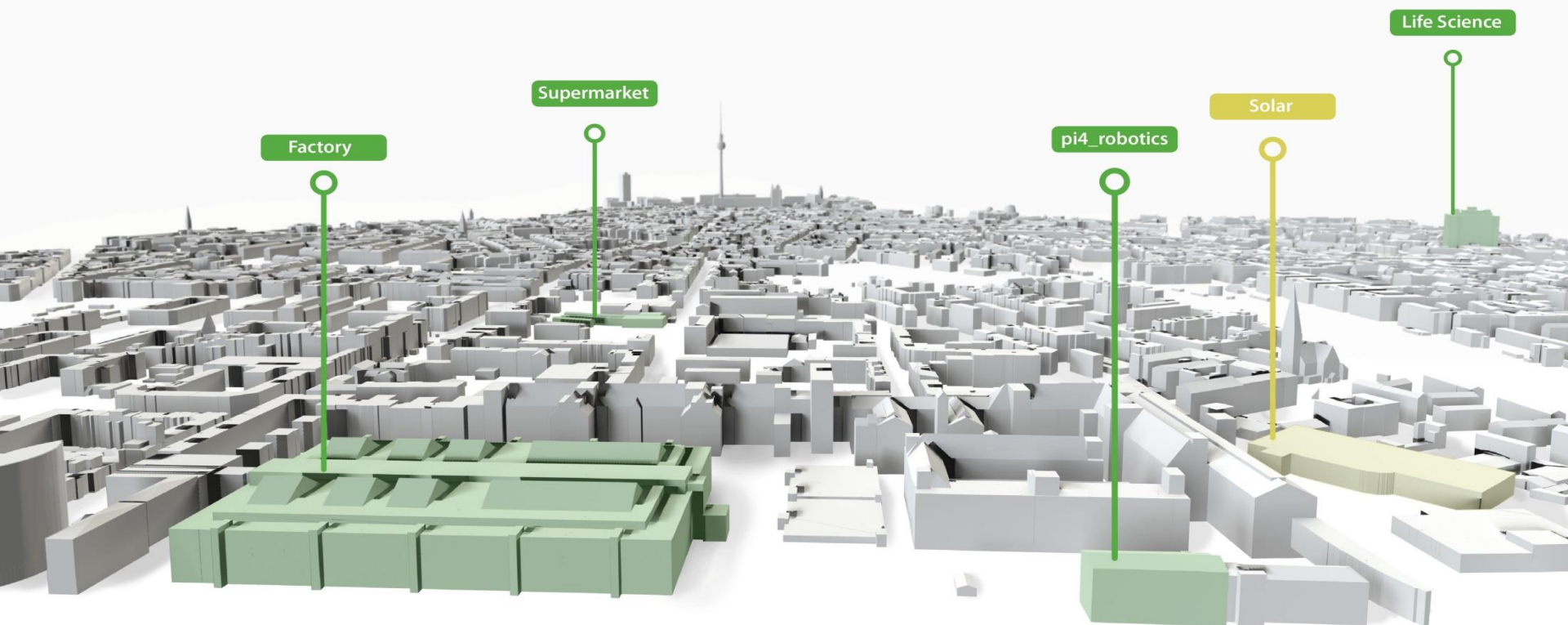
Workerbot4 – Concierge robot



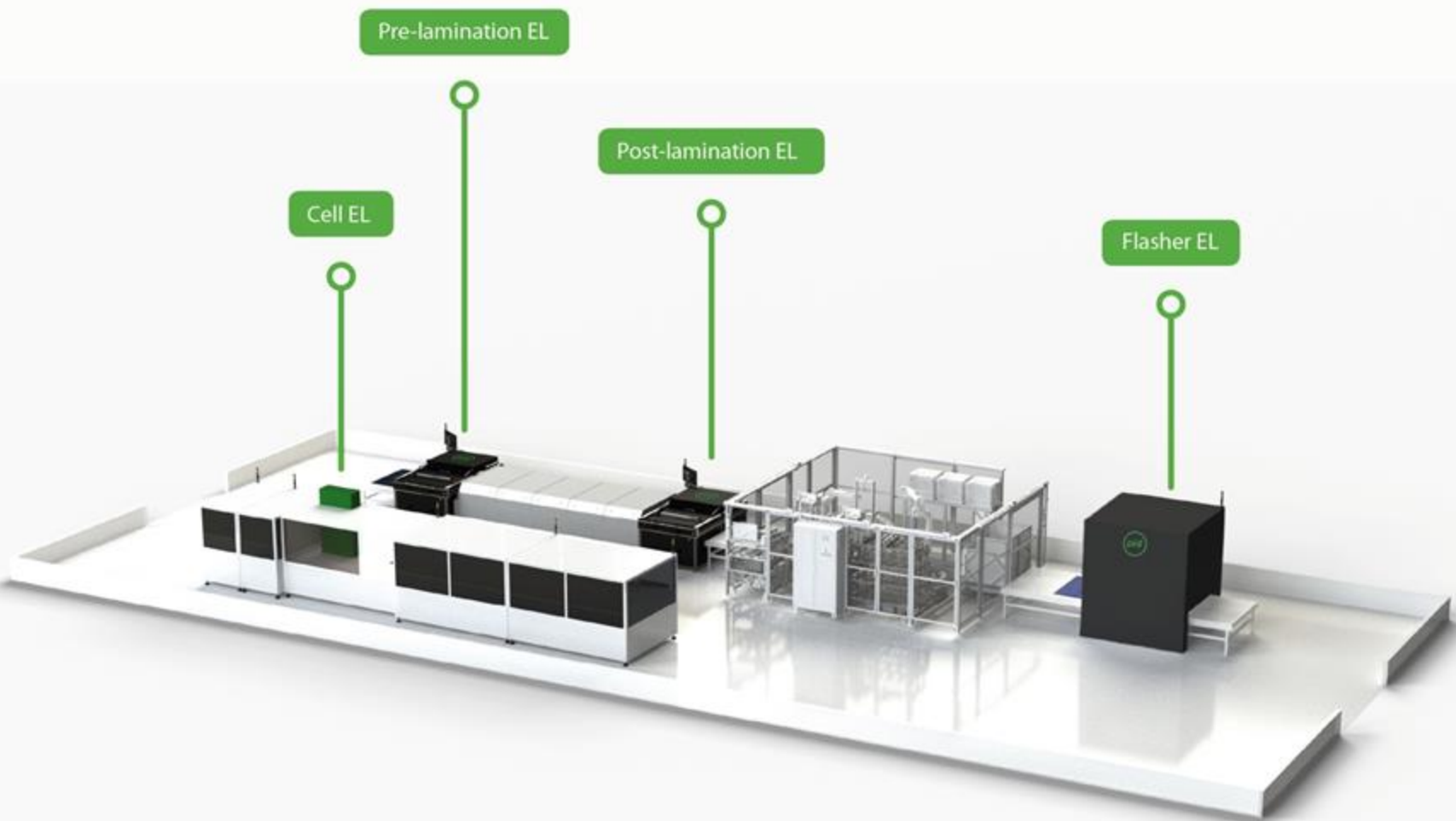




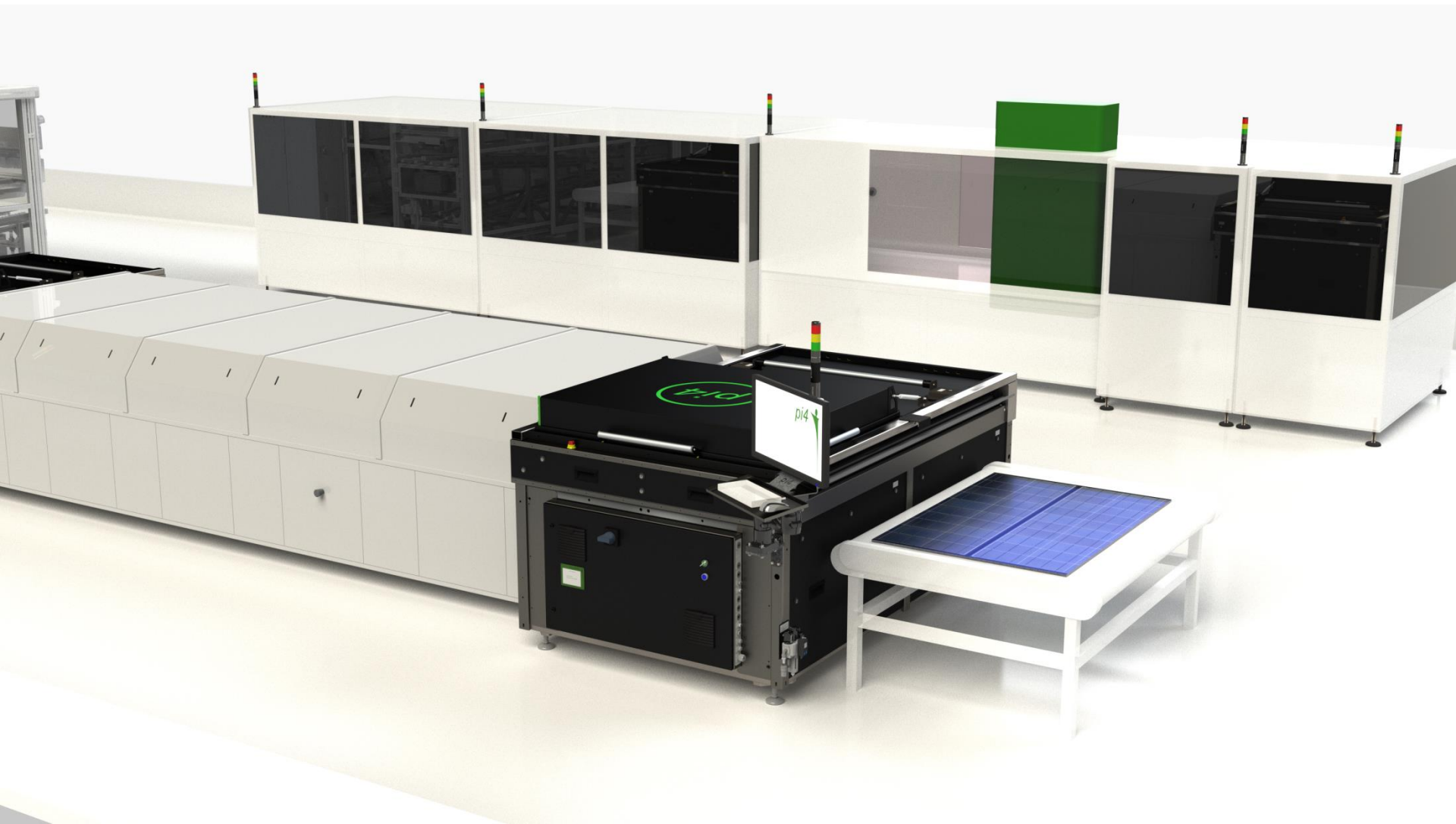








Inspection products for the photovoltaic production



Full automatic Pre-lamination EL inspection



## PV-IDent™

### What precisely is PV-IDent?

⇒ PV-IDent is traceability of your PV-products without the need of visual marking methods.

Unique characteristics not shown in visual light are extracted from electroluminescent (EL)-images. These are saved as a data vector compressed to a few bytes instead of 120 Gbytes, if you would be storing all high resolution EL images.

⇒ PV-IDent is more than just a serial number, PV-IDent is an EL-image fingerprint of our modules.

Product condition is monitored prior to shipment, warranty claims can be rejected if they are related to transport damage. Crystal structure, impurities, cell defects and low efficient areas are stored by PV-IDent providing a data base for your quality control.



## PV-IDent™

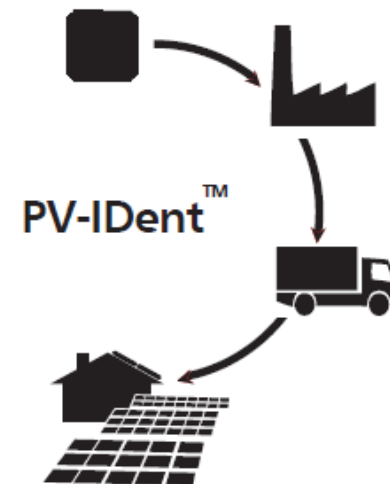
⇒ PV-IDent provides excellent features for the traceability of your photovoltaic (PV) products.

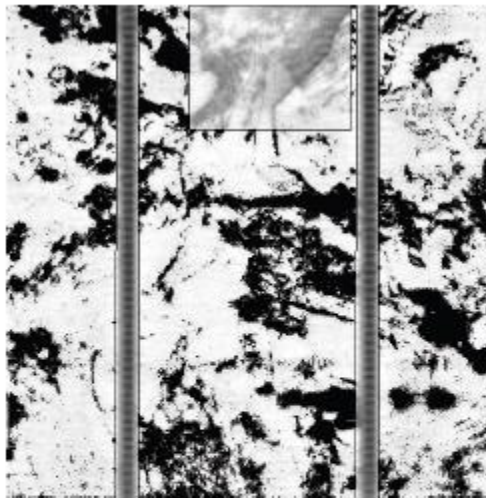
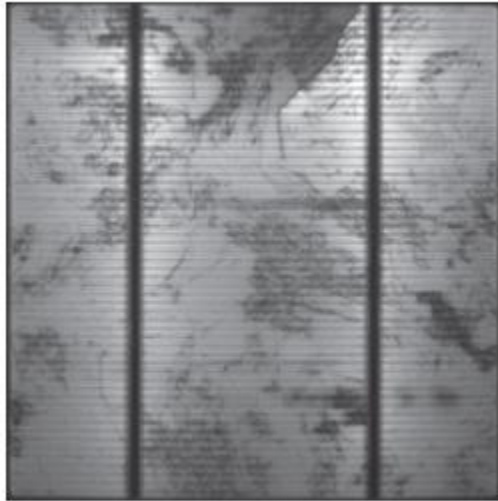
A unique data set is stored for each of your products, containing:

- Customer ID / date of inspection
- product conditions before shipment
- shape of gridfingers, busbars, cells, panels
- native silicon defects
- production related defects

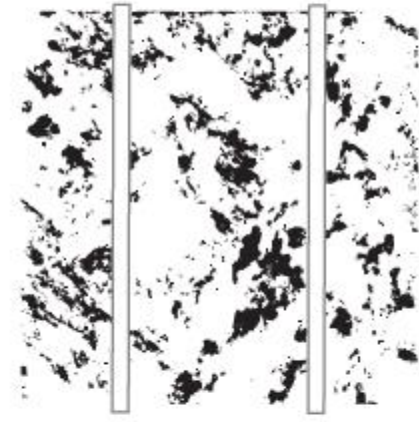
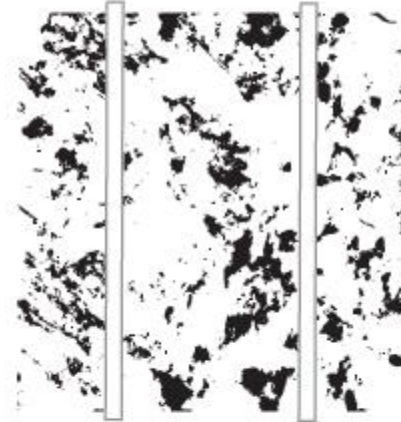
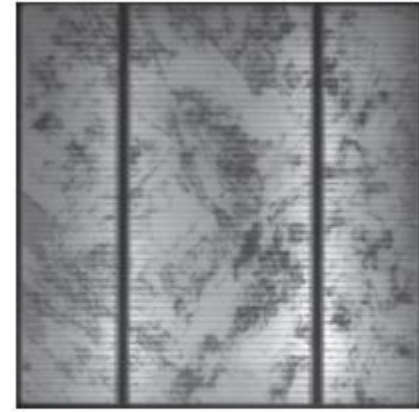
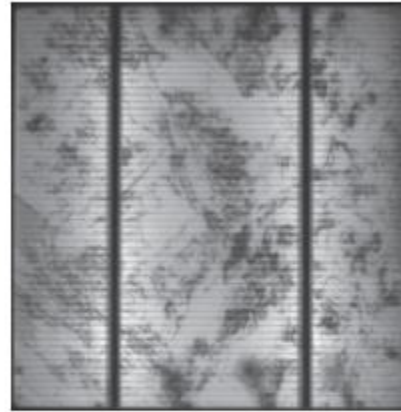
⇒ PV-IDent is a powerful tool for product life time monitoring and warranty control:

- monitoring of degradation
- detection of transport damage
- panel mounting damage
- vandalism damage
- product plagiarism





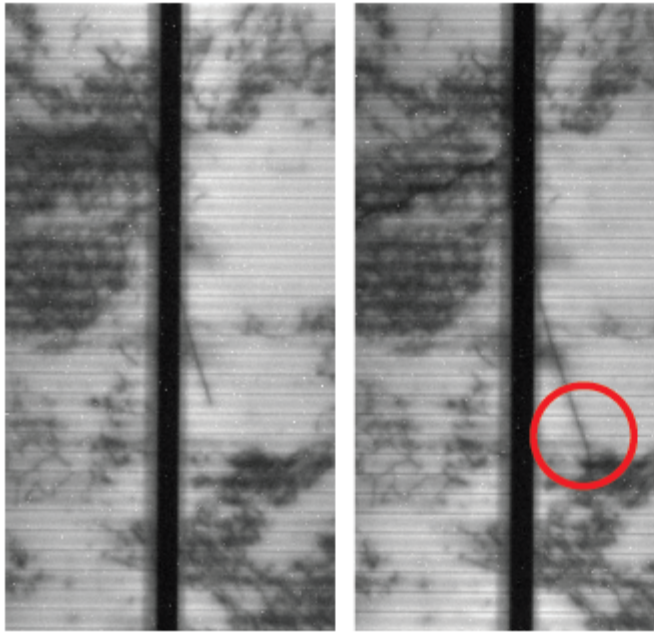
Cell defects



## Uniqueness

Wavers originating in the same rod (ingot) show the least possible difference due to vertically-advancing crystal structures. Cells made of one ingot can be matched to each other to find the order in which they were arranged inside the ingot.





## Warranty cases

Warranty claims can be approved and rejected if the reduced efficiency factor of a returned module is not related to natural degradation. Damage caused by installation, transport or vandalism can be identified. Defect modules due to natural degradation will pass this check and provide at same time valuable information about aging of your products. These data sets can be used to upgrade your production line or materials.

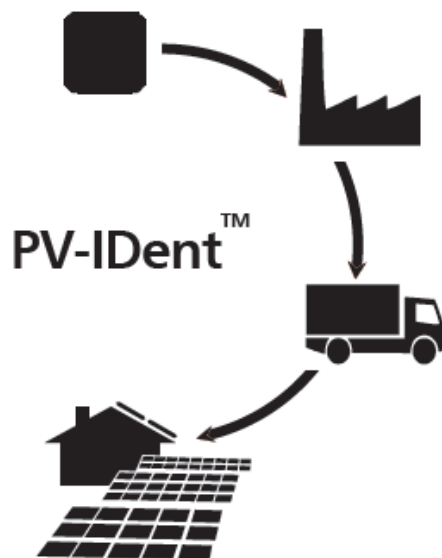
Left: Micro crack growth due to aging

## Natural degradation

Spatially stored data can be used for better understanding of natural degradation. Modules returned to the manufacturer are compared to database entries to visualize and evaluate degradation. Monitoring of the product life time pinpoints necessary improvements of your production lines, mounting equipment or transport systems.

## Ownership certificate

Registration of crystalline fingerprints will link PV modules to its owner. Any solar product which has been approved by PV-IDent can be returned to its original owner, should it be stolen. No markings or external labels are needed. Crystalline fingerprints cannot be disabled or modified beyond recognition.



## Life-time-monitoring

Tracing of cells and modules back to manufacturers. Cells, strings and modules are recognized by an EL fingerprint and can be matched to database entries. It is possible to trace and document the entire production and installation process. Defect cells can still be matched by examining the spatial position on its module. Database entries list the first occurrence of a product defect.

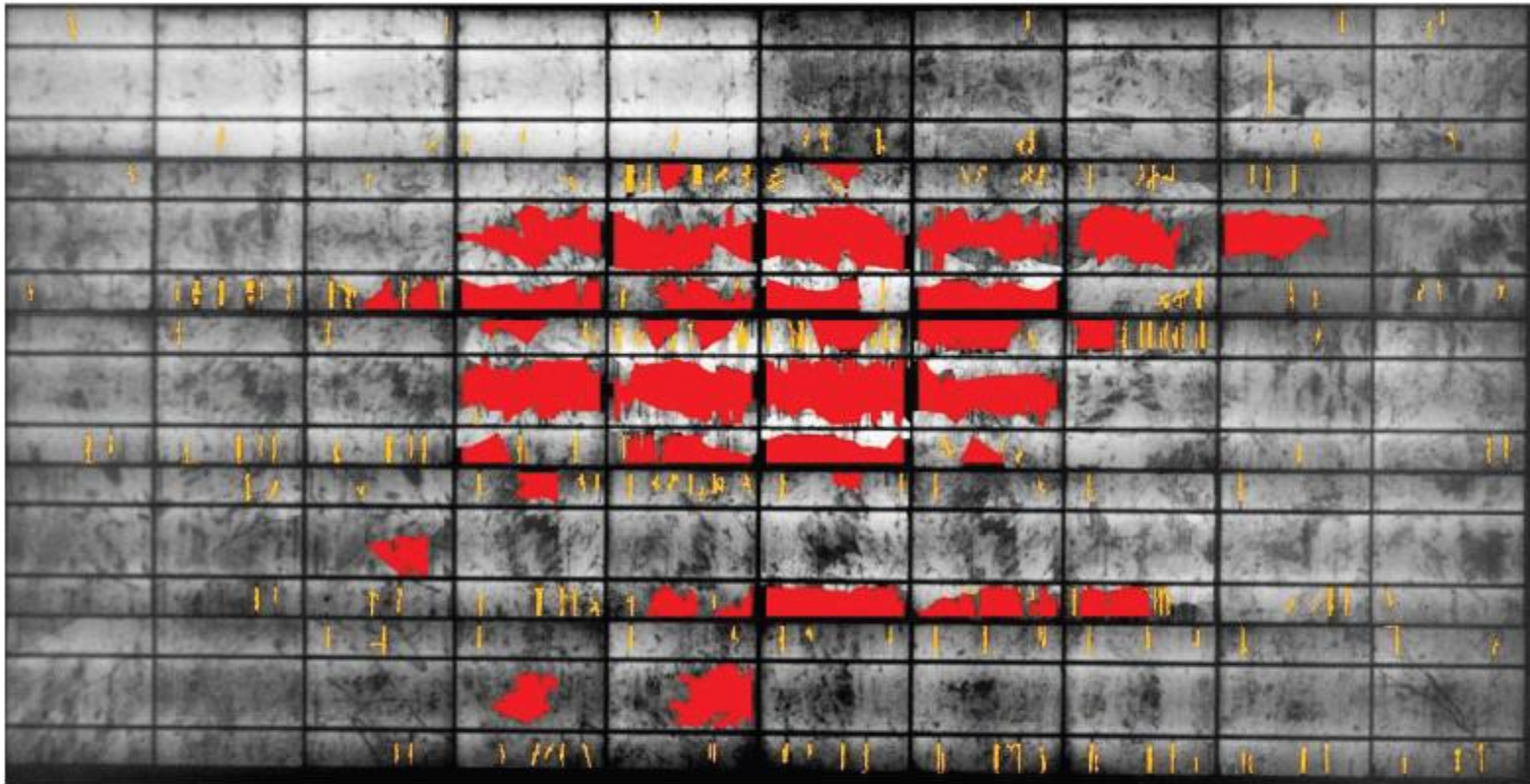
## Spatial DB storage

Product condition is monitored during the production process and prior to shipment. Crystalline fingerprints, cracks, dark spots, impurities, cell defects and low efficient areas are stored by PV-IDent providing a data base for your quality control. Efficient database queries are able to identify new defects not previously stored.



## Plagiarism detection

In the future, warranty and plagiarism issues will additionally motivate for a PV module tracing throughout the whole product life time. In addition to sole identifying, PV module manufacturers also need to verify the module's originality, modules without an registered EL fingerprint can be easily distinguished from imitated PV products.



## Transport & mounting damage

PV-IDent is able to identify and differentiate natural degradation from other damage types to reject warranty claims. E.g. transport or mounting damage can be evaluated. A comparison between stored data, manufacturing detects and damage caused by transportation or installation is carried out. PV-IDent is gathering data about typical damage types of your products as a basis for an evaluation.



**2021** Innovator des Jahres \* **2020** Innovator des Jahres \* **2019** Innovator des Jahres \* **2018** Innovator des Jahres  
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**2016** Best of Industry \* **2015** Innovationspreis Berlin-Brandenburg finalist \* **2014** Handling Award Top Ten  
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# Robotics & Machine Vision

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