



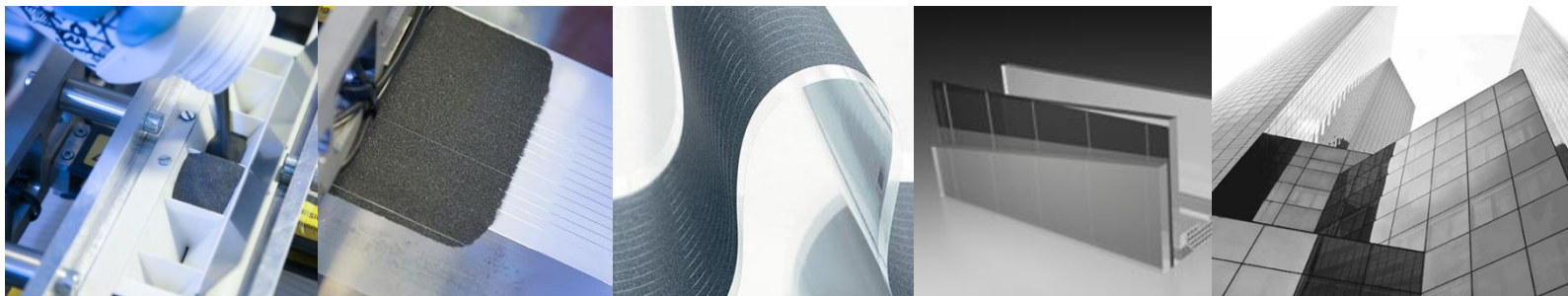
crystalsol

Next Generation BIPV

March 2019



crystalsol has developed and patented an entirely new type of **flexible photovoltaic technology** that combines the advantages of **high efficiency mono-crystalline material** and **low cost roll-to-roll module production** that will offer the **Building Integrated PhotoVoltaic** market the **first cost-efficient and aesthetic fully integrated BIPV** for facade, glass and roof-top applications.



About the company



- Founded in 2008
- Total headcount in two locations 30
- Total investments over 20 mio EUR



crystalsol

Tallinn, Estonia

CZTS powder production and development:
Copper, Zinc, Tin, Sulfur & Selenium

Vienna, Austria

Module production and development:
Roll-to-roll printing process

Funding



FFG



EAS
Enterprise Estonia



Awards





- **Versatile applications**

Flexible (semi-)sealed PV-modules and defined application processes (pressure, temperature, adhesives etc.) for rapid integration into various applications.

- **Tailored solutions and larger product range**

Size, shape, transparency and colour of the modules can be tailored according to customer needs and architectural requirements.

- **Cost-efficiency and good conversion performance of BIPV modules**

Abundant low cost materials and high throughput roll-to-roll non-vacuum based module production; comparable technologies at 6-7% level.

- **High durability**

Modules are flexible and durable.

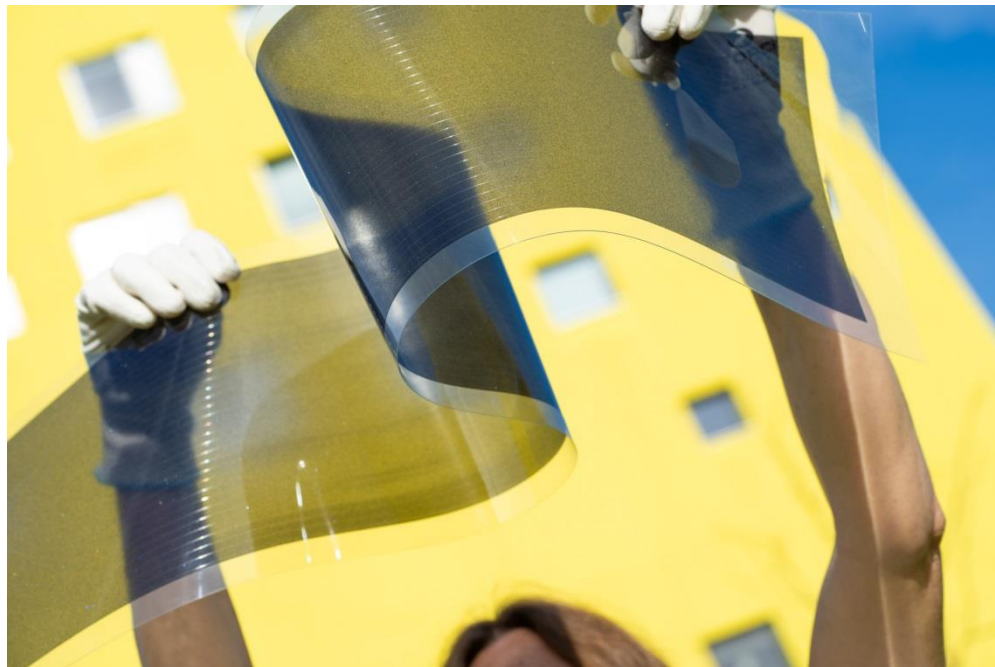




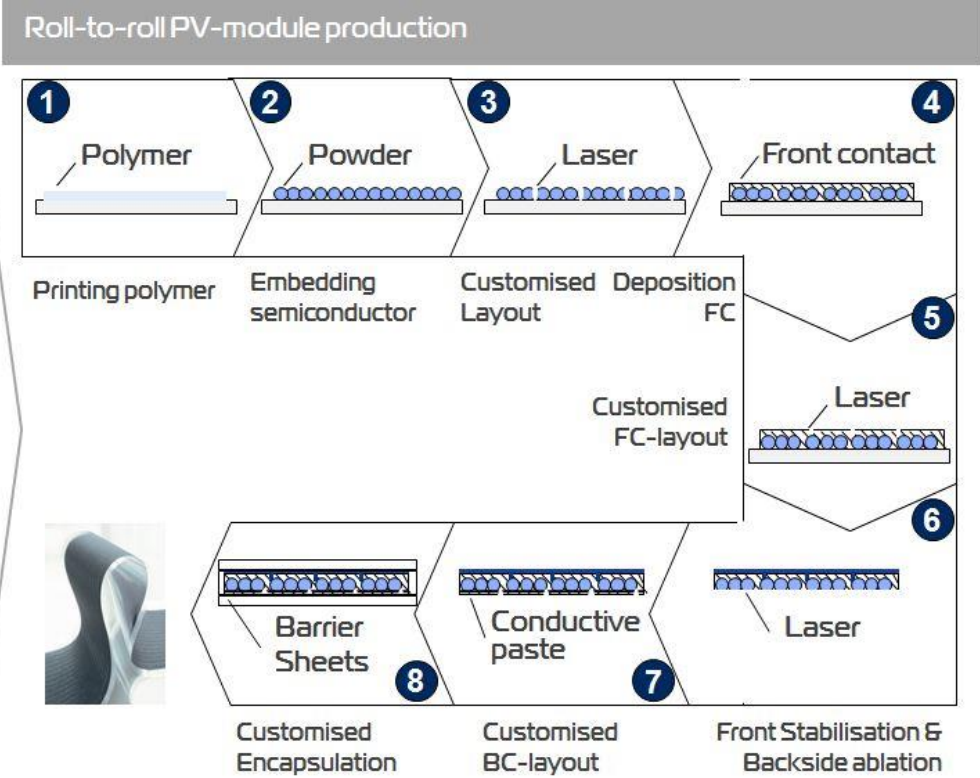
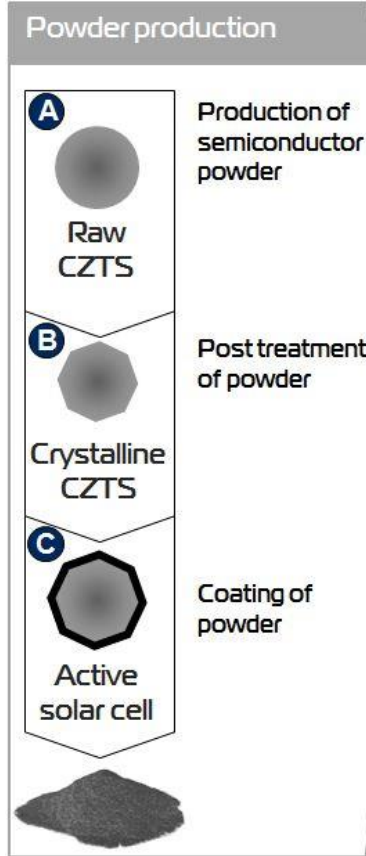
crystalsol's technology is offering customisable PV-modules with a varying degree of transparency!

The transparent modules are perfect solutions as shadings on glass walls and windows.

Highly stable monocrystalline material in **crystalsol modules enables to outlive the other transparent products.**



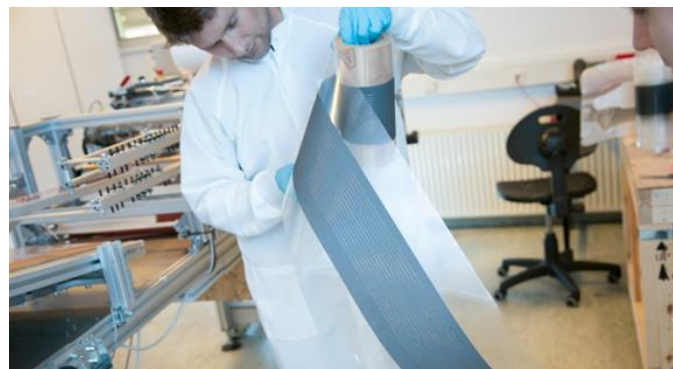
Technology overview



Technology overview – in-house module production



- Module pilot production line is fully operational
- Semi-automatic production up to 50 m/day
- Continuous roll-to-roll production process with no dependence on vacuum processes
- Capital requirements significantly lower from currently available technologies
- **Next step:** licensing of the patented production process to printing companies for upscaling and mass production





Crystalline silicon

Non-integrated PV products for app. **160 €/m²**.

Main disadvantages for BIPV:

- **high price per m²**
- **heavy weight**
- **rigid structure**
- **low flexibility in size**
- **no possibility for transparent solutions** (pc-Si).

This constrains their use to mostly solar roofs as they require sturdy support frames which are not applicable in wall panels.

Thin film

Non-integrated PV: from **70 €/m² for a-Si; beyond 100 €/m² for CIGS**.

Main disadvantages for BIPV:

- **high price per m²**
- **shorter lifetime**
- **rigid structure, only glass substrate**

Due to the high costs, thin film technology is mainly offering retrofitted solar panels instead of actual BIPV applications.

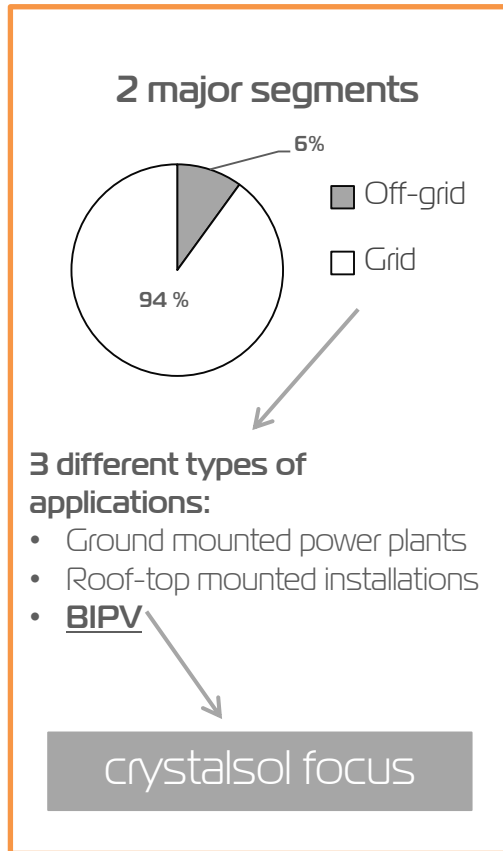
Dye sensitized/Organic

At the beginning of commercialisation.

Main disadvantages for BIPV:

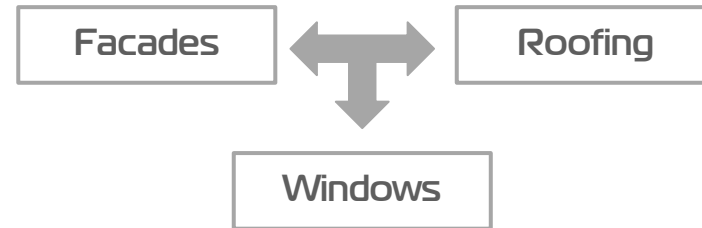
- **rapid degradation**

Due to the high costs, thin film technology is mainly offering retrofitted solar panels instead of actual BIPV applications.



BIPV market will grow from ca 2,5 bio EUR in 2019 to over 5 bio EUR in 2023, and double to 10 EUR bio by 2027¹

Today, about 40% of the global energy demand is consumed in residential and commercial buildings, offering the BIPV an essentially limitless market potential.²



crystalsol's BIPV module is a flexible product with ideal characteristics for true and aesthetic integration in windows, facades and rooftops of any type

¹n-tech Research Report 'BIPV Market Forecast and Analysis 2018-2027' Issue date: Aug. 6, 2018

²SUPSI-SEAC BIPV Status Report 2017 'Building Integrated Photovoltaics: Product overview for solar building skins', Sept. 25, 2017

crystalsol business model and concept



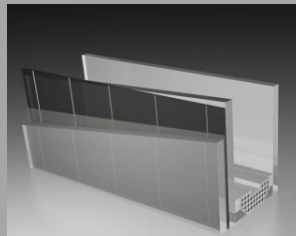
crystalsol / licensee



Powder



Module



Product makers



End-user



Product cost example – BIPV facade ³		
Conventional facade	Thin film BIPV facade	crystalsol BIPV
*From 30 to 1100 EUR/m ²	*From 250 to 600 EUR/m ²	From 130 EUR/m ²

For certain BIPV segments, products with integrated PV are very comparable in price with conventional building material, and are therefore cost-wise more beneficial replacement.

crystalsol offers PV integration at a very low cost!

³ SUPSI-SEAC, "BIPV Status Report 2015," 2015

* Dependant on the facade material



crystalsol offers the world's first truly integrated and economically viable BIPV modules!

The technology will allow a true integration of PV within existing and new construction elements of commercial, industrial, and residential buildings, which is of special value for the application in urban environments.



crystalsol

info@crystalsol.com
www.crystalsol.com