



“New approaches for BIPV elements: from thin film terra-cotta to crystalline white modules”

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# Photovoltaic Research

A competence center



- Basic research
- Advanced devices

- Applied research
- From lab to industry



EPFL- PVLAB

CSEM PV-center

# Photovoltaic in buildings

An incredible potential

In Switzerland, 30% of our electricity needs would be covered by using PV modules (10% efficiency) on well oriented roof (130km<sup>2</sup>)



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Facades are very interesting and necessary !



# Photovoltaic in buildings

not anymore an option

- Positive energy buildings
- MoPEC 2014



# Photovoltaic in buildings

Integration & Aesthetic

More than a challenge, a necessity!



# Photovoltaic in buildings

some numbers

Wood: 150 CHF/m<sup>2</sup>

Ceramic: 250 CHF/m<sup>2</sup>

Metal: 300 CHF/m<sup>2</sup>

Glass: 600 CHF/m<sup>2</sup>

Marmor: 1000 CHF/m<sup>2</sup>

**Micromorph PV module: 90 CHF/m<sup>2</sup>**



# Photovoltaic in buildings

A multidisciplinary challenge

- Attractive dedicated modules designed with architects, builders, installers...

colored modules,

optical effect,

size, shape, dummies

- Multi-functional building elements

building skin,

insulation, ventilated façade,

windows.



# Photovoltaic in buildings

A multidisciplinary challenge

But also...

- Identification of the operational barriers
- Holistic strategies - from industry to implementation
- Legislations and regulators, architects, suppliers, integrators, builders...
- Cultural, societal, emotional barriers

NRP 70 “ Active Interface”

# Photovoltaic in buildings

N i c e   a n d   a t   l o w   c o s t

Transforming and modifying a standard PV module without touching the core technology is a efficient way to modify overall aesthetics without increasing the module costs.

# PV instead of tiles

from lab to fab

2010

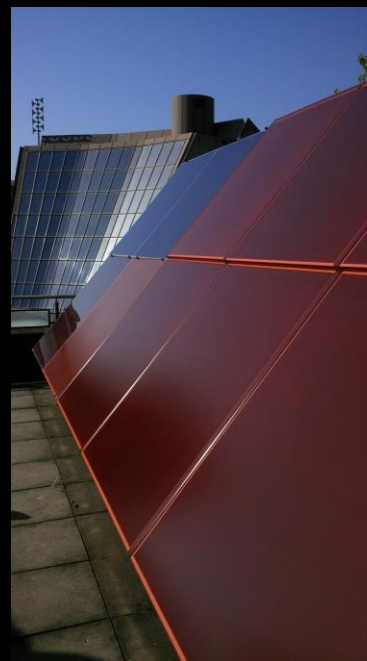


Archinsolar  
project

2013

Development &  
Integration

Transfer &  
Industrialization



TODAY



**ÜSERHUUS**

[www.userhuus.ch](http://www.userhuus.ch)

# Terra-cotta PV

An example of technological transfer

Thin-film terra-cotta

Mat or shiny finish

Sizes: full size ( 1100 x 1400) and small size available

IEC certification and Swiss PV label in process

“April Showers bring May Flowers”

# OPENING OF ÜSERHUUS

by JR Partners

at the **bre**  
Innovation park  
Watford

**Beginning May 2015**

**Never seen before!**  
Fully building integrated TERRA COTTA  
photovoltaic as roofing and cladding  
material as a result of cooperation between  
ÜserHuus AG, CSEM SA, NexPower Corp,  
Swift Manufacturing Solutions Ltd and  
GenClad Ltd.

ÜSERHUUS :: csem NexPower SMS GenClad

# Photovoltaic in buildings

A test installation in Fribourg



# Photovoltaic in buildings

terra-cotta roofs - simulation



And what about white?

# White photovoltaic module

for building facade

Cool & fresh



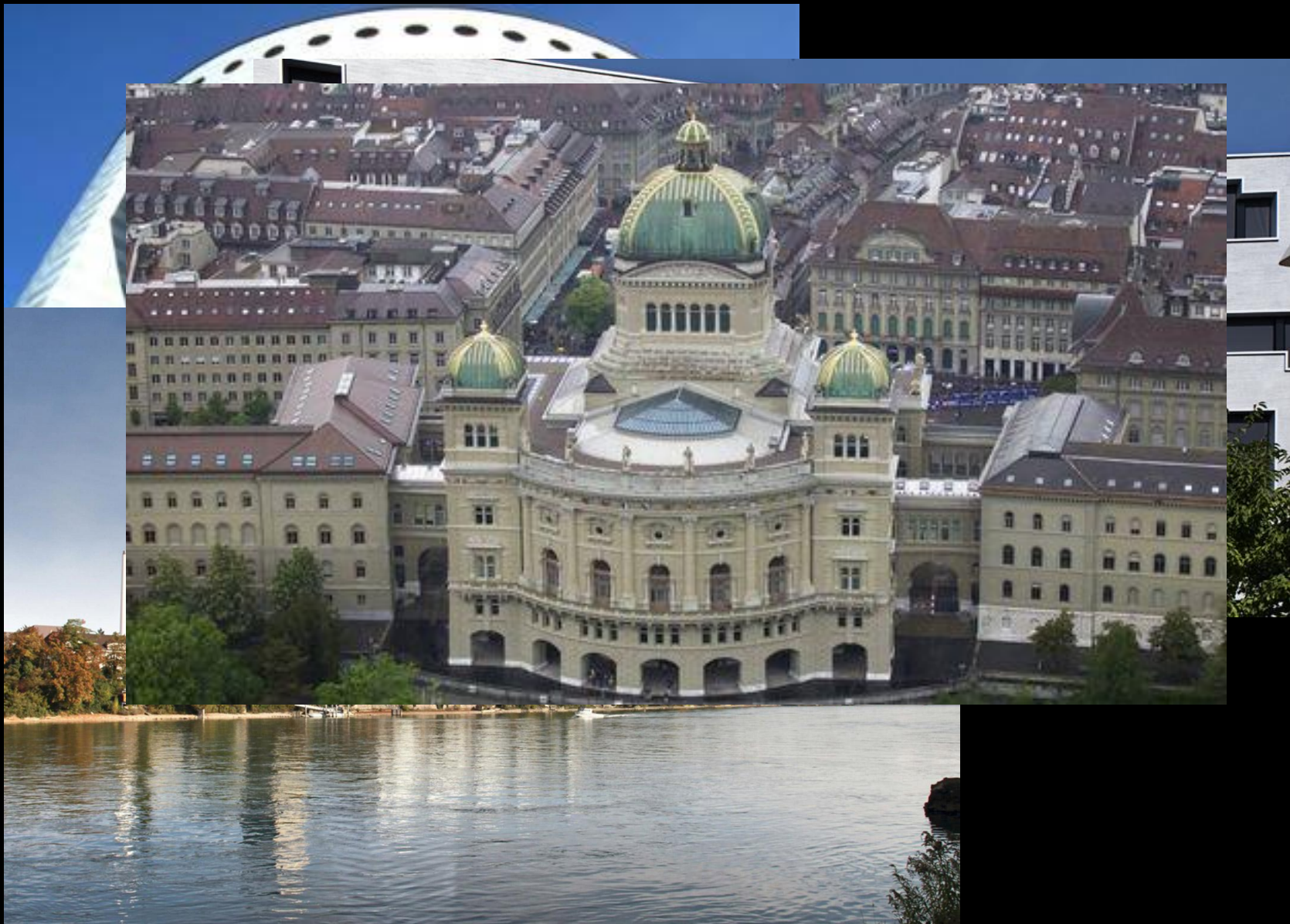
Elegant



Fits to any architectural style







# White photovoltaic module for building facade

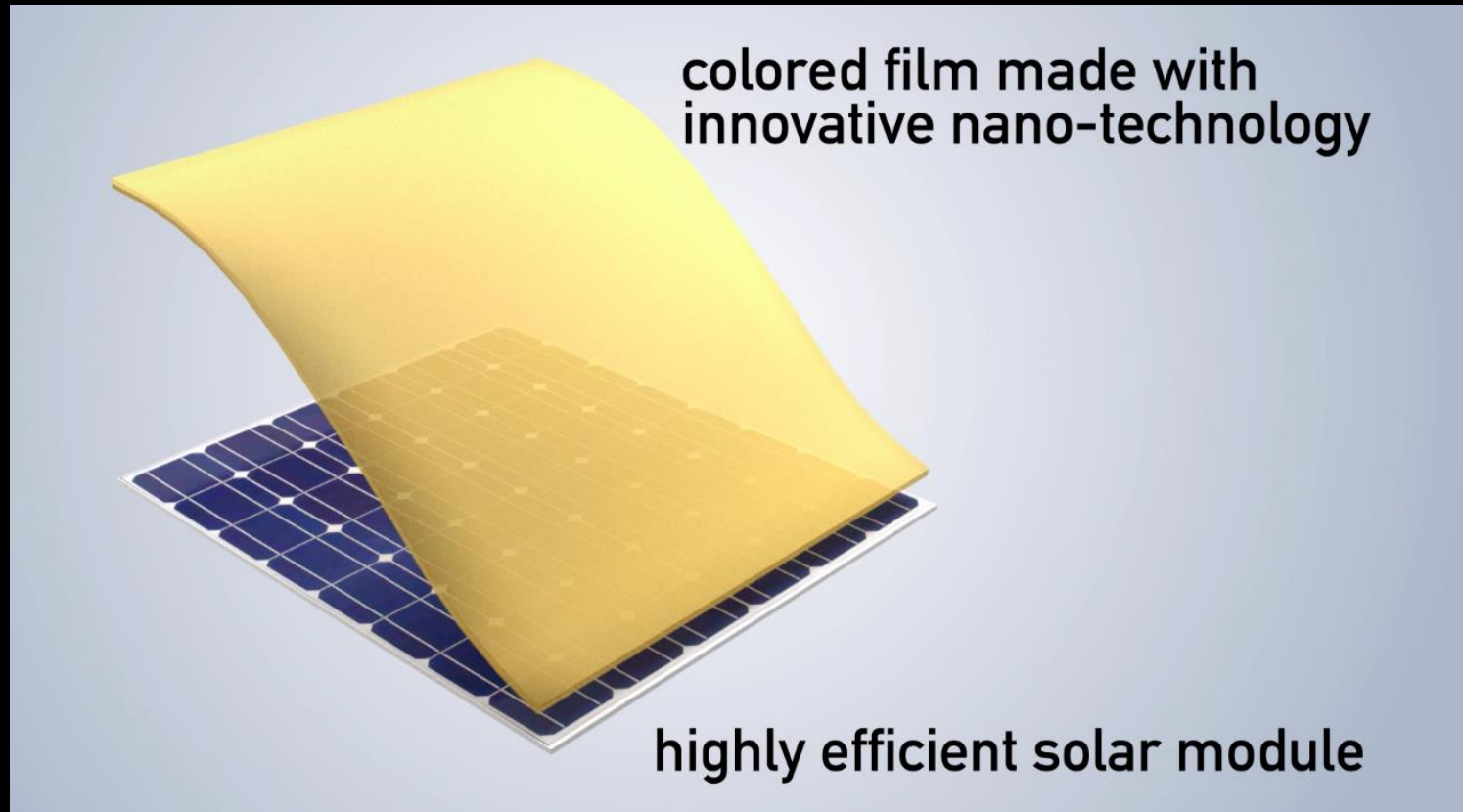


>10% efficiency



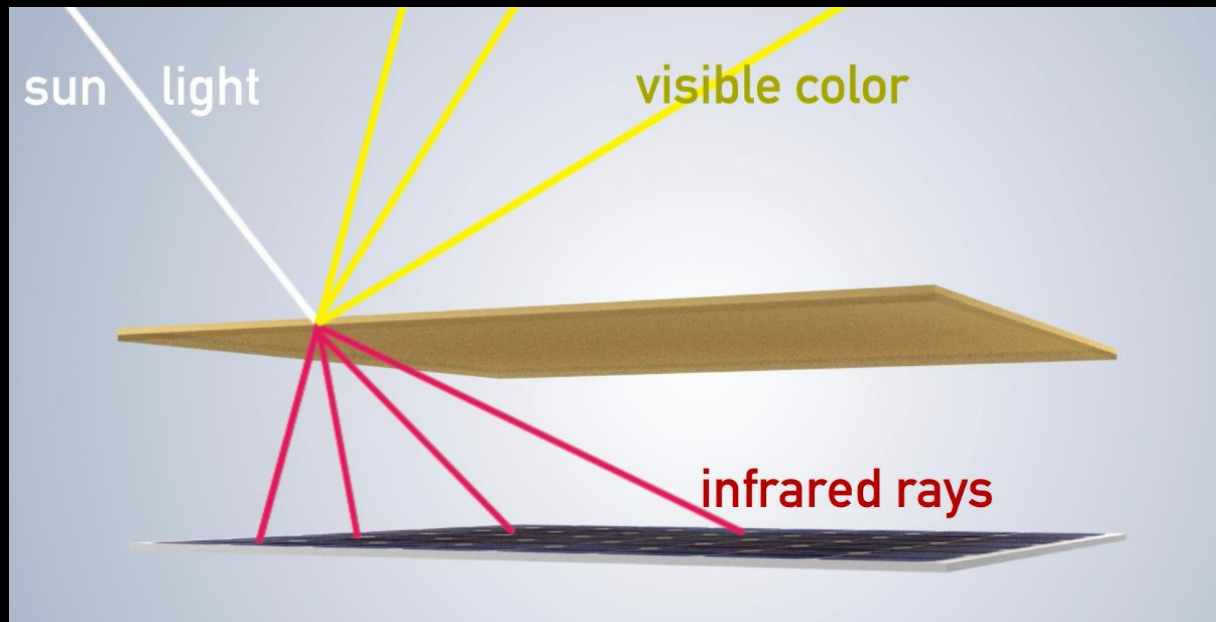
# White photovoltaic modules

How does it work



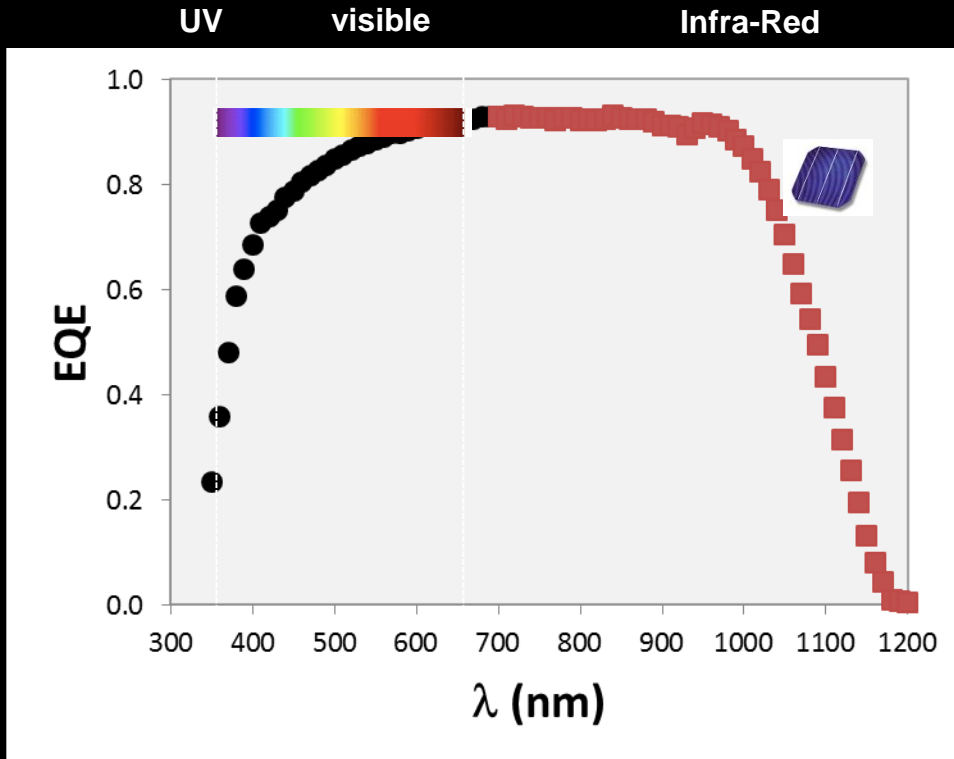
# White photovoltaic modules

How does it work

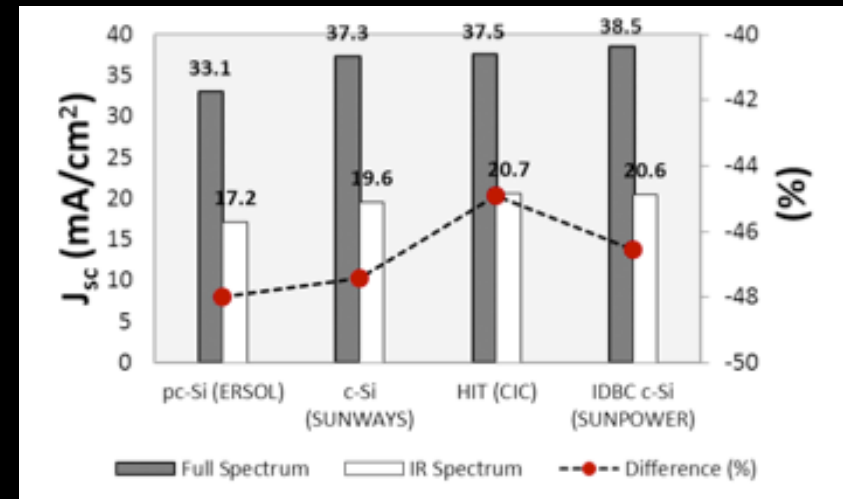


# White photovoltaic modules

How does it work



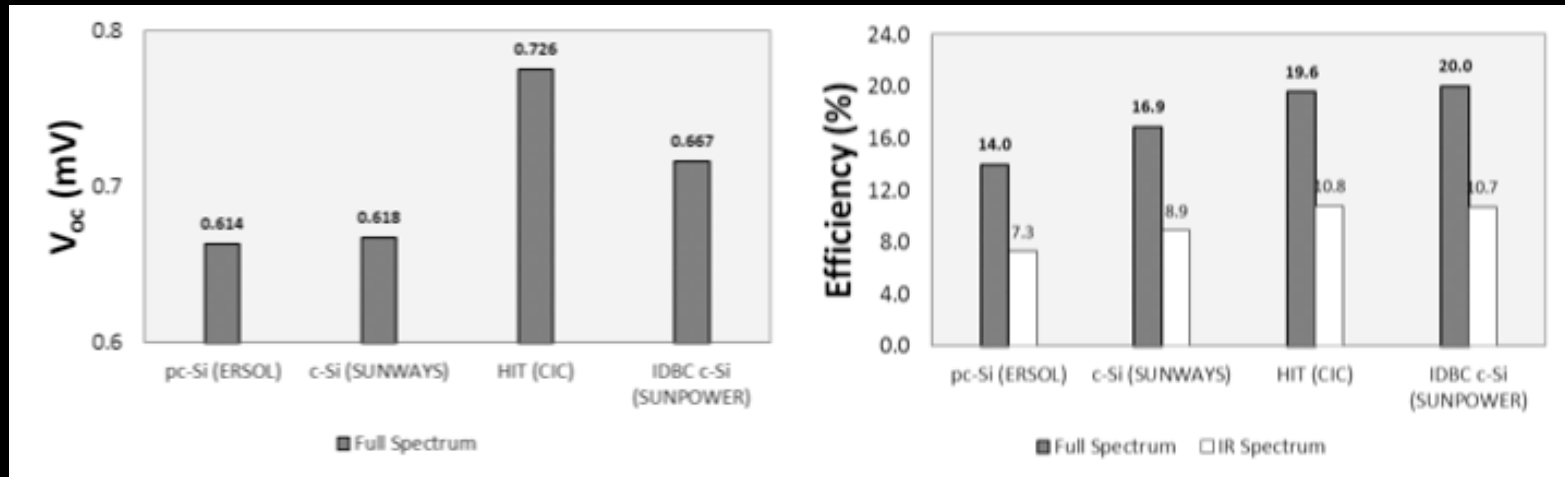
IR response for different silicon solar cells technologies



- HJT solar cells have a particularly high response in the IR part of the spectra
- 55% of its current comes from IR (700-1200nm).

# White photovoltaic modules

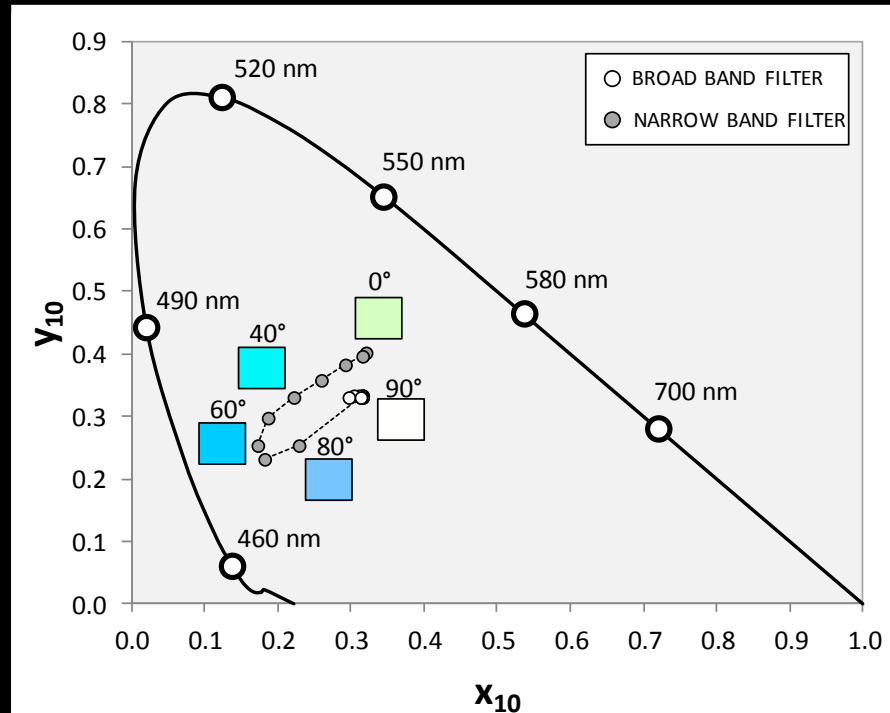
How does it work



- HJT solar cells reach a  $V_o$  close to 730 mV ( standard c-Si cell 630 mV)
- Even without the visible part of the spectra, the overall conversion efficiency can be over 10% !

# White photovoltaic modules

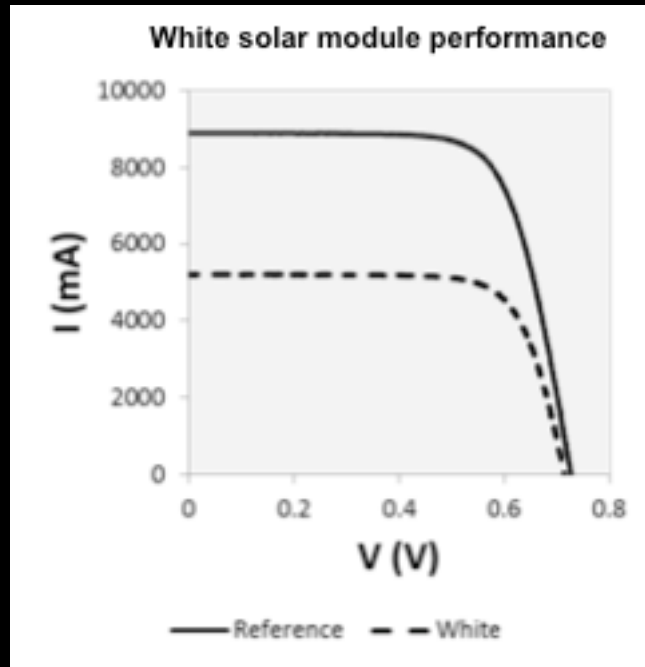
How does it work



Very stable color at every angle of vision (use of broad-band filters)

# White photovoltaic modules

How does it work



Sample	$V_{oc}$ (V)	FF (%)	$J_{sc}$ (mA/cm <sup>2</sup> )	Eff. (%)
Reference	0.727	71.8	36.56	19.1
White	0.714	74.7	21.38	11.4
D (%)	-1.8	4.0	-41.5	-40.2

Cell area (cm <sup>2</sup> )	243.4
Module area (cm <sup>2</sup> )	400

- Homogeneous white appearance
- Module efficiency above 11%



# White photovoltaic modules

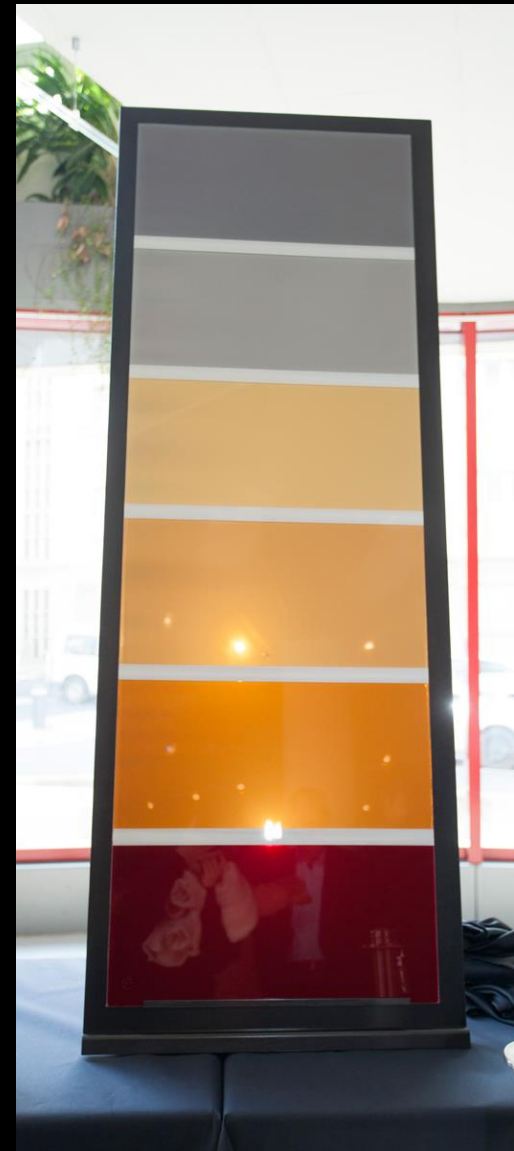
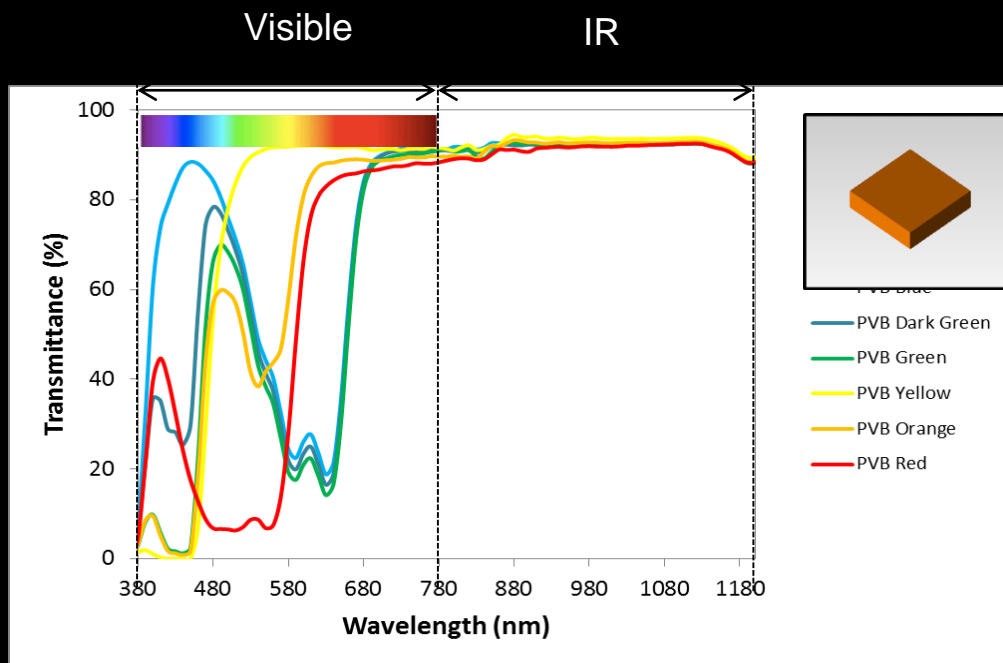
from lab to fab

**SOLAXESS**  
white solar technology

[www.solaxess.ch](http://www.solaxess.ch)

# Colored photovoltaic modules

Next step



# Photovoltaic in buildings

white color



# Photovoltaic in buildings

white & color



# Photovoltaic in buildings

white & color



# White photovoltaic modules

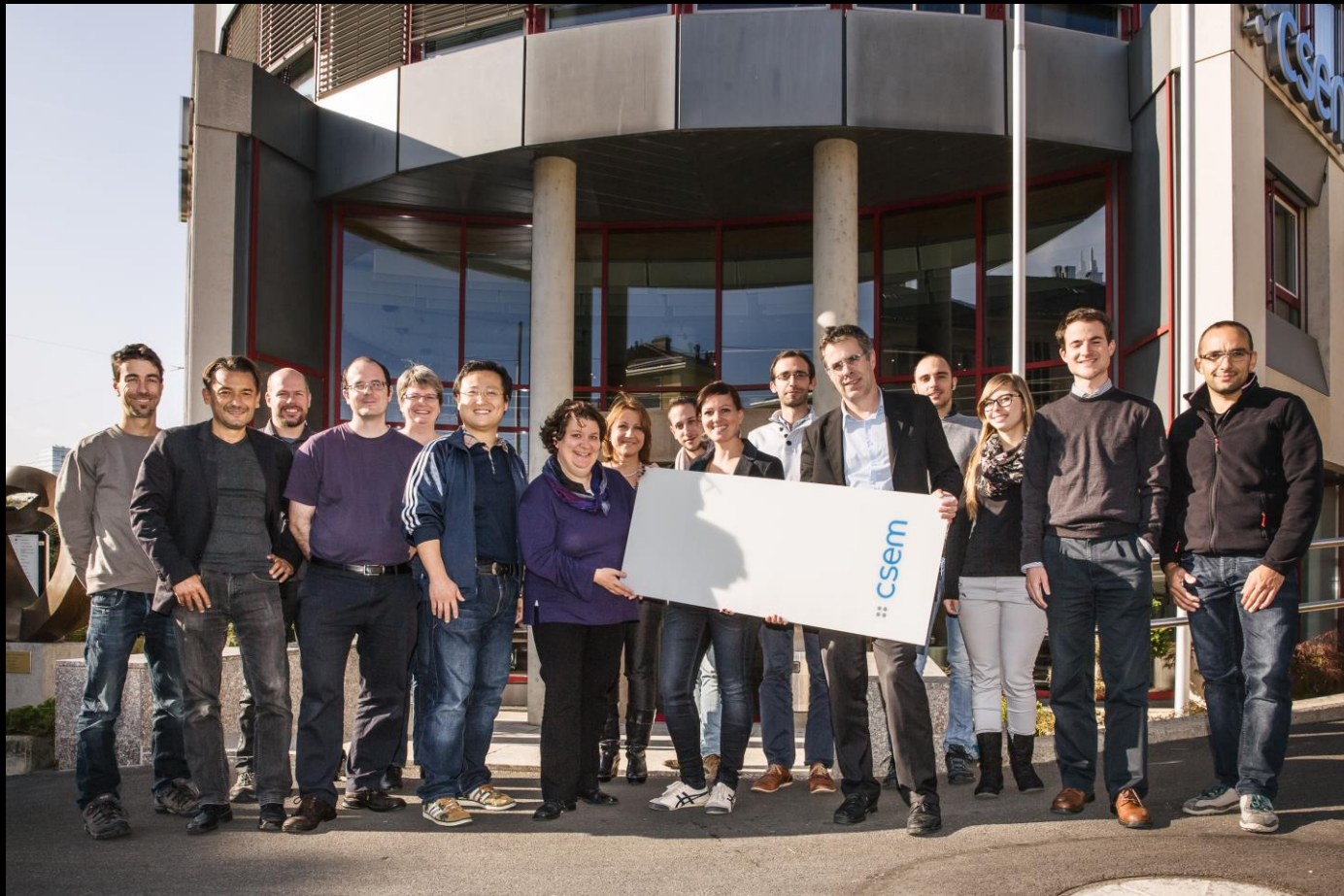
A new building material



From inactive to active building façade!!

# White photovoltaic modules

Who did the work



# Thank you for you attention



Swiss PV flag at 10% efficiency