Scuola universitaria professionale della Svizzera italiana
Dipartimento ambiente costruzioni e design
Istituto sostenibilità applicata all'ambiente costruito

SUPSI

BIPV Status in Europe:
Lessons learned from 40 years of projects

Prof. Francesco Frontini
head of Building System Sector, SUPSI-ISAAC
Swiss BIPV Competence Centre

5 luglio 2021

SUPSI-ISAAC: Building System Sector (www.supsi/isaac)

- Over 18 years of experience in the use of Photovoltaics in architecture in cooperation with industry
- First BIPV project in 2002-3
- Multidisciplinary team: architects, engineers, physicists, technicians
- Unique ISO 17025 accreditated PV Lab in Switzerland

Demonstration and applied research | Test & Qualification | New technology | Sensitization and awareness raising

www.solarchitecture.ch

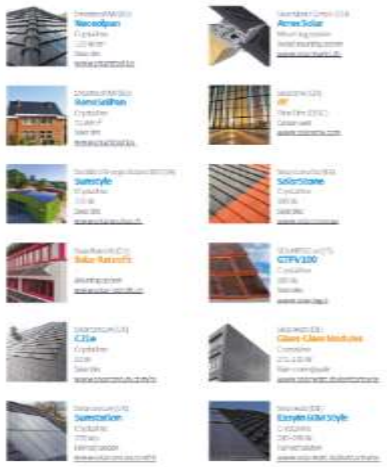
Solar Architecture a long story

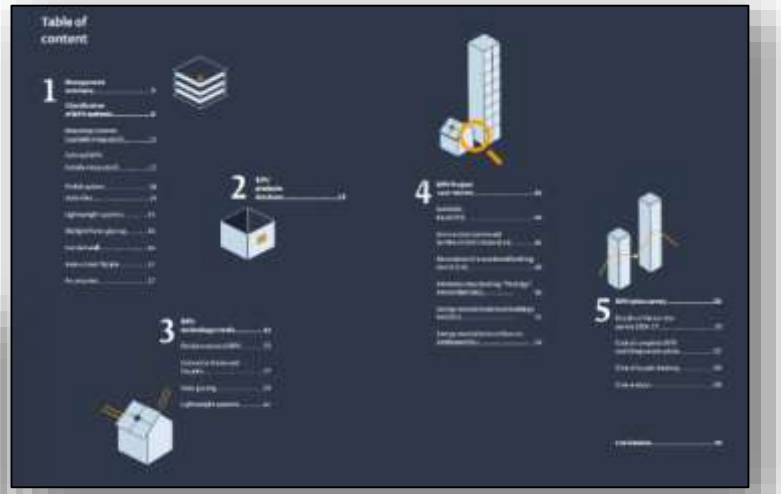
MIT Solar House I, 1939 (direttore di ricerca H.C. Hottel)
First solar Thermal integration into the roof

Edifici residenziali a Monaco (D), Thomas Herzog con Fraunhofer ISE , 1979-82.
In the tilted envelope (the facade and roof are no longer distinguishable) one of the first photovoltaic integrations into the transparent envelope takes place. The architectural strategy of integration can be defined technomorphic since the morphological solution is also designed with the aim of optimizing energy production.

APPROXIMATELY 200 AVAILABLE EUROPEAN PRODUCTS. AN OUTCOME OF THIS ANALYSIS IS THAT THE MOST WIDESPREAD PRODUCTS ARE “FULL ROOF SOLUTIONS” AND “SOLAR GLAZING”. BASED ON THE NUMBER OF PRODUCTS, INROOF (TILES-LIKE) APPLICATIONS HAVE THE LARGEST MARKET SEGMENT

New BIPV Status Report available @ www.solarchitecture.ch





Frontini F., Bonomo P, Chatzipanagi A, Verberne G, van den Donker M, Folkerts W BIPV product overview for solar facades and roofs. Report 2015, SUPSI-SEAC. Available at: www.bipv.ch/index.php/en/component/content/article?id=227:pubblicazioni-posters&catid=58

Solar evolution: beyond technology, beyond cosmetics

1979

© Thomas Herzog, Solar house in Munich

2000

® Rolf Disch, Solar Settlement, Freiburg

2018

© HUGGENBERGERFRIES, Solaris, Zurich

2019

© Rohspace, Hanwha Group, UNStudio arch. Seoul

First Age

Second Age

University of Applied Sciences and Arts of Southern Switzerland
SUPSI

BECQUEREL INSTITUTE

BIPV boost

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Federal Office of Energy SFOE

SOLAXESS white solar technology

ALSOLIS IMPIANTI FOTOVOLTAICI

SOLEAN

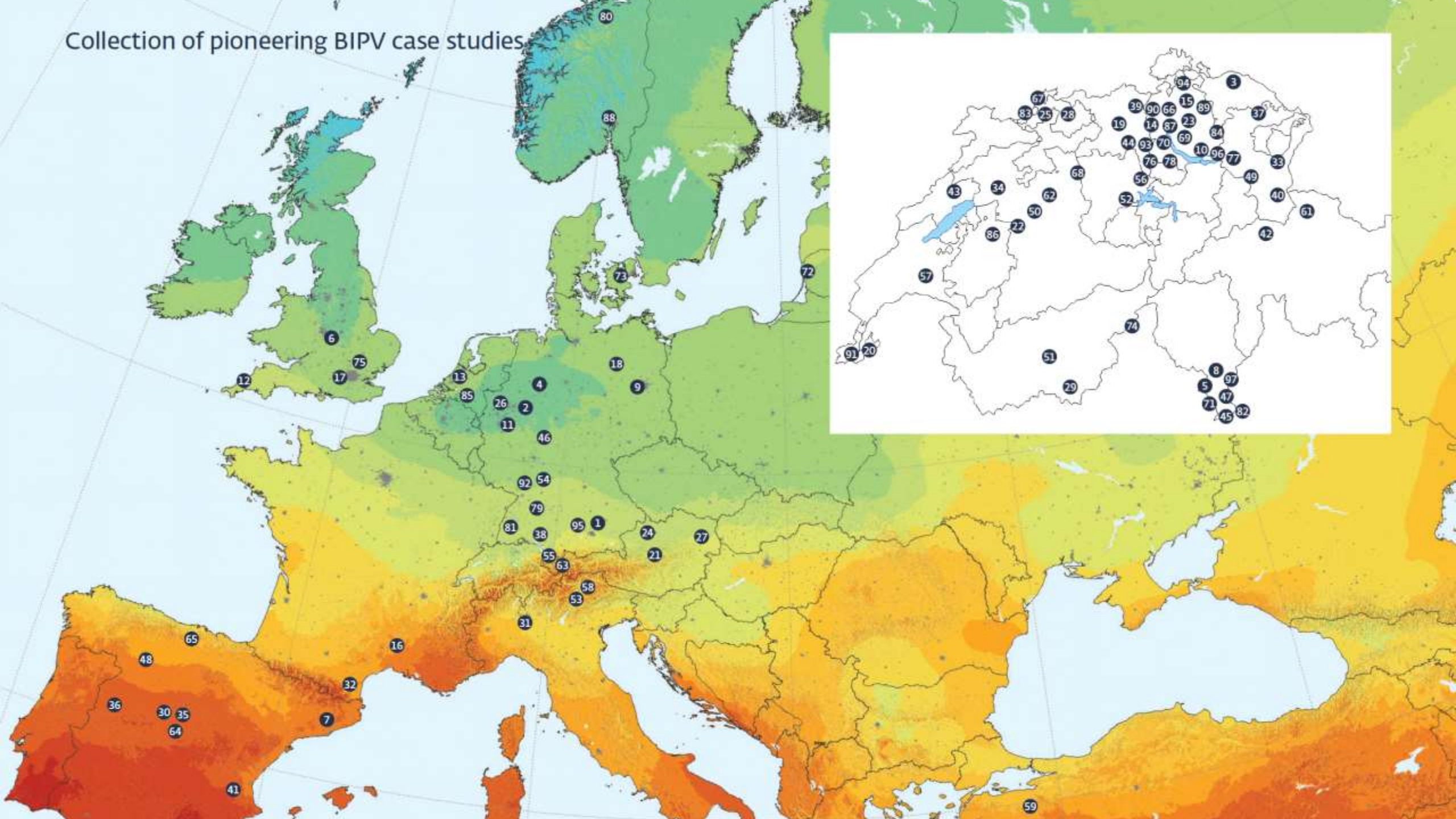
SUNOVATION

Status Report BIPV 2020

A practical handbook for Solar buildings' stakeholders

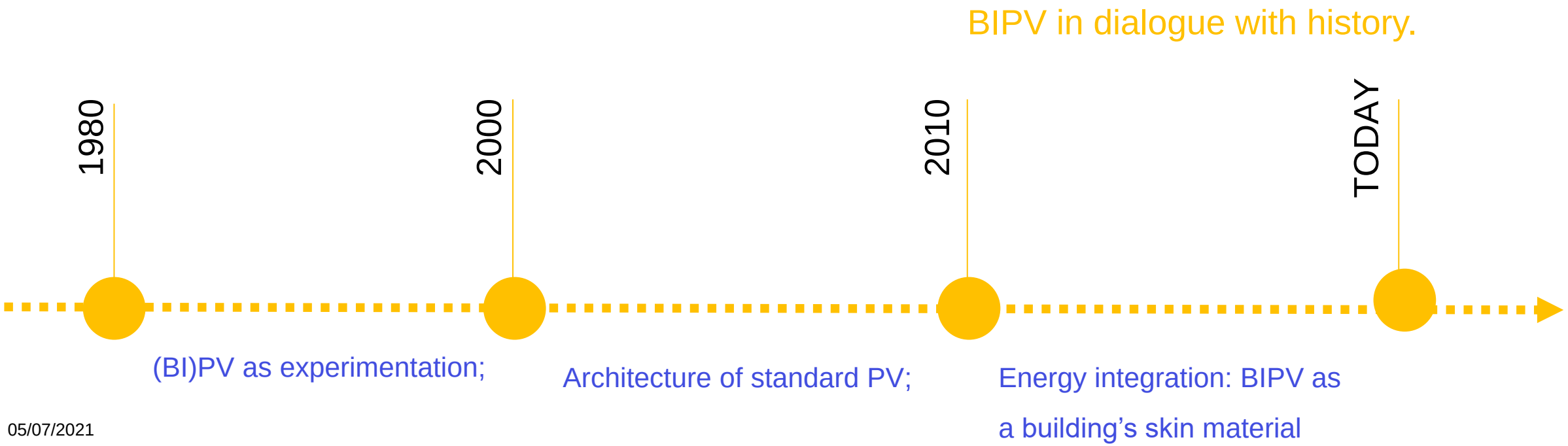
Scan the QR code to download the BIPV Status Report 2020 or connect to solarchitecture.ch for more info

Collection of pioneering BIPV case studies



3+1 different approaches for three different time period

The BIPV case studies are grouped in four characterizing clusters, identified on the base of the historical milestones reached during the evolutionary development of BIPV installations:



BIPV timeline

1970's

First PV solutions for buildings

1982

Wohnanlage Richter (1)

Credits: BDA

First integrated solar installation on a glass surface

1990's

BIPV systems commercially available, concept of multifunctional construction material

1998

Pompeu Fabra Library (7)

Credits: Roberts S., Guariento N.

Experimental semi-transparent curtain wall

1999

"Architects encounter several problems when designing PV buildings. One of the main problems is that PV systems do not correspond with building sizes, [...] the colours and sizes of PV panels are too limited." Task 7 IEA PVPS.

2000

Renewable Energy Sources Act, principles of feed-in-tariff

2001

Tourism Office (16)

Credits: objectifgard.com

Example of BIPV renovation of cultural heritage

2002

BedZed (17)

Credits: ZEDFactory

The first example of Plus Energy District

2009

Monte Rosa Hut (29)

Credits: ETH Zurich

A BIPV plant at 2,883 meters above the sea level

2011

Market Bejar (36)

Credits: Onyx Solar

Refurbishment: coloured and semi-transparent modules

2014

Omicron Headquarters (55)

Credits: Sunovation

BIPV façade and LED glass elements in CI colours

2017

Grosspeter Tower (83)

Credits: NICE Solar Energy

The solar skyscraper in Switzerland

2018

BIPVBOOST. Bringing down the cost of multifunctional building-integrated photovoltaic (BIPV) systems

Definition of BIPV. IEA-PVPS T15-04 International definitions of "BIPV"

2018

"Nobody can know that it is a solar-powered house." Architect Erika Fries, HUGGENBERGERFRIES Architects

2018

Rural House Galley (86)

Credits: CSEM

Coloured terracotta modules in a refurbishment

2021

CP Pregassona (97)

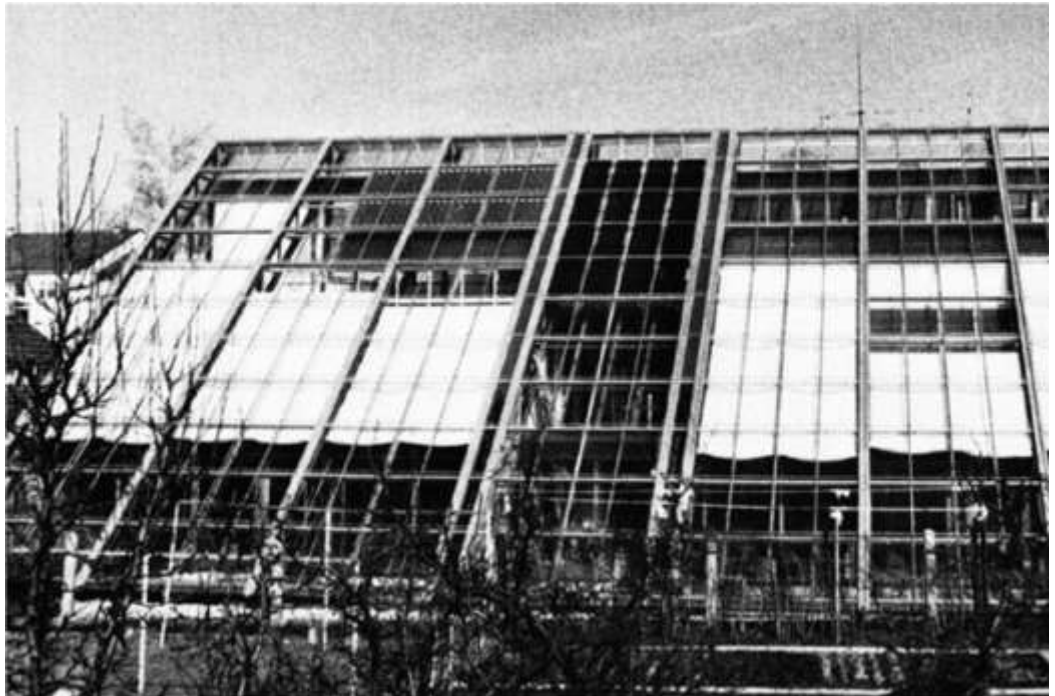
Credits: Alsolis

The largest BIPV façade in Ticino (CH)

www.solarchitecture.ch

(BI)PV as experimentation: 1982 the “first” solar house in Munich

- The first PV solutions for buildings began appearing in the 1970s
- but it is only from the 1980s that photovoltaic solutions’ add-ons to roofs began being demonstrated
- It is only from the 1990s that the first PV systems to be integrated in the building envelope became commercially available



Wohnanlage Richter, Germany. Credits: Bund Deutscher Architekten and e-periodica.ch.

90s: Public library Pompeu Fabra, Matarò, Spain.

- This project aimed to show the potential of the European photovoltaic industry
- The facade consists of 225 m2 of photovoltaic solar panels of polycrystalline silicon.
- Inside the building, the panels allow the entry of natural light.

Source: Roberts, Simon and Guariento, Nicolò. Building Integrated Photovoltaics: A Handbook. Basel: Birkhäuser, 2009

© Pedro Armestre / Greenpeace

The early 2000s

- In the early 2000s, the solar industry demonstrated that solar PV technology could be efficiently deployed, at various scales, with several installations around the world.



- However, despite the efforts to enlarge the market spread of BIPV systems, by the end of 2009, solar systems that are partially or fully integrated to the building skin accounted for about 1% of the installed capacity of distributed PV systems worldwide
- the upfront investment costs of BIPV systems were one of the major impediments to wider market penetration
- In 2003, the average cost of a conventional PV system was appointed at 8,75 $/Wp * .
- In order to speed up the diffusion of such systems, around the end of the 2000s, subsidies for solar systems were introduced by various local governments.

* Feldman, David, et al. Photovoltaic (PV) Pricing Trends: Historical, Recent, and Near-Term Projections. s.l.: U.S. Department of Energy, 2012.

Architecture of standard PV

- Built in 2012 by the architects Viriden+Partner AG
- Retrofit building
- Covered with 295m² of standard c-Si PV modules integrated on the façade
- Additional 110m² of building applied PV (BAPV) on roof
- Positive energy balance.

MFH Alleestrasse, Romanshorn, Switzerland.
Credits: Viridén + Partners.

MFH Alleestrasse, Romanshorn, Switzerland. arch: Viridén + Partners.

Credits: EcoRenova AG, Zürich

Credits: EcoRenova AG, Zürich

TODAY the Energy integration: BIPV as building's skin material

- Thanks to industrial developments, during the first decade of the 2000s, a wide range of solar products for the building sector became available at attractive prices.
- The BIPV products developed today inverted the trend and made a breakthrough approach available:
  → **PV can become a conventional construction element.**

Copenhagen International School, Copenhagen, Denmark.

Credits: C.F. Moller Architects.

VARIEGATED (NEW) MARKET DEMANDS AND DESIGN COMPLEXITY

«MY PV ROOF» «AVARAGE» BUILDINGS «VALUABLE» BUILDINGS NZEB or PEB

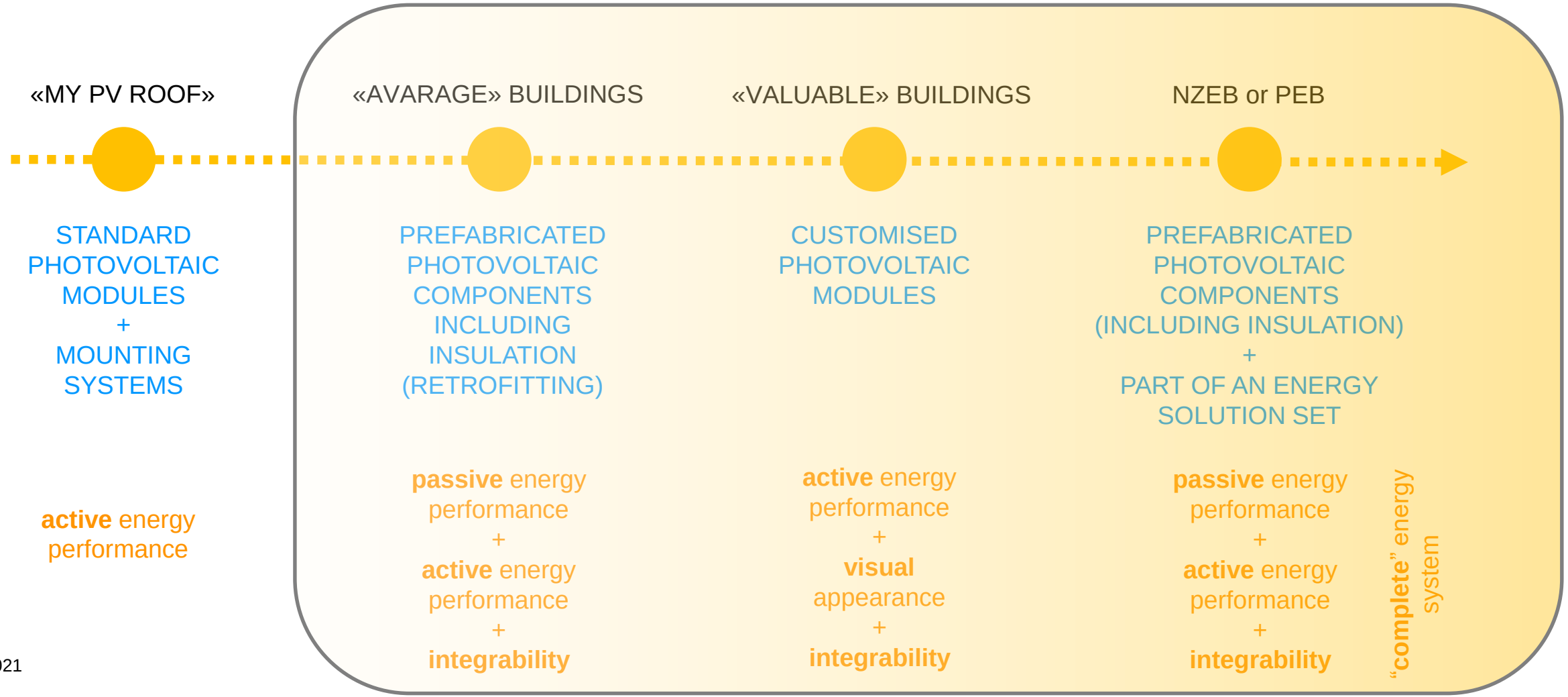
RETROFIT **NEW**

Scognamiglio A., Frontini F, "BIPV". GETTING THE TECHNOLOGY AND INTEGRATION BALANCE RIGHT, 32nd European Photovoltaic Solar Energy Conference | EUPVSEC

NEW REQUIREMENTS (COMPLEXITY)

R&D FOR DIFFERENT ACTORS

INNOVATION POTENTIAL



Roof solutions

Full integration, dimension and color

Source: www.solarchitecture.ch, Casa Schneller Bader
Arch. Lutz architectes
Tiles: Ernst Schweizer AG, Solstis AG, CSEM

Source: www.solarchitecture.ch, Casa Schneller Bader
Arch. Bearth & Deplazes Architekten AG
Tiles: 3S Solar Plus

Roof solutions

Different forms and dimensions possible

SchweizerMetalabau

Soltop, 996x1660 mm

3S Solar Plus, Megaslate tiles, min 985x875

Flisom lightweigh roof solution

Panotron, 375x155mm

Swisspearl, Integral, 1300x900mm

Solariresuisse, Sunstyle, 870x870mm

Flisom lightweigh roof solution

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© energieSchweiz, SUPSI. Photo: C. Martig
Lauper Pilot Installation

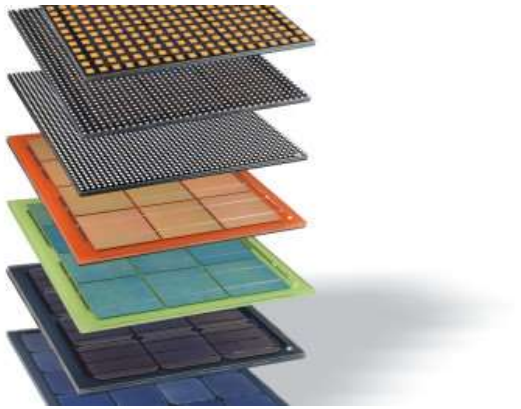
Façade solutions: opaque vs transparent

(source: Kamaleon Solar)

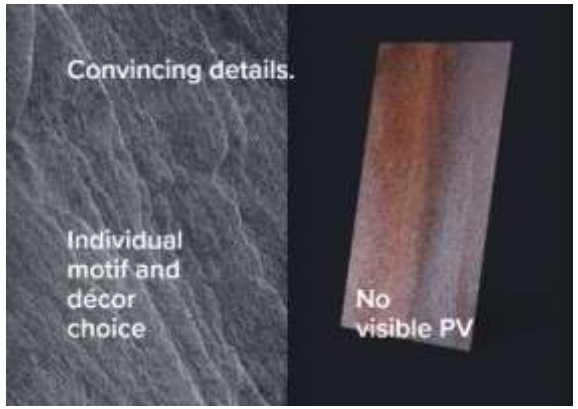
(source: AGC Technovation center, Gosselies, Belgium)

New aesthetic potentials for active opaque facades

(source: ISSOL)

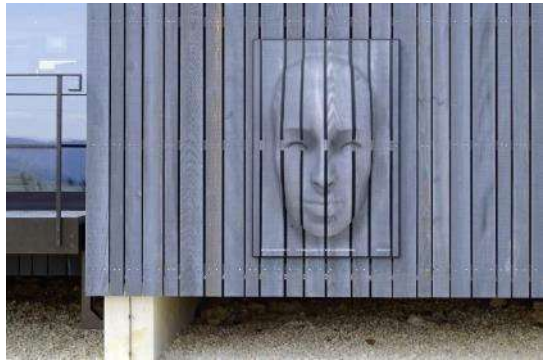


(source: ERTEX)



(source: SUNOVATION)

(source: Kamaleon Solar)



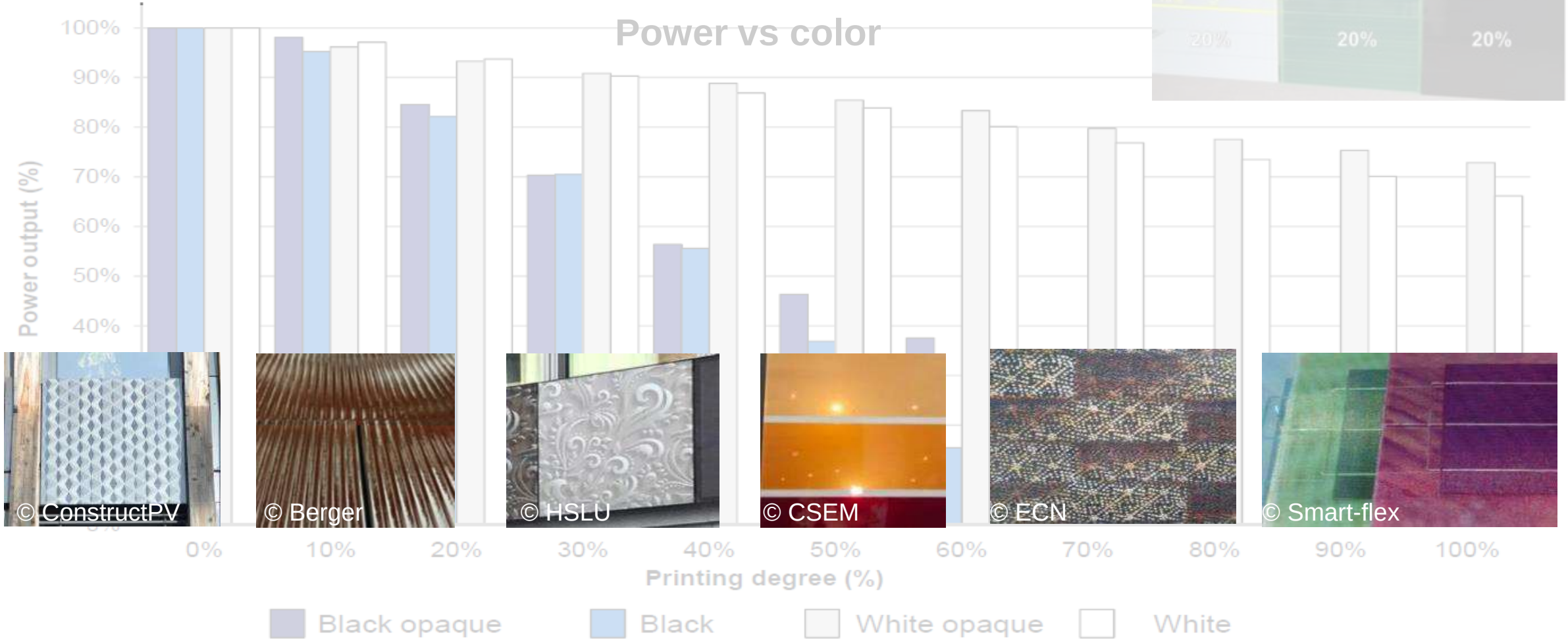
(source: COMPAZ)

(source: SWISSINSO)

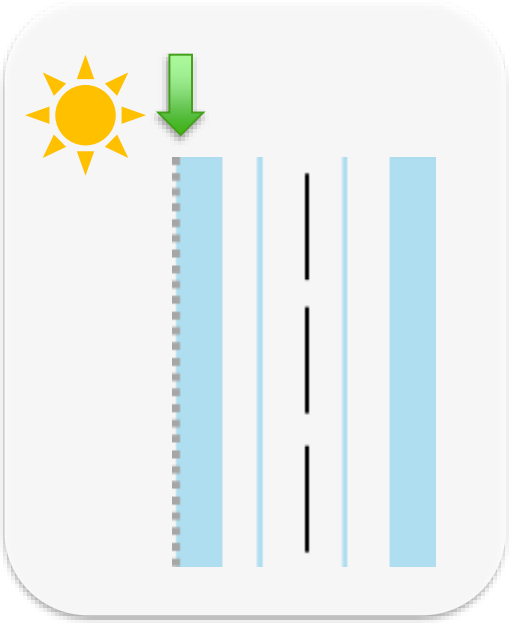
(source: SOLAXESS)

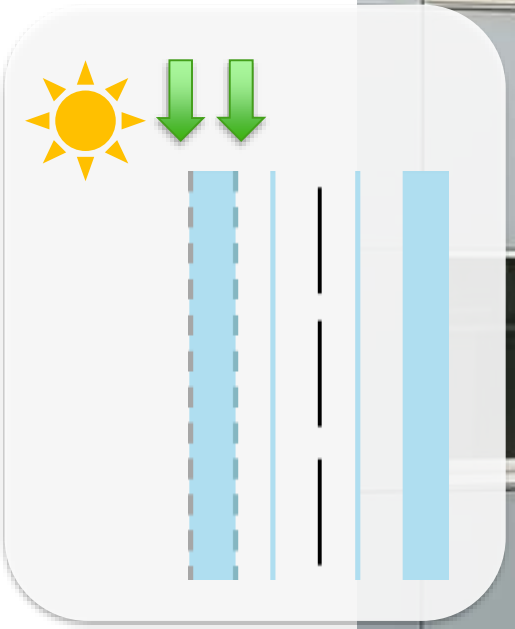
(source: Sunage SunCol)

How much does the aesthetics "cost"?

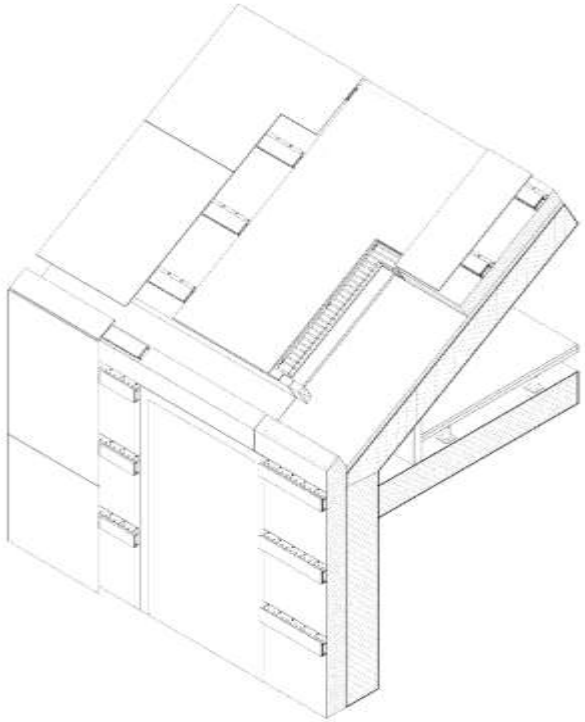


IEA PVPS Task 15: ST-E report: Coloured BIPV : Market, Research and Development





source: Solarchitecture.ch
Drawing: Project of the facade and roof by ETHZ (BUK)



Vacallo, arch. DELTAZERO
© Picture: Frontini

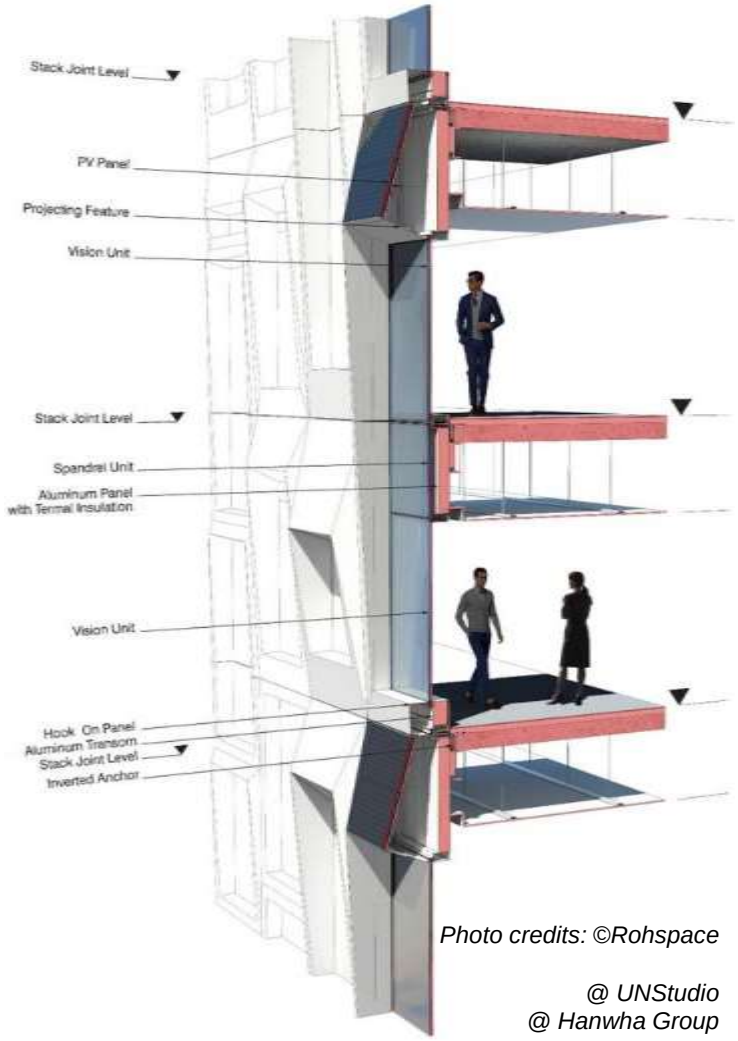
New opportunities for active transparent facades

The glass facade market is very big (~900'000 m^2 every year only in Switzerland)

In Asia and US the high-rise building market is still very big and need special solution

Challanges:

- Transparency
- Glare
- Visual appearence
- Solar Control
- Static and dynamic solutions



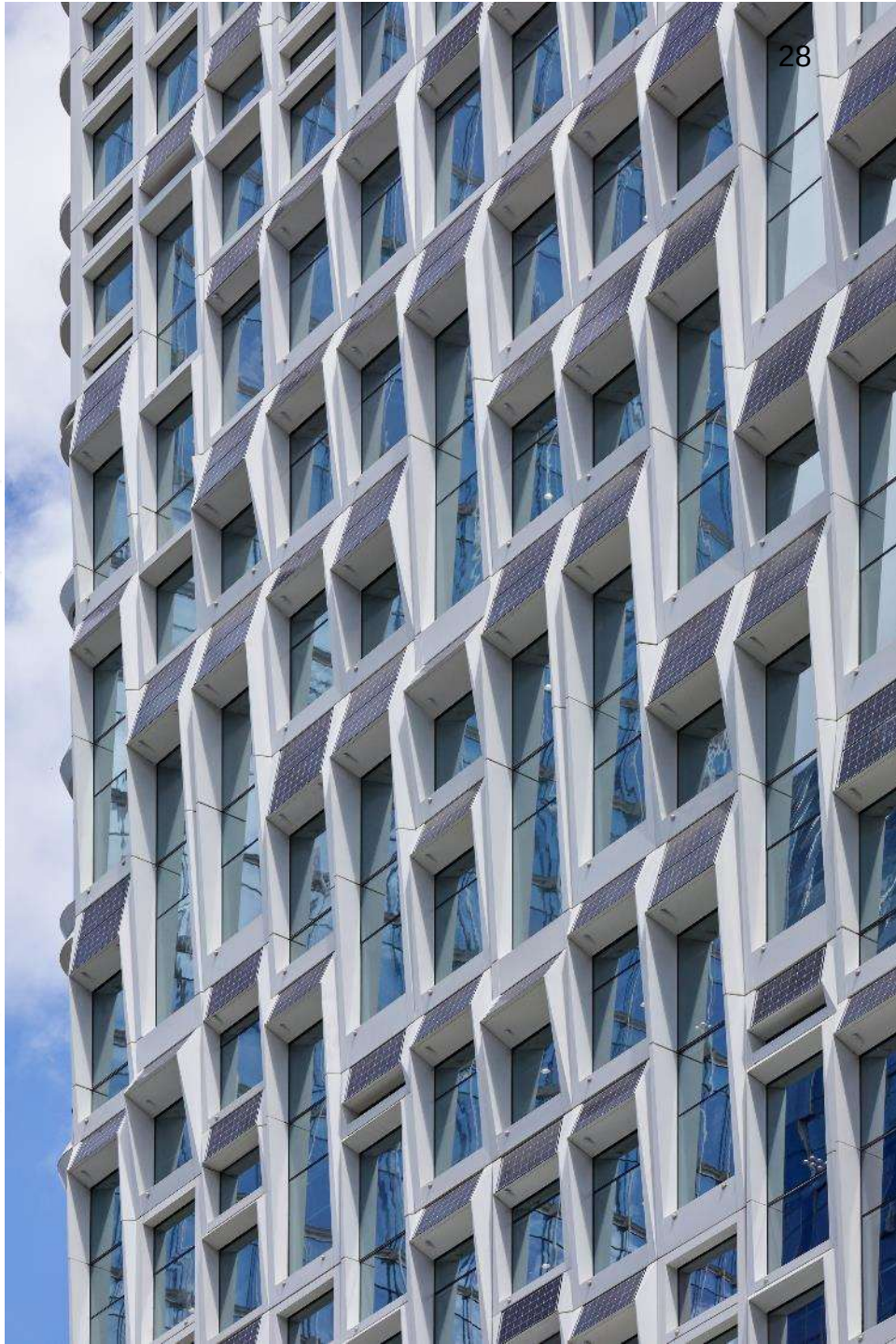


Photo credits: ©Rohspace

@ UNStudio
@ Hanwha Group

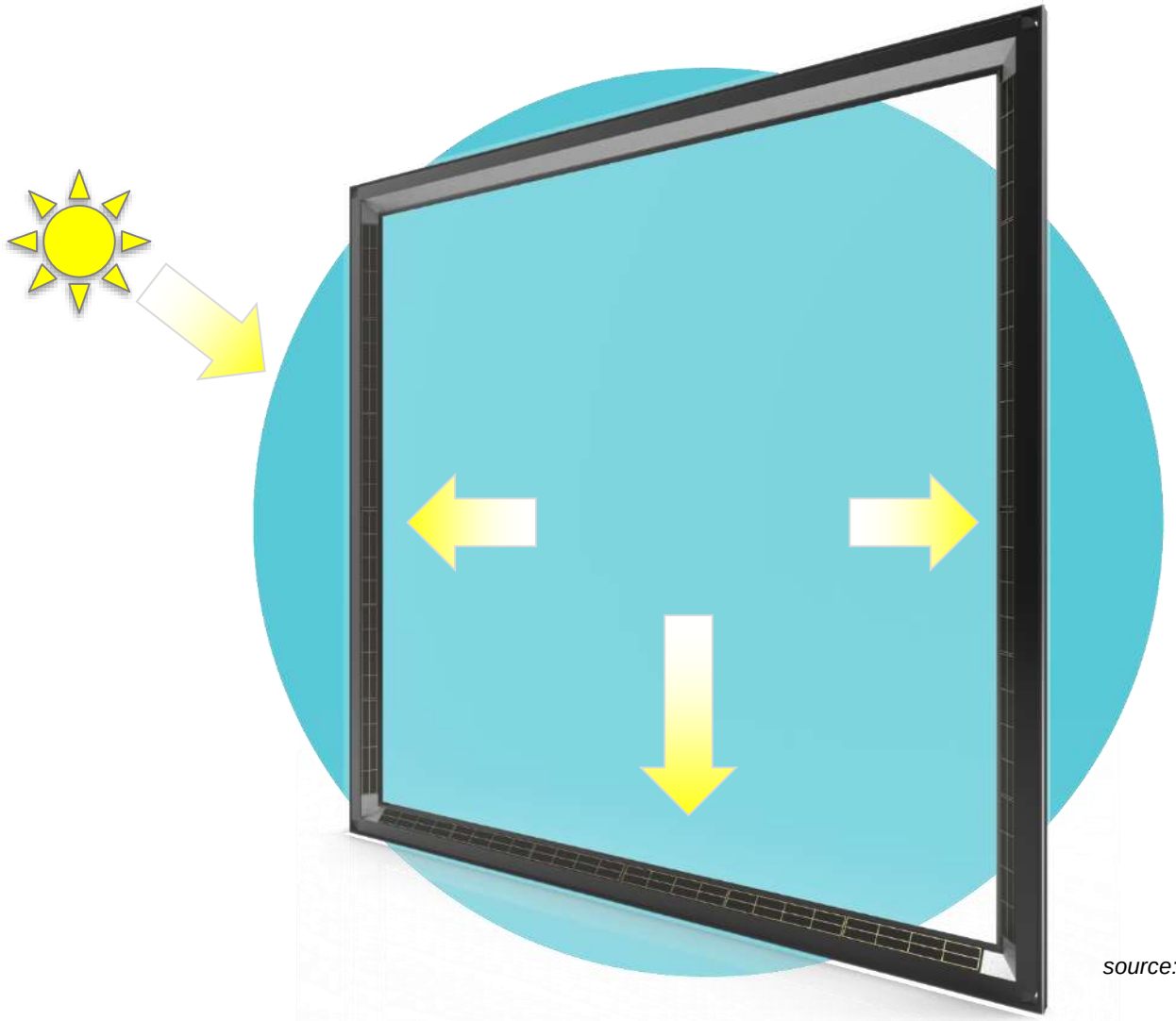
How to keep transparency while producing renewable energy?

source: AGC Glass Europe
Second skin in SunEwat Vision Square

source: Physee

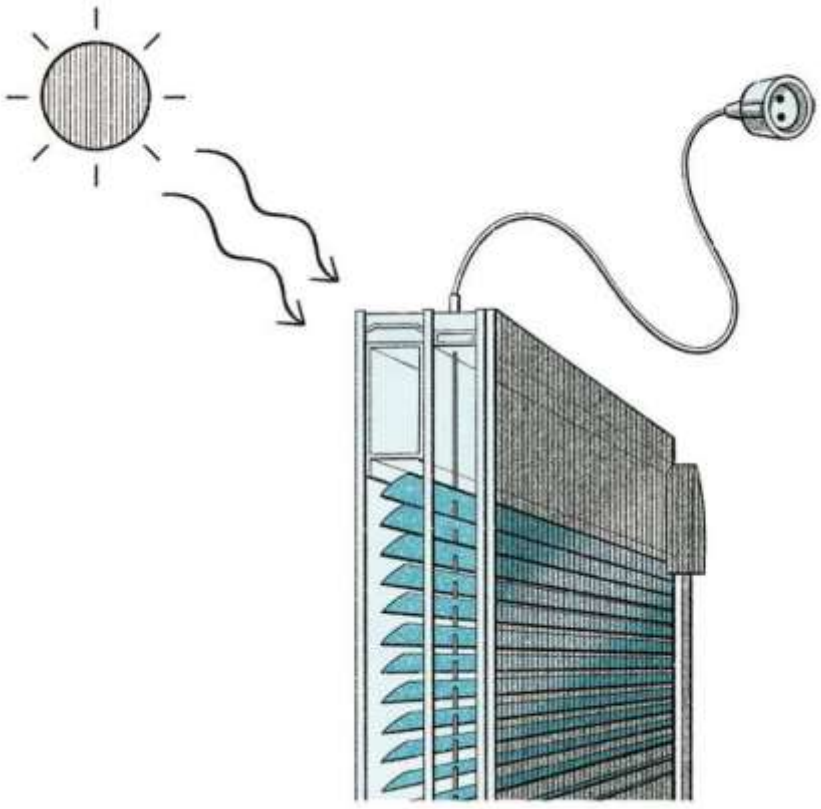
Power and transparency

- Insulated glass unit
- Luminescent solar concetrator
- Light re-direction
- High Efficient solar cell
- Possible also in Retrofit

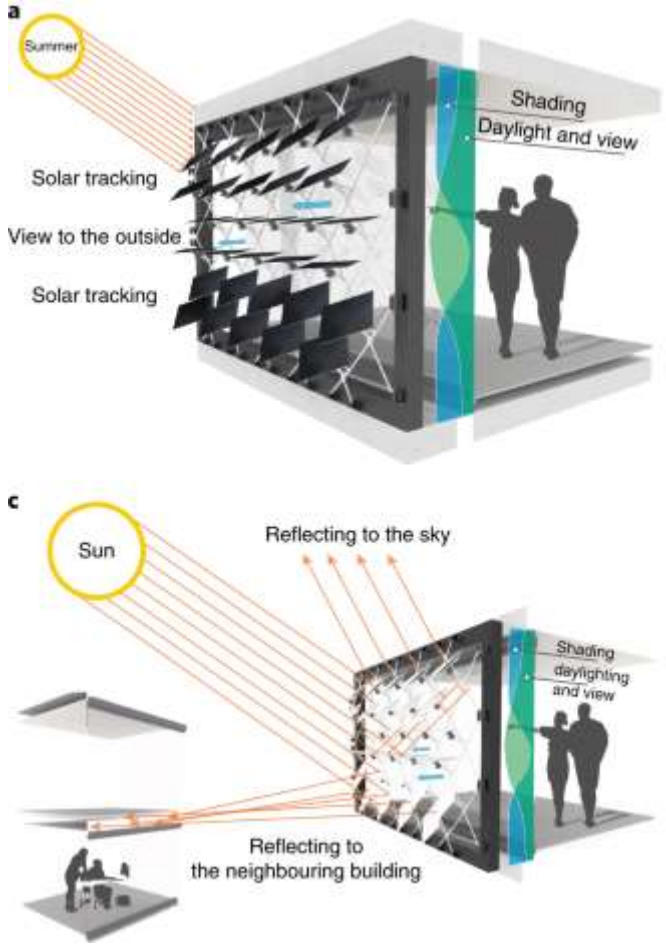


source: Physee

Power and Solar Protection through adaptive facade



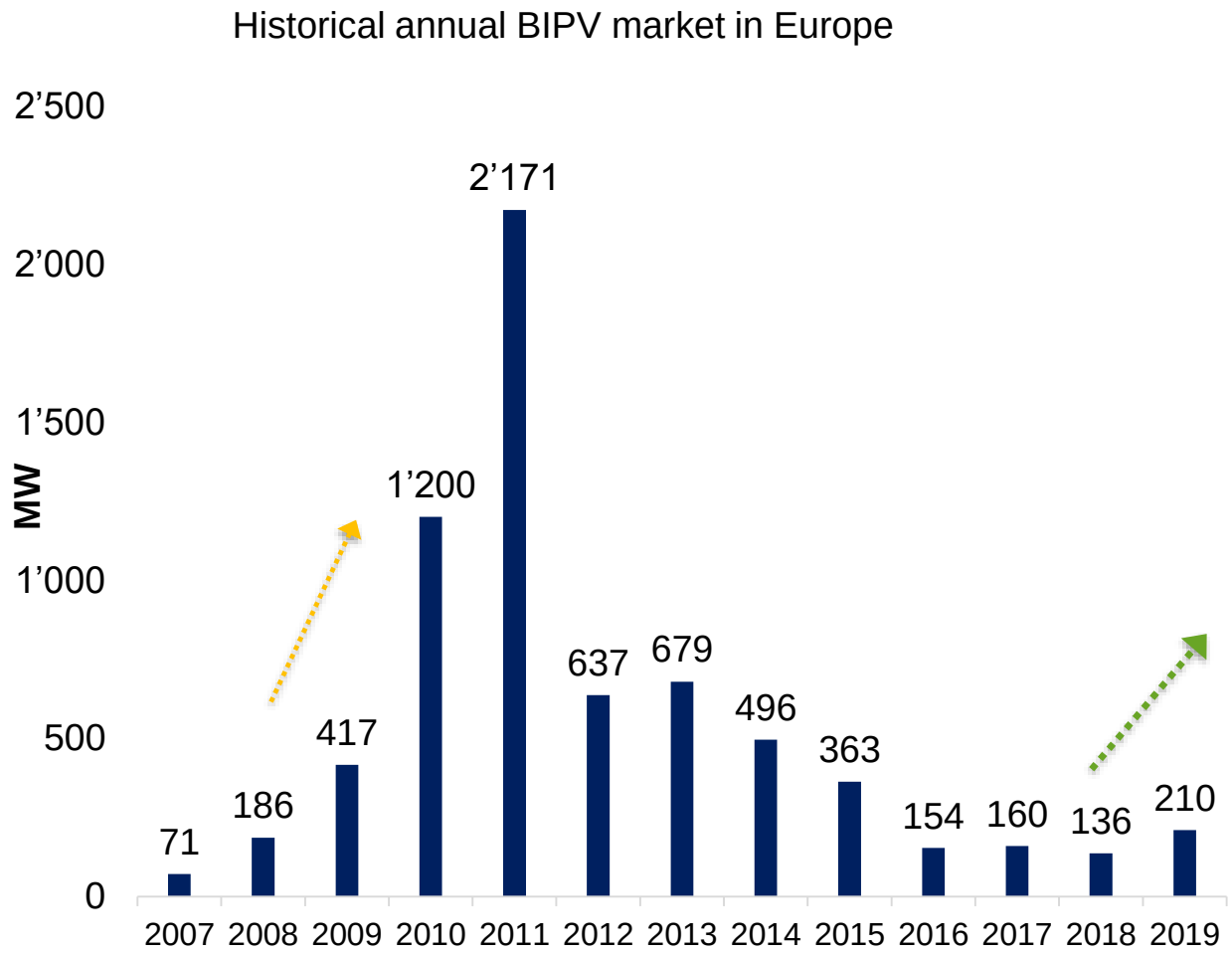
https://www.horizons-mag.ch/2020/06/04/projects-for-a-better-climate/
www.iwin.ch



Svetozarevic, B., Begle, M., Jayathissa, P. et al. Dynamic photovoltaic building envelopes for adaptive energy and comfort management. Nat Energy 4, 671–682 (2019). https://doi.org/10.1038/s41560-019-0424-0

The BIPV market peaked about 10 years ago

- Historical BIPV market grew significantly from 2008 to 2011.
- This can be explained by generous support schemes for BIPV.
- BUT the definition of BIPV applied in those years is incomparable to today's definition.
- The modification and/or disappearance of these incentives caused the BIPV market to sharply slow down.

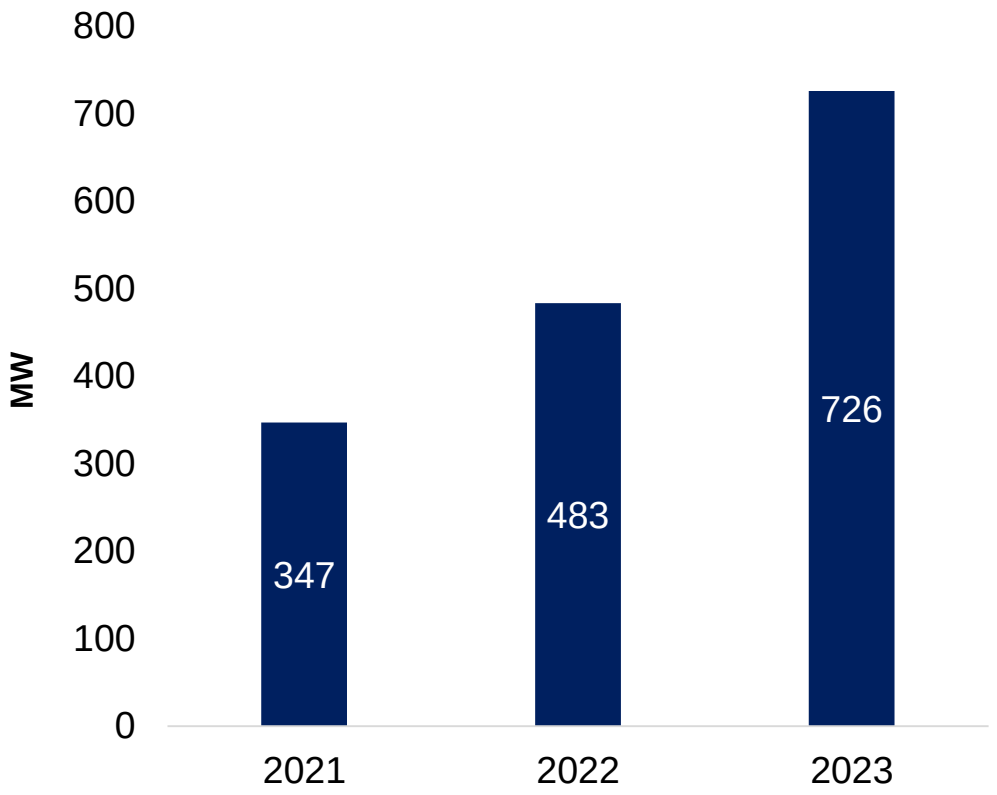


Source: Becquerel Institute

Perspectives for the European BIPV market are favourable

- The BIPV market should keep on growing, potentially reaching 500 MWp by 2022.
- Main markets: France, Netherlands, Switzerland, United Kingdom.
- All BIPV segments are expected to grow.
- In particular, the residential segment is expected to lead the market, via BIPV roofing solutions.

Projected annual BIPV market in Europe (in MWp)



Source: Becquerel Institute

Concludions: how to win this game?

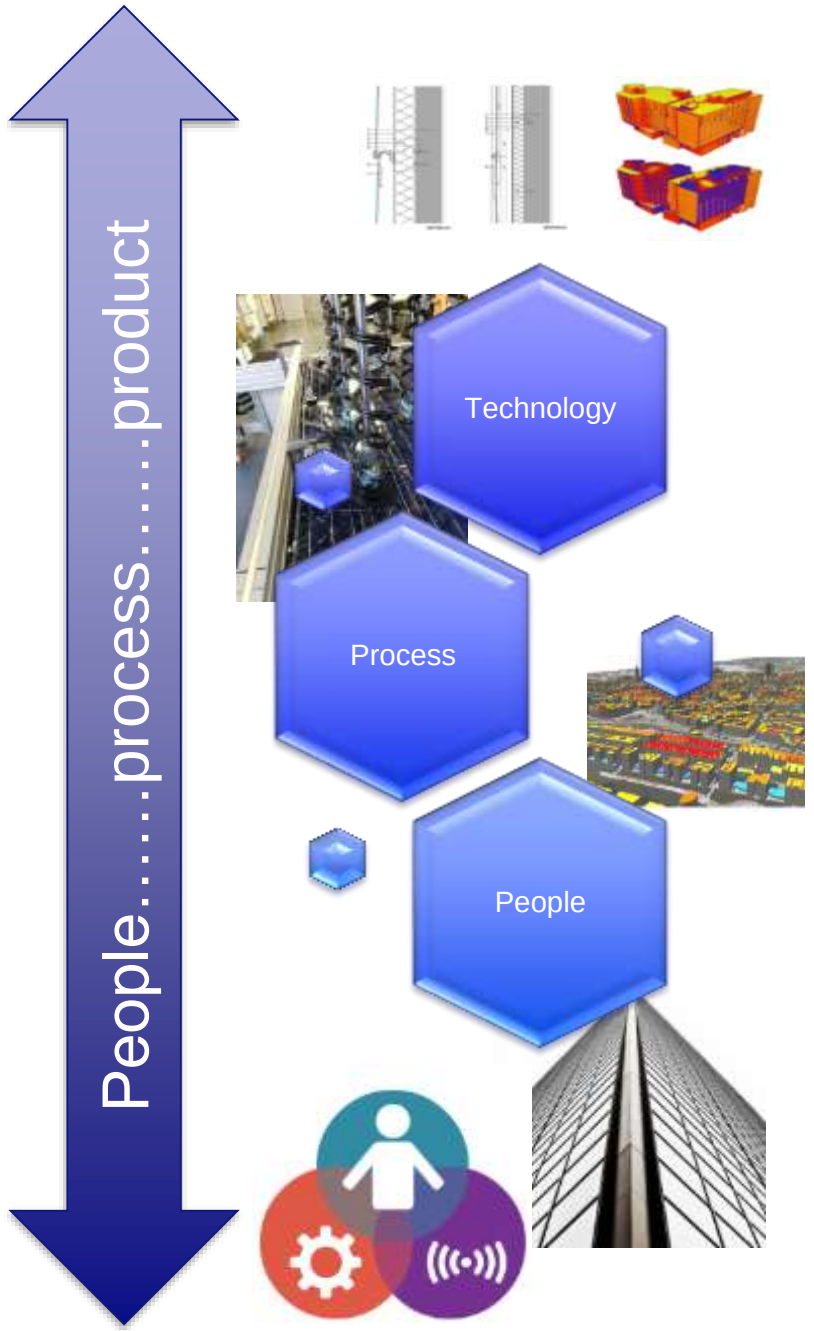
*(1) implementing a large degree of **flexibility and automation** in the manufacturing of BIPV*

*(2) developing a range of **multifunctional** and **cost-competitive solutions** for building skins*

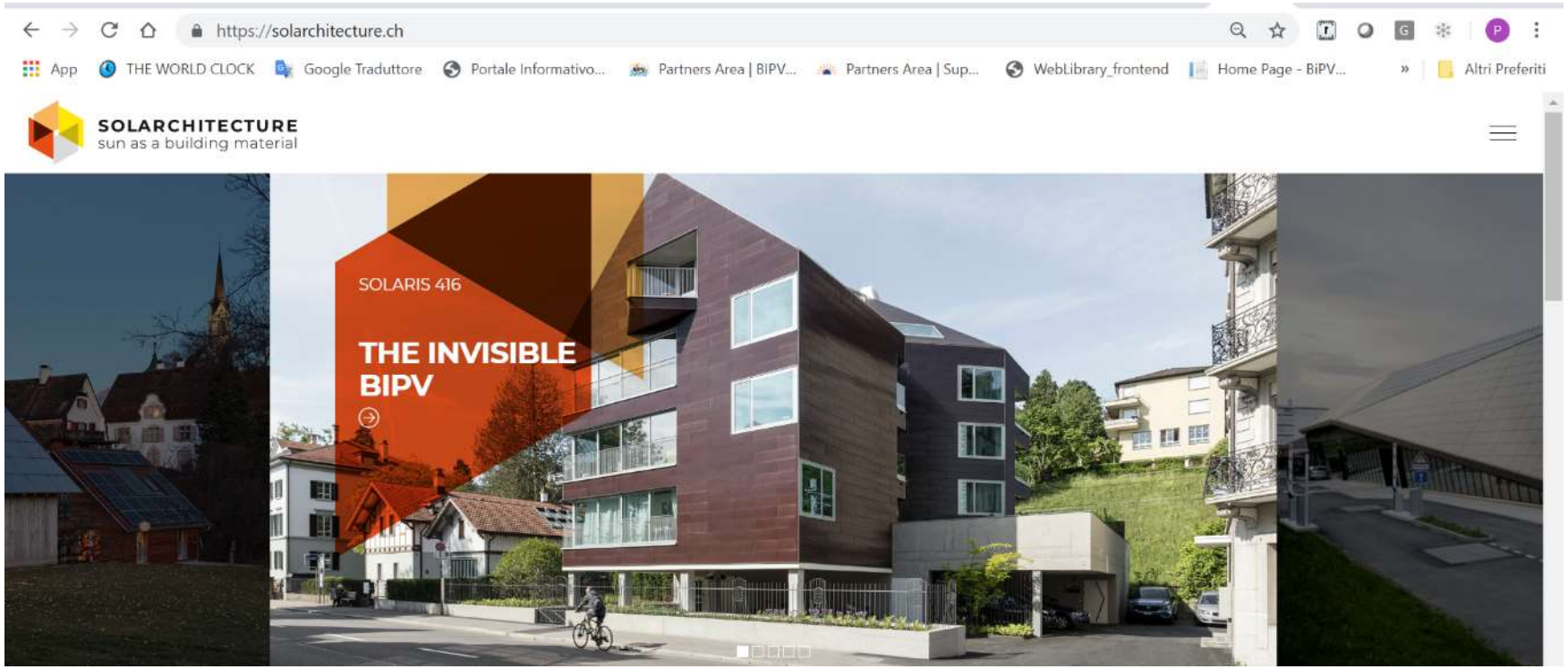
- Aesthetics, dimensions, static vs dynamic solution

*(3) defining a **qualification (measurement) process** that simplifies the standardization framework*

*(4) new **BIM-based digital solutions** to enhance the collaboration throughout the value chain*



Platform for «sun as a building material»: www.solarchitecture.ch



Thank you for your attention

Scuola Università Professionale della Svizzera Italiana - SUPSI
Institute for Applied Sustainability to the Built Environment - ISAAC

francesco.frontini@supsi.ch

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