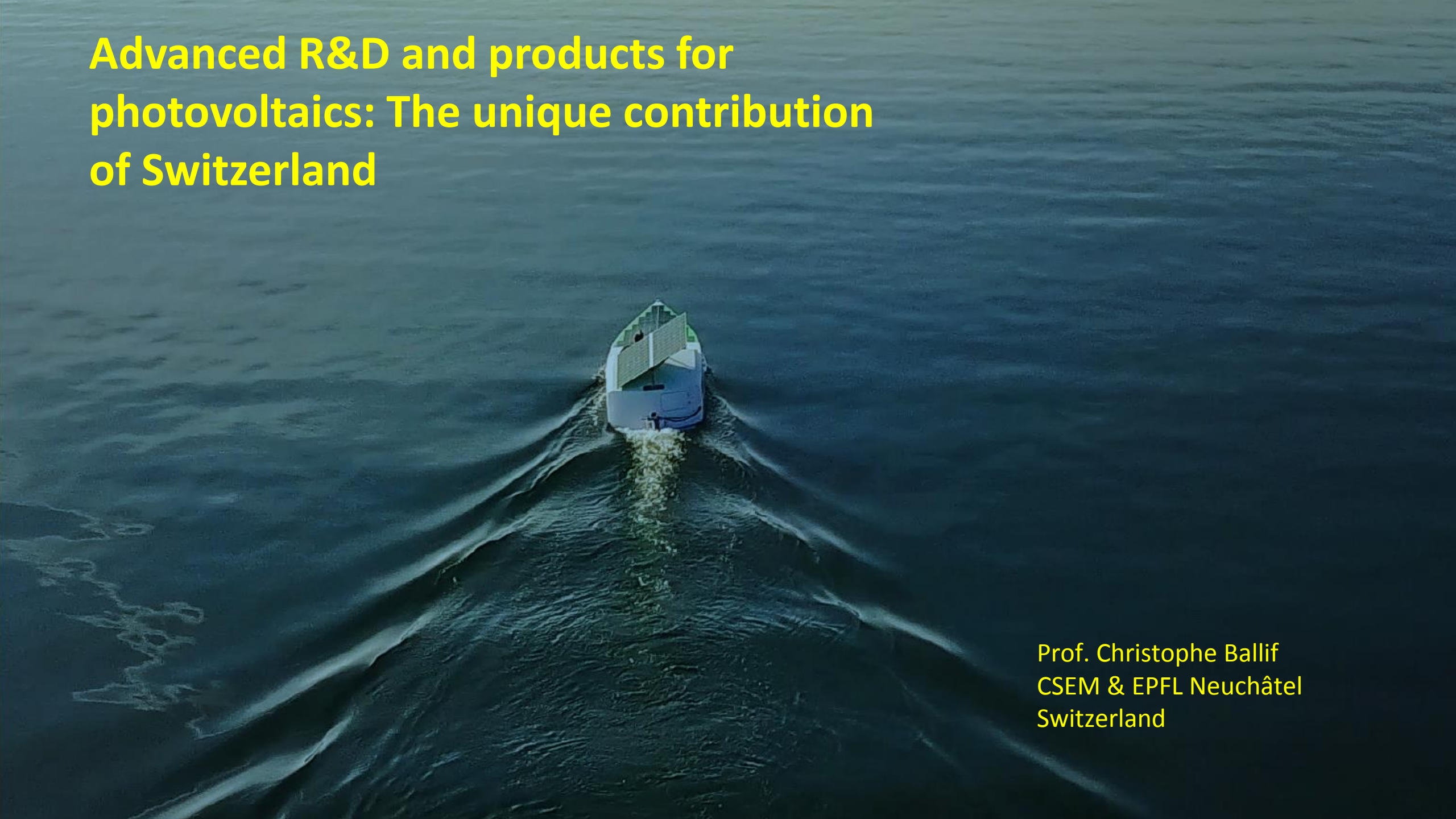
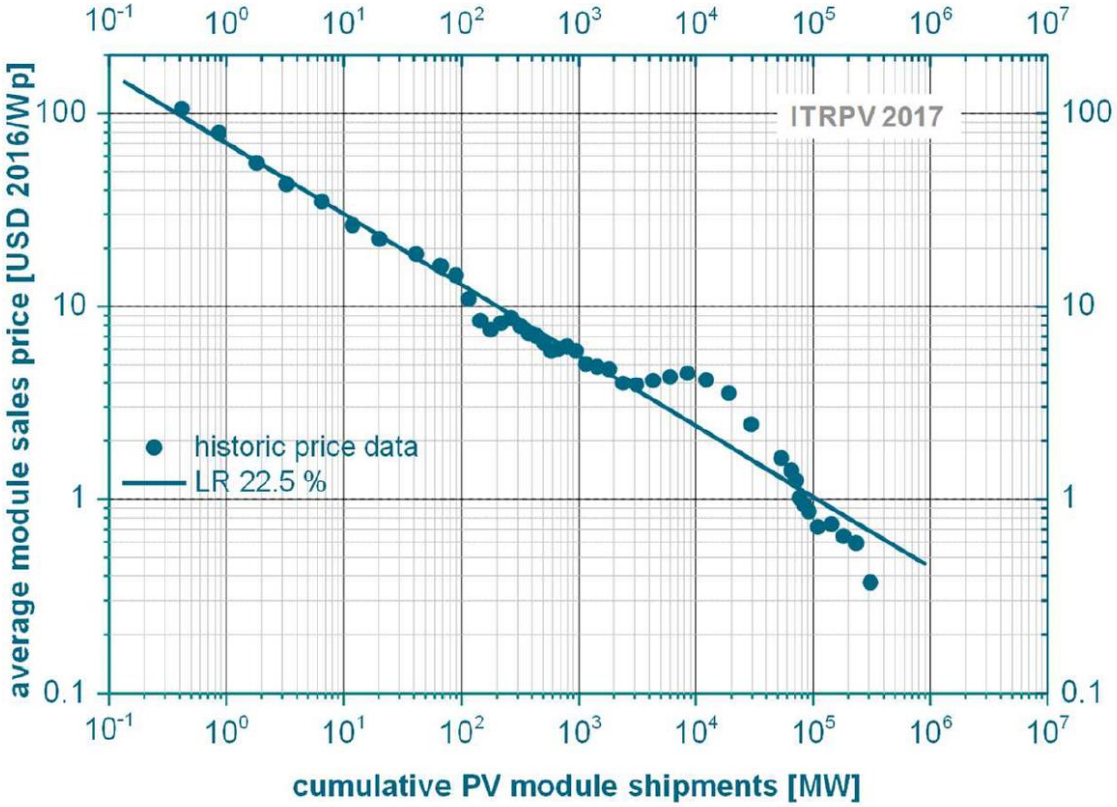
Advanced R&D and products for photovoltaics: The unique contribution of Switzerland



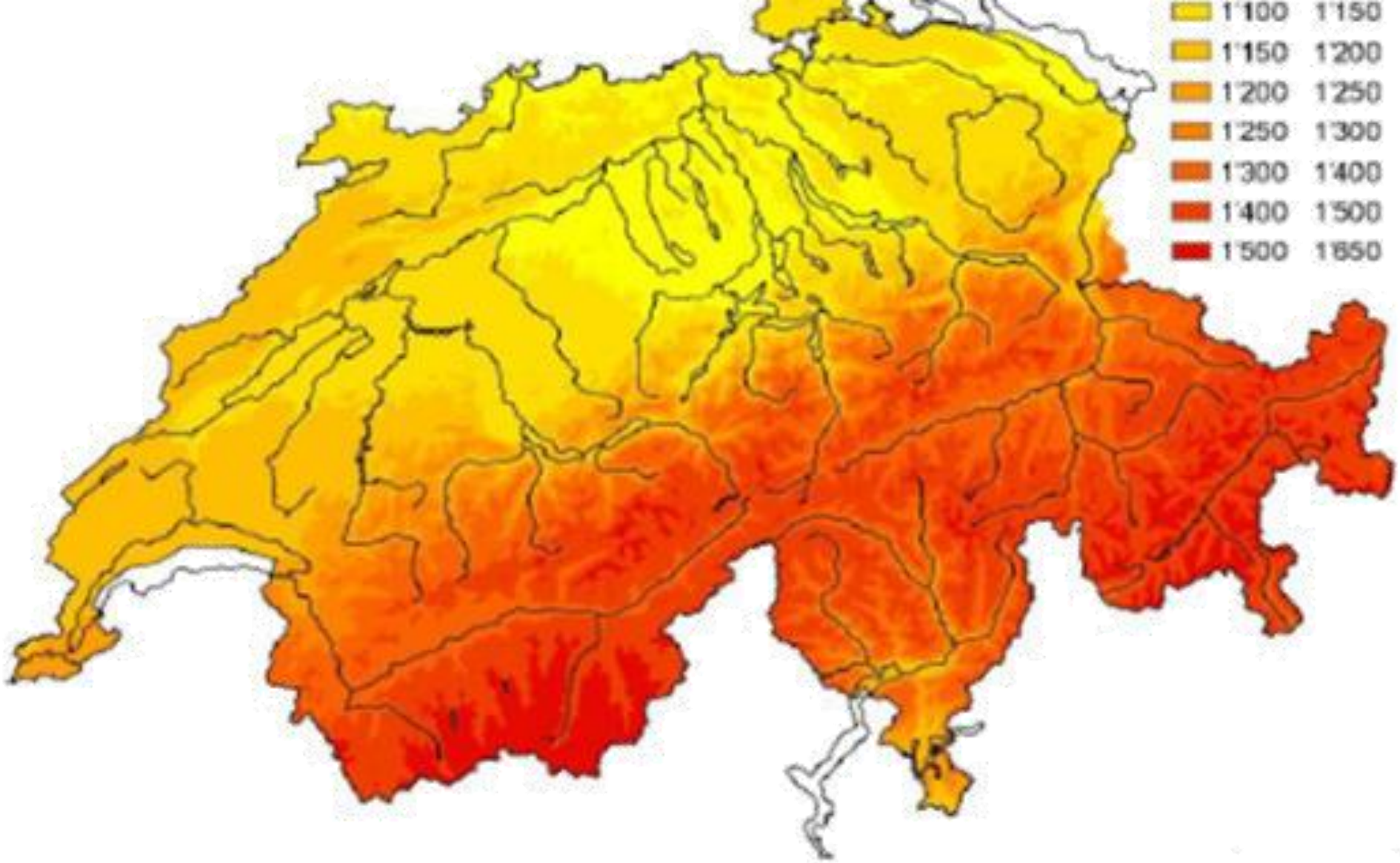
Prof. Christophe Ballif
CSEM & EPFL Neuchâtel
Switzerland

In the best «tender» for large scale PV electricity

Sunny countries : 2-3 cts/kWh
Germany: 4 cts/kWh



- PV has become the absolute lowest source of electricity for large system
- A current 90 GW new cap. per year, with more needed
- Improve efficiency and reduce cost further → free money for electricity management



Industrie:
Entwicklung, Umsetzung, Markt

Hochschulen:
Forschung, Entwicklung, Pilot

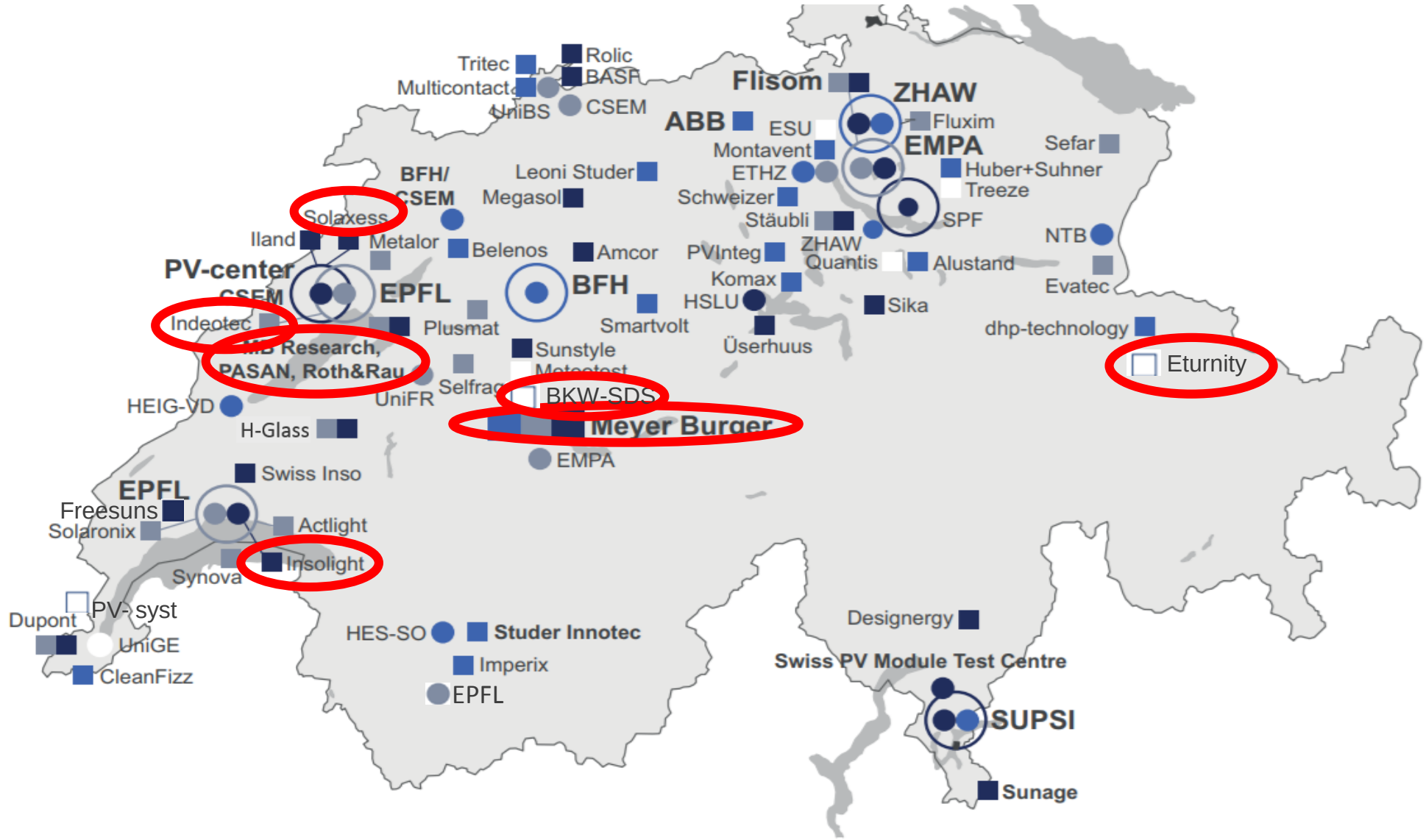
Solarzellen
Module und Gebäudeintegration
Systemtechnik und Montage
andere (Umwelt, Meteo...)

Schwerpunkte und Kompetenzzentren

Adapted from: S. Oberholzer, BFE 2017

Unique «solar» landscape

- Academics and research: CSEM, EPFL, EMPA
- Univ. of Applied-science: ZHAW, SUSPI, BFH, HSLU, SPF,..
- > 50 Industries and Start-up
- >> 200 installers and engineering offices
- A perfect country for mass implementation of fluctuating renewables



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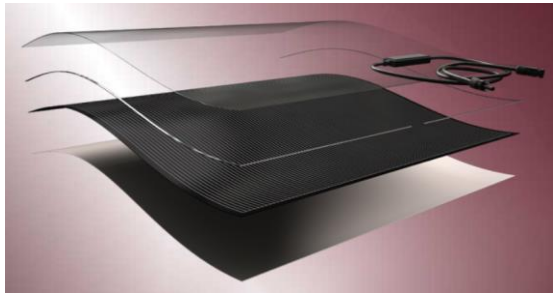
World references along the value chain

MEYER BURGER

STÄUBLI

ABB

PVSYST
PHOTOVOLTAIC SOFTWARE



Flisom
Flexible Solar Modules

STUDER

R&D in photovoltaics and energy systems in Neuchâtel

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

PV-lab IMT NEUCHATEL

csem PV-Center

EPFL

IMT/PV-Lab (1984)

- Fundamental research
- Advanced devices

CSEM, RTO

PV-Center (since 2013)

- Focus on techn. transfer
- Dev. for industry, innovation

Production and commercialization

Industrial partners

Spin-off, Start-ups

In contracts with over 40 companies

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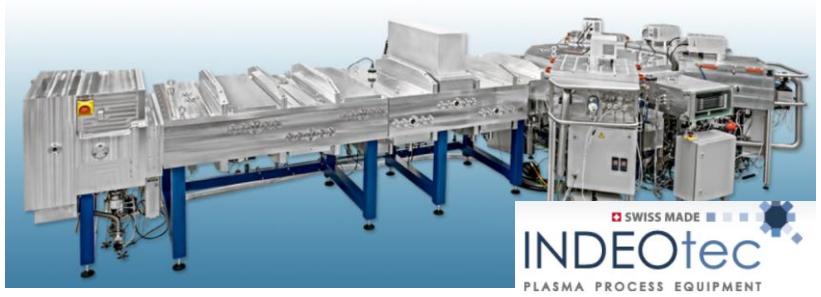
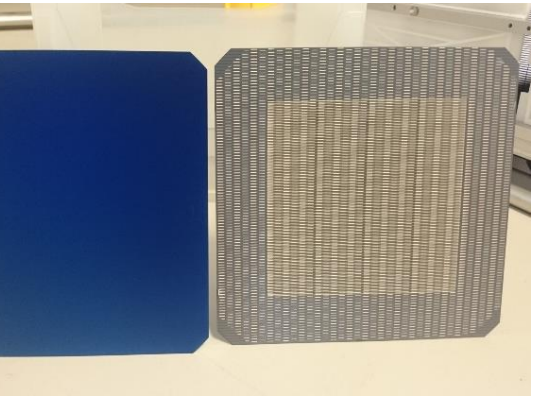
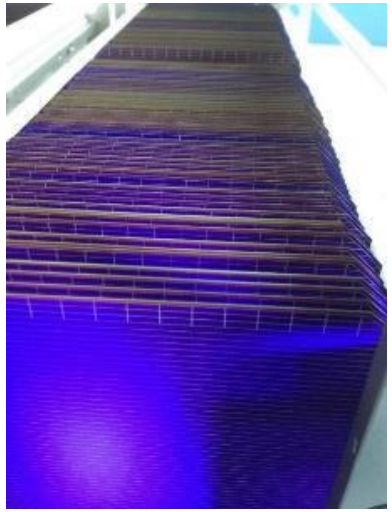
2000 m2 research and piloting… 100 researchers at EPFL and CSEM PV-center..

Powerpure

technologies for lowest cost solar electricity: some focus at CSEM/EPFL







- Silicon Heterojunction solar cells (24%)
- Back-contacted heterojunction (24.6%)
- Lean process for (Both sides) Passivating (23%) contacts devices (PERC upgrade)
- Better interconnection technologies

- Few process steps
- High(er) efficiency
- Higher energy yield
- Bifacial
- Work with 100 micron wafers

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Example: silicon heterojunction technology with «multi-wire interconnection»

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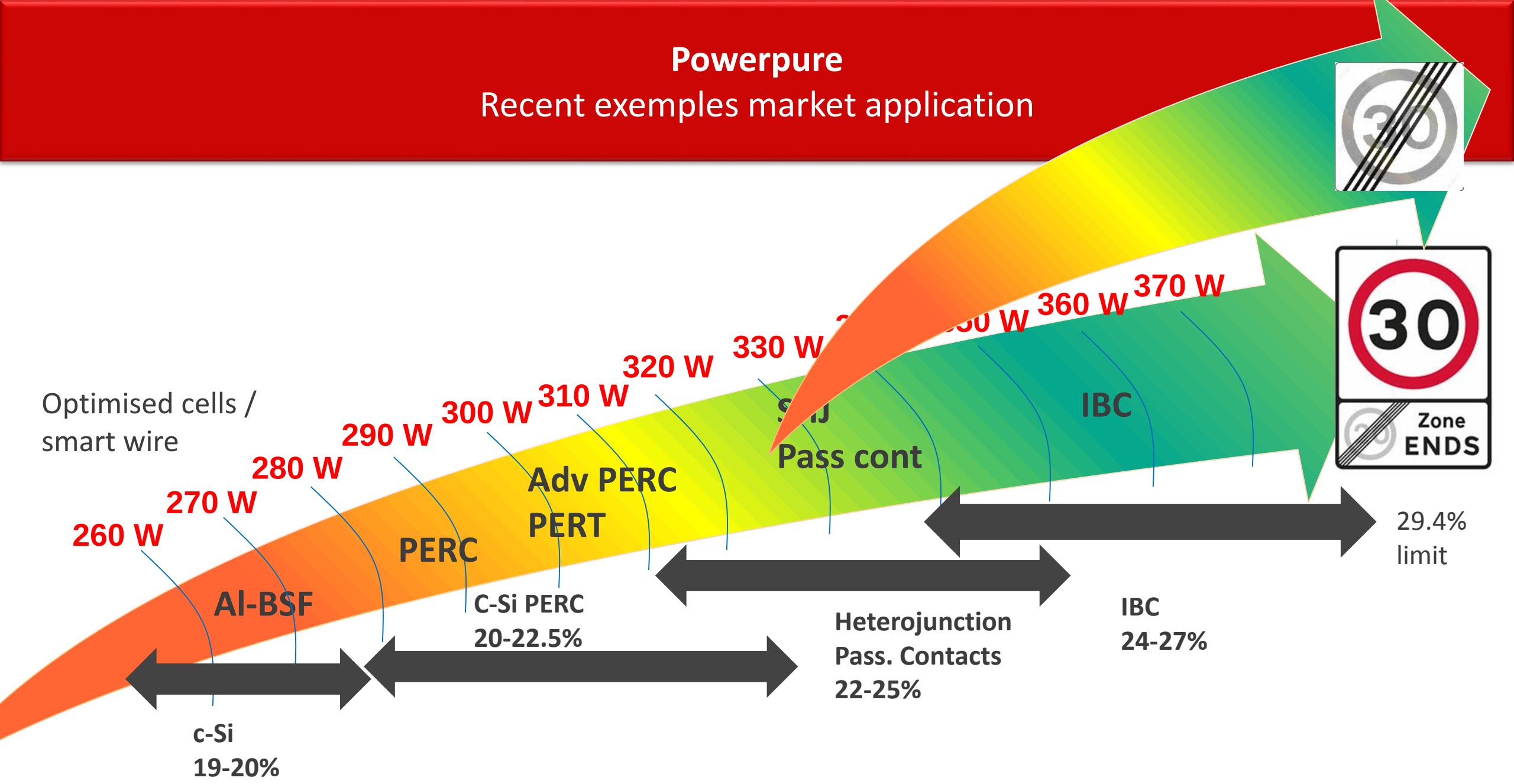
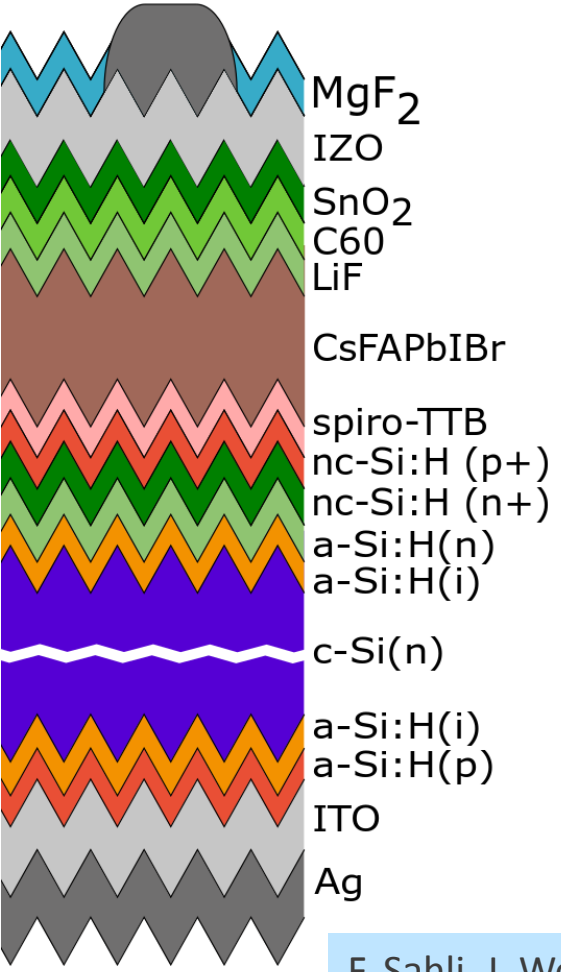
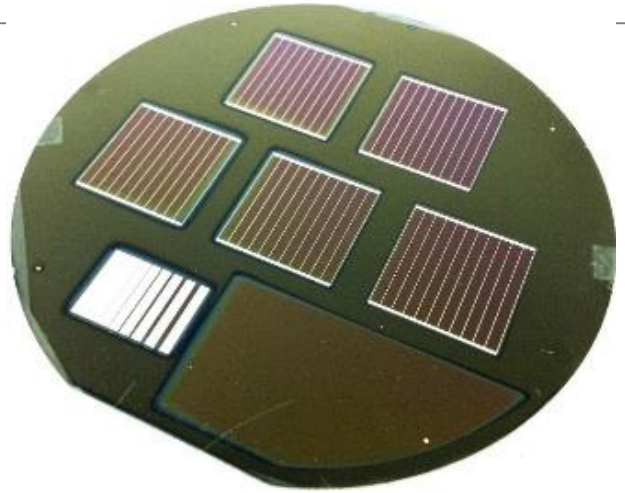
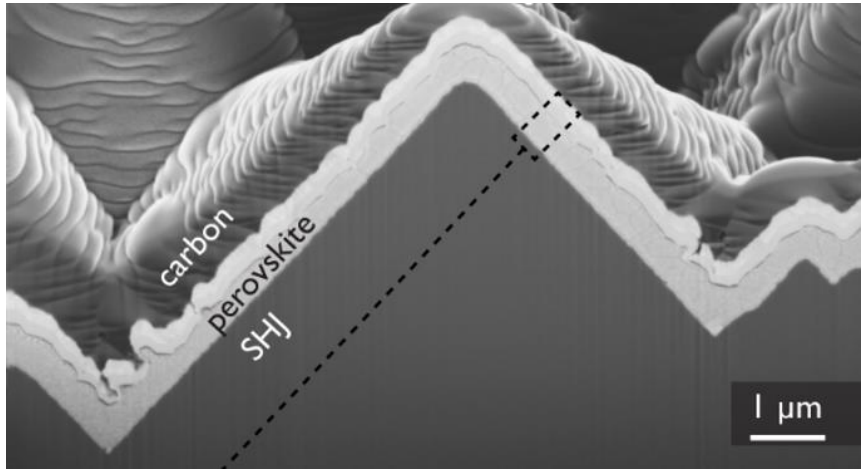
Powerpure
Recent exemples market application



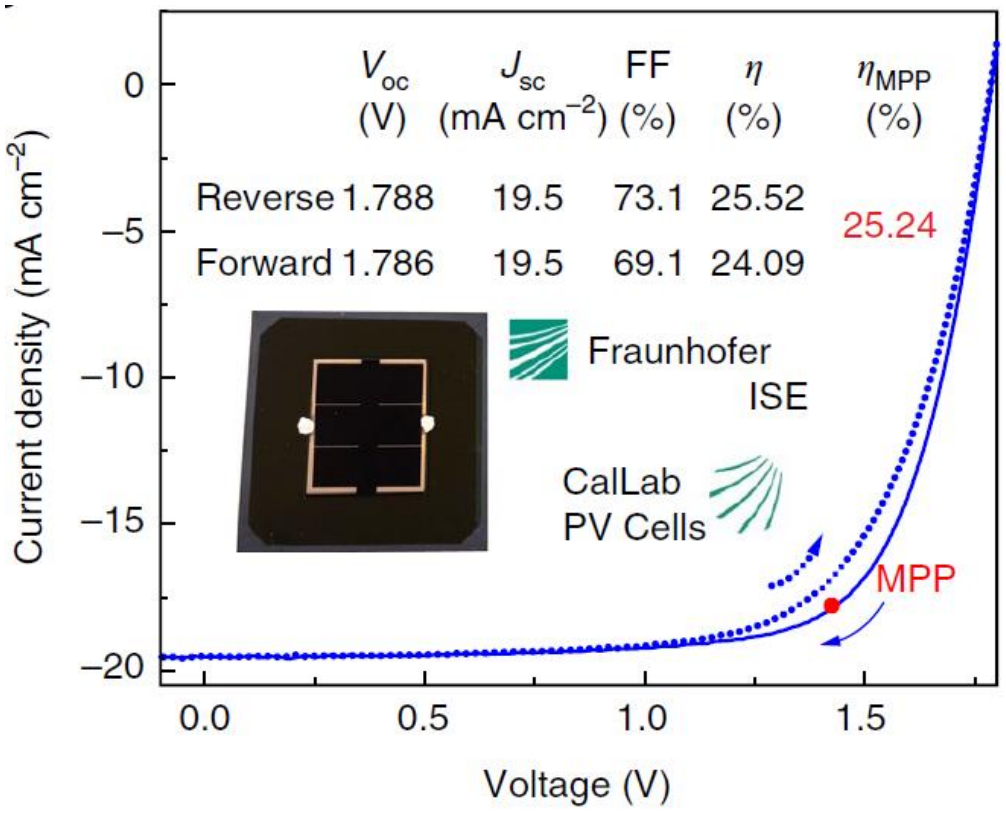
Combining perovksite on top of textured silicon solar cells







F. Sahli. J. Werner, et al. Nature Materials 2018



> 25.2% with potential for 30%

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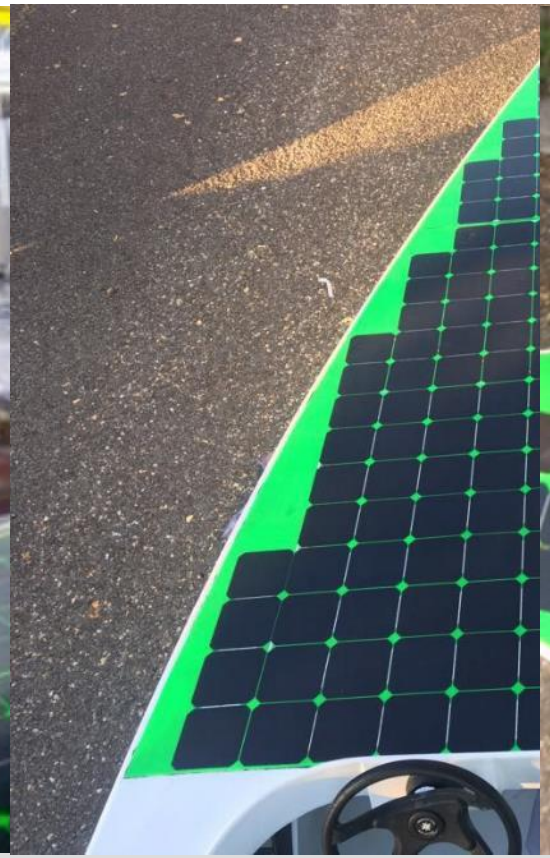
Explore

customized PV products from the water to the air

- High-fashion modules for competition and exploration boat

Artic solar with Anne Qéméré



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Explore

customized PV products from the water to the air

- Light weight specialty modules for terrestrial and space application

Solarstratos first flight

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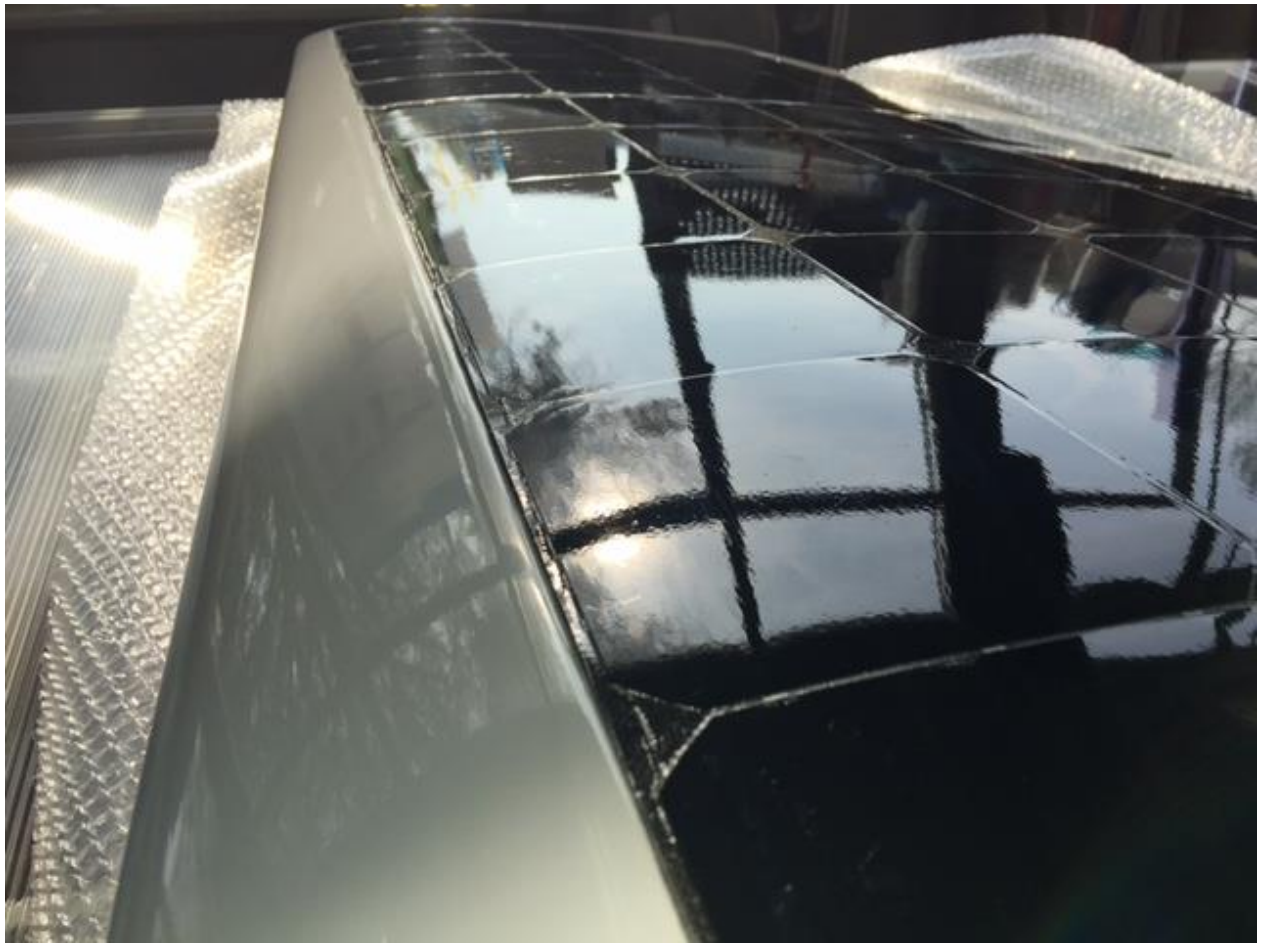
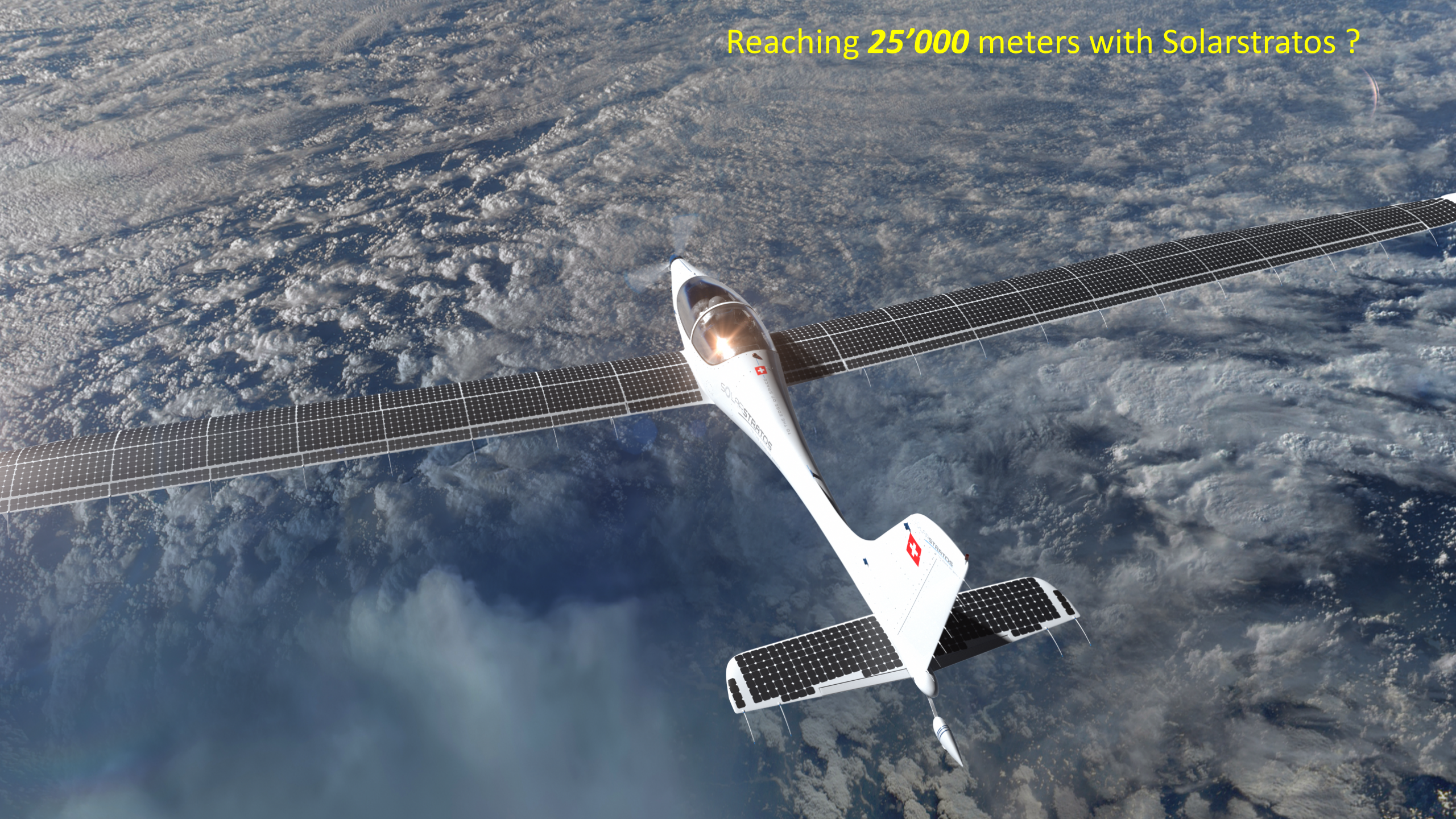
Lightest weight

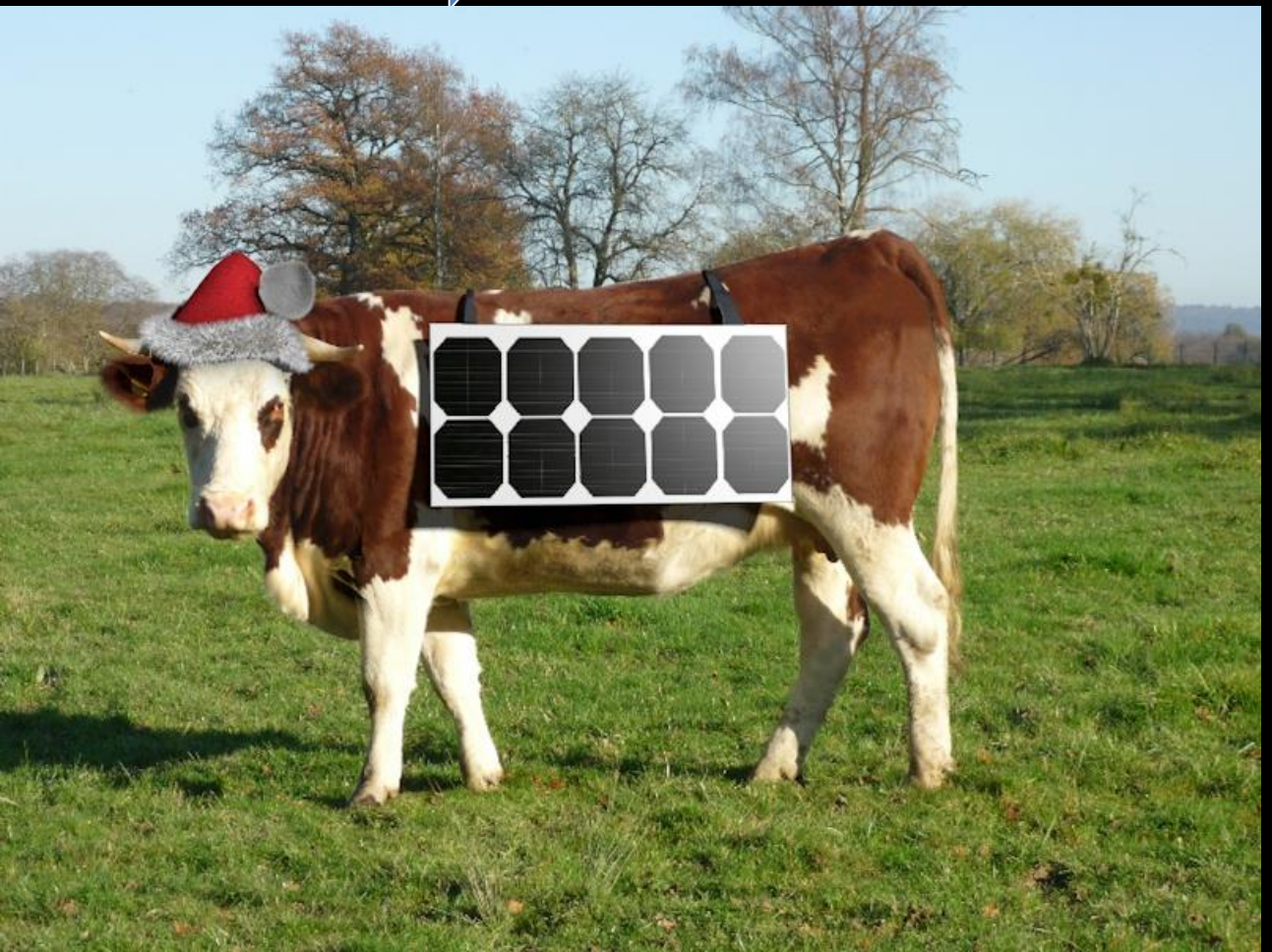


Reaching ***25'000*** meters with Solarstratos ?



Switzerland, sensitive to acceptance in Rural and Urban Environment

Sensitive to aesthetics



Elegance and architecture
Transforming building and cities, renovating houses

Swiss Inso, Solaxess, Freesuns, Designery, Megasol, Meyer Burger, Schweizer, Glass Troesch, Panotron,… + R&D institutes

Glass Troesch/ Fachhochschule Luzern

Freesuns solar tiles
Colombier sur morges

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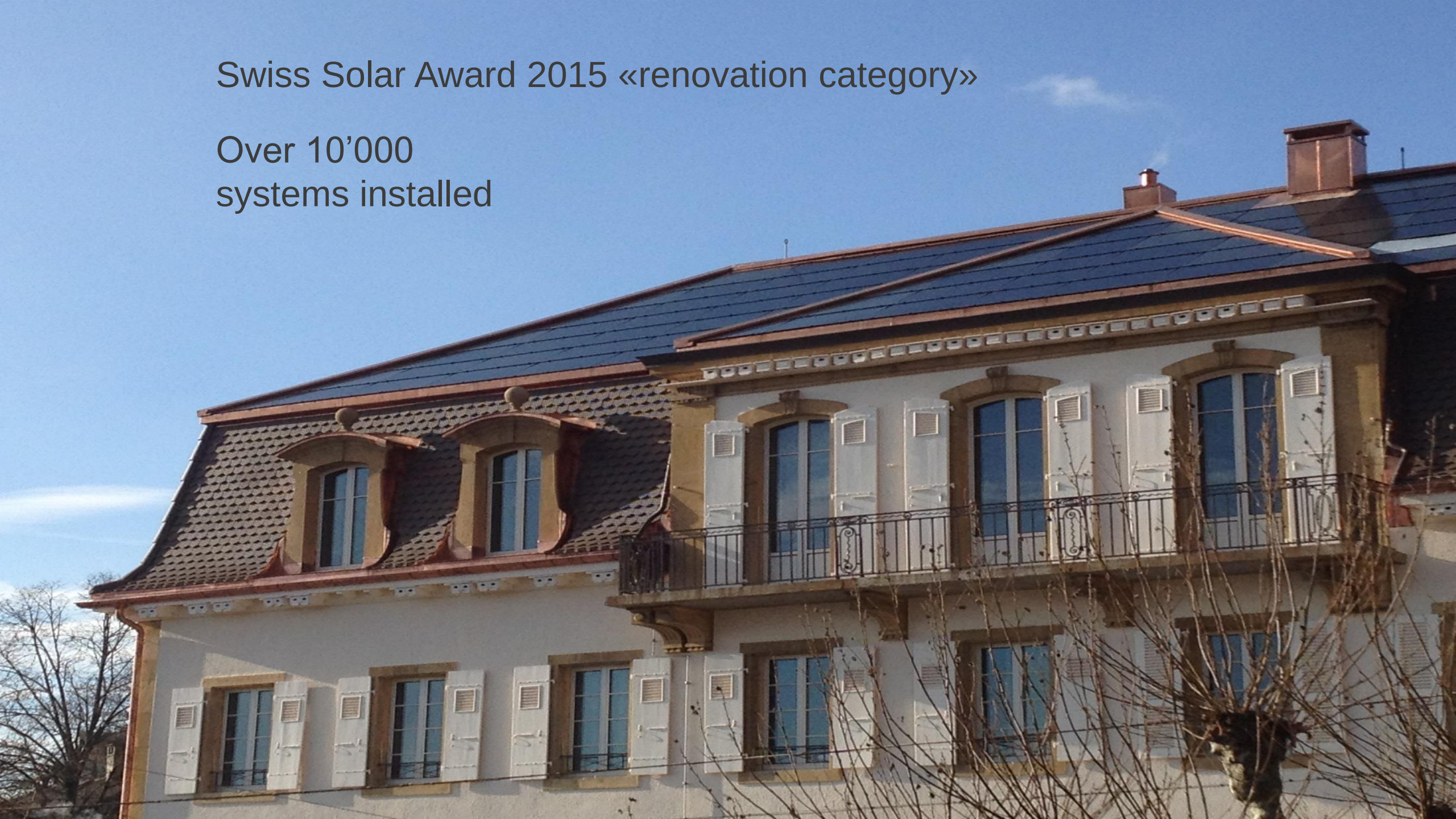
Swiss Solar Award 2015 «renovation category»

Over 10’000
systems installed



Elegance and architecture
Transforming building and cities

- Based on polymer design, coatings, and module tech. platform

Manipulation of adhesion, temperature, Creating color films, ….

White PV panels, together with SOLAXESS white solar technology

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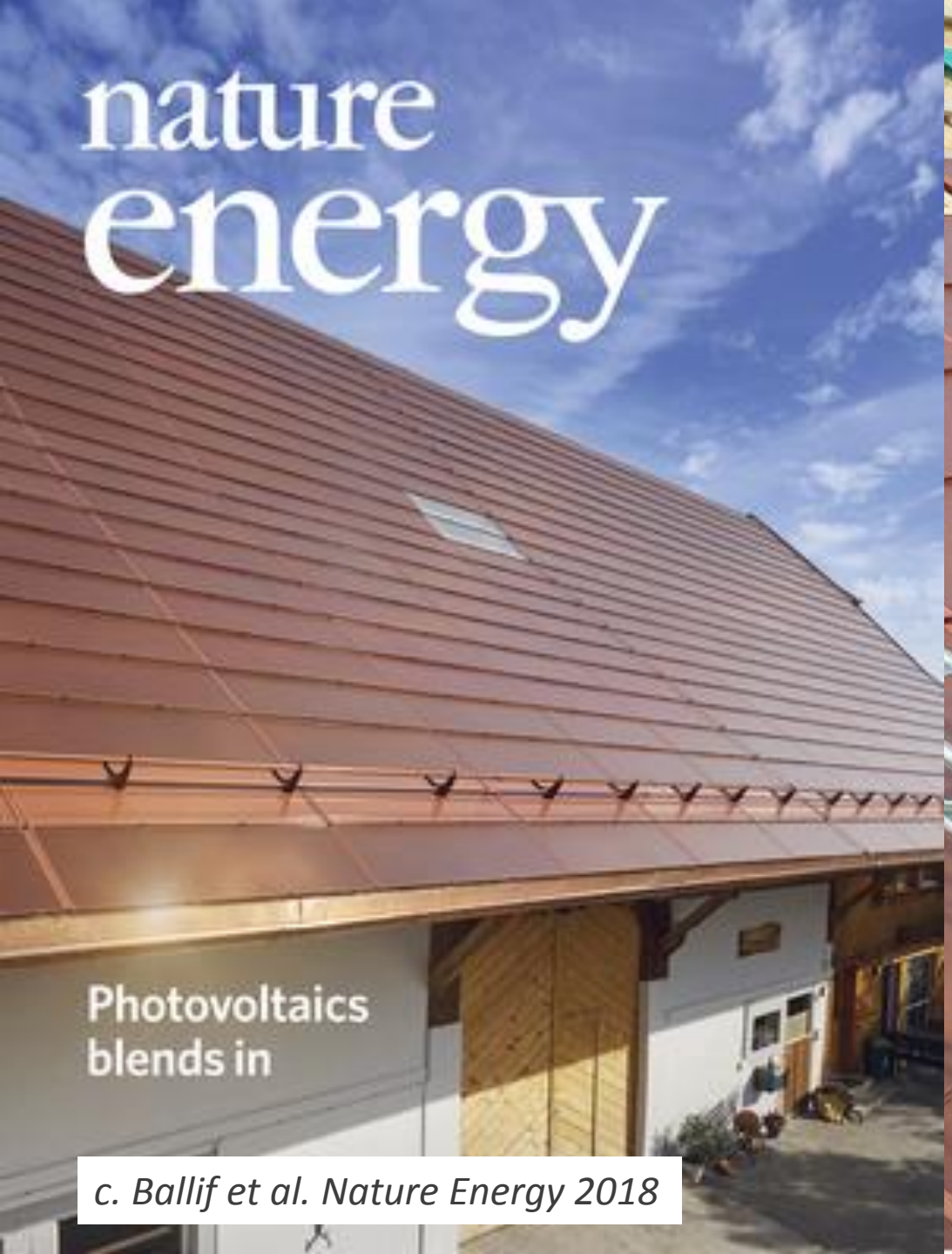
AREA
DO NOT

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

One of the Terra-cotta Tones, with ISSOL, Solstis Userhuus, SFOE



c. Ballif et al. Nature Energy 2018

- Up-to where can you modify PV ?

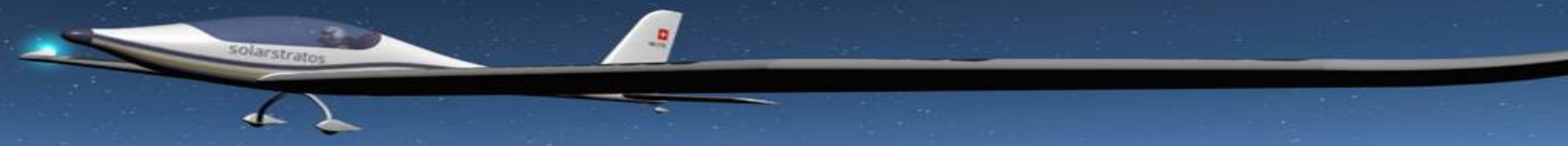
The Kaleo project ….

cse

Kaleo with BCN

Photovoltaics

- PV to becomes by far the cheapest/most abundant source of electricity
- Beginning and not the end of the global PV market and technology developments
- Huge application potential, everywhere
- Switzerland and CSEM as a partner for industrial developments



Jamais le soleil ne voit l'ombre

(The sun has never seen a shadow)

Léonard de Vinci

Solarstratos

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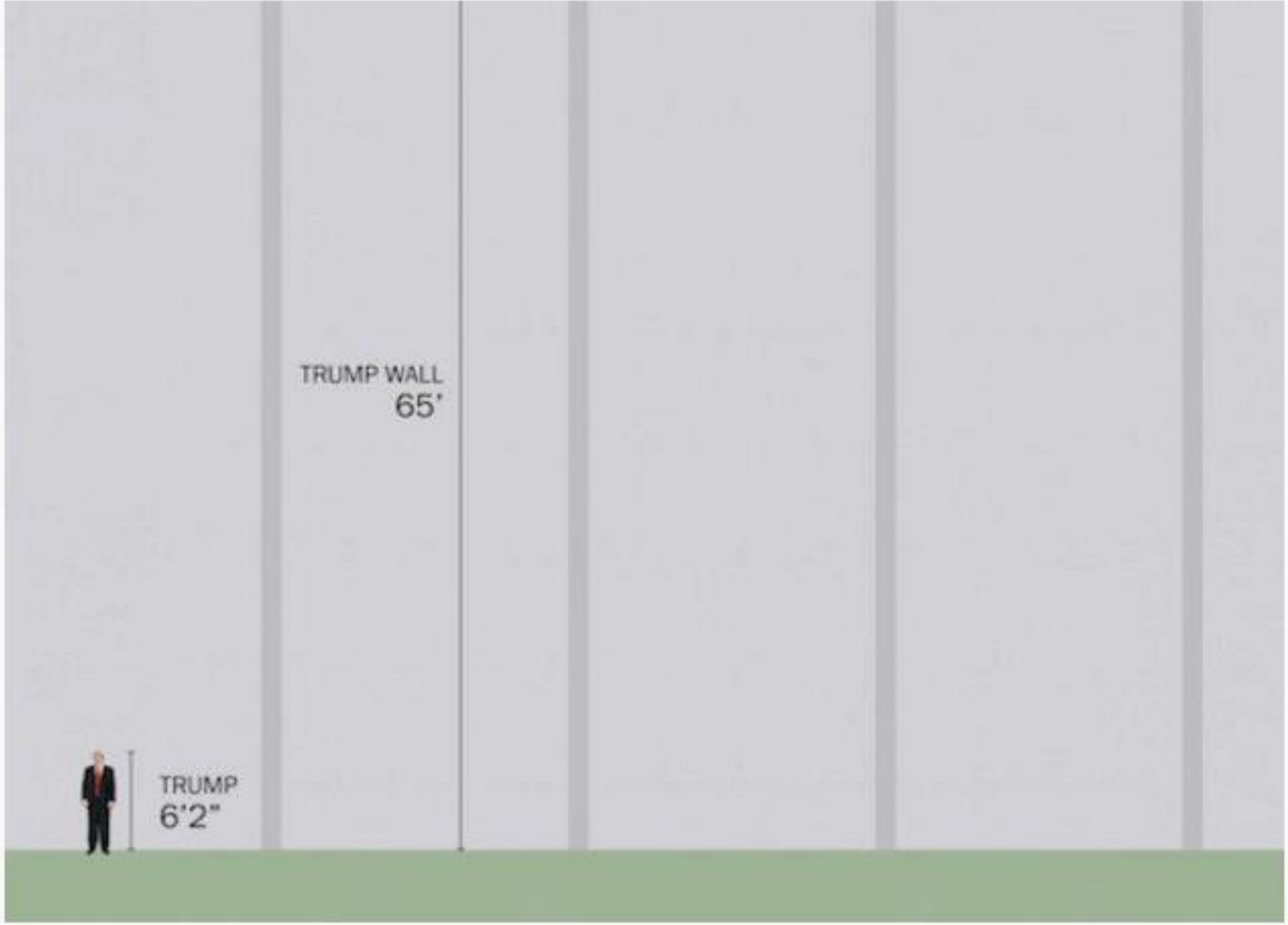

Source: Jigar Shah, LinkedIn

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