The Bearable Lightness of Solar Modules

Part I

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Outline

PART I

- *Solar photovoltaic (PV) electricity: some facts*
  - *short supply chains*
  - *global (& CH) context*
  - *cost-effectiveness*

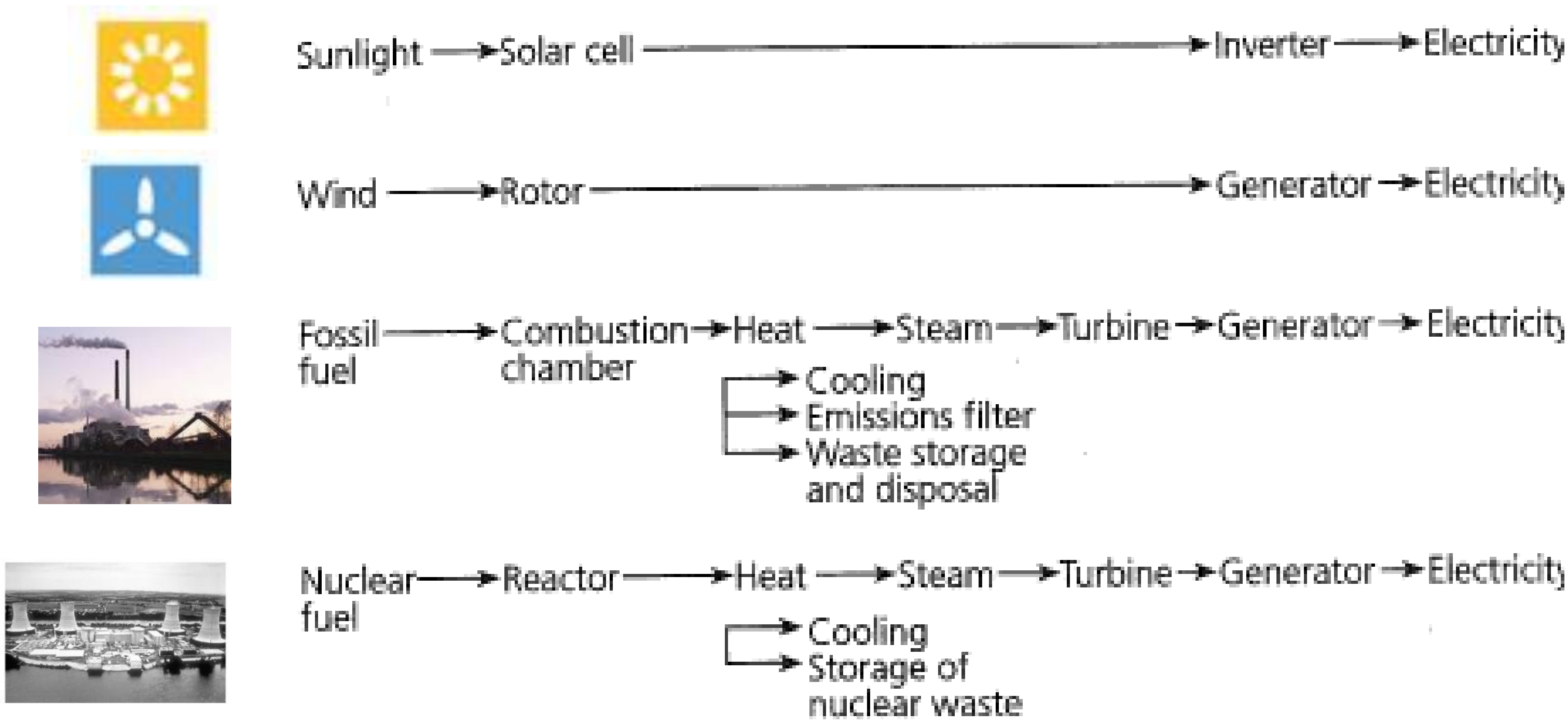
- *PV in buildings*
  - *BIPV vs BAPV*
  - *Potential & challenges*
  - *Standardization*

PART II

- *Lightweight solar PV modules*

Short supply chains (1): the greater productivity potential of renewables

Processing steps in solar & fossil fuel/nuclear electricity generation.



Source: Hermann Scheer, The Solar Economy, ed. Earthscan Pub., 2002;

Short supply chains (2): fuels

Once the infrastructure is there, you need "fuel" to run an electricity plant.

PHOTOVOLTAICS

Sun → PV plant

OIL

Extraction → Transport → Refining storage → Transport + wholesaler storage → Oil-fired Power plant

NUCLEAR

Mineral's extraction → Transp. → Uranium extraction → Transp. → Enrichment → Transp. → Nuclear Power plant + storage

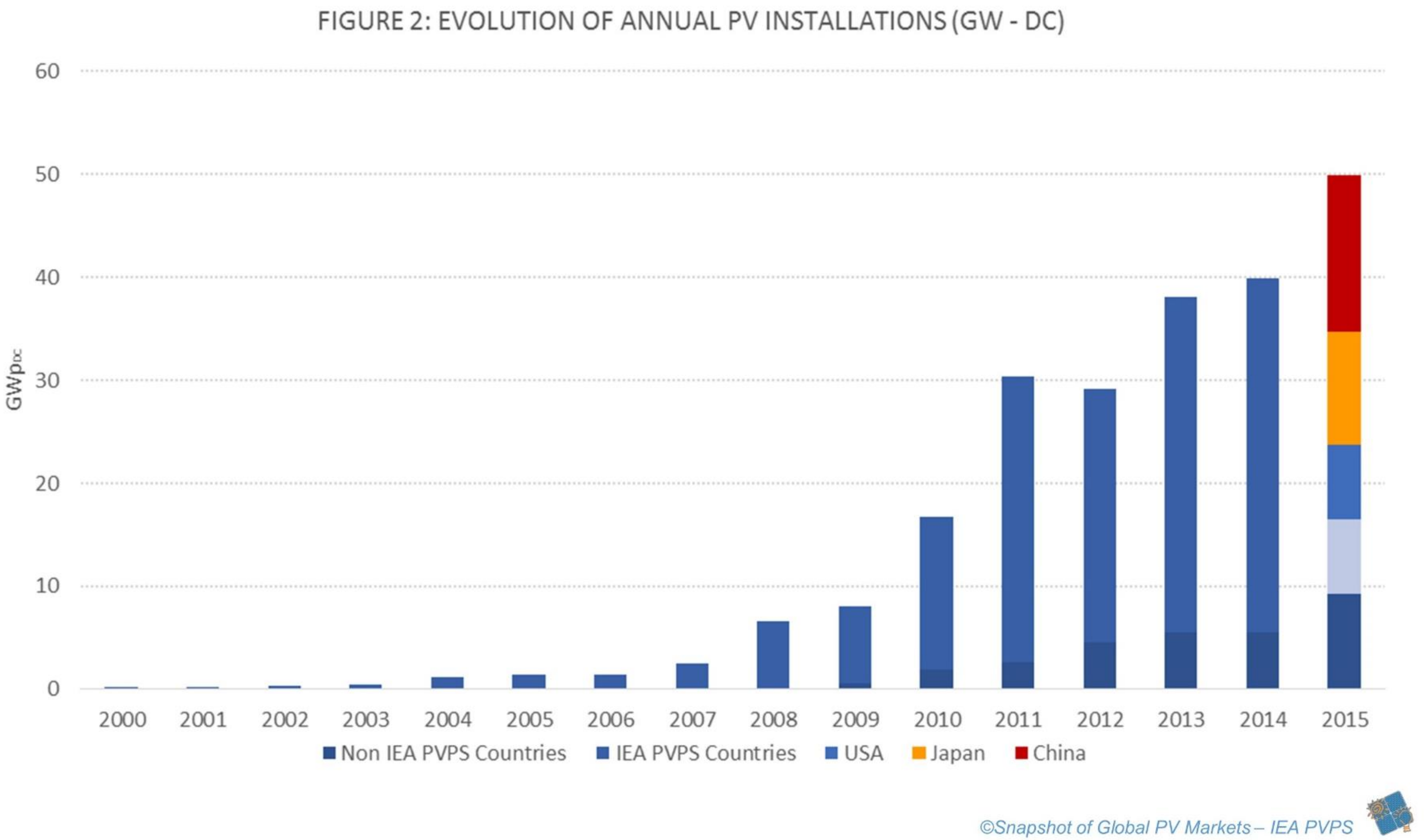
Solar PV electricity is the ***simplest*** way to generate electricity.

Source: Hermann Scheer, *idem*

For those who believe that SIMPLICITY is a synonim of ELEGANCE…

……PV is the most «elegant» way to generate electricity.

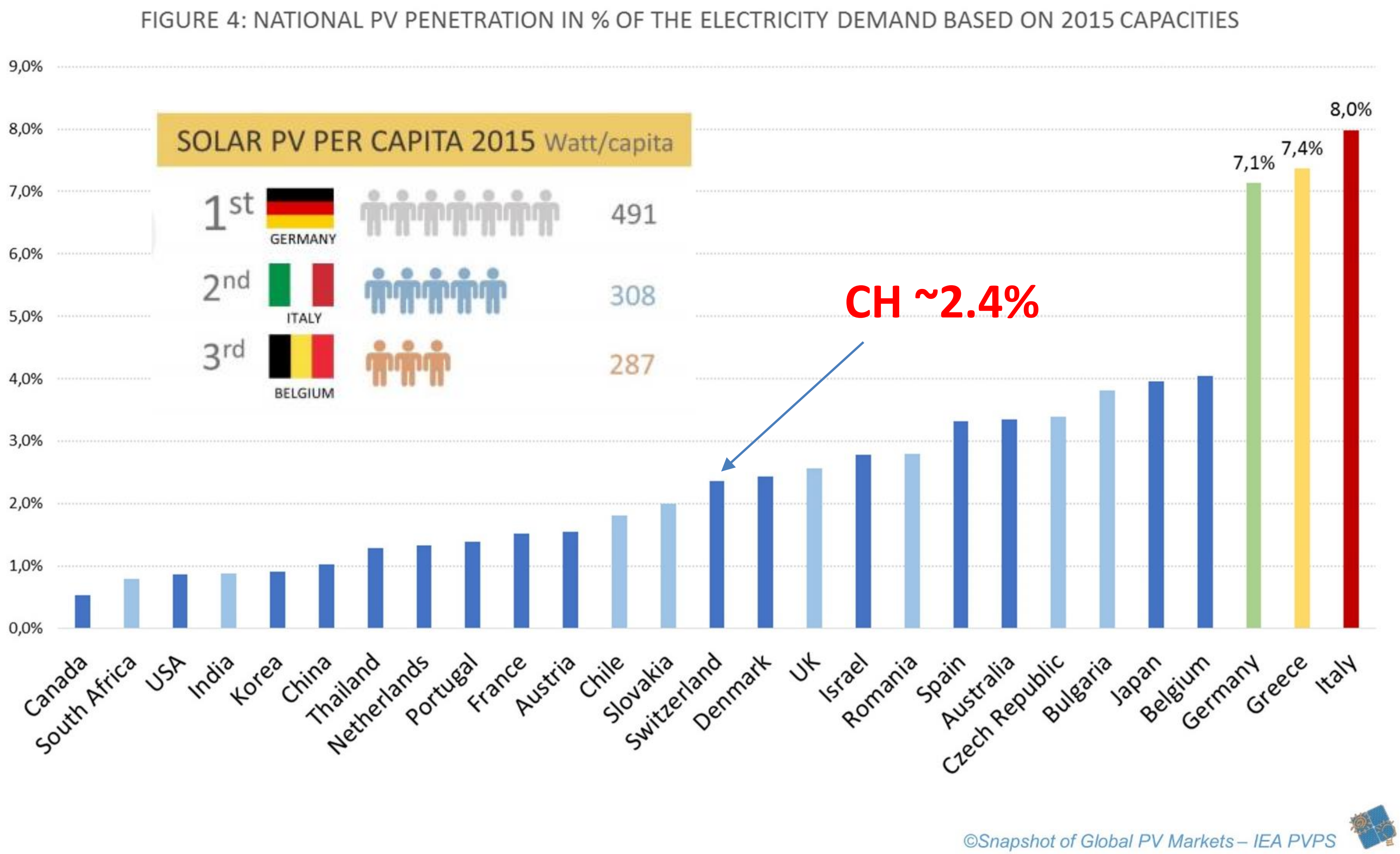
Global annual installations of solar PV



2016:
65 GW_p
(+30%)

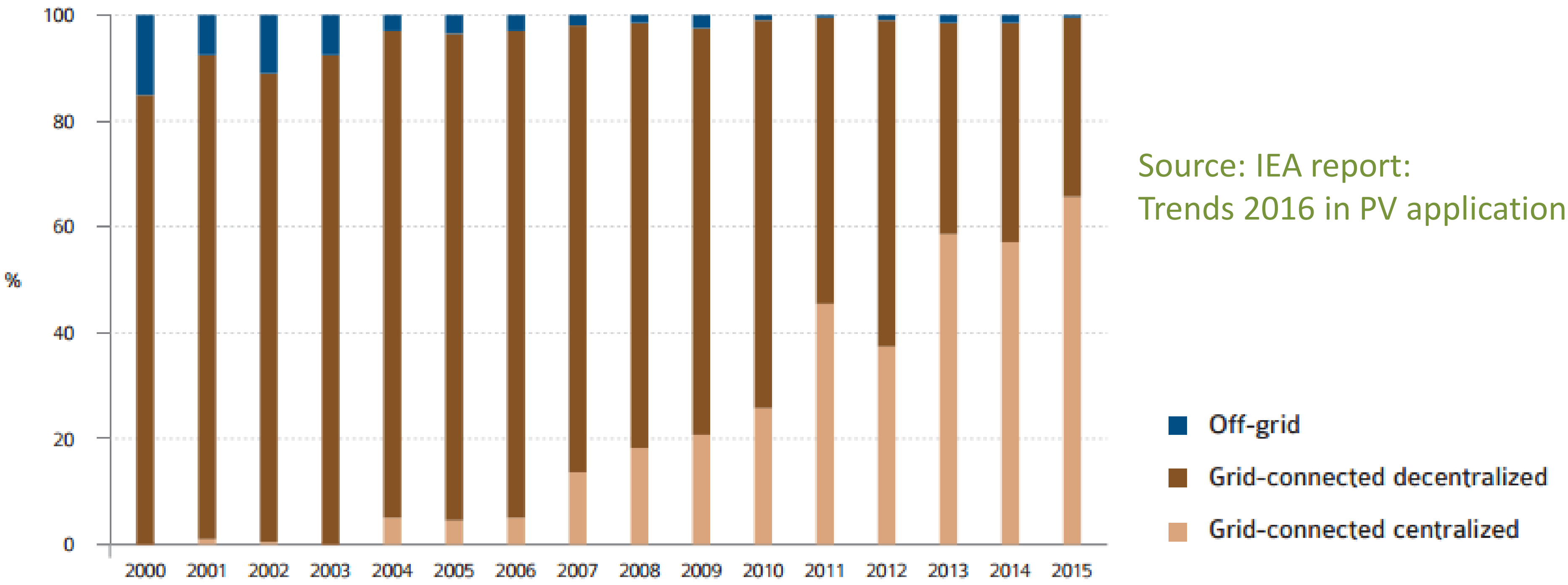
Source: IEA report: A snapshot of global PV markets - 2015

Share of PV (%) on electricity demand - 2015



Source: IEA report: A snapshot of global PV markets - 2015

Share of grid-connected & off-grid installations 2000-2015

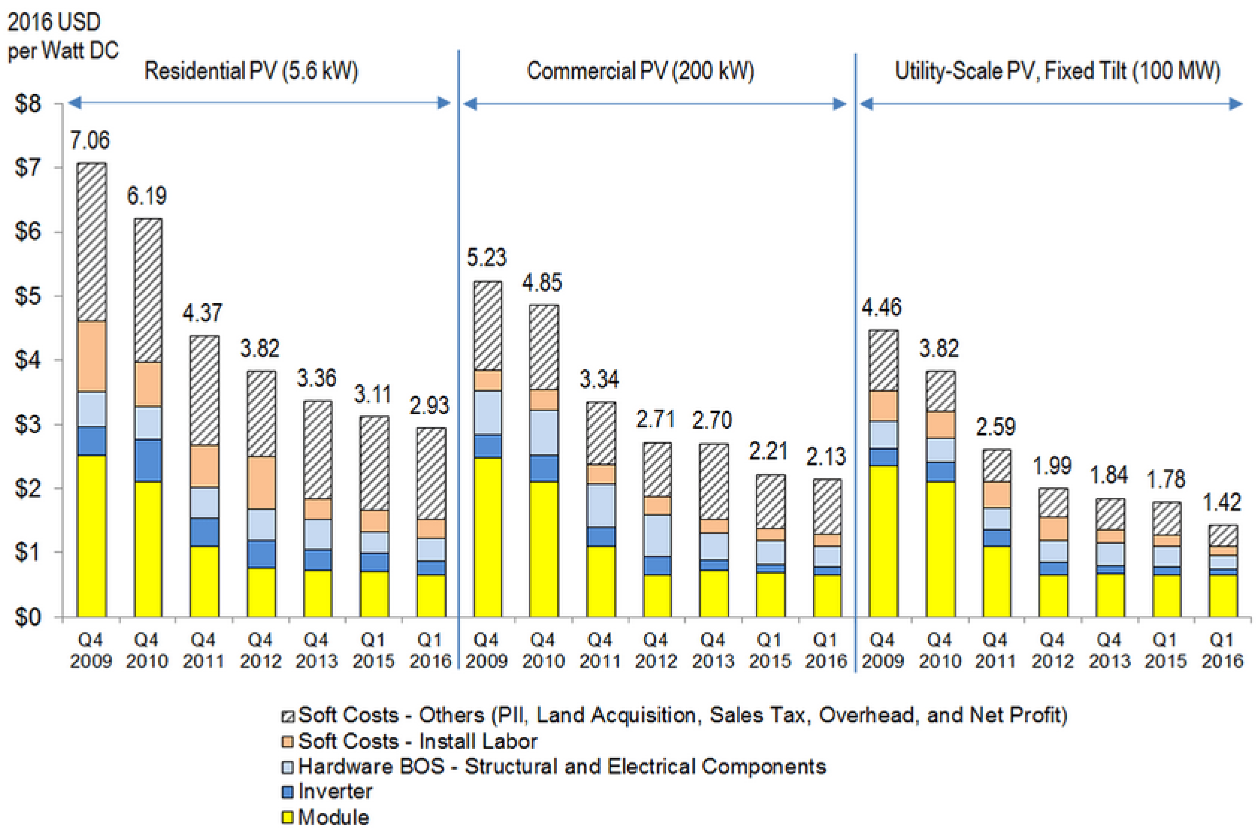


Source: IEA report:
Trends 2016 in PV applications

>96% of PV is grid-connected

~40% of installation on buildings (roof-top) >>> link to the building sector.

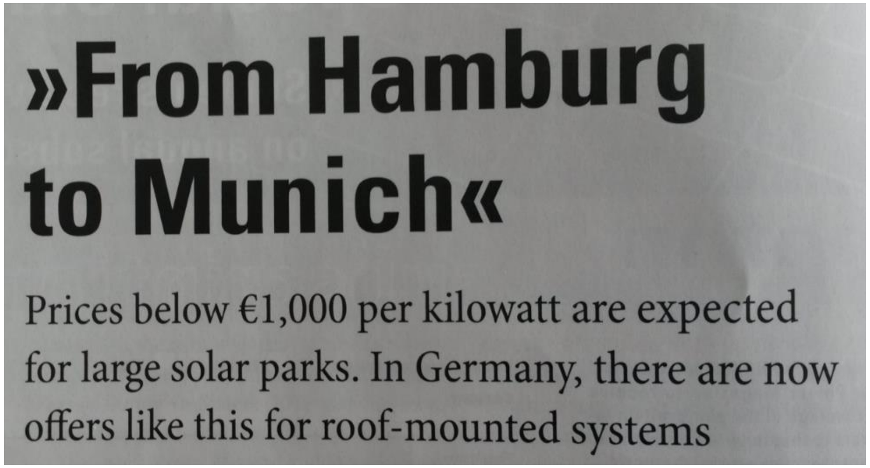
Cost of PV systems continuing to fall – US: 2009-2016



Source:
NREL 2016

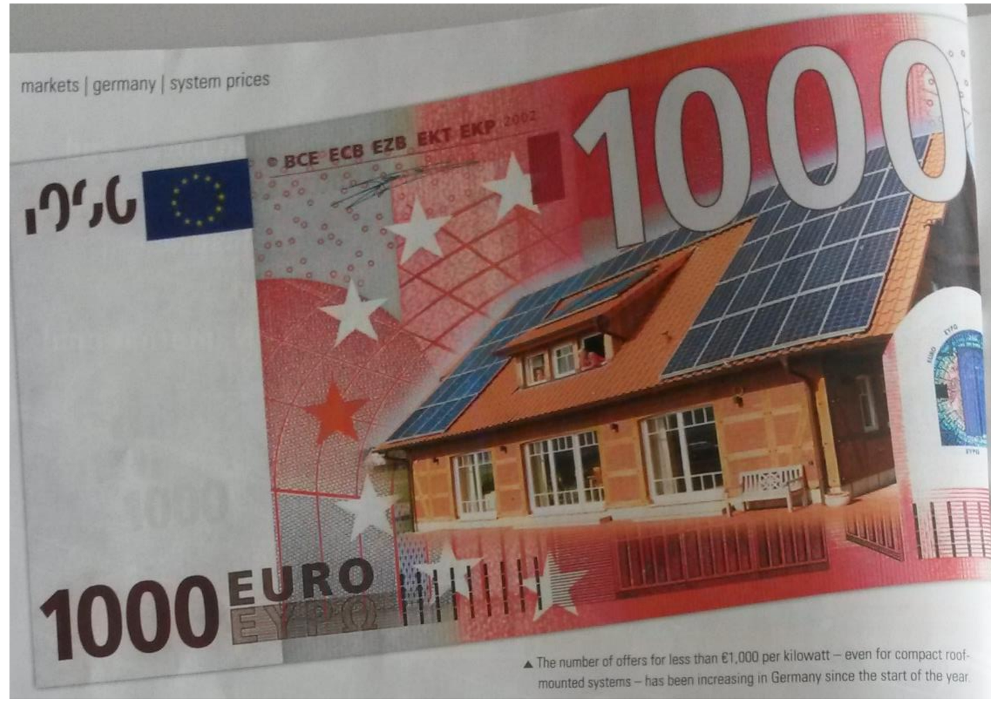
Prices in US and CH are similar (residential & commercial);
Prices in Europe are considerably lower (even down a factor of 2).
Further price decline (modules) in Q3-4 2016.

Cost of PV systems continuing to fall – EU 2017



»From Hamburg to Munich«

Prices below €1,000 per kilowatt are expected for large solar parks. In Germany, there are now offers like this for roof-mounted systems

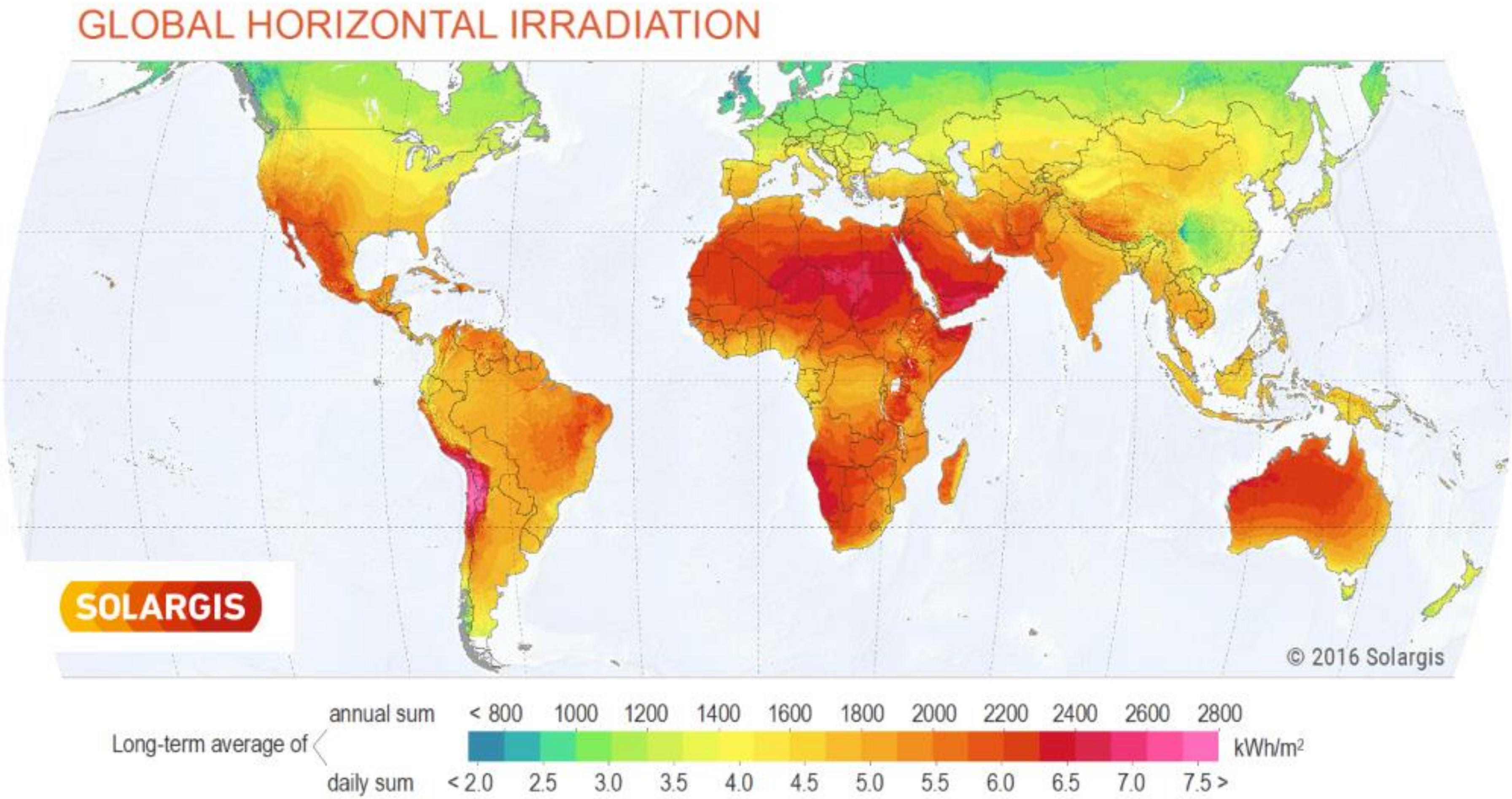


No VAT, no storage

Source:
Photon International Feb 2017

Sharp decrease of module prices in Q3-4 2016 >>> many installers now pass on more favourable purchasing conditions on customers.

The sun is ubiquitous



Source: SolarGis

Solar PV electricity – a societal «revolution»

Solar electricity (& more-in-general renewables) is:

- "**simple**" (*straightforward* and "elegant"?) >>>> short supply-chains;
- "**democratic**": breaking down monopolies and consolidated income positions;
- "**peaceful**": no need to send out troops to secure oil/uranium reserves;
- a "**mature technology**" with an increased reputation for **reliability** (yet not-everywhere);
- "**equitable**": transforming citizens from passive consumers into active "**PRO-SUMERS**" & leveraging out inequalities;
- **cost-effective**: at today's prices solar PV is a *no-brainer*, provided:

  the proper exposure, proper design of system& selection of components.

Challenges/limits:

- Storage + grid-integration (@ high levels of PV penetration);
- matching demand & consumption

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PV in/on buildings (1) - SIZE

- **Ground-mounted** (any size: > 5 MW utility-scale)
- **PV on/in buildings**

  (vast majority ***roof-top PV: ~40% of market in 2015***)
  - Residential (1 – 10 kWp)
  - Commercial & Industrial (10 kWp – 5 MWp)

PV in/on buildings (2)

TYPOLOGY OF INSTALATION: BAPV vs BIPV

- BAPV (Building Added PV): addition to existing building elements
- BIPV (Building integrated PV): full integration of PV system into the building envelope

BAPV

BIPV: Neuchatel

PV in/on buildings (3)

Availability of land plays a big role. Some countries have a large potential of integrating PV in buildings.

Two extremes:

South-Africa (2015)

- Ground-mounted: ~90%
- BAPV: ~10%
- BIPV: 0 %

Switzerland (2015)

- Ground-mounted: <<1%
- BAPV: 85%
- BIPV: 15% (special premium offered by Swiss FiT +and direct subsidy scheme)

Qualification testing for PV modules

Modules expected to «leave» 25-30+ years in the field exposed to harsh environmental conditions.

Type aproval or qualification testing (**IEC 61215:2016**) subjects modules to stresses:

- **Mechanical test**: static mechanical load, hail impact
- **Climatic tests**: UV & sunlight exposure, damp-heat, themal cycling (200/50 cycles), humidity freeze,...
- **Electrical tests**: insulation, wet-leakage, by-pass diode.....

These set of standards have contributed drammatically in increasing the **reliability** (reputation) of PV.

Still some **criticism** exist: sequences do not predict life-time, do not differentiate between climates & typology of installation (BIPV vs rack-mount)

The double-nature of BIPV

Requirements for BIPV are much more stringent than for BAPV.

Lack of standardization/harmonization has long been an issue: now partly solved.

Building codes,
CEN standards,
Eu directives, ….
CPR 305/2011

Electrotechnical norms,
IEC + CENELEC standards,
Eu directives, ….
IEC 61215/61730

New **EN 50583:2016** "PVs in buildings"
Part 1 – BIPV modules
Part 2 – BIPV systems

Missing gaps: fire test, arcing (PV as a source of fire), dynamic loads, temperature ranges, ...

BIPV: other barriers

Why is BIPV not routinely specified in construction projects?

Barriers are many, but known and solvable.

- **Suitable standards** will help
- **Awareness**
  - Most often driven by client specification
  - Poorly understood
- **Fear of failure**
  - Mechanical failure - as a building component
  - Maintainability - replacement parts?
  - Changes in appearance over time
  - Fire?
  - Architects' reputation at stake!

Main <u>takeaway</u>: ideas, products and SOLUTIONS exist.

Policy drivers for PV in buildings in Europe

In the EU the **Energy Performance in Buildings Directive** (**EPBD**) imposes to look for ways to decrease the local energy consumption in buildings from 2020 onwards.

This should favor decentralized energy sources, among which PV appears to be the most promising one.

Two concepts :

- **Near Zero Energy Buildings** (reduced energy consumption but still a negative balance);
- **Positive Energy Buildings** (buildings producing more energy than what they consume).

>>> A considerable momentum for solar PV electricity in buildings (including BIPV) is expected.

Support policies at country level:
E.g. CH: in 2015 the cantons agreed that in the future residential buildings must install 10W of PV per square meter heated area and some cantons introduced direct ubsidies for storage.

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- *Lightweight solar PV modules*

……we have found a SOLUTION to a PROBLEM (weight), but we are still in search of an APPLICATION.

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Thank you for your attention

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