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# PV Market & Industry Status and Vision on PV Business Models

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*Advanced Intelligence & Research on Solar PV*



# Becquerel Institute at a glance

- Est. 2014 in Brussels, Belgium
- Applied research institute and strategic consulting company focusing on solar PV technologies and their
- Global PV Market Analysis including competitiveness and economics
- Industry analysis including technologies as well as quality & reliability
- Techno-economic modelling
- Integration into electricity systems (grids and markets)
- Customers in Europe, Asia, Middle-East, Africa, America.
- **PV Market Alliance** partner

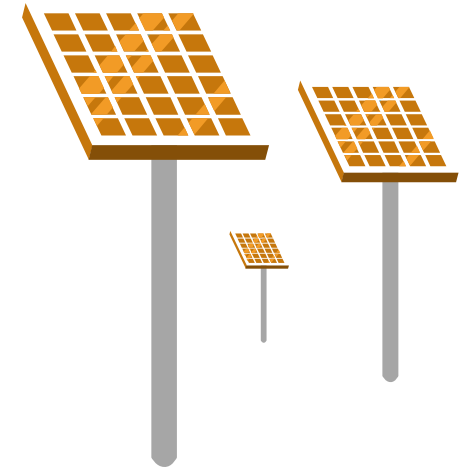


10- 11 September 2019 | 36th EU PVSEC  
Marseille Chanot Convention and Exhibition Centre  
Marseille, France



# Today's agenda

- 1 Looking at the big picture: PV market & industry status
- 2 A word on prices
- 3 Towards a new paradigm
- 4 Conclusion & Outlook







# PV market status





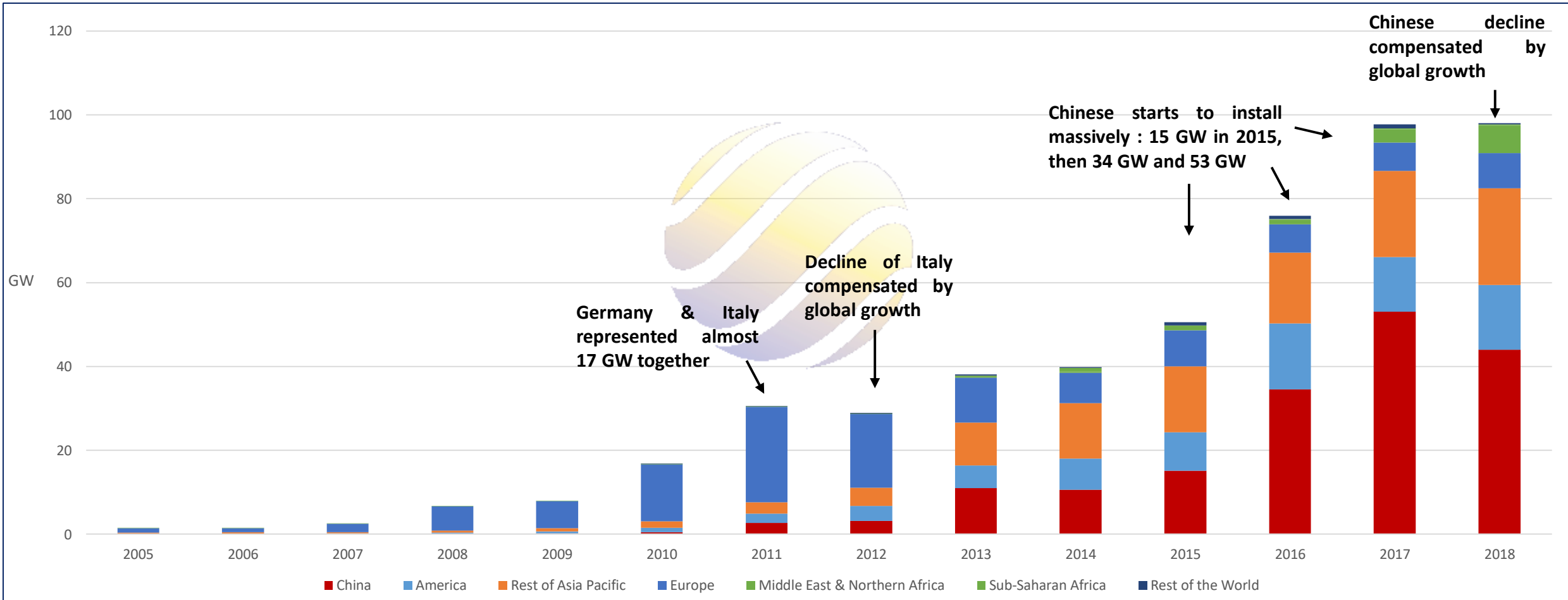
# Saving the climate: our PV 10 years challenge !



# An (almost) ever growing market

The core of the global market shifted from Europe to Asia

Evolution of PV capacity installed annually worldwide



Sources: IEA-PVPS & PV Market Alliance

# Main events in the global PV sector in 2018

The most impactful one has been the Chinese decision, which had a clear and serious global effect

## **China** decided to limit its market – May 31 decision

- Due to the gap between supply and demand on the domestic market, PV module price steeply decreased in China but also on the global market
  - Consolidation within the industry
  - Pressure for product differentiation
  - The expected market dip was not as strong as expected

## Protectionist measures appeared on other major markets

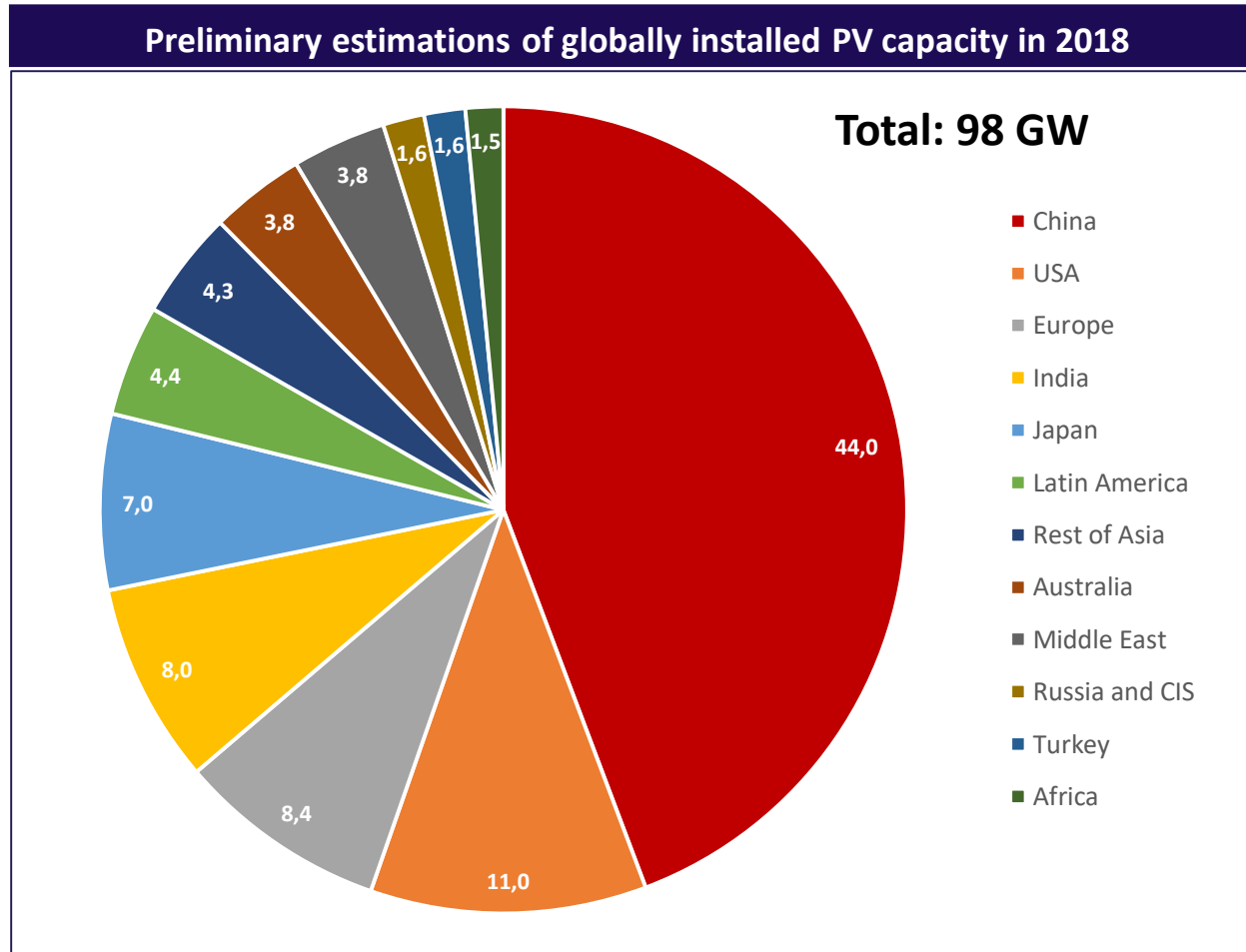
- Quotas and decreasing tariff enacted in the **US** on cells & modules for a four-year period
- Safeguard duties of 25% imposed in **India** on solar cells imported from China & Malaysia

## End of the MIP in **Europe**, with limited consequences, if any, on market trends



# The PV market remained stable in 2018 despite political turmoil

China, and to another extent Asia, strongly dominated the market



Source: The PV Market Alliance

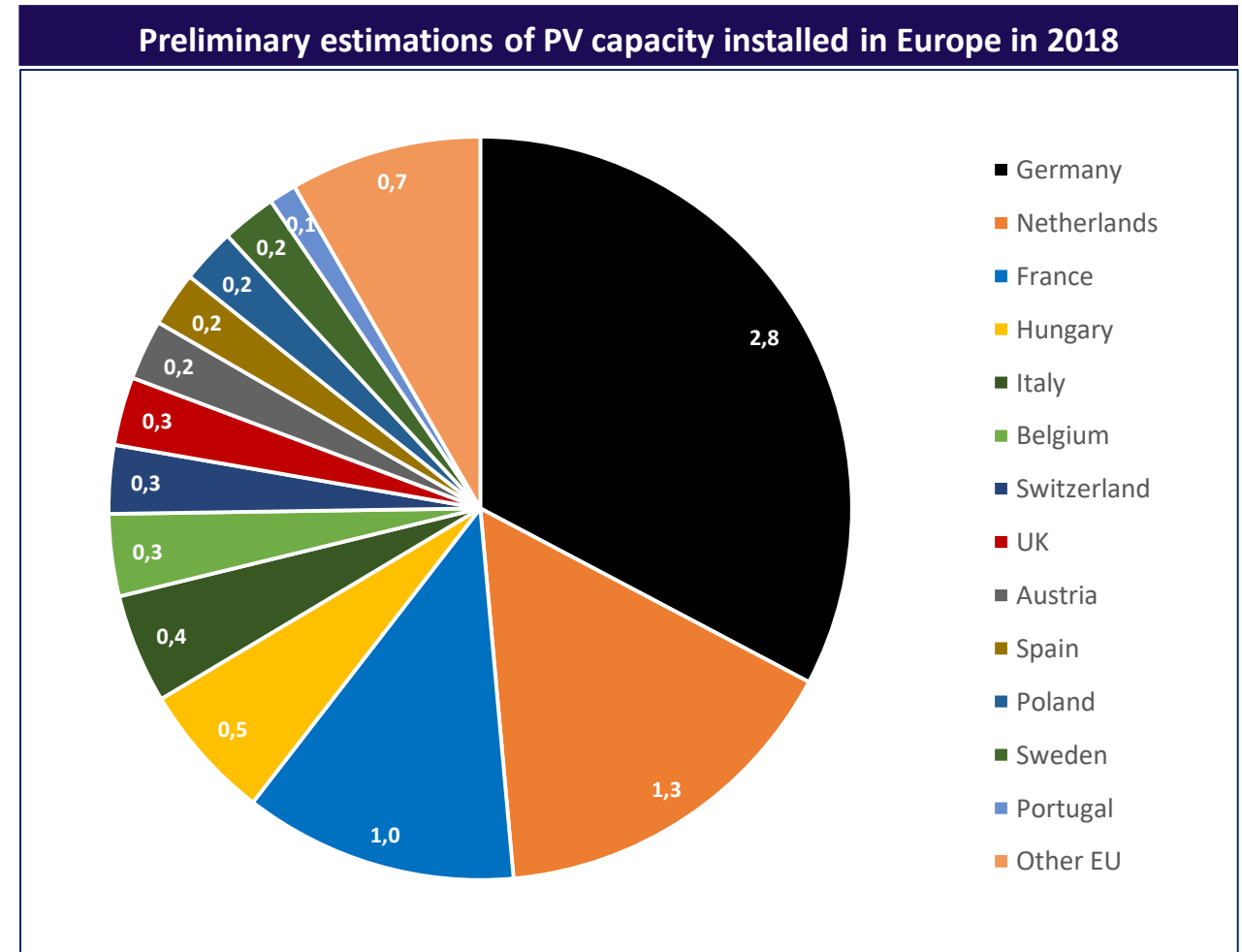
- In a decade, the market was multiplied by a factor 15
- From 6,6 GWp in 2008 to (at least) 98 GW in 2018.
- Cumulative capacity reached 500 GW
- Chinese market decreased by 17%. But the country installed more than expected
- Non-China markets reached 54 GW, from 46 GW in 2017
- USA and Japan stable, while India slightly slowed down.



# The European PV market is gaining momentum – again

Mature markets such as Germany and France lead the way, while new ones remain strong

- Growth of approximately 25% year-on-year
- Europe (EU+) reached almost 9 GW
- Germany still leading, thanks to its utility-scale market
- Market is growing in spite of the reduction of support schemes

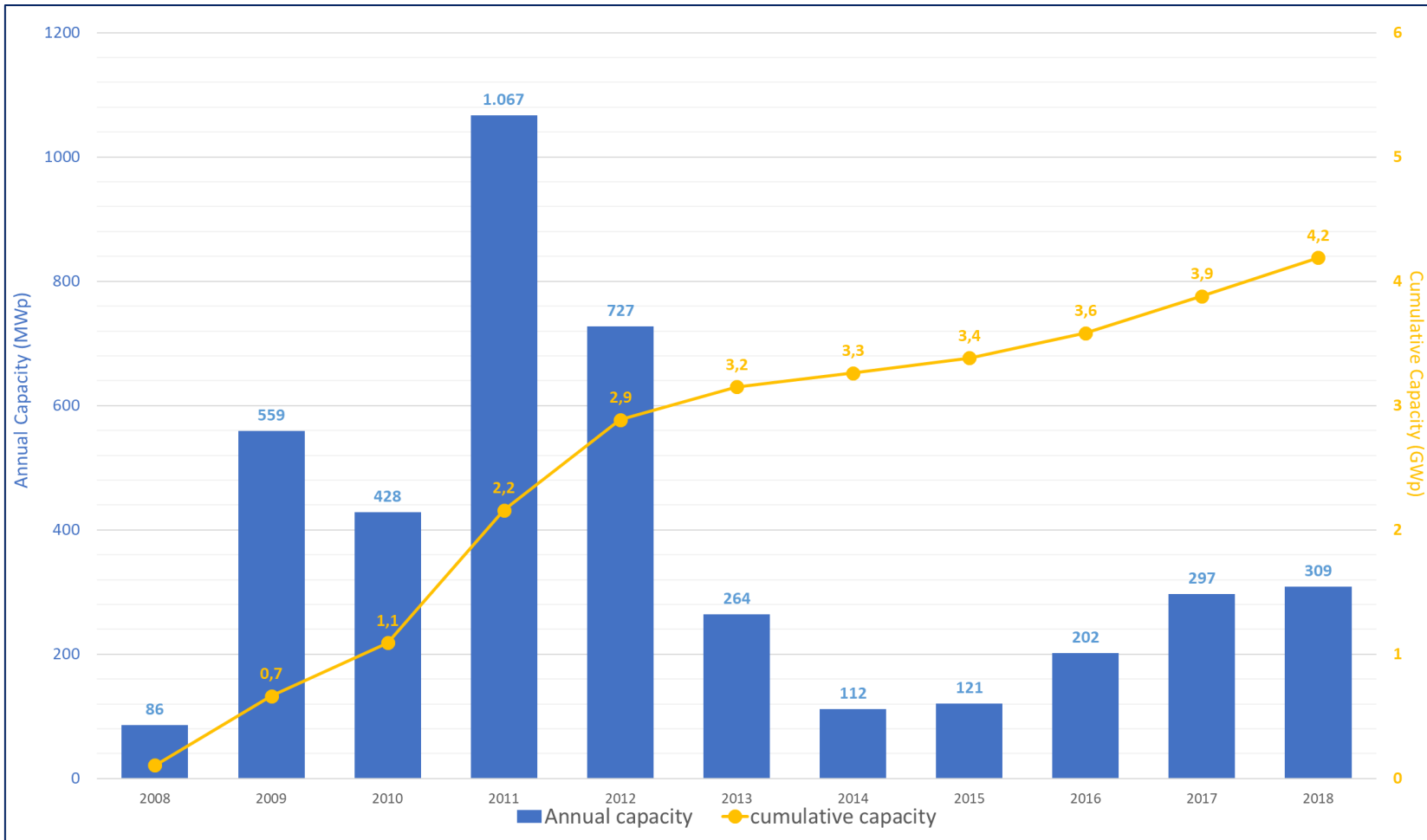


Source: The PV Market Alliance

# Belgian is also steadily increasing

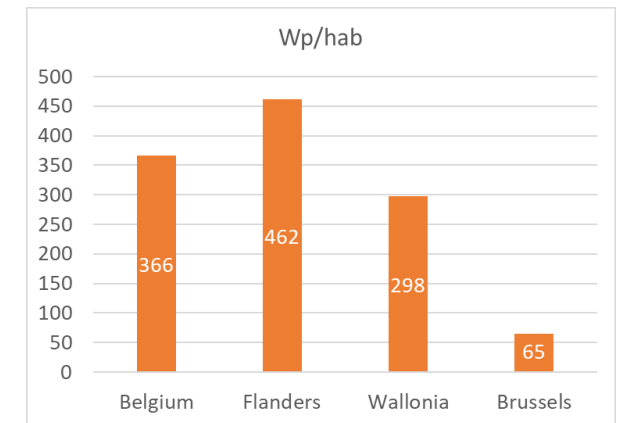
But the market remains far away from its golden age

### Annual and cumulative PV capacity in Belgium



Source: IEA PVPS

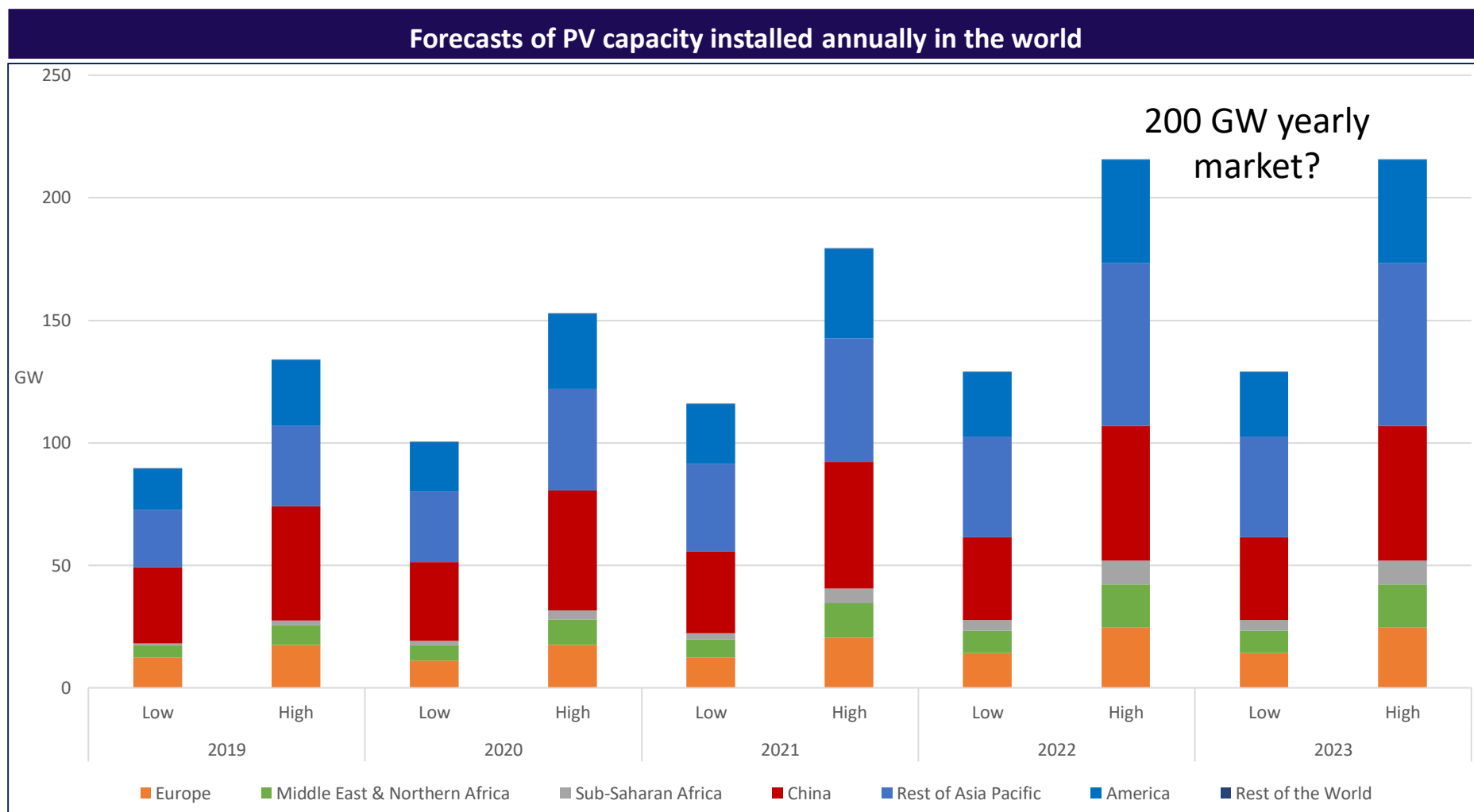
- Boom 2009-2012
  - Fast declining system prices
  - Too generous subsidies
- Market crashed in 2013
- Followed by 5 years of growth
- More than 4 GW cumulative capacity
- 366 Wp/capita. Only Germany (514) and Japan (390) are higher



# An (almost) ever growing market

The core of the global market shifted from Europe to Asia

- Risk of global market decline exists in 2019 if Chinese market decreases but it is unlikely: 2020 target is being reviewed.
- Market above 110 GW is a credible forecast, with potential until 120 GW (high probability), or more (lower probability).
- EU, India, Middle-East, and more will be source of growth.
- Market diversification with innovative applications and... new business models



Sources: PV Market Alliance





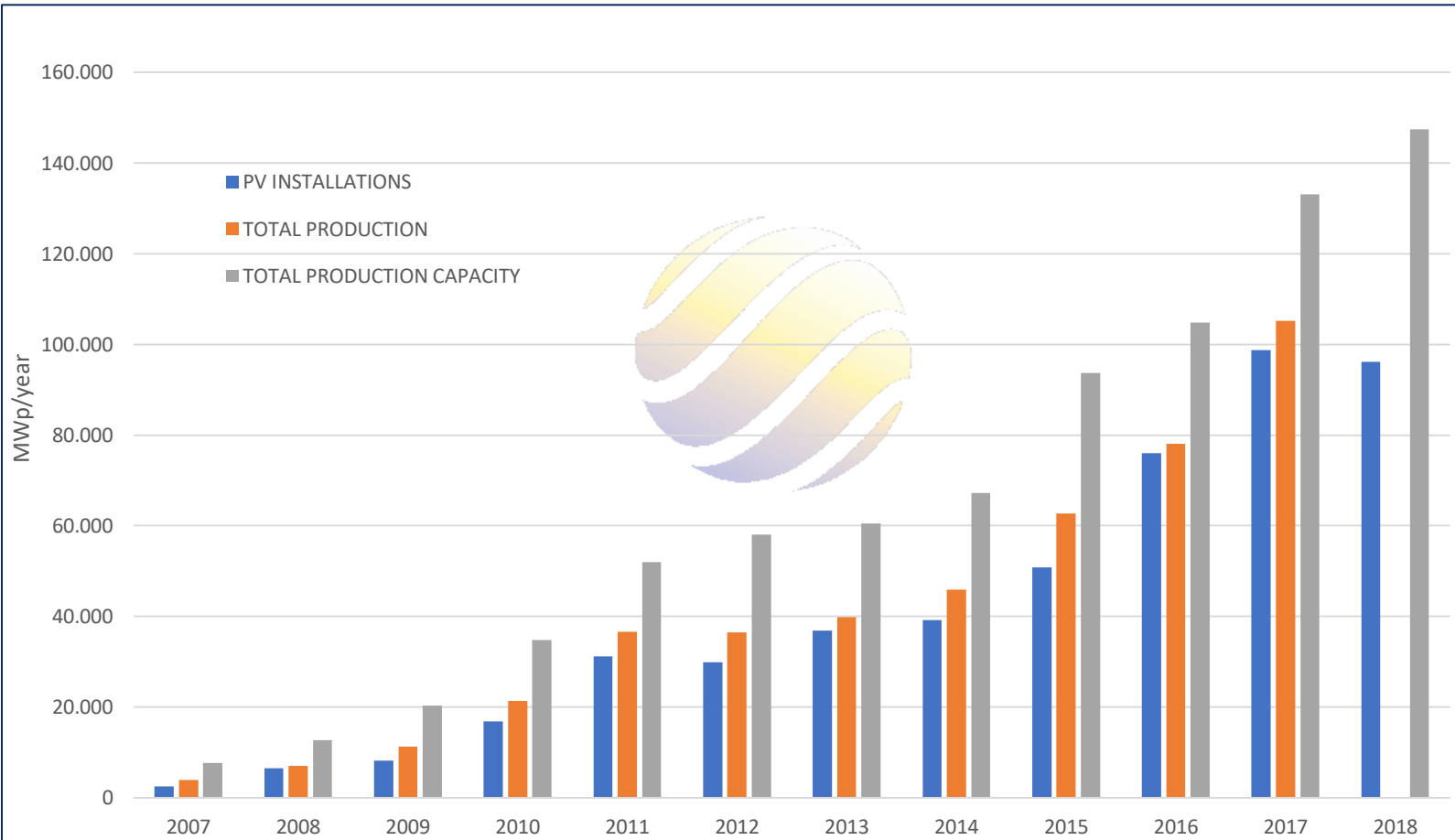
# Pricing of PV components



# Module production capacity increased sharply in 2018

Despite lower than expected market developments and the risk of overcapacity

Global PV Modules Production & Capacity



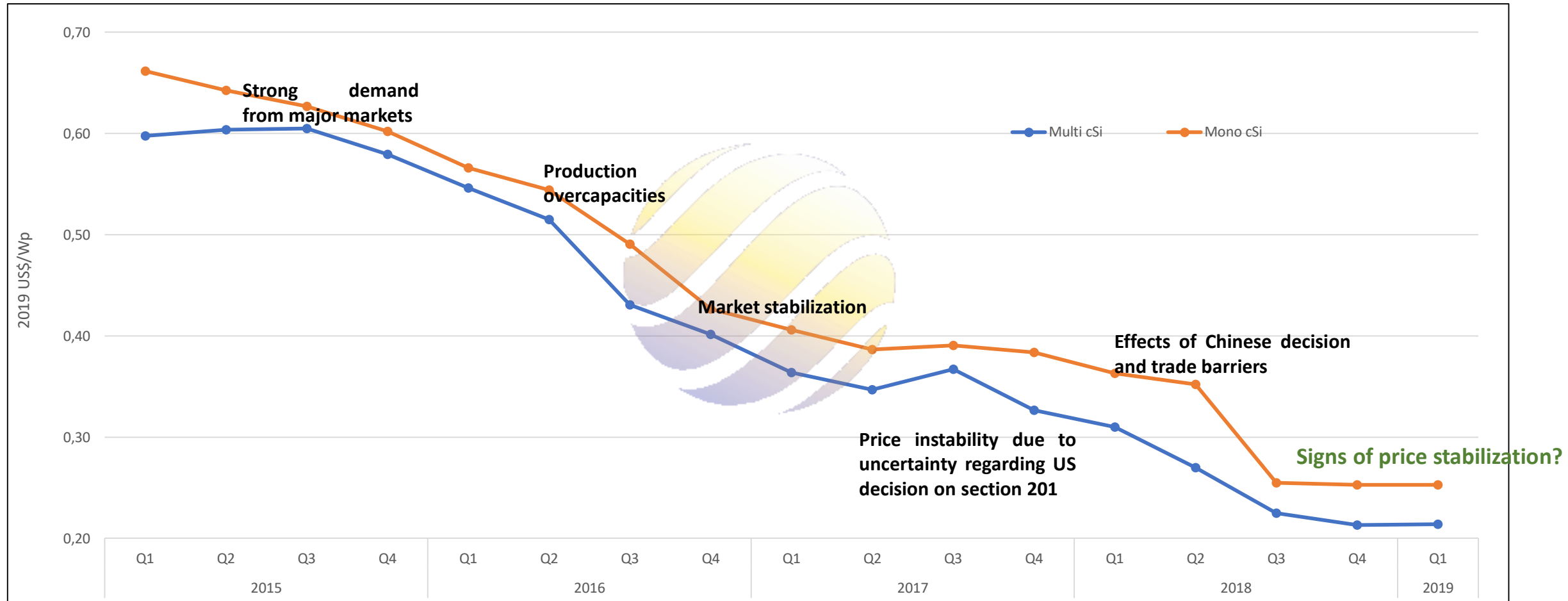
Source: RTS Corporation (production capacities), The PV Market Alliance (market numbers)

- Global production capacity kept increasing in 2018: expansion plans of various major PV players
- Threat of offer/demand unbalance if PV market does not grow
- Small players with suboptimal manufacturing technologies and limited distribution channels will struggle.

# Average PV modules prices are now close to 0,2 US\$/Wp

Modules initially intended to be sold in China have overwhelmed the global market

Evolution of module prices – End of quarter average spot prices



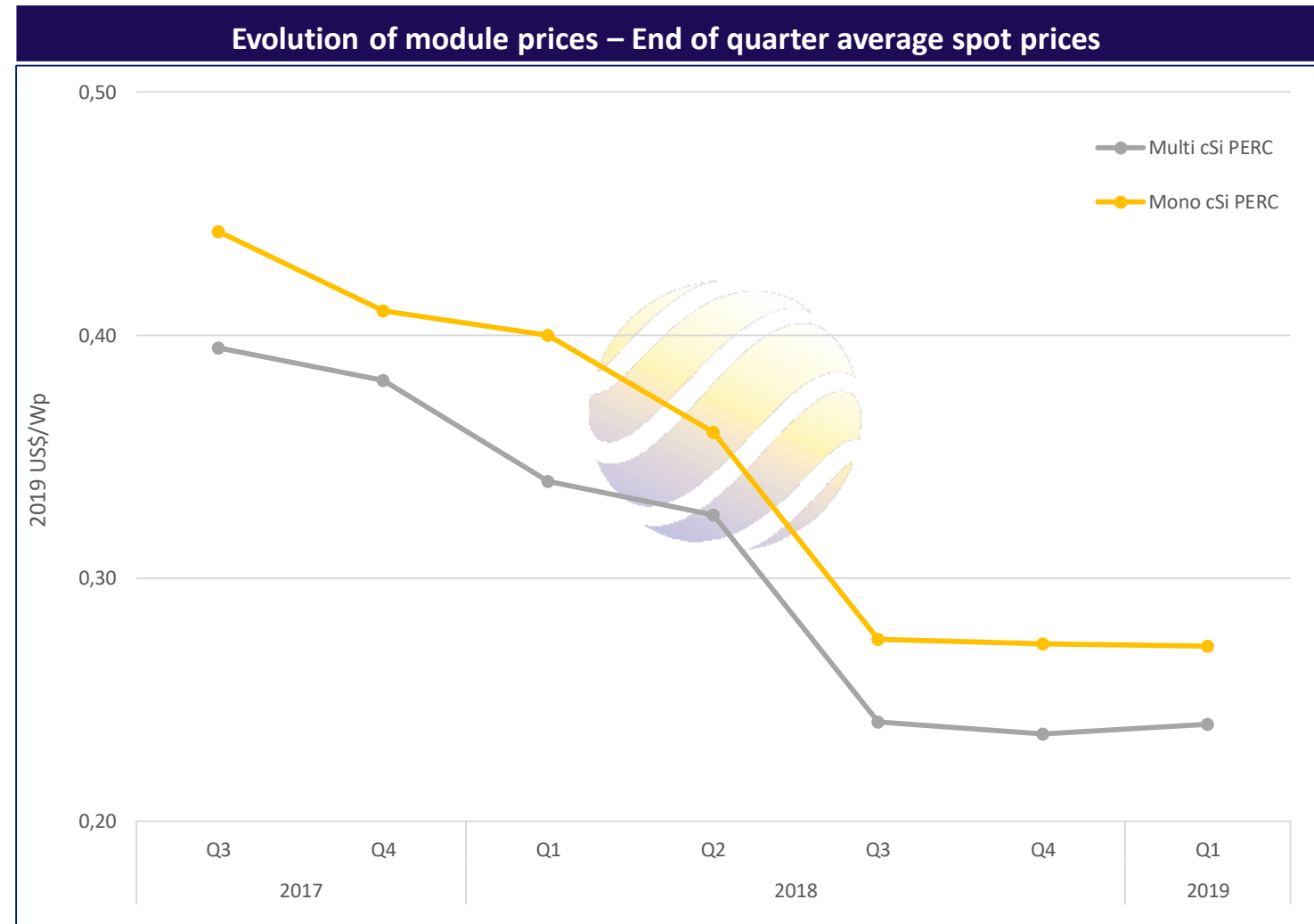
Source: Becquerel Institute



# High-efficiency products' prices are plunging as well

Although, the decrease of prices seems to be cooling down

- Demand for high-efficiency products was stable and was even **reinforced** on various markets.
- In China, this can be explained by the “Top-runner program” and in other markets, by an increased appetite for qualitative products.
- Production capacity of PERC modules is increasing very fast and stands today 60 GW.
- Price stabilization:
  - Tier-2 manufacturers who have been panicking since 31/5 decision, and fire-selling their modules have now emptied their inventories.
  - Some of them already stopped or strongly reduced their activities.
  - Market decrease has not been as strong as expected.

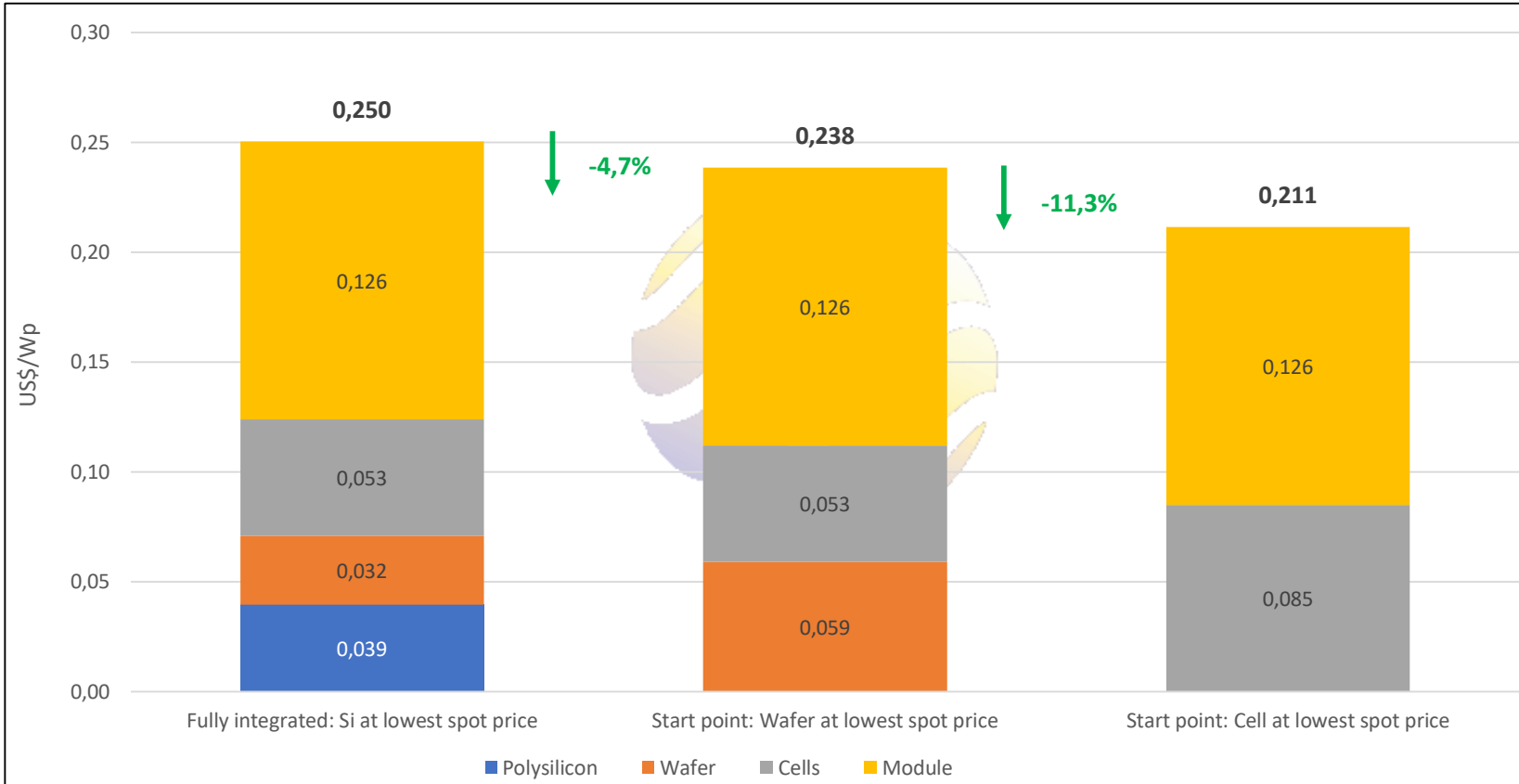


Source: Becquerel Institute

# PV components' market spot prices create turmoil

The ability of vertically integrated PV companies to maintain their competitive advantage is challenged

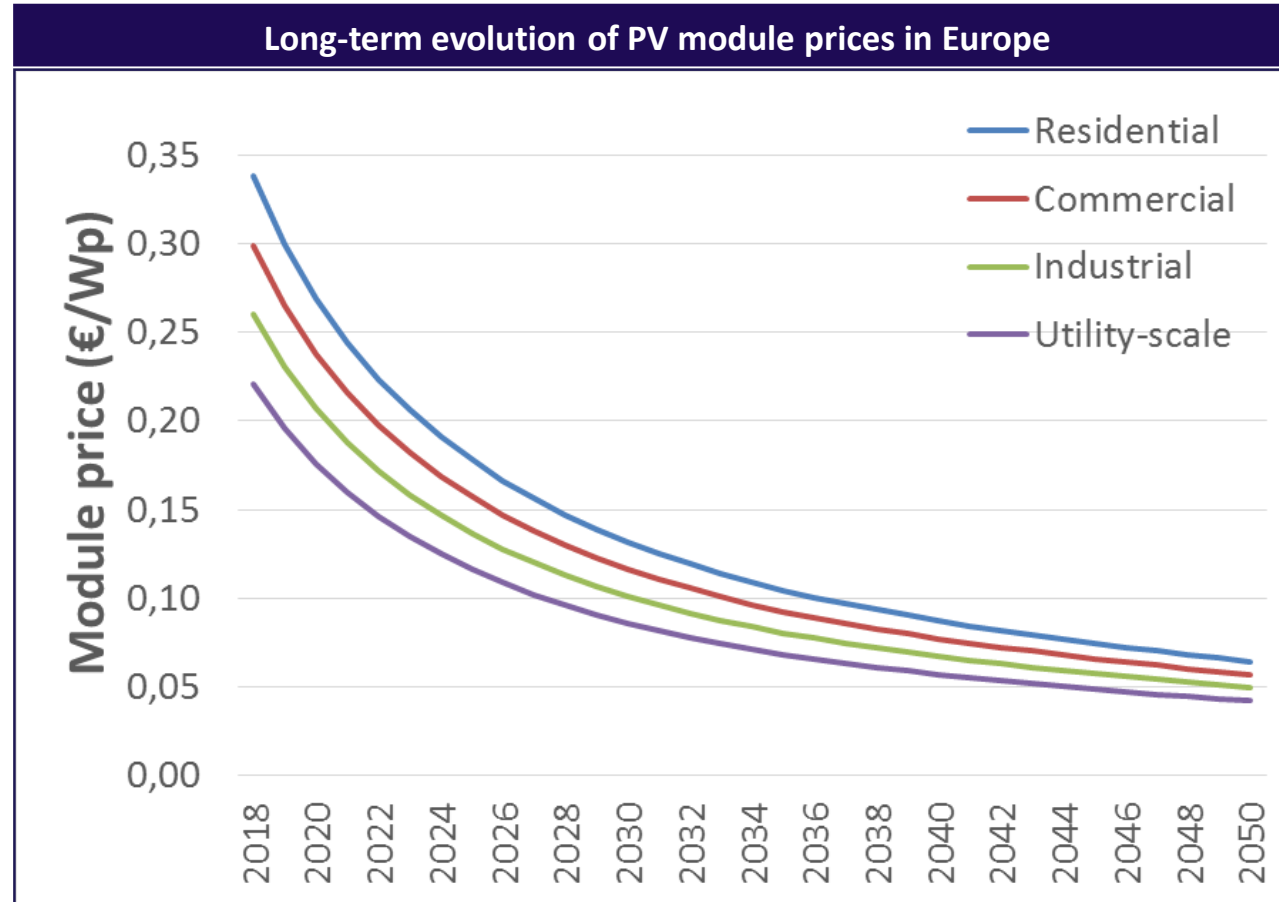
## Manufacturing cost of multicrystalline silicon modules at factory gate – **Lowest** market spot price



- Overview of what can be potentially reached, in the best case, by module manufacturers in function of their level of vertical integration.
- If prices are lower than computed production costs, what could happen?
- But average selling price is higher than the lowest prices: these latter are only representative of the situation of a minor share of the market, i.e. super competitive tenders
- 10 GW is the new normal, but are vertically integrated factories the absolute must ?

# PV module prices could be below 0,10 €/Wp in Europe by 2030

But history has shown that price long-term price trends are unpredictable

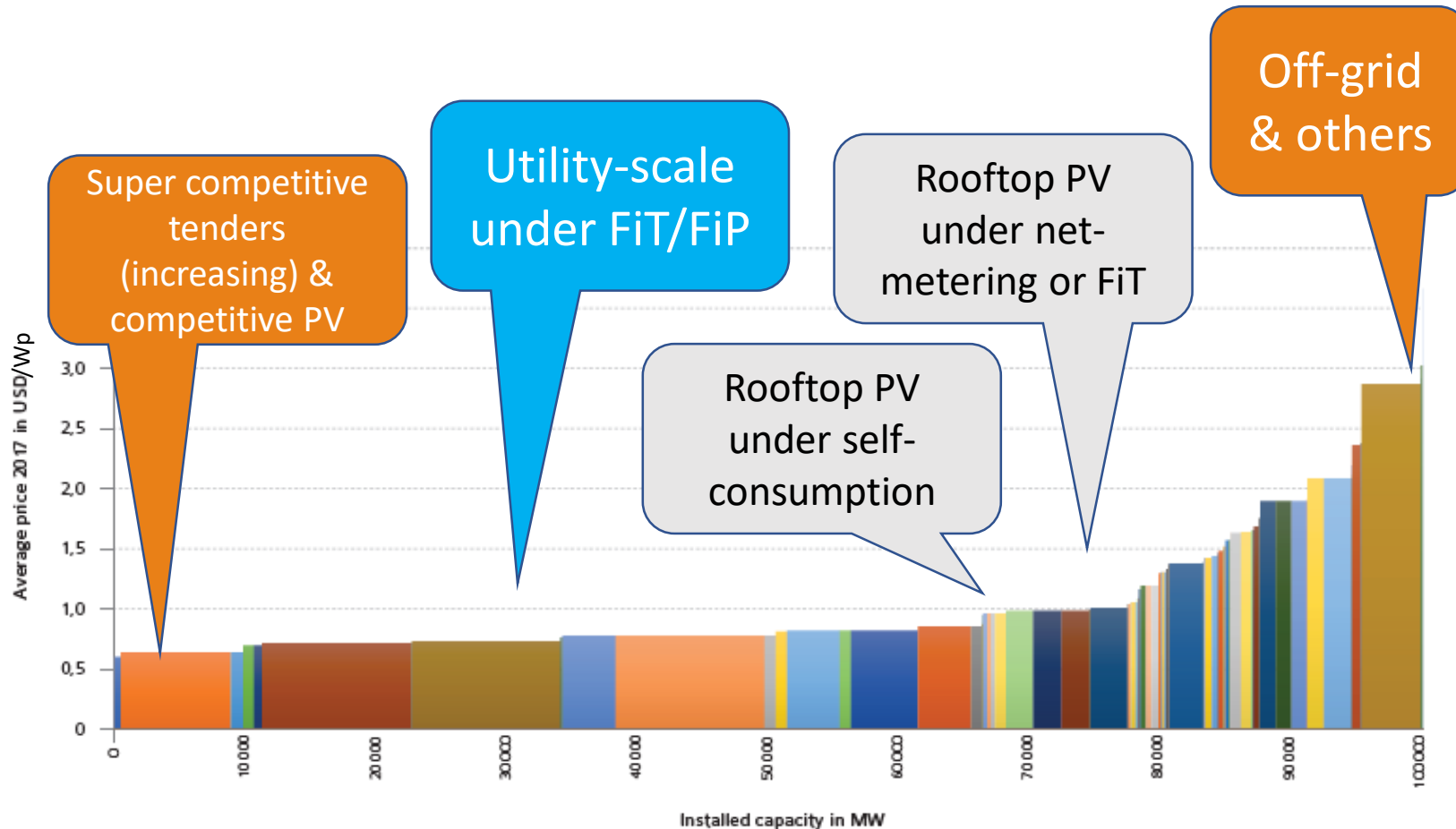


Source: ETIP PV



# Final prices of systems are highly uneven across the global market

Only a minor share of the PV installations is installed at the record low-prices making the headlines of the news



Source: IEA PVPS, Becquerel Institute

- < 10 GWp of the PV capacity installed worldwide at the most competitive system prices, i.e. around, 0,6 US\$/Wp.
- Other utility-scale installations: reduced price but not as low.
- Rooftop PV: higher but can go below 1 US\$/Wp, in best cases.
- Residential segment: can hardly go below 1,1-1,2 US\$/Wp. Overall, this is the segment with the most heterogeneous price ranges.

# Solar PV electricity below 0,02 US\$/kWh ?

Even in Europe solar PV energy price can be on a par with wholesale market prices

## Saudi Arabia's 300 MW solar tender may conclude with lowest bid ever

A consortium formed by UAE-based Masdar and French energy giant EDF has offered to deploy all the tendered capacity at a LCOE of 0.06697 SAR (\$0.0178) per kWh. In addition, seven of the eight bids were under \$0.03 per kWh. The tender's bidders will be announced by the end of January 2018.

OCTOBER 4, 2017 EMILIANO BELLINI

MARKETS UTILITY-SCALE PV SAUDI ARABIA



0,0168 US\$ per kWh

## Germany's auction for large-scale solar concludes at €0.0429 per kWh

The average price for bids submitted in Germany's auction for large-scale solar has fallen below the mark of €0.050/kWh for the first time. A total of 20 projects with a combined capacity of 222 MW were awarded by the Federal Network Agency.

OCTOBER 16, 2017 SANDRA ENKHARDT

UTILITY-SCALE PV GERMANY



## Spain's auction allocates 3.5 GW of PV capacity

Solar had the largest share in Spain's renewable energy auction, leaving wind power, which won all the allocated capacity in the previous auction, with just 720 MW.

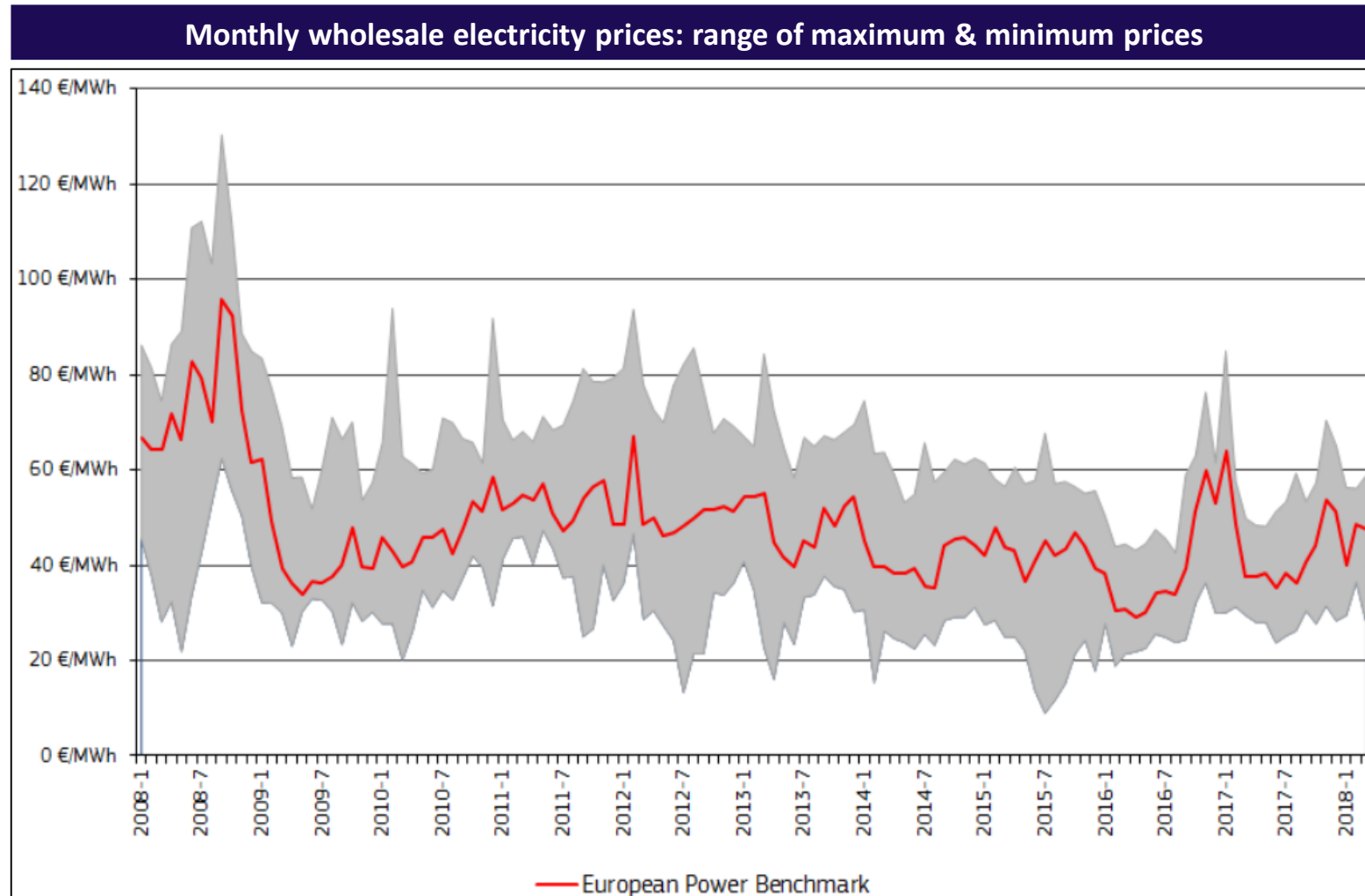
JULY 26, 2017 EMILIANO BELLINI

MARKETS UTILITY-SCALE PV SPAIN

0,038 € per kWh

# Solar PV electricity below 0,04 €/kWh ?

Even in Europe solar PV energy price can be on a par with wholesale market prices

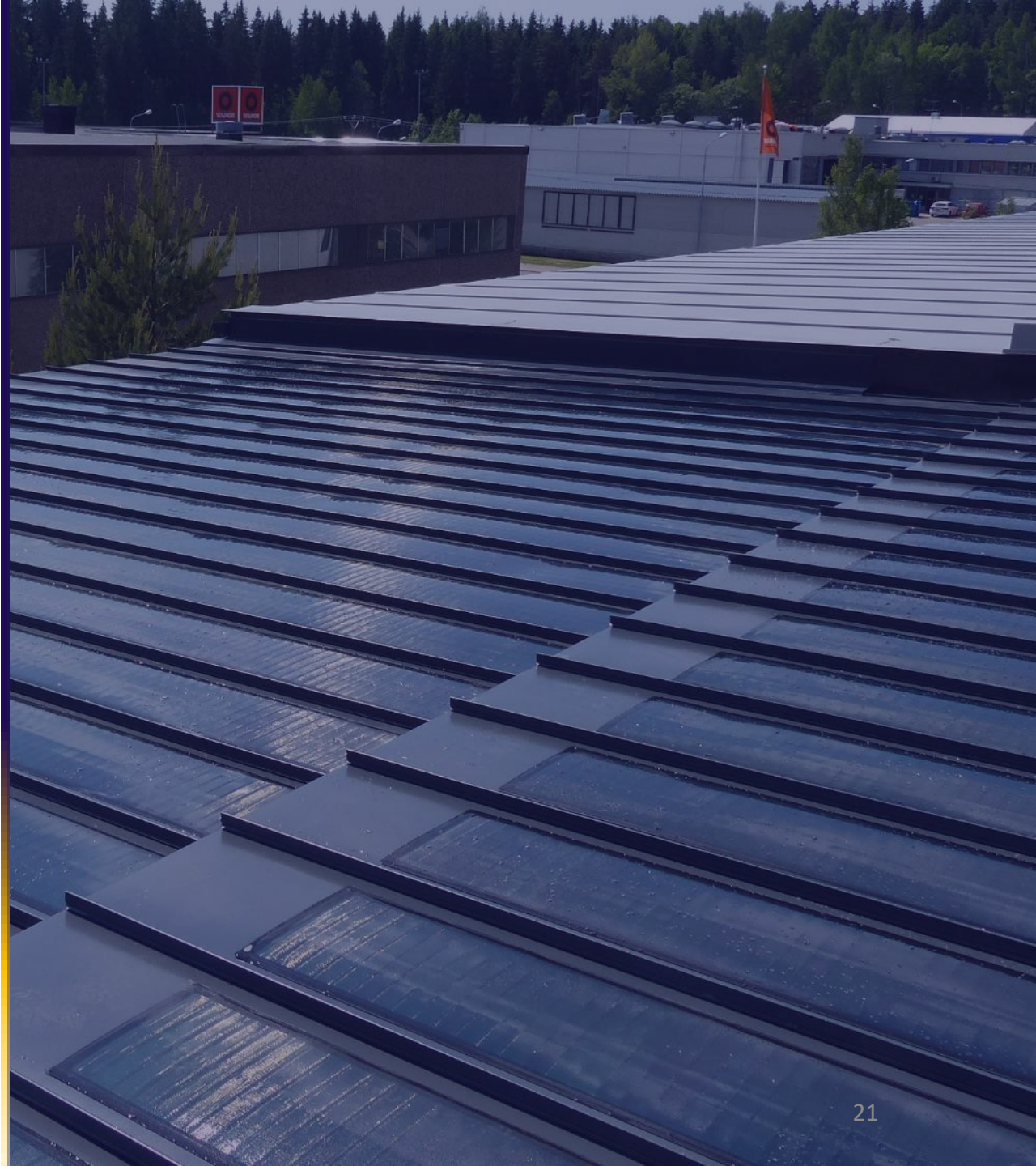


Source: European Commission





# Business models in PV: towards a new paradigm



# Different business models for different applications

Distributed (decentralized) PV has become minor compared to centralized PV systems

Cumulative global PV capacity – Segmentation of grid connected installations



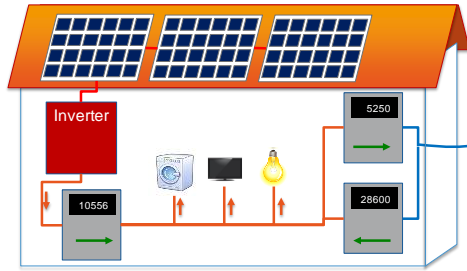
Source: IEA PVPS

- 2018? A large-part of the global growth was in the utility-scale segment, especially in emerging markets
- Market segmentation has been dominated by utility-scale PV plants in the last 6 years, with a change coming from China in 2017.
- Innovative applications still marginal:
  - Floating < 1 GW
  - BIPV < 1 GW
  - AgriPV is new and growing slow
  - VIPV is still in its infancy



# Different business models for different applications

Each segment has its own competitive environment



Distributed PV

Producers

Self-consumption, energy efficiency, grid parity, competition with utilities' **distribution** business

Prosumers

One technology

Grid injection, PPA, competition with electricity **generation** business of utilities

Centralized PV



# Distributed PV is highly dependent of regulation...

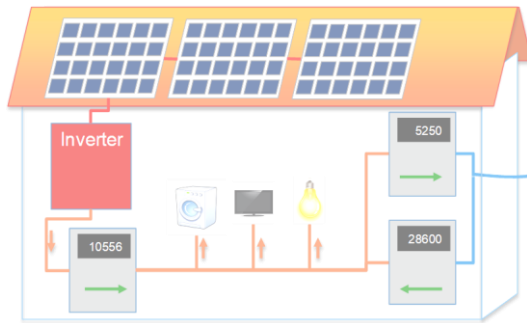
... and its unexpected changes



# Distributed PV business models need to rely on self-consumption

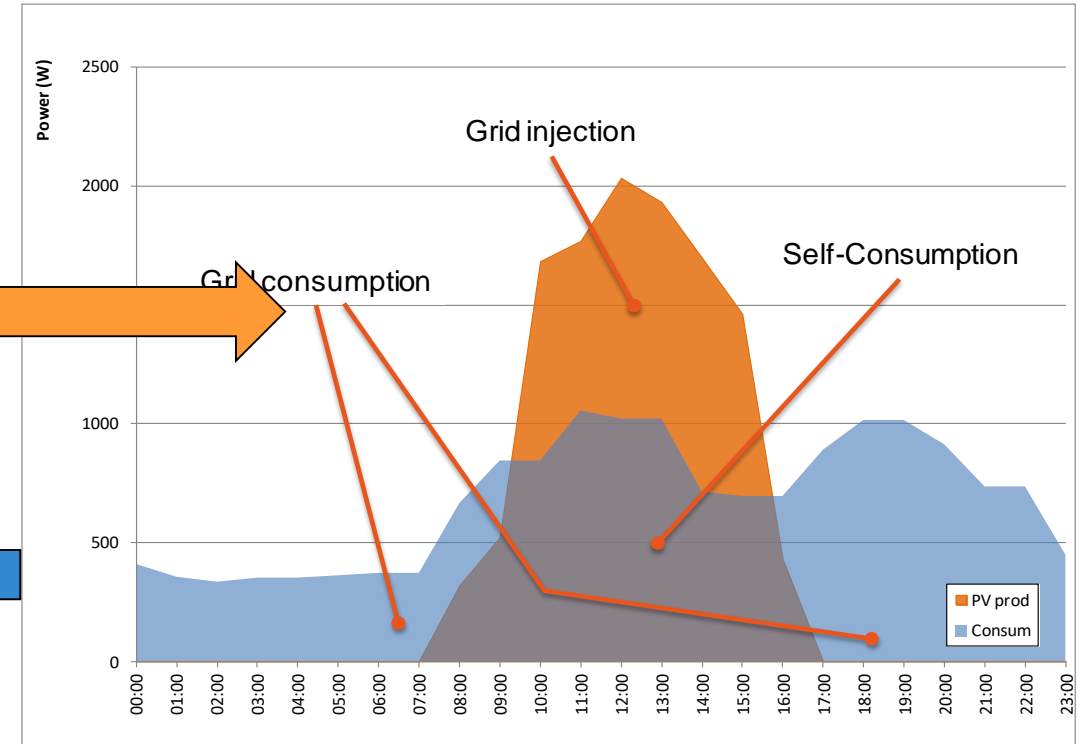
And to be competitive against retail electricity prices

Self-consumption of PV installations:  
From 30% (or less...) to 100%



**Challenge:** minimizing grid injection

**Solutions:** decrease PV system size, DSM, Storage



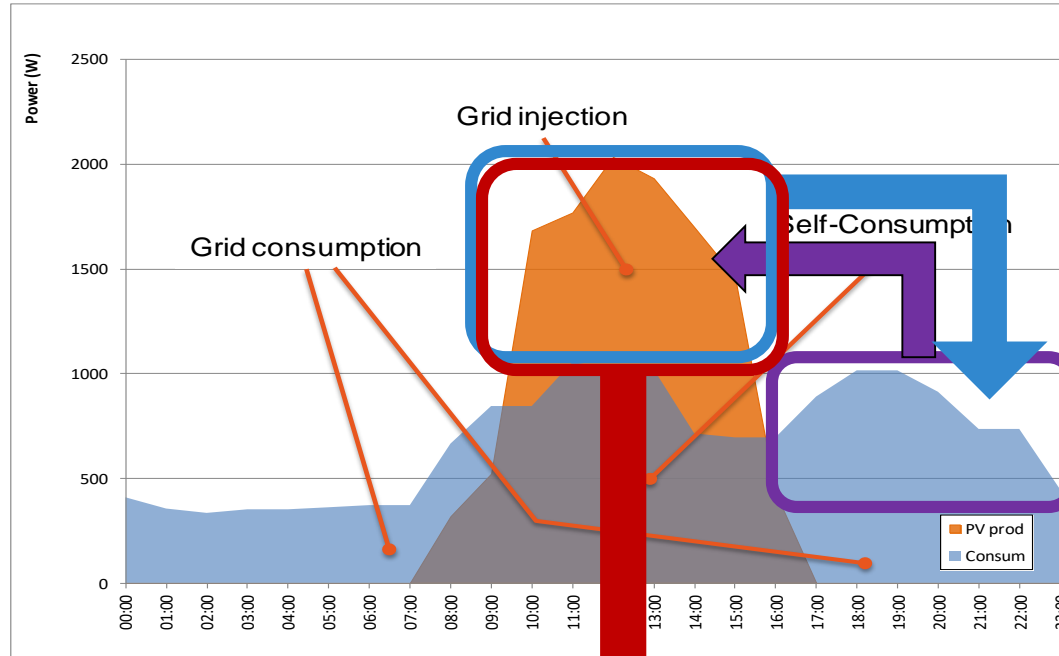
# Distributed PV business models need to rely on self-consumption

And to be competitive against retail electricity prices

DSM

Electricity Storage

Other uses(out of the load)



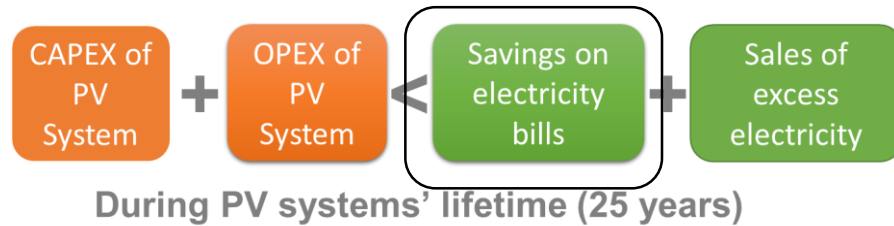
H&C, Transport



But is local maximization of SC optimum from a system point of view ?

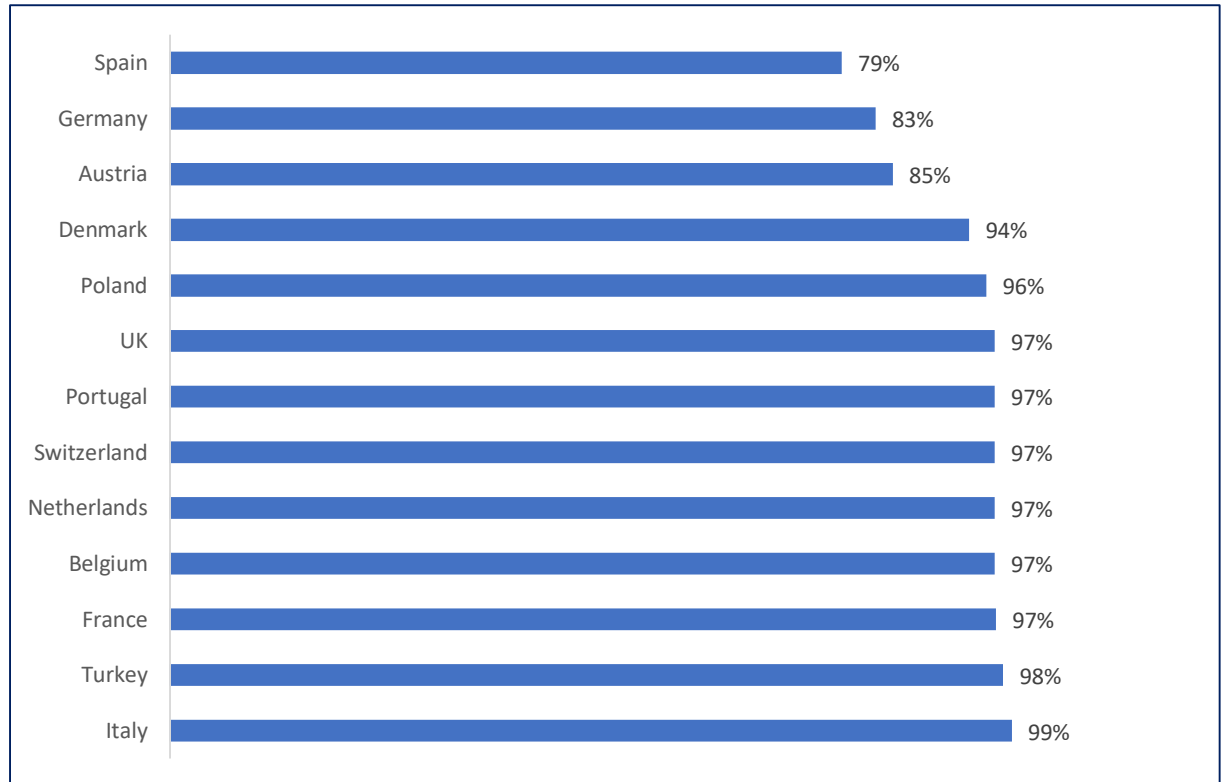
# Focus on profits from electricity bills savings

Compensability of retail electricity prices impact PV profitability



- What are the fixed and variable parts of the electricity bill?
- How much can be compensated from the electricity bill ?

## Maximum savings on electricity bills in 2017 (average)



Source: IEA PVPS



# Increasing self-consumption can be a threat for grid financing

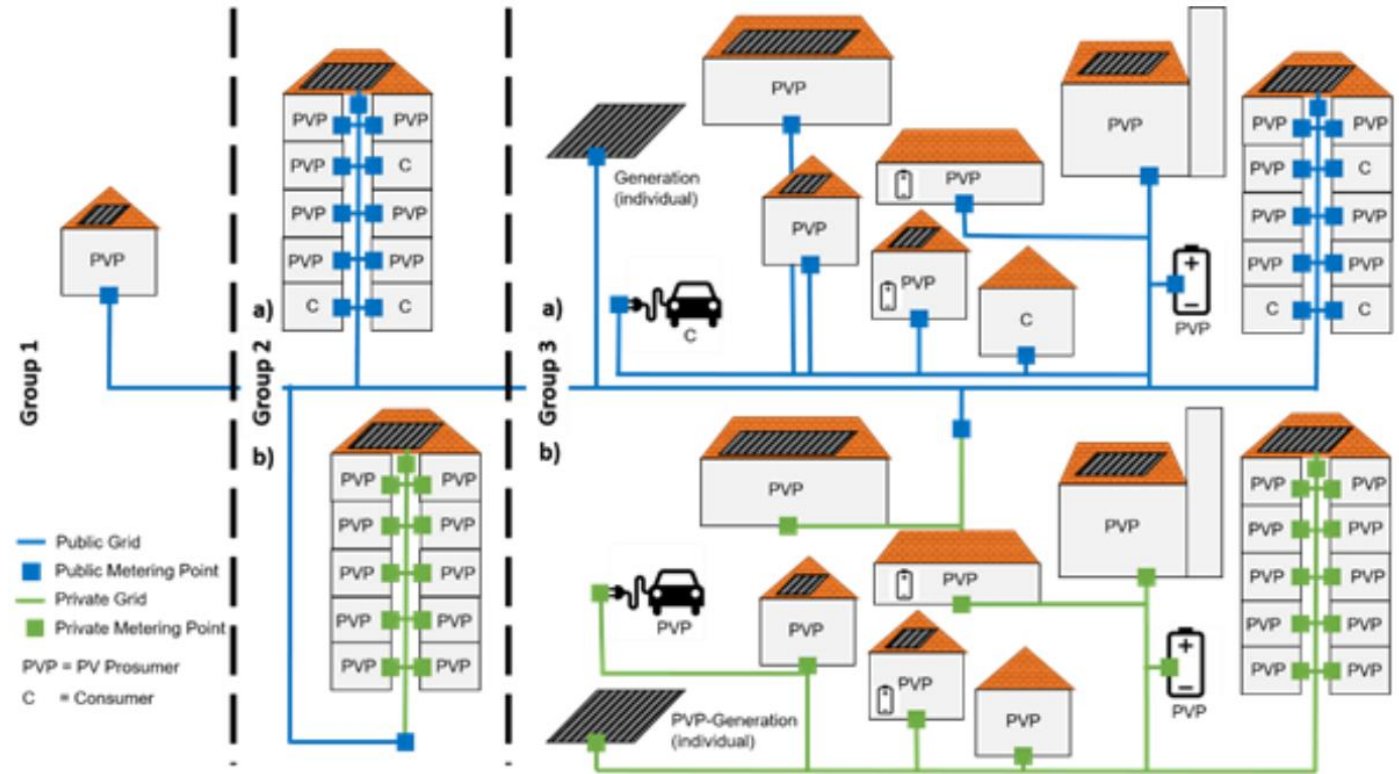
A capacity-based infrastructure financed through energy demand

- Grids are mostly financed on an energy basis, but their deployment is capacity-based.
- Average Energy/capacity tariffs in Europe depends on country and segment.
- How to adapt to PV development ?
- Grid tariffs depend on policy choices
- Most countries so far: Grid costs to be paid on the really consumed electricity
  - Belgium: prosumer's tariff = ~ grid costs for prosumers round 80-90 EUR/kWp (but net-metering)
  - Spain: ~~Sun tax – same idea, different application~~ Just removed !
  - Italy: “scambio sul posto” – but favourable to PV
  - Many discussions about net-metering in the USA

# Example of innovative BM: “collective” self-consumption

From isolated prosumers to communities of energy prosumers and consumers

- New regulations are being developed in various Member states to be in phase with the new European directive → allow local energy communities
- France at the forefront: regulation has been existing for more than 1 year already but... limited deployment due to the complexity of the scheme
- Netherlands also: “postcoderoos” regulation
- Austria & Germany: only within the same building



# Towards an expanded self-consumption concept

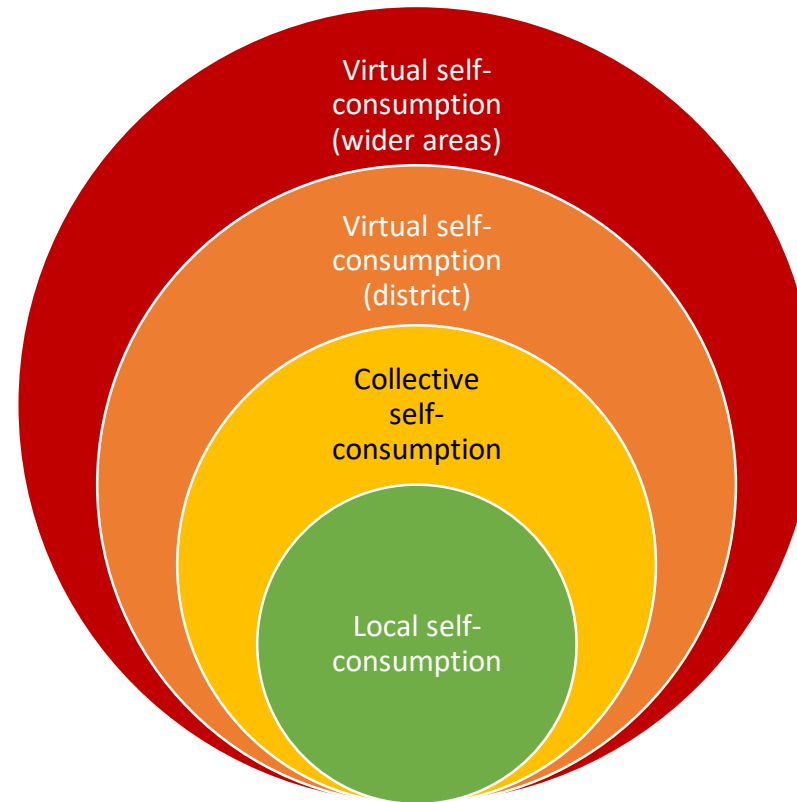
A new paradigm will develop, helped by innovative "smart" technologies

Remuneration of the transmission grid necessary

Remuneration of the distribution grid necessary

How to share energy? Grid costs management similar.

Grid costs paid for consumed electricity and mutualized for self-consumption



- Utility-scale plant to power public buildings in cities
- Virtual compensation between buildings in the same city
- Charging EVs in the office with PV electricity produced at home (or the opposite)
- Storage, EV, PV, H&C in buildings, connected and exchanging electricity.

Source: TU Wien & Becquerel Institute



# Conclusions and short-term outlook

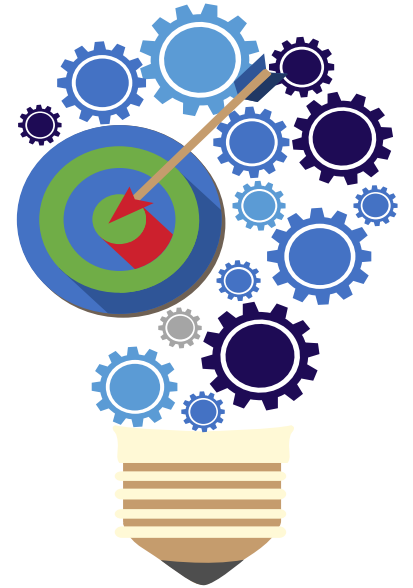
# Solar PV will keep strengthening its position

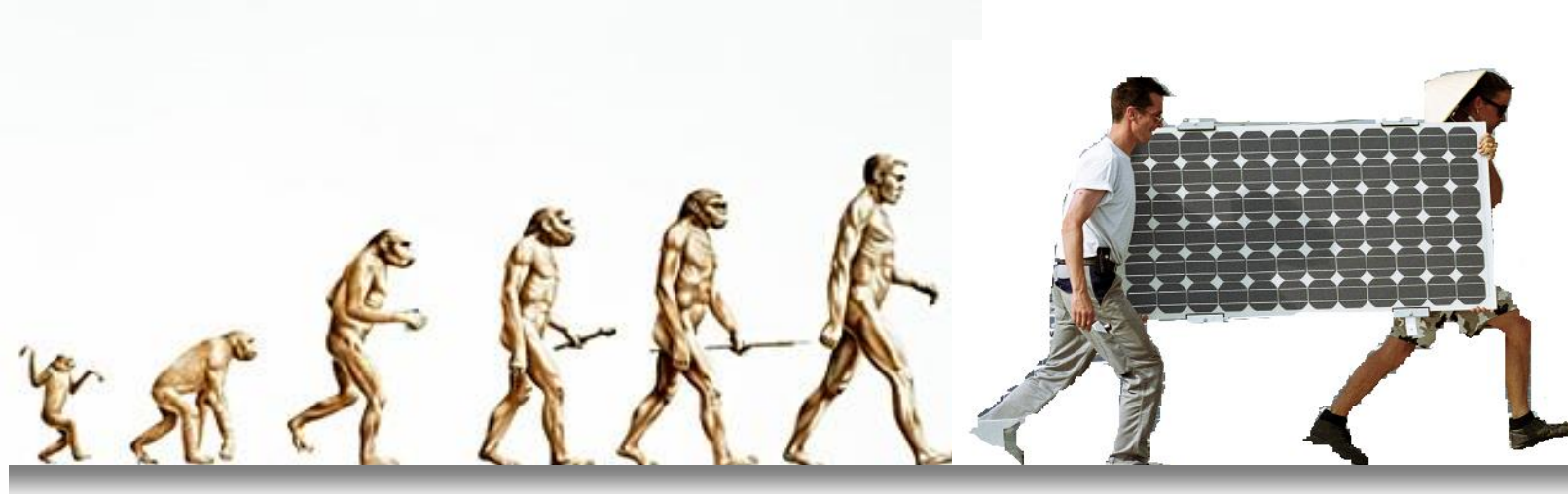
Decreasing prices, new applications and innovative business models

- ☉ With a stable PV market (even slightly growing), the **pressure on the prices** will continue to be high: overcapacity threat
- ☉ **Consolidation** in the industry has already started.
- ☉ Costs will continue to go down, but prices are already **making PV competitive in many segments** and countries.
- ☉ Increase of trade duties will temporarily slow down some specific PV markets → **shift to new markets**
- ☉ **Market resilience** of the PV market was higher than expected!
- ☉ Medium-term potential for at least **200 GW a year**
- ☉ The **revolution** has just started...
- ☉ From **simple modules** to BIPV, roads, floating PV, urban furniture, cars, trains, planes...
- ☉ PV will be the **CHEAPEST** source of energy in this century.
- ☉ The **grid must adapt** to new uses and is not a definitive concept



« PV is **not** the source of electricity of the future...  
... it is already a reality **today** »





Let's not miss the next step in evolution !



**BECQUEREL  
INSTITUTE**

*Advanced Intelligence and Research on Solar*

**THANKS FOR YOUR ATTENTION**

**CONTACT**

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