Bundesministerium für Wirtschaft und Technologie

renac renewables academy

INDO-GERMAN AHK Indo-German Chamber of Commerce
Deutsch-Indische Handelskammer
Mumbai · Delhi · Kolkata · Chennai
Bangalore · Pune · Düsseldorf

Energy

The big picture – Needs for and benefit of solar PV in Europe and India

Ruggero Schleicher-Tappeser, sustainable strategies, Berlin
India – Germany: Expert Workshop PV Policies
Bangalore, November 3, 2011

renewables Made in Germany

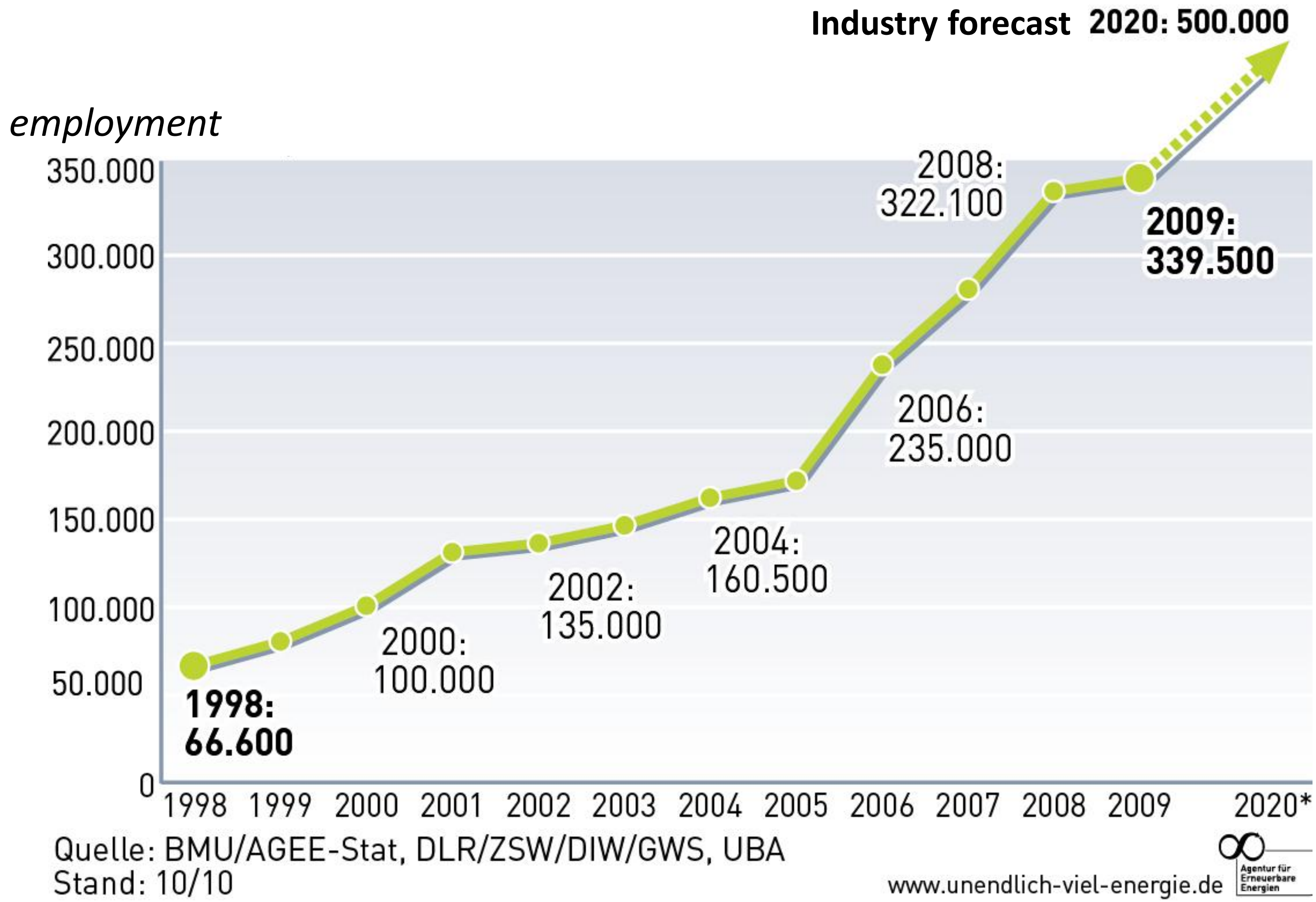
BSW

sustainable strategies ruggero schleicher-tappeser

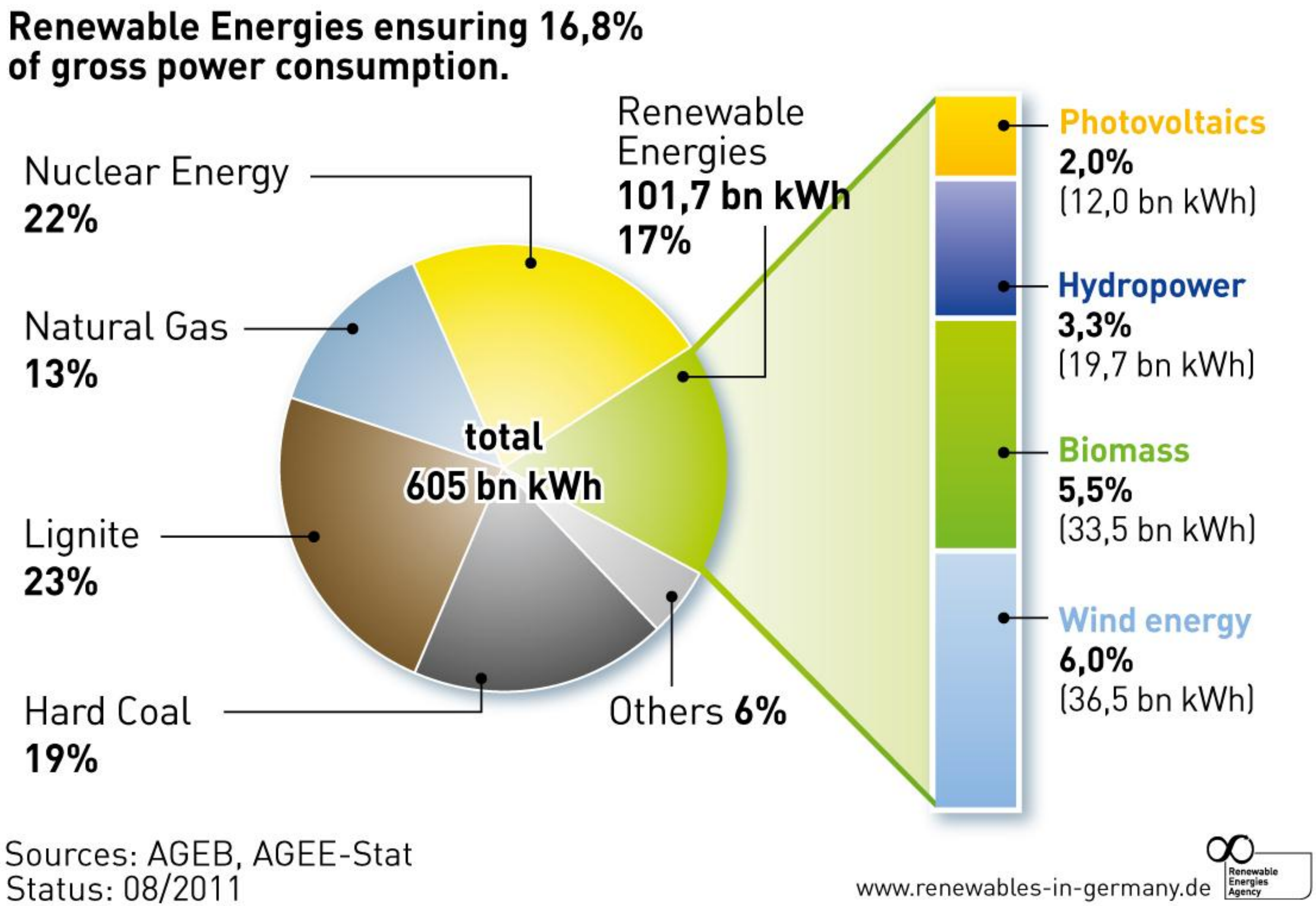
Converging political targets in Europe: 100% renewable electricity by 2050

- EU decision in 2009, compulsory:
  <u>20% renewable energy in Europe 2020</u> → ca. 35% renewable electricity
- German RE Industry Association 2008:
  47% renewable electricity in Germany by 2020
- German environmental minister Röttgen 2010:
  his aim: 100% renewable *electricity* in Germany 2050
- EREC (European RE Industry Association) 2010/11:
  100% renewable *energy* in Europe 2050, 45% in 2030
- German Advisory Council on the Environment 2010:
  100% renewable *electricity* in Germany possible and necessary by2050
- European Climate foundation / PriceWaterhouseCoopers 2010:
  100% renewable *electricity* in Europe possible by 2050
- WWF 2011 worldwide scenarios:
  100% renewable *energy* 2050
- EU Commission Energy scenarios 2011:
  ??? % renewable energy in Europe 2050

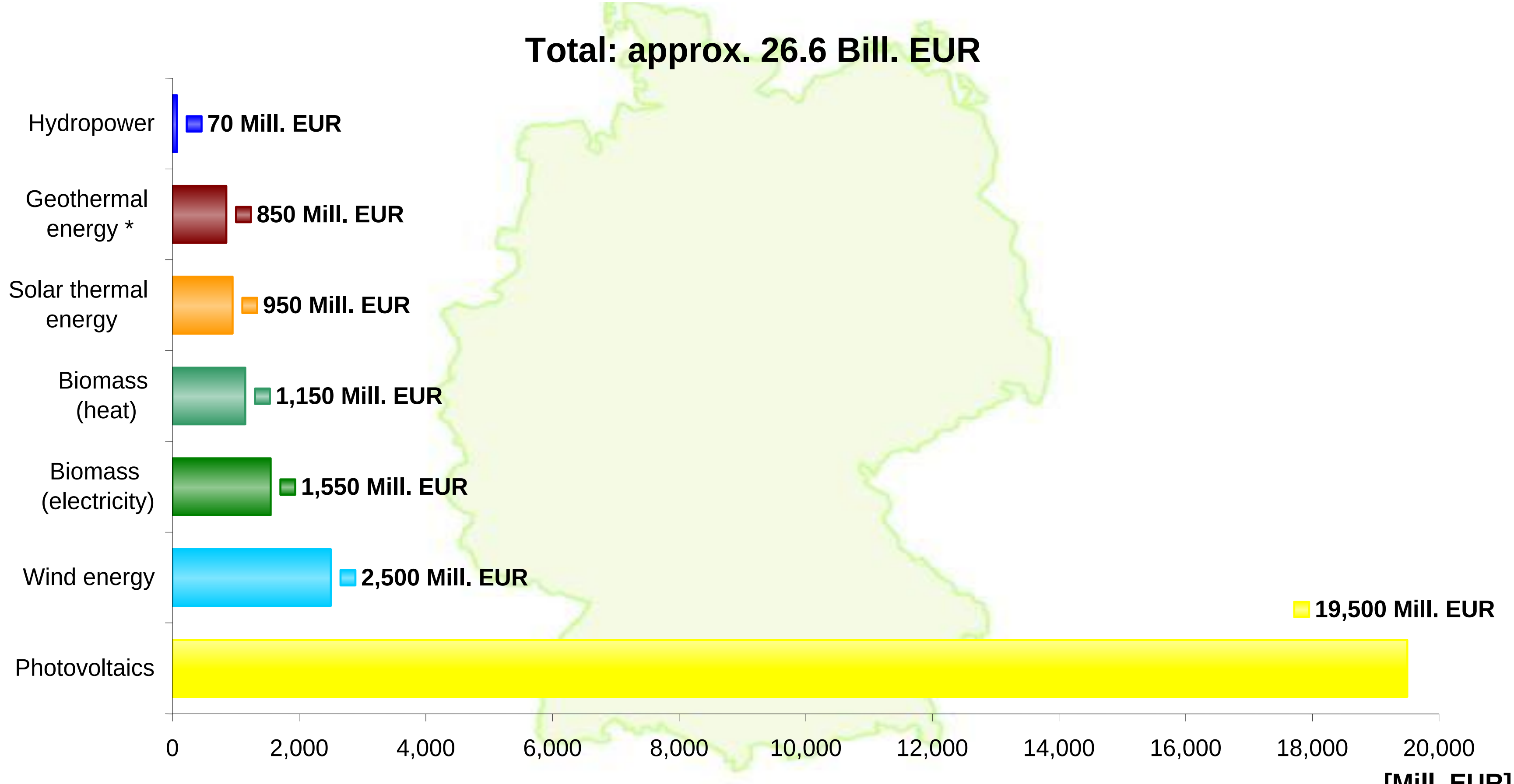
Employment in renewable energies in Germany



Electricity production mix in Germany 2010

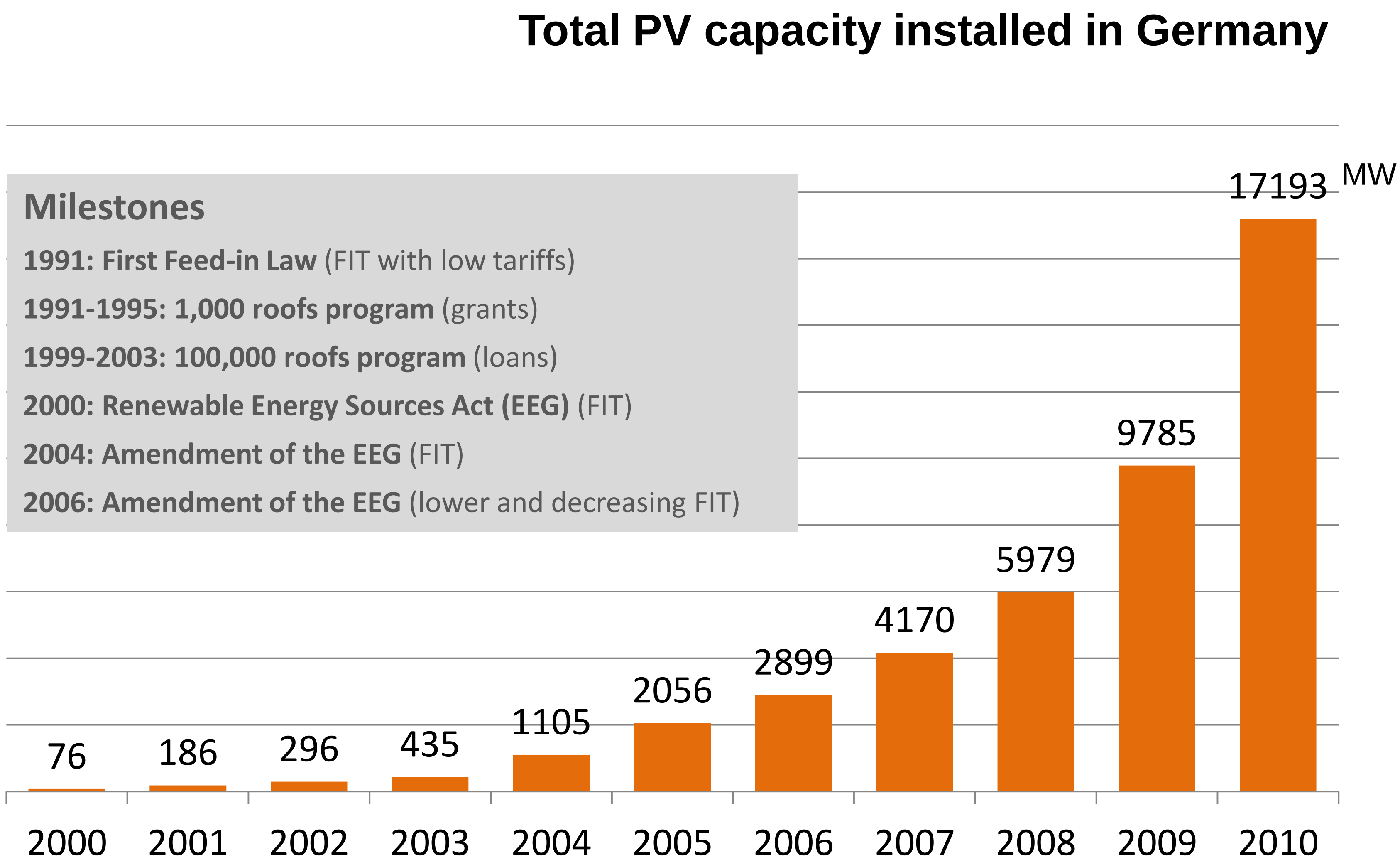


Investments in renewable energy installations in Germany 2010



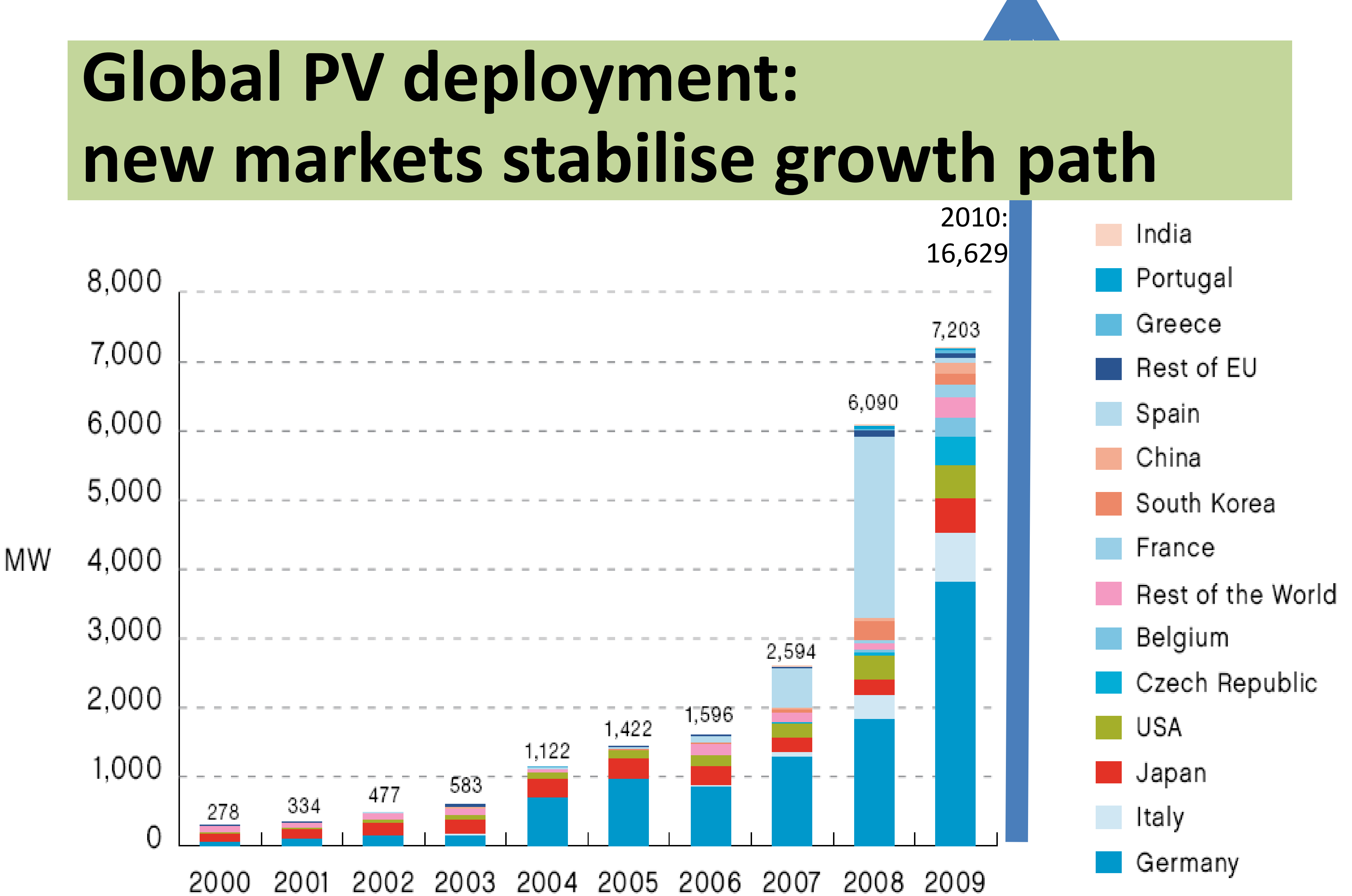
* Large plants and heat pumps; deviations in the totals are due to rounding;
Source: BMU-KI III 1 according to the Centre for Solar Energy and Hydrogen Research Baden-Wuerttemberg (ZSW); as at: July 2011; all figures provisional

Germany has triggered the take-off of the world PV market



Source: BMU, BSW

Global PV deployment: new markets stabilise growth path



Success factors

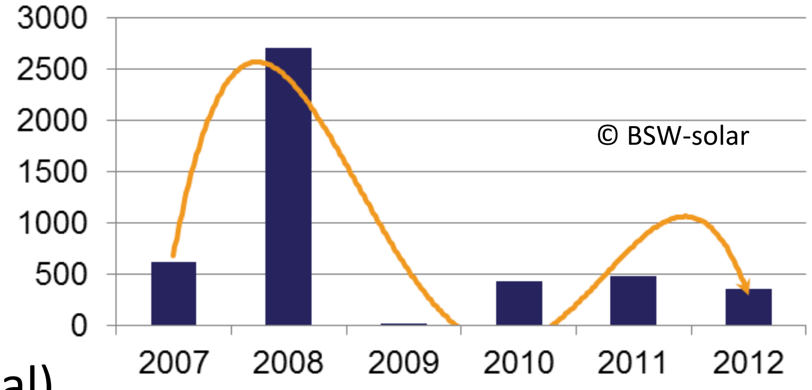
- A reliable investment context with guaranteed feed-in tariffs for 20 years after installation
- Continuous adaptation of the FiT for new systems to market development → steady growth
- A simple scheme: no other incentives, just FiT
- No complicated permitting procedures

- ➢ Banks have learned that PV investments are low risk → low capital costs
- ➢ Industry and craftsmen have invested in production and training → reliable quality, low system price
- ➢ Hundreds of thousands of new private investors

Creating a stable market with feed-in-tariffs

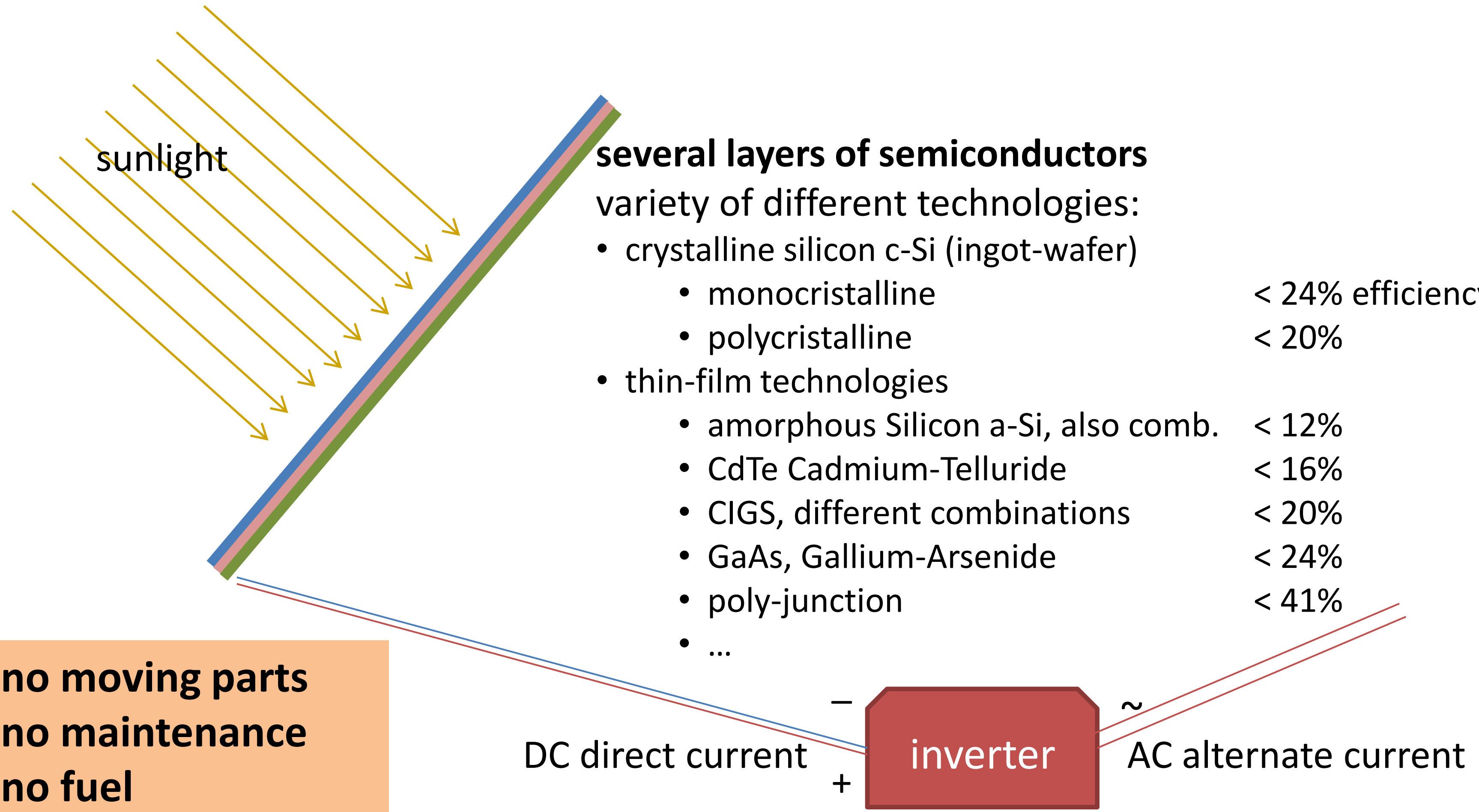
- Earlier promising PV programmes pushed by the USA (President Carter) in the early eighties, then by Japan in the nineties were less transparent and terminated to early
- The feed-in-tariff has become an international success story: 61 countries with FiT. They have strongest PV growth
- Pitfalls to be avoided:
  - Unsustainable high tariffs (Spain, Czech Republic, UK)
  - Unbalanced market without small players (Spain)
  - Slow FiT adaptation
  - Complicated, incalculable per-mitting procedures (Greece, Portugal)
  - Retroactive changes (Czech Republic)

Market development in Spain



PHOTOVOLTAICS –
A DISRUPTIVE TECHNOLOGY

PV is a Semiconductor technology: Direct transformation of sunlight into electricity



several layers of semiconductors

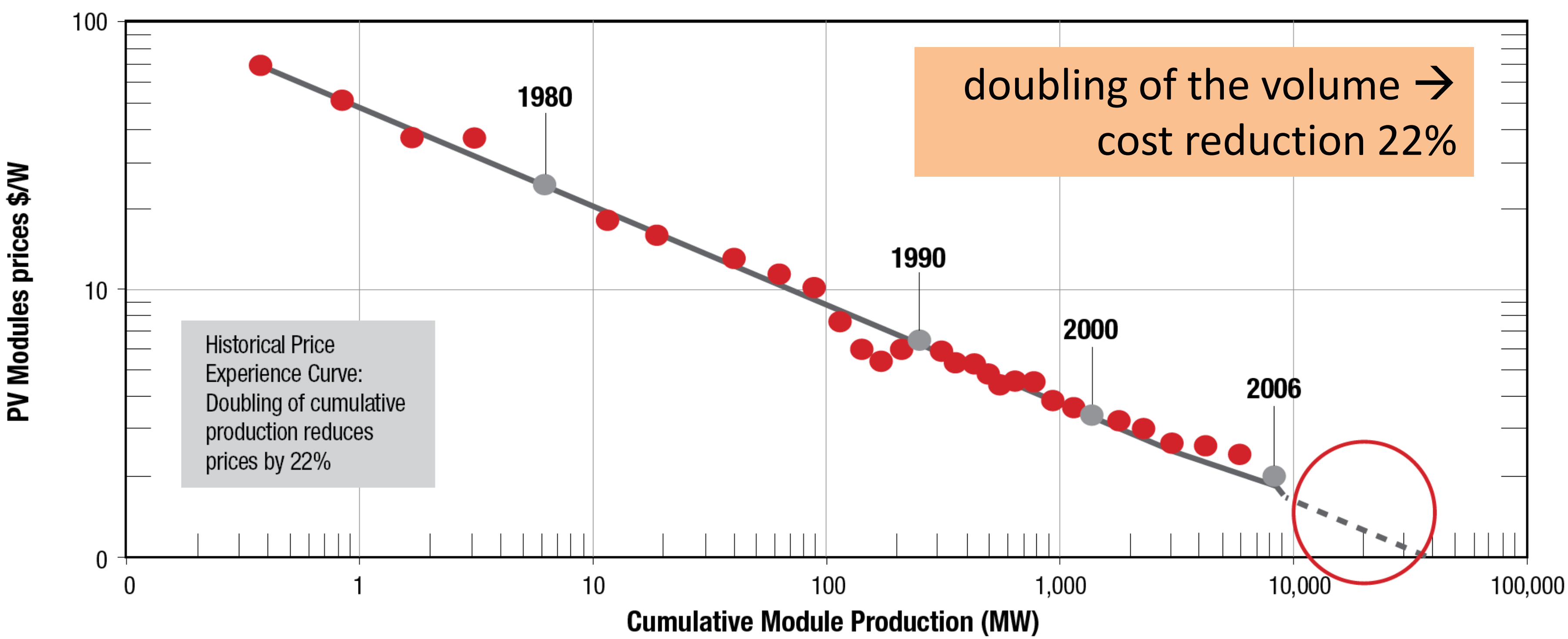
variety of different technologies:

- crystalline silicon c-Si (ingot-wafer)
  - monocristalline < 24% efficiency
  - polycristalline < 20%
- thin-film technologies
  - amorphous Silicon a-Si, also comb. < 12%
  - CdTe Cadmium-Telluride < 16%
  - CIGS, different combinations < 20%
  - GaAs, Gallium-Arsenide < 24%
  - poly-junction < 41%
  - …

- **no moving parts**
- **no maintenance**
- **no fuel**
- **high cost reduction potential**

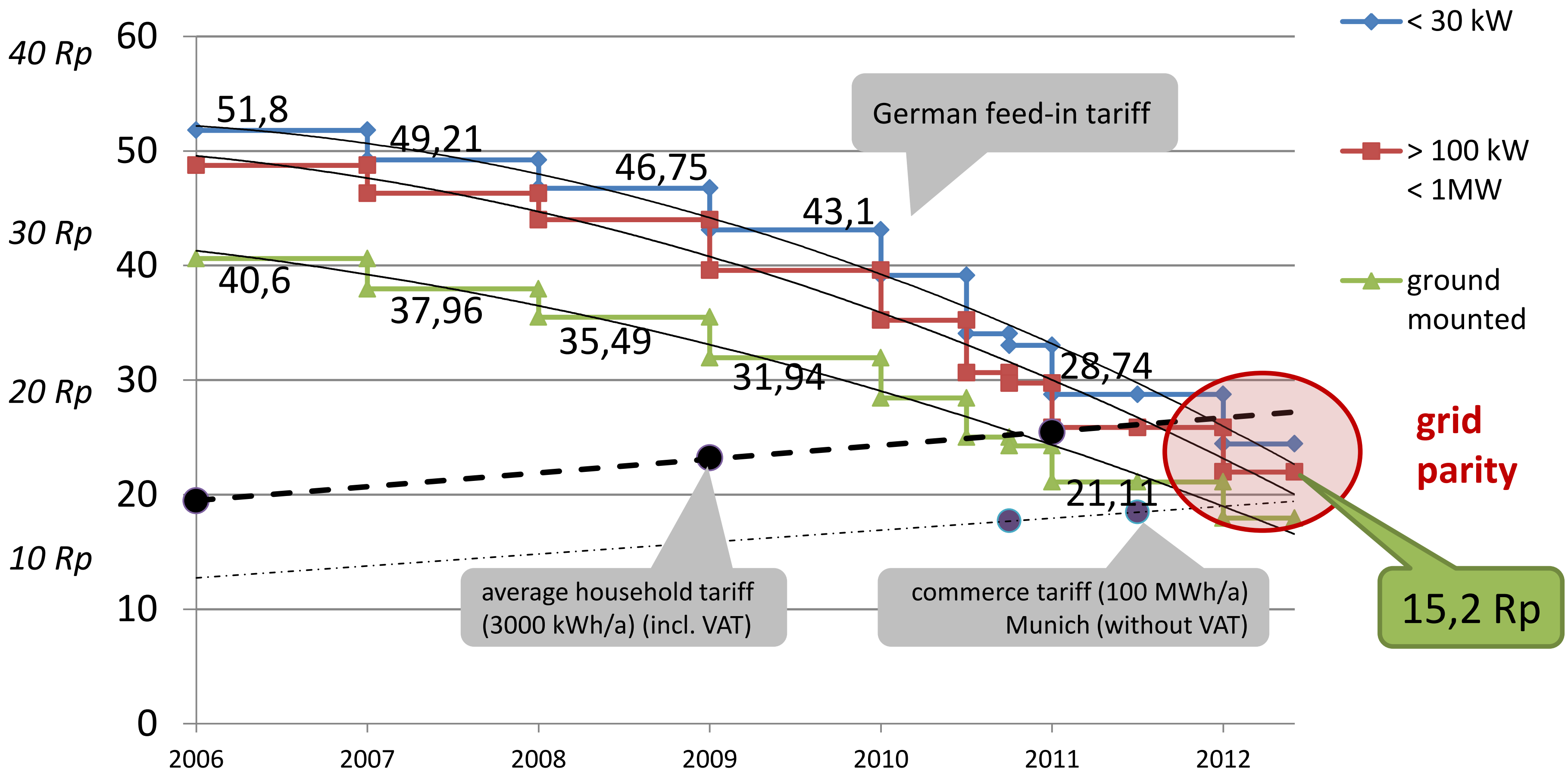
A scalable technology:
mass production of standardised cells

Rapidly decreasing Costs: The historical learning curve of PV

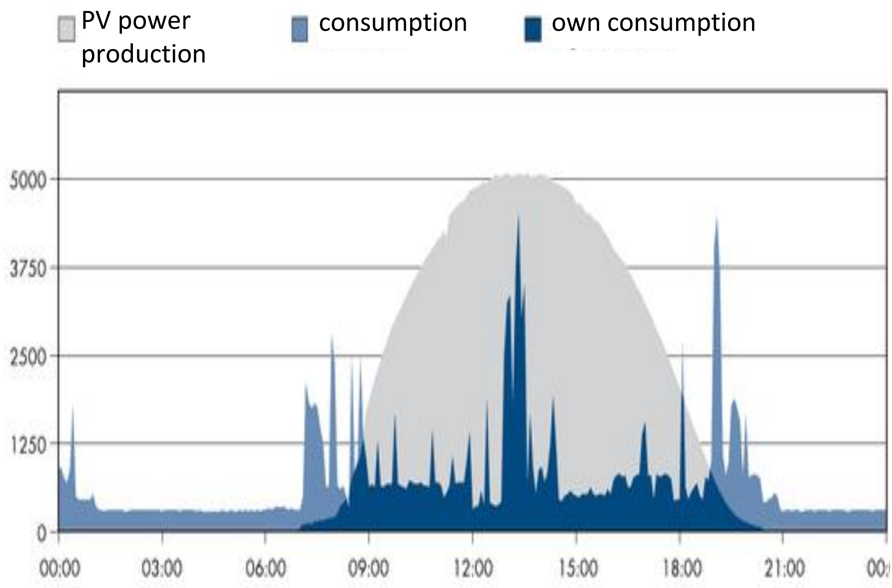


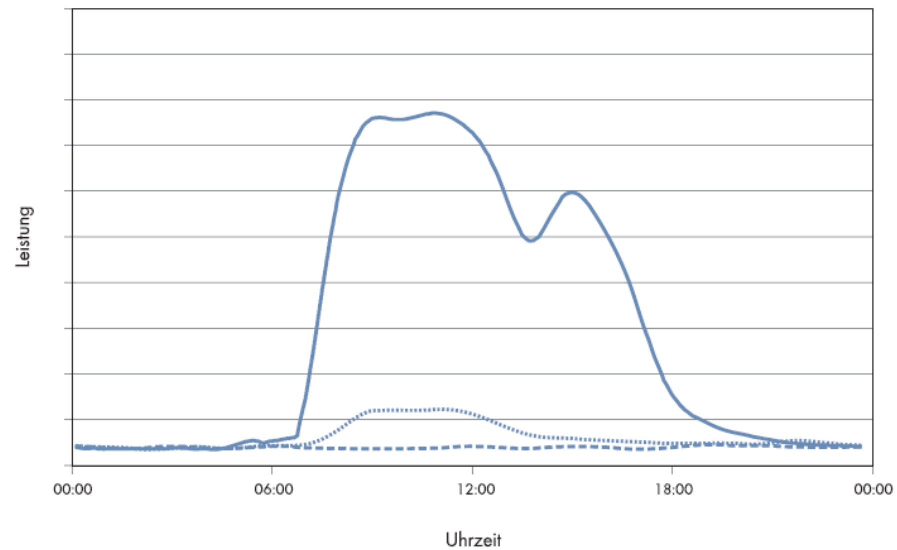
Sources: EU Joint Research Centre - EIA - National Renewable Energy Laboratory - A.T. Kearney analysis.

Rapidly decreasing German feed-in-tariffs: grid parity residential in 2012



Power need when the sun does not shine: different potentials for own consumption





Private household in Germany

clouless summer day, 4 persons,

PV installation 5 kWp

→ Efforts needed for > 30% of own consumption

Commerce

working day 8-18h

BDEW Lastprofil G1

→ Good conditions for high share of own consumption

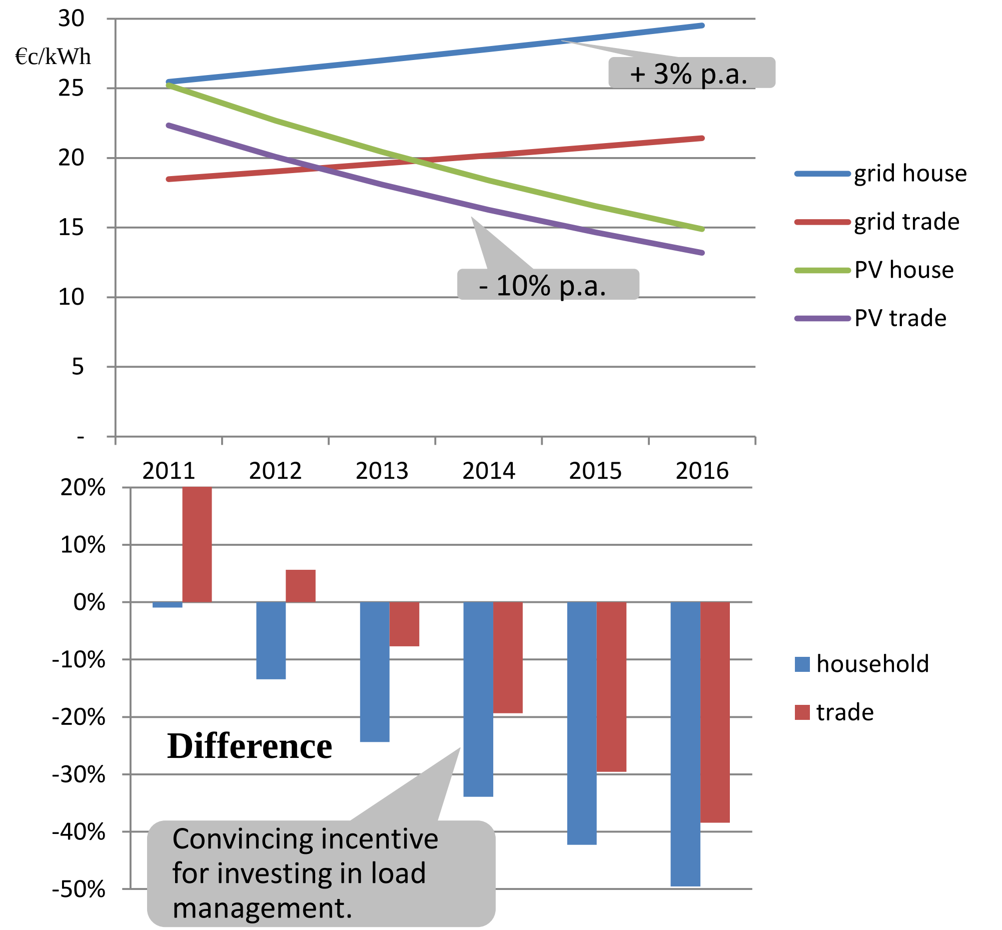
Attractiveness for own power production: Germany - Scenario for the next five years

- In the last four years the average PV system price declined by 50% (3Q07-3Q11, <100kWp, Germany) corresponding to *-16% p.a*.

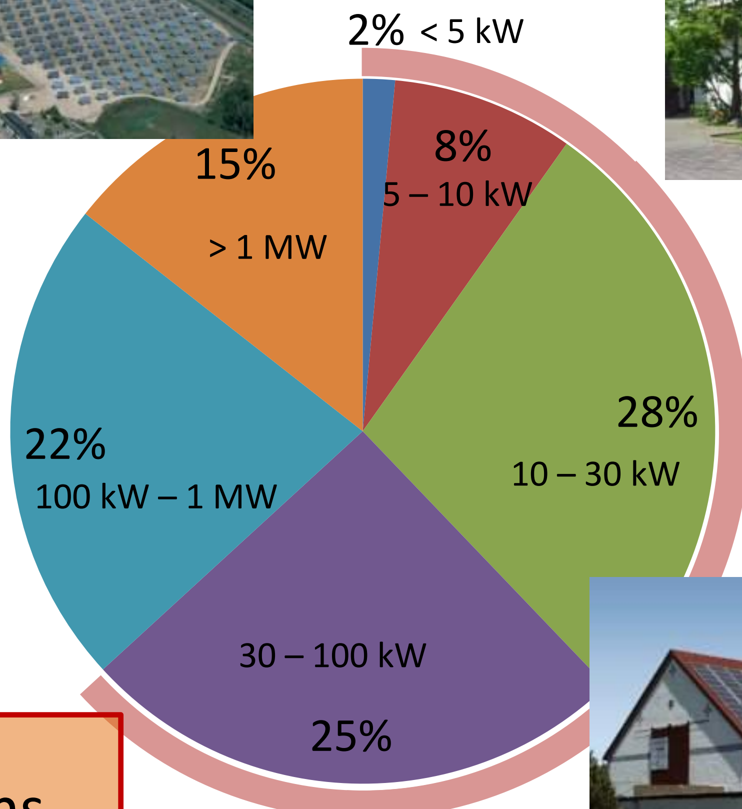
- Scenario assumptions
  - System price development: *-10% p.a*.
  - Power from the grid: + 3% p.a.
  - present FIT in Germany represent present PV power costs

➢ In five years PV power from the roof could cost 40% less than power from the grid

Evolution of the difference between grid tariffs and own PV power costs



From 2013: large shares of the German PV market interesting for own consumption



Installations
january – september **2010**

60% of
new installations
< 100 kW

ruggero@schleicher-tappeser.eu

data: BNetzA 2010

The coming boom: captive power generation

Attractive investments even without incentives

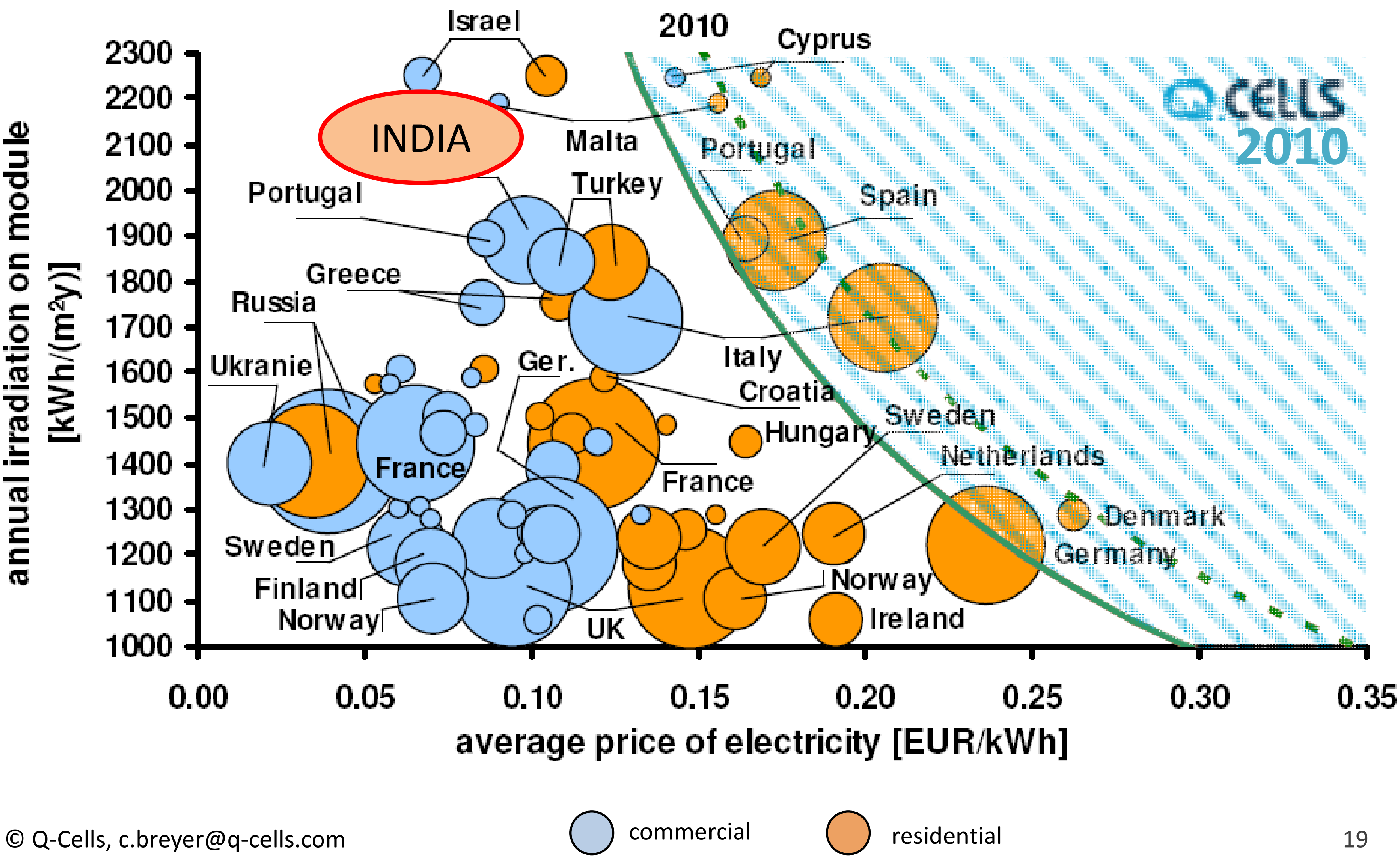
Timeline in Germany:

- In two years: PV power for own consumption in commerce and services
- In three years: Supplementary investments for increasing the share of own consumption

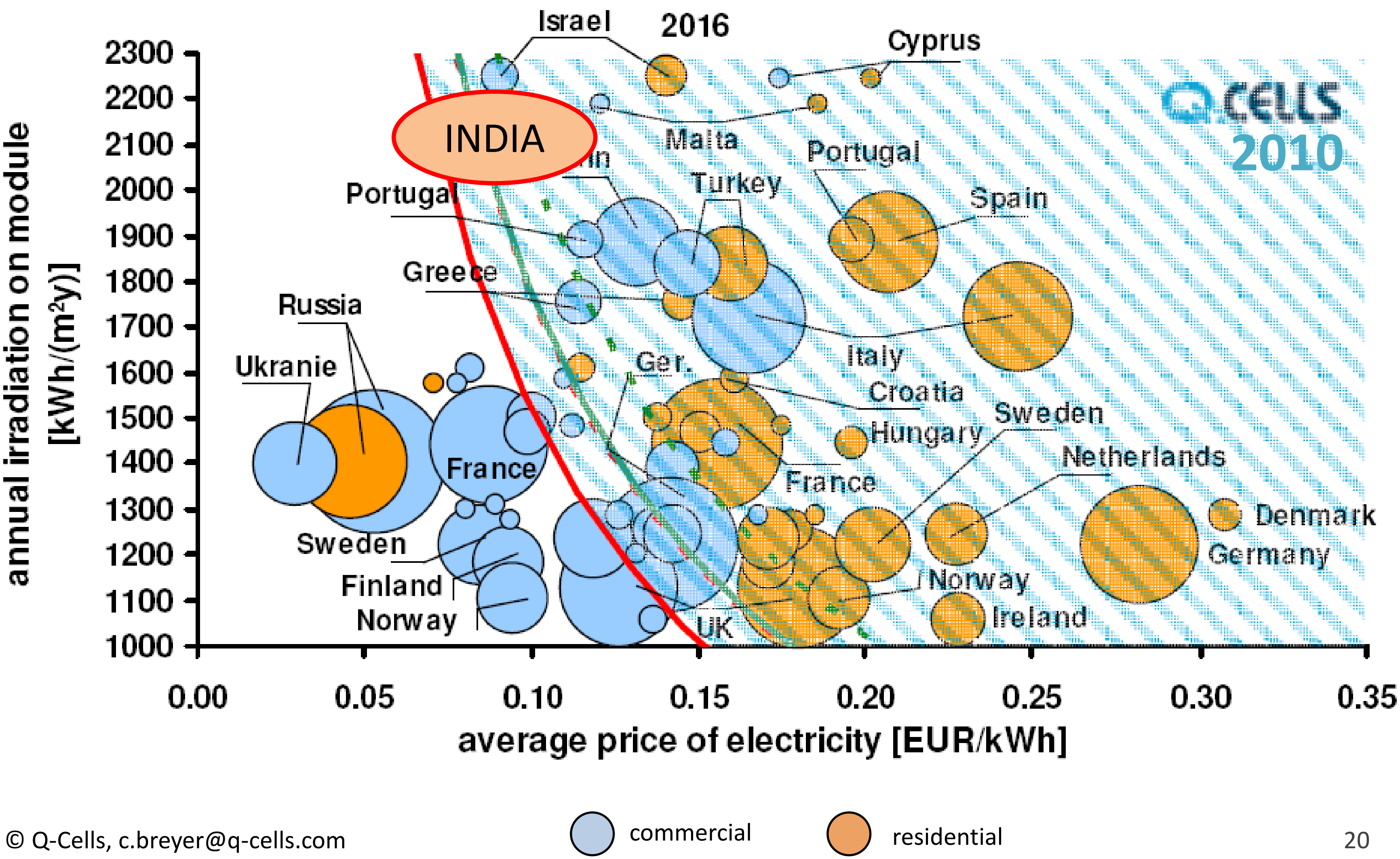
➢ PV growth independent from incentives

➢ Boom in power management technologies

Grid parity in Europe 2010



Grid parity in Europe 2016
(forecast in 2010)



Growing opportunity in India: Captive PV Power competing with diesel backup

- 30% of industrial consumption: in-house power plants
- Wind power market mainly driven by captive power for manufacturing industries (70% of customers in 2008)
- Widely used diesel backup power costs 15 – 17 Rp/kWh
- Example: factories in a central Indian city
  - Highly dynamic economic development
  - 12-14h power cuts per day unscheduled for longer periods
  - Diesel backup running 10-12h/day in process industries
  - High indirect costs and efficiency losses due to power cuts
  - Many factories working at night for avoiding power cuts
- High reliability of sunshine during most of the year

Where grid is weak, distributed PV is already competitive today – if needed as PV-diesel-hybrid

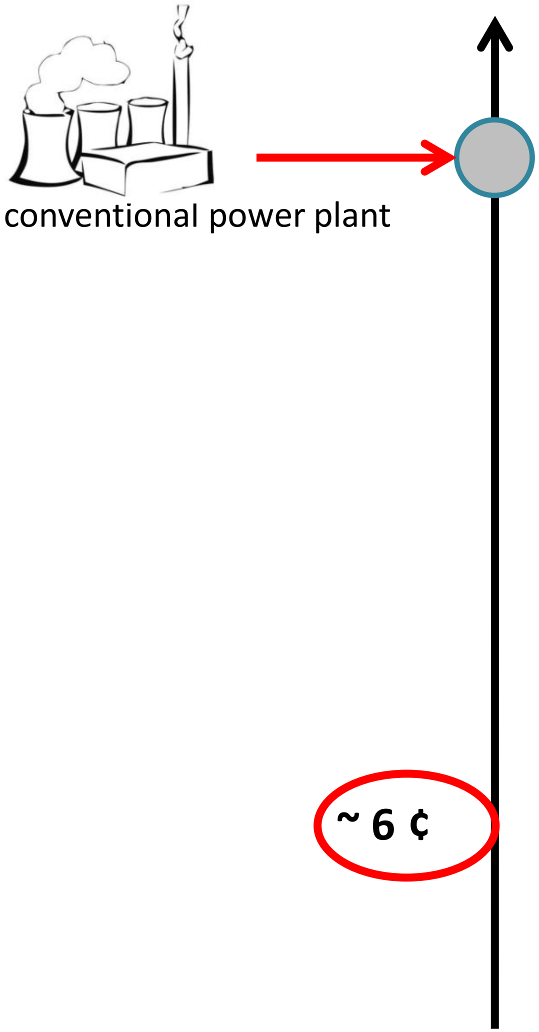
Even more competitive: substituting PV for battery capacity

- Huge market for backup batteries in India:
  - battery-based backup systems („inverters“) for residential use (> 1 million systems / year)
  - UPS (Uninterrupted Power Supply), mainly for IT
- Where grid functions only for a few hours, PV can
  - increase comfort
  - reduce need for large batteries
  - reduce overall costs

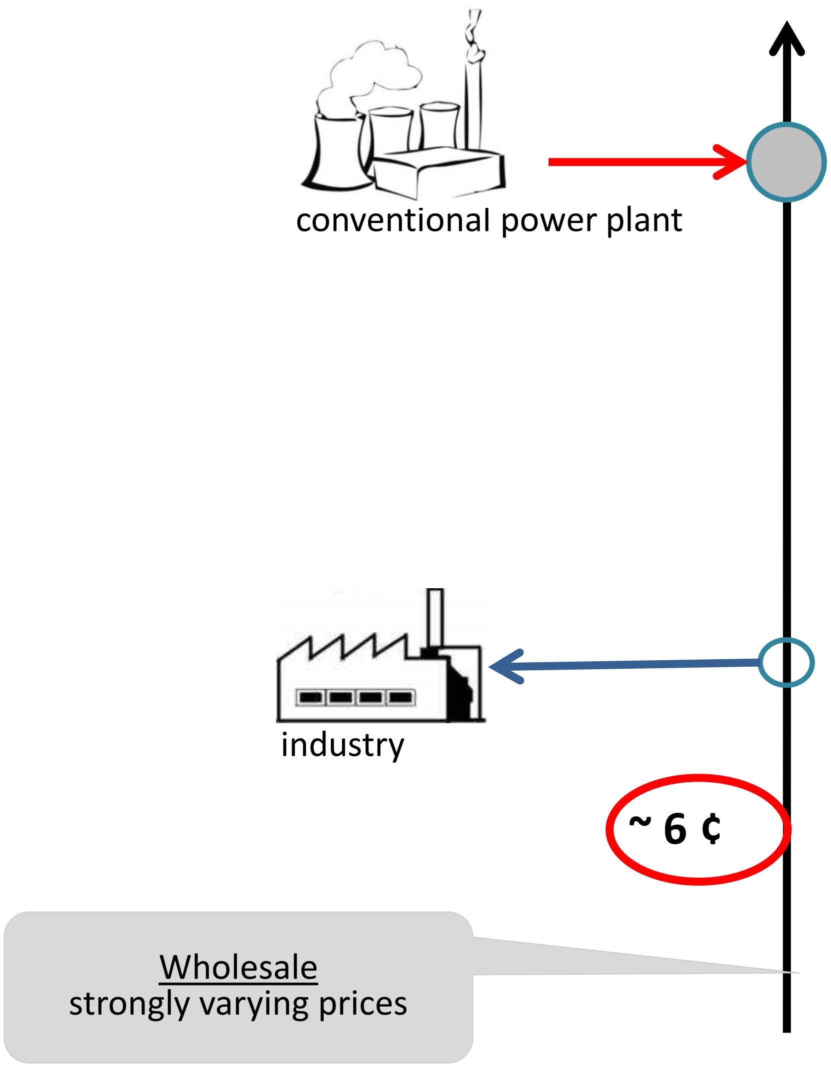
➢ This market alone might have a potential beyond officially discussed PV market sizes for the next years

TOWARDS A NEW CONTROL LOGIC OF THE ELECTRICITY SYSTEM

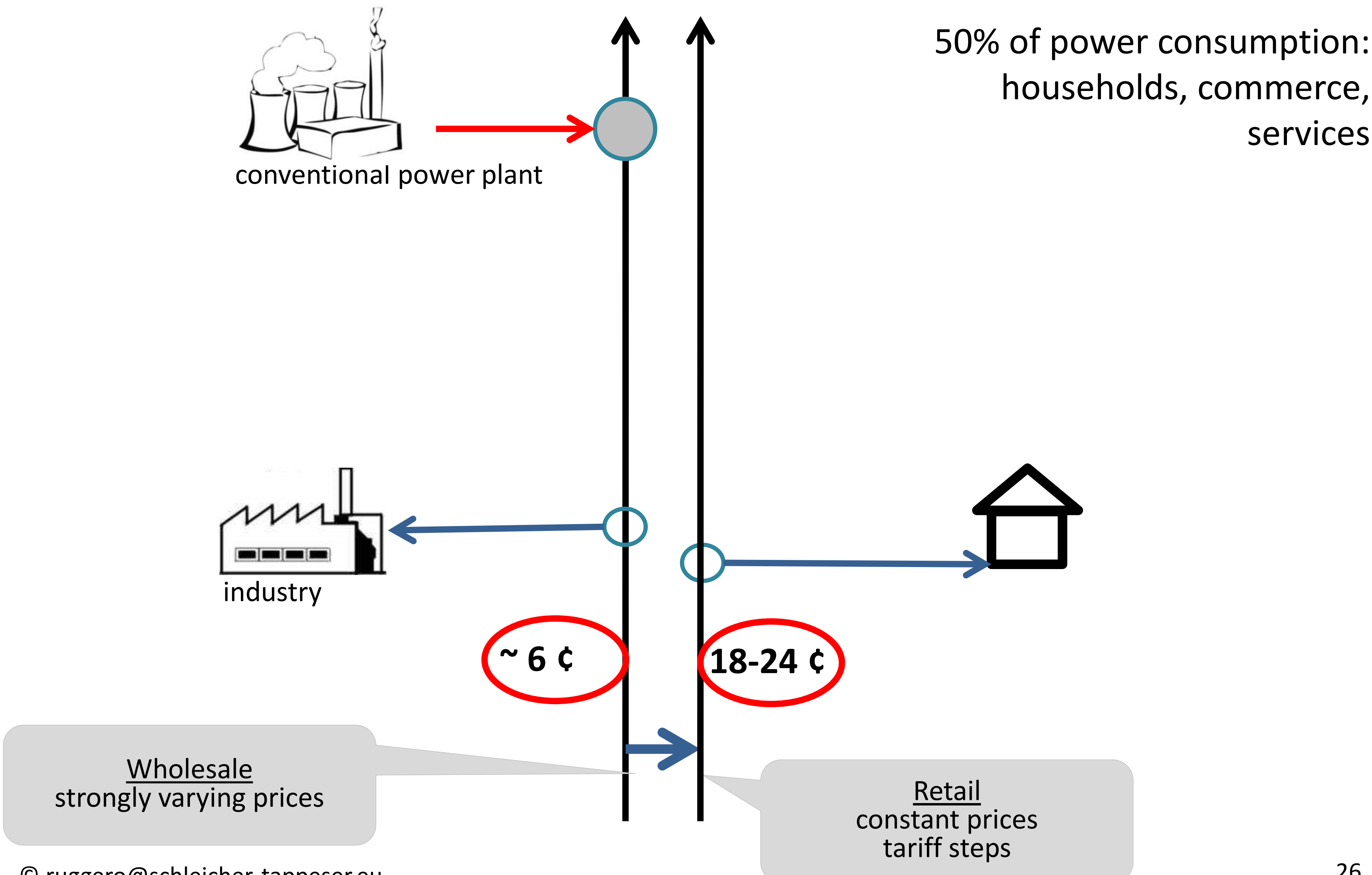
Photovoltaics is a modular technology: competing on the retail side



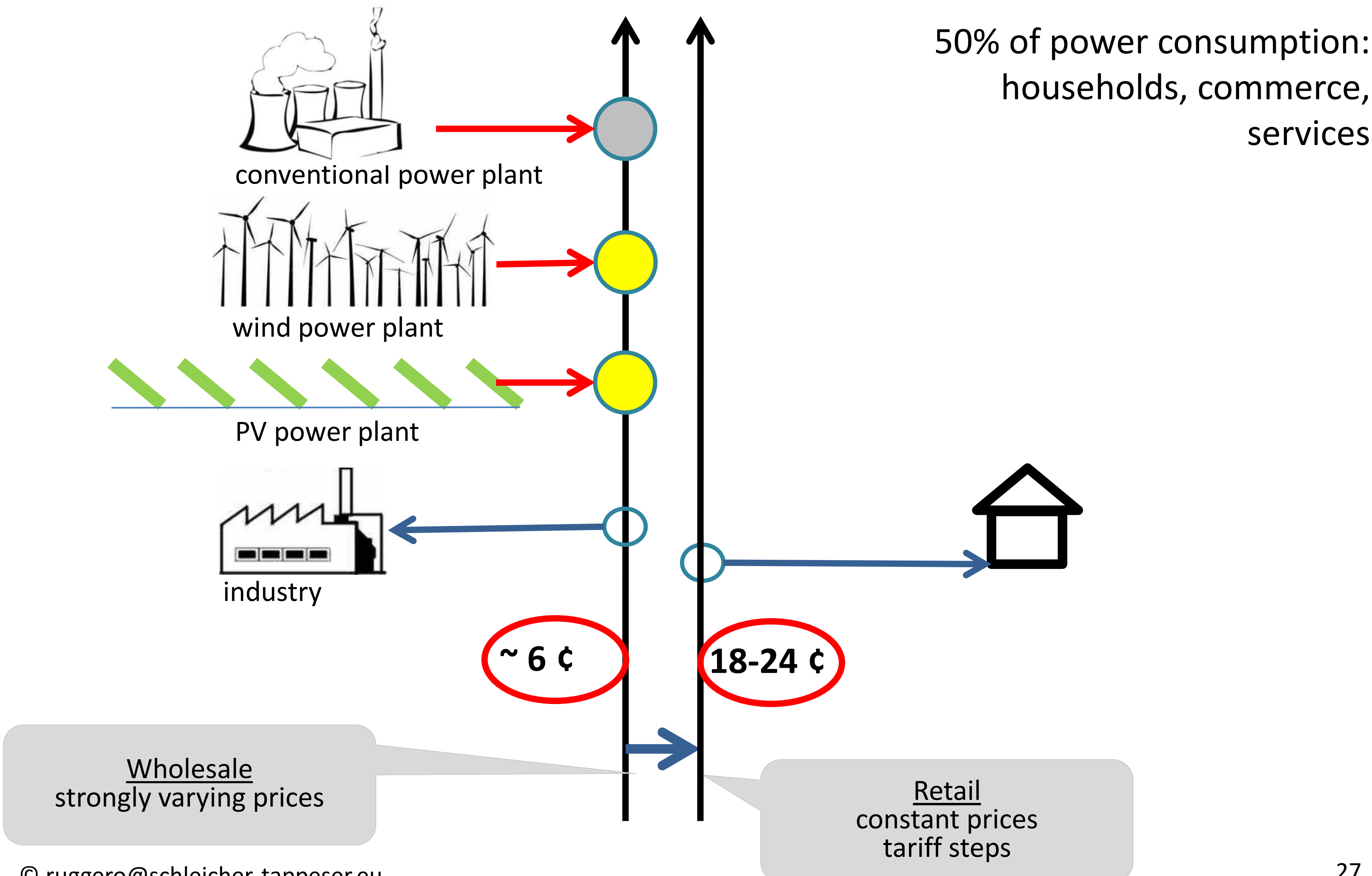
Photovoltaics is a modular technology: competing on the retail side



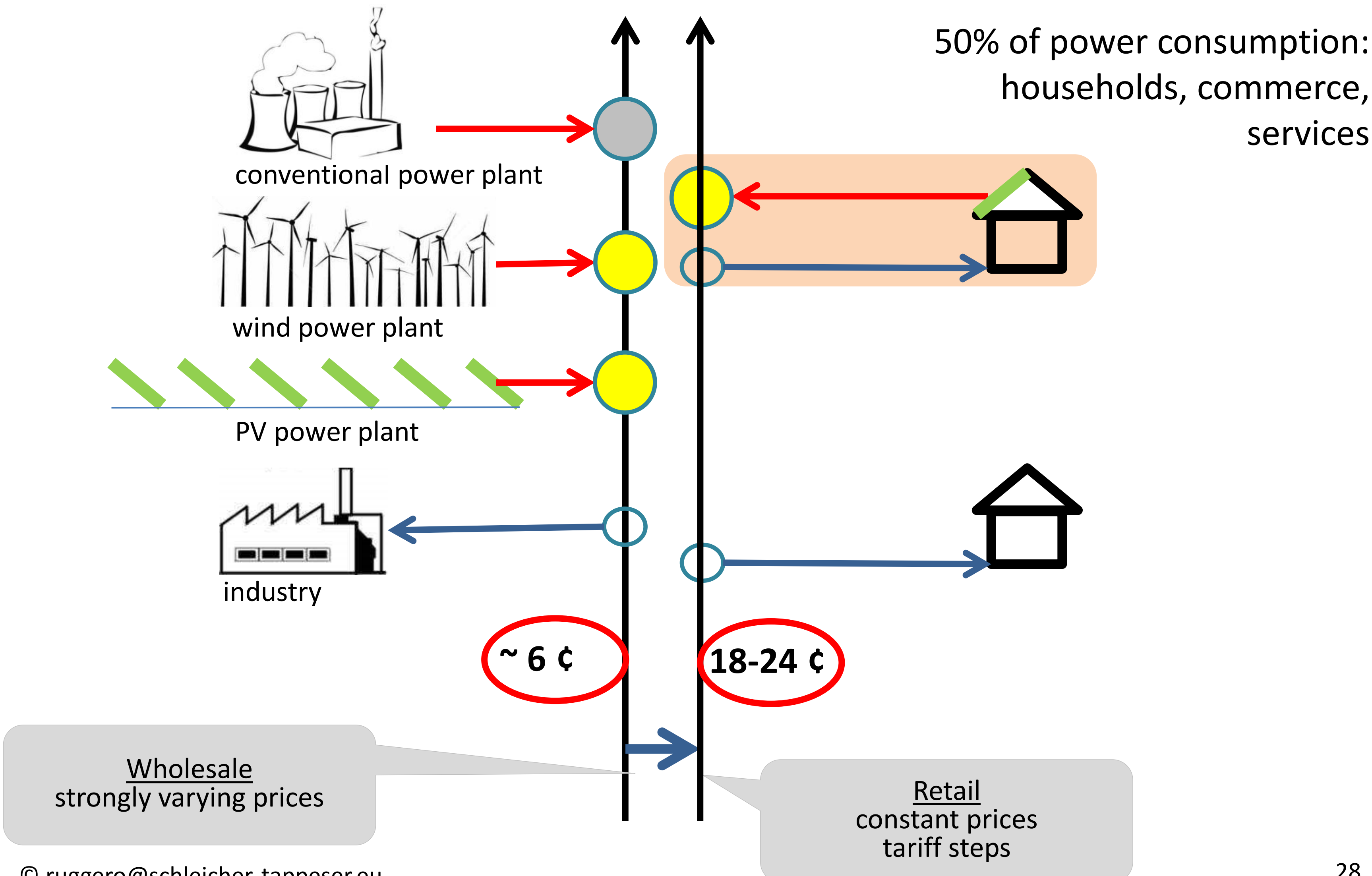
Photovoltaics is a modular technology: competing on the retail side



Photovoltaics is a modular technology: competing on the retail side

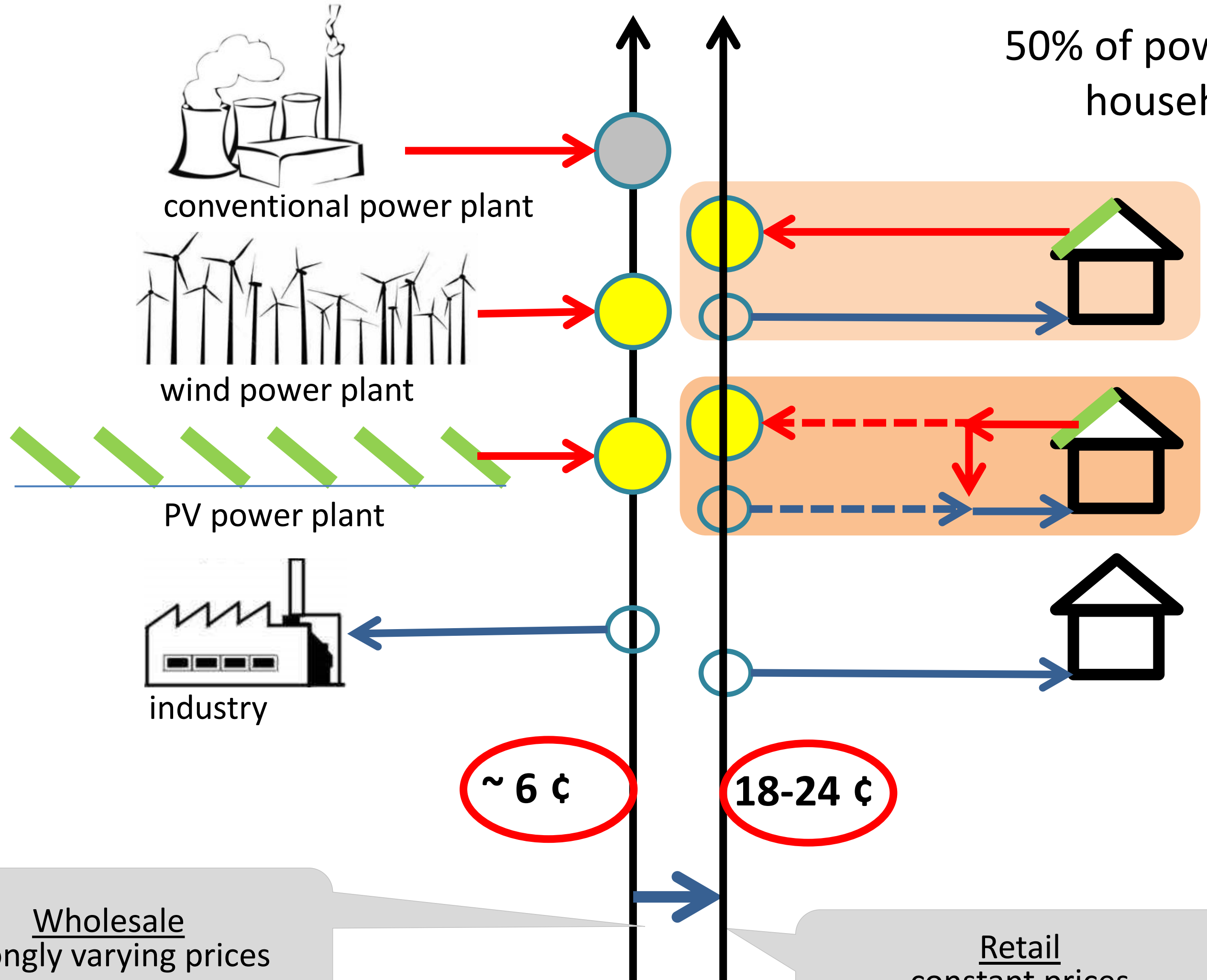


Photovoltaics is a modular technology: competing on the retail side



Photovoltaics is a modular technology: competing on the retail side

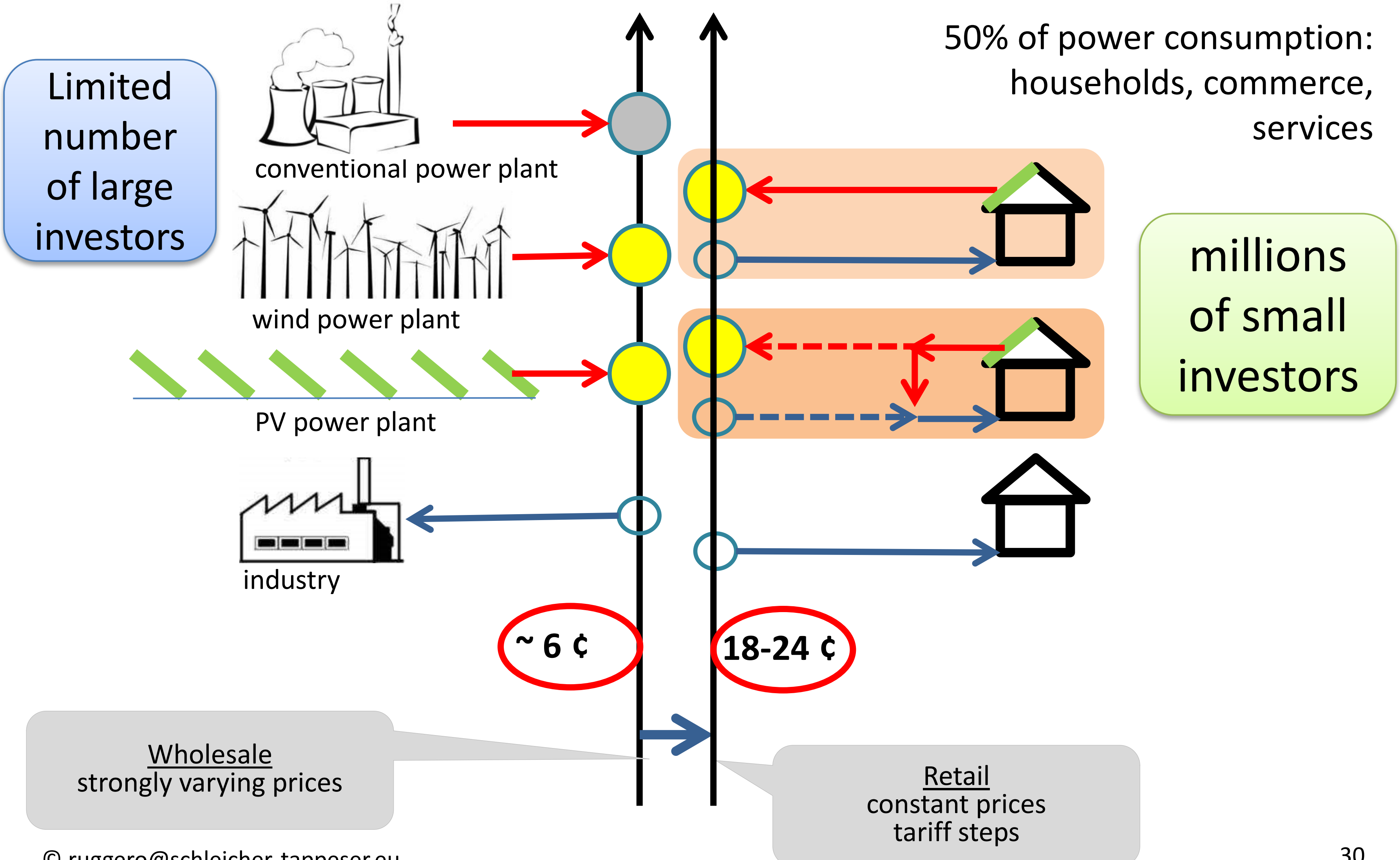
50% of power consumption: households, commerce, services



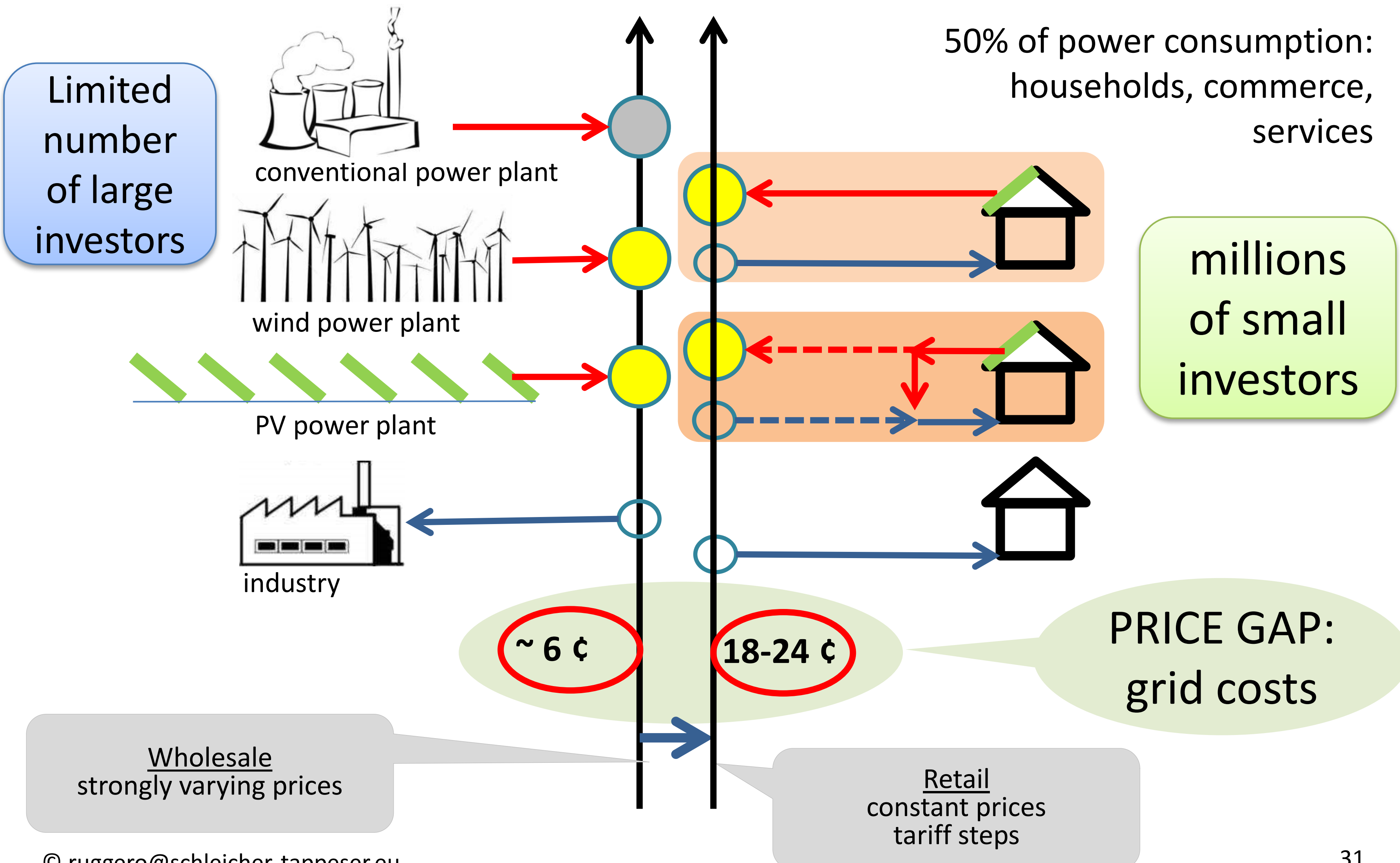
Wholesale
strongly varying prices

Retail
constant prices
tariff steps

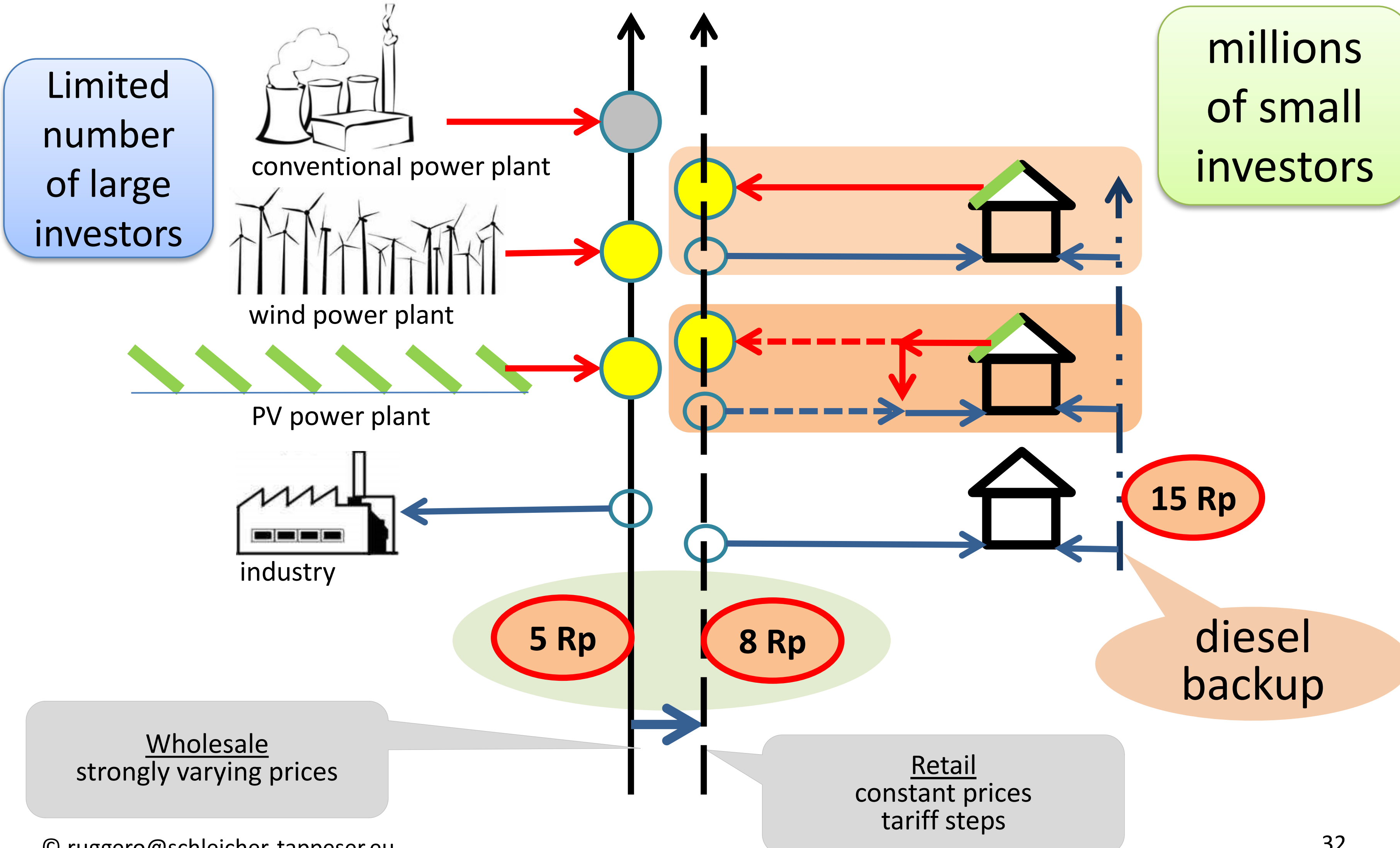
Photovoltaics is a modular technology: competing on the retail side



Photovoltaics is a modular technology: competing on the retail side



India: Photovoltaics in weak grids competing against diesel backup



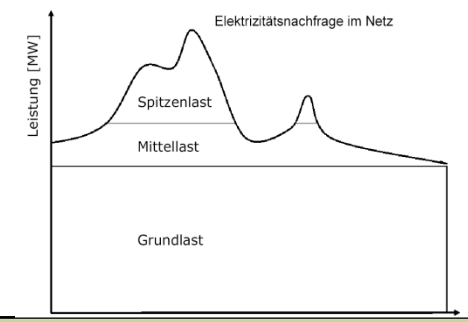
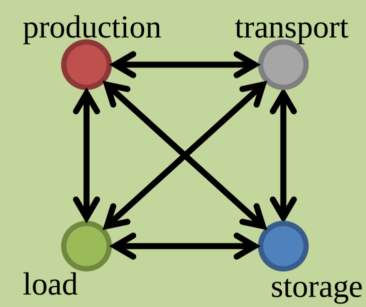
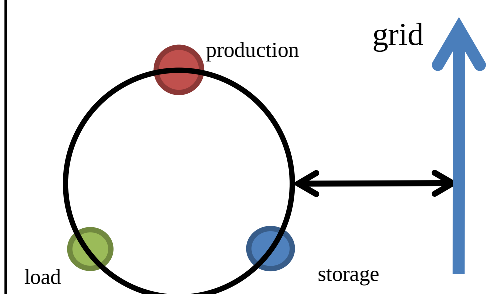
Efforts for increasing the share of captive PV consumption = dealing with fluctuation locally

- Load management
  - Temporal shift of operation
  - Thermal storage in heating and cooling applications
  - Storage of compressed air for mechanical applications
  - Combination of different users
- Additional, non time-critical loads
  - Loading electrical vehicles
  - Heat pumps: substitution of other kinds of heat production
  - Production of synth. methane or hydrogen (larger plants)
- Storage of electricity
  - Batteries
  - Flywheels

➢ Innovation wave in Energy management

➢ Flexibility of the user system increases

Captive PV Power can support the change of the control logic of the electricity system

Traditional Large power plants fossil and nuclear Transformation	• Production follows demand: base / middle / peak load • Load management only with large consumers • Central control	
Supply 100% REN Integrated optimisation of the whole system	• Fluctuating production with wind and sun dominates • Load management, storage • Complexity requires optimisation on several levels	
Contribution ***Captive power production*** *Optimisation on the consumption level*	• Optimisation subsystem • Partial buffering of fluctuations at the local level • Facilitation of optimisation at higher levels	

… and captive PV power challenges present market & control structures

- Grid increasingly reduced to buffer function → rising costs per kWh → need to use consumer flexibility for own optimisation
- Present tariffs favour new peak grid loads (in and out)
- FiT level looses control over PV growth
- FiT remains essential for installations with low own consumption

➢ Need for time-dependent and power-limiting tariffs guiding the input/output optimisation of private systems

❖ Every distribution grid has its own optimisation requirements: grid pattern, generation and consumption structures differ

→ → Under present rules, optimised private systems may rapidly produce new heavy burdens to the public grid infrastructure

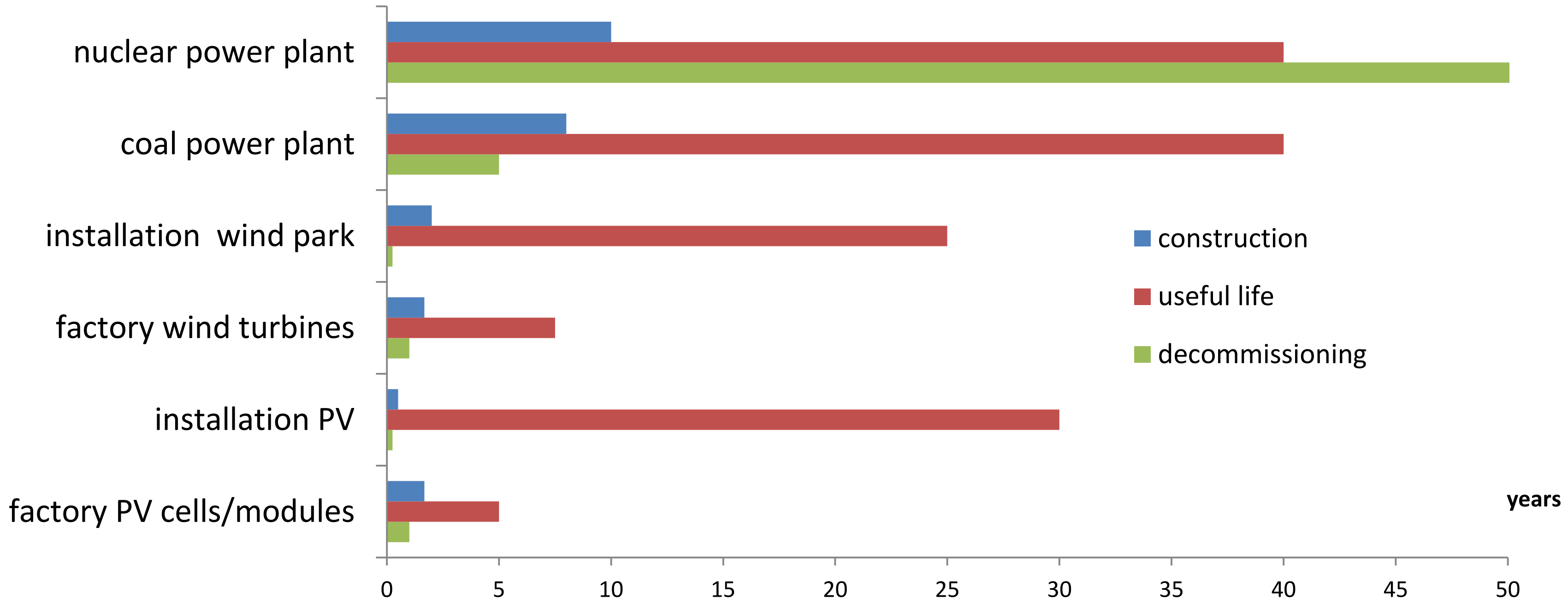
Unfamiliar to energy business: 4 to 10 times shorter innovation cycles

→ More rapid build-up of capacities

→ More rapid decrease of costs

→ More rapid transformation of the electricity sector

Dramatic acceleration compared to traditional energy technologies



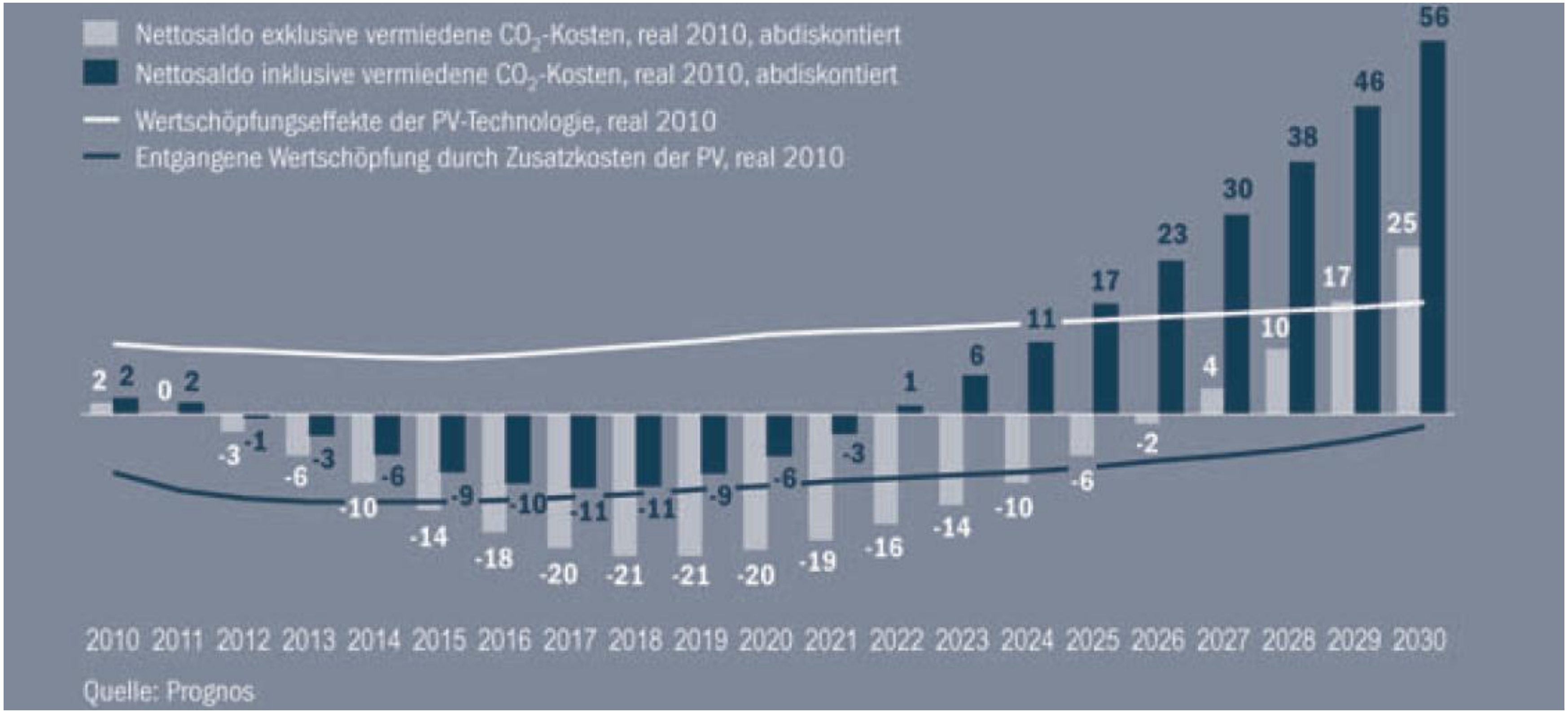
ECONOMIC IMPACTS

PV brings important economic advantages for society

- No fuel imports
- High value added at the regional level: employment, profits, taxes
- Several value-added steps with a broad variety of qualifications required
- Overall balance soon positive: start-up financing paid back rapidly
- High security of supply, avoidance of international conflicts
- No follow-up costs for future generations (e.g. climate damages, pollution, waste …)

Economic balance in Germany: despite expensive start phase positive before 2022

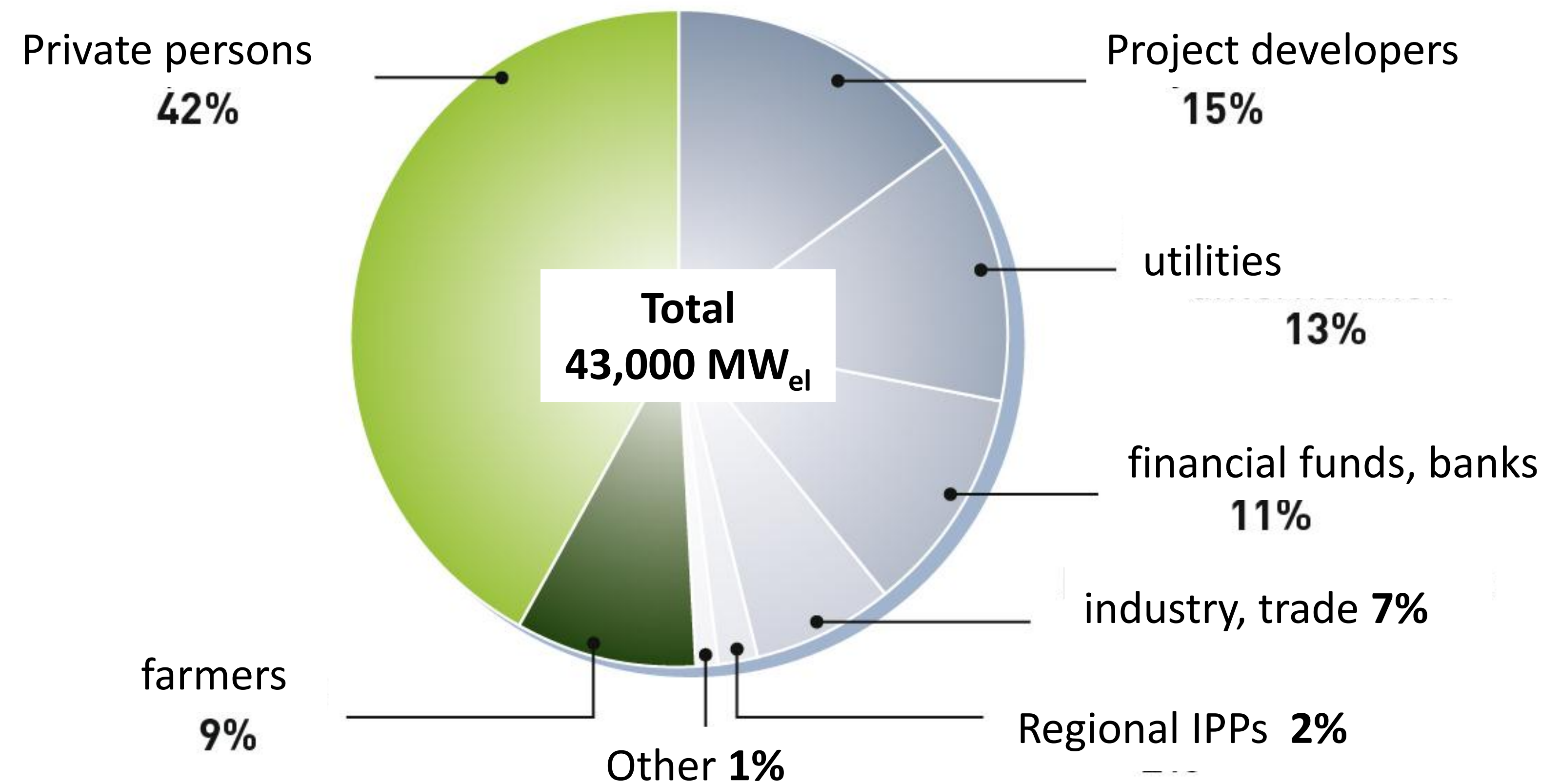
- Roland Berger / PROGNOS 2010 with very prudent assumptions:



- ATKearney 2010: <u>positive balance already in 2012</u>

Citizens participation: Distribution of ownership

Ownership of installations for renewable electricity production in Germany (end of 2009)



Quelle: trend research 2010; Stand: 10/2010

www.unendlich-viel-energie.de Agentur für Erneuerbare Energien

The value chain:
smaller installations – more local content

↓ Research institutes	international
↓ Manufacturers of production plants	international
↓ Banks and financing companies	can be local
↓ Manufacturers	
– silicon	international
– wafers, cells	international
– modules	can be local
↓ Traders	can be local
↓ System integrators, EPC contractors	can be local
↓ craftsmen in the construction business	local
▪ operating company	can be local

smaller installations – more opportunities for local added value

PV triggers the next boom: Energy management → Big opportunity for Indian IT industry

- Captive PV power generation in buildings and factories calls for in-house energy management
- Understanding and modelling of energy systems
- Coupling with heat and transport markets
- Smart management of transmission, storage, consumption at several levels

- ➢ Software, hardware and services needed
- ➢ Boom of innovations ahead
- ➢ Opportunity for Indian IT business to play important global role based on consistent experience in domestic market
- ➢ Create co-operations in time

CONCLUSIONS

Reasons for a determined PV policy

- Distributed and later also centralised Photovoltaics is inevitably going to play an important role in energy supply
- Photovoltaics will transform electricity markets rapidly and thoroughly – be prepared
- Photovoltaics has important economic advantages for society
- India is in a good position to take advantage from coming innovation wave and deep transformation of electricity markets
- No time to loose – Building up appropriate competencies and equilibrated markets takes time
- Adapting electricity markets and offering transparent support for PV during a very short period allows for steady growth and strong position of domestic industry

Building blocs for a PV strategy

- Structures of electricity markets
- Financial support
- Technical aspects of grid connection
- Permitting procedures
- Industry policy, innovation policy
- Training, ensuring quality
- Financing and insurance
- Mobilisation of final customers, local gov.

Federal Ministry of Economics and Technology

renac renewables academy

INDO-GERMAN AHK Indo-German Chamber of Commerce
Deutsch-Indische Handelskammer
Mumbai · Delhi · Kolkata · Chennai
Bangalore · Pune · Düsseldorf

Energy

Thank you for your interest

www.schleicher-tappeser.eu

renewables Made in Germany

BSW

sustainable strategies
ruggero schleicher-tappeser