Photovoltaics: technology and market developments – the role of Germany

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Outline

I am a free-lance consultant working closely with the German Solar Industry Association BSW-solar. Therefore I partly use BSW-solar documentation.

1. Germany – growth dynamics of the world's largest PV market (BSW-solar)
2. Outlook on the years ahead
3. Innovation & emerging technologies
4. Fostering an international learning process

GERMANY – GROWTH DYNAMICS OF THE WORLD'S LARGEST PV MARKET

German Solar Industry Association

Bundesverband Solarwirtschaft – BSW-Solar

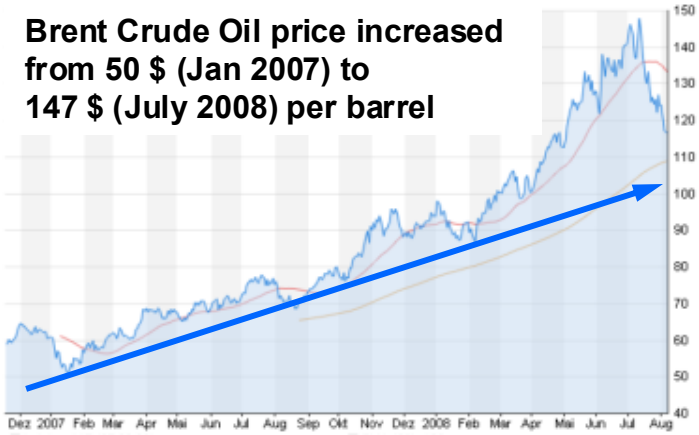
TASK	Represent the German solar industry in the solar thermal energy and photovoltaics sectors
VISION	A worldwide sustainable energy supply provided by solar energy
ACTIVITIES	Lobbying, political advice, public relations, market observation, standardization
TIME	Over 25 years of activity in the solar energy sector
MEMBERS	More than 600 solar producers, suppliers, wholesalers, installers and other companies active in the solar business
HEADQUARTERS	Berlin

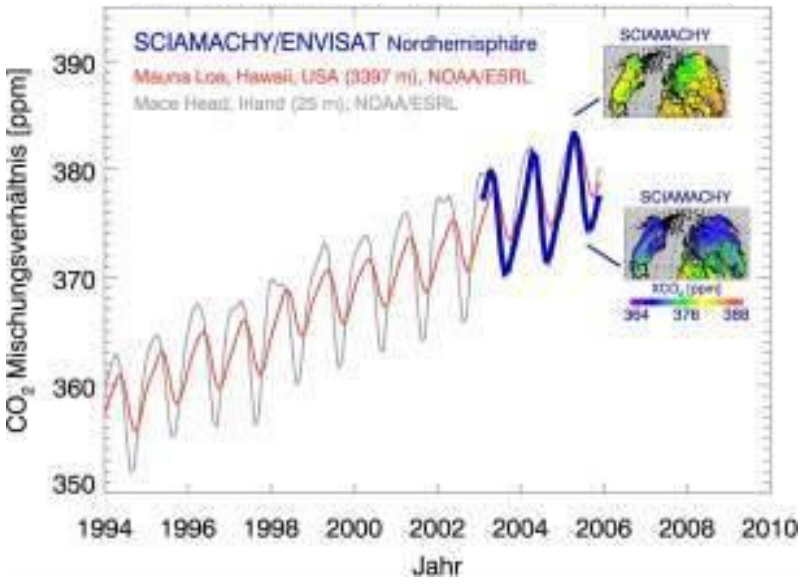
„We should leave oil before it leaves us“
Fatih Birol, chief economist IEA, March 2008

Very Good Reasons to change our Energy Supply System

- **ENERGY SUPPLY IS NOT SECURE**
  Energy import dependency is growing strongly
- **FOSSIL AND NUCLEAR ENERGY SOURCES ARE FINITE**
  Growing demand and limited resources lead to exploding energy prices
- **CLIMATE CHANGE REQUIRES ACTION**
  Climate change is mainly caused by fossil energy consumption, we have to reduce CO_2-emissions worldwide

Brent Crude Oil price increased from 50 $ (Jan 2007) to 147 $ (July 2008) per barrel



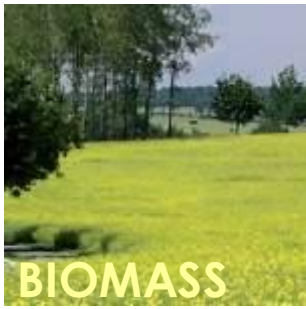


CO_2-Concentration is growing continuously (IPCC 2007)

The Sustainable Solution: Mix of Renewable Energies

Only Renewable Energy Sources

- are everlasting
- are „domestic“ energy sources
- are sustainable
- do not harm the climate
- are becoming cheaper and cheaper
- increase domestic and regional added value
- are creating jobs

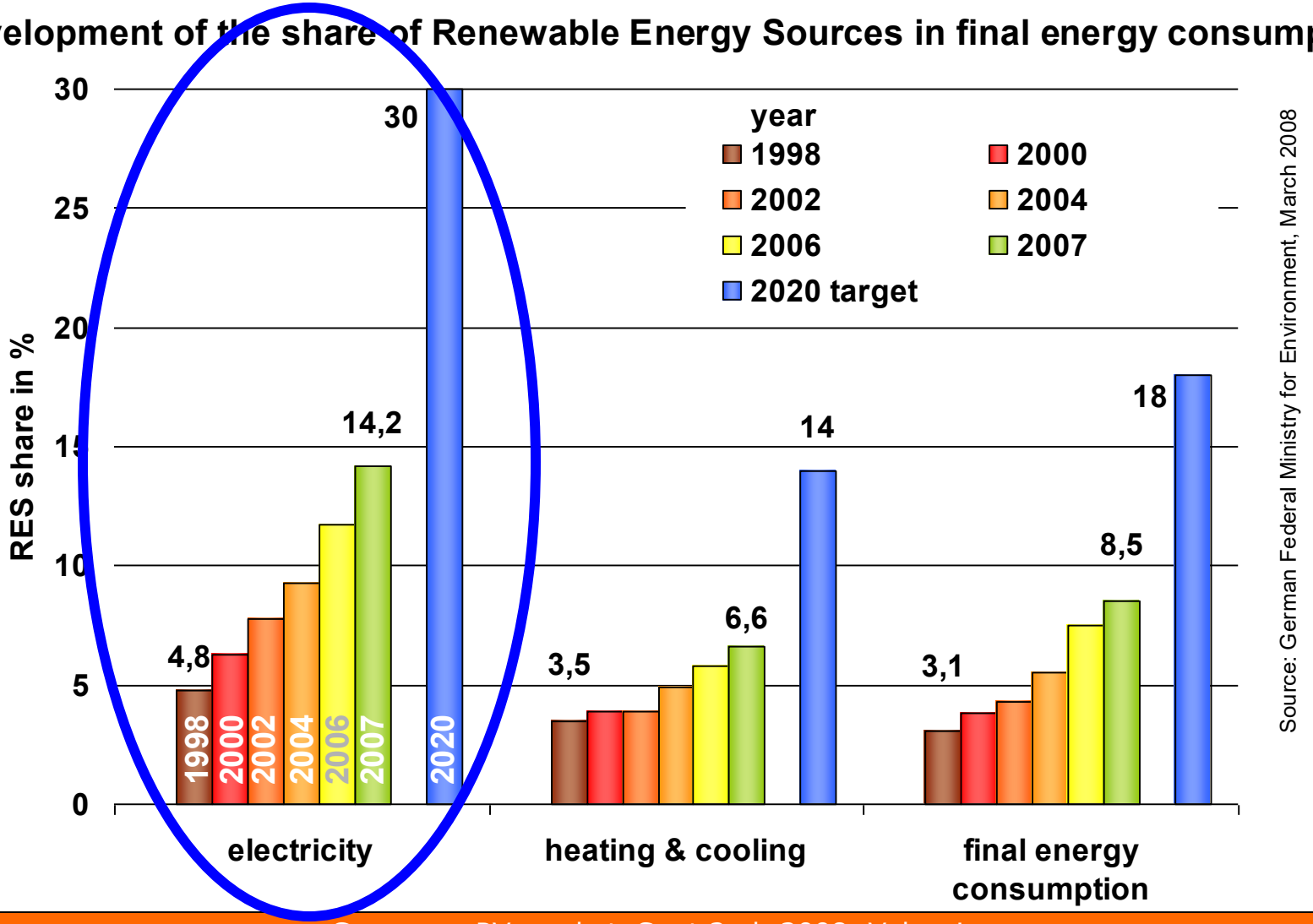


Quelle: Aus BMU, Daten EE, Juni 2007

Challenges for RES are

- **the financing of investments** as long as RES are more expensive than fossil and nuclear energy
- **the reconstruction of the energy supply system** to a distributed generation system based on RES

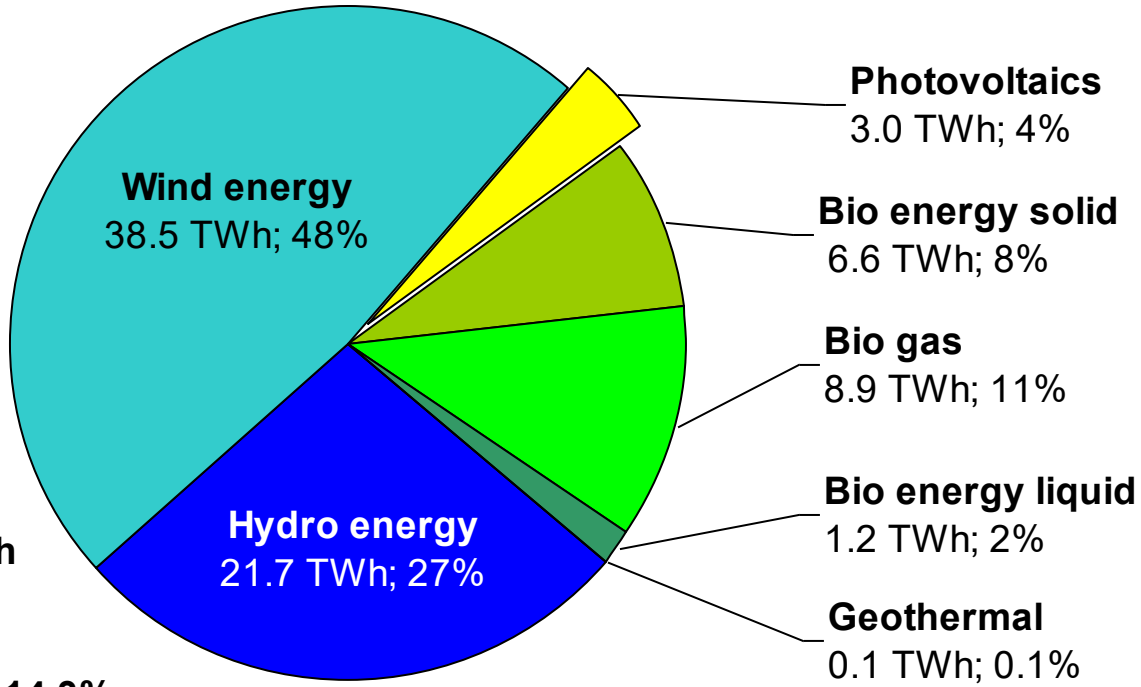
Basis of the German Success in Renewable Energy Sources: A Clear and Continous Policy to Increase the Share of RES



Share of Solar Electricity in Germany

Share of PV electricity
- of electricity consumption 2007: 0.6% (2006: 0.44%)
- of renewable energy electricity 2007: 3.5% (2006: 3.1%)

Distribution of Renewable Energy Electricity Production in Germany 2007



Total RES electricity production 2007: 86.7 TWh
RES share of electricity consumption: 14.3%

Source: BEE, Jan 2008

Development of the German PV market

PV Market Data 2007	
Newly installed power	1 100 MWp
Total installed power	3 834 MWp
No. of newly installed systems	130 000
No. of total systems installed	430 000
Turnover 2007	5 Bln €/7.25 Bln $
Employees	40 000

Milestones

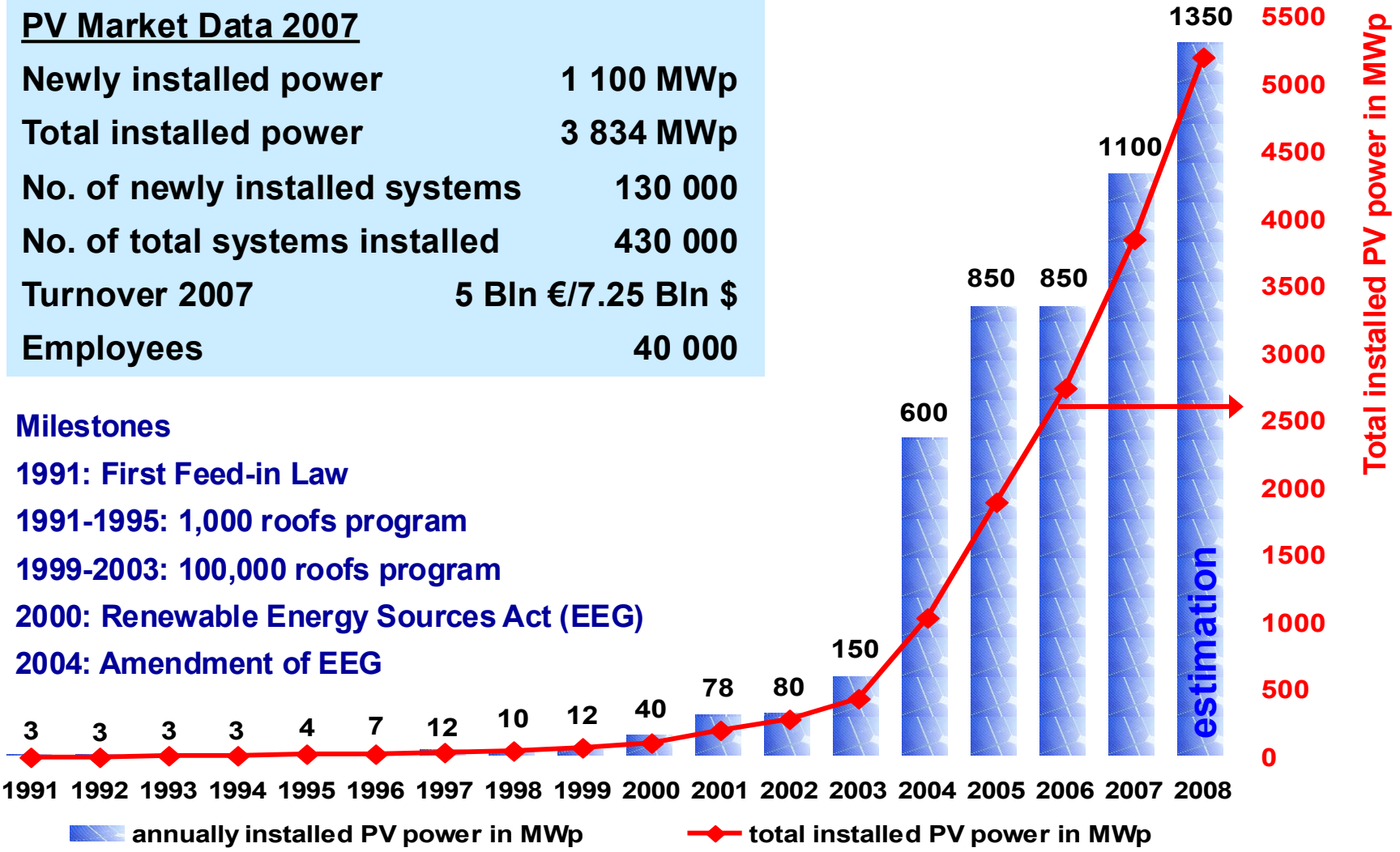
1991: First Feed-in Law

1991-1995: 1,000 roofs program

1999-2003: 100,000 roofs program

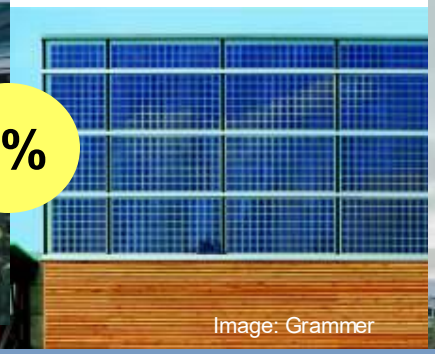
2000: Renewable Energy Sources Act (EEG)

2004: Amendment of EEG



Germany: Market Segments of on-grid PV Systems

1%

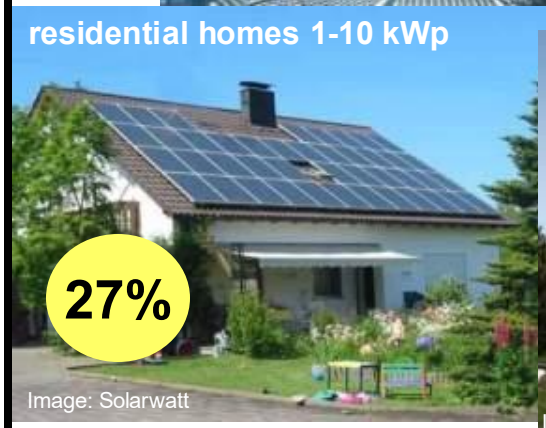


BIPV

Effort of mounting

Roof top

residential homes 1-10 kWp



27%

multi family houses, public + social buildings, farms, commercial plants 10-100 kWp

49%

Large and very large commercial > 100 kWp

13%

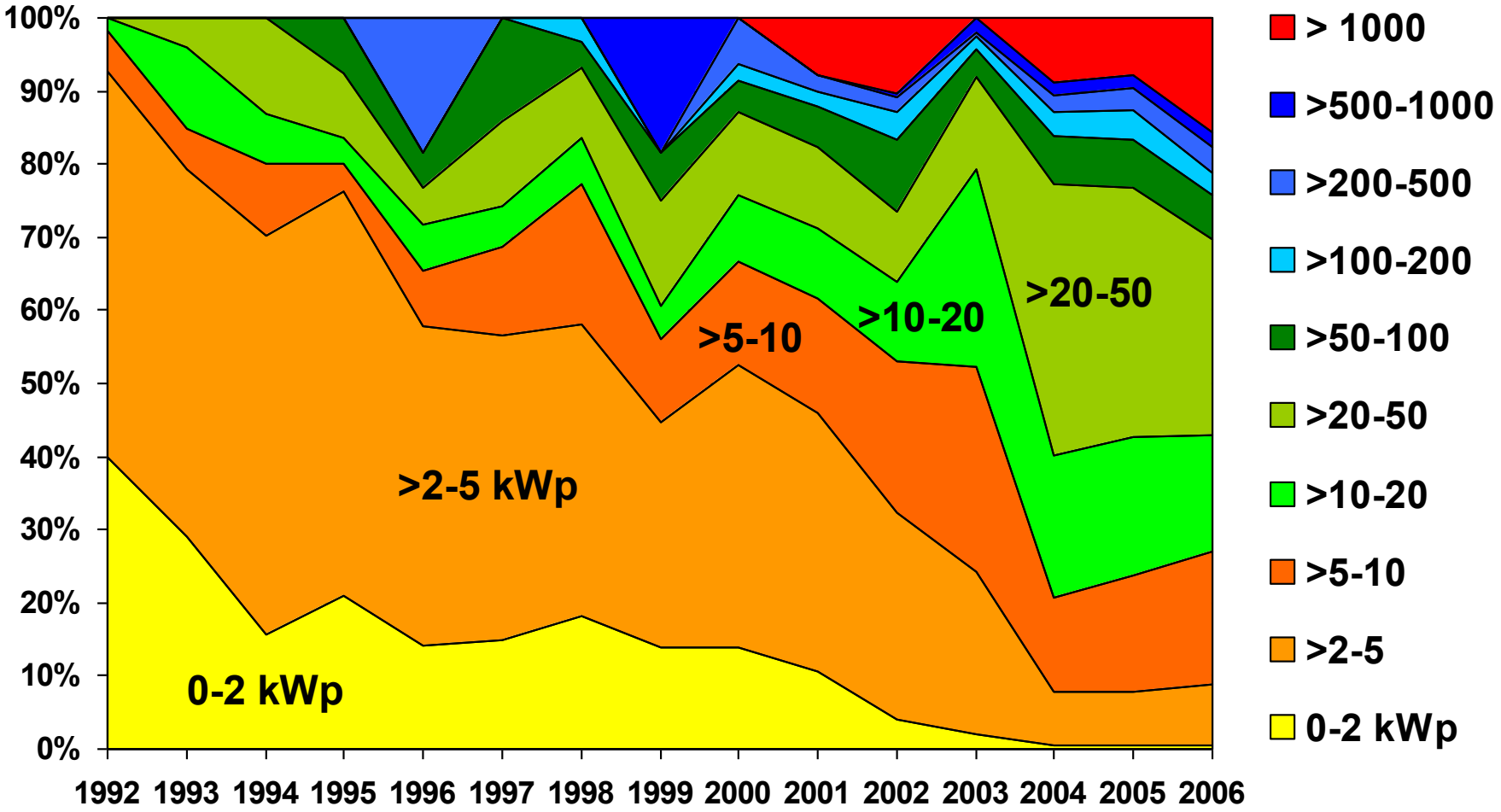
Ground mounted

Market share in 2006

10%

Size of the system

Market share of PV systems according to size



Source: BSW-Solar, calculated from data of 2.2 GWp PV systems from EnBW, EON, RWE, Vattenfall

Small, medium and large rooftop installations

Examples for ground-mounted PV systems


Image:Geosol

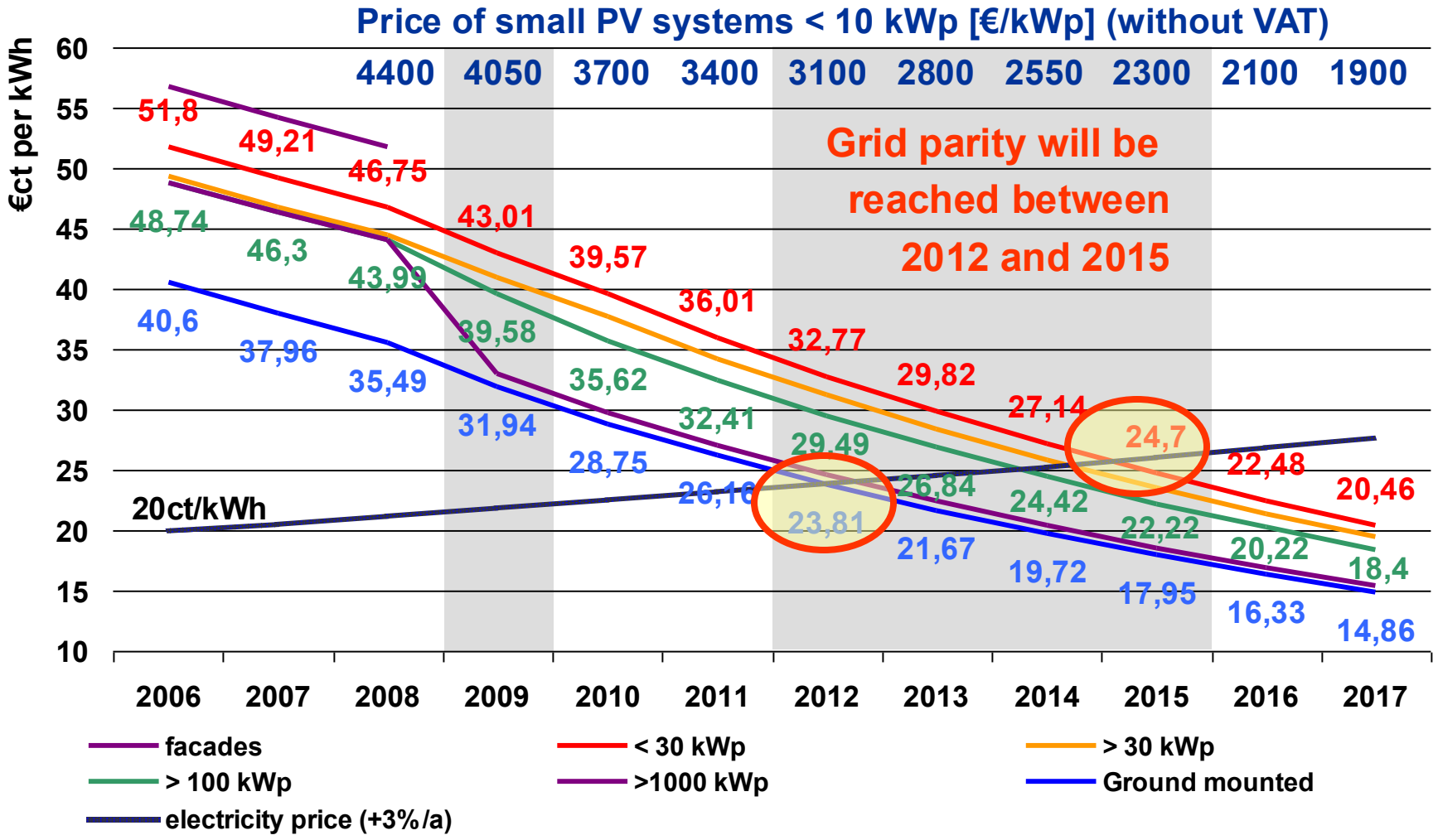

Image:Phönix


Image: Geosol


Image: EpuronI

Feed-in Tariffs for PV within the German EEG

Based on degression rates decided on June 6th, 2008



Photovoltaic market entrance strategy

1. Create PV demand by:
- Granting the right of solar electricity production and grid connection
- Making solar electricity production financially attractive

2. Building up:
- PV market
- PV production
- Installation capacitie

Reduction of costs
Less energy imports
Creation of jobs

3. PV will become:
- Cost-competitive
- An important pillar of the sustainable energy system

First results

- **More than €15 billion have been invested in PV systems since 2000**
- **More than €3 billion have been invested in manufacturing plants since 2000**
- **Drop in costs** for PV systems of
  - approx. 25% from 1999 to 2003
  - approx. 5% annually since mid 2006

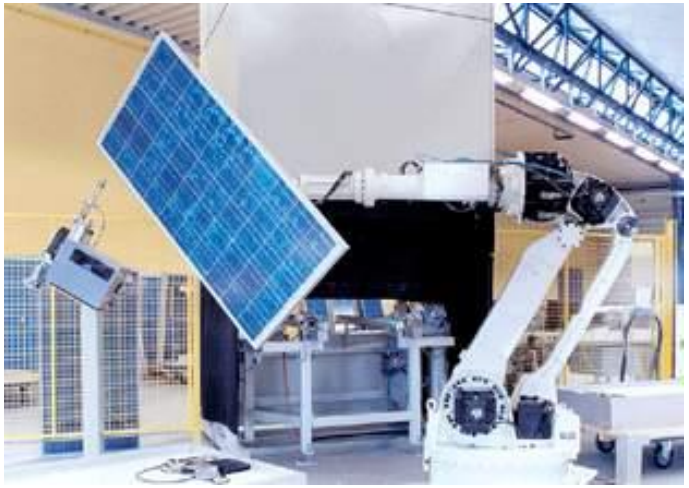
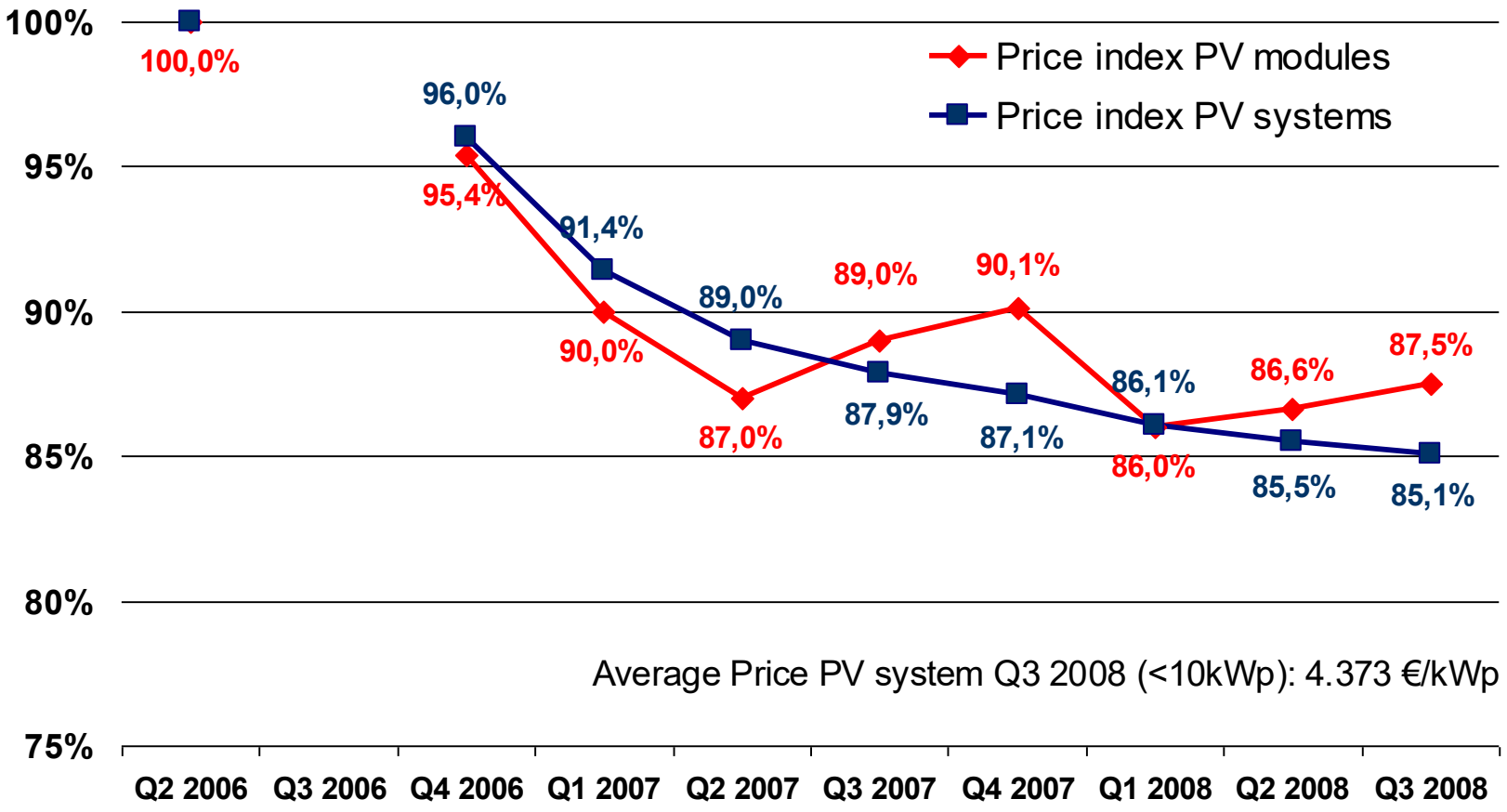


Image: Aleo

BSW-Solar German PV Price Index

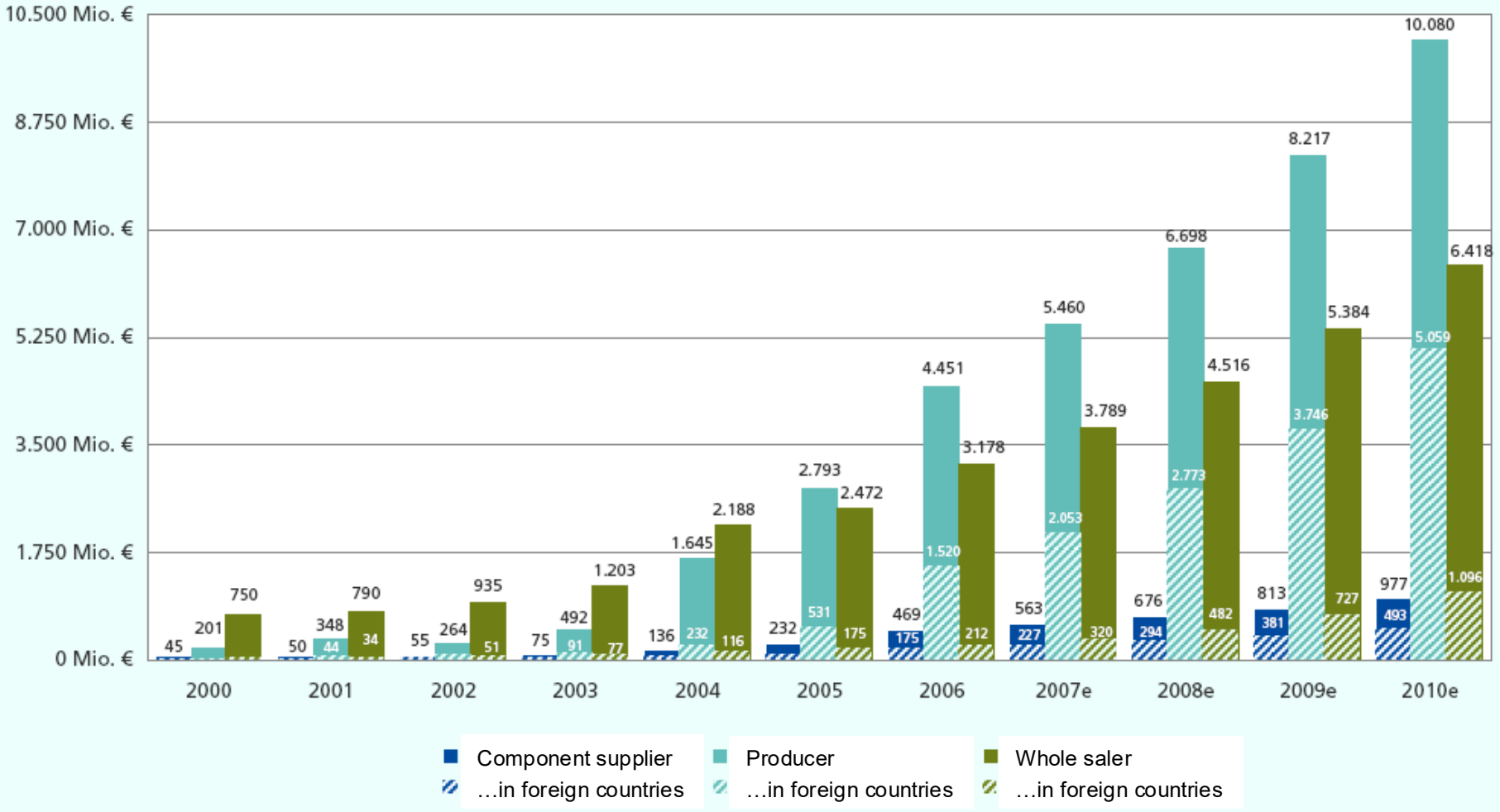


PV Moduls = Wholesale price for installer, PV systems = final customer price, ready installed

Source: Representative independent poll of 100 installers by EUPD-Research on behalf of BSW-Solar

Sales volume of the German PV industry

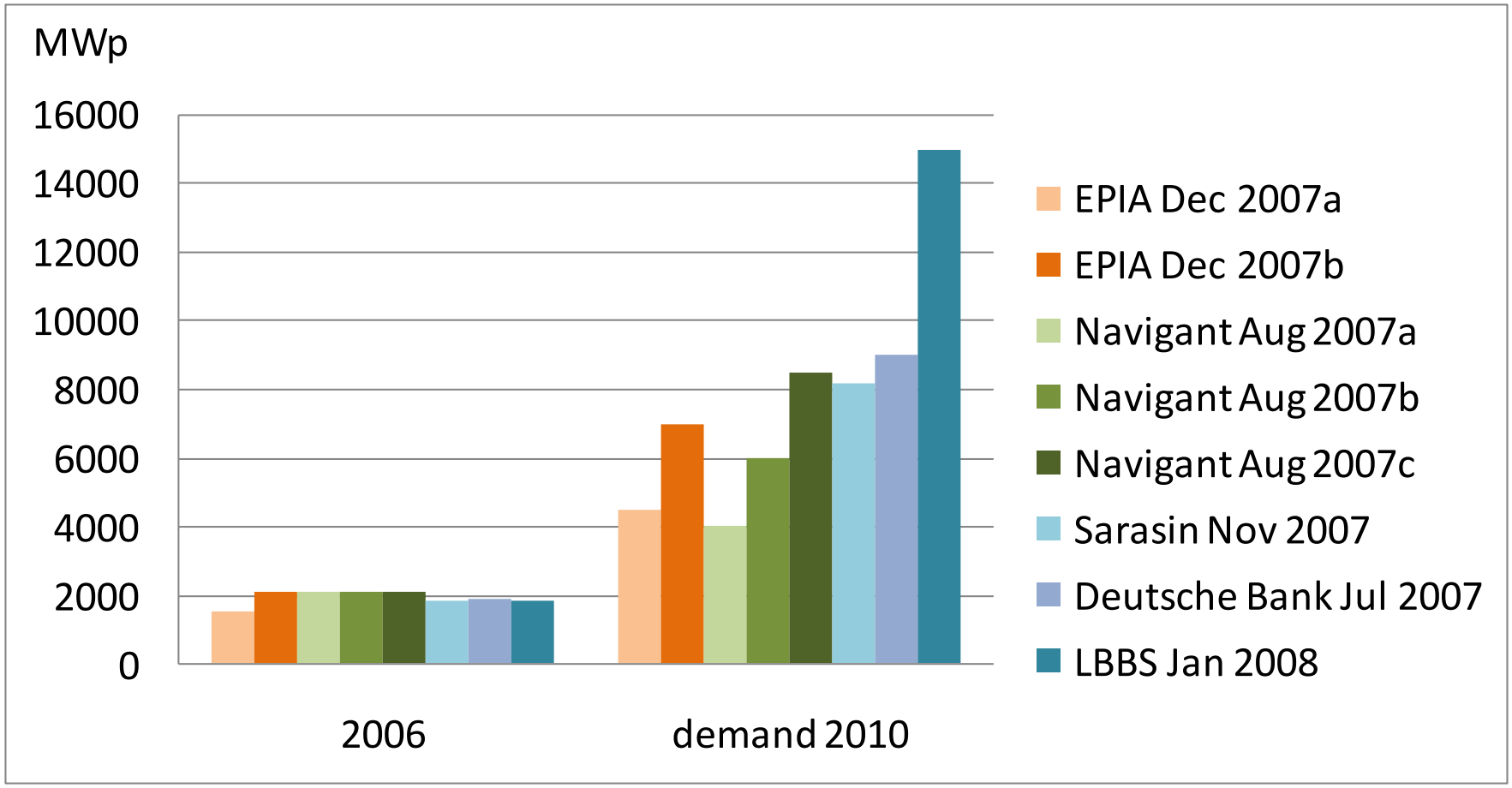
Quelle: EuPD Research 2008



Source: Standortgutachten EuPD Research/ifo 2008

CHALLENGES AHEAD

Large variations in global PV market forecasts for 2010

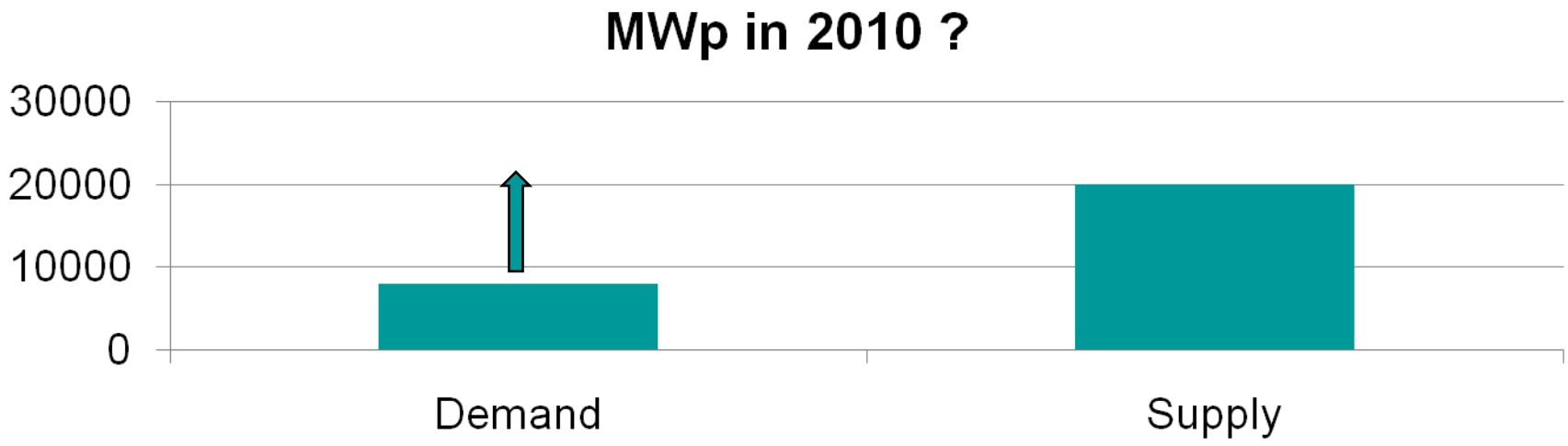


Worldwide PV overcapacity coming soon?

- Announcements for production in 2010 amount to nearly 20 GWp
- Demand estimates range between 4 and 14 GWp

→ Big efforts in market development are necessary for avoiding overcapacity

→ Only strong and high quality producers will survive



EPIA: Grid Parity Competitive Market in the EU

Learning curves
- realistic: 100% increase of installed PV → 20% cost reduction
- conservative: 100% increase of installed PV → 15% cost reduction

Grid electricity price increases

→ Step by step grid parity will be reached in all important markets in the coming years

Share of EU electicity markets where grid parity is reached:

	2008	2012	2016	2020
15% learning curve	0%	5%	25%	60%
20% learning curve	0%	10%	50%	90%

Source: EPIA / Millner, September 2008

Which part of this volume is really accessible?

New EPIA targets for 2020

- Cumulative PV installed in Europe 2020: 350 GWp
- PV Electricity production in Europe 2020: 420 TWh
- PV share of EU electicity generation: 12%
- CAGR of installed PV base: 40%

EPIA proposes to set this as target for EU energy policies:

→ appropriate policies must be developed

→ Ensuring market growth

→ Development of technologies

Source: EPIA / Millner, September 2008

INNOVATION AND EMERGING TECHNOLOGIES

Boosting innovation in photovoltaics

The new markets opened by the German Feed-in-tariff and followers since 2003 have boosted innovation activities in the PV sector

- Efficiency gains in c-Si cells
- Thin film technologies: aSi, µc-Si, micromorph Si, CIGS, CdTe …
- Concentrating photovoltaic systems
- New PV concepts
  - Dye sensitised cells
  - Organic dye luminescent solar concentrators
  - Hybrid systems (electricity/heat)
  - …
- Building integration of PV (BIPV)
- Tracking and support systems
- Grid integration concepts

Thin film PV: decreasing prices, increasing market share

- Estimated growth (LBBW):
  - 2007: ca. 500 MW
  - 2012: ca. 5600 MW
  - ► Average growth rate 65%
- Mainly a-Si/µc-Si and CdTe

- Production Mainly in EU and US
- Turnkey fabs from large equipment producers
- All production steps in one line
- Logistics become important

All major TF technologies – a-Si/µc-Si, CdTe and CIGS – have interesting prospects with different characteristics. Companies like Q-Cells invest in all strands

The importance of system costs

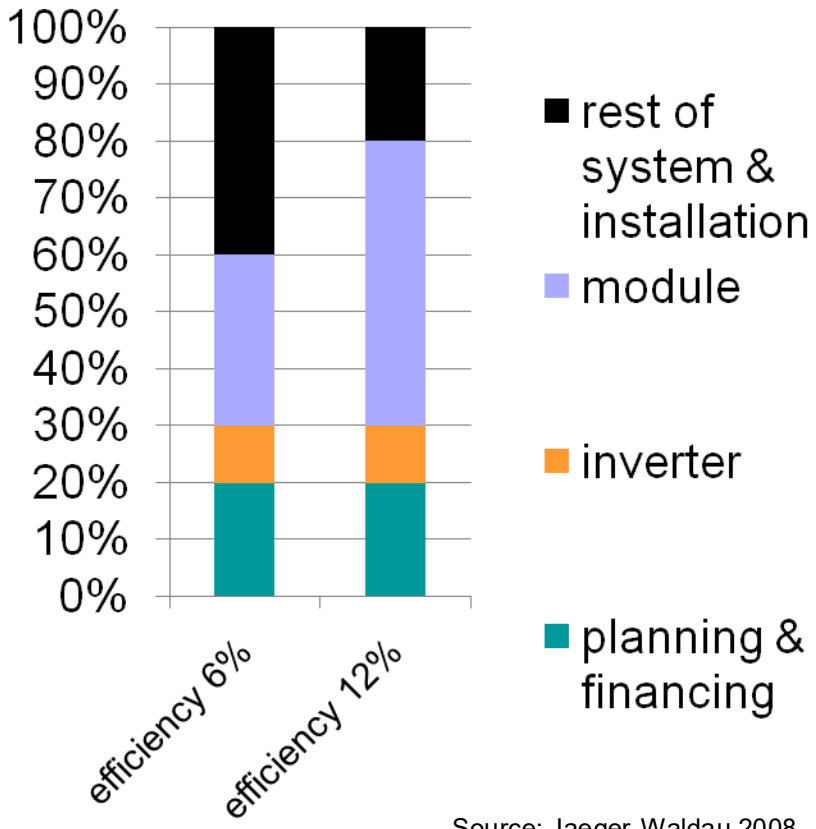
- Lower efficiency requires larger surfaces
- At low efficiency module costs may make up for only 1/3 of system costs

→ Efficiency matters

→ Costs of the rest of the system matter

→ Interesting prospects for innovative BIPV with low cost cells

Cost components at overall system costs of 2 € / Wp



Source: Jaeger-Waldau 2008

A COLLECTIVE INTERNATIONAL LEARNING PROCESS

Fascinating challenges asking for joint efforts

- PV will be able to deliver large parts of worldwide electricity at competitive costs
- Huge growth opportunities for the PV industry

<u>Challenges</u>

→ Bridging of the cost gap until grid parity, ensuring continuous market growth (► politics)

→ Reducing administrative barriers for PV (► administration,politics)

→ Bringing down the costs through continuous innovation (► industry, research)

→ Ensuring high quality with qualified personnel (► industry, training institutions)

→ Creating new markets with new applications, BIPV (► industry)

→ Supporting the growth of PV markets worldwide (► industry, politics)

Rapid growth requires to learn quickly: avoid known traps in time

- Unbalanced growth and disruptive changes in market regulation – such as in Spain – destroy capacities and confidence in the new technology
- Bad quality installations undermine confidence in the whole sector
- Possible bottlenecks need to be identified in time
  - Qualified personnel
  - Availability of key materials
  - Grid capacity
  - Financing mechanisms
- Creating new markets can be more rewarding than competing for existing ones

Rapid learning requires co-operation

- Co-operation along the value creation chain
- Co-operation between research and industry
- Co-operation between national industry associations
- Co-operation between governments in order to ensure a balanced market growth

- The new **International Renewable Energy Agency** IRENA may play an important role for enhancing co-operation and improving frame conditions
  - Negotiations for an international treaty ongoing
  - Foundation scheduled for January

MAIN CONCLUSIONS

- German feed-in-tariff has triggered wolrd-wide PV growth
- Strong public support for PV in Germany
- Germany has a large and reliable market for PV
- Germany has a strong PV industry along the whole value chain

- Continuous market growth is important for achieving cost reductions
- Grid parity will be reached step by step for the majority of the world electricity market within the next ten years
- Public support is needed in the transition phase
- Co-operation is needed for rapidly overcoming difficulties
- The PV industry has a bright future