Federal Ministry
of Economics
and Technology

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Energy

# Photovoltaics: technology and market development – the role of Germany

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AHK, Prague, May 26, 2009

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renewables Made in Germany

# 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
2. PV Market challenges ahead
3. Innovation & emerging technologies
4. Fostering an international learning process

# German Solar Industry Association

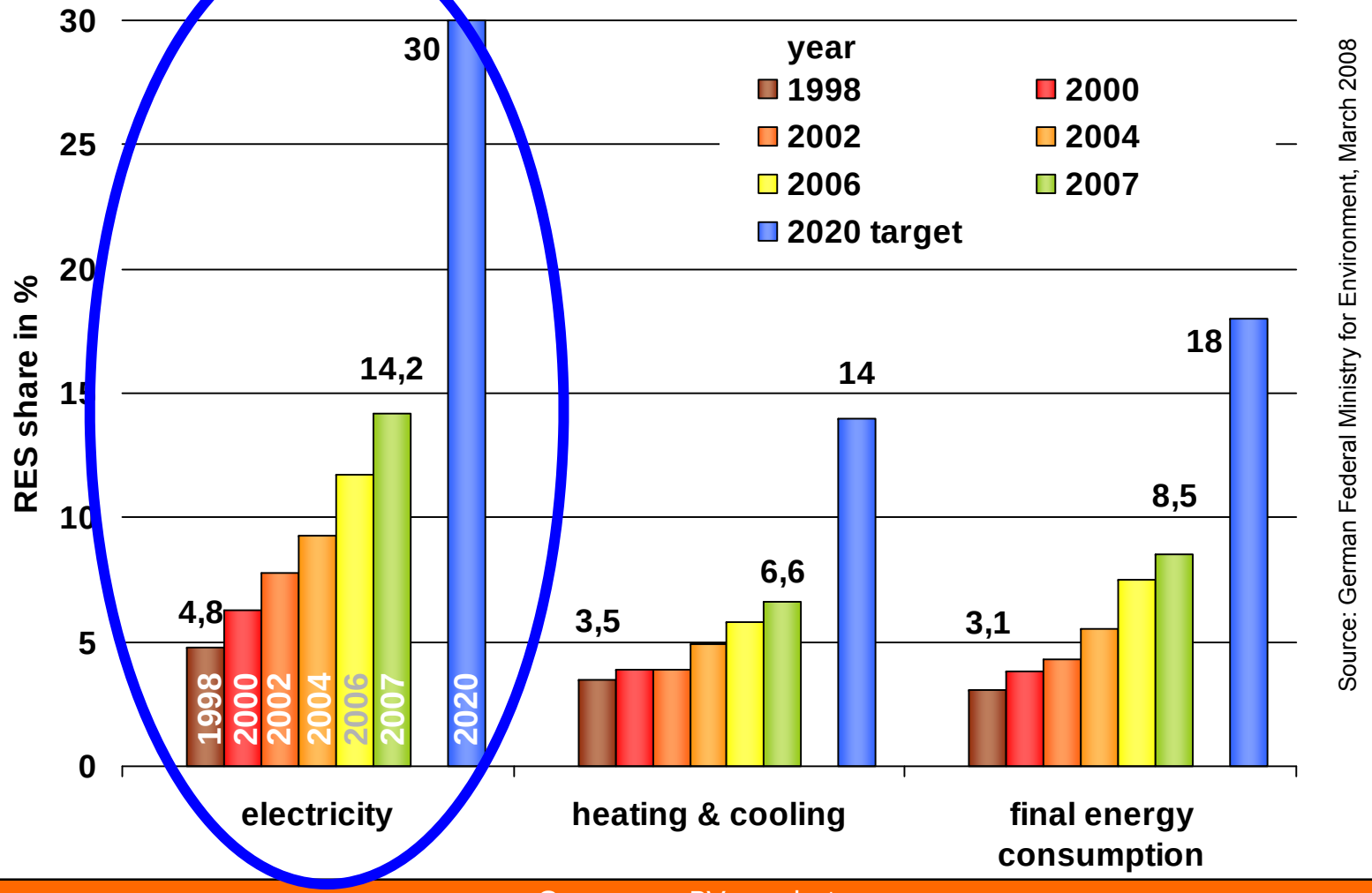
*Bundesverband Solarwirtschaft – BSW-Solar*

| | |
|---|---|
| **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 |

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

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

**Development of the share of Renewable Energy Sources in final energy consumption**

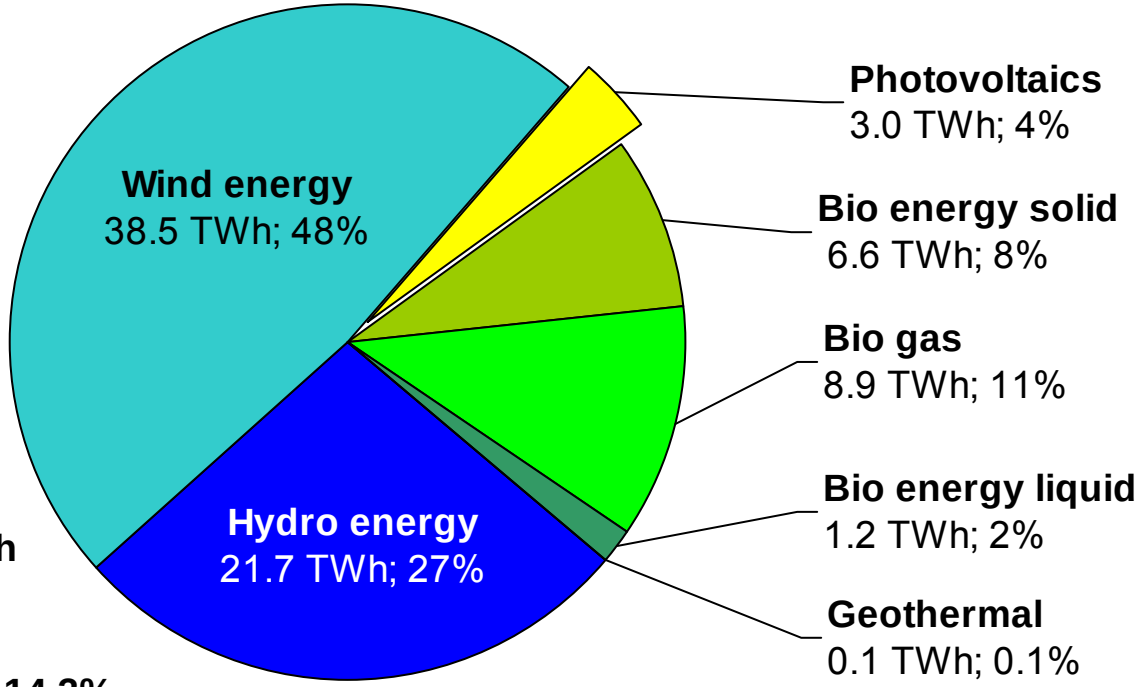



Source: German Federal Ministry for Environment, March 2008

# 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

# Why promote photovoltaics?

A method for the production of electricity with exceptional advantages:

- Applicable anywhere in the world
- Applicable at all scales, grid-connected and off-grid
- No problems for the environment
- Costs coming down rapidly, starts become competitive with traditional electricity production
- A practically unlimited potential

# Development of the German PV market

**PV Market Data 2008**

| | |
|---|---|
| **Newly installed power** | **1 500 MWp** |
| **Total installed power** | **5 334 MWp** |
| **No. of total systems installed** | **ca. 500 000** |
| **Turnover 2008** | **6 Bln €** / 8.1 Bln $ |
| **Employees** | **45 000** |

**Milestones**

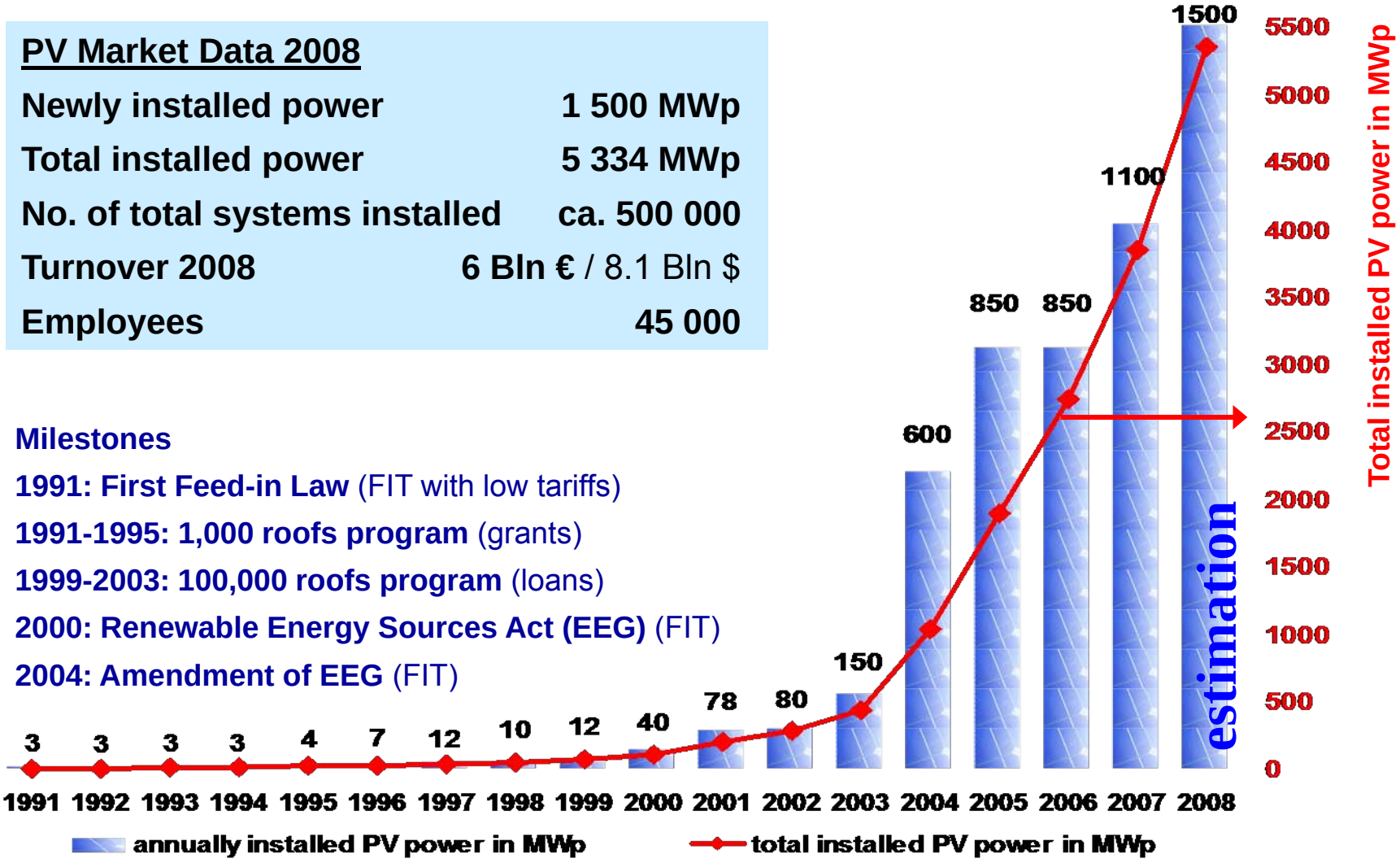
**1991: First Feed-in Law** (FIT with low tariffs)

**1991-1995: 1,000 roofs program** (grants)

**1999-2003: 100,000 roofs program** (loans)

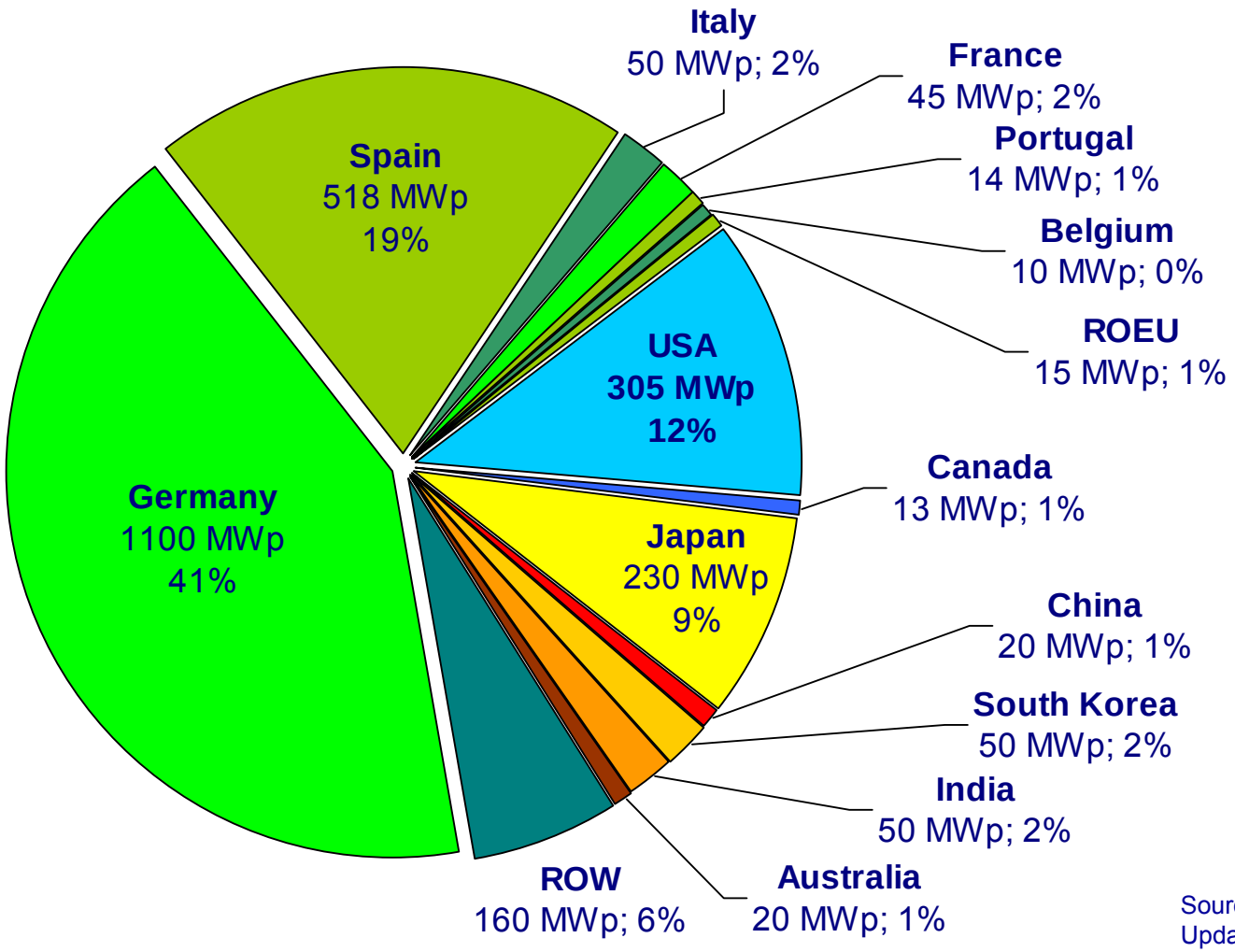
**2000: Renewable Energy Sources Act (EEG)** (FIT)

**2004: Amendment of EEG** (FIT)



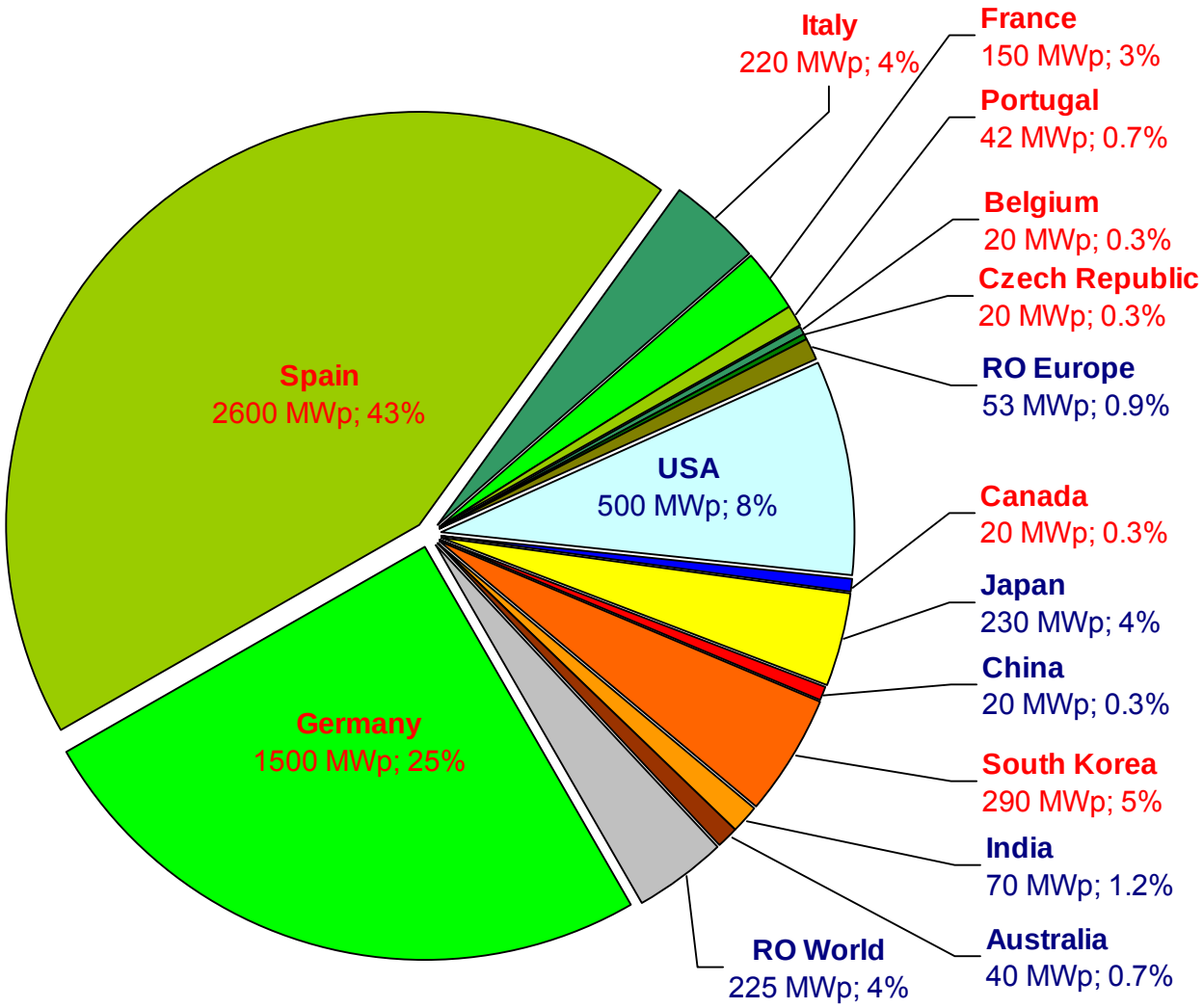
# Photovoltaic World Market 2007

## Newly installed PV Power : 2.6 GWp




Source: BSW-Solar, EPIA, NNPVA
Updated 5 September 2008

# Photovoltaic World Market 2008




**New installed PV Power**

**2006: 1600 MWp**

**2007: 2650 MWp** (+66%)

**2008: 6000 MWp** (+126%)

**Red Letters: Countries with Feed-in tariff schemes**

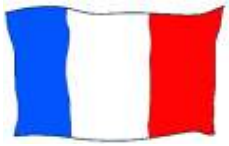
Source: Preliminary figures of National PV Associations, Stryi-Hipp, Feb 26th 2009

# Developments in important European PV Markets

| | |
|---|---|
| **Germany** | Amendment of the EEG in June 2008 provides continuity for the 2009 – 2012 period, changes can be made earlier by the parliament if unexpected developments happen |

| | |
|---|---|
| **Spain** | PV market exploded in 2008 to 2.6 GWp or more, the Royal Decree from September 2008 reduces the PV market to 500 MWp in 2009 and forsees a market growth of 10% annually |

| | |
|---|---|
| **Italy** | Stable feed-in tariff conditions, goal of 3 GWp PV installations, good market development expected, but administrative barriers on regional level slow the market growth |



| | |
|---|---|
| **France** | Stable support scheme, good market development expected, favorable conditions only for building integrated PV, general improvements of the support scheme |

| | |
|---|---|
| **Greece** | Feed-in tariff is very attractive but administrative barriers prevented the market development up to now, it is expected that the new PV law from December 2008 will push the market |

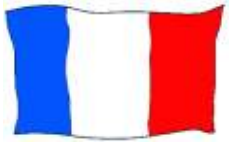
Other promising European PV markets:
Belgium, Czech Republic, Portugal, Slovenia, UK,…

# Typical system in Spain (Menorca): 3.2 MWp

Image: Sunenergy

# Feed-in tariffs of important European PV Markets

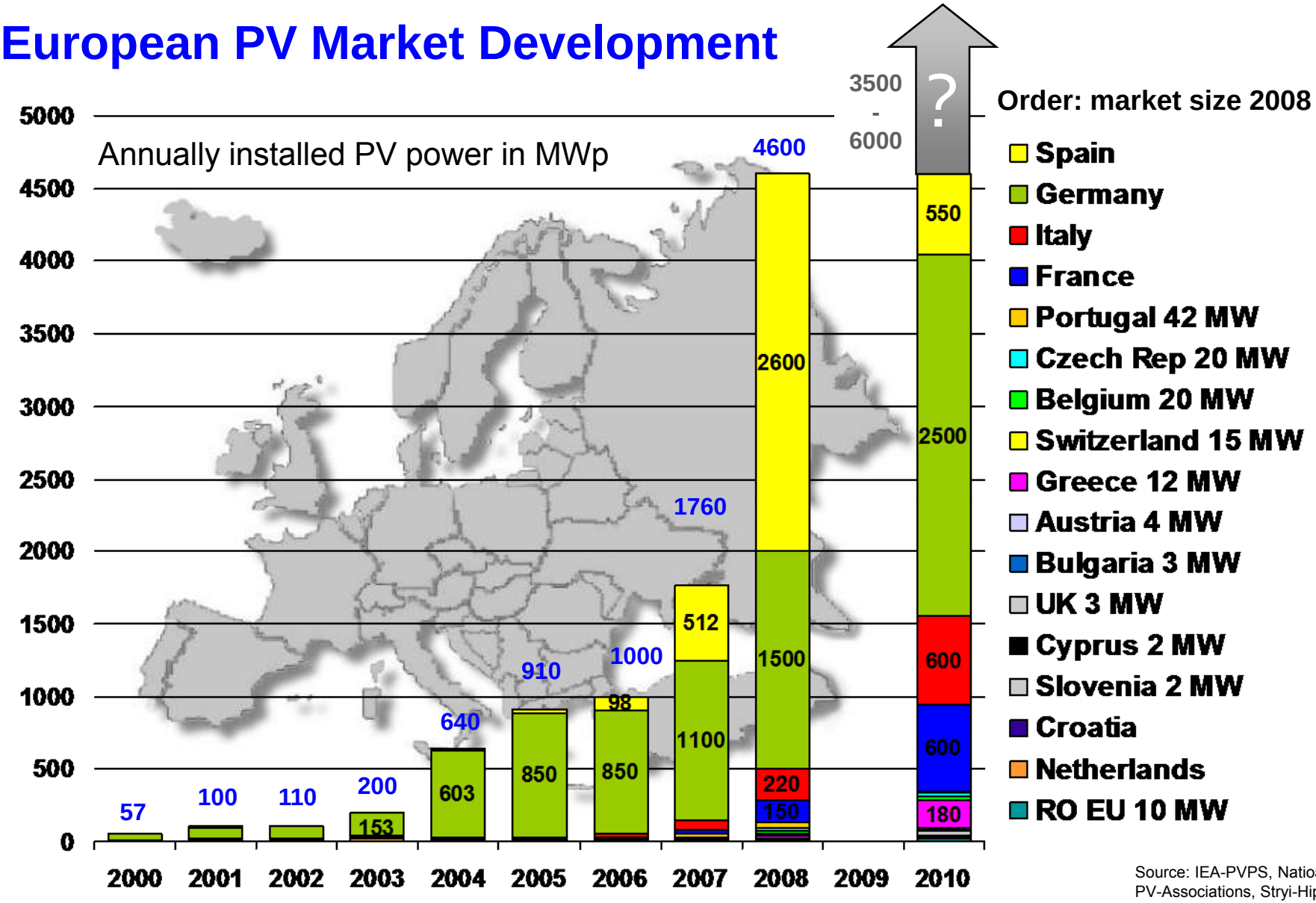



| | Feed-in tariffs [€ct/kWh] | | | Market size [MWp] | | |
|---|---|---|---|---|---|---|
| Year | 2008 | 2009 | Growth | 2008 | 2010 | Growth |
| Germany | 37.96<br>54.21 | 31.94<br>43.01 | -8%<br>-10% | 1500 | 2500 | x1.7 |
| Spain | 23<br>44 | 32<br>34 | -25% | 2600 | 550 | x0.2 |
| Italy | 36<br>49 | 35.28<br>48.02 | -2% | 150 | 600 | x4 |
| France* | 31.19<br>57.16 | 32.82<br>60.17 | +5% | 150 | 600 | X4 |
| Greece** | 40<br>50 | 40<br>50 | 0% | 10 | 200 | x20 |

* plus tax reduction ** plus subsidies Source: National PV associations

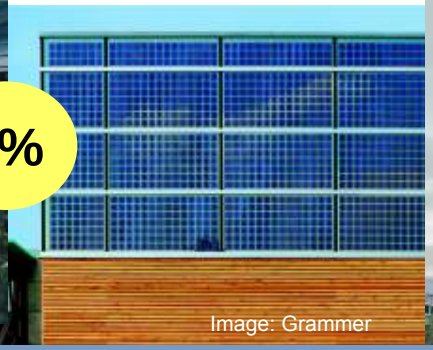
# European PV Market Development




Source: IEA-PVPS, Natioal PV-Associations, Stryi-Hipp

# 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%

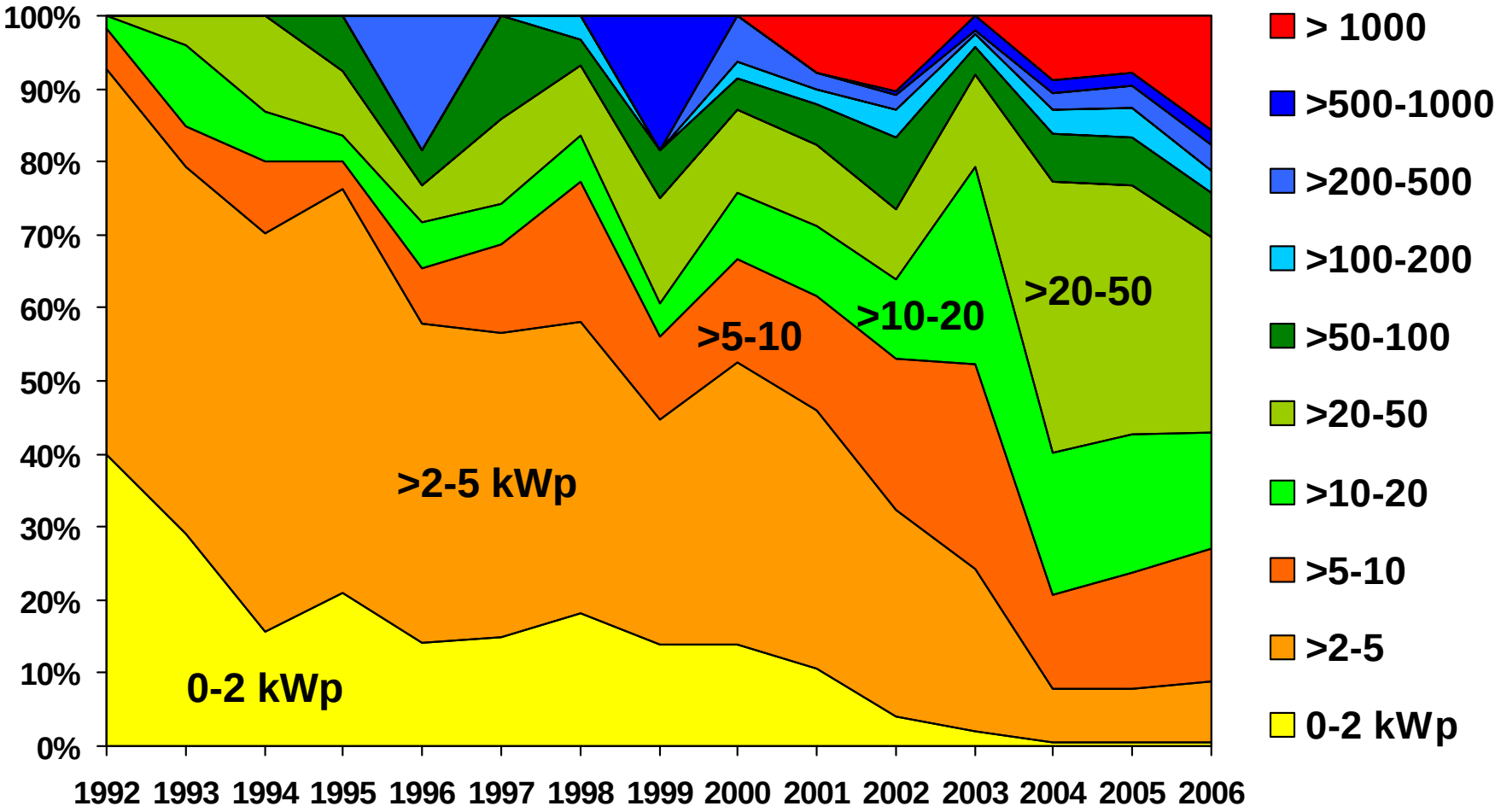
Ground mounted

Market share in 2006


10%

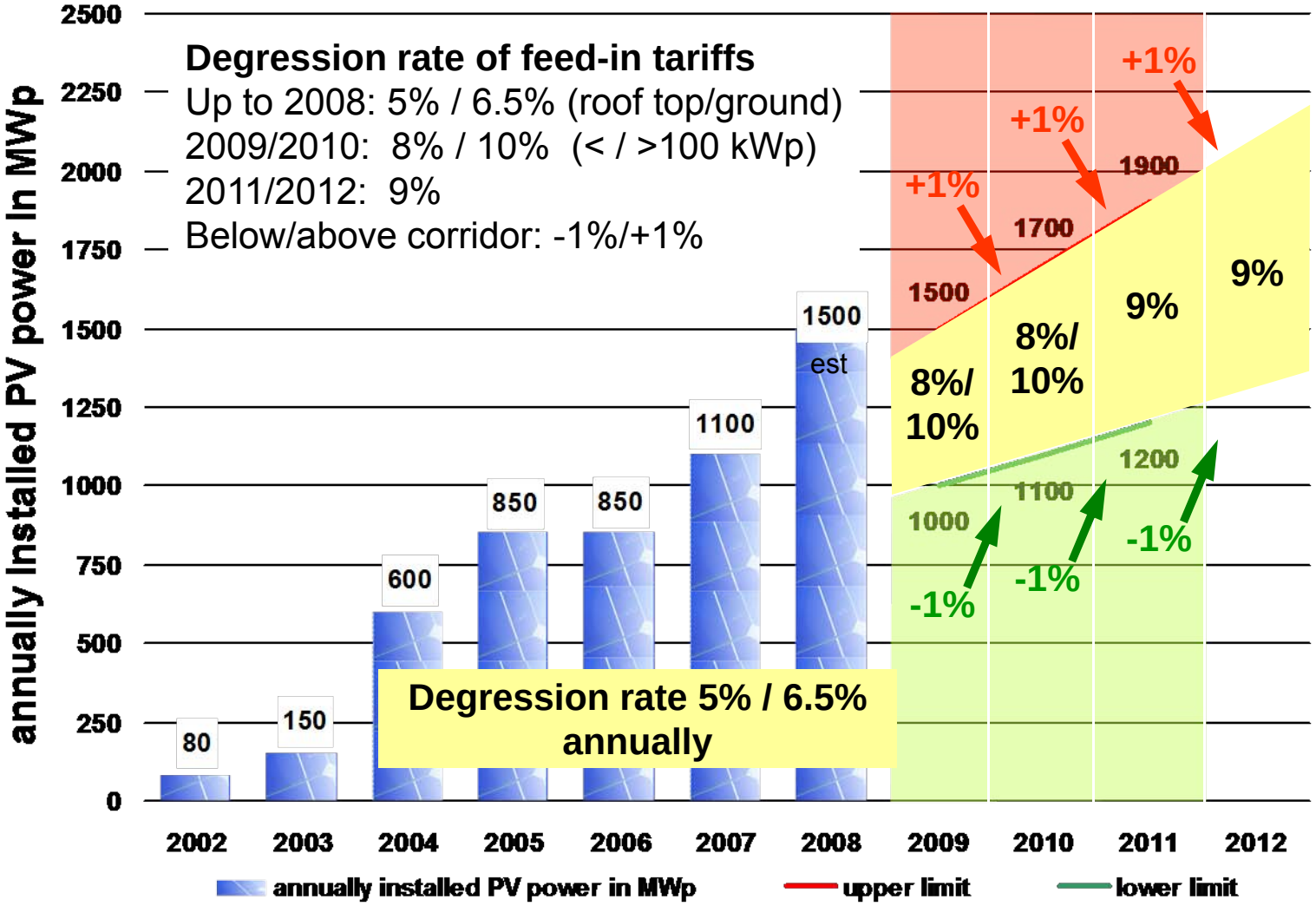

Size of the system

# Market share of PV systems according to size



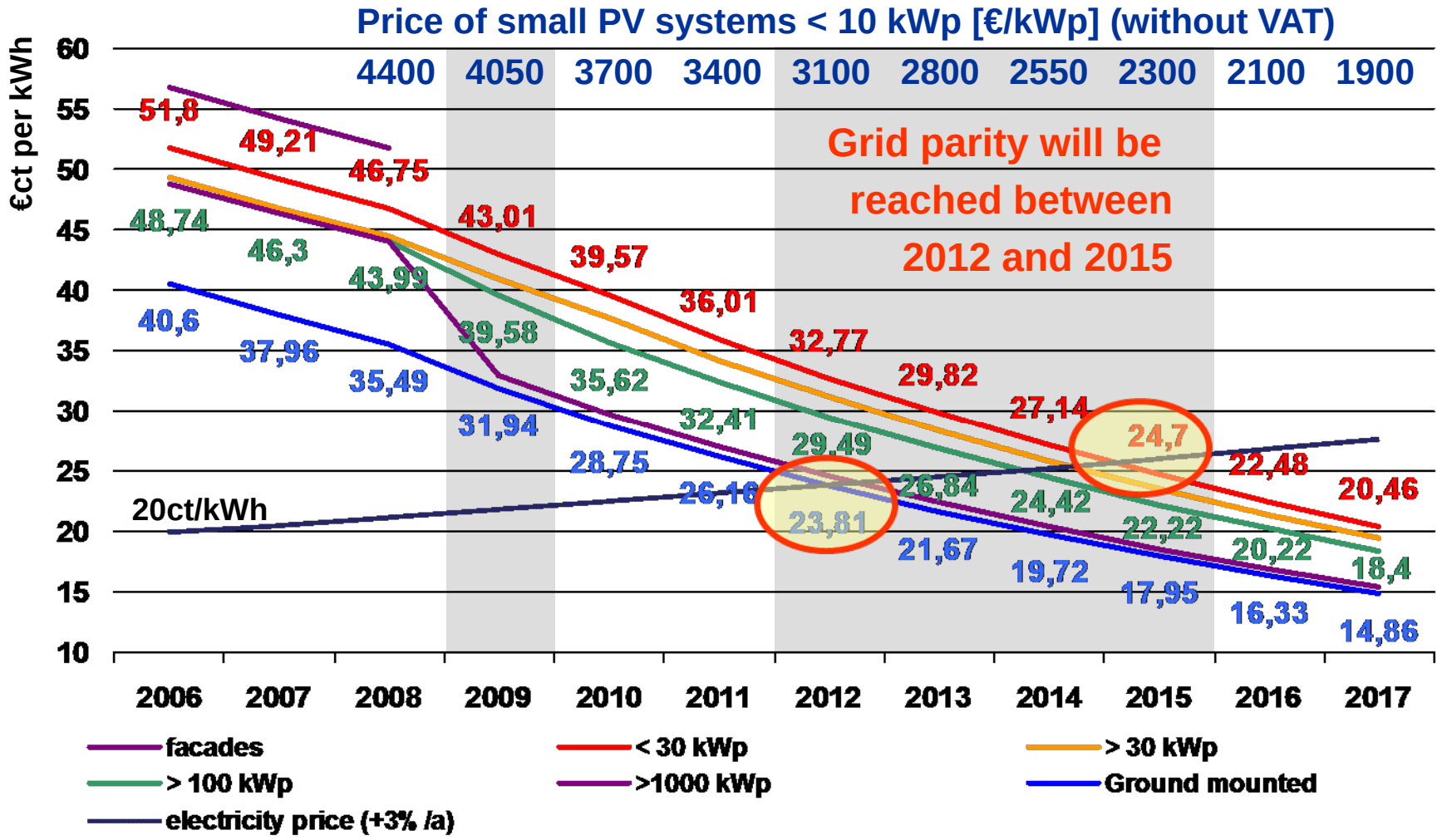

Source: BSW-Solar, calculated from data of 2.2 GWp PV systems from EnBW, EON, RWE, Vattenfall

# Amendment of the EEG from June 2008:
# Feed-in Tariffs for PV will be reduced faster as of 2009



# 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 import**
**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

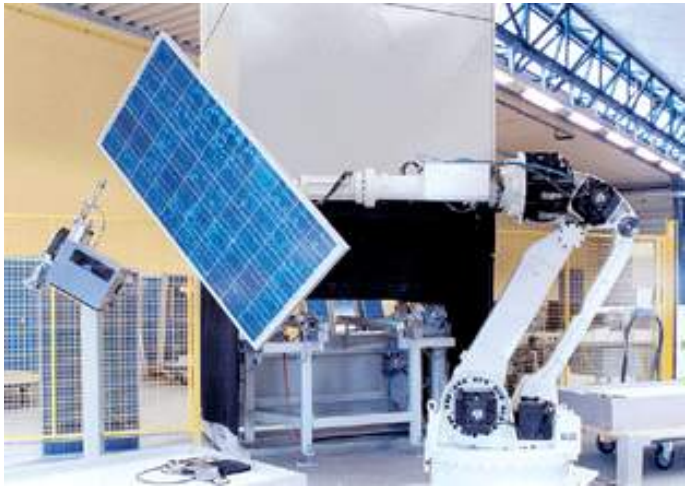
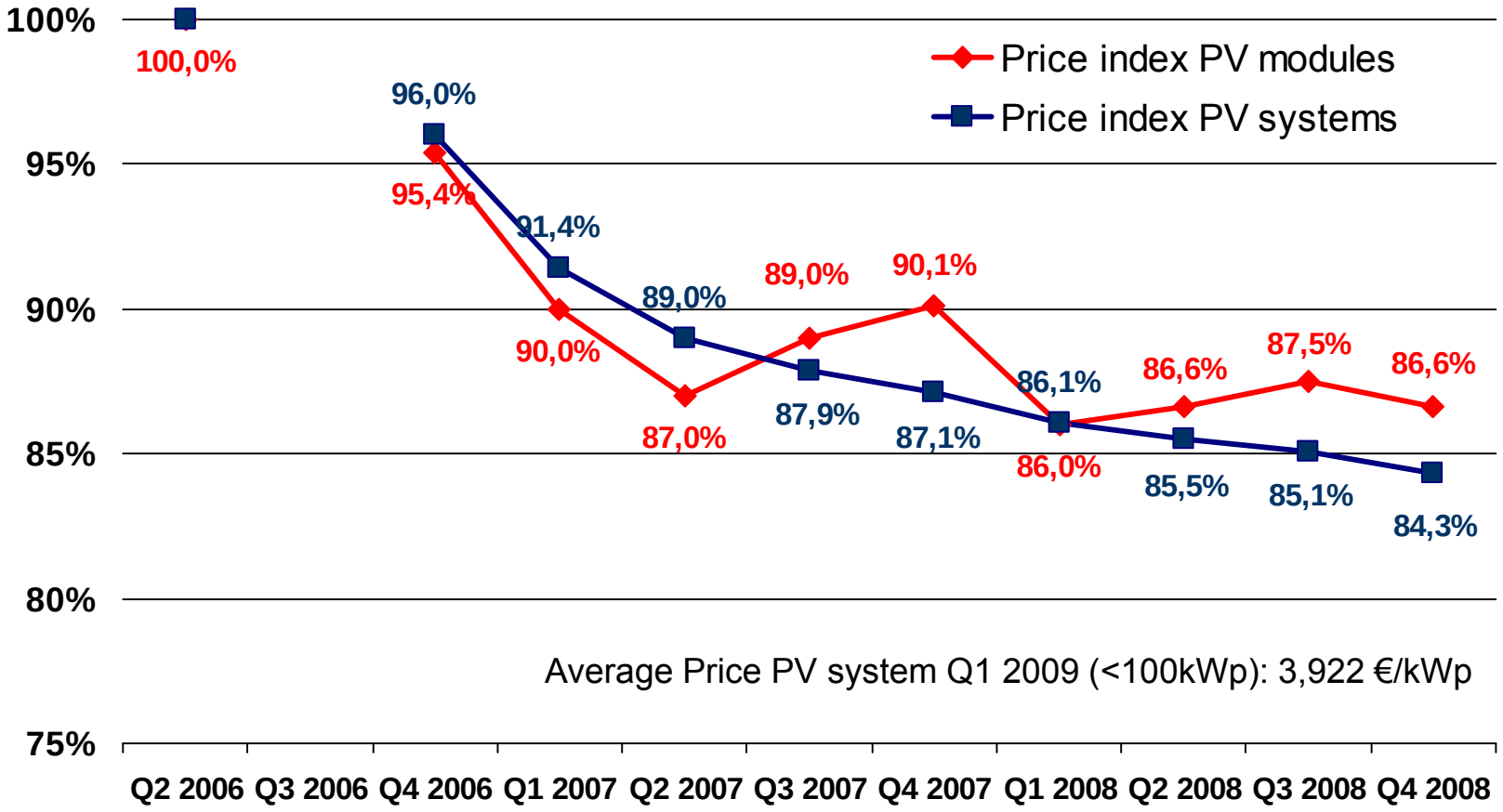


Image: Aleo

# Price of PV Modules and Systems is Declining:

## BSW-Solar German PV Price Index




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

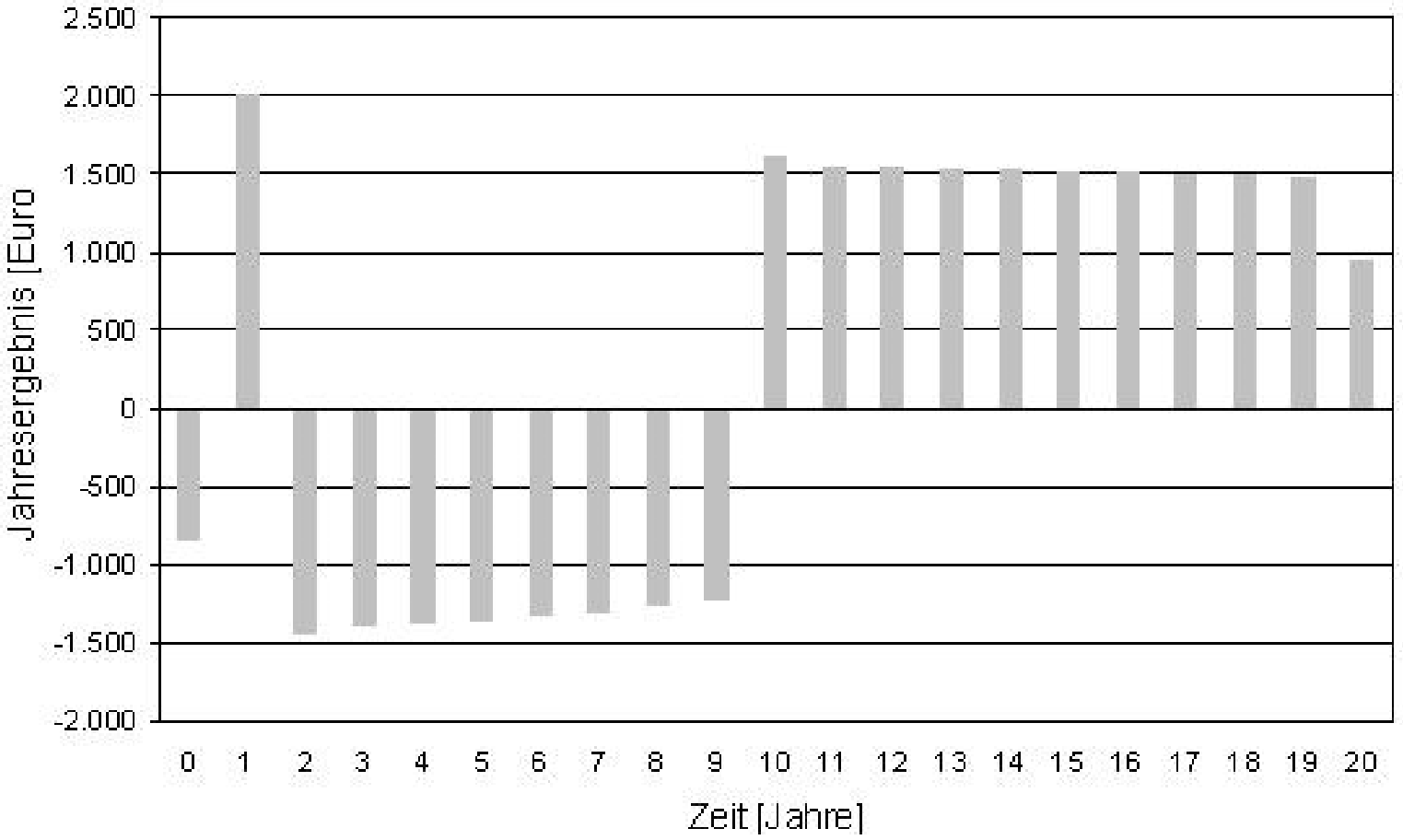
Source: Representative independent poll of 100 installers by EUPD-Research on behalf of BSW-Solar

# Profitability of PV plants: influencing factors

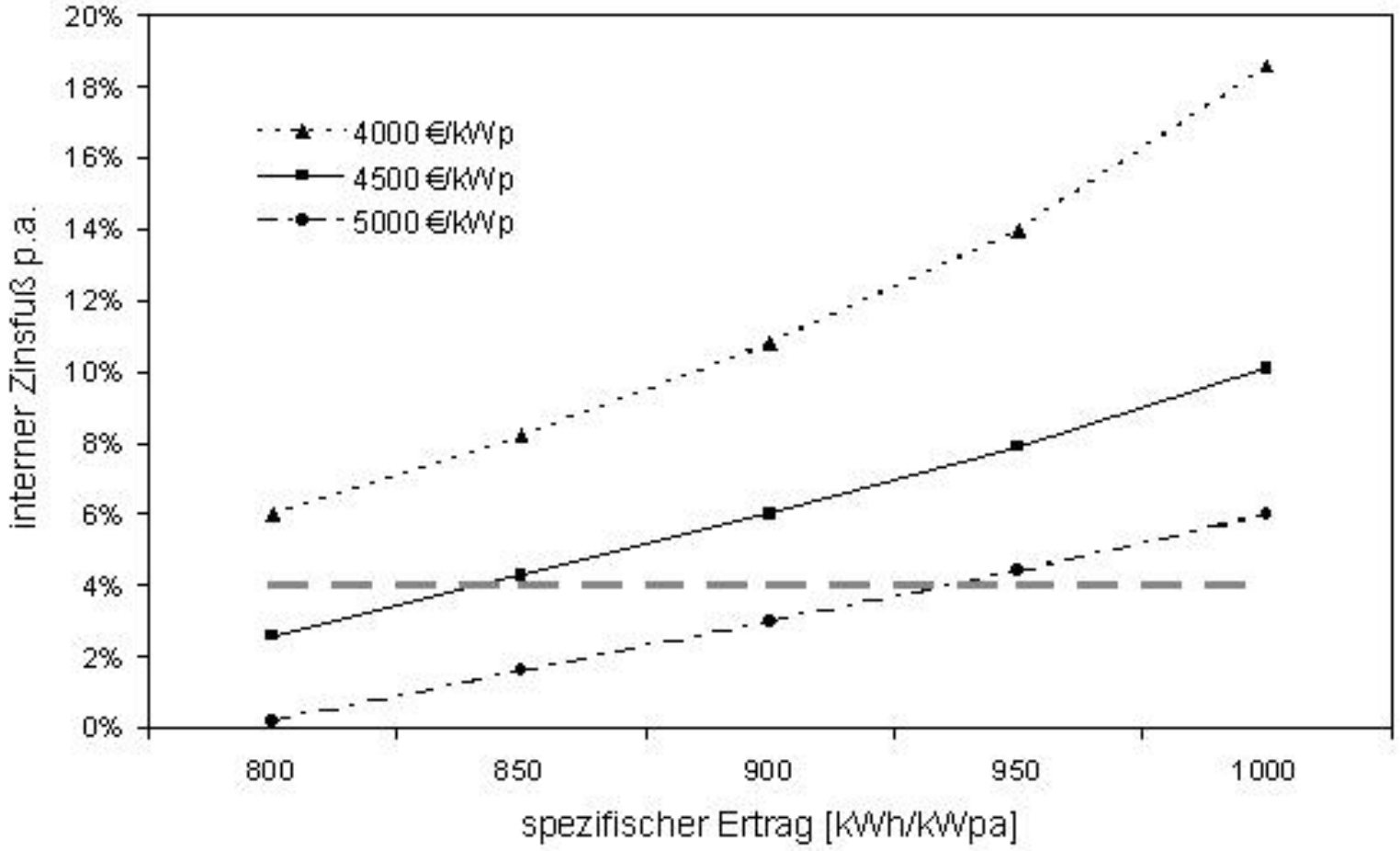
- Costs of the system (modules [ca. 50%], rest of the system, installation)
- Running costs (ca. 1% p.a.: maintenance, insurance; taxes)
- Electricity yield of the system (location, orientation, quality of the installation)
- Duration of the installation, of the warranty (20-25a)
- Feed-in-tariff: amount / duration
- Financial support for investment (taxes, other subsidies)
- Bank credit: amount / structure / interests

# Typical financial results over time

Small plant (5kWp, 22.500 EUR, 900kW/kWpa)



# Germany: return on investment – dependence on yield and costs




Internal interest rate / Yield / Costs for a standard small system

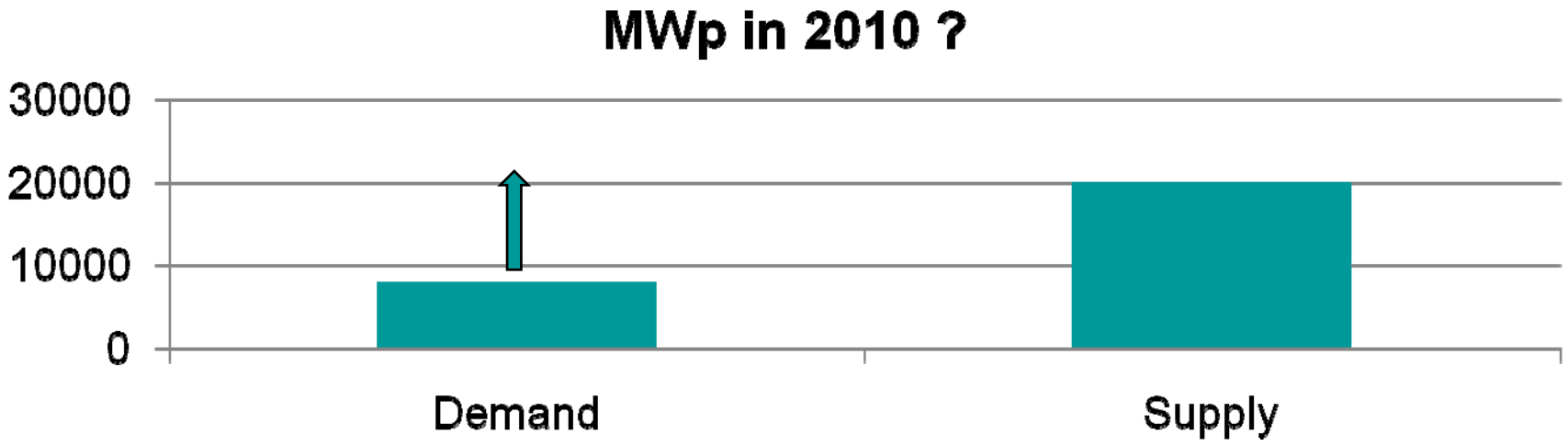
# PV: CHALLENGES AHEAD

# Independent from the economic crisis: worldwide PV overcapacity

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

→ Big efforts in market development are necessary

→ Only strong and high quality producers will survive



# EU sets ambitious targets for 2020

- In December 2008 the EU decided compulsory targets for 2020
  - Decrease of CO2 emissions: -20%
  - Reduction of energy consumption: -20%
  - Share of renewables in final energy consumption 20%
- National targets agreed, national action plans required, regular reporting
- Detailed policies for electricity, heat
- →Electricity needs 35-40% renewables by 2020

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# German Renewable Energy Association: Prognosis exceeds EU targets

Share of total electricity production in Germany

| | share 2020 | growth 2007-2020 |
|---|---|---|
| • Biomass | 9% | +119% |
| • Geothermie | 1% | |
| • PV | 7% | +1217% |
| • Hydro | 5% | +54% |
| • Wind onshore | 19% | +182% |
| • Wind offshore | 6% | |
| • **TOTAL** | **47%** | |

# EPIA is more ambitious: Towards PV competitivity in Europe

European Photovoltaic Industry Association EPIA:

- Realistic learning curve:
  100% increase of installed PV → 20% cost reduction

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

| | 2008 | 2012 | 2016 | 2020 |
|---|---|---|---|---|
| Share of EU electricity markets where grid parity is reached | 0% | 10% | 50% | 90% |

EPIA proposes as target for EU policies :

- Cumulative PV installed in Europe 2020 : 350 GWp
- PV share of EU electricity generation : 12%
- Annual growth rate of installed PV base : 40%

# The crisis: impact on business

- Medium term growth prospects for renewables better than ever
- Credit crunch brings problems to project financing – utilities and private investors not touched
- Government aid programs support growth of renewables – safe haven for investments
- Low oil price: temporary problems
- PV - a special case:
  - overcapacity brings consolidation of the sector
  - emphasis on quality
  - sinking prices, increased competitiveness
  - new markets needed

# INNOVATION AND EMERGING TECHNOLOGIES

# Boosting innovation in photovoltaics

The new PV markets opened since 2003 by the German feed-in-tariff, enlarged by Spain and later followers have boosted innovation activities in the PV sector:

- Increased and lower cost silicon production
- Lower costs and efficiency gains in c-Si cells
- Thin film technologies: aSi, µc-Si, micromorph Si, CIGS, CdTe …
- Concentrating photovoltaic systems CPV
- New PV concepts
- Building integration of PV (BIPV)
- Tracking and support systems
- Grid integration concepts

→Innovation and cost reduction are accelerating

# New developments in thin film PV

- More than 100 companies have announced time frames and capacities for TF PV production [1]
  - 40 Europe, 27 China, 12 Taiwan, 19 USA, 8 Japan
  - 82 Si, 19 CIGS, 7 CdTe, 5 Dye & others
- More than 12 companies offer “turn-key” production systems [1]
- Estimates for 2010: nearly 5 GW [2]
- Steady correlation since 30y: doubling volume → 22% cost reduction
- Thin film factories mushrooming, also in Germany
  - Q-cells (a-Si/µc-Si, CdTe/CdS, CIGS)
  - Ersol – now a Bosch subsidiary aiming at rapid expansion (a-Si)
  - Masdar initiative (Si, Applied Materials)
  - A series of smaller companies
  - Equipment providers (Roth & Rau, Manz, Centrotherm, etc. )

[1] Jaeger-Waldau 2008 [2] LBBW 2008

# The importance of system costs

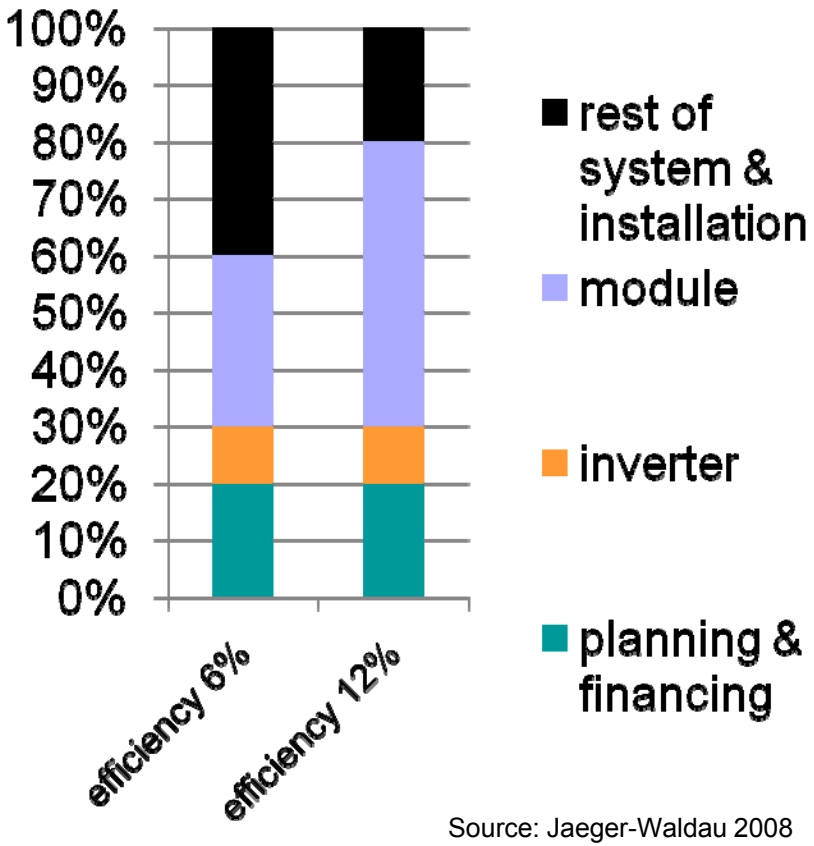
- Lower efficiency requires larger surfaces
- At low efficiency module costs may make up for only 1/3 of system costs

→ 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

# Concentrating Photovoltaic Systems CPV

- Low-concentration (factor < 10) and high-concentration (factor >100) systems
- Low concentration modules (10x) with conventional Si-cells: high yield with low system costs
  Germany: Archimedes (ZEW Stuttgart spin-off)
- New high-yield cells open new prospects
  - World record 40,8% efficiency with triple-junction cells

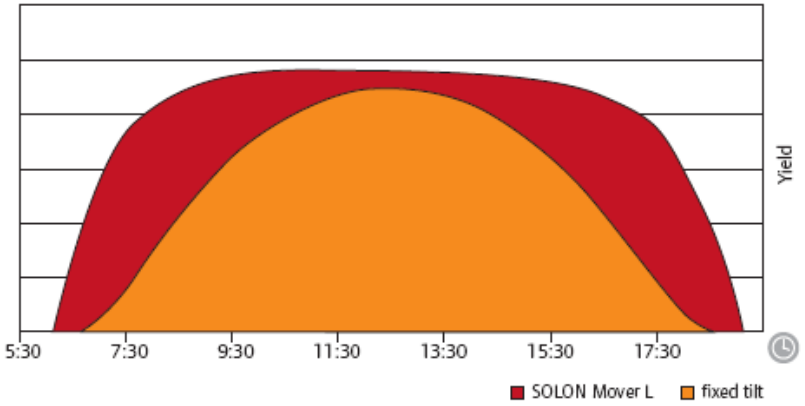

© Archimedes

- Integrated concentrator modules (500x) promise low costs for sunny regions
  - 5,6 MW plant near Sevilla with Concentrix fresnel-lens modules shows 23% efficiency (Concentrix is an ISE spin-off with Albengoa capital)
  - new Concentrix modules: efficiency over 27%, energy payback time <1 year
  - automated 25 MW production line opened Sept 2008 in Freiburg


© Concentrix

# Two axis tracker systems

- Higher yield
- Higher costs
- More surface required (5ha/MWp)

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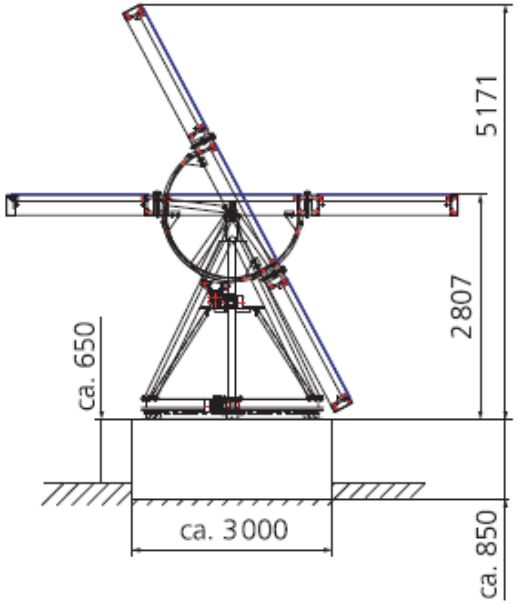
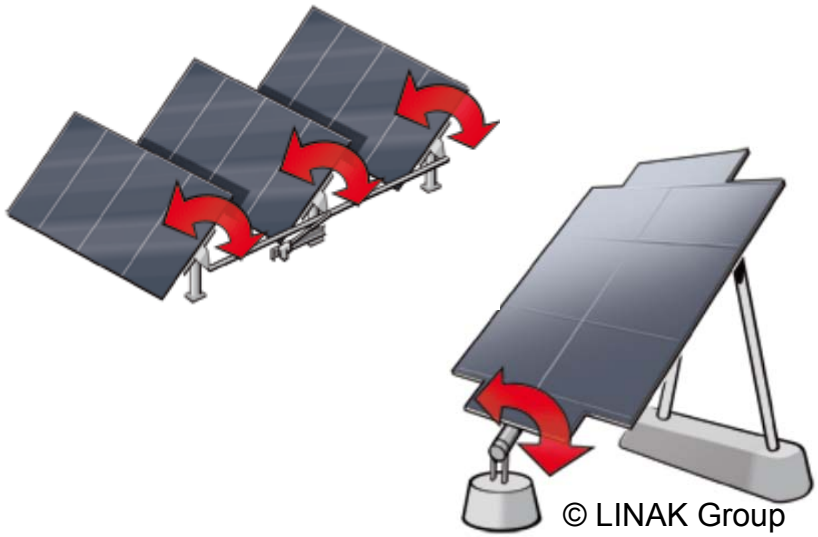



# Single axis tracker systems

- Lower additional costs (system, installation, maintenance)
- Lower surface requirements (2,5 ha/MWp)



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# Building Integrated PV (BIPV)

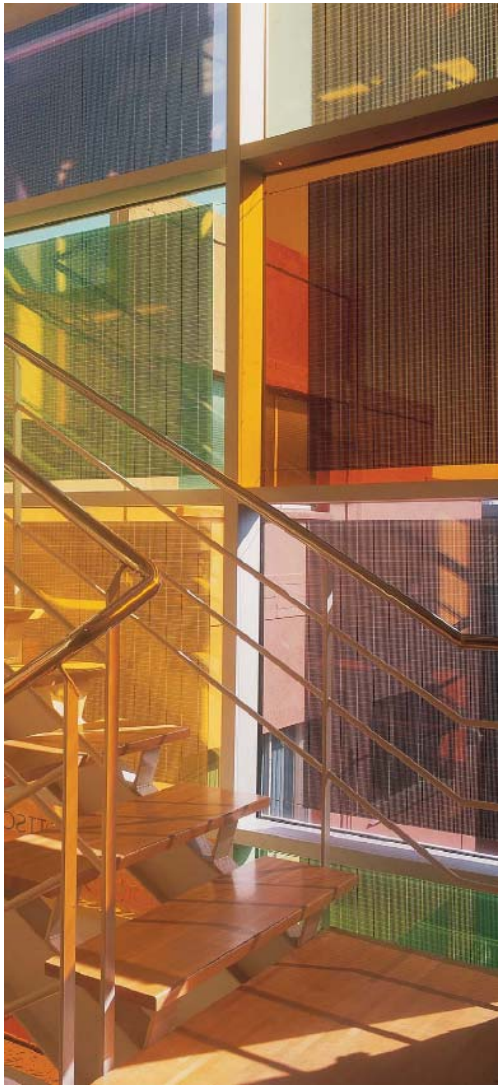
- Whole roofs as a first step
- Other components of the building shell require more sophisticated solutions / integration with
  - standard building components
  - planning and building processes
  - construction industry
- Very high potential but little commercial progress in the last years
- Research in Germany: Fraunhofer ISE etc.
- Innovative Systems and Components:
  - Schott
  - Schüco
  - Systaic
- New opportunities with thin film products

© Solarsiedlungs-GmbH

# Building Integrated PV (BIPV) 2

- Wide range of possible applications
- Increasing aesthetical options
- Low or no additional costs for support structures
- System solutions required

© Schott



# Building Integrated PV (BIPV) 3


© Saint Gobain

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# Grid integration

- Reduced scepticism concerning grid management: Inverter industry : no problem with up to 50% solar electricity in German grid
- Inverters have to take over tasks in grid stabilisation
- “Kombi-Kraftwerk”: virtual hybrid power station combining wind, solar, biogas & hydro has shown high performance in matching demand
- slow but systematic progress in net metering: adapting demand to the offer

# Mini-grids & hybrid systems

- Mini-grids:
  - improved inverters & controls → bottom-up construction of grids increasingly attractive: scalable mini-grids with usual 230V appliances
  - hybrid systems combining PV, wind and biofuels increasingly standardised
  - Improving storage technologies
- PV markets off centralised grids with huge potential
  - high diesel costs call for new approaches
  - declining costs of PV-focused mini-grids offer new solutions
  - rural population needs electricity
- Important contributions from research institutes and industry (ISET Kassel, Fraunhofer ISE, SMA, Kaco, Steca, Fronius, Energiebau ..)

# 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
- New opportunities for areas with no or weak grids
- Huge growth opportunities for the PV industry

Challenges

→ 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 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

# International cooperation needed
# A new important player: IRENA

We are in a rapid global learning process, facilitators are needed, an important one could be:

- The International Renewable Energy Agency (IRENA): a dedicated International Organisation for renewables
- Founded in Bonn on January 26, 2009
- 78 countries signed
- Headquarters and DG to be decided in June
- An important signal, far beyond the organisation itself: Renewables are being taken serious

# Thank you

www.bsw-solar.de

www.irena.org

www.schleicher-tappeser.eu