# Development and Perspectives of Solar Energy in Germany

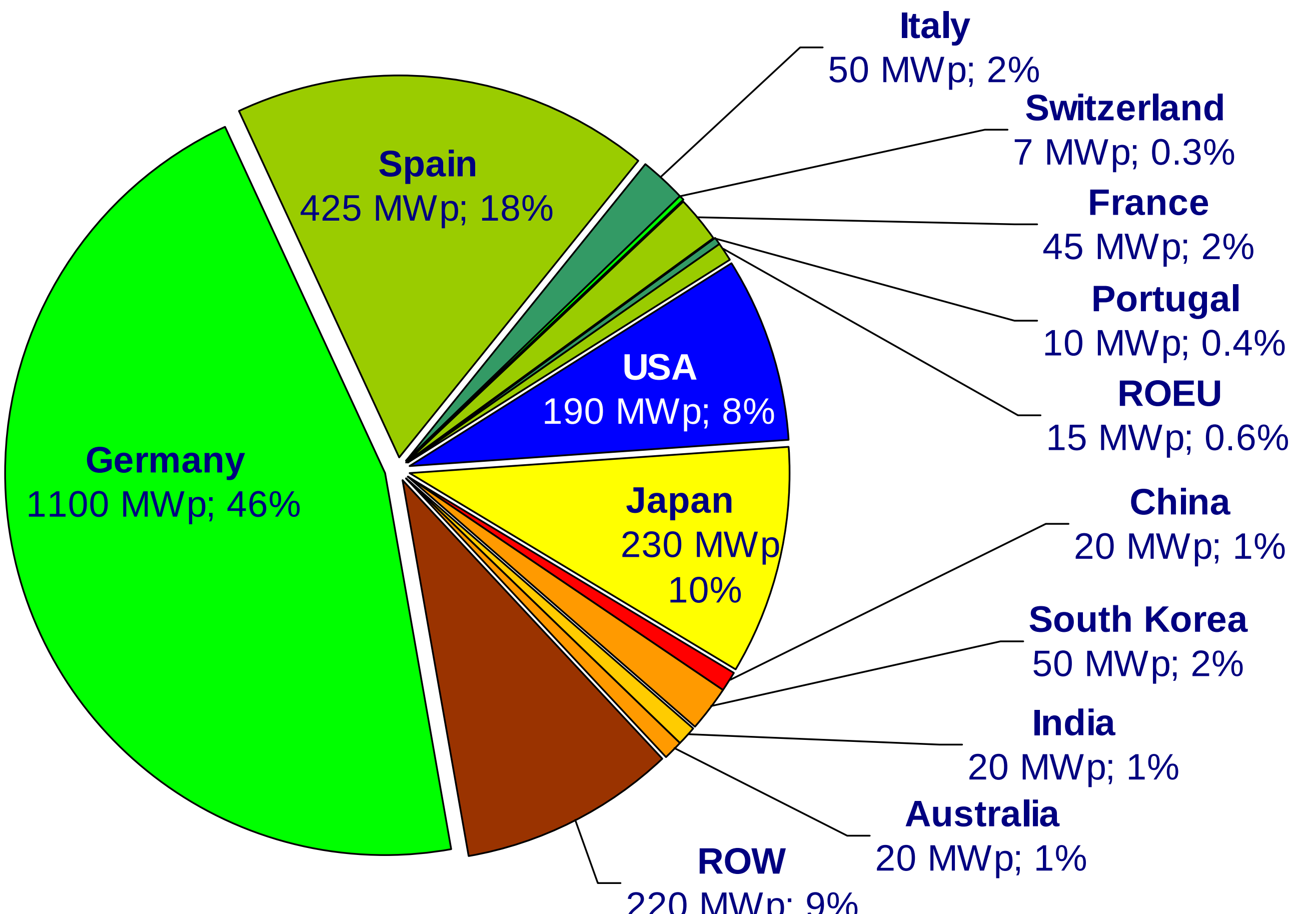
On the occasion of the visit of a Solar Delegation from
Dezhou City, Shandong Province

Germany Embassy, Beijing
Beijing, December 1, 2008

EU-China Energy & Environment Programme
Frank Haugwitz (韩飞)

# Global PV Market Perspectives

## Newly installed PV Power in 2007: 2.4 GWp



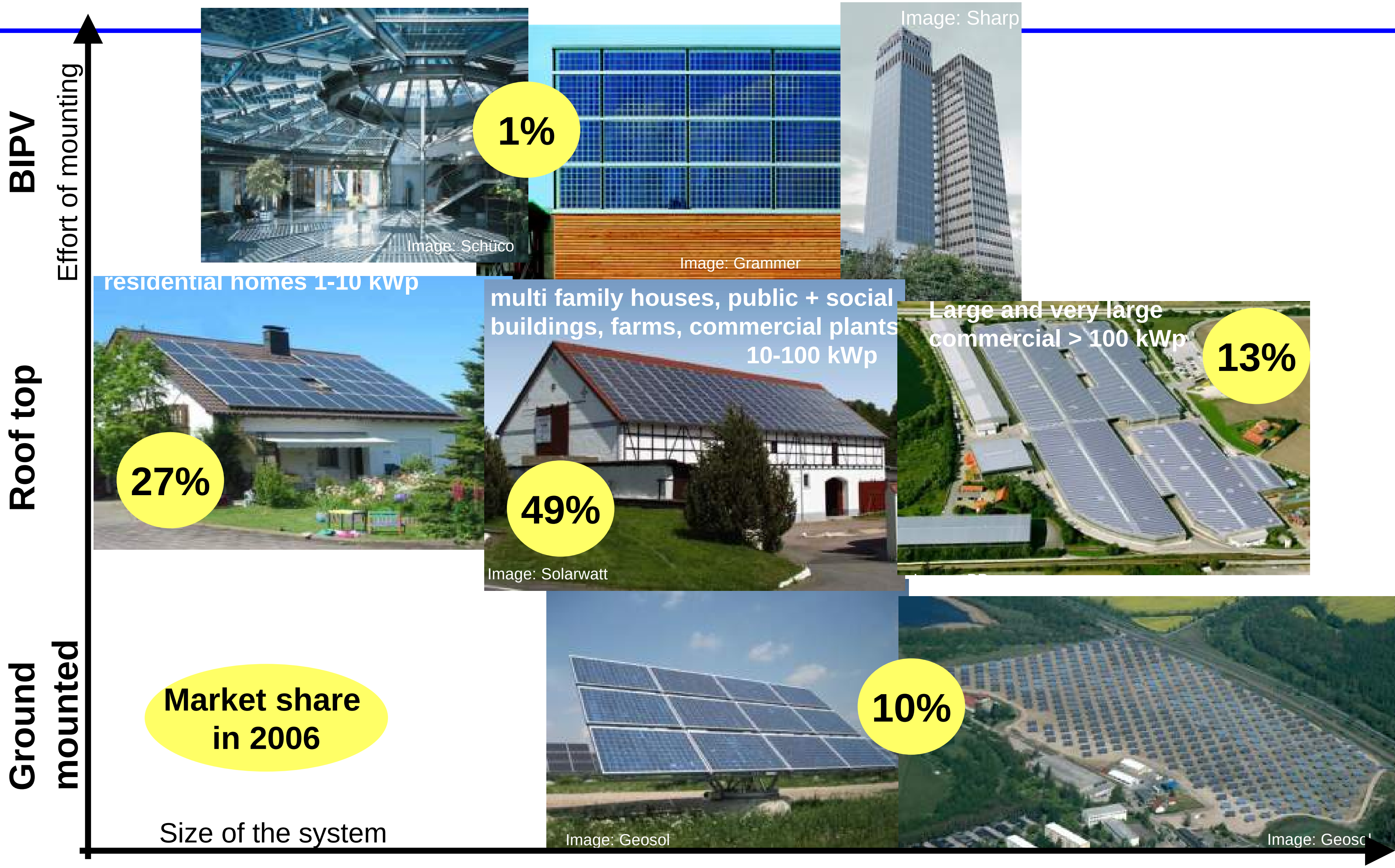

**Forecast for 2008:**

**3.6-4 GWp (+50%)**

Source: EPIA, BSW, ASIF, SEIA
Updated 15 July 2008

Source: BSW

# Germany: Market Segments of on-grid PV Systems



# Small, Medium & Large Rooftop Sys.




# Ground-Mounted PV Systems




# GERMANY – Market Development

## Market Data 2007

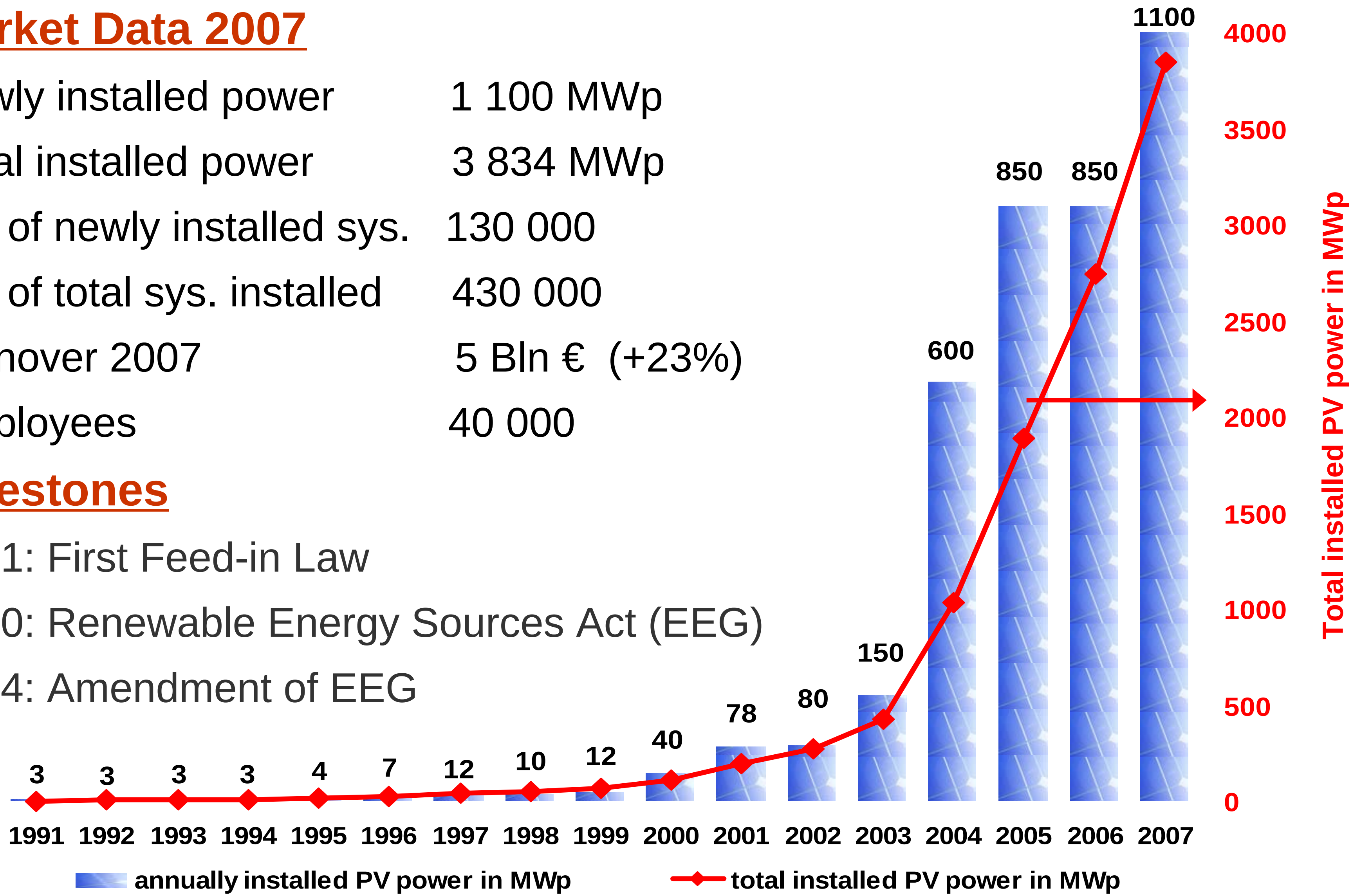
| | |
|---|---|
| Newly installed power | 1 100 MWp |
| Total installed power | 3 834 MWp |
| No. of newly installed sys. | 130 000 |
| No. of total sys. installed | 430 000 |
| Turnover 2007 | 5 Bln € (+23%) |
| Employees | 40 000 |

## Milestones

1991: First Feed-in Law

2000: Renewable Energy Sources Act (EEG)

2004: Amendment of EEG



# How does the German Feed-in Law (EEG) work?

## Principles

- **Priority connection** for all PV systems granted
- Each solar kWh **has to be purchased** by the utility
- **Fixed feed-in tariff payment for 20 years**
- **Reduction of the feed-in tariff each year by 8-10%** for newly installed PV systems from 2009 onwards

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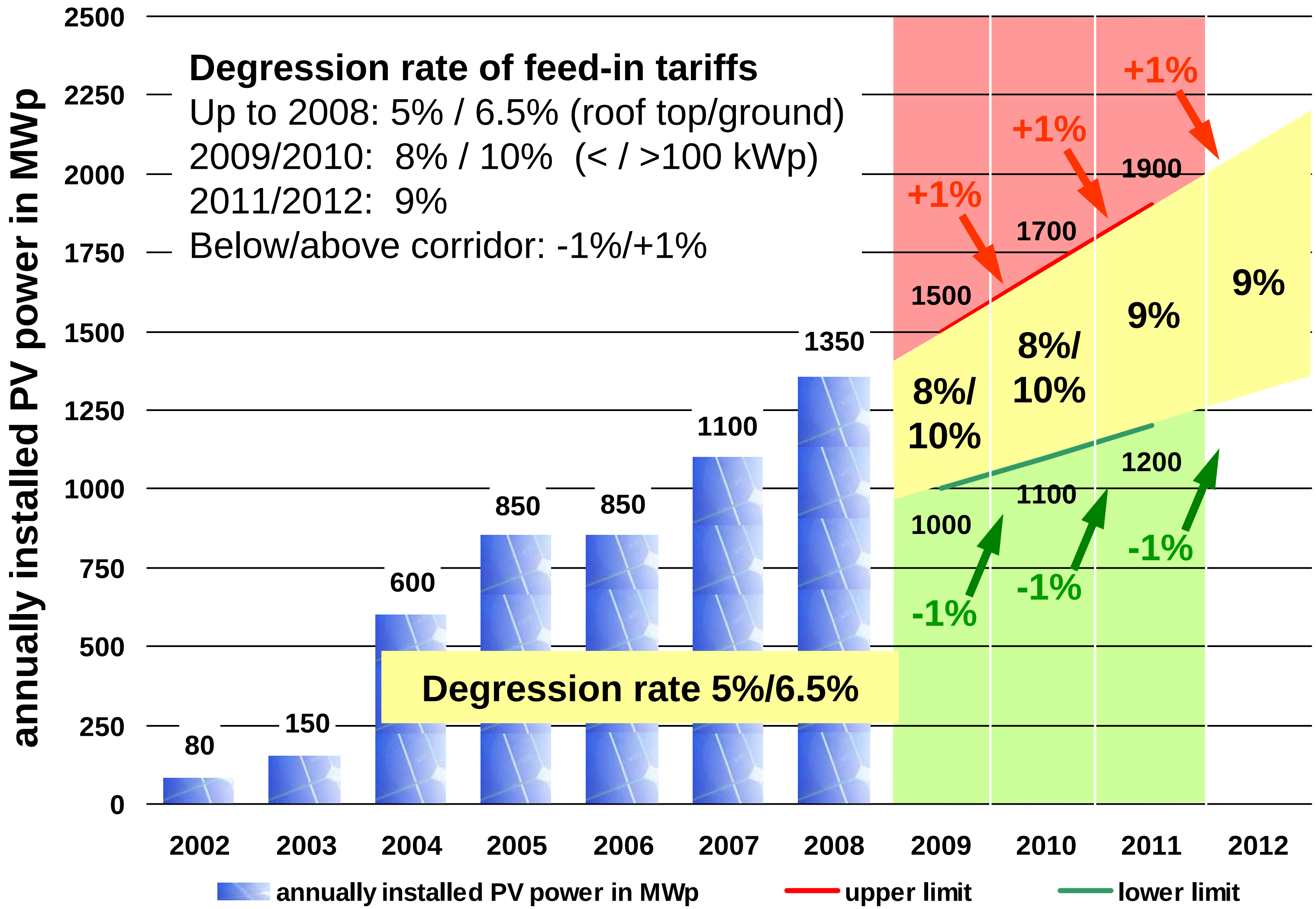
# Feed-in Tariffs in Germany 2008

| Feed-in tariff per kWh | < 30 kWp | 30–100 kWp | > 100 kWp |
|---|---|---|---|
| on buildings and noise protection walls | **€ct 46.75** $ct 67.8 | **€ct 44.48** $ct 64.5 | **€ct 43.99** $ct 63.8 |
| Façade-integrated | **additional €ct 5** $ct 7.25 | | |
| Open land (ground-mounted) | **€ct 35.49** $ct 51.5 | | |


Image: Solar-Fabrik

Image: Degussa

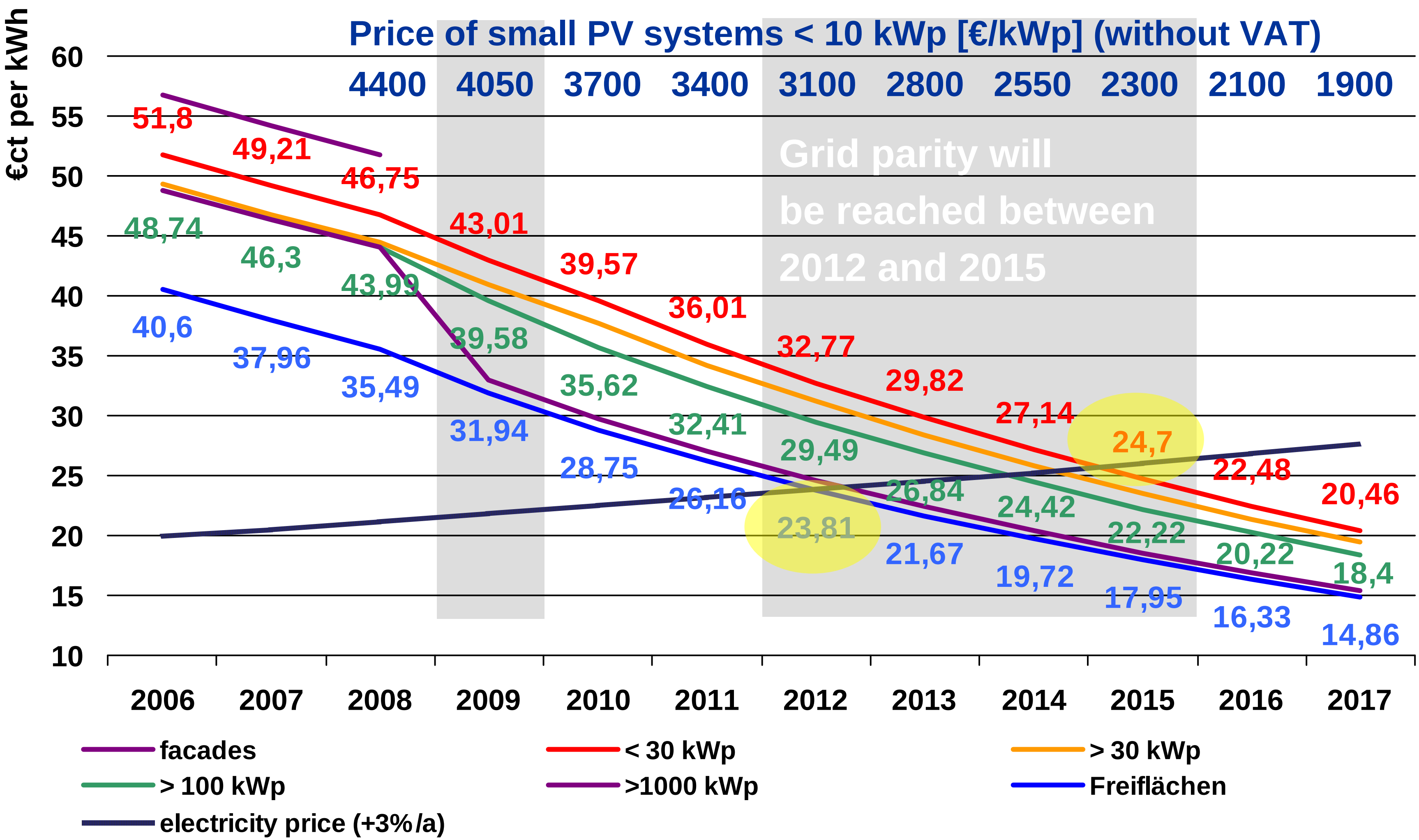
# German PV Market up to 2008 and Feed-in Tariffs as of 2009




Source: BSW

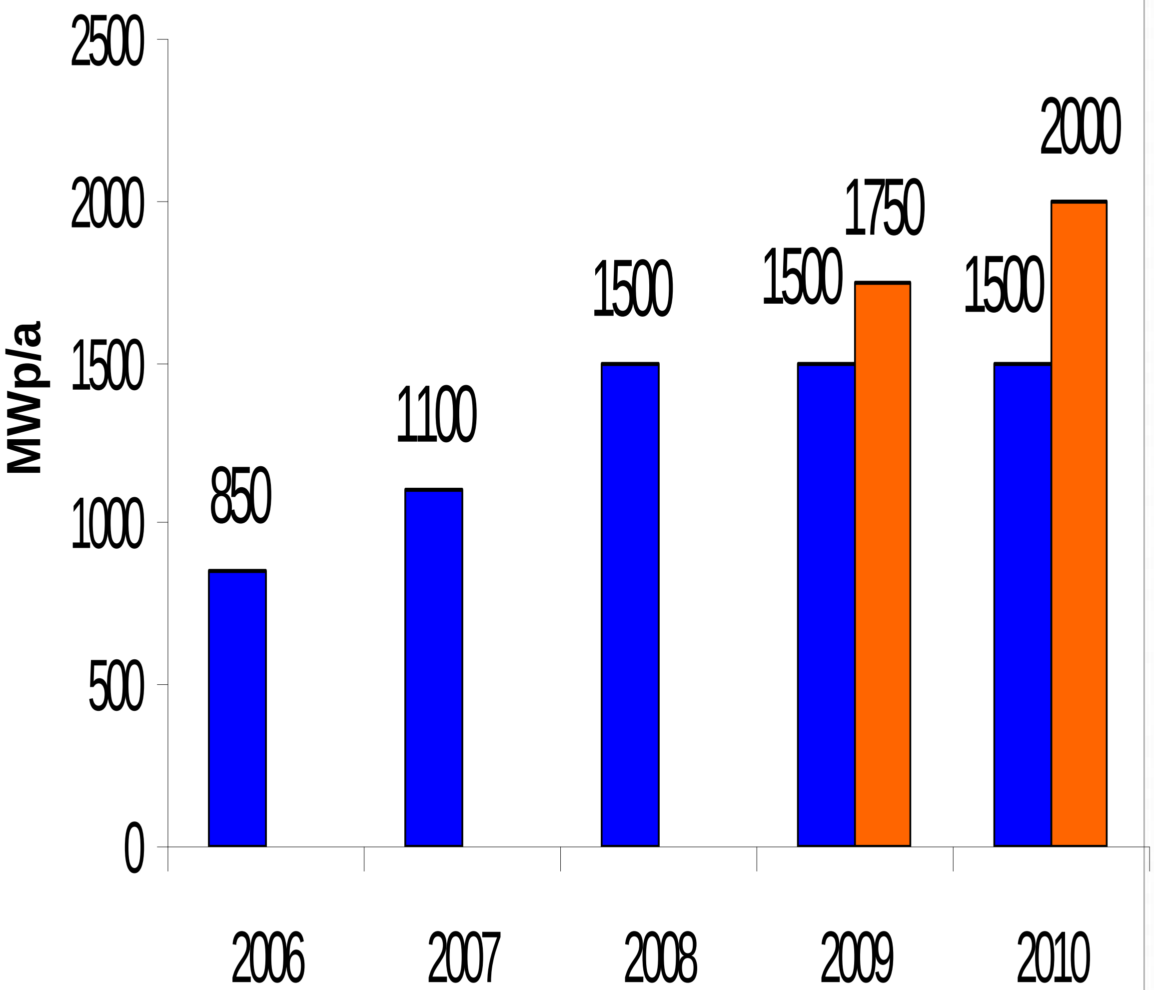
# Feed-in Tariffs for PV within the German EEG

Based on higher degression rates as of 2009, decided on June 6, 2008

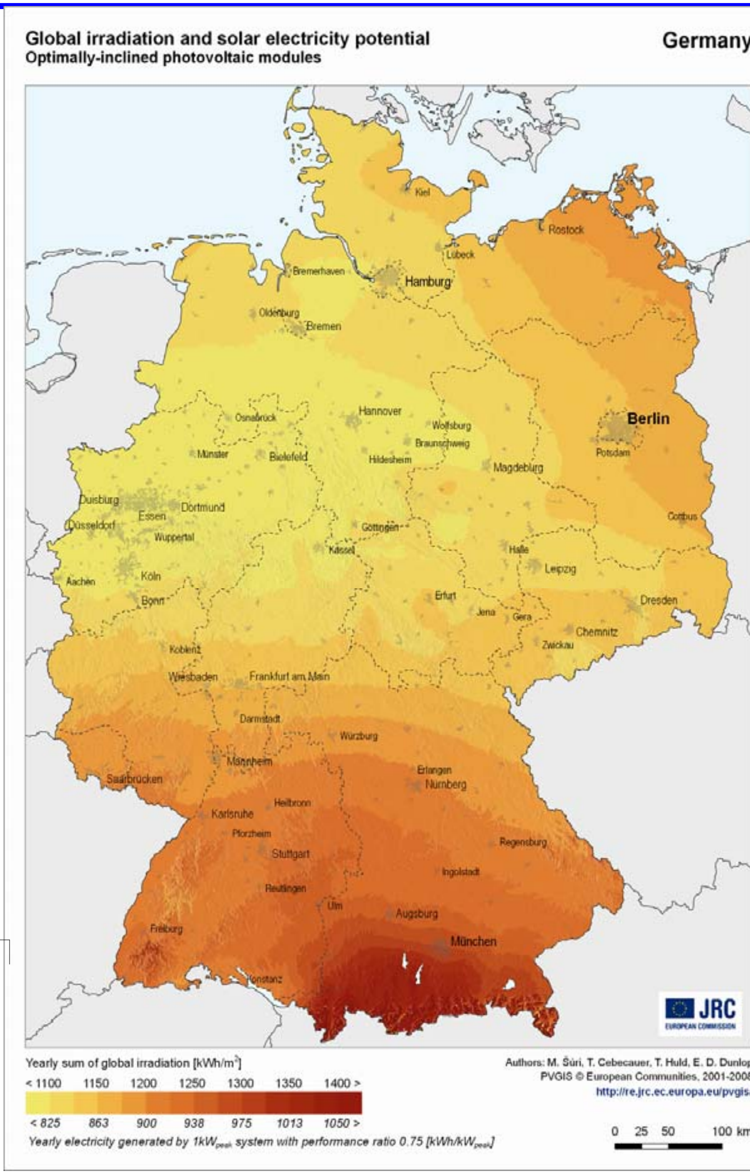



Source: BSW

# GERMANY – Market Perspectives




Source: BSW, EPIA (annual figures)

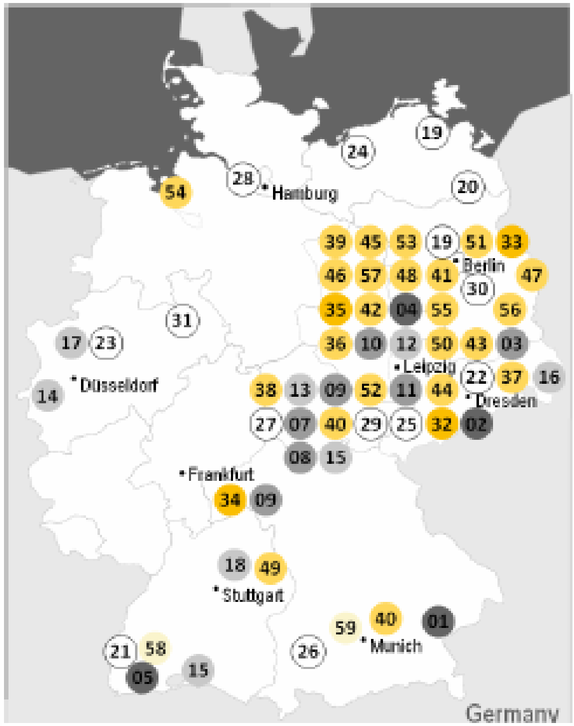


# GERMANY – Market Perspectives

- Market Growth 2008: 35% (1500 MW)
- Annual Turnover 2008: 8 Bln €
- Export Volume 2008: 3,2 Bln € / 46%
  2 Bln € / 38% ( 2007)
  5,5 Bln € / 56% (2010)
- Investment 2008: 1,8 Bln €/a (2010: 2,6 Bln €/a )
- R&D expenditure 2008: 175 Mio € (2010: 225 Mio €)
- Employment in 2010: 60000 (2007: 40000)

# Destination ⇉ Made in Germany

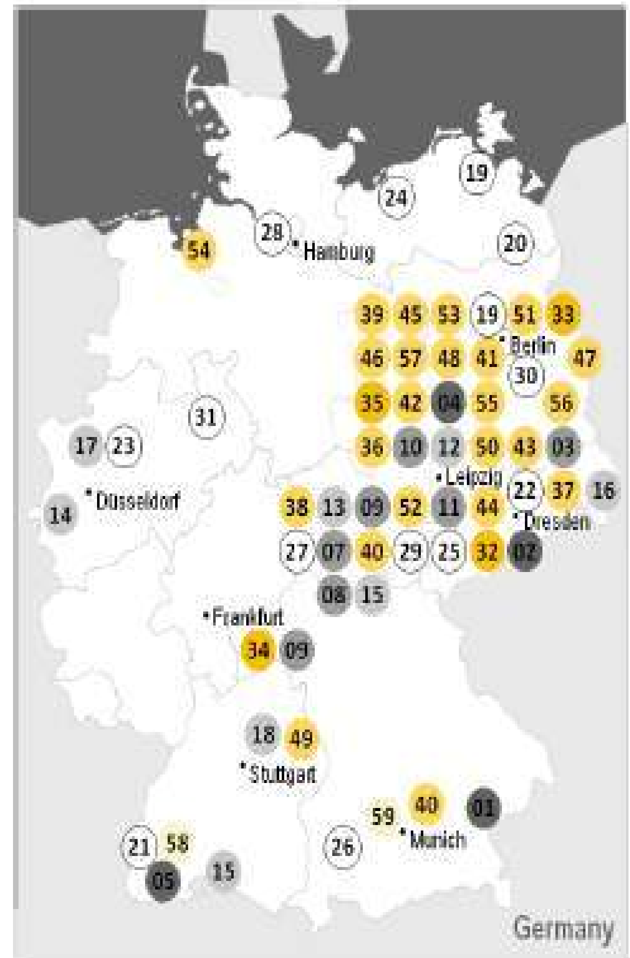
| Value chain | No. | Company | Location | Capacity 2008 [MWp] | Current Empl. |
|---|---|---|---|---|---|
| Silicon | 1 | Wacker Chemie | Burghausen | 10,000t | 960 |
| | 2 | Scheuten Solar World Solizium | Freiberg[1] | 1000t | n/a |
| | 3 | Sunways | Spreewitz[1] | 1000t | n/a |
| | 4 | PV Silicon | Bitterfeld-Wolfen[1] | 900t | 15 |
| | 5 | Joint Solar Silicon | Rheinfelden[1] | 850t | n/a |
| | 6 | City Solar | Bitterfeld-Wolfen[1] | n/a | 25 |
| Wafers | 7 | PV Silicon[2] | Erfurt | 290 | 140 |
| | 8 | ASi Industries[3] | Arnstadt | 180 | 220 |
| | 9 | Wacker Schott Solar | Alzenau, Jena[1] | 160 | 120 |
| | 10 | Q-Cells | Thalheim[1] | 80 | 10 |
| | 11 | WPI Wafer Production Int.[2] | Leipzig | n/a | n/a |
| Cells | 12 | Q-Cells | Thalheim | 875 | 1460 |
| | 13 | Ersol Solar Energy | Erfurt, Arnstadt | 220 | 350 |
| | 14 | Solland Solar Cells | Aachen | 170 | 200 |
| | 15 | Sunways | Konstanz, Arnstadt | 115 | 130 |
| | 16 | Arise Technologies | Bischofswerda | 35 | 10 |
| | 17 | Scheuten Solar Cells | Gelsenkirchen | 35 | 80 |
| | 18 | Solarwatt | Heilbronn | 25 | 60 |
| Modules | 19 | Solon | Berlin, Greifswald | 260 | 400 |
| | 20 | Aleo Solar | Prenzlau | 170 | 425 |
| | 21 | Solar-Fabrik | Freiburg | 130 | 270 |
| | 22 | Solarwatt | Dresden | 110 | 350 |
| | 23 | Scheuten Solar Technology | Gelsenkirchen | 90 | 140 |
| | 24 | Solara Sonnenstromfabrik | Wismar | 80 | 130 |
| | 25 | Heckert Solar | Chemnitz | 60 | 80 |
| | 26 | Webasto Solar | Landsberg/Lech | 35 | 20 |
| | 27 | Asola | Erfurt | 30 | 80 |
| | 28 | Solarnova | Wedel | 10 | 30 |
| | 29 | GSS | Löbichau | 10 | 30 |
| | 30 | PVflex Solar | Fürstenwalde | 5 | 30 |
| | 31 | Schüco Solar | Bielefeld | 5 | n/a |




Source: Invest in Germany, March 2008

# Destination ⇉ Made in Germany

| | | | | | |
|---|---|---|---|---|---|
| Fully Integrated | 32 | Solarworld[6] | Freiberg | 450/300/250 | 900 |
| (Wafers/Cells/ Modules) | 33 | Conergy | Frankfurt (Oder) | 300/275/250 | 370 |
| | 34 | Schott Solar | Alzenau | 160/275/200 | 1000 |
| | 35 | EverQ | Thalheim | 100/100/100 | 450 |
| Thin Film | | | | | |
| Poly-Si | 36 | CSG Solar | Thalheim | 20 | 140 |
| a-Si a-Si/µc-Si | 37 | Sunfilm | Großröhrsdorf[1] | 60 | 10 |
| | 38 | Ersol Thin Film | Erfurt | 40 | 130 |
| | 39 | Malibu | Osterweddingen[1] | 40 | n/a |
| | 40 | Schott Solar | Jena, Putzbrunn[1] | 30 | 160 |
| | 41 | Inventux | Berlin[1] | 30 | n/a |
| | 42 | Brilliant 234.[4] | Thalheim | 25 | 60 |
| | 43 | EPV | Senftenberg[1] | 25 | n/a |
| | 44 | Signet Solar | Mochau[1] | 20 | 10 |
| CIS CIGS CIGSSe | 45 | Johanna Solar Technology | Brandenburg | 30 | 100 |
| | 46 | Solibro[4] | Thalheim[1] | 30 | 20 |
| | 47 | Odersun | Frankfurt (Oder), Fürstenwalde[1] | 30 | 80 |
| | 48 | Global Solar Energy | Berlin[1] | 30 | n/a |
| | 49 | Würth Solar | Schwäbisch Hall | 30 | 220 |
| | 50 | Avancis | Torgau[1] | 20 | 60 |
| | 51 | PVflex Solar | Fürstenwalde | 10 | 30 |
| | 52 | Solarion | Leipzig | 10 | 20 |
| | 53 | Sulfurcell | Berlin | 5 | 60 |
| | 54 | CIS-Solartechnik | Bremerhaven | Pilot | 20 |
| | 55 | Nanosolar | Luckenwalde[1] | n/a | 50 |
| CdTe | 56 | First Solar | Frankfurt (Oder) | 160 | 500 |
| | 57 | Calyxo[4] | Thalheim | 25 | 40 |
| CPV | 58 | Concentrix Solar | Freiburg | 10 | 40 |
| | 59 | SolarTec | Munich | 10 | 50 |




Source: Invest in Germany, March 2008

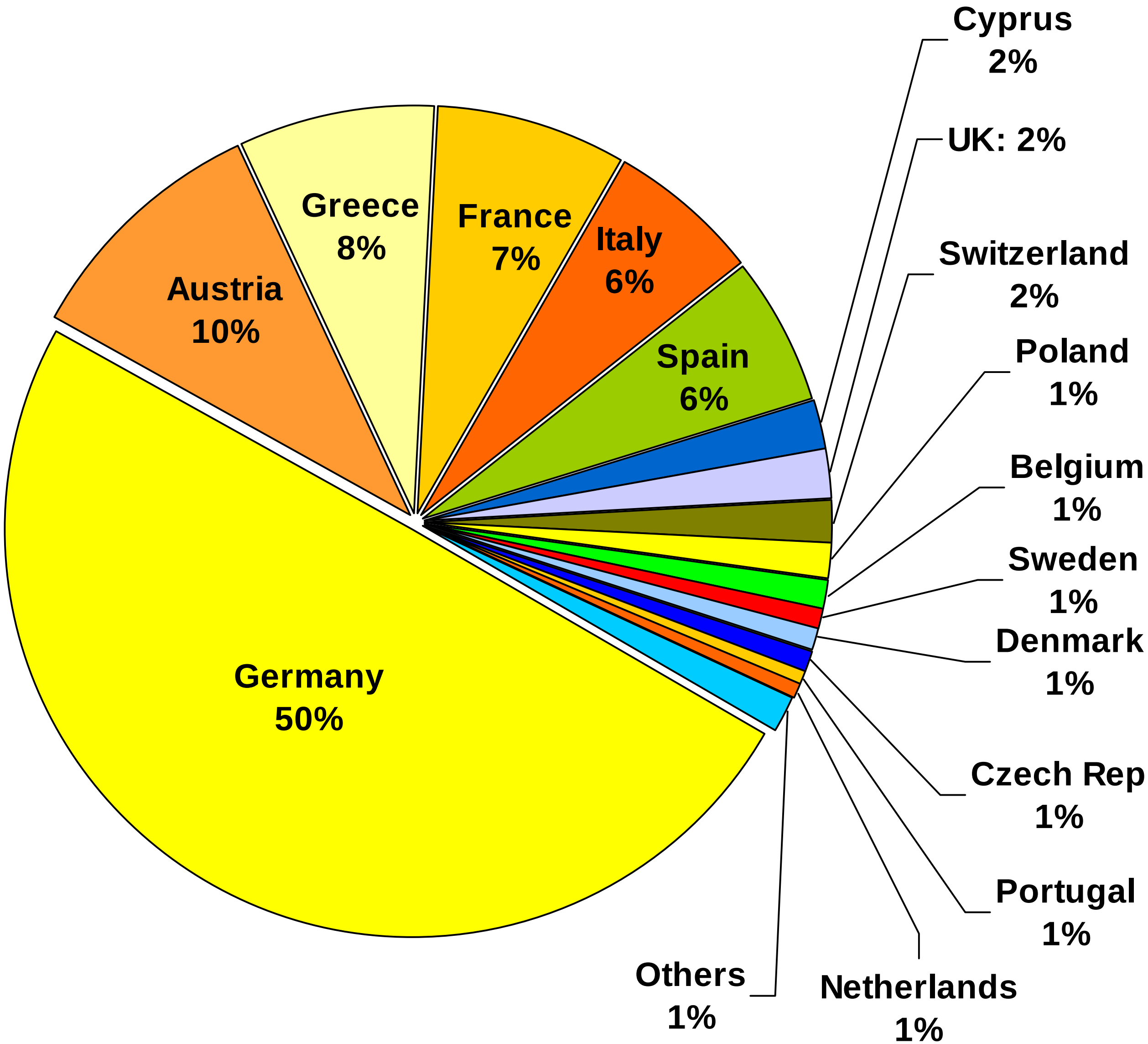
# Solarvalley Mitteldeutschland

- **High-Tech Strategy Germany**
  - Industry Cluster Contest “Ignite Ideas” (3 years of qualification)
  - 27 PV Companies, 12 Research Institutes
  - 200 Mio € govt. support for R&D for 5 years
  - Grid Parity by 2015 !

- **Competence Center Thin-Film and Nano Technology to be founded summer 2009**

- **Fraunhofer - Center for Silicon Photovoltaic (CSP) founded 2/2008**
  - R&D → Analysis of Crystallization and Materials, Thin-Film, Module Integration
  - Aim to maintain global technological leadership
  - 60 Mio € investment

# European Solar Thermal Markets 2006



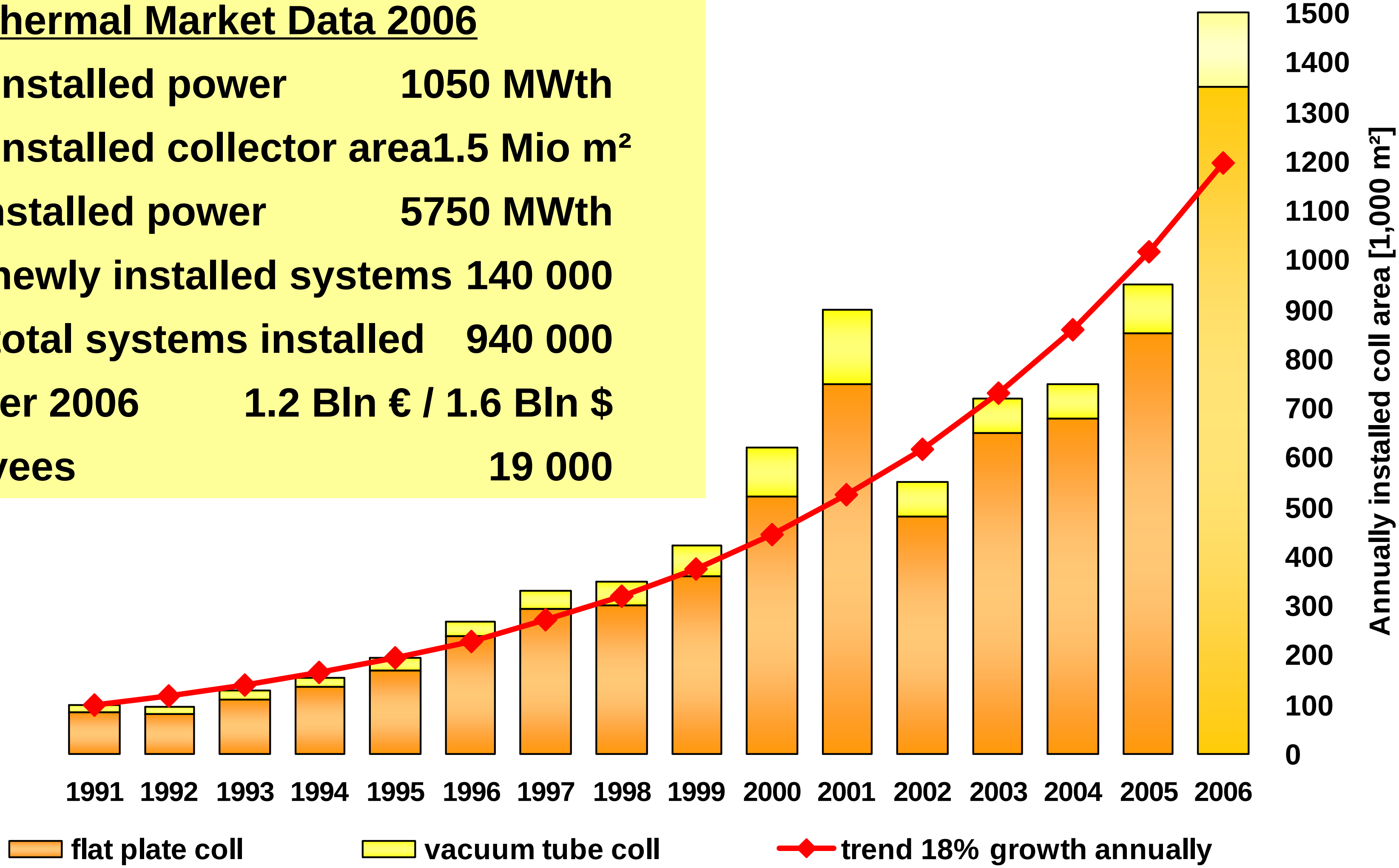

**European Market 2006:**
**3.0 Mio m²**
**2.1 GWth**

Source: ESTIF/BSW

# Solar Thermal Market Development in Germany

**Solar Thermal Market Data 2006**

| | |
|---|---|
| Newly installed power | 1050 MWth |
| Newly installed collector area | 1.5 Mio m² |
| Total installed power | 5750 MWth |
| No. of newly installed systems | 140 000 |
| No. of total systems installed | 940 000 |
| Turnover 2006 | 1.2 Bln € / 1.6 Bln $ |
| Employees | 19 000 |



# Domestic Hot Water Production

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**Market share in Germany: 55%**

**<u>Typical data for Germany (4-person household)</u>**

- **Forced circulation**
- **5-6m² collector area**
- **300-400 l. solar storage tank**
- **Costs ~ €4,000 – 5,000** ($5,800 – 7,500)

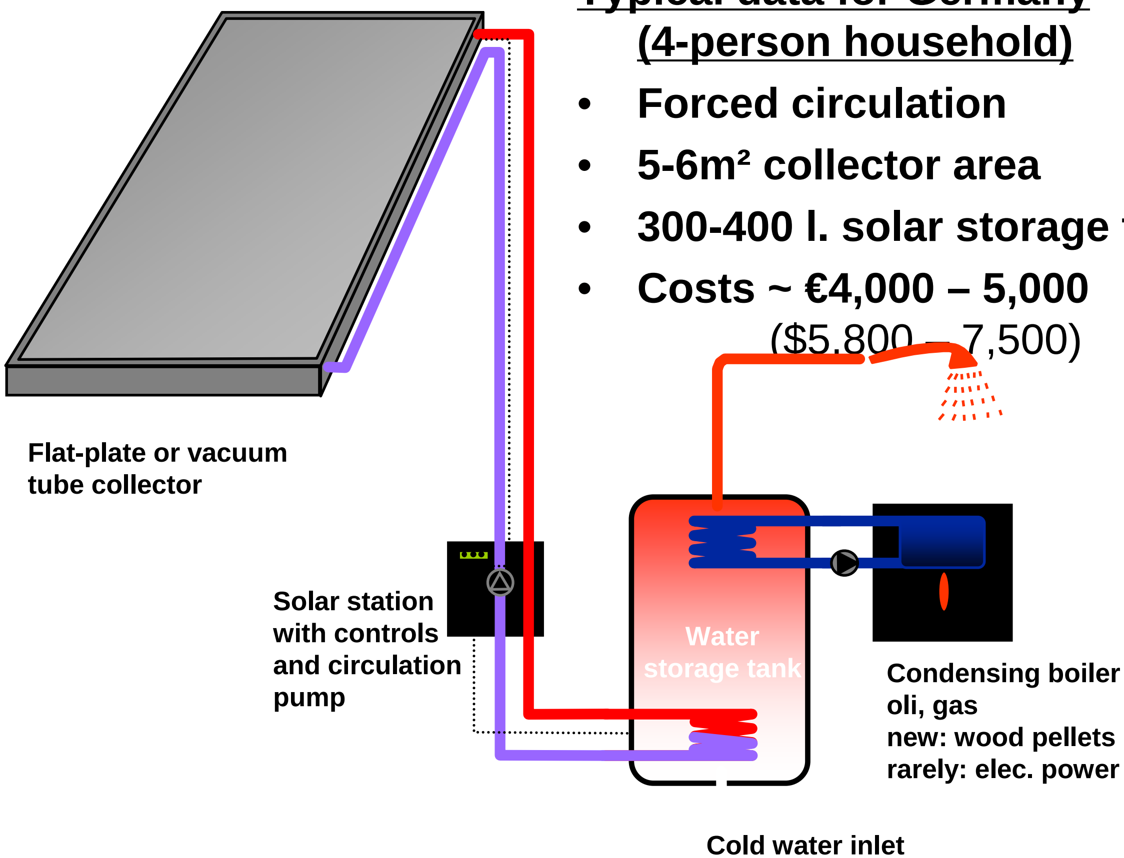




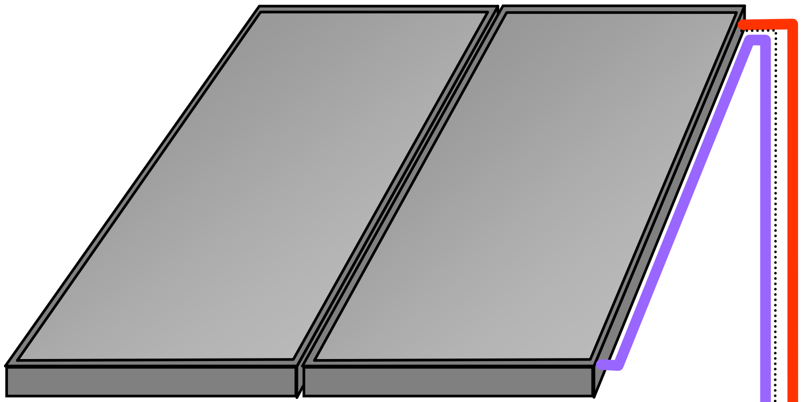
Image: Schüco

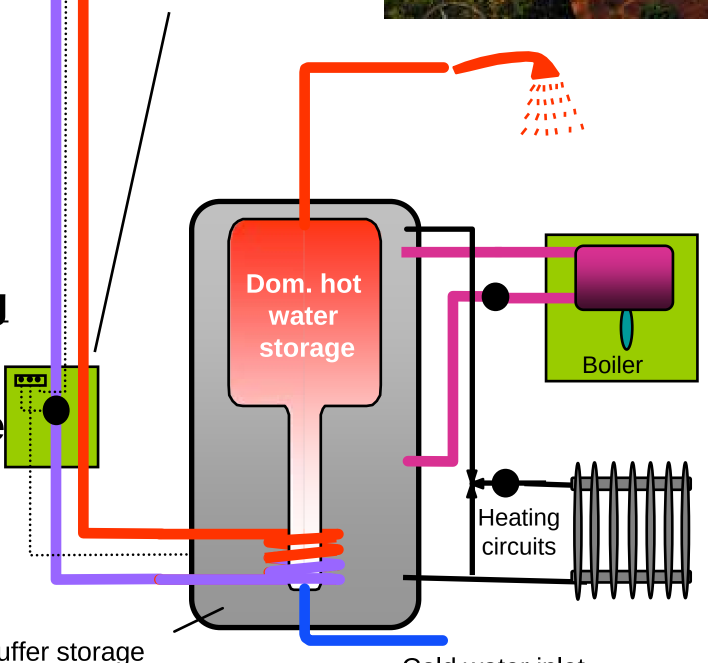

Image: Paradigma

# Solar Thermal Combined System

EU-CHINA

**Market share in Germany: 45%**




Flat-plate or vacuum tube collector

**<u>Combined solar thermal system for DHW and auxiliary room heating</u>**

- **8-15 m² collector area**
- **500-1,000 litres combined storage**
- **Costs ~ €10,000 – €15,000** ($14,500 – $22,000)
- **Forced circulation system**

Combi storage

Image: Paradigma

EU-CHINA

# Special Know-how in Large Scale Solar Thermal Systems

Large solar thermal systems for multi-family houses, hotels, hospitals, nursing homes etc.

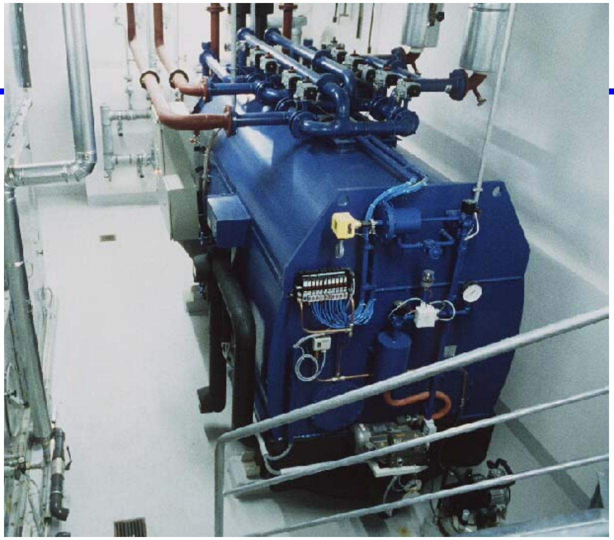
German companies have a lot of experience and offer matured systems

Image: Solvis


Image: Wagner & Co

# New Application: Solar Assisted Cooling

- Solar thermal driven cooling machines
- Cooling demand and solar supply are fitting well
- There are more than 100 systems installed in Europe and they are working well
- Small systems for office buildings and one/two-family houses are under development



Adsorption cooling machine

Bundespresseamt Berlin

Source: Viessmann

IHK Freiburg

Source: Fraunhofer ISE

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