Solar Photovoltaic (PV) in Germany

Pictures: SOLON Energy, GIZ

Conference on Mini-Grid Development in India

12-13 August 2013, Raipur

Anil Misra, GIZ

GIZ profile

- Federal enterprise to support the **German Government** in achieving its objectives in the field of **international cooperation** for sustainable development
- Operations in Germany and in over **130 countries** around the world
- Around **17,000 employees**
- Operates **in India since 60 years.** Currently **250 staff members** in India

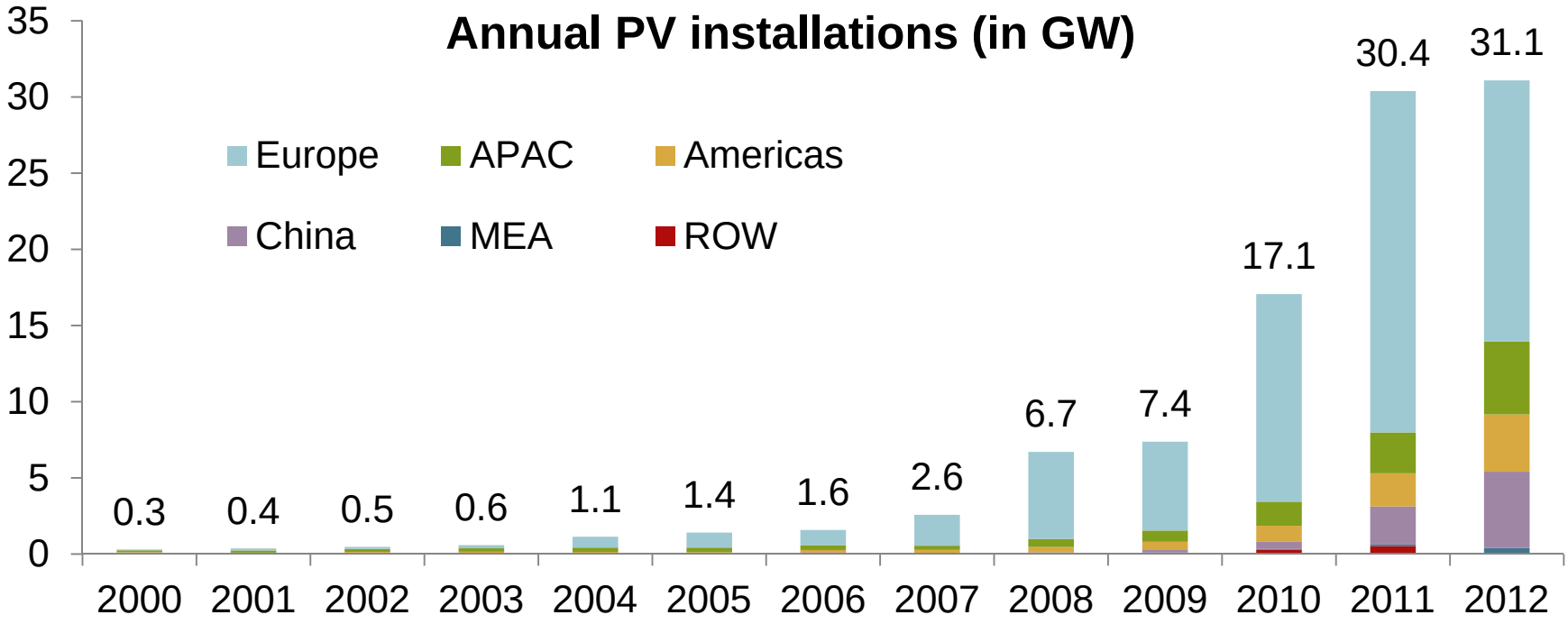
Pictures: GIZ, DB

- **Global PV Market Highlights**
- German PV Framework
- Examples
- Lessons learnt

Global PV Market - Trends 2012

(Sources: IEA PVPS, EPIA , BSW)

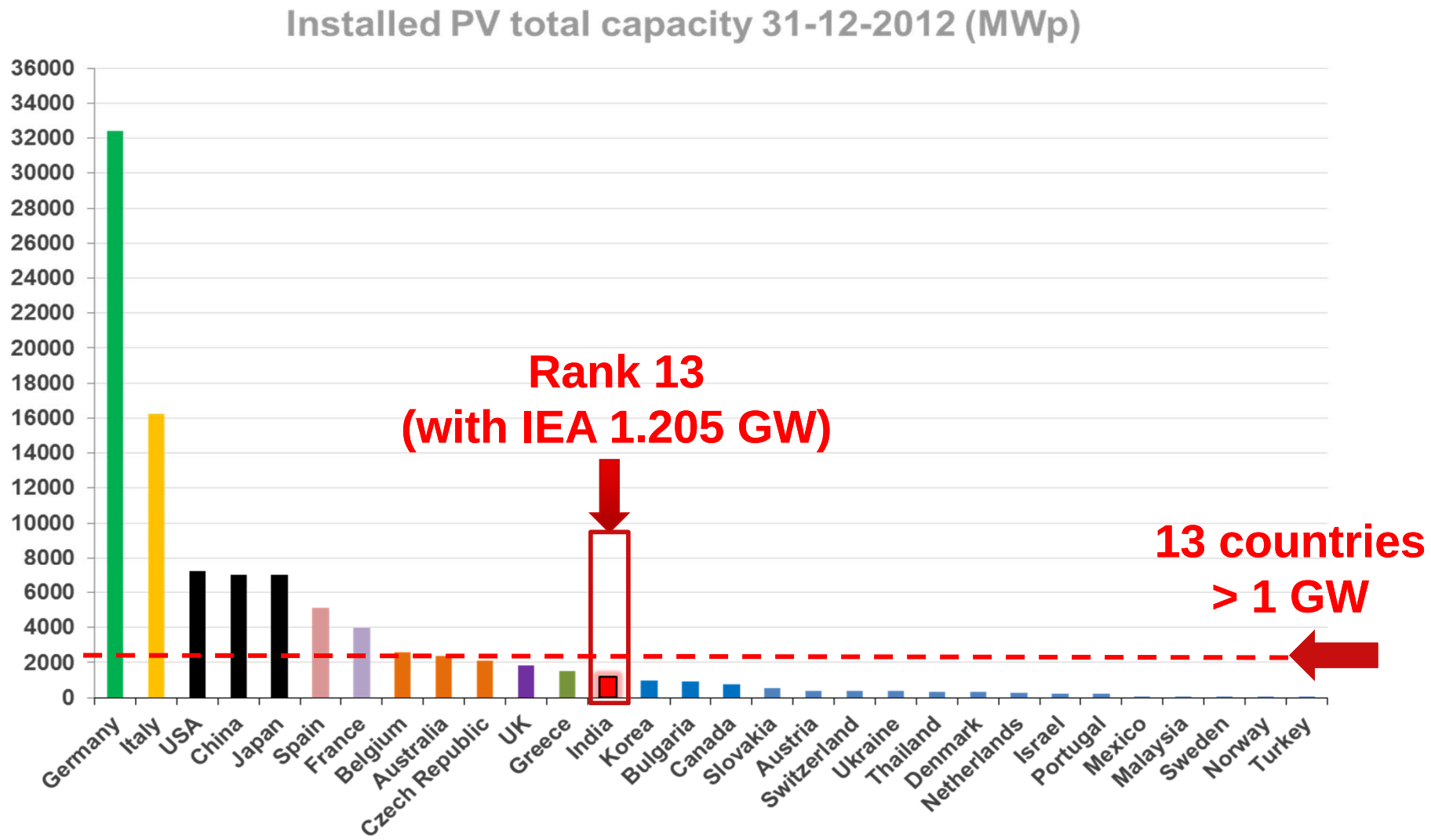
EU	TOP 3 PV	Annual growth	Global Capacity	Highest growth
1st PV 2nd Wind	Germany China Italy	Stabilised @ 29 GW	100 GW	Asia +66%



ROW: Rest of the World, **MEA**: Middle East and Africa, **APAC**: Asia Pacific

Country ranking by cumulative capacity

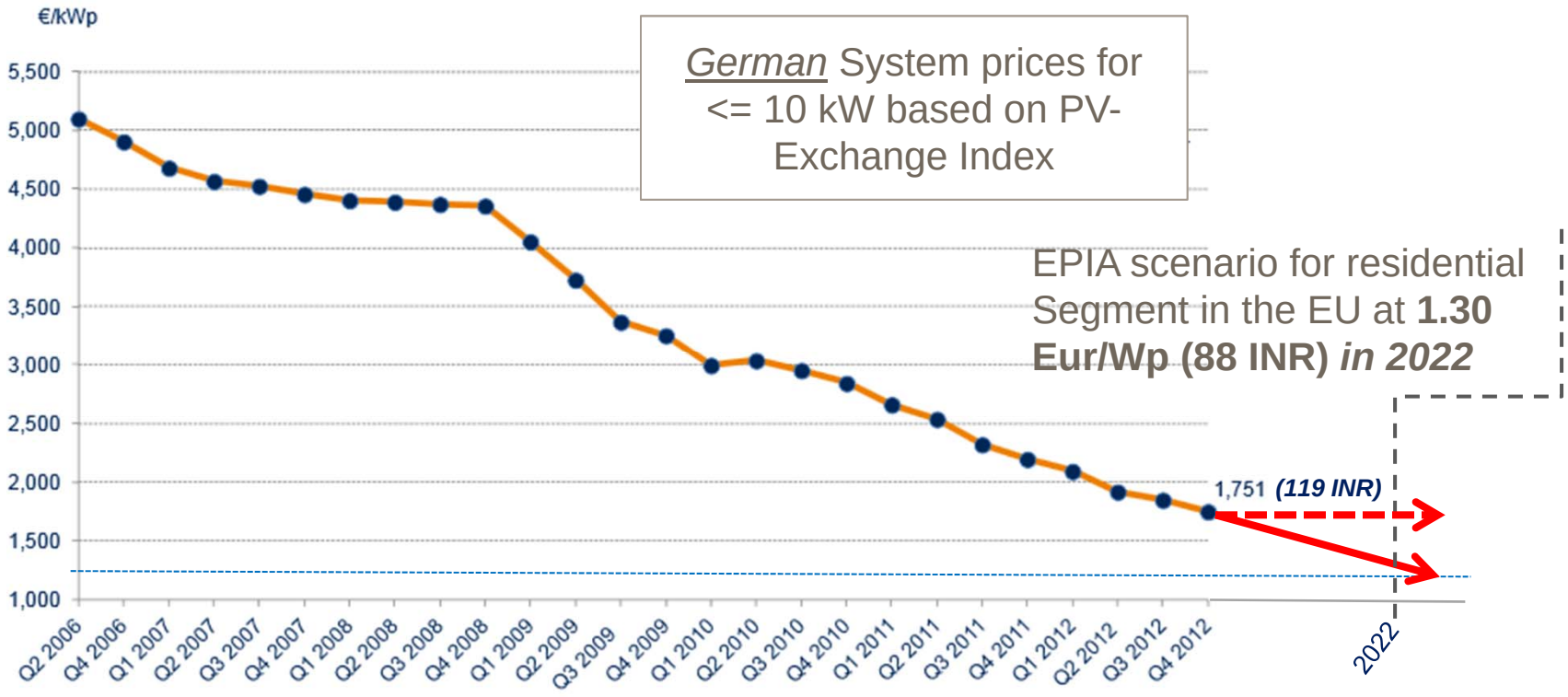
(Source: IEA PVPS)



Massive PV system price reduction

(Source: BSW, PV-Exchange 2012, own calculations)

- **Cost reduction to 1/3 in last 6 years (340 INR to 119 INR/ Wp)**
- **LCOE decrease 16 INR to 7 INR/ kWh (LCOE over 20 yrs @ CUF 15%)**
- **Still big differences in country specific prices (especially residential)**



Global PV Trends 2012 – Summary & Conclusions

- **100 GWp** capacity exceeded worldwide
- First **drop in EU PV Growth** within last 10 years (ever)
- System **costs reduced to 1/3** within last 6 years
- **13 countries** entered the **GW capacity class** (9 more are close)

➔ **PV will play a key role in the global electricity mix**

Pictures: SOLON Energy

- Global PV Market Highlights
- **German PV Framework**
- Examples
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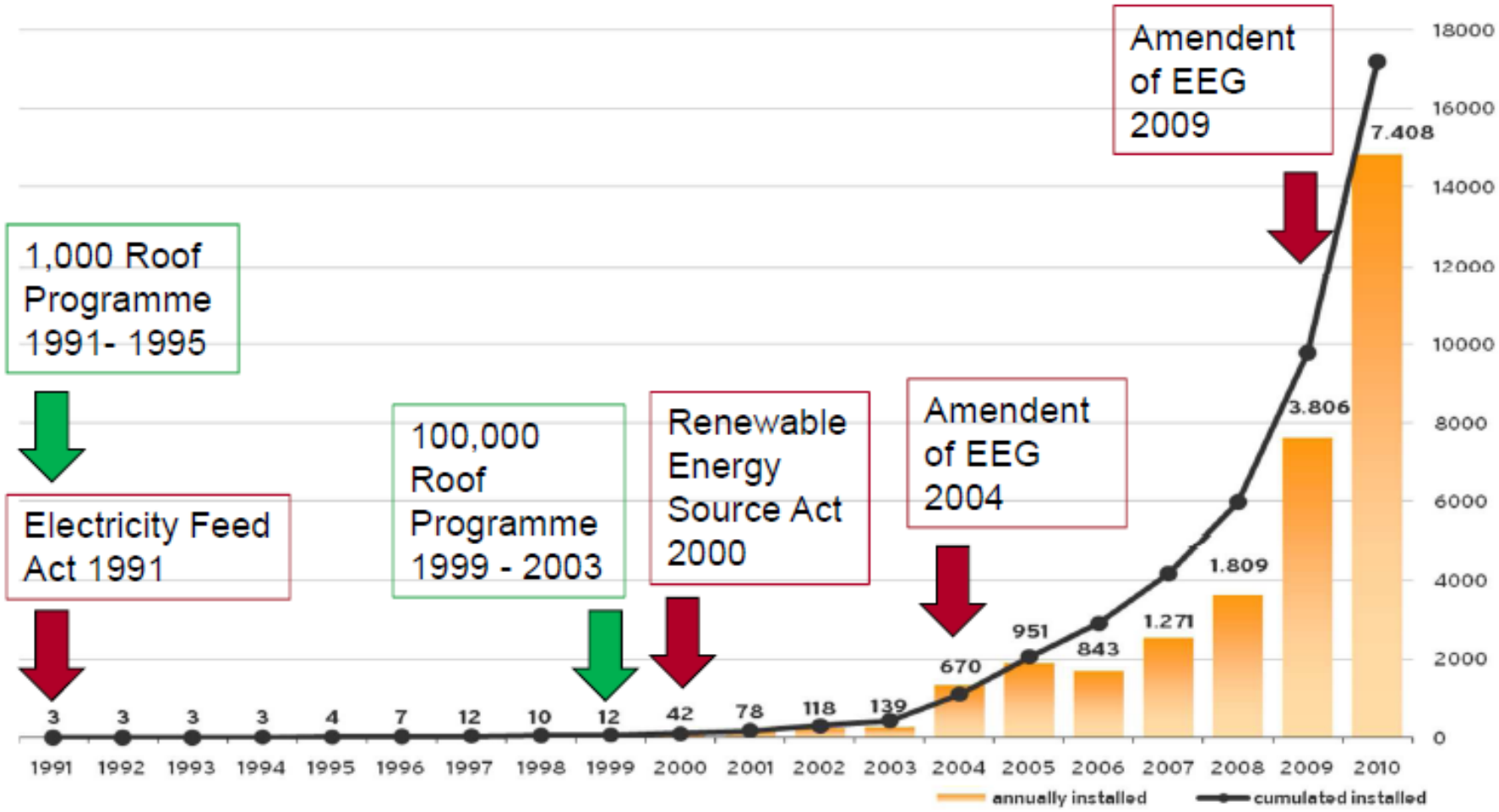
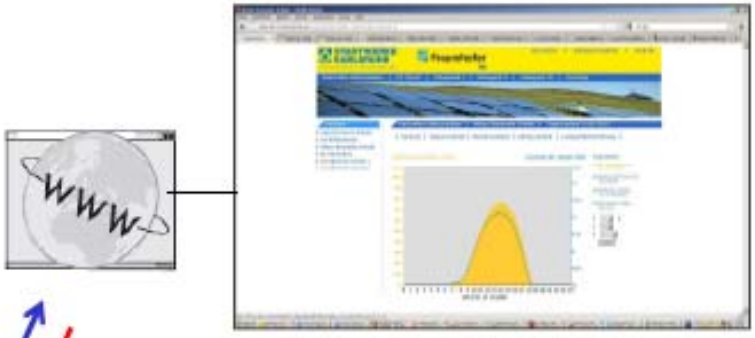
Policy Milestones and Historical Development of PV sector



Remote Control for Data acquisition, Monitoring & Benchmarking - Direct Online Access to Operational data

Source: SMA



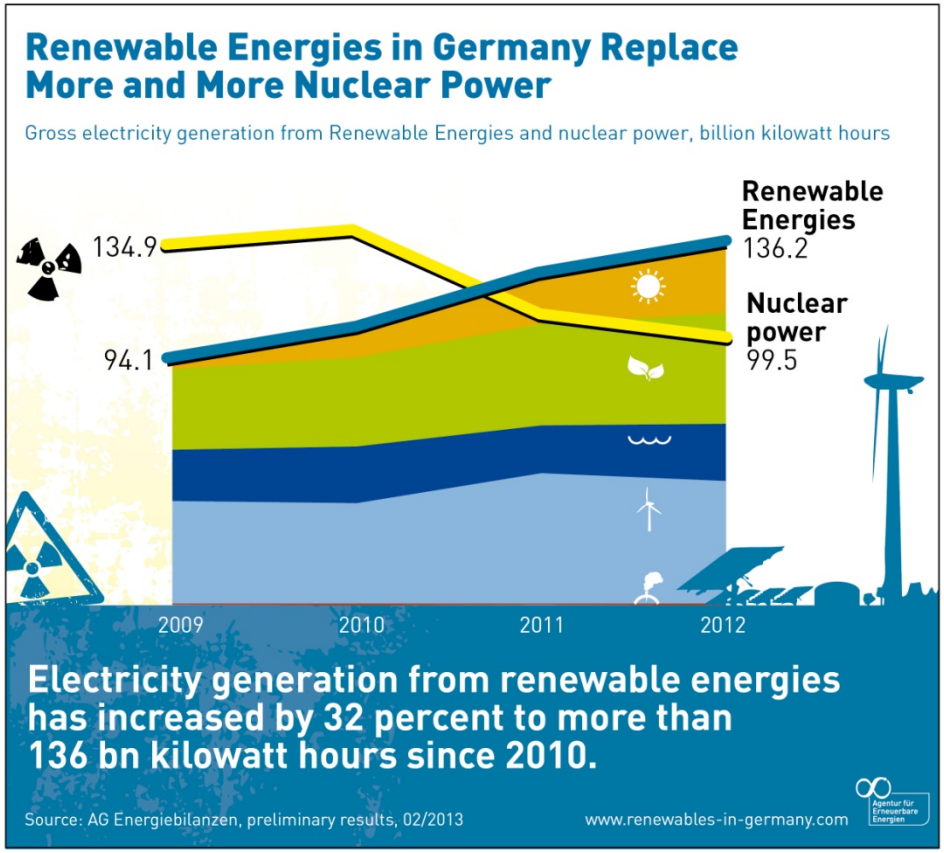
Data evaluation programmes,
Automatic control algorithmes

Internet Accessable
(VPN) Remote Control

Why is Germany pushing the pedal?

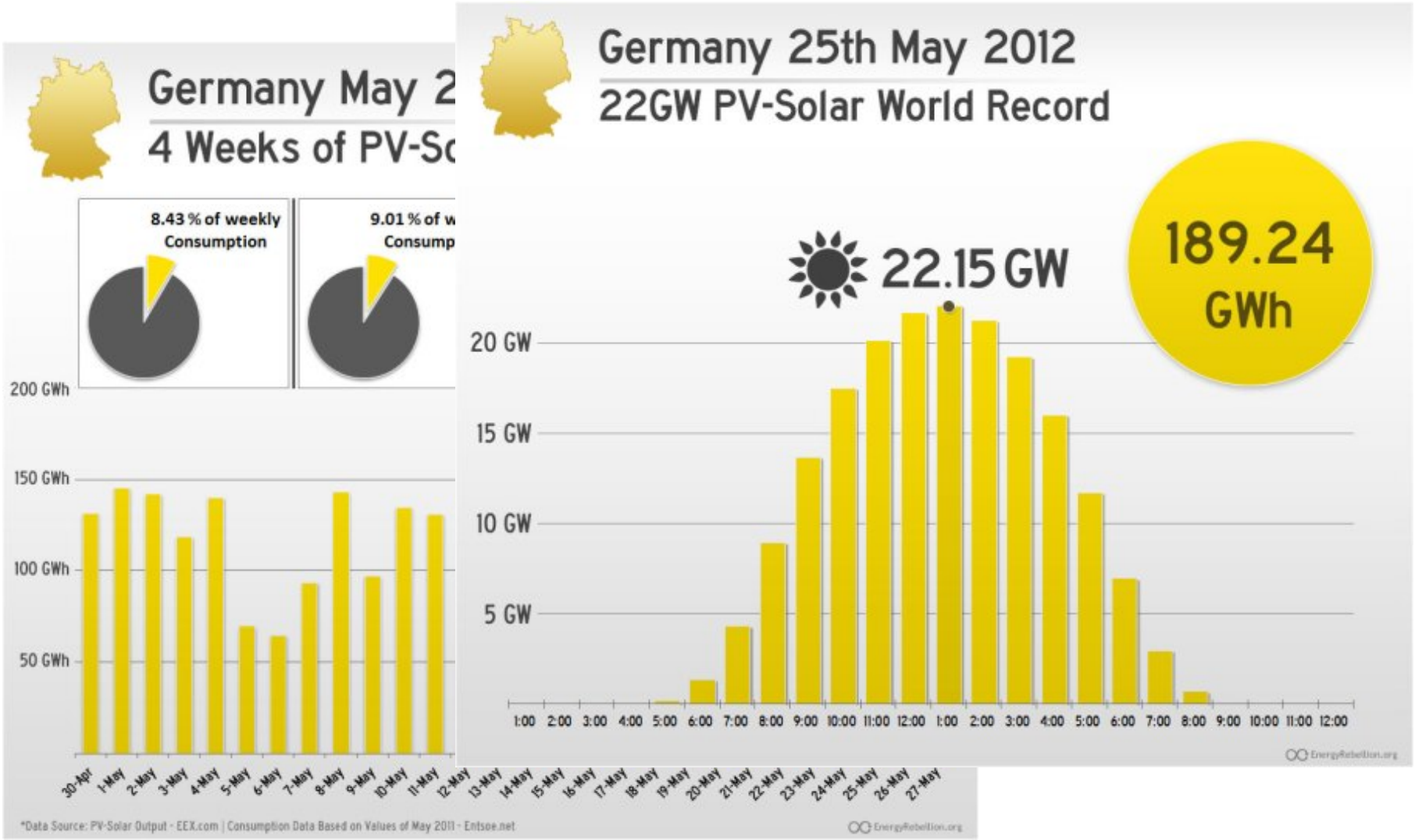
The energy transition: 80% RE 2050 & nuclear phase out until 2022 is planed to:

- Fight climate change
- Reduce energy imports
- Stimulate innovation & green economy
- Strengthen energy security & local economy

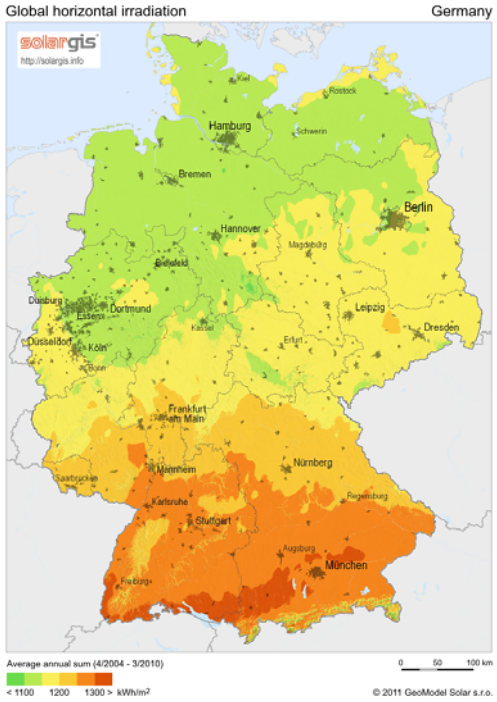


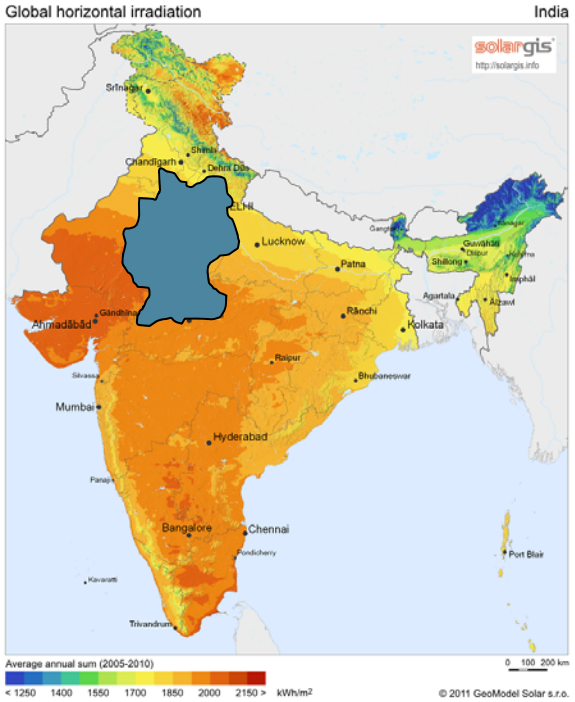
More details: www.energytransition.de

Beyond Gigawatts



Relevant key facts compared:





सत्यमेव जयते

900-1300 kWh/m²

80.3 Mio

357 021 km²

1250-2150 kWh/m²

1.2 Bn

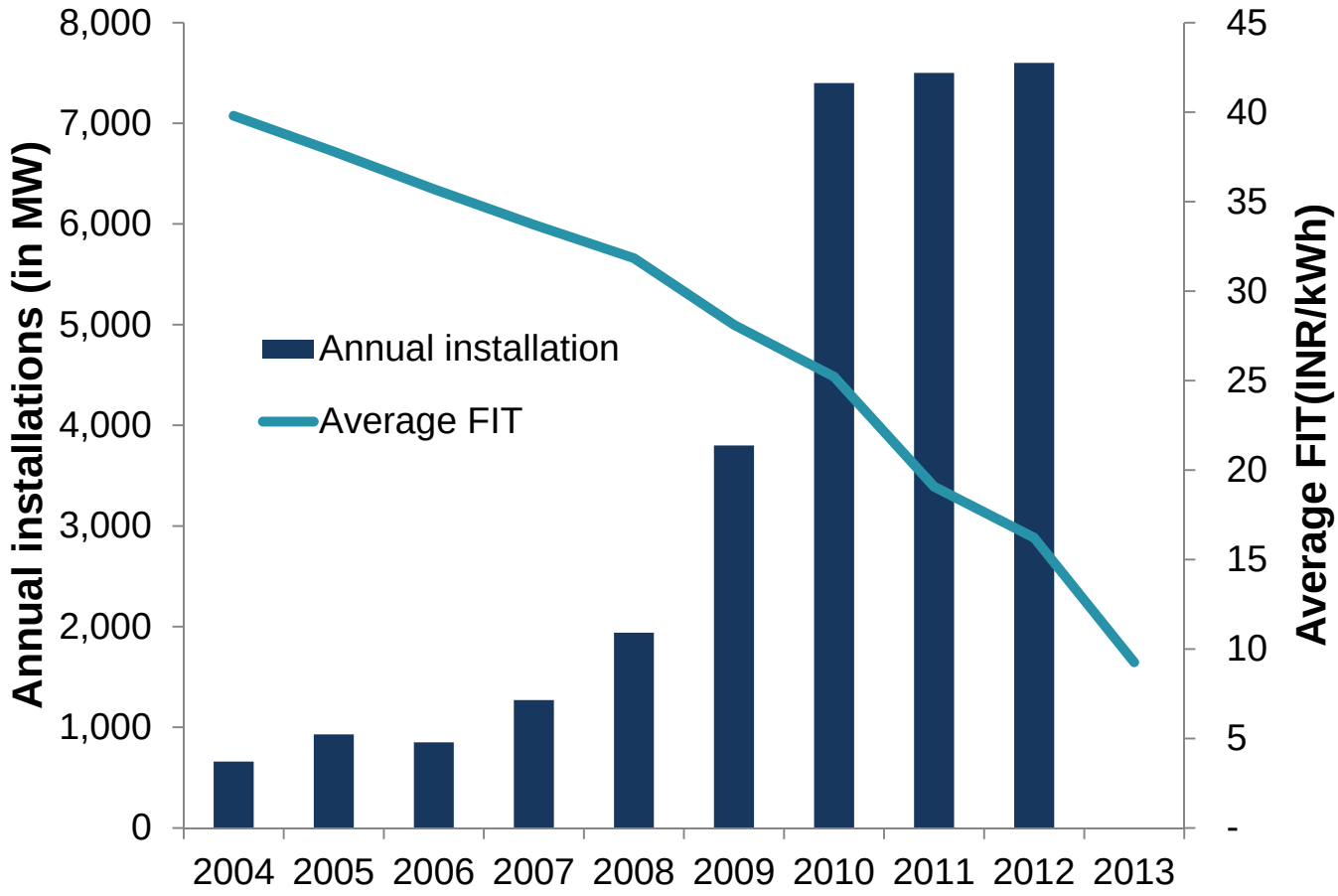
3 287 263 km²

German PV Market 2012

(Source: BSW-Solar, own calculations)

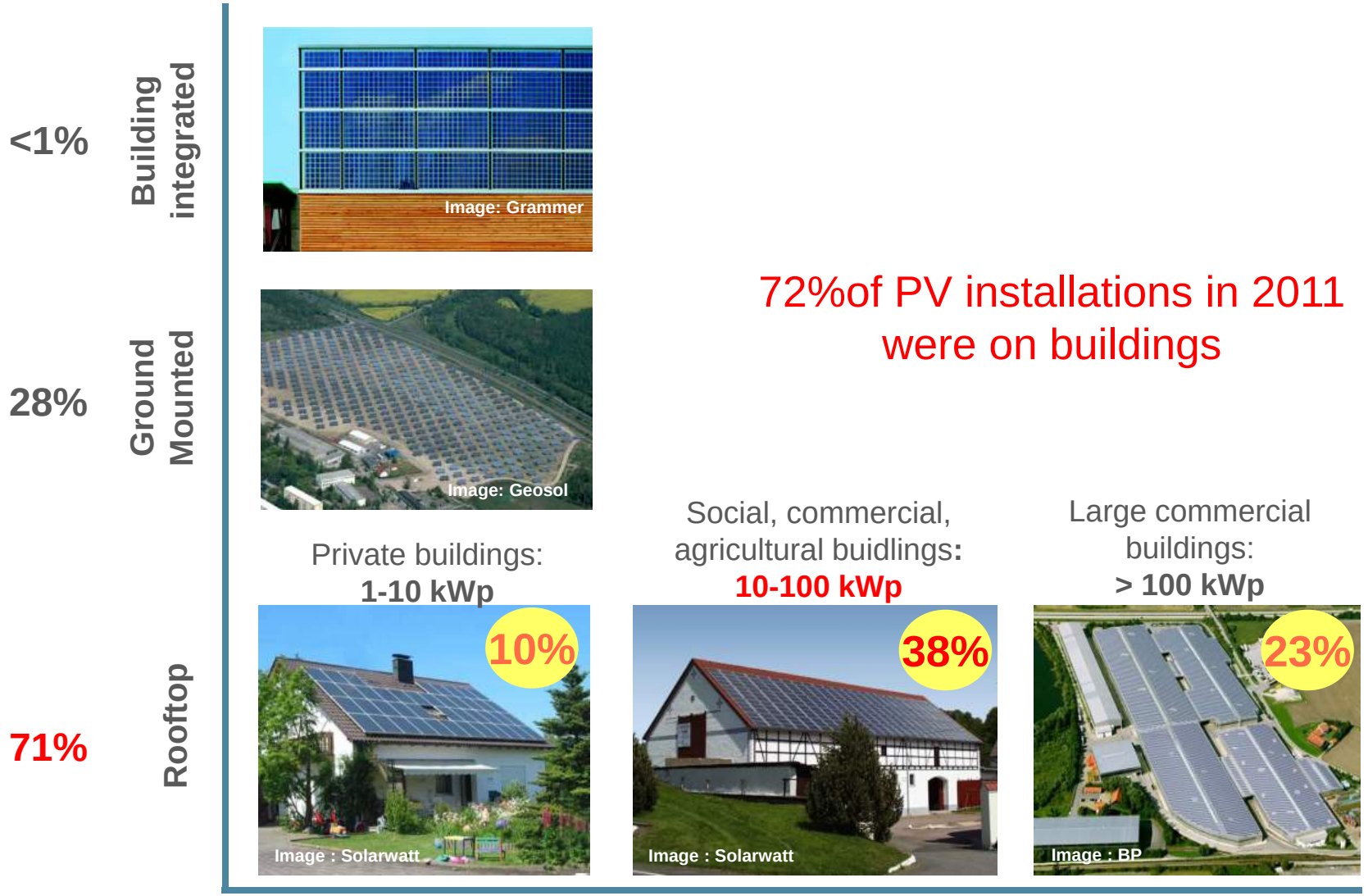
By 31.12.2012:

- Total installed capacity: **32,400 MWp**
- Number of grid connected PV systems: **1,280,000**



➔ **Subsidies to be phased out by 2020 – 52 GW**

PV market segments in Germany

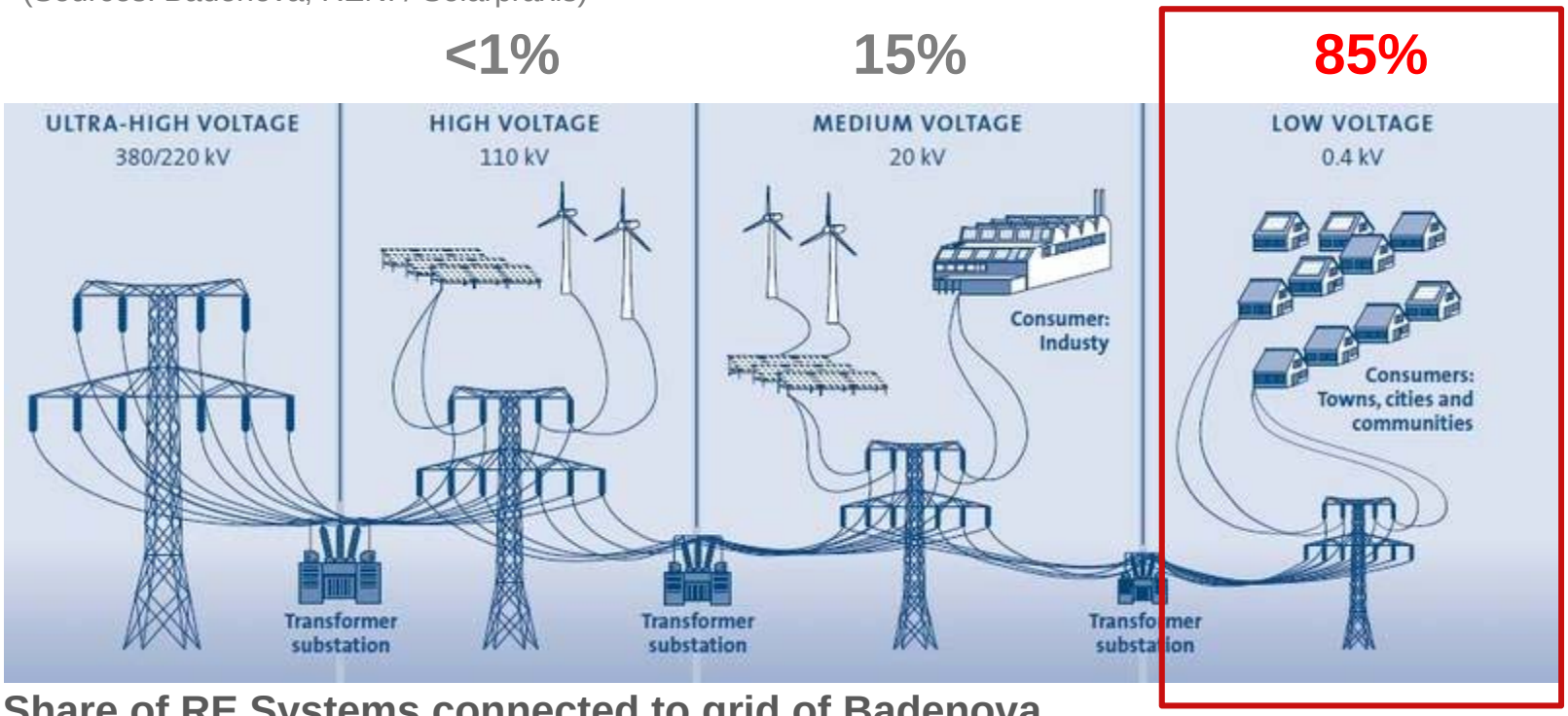


72%of PV installations in 2011 were on buildings

Source: BSW-Solar, E.Quadrat GmbH

Grid connection

(Sources: Badenova, RENI / Solarpraxis)



Share of RE Systems connected to grid of Badenova

- From top-down structure to fluctuating bi-directional power flow
- Distribution grid becomes “collector grid”

➔ **Distributed PV has main impact on LV distribution grid**

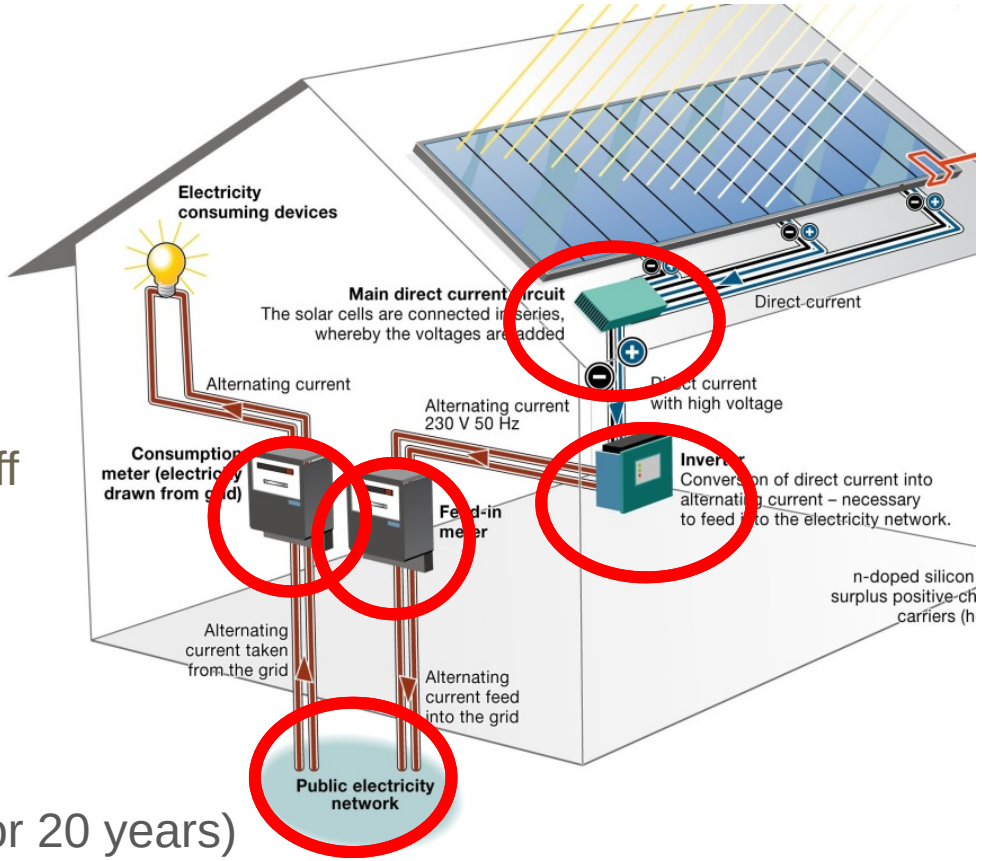
Typical German FIT Single line / scheme

(Picture Source: Agentur fuer Erneuerbare Energien)

- DC Switch / Junction Box
- Grid-tied Inverter
- Unidirectional Meter Feed-in
- Connection at Distribution board
- Unidirectional Meter Consumption

➔ Inverter will switch off when grid is off spec

➔ Solutions for captive supply now ramping up (e.g. new storage law)



Applicable EEG FIT as of 1st May (for 20 years)

Up to	**10 kWp**	**40 kWp**	**1 MWp**	**10 MWp**
Eur/cent	15.63	14.83	13.23	10.82
INR	10.63	10.08	9.00	7.36

Germany PV Market - Conclusions

1. **Distributed PV is a success model**

   ➔ *Potential alone for "not-so-sunny" Germany: 203 GW (following calculations of Prof. Drg. Ing. Volker Quaschning HTW Berlin)*

2. **Grid Integration is possible without problems**

   ➔ *Proven with 32 GWp in more than 1.2 Mio Systems on the grid*

3. **Solar PV is economical feasible & competitive – today**

   ➔ *Storage is the next big issue coming up*

Pictures: GIZ

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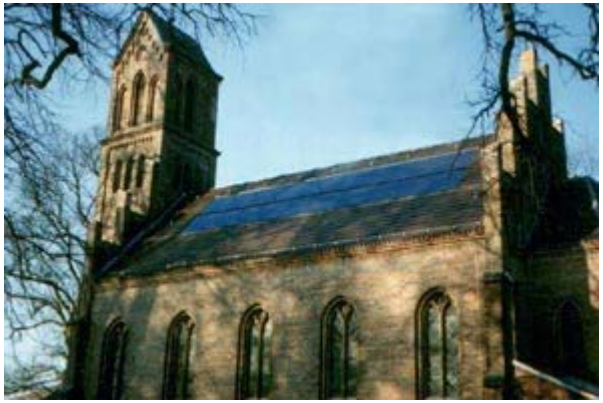
- German PV Framework
- **Examples**
- Lessons learnt

Examples: Standard Rooftop



Picture: Parabel AG

Church – 5 KWp
Kablow, Berlin, Germany, 1994

Picture: Parabel AG

Cowshed 61,27 KWp
Hohenreinkendorf, Germany, 2005

Picture: IEA PVPS

Community center 135 KWp
Sonnenschiff, Freiburg, Germany, 2003

Picture: SOLON AG

Family home 9,7 KWp
Brieselang, Germany

Examples: Integrated PV

Picture: PVPS / BMW

Roof – integrated 824 KW

BMW World, Munich, Germany

Picture: SOLON AG

Facade – integrated 12 KW

Zara, Cologne, Germany, 2002

Picture: DB

Roof – integrated 189 KW

Mainstation, Berlin, Germany, 2002

Picture: SOLON AG

Roof – integrated 123 KW

Paul-Loebe-Haus, Berlin, Germany, 2002

Examples: Added value Systems

Picture: SOLON AG

Busport 2MW
Sevilla, Spain, SOLON AG

Picture: IEA-PVPS

Noise Protection 500 kW
Highway, Freiburg, Germany

Picture: Autohaus

Carport, 251 kW
Mainz, Germany, Juwi Solar

Picture: MEMC

Water protection 1 MW
Narmada Canal, India/ SunEdison/MEMC

Examples: Large Scale

Picture: IEA PVPS

Large rooftop

3.8 MW

Muggensturm,Germany.

2006, TAUBER-SOLAR

Picture: Q-Cells

Freeland

91 MW

Briest, Germany.

2011, Q-Cells

➔ Further case studies incl. details see http://www.pvdatabase.org/

Top 3 benefits of distributed PV systems

1. **Cost competitive distributed generation – at place of consumption**

   ➔ *Grid Stabilization, elimination of transmission losses, fast installation (see http://www.smallisprofitable.org/207Benefits.html for 207 more benefits)*

2. **Green local value creation**

   ➔ *Creation of jobs (e.g. local installers), saving of fossil fuels thus prevention of value flow abroad, generation of local tax and lease revenues – all without producing any emissions*

3. **No additional occupation of land**

   ➔ *Indian roofs have, following calculations of Prof. Atul H. Chokshi [1], a potential to generate 1900 TWh p.a..*

[1] *Indian Institute of Science, Bangalore, "nuclear ridles", current science 2012*

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- Examples
- **Lessons learnt**

Top 3 Lessons learned

1. **Simple opportunities/ low hanging fruits first**

   ➔ *Integrated- and added value-systems induce extra efforts/ benefits*

2. **Quality should have highest priority**

   ➔ *Cheap hardware will cause high lifecycle costs and lower yields*

3. **PV is not destabilizing the grid**

   ➔ *32 GW / 1.2 Mio Systems connected without smart grid approaches – with no verifiable effect on stability.*

   ➔ *Of course proper implementation with view on final feeder/ distribution grid overvoltage and harmonics is required.*

Thank you!

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