

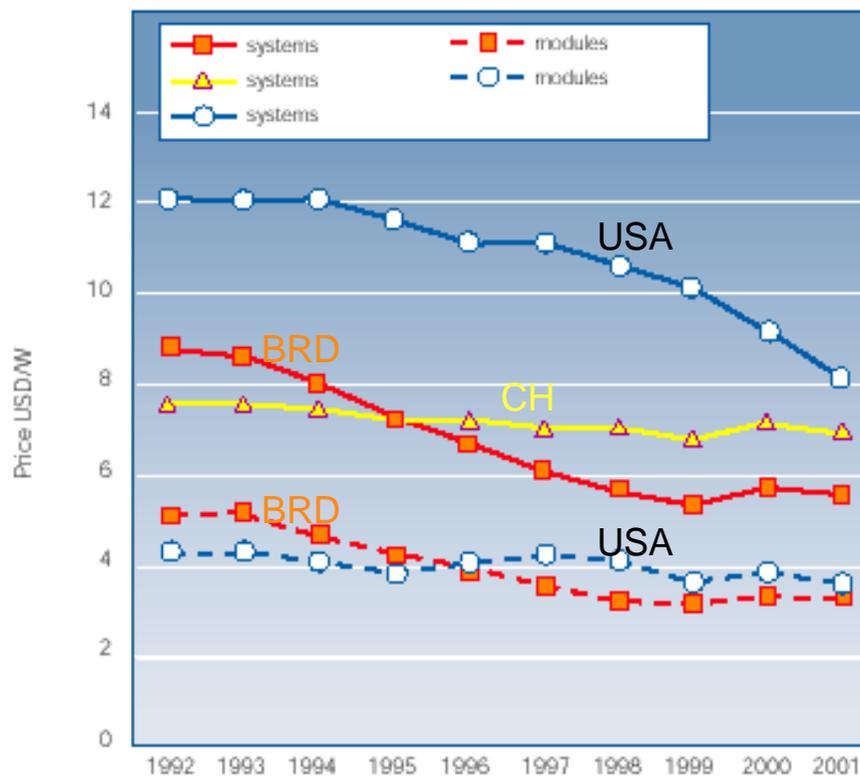
# Experience curve analysis

## Concerns and pitfalls in data use



# Example of a data source

Figure 5 - PV system price trends in some reporting countries



Source: IEA, *Trends in Photovoltaic Applications in selected IEA countries between 1992 and 2001*, August 2002

Indicative system data:

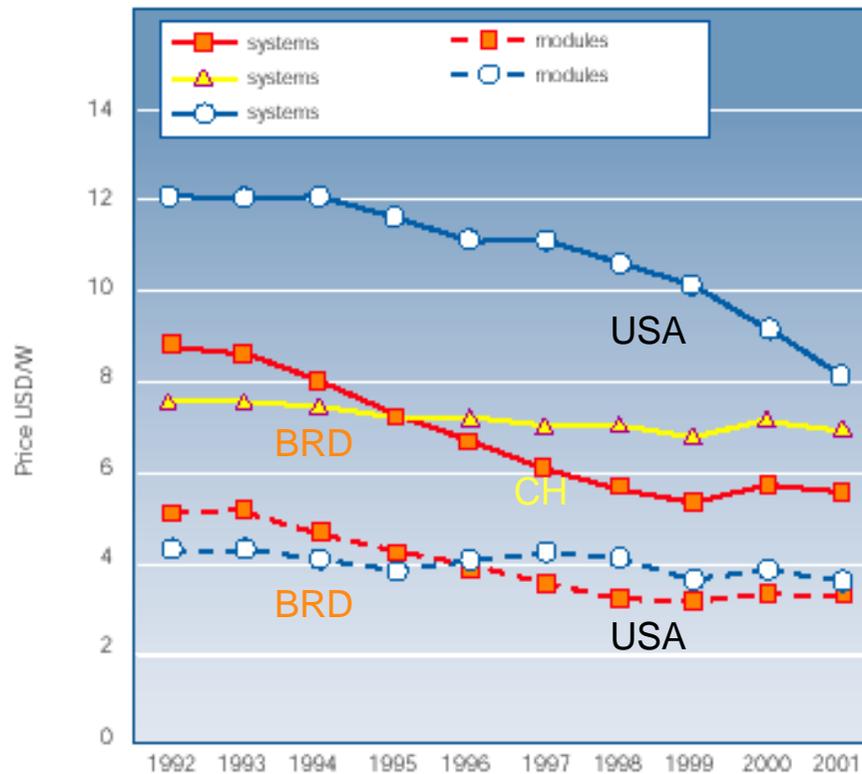
1992: 10 USD/Wp

2001: 7 USD/Wp

Capacity increase factor 5

Resulting PR=0.88

**Figure 5 - PV system price trends in some reporting countries**



Are these nominal or real prices?

Is the data-set reliable?



# Data properties

- System size can vary from small (40 W) to large (100 kW)
- Residential systems: roof-top versus integrated
- Grid-connected or stand-alone
- Quality of each datapoint ( $n=1$  vs  $n \gg 1$ )
- How have data been collected (inquiry, bid, manipulation)
- Data provenance mentioned or not?

*Data in graph are nominal Dollars, prices in Euro and Swiss Franc have been converted to Dollars → PR cannot be deduced from nominal prices!*

# System price data

	System price USA per $W_p$		System price Germany per $W_p$		System price Switzerland per $W_p$	
	Nominal \$	Real Euro 2000	Nominal Euro	Real Euro 2000	Nominal CHF	Real Euro 2000
1992	12.00	13.96	10.23	12.03	13.40	9.13
1993	12.00	13.58	9.92	11.11	13.30	8.83
1994	12.00	13.24	9.25	9.99	13.20	8.53
1995	11.00 - 12.00	11.88 - 12.96	8.39	8.84	12.80	8.14
1996	10.00 - 12.00	10.57 - 12.68	7.72	7.98	12.60	7.93
1997	10.00 - 12.00	10.37 - 12.45	7.06	7.22	12.30	7.71
1998	10.00 - 11.00	10.18 - 11.20	6.54	6.64	12.30	7.71
1999	9.00 - 11.00	9.05 - 11.07	6.19	6.22	11.90	7.46
2000	8.00 - 10.00	7.94 - 9.92	6.54	6.54	12.50	7.79
2001	7.00 - 9.00	6.78 - 8.72	6.40	6.43*	12.20	7.53

*Data from IEA, Trends in Photovoltaic Applications in selected IEA countries between 1992 and 2001, August 2002. Nominal prices have been converted to real prices using country-specific GDP-deflators*

\* This real value is higher than the nominal value due to a *negative* GDP deflator for Germany in the year 2000

# Calculating PR

## **Which cumulative capacity to use for calculating PR?**

Example: system price in Germany

Possible capacities are:

- World-wide PV shipment
- German installed capacity
- German installed domestic capacity



# Influence of choice on PR

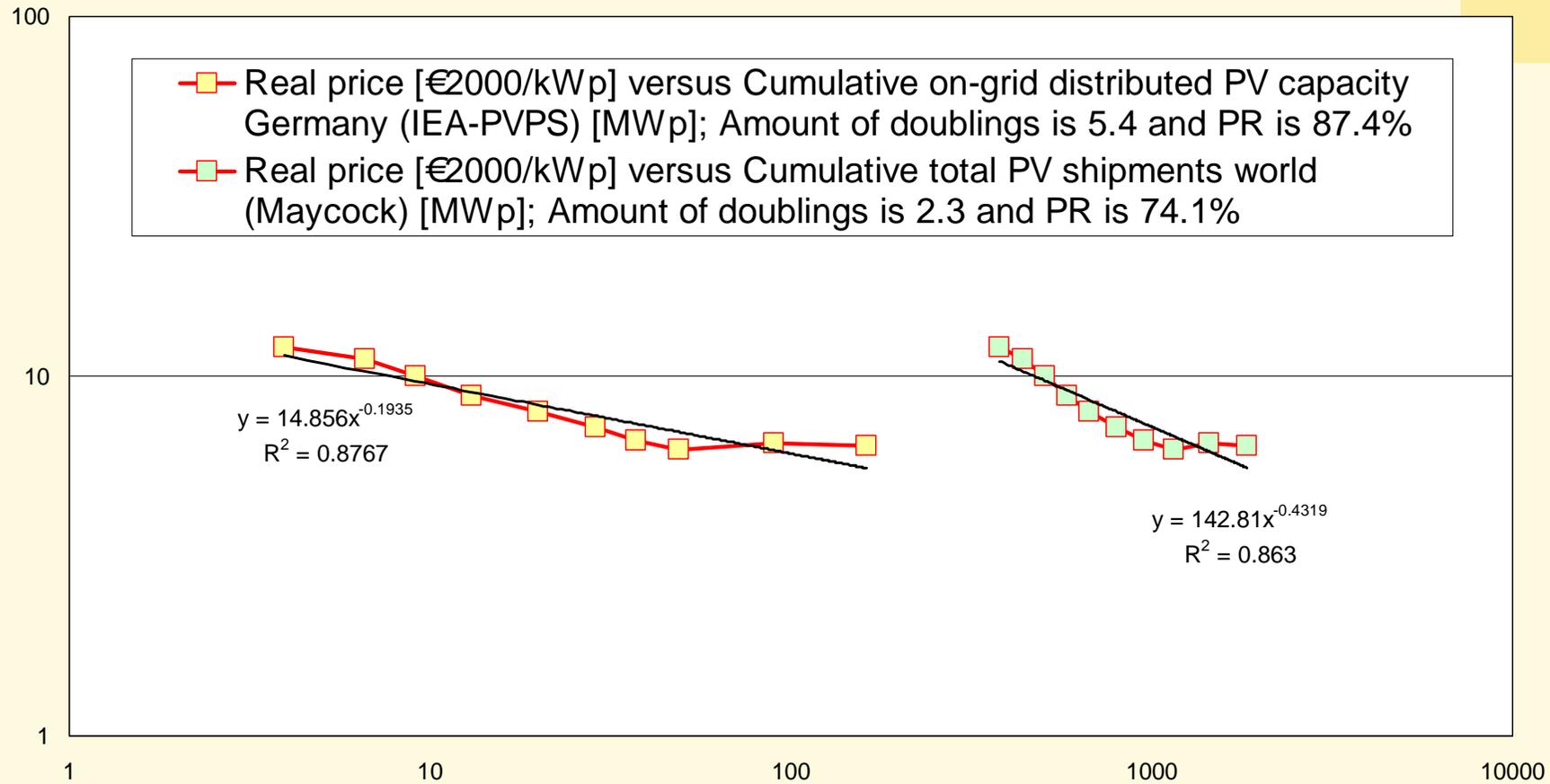
**What happens to PR when changing the amount of capacity doublings?**

Using the same prices [ $\text{€}_{2000}/\text{kW}_p$ ]:

- Increasing the amount of doublings worsens PR
- Decreasing the amount of doublings improves PR

**For Germany 1992-2001 this can make PR vary from 74% to 87%**

German system prices versus two different power development assumptions  
Prices based on country report Germany (www.iea-pvps.org, February 2002)  
Period 1992-2001



# Outcome for German case

Different assumptions on cumulative capacity can have strong impact on resulting PR (period 1992-2001):

	Real prices			Nominal prices		
	On-grid German capacity	Total German capacity	World-wide shipment	On-grid German capacity	Total German capacity	World-wide shipment
doublings capacity:	5.4	5.1	2.3	5.4	5.1	2.3
m:	-0.1935	-0.2020	-0.4319	-0.1519	-0.1586	-0.3407
PR:	87.4%	86.9%	74.1%	90.0%	89.6%	79.0%

*Capacity data for on-grid distributed capacity, total capacity from IEA, world-wide shipment data from Maycock. Price data from IEA, Trends in Photovoltaic Applications in selected IEA countries between 1992 and 2001, August 2002*

*Note: Resulting PR from nominal prices have been displayed for indication only. These do not have a useful meaning.*



# Outcome for systems USA, Germany and Switzerland

Maycock world-wide shipment data 1992-2001 show an amount of doublings of 2.3

For both USA and Switzerland the total installed capacity doubling is 1.9 in that same period (2.8 and 2.6 for on-grid distributed capacity respectively)

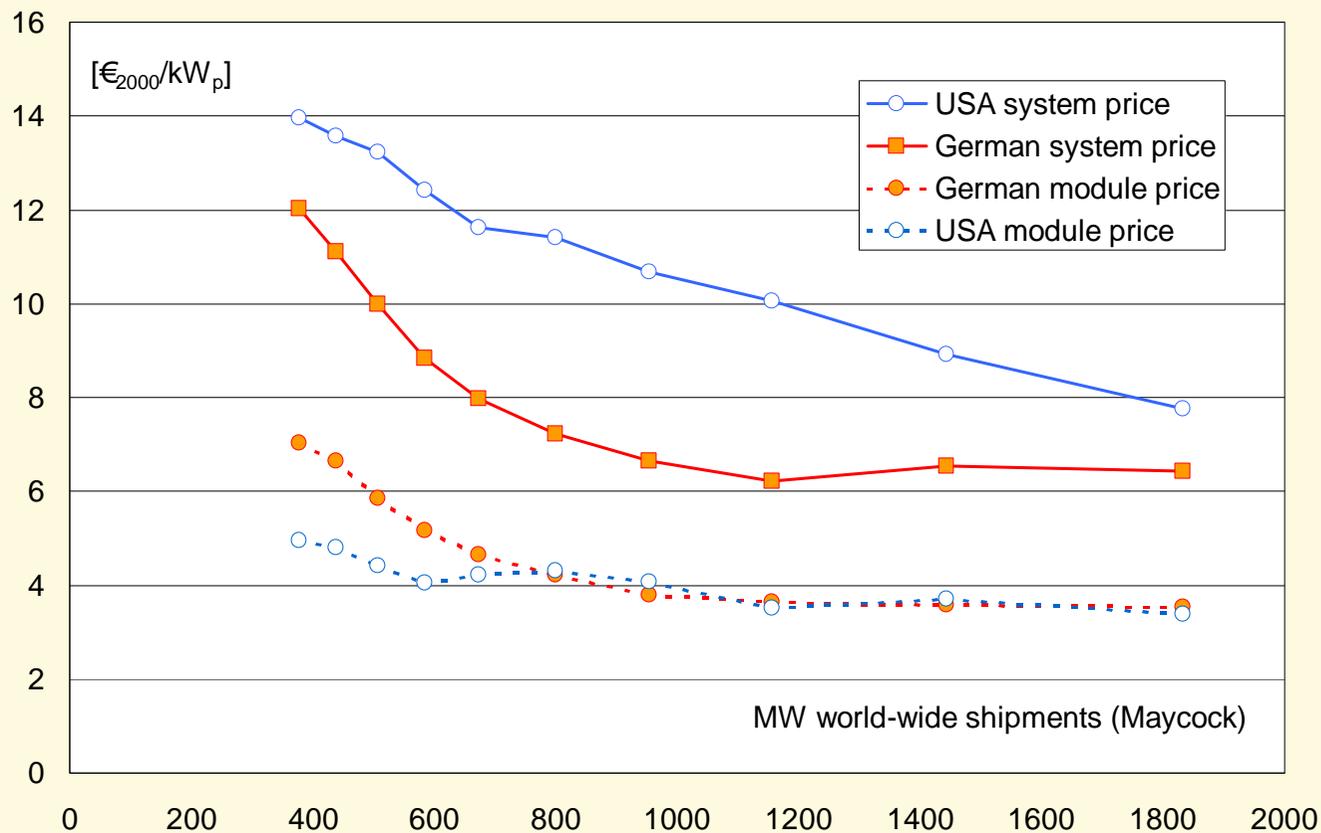
Values for PR have been calculated based on Maycock world-wide shipment data:

	USA (IEA, 2002)	Germany (IEA, 2002)	Switzerland (IEA, 2002)
PR (on-grid domestic growth)	80.9%	87.4%	92.9%
PR (based on Maycock growth)	77.9%	74.1%	92.2%

*PV system progress ratios calculated for the period 1992-2001 based on real prices (€<sub>2000</sub>) versus cumulative on-grid distributed applications in the respective countries and versus module shipments according to (Maycock, 2002). Data for Germany refer to 2-3 kW<sub>p</sub> rooftop systems, for Switzerland 3-4 kW<sub>p</sub> residential systems.*

# System and module data for Germany and USA

System and module price 1992-2001 (IEA 2002)



# Comparison of system and module price yields PR for BOS

Germany: module price decreases faster than system: BOS has worse PR than overall system

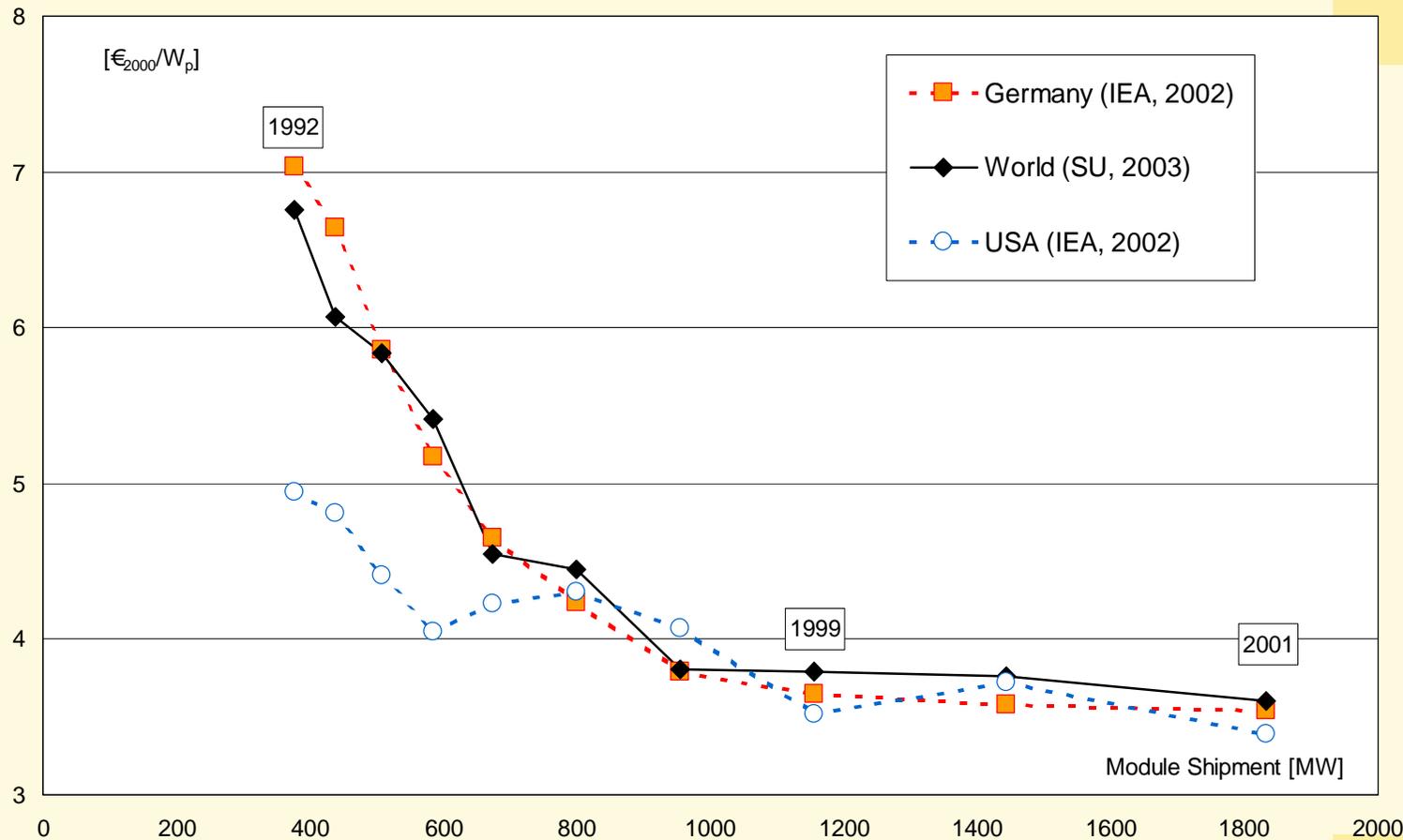
USA: module price decreases slower than system: BOS has better PR than overall system

	System		Module		BOS = System minus module	
	Germany	USA	Germany	USA	Germany	USA
PR based on global market	74.1%	77.9%	71.9%	85.8%	77.2%	73.4%
PR based on local market	87.4%	80.9%	86.3%	87.9%	89.0%	76.9%

Price data have been fitted using world-wide shipment data (Maycock) for global market, and IEA realisations for on-grid distributed capacity for local market



# A closer look to module costs:



Price data have been fitted using world-wide shipment data (Maycock)

IEA: International Energy Agency

SU: Strategies Unlimited, Photovoltaic Five-Year Market Forecast, #PM-52, March 2003

PHOTEX Workshop - June 2003

Luuk Beurskens, ECN Policy Studies



# A closer look to **module** costs: PR

	World (SU, 2003)	USA (IEA, 2002)	Germany (IEA, 2002)
m	-0.4206	-0.2210	-0.4761
PR	74.7%	85.8%	71.9%

*PV module progress ratios calculated for the period 1992-2001 based on real prices (€<sub>2000</sub>, prices from factory) versus cumulative module shipments according to (Maycock, 2002). The current \$ prices from (SU, 2003) have been corrected using the USA GDP-deflator. Primary price data for USA from “Photovoltaic Markets, Technology, Performance and Cost: 1975-2010” published by PV Energy Systems, Inc. Reference web page at “pvenergy.com”. German data from own inquiry by German participant on the IEA-PVPS Task 1 (WIP)*



# Conclusions

- It is necessary to know the primary source of data. For the three countries discussed here, the methods of primary data collection are not equal (or no information is available), which makes a comparison difficult
- Depending on capacity data used to calculate a PR, this value in specific cases can vary from “very bad” to “very good”.
- Comparing different countries can be done in the safest way by using an amount of doublings based on the world-wide PV module shipment
- German PV market grows faster than world PV market; this makes that a heavier burden is on Germany, which invests relatively more in learning compared to other countries
- For modules, SU and German data show better values for PR than USA data

