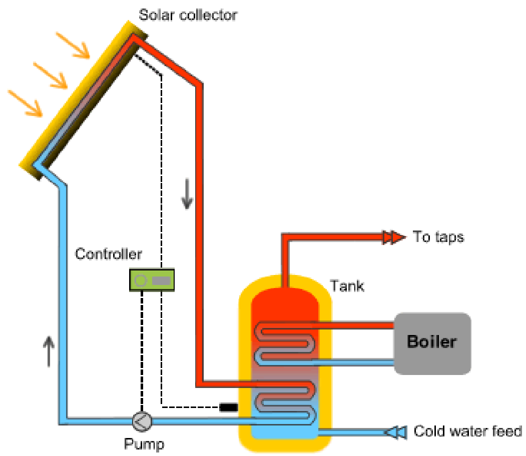
Solar Technology and China

October 21, 2010 / Stanford University

Stefan Kratz

US – Asia Technology Management Center Lecture Series

What do we mean when we say “solar”?

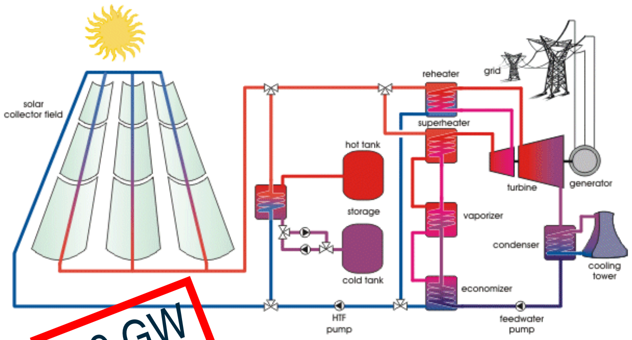


190 GW_{Th}

Solar thermal
for water heating

20 GW

Photovoltaic
(PV)



0.9 GW

Concentrated Solar
Thermal (CST)

Sources: climatelab.org, solareis.anl.gov, volker-quaschning.de

worldwide installations as of 2009

China is World Leader in Solar Thermal for Water

Figure 9. Solar Hot Water/Heating Existing Capacity, Top 10 Countries/Regions, 2008

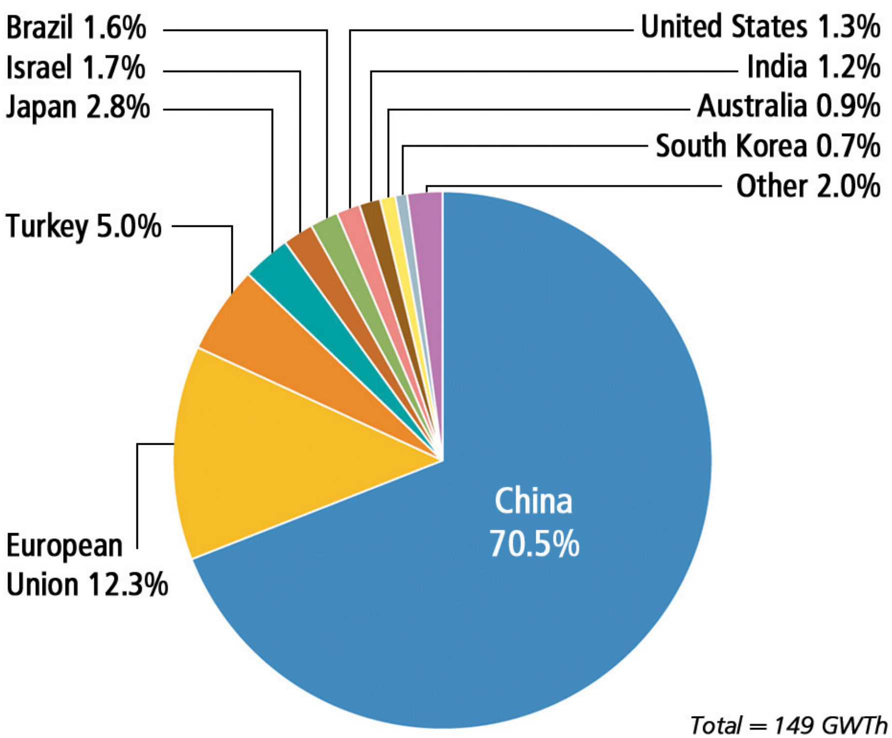
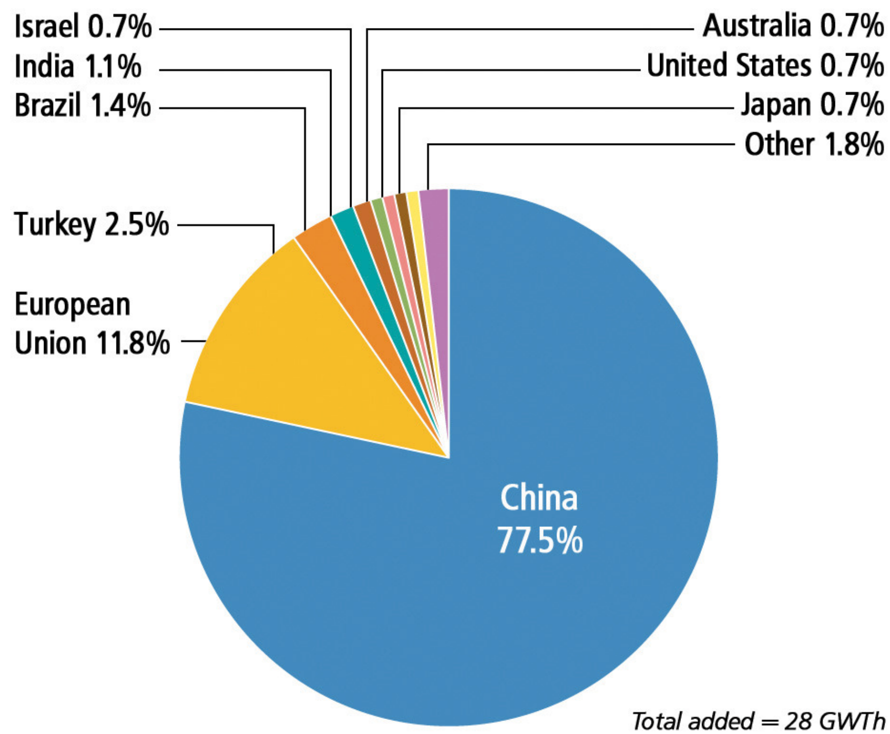


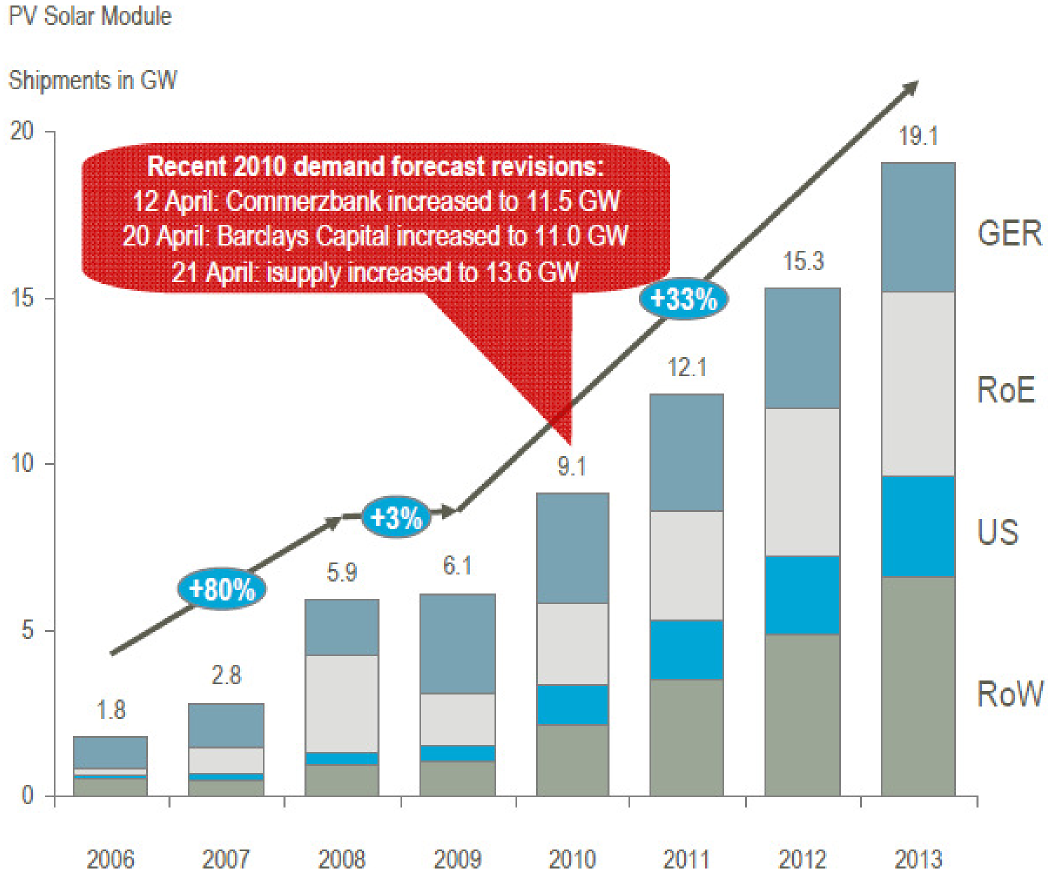
Figure 10. Solar Hot Water/Heating Capacity Added, Top 10 Countries/Regions, 2008



Source: REN21 Renewables Global Status Report 2010

Solar water heaters in China are ubiquitous…

... but the growth story is in photovoltaic (PV) solar



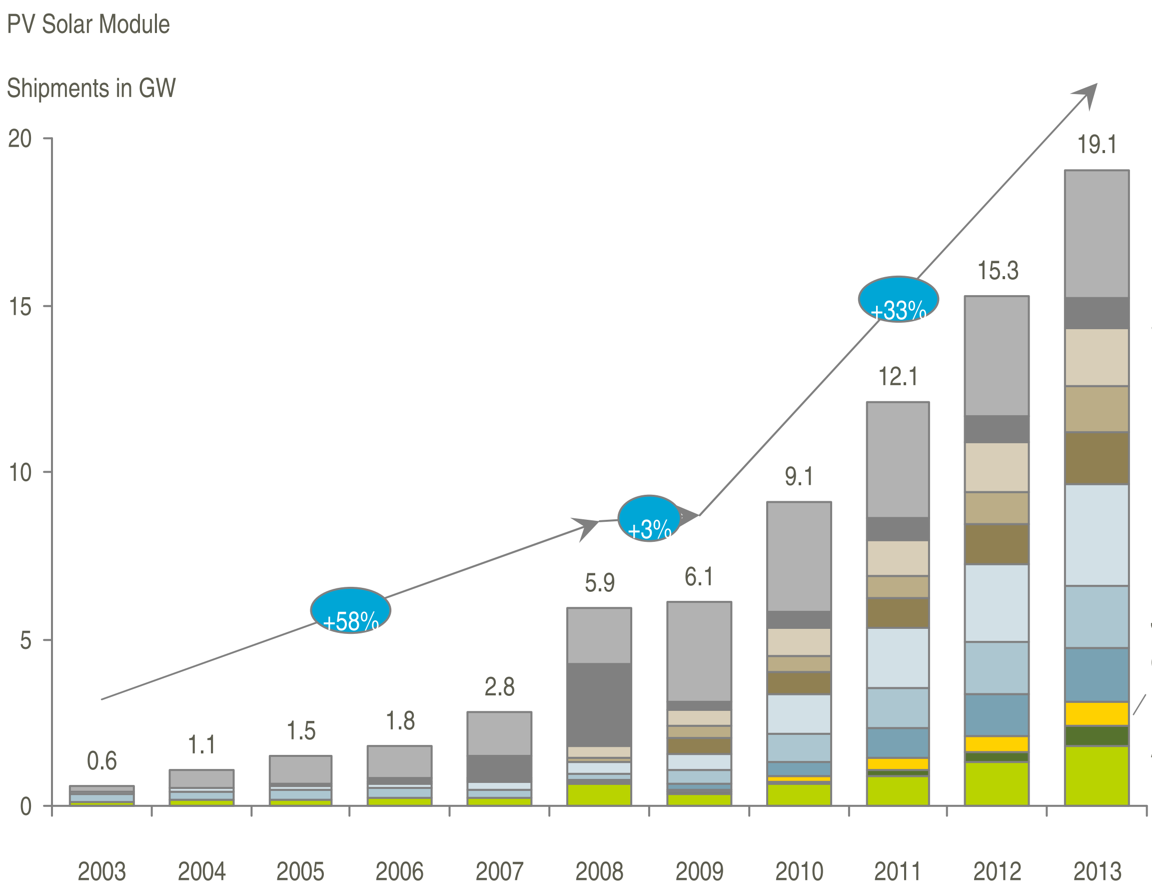
	CAGR 09–13	2013 [GW]
GER	6.2%	3.8
RoE	38.4%	5.6
US	57.1%	3.0
RoW	57.7%	6.6
	33.0%	19.06

Europe 9.4 GW

Source: Q-Cells; Analyst reports; press research

... but the growth story is in photovoltaic (PV) solar

Demand side



		CAGR 09–13	2013 [GW]
Germany	20% CAGR	6.2%	3.8
Spain		47.1%	0.9
Italy		36.8%	1.8
France		39.4%	1.3
Rest of Europe		35.2%	1.6
US	57% CAGR	57.1%	3.0
Japan		46.8%	1.8
China		69.2%	1.6
India		77.8%	0.7
Australia		134.0%	0.6
RoW		47.9%	1.8
		33.0%	**19.06**

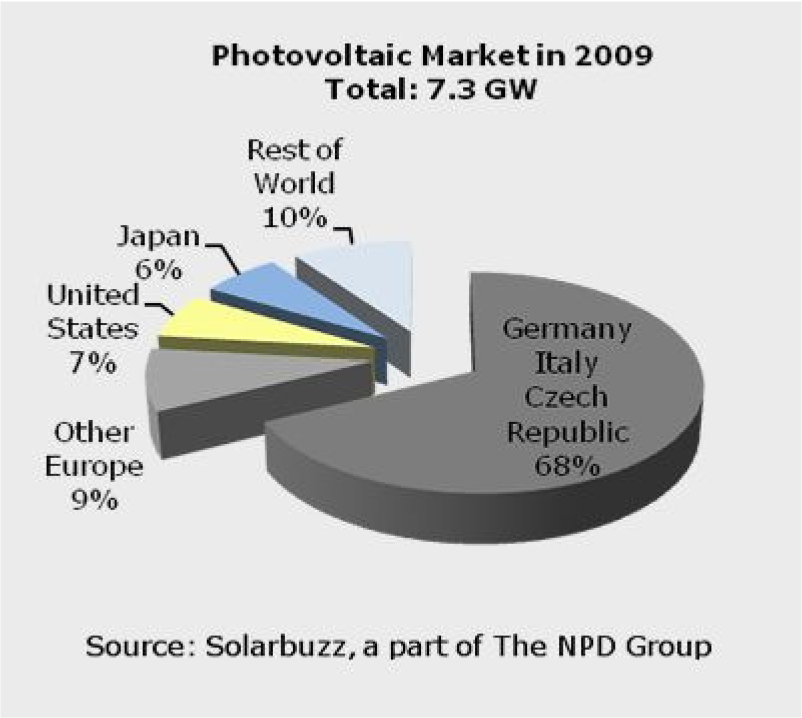
Europe
9,4 GW

Largest growth will come from new emerging markets, such as US, China, India and Australia

Source: Q-Cells, Analyst reports; press research

World PV Market in 2009 and 2010

New Installations in 2009



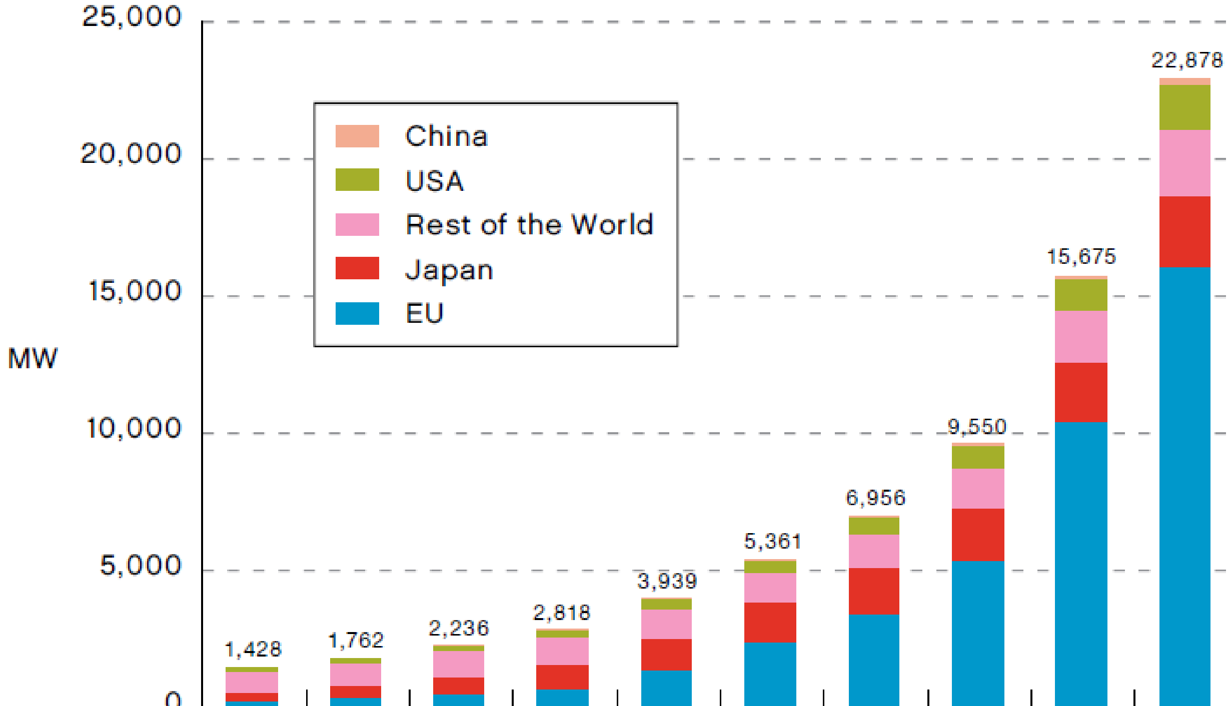
Expected Installations in 2010 (conservative estimate in September)

Total:	~14.3 GW	
Germany:	8 GW	(55%)
Italy:	1.3 GW	(9%)
USA:	850 MW	(6%)
Japan:	750 MW	(5%)
China:	240 MW	(1.7%)
India:	42 MW	(0.3%)

Source: New Energy Finance

Expectations revised in Oct. to > 16 GW, an annual increase of 126 % !!

Cumulative PV installations in 2009



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
China	19	30	45	55	64	68	80	100	145	305
USA	139	168	212	275	365	479	624	831	1,173	1,650
ROW	763	825	913	1,000	1,044	1,051	1,235	1,422	1,870	2,347
Japan	318	452	637	860	1,132	1,422	1,708	1,919	2,149	2,633
EU	189	286	429	628	1,334	2,341	3,309	5,279	10,338	15,943
Total	1,428	1,762	2,236	2,818	3,939	5,361	6,956	9,550	15,675	22,878

Source: European Photovoltaic Industry Association (EPIA), Global Market Outlook for Photovoltaics until 2014

Q-Cells Mission and Vision

CLEAN ENERGY

FOR EVERYONE

FOREVER

As a leading global Photovoltaic company,

we provide the best technologies, products and solutions

to rapidly drive solar energy to be the top energy choice

for the benefit of all our partners, employees and – most importantly – our planet.

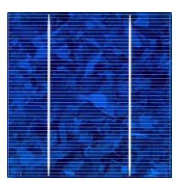
Our Story

1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009

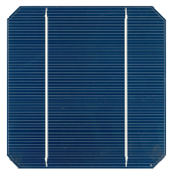
1999: Foundation of Q-Cells AG

2001: Start of production

2002: Setting the world standard with the 6 inch cell



2003: Market launch of mono cell and new production line



2004: Market launch of larger format Q6L

2005: IPO in Frankfurt

2006: First investments in thin-film (a-Si and CdTe)

2007: Investment in CIGS thin-film

Systems business established

2008: Strong growth in project business

Ramp-up of CIGS thin-film

2009: Start of cell production in Malaysia

Our Product Offering

Q-Cells Solar Cells

Multi

Mono

New Mono

- High-quality, high-efficiency
- 20% efficiency targeted for 2011

Q-Cells Modules

Q.Pro

Q.Smart

Q.Base

- Q-Pro: High efficiency c-Si
- Q-Smart (CIGS): Highest efficiency thin-film module in market
- Q-Base: High performance for large-scale PV plants

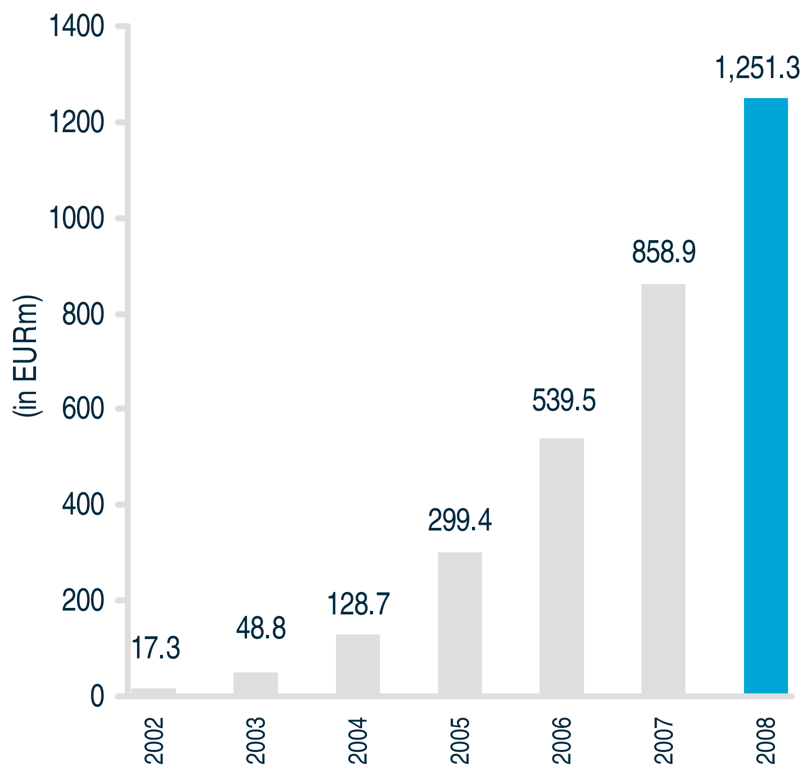
Q-Cells Systems

- Largest systems installer in 2009: 150MW
- 2 of world's largest 10 systems built by Q-Cells

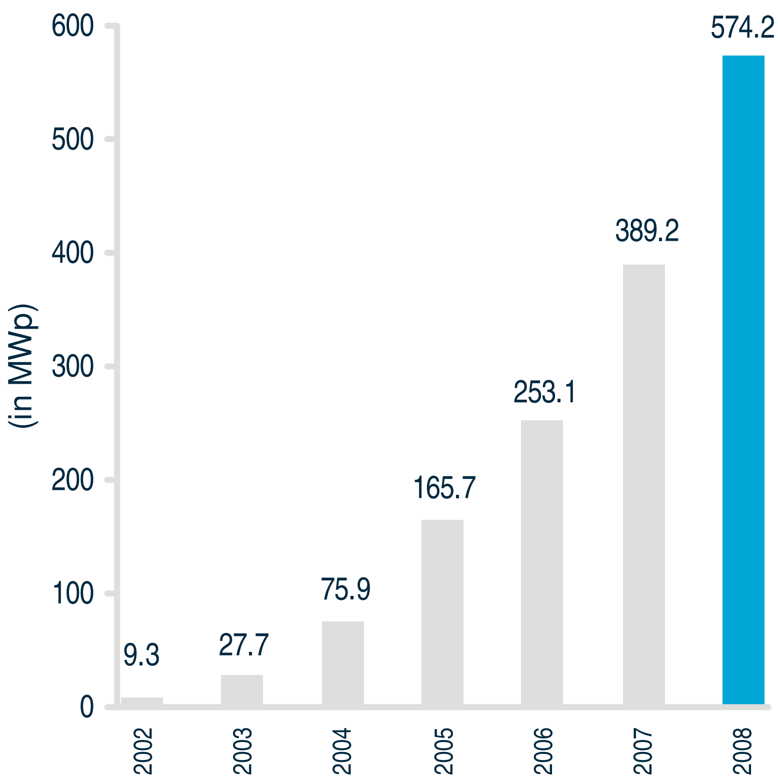
* In development, subject to successful milestone realisation

Strong growth from 2002 to 2008

Sales



Production

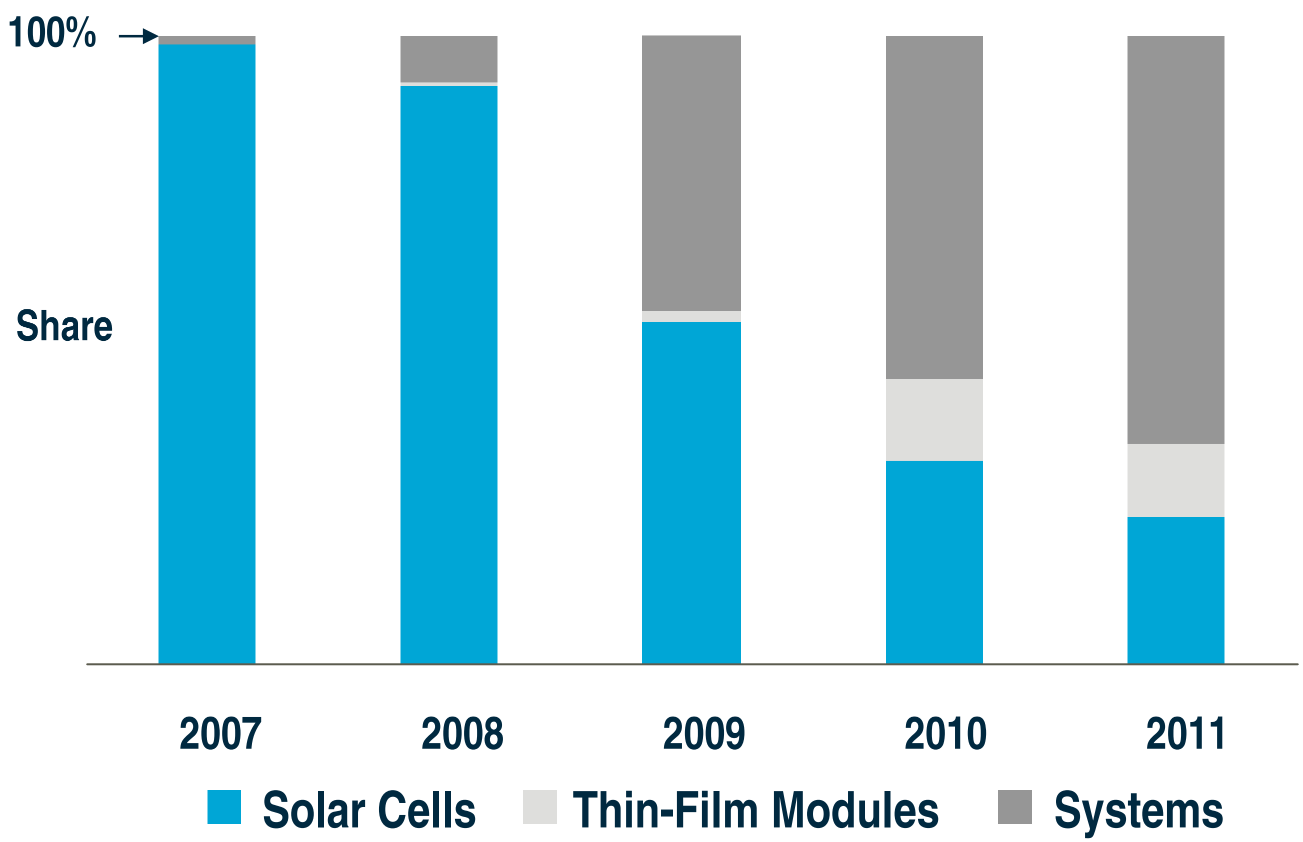


In 2009, Sales dropped to € 802 m and Production dropped slightly to 551 MW

Future Direction of Q-Cells Business Model

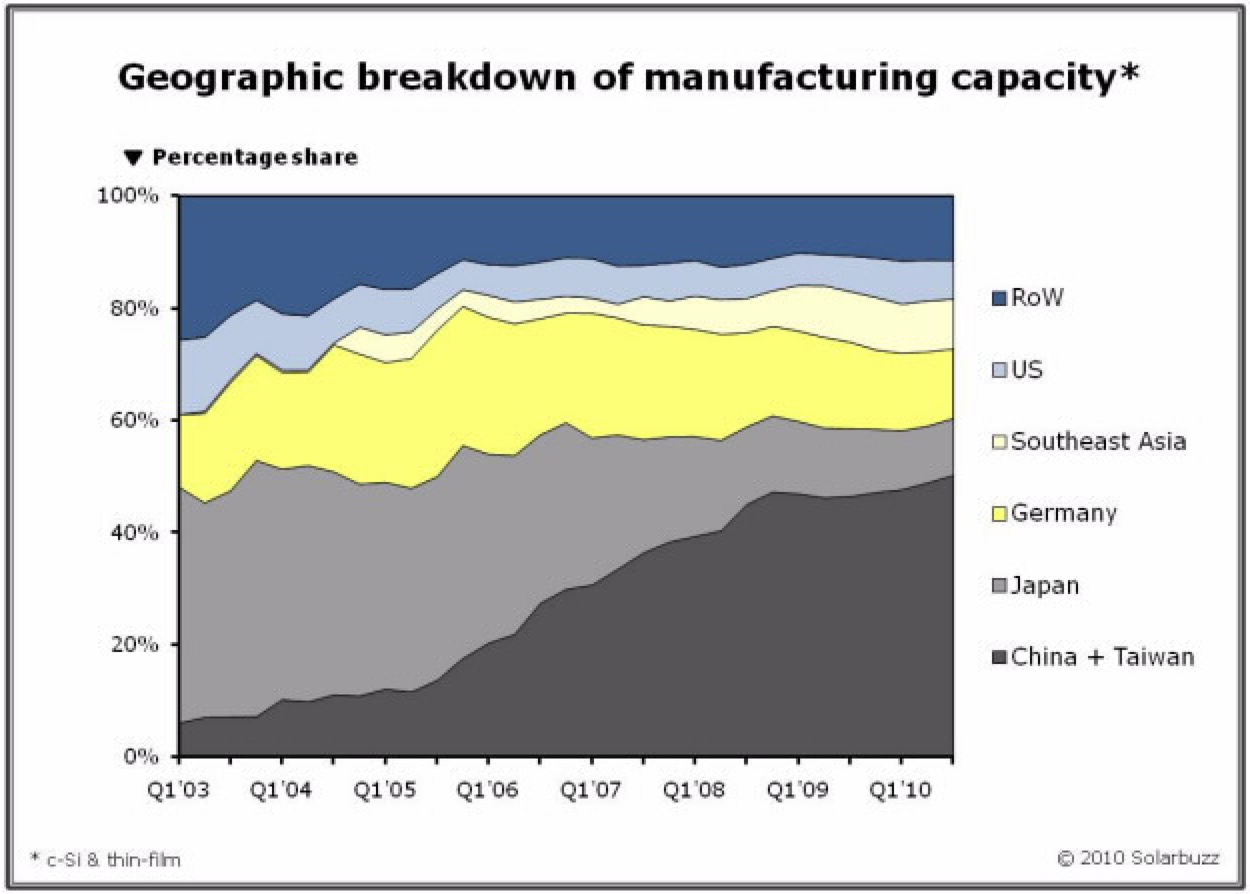
- Indicative -

Revenue trend



Transformation from a focused cell producer to a provider of PV systems and products

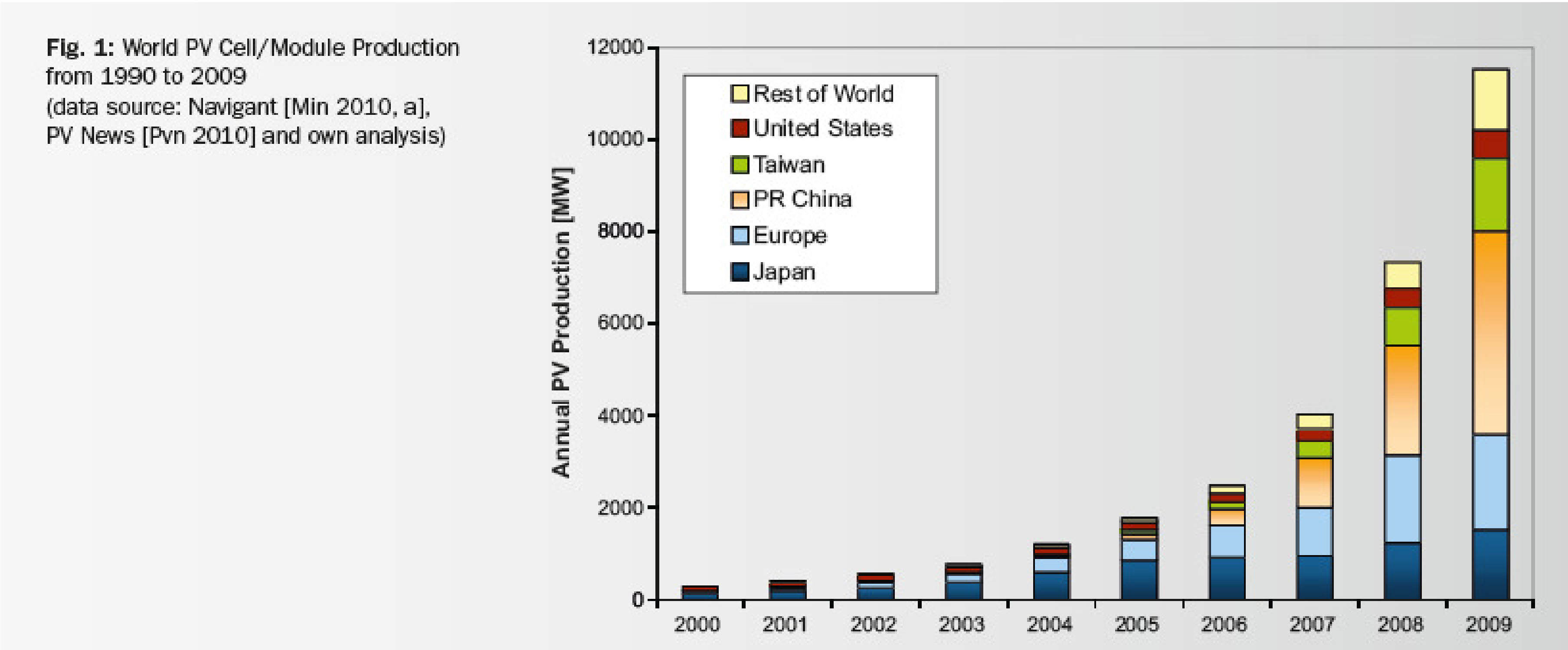
Trends in Global PV Manufacturing Capacity



Source: Solarbuzz, SEMI PVGroup.

As of 2010, China and Taiwan produce more than 50% of the world's solar PV modules

Trends in Global PV Production



Source: European Commission Joint Research Centre, PV Status Report 2010

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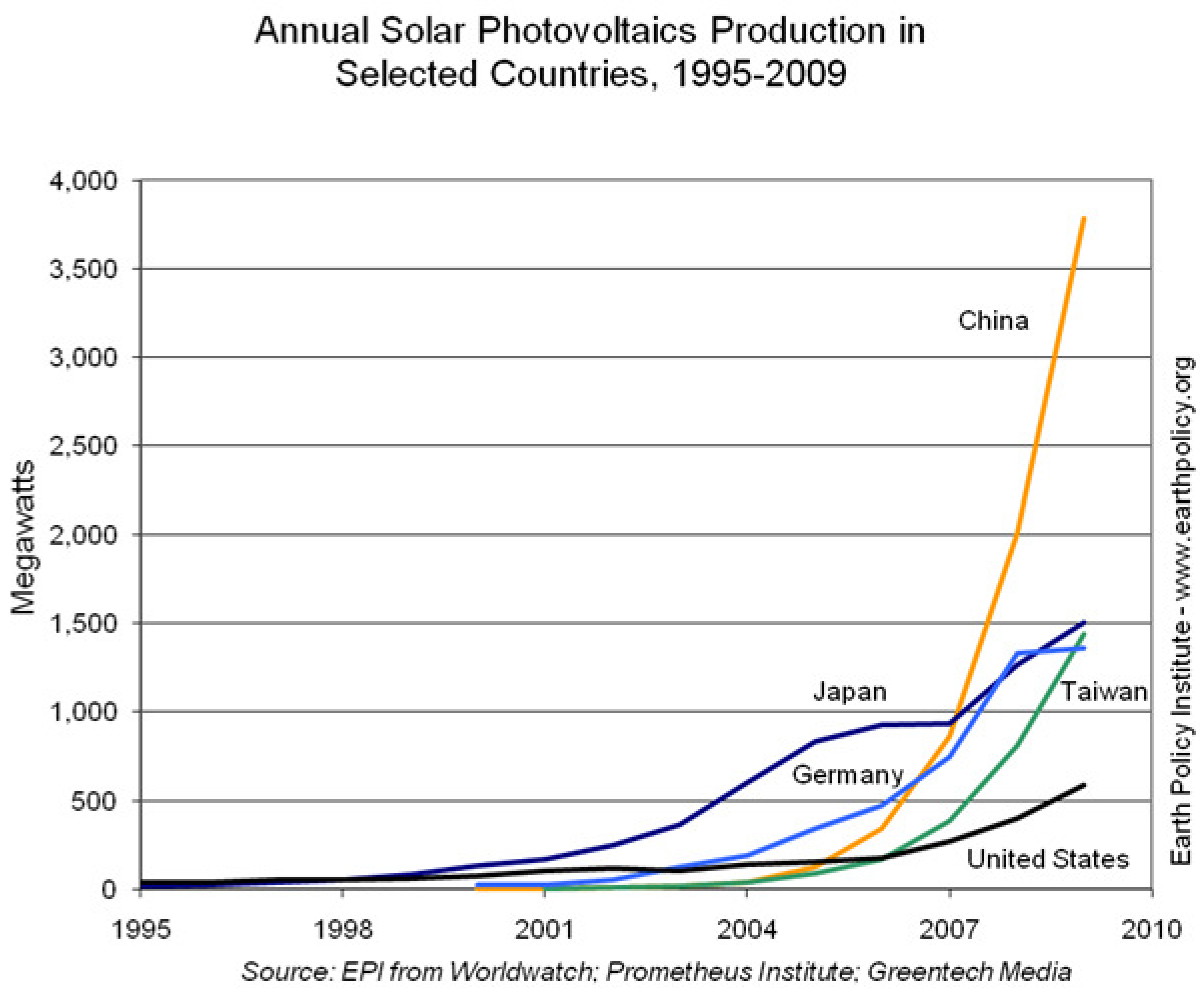
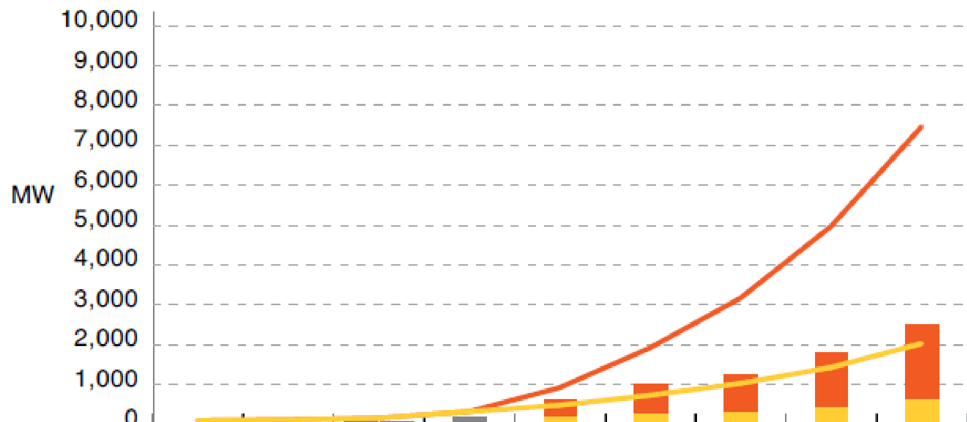
Q.CELLS

Trends in Global PV Production



China's Production vs. Market

- More than 90% of PV products made in China are exported
- Chinese government has committed to 20 GW of installed capacity by 2020
- Market in China this year is expected to be around 160MW (still small)
- There are some initial subsidy programs in place
- China is expected to accelerate PV market in China as prices continue to fall



		2006	2007	2008	2009	2010e	2011e	2012e	2013e	2014e
Annual market (MW)	EPIA Moderate scenario	12	20	45	160	160	250	300	400	600
	EPIA Policy-Driven scenario					600	1,000	1,250	1,800	2,500
Projected cumulative PV power installed (MW)	EPIA Moderate scenario CUM	80	100	145	305	465	715	1,015	1,415	2,015
	EPIA Policy-Driven scenario CUM					905	1,905	3,155	4,955	7,455

Source: European Photovoltaic Industry Association (EPIA), Global Market Outlook for Photovoltaics until 2014

Concluding Remarks

- Japan was the first large PV market in the world, leading the way
- Europe now represents the largest regional market in the world, and European companies benefit as a result
- The solar industry has been waiting for the US market to truly emerge
- Q-Cells is adapting to the new industry environment by:
  - Focusing on products with high-technological content
  - Moving downstream to higher margin portion of the supply chain closer to the end customer

THANK YOU!

Please feel free to contact me at:

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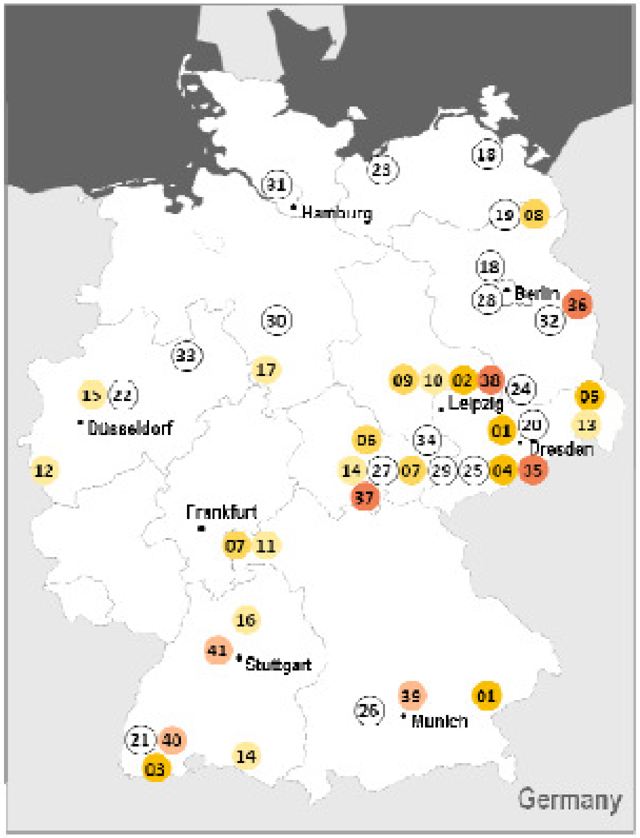
Germany's PV industry

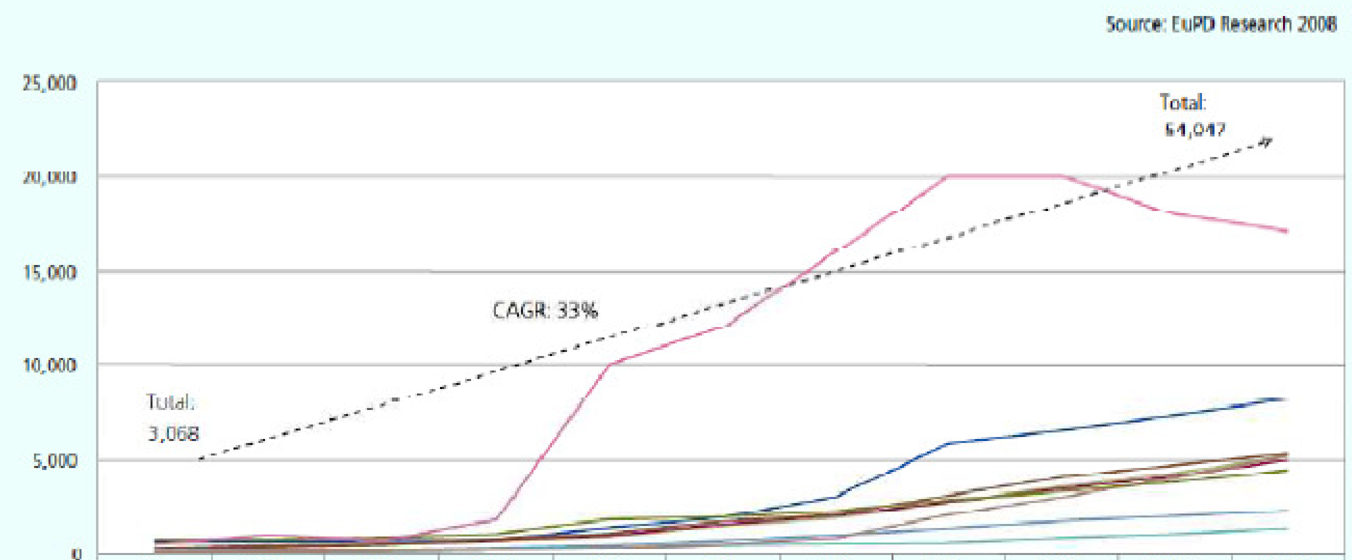
Germany hosts the world's largest PV cluster (1) Companies in wafer-based technologies

Value Chain	No.	Company	Location	Capacity 2009 [MWp]	Current Empl.
Silicon	1	Wacker Chemie	Burghausen, Nünchritz	15,000t	1200
	2	PV Silicon	Bitterfeld-Wolfen	900t	50
	3	Joint Solar Silicon	Rheinfelden	850t	10
	4	Scheuten SolarWorld Solizium	Freiberg[1]	500t	n/a
	5	Silicon Pilot Production	Spreewitz[1]	240t	n/a
Wafer	6	PV Silicon[2]	Erfurt	290	160
	7	WACKER SCHOTT Solar	Alzenau, Jena	275	350
	8	Mola Solaire Produktion	Pasewalk[1]	120	140
	9	Q-Cells	Thalheim[1]	n/a	n/a
Cell	10	Q-Cells	Thalheim	1300	1900
	11	SCHOTT Solar	Alzenau	320	520
	12	Solland Solar Cells	Aachen	170	400
	13	ARISE Technologies	Bischofswerda	120	60
	14	Sunways	Konstanz, Arnstadt	116	370
	15	Scheuten Solar Cells	Gelsenkirchen	22	60
	16	SOLARWATT CELLS	Heilbronn	20	60
	17	STIEBEL ELTRON	Holzminden[1]	n/a	n/a
Module	18	SOLON	Berlin, Greifswald	260	429
	19	aleo solar	Prenzlau	180	565
	20	SOLARWATT	Dresden	165	430
	21	Solar-Fabrik	Freiburg	130	340
	22	Scheuten Solar Technology	Gelsenkirchen	130	260
	23	CENTROSOLAR	Wismar	120	290
	24	ALGATEC Solar	Elsterwerda	100	90
	25	Heckert Solar	Chemnitz	90	120
	26	Webasto Solar	Landsberg/Lech	36	n/a
	27	asola	Erfurt	32	90
	28	arinna AG	Berlin	20	70
	29	GSS	Löbichau	20	49
	30	alfasolar	Hannover[1]	12	n/a
	31	solarnova	Wedel	11	35
	32	PVflex Solar	Fürstenwalde	5-10	30
	33	Schüco Solar	Bielefeld	5	450
	34	Sunplastics	Löbichau[1]	1	3
Fully Integrated (Wafer/Cell/Module)	35	SolarWorld[3]	Freiberg	750/200/140	1000
	36	Conergy[2]	Frankfurt (Oder)[1]	300/275/250	500
	37	Ersol Bosch Group[4]	Erfurt, Arnstadt	280/280/n/a[1]	920
	38	Sovello	Thalheim	180/180/180	1150
CPV	39	SolarTec	Munich	45	40
	40	Concentrix Solar	Freiburg	25	60
	41	Archimedes Solar	Stuttgart	5	n/a



1) Planned / under construction
2) Excluding ingots
3) Subsidiaries of SolarWorld: Deutsche Solar, Deutsche Cell, Solar Factory
4) Subsidiaries of ersol Bosch Group: ASI Industries, ersol Solar Energy, ersol Crystalline Modules
5) Subsidiary of Q-Cells

Jobs in the German PV Industry



	2000	2001	2002	2003	2004	2005	2006	2007e	2008e	2009e	2010e
Suppliers	666	666	713	761	1,379	1,937	3,036	5,847	6,551	7,339	8,222
Silicon	84	119	151	217	295	475	531	576	844	1,064	1,348
Wafers/Ingots	122	173	219	316	428	690	996	1,332	1,732	1,992	2,286
Cells	260	368	465	671	909	1,465	1,877	2,742	3,549	4,283	5,168
Modules	275	389	492	710	962	1,550	2,022	2,740	3,443	4,132	4,966
Modules (thin film)	88	124	157	226	307	495	828	2,057	3,014	4,036	5,210
BOS	306	433	548	790	1,071	1,727	2,067	3,105	4,086	4,722	5,299
Wholesalers	760	760	865	1,057	1,826	1,960	2,278	2,861	3,314	3,849	4,148
Trades' companies	500	1,000	700	1,800	10,000	12,000	16,000	20,000	20,000	18,000	17,100
Total	3,068	4,041	4,310	6,548	17,176	22,298	29,633	41,260	46,533	49,408	54,047

Top 10 Suppliers of PV Manufacturing Equipment

Top 10 Suppliers of PV Manufacturing Equipment

Company	Revenues ($M) 2007	Revenues ($M) 2008	Rank 2008
Applied Materials	73	797	1
Oerlikon Solar	222	552	2
GT Solar International	130	535	3
Gebr. Schmid	301	512	4
centrotherm photovoltaics AG	197	502	5
Meyer Burger	149	391	6
Roth & Rau AG	188	375	7
Ulvac, Inc.	83	282	8
Manz Automation AG	70	207	9
Von Ardenne Anlagentechnik	96	132	10

Source: VLSI Research Inc
PV-Solar

Production Capacity – Thin-film vs. crystalline-Si

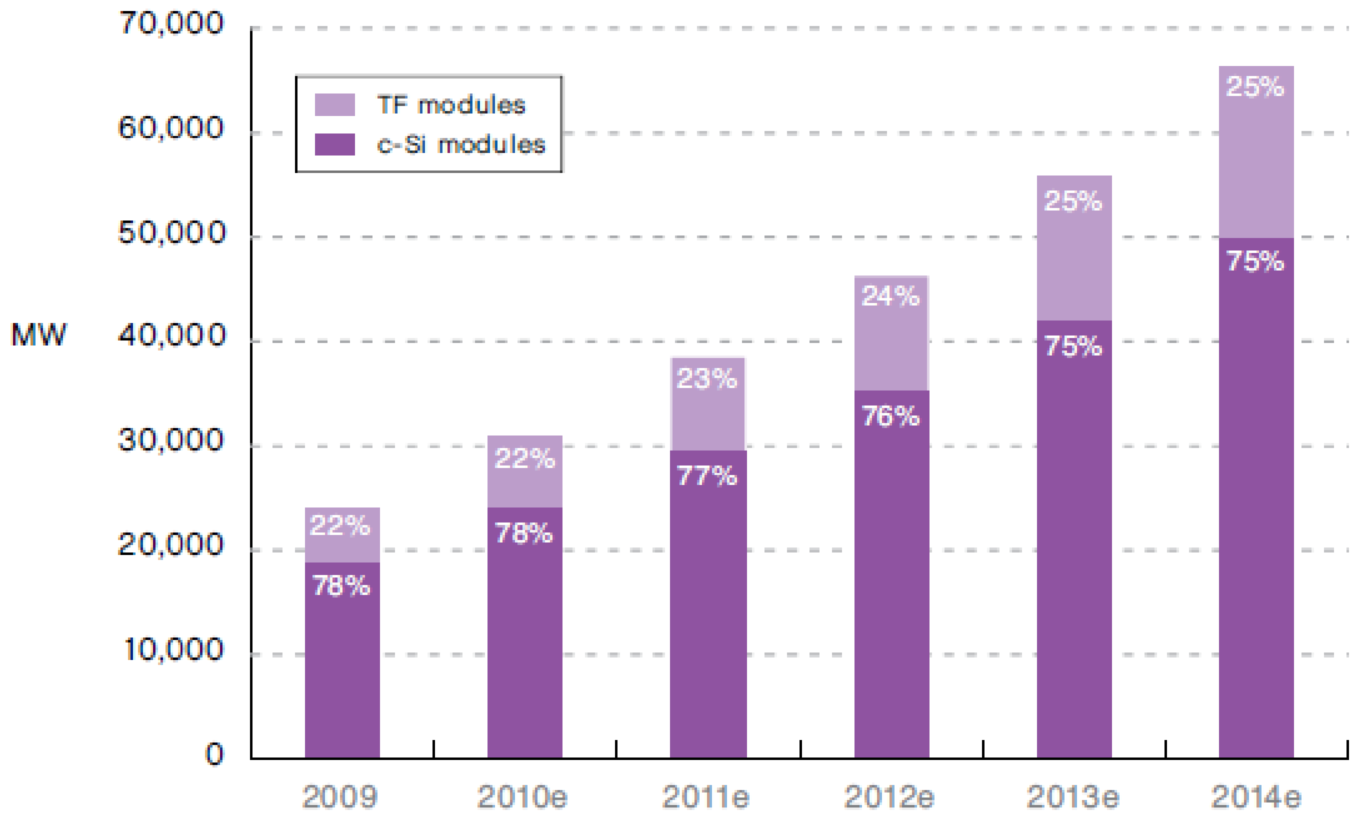


Figure 25 - Production Capacity Outlook – Crystalline and Thin Film technologies
(Technologies with market share below 0.5% are not represented)

Source: European Photovoltaic Industry Association (EPIA), Global Market Outlook for Photovoltaics until 2014

German Feed-In Tariff in Q4 2010

Tariffs for new installations between 1st October to 31th December 2010:

Roof-top

- System size < 30 kW: 0.3303 €/kWh
- System size 30 to 100 kW: 0.3142 €/kWh
- System size 100 kW to 1 MW: 0.2973 €/kWh
- System size > 1 MW: 0.2479 €/kWh

Roof-top with auto consumption:

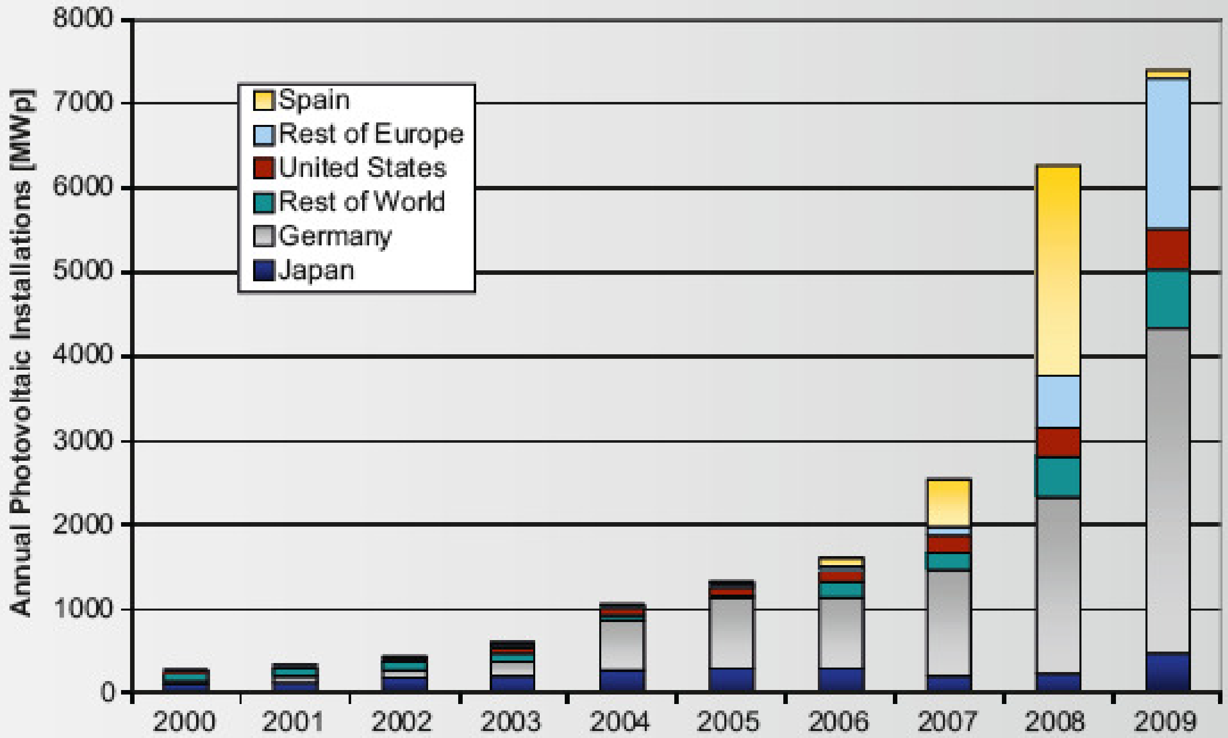
- System size < 30 kW: first 30 % 0.1665 €/kWh
  remaining 70 % 0.2103 €/kWh
- System size 30 to 100 kW: first 30 % 0.1504 €/kWh
  remaining 70 % 0.1942 €/kWh
- System size 100 to 500 kW: first 30 % 0.1335 €/kWh
  remaining 70 % 0.1773 €/kWh

Ground-mounted installations: 0.2426 €/kWh

Ground-mounted installations in redevelopment areas: 0.2537 €/kWh

Annual PV Installations 2000-2009

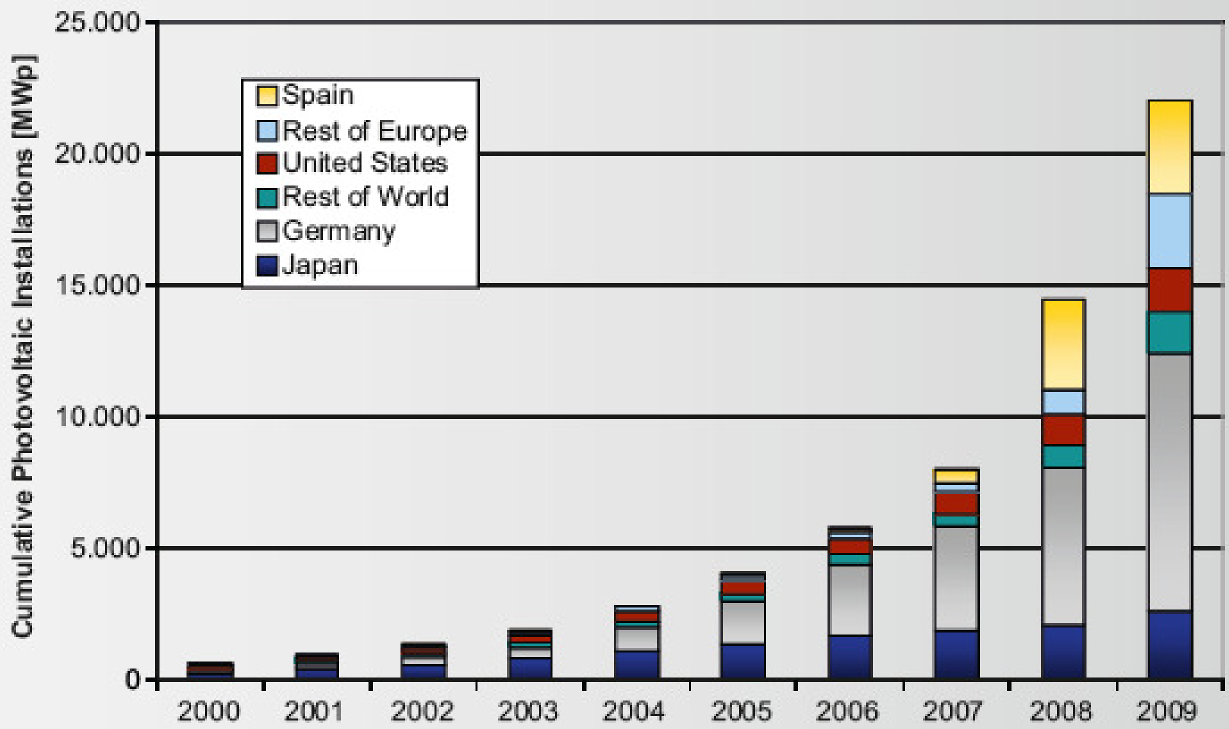
Fig. 2: Annual Photovoltaic Installations from 2000 to 2009 (data source: EPIA [Epi 2010], Eurobserver [Sys 2010] and own analysis)



Source: European Commission Joint Research Centre, PV Status Report 2010

Cumulative PV Installations 2000-2009

Fig. 3: Cumulative Photovoltaic Installations from 2000 to 2009 (data source: EPIA [Epi 2010], Eurobserver [Sys 2010] and own analysis)



Source: European Commission Joint Research Centre, PV Status Report 2010