PV Solar Electricity – A Future Major Technology

Semicon 2007

Invest in Germany – Executive Luncheon

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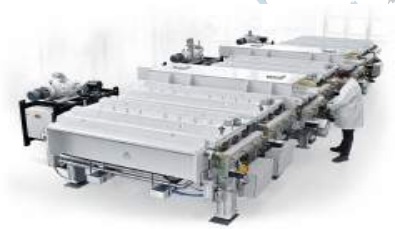
Applied Materials Overview

Vision: We apply nanomanufacturing technology™ to improve the way people live

▪ Revenue (Past 4 Qtrs.)	– **$9,868 Million**
▪ Worldwide Employees	– **Approx. 14,000**
▪ Worldwide Locations	– **18 Countries**

Solar Business Group

Power $/W



Area $/m²

European Photovoltaic Industry Association

110 members of the PV Solar Electricity Industry

President

European Renewable Energy Council

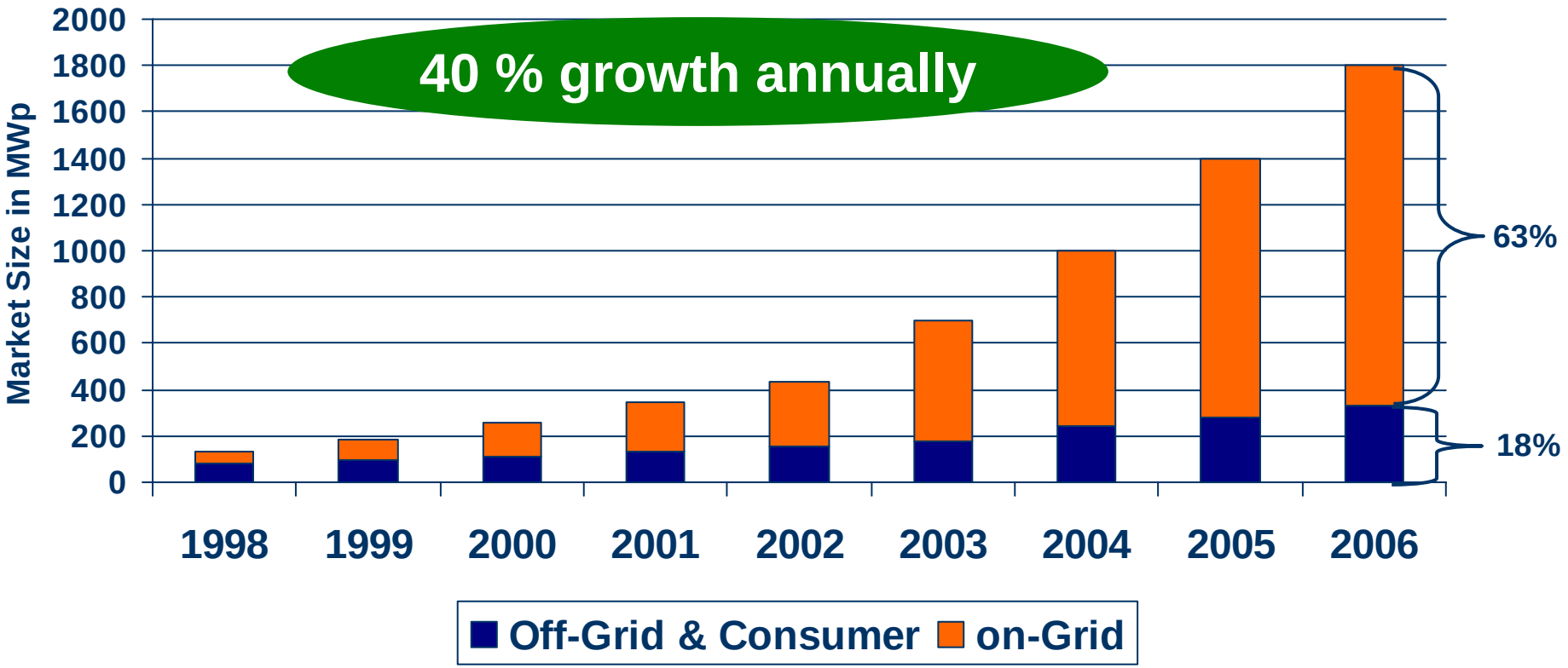
Director

Bundesverband Solarwirtschaft (German Solar Industry Association)

600 members of the Solar Thermal and PV Solar Electricity Industry

President

World PV Market Size and Application Segmentation



Source: EPIA & own estimates

European Market Support Programs

Country	Feed-in law			yearly market [MW]	
	Tariff [€ct/kWh]	Duration [a]	Cap [MW]	2005	2006 (est.)
Germany	38 – 49 BIPV + 5ct	20	-	750	750
Italy	36 – 49	20	1,200	5	12
Portugal	31 – 45		150	1	1
Spain	22 – 41	25	400	20	63
France	30 - 40 BIPV + 15-25	20	-	5	12
Greece	40 – 50	20		1	1
Other countries	Feed in Laws: Switzerland (1991); Denmark (1993); Sweden (1997); Norway, Slovenia (1999); Latvia (2001); Austria, Czech Republic, Lithuania (2002); Cyprus, Estonia, Hungary, Slovak Republic (2003); Turkey, Ireland (2005)				

Source: BSW, EPIA (2007)

Development of the German PV-market

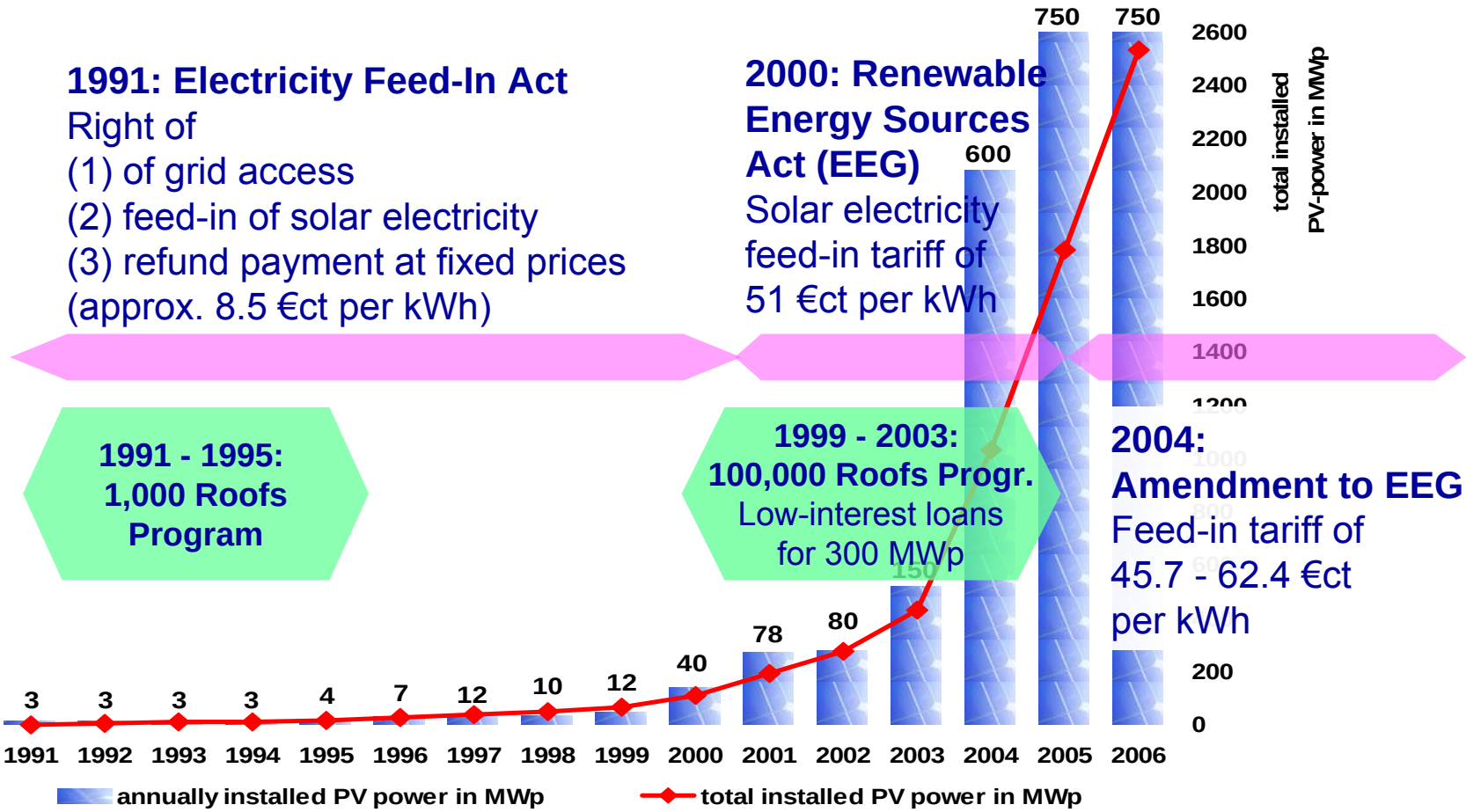
1991: Electricity Feed-In Act
Right of
(1) of grid access
(2) feed-in of solar electricity
(3) refund payment at fixed prices
(approx. 8.5 €ct per kWh)

2000: Renewable Energy Sources Act (EEG)
Solar electricity feed-in tariff of 51 €ct per kWh

1991 - 1995: 1,000 Roofs Program

1999 - 2003: 100,000 Roofs Progr.
Low-interest loans for 300 MWp

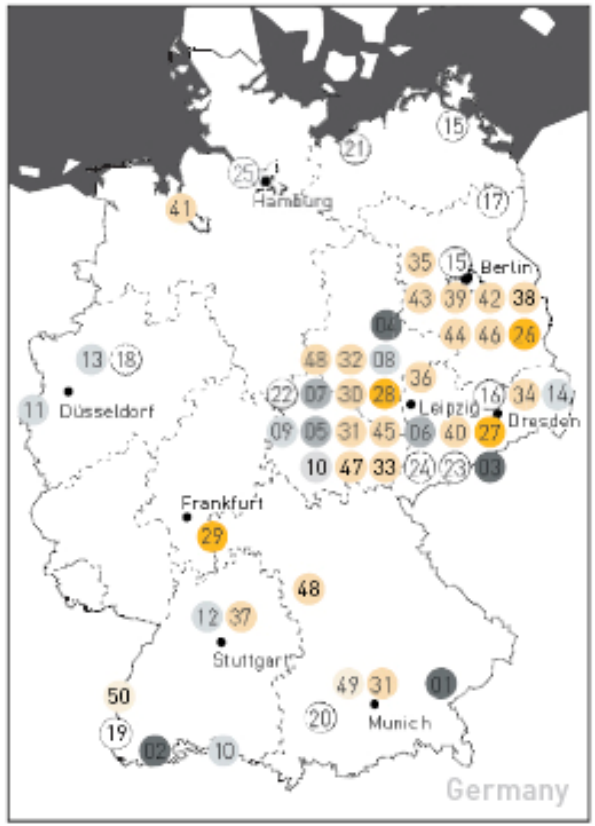
2004: Amendment to EEG
Feed-in tariff of 45.7 - 62.4 €ct per kWh



Source: BSW (2007)

PV Companies in Germany I

Value chain		Company	Location	Capacity 2007 (MWp)	Empl.
Silicon	1	Wacker Chemie	Burghausen	6000t	920
	2	Joint Solar Silicon	Rheinfelden[2]	100t	-
	3	Scheuten SolarWorld Solizium	Freiberg[1]	-	-
	4	City Solar	Wolfen-Bitterfeld[1]	-	-
Wafers	5	ASi Industries[3]	Arnstadt	100	160
	6	WPI Wafer Production Int.	Leipzig	100	40
	7	PV Silicon	Erfurt	n.a.	120
Cells	8	Q-Cells	Thalheim	645	940
	9	Ersol Solar Energy	Erfurt, Arnstadt[2]	180	230
	10	Sunways	Konstanz, Arnstadt	45	130
	11	Solland Solar Cells	Aachen	20	120
	12	Solarwatt Cells	Heilbronn	15	60
	13	Scheuten Solar Cells	Gelsenkirchen	n.a.	80
	14	Arise Technologies	Bischofswerda[1]	-	-
Modules	15	Solon	Berlin, Greifswald	110	310
	16	Solarwatt Solar-Systeme	Dresden	100	320
	17	Aleo Solar	Prenzlau	90	280
	18	Scheuten Solar Technology	Gelsenkirchen	80	130
	19	Solar-Fabrik	Freiburg	50	200
	20	Systaic	Landsberg am Lech	35	10
	21	Solara Sonnenstromfabrik	Wismar	25	100
	22	ASS Automotive Solar Systems	Erfurt	25	50
	23	Heckert-B.X.T. Solar	Chemnitz	25	40
	24	GSS	Löbichau	15	30
	25	Solarnova	Wedel	10	30



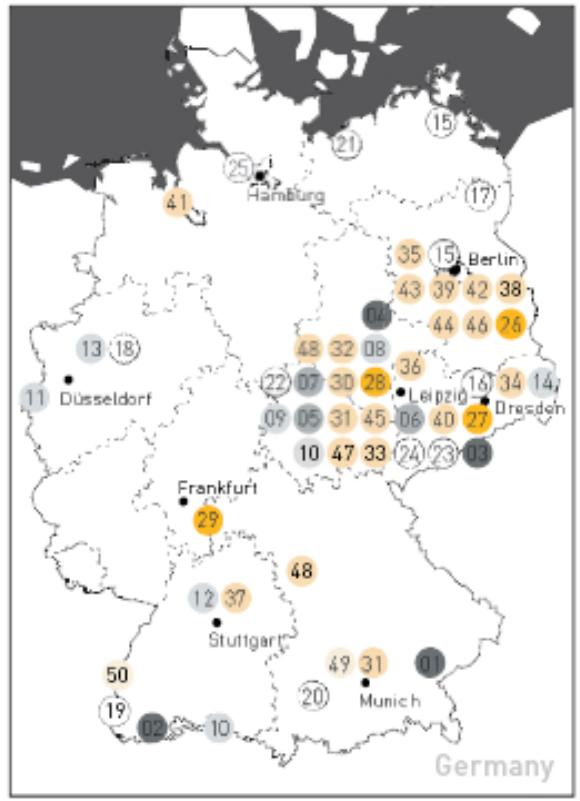
1) Planned
2) Under construction
3) Subsidiary of Ersol
4) Subsidiaries of Solarworld:
Deutsche Solar, Deutsche Cell, Solar Factory
5) Subsidary of Q-Cells

Source: IiG research, April 07

Source: BSW (2007)

PV Companies in Germany II

Fully Integrated	26	Conergy	Frankfurt (Oder)[2]	300/275/250	80
Wafers/Cells/ Modules	27	Solarworld[4]	Freiberg	270/160/n.a.	810
	28	EverQ	Thalheim	100/100/100	480
	29	Schott Solar	Alzenau	20/115/25	450
Thin Films					
poly-Si	30	CSG Solar	Thalheim	20	140
a-Si a-Si/µc-Si	31	Ersol Thin Film[3]	Erfurt[2]	40	40
	32	Brilliant 234.[5]	Thalheim[2]	25	10
	33	Schott Solar	Jena, Putzbrunn[2]	20	80
	34	Sunfilm	Großröhrsdorf[1]	-	-
CIS CIGS CIGSSe	35	Johanna Solar Technology	Brandenburg[2]	30	70
	36	Avancis	Torgau[1]	20	n.a.
	37	Würth Solar	Schwäbisch Hall	15	180
	38	Odersun	Frankfurt (Oder)	n.a.	n.a.
	39	Sulfurcell Solartechnik	Berlin	Pilot	60
	40	Solarion	Leipzig	Pilot	20
	41	CIS-Solartechnik	Bremerhaven	Pilot	20
	42	PVflex Solar	Fürstenwalde	Pilot	20
	43	Global Solar Energy	Berlin[2]	n.a.	n.a.
	44	Nanosolar	Luckenwalde[1]	n.a.	n.a.
	45	Solibro[5]	Thalheim[1]	-	-
CdTe	46	First Solar Manufacturing	Frankfurt (Oder)[2]	100	380
	47	Antec Solar Energy	Arnstadt	10	100
	48	Calyxo[5]	Thalheim[2]	25	20
CPV	49	SolarTec	Munich	Pilot	30
	50	Concentrix Solar	Freiburg	Pilot	30



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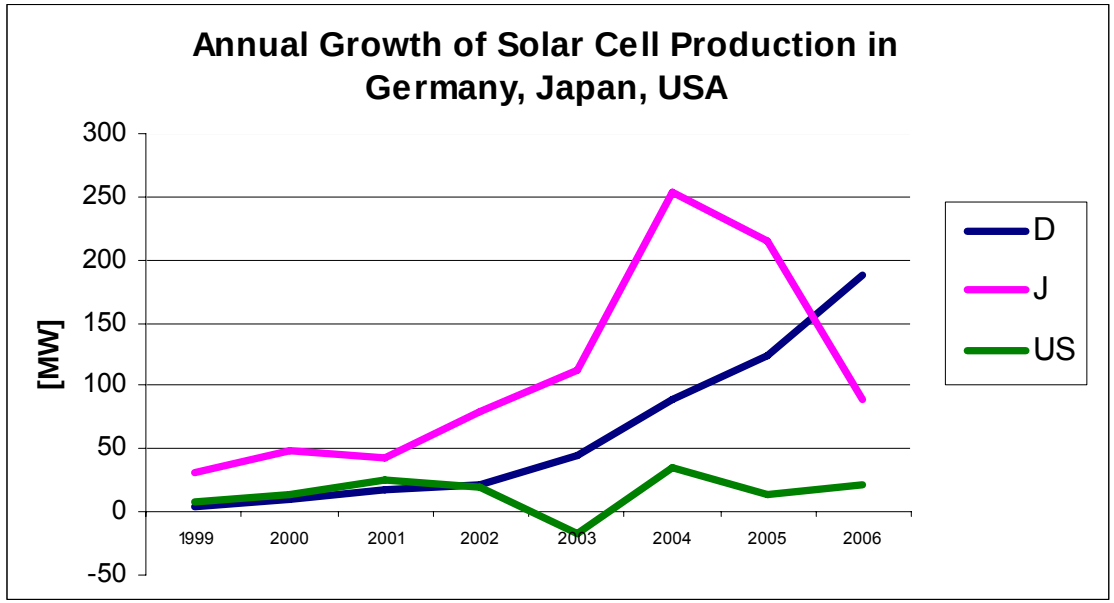
Source: IiG research, April 07

Source: BSW (2007)

German PV Production is growing fast

- In 2006 German solar cell production grew by 50%, Japan by 10%
- Germany has the highest density of PV producer worldwide



- In 2007 and 2008 another 15 PV factories are planned with investments of about €1 billion on all steps of the value chain
- Growing turnover in foreign countries of German PV companies: about €1 billion in 2006

Source: BSW (2007)

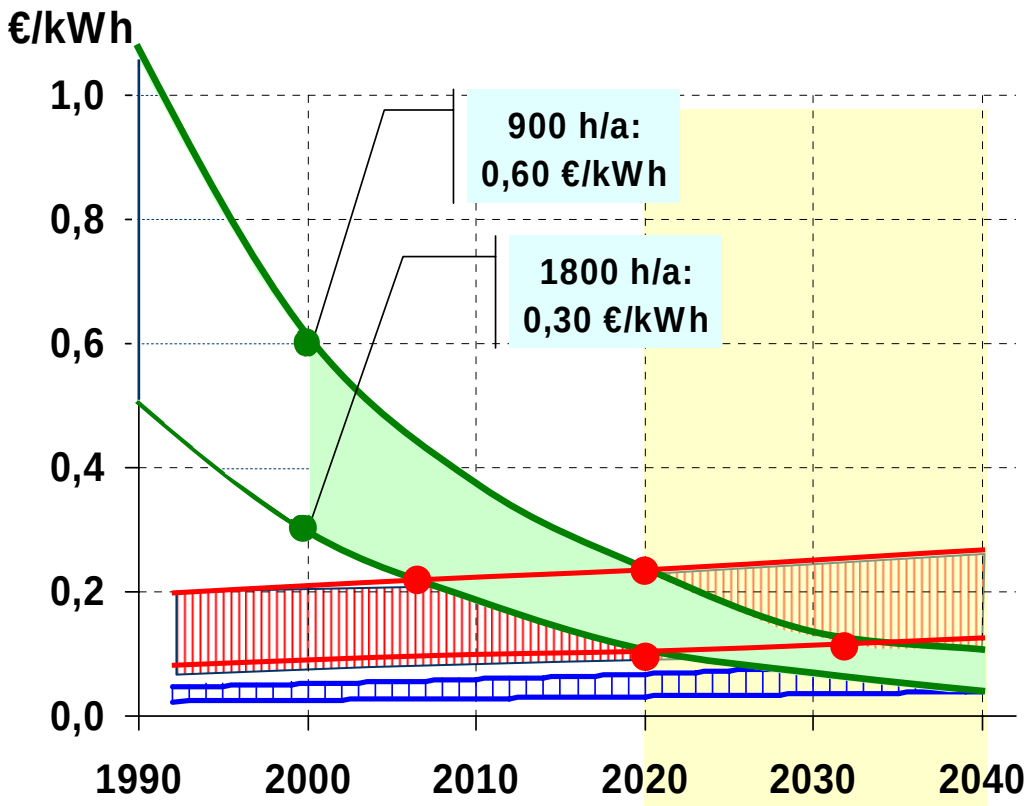
Customer Needs

on-grid	off-grid	consumer	high efficiency
			
€/kWh	€/hr light	W/m²	g/W
			
€/m² / aesthetics	€/W	flexibility	W/mm²

Source: Fraunhofer ISE

Competitiveness between Electricity Generating Cost for PV and Utility Prices

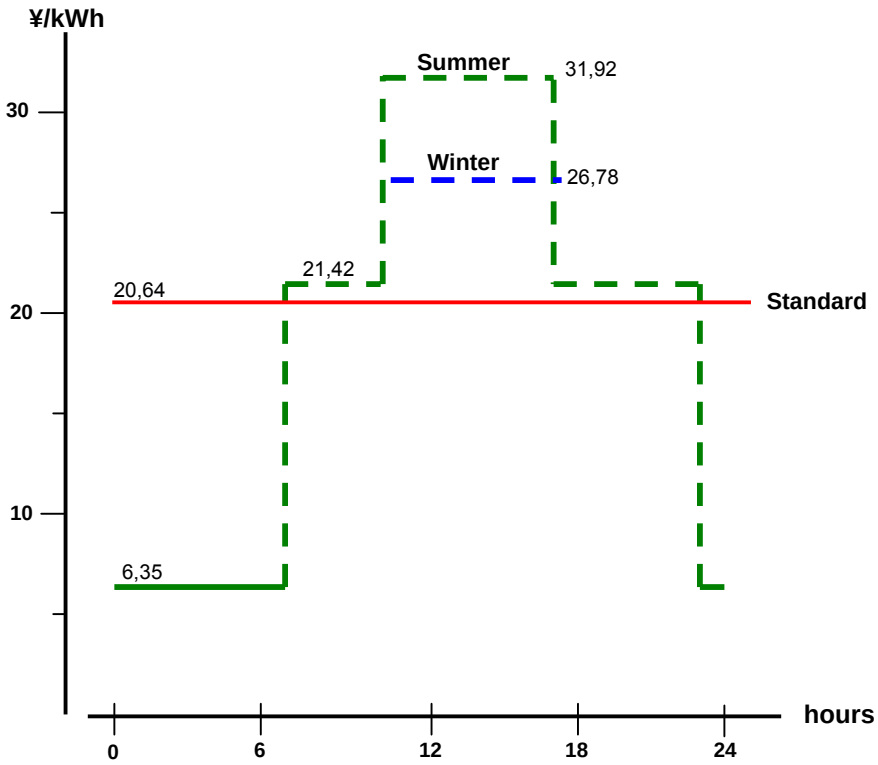
- Photovoltaics
- Retail prices private and small business
- Large power consuming industries



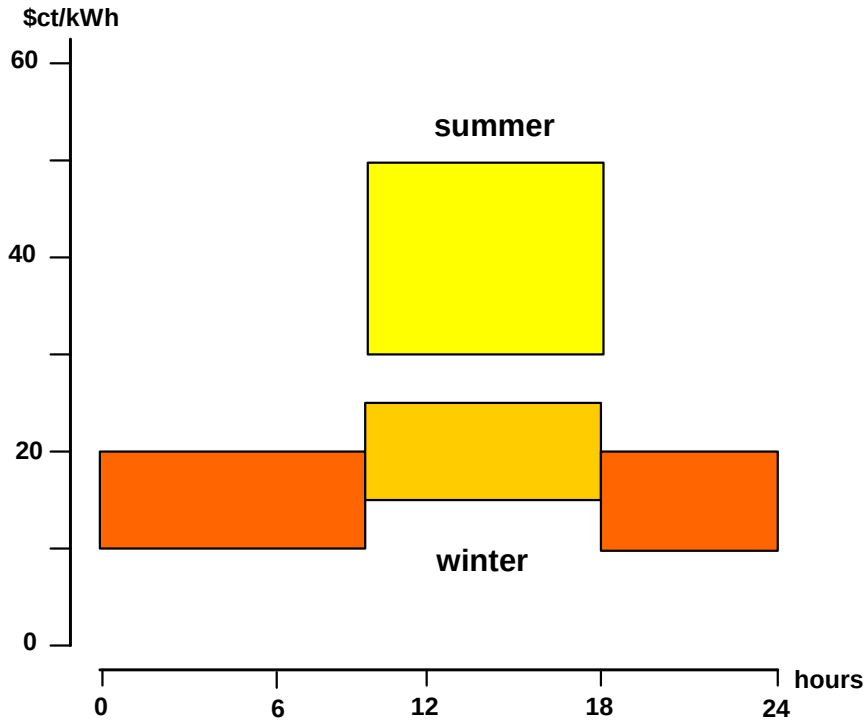
market support programs necessary:

Source: RWE Energie AG and SCHOTT Solar GmbH

Tokyo Electric Power Cooperation (Jp) Tariff 2005

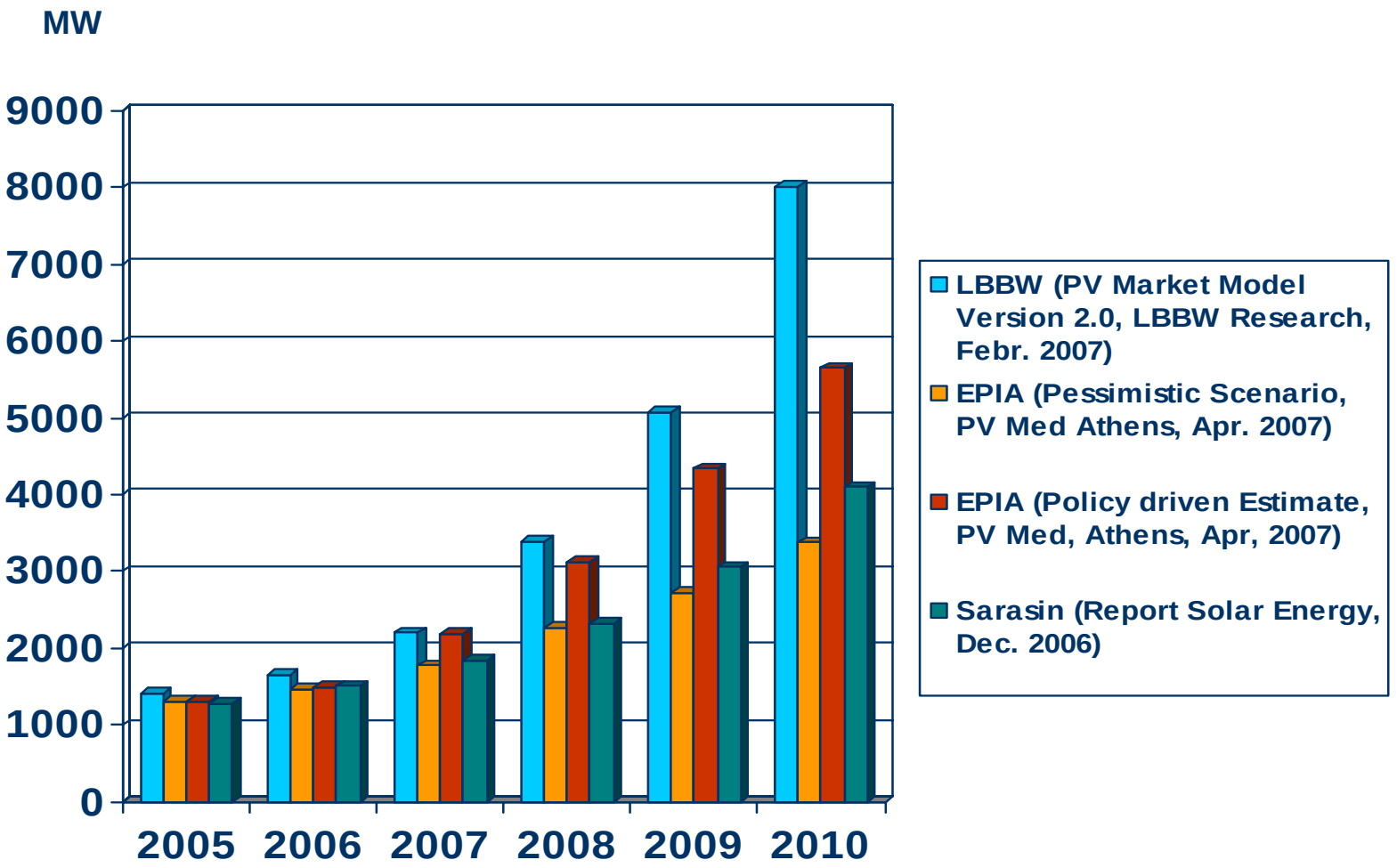


Range of Electricity Prices in California

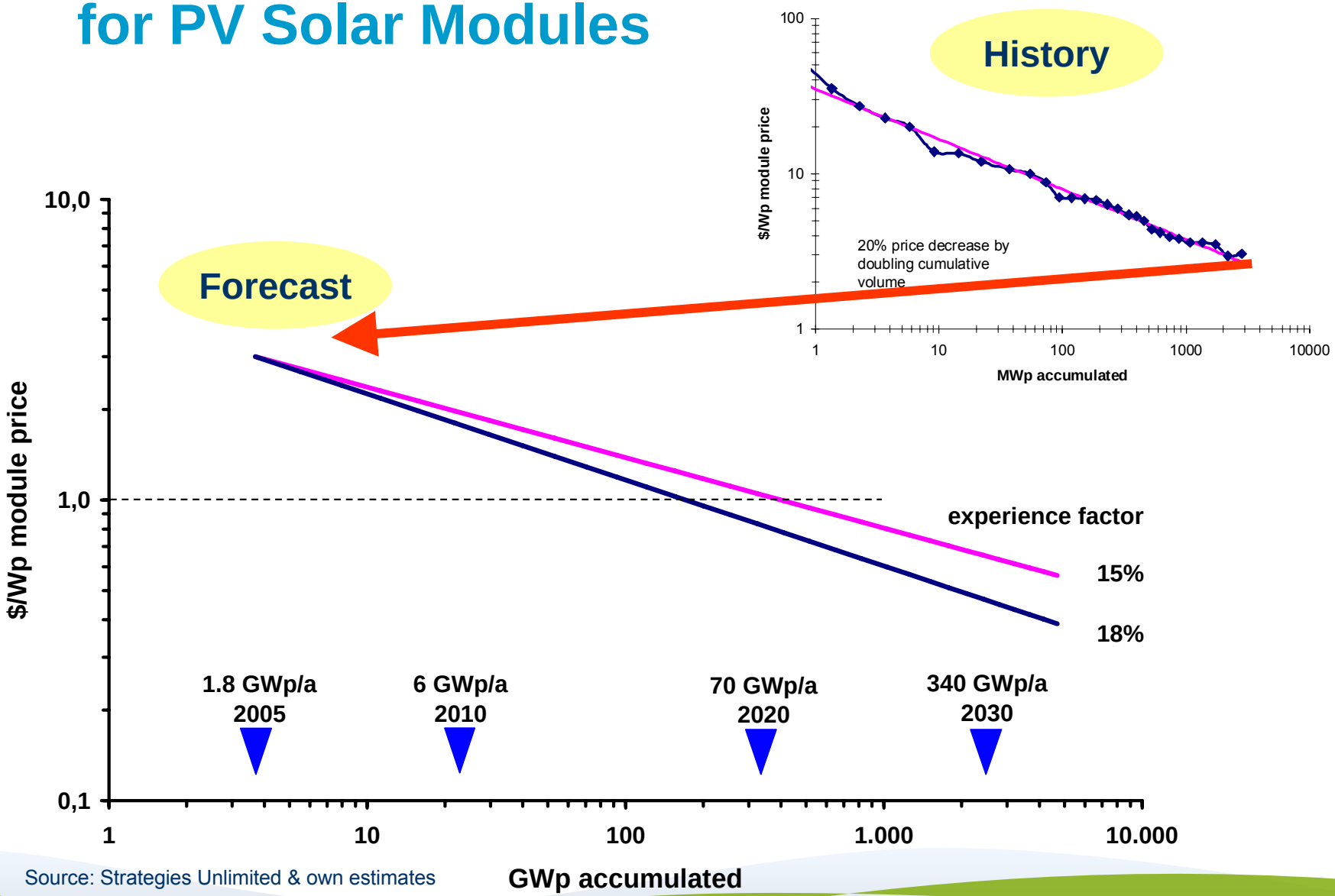


Source: public information TEPCO (left)
data from Alison Hyde, BSW (right)

Different World PV Market Projections until 2010

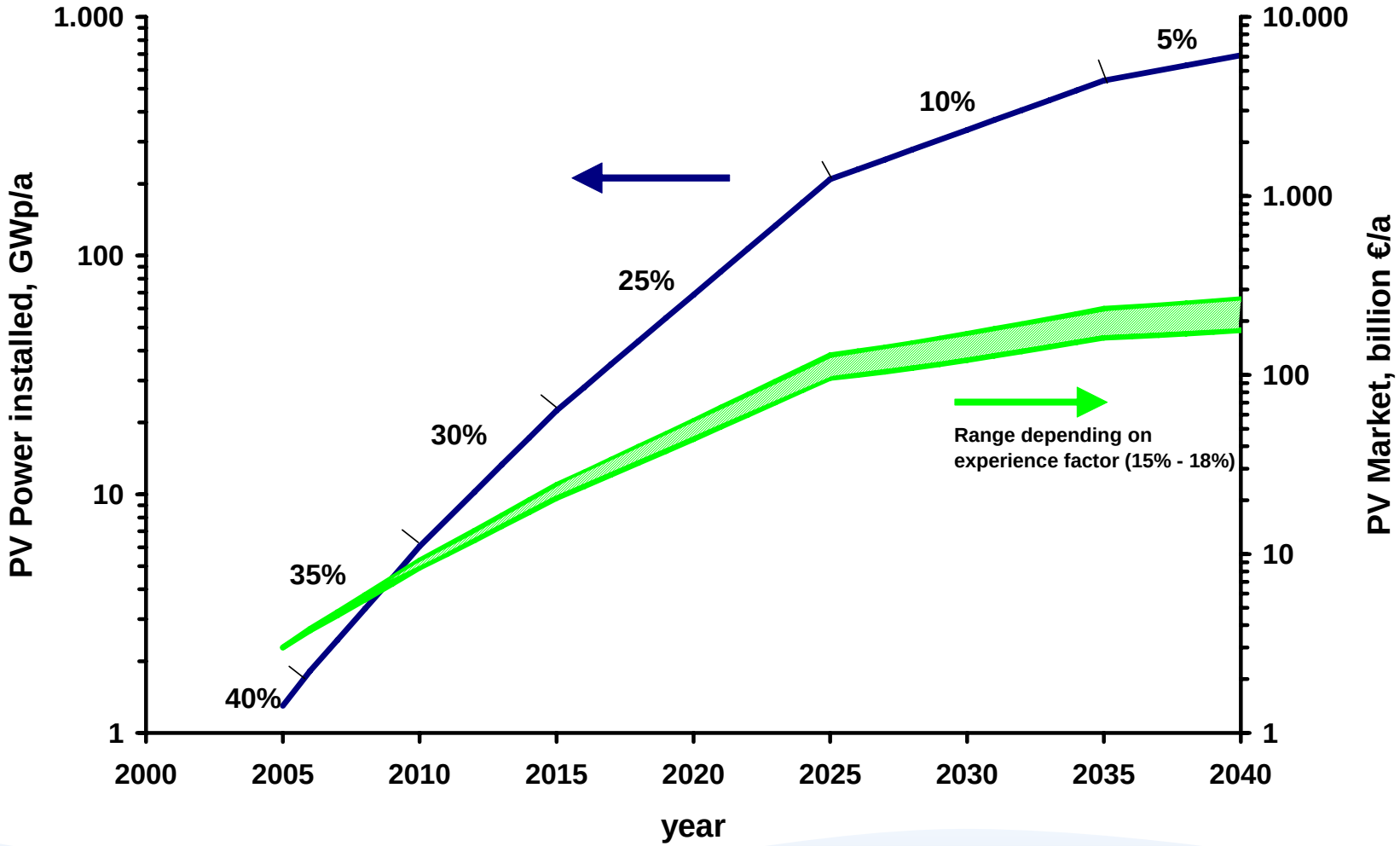


Price Experience Curve for PV Solar Modules



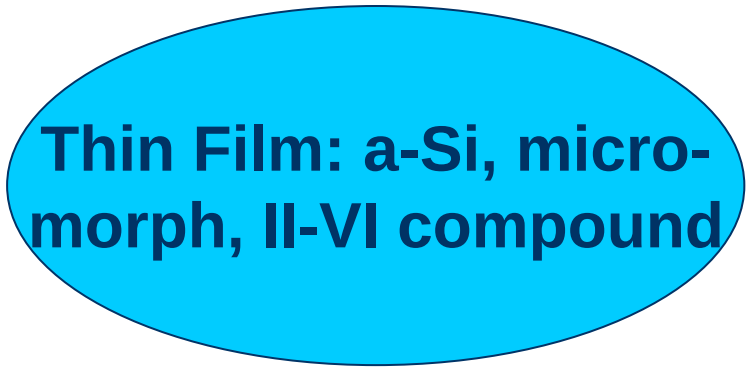
Source: Strategies Unlimited & own estimates

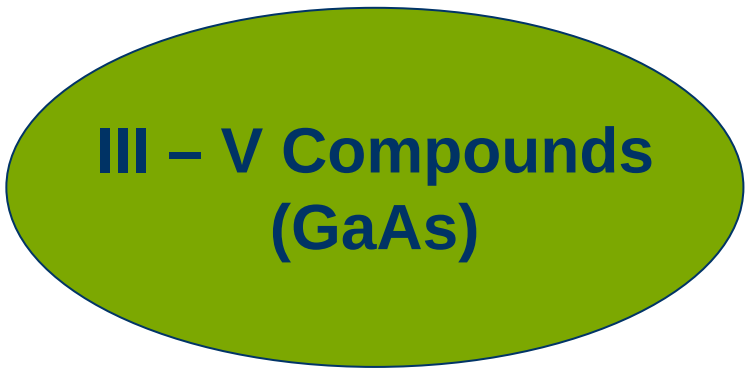
Future Growth Forecast of the Global PV Solar Electricity Market in GW and bn€ turnover

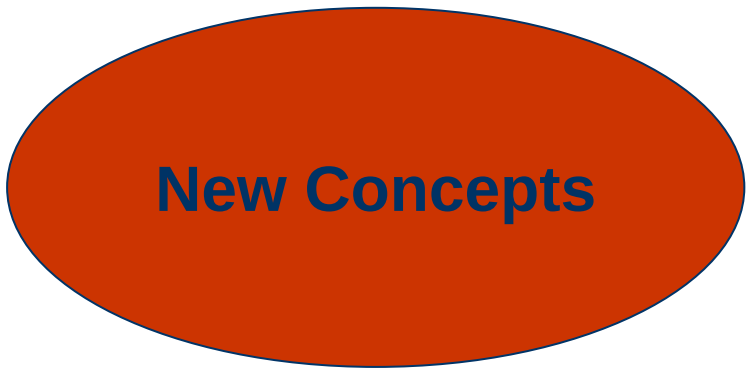


Source: pricedata from Fig 14
Growth figures own estimates

The four main technology routes







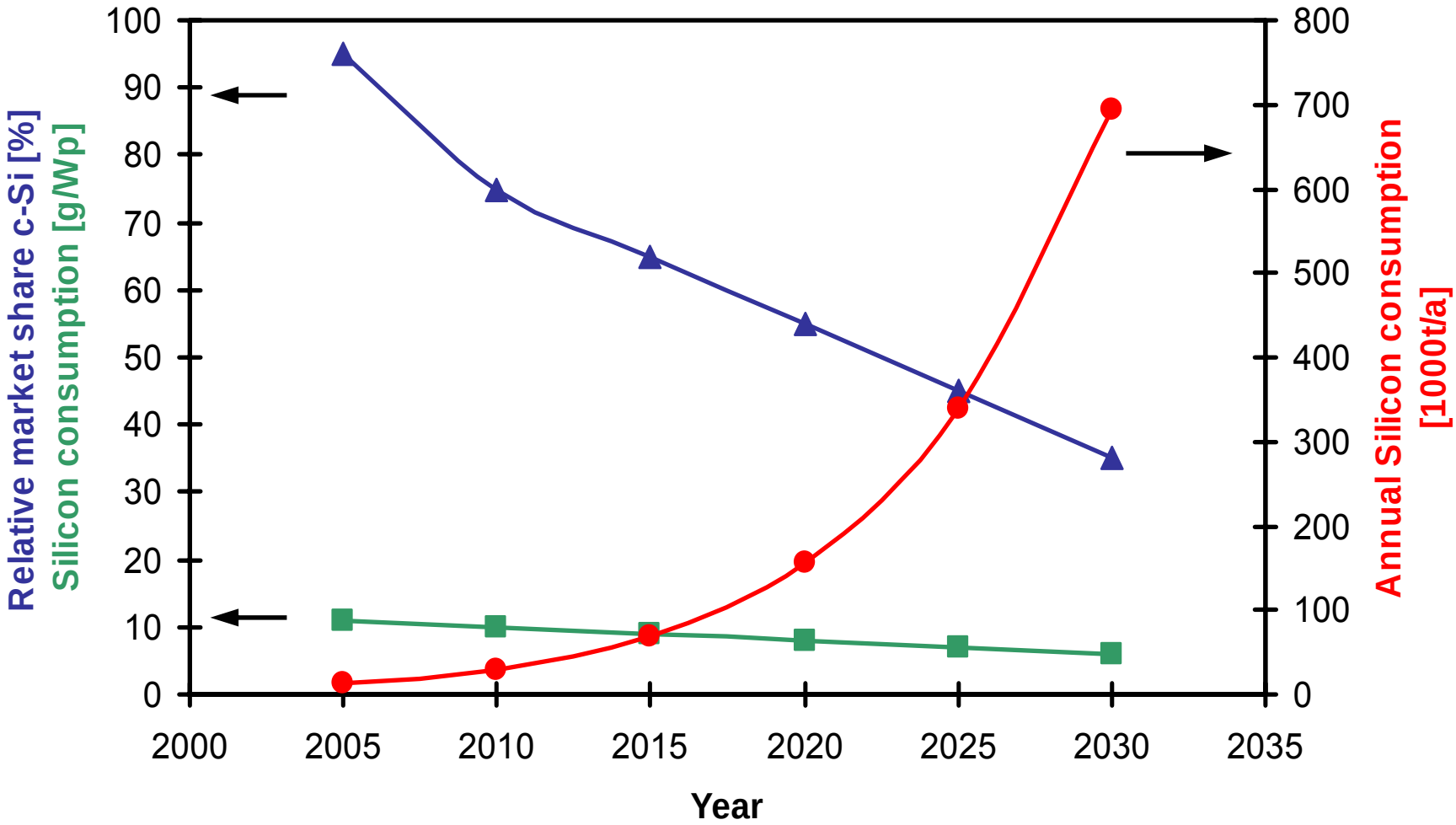
c-Si Technology

		2000	2010	2020
wafer	[µm]	300	180	100
kerf loss	[µm]	250	200	150
cell efficiency	[%]	14-17	17-22	19-24 %
module		long term stable, low cost/m² technology		

In the long run integrated manufacturing of ultrathin wafers (100 µm or less) and subsequent cell and laminating processes will drive factory efficiencies and effectiveness.

Source: EPIA & own estimates

Development of c-Si and TF / New Concepts Share and Annual Silicon Consumption



Source: EPIA & own estimates

Thin Film Technologies

a) **Low cost (price) per m²** (BIPV) at lower eta (4-6%)

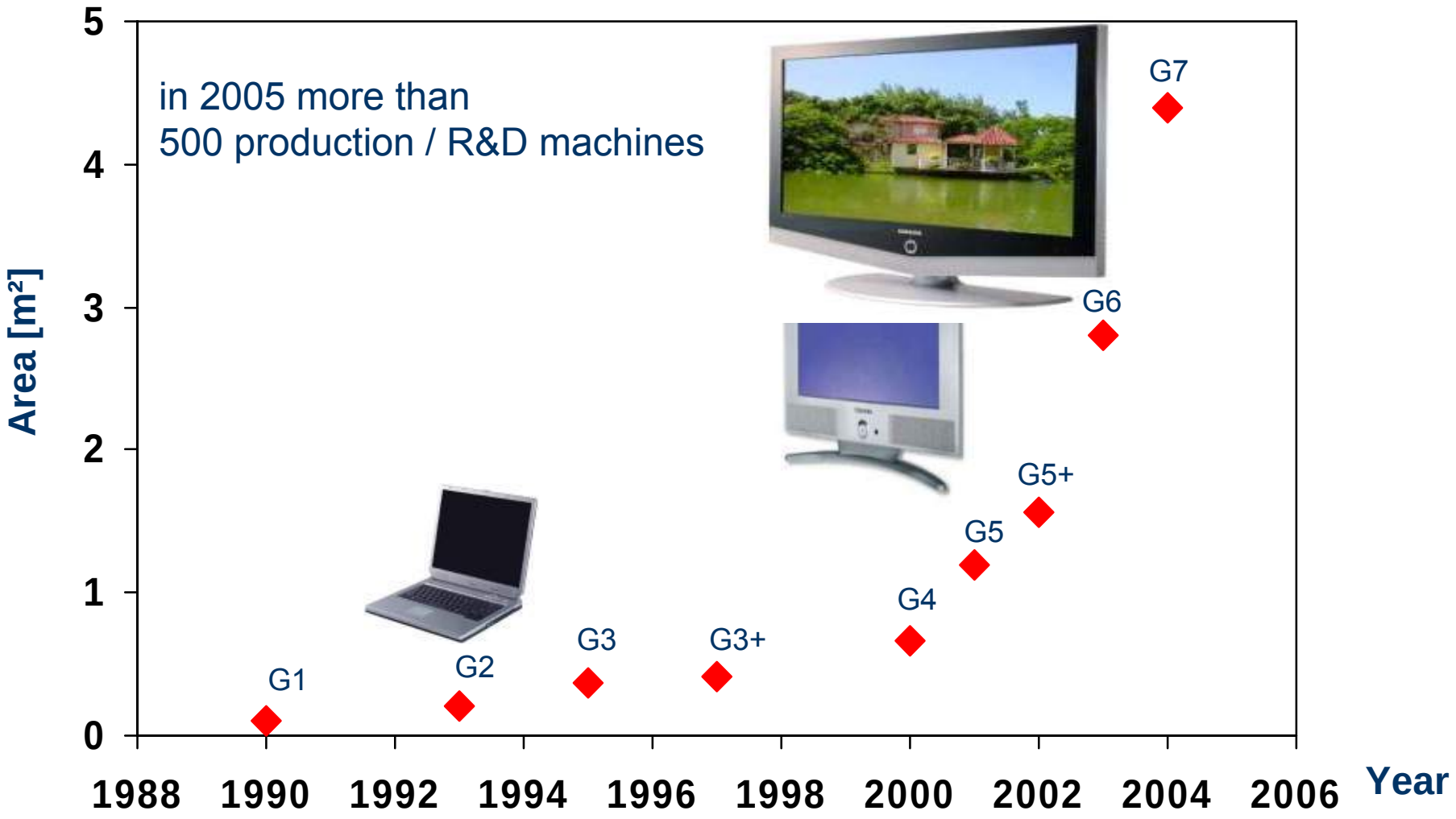
- deposition area: 0,6 → 1,4 → 3 → 5 → 10 m²
- utilize technology development in TFT technology (e.g. ASI)
- creation of semitransparency by thin-layers
- flexible solar cells (… web coaters)

b) **Low cost (price) per Wp**

- ASI/µc-Si and II – VI compound (CIS, CTS)
- efficiency from 8 – 12 % today up to 10 – 15 % in 2010 and 14 – 20 % in 2030

Source: EPIA & own estimates

Thin film:
TFT Display Technology Development



Source: Applied Materials

Electricity generating cost [€ct/kWh] Eurelectric / VGB Power Tech	Today 2005	Tomorrow 2030	Day after tomorrow 2050
Fossile (coal, gas)	4 - 4.5	6-7	6.5 - 9
Nuclear (PWR, HTR, FBR)	4 – 6	3.5 – 7	3.5 - 6
PV solar electricity (south/north)	20/40	5/10	3/6

= own estimates

END

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