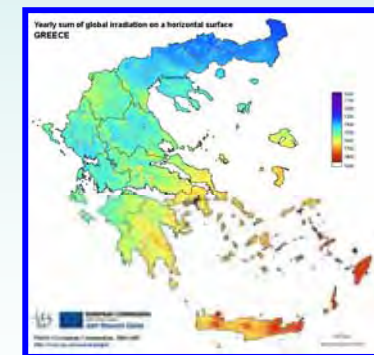
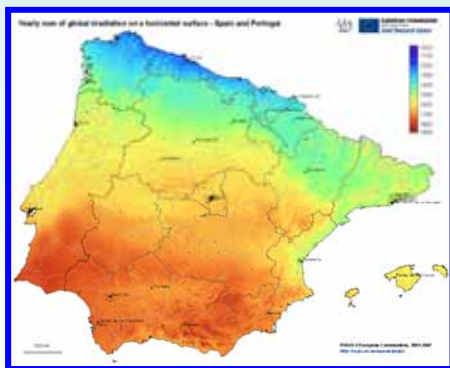


# *Status of Photovoltaic Industry, Market and Deployment in Spain: The risk of the Success*

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Division of Renewable Energy  
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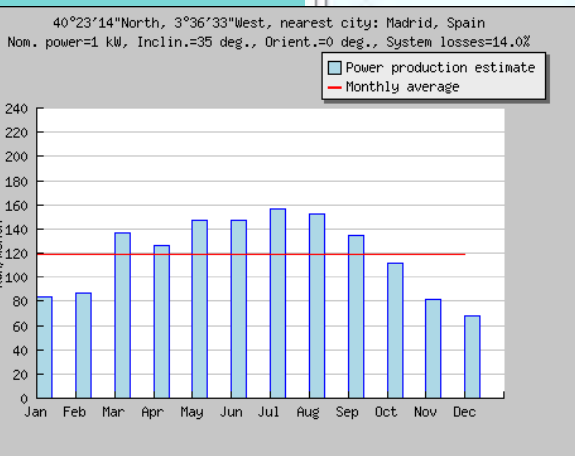
**Athens Energy Week '08: Photovoltaic Seminar**  
November 12th, 2008



# Photovoltaic Solar Electricity Potential in European Countries

ies EUROPEAN COMMISSION  
 DIRECTORATE-GENERAL Joint Research Centre  
 © European Communities, 2006  
<http://re.jrc.ec.europa.eu/pvgis/>

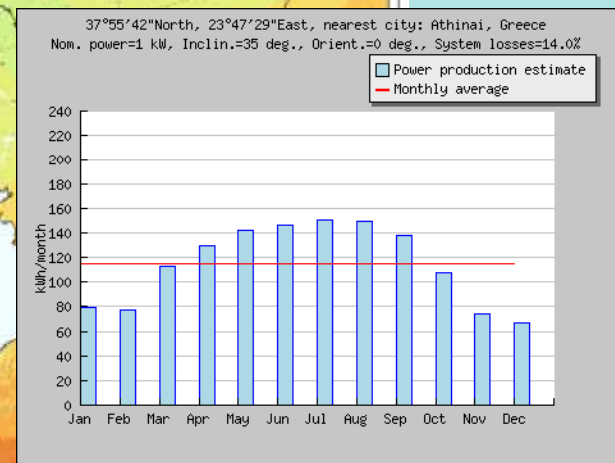
Madrid



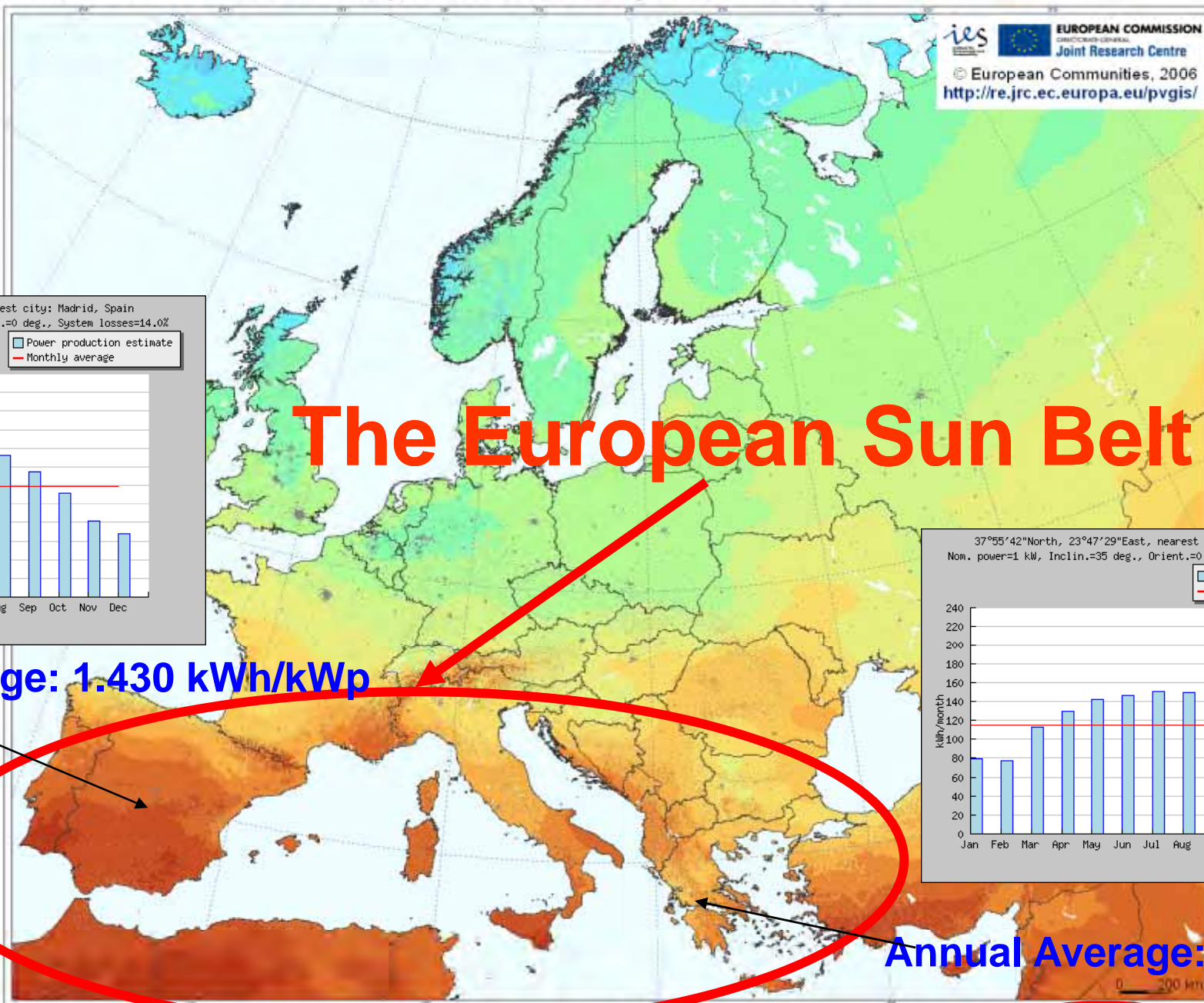
The European Sun Belt

Athens

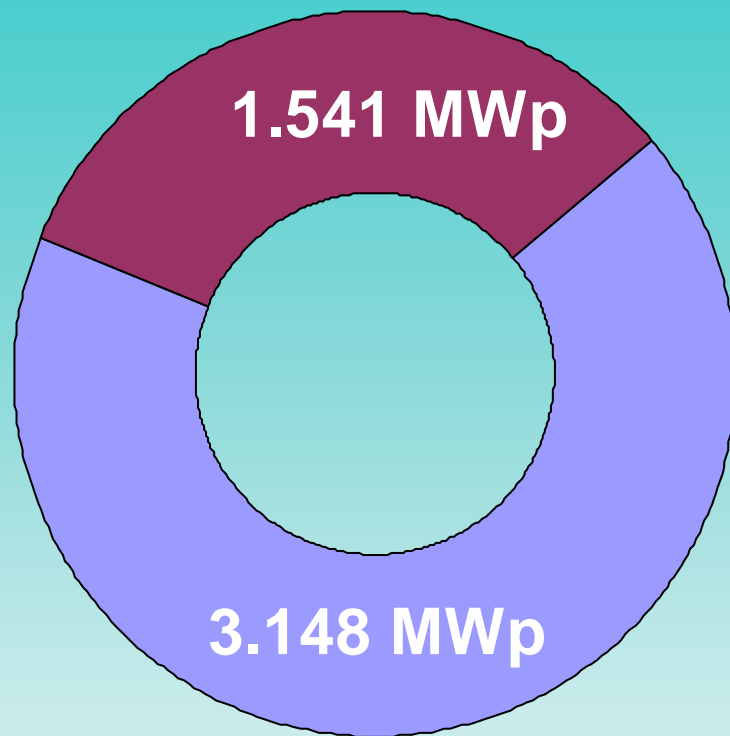
Annual Average: 1.430 kWh/kWp



Annual Average: 1.350 kWh/kWp



Accumulated PV Power in EUROPE 2007: 4,69 GW



- Accumulated PV Power in Europe until 2006
- Installed PV Power in Europe during 2007

*ii 33% of the total PV Power was installed 2007 !!*

*(Germany and Spain)*

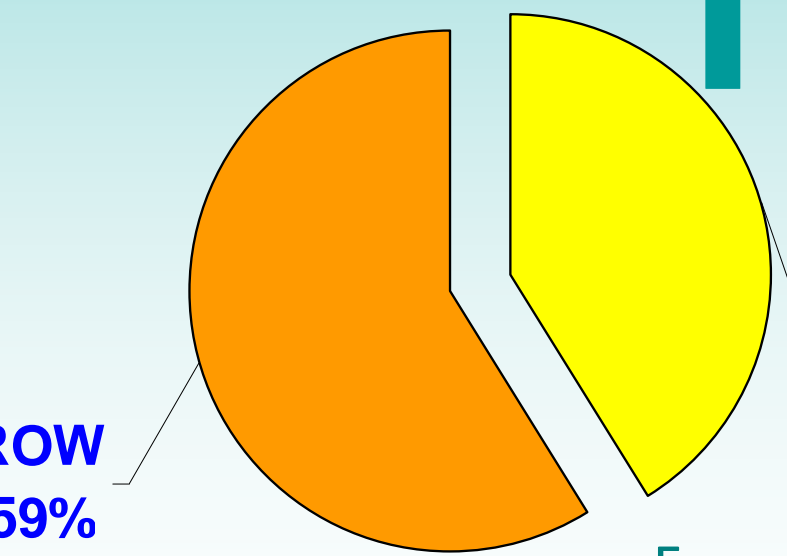
World Photovoltaic Market 2008\*: 3,62 GWp.

Spanish Market 2008\*: 300 MWp\*

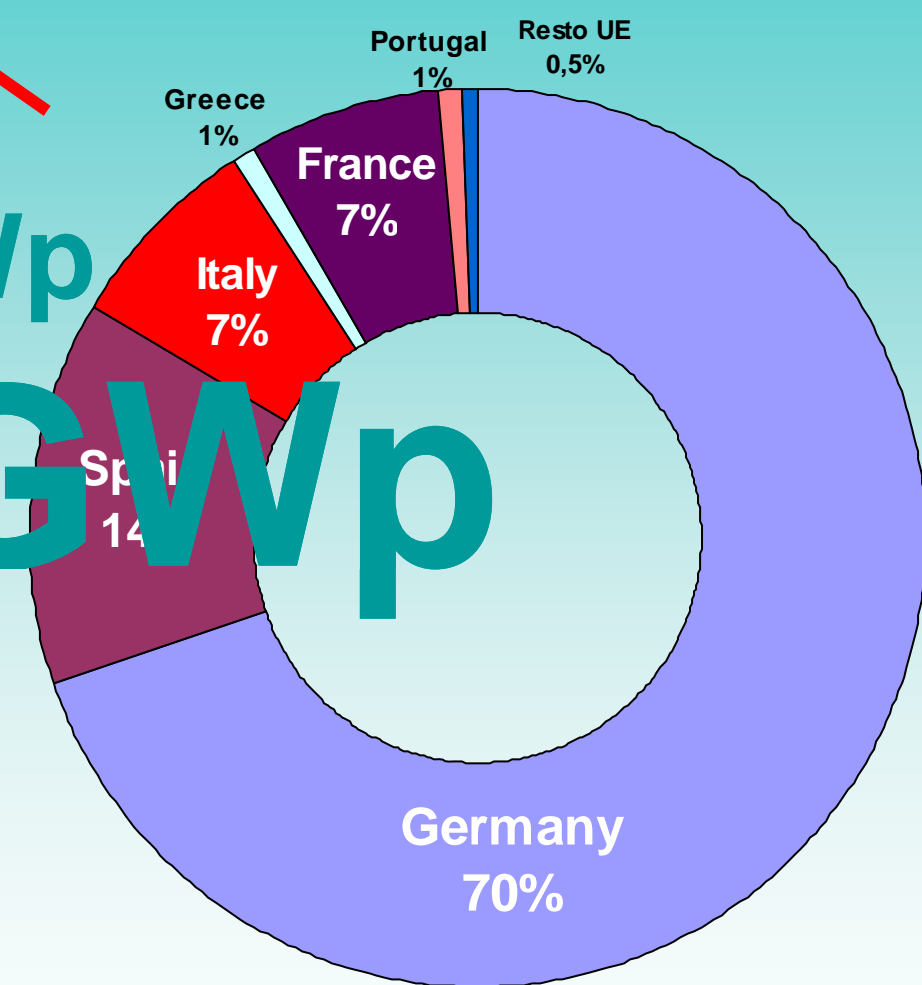
Estimated figures\*

~~1-1,2 GWp~~

~~1,6 GWp~~



Germany 41%



European Photovoltaic Market Distribution 2007

# Deployment and Policy Framework:

## - Renewable Energies National Plan



# Legal and Regulatory Framework:

## -Royal Decree 661/2007.

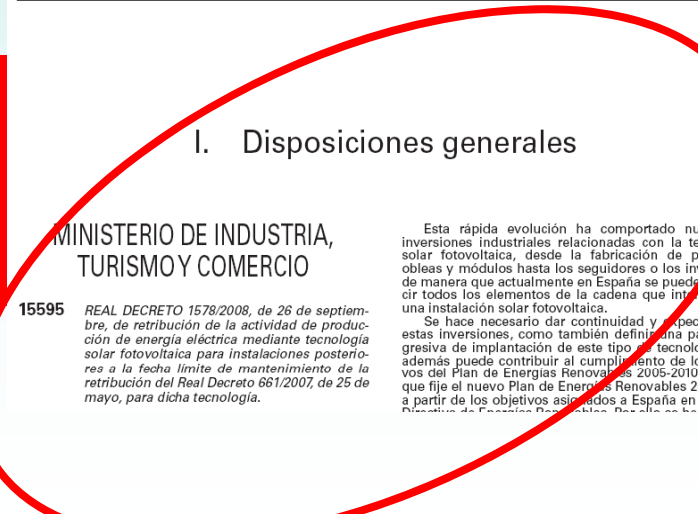


## -Technical Building Code. ( Since September 2007)



BOE núm. 234      Sábado 27 septiembre 2008      39

# - New Royal Decree 1578/2008 (In force after September 29th).



# Deployment and Policy Framework: Targets PER 2005-2010

## Renewable Energies Plan 2005-2010

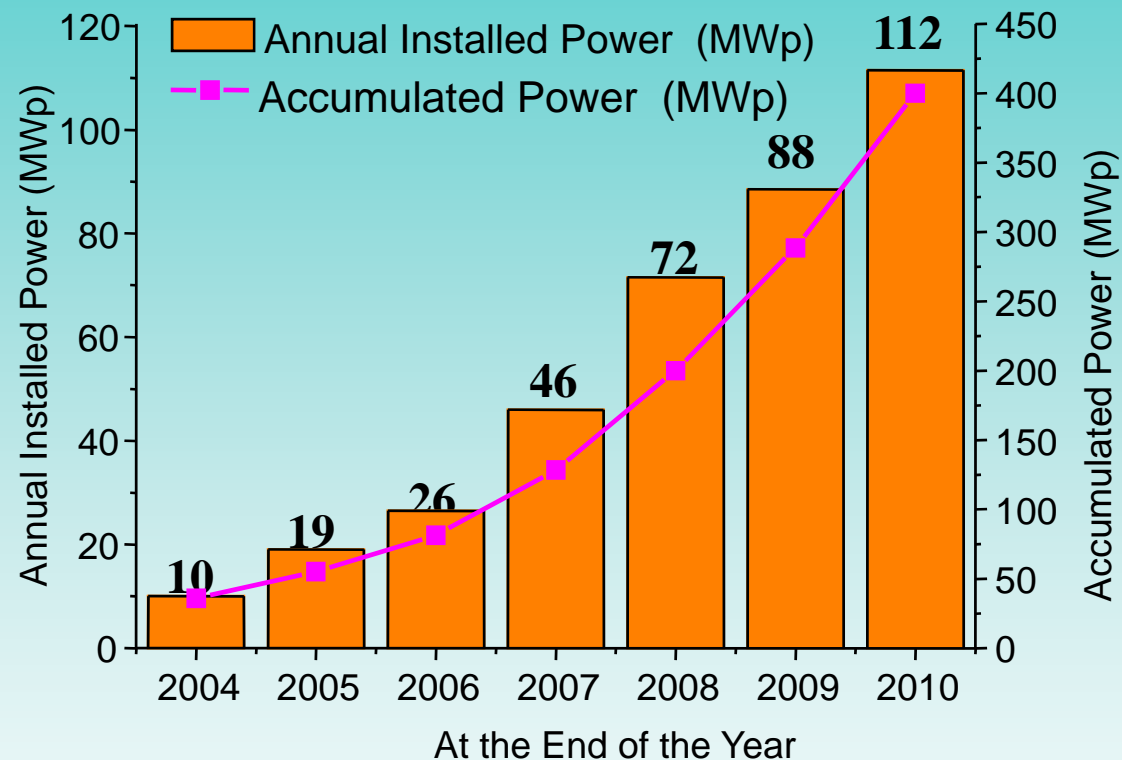
### Photovoltaics Targets PER 2010

#### Goal

(2010): **400 MW**

#### Increase

(2005-2010): **363 MW**



#### Breakdown by Installation Categories (2010):

Off-Grid	On-Grid P<100kW	On-Grid P<100kW (Sun Tracking)	On-Grid P>100kW
<b>15 MW</b>	<b>205 MW</b>	<b>112 MW</b>	<b>31 MW</b>

# PV Status in Spain at the beginning of 2008

RD 436/2004

RD 661/2007

## Feed in Tariff Regulation: Evolution of on-Grid PV Installations

	2003	2004	2005	2006	2007	Growth 2003-2007
<b>Number of Installations</b>	<b>1.554</b>	<b>3.207</b>	<b>5.271</b>	<b>9.533</b>	<b>14.567</b>	<b>837 %</b>
P ≤ 5kWp	1.498	3.007	4.552	6.703	8.561	471 %
5 kWp < P ≤ 100 kWp	52	195	713	2.851	5.988	11.415 %
P > 100 kWp	4	5	6	9	18	350 %
<b>Installed Capacity (MWp)</b>	<b>11</b>	<b>22</b>	<b>44</b>	<b>141</b>	<b>256</b>	<b>3.136%</b>
P ≤ 5kWp	7	14	21	32	40	471 %
5 kWp < P ≤ 100 kWp	1	5	20	103	289	28.800 %
P > 100 kWp	3	3	3	6	27	800 %

Source: National Energy Commission

## 2007 PRODUCTION OF CELLS AND MODULES IN SPAIN

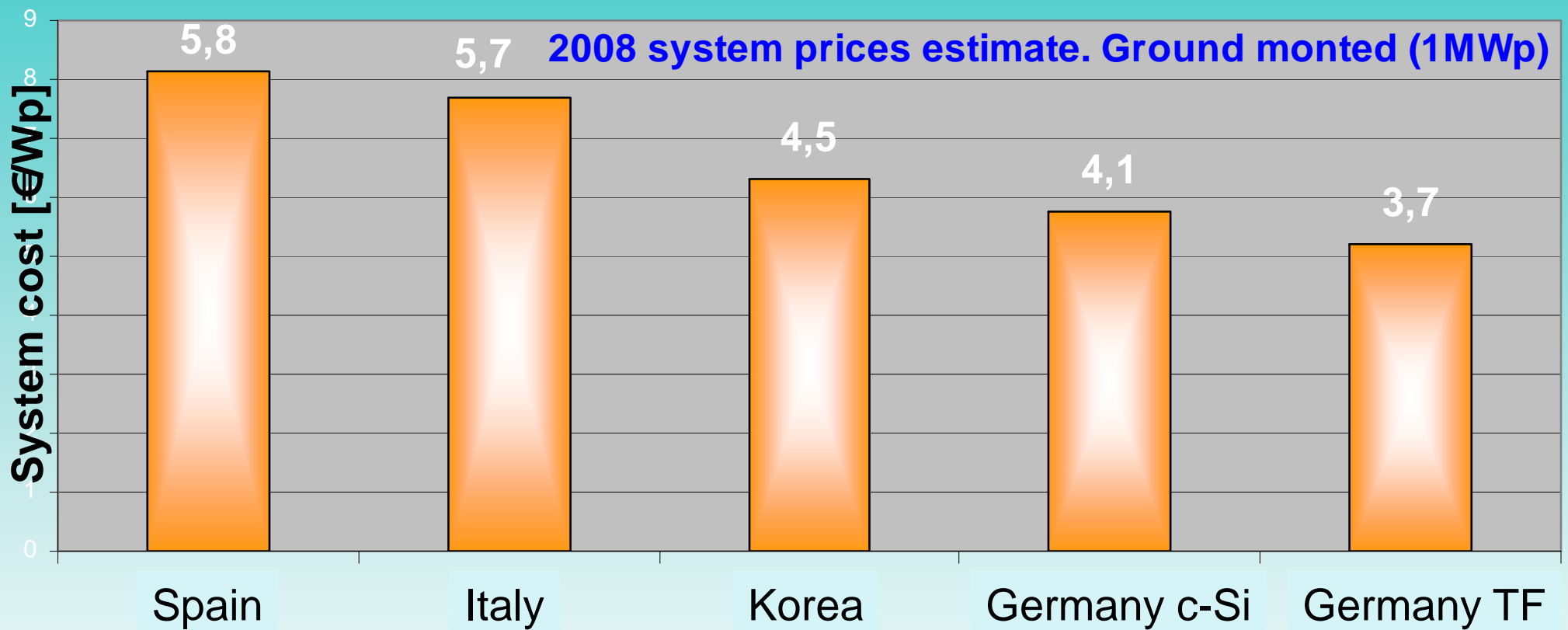
	Cells		Modules	
	Production MWp	Capacity MWp	Production MWp	Capacity MWp
Polysilicon	115,00	165,00	149,53	340,30
Thin Films	n/a	n/a	n/a	¿20-30?
Concentration	n/a	n/a	5	7
<b>TOTAL</b>	<b>115,0</b>	<b>165,0</b>	<b>154,5</b>	<b>347,3</b>

## 2007 SPANISH PV INDUSTRY GLOBAL POSITION

Spanish Cell Production/World Production	4%
Spanish Module Production/World Production	5%
Spanish Cell Capacity/World Capacity	10%
Spanish Module Capacity/World Capacity	18%



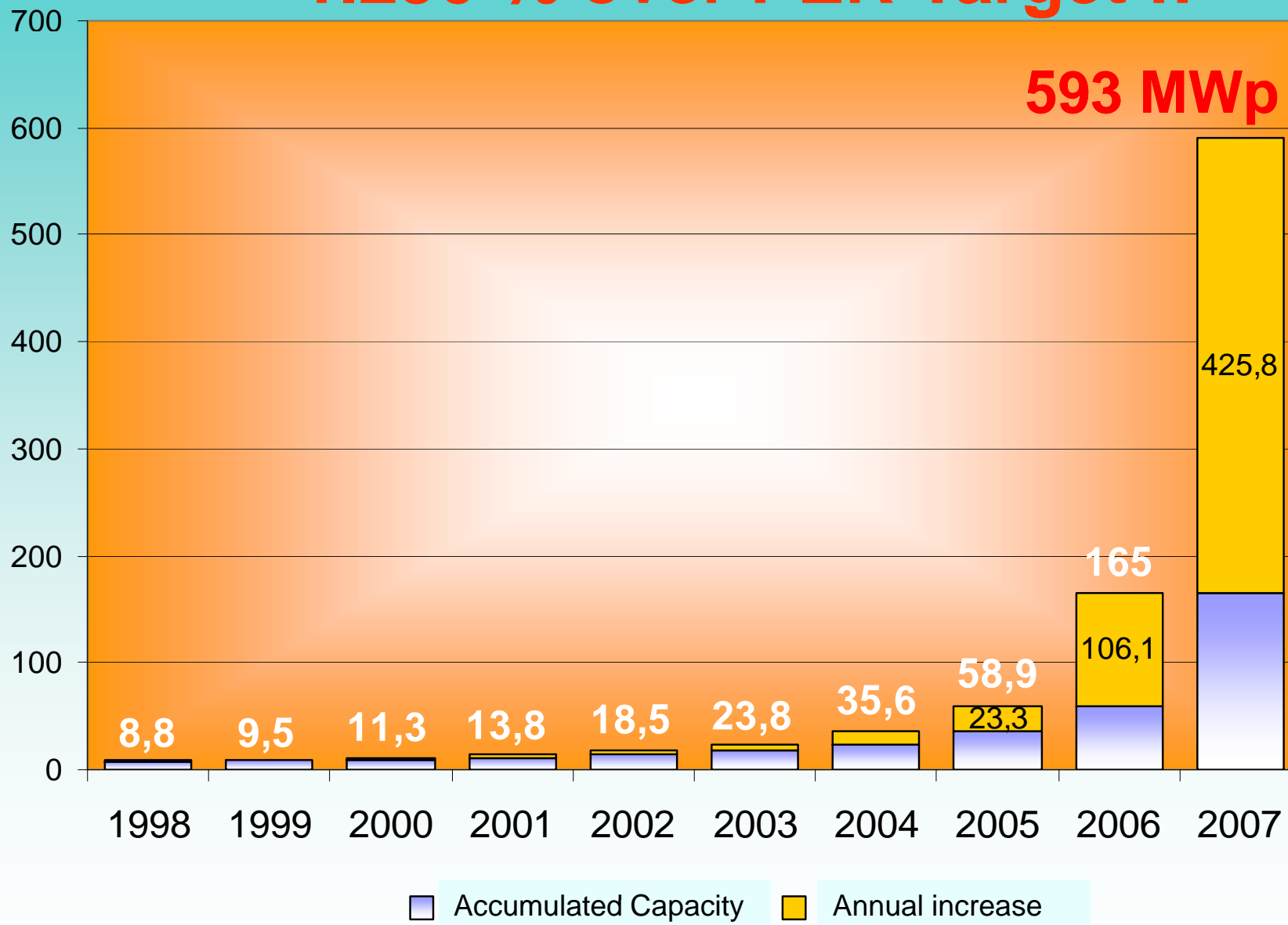
# Cost of the PV Solar Systems in Spain



Higher system prices than in equivalent large-scale PV Market

# New and Accumulated PV Systems

**1.290 % over PER Target !!**



## Photovoltaic Investment in Spain (M€)

Factories and Manufacturing:	400
PV Installations and Systems:	2.500
Stock Exchange:	2.100
<b>TOTAL</b>	<b>5.000</b>



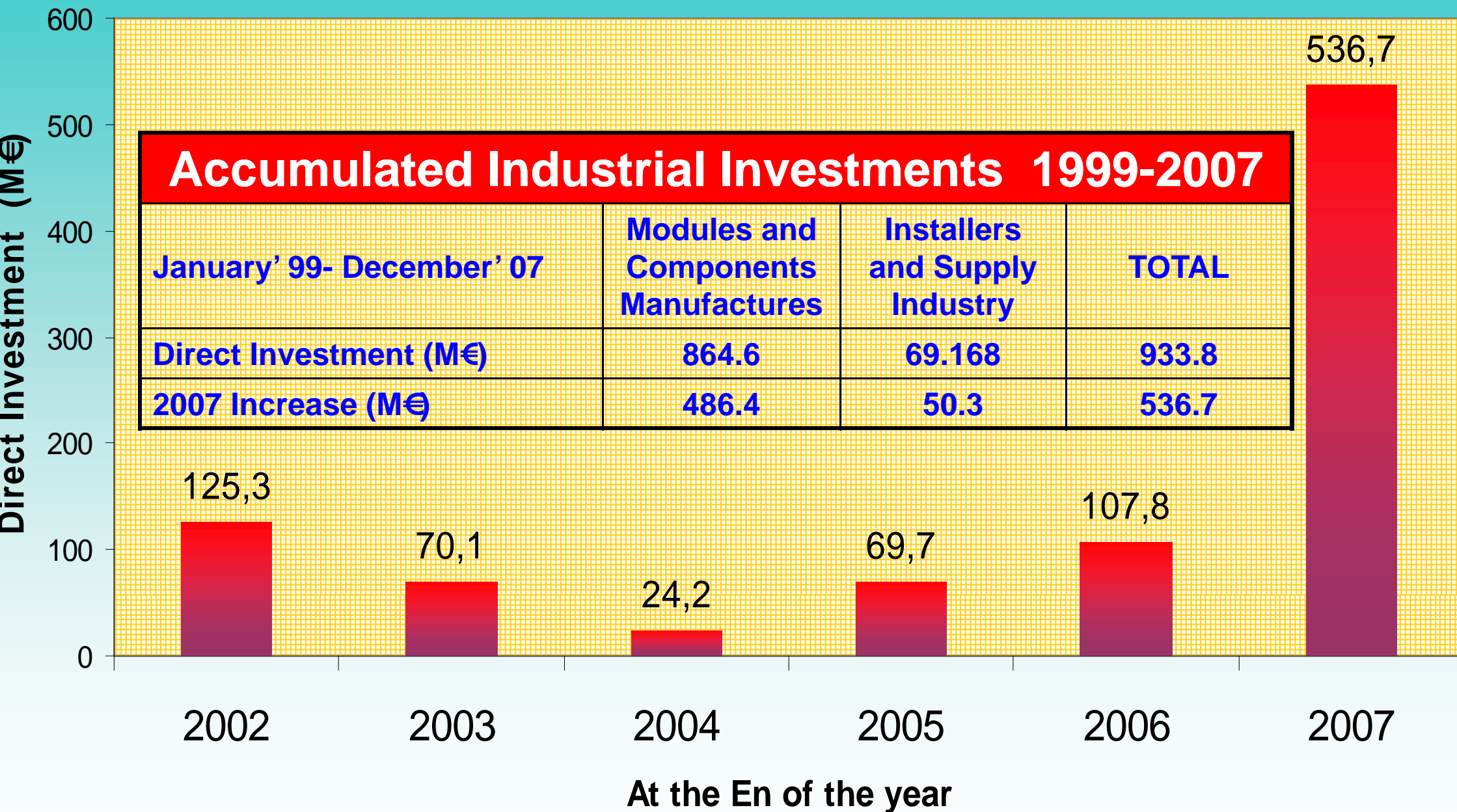
## Spanish Photovoltaic Sector Sales (M€)

PV Installations and Systems:	7.500
Sale of PV-Electricity:	250
<b>TOTAL</b>	<b>7.750 M€</b>



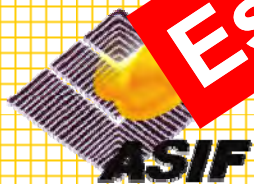
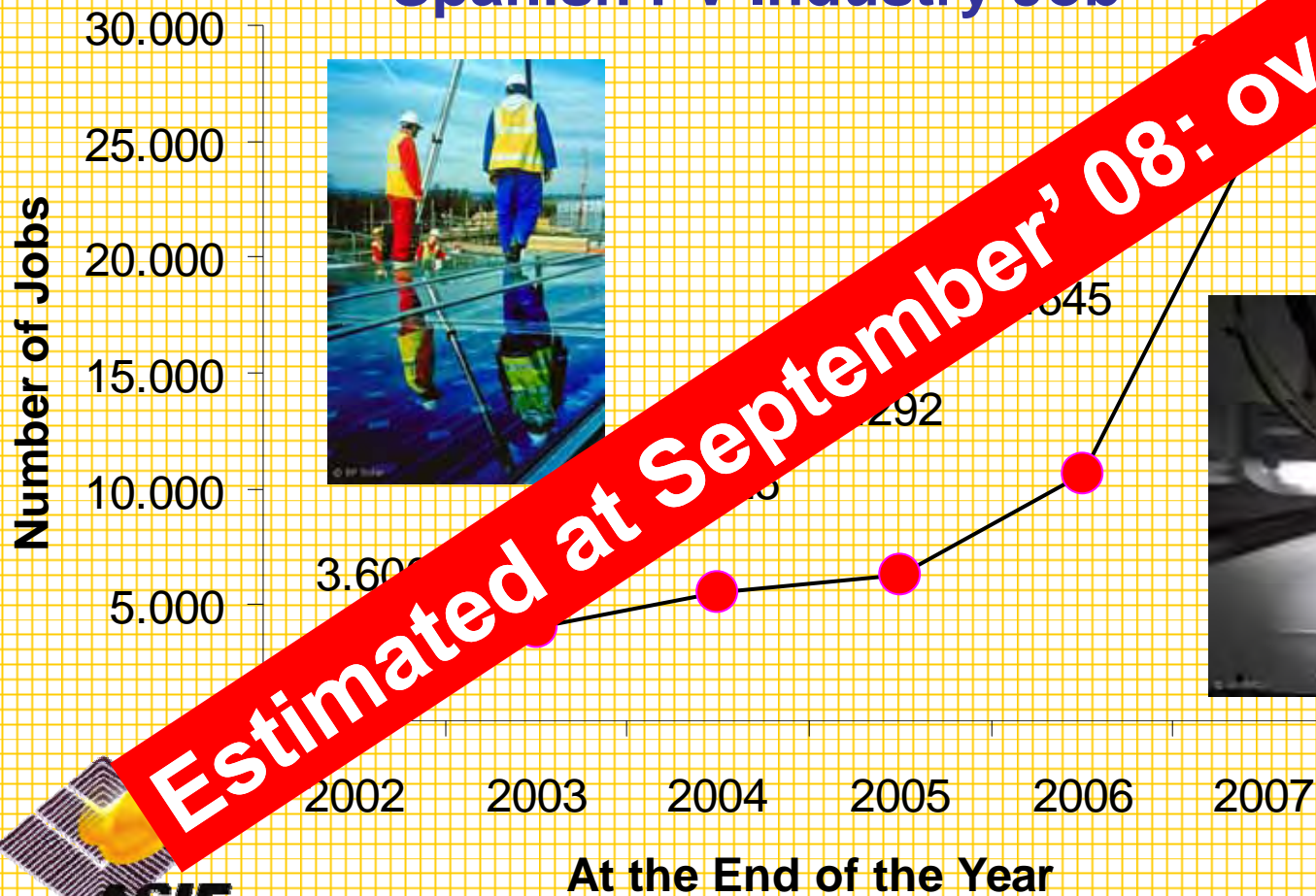
**Imported Modules: 2.500 M€ !!**





# Employ Generation

## Spanish PV Industry Job



# The Photovoltaic Paradox in Spain:



**The risks of the success**

**R.D. 1578/2008**

# Spanish PV Regulatory and legal Framework 2007- Sept 2008: Feed in Tariff Regulation RD 661/2007

-Determines a feed-in-tariff for PV, annual revision according with the inflation rates.

Tariff	Installed Power	Installed Power	Installed Power
	$P \leq 100 \text{ kW}$	$100 \text{ kW} < P < 10 \text{ MW}$	$10 \text{ MW} < P \leq 50 \text{ MW}$
First 25 Years (€cent/kWh)	44,0381	41,7500	22,9764
After 25 Years (€cent/kWh)	35,2305	33,4000	18,3811

- Cap Limit 371 MWp (PER). Revision of the tariff every four years, or if PER objective is reached. Revisions will not retroactive.

- PER Objective reached in August 2008. One year to connect new installations to the grid according to RD 661/2007. **September 2008, after that .....**

# Spanish PV Feed-in-Tariff situation at the End of 2006: RD 661/2007. Why and consequences.

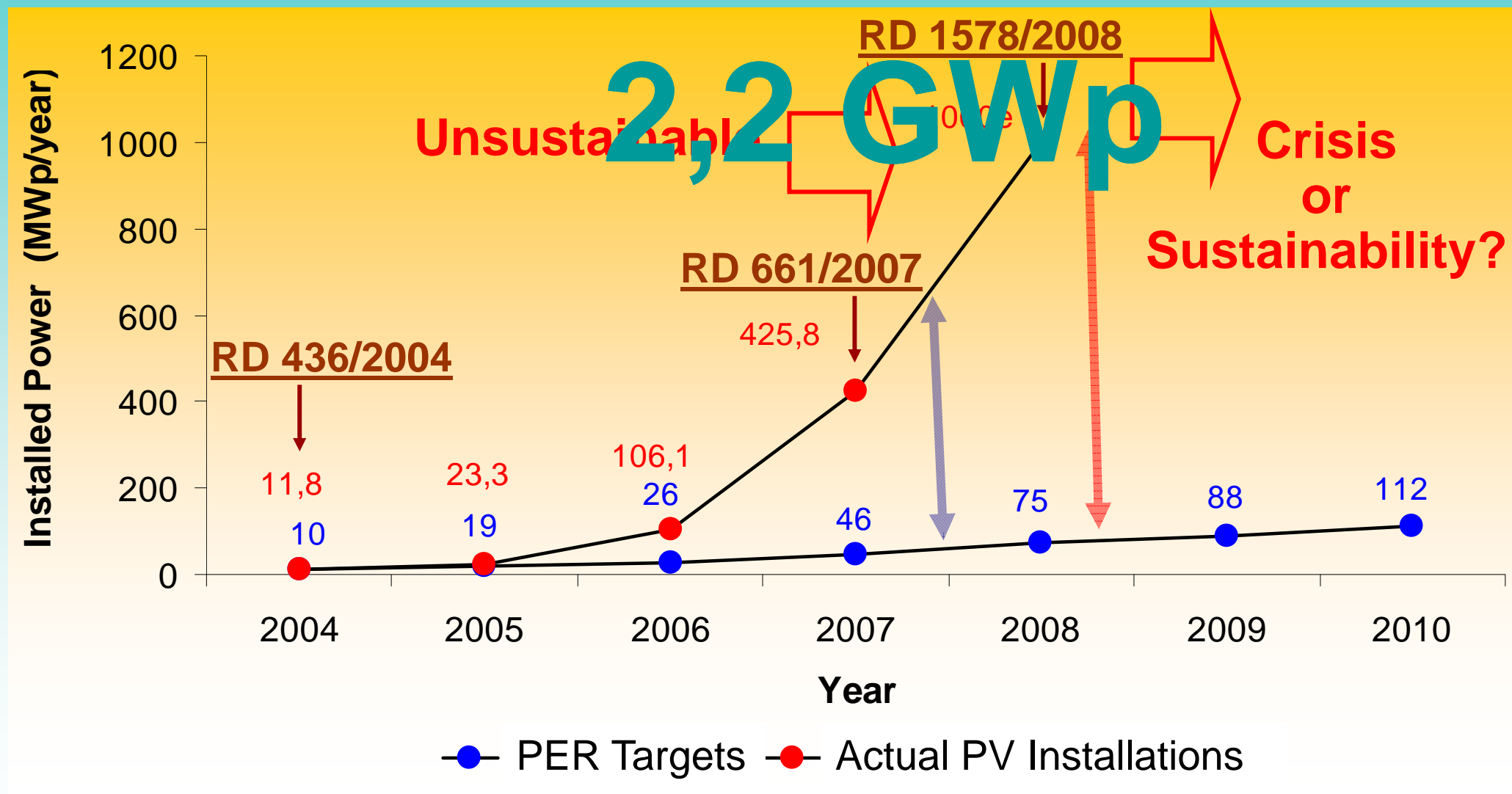
Objectives	Status September 2008
To reach PER PV Targets	Surpassed
Adequate times for Investment return.	Surpassed
To support the Spanish PV Industry	Reached
Results	
Fast growth but un-sustainable	
Feed-in-Tariff cost out control*	

\*Cost determined by PER during the period 2005-2010: **500 M€**

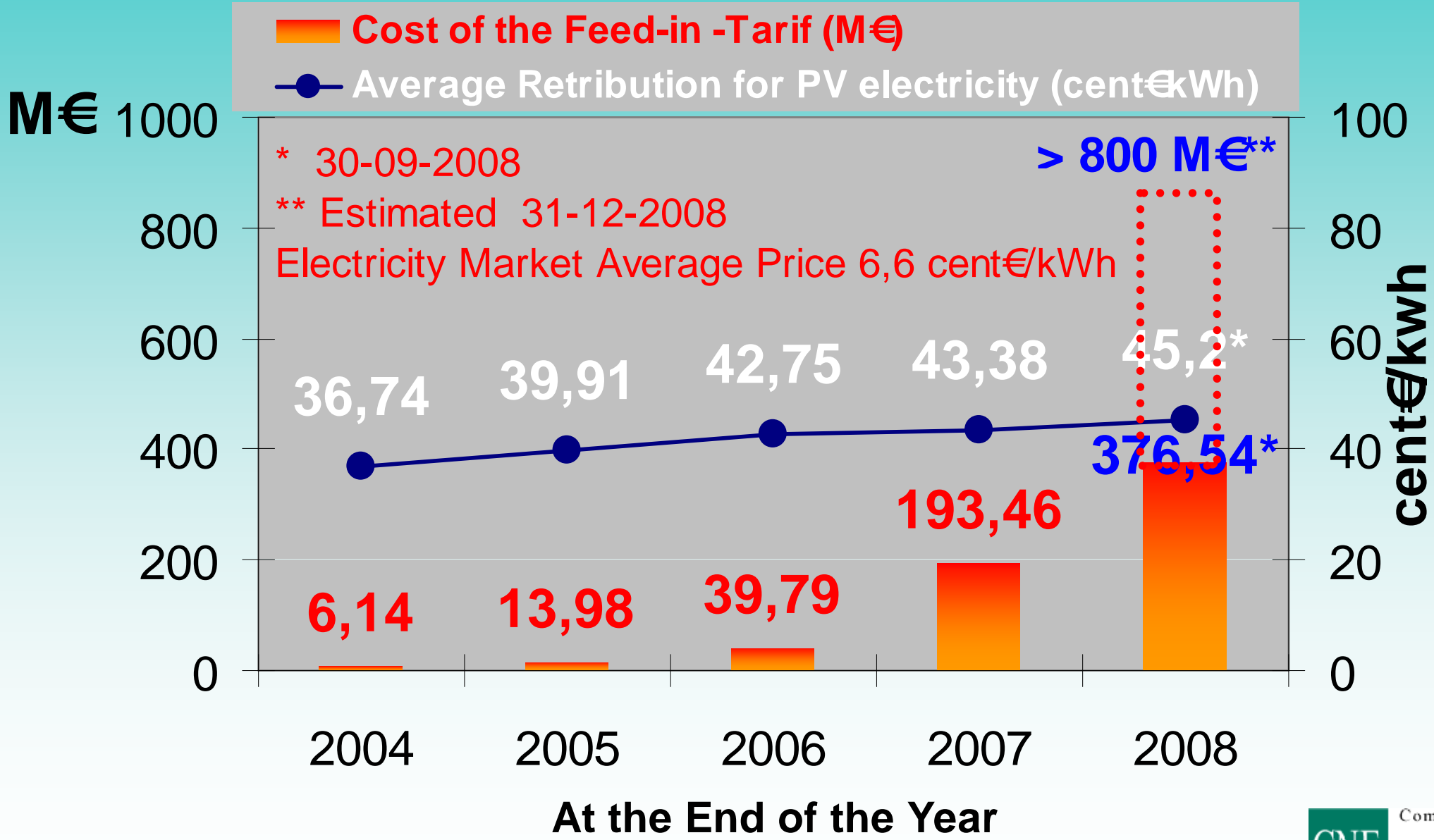
Cost estimated during 2008: **> 800 M€**



# The Photovoltaic Paradox in Spain: Effect on the Installations



# Crisis o Sustainability?: Cost of the PV' Feed-in Tariff



New R.D. 1578/2008 (September 27<sup>th</sup>).

Retribution of the electricity energy production by photovoltaic solar technology

## Establish: Two Class of Installations:

**Type I: Installations on-roof, facades, sound barriers, pergolas, farms, ..... ,**

**Type I.1  $P \leq 20$  kW**

**Type I.2  $P > 20$  kW**

**$P_{\max}$  2 MW**

**Typo II: On-ground**

**$P_{\max}$  10 MW**

**The size of the installation is determined by the sum of all installation connected to the same point of evacuation of the electricity to the grid**



GOBIERNO  
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E INNOVACIÓN

**Ciemat**

Centro de Investigaciones  
Energéticas, Medioambientales  
y Tecnológicas

New R.D. 1578/2008 (September 27<sup>th</sup>).

## Establish:

A Pre-Assignment Register for FIT quota. With four annual calls, and timing for calls and definitive quota assignments.

## Establish:

◆ Base power for the first year.

◆ 1st Call 15/10/2008-15/11/2008. Assignment 16/01/2009

Type I: 267/m MWp

Type I.1: 10%

Type I.2: 90%

Tipo II: 133/m MWp

m = n<sup>o</sup> annual calls

New R.D. 1578/2008 (September 27<sup>th</sup>).

## Establish:

- ◆ The economic regime of the PV installations ascribe to R.D.
- ◆ The Feed-in-Tariff for the 1<sup>st</sup> call

Typology		Tariff (c€/kWh)
Type I	Subtype I.1	34,00
	Subtype I.2	32,00
Type II		32,00

## Establish:

- ◆ The calculus of the tariff ( $T_n$ ) is determined by tariff and power pre-registered in the previous call ( $T_{n-1}$  y  $P_{n-1}$ ).
- ◆ Correction by inflation is not determined.
- ◆ Maximum time for perception 25 years.

$$\text{If } P_{n-1} \geq 0,75 \times P_0 \quad T_n = T_{n-1} [(1-A) \times (P_0 - P_{n-1}) / (0,25 \times P_0) + A]$$

$$\text{If } P_{n-1} < 0,75 \times P_0 \quad T_n = T_{n-1}$$

$A = 0,9^{1/m}$ ;  $P_{n-1}$  power pre-registered in the call n-1;  $P_0$  quota of power assigned in the call n-1.

**On the best of the case  $P_0 = P_{n-1}$ .  $T_n = 0,974 T_{n-1}$**   
**Thus  $P_0^n = 1,026 P_0$**

$$T_n = T_{n-1} \frac{(1 - A) \times (P_0^{n-1} - P_{n-1})}{(0,25 \times P_0)} + A \quad ; A = 0,9^{1/m}$$

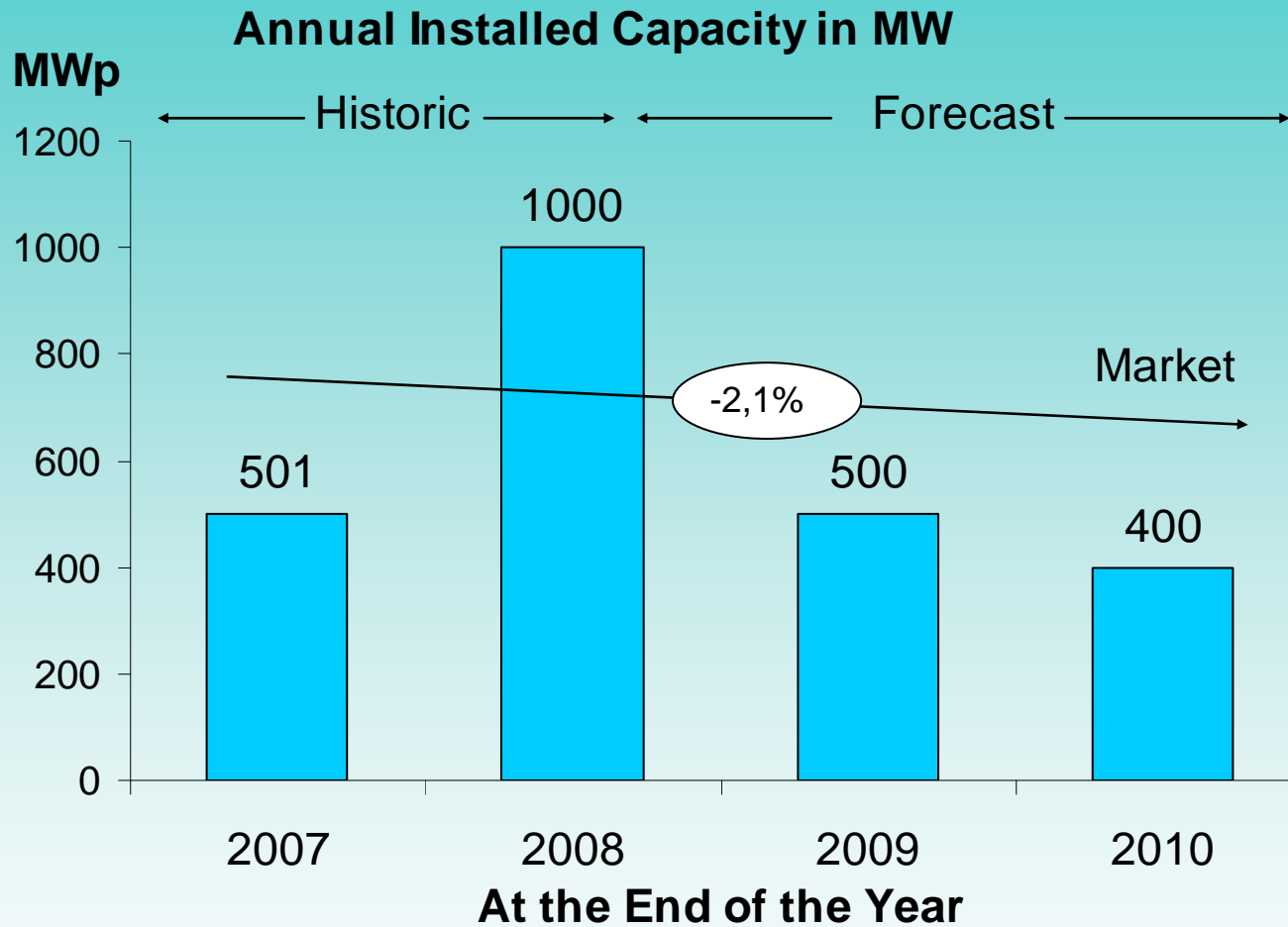
New R.D. 1578/2008 (September 27<sup>th</sup>).

Direct consequence:

***Tariff decrease and quota arise :***  
***ii 2,6 %/call !!***  
***annual 10,0%***



## Direct consequence: Market Restriction (2008-2010).



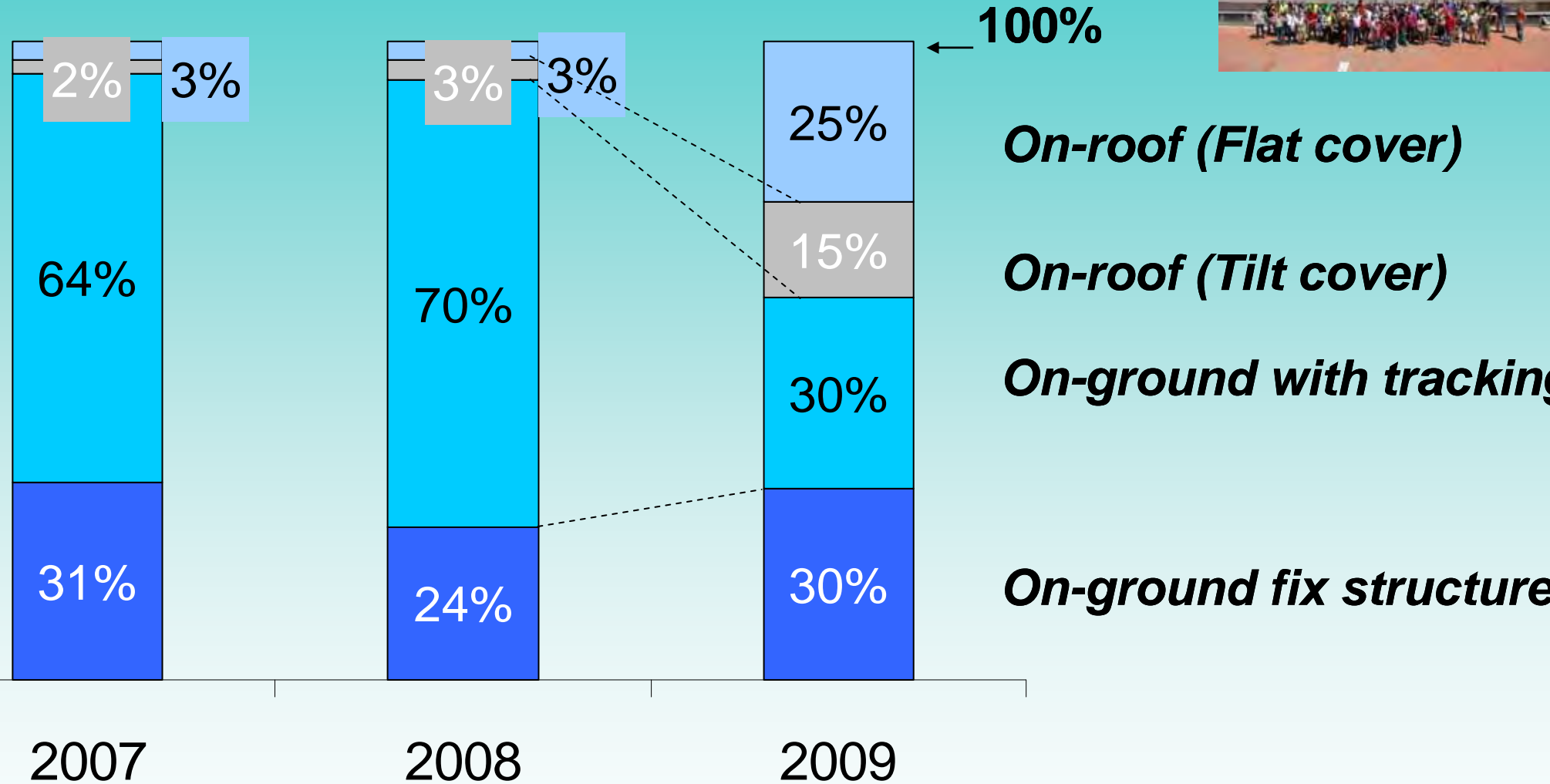
— (XX%) → **Market-Compound Annual Growth Rate (CAGR)**

Source: LLBBW (02.2008), Merrill Lynch (01.2008), Photon Consulting (03.2008), ASIF (03.2008).





### Installation by Type (MWp)

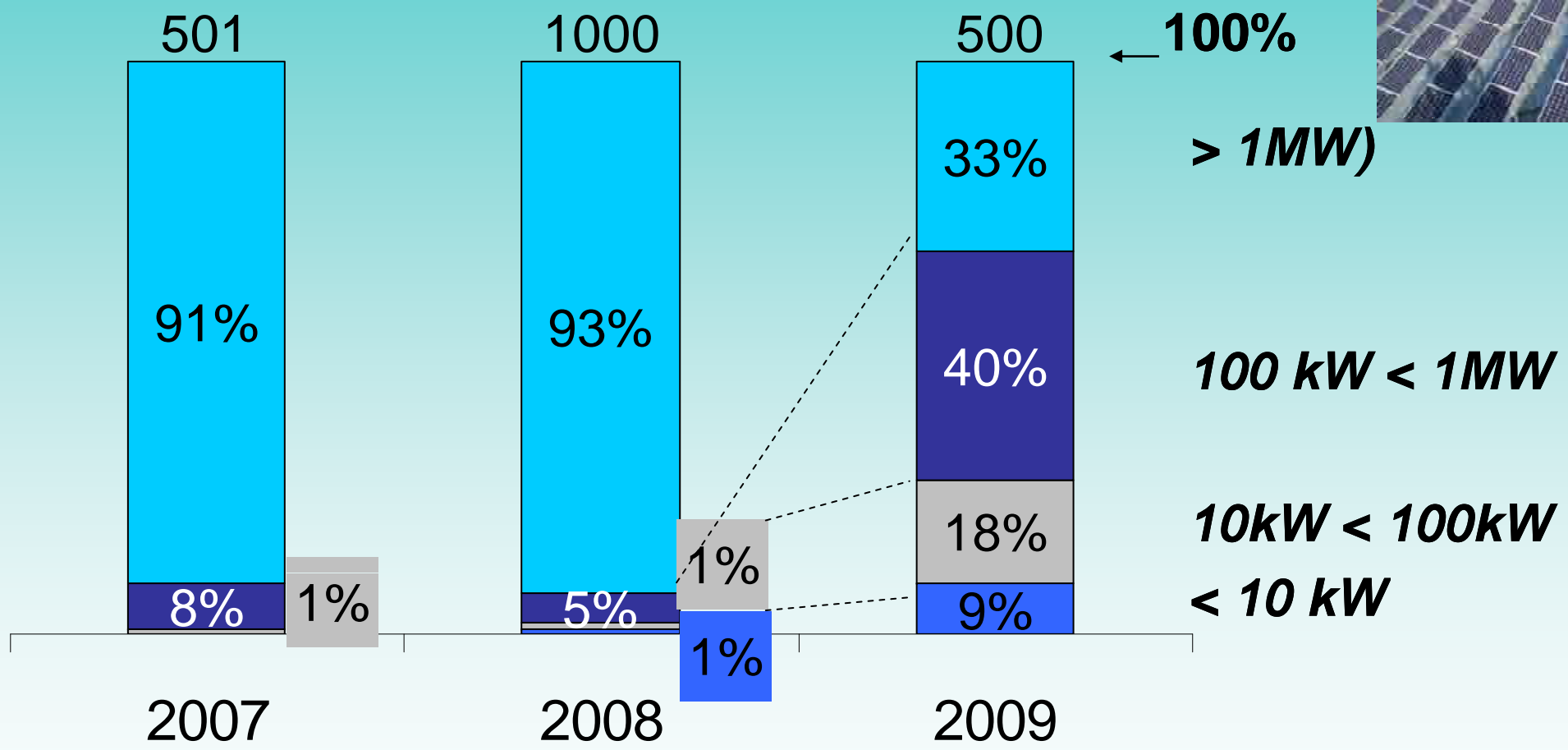


- 94% of the installed power '08 corresponds to on-ground systems.
- 70% with tracking

Consequence foresight: New market Structure.



Installations by System Size (MW)



93% of the installed power '08 corresponds to systems > 1MWp.

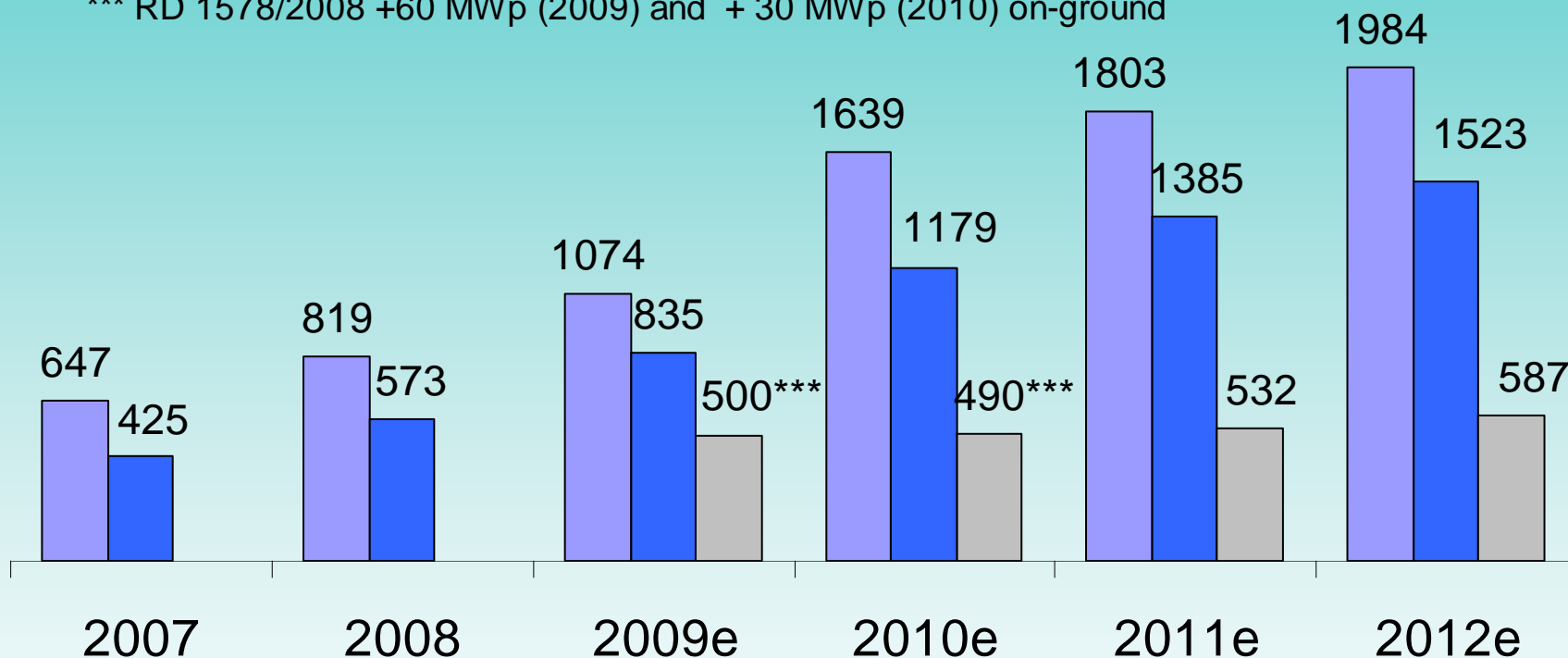
## Consequence foresight: Less industry.

■ Production Capacity\*   ■ Production\*   ■ Annual quota (  $P_o = P_{n-1}$  )\*\*

\*Estimated according RD 661/2007.

\*\*According to RD 1578/2008 ( $P_o = P_{n-1}$ )

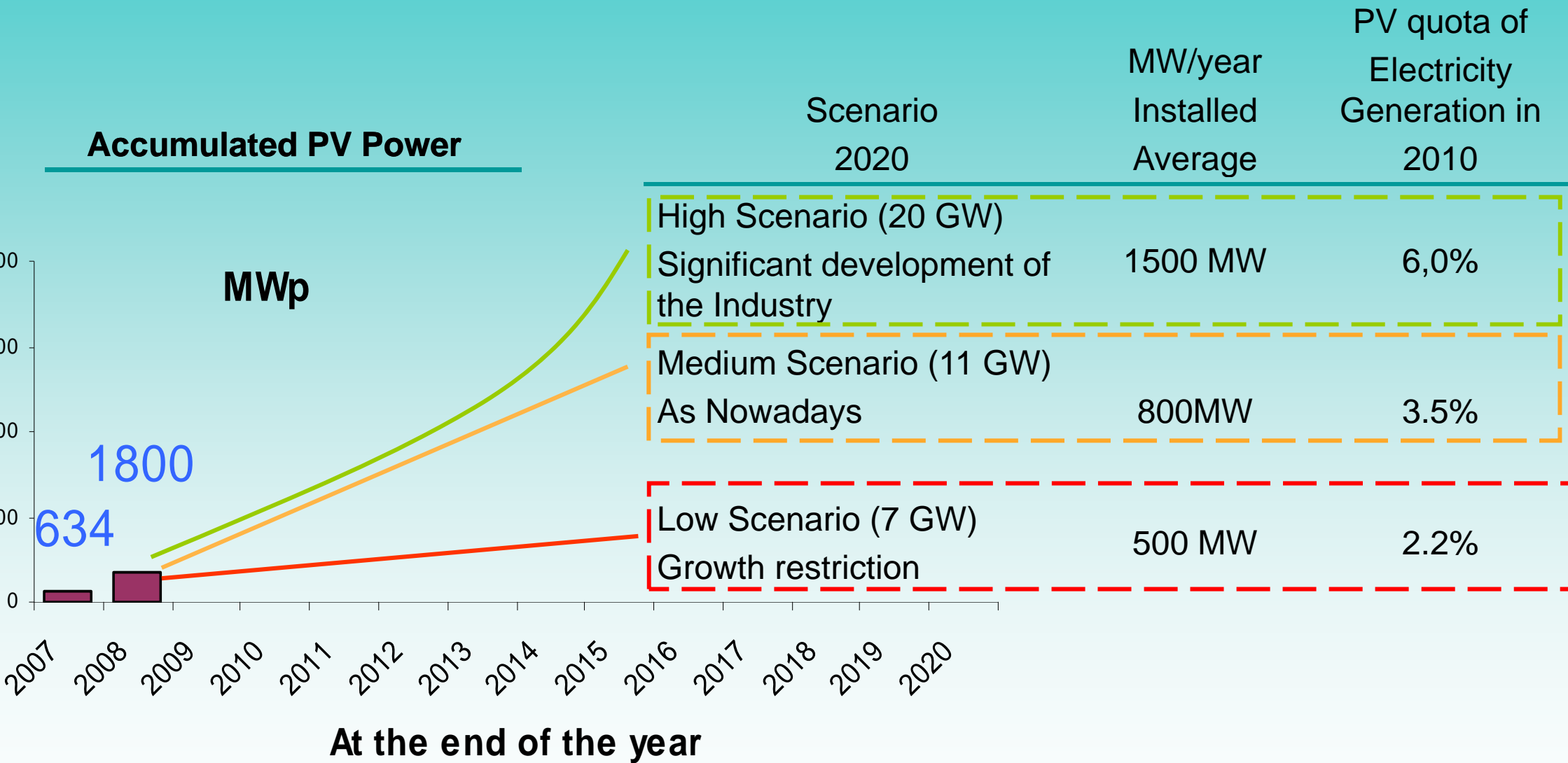
\*\*\* RD 1578/2008 +60 MWp (2009) and + 30 MWp (2010) on-ground



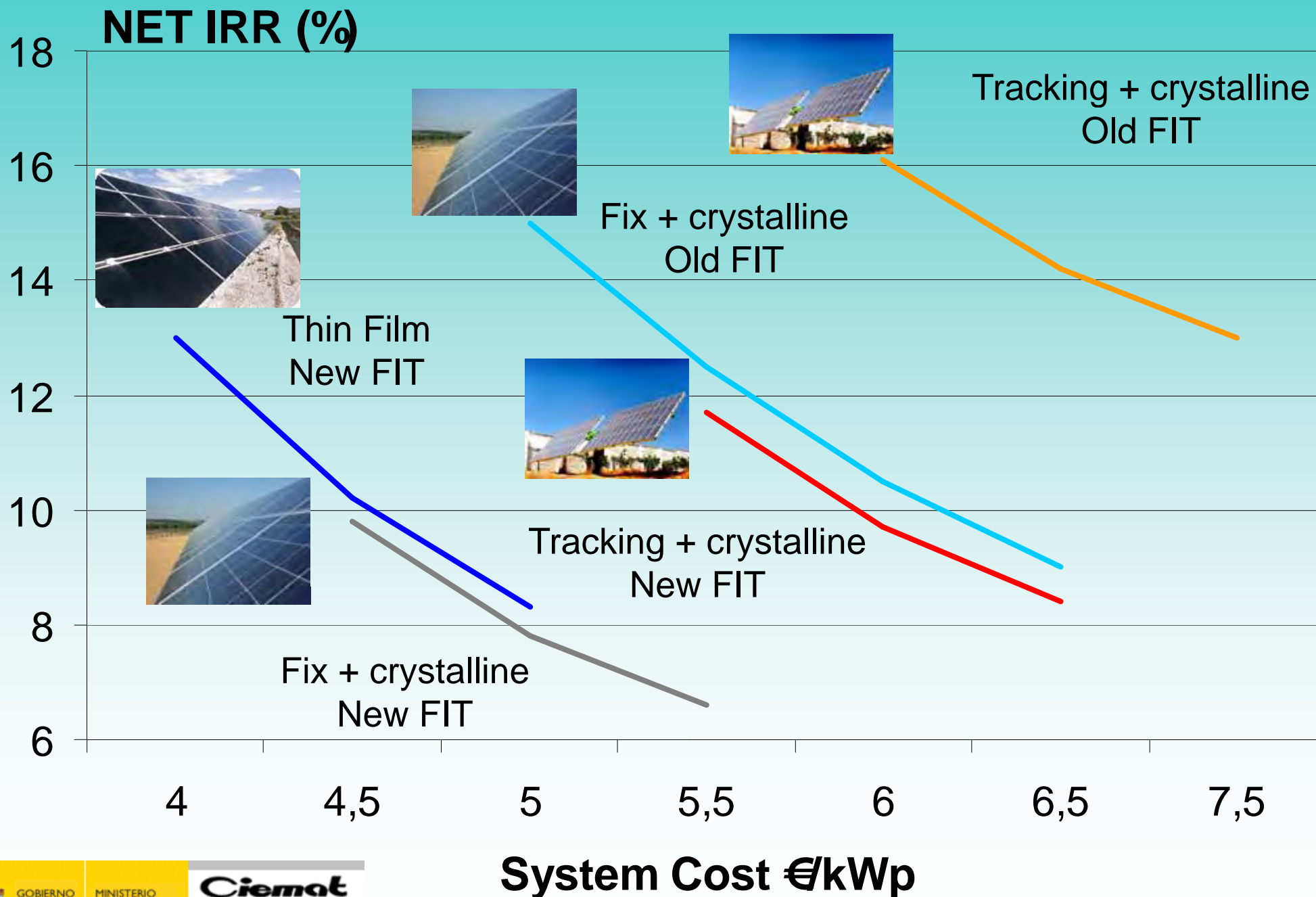
■ BE: Delocalization of Production and Investment: China, Italy, Portugal, ..

■ SME: Restriction for market access.

## Consequence foresight: Restriction of the Growth



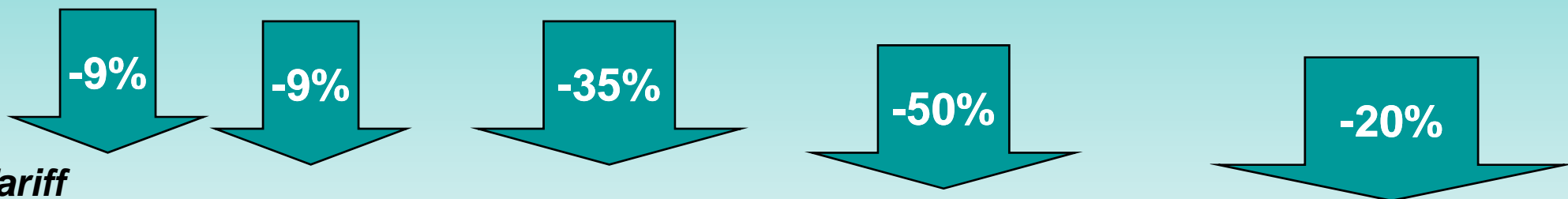
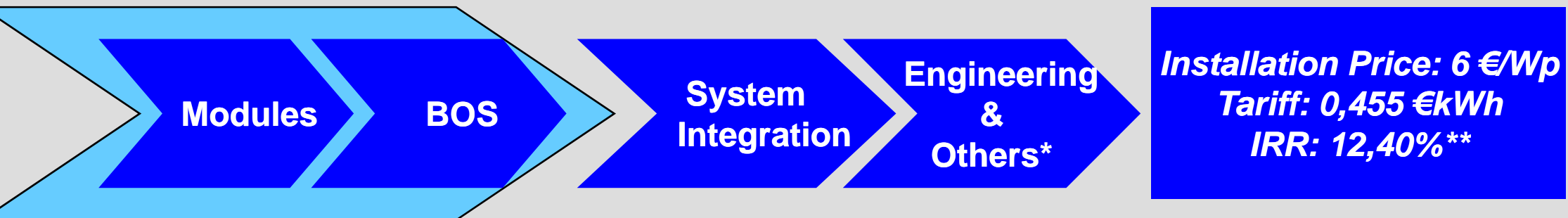
Consequence foresight: Diminution of the profit or costs reduction.



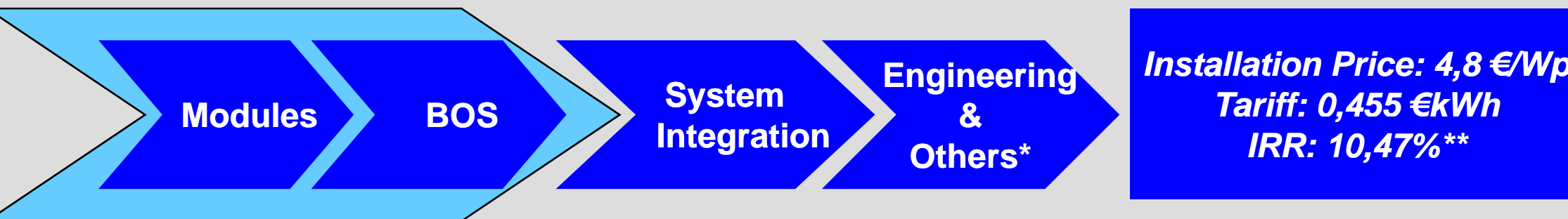
# New R.D. 1578/2008 (September 27<sup>th</sup>).

Consequence foresight: Diminution of the profit or costs reduction.

Tariff R.D. 661/2007



New Tariff



\*Grid connection, Insurance, Administrative costs, ....

\*\*Installation place equivalent to Athens

**On-roof  
m-Si Modules**



# Conclusions (1/2)

## Change of mind sets: from an uncontrolled market to a sustainable framework

- ❑ Costs reduction.
- ❑ Improvement of PV systems concepts :Size, application, integration....

## Change of perception of the System Authorities.

- ❑ Elimination of caps for installed power.
- ❑ Links between annual installed power and tariff variation.

**The new magic formula:**

$$\frac{P_0}{T_0} \geq \frac{P_n}{T_n^c}$$

C: The new PV “charmed” particle

$C \geq 1$  o  $C < 1$

# Conclusions (2/2)

☐ Photovoltaics is still a sustainable and profitable business:  
The key, lower cost and introduction of new concepts.

For Instance:

	Feed-in-Tariff R.D. 661/2007		New tariff R.D. 1578/2008	
	Price of the system	IRR	Price of the System	IRR
x-Si	6 €/Wp	12,18 %	4,8 €/Wp	10,47 %
Thin Film (CdTe)	5,2 €/Wp	17,48 %	4,6 €/Wp	12,40 %

J. Esteban:



CONEREZ



*Thanks you for your Attention i.*



# Who was the "stupid", which though the "famous" formula ?

$$T_n = T_{n-1} \frac{(1 - A) \times (P_0^{n-1} - P_{n-1})}{(0,25 \times P_0)} + A \quad ; A = 0,9^{1/m}$$

□ **The Answer:** He was very clever. The real guilty is the "famous" EPIA Learning Curve

□ If we can follow the EPIA slope:  $\frac{\partial Cost}{\partial P_{Installed}}$

$$IRR = \frac{f(\eta, Performance_{ratio})}{f(Module_{cost}, Installation_{cost}, O \& M_{cost},)}$$

□ If: **Yes, WE CAN !!** Then Business (€)

But, Two more questions:

□ Is it possible always the follow up of the learning curve?

□ Is it possible another "Sink Country" of PV Modules, like formerly Spain, with extremely advantageous FIT?

