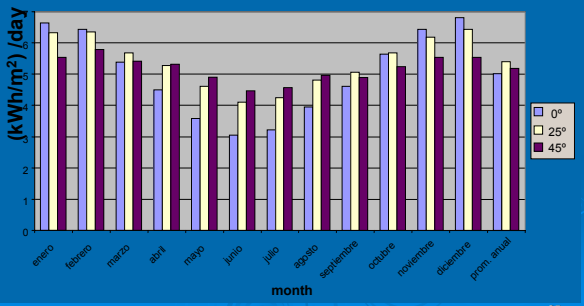
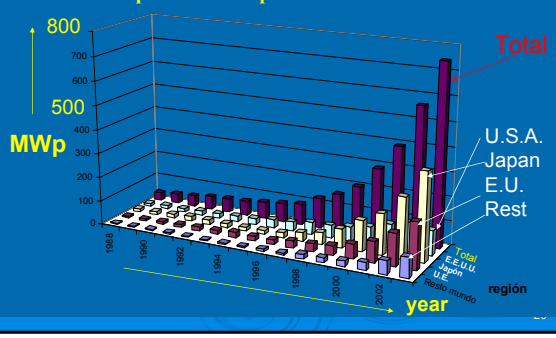
Global Solar Radiation

Global Solar Radiation Vs inclination angle of the pannel

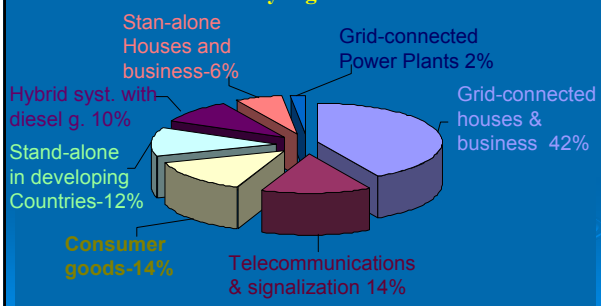


Evolution of Photovoltaic cells production



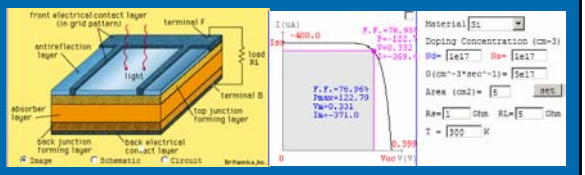
PHOTOVOLTAIC MARKET SEGMENTS

Global market by segments



Photovoltaic Cell Characteristics

Solar Cell: Design Calculation



Source:
http://jas2.eng.buffalo.edu/applets/education/pnapp/solarcell/index.html

Silicon Cells

- Single-Crystalline Silicon: presents a completely ordered structure, whose uniform behavior turns it optimal semiconductor, but of onerous manufacture. Easily reconocible by his dark and metallic bluish monochrome.
- Polycrystalline Silicon: presents ordered structures separated by regions. The irregular connections of the crystalline borders diminish the yield of the cell, limiting the photocurrent generation. Its aspect is a composition of different crystal of metallic bluish and gray color.

Amorphous Silicon Cells

- They differ from the other crystalline structures presenting a high degree of disorder in the structure of the atoms. They contain a great number of structural defects and connections.
- Presenting a spectral response with displacement to the blue, are very efficient under artificial illumination (mainly under fluorescent lamps).
- The efficiency - in this case – is superior to the crystalline silicon. Amorphous silicon cells have a simpler manufacturing process than crystalline cells and, therefore, a lower cost.

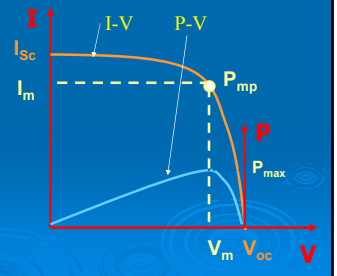
Thin film photovoltaic cells

- Thin film cells use Copper Indium Diselenide, Cadmium Telluride (CdTe), and Gallium Arsenide as thin film materials, typically a few μm or less in thickness, directly deposited on glass, stainless steel, ceramic or other compatible substrate materials.
- Thin film technology uses less material per square area of the cell, hence, is less expensive per watt of power generated.

Equation and characteristics of the solar panel

$$I = I_L - I_S\left[e^{\frac{qV}{kT}} - 1\right]$$

I: pannel current.
V: panel voltage.
I_L: photogenerated current.
I_S: reverse saturation current.
q: electron charge.
k: Boltzman constant.
T: semiconductor temperature.



Efficiency of Photovoltaic Cells

Silicon cells	Eff.	Area cm2	Voc	Jsc mA/ cm2	FF % Fill Fact	Test Center	Descrip tion
Si (crystalline)	24.7 ±0-5	4.00 (da)	0.706	42-2	82-8	Sandi a (3/99)	UNSW PERL7
Si (multicrystalline)	19-8±0-5	l.09(ap)	0.654	38-1	79.5	Sandi a (2/98)	UNSW/ Eurosolare-
Si (thin film transfer)	16-6 ±0.4	4.017 (ap)	0.645	32.8	78.2	FhG-ISE(7/ 01)	University of Stuttgart
							(45 |^m thick)8

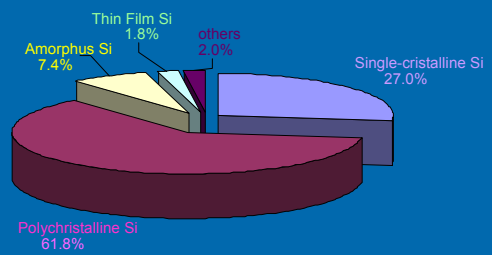
Source: Martin A. Green e.a.-Progress in Photovoltics Research and Applications 2003-11

Efficiency of Photovoltaic Cells

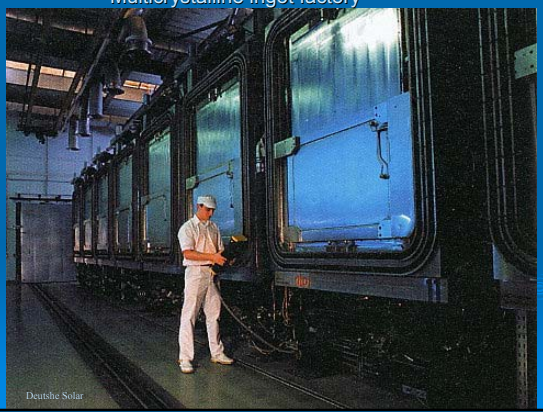
III-V cells							
GaAs (crystalline)	25.1 ±0.8	3.91 (t)	1.022	28. 2	87.1	NREL (3/90)	Kopin, AlGaAs window
GaAs (thin film)	23.3 ±0.7	4.00 (ap)	1.011	27. 6	83.8	NREL (4/90)	Kopin, 5 mm CLEFT9
GaAs (multicrysta lline)	18.2 ±0.5	4.011 (t)	0.994	23. 0	79.7	NREL (11/95)	RTI, Ge substrate 10
InP (crystalline)	21.9±0.7	4.02 (t)	0.878	29. 3	85.4	NREL (4/90)	Spire, epitaxial"
Polycrystalline thin film							
CIGS (cell)	18.4±0.5' '	1.04 (ap)	0.669	35. 7	77.0	NREL (2/01)	NREL, CIGS on glass12
CIGS (submodule	16.6 ±0.4	16.0 (ap)	2.643	8.3 5	75.1	FhG-ISE (3/00)	University of Uppsala,

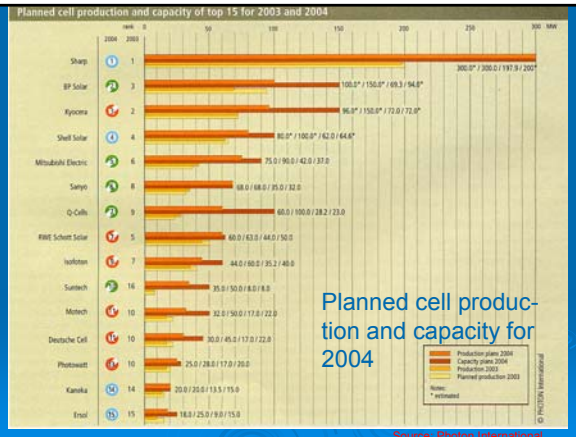
Source: Martin A. Green e.a.-Progress in Photovoltics Research and Applications 2003-11

Cell types global production



Multicrystalline ingot factory

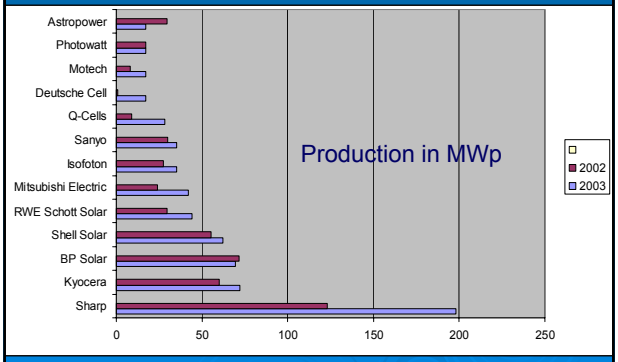




Planned cell production and capacity for 2004

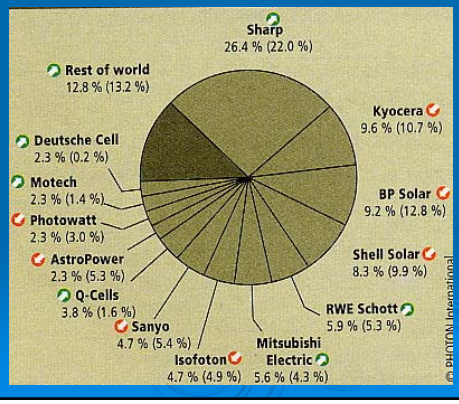
Source: Photon International April 2004

Top cell producers in 2002 and 2003

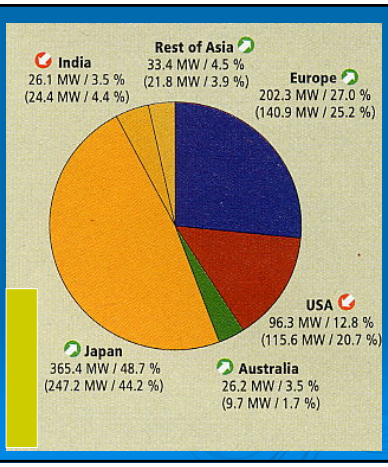


Source: Photon International April 2004

Cell production shares in 2003



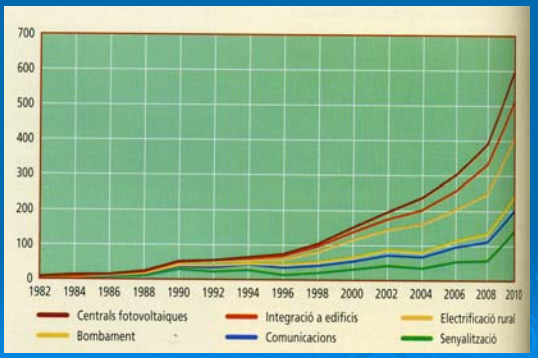
Source: Photon International 04/2004



Cell production shares per continent in 2003

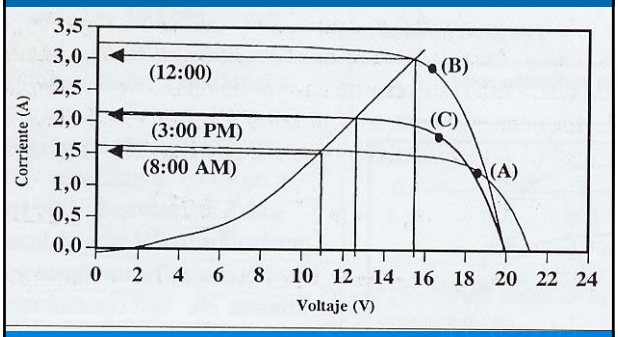
Source: Photon International April 2004

Forecast fields of PV applications

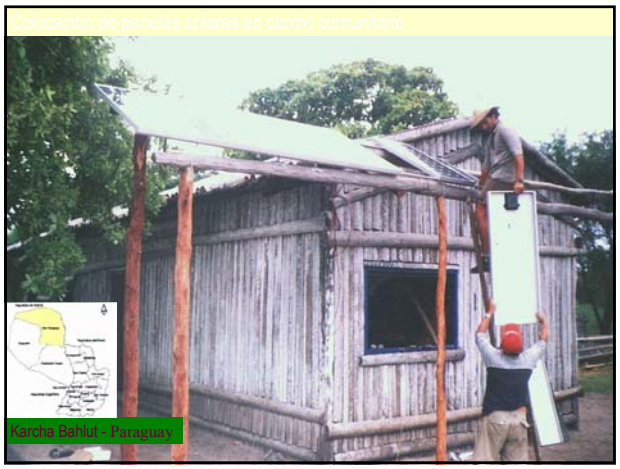


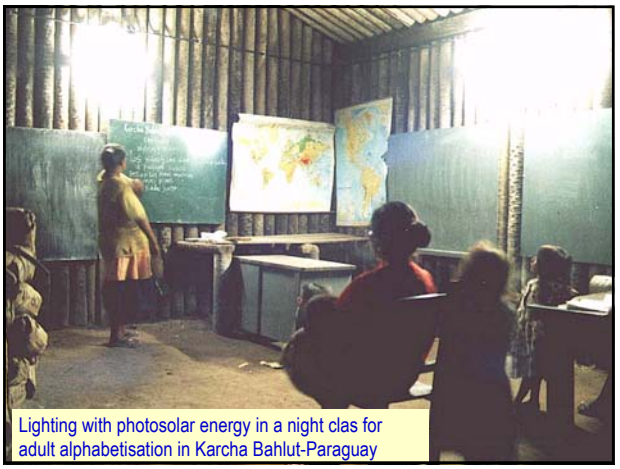
DC/DC Converters for simple applications

Simple charges directly connected



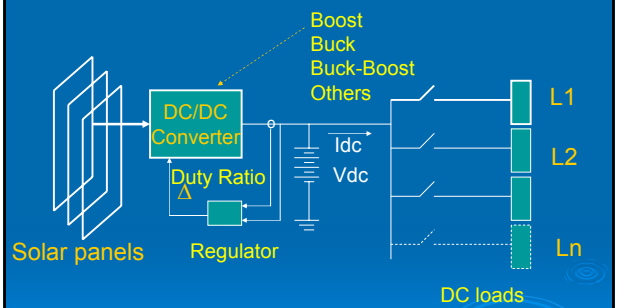
DC motor water pump connected to a photovoltaic module





Lighting with photosolar energy in a night clas for adult alphabetisation in Karcha Bahlut-Paraguay

DC/DC Converters for simple applications



Stand - alone plants for local consumers