



PARTAGE DU SAVOIR EN MEDITERRANEE

9 MAI 2013

**Opportunités pour les
énergies renouvelables
solaires en Méditerranée
Ph. COSTERG**

partage du savoir en Méditerranée Mai 2013



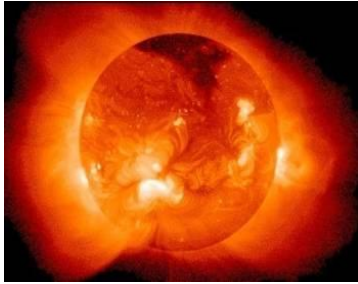
PV INDUSTRY FOR GROWTH

- Global Solar Photovoltaic market
- The potential of renewable energy in the Mediterranean region
- Total : Current positions and strategy in the region
- Going further: Which ways towards Solar PV competitiveness?
- Conclusion and Outlook

GLOBAL SOLAR PHOTOVOLTAIC MARKET

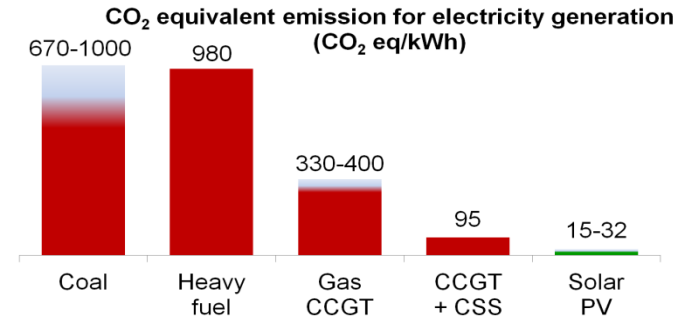
THE FUNDAMENTALS: THE RATIONALE FOR SOLAR ENERGY

1 An unlimited and gigantic source of Energy



The sun delivers the equivalent of 10 000 times the current global energy consumption

2 A clean source of power

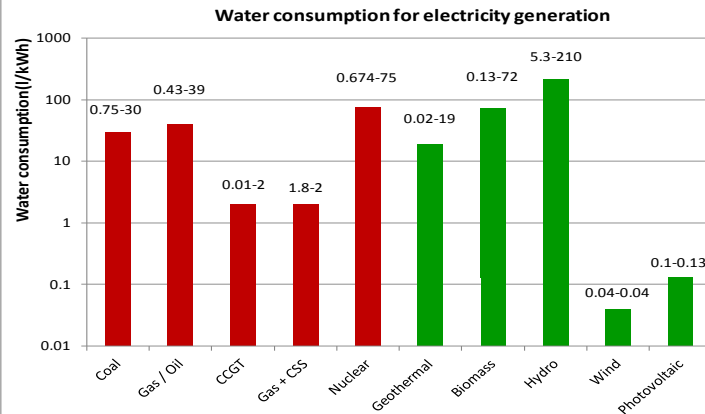


The level of CO₂ emissions/kWh from a solar PV system is between 5 to 50 times less compared to a traditional fossil fueled power plant

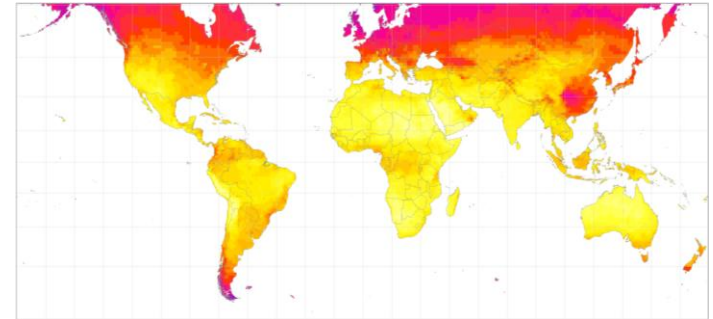
Source : EPIA

Advantages

3 Water consumption comparison across different energy sources



4 A source of energy spread across the whole planet



Levels of sunshine on Earth: the countries of the North and South have the necessary resources

Solar energy relies on strong drivers which will turn it into a key source of energy in the long-term

The fundamentals: 4 ways to use the solar



Passive solar building design



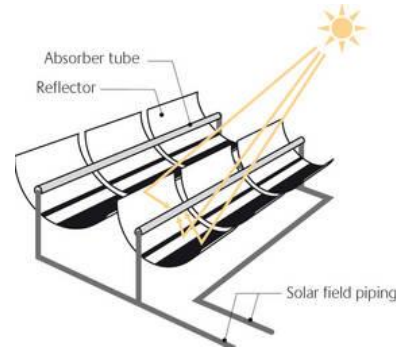
Uses the sun's daily and annual cycles to maintain building thermal comfort



Solar thermal energy



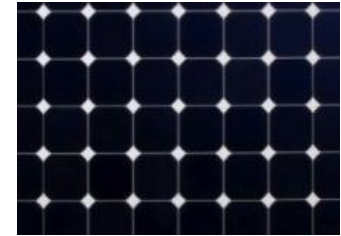
Uses the thermal energy directly from the sun to heat domestic water



Concentrating solar power (CSP)



Uses concentrated solar radiation as a high temperature energy source to produce electrical power



Solar Photovoltaic (PV)



Generates electricity through the direct conversion of sunlight

3 SOLAR STAKES



Become competitive with grid electricity

- *Reduce costs,*
- *Improve cells and panels' efficiency*



Adapt the grid to new energies

- *Smartgrid*
- *Storage*



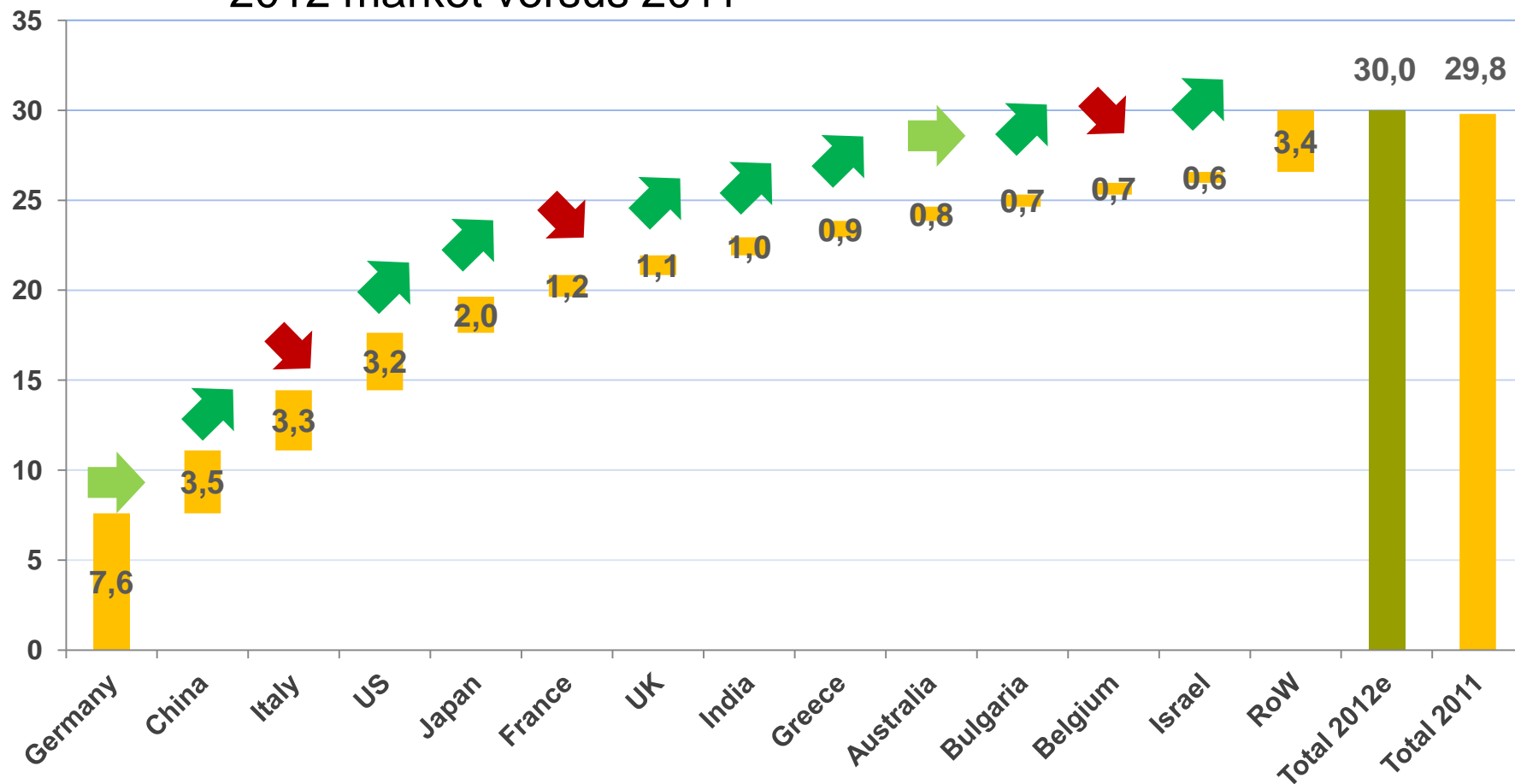
Integrate solar to building

- *Building functions and codes*
- *Building industry penetration*
- *Aesthetics*

WHERE ARE THE MARKETS?

2012 market versus 2011

Source: EPIA Market Report 2012

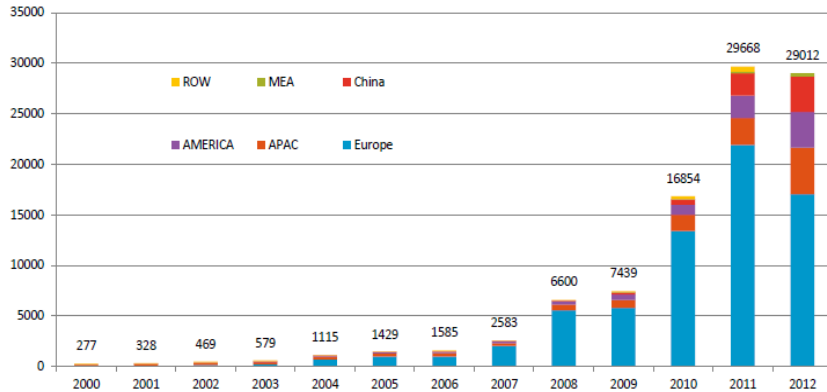


- > 2012 global market is stable – Global installed capacity reached 100GW in 2012
- > Europe market decreased, but this has been compensated by fast-growing markets in Asia (China & Japan) and the US

PHOTOVOLTAIC TODAY IN THE WORLD

2012 PV market at 29GW

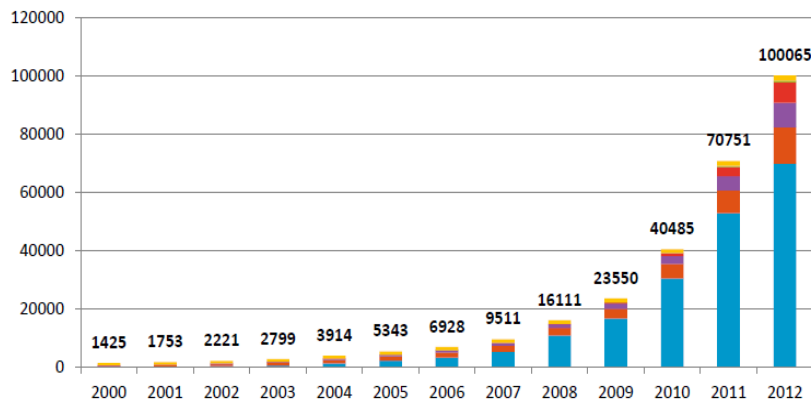
Evolution of Global Annual Installations 2000 - 2012 (MW)



Evolution of PV capacity 2000-2012

100 GW most probably reached.

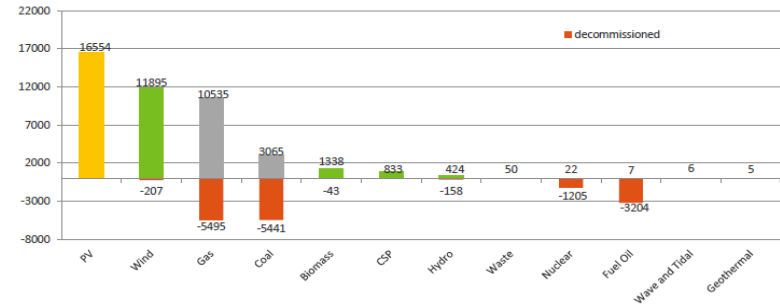
Evolution of Global Cumulative Capacity 2000 - 2012 (MW)



Capacity Additions in Europe (GW)

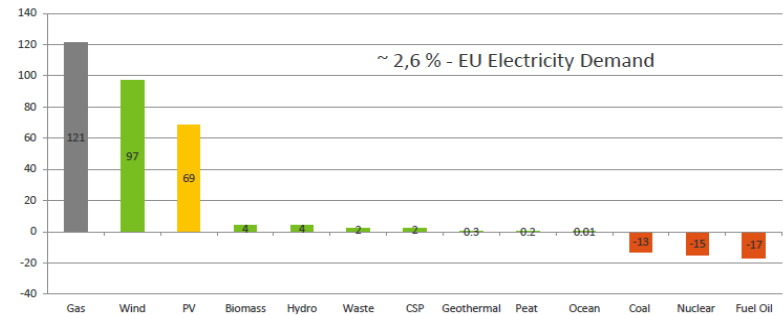
Source: EWEA, EPIA

Power generation capacities added in 2012 in EU27 (MW)



Capacity Additions in Europe (GW)

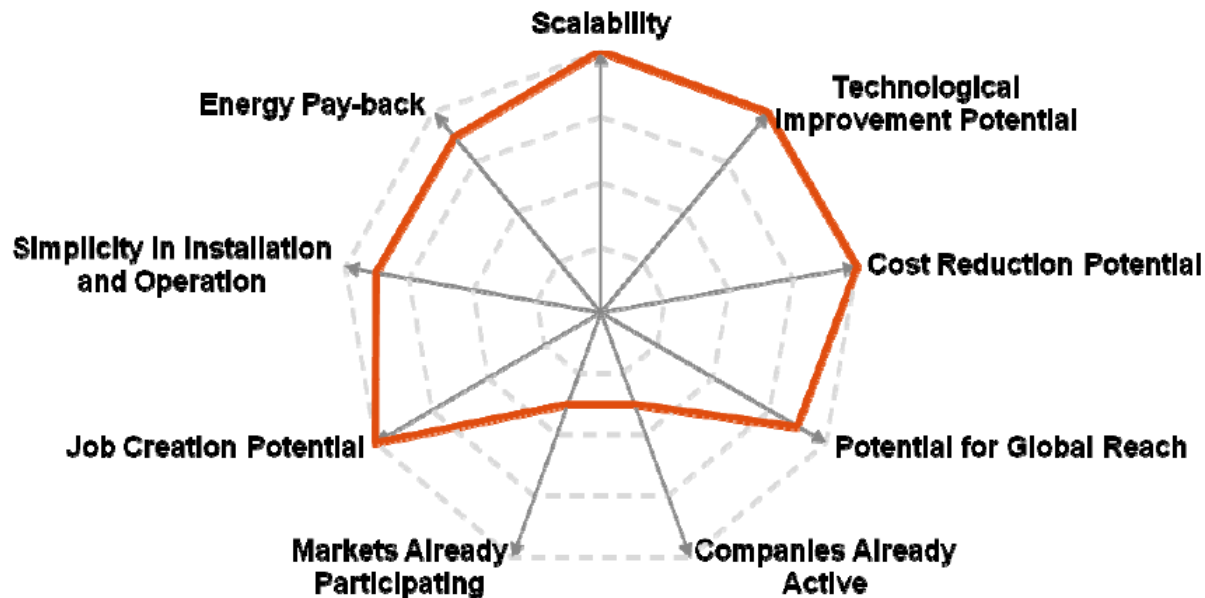
Net generation capacity added in EU 2000-2012 (GW)



Sources: EPIA, Enerdata, WEO 2011, EER, NREAP, REN 21, EGP

SOLAR PHOTOVOLTAIC DRIVERS FOR GROWTH

Solar Photovoltaic: Competitive Footprint



Source: EPIA

**Solar Photovoltaic remains the single most versatile energy technology
Periods of outstanding growth are still ahead of us**

THE FUNDAMENTALS OF THE PHOTOVOLTAIC SECTOR : DIVERSITY OF APPLICATIONS

Grid connection



Power plants



Farms, industrial, service sector buildings



Private houses



Other examples of ground mounted systems



Off-grid activities



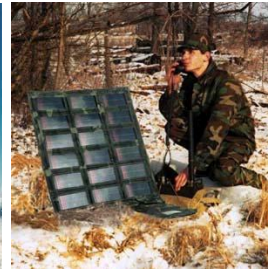
Solar water pumping



Remote sites and rural electrification



Telecom and Oil & gas



Standalone devices

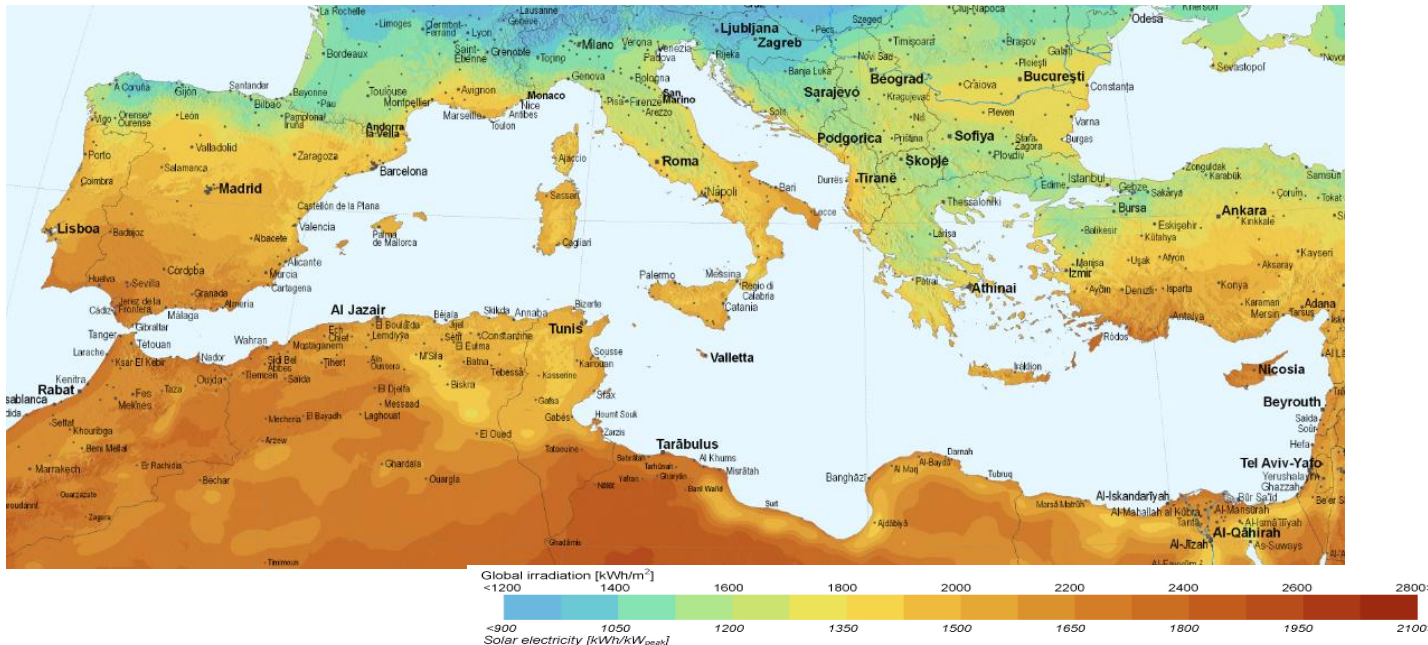
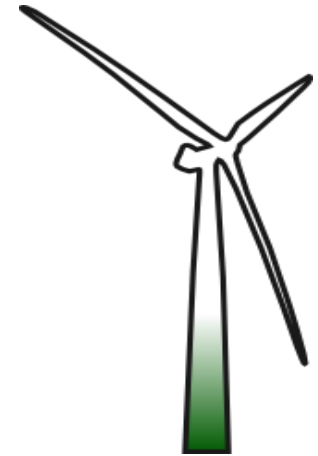
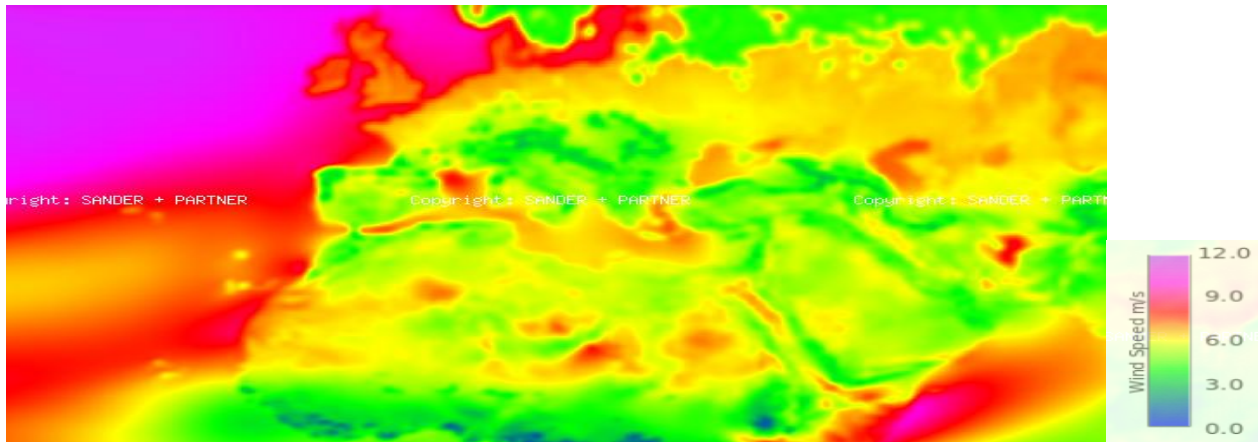


PV systems are highly modular, i.e. modules can be linked together to provide power ranging from a few watts to tens of megawatts (MW)

THE POTENTIAL OF SOLAR ENERGY IN THE MEDITERRANEAN REGION

Saudi Arabia aspires to export as much solar energy in the future as it exports oil now
Ali Al Naimi, Saudi Minister for Petroleum and mineral Resources

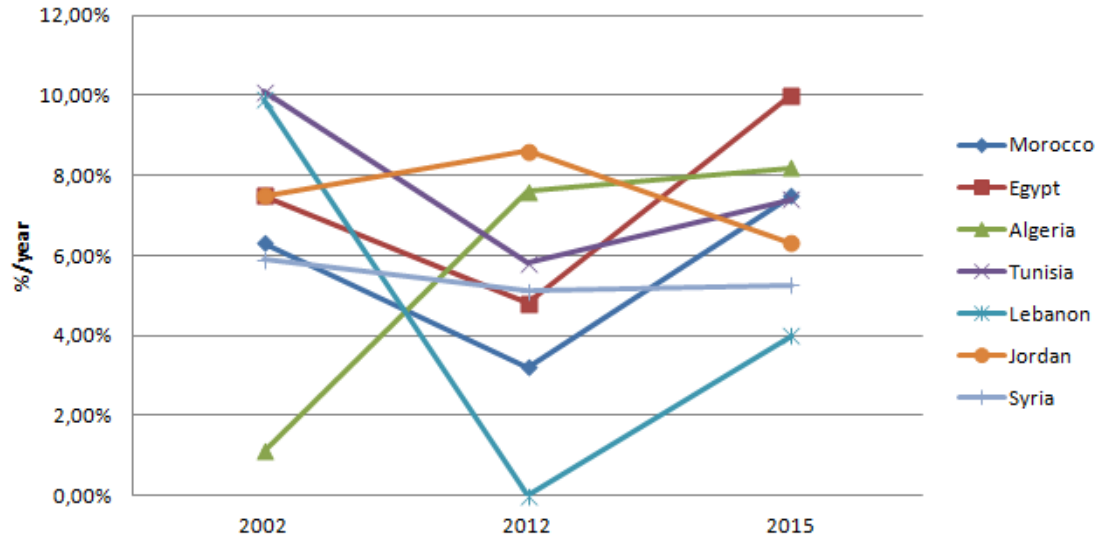
WIND & SOLAR ENERGY ATLAS FOR THE MEDITERRANEAN REGION



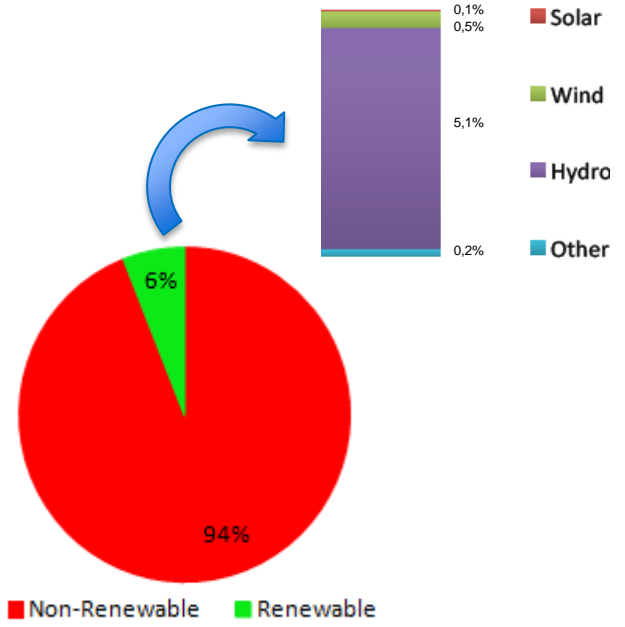
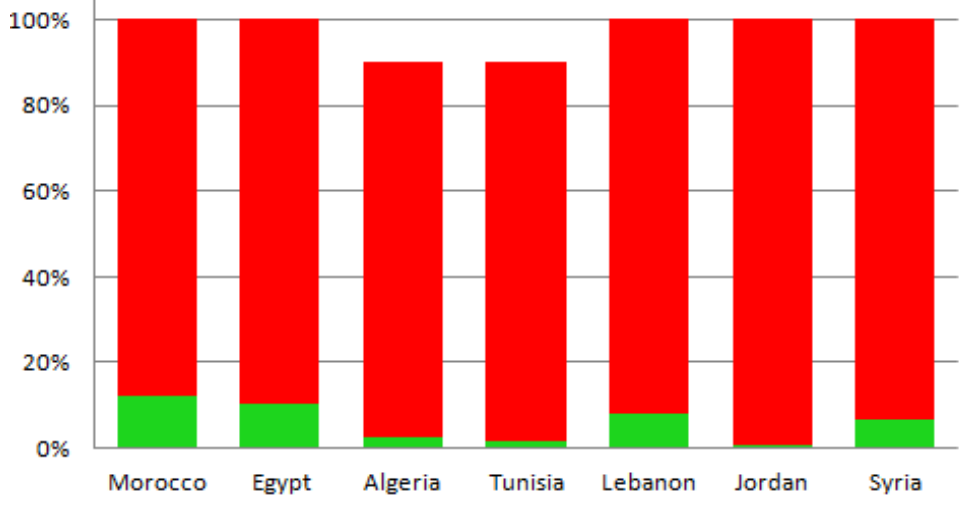
Source: PVGIS

CURRENT POWER MARKET

Electricity demande growth

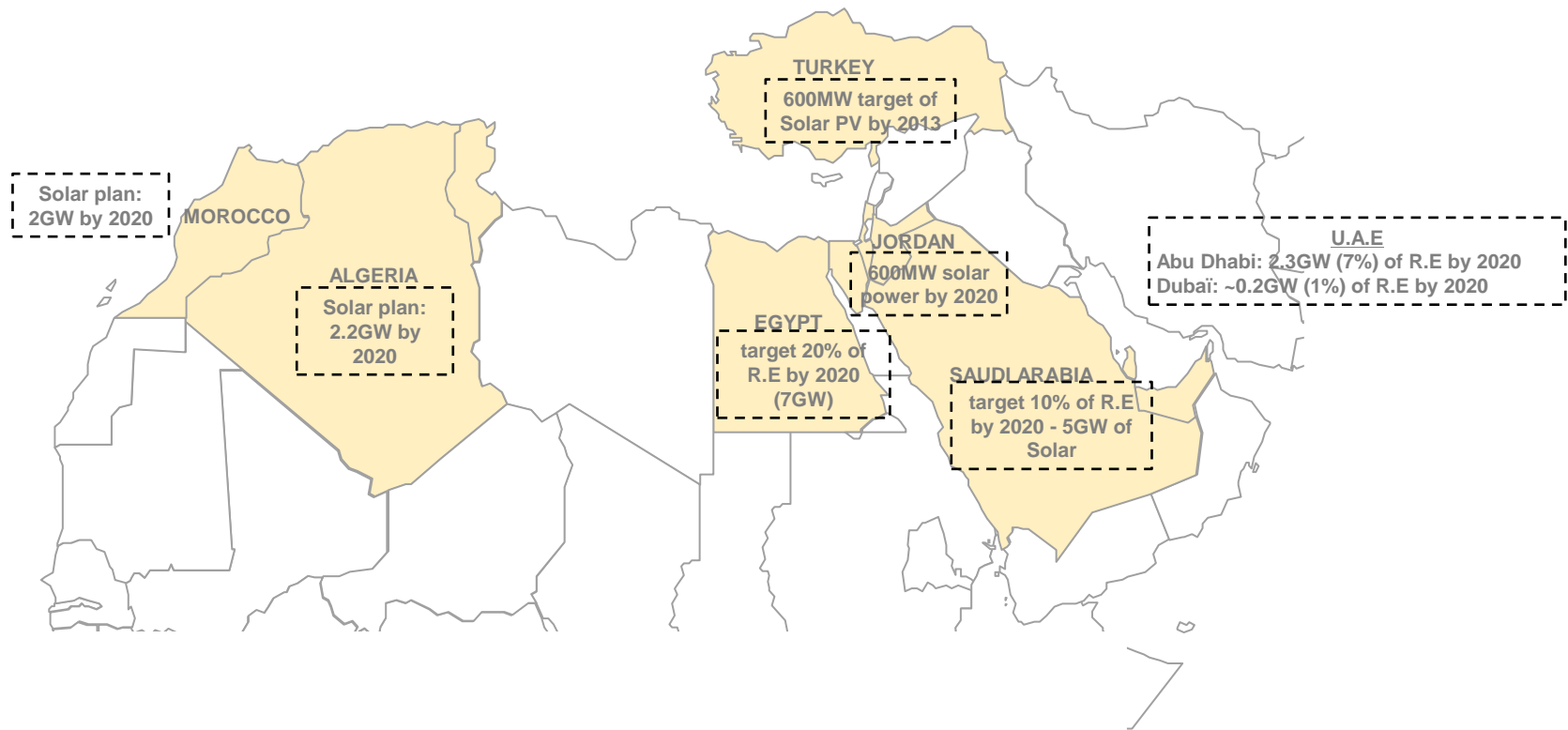


RE source as share of electricity generation



Source: Indexmundi.com

SOUTH AND EASTERN MEDITERRANEAN COUNTRIES: HUGE SOLAR ENERGY DEVELOPMENT POTENTIAL



Most of the Governments of the region have already committed to development objectives of Renewable Electricity - including solar targets

SEGMENT-SPECIFIC APPROACHES

In the residential, commercial and industrial segments

- **Self-consumption:** allow final consumers to use the solar electricity generated by their PV systems to offset their consumption before exporting the excess power to the grid
- **Net metering:** allow the compensation to be calculated on a longer period of time (in general one year), in order to reduce the overall cost of support schemes

In the utility-scale segment

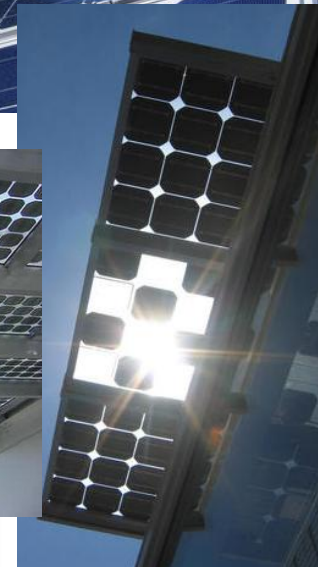
- **Call for tender mechanisms:** these calls should be multi-annual in nature, guarantee sufficient volume and transparent, rapid and simple bidding process to ensure they enable market growth
- **Obligation on utilities for increasing their share of renewables/PV** in their resource portfolios, combined with power purchase agreements that ensure fixed prices

EXAMPLES OF TECHNOLOGIES ON THE MARKET

Thin film based technologies

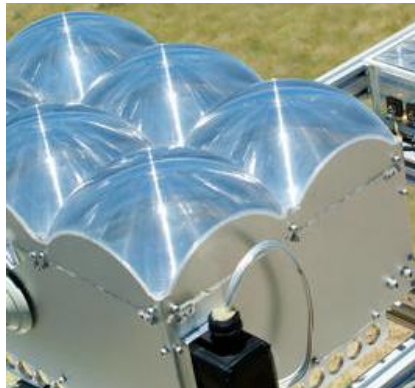


Bulk-Si based technology



HIGH PERFORMANCE PV CONCENTRATORS

Fresnel lenses



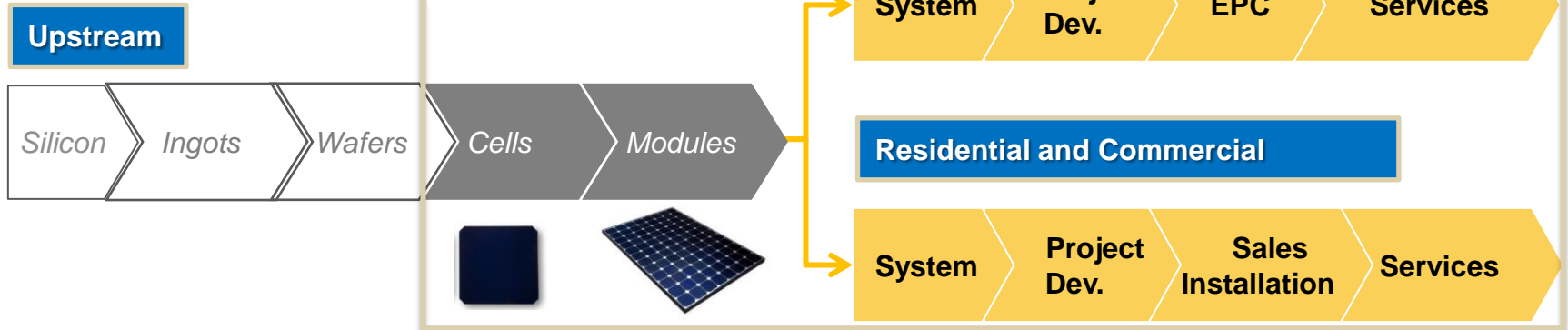
Parabolic mirrors



TOTAL : CURRENT POSITIONS AND STRATEGY

TOTAL POSITIONING ON THE PV VALUE CHAIN

TOTAL holds 66% share of the global integrated PV player SunPower



TOTAL is a 20% shareholder in the Shams Concentrated solar power farm (100MW) in the UAE



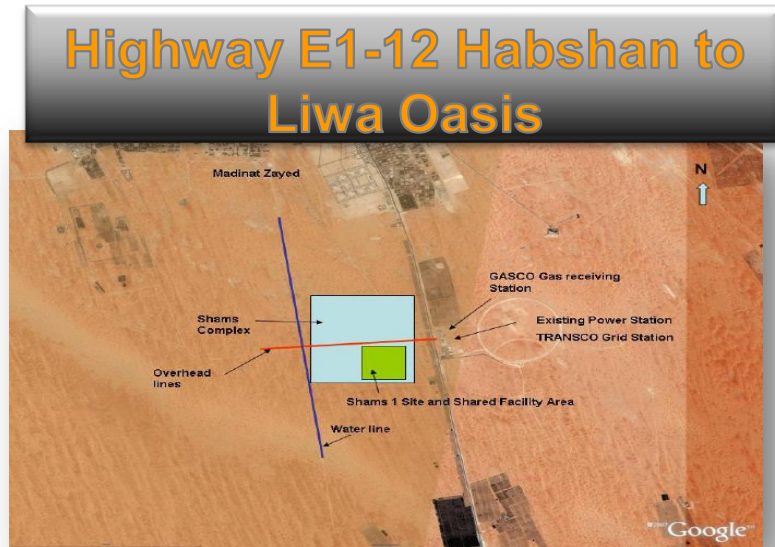
SHAMS 1: SALIENT FEATURES



Location	Madinat Zayed
Rated Power	109 MW
Annual Average Production	210 GWh
Approx Investment	600M\$
Technology	Parabolic Trough Dry Cooling
Gas consumption to overheat the steam	540 000 MBTU (LHV)
Capacity on Gas only	50MW
Linear length of solar collectors	110 Km (768 collectors in 192 loops)
Surface Area of Solar Field	230 hectares (627,840 m ² of solar field aperture area)
Direct jobs (average)	2 000 during construction 100 during operation
Financing	578 musd of debt signed with 10 banks

SHAMS 1

- ▶ Shams 1 is a 100 MW concentrated solar power (CSP) plant
- ▶ It is located in the Western Region of the Abu Dhabi Emirate



Construction is completed, and first electricity was injected into the National grid in January 2013

The plant was officially launch in March 2013

SHAMS 1 DELIVERS IMMEDIATE ECONOMIC, SOCIAL AND ENVIRONMENTAL IMPACT

Through the use of solar power, the UAE can reduce its need for “peak shaving” generators, which are expensive and idle most of the year.

Shams 1 saves 175,000 tonnes of CO₂ per year, contributing to the UAE’s commitment to reduce its carbon footprint.

Domestic renewable energy production extends the life of the UAE’s hydrocarbon supply, supporting long-term energy and economic security.

Shams 1 is creating 100 green jobs – including 30 percent UAE nationals – and we expect this number to grow.

Shams 1 is empowering the UAE’s human capital

- Extensive training program
- Technology transfer

CONTINUOUS RESEARCH AND INNOVATION



Solar Impulse:
The project eventually hopes to succeed in the first circling of the earth with a piloted fixed-wing aircraft using only solar power.

A single-seater, capable of taking off under its own power, and intended to remain airborne up to 36 hours.

It first flew an entire diurnal solar cycle, including nearly 9 hours of night flying, in a 26-hour flight on 7–8 July 2010.



Planet Solar:
an entirely solar powered boat that was launched on 31 March 2010.

The plan is to set a round-the-world record, promoting the use of sustainable energy.

Two records: fastest crossing of the Atlantic Ocean by solar boat and longest distance ever covered by a solar electric vehicle.



Temasol : A Few Relevant Figures

- 22.500 functioning installations.
- Temasol's workforce: 72 employees – 17 in HQs and 55 in community agencies.
- 11 community agencies.
- Intervention in 23 provinces.
- Collection rate: 96%.
- 1,5 millions kilometers per year
- Average of 100 after sales service visits per day

Change of main components by the end of December 2012

- 31.060 lamps of 7 W & 11 W.
- 7.200 charge regulators.
- 32 500 batteries.





► **RESCO Temasol – Morocco : 22 500 customers**



RESCO KES – South Africa : 21 500 customers



► **RESCO Koraye Kurumba – Mali : 550 customers**
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► **Senegal : Kinkeliba medical centre**

RESCO = Rural Energy Services Company



BIPV – TOTAL PETROL STATION (FRANCE)



BIPV : Build Integrated Photovoltaic

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ROOF SOLAR PV POWER PLANT – TOTAL PETROL STATION



GOING FURTHER : WHICH WAYS TOWARDS SOLAR PV COMPETITIVENESS? VERY HIGH PERFORMANCE SOLAR CELLS

SELECTED R&D ISSUES (PV TECHNOLOGY PLATFORM)

Common for all module technologies



Efficiency, Energy yield, stability and lifetime

High productivity, manufacturing, in-process monitoring & control

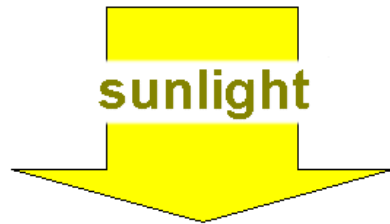
Environmental sustainability (energy & materials)

Recyclability

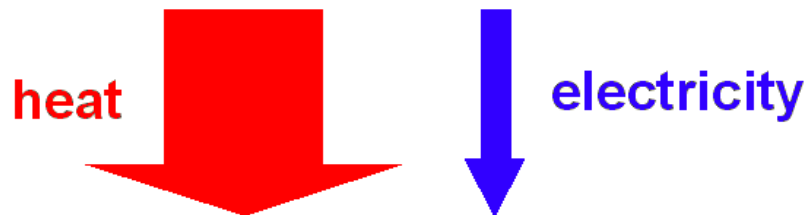
Applicability

ENERGETIC PHOTONS PRODUCE PHONON FLUXES THAT ENDS AS THERMALIZATION

Today



solar cell



Desired

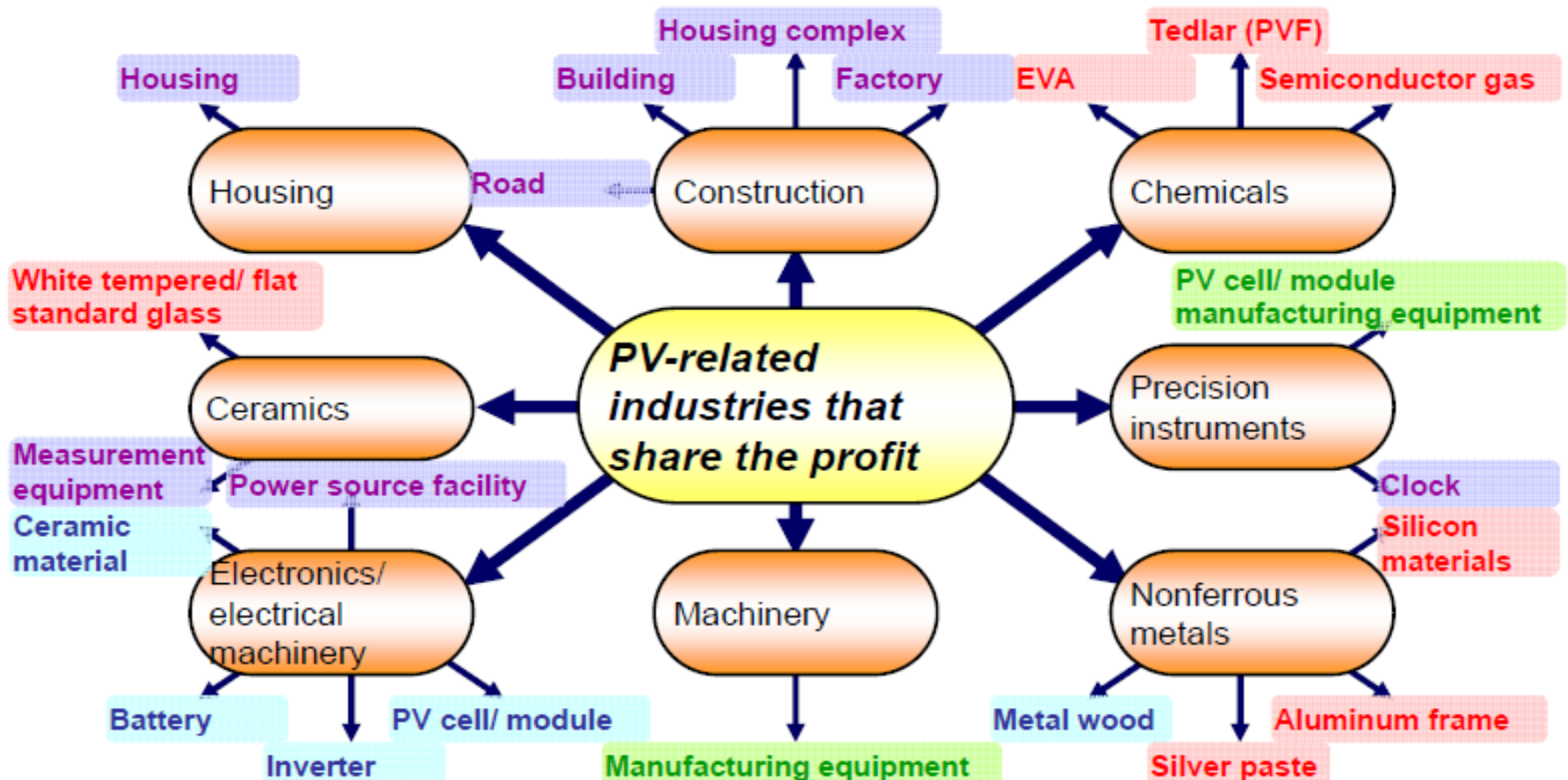


solar panel



CONCLUSION AND OUTLOOK

PV INDUSTRY STRUCTURE FOR FURTHER GROWTH AND LOCAL CONTENT



[1] Raw materials [2] PV/ BOS components [3] Manufacturing equipment [4] PV system applications

Source : RTS Corporation

PHOTOVOLTAIC GREENHOUSES

Benefits of PV

- **Solar farms and greenhouses are PV processes : how to find the best trade-off for the share of photons?**
- **Double functions : electricity + crop production**

Interdisciplinary R&D is needed
(source INRA)

- **Innovative solar panels able to maximize the transmission of the crops's useful wavelengths**
- **Selection of innovative cropping systems adapted to this system of production**

Perspectives for optimization are important for such a synergetic mixed system



Example of innovative PV using cylindrical modules (Solyndra inc.) and Poinsettia cultivation

Energy Harvesting Greenhouses



PRECONDITIONS FOR THE DEVELOPMENT OF SOLAR PV IN MENA REGION

- A defined energy vision and investment planning for Solar energy
- Financial support guaranteed over a predefined period of time, without retroactivity
- Removal of barriers through streamlined administrative procedures and efficient grid connection processes
- Guaranteed grid access and transmission
- Information and awareness of the population/investors about the benefits related to PV



Innofusion for sustainable technologies as an expanding spiral

- Education and certification of installers
- Grid infrastructure development

MERCI



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