International training
"Energy efficiency of buildings and ecological construction materials"
6-8 December 2010, Sigulda, Latvia

Photovoltaic power generation in the buildings. Building integrated photovoltaic – BIPV

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Vilnius - 2010

Contentus
Solar Energy Shop In UK

intense energy efficiency

BEF BALTIC ENVIRONMENTAL FORUM

Intelligent Energy Europe

Presentation introduction

Solar energy

Brief introduction of photovoltaic (PV) power for homes

Grid connected photovoltaic and as supporting power for households appliances

PV applications schemes for residential and industrial buildings

BIPV objectives and advantages through European success stories

Solar Energy

Solar Energy

Solar energy has existed for as long as the sun was born.
People have been using it for thousands of years.

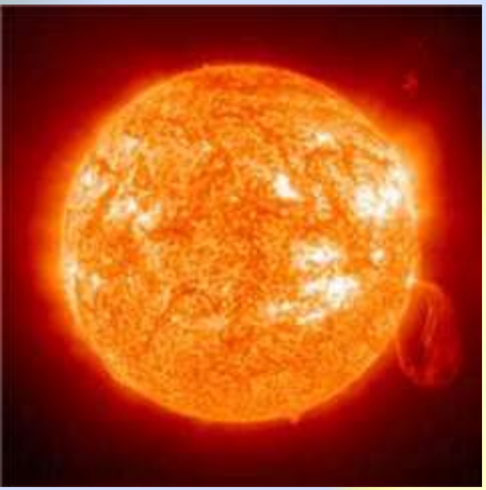
Since ages, human have been using solar energy to burn fire, drying clothing, heating homes, cocking food and many other purposes

In 15 minutes the sun radiates as much energy as mankind consumes in all energy forms, during an entire year.

Sun is the primary source of fossil fuels and even nuclear . The wind, ocean waves, biomass and hydropower are all transformed forms of solar energy.

intense energy efficiency

Solar Energy



Solar potential are unlimited and everlasting

Does not cost

Are „domestic“ or local energy source

Are sustainable

Solar energy devices operate without making noise

No mechanical wear. No expensive maintenance

Cleanest way for energy producing

Do not harm the climate are emission -free absolutely

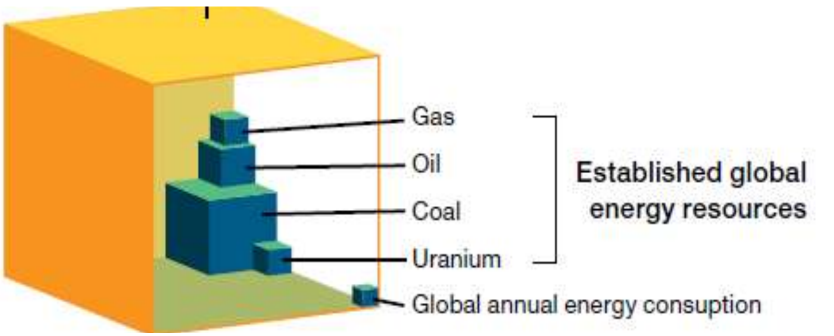
Biggest potential for research & development and market growth, worldwide

commercially payable in near years

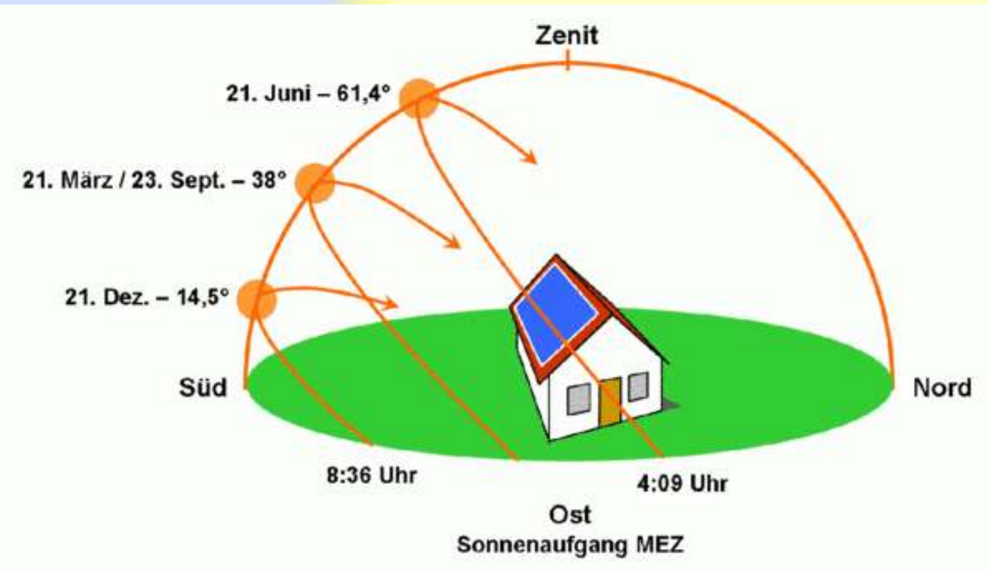
Added value and creating jobs for local region

Solar Energy

Annual solar irradiation to the earth

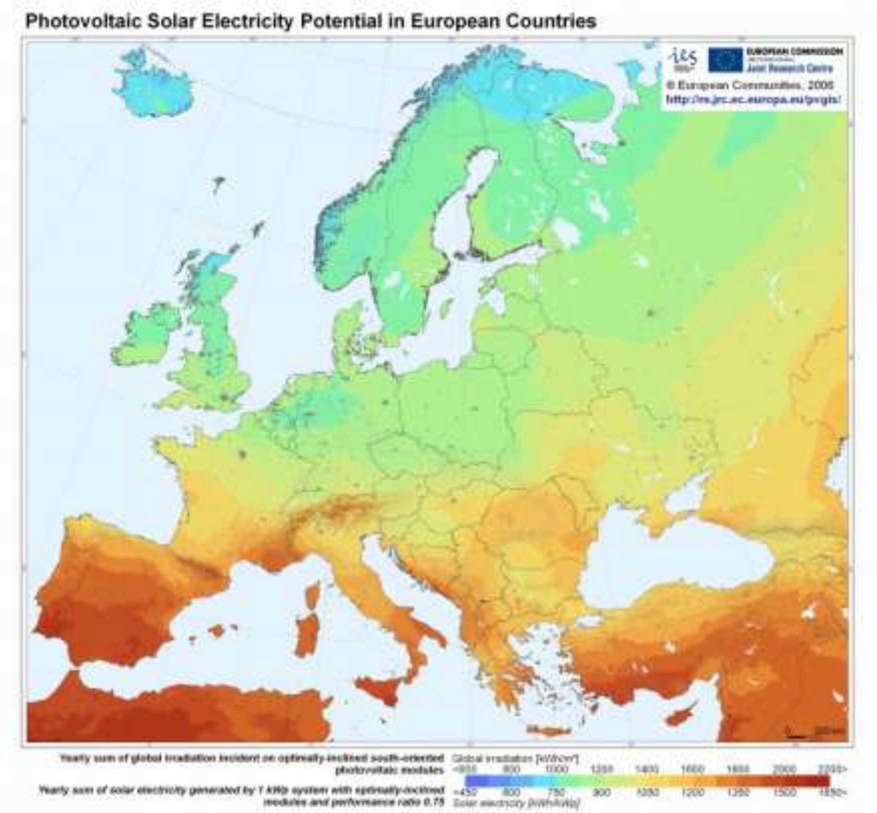


In one day the sun radiates enough energy on the country to power the entire nation for a year and a half. Not only that, but it does it every day – for free



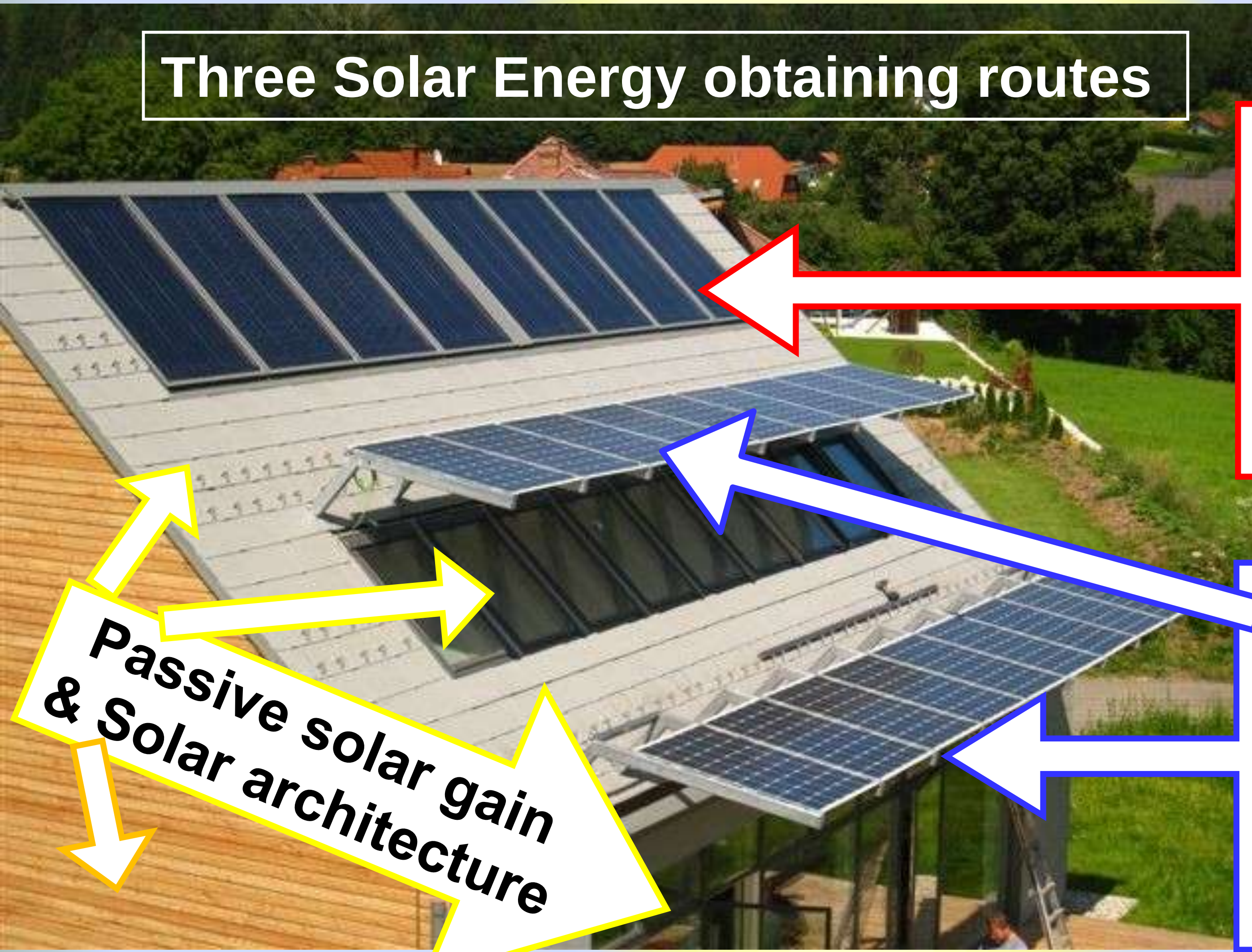
http://re.jrc.ec.europa.eu/pvgis/cmaps/eur.htm

http://re.jrc.ec.europa.eu/pvgis/apps/pvreg.php



Solar radiation is as daylight when the Sun is above the horizont. Direct sunlight includes **infrared, visible, and ultra-violet light.** **Local site insolation rate** or **solar irradiance on panels surface** – are very important factor for performance efficiency and designs of photovoltaic power generation , concentrated solar power (CSP) solar-thermal systems and plants,

Solar Energy

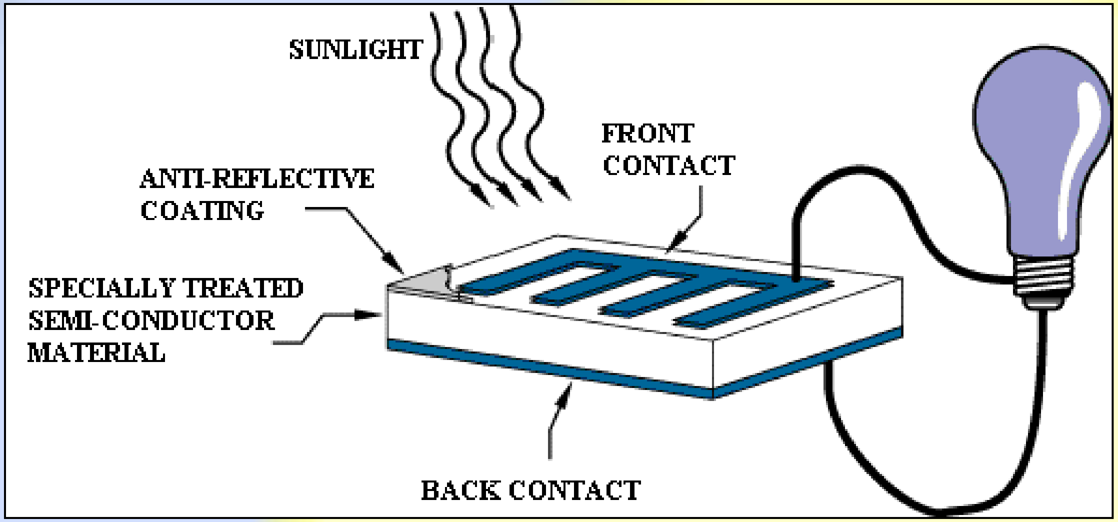


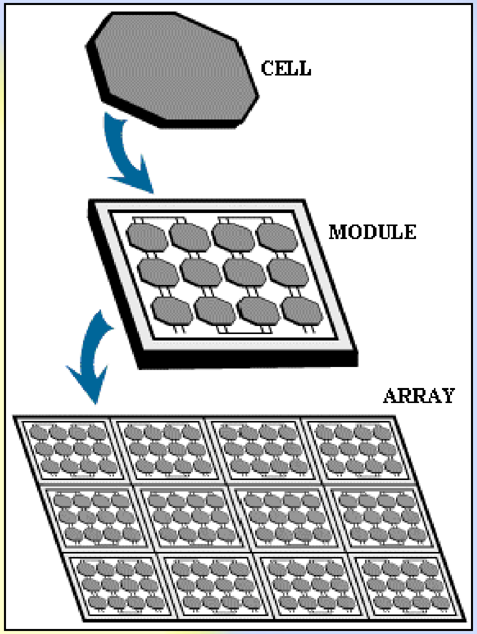
Solar thermal
– for upgrading DHW and HVAC, simming pools, heat store (stock).
Large CSP plants

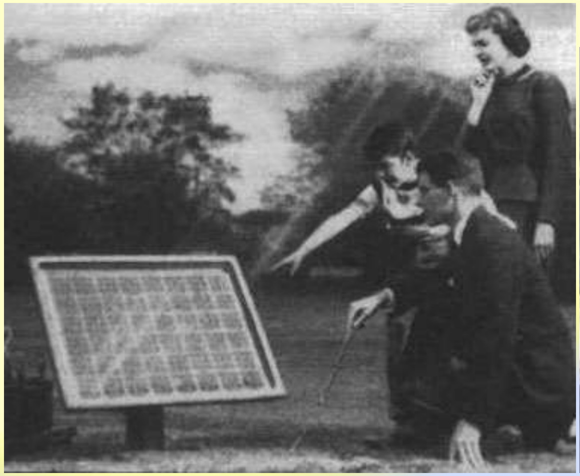
Solar Photovoltaic -
Electric DC power generation and converting to AC systems and plants

Brief introduction of photovoltaic (PV) power for homes

Brief introduction photovoltaic power (PV) for homes





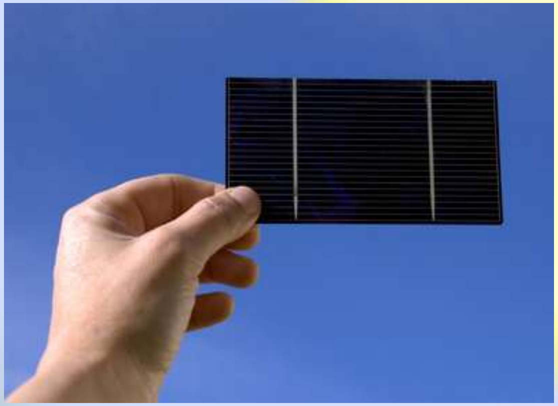


Brief introduction photovoltaic power (PV) for homes

Photovoltaic energy (PV) uses energy from the sun to create electricity to run appliances and lighting. Photovoltaic system requires daylight – not only direct sunlight but also diffuse light – to generate electricity

The most important parts of a PV systems are:

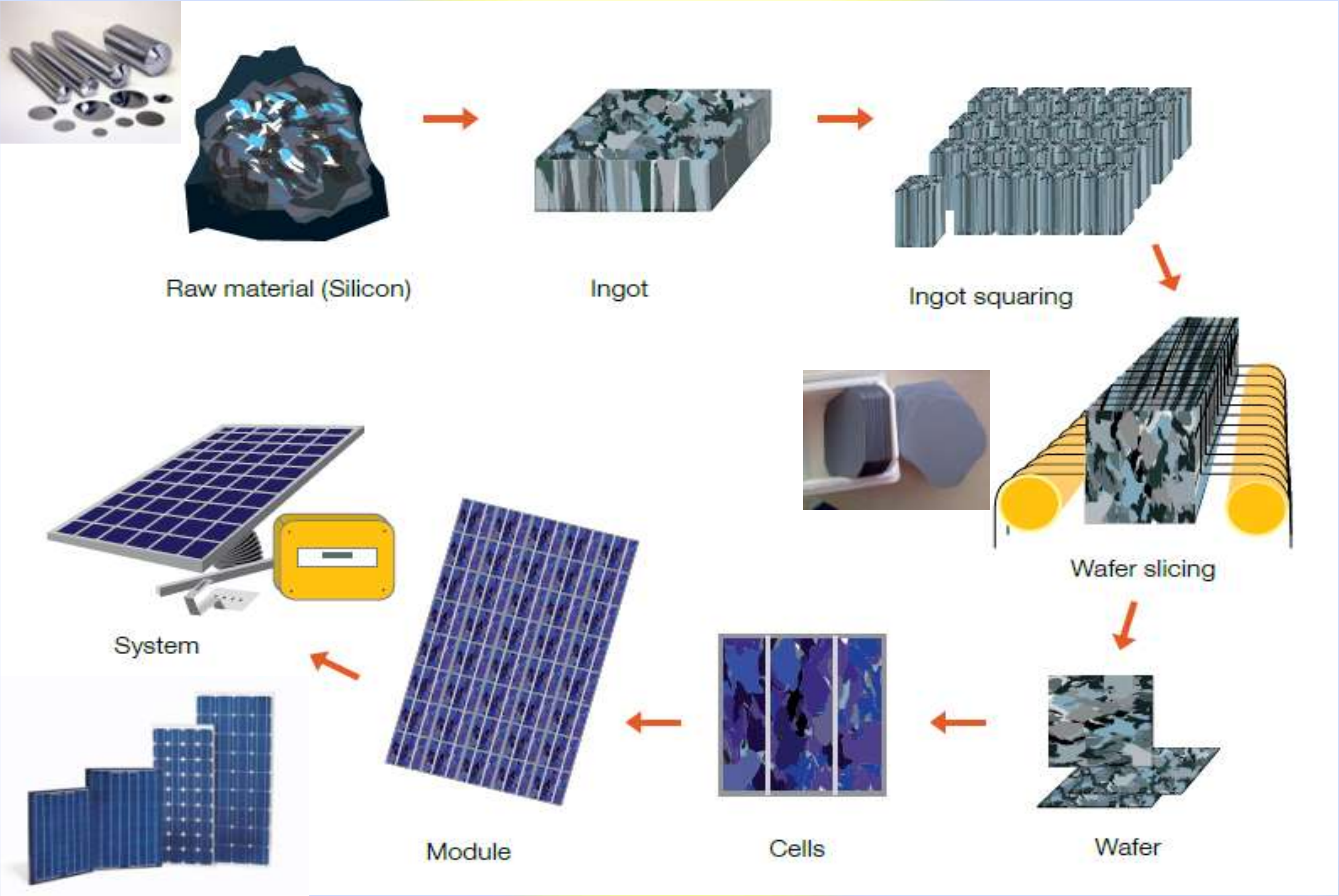
Cells which form the basic building blocks of the PV unit, collecting the sun's light



Modules which bring together large numbers of cells into a unit – then modules arrays

Inverters used to convert generated DC electricity into AC - a form suitable for everyday use

Brief introduction photovoltaic power (PV) for homes



European Photovoltaic Industry Association brochure Photovoltaic energy electricity from the sun, ww.epia.org

Brief introduction photovoltaic power (PV) for homes

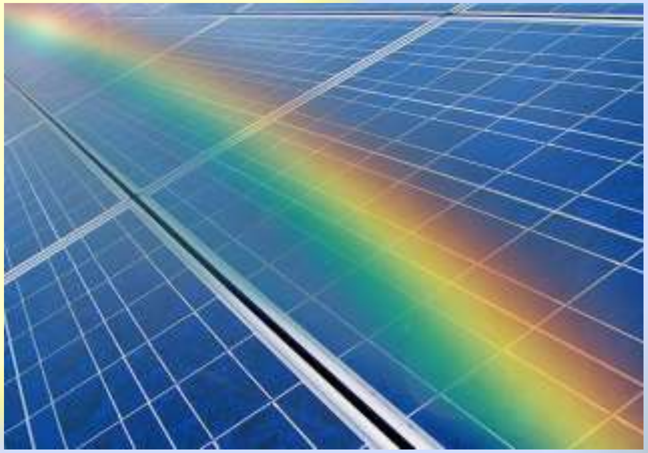
Photovoltaic systems use cells to convert solar radiation into electricity. The cell consists of one or two layers of a semi-conducting material. When light shines on the cell it creates an electric field across the layers, causing electricity to flow. **The greater the intensity of the light, the greater the flow of electricity is.**

Three main types of crystalline cells can be determinate:

- Mono-crystalline (Mono c-Si)
- Poly-crystalline (or - multi c-Si)
- Ribbon sheets (ribbon-sheet c-Si)

Challenges for crystalline technologies are:

- Limited possibilities to reduce producing cost of crystalline modules and reach PV energy price competitive to electric power produced by common generating.
- Laboratory conditions for multiplex testing of ready made wafers, cells and modules.
- Limited efficiency boundaries (<30%) appointed by scientific tests.
- Relatively high amount of primary energy is needed for purification of silicon. (more than 50% of cleaned silicon are used in electronic production worldwide)



Brief introduction photovoltaic power (PV) for homes

PV modules main technical characteristics:

Module Type) -
Max power Pm(Wp)±5% -
Voltage Vmpp(V) -
Current Impp(A) -
Voc(V) -
Isc(A) -
Module size(mm) -
Weight NET(kg) - 11.9

Efficiency of the Module

Solar cells: 36 pieces of 156×156mm mono-Si
Layout: 4×9
Front Side: High-transmission 3.2mm tempered glass
Back Side: TPT (tedlar/pet/tedlar) or TPE
Frame: Clear anodized aluminum frame
Connection box: Protection Class IP65

Operation Temperature Range: -40℃～85 ℃
Temperature coefficients of Im: +0.1 %/℃ ; of Vm: -0.38 %/℃
Maximum System Voltage: DC715/1000V

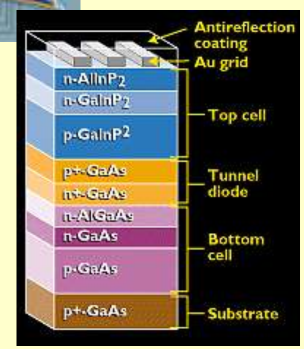
Standard Test Conditions STC: Radiation 1000 watt/m2 with a spectrum of AM 1.5 at a cell temperature of 25°C.

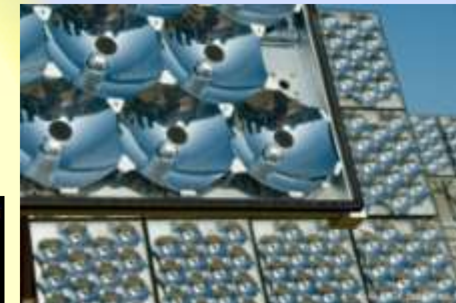
Brief introduction photovoltaic power (PV) for homes

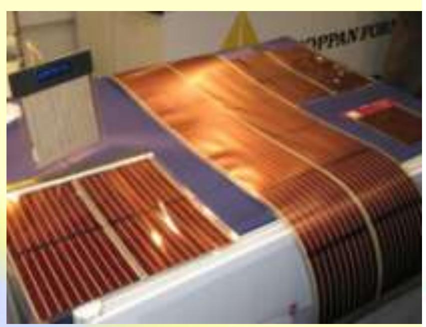
Were invented other cell types. It 's secondary and thirdly generation of PV

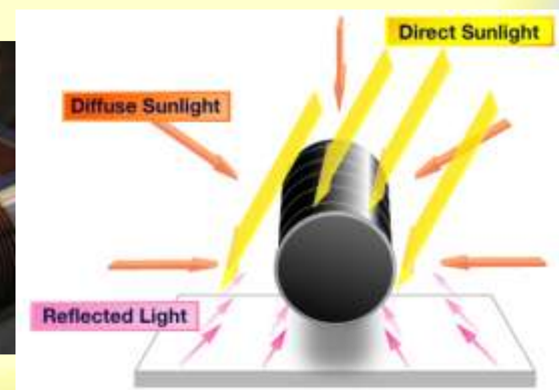
There are several other types of photovoltaic technologies developed and commercialised today or just starting to being

- **Available innovative photovoltaic technologies**
- **Thin Film modules**
- **Multujunction thin-film PV modules**
- **Concentrated photovoltaic**
- **Flexible cells.**
- **Tracking devices**









Brief introduction photovoltaic power (PV) for homes

Advanced PV technologies

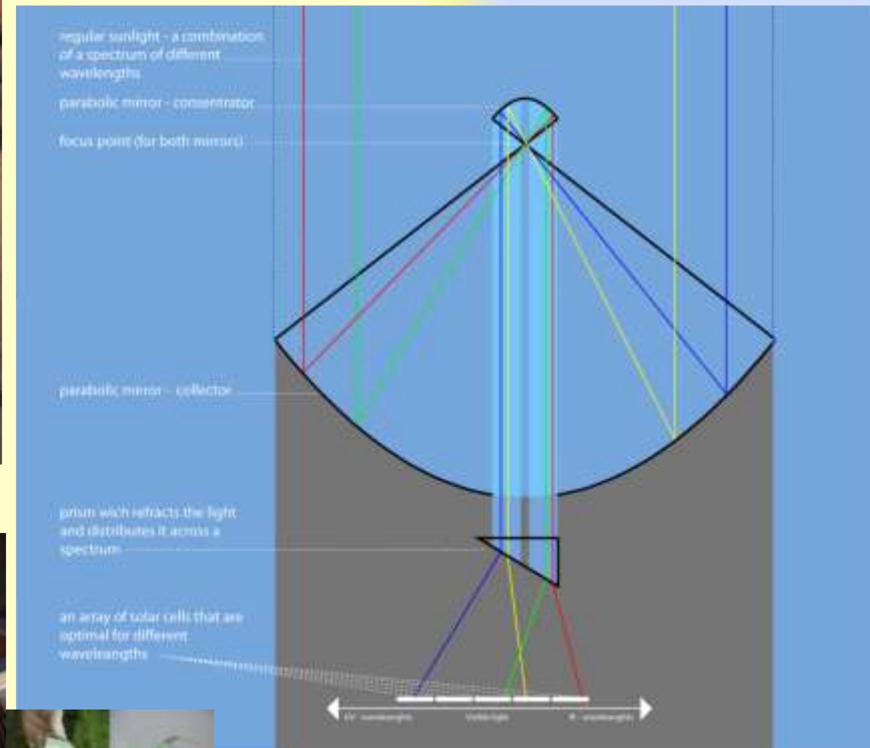
Some of them are commercialized, and some still are at the research level:

Use of **excess thermal generation** (caused by UV light) to enhance voltages or **use of infrared spectrum** to produce electricity even at night

Spray-On Solar power cells

The solar cells material uses nanotechnology and are able to harness the sun's invisible, infrared rays. Promising to become five times more efficient than current solar cell technology.
Solar cells material is sprayed like paint on window glass. The composite can be sprayed onto other materials and used as portable electricity. Coated in the material could power a cell phone or other wireless devices. Could potentially convert enough energy into electricity car's to continually recharge the battery.

Modifying spectrum or light rays using Frensel lenses and mirrors



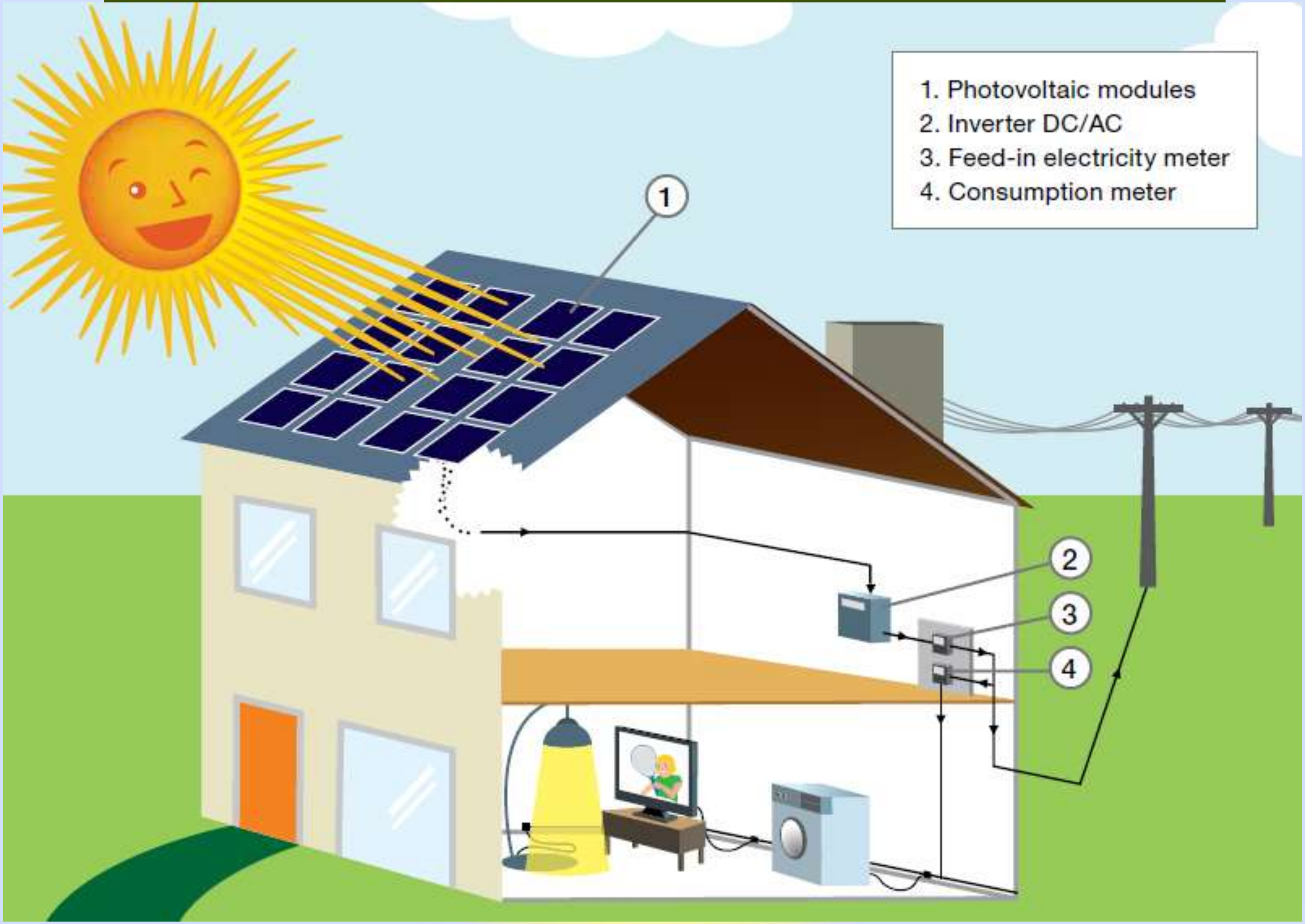
Nano-solar utility panels

Advanced PV technologies

Use organic semiconductor materials for producing flexible PV thin-tin modules

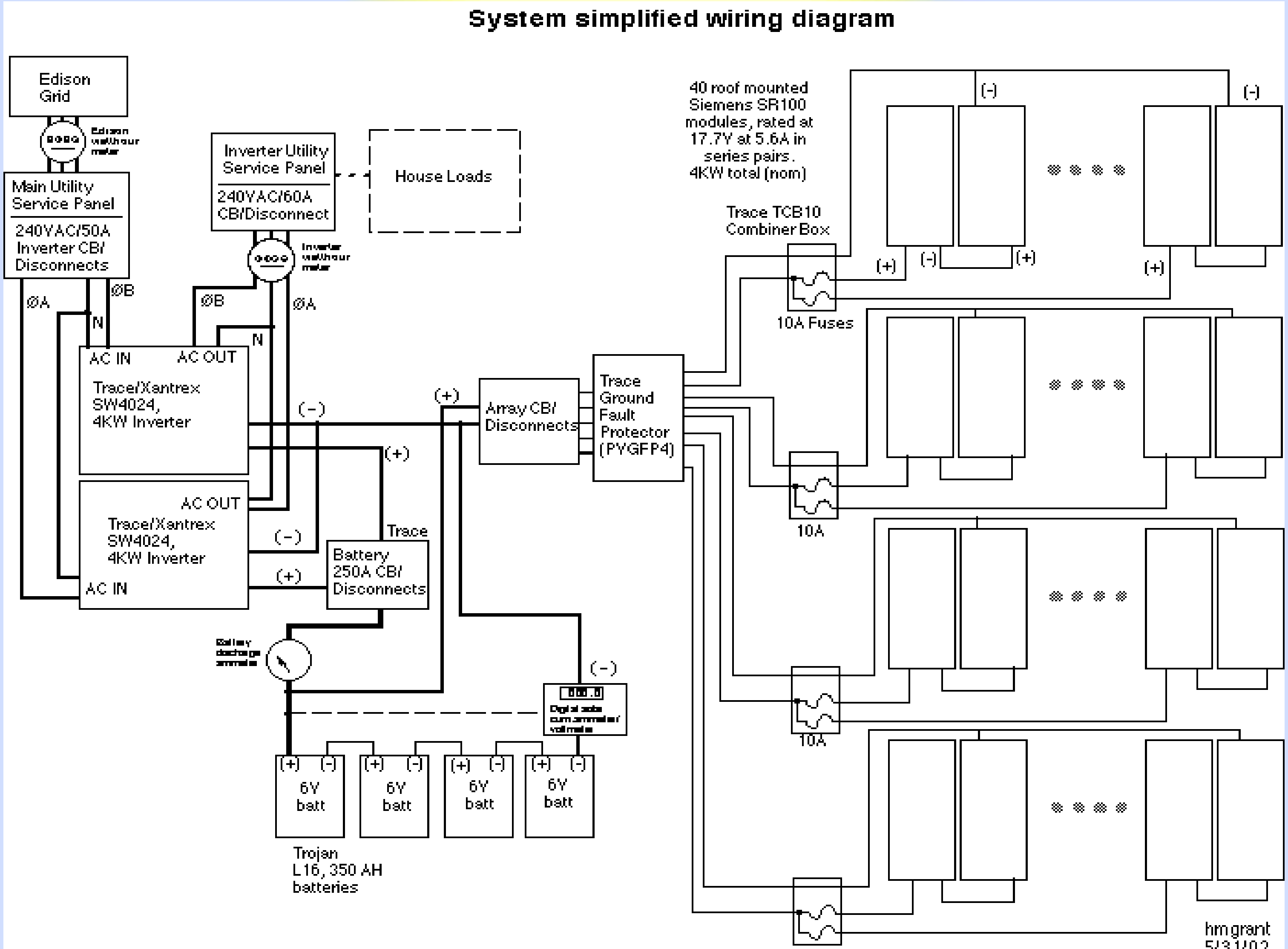
Grid connected photovoltaic and as supporting power for households appliances

Grid connected photovoltaic and as supporting power for households appliances



Source :European Photovoltaic Industry Association brochure Photovoltaic energy electricity from the sun, ww.epia.org

Grid connected photovoltaic and as supporting power for households appliances

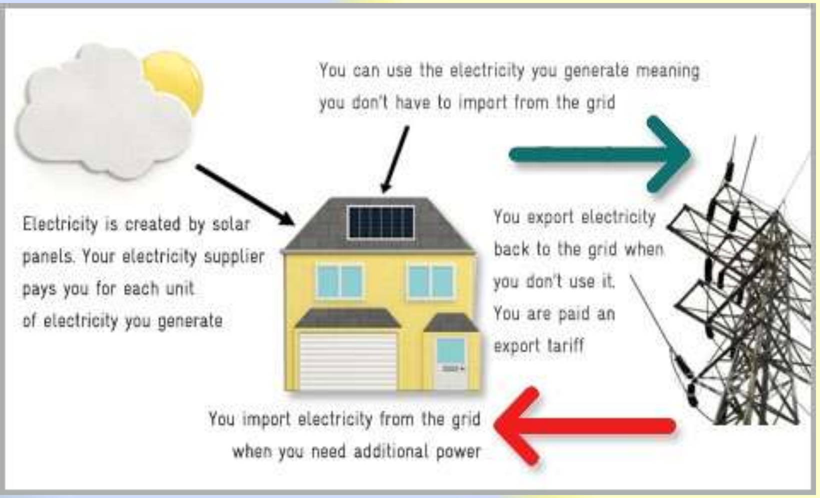


Grid connected photovoltaic and as supporting power for households appliances

Feed-in tariff – key factor for PV market development

The Feed-in Tariff - the main driver of solar success.
Feed-in Tariffs (FiTs) are widely recognised as the most effective way to develop new markets for PV.

The concept is that solar electricity producers:
- have the right to feed solar electricity into the public grid
- receive a reasonable premium tariff per generated kWh reflecting the benefits of solar electricity to compensate for the current extra costs of PV electricity
- receive the premium tariff over a fixed period of time.



Feed-in Tariffs in Great Britain on 1st April 2010

Tariff levels, for technologies installed between 15th July 2009 and 31st March 2012 of most significance to householders

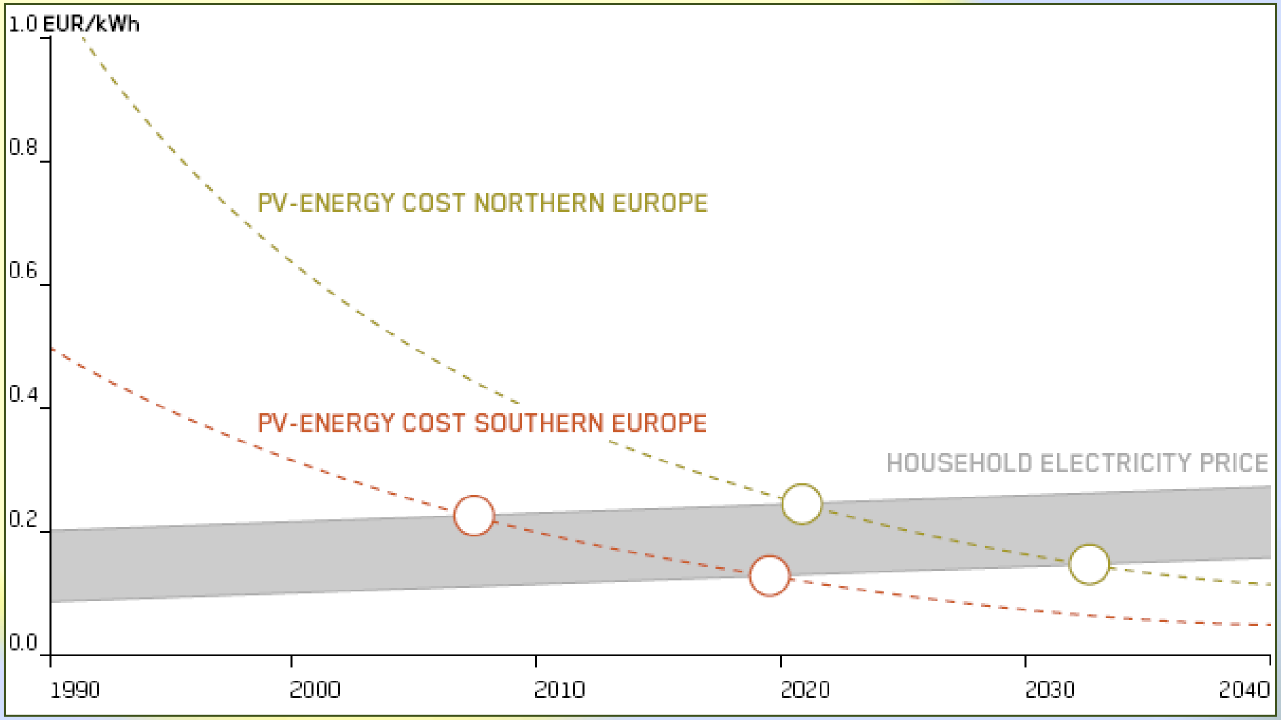
Technology	Scale	Tariff level (p/kWh)	Tarifflifetime (years)
Solar electricity (PV)	≤4 kW (retro fit)	41.3	25
Solar electricity (PV)	≤4 kW (new build)	36.1	25
Wind	≤1.5 kW	34.5	20
Wind	>1.5 - 15 kW	26.7	20
Micro CHP	≤2kW	10.0	10
Hydroelectricity	≤15 kW	19.9	20

Tariff levels, for technologies installed between 15th July 2009 and 31st March 2012 of most significance to householders
Tariff levels vary depending on the scale of the installation.
The tariff levels shown in the table above apply to installations completed from 15th July 2009 to 31st March 2012 for the lifetime of the tariff. After this date, the rates decrease each year for new entrants into the scheme.

Grid connected photovoltaic and as supporting power for households appliances

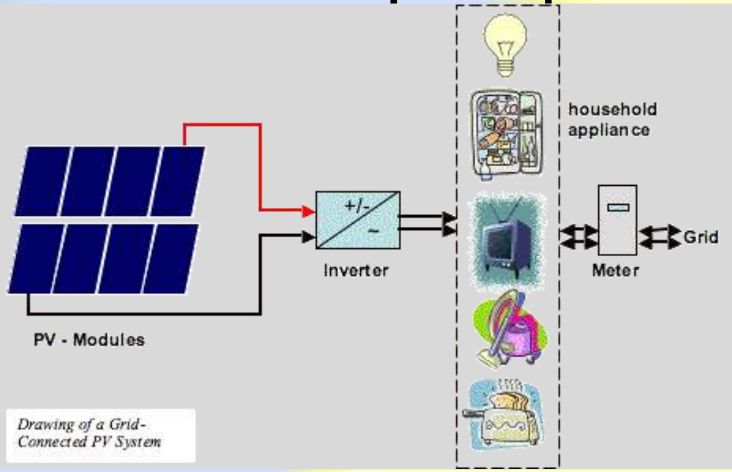
How do feed-in tariff mechanisms work in practice?
If you install a PV system at home, all electricity generated can be injected and sold to the electricity provider at higher price than the price paid in your monthly electricity bill. This mechanism **enables you to pay-back your investment** in a short time. The country which has best succeeded to develop photovoltaic energy today is Germany. Spain, Italy, France and Greece have also developed this system and step by step electricity consumers, aware of the importance of renewable energies, are switching to solar electricity receiving a compensation for their effort.
Some other systems exist to develop and support renewables (green certificates, tendering, tax credit) but they have not proved to be as efficient in particular when they depend from State budgets.
More information is available on www.epia.org.

In the long run no more support will be required to help the development of photovoltaic electricity. With increasing sales leading to scale economies and efforts realised by producers to reduce the cost of photovoltaic products, it is expected that photovoltaic will be competitive with electricity prices in the South of Europe by 2015 and in most of Europe by 2020.



Grid connected photovoltaic and as supporting power for households appliances

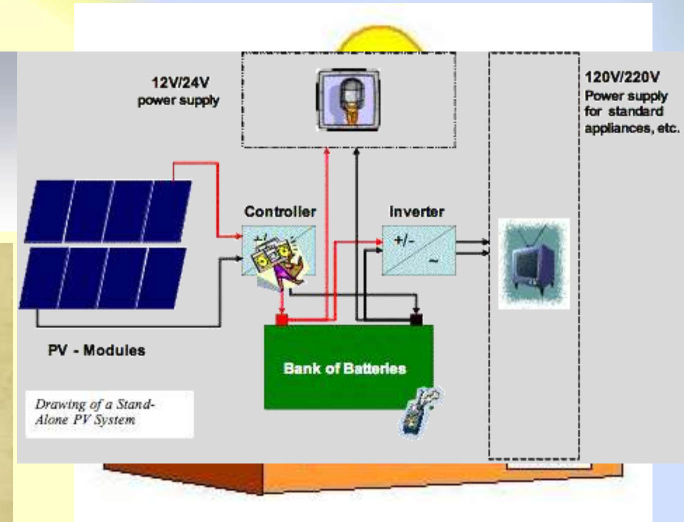
Grid-connected power plants



These applications are located on residential homes, on large industrial buildings such as airport terminals or railway stations.

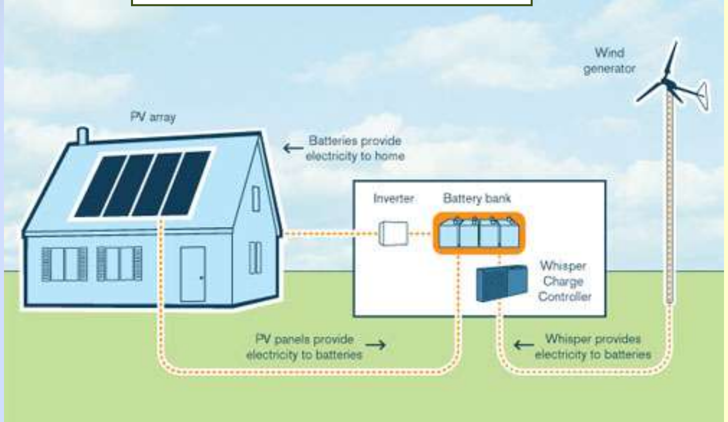
Grid connected photovoltaic and as supporting power for households appliances

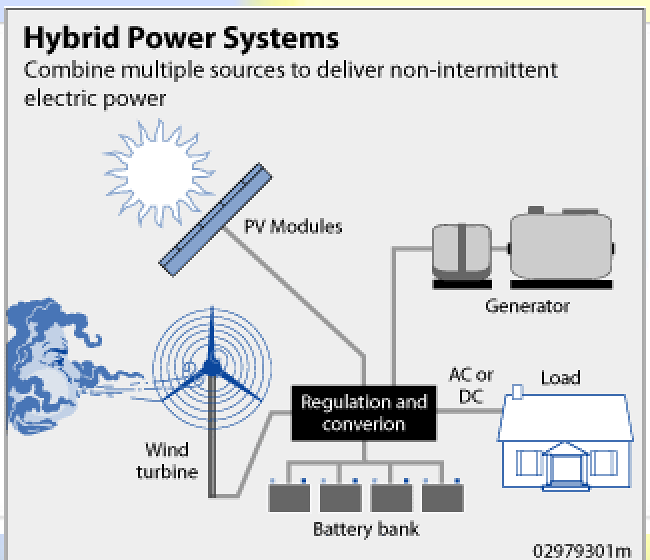
Off-grid systems for rural remote electrification



Grid connected photovoltaic and as supporting power for households appliances

Hybrid systems





Hybrid systems
A solar system can be combined with another source of power - a biomass generator, a wind turbine or diesel generator - to ensure a consistent supply of electricity. A hybrid system can be grid-connected, stand-alone or grid-support.

Grid connected photovoltaic and as supporting power for households appliances

Consumer goods

Air Solar heaters – as supplement heating and ventilation premises.

Solar attic vent-fan, suitable bots, cams, summer huts and others

PV Kit - 1.35kW

Mastervolt XS2000 Grid tie inverter. AC and DC Disconnect boxes. Six 225W MCS Approved solar panels. Offgen approved meter; MC4 Connectors; 30 Meters of premium solar cable; Roof mounting system

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Grid connected photovoltaic and as supporting power for households appliances

iPod/iPhone chargers

powertraveller

Chargers for mobile phones, mp3 players, GPS, cameras

PC and iPad chargers

flexcell
Smart power. Brilliant solutions.

Grid connected photovoltaic and as supporting power for households appliances

Off-grid industrial applications

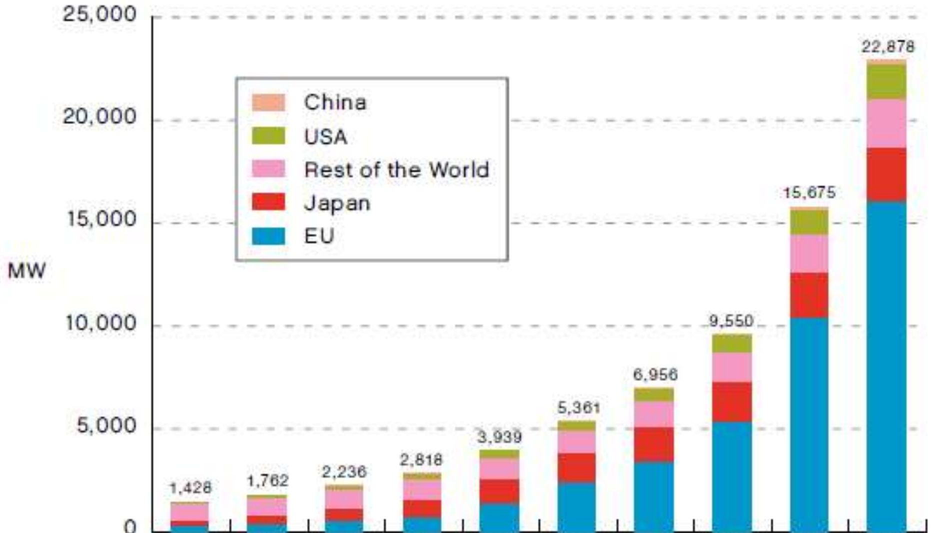
Grid connected photovoltaic and as supporting power for households appliances

Off-grid industrial applications





PV world market expanding 2000-2010 & forecast until 2014, 2050



	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

Despite word economy recession, PV sector has grows sine 2003, significantly –almost 30% annually.
The last decade has seen PV technology emerging as a potentially major technology for power generation in the World. Today, almost 23 GW are installed globally which produce about 25 TWh of electricity on a yearly basis.
Europe is leading the way with almost 16 GW of installed capacity in 2009, representing about 70% of the World cumulative PV power installed at the end of 2009 while Japan (2.6 GW) and the US (1.6 GW) are following behind. China makes its entry into the TOP 10 of the World PV markets and is expected to become a major player in the coming years.

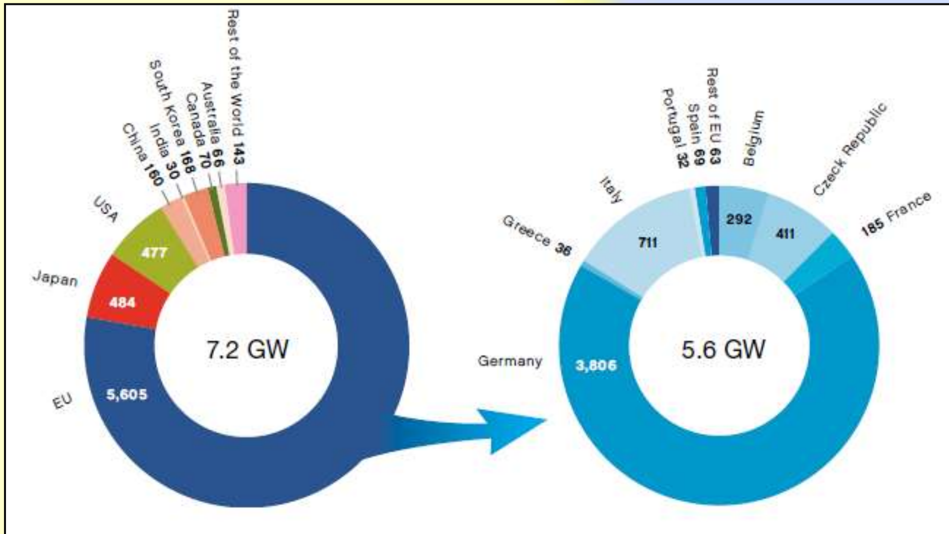
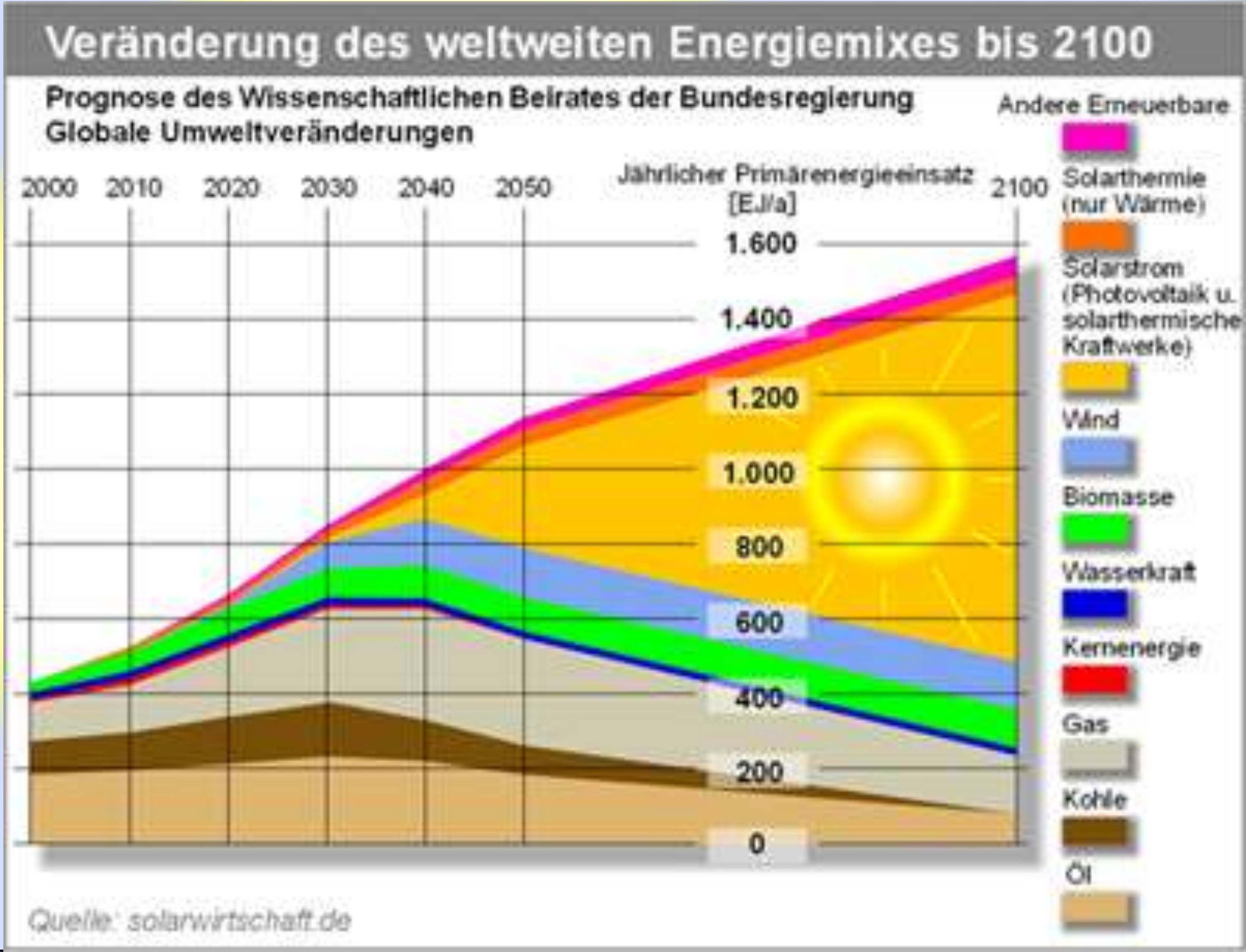


Figure 3 - World and European PV markets in 2009 in MW

This progression in 2009 is mainly due to the development of the German market which almost doubled in one year from 1.8 GW in 2008 to around 3.8 GW installed in 2009, representing more than 52% of the World PV market.
The Italian market installed 711 MW, making it clearly the second largest market world-wide.
Impressive progress made Czech Republic and Belgium in 2009, with 411 MW and 292 MW installed, respectively.

PV world market expanding 2000-2010 & forecast until 2014, 2050

German Advisory Council on Global Change – WBGU *has* calculated in the end of this century Solar energy will become leading primary energy source. Regarding them prognosis solar energy share will exceed by 24% in 2050 , and 63% in 2100. At the same time portion fossil as primary energy sources significant will decrease



PV applications schemes for residential and industrial buildings

intense
energy efficiency

PV applications schemes for residential and industrial buildings

Household PV power plants samples

http://www.sunways.eu/en/electricity-producer/

PV applications schemes for residential and industrial buildings

Location: Ecaussines, **Belgium**
Commissioning: 11/7/2005
System power: **4.92 kWp.** Annual Production: approx. 3,700 kWh (**752 kWh/kWp**) CO_2 avoided: Approx. 1.7 tons per annum
41 Modules: Solarwatt M 120-72 (120 W) (TUV, CE, IEC61215)
Inverters SB 2500 ir SB 3000
Inclination angle- 35
Azimut– 224

SUNNY PORTAL **http://www.sunnyportal.com/Templates/PublicPagesPlantList.aspx**

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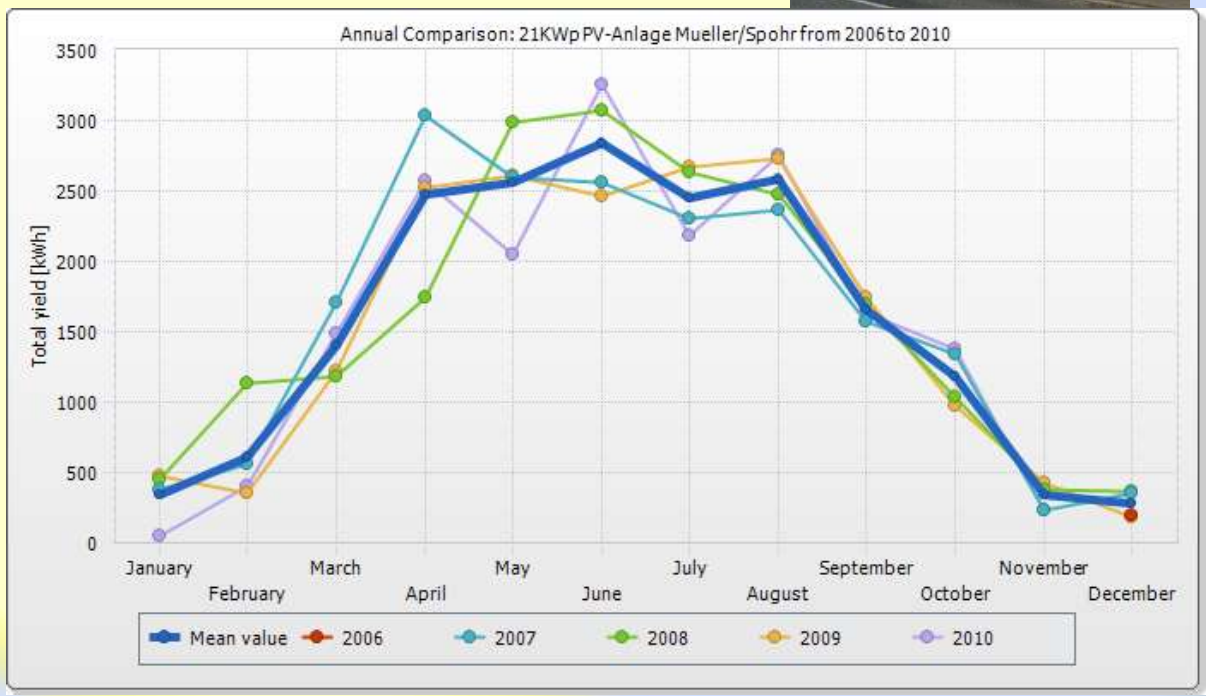
PV applications schemes for residential and industrial buildings

Location: Ottrau, Germany
Operator: Müller/Spohr
Commissioning: 8/1/2006
System power: 25.36 kWp
Annual Production: approx. 23,838 kWh (940 kWh/kWp)
CO_2 avoided: Approx. 16.7 tons per annum



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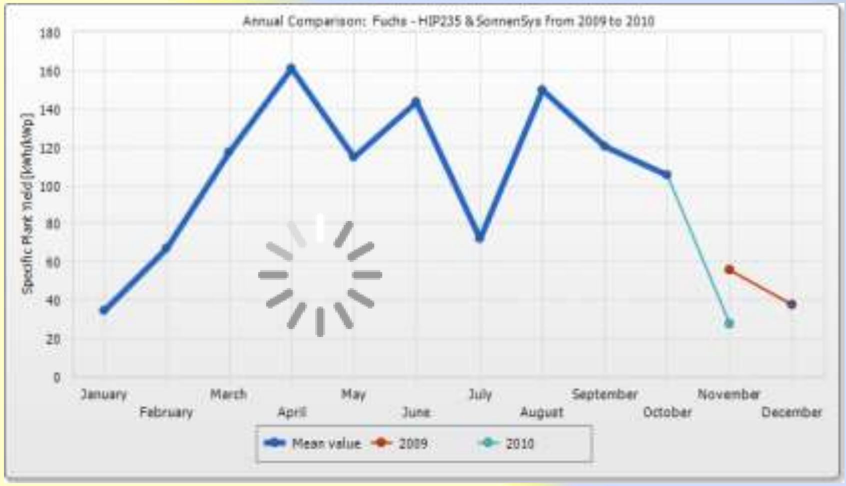
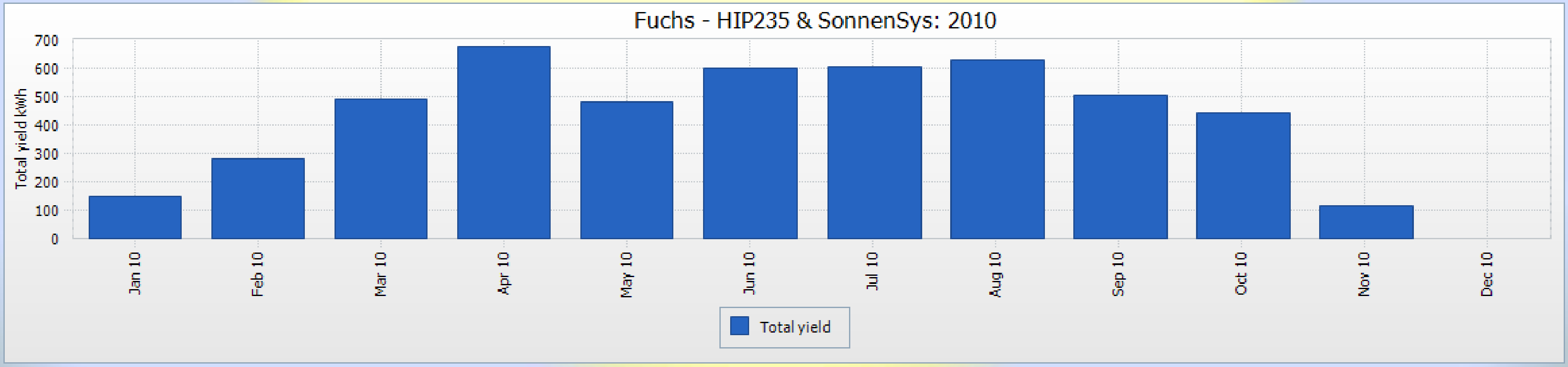
PV applications schemes for residential and industrial buildings



Location: Neulengbach, **Austria;** Commissioning: 11/5/2009
System power: 4.20 kWp ; 18 Modules: Sanyo HIP-235HDE4
Inverter: Sunny Boy 4000TL
Communication: Sunny WebBox

When tracker devices moves PV panels - specific PV plant yield 1200 kWh/kWp annually are expected 2010



PV applications schemes for residential and industrial buildings

ABB string **inverters*, rated from 4 to 8 kW, and one 120 kW** ABB central inverter** are used in the **1,200 square meter** solar module area
Is expected to generate about **160,000 kWh** per year. **884 kWh/kWp/y**

The project, which costs approximately **500,000 EUR**, is partly funded by Finland's Ministry of Employment and the Economy from its renewable energy system investment fund that invests in future and renewable technologies as part of its strategy to create new technologies and jobs within these sectors. € 2762 per 1kWp (inverter's cost partly covered by ABB)

- The **181 kilowatt** (kW) solar power system is on the rooftop of ABB's low voltage AC drives factory at Pitäjänmäki, in **Helsinki, Finland**. The electricity it generates is to be used **for charging the batteries of the factory's fork lift trucks**, and **for cutting energy consumption peaks** at the factory.

intense energy efficiency

PV applications schemes for residential and industrial buildings

On the planning & construction stages now are lot of new photovoltaic plants:
- Rancho Cielo Solar Farm, USA - 600MW
- Topaz Solar Farm, USA - 550MW
- High Plains Ranch, USA - 250MW
- Mildura Solar concentrator power station, Australia -154MW

Large scale PV plants

PV applications schemes for residential and industrial buildings

Solar park Lieberose in Germany near Frankfurt. Mounted On in military training area of the Soviet Army an area of 162 ha – which is roughly the size of 210 football fields former. Completed in August 2009.
Installed peak Power output– **53** MWp; Annual power production is approx **53** mln. kWh. Solar park produces energy for 15.000 households.
Saves around 35.000 tons of carbon dioxide (CO_2) per year
700.000 thin-film modules – First Solar FS-272
Inverters: 37 x SMA SC 1250 MW, 1 x SMA SC 900 MW
Investment cost – 160 mln. EUR

http://www.pvresources.com/en/top50pv.php

Largest photovoltaic power plant in Central, South and Eastern Europe was held in the town Vepřek Czech Republic on the 8th of September 2010. The complex puts out an impressive 35 MWp.

BIPV objectives and advantages through European success stories

BIPV objectives and advantages through European success stories

Building Integrated photovoltaic - BIPV

Residental building

Infrastructure building

Public building

Industrial & agriculture building

Commercial & offices building

BIPV objectives and advantages through European success stories

Building Integrated photovoltaic – BIPV - structures

Roof & skylights

Facades

Blind covers

Balcones

Shelters, penthouses

BIPV objectives and advantages through European success stories

Advantages with BIPV

BIPV special - Semitransparent PV glass modules - form, colours, structure and composition of the multifunctional modules comply with all actual architectural demands on modern building services engineering:

Thermal insulation
Noise protection
Safety
Wind and weather stability

BIPV substitutes conventional building materials such as concrete and plaster on the facade or tiles, or glass on rooftops

BIPV objectives and advantages through European success stories

The **CIS tower in Manchester** has three of its four sides completely clad in photovoltaic cells. This allows the building to harvest the sun's power throughout the day. This building is a perfect example of the kind of mega-scale use of solar panels.
Constructed in 1962, 5200 sq.m. of concrete facades were covered by PV panels during renovating in 2005. Nominal power – 391 kWp, Output – 180000 kWh/a.

BIPV objectives and advantages through European success stories

World Jewellery Centre in Milano

One of the EXPO 2015 buildings.
Completed in 2009, consist of 2, 9 ir 19 floor blocks -13000m2
1071 thin-film CIS modules of 80kWp power capacity integrated into facades
On a roof added 174 Würth Solar mono-Si modules – 40 kWp,
BIPV systems produce 60000 kWh power annually, with feeds air-conditioning and geothermal heat pump of the building

BIPV objectives and advantages through European success stories

MegaSlate® patent roof covering PV system. 3S Swiss Solar Systems.
Launched in March 2003
Nom.power - 10.2 kWp
Output- 9,500 kWh/a
92 frame-less modules (90m2), are as roof cover - grid connected electricity generating plant.

BIPV objectives and advantages through European success stories

Energie AG Power Tower in Linz, Upper Austria

First office tower has been constructed **with a passive energy character**.

Solar Power Station

With its surface of about 650 square meters, the solar plant on the south-west façade of the Power Tower is one of the biggest solar plants that are integrated into a building façade in Austria. The plant produces about 42,000 kWh of electricity per year and ecologically satisfies part of the building‘s electricity demand.

BIPV objectives and advantages through European success stories

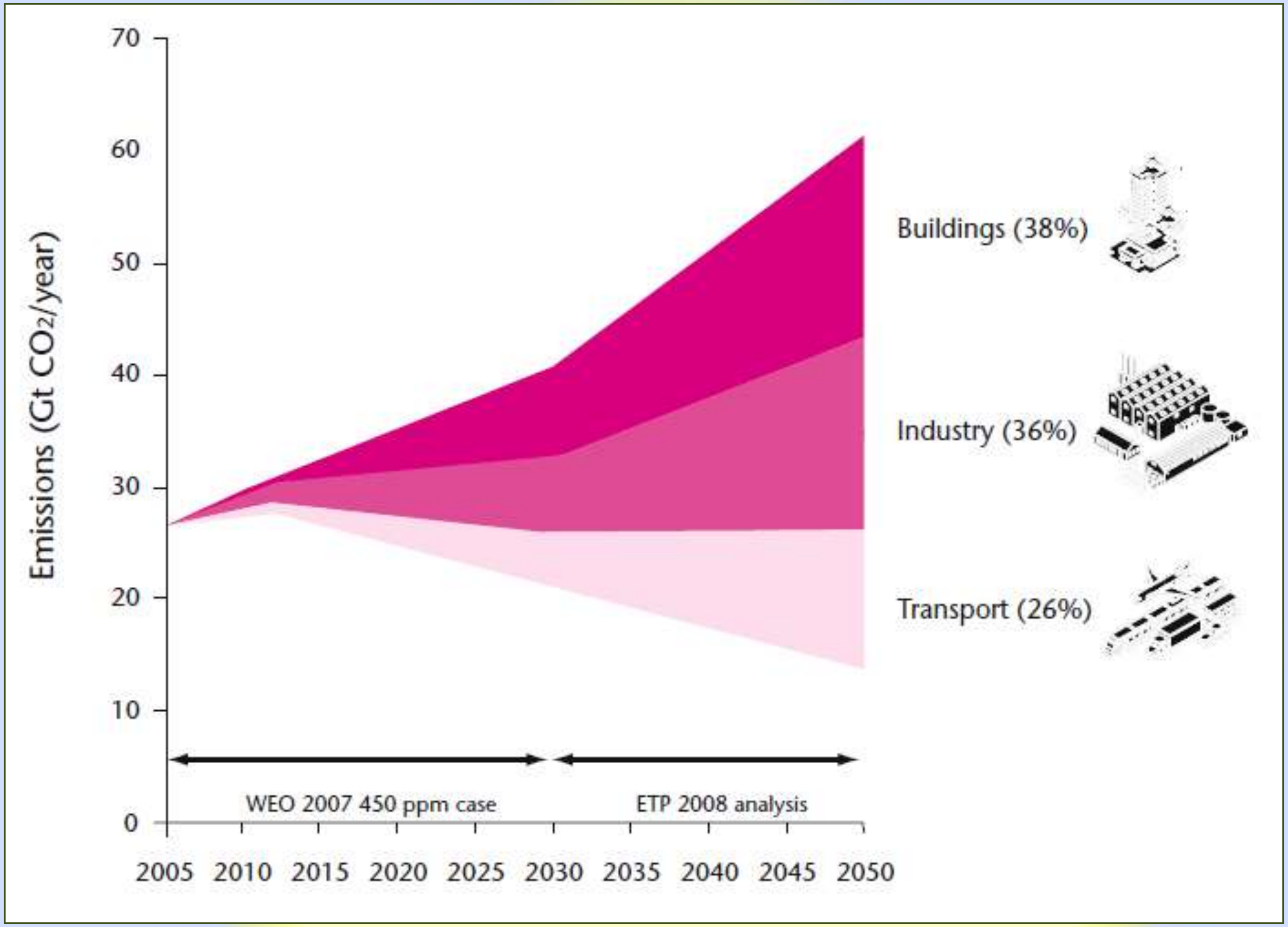
The roof of the town hall of the **Municipality of the Dutch city Dongen** has a total surface area of **545 m2**. The 100-tilted roof consists of **288** custom-made isolated semi transparent glass-glass modules with cell coverage of **85%.** Each **module has a size of 1,8 m2**, and a power output of **184 Wp** and a weight of 100 kg. The PV modules are all connected to 16 SMA SWR 2,500 inverters, which are all monitored by a computer. A **central display at the main entrance** shows the performance of the PV-system for all visitors of the town hall. **Rated power - 53 kWp**. Installed - January **2002**

BIPV objectives and advantages through European success stories

3S Swiss Solar Systems - HT company - PV technology equipments manufacturing producers equipped BIPV on a office building in St.Moritz. Thin-film photovoltaic modules are fixed on facades, roof, skylights, shelters - instead of ordinary materials. As benefit it generates electric power for the building.

St. Moritz (Switzerland)
http://www.3-s.ch/en

Frameless photovoltaic panels created an excellent aesthetics, reflected the landscape and are energy-supplying facades.



DIRECTIVE 2010/31/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 May 2010 on the energy performance of buildings
resolved to require all buildings constructed after 2018 to generate as much energy as they consume. Solar collectors, BIPV and heat pumps are ways that buildings could meet this requirement.

Thank for your attention