Global Status of Photovoltaic Solar Energy

Arnulf Jäger-Waldau
Thomas Huld
Heinz Ossenbrink
Irene Pinedo Pascua

European Commission, DG JRC, Ispra
Institute for Energy
Renewable Energy Unit

ECREEE Regional Forum on the ECOWAS Solar Energy Initiative

Dakar, 19th October 2010
Overview

PV Status Report 2010:
- Current status.
- Outlook to 2050.

*Just a few minutes...*

Photovoltaic Geographic Information System, PVGIS

AFRETEP project
PV produced

Annual PV Production [MW]

- Rest of World
- United States
- Taiwan
- PR China
- Europe
- Japan

Range of estimates

Data source: PV News, Photon International, Navigant Consulting, i-Suppli and own analysis
Annual Photovoltaic Installations [MWp]

- Spain
- Rest of Europe
- United States
- Rest of World
- Germany
- Japan

Data source: PV News, Photon International, Navigant Consulting, i-Suppli and own analysis
PV cumulative installed

Data source: PV News, Photon International, Navigant Consulting, i-Suppli and own analysis
PV Production Champion: China, 4.4 GW

PV Installation Champion: Europe, 5.8 GW
(16 GW cumulative)

Asia: 75% of World PV production

Europe: 78% of Worlds (grid-connected) Installation
Announced Capacity Increases

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Europe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>China</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taiwan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Korea</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROW</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Announced Capacity Increases

- Crystalline Wafer Silicon
- Thin Films
PV module price

PV Module price experience Curve since 1979 (2009 $/W)

- Historical price experience curve:
  - Doubling of cumulative sold volume reduces price by 22%

Source: SET for 2020, EPIA 2009
Photovoltaic Electricity Prices in 2020?

Assumptions: $2/\text{kWp}$; 4% interest; 0.5%/yr O&M; 30 yr operational life

Source: EC Joint Research Centre, PVGIS
## PV Scenarios

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenpeace (reference scenario)*</td>
<td>14</td>
<td>80</td>
<td>184</td>
<td>420</td>
</tr>
<tr>
<td>Greenpeace ([r]evolution scenario)*</td>
<td>18</td>
<td>355</td>
<td>1,036</td>
<td>2,968</td>
</tr>
<tr>
<td>Greenpeace (advanced scenario)*</td>
<td>21</td>
<td>439</td>
<td>1,330</td>
<td>4,318</td>
</tr>
<tr>
<td>IEA Reference Scenario</td>
<td>10</td>
<td>30</td>
<td>&lt;60</td>
<td>Non competitive</td>
</tr>
<tr>
<td>IEA ACT Map</td>
<td>22</td>
<td>80</td>
<td>130</td>
<td>600</td>
</tr>
<tr>
<td>IEA Blue Map</td>
<td>27</td>
<td>130</td>
<td>230</td>
<td>1,150</td>
</tr>
<tr>
<td>IEA PV Technology Roadmap</td>
<td>27</td>
<td>210</td>
<td>870</td>
<td>3,155</td>
</tr>
</tbody>
</table>

* 2010 values are extrapolated as only 2007 and 2015 values are given.
Further Outlook

• After 2020 the European Market for newly installed PV systems will represent less than the 50% anticipated until then.
• Large markets will be China, Europe, India and US.
• Africa and South-East Asia will emerge as large markets.
• Off-grid installations will grow faster than grid-connected installations.

Required:
• Grid Management.
• World-wide Emission Trading.
Conclusions

✔ Growth of PV electricity installations is much faster than predicted by most scenarios.
  ! Adaptation of current grid structures to accommodate larger share of decentralised RES is needed to enable a large scale use of PV electricity.

✔ Only increasing markets ensure that PV electricity prices are continuously declining.
  ! For the next decade solar PV will still need support.

✔ Photovoltaics is one of the most important building blocks for decentralised rural electrification.

PV electricity is an important building block to realise a decarbonised energy supply
PVGIS

What is PVGIS?

- a database of solar radiation and temperature data combined with a web interface that lets users calculate the energy output of photovoltaic (PV) systems.
- a scientific tool that allows us to do research on the performance of PV systems over large geographical areas and estimate the potential for solar energy deployment in Europe and Africa.

How was it obtained?

- Europe: Long-term monthly averages global and diffuse irradiation from ground stations are interpolated onto a spatial grid. Data collected by ESRA over the period 1981-1990
- Africa: Daily values of global irradiation sums from the HelioClim-1 database, estimated from MFG satellite data, with a spatial resolution of 15’. Time period 1985-2004
- The online calculation also includes the effects of shadows from nearby mountains (based on the SRTM-3 DEM, resolution of 3 arc-seconds, ~90m at the equator).
PVGIS: web interface features

- Covers Europe and Africa
- Various types of PV installations: fixed or tracking, models for different PV technologies
- Calculator for stand-alone PV applications (Africa only)
- High-resolution terrain data allows calculation of the effects of shadowing
- Google Maps interface with search and zoom facilities.
PVGIS

[Click here]

Then click here

Performance of Grid-connected PV

1000-2000 hits per day
AFRETEP

Scientific and Technical Support to Sustainable Energy Development in Africa: rural electrification, renewable energy and communication.

*Founded by:* European Commission, Europe Aid Co-operation Office.

3 years.

Tasks:

- Increase Scientific and technological knowledge sharing.
- Establish a network of African Research Institutions.
- Promote cooperation and coordination.
- Provide scientific information, geographical data and appropriate tools.
AFRETEP

- 1st AFRETEP Meeting: Cameroon, Senegal, Uganda, Ethiopia, Burkina Faso, Cape Verde, Ghana, Tanzania, Botswana, EU.
- Activities:
  - Capacity building.
  - Gather high quality renewable energy resource geographical information in Africa.
  - Decision support system tool.
Thanks for your attention.

For more information, please contact:
Arnulf.JAEGER-WALDAU@ec.europa.eu (PV Status Report 2010)
Thomas.HULD@jrc.ec.europa.eu (PVGIS)
Heinz.OSENBRINK@ec.europa.eu (HU Renewable Energy)
Irene.PINEDO@jrc.ec.europa.eu (AFRETEP)