

### Critical implementation conditions

From case studies across the globe, significant experience has been gained regarding successful installation and operation of PV systems.

- Usefulness for the users: the system should be of appropriate size (e.g. 120W for a typical village household), technology, and energy provision for the users;
- Sense of ownership: users need to feel connected and responsible for the system, which will increase if they use the system regularly;
- Affordability for the end-user, typically a household or village. The main problem is to guarantee affordability for households with extremely low incomes;
- Post-commissioning: ensuring that the villages can take responsibility for simple operation and maintenance actions as much as possible, and provide (both financially as in terms of the service company) for the circumstances where more demanding repair is needed. This term also includes further provisions that enable the villages to generate extra income.

### Financing for PV

Adequate financing is probably the largest barrier for implementing PV systems in remote areas. Several different arrangements can be made for both individually and community owned installations.

- Cash sales: the system is sold directly to the end-user who immediately owns the system;
- Credit system: the end-user receives a credit in order to acquire the system. Banks, technology provider, public-private partnerships or the government may be providers of credit;
- Fee for service: the end-user pays a fee to an energy service company (ESCO) and in turn receives an energy service.

Many governments in ASEAN countries have subsidy schemes in place, which may significantly increase viability for end-users,

energy companies or implementing organisations. The Clean Development Mechanism, particular small-scale, may also provide interesting options. Some however view subsidies as ruining the market. Selco is an example of a successful Indian company providing PV systems technology as well as credit ([www.selco-india.com](http://www.selco-india.com)).

### References

IEA, 2004. *Trends in photovoltaic applications. Survey report of selected IEA countries between 1992 and 2003. Report IEA-PVPS T1-13:2004.* [www.iea-pvps.org](http://www.iea-pvps.org)

ECN, 2005. *Providing electricity to remote villages.* ECN-C--05-0



## Potential and Cost for PV Power Generation

Estimates for implementation and cost reduction potential of a certain technology usually cover a wide range of possible scenarios. In case of PV, this depends on assumptions regarding climate and renewables policy, R&D, learning potential and technical power system limitations. These assumptions vary in practice among scientists, PV industry

and government publications. A brief overview of some publications may provide some insight.

For the EU-15, ECN (2003) has estimated a realisable potential of 100-4000 GW<sub>p</sub> in 2050. Using a wide range of sources, this is based on 16,000 km<sup>2</sup> roof and façade area, 5-8 €/W<sub>p</sub> current investment cost, 20% cost reduction at double cumulative PV production and 12-16% load factor.

Resulting from a modelling exercise, Zwaan and Rabl (2004) conclude that "PV electricity is unlikely to play a major role in global energy supply". However, due to significant cost reductions, beyond 2020 its contribution may become significant.

An EU PV industry group, the Photovoltaic Technology Research Advisory Council (PV-TRAC), foresees a possible 4% contribution to global power production by 2030. This corresponds to well over 1000 GW<sub>p</sub> installed capacity. Among others, it advocates strengthening the relationship with developing countries in order to bring affordable energy service to the population of these countries.

Meanwhile at European policy level, the White Paper for a Community Strategy and Action Plan sets a target of 3 GW<sub>p</sub> installed PV capacity by 2010.

A report by an interesting alliance of Greenpeace and the European Photovoltaic Industry Association states that there are "no technical, economical or resource barriers to supplying 1.1% of the world's electricity needs from solar power by 2020".

#### *Cost reduction*

This scenario is rather optimistic according to the European roadmap for PV R&D, as it would imply strong PV system cost reduction to 1 \$/W<sub>p</sub> before 2025. The European Commission views 1.5-2.53 \$/W<sub>p</sub> by 2025 as more realistic.

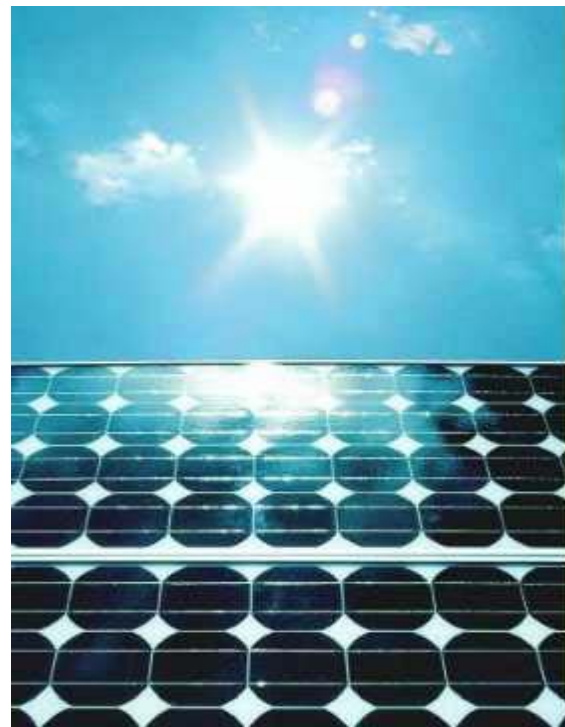
Zwaan and Rabl (2004) use the so-called "learning curve" approach to estimate the potential for cost reduction of PV electricity. The progress ratio, the most important factor in the learning curve is estimated to be 0.8, meaning that kWh cost decrease with 20% at every doubling of cumulative installed PV capacity. To reach the break-even cost of 1 \$/W<sub>p</sub>, capacity needs to grow to 150 GW<sub>p</sub>. This would amount to

approximately \$64 billion excess cost. These figures are however very sensitive to the progress ratio, which if decreased to 0.75 would imply only 50 GW<sub>p</sub> installed and \$27 billion excess cost.

#### *External cost*

The authors also argue that, under conservative assumptions, accounting for the external effects such as climate change and human health, can reduce the "cost gap" between PV and fossil-based power generation. Damage is mainly caused by CO<sub>2</sub>, particulate and acidifying emissions from coal in particular, and are conservatively estimated to be 0.01 \$/kWh or 0.25 \$/W<sub>p</sub>. Installing 150 GW<sub>p</sub> would then avoid the substantial amount of \$37 billion, or 37% of the excess cost.

It is important to note that although PV cost reduction has followed the 0.8 progress ratio, this by no means implies this development will continue until a mature market stage (as confirmed by the early death of many promising technologies). Therefore it is crucial that PV niche markets such as solar home systems are extensively used. In addition, strong policy support is required, possibly by setting targets for PV share in power production.



*A brighter future*



Solar installation in Malaysia

## References

Zwaan, B. Van der and A. Rabl, 2004. *The learning potential of photovoltaics: implications for energy policy. Energy policy 32 (2004) 1545-1554.*

Greenpeace and EPIA, 2005. *Solar generation. Solar electricity for over 1 billion people and 2 million jobs by 2020.*

European Commission, 2004. *PV NET. European roadmap for PV R&D. report EUR 21087 EN.*

ECN, 2003. *Potential and cost for renewable electricity generation. A data overview. Report ECN-C-03--006.*

PTM Energy Smart Issue 0012, 2004.

PTM Draft Final Report, 2005, *Information for the Commercialisation of Renewables In ASEAN (ICRA).*

PTM 2004, *Malaysia Building Integrated Photovoltaic. Project document*

The *GrIPP Net Newsletter*, the official publication of the Green IPP Network, is published quarterly to communicate network activities and to support the dissemination of relevant information and network results. It is provided free to network members and interested stakeholders, and can be downloaded from this site: [www.EC-ASEAN-GreenIPPnetwork.net](http://www.EC-ASEAN-GreenIPPnetwork.net).

This *Newsletter* has been produced with the financial assistance of the European Community – ASEAN Energy Facility. The views expressed herein are those of the authors and can therefore in no way be taken to reflect the official opinion of the European Commission.

### Editorial Board

<b>PTM, Malaysia</b> Dr. Anuar Abdul Rahman	<b>ECN, The Netherlands</b> Stefan Bakker
<b>IIP, Germany</b> Prof. Dr. Rentz/D. Möst	<b>IMA/CEED, Thailand</b> Prof. Lefevre/R. Sukatipan
<b>Risoe, Denmark</b> Dr. Romeo Pacudan	<b>UPSL, Philippines</b> R. del Mundo/G. Padilla

## GrIPP Net Calendar

### June 2005

EC-ASEAN Green IPP Network First National Workshop  
"Current development of Green IPPs: Experiences, challenges, and strategies"

28 June 2005, Kuala Lumpur, Malaysia

### July 2005

EC-ASEAN Green IPP Network Second National Workshop  
"Current development of Green IPPs: Experiences, challenges, and strategies"

Tentative dates: July 2005, Manila, Philippines

### August 2005

EC-ASEAN Green IPP Network Third National Workshop  
"Update on the development of Green IPPs in Thailand: Challenges, strategies, and case studies"

10 August 2005, Bangkok, Thailand

### September 2005

EC-ASEAN Green IPP Network Regional Workshop  
"Current development of Green IPPs: Experiences, challenges, and strategies"

15 - 16 September 2005, Karlsruhe, Germany

## Calendar of Events

### July 2005

International Energy Workshop 2005  
5 - 7 July 2005, Kyoto, Japan

Renewable Energy Thailand 2005  
7 - 10 July 2005, Bangkok, Thailand

### August 2005

Production Forecasting in Upstream Oil and Gas  
23 - 24 August 2005, Kuala Lumpur, Malaysia

6th European Wave and Tidal Energy Conference  
29 August - 2 September 2005, Glasgow, UK

### September 2005

RENEXPO 2005  
22 - 25 September 2005, Augsburg, Germany

Eolica Expo Mediterranean 2005  
29 September - 10 October 2005, Rome, Italy