Int. J. of Thermal & Environmental Engineering
Volume 1, No. 1 (2010) 51-55

Renewable Energies: A Sustainable Future or a Prosperous Business

Ammar Moussi[a]*, Greg Asher[b]

[a] *University of Biskra, Biskra, Algeria, 07000*
[b] *University of Nottingham, Nottingham, UK, NG7-2RD*

Abstract

Recent global developments appear to guarantee a market for green renewable energy. Among several sources of renewable energy currently explored, photovoltaic systems appear to be promising in view of their environmentally clean nature and the advantage of direct conversion to electrical power. In spite its high initial cost, solar energy production is rising steadily. Today's investment in the sector of renewable energy shows that a promising industry is being inaugurated. This paper discusses through the outcome of statistical and technical facts the paradoxical issues between environment sustainability and business development.

Keywords: *Renewable energy, Sustainability, Investment.*

1. Introduction

The sun already provides almost all the energy needed to support life. The challenge for a sustainable future is to tap a tiny fraction of this energy to supply the relative modest demands of human activities; and since the first *New York Times* newspaper front-page heading reported in 1954 announcing that ``Vast power of the *Sun* is tapped by battery using *Sand* ingredient``, much effort has been deployed to make this statement true, even if it was grandiose at the time. Nowadays, recent global developments appear to guarantee a market for green renewable energies where photovoltaic systems appear to be promising in view of their environmentally clean nature and the advantage of straight forwardness conversion into electrical energy.

However, if solar energy has switched from a green aspiration to a solid business in the developed world, it is still a hope and prospective ambition for most of the developing countries. About only 1 billion of people have energy and its technologies of use and implementation at their disposal and particularly the technologies of implementation of solar energy, whereas more than 4 billion have no energy at their disposal and might envisage in solar energy the lone outcome. Unfortunately the majority will not see this of their life.. The awareness is that the concern about a "sustainable future" will swap into a "prospective solid business".

The proposed paper exposes PV systems development, cost development, market growth, new investment and future evolution; and through the outcome of these issues discusses the trends and expectation in PV systems applications and the aspects of future implementation of renewable energies as a thoughtful commitment or a prosperous business.

2. PV Systems Technology Development

PV systems are not yet fully cost competitive with fossil fuel-based generators. A majority of the systems to date have been installed in niche applications with the help of subsidies or government purchasing programs. However, the combination of government and private investment has inspired communities to opt for this alternative as a green alternative or unique choice for energy supply, bringing therefore total PV system costs down.

2.1. PV modules

Individual PV module outputs range between 10Wp to 300 Wp. virtually, all of the installed PV systems in the world are "flat-plate" systems that use large areas of semiconductors to convert direct and diffuse solar radiation. Most of these flat-plate systems are fixed and have no moving parts. Alternatively, PV systems known as "concentrators", utilize optic lenses to focus direct sunlight onto comparatively smaller areas, thereby reducing the amount of necessary semiconducting material.

Silicon is the most common semiconducting material in use in PV modules due to its abundance. Monocrystalline silicon, semiconductors are the most efficient, but are also the most expensive. Polycrystalline silicon is the next most prevalent type of semiconductor, It is less expensive to manufacture than

* Corresponding author. Tel.: +213(0)661586105
Fax: +213(0)33749154; E-mail: moussi_am@hotmail.com

DOI: 10.5383/ijtee.01.01.008

monocrystalline silicon, however, it is less efficient. The emerging alternative to crystalline silicon is thin-film PV which use 1/20 to 1/100 of the material needed for crystalline silicon resulting thus in material economy as compared with crystalline silicon. Table 1 shows leading countries in PV cells and modules production.

2.2. Balance-of-system (BOS)

Auxiliary equipment, referred to as the balance-of-system (BOS), requirements vary between applications due to site-specific power and reliability requirements, environmental conditions, and power storage needs. BOS components include mounting equipment such as frames and ballasts to support and elevate the PV module/panel. A small portion of installed PV systems also use power conditioning equipment to limits current and voltage, and converts direct-current (dc) electricity generated by the PV array into alternating current (ac) electricity through a dc/ac inverter and of course to maximize the system efficiency. Power storage is a desirable and in many instances a compulsory requirement. Also PV systems necessitate protective electrical hardware such as diodes, fuses, circuit breakers, safety switches and grounds, as well as wiring to connect the PV module and BOS components.

Sometimes, in applications where a PV system will be supplying a critical load, a PV system is usually integrated with an auxiliary electric generator. This hybrid system will, therefore impact the overall sizing of the PV system and of course affects the final installation price.

Table 1: PV industry production in 2005 by world region

	Japan	USA	Europe	Rest	Total
Cell production	824 MW 54,93%	156 MW 10,4%	479 MW 31,93%	41 MW 2,73%	1500 MW
Module production	773 MW 50,46%	196 MW 12,79%	515 MW 33,62%	46 MW 3,00%	1532 MW

3. PV system cost

PV module "cost reductions" are the result of either a decrease in manufacturing cost or an improvement in module efficiency. Figure 1 illustrates that since the start of commercial manufacture of solar cells in 1976, crystalline silicon PV cell prices have decreased tremendously.

As mentioned earlier, photovoltaic system costs encompass both module and BOS costs. Indeed, module costs typically constitute about 40-60% of total PV system costs. The module's share of total system costs is largely influenced by the necessity of a battery that commonly represents half of all BOS costs, and an ac/dc inverter. It is difficult to quantify "typical" BOS cost contributions as system requirements can vary significantly for each application. Of note: total system installed costs can also vary significantly, possibly including costs for site preparation, laying a foundation, system design and engineering, permitting, as well as assembly and installation labor.

As for module costs, BOS costs have fallen in unison during the last three decades. However, due to the natural distinctiveness of PV system applications, there is no appropriate single rule that may describe BOS costs. While individual BOS components have experienced little cost reduction since 1976, the cumulative experience of the PV system designers and installers has resulted in a considerable cost reductions, equal to or even greater than that of modules. Cost reductions have been attained through greater system integration and a reduction in the number BOS parts. As signaled by on-going research initiatives, one strategic opportunity for further reducing BOS costs is standardizing BOS to the greatest degree possible and efficiently packaging components so that on-site integration and installation in minimized. It can be inferred that while module costs are uniform, total PV system costs differ, dependent upon BOS requirements and the experience of the PV industry of a given region.

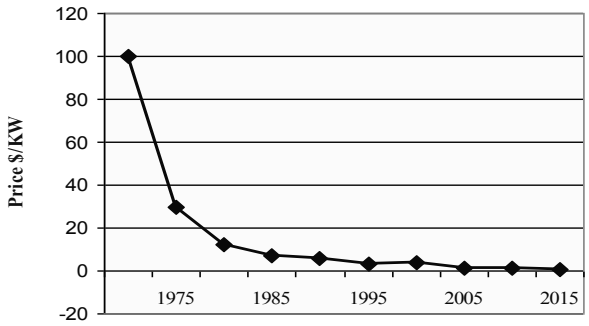


Fig. 1 Average cell price

4. Current situation

Overall figures show that, renewable power capacity has expanded to more than 210 GW, up from 160 GW in 2004 (excluding large hydropower). The top six countries were China (55 GW), Germany (25 GW), the United States (23 GW), Spain (15 GW), India (9 GW), and Japan (8 GW). The capacity in developing countries grew from 70 GW to more than 85 GW, Figure 2.

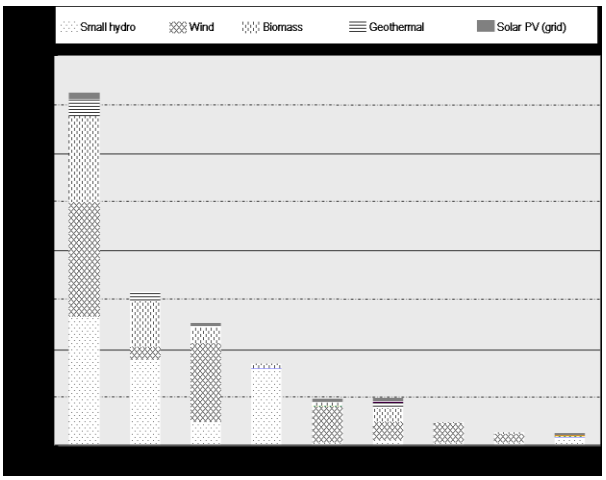


Fig. 2 Renewable power capacities, Eu, top 6 countries and developing world (excl. Large hydro), 2006

5. PV market growth

Photovoltaic technology was initially developed during the late 1950s to provide long term reliable power for satellites. Companies began to offer PV technology for commercial application in the mid-1970s. The PV market has reached a consistent average annual growth of 15-16% for stand alone systems and up to ≈55% for grid connected systems. Figure 3 illustrates the cumulative shipment of PV modules that has grown from less than a 100 megawatt in 1985 to more than 2200 MWp in 2005 reflecting an ever expanding global market for generating capacity engendered by the continuous decline in PV system costs.

In 1995, the 579 MW cumulative installed capacity of PV technology represented just 0.02% of the global power generating capacity of 3,1 GW. At the present time, Grid-tied solar PV, with 50-60% annual growth rate, accounts for almost 8 GW. Altogether, these new renewable now provide 240 GW of electric power capacity, Figure 4.

For comparison, total global power capacity is on the order of 4,300 GW and the share is incessantly increasing.
By 2020, the International Energy Agency projects that global power demands will be in the neighborhood of 5,900 GW. To capture these opportunities, continued public and private investment into PV system RD&D will be required.

6. Investment in the PV market

Renewable energy has clearly become main stream since the Kyoto Protocol was adopted in 1997. Nothing demonstrates that better than investment flows. In 2007, global annual investment in renewable energy exceeded $100 billion up from just $8 billion in 1997). This tendency is to continue as the costs of renewable technologies maintained their continuous decline and as the renewable industries continues to promote new PV applications and diversify technology products. In addition, renewable technologies broadened to multiple countries, including emerging economies.

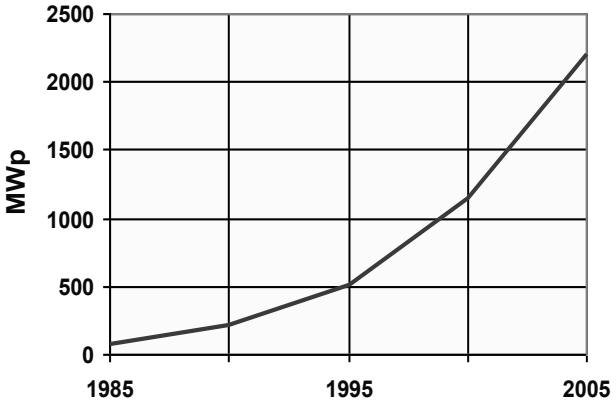


Fig. 3 Cumulative worldwide PV module shipments

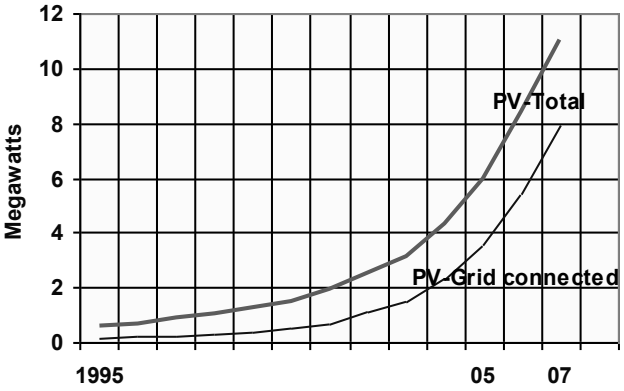
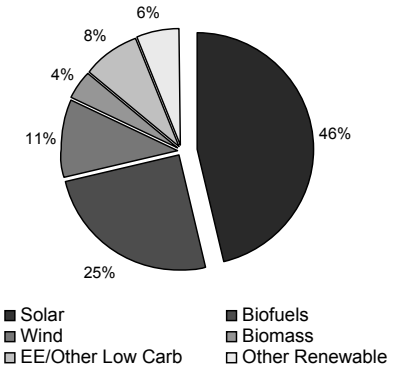
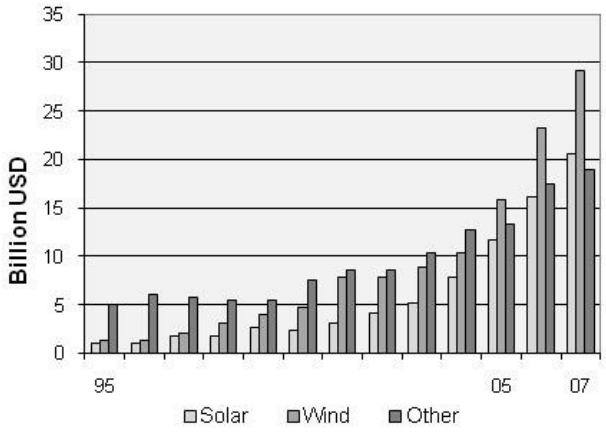


Fig. 4 Solar PV, existing world capacity



(a) Public market investment activity by Tech.-2006



(b) Annual investment in renewable energy

Fig. 5 Investment in renewable energy (a) Public market investment activity by Tech.-2006, (b) Annual investment in renewable energy

Investment in sustainable energy in 2006 was widely spread over the leading technology sectors. Overall, the wind sector attracted the most investment. Whereas solar receives most of its capital via share issues in the public markets, dominating the public market arena in 2006 where it has experienced a $5.7 billion of investment activity (see Figure 5).

This trends was sustained by new policies which were extended, revised, and added or supplemented (production tax credit in USA. feed-in policies, New feed-in laws enacted in India, Spain, the first country to mandate solar PV in new construction)

In rural electrification, policies and programs using renewable energy continued to emerge and progress. The number of solar home systems added in 2005 was more than 270,000 in 2005, bringing the world total to around 2.4 million households. One investment firm commented that clients really weren't interested in renewables back in 2002 and 2003, but in the last years "the market has exploded. Certainly, renewable energy has risen up from $30 billion in 2004 to more than $38 billion invested in new renewable energy capacity worldwide in 2005. $6 billion of it in PV sector which was expected to reach $13-15 billion in 2009.

This Industry captured investors' attention, as the number of renewable energy companies or divisions with market valuations greater than $40 million increased from 60 to 85. The estimated total valuation of companies in this category was $50 billion, double the 2004 estimate.

It is reported that The largest number of companies is in the solar PV industry, which is becoming one of the world's fastest growing, most profitable industries. Global production increased from 1150 MW in 2004 to over 1700 MW in 2005. Japan was the leader in cell production (830 MW), followed by Europe (470 MW), China (200 MW), and the United States (150 MW). Capacity expansion plans by the solar PV industry for 2006–08 total at least several hundred megawatts and potentially two gigawatts.

7. Future market evolution

For the short and ,medium term programs, new solar PV promotion programs continued to appear around the world, at national, state/provincial, and local levels. In USA, government has enacted a 30 percent federal tax credit for solar PV, valid through 2007.23 California extended its solar PV subsidy program to 2011 and enacted a $3.2 billion, 11-year plan to install 3 GW of solar PV by 2017 for homes, schools, businesses, and farms. In France, in addition to its existing target of 21 percent of electricity by 2010, announced new targets of 7 percent primary energy by 2010 and 10 percent by 2015. The Netherlands announced an additional target of 10 percent of primary energy by 2020. Spain set a target to increase the share of primary energy from renewables from 6.9 up to 12.1 percent in 2010.

Rural electrification policies and programs using renewable energy continue to emerge and progress intensely. To state, after the "China Township Electrification Program" was accomplished in 2005, China planned the next program, which will focus on villages, with plans to electrify 10,000 villages and 3.5 million rural households with renewables by 2010. In Brazil, after the "Luz para todos" program fulfilled efficiently its goals; a full rural electrification is planned by 2015. In 2006, Pakistan launched a propitious program to electrify 8,000 villages with renewable energy. India has recently proposed to augment cooking, lighting, and motive power with renewables in 600,000 villages by 2032, starting with 10,000 remote un-electrified villages by 2012.

Also, prosperous projects are already considering large CSP generators plants in the southern Mediterranean countries, with their energy exported to Europe via HVDC submarine cables, CSP has huge low-cost potential in Africa, the Middle East and Oceania. It is expected that costs can be cut by more than 50% relative to current demonstration projects. The potential below US$0.10 /kWh would then amount to many times the current electricity consumption. It is expected that by 2050, large parts of the abundant solar photovoltaic (PV) potential will be available at costs below US$0.10 /kWh in regions beyond Africa, the Middle East and Oceania. This would be cost-competitive when consumed on site.

8. Business and sustainability

Though some researcher assert that the market for PV technology in the long-term future is uncertain, the optimistic marketing figures listed previously presume that market trends will not diverge radically from its present annual growth rate in the next decade. Present marketing and technological figures confirm that the future of PV market is the most prosperous among other businesses.

Even if PV manufacture is thought a high-technology industry, one has to tell apart between system components. While PV cell technology is set to developed world destiny, BOS technological requirement should not present any hurdle for developing counties, nevertheless, the last decades didn't show any tendency toward the implication of all partner to work together for a sustainable future. Indeed, developing nations represent an important expanding market (buyer position), where PV systems are a cost competitive alternatives to electric grid extensions. In 1997, the developing world received 22% (10,794 kWp) of PV modules exported from the US. This export market for PV technology is anticipated to continue to grow due to increasing electricity demand in developing nations and projected future market in the southern region.

9. Conclusion

At this stage, one can consider whether this rapid growth in PV market which is initiated first for scientific purposes in the fifties to provide energy for satellites, became a future alternative for fissile fuel in the seventies after the oil crisis, thereafter an ambitions solution for climate preservation in the late eighties and nineties after the Kyoto protocol and nowadays it has became a rapidly expanding profitable business, just to ask "*are the initial aspirations for a universal concern about the future of our planet is still the primary key question or other intrusive intentions raised by time*". This question is justified by the week content reached by the climate talks in Bali. The most disappointing was the rejection of strong proposals from developing countries on adaptation,

technology transfer, and reduced deforestation.

Substantial effort should be deployed by leading countries in order to help less developed ones to acquire the basic knowledge and arise their own technology. Through this action, one can succumb to the international commitment and guarantee a speedy awareness about the ecological concern and a sharp increase in PV installation worldwide. There is a long-term *"sustainability ideal"* that says we should work to reduce the environment degradation caused by contemporaneous human activities. However, one fears that all of the improvements have been made in the interest of building a strong "*sustainable business"*.

References

[1] Martin Green, Power to the People, UNSW Press book.

[2] Tim Jackson, Mark Oliver "The Viability Of Solar Photovoltaics", Energy Policy, Vol. 28, 2000, 983-988. doi:10.1016/S0301-4215(00)00085-9

[3] M. Oliver, T. Jackson, "The market for solar photovoltaics" Energy Policy, Vol 27, 1999, 371-385. doi:10.1016/S0301-4215(99)00038-5

[4] "A Vision for Photovoltaic Technology "Report By The Photovoltaic Technology Research Advisory Council (PV-TRAC), 2005.

[5] "Trends In Photovoltaic Applications "Survey Report Of Selected IEA Countries Between 1992 And 2003, Report IEA-PVPS T1-13; 2004.

[6] A. Moussi, G. Asher 2007, "Photovoltaic Systems, Trends and Expectations". International Conference on Integrated Sustainable Energy Resources in Arid Regions, Jan. 2007, Abu Dhabi, United Arab Emirates

[7] A. Moussi , A. Saadi , G. Asher , 2004 "Photovoltaic Pumping Systems Trends" 9th International Conference on "Optimization Of Electrical And Electronic Equipment Optim '04", Brasov, Romania, May 2004,

[8] A. Moussi, A. Betka , B. Azzoui , "Optimised Photovoltaic Pumping System", UPEC 99, Leicester University , UK, Oct. 99

[9] A. Moussi, A. Terki, G. Asher, "Hysteresis Current Control Of A Permanent Magnet Brushless Dc Motor Pv Pumping System" The 2005 Solar World Congress, ISEC'2005, Orlando, Florida, USA, August 6-12, 2005.

[10] Greenwood C., Global trends in Sustainable energy Investment 2007, United Nations Environment Programme reports, France.

[11] REN21. 2006. Renewables Global Status Report 2006 Update, Paris: REN21 Secretariat and Washington, DC: Worldwatch Institute.

[12] A. Maafi, "A Survey On Photovoltaic Activities In Algeria" Renewable Energy, Vol 20, 2000, pp:9-17. doi:10.1016/S0960-1481(99)00096-8

[13] Strategies Energétiques au Maghreb. COMELEC revue, Vol 5, 1995, pp: 14-36.

[14] "Prefeasibility study for the integration of renewable energies for electricity production in the southern Mediterranean countries." INTERSUD MED, Project joule No. JOR3-CT95-0066.

[15] M. A. Muntasser et all "Photovoltaic Marketing In Developing Countries", Applied Energy, Vol. 65, 2000, pp: 67-72.

[16] James E. Rannels "Advancements In The United States Photovoltaic Program" Renewable Energy, Vol 19, 2000, pp:75-84. doi:10.1016/S0960-1481(99)00019-1

[17] S. Awerbuch, "Investing in photovoltaics: risk, accounting and the value of new technology" Energy Policy, Vol 28, 2000, 1023-1035. doi:10.1016/S0301-4215(00)00089-6

[18] A. B. Lovins, L. H. Lovins, Brittle Power: Energy Strategy for National Security, Brick House Publishing, Andover, MA. 1982