1. Introduction

Despite the internal migration of rural people to urban areas, around 4 billion people still live in rural areas of developing countries and most of them with little or no access to electricity. Only, in few cases, electric power is produced by stand-alone generator sets. Social life in the evenings is usually extended for a couple of hours by a kerosene lamp. What is common to all, however, is that sunrise and sunset still mark the beginning and end of every day. It is widely accepted that electricity still spurs the social and economic development of rural areas. Availability of electric power is decisive for the supply of good drinking water, the conservation of food, the storage of medical supplies, radio, TV, telecommunication, etc.

It is also obvious that along the anticipated path for development, many developing countries will increase their energy consumption, a large potion of which will be covered by conventional sources like oil, gas and coal. This will undoubtedly contribute to an increase in the world’s carbon-dioxide (CO2) production. Solar technology has the advantage of being one the very few CO2-free energy converting technologies.

It was after the so-called energy crises of the Seventies that the interest and focus on renewable energy sources of energy. Particularly, solar energy had jumped upward almost overnight and that interest kept increasing over the years. Solar energy is divided into two main categories: solar-thermal and photovoltaics. While solar-thermal is self-explanatory, PV is a special technical term uncommonly recognized by the layman particularly in developing countries. PV is simply a technology that converts light into electricity, irrespective of the source of light. However, there are many PV materials and devices, and their design, fabrication, and performance vary a great deal from one PV material to another and from one cell design to another.

Photovoltaics have been shown to offer many advantages:
- PV systems do not need fuels; in remote areas of developing countries in particular, diesel or kerosene fuel supplies are unreliable and expensive.
- PV systems are modular; therefore an array which is composed of several modules can be tailored to size to meet a particular load.
- PV systems are highly reliable as compared to those of diesel generators.
- PV systems are easy to maintain compared to alternative technologies.
- PV modules have long lifetime with little degradation in performance over 20 years.
- PV systems are environmentally benign causing no pollution and no contribution to global warming.
- PV systems have proven recently to be economically viable for small-scale applications as compared with diesel systems or other small power supplies.
- PV systems can improve the quality of life, for instance, lighting in a rural school, refrigeration of vaccines at a rural clinic or powering a radio transceiver or a TV in a remote location.

Applications of photovoltaics cover a wide range covering almost every aspect of rural activities. Examples are:
- Rural electrification,
- Water pumping and treatment systems,
- Health care systems,
- Communications,
- Transport aids like road signs and hazard signals,
- Security systems,
- Corrosion protection systems,
- Miscellaneous like consumer devices, feeding systems on fish farms, aeration systems in stagnant lakes, earthquake monitoring systems, fountains and emergency power for disaster relief,
- Income generating activities like battery charging, TV and video pay stations, village industry power and refrigeration services.

Egypt is one of the countries, which has favorable solar energy conditions and good potential for solar energy utilization. The amount of solar energy incidence per square meter varies between 5 and 8 kWh per day with duration of 3000-4000 hours per year. The majority of Egypt's population (60 million people in 1999) is living in only 6% of the land, with the remaining 94% of the land as desert. A national program to develop renewable energy systems was started in 1957 in National Research Center of Egypt. Since then many academic institutions have been involved in academic research on different aspects of solar cell technology. Few institutions have been involved in field applications of PV systems for community development. The potential for practical use of PV power was first tested in the field of Basaisa Village [1] in (Al-Sharkiya Governorate) in Sept. 1977. A solar module (18-watt peak) was used to power a 12-inch black and white communal TV set which was installed in the common hall “Mandara” of Basaisa.

The interest in renewable energy sources started with a promotion for replacing the depleting commercial sources but now the interest has taken a more important dimension that renewable energy sources are clean sources with no harmful effect on the environment. The theme of the first World Renewable Energy Congress held at Reading, U.K., Sept. 1990 was taken as Energy and Environment into the 1990s. Less than two months after, the second International Symposium on Renewable Energy was held in Cairo (Oct. 1-4, 1990). About 150 research papers from 30 countries were presented during 24 sessions during the symposium. The general message was clean energy for better environment.

2. Photovoltaics And Community Development

The relationship between energy and community development is a dynamic one, in which the amount, type and quality of economic growth are mutually dependent variables on the quantity, kind and price of energy available. There is a growing consensus that successful development requires a firm agricultural foundation, that the basic quality of life must be improved for and with the active participation of the poor majority of the population living in the countryside. Collective PV power systems for the thousands of small village communities and new desert settlements can be an attractive approach to successful community development in rural areas of the developing nations. If this can be done (no one suggests that it can be done either easily or quickly) then the rural poor may have reason and ability to reduce their birth rates, increase their production, and may no longer be migrate to already overcrowded towns and cities. The present vicious circle of over-populations, over-consumption of fuel, low-productivity of land and labor, health and economic hazards makes meetings even existing hazards energy needs a considerable task. Installation of PV power systems is but means for rural community development not the end in itself. Table 1 shows a list of PV applications in Egypt as of 1999 with their location and source of funding [5].

There are four main field studies addressing integrated approach to rural community development. The Desert Development Center at Sadat City, Basaisa project in Al-Sharkiya Governorate, both sponsored by The American University in Cairo (AUC); the project at Meet Abou-El Kom village, in Al-Menoufia Governorate, which is sponsored by the National Research Center (NRC), and the pumping system at Nobareya area, which is sponsored by Germany. All four projects have used photovoltaics for different applications.

Desert Development Center

Two photovoltaic systems were installed in the summer of 1981. These are a 10 kW peak system, which through an inverter provides the 220V, 50 Hz, necessary to power the center’s headquarter building as well as an AC submersible pump at Sadat City. In addition, a 3 kW peak DC system exclusively devoted to power a deep (42 meters) well pump as well as a booster pump for irrigation. Field testing of these systems, monitoring their performance and demonstrating their feasibility has been a major activity of the energy group of the center.

AUC-Basaisa Village Integrated Field Project

Small PV system were introduced as response to village expressed needs during long dialogues and discussions that took place in the common hall “Mandara” of the village, between the project team and village inhabitants. The systems included: light for training and education classes, TV for community club, radio recorder, slide projector, loudspeaker for the mosque, portable and fixed irrigation pumps, PV powered video training system and lately a medical refrigerator.

Introduced as communal systems, it did not cater to the more wealthy villagers. All villagers become members of a newly formed community cooperative for development at Basaisa with each person paying one Egyptian pound a year as membership fee. They also contribute shares to the production section of the cooperative. Each collective project must have a local responsible person. The responsible persons were trained (through intensive training courses offered on-site for specific purposes) to install, operate, maintain and repair the technical systems as well as assist the project team in collecting data and record keeping.

In case of actual breakdown of a system or one component their first resource is to try to fix it themselves and only...
when that proves impossible, does the project team intervene and help. Costs of repair and maintenance as well as the incentives given to the responsible persons are paid from the cooperative budget. Light was used for training on income generating activities like knitting, dressmaking and handicrafts and as emergency light for such activities in case of electricity cutoff.

Meet Abou-El-Kom Village Project

The late president of Egypt Mohamed Anwar EL-Sadat (in his village) supported this project. PV systems include:

2. 1.47 kW peak for two medical refrigerators in the village health clinic introduced in 1981.
3. PV array (170 W peak) for colored TV in the Youth club in the village installed in 1982.

Nobareya Pumping Project

Within the frame of the Egyptian-German cooperation (represented by the New and Renewable Energy Authority (NREA) of Ministry of Electricity and Energy and the Deutsche Forschungsanstalt fur Luft and Raumfahrt (DLR) of the Ministry of Research and Technology (MBFT)) a portable photovoltaic water pumping testing unit has been installed at west Nobareya (130 km from Cairo) to drip irrigate

Table 1. List of PV applications in Egypt

<table>
<thead>
<tr>
<th>Application</th>
<th>Size kW (peak)</th>
<th>PV Supplier</th>
<th>Location</th>
<th>Funding Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pumping</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water lifting with instru-mentation</td>
<td>3</td>
<td>Arco Solar</td>
<td>Sadat City</td>
<td>World Bank &amp; UNDP</td>
</tr>
<tr>
<td>Water lifting</td>
<td>18</td>
<td>Lucas Solar</td>
<td>East Oweinat</td>
<td>Italy</td>
</tr>
<tr>
<td>Water lifting</td>
<td>28</td>
<td>A.E.G.</td>
<td>East Oweinat</td>
<td>Italy</td>
</tr>
<tr>
<td>Water lifting</td>
<td>0.24</td>
<td>Solarex</td>
<td>To come</td>
<td>U.S. AID</td>
</tr>
<tr>
<td>Irrigation pump</td>
<td>1.85</td>
<td>Under study</td>
<td>To come</td>
<td>Germany</td>
</tr>
<tr>
<td>Irrigation pumps</td>
<td>2.20</td>
<td>Siemens</td>
<td>Nobareya</td>
<td>DLR</td>
</tr>
<tr>
<td>Portable pumping system</td>
<td>18</td>
<td>Siemens</td>
<td>Wadi ElEltron</td>
<td>Germany</td>
</tr>
</tbody>
</table>

| Telecommunication                  |                |             |                               |                         |
| 7 Telecommunication Systems        | 0.24           | BP Solar    | Hurgada, Abu-Ghossoun, Matrouh, Siwa EL-Gara Petroleum Co. West Desert | UN/UNDP, Italy          |

| Desalination                       |                |             |                               |                         |
| Sea water desalination.            | 8.3            | A.E.G.      | Abu-Ghossoun                  | UN/UNDP                |
| Desalination system.               | 28-30          | Under study | To come                       | U.S. AID               |
| Water purification system.         | 7              | A.E.G.      | High Tension Laboratory       | Germany                 |

| Refrigerators                      |                |             |                               |                         |
| 29 lit. Vaccine fridge.            | 2              | A.E.G.      | Cairo                         | UN/UNDP, Germany        |
| 10 lit. Vaccine fridge + colored TV| 3.6            | Solarex     | Meet Abu El-Kom               | Germany                 |
| Ice-maker vaccine refriger.        | 0.50           | Sensor Tech | Basaisa                       | AUC-NASA, U.S.AID       |
| Others                             |                |             |                               |                         |
| Power generation.                  | 10             | Philips     | Sadat City                    | World Bank              |
| Solar powered comm. TV.            | 32             | Philips     | Basaisa                       | AUC-NSF                 |
| Solar powered comm. video.         | 100            | Solarex     | Basaisa                       | ADF                     |
| PV/Wind/Diesel hybrid              | 200            | Pragma      | East Oweinat                  | UNDP, Italy             |
| Navigation alarm.                  | 0.86           | A.E.G.      | Lake Naser                    | Germany                 |
| Battery charger.                   | 0.11           | A.E.G.      | Mansoura                      | Germany                 |
| Microwave repeater.                | 27             | A.E.G.      | To come                       | Germany                 |
| Traffic control.                   | 1.5            | A.E.G.      | Wadi Natron                   | Germany                 |
| Two air-traffic stations.          | 66             | Solarex     | Ismailia, EI                  | U.S.AID                 |
| 24 Repeat stations.                | 120            | Solarex     | Saff, Helwan                  | U.S.AID                 |

| Others                             |                |             |                               |                         |
| Power generation.                  | 4              | Arco        | Petroleum Pipes               | U.S.AID                 |
| Solar powered comm. TV.            | 13             | Solarex     | Suez Canal                    | U.S.AID                 |
| 20 Units for home lighting         | 4.24           | Siemens     | Wadi ElEltron                 | Germany                 |
| 10 Units for street lighting       | 1              | Siemens     | Wadi ElEltron                 | Germany                 |
| 15 Units for street lighting       | 1.5            | Siemens     | Zafrana                       | Germany                 |
an area of 3 feddans. The main components of the unit are:

(1) Steel container, which holds the unit component whenever needed to be transported.
(2) 62 monocrystraline Siemens solar modules, each 38 Wp.
(3) Pressurized tank.
(4) Deep well pump and surface pump 1.1 kW each.
(5) DC-AC inverter.
(6) Weather station.
(7) Data Acquisition System (DAS).
(8) PC connected to DAS to store and display the received data instantaneously, daily or monthly values and trace curves whenever needed.
(9) Two batteries to ensure computer continuous operation through small inverter.

3. Demonstration Systems At Eredo [2]

At the Egyptian Renewable Energy Organization (EREDO) installed three systems:

**PV Powered AC Household Electrification System 3 kWp**

The objective of this system is to demonstrate the use of PV power in household electrification system in two different modes:

(a) Stand alone mode feeding AC loads

The storage system consists of 60 lead acid batteries. Each battery has an operating voltage of 2V and has a capacity of 260Ah. The system control includes some safety features, surge current protection, etc. The temperature compensated charge regulation unit is the main component of the system control. It has the function of controlling the current flow to the battery and to the loads according to the state of charge of the battery itself. Avoiding deep discharge and overcharge, the battery life is extended up to the predicted time. The system is equipped with a stand-alone inverter, which converts direct current (DC) into a true sine wave output voltage with very low harmonic distortion at high efficiency values. The efficiency of the inverter ranges between 85-90% at an output power of 10-100% nominal power. The loads of the system are: 5 lamps, 18 W each; 2 cocking stove, 1 kW each; vaccine refrigerator; drilling machine; refrigerator; television and radio.

(b) Grid connection mode

The system is equipped with a grid-connected inverter that provides a true sine wave output voltage with very low harmonic distortion at high efficiency values and a powerful protection/interface control to the grid. The PV array system includes 60 monocrystraline modules 50 Wp each, and an average efficiency of 10.9%. The system is connected as 6 strings, 10 modules/string. All the data collection and efficiency calculations are done via datalogger and PC, with probes reading all the desired parameters.

**PV powered DC household electrification system 500 Wp**

This system demonstrates the use of PV power in household electrification system working at stand-alone conditions and a system operating voltage of 24V. The system includes 12 monocrystraline PV modules; 45 Wp each and an average efficiency of 10.9%. The PV system is electrically connected as 6 strings, 2 modules/string. For any household system, a storage system is needed to supply power to the loads at night. 12 lead acid batteries are used. Each battery has an operating voltage of 2V and has the capacity of 25Ah. The system control includes some safety features, surge current protection, etc. The temperature compensated charge regulation unit is the main component of the system control. The system feeds the following DC loads: refrigerator 50 litres; 4 fluorescent lamps 11W each; 4 fluorescent lamps 18W each; 4 fluorescent lamps 36W each and 2 rheostats.

**PV pumping system 1500 Wp**

The objective of this system is to monitor the performance of submersible pumps using a closed loop hydraulic system. The system feeds a submersible electric water pump with an AC motor, which pumps the water to a 1m3 storage tank. The tank is equipped with all the meters needed to measure the flow and pressure. It also contains a control valve that takes its control signal from the pump inverter/controller. The pump is able to pump 26m3/day. The pump inverter/controller provides AC power to the pump and constantly supervises the system by measuring the array current, array voltage and the internal temperature. It has built-in control procedures in case of any fault detection. The PV array of the system includes 35 polycrystraline modules, 42Wp each and an average efficiency of 10%.

4. Lessons Learned and Recommendations

a) Energy development strategies, programs, and projects directed towards meeting the needs of the poor majority are bound to fail, if no effort is made at the same time on the development of the economic, social, and technological capabilities of the rural people, as well as the infrastructure at community level.

b) Photovoltaics should be promoted as an energy generator to do productive work for increasing income, for effective training and for better and healthier environment.

c) Public participation on all phases of PV field projects, as well as appropriate training of end-users at the local level, have been stressed by all investigators and project directors to be important for the success of any project.

d) Small-scale PV power systems appear to have the most flexibility and reliability for meeting a large variety of small scale, decentralized, electrical energy needs of rural communities in Egypt as well as in other developing countries. There is a significant market potential for PV systems in village applications in Egypt.

e) It is found necessary to develop micro-organizations at the village level; a sort of rural energy cooperative to:
manage the new technologies introduced and sustain the ongoing productive and service activities based on them, integrate the different activities for a positive and comprehensive local development, generate funds needed to install, operate, maintain, repair, and replace if necessary the community energy systems.

f) We have to pay more attention to the training and education of the local technical staff. Human resources are important for projects and programs implementation and for sustainable development.

5. Barriers and Constraints

With all the above advantages (see Introduction) one would have expected PV applications to spread everywhere in the world. This did not happen. Why is that? There were and still are barriers to the diffusion of this interesting technology.

Until recently, price has been the main barrier to the widespread use of PV. In 1970, for example, this was over $100/W and in 1975 it went down to $30/W. Since then, improvements in manufacturing technology and increased scale of production have reduced prices to their present 2000 levels of $3/W for the modules.

The above price was not attained without improvements in other aspects of PV technologies. Improvements in conversion efficiencies, for example, had gone far from the initial 1% reported in 1940. In the late fifties, crystalline silicon cells were developed with high enough conversion efficiencies to enable their use for power generation. Development in conversion efficiencies was due to the active space program in the USA, which resulted in the launching of the first powered satellite, Vanguard I, in 1958. The output of PV modules for terrestrial applications matured around 1983 with the introduction of automated production facilities. The output then jumped 4 folds over 1991. The output kept increasing till it reached over 50 MW in 1990.

Over the past decade, the price of PV modules and systems has been steadily falling in real terms. Module prices for mono- and poly-crystalline silicon are currently around $4/Wp for large orders exclusive of delivery cost and taxes. The use of cheaper silicon and fully automated manufacturing plants may produce further reduction of PV module prices to $2-3/Wp. With thin film technology, further lower prices are attainable. However, crystalline silicon cells will continue to be competitive with thin film processes for several years because thin film systems are not yet suitable for power generation which is still a dominant feature of crystalline silicon systems.

An interesting research, conducted in Europe and the USA, on possible ways to incorporate social costs in decisions on energy systems concluded, taking into account the results on CO₂, that the differences of costs not included in the price of conventional energy and photovoltaics averages 10 cents/kWh for new power stations. Compared to power stations without smoke gas de-sulfurization, PV has an advantage of 12 cents/kWh. The overall range for this difference in the cost not included in the market prices of electricity runs from 4 to 19 cents/kWh. In fact comparing costs of operation and maintenance plus fuel gave the PV option a significant lead.

6. Market Development

Developing countries have been considered as a very large potential market but, due to financing problems, actual commercial sales in these countries are still very small. In fact, the greater part of the systems installed to date in these countries has been assisted by external bilateral or multilateral aid agencies. Developing countries are rightly concerned to ensure that at the right time PV technology is transferred to them, rather than find themselves dependent yet again on an imported technology. In due course, it is likely that most developing countries will have their own PV industry, but this may take many years to establish unless some global solution is found, perhaps as proposed here below, or through the establishment of the International Solar Energy Agency (ISEA) under the aegis of the United Nations as proposed by Eurosolar. In the meantime, there will be a need to import systems for demonstration projects, professional and key community applications. At present, of all the developing countries, PV manufacturing facilities on a commercial scale exist only in Brazil, China, and India.

Significant markets can be expected to develop for professional systems, particularly for telecommunications, village water supply and generators for police posts and health centers. It is estimated that, if system costs can be brought down to about $5/Wp, rural electrification using PV will become a viable option in many situations with market potential estimated in many hundred megawatts per annum.

7. Marketability in Developing Countries

It appears from the above that marketability of photovoltaics in developing countries [3], meaning the ability to penetrate the potential market there, is facing tremendous hurdles. Considering the financial and economic conditions in most of these developing countries, the present prices of PV modules or systems are still unaffordable by these countries. As mentioned earlier, Brazil, China and India have PV manufacturing facilities and export potential. However, these manufacturing facilities are not operating at their potential due to the lack of marketability in the developing countries. The quality and prices of the products of these three countries are not, at present, competitive with those of the developed countries.

There has been a sizable export to many developing countries by the developed countries, not because such PV systems were delivered as part of bilateral, multilateral or cost-sharing technical assistance programs. An example of these deliveries was the cost-shared SOLARS Project by the USA and Saudi Arabia.

8. Marketability Requirements

In order to penetrate the market in the developing countries, it is necessary to identify the necessary requirements for PV marketability. One starts by realizing that sovereignty of
each country requires that decision-makers must be made to accept the PV technology. Outsiders like PV suppliers cannot push their products into a country without local permission. Then, the public must be made aware of the utility of the technology otherwise there shall be no buyers. Finally, the prices must be right, which will require availability of financing in view of the capital cost requirements at the current PV prices.

9. Educating Decision-Makers

What is needed here is educating the decision-makers so that they would believe in PV and then may open the door for its technology to be admitted to their countries. Holding seminars or workshops is not a sufficient solution because usually the participants selected or permitted to attend these meetings are usually junior officials or engineers, who cannot make decisions. Their superiors, who usually were not educated themselves, if favorable, will not endorse even their recommendations. Study tours of the various PV industries and some successfully working PV projects may be more effective, provided that the participants are truly decision-makers.

Selection of such decision-makers must not be limited to the energy sector alone, but should represent a mix from all the fields represented in any project being visited. Such visits unfortunately require funding and the governments of these developing countries will not normally endorse such spending from their own treasuries. The likely source of funding for such education would be through the two external beneficiaries, namely the PV industry and the government of aid agency in the country where such industry is located. One of the important issues, which should be overlooked, is the involvement of women in the decision-making process and projects formulation.

10. Public Awareness

Among the uncertainties affecting PV is future demand for electricity and the overall role that electricity will play in development. Therefore, it is direct economic viability rather than electricity growth that is important in assessing the future of PV. If solar electricity becomes economically competitive with conventional energy sources, there will almost certainly be enough potential uses available to support rapid growth in the PV business for years to come.

While the above is logical, it is left up to the public to be convinced of it. Of course, this is tied in with the right price for PV systems and their affordability by people living or per capita incomes, which are germane to most developing countries. Therefore, like educating decision-makers above, the public certainly needs educating through campaigns of awareness. This is closely connected with any incentive a government may wish to offer its people in order to enhance the use of PV and alleviate the heavy burden on rural electrification, for instance, which is caused when using imported conventional sources of energy.

Once again, the involvement of women will be necessary for any campaign or public awareness to succeed.

10. Financing Opportunities

Electricity needs in rural areas of developing countries are modest, typically in the range of 2 to 5 kWh/day for grid-connected households. While more than 50% of the households in developing countries are not grid-connected, those who are, would not have consumed up to the level of 5 kWh/day had not one form or another of subsidy existed. If these households are to buy PV systems to provide the same electric output, they will have to pay systems costs of $10,000 based on today’s prices. These costs certainly, are not affordable by the average household in developing countries. However, it has been recognized that for PV technologies to be disseminated, households must in the end agree to subscribe to some scheme, which produces electricity through PV systems. This does not require the household to actually buy the system if it can receive the service. This is now the key to PV dissemination in developing countries, where the average cannot afford to buy the system.

What emerges from the above is a solution, which may be considered along with other incentives which have been offered over the last decade. Some of these incentives may have merits, none-the-less, but most governments have not opted for that because of lack of education on the part of the decision-makers. One interesting example was suggested in Egypt in early Eighties by the Ministry of Petroleum and Mineral Wealth, which translated then into providing anyone who would conserve on the use of oil, an incentive equivalent to 50% of the cost of the amount of oil saved. In other way, this represented rebate of 50%. Another incentive was to allow householders to borrow from the local Social Development Banks with monthly payments not exceeding their usual monthly bills for electricity-connected services. The “National Strategy for the Use of Renewable Sources of Energy in Egypt” had suggested introducing an excise tax on imported equipment, which uses traditional sources of energy, including electrical appliances. The proceeds from this tax would have constituted a fund to be utilized towards the needed subsidy for renewable energy technologies. There are more examples of such incentives, which vary from country to country. Even in the developed world, incentives were offered in California, USA, and in Denmark, albeit for electricity generation using wind energy, as well as in other countries.

The above shows that the individual household will need some form of financing, in order to overcome the hurdle of affording the relatively high capital cost of PV systems.

The PV Finance Forum (held in Vienna in July 1998, organized by WIP-Munich, the European Photovoltaic Industry Association and Albasolar-Madrid) and the International Symposium on Financing Solar Energy in India (held in New Delhi in March 1999, organized by WIP-Munich and the Tata Energy Research Institute-New Delhi) have all aimed to focus on a specific aspect of financing renewables at the global level [4]. The PV Finance Forum event attracted over 100 participants at the plenary and the ‘meet the industry’ sessions and included executives from the lea-
“PV Development Fund (PVDF)” from which the utility, in any country member of this PVDF, can borrow for any PV system needed. Borrowing will have to be according to some rules. It could be the rules based on socio-economic return benefits. In other words, when a utility applies for a loan, this should be accompanied by a feasibility study showing its viability. The PVDF will then appraise the proposed project, and in some cases, if in doubt, may send an appraisal mission to the country concerned in order to satisfy certain requirements. In a way, this is reminiscent of the proposal for establishing the “Energy Fund” which was spearheaded by the World Bank following the energy crises of the Seventies. The operation of the PVDF would also follow the practice of international institutions like the World Bank, CES, USAID, etc.

Now, who contribute to this PVDF? Firstly, the membership will be open to the interested countries whose magnitude of contributions to the PVDF will be regarded as level of membership. The drawing rights from the PVDF will be proportional to the degree of this level of membership relative to the total capital of PVDF. Secondly, it is expected that the PV industry, particularly in developed countries, will be a major contributor but with another category and level of membership commensurate with their contributions. Thirdly, the international and bilateral aid and financing agencies will be invited to join the PVDF giving a third category of membership. Borrowing is not a handout, meaning that it will not be for free, but each category of membership may be treated differently as far as borrowing is concerned. In other words, a developing country member of PVDF seeking a loan will receive preferential treatment as compared to a loan requested by a major PV supplier (also a member of PVDF), This will encourage the developing countries to seek support for their projects. The PVDF may even accept individual contributors who have confidence in, or who support the cause of PV. Obviously, the PVDF will be run as a profit organization or a “bank”. The organization of PVDF will need further study by a group of specialized consultants covering a wide range of expertise.

How can this PVDF be realized?

This will require propagating this proposal everywhere. For this propagation to be practical and in order to reach high degree of dissemination of idea worldwide, a “Forum” is needed to have this idea emanate from and which will champion this worthy cause. This Forum may need to be a non-profit organization, which will accept to take up this responsibility. The proposed fund may not be limited to PV alone, but can be extended at some stage to engulf all sources of clean energy.

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