Strategic Management for Photovoltaic Power System and Development in Developing Countries

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ABSTRACT

The process of information dissemination for the successful implementation for photovoltaic (PV) programme in developing countries is necessary. It is essential to consider the modelling for implementation of a PV project to ensure that it will be successful. This paper proposes a modelling of strategic management for PV power system and development. The roles of key players in the modelling and the implementation of the strategy and the responsibilities of these organizations are addressed.

1. Introduction

Thailand is a country with abundant sunshine and stand-alone PV systems can be applied throughout those rural areas that are located far from the national utility grid. PV power system in Thailand have been applied nationwide since 1976. The common PV applications in Thailand were PV battery charging stations, PV water pumping systems and PV telecommunication systems. Rural electrification is a major infrastructure programme of Thai Government. It aims to accelerate socioeconomic development in remote areas by providing new and better opportunities for increasing income, facilitating communication and mobility as well as improving the general awareness and self-reliance of the people. In general, rural people have a low income. This is because the rural economy has developed only to the subsistence level. Progress to higher levels through rural development will depend on the provision of infrastructures such as roads, water supply, health service and education as well as electrical power, but electricity is a major facilitating factor in the provision of those other infrastructures. There are two basic approaches to the electrification of a Thai village: central generation with a local distribution network or an individual self-contained system for each house. Thailand has tended in the past towards central generation via battery charging stations, in contrast to most other countries. In typical rural Thai villages the basic loads for each household are lighting and a radio. The loads for public use are water pumping and street lighting. A school in the village would need lights and a TV set with a video recorder, whilst a medical centre needs lighting and a vaccine refrigerator. The main PV rural applications in Thailand have been battery charging, telecommunications and water pumping systems. Thailand differs from neighboring countries in promoting village battery charging rather than solar home systems, although this seems likely to change in the future.

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2. Roles of key players

Both international and national institutions have an essential role to play in the dissemination and development of PV in the rural areas of developing countries. The roles of these institutions can be described as follows:

2.1 Role of the National Government

In many situations, a PV system is the most cost-effective means of providing electricity for small loads in remote areas in the short term. Its modular nature also means that the funds allocated produce visible results quickly, rather than having to wait for the completion of utility grid extension after many years. The key role of the government can include: (i) *Collaboration*, The government must work with national or international lending institutions to establish the credit channels necessary to provide rural households with the initial capital needed to buy the PV system. (ii) *National policy*, In particular, policies intended to assist rural areas through subsidies on say kerosene, can hinder the expansion of PV. Government needs to consider all of the factors which promote or hinder rural development and introduce policy changes at national level which optimise this development, and address PV policy and planning, funding and financing, technology research and development. (iii) *PV centre*, The government can facilitate the installation of good quality systems by funding a National PV Centre (see Fig. 1). A centre must have the technical resources sufficient to undertake PV activities, such as R&D, information collection and dissemination, consultancy, testing and training programmes including setting standards for PV suppliers and taking measures to ensure that they are observed. The National Standard should normally be based on accepted international standards. (iv) *Duty and tax structure*, The government plays an important role in facilitating the import of PV systems, and can also facilitate appropriate economic and political climates to attract international investment in the production of PV technology. Where some PV components need to be imported, the tax on these goods should be kept as low as possible, so as not to disadvantage local systems suppliers. (v) *Encourage*, The government must encourage the private sector and stimulate small local industries into a step by step development of the technology. The government can also promote public awareness of the environmental and other benefits of PV technologies. (vi) *Funding and dissemination*, Some PV projects attend to the social needs of communities rather than the private needs of individuals. Projects such as the provision of clean water, power for schools and medical or community centres are a Government responsibility in rural areas, just as they are in urban areas, and should be funded on the same basis. Because of the large macro-economic benefits of rural electrification, and the cost-effectiveness of PV in this context, it is to the benefit of the Government to promote the use of PV by individuals for their private use. The establishment of demonstration projects, to familiarize people with the use and the benefits of PV technology, is a valid use of public funds, and these should be part of any information dissemination campaigns to the general public.

2.2 Role of donor agencies

International donor agencies have an important role to play as sources of PV project funding and

often as sources of expertise. The World Bank group has provided funding for PV projects for many years. Within the World Bank there are areas particularly concerned with PV which have great experience in PV applications and in "best practice" in designing PV projects. The United Nations, particularly the UNDP and UNIDO, and other multilateral lending institutions have provided support for PV projects in many countries. Many other agencies have also played key roles in promoting PV in developing countries. The European Union has provided considerable funding for PV, and promoted technology transfer and training in many countries. The USAID of the USA, GTZ of Germany and NEDO of Japan have also been very active in installing demonstration systems and in training of local personnel. All of these agencies play an important part in knowledge and technology transfer, through the dissemination of information on PV technologies, proper design, system management, planning and training.

2.3 Role of the electric utilities

The utilities are the most appropriate bodies to develop a code of practice for the installation of PV technologies appropriate for power generation, while the government should coordinate the efforts. They can be a partner in schemes to bring PV systems to non-electrified areas, and can also provide training courses for local installers, technicians and end-users. Quality control and reliability can be maintained through the technical expertise available within the electric utilities. The electric utilities in Thailand have been involved with PV programmes for many years. EGAT introduced PV into its renewable energy programme in the late 1970s and has been active ever since.

2.4 Role of educational institutions

They are the most appropriate institutes to carry out, (i) Research and development (where the expertise and resources exist), (ii) Co-operation in international, national, regional programme in collaboration with the government and private sector, (iii) Training of engineers, technicians and end-users, (iv) PV dissemination campaigns, (v) Provision of PV workshops and seminars for both national and international audiences, (vi) Demonstration of the PV systems in applications with educational technologies.

2.5 Role of the private sector / NGOs

Private companies in developing countries can gain a foothold in the PV market through installation and maintenance of systems as part of a Government or international PV project. The next step would be to begin to help in the design of systems for local conditions, and later to begin local manufacture of BOS components. Those countries with an engineering capability could eventually manufacture all the components of a system, although it is probably unwise for the large majority of countries to contemplate the manufacture of solar cells because their cost is so dependent on the scale of manufacture that only a few companies worldwide will remain in the business over the next 10 years.

The role of the private sector in a country such as Thailand is in the local installation and maintenance of PV systems, the manufacture of some BOS components and the production of PV systems from local and imported components. They can also take responsibility for the demonstration of PV systems and training in rural areas in partnership

with the government and/or international agencies. NGOs usually work closely with local communities and are trusted to give impartial information. They can thus be very important in disseminating information and promoting technology acquisition to grassroots communities. They can take action as a local partner with other organisations for rural PV programmes, whilst a few NGOs (those with international outreach) can provide financing and can facilitate the flow of capital from international markets to local users.

3 Strategy and Implementation Scheme

As mentioned earlier, the key players in the implementation of the strategy are international donor agencies, the government and its agencies, the electric utilities, educational/research institutions, the private sector and NGOs. These institutions must work hand in hand with the full participation of the rural communities for the successful dissemination and development of PV in developing countries. Figure 1 shows a modelling for PV development and dissemination in Thailand.

Although the promotion of PV in Thailand has been successful, the rate of capacity growth from 1971 until today has been quite low. Lack of any financing mechanism is one of the most important reasons for this slow development, particularly since there has been an emphasis on central battery charging systems rather than on small solar home systems. In general, previous PV projects needed to be funded by Government agencies. For future, larger scale projects it would be more appropriate to seek funding by international donor agencies who have the potential to help in the development of sector programmes and projects, assist in financing, and give technical assistance and training and carry out post project appraisals. The role of the World Bank should be strongly promoted in Thailand for PV programmes. Most PV projects in Thailand were funded by the Government through its agencies and/or the electric utilities (with technical assistance by international organisations in some projects). To gain increased support from international donor organisations, the Government needs to set a target for installed PV, as part of a long-term plan of action for rural infrastructure development. There needs to be a careful consideration as to whether the programme should promote central battery charging stations or the Solar Home Systems which are such a proven success in most other countries.

3.1 Institutional approaches for the introduction of PV systems to end-users

The strategy of dissemination or promoting PV systems through institutions to local communities must be implemented in a number of different ways, depending on the degree of penetration of PV systems into an area. When PV system is introduced into an area, the funding and the personnel must come usually from Government and its agencies, in the form of demonstration projects. Local companies and individuals can be trained during these projects in installation and maintenance, and the users can be given training in the operation of the PV systems and realistic expectations of their performance. The local companies can establish relations with a central supplier of systems and components, and with a source of finance. They can then begin to sell PV systems in their area on a commercial basis. Expansion of the PV programme can build on this experience to set up local companies to install and

maintain systems designed and funded by central Government or international agencies. It is essential that the users are charged a fair price for their PV systems during these early stages, so that the dissemination projects can lead into a situation where systems are supplied and all costs are recovered on a commercial basis.

3.2 PV market development

The Government should act in the first instance to remove barriers to market expansion, by removing excessive duties and taxes on PV components and systems, removing subsidies on products which compete with PV systems, such as kerosene. They should also provide information on the benefits and costs of PV to the public, to Government agencies and power utilities and to financial institutions. The Government may choose to go beyond the removal of discrimination against PV and decide actively to promote its use. It can reduce the cost of PV systems by reducing or even abolishing import duties and taxes on PV systems or components.

The Government could introduce new regulations for the promotion of PV systems through tax reduction for investments in PV by private industry or individuals. Government Departments should always include PV as an option for powering schools, medical centres, community centres, street lighting etc., and it should be used wherever it is cost-effective on a life-cycle basis. The Government should support efforts to develop innovative financing mechanisms which allow lenders to offer long term credit on reasonable terms. This may be through commercial banks via risk-reduction guarantees, through Rural Development Agencies or Credit Unions, or by on-lending of low-cost international credit from mechanisms.

3.3 Training

On the PV modelling, the Universities and research institutions should provide professional training with courses, seminars or workshops on all aspects of PV science and technology [1]. The technical colleges and the electric utilities should also provide training in technical practices for installation and maintenance. The government, with PV industry support, should set up specialist regional/local training centres. Although in the early years of PV dissemination, lower level training activities can be carried out by itinerant staff as and when needed in a local school or technical collage, in the later years technical training will be required at many different levels, and it is most effective if the expertise and facilities are concentrated in a small number of centres. These centres could, in particular, provide the training for those who provide the low-level local training of installation and maintenance technicians. Training in business practices is essential if the local companies are to be successful, and training of financial staff is critical to the success of a funding agency. The government should provide and support training activities in collaboration with private sector PV providers, since the existence of these trained personnel is essential if PV is to develop as an indigenous business.

3.4 Assessment and feedback

Certainly, all PV projects should be evaluated after they have been operational for a year and each year thereafter. The results must be fed back to a central agency, responsible to the Government, since lessons learned from each region could be even more valuable if they are compared at national level. The assessment can be conducted by any independent

body, either a local company, the electric utilities and NGO or some international organisations. The feedback from these studies is essential to determine the best-practice in design and installation, and to obtain the opinions of the users. In addition, the electric utilities should have a quality control system, which not only checks the suitability of the PV systems on offer, but should visit each village to check on the system performance and to obtain feedback on the satisfaction of the villagers.

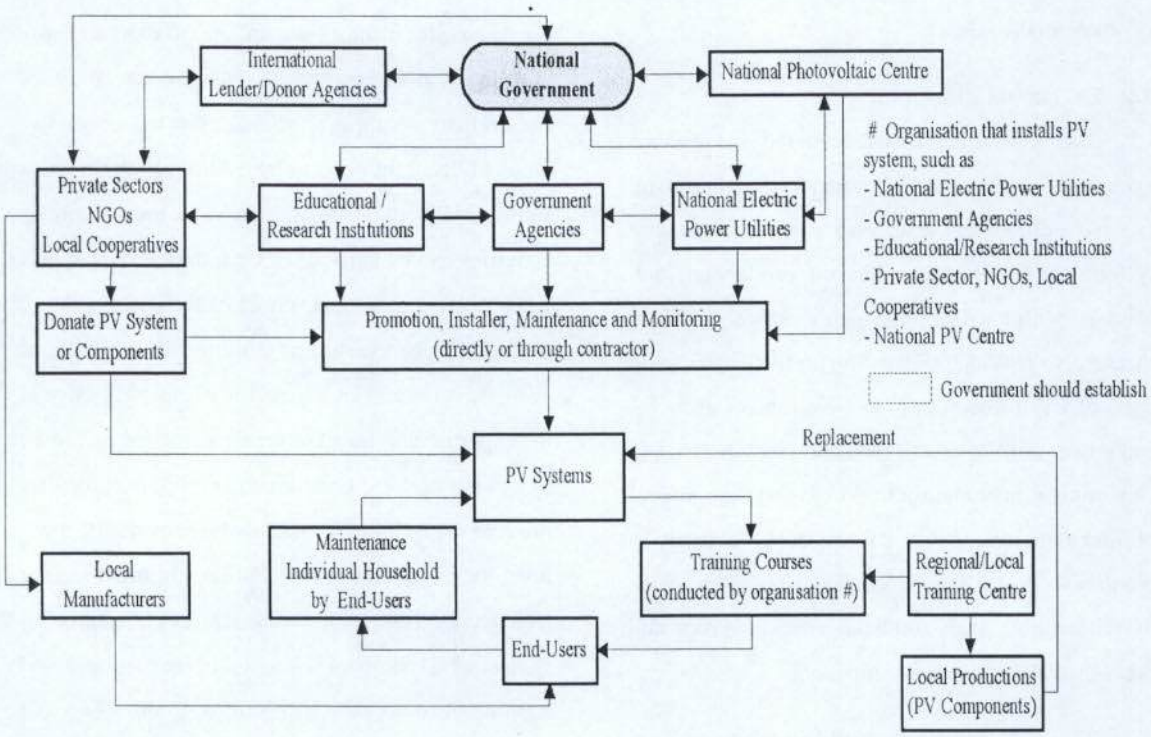

Fig. 1 Strategic management for photovoltaic power system and development

4. Propose of Solar Home System Projects

On a life cycle cost basis, PV lighting has been shown to be cheaper than that from a kerosene or hurricane lamp. Solar home systems (SHS) are economically the least-cost option, compared with kerosene mantle and wick lamps for lighting and rechargeable batteries used for operating small appliance such as TV and radio. SHS is now most common PV application in many developing countries. Based on the analysis of existing projects in rural areas of Thailand, SHSs should be much more encouraged.

4.1 Implementation

PV programmes on dissemination of SHSs have been initiated in many Asia Pacific countries, such as India, China, Nepal, Bangladesh, Indonesia, Sri Lanka, the Philippines and South Pacific island communities during the last 15 years [2]. In many countries, the electric utilities are responsible for technical aspects and quality control of PV electrification, sometimes with a technical assistance programme from international organisations. For countries which are beyond the stage of small demonstration projects, local private companies are

contracted to install the systems and provide the training of the users. Local government agencies and NGOs are used to disseminate information, and in areas of extreme poverty, the end-users can pay some or all of their contribution to capital costs by participation in construction and maintenance. The system monitoring and an assessment of both technical performance and social issues arising from the introduction of PV can be cooperated by research institutions.

4.2 Financing

Basically, the capital cost of a system depends on many factors, apart from the international prices charged to the importer. The price paid by the customer also depends on the cost of finance, and will vary depending on interest rates and on how long the customer takes to repay the loan. The possible down payment by the customer depends on their income streams, and on the policies of the central Government. Ideally, the repayment period should be short since the total interest charged will increase if the repayment period increases. To increase the number of households able to pay for SHS, the repayment strategy should be flexible. In countries where the cash income is very low, donor agencies and energy planners must find a balance between the users' ability to pay and the programme goals. If the PV programme is to be sustainable then the users must pay at least the cost of maintenance and battery replacements. This can be ensured by setting up a fund into which end-users pay a small monthly charge. This is usually sufficient to make the monthly payment needed to purchase a basic SHS over about five years on a purely commercial basis. It seems clear that SHS provide a suitable level of service for households in rural areas at a monthly cost which is comparable to their present monthly outlay on lighting and small power. This contrasts with the situation for battery charging stations where the capital cost is beyond the capabilities of almost all individuals or local companies.

5. Conclusions

It is also essential that the policy makers consider the lessons from other countries in choosing the type of PV system to be installed. SHS have already been proven, in some countries, to be commercially viable. It seems sensible therefore to move towards a commercial market for SHS with Government provision of PV systems for public services in health, education and communal buildings. Modelling shown in this paper is appropriate and is the only possible one for a country, such as Thailand, which is in the early stages of PV development and dissemination. It must be clearly recognised by policy makers and all of the other actors that their roles will change over time, as PV becomes established as a rural power source, and that the ultimate aim is for the role of Government and its agencies to be regulators of quality and performance, whilst some local companies and institutions take on the tasks of design, procurement and supply, installation and maintenance, and of marketing and finance. This can ensure a smooth transition from demonstration stages to the mature stage of commercial provision of PV systems to the majority of the rural population in Thailand.

6. References

1. S. Hiranvarodom, *A Role of the National PV Centre for Dissemination of PV Development in Thailand*, 17th European PVSEC, Munich, Germany, 2001, pp. 2026-2030.

2. D. C. Barua et al, *A Photovoltaic Solar Home System Dissemination Model*, Progress in Photovoltaics : Research and Applications, July-August 2001, pp 313-322.