IMPACT EVALUATION OF THE CHINESE BRIGHTNESS-PROGRAMME IMPLEMENTED DURING 1996-2006

Frank Haugwitz
GTZ German Technical Cooperation, 100004 Beijing, P.R. China,
Tel: 0086 (010) 8532 3489 Ext. 26 / Fax: 0086 (010) 8532 3481
Mail: Frank.Haugwitz@gtz.de

ABSTRACT: Aiming at an improvement of the living and working conditions of people in remote un-electrified areas of Western China the at that time State Development Planning Commission (SDPC) today National Development and Reform Commission (NDRC), initiated the so-called "Brightness Programme" in 1996. According to the objective of the Brightness Programme it is planned that approximately 23 million people in remote area shall be electrified by means of decentralized wind and PV technologies by 2010. Back in 1996 a number of challenges and problems like financing and affordability, technical quality, sales- and service network, and education and training for end-user which could be encountered in the course of implementation were identified. After a pilot phase (1999-2002) China launched the globally most ambitious national rural electrification programme, the so-called Township Programme in 2002 which today is considered to be the major reason for the stimulation of the phenomenal development of the Chinese PV industry. Until recently, the Chinese PV industry was relatively unknown but is today in terms of production capacities for solar cells just behind Japan and Germany.

Keywords: National Programme, Rural Electrification, Dissemination, Developing Country, China,

1 Background

China has extensive historical experience with the development of renewable energy systems for rural electrification. Since the late 70s until the end of the 80s relevant stakeholders like system integrators and equipment manufacturers experienced a period of capacity building, developing experience with government supported demonstration programmes and a commercial market for remote telecommunication systems and other industrial applications.

Against the background that in the mid 90s still more than 25,000 villages or 3,55% of the entire population of China were not supplied with electricity the at that time State Development Planning Commission (today National Development and Reform Commission) initiated the Brightness Programme in 1996. The decision to launch this large-scale rural electrification programme derived from the fact that in addition to a widening gap between the relatively developed Eastern China and the relatively backward Western China a further grid extension was financially not viable and could not be expected in the foreseeable future.

The overall objective of the Brightness Programme was to improve the living and working conditions of people in remote areas by means of decentralized renewable energy systems. The target was to supply 23 Mio. people with electricity by installing decentralized photovoltaic and wind energy systems by 2010. Per capita 100 Wp power generation capacity shall be install. In addition, boarder, relay, road service, oil pipeline, railway signal stations in remote areas shall be equipped as well.

2 Challenges and Problems

The challenges and problems identified during the designing stage of the Brightness Programme were [1]:

Financing and Affordability

Rural electrification by means of renewable energies creates a heavy financial burden on the responsible governmental institutions mainly caused by the high initial investment required for the procurement and installation of hardware. In addition, the relatively low level of creditworthiness of the target group with an annual cash income of often lower than EUR 50 and the unfamiliarity of local financial institutions with e.g. mirco-credit schemes create additional barriers.

Technical Quality

In order to create a market demand for e.g. Solar-Home-Systems (SHS) which in the long run is rather demand-driven by potential end-users and not driven by governmental financed programmes, the purchasable SHS-Systems must have a reputation of both high technical quality and technical reliability which is crucial for the acceptance by the end users.

Sales- and Service-Network

In order to achieve a sustained demand driven market development the establishment of an organized sales- and service network through relevant information could be disseminated and maintenance service can be offered were necessary.

User Education and Training

Due to the fact that the target group have only a relatively low level of education and additionally a rather limited understanding of renewable energy systems it made it indispensable to inform them about the technical limitations of e.g. SHS-Systems and RE-village systems.

3 Pilot Phase 1999 – 2002

As a first step towards realization the ambitious objectives of the Brightness Programme a three year pilot phase was launched in 1999. Inner Mongolia, Gansu and Tibet Autonomous Region (TAR) were selected as pilot provinces. The total investment of EUR 2 Mio. facilitated that by the end of 2002 in Inner Mongolia 5500 hybrid PV/wind/battery household systems; in Gansu 10,000 SHS; in Tibet 30 PV/battery village power systems and 11,000 SHS were installed. According to estimations approx. 50,000 persons have been supplied with electricity [2].

In each pilot province an executing agency affiliated with the local Provincial Development and Planning

Commission (PDPC) was founded. In Inner Mongolia the "Inner Mongolia Taifeng Energy Co. Ltd.", in Gansu the "Gansu Huineng New Energy Technology Development Co. Ltd." and in Tibet the "Lhasa Service and Training Center". Their main tasks were to ensure a sustainable operation and maintenance of the installed systems. SDPC encouraged the implementation agencies to establish a provincial-wide service network connecting the provincial capital with the county capitals, townships and administrative villages in order to be in the position to quickly respond to end-users needs. Due to the vastness of Inner Mongolia the Taifeng Co. Ltd. invested approximately EUR 300,000 to set up two additional service companies in order to better serve 19 counties of the province.

In addition to the establishment of executing agencies the central government entrusted the PV / Wind Quality Test and Evaluation Center of the Chinese Academy of Science (CAS) to ensure that only certified products will be used in the course of installation. Regulations issued by SDPC covered quality standards for various components and guidelines for installation, operation and maintenance. A monitoring and evaluation group consisting of representative of SDPC, provincial and county government, CAS and the Beijing Jikedian Renewable Energy Center (JKD) were established in order to inspect and monitor the implementation of the pilot phase.

Aiming at building up capacities within the established implementing agencies and at both county and village level, carefully selected persons received comprehensive trainings covering issues related to installation, operation, maintenance and trouble shooting. In order to increase the awareness among the population in general and the potential end-users in particular, articles were published in newspapers and broadcasted via radio and TV.

A survey conducted by JKD in Inner Mongolia in late 2003 revealed that out of 5240 PV/wind/battery hybrid systems of which statistics were available 2119 systems (40,4%) were malfunctioning. The inverter/charge controller accounted for 1099 sets (20,9%) followed by 657 batteries (12,5%) and 363 wind turbines (6,9%). On-site investigations suggested that the bearings of wind turbines were made out of unsuitable copper material. The main reasons for the exceptionally high proportion of malfunctioning charge controllers/inverters were a poor technical design and the utilization of unsuitable material during assembling. Consequently the malfunctioning charge controller/inverter caused a shortened life time of 657 batteries. As result, a general dissatisfaction among the end-user prevailed and led in many cases to the refusal to remit the final instalment for the systems [7].

3 Township Programme 2002 – 2004

Authorized by the State Council in 2001 SDPC started the preparation of a major national rural electrification programme. The national Township Programme was initiated in mid 2002 with the goal of electrifying the remaining 1065 administrative townships in rural western China. The programme was funded with EUR 200 Mio. from the central government and EUR 270 Mio. from provincial and township governments. Through a competitive bidding procedure at the provincial level the so-called system integrators responsible for installation, operation and maintenance for three years were selected. Most systems were installed during the mid 2002 to 2004.

To date, 721 community scale village power systems consisting primarily of PV/battery systems but also including both some wind and diesel back-up generators with a cumulative capacity of 15,5 MW have been installed. Average capacity of these township systems is 21,4 kW while the range is from 10 kW to 210 kW.

Table I: Township Programme Installed Systems [3]

Province	No. of PV/Wind Hybrid Sys.	Instal. Capa. (kWp)	Ø – instal. Capa- (kWp)	No. of instal. SHS	Instal. Capa. (kWp)
Hunan	1	20	20	0	0
Shaanxi	9	100	11,1	0	0
Qinghai	112	2715	24,2	6800	136
Gansu	23	995	43,2	0	0
Xinjiang	159	2378	14,9	7133	356
I.Mongolia	42	752	17,9	1525	610
Sichuan	46	1817	39,5	0	0
Tibet	329	6763	20,6	0	0
Total	**721**	**15540**	**21,5**	**15458**	**1102**

These township systems have been installed in Tibet, Qinghai, Xinjiang, Gansu, Inner Mongolia, Sichuan, and Shaanxi provinces and autonomous regions. In addition to these systems in Qinghai, Inner Mongolia and Xinjiang with a cumulative capacity of 1102 kW in total 15458 SHS have been installed. Further 302 townships have been targeted where small hydropower systems with an estimated cumulated capacity of approximately 274 MW in 10 provinces/autonomous regions and Chongqing shall be installed. Overall, in the course of its implementation the Township Programme enabled the supply of approx. 1,3 Mio. people with electricity.

Figure I: Geographical Distribution of Township Systems

An extreme rapid execution of the Township Programme, focusing on bidding, contracting and installation has created a host of problems which NDRC, the responsible political institution, is trying to solve [3].

Ownership

Different models which shall ensure that after the transfer of ownership of the systems from the central government to provincial and township authorities remains a state asset are under discussion.

Tariff Regulations

At present no uniform tariff regulations exists. The charged tariffs can substantially differ between the provinces and within the province. Based on a survey conducted by UNDP in 2005, nowadays the range is from EUR 0 – 0,2 per kWh.

Financial Support

An imposed uniform tariff regulation will not be sufficient to cover the expenses required for the replacement of battery bank or major repairs. At present NDRC is considering various options e.g. allocate a subsidy according to the installed capacity (e.g. 1 KW requires EUR 400 / a) or according to the actual number of kWh generated, which shall ensure a sustainable long-term operation and maintenance of these systems.

Management

The contract signed between the provincial government and the system integrators stipulates that for three years after installation of the systems the integrators are responsible for operation and maintenance. To date, two years after expiry of the contract various management models e.g. local power utilities will own, operate and maintain; through lease contracts between the township and a professional management companies; township owns, operate and maintain; system integrators establish a RESCO to manage the systems under a contract with the townships are being taken into consideration.

Training

The training requirements are substantial and exist on various levels e.g. national, provincial, county, township, and villages, system operators and integrators, management, equipment manufacturer, govt. officials, etc.

In June 2007 the World Bank through its China Renewable Energy Development Programme (REDP) has commissioned JKD to draft proposals how the Townships Systems can be operated and maintained on a commercial basis for over a period for in total 20 years.

4 Future of the Brightness Programme

Today, China still has approximately 20,000 to 25,000 un-electrified villages mainly scattered in western provinces. During the 11 Five-Year-Plan (2006-2011) the central government made a commitment to expand the ongoing Brightness Programme known as the “Village Programme” which aims to supply 3,5 Mio. households with electricity by means of renewable energies until 2011.

Currently, the design of the Village Programme is under preparation. However, since NDRC has encountered significant difficulties ensuring the sustainable operation and maintenance of the township systems the original approach to again focus mainly on decentralized systems might be reconsidered. In this context State Grid Cooperation has been entrusted by the Chinese People Congress (CPC) to carry out the so-called “Huhutong Programme” or “Power for All Programme” which aims at an electrification of rural areas in 20 provinces by grid extension [6]. The total budget is in the order of magnitude of EUR 2,3 Bill. and shall solve the electricity supply of 1,2 Mio. households or approximately 4,5 Mio. people. Against this background, late 2006 the Province of Gansu has been selected to be electrified by gird extension. All settlements with no less of five households shall be connected to the grid until the end of 2008.

The author assumes that the responsible governmental institution in the course of designing the “Township Programme” underestimated the complexity of national rural electrification programmes. To ensure a long-term sustainable operation of such decentralized RE systems requires more than the allocation of a budget earmarked for the procurement of hardware only in order to meet the targets stipulated in the national development plan. Since the prevailing problems of the Township Programme remain unsolved until today it appears that NDRC does not want to create even more problems with additionally installed decentralized systems and rather favours rural electrification by grid extension. Such an approach would indeed limit the possible problems encountered in the long-run to a minimum, although the total costs might be substantially higher than installing decentralized systems.

5 Impact Evaluation of Brightness Programme

The impact of the Brightness Programme ten years after its launch remains difficult to quantify and to verify, due to the fact that in the same period China experienced an average economic growth rate of approximately 10% per year. In addition, in the late 90s the central government launched the so-called “Go West” campaign which explicitly aimed at an improvement of the overall infrastructure in western China and invested billions of EUR in order to realize its ambitious western region development targets.

Regarding the above mentioned four challenges and problems identified before the launch of the Brightness Programme in 1996 the following statements can be made.

Financing and Affordability

In the meantime local financial institutions have gained considerable experience regarding renewable energies, however not particularly concerning off-grid applications like SHS and pico-hydropower systems designed for remote rural areas. Nowadays provincial Poverty Alleviation Offices (PAO) and Rural Credit Cooperatives are mainly engaged in e.g. to facilitate through micro-credit schemes the purchase of aforementioned systems for people living in remote off-grid areas. The generally increased cash income of potential end-user facilitates the purchase of off-grid RE systems.

Technical Quality

Along the implementation of the pilot phase and Township Programme different Chinese Technical and Industrial Standardization Committees were involved in drafting together with practitioners, manufacturer, installers and operators a host of relevant technical standards, regulations, etc. either for components or systems. A comparison of test results of charge controllers from local manufacturer carried out on behalf of the World Bank REDP (2005-2007) revealed that although the quality has remarkably improved, it still leaves room for further improvement [4]. An analysis of a two year (2005-2007) lasting technical monitoring carried out in 14 township systems in Qinghai supported by the German Development Agency (GTZ), Fraunhofer Institute for Solar Energy Systems (ISE), and the Centre for Solar Energy and Hydrogen (ZSW) verifies an acceptable technical quality of the components and

overall system performance.

Sales- and Service-Network

Today all provincial, county, and prefecture capitals of western provinces are home to countless SHS retailers, some offer even beyond the sale over the counter as well after-sales-services as part of the purchase. To ensure in a relatively short period (best case 24 hrs) a repair of a malfunctioning township system, the vast countryside made it inevitably for the system integrators to set-up several service points throughout their corresponding provinces.

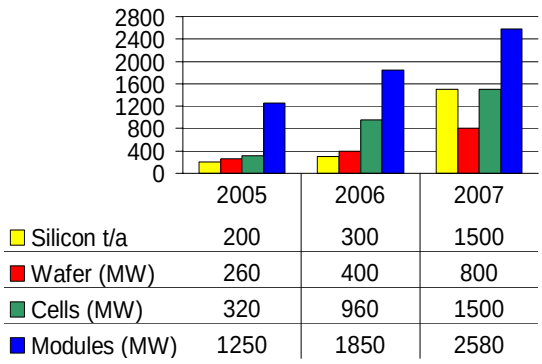
User Education and Training

Especially in the course of the implementation of the Township Programme each system integrator responsible for installation, operation and maintenance issued as part of their contract a guidebook in order to illustrate the basic functions of such systems. These guidebooks were used during training sessions. Additionally, with the support of various international donor agencies numerous training schemes have been developed and put into practice. However, isolated trainings have proven being not very sustainable, i.e. trainings either funded by the Chinese government and/or foreign development organizations will terminate once the budget has been spent or the Technical Assistance came to an end. Against this background, at present, an apprenticeship is under elaboration which shall be incorporated into the national training and education system managed by the Ministry of Labour and Social Security. An institutionalization of such a training schemes, i.e. only accredited training institutions are authorized to carry out such trainings and to issue an examination certificate shall ensure official recognition.

In general, the prominent status of renewable energies within the context of the national energy policy today can to some extend attributed to the Brightness Programme. The Renewable Energy Promotion Law which came into effect January 2006 and its supplementary regulations or the formulation of national development targets for all renewable energies within the 11 Five-Year-Plan (2006-2011), all underline the importance of renewable energies in China's energy mix.

As a result, over the last couple of years the deployment of renewable energy technologies has gained considerable momentum and the extraordinary development of e.g. the Chinese Photovoltaic Industry is often linked to the Brightness Programme.

Figure 2: PV-Industry Production Capacities in MW [8]



	2005	2006	2007
Silicon t/a	200	300	1500
Wafer (MW)	260	400	800
Cells (MW)	320	960	1500
Modules (MW)	1250	1850	2580

Looking at the historical development of the Chinese PV Industry, the early days were dominated by assembling PV-Modules and nowadays approx. 500 production lines are manufacturing relevant products covering the entire value chain. In 2006, the Chinese PV Industry next to Japan and Germany has become the country with the third largest production capacities for solar cells [5].

6 References

[1] H.P. Chen; H. Zhou; S.H. Ma; Brightness Programme and its progress, January 2002.

[2] S.C. Wang, Proceedings of the APEC Renewable Energy Workshop, September 26-27, 2005, Beijing, China, pp. 126-153.

[3] UNDP, SDDX Survey and Recommendations, December 2005.

[4] REDP, Charge Controller Quality Monitoring; April 2007.

[5] Greenpeace, EPIA, CREIA, Review of PV Development in China, September 2007.

[6] State Grid Cooperation, Huhutong Programme, www.sgcc.com.cn

[7] Brightness Pilot Phase Final Report, JKD, October 2003.

[8] ENF Study on Chinese Solar Cell and Module Manufacturer, June 2006.

[9] Monitoring of Village Power Supply Systems in China, GTZ, Fraunhofer ISE, ZSW, June 2007.