

APPROACHES TO USING RENEWABLE ENERGY IN RURAL AREAS OF CHINA

Long Seng To
School of Photovoltaic & Renewable Energy Engineering
The University of New South Wales
UNSW Sydney, NSW 2052, Australia
l.to@student.unsw.edu.au

ABSTRACT

The Chinese Government has made strong policy commitments to expand the use of renewable energy systems in rural electrification as a means of achieving sustainable development. International experience has shown that there are technical, social, cultural, institutional and economic barriers to the deployment of renewable energy systems and, thus, to their ability to contribute to the development goals of the community over the long term. This paper aims to identify promising approaches for overcoming these barriers in the context of rural China. It includes (a) a literature review of key renewable energy projects in rural China¹, (b) a comparison of the lessons learnt from renewable energy rural electrification programs in other countries, (c) an assessment of the contribution of these projects to our understanding of renewable energy projects in rural areas.

Keywords: China, renewable energy, rural, electrification

1. INTRODUCTION

China has made tremendous progress in improving the standard of living for its citizens [p 22, 1] due in part to its rural electrification policies which have increased the population with access to electricity from 40% in the 1950's to 95% in 2004 [2]. However, this still leaves an estimated 9 million to 22 million people [3] in remote areas without access to electricity. Renewable energy systems can be a cost-effective and sustainable electricity supply in this context [4]. China continues to set ambitious goals for implementing renewable energy where electricity grid extension is not viable through its Renewable Energy Law (2006) and rural electrification programs.

The aim of this paper is to identify the opportunities for learning from Chinese renewable energy programs in rural

areas via comparisons with studies of analogous programs elsewhere. This paper will review the international experience with implementing renewable energy in rural areas; review the approaches used to implement renewable energy rural electrification in three recent programs in western China; compare these approaches to lessons learnt from other countries; and provide an initial assessment of the contribution of these projects to our understanding of how to successfully implement renewable energy projects in rural areas.

2. INTERNATIONAL EXPERIENCE IN RENEWABLE ENERGY RURAL ELECTRIFICATION

Renewable energy for rural electrification projects outside of China funded by development agencies and developing country governments in the 1970s - 80s were focused narrowly on technology deployment. These projects commonly had poor technical performance, were poorly matched with user requirements and ultimately failed because of lack of attention to such things as institutional infrastructure and maintenance requirements [5]. A limited literature review of solar home system project evaluations in rural areas showed that only 58% of systems were fully functioning at the time that the studies were conducted [6].

In order to promote more "sustainable technology diffusion and markets" [p 314, 5], market-orientated approaches have become more prominent since the 1990s to overcome problems in implementing renewable energy. Drawing on the experience of ten developing countries, the Global Network on Energy for Sustainable Development found that the main problems were: lack of policy attention and inadequate attention to institutional frameworks; financial barriers; low quality technology, installation, operation and maintenance; missing capacity and; low awareness of renewable energy technologies [7].

Several renewable energy implementation models that systematically address these problems exist, but there is no consensus yet on the best model for a given situation [8].

¹ This paper is limited to projects that have been documented in the English language.

Building upon a database of projects in developing countries, the International Solar Energy Society RESuM project [9] classifies the various rural renewable energy deployment models according to how they address financial barriers. The financial deployment models identified were: cash sales, credit, leasing and energy service provision (similar classifications can be found in [10, 11]). Training and standards are also important for ensuring the quality of renewable energy systems.

Evaluations of renewable energy rural electrification projects show that access to electricity improves the quality of life and is highly valued by users. Sustainable energy is an enabling factor in development [12], but the impact of renewable energy systems on income generation can be indirect. This means that economic development does not necessarily occur where other factors required for economic development are missing, e.g. no access to markets [5, 10, 13]. Strategies to maximize development outcomes include user needs analysis, community participation,, gender-sensitive energy planning and integration with wider rural development planning.

3. APPROACHES TO RENEWABLE ENERGY RURAL ELECTRIFICATION IN CHINA

This section will discuss the approaches to renewable energy for rural electrification adopted in three recent major programs in Western China (see Table 1 for more details):

- the Brightness Program,
- the Township Electrification Program, and

- the China Renewable Energy Development Project (CREDP) funded jointly with the World Bank and the Global Environment Facility.

This list is by no means exhaustive and this paper will not discuss programs that aim at developing the renewable energy sector in general.

3.1 Government Support

There are indications that there is strong government support for renewable energy rural electrification programs in China. Firstly, all three programs examined in this paper were run under the leadership of the National Development and Reform Commission (NDRC, formerly called the State Development Planning Commission). This powerful agency is responsible for broad economic and social development policy. The implementation of renewable energy rural electrification programs by the NDRC indicates that these programs are integrated with the broader rural development planning of the agency. However, many government agencies are involved in renewable energy projects in rural China and in the past, there has been little coordination between them [p38, 16]. Secondly, the scale of the programs is large in terms of financial investment, the number of households reached and installed capacity relative to experience elsewhere [14]. Also note that the largest renewable energy rural electrification programs in Table 1 are solely funded by the Chinese government. Thirdly, China has continued with more renewable energy rural electrification programs. Building on the experience of the Township Electrification Program, the Village Electrification Program aims to electrify 200,000 villages using renewable energy between 2005 and 2010 [15].

TABLE 1: SUMMARY OF RENEWABLE ENREGY RURAL ELECTRIFICAION PROGRAMS DISCUSSED

PROGRAM	INSTITUTION	DATE	AIM	BUDGET	LOCATION
Brightness Program [16-18]	State Development Planning Commission (now renamed the NDRC)	1996 – 2010	Provide electricity for 23 million people in remote areas using wind and photovoltaic technologies with an average capacity of 100W/ person.	US\$50 million for 2001-2005	Gansu; Qinghai; Inner Mongolia; Tibet; Xinjiang provinces
Township Electrification Program [14, 15, 18]	National Development & Reform Commission (NDRC)	2001 – 2003	Provide electricity via renewable energy to 1061 townships that could not be feasibly reached by grid extension.	NDRC – US\$240 million Provinces - US\$100 million	Xinjiang; Qinghai; Gansu; Inner Mongolia; Shaanxi; Sichuan; Hunan; Yunnan; Tibet
China Renewable Energy Development Project (CREDP) [19, 20]	National Development & Reform Commission/ World Bank/ Global Environment Facility	2001 – 2007	Reduce the cost of solar photovoltaic (PV) systems, improve PV product quality, develop the potential rural PV market and improve after-sale services for PV systems in remote rural areas.	US\$139 million	Inner Mongolia; Gansu; Qinghai; Xinjiang; Tibet; Sichuan; Ningxia; Shan'xi and Yunnan.

3.2 Capacity Building & Quality

Capacity building plays an important part in Chinese renewable energy rural electrification programs. Almost 30% of the Township Electrification Program budget was allocated for training and institutional development [p 22, 18]. A national training accreditation system was set up for renewable energy system installation and maintenance. The Brightness Program also assisted enterprises in the supply chain, as well as installing a technical training system [16]. CREDP supports a cash sales market by allocating grants to organizations to improve sales and after-sales services for renewable energy systems [19].

The quality of the renewable energy systems in the Township Electrification Program was enhanced by requiring that system integrators guarantee the systems for 3 years with an availability of at least 93-97% [14]. Increasing system load may threaten the availability of the system, so load management strategies are essential for the long-term operation of these systems [14]. CREDP sets quality standards as part of the eligibility criteria for enterprise and sales grants [19].

3.3 Overcoming Financial Barriers

Although renewable energy systems are often the least-cost option for rural electrification [4, 17], a high proportion of capital subsidy is needed in order to make the systems affordable for the user [21]. The programs all offer capital subsidies for the cost of the renewable energy system. The Brightness and Township Electrification Programs offered grants to system integrators through a bidding process [14, 16]. While CREDP provides US\$1.50 – \$2 per peak Watt subsidy to retailers that meet their quality criteria, in order to foster a cash sales market for solar home systems. The subsidy level is the same for all users irrespective of their income [18]. In addition to the initial capital subsidy, long-term subsidies will be needed for maintenance costs [17]. The Chinese government is currently drafting guidelines for user tariffs and system ownership to address concerns about the long-term financial sustainability of the systems in the Township Electrification program.

3.4 Monitoring & Evaluation

The key measurement used in the Brightness Program and the Township Electrification Program is the number of people with access to electricity and the number of systems installed in Townships respectively. The social and economic development benefits are implied, but not measured directly as part of the program. A baseline survey for the Township Electrification Program was conducted in 2005 [22], but no monitoring processes have been published yet.

4. COMPARISON & CONTRIBUTION

The barriers to renewable energy deployment in rural China are similar to those experienced overseas (compare Section 2 and [p36-40, 16]). Therefore, the lessons from the three Chinese programs examined in this paper could be helpful in formulating programs in other countries. It is especially important to learn from the Chinese renewable energy rural electrification programs discussed in this paper because they are large-scale and have “enough critical mass to spawn a truly robust and sustainable renewable energy infrastructure” [p 67, 14]. Most renewable energy programs implemented in rural areas internationally are small-scale (one survey showed that over 70% of solar home system programs installed less than 1000 systems each [p 460, 10]).

The importance placed on capacity building in the three Chinese programs examined in this paper could be considered as international best practice. Programs implemented in the 1980’s typically allocated less than 10% of their budget for capacity building [p 313, 10]. These programs underestimated the role of technical and institutional capacity building for the long-term success of its renewable energy programs and led to technical problems in the field. Chinese programs seem to place a heavy emphasis on capacity building and it will be important to document their experience in this area.

The approach to renewable energy rural electrification in the projects examined in this paper is based on capital subsidies. This is an appropriate mechanism, given the low income-level in the provinces within which the programs operate. The programs also address the issues experienced in implementing renewable energy in rural areas internationally, but in different ways. CREDP takes the market-orientated approach explicitly, while the Brightness and Township Electrification Programs address many of the barriers to renewable energy deployment in the program designs. However, market-orientated approaches based on lessons learnt in other countries must be applied carefully in rural China. The situation in rural China is unique in that it is undergoing economic reform from a command economy to a more market-orientated one. Fieldwork by Ling showed that photovoltaic system subsidy policies in rural areas tended to favor well-established state-owned or quasi-state owned enterprises over smaller private enterprises [3]. While this is not necessarily a negative outcome, it does show that the unique economic context of rural China must be taken into account when assessing the suitability of program design for projects in other countries.

5. CONCLUSION & FURTHER WORK

This paper has examined three large-scale renewable energy rural electrification programs that have been implemented in

western China recently. Monitoring and evaluation of the systems, as well as documenting how emerging sustainability issues are addressed will be essential. This provides an important opportunity for learning by the Chinese government for its future programs and for programs in other countries. A focus on the effect of the renewable energy systems on social and economic development would be especially useful as this link is not strongly shown in the existing literature.

This paper is the first stage in a larger project examining renewable energy in rural China. Future work may compare the programs examined in this paper with China's successful policies for small hydro power deployment since the 1950's and small-scale wind power in Inner Mongolia, in addition to programs implemented in Indonesia and other developing countries. This could provide valuable lessons for China's current projects, including lessons on long-term financial sustainability of the projects. Research into renewable energy projects in China could also show the limitations of current market-based approaches, due to the unique economic context of China. In conclusion, China's renewable energy programs in rural areas offer a unique opportunity for learning regarding effective approaches to the long-term sustainability of large-scale renewable energy projects.

6. ACKNOWLEDGMENTS

I am most grateful to Dr Muriel Watt and Dr Stephen Healy for their guidance and comments throughout the process of writing this paper. However, any errors in this paper are entirely my responsibility.

7. REFERENCES

1. CDRF & UNDP, *China Human Development Report*. 2005, China Development Research Foundation & United Nations Development Programme: Beijing.
2. Luo, Z. and J.C. Cutler, *Rural Energy in China*, in *Encyclopedia of Energy*. 2004, Elsevier: New York. p. 493-506.
3. Ling, S., J. Twidell, and B. Boardman, *Household Photovoltaic Market in Xining, Qinghai Province, China: The Role of Local PV Business*. *Solar Energy*, 2002. **73**(4): p. 227-240.
4. Byrne, J., B. Shen, and W. Wallace, *The Economics of Sustainable Energy for Rural Development: A Study of Renewable Energy in Rural China*. *Energy Policy*, 1998. **26**(1): p. 45-54.
5. Martinot, E., et al., *Renewable Energy Markets in Developing Countries*. *Annual Review of Energy and the Environment*, 2002. **27**: p. 497-530.
6. Stone, J.L., et al., *PV electrification in India and China: the NREL's experience in international cooperation*. *Progress in Photovoltaics: Research and Applications*, 1998. **6**(5): p. 341-356.
7. GNESD, *Renewable Energy Technologies and Poverty Alleviation: Overcoming Barriers and Unlocking Potentials*. 2007, Global Network on Energy for Sustainable Development: Roskilde.
8. Martinot, E., A. Cabraal, and S. Mathur, *World Bank/GEF solar home system projects: experiences and lessons learned 1993-2000*. *Renewable and Sustainable Energy Reviews*, 2001. **5**(1): p. 39-57.
9. ISES. *RESuM: Rural Energy Supply Models*. [cited 2007 24 June]; Available from: <http://resum.ises.org/>.
10. Nieuwenhout, F.D.J., et al., *Experience with solar home systems in developing countries: a review*. *Progress in Photovoltaics: Research and Applications*, 2001. **9**(6): p. 455-474.
11. IEA-PVPS, *Summary of Models for Implementation of Photovoltaic Solar Home Systems in Developing Countries Part 1 & 2*. 2003, International Energy Agency.
12. UN-Energy, *The Energy Challenge for Achieving the Millennium Development Goals*. 2005, United Nations - Energy: New York.
13. GNESD, *Poverty Reduction - Can Renewable Energy make a real contribution? Summary for Policy Makers*. 2006, Global Network on Energy for Sustainable Development.
14. NREL, *Renewable Energy in China: Brightness Rural Electrification Program*, National Renewable Energy Laboratory, Editor. 2004, NREL.
15. Ma, S. *China Brightness and Township Electrification Programs*. in *Renewables 2004*. 2004. Bonn, Germany.
16. Gao, H., Z. Wang, and Y.Q. Zhao, *Renewable Energy Options in Improving the Life of Western Rural Poor Population in China*, in *Renewable Energy Technologies*, Global Network on Energy for Sustainable Development, Editor. 2005: Roskilde.
17. NREL, *Renewable Energy in China: Township Electrification Program*, National Renewable Energy Laboratory, US Department of Energy, Editor. 2004, NREL.
18. Ku, J., D. Lew, and S. Ma, *Sending Electricity to Townships in Renewable Energy World*. 2003. p. 56-67.
19. REDP. *China Renewable Energy Development Project*. 2007 [cited 2007 4 May]; Available from: <http://www.ndrcrdp.com/english/>.
20. NREL, *Renewable Energy in China: WB/GEF Renewable Energy Development Project*, National Renewable Energy Laboratory, Editor. 2004, NREL.
21. Ma, S., H. Yin, and D.M. Kline, *Efficient System Design and Sustainable Finance for China's Village Electrification Program*, in *Solar 2006 Conference and Exhibition*. 2006: Denver, Colorado.
22. Wallace, W.L., H. Wu, and Z.Y. Wang, *Experience for Sustainable Development of Rural Energy in China*, in *Great Wall World Renewable Energy Forum*. 2006: Beijing.