EVALUATING THE IMPACT OF WIND GENERATORS IN INNER MONGOLIA

PROJECT SUMMARY REPORT

Simon Batchelor (Gamos)
Nigel Scott (Gamos)
Liu Daoqi (IMEPC)
Bagen (IMEPC)

Department for International Development
94 Victoria Street
LONDON
SW1E 5JL

Contract No: R7106

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152 Cumberland Road
Reading
RG1 3JY
UK

phone: 44 (0)118 926 7039
fax: 44 (0)118 935 1374
email:

Gamos Ltd.

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Introduction

The scale of use of small wind generators in Northern China is unlike any other location on earth. Over 130,000 stand alone, small wind generators are being used by nomadic people. Whilst it has been assumed that the impact of such generators is beneficial, and the numbers involved would seem to indicate so, no objective study has been carried out and there is much the world could learn. There is little published information on the processes of dissemination used by the Chinese. This project attempts to assess the impact on the lives of the owners, and to record and note lessons learned which may prove useful for planning programmes in other parts of the world.

The Field Survey

The methodology of the study included the use of secondary data sources, semi structured interviews and particpatory exercises with end users. The project team included both Gamos staff and members of the Inner Mongolia Electric Power College (IMEPC), so the project also helped in capacity building for IMEPC staff. The itinerary included 2 formal meetings with experts and officials (12 in total), semi-structured interviews with groups representing 51 families, visits to a factory and several service centres, and informal meetings with field staff. Most families represented owned small wind generators, but owners of diesel generators, solar and wind/PV hybrid systems, and those without electricity were also represented (see table below, which also gives a wealth indicator). Interviews were used to gather practical information such as sales and finance mechanisms used, faults and repairs, and training received by users. Participatory exercises were used to rank reasons for preferring a wind generator (over alternatives), electrical appliances used, and a wider range of household and farm equipment; an exercise was also used to assess awareness of seasonal wind energy availability

system	***number of families***	***average flock size***
none	4	60
50 W wind generator 100 W wind generator diesel generator	1 36 1	340
diesel and wind generators	3	400
solar PV	1	40[1]
300 W wind generator	1	1,000
hybrid 300 wind / 100 W PV	4	830

[1] this was a salaried individual, so this figure does not represent his wealth.

Small Wind Generators in Inner Mongolia

The wind systems are mainly used by isolated households. These include ethnic Mongolian and Han Chinese. The main livelihood of these people is livestock - sheep and goats (cashmere). The government estimates that even by the year 2020, the number of households too remote for grid connection to be economically viable will be 350,000. Whilst the government is committed to making electricity available to these households, the change in

economic conditions within China means that mechanisms for making stand alone systems available are coming to rely more on the private sector.

Typical small wind generator

The Science & Technology Commission have learned to work with the emerging free market. In 1987 a herdsman started buying machines from the banner S&TC at 600 RMB, and selling them on at 630 RMB. An S&TC technician always went with him to install machines, and their only condition was that he did not sell outside the banner. He sold over 40 machines.

Dissemination of Small Wind Generators in Inner Mongolia

The Chinese government has adopted a similar approach to the introduction of a number of renewable energy technologies:

- setting up research and development centres, including universities
- establishing manufacturing capabilities
- pilot schemes and demonstration programmes
- dissemination programmes.

Research started in the 1970s and the first demonstration of small wind generators in Inner Mongolia was set up in 1977. After 1978 the Inner Mongolia Science and Technology Commission became involved in a second initiative which provided training and maintenance services. At this time problems with insufficient demand, quality and technical issues inhibited sales of machines. A further initiative in 1980 resulted in the setting up of a network of service centres which now covers 60% of banners (second tier of government) in the region. A wider programme was run between 1984 and 1989, during which time sales took off.

S&TC service centres are well stocked and carry out most repairs - users pay for parts only

Although the Inner Mongolia Science and Technology Commission appears to have been the driving force behind the dissemination of wind generators, there was a parallel programme run from 1984 to 1992 by a bureau of the Ministry of Agriculture, estimated to have disbursed 25% of the subsidies paid to date. A subsidy of 200 RMB was made widely available from 1986 (15% of system cost at that time). Although still in place, this has been kept at the same monetary value, making it much less significant now. The total of direct subsidies paid to date is in the order of 30 million RMB. Herdsmen have always paid for wind generators using their own money; in the 1970s they received salaries, but now they generally raise income from livestock sales.

Survey Results

Use of Systems

Systems consist of wind generator, battery, controller, inverter (on more modern systems), wiring harness and electrical appliances. Wind generators are generally erected close to the rear of dwellings so that a cable can be slung across the gap without trailing on the ground. The figure shows an especially well cared for example of batteries, controller and inverter, which are usually located indoors or in outhouses. The vast majority of machines are of 100 W rated capacity.

Wind generator located to rear of house

Inverter, controller and batteries

A typical small system (100 W wind generator) provides electricity for lighting, TV and radio (130 kWh/a.). Several people complained that their system does not provide sufficient power during the summer. Only in relatively low wind speed areas (e.g. annual mean wind speed of 4.6 m/s) would shortages of power be expected during summer months. It appears, therefore, that some families are not using systems to maximum effect. Improved training on two major issues could address this:

- unnecessary furling of wind generator (it is in high wind speeds that large amounts of energy can be stored in the batteries)
- poor battery care.

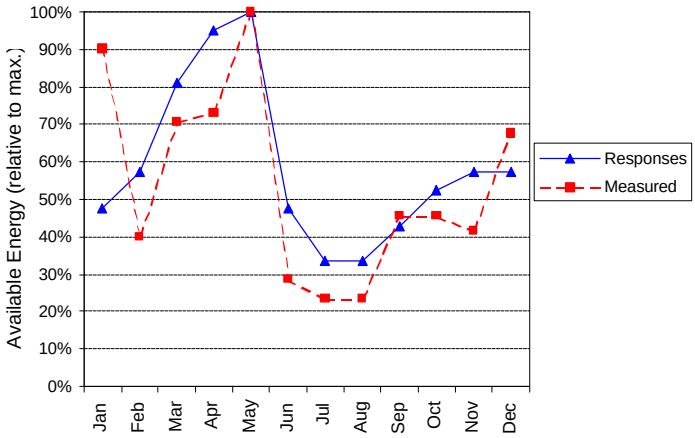
A quiet, old lady showed how after preparing each meal over a fire of dried dung, she places a large wok over the hearth to heat up water as the fire dies down. When the batteries need topping up, she uses condensation that forms on the lid of the wok.

Participatory Exercises

Reasons for preferring a wind generator, and commonly used equipment, were identified during initial interviews, and then used in participatory exercises. Results of the ranking exercises can be summarised as follows:

- reasons for preferring a wind generator – economics is not the main driving force; ease of repair and reliability are important values.
- electrical equipment - light for people and TV are most important; light for animals was also regarded as important, although only needed for a couple of months during lambing.
- general equipment - items for economic activities (e.g. fencing, transport) are more important than electrical items.
- energy availability - remarkable agreement with figures based on measured data from a wind farm site in Inner Mongolia shows that herdsmen are well aware of the performance of systems, and indicates how important they are.

Participatory exercises using matches and cards



Responses closely match energy availability calculated from measured data

A small group in a famiy home

Manufacturers

11 manufacturers in Inner Mongolia were identified, 3 of which have discontinued production. Companies range from small (16 employees) to large (1,200). The two dominant companies depend largely on sales of wind generators. Intervention of the S&TC had a major impact on sales, and local offices act as agents for the main manufacturers. Although most companies claim to advertise through TV and newspapers, the level appears low. Although most original designs were indigenous, companies are now developing products through international co-operation as they look to the future. A survey of over 80 international companies revealed only 2 who had exported small numbers of machines to China for telecommunications applications (2 – 10 kW).

"They now advertise on TV and newspapers, but maybe only once a year. In the beginning they didn't use the TV, but relied on word of mouth. In the early days there were other factories in the E. & W. of IM, so they concentrated on the local area. However, now they have increased coverage to 90% of Inner Mongolia. They have survived by achieving good quality, whilst others have had quality problems, and by product development. They make frequent use of "nadamo" - the traditional Mongolian trade fair, and trade fairs in other parts of China. A few years ago the league and banner nadamos were the main source of sales. More recently they have been instructed by their Ministry to attend, but this has been more to promote their name." - notes from interviews at Shangdu Livestock Machinery Factory.

Findings

Data from various sources confirm that large numbers of wind generators are indeed being used in Inner Mongolia. Casual observations indicate that only about 10% are out of service, having either failed or reached the end of their useful life. People quote light and TV as their motivation for getting electricity, and exercises showed light to be most significant. However, anecdotal evidence indicates that light alone is not a sufficiently strong motivator – TV is the critical factor. Although electric lighting has displaced oil and candles, it is difficult to see what quantifiable affect this has had on the lives of herdsmen - books and magazines are not common and children tend to be sent to towns and cities for schooling. Similarly with the introduction of television – families report watching several hours each night, yet none could give an example of how it had materially affected their lives.

Respondent:- "We learnt about the break up of the Soviet Union from the television".
Other group member:- "Yes, but that wasn't useful to our lives, was it!"

The table below lists 21 factors identified as significant to the success of the dissemination of wind generators. For each of these it gives a brief description of the lesson that can be applied to any similar programme addressing technology dissemination, along with an illustration drawn from this survey. Finally, the table places lessons within the context of "conventional wisdom", indicating whether findings confirm or contradict widely held opinions. Although many are well recognised and simply confirm common understanding, the following are regarded as offering something new towards understanding the process of technology transfer.

Technology and Technology Support

Perhaps the most interesting (and unexpected) of the lessons learned from the survey are those regarding cost and the motivation to buy. Results of participatory exercises clearly show that economics has not been the main driving force in the dissemination of wind generators, and this indicates that subsidies have not, therefore, played a major part in the success of the programme. Results from participatory exercises show that lighting for people is regarded as the most important use of electricity, but this was not sufficient to sell the technology. Although the S&TC also embarked on a number of influential initiatives in the early 1980s, it was the introduction of a broadcasting station in Inner Mongolia in 1980 that created a demand for TVs, and consequently a surge in demand for wind generators. This demonstrates the importance of identifying demand, and attributing a value to it.

"They first got electricity in 1988/89. Wanted for lighting & TV. Woman favoured a wind generator because of strong winds, not too expensive, and easy to repair. Bought from broadcasting centre in banner capital at a cost of 750 RMB (excluding battery) with no subsidy." - survey notes.

One of the most impressive features of the case study is the way in which the original product (allegedly of poor quality and unreliable) has successfully evolved into a product suited to the needs and capabilities of the consumers. Effective feedback loops comprised service centres to collect information, manufacturers motivated to take action and research centres to provide expertise. A total system package should also be made available to ensure that potential benefits of the technology are realised, especially at the start of the programme. In addition, the weak link in any total system should be identified and addressed.

Programme Issues

Manufacturing companies are usually selected on the basis that they can accept the risk associated with new a technology, and that they have the financial resources to withstand early losses. They tend, therefore, to be large. Successful companies in Inner Mongolia are relatively small and rely heavily on wind generator sales, so it is argued that companies should be selected on the basis of their commitment to the success of the product and their ability to respond to feedback from the market. The importance of demonstration projects should also be stressed as almost all respondents learned of the technology from friends and neighbours or the S&TC. The other aspect of a demonstration is that it highlights design faults, initiating the start of the feedback loop to manufacturers.

Another interesting feature is that no credit system was needed in Inner Mongolia. However, users have capital assets in the form of sheep and goats, which can readily be converted at the local market. Also, the authorities provided training at several levels, yet the most commonly reported source of information at the user level was written instructions. This shows how printed instructions can make up for shortcomings in training and extension services.

"They heard about wind generators through TV, radio, magazines and friends - the first man got his information from the newspapers. He likes machines and repairs cars/bikes for the others. On reading advert, he was convinced by having only a single investment - not having to pay fuel. He bought a Shangdu Livestock machine from another banner which cost 990 RMB, equivalent to approximately 12 sheep." - survey notes.

Institutional

With regard to the institutional framework within which a dissemination programme is set up, political will and stability emerge as important factors. The Inner Mongolia programme had no external support (e.g. non-governmental organisations, NGOs), but it is assumed that any programme driven by an NGO would need the support of a host government. A government needs to be prepared not only to commit resources to a programme, but also to commit itself to supporting the programme over a long period of time. For the wind generators, the lead time from first research to sustainable sales was around 20 years, which is well in excess of the planning horizon for political parties in most democracies.

Use of the Report

The purpose of the project is to disseminate the findings as widely as possible. Findings have been drawn from a case study of a successful application of renewable energy technology, so it is likely that they may be most pertinent to programmes addressing energy technologies. However, it is expected that many of the lessons drawn will be of use to those planning programmes including any element of technology transfer e.g. multilateral climate change initiatives.

This report is a summary of the full Project Technical Report which is available from the authors.

Keyword	*Generic Lesson*	*Illustration from Inner Mongolia*		*Conventional Wisdom*
Technical Issues				
Total System package	User should be offered a Total System Package to maximise immediate use.	Rather than simply introducing the new wind generator and leaving the herdsmen to work out how to apply it to their own needs, the S&TC offered a complete package including suitable appliances		Total system is important
Service Network	It is important to provide a Service Network for spares and repairs.	Whether set up by the state or encouraged from private enterprise, service centres were needed to keep the technology running and effective.		The importance of technical support is well recognised.
Restricted Choice	Promotion of a particular technology becomes relatively straight forward in situations where choice is restricted.	At the time when wind generators were introduced, there would have been no alternative sources of electricity for herdsmen other than diesel gensets.		Many situations have multiple choices. Some Govts restrict choice by a national standard.
Identify and quantify demand	Technology will only become popular if there is an identifiable benefit to the user.	The benefits of electric light were generally insufficient to justify investment in the wind generator system, but the added benefit of TV tipped the balance.		Projects often assume benefits are obvious.
Quality and feedback loops	It is important to have feedback loops, particularly in the early period, to adjust quality and performance to acceptable standards.	The effectiveness of early demonstration programmes was hampered by poor quality of wind generators and insufficient power capacity. An important feature of the Inner Mongolian infrastructure is that it included a feedback loop (through the S&TC staff) through which complaints were relayed back to the manufacturers. The fact that 15 year old machines were commonly found testifies that early problems were effectively addressed.		Although regarded as important, feedback loops often fail in practice.
Find the weak link	The system performance is subject to its weakest link.	The authorities have addressed different components of the system as problems were identified. The majority of feedback on the system now regards batteries, which fail earlier than expected. Total energy utilisation seems limited by the batteries.		Most development tends to focus on the main system component.
Programme Related Issues				
Ownership and community	Community owned projects can fail purely due to the social factors.	Their experience was that community systems suffered from neglect, whereas herdsmen looked after individually owned machines		Sense of ownership recognised as essential for success.
Economics	People do not decide solely on the economics of the case. Factors such as convenience are important.	The ranking of reasons for choosing a wind generator clearly shows convenience issues (e.g. ease of repair, reliability) are more important that cost ("cheaper than diesel generator" ranked towards the bottom), indicating that total cost was not an important factor in the promotion.		Decision making is complex.
Subsidies	Subsidies are not always required.	A number of herdsmen bought systems without the government subsidy, indicating that in this case subsidies were not an important factor in promotion. The subsidies probably were an important expression of Government endorsement.		Subsidies are often unhelpful in the long term.
Money Flow	Any system of subsidies should avoid handling a large amount of small transactions.	Initially, subsidies were paid at the point of purchase but this was changed so that subsidies were paid directly to manufacturers. It is likely that problems were encountered with passing relatively small amounts of money down through several levels of government.		Problems commonly occur when handling money.
Income and capital	Users need access to realisable capital to invest in renewable energy equipment.	Herdsmen in Inner Mongolia are different from many potential target groups in developing countries in that they generally have substantial capital assets - a flock of sheep and goats, and this is readily convertible at the local market.		Users should have access to resources to pay for technology.
Finance - credit services	A credit system is not the only and essential means of promoting a system.	It is interesting to note that although borrowing money is common practice amongst herdsmen (one group said they all had loans for fencing, and another group mentioned that it is becoming more difficult to obtain loans from the Agricultural Bank of China), no-one reported borrowing money to purchase a wind generator.		Most literature advocates a formal credit system as a prerequisite for technology dissemination

Demonstration stages	Demonstration systems are required to pilot the technology.	The wind generator demonstration programmes fulfilled two purposes: i).transfer understanding and experience of technology to target group, ii) highlight design problems.	👍	Demonstrations are important.
Manufacturing companies	Companies that can respond to feedback and depend heavily on the product are more likely to develop successful products and generate market push for the technology.	The two manufacturers that now dominate the market in Inner Mongolia rely heavily on wind generator sales for their survival.	👎	Most programmes select manufacturers with a diverse range of products.
Training and maintenance	Responsibility for various aspects of training should be clearly defined. Training should be comprehensive, covering both installation and maintenance.	Training of users and support personnel was a feature of the S&TC work. Although small wind generators now achieve high reliability with minimal maintenance requirements, some problems were identified which illustrate deficiencies in training at user level.	👍	Training is well recognised as an essential part of any programme.
Printed instructions	Good printed instructions can cover a considerable gap in training	The most commonly reported source of information on wind generator systems was written instructions.	👎	Training and extension services are often relied on for information dissemination.
Increasing aspirations	Consider how a technology may develop after being introduced in a simple configuration.	Development is evident in the growing demand for higher capacity electricity systems as herdsmen now aspire to a higher standard of living, including colour TVs, fridges etc. Two implementation policy issues: i). for how long will the promoted technology be appropriate (before increasing aspirations render it redundant)? ii). what provision should be made to meet following stages of demand as aspirations increase?	🚩	
Institutional Issues				
Long term view	A long term view is required from the implementing agent.	The Chinese authorities have approached the introduction of small scale renewable energy with a long term view. Research into small wind generators started in the 1970s, followed by demonstration programmes in the 1980s and herdsmen have been enjoying electricity into the 1990s.	👍	Programmes can often take a long time to achieve success.
Realistic assessments	Predictions of future activities should be realistic.	A realistic acknowledgement of the limited potential of grid extension meant that the government incorporated the development of the renewable energy technology into its long term policy.	👍	Realistic assessments are essential.
Political will	There needs to be a commitment from a stable government.	It was emphasised during a workshop session that the importance of political will is often overlooked in studies from outside China.	👎	Political will is rarely mentioned as a factor in the literature
General level of education	Adoption and training is easier if there is a relatively high level of general training.	When setting up the New Energy Office for promoting wind generators in West Sunid Banner, the director was able to recruit skilled people locally, and no special training was needed. Motor vehicles are common amongst herdsmen, so they are familiar with aspects of the technology such as bearings, generators and DC electricity.	🚩	

Key:

👍 - lesson confirms conventional wisdom

👎 - lesson contradicts conventional wisdom

🚩 - issue to be considered, which is beyond the control of a programme.