Ex post evaluation – People's Republic of China

Sector: 23230 Solar energy
Programme/Project: Solar energy Xinjiang (BMZ No. 200066381)*; Qinghai (200265736, CP), Yunnan (200166439)**, Gansu (200365916, CP)
Implementing agency: Xinjiang Wind Energy Co. Ltd.; Yunnan Brightness Engineering Company; Qinghai Brightness Engineering Company; Gansu Huineng New Energy Technology Development Co., Ltd.

Ex post evaluation report: 2015

		Project A (Planned)	Project A (Actual)
Investment costs (total)	EUR million	39.44	30.15
Counterpart contribution	EUR million	13.22	10.70
Funding	EUR million	26.22	18.92
of which BMZ budget funds	EUR million	26.22	18.92

*) Projects in 2015 random sample **) Projects in 2016 random sample

Summary: The solar energy programme included the construction of photovoltaic and combined photovoltaic-diesel systems to supply villages with electricity in selected remote locations of the Xinjiang, Yunnan, Qinghai and Gansu provinces.

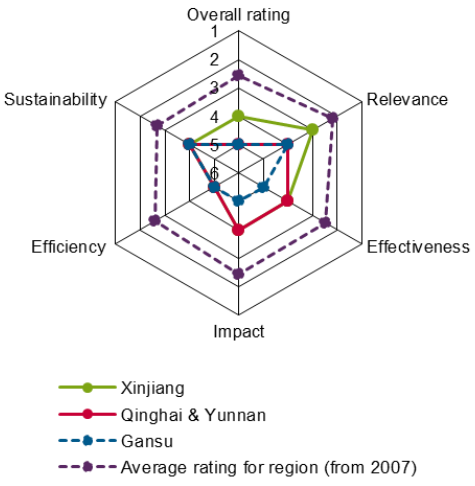
Objectives: The objective of the four projects was the sustainable and environmentally friendly supply of electricity through the provision of off-grid solar and diesel generators, as well as the development of a local low-voltage supply network. The overarching development objectives defined for the projects were to improve the living conditions for the target groups and contribute to environmental protection and resource conservation.

Target group: The target group was the resident population in the provinces of Xinjiang, Qinghai, Yunnan and Gansu, living in the villages where the measures were implemented. Measures targeted to improve socio-economic living conditions by providing and ensuring a supply of electricity in villages where it was assumed during the project appraisal in 2001-2003 that they would not be connected to the regional/local energy grid in the medium term on account of their rural position and the size of their population.

Overall rating: 4 Xinjiang, 5 Qinghai/Yunnan/Gansu

Rationale: The connection of rural regions to the national grid was underestimated. Far fewer systems were implemented than planned, at high specific costs and low degrees of utilisation. Sustainability and ownership are weak. The programme was not coordinated sufficiently enough with Chinese programmes.

Highlights: During the time between the first project appraisal in 2001 and the ex post evaluation in 2015 the solar energy industry has undergone radical change, which means from today's perspective; German tied aid seems unreasonable in light of the adequate quality of Chinese production.



Rating according to DAC criteria

Overall rating: 4 (Xinjiang), 5 (Qinghai, Yunnan, Gansu)

Although the FC solar energy programmes in Xinjiang, Qinghai, Yunnan and Gansu were consistent with German development strategies for renewable energies and Chinese development strategies for the western provinces, they were not, however, sufficiently coordinated with the programmes of the partner country. The majority of indicators defined at the programme appraisal were not met. The projects proved to be cost-intensive with very high specific investment costs and require long-term subsidisation, but this has not been secured. Tied aid related to solar installations from Germany to China seems inappropriate from today's perspective. The project scope had to be revised and reduced in all regions. As the result of progressive connections to the national grid and the failure to complete maintenance and renewal measures, the majority of the systems are now no longer in operation. It should have been evident while the programme was being implemented that the intended impacts could not be achieved. The approach, which was essentially reasonable, was therefore assessed as unsatisfactory in relation to the first phase, while the other phases were assessed as clearly insufficient.

Breakdown of total costs

		Xinjiang (Actual)	Xinjiang (Planned)	Qinghai II (Actual)	Qinghai II (Planned)
Investment costs (total)	EUR million	7.91	8.31	11.57*	11.38**
Counterpart contribution	EUR million	2.80	3.20	3.63**	3.33
Financing (BMZ funds)	EUR million	5.11	5.11	7.94	8.05

* Incl. TC co-financing of EUR 0.05 million

** Depending on source, figure fluctuates between EUR 3.63 million and EUR 3.42 million.

		Yunnan (Actual)	Yunnan (Planned)	Gansu (Actual)	Gansu (Planned)	Total (Actual)
Investment costs (total)	in EUR million	7.87*	8.35*	2.80	11.50	30.15
Counterpart contribution	in EUR million	3.17	3.19	1.10	3.50	10.70
Financing (BMZ funds)	in EUR million	4.70	5.16	1.70	8.00	19.45

* Incl. TC co-financing of EUR 0.05 million

Relevance

The approach of ensuring a minimum supply of electrical energy for off-grid villages and therefore eliminating a barrier to development is essentially of relevance to development policy. Most of China's landmass, including the project provinces of Xinjiang, Qinghai, Yunnan and Gansu, enjoys a high number of sunshine hours and high radiation intensity. The environmentally and climate-friendly use of solar energy is therefore a suitable option in the country in principle. In remote, off-grid regions it seems reasonable to consider decentralised solutions.

In a decentralised context, hybrid energy systems (photovoltaic-diesel) present a good technical solution to absorb peak loads with the additional diesel system and extend the supply of electricity. To allow hybrid systems to use their full potential, however, the transport of diesel and related costs as well as the maintenance of the systems must be taken into consideration.

Since 1996, the Chinese government has targeted to electrify rural areas using renewable energies and grid connections as part of the Brightness Programme. In the context of the project appraisals from 2001 onwards it was assumed that the Chinese government did not plan to ensure a minimum supply of electricity for off-grid villages in the provinces of Xinjiang, Qinghai, Yunnan and Gansu. It was also believed at that time that there would be no connections to the regional power grid in the medium term due to the unfavourable topographical situation. This assessment proved to be wrong. The speed of expansion of the Chinese network was underestimated.

Although the FC projects were generally in line with the Chinese development strategies and priorities in relation to rural electrification through renewable energies, there was no concrete coordination with Chinese programmes aimed at the development of rural regions. Complementarity and consistency with national strategies were not ensured; instead, the projects were implemented parallel to Chinese national programmes. Especially in a country like China, which has developed very quickly and dynamically, the speed of implementation of national development strategies was underestimated. Ownership of the projects on the Chinese side thus remains questionable.

The selection of the target regions Xinjiang, Qinghai, Yunnan and Gansu seemed appropriate at the time. However, it quickly became evident during the implementation in Xinjiang – the first project region – that the expansion of the power grid into rural and remote areas by the Chinese government was proceeding much faster than anticipated. Due to Chinese support programmes, the connection to the national distribution network and the migration of the population from rural to urban areas, the relevance of the projects from today's perspective must be considered substantially lower than at the project appraisal.

Given the lack of knowledge and experience, the relevance of the first project to be implemented, in Xinjiang, was rated better than that of the subsequent projects in Qinghai, Yunnan and Gansu. As a result of knowledge of the challenges and the experience gained from the Xinjiang project, a modified and adapted design, or even an earlier termination of the programme, might have been expected rather than waiting until implementation of the fourth project, when the programme was eventually terminated.

Relevance rating: For Xinjiang: 3; for Qinghai, Yunnan and Gansu: 4

Effectiveness

The objective of the four projects was the sustainable and environmentally friendly supply of electricity through the provision of off-grid solar and diesel generators, as well as the development of a low-voltage supply network.

Within the context of project implementation there were significant discrepancies in key planning criteria such as timeline, site selection, system dimensioning and operational management. The intended locations for the photovoltaic diesel hybrid systems had to be moved several times in the course of the FC programmes due to the rapidly progressing connection of villages to the Chinese network. This resulted in significant delays to the planning and implementation of services, which were accompanied by significant cost increases. Accordingly, the originally envisaged services involving the construction of a total of up to 375 solar PV diesel hybrid systems with a maximum output of up to 960 kilowatts peak (kWp) had to be reduced to 167 solar PV diesel hybrid systems with a maximum output of 498 kWp. In addition, some of the systems are no longer in operation due to outdated batteries. The intended impact of the projects is therefore achieved only to a very limited extent by those facilities that are still in operation.

Province	Planning - number of systems	Realisation: number of systems - of which in use
Xinjiang	70	34 -12 (as of 2015)
Qinghai	80	56 - according to reports, 52 systems in use.
Yunnan	100	52 - 33 (status as of 2012, 19 villages were later connected to the electricity grid).
Gansu	125	25 - 3 (as of 2015) The number was revised at the start of the implementation process and reduced in the ratio 1:4. The actual implementation was still below this reduced value, however.

The indicators formulated at the project appraisal for determining the achievement of the project objectives were the same for all four projects and used the same target values.

Indicator	Status PA	Ex post evaluation
(1) The proportion of the target households supplied with electricity is 5,000 households or 25,000 people per province.	Xinjiang, Qinghai, Yunnan, Gansu: 80% of target households were reached. Adjustment for Gansu: reduction to 820 households.	Not achieved. Xinjiang: 38%. Qinghai: 71%. Yunnan: 32%. Gansu: around 5% of the adjusted target value.
(2) The electricity demand that can be served (from the third year of operation) amounts to 400-550 MWh/year for each province.	Xinjiang: 400-500 MWh/year Qinghai: 550 MWh/year Yunnan: 400-500 MWh/year Gansu: 430 MWh/year; subsequent adjustment to 112.5 MWh/year	Not achieved. Xinjiang: 138 MWh/year Qinghai: 131 MWh/year Yunnan: 118 MWh/year Gansu: 17.6 MWh/year
(3) The percentage of users who pay electricity bills regularly is 90%.	Xinjiang, Qinghai, Yunnan, Gansu: 90% of all users pay their electricity bills regularly. Adjustment for Gansu in absolute figures (percentage of users) due to the reduction in households.	Not achieved. Xinjiang: 0%. Qinghai: 0%. Yunnan: 2012: more than 90%. Today: unclear. Gansu: 0%.

As part of the FC project, training activities were offered in Qinghai, Yunnan and Gansu, conducted by GIZ as part of the TC project “Rural development through renewable energy sources”. Training was also provided for the operating organisations and the local operating staff with regard to the functioning, operation, maintenance and repair of equipment. To systematically cover future training requirements, a train-the-trainer concept was applied and a training manual which includes all essential operating and maintenance instructions was developed for the Gansu project. A refresher training course was also organised in 2008. The measures were implemented as planned and evaluated positively by the project-executing agency. The measures have had no lasting impact, however, as the majority of systems are out of service and it is unclear whether the knowledge gained can be applied elsewhere.

In 2006, a 12-day training trip to Germany for three employees of the project-executing agency was funded as a basic and advanced training measure as part of the Xinjiang project. Once there, the employees visited German solar energy sites and companies. The participants reported the trip in a positive light. To what extent knowledge could be transferred in a sustainable way with just three participants, however, remains unclear and rather dubious.

To date, only a very limited number of systems lying dormant have been assigned an alternative use (dismantling of the system and rebuilding in another location) or a new function (e.g. connecting the systems to the grid or using the plants as back-ups for emergency power). A lasting impact for the target groups was achieved only partly and on a small scale.

Effectiveness rating: Xinjiang, Yunnan, Qinghai: 4 / Gansu: 5

Efficiency

The supply of the solar power systems was carried out by means of a public tender limited to Germany. To what extent this negatively influenced the costs and the efficiency cannot be determined in retrospect. A few years after the FC-funded deliveries, Chinese industry was already in a position to build high-quality solar power systems. Deliveries became more expensive due to project-specific delays, contrary to the

long-term trend of the falling prices of photovoltaic systems, because the deliveries took place in a time of high global demand and higher raw material prices (raw silicon, steel, aluminium).

The utilisation degree of the systems was much lower than anticipated, resulting in higher specific power generation costs. The actual cost per installed kW of peak performance in the photovoltaic modules was EUR 22,000 on average, and thus almost 30% higher than the estimated amount. In addition, costs for diesel generators, batteries and fuel transport were not taken into consideration in the original calculation.

The average take-up efficiency (energy consumed versus energy produced by the installed systems) fell far short of the targets. As a result, the average take-up efficiency during the year in which all the systems were in operation was 60% for Gansu and 38% for Qinghai, for example.

The dimensions of the systems were largely inappropriate as the system designs were too large (in the sense of maximum output). On the one hand the consumption of each individual household was set too high, while on the other hand, the total number of households decreased.

The operational management of the systems does not correspond to the original planning to a large extent, as the diesel generators are not used or are used only in exceptional cases for reasons of cost. The diesel generators are not operated as the costs of purchasing and transporting the fuel are too high. It was not possible to ensure the sustainable operation of the systems (maintenance, repair, replacement investments).

As part of the projects, a consumption-dependent and accepted, socially compatible tariff system was introduced. To ensure the financially sustainable operation of the systems, an end user tariff of around RMB 2 per kWh (EUR 0.26 per kWh, initial investment fully subsidised) was calculated at the PA to cover operating costs. This end user tariff was calculated working on the assumption that it would correspond to the target group's ability to pay. At the time, a tariff which covered the full costs would have been around RMB 13 per kWh (EUR 1.72 per kWh). It became evident in the course of the project, however, that the target group was not able to pay even the subsidised rates, and as a result the tariff was further reduced to RMB 0.6 per kWh (EUR 0.08 per kWh), similar to the average electricity tariff in China. Yet these rates are not sufficient to cover the necessary replacement investments. Today, tariffs are reportedly no longer paid in Xinjiang, Qinghai and Gansu.

While the projects are not profitable from a business perspective, the environmental and climate impacts should be considered in order to ensure a comprehensive economic analysis. As a result of the small-scale measures, this analysis has not been quantified. Given the coal-dominated power generation in China, solar-based systems are fundamentally beneficial from an environmental and climate protection perspective, provided they are in operation for a sufficient time.

Despite this, the allocation efficiency is assessed as negative as any positive impact achieved was limited and associated with very high costs.

Despite the overall economic benefit of solar power systems through the avoidance of environmental costs, the efficiency of the projects must therefore be rated as clearly inadequate.

Efficiency rating: 5 (all projects)

Impact

The overarching development objectives defined for the projects were to improve the living conditions for the target groups and contribute to environmental protection and resource conservation. The supply of electricity through photovoltaic-diesel hybrid systems was intended to contribute to this goal.

From today's perspective hardly any developmental impact can be attributed to the projects, as on the one hand they were overtaken by the Chinese development programmes, and on the other they were implemented only with a reduced scope (see Effectiveness).

The following indicators were defined for all projects, in order to approximate the overarching developmental impact:

Indicator	Status PA	Ex post evaluation
(1) Target households in the programme areas supplied by the installed systems are equipped with electric lighting after the third year of operation.	At least 80%.	Partially achieved. At the time of the project completion reports, the households connected as part of the project generally had electric lighting. More detailed data is not available. As a result of the significantly reduced scope of the overall project, the impact is far less extensive than intended.
(2) Target households have direct access to information (via power-operated television and radio equipment) in the third year of operation.	30% of target households.	Partially achieved. At the time of the project completion reports, the households connected as part of the project had power-operated devices which allowed them access to information often (Yunnan), in 50% of cases (Qunghai) and in 23% of cases (Gansu). No data is available for Xinjiang. As a result of the significantly reduced scope of the overall project, the impact is far less extensive than intended.

The expansion of the network also enabled households in the target villages of the FC projects to be supplied with electricity. The people living there were able in principle to use the existing power supply for lighting, access to information and other electrical functions. Any changes which took place were not attributable to the FC project, however, and therefore were not included in the achievement of the indicators.

Furthermore, access to information through radio, television and possibly also the Internet does not give much insight into developmental impact. An indication of plausible impacts was given by a quasi-experimental impact assessment published on rural electrification in China, which included villages in Gansu province and thus had a similar context to the FC projects. This study identified positive impacts on per capita income. A 2007 study conducted by GIZ into the impacts of the DC programme, including the FC measures, in Gansu, Yunnan and Qinghai, reported the target group's perception to be positive, indicating improved domestic learning and working conditions. The study also assumes a positive impact on health as the result of lighting provided by electric lights instead of candles.

CO2 emissions can be reduced through the use of solar (hybrid) power systems, thereby contributing to environmental protection and resource conservation. Because the benefits of the projects were reduced as a whole, these impacts were much lower than envisaged. The reduction in CO2 emissions was not quantified due to the small-scale measures.

The FC projects did not achieve a broad impact and were not replicated. They were not connected with the further expansion of the electricity grid and the promotion of renewable energies in China. Due to the low detectable impacts which, although positive, were far below the scale expected, the overarching impact is assessed as unsatisfactory for the first three projects. In the case of Gansu, the impact is assessed as clearly inadequate since, as a result of project termination, measures were implemented on a very small scale only.

Impact rating: 4 (Yunnan, Xinjiang und Qinghai), sub-rating 5 (Gansu)

Sustainability

There is a high likelihood that the weak developmental impact (see overarching developmental impact) will not improve, but will instead worsen. The premature termination of the last project (Gansu) is symptomatic of all projects that were overtaken by Chinese development programmes. The majority of the systems are now no longer in operation and will only be used for emergency power supply.

With regard to the utilisation of the systems, it is expected from experience of recent years that further villages will be connected to the grid and therefore that more solar power systems will be decommissioned. The upgrading of the systems so that they can feed into the grid seems unlikely given previous experience.

The risks that the operation of the photovoltaic-diesel hybrid systems will not be sustained can be considered very high. Additional funding for operation and maintenance has not been comprehensively clarified or secured (see Efficiency). The adjusted tariff at low levels of consumption is able to cover neither the operating costs of the systems nor subsequent replacement investments.

The funding gap can only be closed by direct government subsidies. However, it was not possible to ensure the economic sustainability of the investments in this way because, amongst other things, there is a lack of legal agreements between the operators and the state.

Sustainability rating: 4 (all projects)

Notes on the methods used to evaluate project success (project rating)

Projects (and programmes) are evaluated on a six-point scale, the criteria being **relevance, effectiveness, efficiency** and **overarching developmental impact**. The ratings are also used to arrive at a **final assessment** of a project's overall developmental efficacy. The scale is as follows:

Level 1	Very good result that clearly exceeds expectations
Level 2	Good result, fully in line with expectations and without any significant shortcomings
Level 3	Satisfactory result – project falls short of expectations but the positive results dominate
Level 4	Unsatisfactory result – significantly below expectations, with negative results dominating despite discernible positive results
Level 5	Clearly inadequate result – despite some positive partial results, the negative results clearly dominate
Level 6	The project has no impact or the situation has actually deteriorated

Rating levels 1-3 denote a positive assessment or successful project while rating levels 4-6 denote a negative assessment.

Sustainability is evaluated according to the following four-point scale:

Sustainability level 1 (very good sustainability): The developmental efficacy of the project (positive to date) is very likely to continue undiminished or even increase.

Sustainability level 2 (good sustainability): The developmental efficacy of the project (positive to date) is very likely to decline only minimally but remain positive overall. (This is what can normally be expected).

Sustainability level 3 (satisfactory sustainability): The developmental efficacy of the project (positive to date) is very likely to decline significantly but remain positive overall. This rating is also assigned if the sustainability of a project is considered inadequate up to the time of the ex post evaluation but is very likely to evolve positively so that the project will ultimately achieve positive developmental efficacy.

Sustainability level 4 (inadequate sustainability): The developmental efficacy of the project is inadequate up to the time of the ex post evaluation and is very unlikely to improve. This rating is also assigned if the sustainability that has been positively evaluated to date is very likely to deteriorate severely and no longer meet the level 3 criteria.

The **overall rating** on the six-point scale is compiled from a weighting of all five individual criteria as appropriate to the project in question. Rating levels 1-3 of the overall rating denote a "successful" project while rating levels 4-6 denote an "unsuccessful" project. It should be noted that a project can generally be considered developmentally "successful" only if the achievement of the project objective ("effectiveness"), the impact on the overall objective ("overarching developmental impact") and the sustainability are rated at least "satisfactory" (level 3).