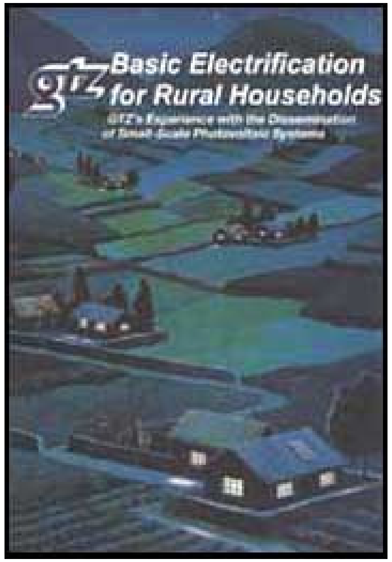

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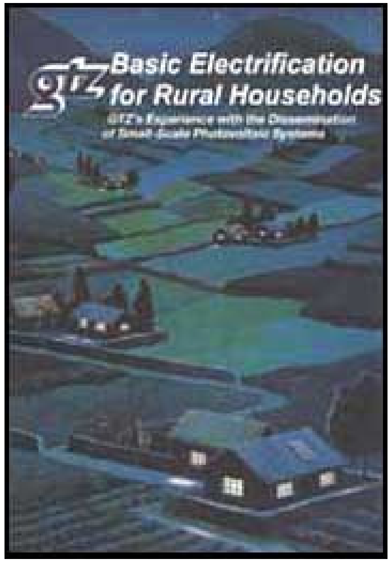

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GTZ's Experience with the Dissemination of Small-Scale Photovoltaic Systems

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A working paper of division 415
- Energy conservation of resources and the environment -

Editors:
Eberhard Biermann
Friedemann Corvinus
Tilman C, Herberg
Horst Hfling

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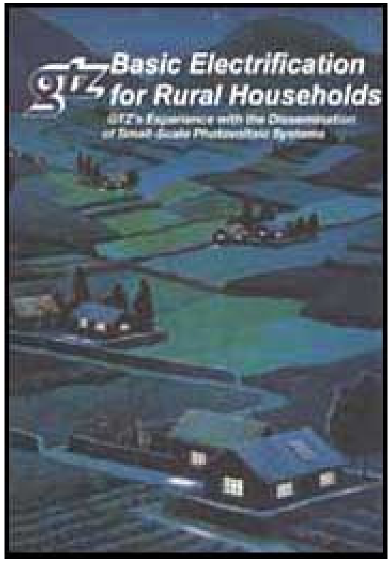

Foreword

In recent years, the use of the photovoltaic technology to provide a minimum basic electricity supply to rural households in sparsely populated areas of Third World countries has increasingly emerged as a genuine alternative to conventional grid-based electrification. In order to succeed, measures aimed at introducing this technology must be geared to disseminating PV systems on a large scale and in turn creating marketing and distribution mechanisms which are capable of meeting the demand on a long-term, sustainable basis without any external assistance. Obviously, the first step in such an undertaking is to define as precisely as possible the goals that are to be achieved, covering the product which is to be promoted and the target group as well as the structures that will be required to carry out the proposed implementation process.

For some ten years now, GTZ has been involved in the dissemination of photovoltaic systems for rural households in developing countries, and we have carried out a broad range of projects in this field. The results of this work have now been systematically compiled and analysed, and we feel that an evaluation of GTZ's experience can provide a basis for the design of generally valid approaches, i. e. strategies which can be applied in most if not all rural regions in the

developing world.

This publication documents in condensed form the principal technical and economic findings of a comparative assessment of these projects and summarizes field experience that is relevant for the design of pilot and full-scale dissemination measures.

Initially, the discussion focuses on the various ways in which the dissemination of PV systems can be integrated into the overall energy supply planning process and on the general conditions that must be met in order for this linking of technology diffusion and supply planning to be successful in practice. Next we endeavour to specify and precisely define the roles of the various actors in the dissemination process.

After this groundwork has been laid, we describe what an organization like GTZ must do in order to ensure that PV systems can be disseminated on a large scale and on a self-sustaining basis.

Thus, the aim of this working paper is to review the various options that are available and the conditions that must be met in order for each to be successfully implemented, and then, based on the results of this review, to outline the essential elements of a realistic dissemination strategy.

In preparing this working paper, we received invaluable technical support from other members of the GTZ headquarters staff and from our project personnel in the field. We are especially grateful to our colleagues in Senegal, Tunisia, Morocco, Colombia, Peru, Rwanda and the Philippines. In numerous areas we were also able

to draw upon an evaluation which had been prepared for the Division by IPC GmbH, a Frankfurt-based consulting firm.

G. Oelert
(Head of Energy Division 415 - Conservation of Resources and Environment)

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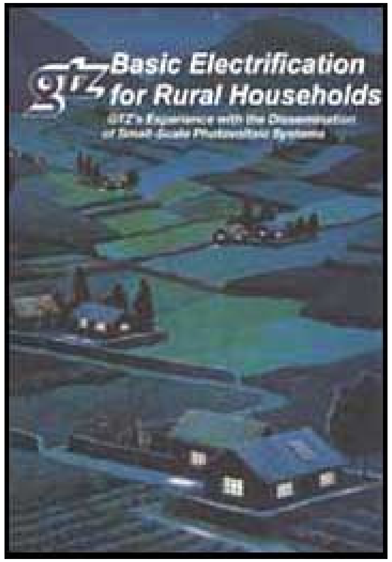

7. References

1. Background information and recommendations

Photovoltaics is already considered to be a viable option for supplying electric power to consumers in remote rural areas and on islands that are far removed from national power grids - especially private households.

However, the dissemination of photovoltaic systems via market mechanisms has proved to be a very complex undertaking. In order for it to work, a wide variety of individual actors at a great many decision-making levels must interact in just the right way. The roles of the individual actors are described in this paper.

In addition to this aspect, which has to do primarily with the design and implementation of energy policy, certain basic prerequisites must be met by the technology itself. In order to tailor the systems to local needs and conditions, an intensive dialogue with the target groups is required. Quality control - including the inspection and certification of locally manufactured components - is also a must. The inhabitants of remote areas will see the purchase of the systems as a way of raising their standard of living and gaining access to modern technology. It is imperative to ensure that they are not used as "Guinea pigs" to test technologies which are not yet technically and economically viable merely because of their low purchasing power.

Finally, it is essential to bear in mind that market-oriented dissemination of photovoltaic systems in rural areas also calls for a rethinking of the financing strategies for such projects. Conventional financing methods involving the provision of bank loans to a small target group that is relatively affluent and thus

credit-worthy in the eyes of formal-sector financial institutions are increasingly being supplanted by new approaches which are tailored to the needs of lower-income segments of the population which have so far had few if any dealings with banks.

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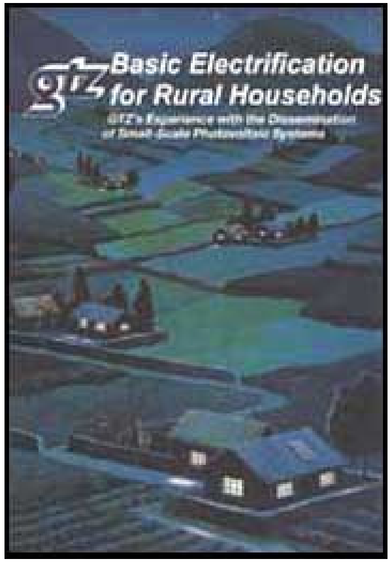

Basic Electrification for Rural Households - GTZ's Experience with the Dissemination of Small-Scale Photovoltaic Systems (GTZ, 1992, 28 p.)

2. Photovoltaics as an energy option for rural areas: benefits and over all social and economic context

GTZ is currently implementing more than 20 projects In the Third World in which photovoltaics plays an important role. As of 1991, PV systems of various types with a total output of about 400 kWp had been installed in GTZ projects, and current plans call for this figure to be doubled to around 800 kWp by the year 1993.

Components of a photovoltaic system

The illustration on the left shows the structure of a simple photovoltaic system. In most instances, solar generators must be supplemented by storage batteries and electronic charging/regulating devices.

Graphic: Siemens

However, photovoltaics as an energy source for rural areas must be seen within the following overall context:

> **- Over 90 % of the energy consumed by rural households is used for cooking. Photovoltaic systems are not suitable for meeting these needs.**
>
> **- Nonetheless, the way in which these households obtain the remaining 10 % of their energy requirements has a major impact on the quality of life in rural areas. For example, the inhabitants of such areas attach great importance to having modem lighting in their dwellings and having access to modem communications media such as radio and television, and the**

requisite electric power can be supplied by the environmentally friendly photovoltaic technology.

- Although the target group of dissemination measures includes the poorest of the poor in developing countries, investments in this superior technological option are still worthwhile because this target group presently spends a large part of its scarce monetary resources on traditional energy sources. Over time, photovoltaic systems will cost the same as the traditional options they are now using, but the PV technology supplies a form of energy that is not only of much higher quality; It is also more reliable than the conventional alternatives and exposes the users to far fewer health risks than those alternatives.

The amounts which households now spend on kerosene and dry-cell batteries are roughly equivalent to what they would have to pay in order to finance a photovoltaic system under annuity conditions (see Table 1). From the point of view of household energy consumers, however, there is an important difference between the two options: With the one they are burdened with a long-term financial obligation involving the repayment of a sizeable debt, while with the other they are free to purchase conventional energy sources on an ad hoc basis in accordance with their needs and financial resources. Thus, the question of financing is of crucial importance for the success of dissemination measures for PV systems which are aimed at low-income segments of the population.

Smaller photovoltaic systems in particular - which are generally referred to as solar home systems (SHS) - have a number of secondary benefits that are important in terms of both raising the individual users' living standards and

helping to narrow the existing gap between urban and rural areas in terms of their level of infrastructural development. Although their direct impact on national energy balances will be small for a long time to come, the use of SHS can conserve conventional energy resources and at the same time yield indirect energy savings, e. 9. by eliminating the necessity of transporting batteries. They can also be expected to produce tangible environmental benefits.

The introduction of SHS leads to a noticeable improvement in the users' standard of living, above all through positive impacts that cannot easily be measured in monetary terms:

- Significantly better light is available, with benefits such as reduced eye strain.

- The smoke and fire hazards in the home that are associated with traditional indoor light sources (e. 9. candles, oil lamps) are eliminated.

- There is no danger of children burning themselves if they come in contact with the light source.

- A constant, reliable supply of energy is ensured.

- The improved light makes it possible for the members of the household to engage in productive activities during the evening hours.

- SHS are a much more environmentally friendly source of electricity than dry-cell batteries, which contain highly toxic substances and often end up as "toys" in the hands of children or are disposed of in such a way that

they pollute sources of drinking water or the soil in livestock grazing areas.

- The utilization of SHS also gives users the feeling that they are participating in, and benefiting from, technical progress.

- Although automobile batteries are already being used for lighting and to power devices such as television sets, their service life is greatly prolonged when they are utilized as part of an SHS: When they are recharged with standard battery chargers like those found in car repair shops, they are often charged too rapidly, and in many cases the users wait too long to have their batteries recharged, thus allowing them to deep discharge to a dangerously low level. Moreover, with SHS the heavy, cumbersome batteries do not need to be regularly disconnected and transported to a charging facility, a time-consuming and sometimes difficult task.

The fact that small photovoltaic systems are available on a large scale and are an affordable option for a significant percentage of the rural population means that measures that will significantly enhance the quality of people's life can now also be carried out in the countryside. Indeed, with photovoltaics the energy supply situation in remote rural areas can be improved to the point that the gap between rural and urban dwellers in terms of the basic material comforts and overall "lifestyle" which they enjoy is visibly narrowed. Moreover, when SHS are utilized, individualized systems can often be supplied which meet the needs of specific consumers and can also be largely financed by the users, resulting in savings for the government (cheaper than state-subsidized grid-based electrification programs). This is an especially attractive option for rural areas that are not likely to be connected to the national or regional power grid in the foreseeable future (i.

e. the promotion of individual household electrification using SHS is a viable rural energy policy).

There are still only a very small number of photovoltaic systems In operation in developing countries, and they have only a negligible impact on national energy consumption. But photovoltaic systems can help to reduce the adverse effects of conventional energy consumption on the climate and the environment if they are mass-produced and employed on a large scale not only in the countryside but also in urban areas. For instance, they can greatly reduce the pollution caused by the improper disposal of dry- cell batteries, millions of which are currently decaying and releasing their toxic contents (heavy metals) into the soil and the groundwater in developing countries. This type of environmental degradation can be avoided by using SHS, although it is usually first necessary to establish a recycling system for the storage batteries that are used in the systems.

Thus, the decision for or against the utilization of decentralized photovoltaic systems will be based on an assessment of factors that operate at three different levels:

- **Micro-economic feasibility, i. e. for individual households.**

- **Economic benefits accruing to user households, taking into account the positive impacts on individual consumers' overall standard of living, including those which are usually unquantifiable, i. e. difficult or impossible to express in monetary terms.**

- **Macro-economic cost-benefit considerations.**

When contemplating the initiation of a broad-based dissemination campaign, energy planners must take all three of these levels into account if they are to arrive at an accurate assessment of both the campaign's prospects for success (-acceptance by users) and the desirability of large-scale dissemination from the stand-point of the economy as a whole. Certain parameters are difficult to quantify but they nevertheless have a major influence on the target group's attitude toward the technology; these factors include subjective judgements as to whether or not it is advantageous to own photovoltaic systems, and here criteria such as "modern" (= taking part in technical progress) and "prestigious" will play an important role in the thinking of members of rural middle and upper classes. In the eyes of these target groups, the fact that the SHS technology is a "time saver" and is "more convenient" than the conventional energy technologies which it substitutes can also be an important selling point.

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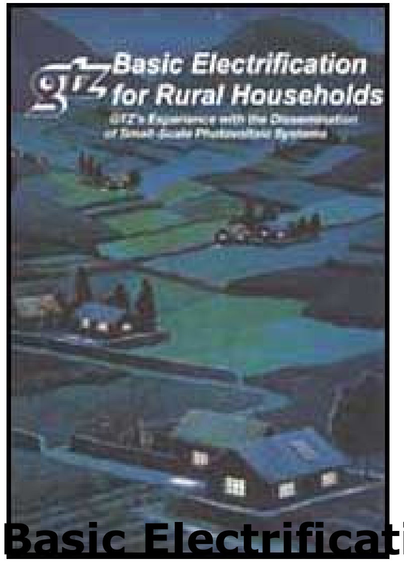


3.2 Solar Home Systems (SHS)

Basic Electrification for Rural Households - GTZ's Experience with the Dissemination of Small-Scale Photovoltaic Systems (GTZ, 1992, 28 p.)

3. PV systems for supplying electric power to rural households

GTZ has acquired most of its practical experience with three PV technology options for rural electricity supply:

- **Central-station village power-supply systems**
- **Battery-charging stations**
- **Solar home systems (SHS).**

Of the three, the central-station approach is most similar to the conventional option of seeing up isolated grids fed by diesel-powered generators to serve large villages. Thus, it also competes economically with diesel-based systems.

Battery-charging stations, by contrast, are decentralized facilities, many of whose customers must haul their automotive batteries considerable distances to be

recharged. Transporting the batteries is inconvenient, time-consuming and expensive, and each time they are recharged they provide only a limited amount of electric power for lighting and to run home entertainment equipment.

The advantage that solar-powered battery-charging stations have over grid-fed or diesel-based facilities Is that they can be installed closer to users. In many cases, the batteries need only be transported a few hundred yards. Moreover, with battery-charging stations the users do not have to buy an expensive solar panel, as they do with SHS. Indeed, the only investment that is required is the outlay to purchase a 12-volt battery, which even the poorest rural dwellers can nearly always afford.

The most decentralized approach is that involving solar home systems. SHS provide only a basic electricity supply for lighting and the operation of cassette players, etc. Thus, the small PV systems hardly ever provide all of the services supplied by a conventional power supply system. Accordingly, they do not compete economically with the classic electrification options, but rather with lighting oil, kerosene, candles, dry-cell batteries and car batteries used in non-automotive applications.

In its projects, GTZ has acquired experience with all three of the options discussed above, and we are therefore in a position to assess their relative advantages and drawbacks.

3.1 Central-Station Village, Power-Supply Systems and PV Battery-Charging Stations

The technical feasibility of central-station village power-supply systems has been clearly demonstrated. Three systems of this type have been installed in GTZ projects in Senegal and the Philippines, and for some time now they have been providing continuous, trouble-free service to the users. But their economic feasibility is doubtful. Central-station village systems do not today constitute a viable alternative to diesel-based isolated grids, and not even a dramatic decline in the price of solar cells would alter this.

It will not be economically feasible to utilize photovoltaic technology and storage bakeries to provide an uninterrupted supply of electric power over a 220-volt alternating current network unless there is a relatively large, continuous demand for that power. And if most of the demand occurs during certain peak periods when lamps and home entertainment equipment such as radios or cassette tape players are operated, this criterion will not be met. If electric power is needed primarily at night, when the output of a PV generator falls to zero, the system will have to include expensive electricity storage facilities (batteries), and in such cases it will usually be cheaper to obtain electricity from diesel generators.

However, if the cost of the panels comes down substantially, solar power stations whose output is fed directly and without intermediate storage into the networks of large demand centres to save fuel and stabilize voltages (in branch networks) could be an attractive option for developing countries at some point in the future.

PV battery-charging stations are small "photovoltaic filling stations" that operate independently of power grids and are designed to serve persons who use 12-volt DC equipment. The users take their own bakeries to the station, and they usually pay around 1.50 US$ per charge.

Diesel generators should only be used as a power source for battery-charging stations if the capacity of the generator will be utilized to a high degree, so as to maximize the efficiency and the service life of the unit. It is common for the diesel generators that are used in battery- charging stations to be used in other applications as well (e. 9. to operate the equipment in a workshop or supply the power to run a boat), and, as a result, they are only available part of the time for charging batteries. In sparsely populated areas the minimum prerequisites for economically feasible operation of a diesel-powered charging station are rarely met, since in such cases systems are needed for small output ranges (below 1 kW). However, diesel generator outputs usually start at around 2 kW. Moreover, diesel-powered units are frequently unsuitable for use at very remote sites because it is difficult to purchase even the small quantities of diesel fuel that are required for their operation on a regular basis and thus to provide a reliable, continuous charging service.

It Is in such cases that the advantages of photovoltaic charging stations quickly become apparent: With just a small number of panels, a technically optimal supply of electric power is ensured even if demand levels are low. If demand increases, the capacity of the station can be expanded very easily by simply adding more panels. The system can also be installed in the immediate vicinity of the users, thus reducing their transport costs.

The target group for battery-charging stations is that part of the population which cannot afford to make major investments to obtain a supply of electricity and also has absolutely no access to credit. The purchase of an SHS is a virtual impossibility for this segment of the rural population, but the livelihood of their being able to buy a suitable battery is high.

It is best for PV charging stations to be operated by utility companies or electricity cooperatives. The reasons for this are as follows:

- The ownership situation is clearly defined (the PV generator and the regulator belong to the financially responsible institution, while the users own the battery and the load equipment).

- Trained personnel will be available to ensure that necessary repair and maintenance work (charging station and batteries) are performed.

- The running costs incurred by the target group are very low.

- Because of the modular nature of the system, its capacity can easily be expanded or reduced in response to changing demand levels.

And if such installations are run by cooperatives and they succeed in keeping the administrative costs down by having their own members carry out all operational and management tasks, then a system of this type is an extremely attractive option for supplying the poorest segments of the population with electricity.

3.2 Solar Home Systems (SHS)

The time has now come to formulate a coherent policy for the dissemination of solar home systems. GTZ has gained extensive experience with various approaches to the diffusion of this technology, ranging from distribution by private enterprises to government-run promotion programs.

Before proceeding, however, let us first take closer look at the technical

components of an SHS. Since certain of the system components have not yet been perfected, it is essential to establish quality standards and require that all future projects adhere to these norms. Minimum technical standards have already been introduced for the charge regulator and the ballast. It should also be determined whether the inability of past programs to set in motion large-scale, self-sustaining dissemination processes has been due to technical problems; this is a distinct possibility.

SHS are small-scale photovoltaic systems that are designed primarily for use in private households. They produce 12-volt direct current, and given their modest output (20 to 100 Wp) they are mainly used to operate transistorized lamps (=fluorescent lamps equipped with electronic ballasts) and home entertainment equipment such as radios and television sets. The basic system components are a PV panel, a charge regulator, a battery and one or more lamps. *)

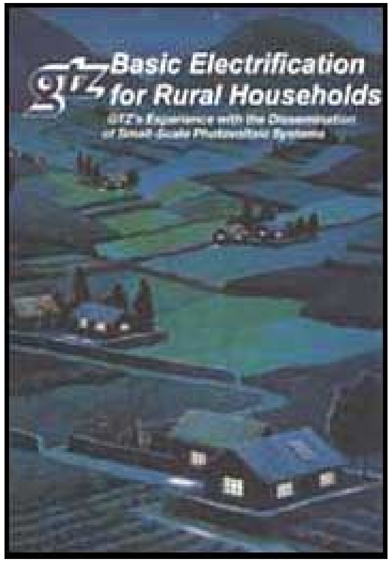
Especially when selecting electronic ballasts and charge regulators, it is essential to choose robust, long-lasting devices that have been specifically designed for SHS applications. In other words, "improvised" or "home-made" equipment should not be used under any circumstances. The utilization of a good charge regulator can prolong the life of the battery considerably, and this in turn has an enormous impact on the economic viability of an SHS.

In the meantime, minimum standards have been established for the charge regulator and the electronic ballast on the basis of data generated by GTZ's field projects. Among other things, they are intended to help eliminate the technical problems that are still being encountered with these components. (For example, operating problems are still being reported due to difficulties with the load

disconnecting relay in the charge regulators, and these problems must be solved.) Moreover, local manufacturers must be held to the same technical standards as equipment suppliers in industrial countries: When it comes to selecting charge regulators for use in SHS, quality must not be sacrificed for the sake of "local content".

Certain components are still not suitable for local production. Thus, for example, it would not be advisable at present for developing countries to set up their own production facilities for solar cells and panels since the equipment that is used in the requisite manufacturing processes is very expensive and the processes themselves are still changing quite rapidly. The electronic devices (regulators and ballasts), on the other hand, are suitable for local production. Here the principal aim must be to significantly improve the quality of locally manufactured products, which so far has fallen considerably short of what is needed. It must be made easier for the relevant firms in developing countries to purchase electronic components; their production facilities must be upgraded through the acquisition of new machines and tools; and the qualifications of their employees, especially those responsible for after-sales service and maintenance work, must be improved. Systematic support for specific aspects of product development can also help to improve the quality of locally produced electronic components. If technical problems are to be eliminated, it will also be imperative to establish binding technical standards and monitor compliance with them. In its role as a Technical Cooperation organization, GTZ can help developing countries to address the existing constraints in all of these areas by providing information and assigning short-term experts to advise relevant government agencies and upgrade the capabilities of local electronics firms.

It might also be possible to substantially improve the quality of locally produced equipment if final assembly of the devices in question were the only part of the production process that took place in developing countries, i. e. if design, product development, specification and component procurement were handled by manufacturers in an industrialized country. With this type of arrangement, the units - charge regulators, for example - would be shipped to the developing country in the form of ready-to-assemble kits in lots of, say, 100, 500 or 1,000 and then assembled, tested and delivered to the firms responsible for puffing together the complete SHS by qualified local manufacturers.



4. The demand situation of potential shs target groups

The energy needs of rural households which could be met by SHS can be characterized as follows:

- Nearly all households require lighting for about 4 hours each day. At present, the bulk of this demand is being met with candles and kerosene or oil lamps.

- Most households own a radio which provides entertainment and information (often with a built-in cassette tape player). These devices are powered by dry-cell batteries, and usually at least four 1.5-volt cells are used each month.

- Most rural households still do not own television sets, but those who do usually have 1 2-volt black-and-white sets which are powered by car batteries.

The demand structure can of course vary from region to region, and sometimes from community to community as well. However, based on our experience it can

be assumed that in most developing countries the structure of household electricity demand in rural areas will conform more or less to the following pattern:

- One group, comprising some 20 % of the households, would need electric power for lighting only. As a rule, these households have very low incomes.

- A second group, accounting for the bulk (approx. 70 %) of rural households, is the most varied. This "middle class" of rural energy consumers is already using several lamps per household, at least in the upper income brackets, and many households have radios and cassette players as well.

- A third group of consumers - making up roughly 10 % of all rural households also owns a TV set and is usually willing to make relatively large outlays to recharge and periodically replace the car battery that is used to operate it.

It is difficult to place an upper limit on these groups' expenditures for non-cooking energy - and thus on what they would be willing to spend if this energy were supplied by an SHS - since highly subjective considerations often determine how much of an individual household's income will be used to operate lamps and home entertainment equipment. For instance, many say that they would be willing to spend more for better light. However, on the basis of past consumption patterns it is difficult to predict with any certainty how many would actually decide to purchase a better product to meet their lighting needs. Obviously, any figures that one might give here are bound to be only very approximate estimates, but based

on our own survey data and other information on rural energy use in developing countries it can be assumed that the monthly expenditures of rural households for lighting and entertainment range between about 3 US$ (Group 1) and 18 US$ (Group 3) (see Table 1).

To sum up, the electric power needs of rural dwellers are as follows (average values):

Table 1: Energy Use in Rural Households

a) Current non-cooking demand		
Group 1:	(poorest segments of the population)	
	- Lighting (kerosene, candles)	4 hours/day
Group 2:	(middle-income groups)	
	- Lighting (kerosene, candles)	6 hours/day
	- Radios (dry-cell batteries)	6 hours/day
	- Cassette players	6 hours/day
Group 3:	(high-income groups)	
	-Lighting (kerosene pressure lamp)	8 hours/day
	-Radios and cassette players	
	(dry-cell batteries)	3 - 5 hours/day

	- Televislon sets (car batteries)	4 hours/day	
b) Current non-cooking energy consumption and costs incurred			
	Group 1	**Group 2**	**Group 3**
Percentage of rural population	20%	70%	10%
Daily non-cooking energy consumption	0.1 kWh	0.2 kWh	0.5-0.7 kWh
Current monthly expenditures for nor-cooking energy	3-4 US$	7-9 US$	12-18 US$
c) Possible monthly payments for an SHS that would meet the households' current non-cooking energy demand (assumed interest rate: 7 %)			
	Group 1	**Group 2**	**Group 3**
Size Of panel	20 Wp	50 Wp	100 Wp
Based on present costs	7.00 US$	11.00 US$	19.50 US$
Based on possible future costs	6.60 US$	8.60 US$	16.00 US$

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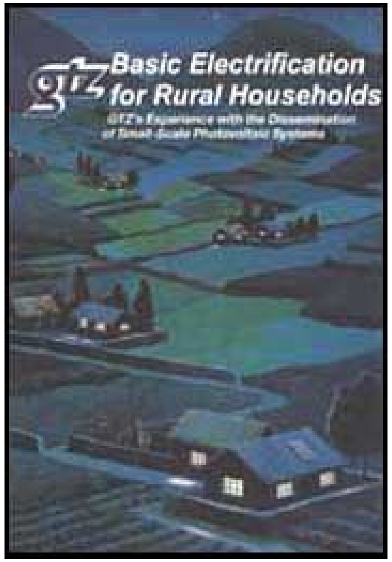

5. Criteria for assessing the economic feasibility and financing options for solar home systems

Depending on the interest rate that is applied, households that utilized an SHS to meet their energy needs for lighting and the operation of radios and TV sets would pay between a fifth and a third more than they are currently paying to meet these needs with candles, kerosene and batteries. Consequently, if electricity is required exclusively for lighting purposes, an SHS will continue to be considerably more expensive than the conventional alternatives, even if the introduction of improved production methods leads to a substantial decrease in solar cell prices. The picture changes in cases where the energy demand is more highly differentiated, as In Group 2 and Group 3 (see Table 1). At some time in the not- too-distant future, the prices of solar cells may decline to the point that SHS will be competitive with - or perhaps even cheaper than - the conventional alternatives for users in these

two groups. In all fairness, though, it should be pointed out that the above comparison does not make allowance for the fact that, unlike the conventional options, the purchase of an SHS involves a large initial outlay, and in most cases this means that the users would have to take out a loan to finance the required investment. However, the segments of the rural population that make up the target group for SHS in developing countries rarely have access to formal-sector credits.

The purchase of an SHS involves a sizeable cash outlay, and the amounts involved are quite substantial for rural households:

approx. 500 US$ for a 20-Wp system
approx. 800 US$ for a 50-Wp system
approx. 1,400 US$ for a 100-Wp system

Thus, if SHS are to be disseminated on a large scale, the technology will have to be offered as part of a package that includes financing arrangements.

The following barriers to financing solar home systems through credit transactions supported by governmental development and private business banks are commonly observed:

- Governmental development banks often do not follow common economic rules. As a result, they are not likely not able to make a special long-term credit offers. Due to exaggerated security (guarantee) requirements, the banks often exclude the very target group in need of credit

- Private banks prefer cities; they are seldom active in rural areas. The

respective credit need is for the most part small so that the specific administrative costs become excessive. Moreover, these banks work with very high interest rates and demand guarantees which usually not can be provided by rural borrowers.

In some instances, informal rural financial systems may be able to cater to the credit needs of the prospective SHS users, especially in West Africa. In rural areas, the informal financial sector includes not only traditional moneylenders, who charge extremely high interest rates (not infrequently in excess of 10 % per month), but also informal savings and loan associations.

However, the most sensible approach is to let the people who sell the systems organize the payment schemes themselves:

- SHS vendors have a very real incentive to grant loans to their customers. They must, however, have some means of financing their lending activities, and thus the banks will be involved in the credit extension process indirectly.

- The vendors retain ownership of the systems until the last instalment has been paid, and thus the entire problem of collateral is neatly avoided (rural target groups are rarely able to provide bankable collateral). In the event of breach of contract, they can simply demand that the equipment be returned. At a practical level, however, this can be difficult because the borrowers risk losing face with the other members of the household if the system is repossessed by the vendor.

In addition to buyers taking out loans themselves and instalment plans offered by vendors, there is a third, very interesting alternative, namely distribution of the solar home systems by the government institutions responsible for rural electric power supply. The panels themselves are "leased", and the users are responsible for acquiring the rest of the system (charge regulator, battery, lamps). The utilities or cooperatives finance the purchase of the equipment with funds allocated from government budgets or loans from international development banks.

However, all of these approaches have one problem in common: each involves the collection of small loan instalments from users living in widely scattered rural settlements, a time-consuming task which pushes up the administrative costs to such a high level that private vendors - and many utility companies as well - Will find that credit extension to SHS owners is unprofitable. Thus, it is extremely important to encourage the initiation of self-help financing activities by cooperatives, especially since these institutions are also working to eliminate other infrastructural deficits in rural regions (e. g. substandard drinking water supply, lack of roads).

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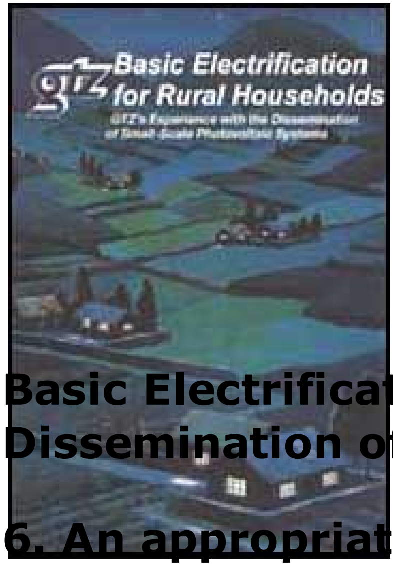
Basic Electrification for Rural Households - GTZ's Experience with the Dissemination of Small-Scale Photovoltaic Systems (GTZ, 1992, 28 p.)

6. An appropriate dissemination strategy for shs and the



Basic Electrification for Rural Households - GTZ's Experience with the Dissemination of Small-Scale Photovoltaic Systems (GTZ, 1992, 28 p.)

6. An appropriate dissemination strategy for shs and the role of GTZ

6.1 A Recommended Approach

For development-policy aspects, care must be taken to ensure that dissemination strategies are based on the following principles:

- **The utilization of SHS should only be promoted if they can be shown to offer both micro- and macro-economic benefits and social advantages. The introduction of the small photovoltaic systems must also be an integral part of a coherent overall energy supply strategy.**

- **The dissemination process should be organized as a commercially viable undertaking.**

- **Priority must be given to non-governmental entities for dissemination activities.**

- Government institutions should not be burdened with tasks that have nothing to do with their actual mission.

- The role of governmental institutions must be to lead the way by introducing the small PV power supply systems at public institutions in rural areas, which will not only serve to demonstrate the viability of the technology but also help to reduce the disparity between rural and urban areas in terms of basic infrastructure development.

- Governments must not be burdened with long-term follow-up costs.

- The dynamic potential of private entrepreneurs acting in their own self-interest must be harnessed to promote the dissemination of the technology, but their activities must also be monitored in order to ensure that the interests of the target group are protected.

- Local production of SHS components should only be promoted in a given country if it can be assumed that the domestic market will be large enough to make it worthwhile, if system costs are significantly reduced in relation to imported systems, and if quality control is ensured.

- In the final analysis, the long-term social- and structural-policy goals which SHS dissemination programs are designed to achieve can only be met if distribution is handled by the private sector. In many cases, though, private firms will be either unwilling or unable to develop the market for this technology and it will be necessary for the government to become involved in the initial stages of the project to "get the ball rolling", i. e.

create an environment in which private enterprises will have an incentive to identify and supply the demand for the small PV systems.

The key actors in dissemination processes in developing countries are:

- The target group, i. e. those segments of the population that are interested in utilizing PV systems.

- Manufacturers and distributors who are able to supply the target group's demand for the technology with high-quality products sold at reasonable prices.

- Political institutions and bodies that regard the use of PV systems as a sensible way to supply rural regions with electricity and are willing to create the overall conditions required for the utilization of these systems on a larger scale.

- Technical Cooperation (TC) institutions which can coordinate communication among the other actors, provide advisory assistance and facilitate the transfer of technology and know-how.

During the early stages of the dissemination process for PV technologies, there is a real risk that the interests of the participating firms and institutions will be promoted at the expense of the interests of the users; program planners may pay too little attention to their needs and they may even be used as "Guinea pigs" to test systems that have not yet been perfected even though they are billed as technically optimized, reliable products. It is here that government agencies - possibly with the support of a TC institution - should intervene to help minimize

the risks for consumers. It is particularly important to ensure that the introduction of this new technology does not make the lives of low-income target groups even more difficult by exposing them to additional economic risks.

A solar home system can be broken down into four elements: the solar panel, the electronic components, the battery, and "other parts" (lamps, lamp fixtures, cables, etc.), and in view Of the number and diversity of the components that are involved, an institution that wishes to promote SHS dissemination will not find a single, "natural" partner in a developing country's manufacturing sector. Indeed, an SHS is not "produced" in the usual sense of the word. Rather, its various parts are assembled to form a system, and it is completely irrelevant whether the company or institution that is in charge of organizing this process also manufactures one or more of the components. It must, however, be capable of carrying out all of the different tasks that are involved in the marketing and distribution of SHS and of providing satisfactory after-sales service.

These tasks include:

1. **Importing the panels and, if necessary, the electronic parts.**

2. **Local procurement of components that can be obtained more cheaply in the developing country (e. 9. batteries, lamp fixtures, cables, miscellaneous fittings, and possibly also electronic parts).**

3. **Organizing the assembly of the individual parts to make the various main components of the SHS (e. g. installation of electronic ballasts in locally purchased lamp fixtures), including quality control.**

4. Organizing distribution in various parts of the country, and establishment and operation of a spare parts depot.

5. Organizing the advertising activities.

6. Organizing the installation process; if necessary, establishment of a central repair service.

7. Organizing the financing arrangements.

8. If state subsidies are provided, possibly also management of government funds and monitoring of expenditures.

In order to perform these tasks properly, firms or institutions which distribute PV systems must have certain minimum qualifications:

- They must have experience in the importation of goods.

- They must have excellent organizational abilities.

- They must have sufficient capital to be able to purchase the components in large enough quantities to benefit from economies of scale.

- They must be sufficiently credit-worthy to obtain the financing required not only to purchase the components but also to offer instalment payment schemes to their customers.

- Last but not least, they must already have a distribution infrastructure in

place that is suitable for marketing PV systems, i. e. one through which products that are in some way similar to SHS (for example, agricultural implements or pumps) are already being marketed to groups within the rural population that are either identical or very similar to the solar home system's target groups.

Marketing will be more efficient and cost-effective if all of these tasks are carried out by a single entity. Of course, depending on the size of a country's market, two or three companies may also become involved in the distribution of SHS, and this would promote competition. In any case, though, if the market is being supplied by several firms, each of them should be capable of performing all of the different tasks involved. Companies that can handle all aspects of distribution and marketing would be a suitable "motor" to drive the dissemination process and ensure that it is self-sustaining, and, initially at least, the provision of assistance to such firms would be one of the focal points of Technical Cooperation activities.

Unfortunately, however, experience has shown that a "single-track" approach of this type Is extremely difficult to implement in practice. It has proved virtually impossible to find a single vendor capable of fulfilling all of the tasks outlined above. In particular, existing companies are typically unable to meet requirements 6 and 7. It therefore makes sense for different institutions or entities to be responsible for assembly, sales and financing. If a government-subsidized distribution program is carried out for disadvantaged segments of the population, a further subdivision of the tasks Is necessary, and consideration must be given to involving additional actors (e. 9. utility companies).

The dissemination measures that have been carried out to date by GTZ have varied

considerably in terms of the distribution strategy employed. Nearly every project has utilized a "tailor-made" approach that was designed to fit the specific conditions found in the country in which it operated. In all cases, however, the focus was initially on utilizing private enterprises to achieve the project's aims.

The range of approaches that have been employed is illustrated by the following examples:

1. **Distribution of SHS on a commercial basis by large trading firms which employ local artisans to assemble and repair the systems (e. 9. in Peru).**

2. **Commercial distribution with the participation of local equipment manufacturers (e. 9. in Colombia, Senegal and the Philippines).**

3. **Encouragement of private-sector initiatives by promoting a government institution (e. 9. in Rwanda).**

4. **Promotion of self-help groups among the users of SHS, with support being provided by cooperatives (e. 9. in Senegal and the Philippines).**

5. **Government-organized programs to develop remote areas by providing basic infrastructure (Including SHS-based rural electrification measures), with consideration being given to the interests of all social groups and private enterprises being given responsibility for supplying and installing the equipment (e. g. in Tunisia).**

The diversity of the approaches outlined in just this small number of examples illustrates the complexity of the conditions that must be met in order to

disseminate just one technology in various countries. A different approach is called for in each situation. Especially during the early stages of a project, the overall climate for dissemination can be improved if government institutions or development cooperation organizations like GTZ furnish technical advice, implement measures to reduce the initial risks, and furnish back-up support for the private commercialization's process (e. g. by providing funding to get things started). Developing-country governments must take steps both to promote the participation of private enterprises in the dissemination program and, once they have become involved, to monitor the quality of their services and products (quality control). Indeed, unless product quality is monitored and compliance with standards is enforced by a neutral agency, and unless the government creates a favourable overall environment for commercialization, dissemination projects will face a situation in which the requisite market forces will either be unable to develop properly or will develop in a way that may work to the disadvantage of the target group.

The task of selecting appropriate financing schemes for the investments that must be made by the target group is quite complex. There is a wide range of different approaches ranging from simple credit extension by a selected bank through highly complex arrangements involving the participation of formal and informal banking institution's operating at the national and regional levels to instalment payment plans in which financing is provided by the manufacturers and/or distributors. In order to select the right option, project planners must know precisely how their dissemination activities are to be structured and who the target group will be and also be thoroughly familiar with the project environment.

The most important tasks of government agencies and/or development-assistance

organizations are:

- Elimination of obstacles to competition in the PV equipment market.

- Abolition or reduction of import duties on PV panels.

- Measures to ensure that banks extend credits to cooperatives to fund their lending to finance the purchase of SHS.

- Establishment of revolving funds administered by government agencies for start-up financing.

- Training of staff for installation and maintenance of equipment.

- Provision of support to small and medium-sized companies engaged in component production, including assistance in establishing contacts with companies in industrial companies.

- Quality control in testing laboratories (granting of "seals of approval', and establishment of production standards.

It is essential that the implementing agencies continue to receive advice and technical assistance on an on-going basis until the dissemination process for this "new technology" has gained sufficient momentum to be self-sustaTnTng, especially since the main activities involved in promoting its diffusion take place far from the centres of political power. Once dissemination has got under way in a given region, people in the local area are usually quick to recognize the technology's benefits, but it takes longer for policy-makers to become aware of

them. Accordingly, efforts to bridge this "information gap" are just as important as the provision of training to the local personnel who will be responsible for installing and maintaining the systems.

It is also crucial to determine whether long-term subsidies are desirable tend if so, how they could be financed), or whether a commercial dissemination strategy would be more appropriate. If the implementing agency opts for subsidies, then it must still decide whether some sort of commercial distribution program might make sense - and be feasible - in addition to the subsidized scheme.

Greater government involvement, as in Tunisia, can Indeed prove worthwhile if the goal is to develop a promotion strategy for disadvantaged regions of the country while at the same time making the development of renewable energies like solar power an integral part of the overall development of the energy sector (e. g. by Introducing a small surcharge on the prices paid for electric power from conventional sources to help pay for PV based rural electrification).

When implementing government dissemination programs, however, care must be taken to avoid impeding private marketing activities. It is also important to remember that the responsible government agencies Will depend on private enterprises to do the installation and maintenance work. Thus, the provision of technical training to local personnel and research and development (e. 9. the design and testing of new PV systems meet the needs of specific segments of the target group) are further areas in which collaboration between government and the private sector is essential.

6.2 Evaluation of the Roles of Individual Actors

So far, we have focused our attention on the importance of creating the prerequisites for successful dissemination that are required in specific situations.

Before concluding our discussion, however, we would also like to point out a few essential aspects which are common to dissemination processes in all countries.

For instance, it is always vital to secure the participation of policy-makers at the highest level right from the beginning, i. e. starting with the project design phase. This has become standard practice in all of our more recent projects, and meeting this objective often calls for the assignment of a full-time staff member to handle this task alone (energy-policy adviser).

When it comes to the actual implementation process at the project level, the situation is more varied. As the examples cited above show, the spectrum of possible strategies ranges from exclusive reliance on private enterprise through approaches involving cooperatives, non-governmental organizations and self-help groups, to collaboration between the private sector and government institutions. In every case, though, project planners must attempt to identify the particular organizational set-up that will best serve the interests of the users.

Although this organizational arrangement will vary from country to country, certain roles can be assigned to each of the principal actors, thus yielding a generally applicable "division of labour" that can be used in all projects.

When decisions are taken in the area of development policy and economic policy to promote the use of photovoltaics, the government and its institutions must restrict themselves to the performance of certain functions:

- They must not perform commercial marketing functions.

- They must not undermine commercial distribution by providing inappropriate subsidies.

- They must not promote local production if this would be detrimental to the interests of the users (toleration of inferior quality in order to maximize the "local content" of systems).

- They should:

> **- Eliminate or reduce duties on imported PV components, even if they are also produced domestically, so as to make the systems more affordable for the target group.**
>
> **- Ensure that the prices charged for competing products (kerosene, lamp oil) reflect their true economic costs.**
>
> **- Provide for quality control by establishing and enforcing equipment standards (granting of technical "seals of approval").**
>
> **- Monitor competition among SHS vendors.**
>
> **- Enable vendors to provide financing to users by ensuring that they have access to appropriate credit facilities.**
>
> **- Monitor the overall dissemination process and assess its effectiveness.**

- Create a favourable climate for dissemination by leading the way in the utilization of the technology, e. 9. by supplying PV systems to institutions such as schools where they will be highly visible and help to create a public awareness of the technology and its benefits.

- Take steps to overcome social disparities, e. g. by supplying equipment to public health-care centres which serve disadvantaged segments of the population.

- Possibly extend credits to purchasers of SHS.

- Create Incentives for private investors in the PV sector.

- Integrate the development of renewable energy (RE) resources into the framework of national energy planning and policy-making.

- Facilitate the relevant activities of self-help groups, cooperatives, NGOs, etc.

Makers of photovoltaic equipment in industrialized countries also have an important role to play. If they wish to take advantage of the opportunities offered by the markets in developing countries, they must:

- Adapt their systems in accordance with operating conditions in those countries and the needs of local target groups.

- Take the initiative and assume the entrepreneurial risks involved in marketing their systems.

- Transfer know-how to local manufacturers and distributors and work with them to provide reliable after-sales service.

- Develop suitable financing and product warranty schemes in cooperation With local institutions and companies so as to reduce the risks incurred by purchasers of SHS.

- Be willing to enter into joint ventures with local companies.

Finally, a TC organization like GTZ must perform the following tasks:

- Provision of advice to governments regarding the selection and evaluation of strategy options (e. g. commercial distribution vs. subsidization).

- Provision of support for long-term dissemination, for example through a dialogue with user groups and decision-makers.

- Technical assistance in the area of financing to help distributors obtain the capital required to purchase PV systems.

- Provision of technical know-how, training of local technicians and artisans, and promotion of efforts to establish and enforce high product quality standards.

- Advisory assistance to distributors.

- Sharing of information with component manufacturers to help them

improve the quality of their products.

GTZ must make its support contingent on the fulfilment of a number of preconditions that are essential for the success of dissemination measures:

- The developing country must demonstrate that it is in fact interested in the dissemination of PV technologies, e. g. by providing for the development of solar energy and other RE resources in a five-year plan.

- The public-sector institution which serves as GTZ's counterpart organization must agree that government agencies will play only a secondary role in the dissemination process, i. e. that their contribution will be limited to creating a favourable overall environment for the diffusion of the technology.

- The developing country must pledge to make certain contributions of its own, e. 9. by equipping public facilities in rural areas with PV systems.

- The institutions collaborating with GTZ must ensure that there will be sufficient latitude for cooperation with private enterprises.

An institution at the policy-formulation level would be the most appropriate counterpart organization for GTZ. The most valuable contribution that GTZ can make to a dissemination process is to allow local institutions to benefit from its extensive experience with different project approaches around the world, which enables it to provide sound advice and meaningful support to both the users and the vendors of PV systems.

Thus, the range of services that could be included in a GTZ assistance package cover the following:

- Selection of appropriate counterparts.

- Development of appropriate individualized implementation strategies, including schedules, definition of tasks and phases, realistic cost calculations, and integration of individual tasks into the general framework of energy supply planning.

- Assistance in creating a favourable overall climate for the initial phase of such a measure.

- Measures to ensure that the design of the systems offered for sale to the target groups and the installation procedures are appropriate to the needs of the users.

- Competent advice for producers and suppliers of PV systems.

- Specialized training for local counterparts.

- Realistic assessment of follow-up costs.

- Analysis of the ecological and socio-cultural impacts of project measures.

- Promotion of an exchange of information and experience among developing countries (South-South cooperation) in order to avoid a duplication of effort.

If the various actors are assigned the right roles in the dissemination process and their activities are coordinated properly, then the developing countries may be able to make the transition to an energy supply in which solar power plays a substantial role more quickly than the industrialized nations. If GTZ continues to receive the support of the German government In its efforts to promote solar energy utilization and it maintains its current working relationship with the German solar equipment industry, it will be able to help establish the environmentally friendly PV technology as a mayor, long-term energy supply option in the Third World, especially for the target group of smallholder households.

Those who are responsible for formulating energy policy and setting priorities for the future development of the energy sector in developing nations should endeavour to assess the potential contribution of solar power in their countries, and if they decide to exploit this energy resource through the large-scale dissemination of household PV systems, they can rely on GTZ to provide a broad range of technical-assistance and other support services.

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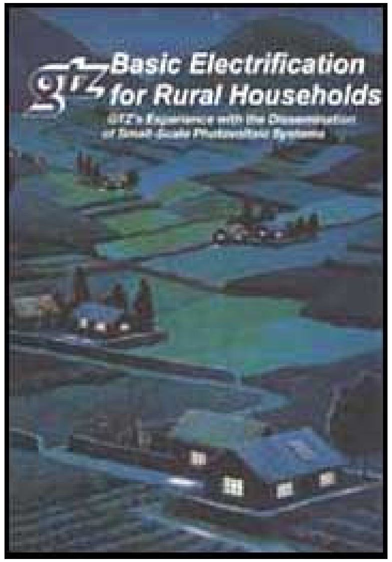

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