Appendix 7 Selection of the Target Villages for PV Electrification

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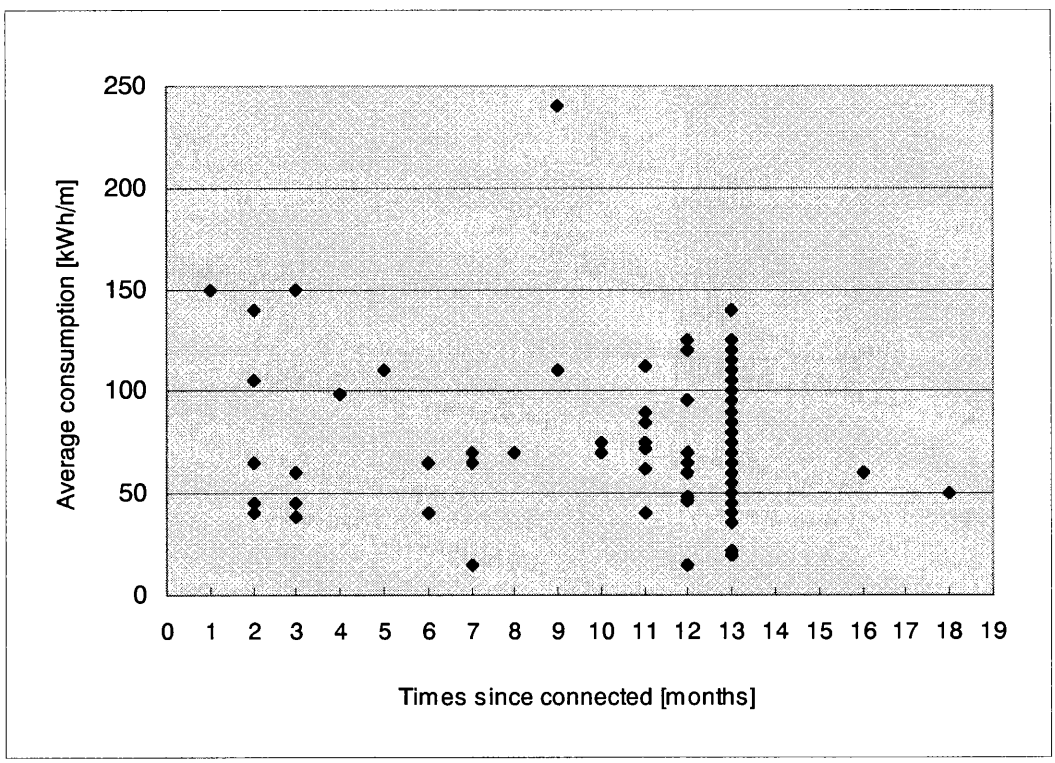
7.1 Least-cost Options for Rural Electrification

7.1.1 Rural Household Electricity Consumption

Appendix Figure 7.1-1 shows the trend of power consumption in rural households in South Africa after connection to the grid. It shows that the consumption level is almost same as in the case of Philippines.



Source: ESKOM

Appendix Figure 7.1-1 Trend of Power Consumption after Connection to Grid Trend of Power Consumption in Rural Village (South Africa)

Appendix Table 7.1-1 shows the average consumption per households of BPC and ESKOM customers. The consumption in a rural household will be much less than the average figures in Appendix Table 7.1-1.

Appendix Table 7.1-1 Average Consumption per Households

	BPC (1999/00)	ESKOM (1998)
Domestic Sales (GWh)	280.4	5,989
Number of Customers	* 76,380	2,376,069
Consumption/Customer (kWh/m)	305	210

* Figure includes all customers other than domestic.

Source: BPC and ESKOM Annual Report

7.1.2 Cost Comparison of SHS Versus the Grid-based Electrification

(1) Case Study-1: Comparison of Costs varying numbers of households at a constant grid extension distance and a constant load

Comparison of costs for grid extension and PV electrification was made on the following basis (detailed description on calculation basis is to be referred to Appendix Document 7.1-1):

* Grid extension distance : 20km
* Electricity consumption per household: SHS 100Wp equivalent (12.2 kWh/m)
* Costs for grid extension was calculated on the total investment cost per km derived from the actual cost expended for BPC's 72 village electrification project and total distance of 72 village extension. It includes construction cost and all of owner side costs such as project teams salaries and other expenses. Reticulation cost in a village was assumed as P4500 per household since remaining villages and localities were assumed much sparsely populated.

  Operation maintenance costs included power generation cost, which was assumed 7.5 Th/kWh as imported electricity cost. Maintenance cost was assumed as 2% of total investment cost.
* Investment cost for SHS systems was derived from the tender results of the Dissemination Project, but unit cost could be reduced down to 70% of awarded unit prices in case of large scale project. It also included owner side costs similarly to grid extension cost. Operation and maintenance costs were derived from actual plan for operation and maintenance planned in business plan of Chapter 13, on BPC cost basis.
* Under the above mentioned assumptions, the total cost calculated for each system over 20 years was discounted at 15% to obtain discounted present value and compared.

The results are shown in Figure 7.1-2.

The village which has 200 households (population; about 1,000) is the break-even point for the grid extension (20km) and PV electrification.

PV electrification is economic in such a village that has less than 200 households.

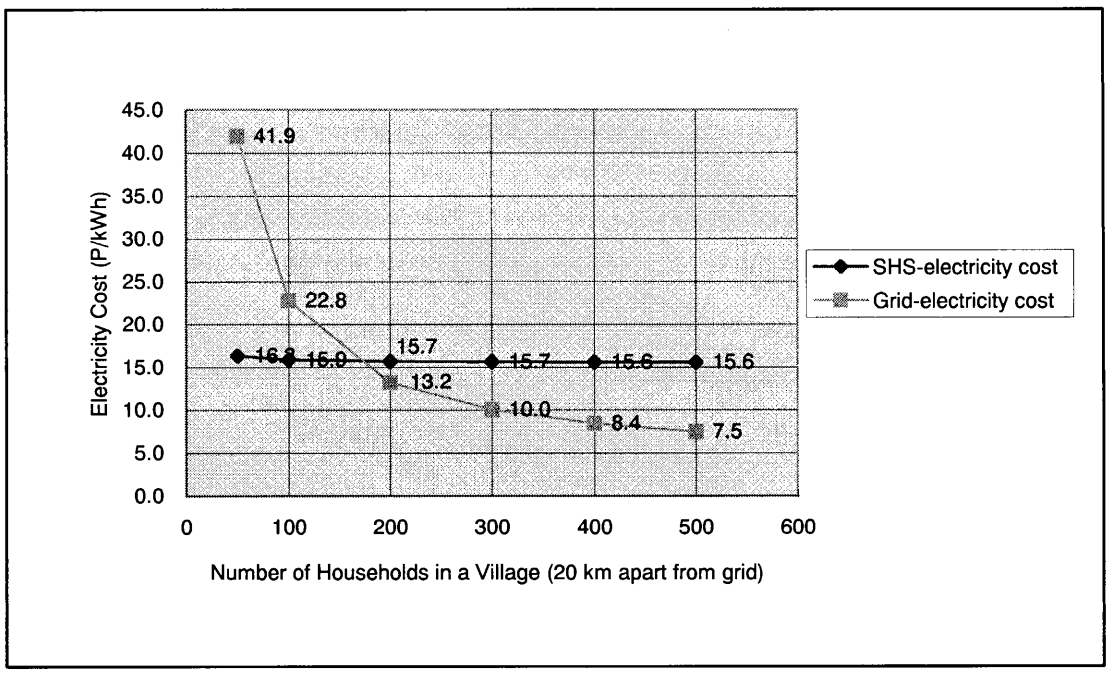


Figure 7.1-2 Electrification Cost SHS Versus Grid-100Wp (BPC Cost Basis)

(2) Case Study-2: Break-even distance from the Grid

Break-even distances on the basis of costs for PV and Grid electrification at electricity consumption levels of 200Wp (24.3kWh/m), 400Wp (48.7kWh/m), and 600Wp (73kWh/m) equivalent per household are calculated on the same assumption made in the Case Study-1. This study was made to find break-even distance when the maximum consumption level in the village was assumed as discussed in Chapter 7, Section 7.2.1 when no limitation of consumption due to affordability of each household (especially for PV) would exist. Detailed calculation results are shown in Appendix Table 7.1-2-1~6).

7.1.3 Comparison of Cost Recovery of SHS Versus the Grid

In the above analysis, a breakeven point was determined under the assumption that the electrification cost is recovered from electricity charges and other sources (or if not fully recovered, the recovery rate is assumed to be same).
Then, simulation was made using BPC's grid extension project covering 72 villages to compare cost recovery in the case of PV electrification.

Assumptions

1) 72 villages (estimated population of 109,577 in total) were supposed to have 21,915 households (assuming that each household consists of five persons), and 60% of which, 13,149 households would be electrified by grid connection or the PV system.
2) Electricity demand was assumed to be ranging between 100Wp and 200Wp in case of SHS. On the other hand, electricity demand by households connected to the grid would be expected to be larger. Namely case studies for the loads of 100Wp (12.2 kWh/month) equivalent, 20, 50 kWh/month and 100 kWh/month were examined.
3) Capital investment and system operation and maintenance costs required during the 20-year period are discounted at an annual rate of 15% to obtain their net present value (NPV). Then, a) an incremental cost due to grid connection (P/kWh) and b) the SHS cost (P/kWh) were estimated.
4) In addition, revenues are estimated on the basis of electricity charges under BPC's current tariff rate structure in the case of grid connection, and the monthly rate of 50Wp – P40/month in the case of PV electrification. Based on the estimated revenues (NPV), the cost recovery rate over 20 years is determined to recoup the above total cost.

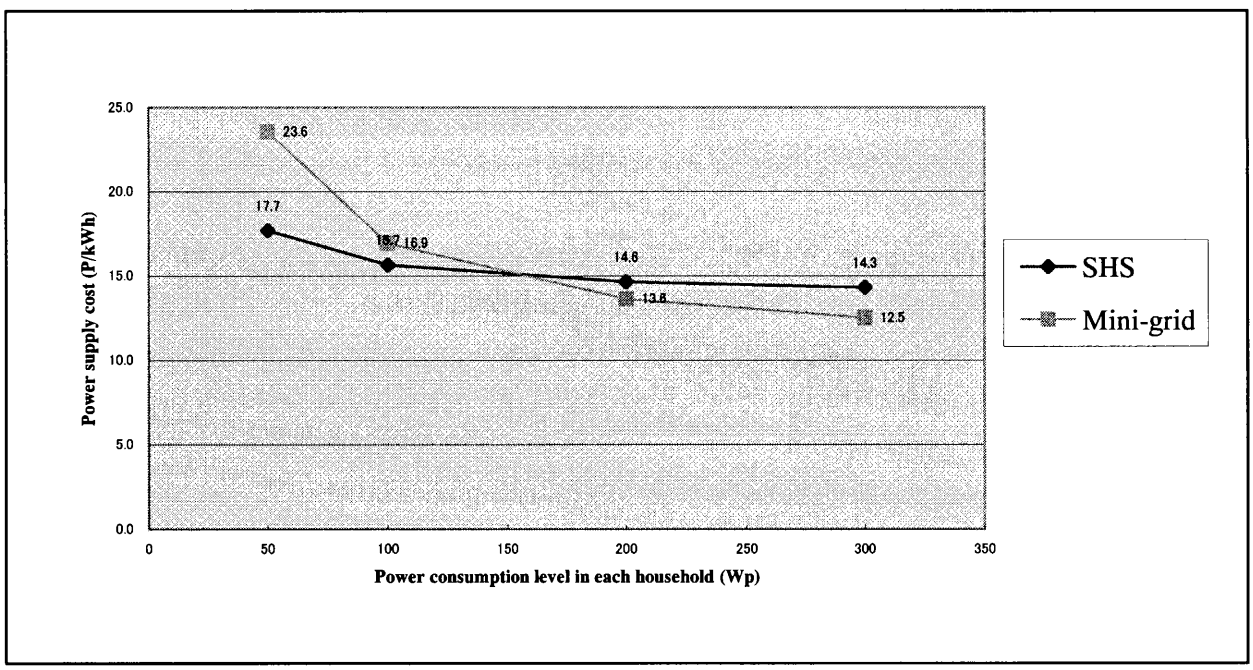
The results are summarized in Appendix Table 7.1-3.

7.1.4 Cost Comparison of SHS with PV Mini-grid Electrification

Similar comparison of costs for PV mini-grid and SHS was made.
Appendix Figure 7.1-3 shows that in case of a village having 300 households average power consumption level of 150Wp is the break-even point. In case of lower power consumption level than 150Wp, SHS is economical.

Appendix Figure 7.1-4 shows such break-even points of cost on the basis of parameters of number of households of the village and average power consumption level. In case of the villages having 100 and 200 households, the break-even points are 170Wp and 155Wp respectively. Refer to the detailed calculation sheet shown in Appendix Table 7.1-4-1~8.

That is to say that PV mini-grid system is only viable in case of dense populated and high level of consumption case.



Appendix Figure 7.1-3 PV-minigrid Versus SHS (300 Households)