Country Reports

Brazil
Cook Islands
Dominican Republic
Ethiopia
French Polynesia
Ghana
India
Indonesia
Kenya
Malaysia
Mongolia
Morocco
Namibia
The Philippines
Senegal
South Africa
Uganda
Tanzania
Thailand
Tuvalu
Vietnam

Brazil

Land Area	274 000 000 km^2
Population	161 million
Population Density	19 inhabs per km^2
GDP per capita	4 652 USD
Urban Population	79 %
Labour Force	72 million
Population Growth Rate (1980-1996)	1.8 %
Literacy Rate	83 %.

General Data			
Insolation	4.9 kWh.m^{-2}.day^{-1}	Latitude	10°S
Population unelectrified	12 %	Terrain	Mostly flat rolling lowlands in North; some plains, hills, mountains and narrow coastal belt.

PV Data	
PV power installed	2.0 MWp (1995)
Technical potential	126 MWp (based on 50 Wp SHS for 65 % of households currently without electricity, assuming 5 people per household.)
PV programmes committed	The Ministry of Energy & Mines has an ongoing project, PRODEEM, to install demonstration PV systems in every state in Brazil.
Government policy	Proposed 14 specific programmes, with target for PV of 50 MWp by 2005
Utility programmes & strategies	Privatisation of the utilities has resulted in little effort being made to extend the national grid beyond the coastal plain, leaving the majority of the interior without supply. The Ministry of Energy and Mines, responsible for rural electrification, has historically relied upon diesel generators feeding 'mini-grids' requiring an annual subsidy of 250 MUSD.
Market sophistication	Advanced
Technical development	All BOS components are manufactured. Modules were manufactured..
Pricing structure	Support available from PRODEEM project. Financing available from the RE programme which provides at preferential rates Various revolving funds and other loan schemes planned or in operation. SHS can also be rented for 13.5 USD/month
Testing & Standards	The Brazil Standards Organisation adopted IEC standards for PV cells and modules. The experience from the systems installed by the NREL/CEPEL project has been used for 'good practice' guidelines. CEPEL has a PV Working Group to address PV commercialisation.

1 Economic and Political Aspects

Between 1945 and 1980, the Brazilian economy expanded very rapidly and a large and diversified industry was developed. Brazil's development during this time was traditionally based on import substitution industrialisation (ISI) and was helped by protectionist policies. In the 1980s ISI faltered: such protectionist policies made the economy inward-looking and inefficient and as a consequence investment collapsed, leading to hyperinflation. Between 1986 and 1991 there were five unsuccessful attempts to stabilise the economy and the name of the Brazilian currency was changed four times.

Trade liberalisation began in 1990 and within four years practically all non-tariff barriers were removed and import tariffs were slashed. The result was an extraordinary rise in labour productivity. Productivity growth per year between 1990 and 1995 was estimated at 6-7 % compared with approximately 1.4 % per year between 1986 and 1990.

A major shift in economic policy occurred in 1993 when a stabilisation programme largely based on market forces was launched. The rate of inflation dropped from 50 % per month in June 1994 to about 2 % per month in the fourth quarter of 1994

In 1996 Brazil had a Gross Domestic Product of 749 BUSD, 14 % of which was supplied by agriculture, and grew at a rate of approximately 5 %. Economic activity was largely located in three south eastern states, which accounted for about 60 % of Brazil's GDP.

2 Grid Electrification Status

Electrical capacity was estimated at 63.8 GW, with annual production of 242 TWh. Over 90 % of the electrical capacity was derived from hydro-electric schemes, with the remainder supplied largely by thermal generating plants. Brazil had a nuclear generating capacity, but was not reliant upon nuclear power. There were more than 20 utilities serving the states and these were in the process of being privatised. Whilst under state control, the grid was being systematically extended into rural areas. Privatisation of the utilities has resulted in little effort being made to extend the national grid beyond the heavily populated coastal plain, leaving the majority of the interior without supply. The Ministry of Energy and Mines, responsible for rural electrification, has historically relied upon diesel generators feeding 'mini-grids' which required an annual subsidy of 250 MUSD. This subsidy was provided by the National Fuel Consumption Account, which drews tariffs from the electricity produced by the large hydro-electric infrastructure. Improving the economic viability of these mini-grids was of particular concern to the newly privatised utilities.

Regional and state distribution concerns were being privatised as were individual generation plants and new generating capacity was being promoted through the private sector. Brazil's grid was connected to those of neighbouring countries, which may be expected to provide further sources of power in the future.

The unelectrified population was variously reported to be in the range 20-35 million people. The majority of these were in the north east of the country where 40 % of the population in the 9 Northern states were said to be without electricity.

3 PV Programme Experiences and Policy Issues

Photovoltaic systems were initially installed in remote areas to power telecommunications relay stations approximately 10 years ago, and had proven successful in this application. This 'service application' continued to be a growth area for photovoltaic power systems, with reports estimating a requirement for up to 7 MWp capacity as the telecommunications industry expanded.

The US Department of Energy through NREL, collaborated with CEPEL and the state-owned utilities from 1992-1995 in a 2-phase project to install over 1 000 stand-alone PV systems in rural areas on a demonstration basis. The project was the largest and most significant PV project in Brazil to date, but was criticised for undermining the indigenous PV industry. The stated objectives were to enhance the movement of PV hardware from the US to Brazil (supplied by Siemens, Solarex and USSC) and establish in-country training and expertise of technical personnel. The US-DoE donated the PV modules, batteries and charge controllers from US suppliers (approximately 50 % of the project cost). All other BOS were procured by the state utilities who were also responsible for installation and maintenance. The projects were far from financially viable, since the SHS users were asked to pay only 1 USD per month - the equivalent of a grid-connection charge with minimum consumption. All sites were further than 7 km from the grid.

The Eldorado-Sun project followed the same pattern as the NREL project, installing 60 kWp of PV systems in Pernambuco state, completed in 1996. Over 400 schools were each provided with a 100 Wp system. The PV modules were provided by Siemens Solar (Germany) funded by GTZ, while the utility CEPEL provided the BOS components and carried out installation.

The Ministry of Energy & Mines had an ongoing project, PRODEEM (run by CEPEL) to install demonstration PV systems in every state in Brazil. The programme was integrated into existing state programmes and was being implemented in five phases. Under Phase 1, 32.5 kWp of community lighting and water-pumping schemes had been installed using imported US equipment by 1995 with a target of 200 kWp. Phase 2 contracts had been awarded for 500 kWp, and Stage 3 was due to start in 1997. Within the PRODEEM programme, the state of Minas Gerais aimed to electrify 100 schools in 1997, with a further 1 000 planned for 1998. The state had announced targets of electrifying 20 000 consumers by 1998, and the state of Bahia had identified 172 localities for implementing SHS and water-pumping projects, plus 280 farms for PV irrigation.

Two major markets for photovoltaic power systems were emerging in Brazil, the upgrading of existing systems and the provision of new systems. As the electrical utilities were privatised it was becoming necessary to improve the efficiency of the diesel powered 'mini-grids'. These systems were originally intended as short term solutions to power requirements during the expansion of the national grid, which has been halted; with the future of the subsidised fuel in doubt, there was a perceived need to introduce substitute generating technology. In addition, the westward expansion in the agricultural industry requires power for irrigation systems and electric fencing, both of which were mature applications for photovoltaic power systems.

Government initiatives on PV were started in earnest in April 1994 when the Ministries of Energy & Mines and Science & Technology produced the Belo Horizonte Statement laying down 53 directives for the development of solar and wind energy in Brazil. A Permanent Forum for Renewable Energy was established in October 1994 to oversee the directives, including a mix of government and non-government organisations. The Permanent Forum staged a conference in Brasilia in June 1995 which enlarged upon the Belo Horizonte Statement with the Brasilia Statement. This proposed 14 specific programmes, with execution guidelines, aimed at achieving targets for renewable energy. The target for PV was set at 50 MWp by 2005.

Import duty on PV modules was around 15%, and VAT also 15%, but the removal of both taxes for renewable energy systems was under review.

4 Domestic PV Industry

Heliodinamica had been the only Brazilian PV cell and module manufacturer since the early 1980s, using locally-produced silicon, however the company was for sale having experienced financial difficulties. Demonstration programmes implemented by international funding agencies, which utilised imported modules, exacerbated these difficulties. The company had a production capacity of 1.8 MWp per year and had reportedly supplied over 5 MWp of modules for the home market (largely professional systems) and export. Heliodinamaca’s modules were comparatively expensive (10 USD/Wp) and in the end could not compete with US imports, despite national tax incentives.

There were also at least two national-level commercial distributors operating in Brazil as well as numerous farming co-operatives and NGOs working in the rural areas who would facilitate the implementation and support of PV systems to local communities.

The expertise for the large scale implementation of PV systems in Brazil was readily available due to the large and established market for ‘professional’ PV systems in Brazil. Telecommunications companies were reported to be currently implementing 7 MWp of PV projects.

5 Financing Options

The two main impediments to the increased implementation of photovoltaic power systems were identified as the lack of financial resources and the expectation that the government would cover the capital costs of generating equipment and charge consumer tariffs based upon monthly consumption - estimated in many rural areas at 1 USD per month.

Government support for PV projects was available from the PRODEEM project in conjunction with the Community Solidarity Programme, plus the Small Farmer

Support Programme (PAPP). Financing assistance was reported to be available from the renewable energy programme (PROERN) of the Banco de Nordeste do Brazil and the Northeast Constitutional Fund of the Northeast Development Bank (BNB), which provided 12-year financing at preferential rates

An attempt was made to recover costs by Electrobras by charging the end-users a minimal fee, corresponding to the cost of a rural connection to the national grid and assuming minimal consumption; additional funds were received from USAID and GTZ. Expansion of the programme was dependent upon continued support from international donors, as the fees collected did not cover the cost of the installations.
Various banks had stated their willingness in principle to provide loan schemes for PV on a commercial basis although there was a lack of intermediary organisations, trusted by potential users, which can negotiate the loans with the banks.

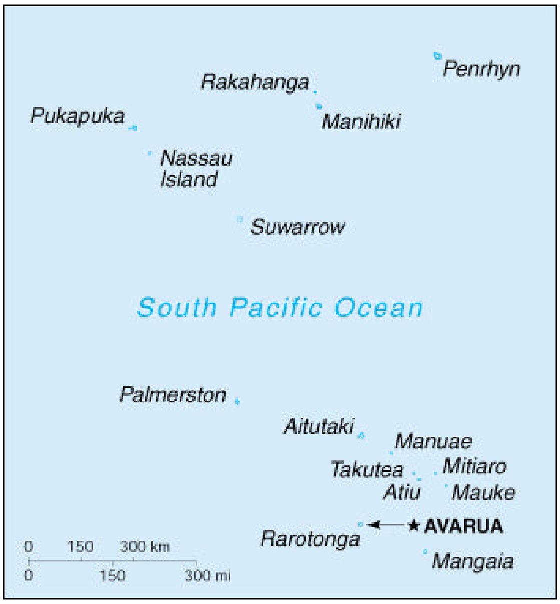
A Belgium NGO SOS-PG had been working with the Association of Small Farmers (APAEB) in Bahia to establish a revolving fund to provide PV electric fencing to local farmers - 15 systems were demonstrated initially, with the aim of installing a further 75.

The University of Sao Paulo has collaborated with the University of Madrid, with development agency support, to set up a revolving fund managed by a rural co-operative in Sao Paulo state. SHS could be bought with an advance of 90 USD followed by monthly payments of 5 USD. Also in Sao Paulo state, the local privatised utility CESP had set up a scheme whereby users can rent a SHS for 13.50 USD per month, aimed at amortising the systems over 20 years.

The Solar Electric Light Fund (SELF) were setting up a small credit scheme for 50 SHS in NE Brazil, with grant funding. The intention was for a full cost-recovery scheme charging 18 % interest on the loan. Discussions were underway to set up SELCO-Brazil as a profit-making PV finance organisation.

A pilot project in remote regions of Pernambuco installed 350, 100 Wp SHS, in 1994 and another scheme in Ceara covered 400 homes (50 Wp) and 14 schools. Responsibility for the installation, maintenance and evaluation after three years lay with the respective state utilities who charged the users 1 USD per month.

Cook Islands



Land Area	240 km^2
Population	20 000
GDP per capita (1993)	3 000 USD (ppp)
Population Density	83 inhabs per km^2
Urban Population	Not Available
Labour Force	6 600
Population Growth Rate (1997 est.)	1.08 %
Literacy Rate	80 %

General Data			
Insolation	kWh.m^{-2}.day^{-1}	Latitude	21 S
Population unelectrified	NA	Terrain	Low coral atolls in north, volcanic hilly islands in South

PV Data	
PV power installed	Unknown
Technical potential	NA
PV programmes committed	Unknown
Government policy	Involved in energy discussions with other countries in the area in an effort to capitalise upon any opportunity to increase the electrification of the islands
Utility programmes & strategies	The Cook Island Electric Company has been supportive of renewable energy sources
Market sophistication	Medium
Technical development	None
Pricing structure	No specific financing available
Testing & Standards	Unknown

1 Economic and Political Aspects

The Cook Islands' economic development was hindered by the isolation of the country from foreign markets, lack of natural resources, periodic devastation from natural disasters, and inadequate infrastructure. Agriculture provides the economic base with major exports made up of copra and citrus fruit. Manufacturing activities were limited to a fruit-processing plant and several clothing factories. Trade deficits were made up for by remittances from emigrants and by foreign aid, largely from New Zealand. In 1996, the government declared bankruptcy, citing a 120 MUSD public debt. Efforts to exploit tourism potential and expanding the mining and fishing industries had not been sufficient to deal with the financial crisis. In an effort to stem further erosion of the economic situation, the government reduced public service salaries by 50 %, condensed the number of government ministries from 52 to 22, reduced the number of civil servants by more than half, began selling government assets, and closed all overseas diplomatic posts except for the one in New Zealand.

The Cook Islands are a small island chain in the Pacific generally included with French Polynesia for statistical purposes. The labour force is estimated at 6 600, with 29 % engaged in agriculture and 27 % in governmental positions.

The Gross Domestic Product of the Cook Islands was estimated to be 57 MUSD (ppp) in 1993 with no figures available on growth rates. The most recent estimates of inflation available, from 1994, indicated a 5.8 % annual increase. With exports in the range of 3.9 MUSD and imports estimated at 67 MUSD, the economy was dependent upon remits from migrants working abroad and bilateral aid from international sources.

2 Grid Electrification Status

Although the population density of the Cook Islands was comparatively high at 83 persons per km^2, it must be noted that the population was spread thinly over separate islands, making a single centralised power supply impractical.

The Cook Islands Electric Company was the sole electricity provider for the islands, with 7.5 MW capacity and annual production estimated at 20 GWh; due to the island nature of the country, electricity was available in a limited area and to only a small portion of the population. While lacking in resources, the Cook Islands' Government had been proactively involved in energy discussions with other countries in the area in an effort to capitalise upon any opportunity to increase the electrification of the islands. A single individual appeared to have greatly influenced the Cook Island's approach, participating heavily in regional energy conferences and lobbying the government to commit to renewable energy.

3 PV Programme Experiences and Policy Issues

The Cook Island Electric Company had been supportive of renewable energy sources, and had maintained ties with French Polynesia, which had a significant photovoltaic industry, able to produce all components with the exception of photovoltaic modules. As early as 1980 a programme was instituted to install Arco modules, which was followed in 1982 by a demonstration project funded by France.

During this time there were some technical difficulties encountered with photovoltaic power systems throughout the greater French Polynesia area.

In 1990 another project was instituted, again funded with Bilateral Aid from France, to electrify the islands using photovoltaic systems. The programme was managed jointly by the Cook Islands' Government and the South Pacific Institute of Renewable Energy (SPIRE), an organisation based in Tahiti in French Polynesia. The systems were installed by a private photovoltaic company, SolerEnergy, and were intended to be maintained by local technicians. Users were charged a monthly fee of 30 USD in order to recover costs.

4 Domestic PV Industry

The Cook Islands did not have a supporting industry, and was unlikely to develop one and was therefore dependent upon imports from French Polynesia, which had an industry able to support photovoltaic power systems. However, due to the cessation of the French nuclear testing programme, the economy of French Polynesia was in question; historically, the testing programme had accounted for approximately 30 % of GDP. Industry collapse in French Polynesia would have implications on the photovoltaic electrification programmes in surrounding countries.

5 Financing Options

The Cook Islands electrification scheme was extremely ambitious in that attempts were being made to meet all of the energy requirements of the population using photovoltaic systems. Projects in developing countries usually focus upon providing power to schools, medical clinics and perhaps community centres, but the end-user expectations in the Cook Islands appeared to be that the programme would provide each household with enough power for domestic lighting, radios, televisions and refrigerators. While this indicated great demand for systems, the local government lacked the resources to provide the necessary financial mechanisms to enable consumers to purchase the products.

The limited economy of the Cook Islands was the major stumbling block to increased development, as it was unable to sustain the large capital costs associated with the electrification of island chains. Without the input of funds, components, and technical assistance from external sources, the expansion of PV systems will be limited.

Dominican Republic

Land Area	48 000 km^2
Population	8 million
Population Density	166 inhabs per km^2
GDP per capita	1 646 USD
Urban Population	63 %
Labour Force	3 million
Population Growth Rate (1980-1996)	2.1 %
Literacy Rate	83 %.

General Data			
Insolation	5.4 kWh.m^{-2}.day^{-1}	Latitude	19°N
Population unelectrified	30 %	Terrain	Rugged highlands and mountains with fertile valleys interspersed.

PV Data	
PV power installed	4 500 SHS
Technical potential	16 MWp (based on 50 Wp SHS for 65 % of households currently without electricity, assuming 5 people per household.)
PV programmes committed	Unknown
Government policy	Negligible policy making in support of solar energy, although PV modules counted as electricity generation equipment and are free of import duties
Utility programmes & strategies	Utility has little money to invest in rural electrification.
Market sophistication	Advanced
Technical development	High
Pricing structure	There are currently four revolving funds active in the Dominican Republic.
Testing & Standards	Unknown

1. Economic and Political Aspects

The latter half of the 1980s and early 1990s saw a deterioration in economic conditions in the Dominican Republic, with diminished growth and increased instability. There was a marked drop in private sector investment, which was replaced to some extent by the public sector. An economic reform programme was introduced in 1990 (the New Economic Policy - NEP) which made some major progress towards stability. Despite some measures (interest rate liberalisation, elimination of sectoral credit allocations, and a lowering of reserve requirements), the financial condition of the banking sector remained precarious, exacerbated by weak central authority supervision and handling of bank failures. A Financial Sector Reform Programme (FSRP) was initiated in 1995 to restore solvency and stability in the financial sector and improve its efficiency in the mobilisation and allocation of resources.

The GDP of the Dominican Republic was estimated to be 13 200 MUSD in 1996, with a growth rate between 1990 and 1996 of 4.7 %, the consumer price index averaged 10.9 % in the same period. It was estimated in 1996 that 25 % of the labour force was engaged in agriculture and unemployment was 16.7 %.

2. Grid Electrification Status

Electricity generating capacity was estimated at 2.3 GW, of which 30 % was hydro power and 65 % oil fired generation: annual generation was estimated at 6 500 GWh. Per capita electricity production was estimated at 813 kWh The generation and distribution industries were dominated by the vertically integrated, state owned utility, Corporacion Dominicana de Electricidad (CDE). The government was considering privatisation of CDE following financial difficulties that resulted in frequent power outages. With CDE struggling to maintain its existing network and reduce black outs and system losses (estimated at 25 %), it was unlikely to invest in rural electrification programmes. However, the government had approved plans for the construction of two new power stations with a combined capacity of 250 MW.

Nearly 30 % of the population had no access to electricity (approx. 2.2 million people) and CDE had little money to invest in rural electrification. Rural areas were therefore unlikely to receive connection to the national grid in the near future, and urban areas were poorly served because of the poor state of the national grid.

3. PV Programme Experiences and Policy Issues

Despite government indifference, the private sector in PV was thriving, with over 4 500 SHS sold since 1985. The private sector activity was developed through aid-sponsored programmes and had been maintained through consumer demand in both rural and urban areas. It was estimated that more than 1 % of rural households had SHS installed, meaning the rural community was more aware of PV than in most countries.

The government had demonstrated a low awareness of, and negligible policy making in support of, solar energy. However, PV modules were counted as electricity generation equipment and were therefore free of import duties. There was a 100 % duty on batteries to protect indigenous suppliers and manufacturers.

4. Domestic PV Industry

PV businesses used imported PV modules and a mixture of imported and locally manufactured BOS components to assemble systems. Major failures of amorphous silicon modules had led to a rejection of this technology. In order to improve system reliability, the quality of locally manufactured batteries needed to be improved or duties removed from imported batteries. Charge controllers and light fixtures were also manufactured locally.

5. Financing Options

The private sector market in the Dominican Republic was limited only by the lack of end-user finance. Financing schemes had been unsubsidised (though supported by training and promotion) and similar to schemes available for other consumer durables.

There were four revolving funds active in the Dominican Republic which were managed by NGOs. The funds were pioneered by Enersol/ADESOL in 1984. There had been other unsuccessful revolving funds set up, but these were dormant. Experience has shown that NGOs, rather than community associations, are best placed to run the funds. The NGOs also performed a role as intermediaries between the equipment suppliers and the customers, feeding back technical problems noted from their monthly visits to collect payment. Major seed funding contributions had also been made by the Catholic Relief Services (CRS) and the GEF small grants program, as well as many other smaller sources.

Typical terms were a 25 % down-payment, followed by monthly payments for 12-36 months at 18-22 % interest. For a 700 USD system this equated to roughly 30 USD per month. The 25 % down payment was noted as a significant barrier to many potential customers. Of the 1 850 systems installed up to 1994 by PV businesses affiliated to ADESOL, only 225 (12 %) were on a credit basis, the remainder were cash purchases. The number of credit purchases was limited by the size of the funds, not lack of demand. Many of the cash purchases were funded by relatives abroad.

Enersol had more recently concentrated its efforts on leasing schemes, with an ‘Energy Service Company’ (ESCO) retaining ownership of a SHS. The ESCO collected a monthly ‘energy service’ fee, and was responsible for maintenance. Leasing schemes were more capital intensive and difficult to run, but have the potential to open up a larger market due to lower monthly repayment fees.

Enersol collaborated with Soluz Inc. (USA) to form Soluz Dominicana in 1994 to act as an ESCO. 750 systems had been leased in Paerto Plata: the smallest system was 20Wp, available at 5 USD per month. Soluz Inc. were now seeking 575 000 USD from various sources to expand to 2 000 leased systems. The longer-term target was to lease 30 000 systems over 7 years, requiring an investment of 8 MUSD.

The market for SHS could be greatly expanded if additional working capital was available to seed revolving funds, for NGOs to expand their resources, for institutional strengthening of PV businesses and for training programmes.

Ethiopia

Land Area	1 100 000 km^2
Population	58 million
GDP per capita	103 USD
Population Density	52.7 inhabs per km^2
Urban Population	16 %
Labour Force	26 million
Population Growth Rate (1980-1996)	2.7 %
Literacy Rate	24 %

General Data			
Insolation	4.75 kWh.m^{-2}.day^{-1}	Latitude	8°N
Population unelectrified	90 %	Terrain	High plateau with central mountain range divided by Great Rift Valley

PV Data	
PV power installed	NA
Technical potential	339 MWp (based on 50 Wp SHS for 65 % of households currently without electricity, assuming 5 people per household.)
PV programmes committed	Unknown
Government policy	Indications are that the government is supportive of solar power systems, but lacks the resources to implement them.
Utility programmes & strategies	Utility is supportive of attempts to provide electricity in rural areas through renewable energy or photovoltaic systems, but lacks the funds to operate a programme independently.
Market sophistication	Low
Technical development	None
Pricing structure	Aid projects only – system users not charged.
Testing & Standards	Unknown

1 Economic and Political Aspects

At the time of writing, Ethiopia was recovering from a long standing civil war, which was finally resolved with the independence of Eritrea, resulting in the loss of Ethiopia's coastal access.

An estimated 16 % of the population of Ethiopia lived in urban areas, while 80 % of the 26 million strong labour force was engaged in agriculture. The education conditions were very poor, with female enrolment in primary school among the lowest in the world and much of the population having no formal education at all.

Economic figures were difficult to obtain, as the country was just beginning to recover from the two droughts in the 1980s and the civil war. Gross Domestic Product in 1996 was estimated to be 5 990 MUSD growing at a rate of 3.9 %, and average inflation of 8.9 % between 1990 and 1996. It was estimated that agriculture, largely coffee, accounted for more than half of GDP, and provided over 90 % of exports. Import and export figures were estimated to be 423 MUSD and 1 150 MUSD respectively.

2 Grid Electrification Status

Electrification was limited to the urban areas, with installed capacity of 330 MW and annual production of approximately 1 300 GWh with annual electricity production per capita of 22 kWh. Hydro-electric schemes generated 80 % of the electricity, with the remaining 20 % provided by traditional thermal generators. A single national electricity authority was responsible for the provision of electricity and was supportive of attempts to provide electricity in rural areas through renewable energy or photovoltaic systems, but lacked the funds to operate a programme independently. In addition, each ministry was responsible for the provision of electricity for its own uses: the ministry of agriculture was responsible for programmes which provided irrigation water, the telecommunications authority was responsible for providing electricity to telecommunications relay stations, etc. Overall, indications were that the government was supportive of solar power systems, but lacked the resources to implement them.

3 PV Programme Experiences and Policy Issues

Four main photovoltaic programmes had been implemented in Ethiopia: Vaccination Refrigeration, Solar Radios, Solar Pumping, and Telecommunications. Each was managed by the respective government ministry, with funds provided by a number of sources, including UNICEF, UNHCR, World Food Programme, USAID, SIDA, NORAD, Oxfam, Save the Children, World Vision, Concern, Goal, Jesuit Refugee Service, NCA, and EECMY. With four programmes being managed separately by four ministries with funds from 14 different Aid Agencies, the particulars of each project were difficult to summarise. In general the projects attempted to train local technicians to install and maintain the systems. The systems were regarded as government property and the end-users were not charged for the installation or use.

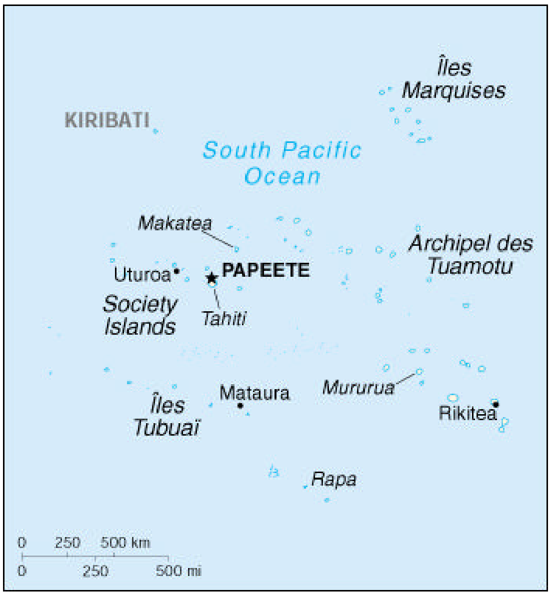
4 Domestic PV Industry

There were no system components manufactured in Ethiopia, nor were they readily available for purchase in the private sector. Attempts were being made at the University of Addis Ababa to develop photovoltaic technology and applications in order to facilitate the electrification of the nation, but the research is lagged far behind the technology that was commercially available outside Ethiopia. While the government considered that having photovoltaic manufacturing capability and a commercial photovoltaic market would be beneficial, the resources and infrastructure were not available to develop the industry.

5 Financing Options

As all systems to date had been provided free of charge, there had not been a cost recovery mechanism developed. It should be noted that while there was a danger that the local population would be unwilling to pay for photovoltaic power systems in the future because past systems have been funded using Aid grants, the community service applications which these systems provided would not otherwise be available.

French Polynesia



Land Area	3 660 km^2
Population	233 500
GDP per capita	8000 USD (ppp)
Population Density	59.5 inhabs per km^2
Urban Population	NA
Labour Force	119 000
Population Growth Rate (1980-1996)	1.89 %
Literacy Rate	98 %

General Data			
Insolation	$kWh.m^{-2}.day^{-1}$	Latitude	15°S
Population unelectrified	12 %	Terrain	Mixture of rugged, high islands and low coral reefs

PV Data	
PV power installed	NA
Technical potential	180 kWp (based on 50 Wp SHS for 65 % of households currently without electricity, assuming 5 people per household.)
PV programmes committed	
Government policy	
Utility programmes & strategies	The electricity utility, Electricité de Tahiti, had opposed the PV electrification of the outlying islands, to the point of installing national grid connections to islands that have had photovoltaic systems installed.
Market sophistication	
Technical development	High - capable of producing all system components except PV modules.
Pricing structure	No specific finance for PV systems
Testing & Standards	Member of international standards organisations through France.

1 Economic and Political Aspects

French Polynesia is a grouping of small island chains located in the South Pacific with a total land area of 3 660 km^2. In 1996 the population was estimated at 233 500, with a growth rate of 1.89 %. Of this, the labour force was estimated at 119 000, the majority of whom worked in tourism-related jobs. Traditionally a high percentage of the population worked in defence related jobs stemming from the French nuclear testing programme; however, this was ended in 1996, and French Polynesia now has an estimated 15 % unemployment. While the literacy rate was officially listed as 98 %, the history of the Polynesian islands has left the country with a disparate collection of native languages.

The Gross Domestic Product (PPP), estimated at 3 600 MUSD, with a growth rate of 2 %, was based almost entirely upon tourism and French subsidies. Inflation was estimated at 1.5 % annually. With exports estimated at 88.9 MUSD and imports estimated at 765 MUSD, the trade deficit was severe. Black pearls accounted for over half of the national exports, but provided little employment and did not require an industrial base. However, the country was heavily subsidised by France; around 1250 MUSD in 1995. After the decision to cease testing nuclear devices in the area this funding was promised for further ten years after which it will end.

2 Grid Electrification Status

The wide spread of the island chains had resulted in uneven development among the population. Papeete, the capital, had a high standard of living, while many of the outlying islands were without electricity and had very limited economic activity.

The installed electrical capacity was estimated at 75 MW, with annual production of 320 GWh; nearly all consumed on the main island. The electrical utility firm, Electricité de Tahiti, had opposed the PV electrification of the outlying islands, to the point of installing national grid connections to islands that had had photovoltaic systems installed.

3 PV Programme Experience and Policy Issues

Solar power systems were introduced in French Polynesia in 1978 through a demonstration programme, funded by the French Government, the E.U. and private consumers and led by GIE Soler. The project was intended to both spur economic activity in the renewable energy field, as well as induce the island populations to remain on the islands by improving the standard of living and providing electricity for local commercial activities. The photovoltaic systems were designed by the South Pacific Institute for Renewable Energy (SPIRE) in conjunction with GIE Soler, and included development of high efficiency appliances. There were a number of technical difficulties during the initial phases of the project, as well as the opposition of the local utility.

The programme was funded through the French Polynesian Ministry of Energy and subsidised by the E.U, ADEME, and CEA. Half of the systems were installed to private consumers, with a 20 % subsidy and 7 % interest on the loan; this required monthly payments of between 15 USD and 20 USD. The rest of the systems were installed to provide collective electrification to islands as a whole, and difficulties have been experienced with cost recovery. The overall programme was managed by SPIRE, with GIE Soler providing installation and maintenance technicians.

4 Domestic PV Industry

By the end of the electrification programme in 1990, French Polynesia had developed a photovoltaic industry capable of producing all of the necessary system components with the exception of the PV modules themselves. This had led to the export of components to the Cook Islands and Tuvalu, which had also implemented photovoltaic electrification programmes.

5 Financing Options

It was anticipated that the island electrification would continue, with expectations that the private local market would be able to sustain the local photovoltaic manufacturing industry. It was difficult to make projections concerning the economy of French Polynesia, as the end of the French nuclear testing programme could present economic difficulties. It is likely that the survival of photovoltaic market will depend upon the ability of black pearl farms and tourist hotels to both afford the systems and expand rapidly enough to sustain the business; additional orders may also be received from other countries in the area, but the electrification of both the Cook Islands and Tuvalu were entirely dependent upon continued international aid.

Ghana

Land Area	239 000 km^2
Population	18 million
Population Density	78.9 inhabs per km^2
Urban Population	36 %
Labour Force	3.7 million
Population Growth Rate (1980-1996)	3.1 %
Literacy Rate	60 %

General Data			
Insolation	4.9 kWh.m^{-2}.day^{-1}	Latitude	8°N
Population unelectrified	60 %	Terrain	Mostly low plains with dissected plateau in south central area

PV Data	
PV power installed	350 kWp (1992)
Technical potential	70 MWp (based on 50 Wp SHS for 65 % of households currently without electricity, assuming 5 people per household.)
PV programmes committed	Solar lighting systems in rural areas fall under the NEP and were therefore duty free. The Spanish Government was to provide a mixed credit loan facility to the Ministry of Mines and Energy for solar electrification.
Government policy	Committed to electrify the whole country by the year 2020. This commitment was being realised within the framework of a National Electrification Programme, initiated in 1980. PV was included as part of NEP.
Utility programmes & strategies	None of the two utilities were known to have been involved with PV to any significant extent but the Northern Electricity Department of VRA was due to play the role of an implementing agency in UNDP/GEF solar electrification project in Northern Ghana.
Market sophistication	Medium
Technical development	In country manufacture of charge controllers and a number of other BOS components including batteries and lamps.
Pricing structure	Little credit available for purchasing PV systems privately, the government was taking positive steps to encourage their use through the NEP
Testing & Standards	Unknown

1 Economic and Political Aspects

The economy of Ghana was almost entirely dependent upon cocoa production, leaving the country reliant upon climactic conditions. Agriculture provided 45% of the Gross Domestic Product (GDP) and employed 55 % of the workforce. GDP was estimated at 6 340 MUSD and grew at an average annual rate of 4.4 % between 1990 and 1996. The consumer price index over the same period was estimated at 29.8 %.

2 Grid Electrification Status

The electricity generation capacity in Ghana was estimated to be 1180 MW in 1995 , almost all of which was generated by the Akosombo hydropower station on Lake Volta. Annual electricity production in 1995 was estimated at 6.2 TWh, with per capita production of 344 kWh.

There were two main power utilities in the country. The Volta River Authority (VRA) was responsible for generation and transmission throughout the country and for distribution in the 4 northernmost regions. The Electricity Corporation of Ghana (ECG) was responsible for distribution in the remaining 6 regions, in southern Ghana. None of these utilities had had any significant previous involvement with PV but the Northern Electricity Department of VRA was due to play the role of an implementing agency in UNDP/GEF solar electrification project in Northern Ghana.

Almost all of Ghana’s electricity is generated from the 912 MW Akosombo Hydropower Station on Lake Volta and the smaller downstream Kpong Dam. Only a tiny fraction was generated by the thermal power (coal, oil, gas) stations. In 1994, low water levels resulted in one-sixth of the country’s industries losing one production day per week. An economic growth rate of 5 % brought about a 10 % to 15 % increase in electricity consumption.

A District Capitals Electrification Programme was initiated to connect all district capitals (including those that had diesel plants) to the national grid by the end of 1994. Of 110 district capitals, 74 (67 %) were connected to the national grid by the target date - work on the remaining capitals was expected to be completed by 1997.

The Government had also made a commitment to extend the reach of electricity to all corners of the country by the year 2020. This commitment was being realised within the framework of a National Electrification Programme, which was initiated in 1980. The estimated percentage of the total population with connections to the electricity supply in Ghana had grown from about 12 % in 1989 to about 40 % in 1996 although approximately 10 million people still did not have access to electricity. The high-voltage electricity grid passed through every region of the country and all regional capitals had access to grid electricity. Electricity consumption growth rates exceeded 10 % since the onset of the NEP; the demand for electricity had outstripped the grid supply capacity and Ghana had now become a net importer of electricity from Côte d'Ivoire. Other options, such as PV were being used as part of this programme to reach the rural areas.

3 PV Programme Experiences and Policy Issues

Solar lighting systems in rural areas were becoming more prevalent, especially since they fell under the NEP and were therefore duty free. Although there was little credit available for purchasing systems privately, the government was taking positive steps to encourage their use.

As of January 1991 there were 335 solar PV installations in Ghana with a total estimated power rating of about 160 kWp. By October 1992 these figures had more than doubled with the number of installations reaching 700 units and an estimated power rating of over 350 kWp. Most of these applications had been in telecommunications which accounted for more than 80 % of systems: of these, 40 % were owned or operated by the Ghana Railway Corporation and the Ghana Education Service.

A recent UNDP/GEF project approved 3.1 MUSD for PV developments in 13 villages. The project proposed to establish a regional operations and maintenance centre in the East Mamprusi District and 3 renewable energy information centres. Three system types were to be deployed in the project: local micro-mini grid systems powered by PV/diesel hybrid units for the larger villages, battery charging centres and stand-alone communal facilities for commercial/collective use; and home PV lighting systems for households in the smaller villages.

The Canadian Aid Agency, CIDA, had provided 1 MCAD for a Renewable Energy for Rural Development Project at University of Science and Technology (UST). The project saw the establishment of three Solar Service Centres (SSC), which provided battery charging services and also sold complete home lighting systems. Co-operatives had been formed in the towns to manage the SSCs to paying local operating costs, such as labour and rent, out of income from the SSCs. The technicians in charge of SSCs had also undergone training at the DME.

The Off-Grid Solar Electrification Project was being administered by the Ministry of Mines and Energy with internally generated financial resources. The project was part of a broader scheme to promote PV electricity in Ghana. The specific objectives included the preparation of an action and work programme for future integration of solar PV electricity into the National Electrification Programme; to establish a local manufacturing capacity in solar technology (charge controllers and inverters) and to establish standards for PV equipment and components as well as design and installation.

The Spanish Government was to provide a mixed credit loan facility to the Ministry of Mines and Energy for solar electrification. The loan was to be used to purchase solar equipment rural electrification, from the Spanish manufacturer - ISOFOTON - which planned to integrate the PV technology backwards by establishing a local facility to produce solar panels, charge regulators, lights etc. Provision was made in the project for training and technology transfer to Ghanaian institutions from both the public and private sectors.

The use PV for rural electrification formed part of the National Electrification Programme (NEP). Therefore, all PV systems imported into the country either by

Government or its agencies, or by private companies for NEP projects, attracted no import duties or taxes. For private project and systems, customs duty of 10 % was imposed on all imported finished solar products. Sales tax (or Value Added Tax) was about 15 %. No import duty and sales tax was charged on raw materials and parts for the production of solar products locally.

4 Domestic PV Industry

There were approximately thirteen companies working with photovoltaic systems in Ghana, although a large number of these had worked on a single programme and had not worked in the field since. The single most important player in the photovoltaic industry in Ghana was the Mechanical Engineering Department, UST. The UST manufactured charge controllers and a number of other BOS components including batteries and lamps. Other companies were also involved in the production of charge controllers.

5 Financing Options

There were no primary lenders or independent financial intermediaries for PV projects in Ghana. PV dealers in the country attributed poor sales to the high initial cost of solar systems and the lack of credit facilities for potential buyers.

Two organisations were known to provide some form of financing, as part of specific projects, for PV systems. The MOME was administering two PV financing schemes as part of its PV Battery Charging Projects in the Upper West Region and in the Greater Accra Region. In both projects the MOME provided interested households with 2 lamps (one 18 W fluorescent tube and one 6 W incandescent bulb), a battery and a regulator; the cost of wiring the house was borne by the occupants. The beneficiaries were required to pay an initial deposit of 18 USD. Take up rates were extremely low possibly due to the costs of wiring etc. The Department of Mechanical Engineering, UST also operated a loan facility as part of its CIDA-funded PV project.

In addition to supporting research and component fabrication at universities and utilising photovoltaic systems as part of the NEP, the government of Ghana was also working in conjunction with the Spanish government to establish a local facility to produce photovoltaic components. The prices (FOB) for the solar equipment, which was to be supplied by ISOFOTON, were 14 USD per Wp for the Home Lighting Systems and 21 USD per Wp for Institutional and Community Lighting Systems. Villages interested in home lighting systems under this facility would be required to pay 30 % of total cost as an initial deposit and spread the remaining 70 % over 10 years, at an interest rate of 2 %. Institutional and community systems would be treated differently, in which case repayment of the total cost would be spread over a period of 8 years, at an interest rate of 6 %.

For most rural and many urban households informal sources provided the bulk of financing supported by extensive systems of rotating savings, savings collectors, and community or social group support funds. Through the 1980s the central bank, with responsibility for rural finance, supported the development of rural banks, but inefficiency and dominance by powerful local interests undermined the effectiveness of many of them until a reform programme was initiated in 1989. At the same time there was a rapid expansion in the number of NGO programmes providing credit, though frequently undermined by a continued presence of, particularly religious, charities offering concessional or gratis funds. Several programmes, however, sought to introduce variants of the Grameen model with NGO support for group formation and awareness raising. Several NGOs concentrated on support for women entrepreneurs (women traditional run the marketing and many other systems in West Africa), including Women's World Banking and an association of professional women. Mass organisations, linked to the Party, especially for women, remained strong and dominated many Government sponsored programmes, benefiting from their high political profile and widespread grassroots organisation.

India

Land Area	2 970 000 km^2
Population	945 million
GDP per capita	USD
Population Density	317.9 inhab per km^2
Urban Population	27 %
Labour Force	408 million
Population Growth Rate (1980-1996)	2.0 %
Literacy Rate	52 %

General Data			
Insolation	5.6 kWh.m^{-2}.day^{-1}	Latitude	20°N
Population unelectrified	68 %	Terrain	Upland plateau in South; flat to rolling plain along Ganges; deserts in West; Himalayas in North

PV Data	
PV power installed	35 MWp
Technical potential	4200 MWp (based on 50 Wp SHS for 65 % of households currently without electricity, assuming 5 people per household.)
PV programmes committed	Numerous programmes were planned and ongoing, including the construction of high capacity power plants to electrify entire regions, small scale domestic lighting / power production, credit provision to encourage market development, and subsidy schemes. In 1998, the GEF/IFC "Photovoltaic Market Transformation Initiative" programme was launched.
Government policy	The Government of India was committed to renewable energy development. The Ministry of Non Conventional Energy Sources was responsible for the specific policy, legislation and support programmes for renewable energy, with the overall aim to achieve a 6 % contribution to power generation from renewable sources by 2002
Utility programmes	Unknown
Market sophistication	Advanced
Technical development	Advanced – full cell, module and BOS manufacturing capability
Pricing structure	A number of banks and non-banking financial companies handle lines of credit and leasing for IREDA's SPV Market Development Programme
Testing & Standards	Unknown

1 Economic and Political Aspects

India had the largest population among the focus countries with an estimated 925 million increasing at a growth rate of 1.8 %. The population was largely rural, with an estimated 23 % living in urban areas. The labour force was estimated at 315 million, with 65 % engaged in rural agriculture. The educational system was poor in rural areas, especially among women; the overall literacy rate was estimated at 52 %.

In 1996 India's Gross Domestic product was estimated at 1.25 TUSD, growing at 5 % to 7 % per year. Agriculture accounts for 34 % of GDP. Since the early 1990s, economic reforms and liberalisation had improved the economic outlook considerably, although inflation was estimated at 10 % per year. India's exports were estimated at 24.4 BUSD, with imports estimated at 25.5 BUSD.

2 Grid Electrification Status

With installed electrical capacity of 81.2 GW and annual generation of 314 TWh, India produced around 439 kWh per capita. Attempts to electrify the country were continuing with nearly every type of energy source under consideration, although India remained reliant upon thermal generation for 71 % of production, followed by 27 % from hydro-electric dams. A further 2 % was generated by 6 nuclear reactors, with 4 more planned. With the majority of the population not serviced, the infrastructure required to meet projected demands will require a substantial investment.

The shortfall between peak electricity demand and supply in India was estimated to be equivalent to 14 000 MW of generating capacity. With the public sector generators and the state-owned electricity distributors unable to meet this shortfall, the Government was beginning to respond to the economic pressure for major tariff reforms and restructuring of the industry to attract new investment.

Independent power producers (IPPs) were actively encouraged to participate, and reductions in subsidies on diesel fuel and petroleum products had recently be legislated. However, with electricity consumption per capita predicted to double over following five years, the shortfall in electricity supply can be expected to increase over the next 10 years.

The positive implications of the electricity supply situation for the PV industry were substantial for the private sector and foreign participation which has been limited to date.

3 PV Programme Experiences and Policy Issues

The Government of India was committed to renewable energy development. The Ministry of Non Conventional Energy Sources (MNES), established in 1991, generated and administered specific policy, legislation and support programmes for renewable energy, with the overall aim of achieving a 6 % contribution to power generation from renewable sources by 2002.

MNES had been providing an impetus to the development and utilisation of new and renewable sources of energy. Awareness promotion, information dissemination, development of standards, operation of test facilities and international co-operation were among the objectives of the Ministry. The responsibility for implementing several vital programmes in solar energy utilisation hadbeen assigned to MNES's financial and promotional arm, the Indian Renewable Energy Development Agency Limited (IREDA).

IREDA's mission was to stimulate, promote, support and accelerate an efficient, environmentally sustainable infrastructure for effective exploitation of New and Renewable Sources of Energy (NRSE) for productive purposes. IREDA operated a revolving fund to develop and promote commercially viable NRSE technologies in the country. Within the initial 9 years of operation, up to 31st March 1996, IREDA had pledged resources to 728 Renewable Energy Projects which amounted to over 328 MUSD.

Government PV purchasing and subsidy programmes had played a significant role in supporting the development of the photovoltaics industry. There were substantial incentives offered by the Indian government for the promotion of renewable energy technologies, including subsidies in the form of financial support and cost-sharing, a wide range of fiscal incentives, and concessional finance.

Government policy and incentives specifically for PV were:

- Government departments'/agencies' own internal programme for "Integration of Renewable Energy" - as illustrated by the Department of Telecommunications' PV powered Rural Automatic Telecommunications Exchanges, etc. which drive the bulk of PV systems sales.
- the socially oriented programmes implemented through nodal agencies and NGOs to install free domestic and street lighting.
- the market oriented programmes administered through the Indian Renewable Energy Agency - IREDA, which utilised donor funds, including the World Bank's 43 MUSD PV Market Development Programme, and other smaller donor schemes. IREDA programmes had extended long-term credit of around 9 MUSD to support 30 projects for installation of solar lanterns, PV pumps and small-scale PV power plants.
- Central and Local Government fiscal and financial incentives, including 100 % capital depreciation, sales tax exemption in certain states and reduced customs and excise duties on PV systems materials and components.
- Incentives for grid connected PV systems, tax holidays on income from PV power sales, low charges for feeding power to the utility grid and favourable buy-back rates.

The installed PV capacity to date is summarised in the following table:

PV system type	Description	Approx. number / kWp
Water pumping	One of the earliest applications tried in India. Initial programme installed 800 small (350 Wp) surface water pumps, subsequent programme expanded by a further 1 000 pumps of higher capacity (600 – 900 Wp). In addition, over 100 deep well pumping systems were installed as part of the National Water Mission to supply drinking water to villages	~2 000
Street lighting systems	Usually comprise two pole-mounted PV modules, charge controller and battery encased at ground level, energy efficient light. Installed by state electricity boards and state renewable energy agencies	30 000
Solar Home Systems	Comprise one PV module, charge controller and battery inside the house, sufficient to power a few energy efficient lights, possibly a small TV	15 000
Community Centre Systems	Also used in Adult Education Centres and Clinics. Standard packages supplied by manufacturers	1 000
Solar Lanterns	Self-contained unit comprising small (10 Wp) module with a (7 W) lantern which houses the battery and electronic control. Programme of supply to villagers currently under expansion	>5 000
PV Power Plants	Small power plants in the range of 2 – 10 kWp had been installed in around 100 villages. Power plants of 100 kWp were also installed in two Uttar Pradesh villages. India's first grid-connected power plant was a 5 kWp system installed in Hyderabad. The feasibility of large grid-connected power plants was under investigation.	~500 kWp
Telecoms.	TV transmitters powered by PV had been in use since 1985. Around 100 low power transmitters had been installed in remote areas. The Department of Telecommunications had procured and installed around 25 000 PV powered radio telephones for rural areas.	> 25 000

Government sponsored programmes were an important component of the 9th Five Year Plan (1997 - 2002). However, further applications for financing under the present IREDA World Bank scheme would not be accepted after March 1998, unless an extension was granted. It was likely that alternative funds would be secured enabling IREDA to perform a modified role in supporting PV.

Numerous future programmes had been developed and were ongoing, including the construction of high capacity power plants to electrify entire regions, small scale domestic lighting / power production, credit provision to encourage market development, and subsidy schemes to assist the impoverished / socially disadvantaged.

The photovoltaic market in India was hampered somewhat by the magnitude of the undertaking. Elements within the Government of India recognised the importance of providing electrical power and the increases in productivity that could be gained through electrification. However, the resources that will be needed to be allocated in order to achieve full electrification are massive.

In 1998, the GEF/IFC “Photovoltaic Market Transformation Initiative” (PVMTI) programme was launched. As part of the programme, 15 MUSD of concessional financing was available for PV support. It should be considered that the PVMTI support will greatly increase the development of the PV industry in India.

Several crucial barriers to implementation of PV in India were identified in the project preparation phase of PVMTI. These are summarised below:

- the unacceptably high incidence of system failure in the field - attributed to a mix of inadequate product specification, quality of installation, and technical competence;
- inadequate marketing, distribution, customer support and after-sales service; attributable to lack of commercial and marketing skills and inadequate levels of investment in appropriate infrastructures;
- dependence on end-user subsidy and too high an incidence of discredited customer credit schemes.

4 Domestic PV Industry

One of the significant features of the PV status in India is that there were several private sector industries competing in the areas of PV system manufacturing including design, assembly, installation and commissioning of systems. There were additionally over 50 small entrepreneurs largely undertaking supply and installation of PV systems and executing contracts.

Most of the PV shipment in the country was through the institutional market route, meaning that PV manufacturers were selling their products to various government organisations and other institutional sectors such as state modal agencies who were distributing these systems directly to beneficiaries. The consumer market in India was marginal; PVMTI could prove beneficial in supporting its development.

Twelve companies accounted for the bulk of output and module capacity, with two state owned (Central Electronics Ltd and Bharat Heavy Electricals Ltd) and four private sector organisations producing over 1 MWp each in 1996. RES and Udhaya Semiconductors were significant indigenous manufacturers, with TATA BP Solar, XL Telecon, Pentafour and Webel the leading organisations with foreign joint venture partnerships. Several companies were experiencing financial difficulties due to over-expansion.

India was able to produce all BOS components, as well as possessing the manufacturing technology for PV module productions. Efficiency and quality of modules varied widely but the larger producers consistently deliver acceptable quality equivalent to international norms. Module prices in India were between 25 % and 30 % above international prices.

In addition to single-crystal silicon modules, MNES had supported research into amorphous silicon production. A pilot plant for amorphous silicon modules was established by Bharat Heavy Electricals Ltd (BHEL) at Gwal Pahari in 1992.

The PV module manufacturing industry imported 100 % of its demand for low iron glass, EVA and Tedlar, and 80 % and 50 % of its demand for wafers and cells. The recent sharp increase in demand for wafers in the US and Japan resulted in a short-term scarcity of raw materials.

In response to the current crisis, a number of systems houses had, or planned to set up small scale module production (< 0.5 MWp), to service their own demand. This backward integration on such a small scale may not remain viable when the market starts to demand improved quality and pricing.

The larger private sector manufacturers made their own inverters, and relied on internal sourcing of charge controllers. The balance relied on imports or a small number of local suppliers. A number of international brand-name battery suppliers manufactured locally, and a solar battery line was also planned by one manufacturer. Power conditioning systems for grid inter-connected power generation were entirely imported.

Around 30 systems houses were involved in the lantern and street lighting programmes, 16 organisations in water pumping and over 15 in solar lighting. Most were small-scale serving a niche local market, with only TATA BP and RES of any significant size.

Only Tata BP Solar, RES Photovoltaics and Udhaya Semiconductors, all manufacturers, had created dealership networks of any significance - as the demand had not encouraged such structures. Only one large organisation with an established dealership network across India was known to be investing in market development and only on a small scale.

Based on appraisals conducted under the IREDA programmes, incidence of systems failure - through poor installation or incorrect or inappropriate BOS specification - was high, at over 30 %.

5 Financing Options

Decentralised electrification of rural areas was considered more cost effective then developing more large power stations and extending the national grid, and the benefits of electrifying the rural areas were considered necessary to the continued development of the nation. The benefits as seen by the Indian government included: increased awareness, support to weaker sections of society, improved healthcare, improved education, and income generation through farming, fisheries, handlooms, and village craftsmen. In addition, providing electricity to a greater portion of the population will increase the market for electrical goods, providing follow on economic benefits.

The World Bank had mobilised a line of credit of 195 MUSD for the "India: Renewable Resources Development project", which envisaged installation of a capacity of 187.5 MW in three renewable energy sectors, of which PV accounted for 43 MUSD of the funds.

A number of banks and non-banking financial companies handled lines of credit and leasing for IREDA's SPV Market Development Programme

Those projects which used World Bank funding utilise a revolving fund, while other projects had provided 50 % subsidies or interest rate subsidies. In general, at least some form of cost recovery was used, usually with collection conducted by local intermediaries. IREDA was the institution that monitored the financial transactions and was the final collector of payments.

Over five years from 1998, PVMTI was expected to invest 15 MUSD at a preferred leverage of 3:1, increasing the annual PV market size from 10 MWp/year in 1997 to 28 MWp per annum.

Indonesia

Land Area	1 812 000 km^2
Population	197 million
Population Density	108.7 inhab per km^2
Urban Population	36 %
Labour Force	91 million
Population Growth Rate (1980-1996)	1.8 %
Literacy Rate	77 %

General Data			
Insolation	4.5 kWh.m^{-2}.day^{-1}	Latitude	5°S
Population unelectrified	70 %	Terrain	Mostly coastal lowlands, larger islands have interior mountains

PV Data	
PV power installed	1.8 MWp
Technical potential	900 MWp (based on 50 Wp SHS for 65 % of households currently without electricity, assuming 5 people per household)
PV programmes committed	1997 programme to install 1 million SHSs nationwide. World Bank and GEF funding was secured for 200 000 homes (10 MWp) in West Java, Lampung and South Sulawesi.
Government policy	Government had made rural electrification a priority and Suharto government gave considerable support to photovoltaic applications. In 1997, the GOI set a target for 50 MWp of PV by 2005.
Utility programmes & strategies	Specific utility involvement unknown.
Market sophistication	Advanced
Technical development	Weaknesses in the Indonesian industry were in the production of high quality batteries and photovoltaic modules, both of which were being addressed
Pricing structure	As part of World Bank/GEF project dealers should receive five year loans at market rates through the commercial banks (refinanced by Bank Indonesia from donor funds). Dealers should set their own terms for clients. Also large potential for cash sales.
Testing & Standards	The Bureau for the Assessment and Application of Technology is responsible for UPT-LSDE, a government laboratory with extensive facilities was responsible for the testing and demonstration of PV technology. Presence of international companies should ensure modules tested to international standards.

1 Economic and Political Aspects

Indonesia is one of the major island groups of Asia, encompassing 1.8 million km^2, and is the fourth most populous country in the world. The 1996 population was estimated at 197 million, with a growth rate of 1.8 %. A fall in the birth rate from 5.6 % in the late 1960s, to 2.9 % in 1996, offset the significant decline in the mortality rate over the same period.

Although the literacy rate was estimated at 77 %, there were a wide variety of languages and dialects, making estimates of literacy difficult to quantify. The proportion of people living in urban areas increased from 22.4 % in 1980 to 36 % in 1996. The urban population had grown at a rate of around 5.4 % a year, compared to a rural population growth of just 0.8 %. A total of 50 million people – 55 % of all those employed - worked in the agricultural sector.

Before the Asian economic crisis of 1998, which had a major impact on both the political and economic environment of Indonesia, the country was known as one of the 'Tiger Economies' of Asia. In 1996, Gross Domestic Product was estimated at 226 BUSD with an annual growth rate of 7.7 % and inflation of 8.8 % between 1990 and 1996. This growth was led by the Indonesian government, which invested heavily in developing infrastructure to support industrial activity - especially in the 'high-tech' sector - and encouraged private sector commercialism. Although Indonesia retained elements of central planning - notably five year plans - it had started to deregulate key areas of the economy.

Prior to 1998, Indonesia had a balanced economy, with output split almost evenly between the three main sectors. Exports were dominated by semi-processed and manufactured goods, following the collapse of gas prices (which was Indonesia's main source of wealth) in the 1980s.

Industry had been the main driver of economic growth. In 1996, it had expanded its share of GDP from 8 % in 1965 to around 24 %. However, in more recent years utilities were the fastest growing sector, averaging annual growth rates of 14 % since 1985.

2 Grid Electrification Status

The Ministry of Mines and Energy was responsible for the national electrical supply, operating through two offices, the Bureau for Planning (BAPPENAS), and the Directorate General of Electricity and Energy Development (DGEED). However, many of the other offices had active involvement in previous PV programmes, depending upon the sector, for example health, industry and R&D.

A single state owned utility, Perusahaan Umum Negara (PLN), provided electrification on the national scale, with an installed generating capacity of 11.6 GW and annual production of 61.2 TWh, the majority of which was provided for industrial loads. As the population was spread across a large number of islands, central infrastructure was only feasible on those islands that had large populations and were supporting economic activity. PLN had historically relied upon hydro-electric and diesel generators to power 'mini-grids' for rural electrification. With 63 % of the rural population estimated to consume under 30 kWh per month, many of the more remote areas were considered uneconomic for operation by PLN, and electricity was provided by small private sources, usually village co-operatives known as 'KUDs'.

Although the government had made rural electrification a priority, the fragmented geography of the archipelago created particular problems for extension of the grid. For this reason many rural population centres were served by isolated diesel mini-grids, with capacities of 20 kW to several megawatts. However, in the smallest and most dispersed communities, these isolated grids were not viable and PV could be an economical option.

The Bureau for the Assessment and Application of Technology (BPPT), under the Ministry of Research and Technology was responsible for the management of all state-initiated PV projects. BPPT was responsible for UPT-LSDE, a government laboratory with extensive facilities for the testing and demonstration of PV technology.

The Ministry of Co-operatives was involved in project implementation due to the high involvement of village co-operatives (KUDs) in SHS projects. It had developed selection criteria for the KUDs involved in previous PV projects and provided the interface between the KUD network and GOI.

Energy production per capita in 1994 was 281 kWh and total national production was 53 414 GWh. The residential share of electricity consumption had fluctuated widely since 1986, with the share in 1993/94 being over 30 %. The industrial share grew strongly up to 1991, and was around 50 % in 1994. In 1995, Perusahaan Umum Negara's (PLN), the state owned electricity company, capacity was 14 370 MW (55 % of the total) and non-PLN capacity was 11 693 (45 % of the total). Of the 124.6 million rural population, 34 % were supplied by PLN for light, 4 % were supplied by non-PLN sources and 62 % used kerosene. Demand for electricity grew at 11.8 % per annum between 1985 and 1995: in 1996 demand was reportedly growing at about 15 % per annum.

There had been a rapid increase in the number of households with access to electricity, increasing from 14 % in 1985 to just under 40 % in 1995. An alternative indicator for rural electrification was the village electrification rate (a village is regarded as electrified if more than twenty households are connected to the electricity supply). There were about 62 000 villages in Indonesia, of which 57.5 % were electrified in 1995. However, there were wide regional variations: Java had the highest ratio at 78 %, whilst Kalimantan had a rate of only 28 %.

3 PV Programme Experiences and Policy Issues

The previous Indonesian government gave considerable support to photovoltaic applications, because President Suharto considered the electrification of the country to be a priority for maintaining economic growth and believed that photovoltaics offered one of the most cost effective methods. It was not known what direction the new government would take regarding the implementation of PV for rural electrification.

By the end of 1996, government sponsored solar PV projects and private initiatives had resulted in the installation of over 1 MWp of PV capacity in rural areas. PV systems were first demonstrated in Indonesia in 1979 through a water pumping project carried out by the German Aid agency GTZ, with the assistance of the Indonesian government.

The first rural electrification was of Sukatani village, Java, where 85 SHS, 7 public systems and 15 street lights were installed in 1989. This was funded by the Dutch aid agency DGIS, and involved the BPPT, the Ministry of Co-operatives, the local government and the international and local branch of PV manufacturer, R&S (now Shell Solar).

The success of the Sukatani project led to a rural electrification scheme in the village of Lebak, in which a further 500 systems were installed; these systems typically had a 45 Wp module, sufficient to power two 6 W lights.

The above pilot programmes were followed by the Presidential Aid Programme, BANPRES, with interest-free credit provided for 3 000 SHS. These were successfully installed and, although cost-recovery was poor, some additional credit schemes had been started through the revolving fund.

Since 1993 the Department of Health had driven the installation of 270 medical clinics with PV lighting and refrigerators, requiring around 75 000 PV modules. Eight hybrid mini-grids had also been installed in eastern Indonesia, on Nusa Penida. The hybrid generators were developed by IPC / Westinghouse and used a meter prepayment system, which aimed to match customer consumption with ability to pay. Additional major projects included the GTZ Eldorado Sun, a project funded by the German Aid agency GTZ to develop solar pumping projects on four islands, and a project funded by the Australian Aid agency AusAid to install 36 400 SHS of 50 Wp each.

In 1997, the World Bank and the Global Environment Facility (GEF) were in the process of launching a programme to assist the Government of Indonesia (GOI) to provide 200 000 Solar Home Systems to households in West Java, South Sulawesi and Lampung, Sumatra.

All solar equipment was exempt from import tax and duties, providing similar products were not manufactured in Indonesia.

4 Domestic PV Industry

All of the major international photovoltaic power system manufacturers, such as BP Solar, Kyocera, Shell Solar, Siemens and Solarex had either a subsidiary or local distributor in Indonesia, an indication that Indonesia's policies encouraging both the implementation of photovoltaics and the use of the local labour force in the manufacture of photovoltaic power system components were successful.

While the use of high import tariffs to protect local industry could lead to stagnation in the market and poor quality, high cost goods, the Indonesian market remained competitive through collaboration with international firms. The two main weaknesses in the Indonesian industry were the absence of the production of high quality batteries and photovoltaic modules, both of which were being addressed. A local battery manufacturer was working in conjunction with BPPT to develop high quality batteries, and attempts were being made to acquire the ‘clean’ manufacturing technology necessary for silicon cell production.

The BPPT had invested considerably in the development of its Test Laboratory, UPT-LSDE, located near to Jakarta in Serpong. This facility was set up in 1979 and was equipped with over 7 kWp of PV test array, which could be configured to provide output voltages of 12 V to 240 V. It had several laboratories for testing electronic control devices and a computer-based data acquisition system, as well as PV pumping and battery test facilities.

BPPT had closely monitored the standards and performance of the existing SHS projects installed. It was partially responsible for developing the specification of the BANPRES SHS, together with the private PV industry involved.

Further assistance in testing and training was being sought as part of the proposed WB/GEF project. This would enable UPT-LSDE to carry out certified approval of each solar home system to be installed by the dealer networks. The criteria were that each 50 Wp or larger system should power at least three fluorescent lights (@ 200 lumens) and a black and white TV for 4 hrs/day or more, assuming average insolation.

5 Financing Options

The Lebak and Sukatani projects were sold to the villagers through the co-operatives (KUD) by means of an interest free loan. Average investment was around 400 USD. The villagers made a downpayment of 5 % followed by monthly payments of around 3 USD for a period of 10 years. This was used to cover maintenance and repairs, with the remaining money used to establish a revolving fund for further projects.

The Indonesian government identified the lack of appropriate financing as the single greatest impediment to increased use of photovoltaic systems for rural electrification. The Presidential Aid Programme (BANPRES), opened personally by President Suharto in 1991, was aimed at providing interest free loans through village level KUDs in 13 provinces. Although the programme led to the purchase of around 3 300 systems, it was considered a promotional programme because of the poor cost recovery record. Purchasers were required to make an initial payment of 5 % of the 400 USD cost, followed by payments of approximately 3 USD per month for ten years.

However, in 1993 it was estimated that BANPRES fee collection was in arrears by 40 %, attributed to seasonal incomes, short term cash crises and inadequate income levels to meet payment obligations. Failure to disconnect, particularly of the village elite, also encouraged non-payment. Consumers expressed the need to make the down payment by instalments over several months. The monthly fee was equivalent to the monthly connection fee on the grid, although it has been noted that other SHS projects with substantially higher fees had equal or better payment records. Demand was considered relatively price inelastic so higher cost recovery and shorter terms could perhaps have been acceptable. A major problem was the need to replace batteries, the high cost of which often resulted in the purchase of inferior technology.

Subsequent projects had targeted end-users that were able to pay for the systems on a consumer financing basis. Three major local dealers - Pt. Sudimara, Pt. Kyocindo and Pt. Walet - offered short term credit (3 years) at around 18 % interest with a 30 % downpayment. Typical monthly fees of around 8 USD were required.

In 1995 Sudimara reported system sales at 400 USD plus 10 % VAT. Around 10 % to 15 % of sales were cash. Credit terms were 140 USD downpayment and 40 monthly payments of 10 USD interest at 1.5 % a month. These were being sold through regional service centres (approximately one per 10 000 to 20 000 families) in three provinces.

One of the major PV manufacturers had also recognised the private sector opportunities and taken an aggressive approach, focusing on the outer provinces which public-funded programmes had not reached. This required substantial investments in capacity building of dealers and end-users. Overall, the company witnessed several thousands of sales by private dealers over the past decade. Some sales were based on informal credit mechanisms, but the company believed that tens of thousands of cash-paying customers would exist if the market were fully developed.

In 1995 it was reported that 13 000 SHSs had been sold privately. Smaller systems were found to be more profitable. Payment plans lasting longer than two years did not seem to work, apparently because battery failure occurred during repayment, at which time collection rates fell sharply.

This private initiative found that collection at village level was enhanced by having village level dealers who knew the individuals concerned. Dealers had to have previous experience of financing as it was not considered worthwhile to train them. Very few sales were through bank credit (perhaps because PV is not a income generating asset). Supplier credit for dealers was considered crucial for successful marketing and distribution. Many systems were sold for cash, and market development was viewed by the initiating company as more of a constraint than was the absence of special financing mechanisms.

In 1997, the GOI set a target for 50 MWp of PV by 2005, to be installed across 6 000 of the 13 000 islands, which make up Indonesia. It aimed to install 1 million SHSs nationwide. Marketing and credit would be managed by local government in co-operation with Co-operative Village Units (KUDs). Donor funds were to be on-lent through Bank Rakyat Indonesia (BRI). KUDs would act as financial intermediaries, with users signing a lease-purchase contract involving monthly fees until the total cost had been paid and ownership transferred. In the meantime, KUDs and suppliers would co-operate for installation and maintenance.

As a part of the above programme, World Bank and GEF funding was secured for 200 000 homes (10 MWp) in West Java, Lampung and South Sulawesi. Around ten dealers should receive five year loans at market rates through the commercial banks (refinanced by Bank Indonesia from donor funds). Dealers should set their own terms for clients, which were expected to be around 80 USD to 100 USD downpayment with subsequent monthly payments for 3 - 4 years. Dealers would receive a GEF grant of 75 USD per unit in Java and 125 USD per unit on the other islands.

Kenya

Land Area	569 000 km^2
Population	27 million
GDP per capita	377 USD
Population Density	47.5 inhab. per km^2
Urban Population	30 %
Labour Force	418 000
Population Growth Rate (1980-1996)	3.1 %
Literacy Rate	69 %

General Data			
Insolation	5.4 $kWh.m^{-2}.day^{-1}$	Latitude	1°00 N
Population unelectrified	90 %; perhaps 1 % of rural population electrified.	Terrain	Low plains rising to central highlands bisected by Great Rift Valley; fertile plateau in west.

PV Data	
PV power installed	Over 2 MWp
Technical potential	155 MWp (based on 50 Wp SHS for 65 % of households currently without electricity, assuming 5 people per household.)
PV programmes committed	Photovoltaic Market Transform Initiative
Government policy	Rural Electrification Master Plan should re-stimulate rural electrification activities. It was anticipated the plan wouldl give specific attention to PV.
Utility programmes & strategies	Kenya Power and Lighting Company responsible for implementation and operation of the Rural Electrification Programme.
Market sophistication	Advanced
Technical development	BOS components manufactured; modules imported.
Pricing structure	Commercial cash sales/ short term credit based market
Testing & Standards	There had been no organised standards, testing or certification programmes.

1 Economic and Political Aspects

Since 1993, the Kenyan government had implemented a programme of economic liberalisation and reform. These reforms included the removal of import licensing and price controls and the privatisation of publicly owned companies.

The population was approximately 29 million people, with a growth rate of 3.1 % between 1990 and 1996. Approximately 20 % of the population was urban based. Nairobi, the capital city, is the primary city of the region.

Gross Domestic Product was estimated to be 356 BUSD in 1996, with a growth rate of 5.8 % between 1990 and 1996: inflation over this period was estimated at 9.9 %. Between 75 % and 80 % of the 8.78 million strong labour force were engaged in agriculture, accounting for some 30 % of GDP. The primary industrial activities were the manufacture of small-scale consumer goods, processing of agricultural products, oil refining, cement and tourism. Imports were estimated at 2.6 BUSD in 1996 compared to exports of 1.9 BUSD. Tea and coffee accounted for nearly 55 % of export earnings. Kenya's main trading partners were Uganda and the United Kingdom.

2 Grid Electrification Status

Electricity generating capacity was estimated at 81.2 GW in 1995, with generation of 415 TWh in that year, providing a production per capita figure of 439 kWh. In 1995, over 83 % of Kenya's electricity was generated from large hydro sources along the Tana and Athi rivers. A further 9 % was generated from oil. There were two privately owned generators providing electricity to Kenya Power and Lighting Company (KPLC). Approximately 15 % of generated electricity was lost through transmission losses and theft. Demand had grown at approximately 6 % per year and the installed generating capacity had been unable to meet this growth in demand resulting in load shedding throughout the country. More than 50 % of the electricity generated was consumed in Nairobi province, with a further 20 % consumed in Coast Province.

Kenya's power sector was in the process of privatisation in an attempt to break the power monopoly of KPLC. The project, launched in 1997 was funded by the World Bank, the European Investment Bank and the Ministry of Energy.

Efforts to provide electricity to the rural areas of Kenya were started by KPLC in the 1960s and were formalised in the Rural Electrification Plan of 1973. However, it was not until the late 1980s that a larger scale development started to take place. The prime objective of the programme was to extend electricity into 'sub-economic rural areas' focusing on supply of electricity to agro-based and other small industries. Individual households were not given priority in REP planning as the costs were too high.

In 1994 the government of Kenya with the African Development Bank initiated the development of the Rural Electrification Master Plan in order to re-stimulate rural electrification activities. It was anticipated that the plan would give specific attention to the potential role of PV as a complement to traditional grid related activities. However, the documentation was not available.

3 PV Programme Experiences and Policy Issues

There had been a number of small PV projects in Kenya over the last 10 years funded by various multilateral and bilateral agencies.

Between 35 and 40 kWp of PV was installed as part of a project to develop commercial fishing in Lake Turkana in 1989. The PV equipment was used for power pumping, security lighting, refrigeration and office power systems. The fisheries project was not a success and much of the equipment was reused in other projects.

Several hundred PV vaccine refrigerators had been installed by the Ministry of Health under the Kenyan Extended Programme of Immunisation since 1990.

A water pumping project was initiated to install 10 to 12 PV pumps for Maasai communities around Amboseli. The project was funded by grants from Swedish donors who were no longer active in Kenya. Of the 10 to 12 pumps originally identified, only five or so were actually installed.

A programme started in 1994 to make low cost solar lanterns widely available in Kenya was started in 1994 funded by the World Bank ESMAP, CSC, the Ashden Trust and the UK DfID.

Government policy towards PV in Kenya was very positive although very little money was actually spent. The Ministry of Energy had a renewable energy and solar power section although it was not well funded. The Ministry of Energy runs 10 energy demonstration centres in various districts of Kenya.

Although duties on PV and associated equipment were lowered in 1994, the duty structures are complex: a PV module without bypass diodes attracts lower duties than one with bypass diodes. This effectively discriminated in favour of amorphous silicon modules. A PV module without bypass diodes attracted 5 % import duty and no VAT whereas a module with bypass diodes attracted between 10 % and 15 % duty and VAT (15 %). Charge controllers attracted full import duties (35 %) and VAT (15 %).

4 Domestic PV Industry

The PV market in Kenya had been active for over a decade and estimates were that over 50 000 solar home systems had been installed on a commercial basis and a large number of government/donor systems had been installed in other remote power markets.

There were as many as 15 PV module distributors and a further 20 or so companies manufacturing balance of system equipment, with hundreds of small independent agents marketing or installing PV systems in rural areas. Many of the large international PV manufacturers had appointed dealers in Kenya: these dealers import both modules and BOS components. There were two local manufacturers of batteries providing both automotive and solar batteries as well as numerous companies manufacturing lamps as well as limited manufacture of charge controllers and inverters.

In 1996 it was estimated that perhaps 270 kWp of PV was installed of which 110 kWp was amorphous silicon technology. Including BOS and installation, the PV market was worth in the region of 5 MUSD in 1997. Between 50 % and 60 % of this was in the solar home systems market.

5 Financing Options

Although there were no operational finance schemes in place for solar home systems in Kenya, hire purchase schemes financed as many as 2 000 systems per year. These schemes were usually over a 12 or 24 month period and interest levels could be as high as 40 %. Kenya's banking system was one of the strongest in East Africa, but it was primarily based in Nairobi and other major cities. Local lenders and donors had prioritised rural credit for businesses and there were a number of initiatives investing in rural credit in the pubic and private sector. Credit was available to agricultural co-operative members through locally based co-operative agencies. However, PV was still a new concept to most banking organisations and no PV financing projects had gone beyond the pilot stage. NGOs have a role to play in the non-formal credit sector and Kenya Rural Enterprise Programme (K-REP) had been active in this area. K-REP had developed and implemented successful methodologies for providing small loans to rural entrepreneurs based on group security mechanisms. K-REP had been involved in a number of solar projects in the past. There were plans for the NGO to split into a Rural Bank (which will be capitalised with 1 MUSD).

The Co-operative Bank of Kenya was the largest rural credit provider in the country and worked with various rural co-operatives. The bank was in the early stages of a pilot financing project for solar home systems.

Over five years from 1998, PVMTI was expected to invest 5 MUSD at a preferred leverage of 2:1, increasing the annual PV market size from the current 300 kWp/year in 1997.

Malaysia

Land Area	329 000 km^2
Population	21 million
GDP per capita	4 724 USD
Population Density	63.8 inhab per km^2
Urban Population	54 %
Labour Force	8 000 000
Population Growth Rate (1980-1996)	2.5 %
Literacy Rate	78 %

General Data			
Insolation	5.1 $kWh.m^{-2}.day^{-1}$	Latitude	2 30 N
Population unelectrified	19 %	Terrain	Coastal plain rising to hills and mountains

PV Data	
PV power installed	640 kWp (1993)
Technical potential	26 MWp
PV programmes committed	Ministry of Rural Development established a rural community initiative encompassing the Sabah, Sarawak and Peninsular Malaysia Provinces in 1996. The 34 MUSD programme was to run for 5 years in 2 phases to improve rural village services.
Government policy	Supportive of PV for rural electrification providing it was economic.
Utility programmes & strategies	TNB utility had installed PV for evaluation purposes.
Market sophistication	Low
Technical development	No PV industry although technical capability exists.
Pricing structure	Unsubsidised
Testing & Standards	Group C member of International Electrotechnical Committee.

1 Economic and Political Aspects

Malaysia has a land area encompassing 329 000 km^2 of isthmus and island in the Pacific rim area, and an estimated population of 21 million in 1996. The population growth rate between 1990 and 1996 was estimated at 2.5 %. Approximately 54 % of the population was urban-based, while 20 % of the 8 million strong labour force was engaged in agriculture. Literacy tares were estimated at 78 %.

Malaysia is one of the "Tiger" economies of Asia, generally considered an emerging, rather than developing market. Gross Domestic Product was estimated to be 99 BUSD in 1996 with a growth rate between 1990 and 1996 of 8.7 %, the highest of the countries in this survey. This growth had resulted in a marked increase in real wages and a substantial reduction in poverty. (It must be noted that the recent financial crises in the area may call the sustainability of this growth into question.)

Prior to the crisis, Malaysia’s economy was export led, with exports estimated at 84.6 BUSD in 1996, compared to imports of 83.2 BUSD in the same year. Exports were mainly of electronic goods and petroleum products to the USA, Singapore and Japan. The consumer price index between 1990 and 1996 averaged 4.2 %.

2 Grid Electrification Status

Installed electricity generating capacity was estimated at 8 GW in 1995, generating some 45.5 TWh in that year. In 1995, approximately 87 % of the generated electricity was from thermal sources and the remainder from hydro. Per capita electricity production was 2 167 kWh. Approximately 99 % of the Malaysian Peninsula was electrified, although in the Sabah and Sarawak regions, electricity only reached approximately 70 % of the population. Projections were that electricity demand would continue to grow for the foreseeable future. During the Seventh Malaysia Plan, (1996-2000) there were plans to commission more than 4 GW of electricity generating capacity. This increased capacity was to be met by the three existing utlitiies: Tenanga National, Sabah Electricity Board and Sarawey electricty Supply Corporation and nine Independent Power Producers. Work on the 2.4 GW Bakun Dam project was suspended indefinitely in 1997 citing an unexpected rise in the project cost due to the country’s economic difficulties.

With regard to the rural areas, grid connection was not regarded as economical, primarily due to low consumption rates (estimated at less than 1 kWh/day). As a result, PV and mini/micro hydro systems were viewed as pre-grid electrification options to introduce the convenience of electricity.

The Malaysian Governments Energy Policy revolved around the supply, utilisation and environmental objectives. Supply objectives aimed to provide the nation with adequate and secure energy supplies: efforts to do this focused on reducing Malaysia’s dependence on oil and by developing and utilising alternative energy sources. The utilisation objective aimed to promote energy efficiency and discouraging wasteful and no-productive patterns of energy consumption. The environmental objective sought to ensure that factors relating to the environment were not neglected in pursuit of the supply and utilisation objectives.

3 PV Programme Experiences and Policy Issues

There were a wide range of different PV systems applications in Malaysia, including water pumping, SHSs, professional systems (particularly telecommunications) and annual procurement with the military.

In the 1980s, the since privatised electricity utility in Malaysia, Tenanga National Berhad, through its R & D arm, TNRD, initiated a programme to evaluate the technical and economic potential of renewable energy, concentrating on mini-hydro and PV projects. Three stand-alone solar home projects were implemented by TNB: 37 houses in Apau, Langkawi; 70 houses in Tembeling, Pahang; and 50 houses in Pulau Sibu, Johor. These systems were all abandoned due to poor performance of the batteries and untrained staff following the departure of the project team.

In 1994 a 10 kWp plant was installed at Manahan, Sabah. The plant was used for supplying lighting and power for refrigeration, TVs and radios for 17 houses. In 1996 a 100 kWp plant was opened at Marak Parak, Sabah to provide power for 300 houses. In 1996 CASE completed the installation of two RAPS systems using PV-wind hybrid systems at two locations in Sarawak.

TNB/TNRD also had plans to install six, 3 kWp to 5 kWp grid connected PV systems at different locations in the Klang Valley between 197 and 1999.

In 1996 the Malaysian government established through the Ministry of Rural Development a rural community initiative encompassing the Sabah, Sarawak and Peninsular Malaysia Provinces. The programme was part of a 5 year programme to improve rural village services and had a major PV component. Phase 1 consisted of the installation of 1 200 stand-alone systems, and Phase 2, (co-funded by AUSAID) will involve the installation of 7 200 systems for home lighting, vaccine refrigerators and school facilities. Phase 1 was worth an estimated 4 MUSD with Phase 2 worth 30 MUSD between 1997 and 2002.

Aside from these programmes, experience with photovoltaic power systems was mainly in the private sector and concentrated in the telecommunications sector.

4 Domestic PV Industry

While Malaysia had a highly developed manufacturing base, photovoltaic production capacity was non-existent. As a result nearly all components, modules and BOS, were imported.

5 Financing Options

The recent financial crisis in the far East had affected the market for PV. The 40 % devaluation of the Ringgit, coupled with the fact that there were no indigenous PV manufacturers resulted in a sharp increase in the price of imported equipment and components and drastically reduced the affordability of PV systems. This situation was compounded by the fact that the rationale behind the Malaysian government's investment in rural electrification was to allow market mechanisms to establish prices. This provided little incentive for private sector involvement in PV.

Mongolia

Land Area	1 570 000 km^2
Population	3 million
GDP per capita	324 USD
Population Density	1.9 inhabs per km^2
Urban Population	61 %
Labour Force	1 000 000
Population Growth Rate (1980-1996)	2.6 %
Literacy Rate	83 %

General Data			
Insolation	4 $kWh.m^{-2}.day^{-1}$	Latitude	46 00 N
Population unelectrified	60 %	Terrain	Vast semi-desert and desert plains; mountains in west and southwest: Gobi desert in southeast.

PV Data			
PV power installed	80 kWp (1993)		
Technical potential	12 MWp	Commercial potential	5 MWp
PV programmes committed	Unknown		
Government policy	PV systems were seen by the Mongolian government as providing a possible method of providing electricity for nomadic herders.		
Utility programmes & strategies			
Market sophistication	Low		
Technical development	Low		
Pricing structure	No specific PV financing available.		
Testing & Standards	Unknown		

1 Economic and Political Aspects

Mongolia is a large, land-locked country sharing borders with China and the former Soviet Union. Mongolia had begun to undergo economic transition from a centrally controlled and planned economy. Mongolia had a population of approximately 3 million people and a land area of 1 570 000 km^2: Mongolia had a population density of 1.9 inhabitants per square kilometre, the lowest of the surveyed countries. Of the population, an estimated 51 % lived in urban areas. The population growth rate was estimated at 2.6%, with literacy estimated at 83 %.

The labour force was estimated at 1 million people, with 51 % engaged in agriculture and 36 % in government positions. The Mongolian lifestyle was traditionally nomadic, and a large number of the agriculture related labour was engaged in nomadic herding of semi-domesticated livestock.

Mongolia's economy was still in transition, the Gross Domestic Product in 1996 was estimated at 972 MUSD with a growth rate of 1.3 % between 1990 and 1996. The government of Mongolia had embarked on a programme of economic liberalisation, relaxing price controls, as well as liberalising domestic and international trade. However, Mongolia’s severe climate, scattered population and large expanses of unproductive land had constrained economic development.

Economic activity had traditionally been based on agriculture, which accounted for nearly 30 % of GDP. In the past, a substantial mining and processing industry in coal, copper, molybdenum, tin, tungsten and gold was developed with support from the former Soviet Union. Copper exports accounted for nearly 50 % of Mongolia’s export earnings but recent low prices had held back economic development.

2 Grid Electrification Status

The energy sector in Mongolia was an interesting mix of traditional resources (animal dung in rural areas), indigenous coal (for electricity production and district heating) and oil fuel (for electricity production and transportation). Electricity generation was the responsibility of the state owned utility. Electricity generating capacity in Mongolia was estimated at 1.25 GW in 1996 and electricity generation in 1994 was estimated at 3.07 GWh.

Electricity generation and distribution and in Mongolia can be divided into four categories. The Interconnected System served the three main cities and a number of larger towns in 6 of 18 provinces. Electricity was generated from coal powered thermal power stations with some electricity imported from Russia. A series of larger decentralised grids, powered by smaller coal fired power stations and diesel generators towns provided power in the other provinces. Smaller decentralised grids, powered by diesel generators of 60 kW and above provided power for rural municipal centres with populations of between 800 and 2 000 inhabitants. Stand-alone systems were used for rural households, these were usually gasoline generators, small wind powered generators and PV systems.

There was no history of renewable energy programmes or photovoltaic programmes in Mongolia, but PV systems were seen by the Mongolian government as providing a possible method of providing electricity for the nomadic herders.

3 Programme Experiences and Policy Issues

In general the experience with PV in Mongolia had been extremely positive and there were no significant technical barriers to utilising the technology. UN and Japanese co-operative projects had successfully demonstrated the effectiveness of the technology.

Research into photovoltaics began in the 1970s in Mongolia under the umbrella of a UNDP project. Between 1979 and 1983 two PV water pumps, a refrigerator and lighting systems were installed along with approximately 35, 6 Wp lighting systems for herding families. A follow on project finanaced by UNDP in 1987 resulted in the laboratory production of PV cells of 13 % efficiency. Small (0.5 Wp) battery chargers for radios were fabricated and field tested and 40 Wp systems for radio ,TV and lighting were imported from the USA for evaluation.

During 1989 and 1990, the Ministry of Energy, Mining and Geology distributed between 2 000 and 3 000 small PV lighting systems imported from China. Each unit consisted of an 11 Wp amorphous silicon module manufactured by Harbin Chronar of China and a Chinese manufactured lantern unit. It was reported that the amorphous silicon modules experienced some initial power degradation although no comprehensive evaluation of the project had been undertaken.

The Institute for Renewable Energy (IRE), in a collaborative project with Japan evaluated the performance of more than 100 PV systems for the nomadic herder families. The systems comprised of a 204 Wp array, a 200 Ah battery and an inverter thus allowing the use of standard domestic appliances.

In the telecommunications sector, 5 mobile communications systems using PV power supplies were in use and their use for repeater stations had been included in the new telecommunications master plan.

4 Domestic PV Industry

There were four organisations in Mongolia with experience of photovoltaics. The Institute of Renewable Energy which had experience in assembling systems using imported components. The Institute of Physics and Technology had manufactured cells from imported wafers and assembled PV modules (0.5 Wp to 6 Wp). These activities were primarily on a laboratory scale and facilities for commercial manufacture were not available.

The ABE Company is the only commercial organisation with PV experience (largely in the telecommunications sector) and had imported a PV module laminator with a capacity to manufacture 100 kWp/yr of modules. It was not known whether this was operational. A joint venture company, Monmar, was primarily involved in the manufacture of wind generator systems but had experience relevant to PV systems.

5 Financing Options

As far as was known there were no financing options for PV systems in place in Mongolia. All PV systems had been supplied as either aid or demonstration projects. It was unknown whether the initial projects would be followed up with further applications of photovoltaic systems, and if so where the funding would come from and whether cost recovery methods would be employed to develop a sustainable market. It was apparent that Mongolia did not have the capability to produce photovoltaic systems without importing primary components from abroad, and it can be assumed that this will be a hindrance to future programmes.

Morocco

Land Area	446 000 km^2
Population	27 million
GDP per capita	1 364 USD
Population Density	60.5 inhabs per km^2
Urban Population	53 %
Labour Force	11 million
Population Growth Rate (1980-1996)	2.1 %
Literacy Rate	35 %

General Data			
Insolation	5.1 kWh.m^{-2}.day^{-1}	Latitude	32°N
Population unelectrified	75 %	Terrain	Northern coast and interior are mountainous with large areas of bordering plateaus, intermontane valleys and rich coastal plains

PV Data	
PV power installed	2 MWp (3.5 MWP in 1998)
Technical potential	130 MWp (based on 50 Wp SHS for 65 % of households currently without electricity, assuming 5 people per household.)
PV programmes committed	PERG/KfW, PVMTI
Government policy	Government was committed to electrifying most of the remainder of the country (1.6 million households) by 2010, and had indicated that approximately 5 % of those households should be electrified using off-grid solar and wind technologies.
Utility programmes & strategies	Utility, ONE, was starting to experiment with contracting the provision of PV-based electricity services to the private sector. ONE has provided funds for 7 000 SHS.
Market sophistication	Medium
Technical development	Six suppliers of modules from international sources and one active local manufacturer of PV modules. A number of firms are involved with BOS component manufacture.
Pricing structure	Micro-credit available from NGOs. The country's largest rural bank, had disbursed loans to entrepreneurs seeking to set up franchises for SHS/Battery charging stations. A number of other banks had expressed interest in co-financing rural electrification projects.
Testing & Standards	The National Centre for Renewable Energy (CDER-Centre de Développement des Energies Renouvables), supported by the German Government (GTZ Special Energy Programme) has a laboratory equipped to test PV components and has prepared national standards and specifications.

1 Economic and Political Aspects

Morocco, on the north-western coast of Africa, had a land area of 446 000 km^2, and a population of 27 million people, which grew at a rate of 2.1 % in 1996. The urban population made up 53 % of the total population, while 50 % of the 11 million strong workforce were dependent upon rural agriculture. The country as a whole had an estimated literacy rate of 35 %.

From the early 1980s the Moroccan government had pursued an economic programme, with the support of the IMF and World Bank, to reduce government spending, reduce inflation, privatise state industries and open the economy to foreign trade and investment. Morocco's GDP was 36.8 BUSD in 1996, or 1 383 USD per capita. GDP grew at a rate 2.1 % between 1990 and 1996. Inflation during this period was 5.5 %. The mainstay of the Moroccan economy was the agricultural sector, although droughts had depressed agricultural activity resulting in a 7.5 % contraction in GDP in 1995. In 1996 exports totalled 7.7 BUSD in 1995 whilst imports were 9.8 BUSD.

2 Grid Electrification Status

The state owned Office National de l'Electricité, (ONE) was responsible for electricity generation and distribution. Installed electricity generation capacity was 2.4 GW of which 95 % was oil and coal generating plant. Electricity generation in 1995 was 12 TWh or 444 kWh per capita.

As of 1997, approximately half of Morocco had been electrified with a grid that was largely reliable. However, in rural sectors the figure was much lower (sources suggest between 16 % & 25 %). Building on a sequence of rural electrification programmes, the government was committed to electrifying most of the remainder of the country (1.6 million households) by 2010, and had indicated that approximately 5 % of those households should be electrified using off-grid solar and wind technologies. The state owned electricity provider, ONE, was starting to experiment with contracting the provision of PV-based electricity services to the private sector. ONE was flexible in its approach for rural electrification and encouraged private sector intervention and development. ONE had adopted two approaches: direct supply of equipment and training to an association who managed revenue collection and maintenance; and a franchising arrangement where the association assumed ownership and management responsibility for the systems and their implementation. ONE installed 2 000 SHS in 1997.

3 PV Programme Experiences and Policy Issues

In an attempt to provide electricity to the thinly spread communities in and beyond the Atlas Mountains, the Moroccan government and bilateral donor agencies had financed rural electrification programmes since 1978. In the early 1990s, the Programme National d'Electrification Rurale (PNER) brought power through grid connection or diesel mini-grids to almost 1 000 of the country's 40 000 villages. The Programme de la Pre-Electrification Rurale (PPER) supported mini-grids, battery charging stations and solar home systems. Under the Phase I of PPER, 22 villages were electrified in 1995, mainly with battery charging stations although in a few villages SHSs were installed. However, system reliability and performance was reportedly poor. In Phase II of PPER, a further 90 villages were to be equipped, 40 with battery charging stations and 50 with SHS. Phase II designs would consist of either 20 Wp or 50 Wp SHS, or battery charging stations.

The German Government through the GTZ Special Energy Programme supported the dissemination through the private sector and revolving funds of 600 SHS in the region of Kenitra and Chefchaouen (1992-97). This experience was the base for the development of the PERG programme with the support of KfW.

In 1995, the government rolled all programmes into the Programme d'Electrification Rurale Globale (PERG), which planned to electrify the entire country by 2010. Preference was to be given to communities that came forward with all financing in place (including a commitment from a minimum number of end users).

A series of projects had also been funded by bilateral donors, from Japan, Spain, Canada and the EU. These had resulted in the installation of off-grid systems in 2 000 villages, although specific PV installations had been limited to the provision of PV electrification for 320 houses, 8 mosques and 5 schools in 7 non-grid connected villages by SODEAN in the Provinces of Chefchaouen and Taounate.

Import duties were levied on PV modules at 2.5% and on balance of systems components at 25 %, this included components not specifically related to PV such as pumps and wiring etc. Import duties on inverters were levied at 17.5 %. Sales taxes were levied at 20 %.

4 Domestic PV Industry

Some 30 organisations were involved in manufacture, systems integration, supply and/or distribution of PV equipment or BOS. There were six suppliers of modules from international sources and one active local manufacturer of PV modules that used cells from Siemens Solar. A number of firms were involved with BOS component manufacture, ranging from battery manufacture, to charge regulators, inverters, ballast/inverters for CFLs and pumps.

The Ministry of Energy and Mines (MEM) indicated that approximately 2 MWp of PV systems were installed by the end of 1994. This took into account the private sector. It was estimated that the total cumulative power installed in 1997 was 3 MWp. Approximately 2 000 villages were equipped partially or totally with SHS, representing perhaps 20 000 systems.

INES, a private sector electrical consumer product firm which had diversified into the PV integration and supply market were installing approximately 100 kWp/year of systems in the private sector and had installed more than 200 kWp since 1994. Many of these installations were with amorphous modules and many with low powered systems with a retail price as low as 120 USD. The field operational performance was unknown but INES advised that many buyers went on to purchase additional modules to increase system size.

The private entrepreneur Afrisol had installed 1 200 SHS systems in Rif, most of which were AC systems ranging from 400 Wp to 2000 Wp. Afrisol imported 10 000 modules/year and supplied as much as 50 % of the PV sector.

The North African Pipeline Corp (NAPC) had equipped 8 villages with SHS and solar pumping systems through a grant of 0.69 MUSD from the Ministry of Interior. NAPC had obtained additional support from the Ministry to partly finance a scheme to be implemented over the next 5 years which would electrify and provide water supply to 500 villages. The first consignment of equipment had been shipped from the USA.

Noorweb, an energy service company, had installed approximately 85 SHS and launched 8 franchises since its inception in 1995. It projected growth to reach 0.5 MWp of installed capacity within 3 years. Sunlight Power Maroc in collaboration with Taqashams, the only indigenous module manufacturer, were a new entrant into the rural electrification market. A pilot programme through FONDEP (Local NGO) was being implemented for several hundred systems.

5 Financing Options

Lack of funding was the main stumbling block to PV implementation in Morocco, although the emergence of micro-credit was an encouraging development for potential PV entrepreneurs. Foundation Zakhoura was Morocco's biggest micro-credit agency. It provided loans in the range of 120 USD to 575 USD, 40 % of which were to commercial clients. Its client base was forecasted to increase from 2 000 to 12 000 by the year 2000, at which time it should become financially sustainable as a non-profit organisation. Loans were provided at 30 % rate of interest with repayment over 6 months with the possibility of refinancing based upon satisfactory performance. Guarantees were offered by a group structure of typically 5 borrowers. The group committed to repay the loan: 8 groups formed a centre and should 2 or 3 borrowers from one centre default, the centre lost the right to refinancing. Zakhoura focused on regions with a population of between 10 000 and 15 000 people. Default rates were 2.4 % for weekly collections and 20 % for monthly collections.

A second NGO, Micro-Development, provided loans of up to 500 USD to rural people, and recovery rates in excess of 95 % were registered.

CNCA, the country's largest rural bank, had disbursed loans to entrepreneurs seeking to set up franchises for SHS/Battery charging stations. The CNCA was the largest rural development bank and had a widespread presence throughout rural Morocco. A number of other banks, including BCM, Morocco's second largest bank and first investment institution, and the privately owned, BMCE - the third largest bank in Morocco –both expressed interest in co-financing rural electrification projects

As of 1998, PVMTI was expected to invest 5 MUSD at a minimum leverage of 1:1 (with co-financing realised directly from the end user or where "relevant co-finance" encompasses only the PV equipment component of the plan). The PVMTI investment was expected to generate a minimum of 20 MUSD of projects with an aggregate across projects of a 2:1 leverage. Growth of the annual PV market from 1.0 MWp/year in1997 to 2.0 MWp per annum over the next five years was anticipated rather than the 1.5 MWp per annum in a business as usual scenario without the PVMTI.

The PERG/ONE programme is essentially a financing scheme where ONE finances 55 % through a 2 % levy on its conventional electricity sales with the remaining 45 % financed by the user (for grid extension projects, the end-user communes contribute 25 % of the cost). The project aims to install some 7000 SHS.

Namibia

Land Area	823 000 km^2
Population	2 million
GDP per capita	1 615 USD
Population Density	2.4 inhabs per km^2
Urban Population	37 %
Labour Force	1 million
Population Growth Rate (1980-1996)	2.7 %
Literacy Rate	38 %

General Data			
Insolation	6.4 kWh.m^{-2}.day^{-1}	Latitude	22°S
Population unelectrified	70 %	Terrain	Mostly high plateau, Namib Desert along coast, Kalahari Desert in East

PV Data	
PV power installed	800 kWp (1.3 MWp in 2000)
Commercial potential	13 MWp (based on 50 Wp SHS for 65 % of households currently without electricity, assuming 5 people per household.)
PV programmes committed	Market oriented dissemination programme in place based on awarness raising, training of local technicians and setting up appropriate financing scheme via revolving fund.
Government policy	In 1993 the Ministry of Mines and Energy launched the programme 'Promotion of the Use of Renewable Energy Sources' where the application of PV systems for rural electricity supply for rural electricity played a predominant role. A market oriented dissemination strategy was developed and has proven successful. PV was then fully integrated into the national energy policy as outlined in the Energy White Paper.
Utility programmes & strategies	A rural electricity distribution masterplan was launched in 1999 integrating grid and off-grid electrification options.
Market sophistication	High
Technical development	Installation and supply of systems capability. Existing capacity to manufacture d.c. refrigeration units and some BOS components such as PV pumps, inverters, state of charge indicators, and regulators. Installation and maintenance capacities established in rural areas.

Pricing structure	Loans accessed from the Bank of Agriculture (Agri Bank), on the same terms as for other agricultural equipment: there was no mechanism for providing subsidies. However, interest rates are slightly lower than commercial rates. A funding scheme, FINESSE, was set up in 1992 to provide financing for small scale energy users. Other developments have subsequently taken place such as the establishment of the revolving fund at Namibian Development Corporation.
Testing & Standards	The SADCC's Technical and Administrative Unit is attempting to develop a regional code of practice covering system design, installation and performance. South African Codes of Practice are in use and the REEE Institute hopes to develop Namibian Standards in the future.

1 Economic and Political Aspects

Namibia, has a land area of 823 000 km^2 and is located on the south-western coast of Africa. The population in 1996 was estimated to be 2 million with growth rate of 2.7 %. The labour force was estimated at 1 000 000, of which 50 % was engaged in rural agriculture, although it was estimated that 30 % of the population lived in urban areas. The literacy rate was estimated at 38%.

The Gross Domestic Product was estimated at 3 230 MUSD in 1996, with a growth rate of 4.1 % between 1990 and 1996 and 2.5 % between 1996 and 2000. The economy was heavily dependent on the extraction and processing of minerals for export and mining accounted for almost 25 % of GDP. Average annual inflation over the period 1990 to 1996 was estimated 11.2 %. Namibia was the fourth largest exporter of non-fuel minerals in Africa and the world's fifth largest producer of uranium. Namibia also produced large quantities of diamonds, lead, zinc, tin, silver and tungsten. However, 60 % of the population depended on agriculture for its livelihood – 85 % of the agricultural income was provided by beef production. Namibia was also one of the main fish exporters in Africa. Exports in 1996 were estimated at 1.45 BUSD and imports were estimated to be 1.55 BUSD.

2 Grid Electrification Status

Installed electrical capacity was estimated at 406 MW, with annual production of 994 GWh (1255 GWh in 1998) and annual consumption per capita of 925 kWh in 1996. Electricity was available to less than 30 % of the population, and was provided by a single, state owned utility, Nampower. Electricity supplies were very sensitive to the available flow at the 240 MW Ruacana hydro station, which provided between 45 % and 60 % of Namibia's electricity. Shortfalls in supply were met by imports from South Africa thorugh a new 400 kV line.

After independence the Namibian Government embarked on an ambitious rural electrification programme. By 1996, a basic infrastructure for rural electrification in the north and east of the country had been completed, although it must be noted that the primary aim was to provide electricity to local government users rather than to households. The rural electrification programme was implemented under the responsibility of the Ministry of Mines and Energy.

3 PV Programme Experiences and Policy Issues

The Government of Namibia had followed an active policy in terms of use of PV: the Ministry of Wildlife, Conservation and Tourism and the Department of Rural Water

Supply of the Ministry of Agriculture, used PV for water pumping, and 150 PV systems had been installed in clinics and schools by the Department of Works of the Ministry of Works, Transport and Communication. The main user of PV systems was the Department of Posts and Telegraphs, which estimated that the savings on diesel costs allowed it to amortise the costs of a typical PV system within 14-26 months. The Ministry of Mines and Energy had given photovoltaic applications high priority for rural electrification, and systems were in use in various service applications.

The development of the PV market in Namibia has been promoted in the framework of a programme on the "Promotion of the Use of Renewable Sources of Energy in Namibia", launched in 1993 by MME and supported by GTZ as part of the bilateral co-operation between Germany and Namibia. This programme created favourable framework conditions for the dissemination of PV systems by creating public awareness, training of local technicians and the provision of a loan scheme for rural households .

Since then, about 2 000 PV refrigeration systems have been installed in small shops; over 2 000 SHSs were installed in private households and a further 50 systems in schools, health clinics (100), shops (200), community farms (about 400 in the communal & commercial sector), and approximately 500 PV pumping systems (700 by the year 2000) had been installed.

Solar pumping stations are in operation to provide potable water, with about 200 in lodges and game parks and about 30 at communal bore holes. 90 railway stations and the national coastal navigation buoy system both relied upon photovoltaic power systems. Photovoltaic power systems were also in use in television relay systems, providing power to those stations not connected to grid power.

4 Domestic PV Industry

It appeared that the local SHS supply industry was competent in terms of ability to supply and install systems although standards and ongoing maintenance were identified as a significant barrier to widespread adoption of SHSs in Namibia. The training of local technicians was one of the priority actions taken by the a.m. MME-GTZ programme. About 100 technicians were trained all over the country in order to establish a local installation and maintenance network. Certification and standardisation of components will be tackled in the near future by a newly to be created "Renewable Energy and Energy Efficiency Institute", which is at present under investigation.

Another important barrier in the past was the non-level playing field between grid and non-grid electrification, which, however, will now hopefully be overcome by the implementation of the Rural Electricity Distribution Masterplan.

There was the capacity in Namibia to manufacture d.c. refrigeration units and some other balance of system components such as PV pumps, inverters, state of charge indicators, and regulators. The manufacture of these components tended to be on a batch basis and some components were only manufactured on request. Batteries and modules were usually imported from South African agents or direct from manufacturers.

Research was ongoing at university level into PV applications, and six private companies were involved in supplying PV systems on a commercial basis and a further 12 companies were involved in PV systems on an occasional basis. The SADCC/TAU was attempting to develop a regional code of practice covering system design, installation and performance.

5 Financing Options

Despite the quality of the solar resource, SHSs were not widespread even though most rural homes were not connected to the electricity grid. The high initial capital outlay in combination with low incomes was a significant barrier. However, the PV market in Namibia had developed without the involvement of aid agencies and operated on a purely commercial basis without the need for subsidies.

SADCC/TAU had carried out an "Assessment of Applications and Markets for the Solar Photovoltaic Systems in the SADCC Region," which identified a lack of inter-regional co-operation, affordable financial mechanisms and historical reliability problems as the primary barriers to the development of photovoltaic power systems in the SADCC area. Suggestions to alleviate the first and last of these barriers included the development of a code of practice to cover system performance, the development of an industry co-operative body to provide training and information concerning the design and installation of systems, and the removal of prejudicial tariffs which were viewed as providing advantage to traditional generating systems. The provision of affordable financing mechanisms remained the most problematic, as the necessary funds were not available at the national level and must be sought from international sources.

A funding scheme, FINESSE, was set up in 1992 to provide financing for small scale energy users, administered by the Southern African Development Co-ordination Conference Technical and Administrative Unit (SADCC/TAU) and administered by the University of Namibia (NUFU), but the results of this programme were not very encouraging due to the lack of funds.

However, since 1994 the PV market in Namibia has developed, supported by bilateral aid from Germany, Norway and the U.S. aiming at the strengthening of the market forces, and is now operated on a purely commercial basis without the need for permanent subsidies.

In 1994, a revolving fund scheme was set-up by the Ministry of Mines and Energy, providing loans to rural households who otherwise would have no access to credit facilities. Out of this loan scheme, about 250 SHS's have been pre-financed, and so far all loans have been paid back according to schedule. This market oriented programme has proven its success and sustainability, however, it reaches only that part of the rural population that can afford monthly paybacks of 15 USD or more, depending on the size of the system purchased. It is, therefore, intended to complement this programme by a government programme in the framework of the a. m. rural electrification policy.

The Philippines

Land Area	298 000 km^2
Population	72 million
GDP per capita	1 164 USD
Population Density	240 inhab per km^2
Urban Population	44 %
Labour Force	30 million
Population Growth Rate (1980-1996)	2.5 %
Literacy Rate	95 %

General Data			
Insolation	5 $kWh.m^{-2}.day^{-1}$	Latitude	13°N
Population unelectrified	45 %	Terrain	Mountains, narrow extensive coastal lowlands

PV Data	
PV power installed	133 kWp
Technical potential	26 MWp (based on 50 Wp SHS for 65 % of households currently without electricity, assuming 5 people per household.)
PV programmes committed	Several programmes targeting SHS and Battery Charging Stations have been scheduled. The Philippine-German Special Energy Programme is scheduled for another phase aiming to motivate Electric Co-operatives to join the SEP initiated *Rural Photovoltaic Electrification* Programme of NEA. The UNDP sponsored FINESSE programme is intended to assist the Development Bank of the Philippines in financing RE projects; a Belgium sponsored 45 kWp central PV plant at Cebu Island ; BP Solar Australia had been contracted to design, supply and install 1 003 PV systems to provide electricity to 387 villages electrifying over 1 million people in one of the biggest solar projects world-wide. A Dutch financed SHS dissemination programme intending to install about 15 000 systems in the Luzon Island is also under preparation.
Government policy	The government aimed to achieve 100 % electrification of all villages by 2010 and connect all potential customers by 2018.
Utility programmes	Rural Electric Co-operatives distributed electricity in remote areas and were the organisations through which the government aimed to extend electrification.
Market sophistication	Medium
Technical development	PV modules were imported whilst other electrical equipment normally manufactured locally
Pricing structure	The Rural PV Electrification programme used the existing REC network to act as financial intermediaries. The RECs own the solar generators, financed them on long term loans and offered them to consumers at low, yet cost covering fees.
Testing & Standards	Project related testing facilities exist with PG-SEP and Solarlab of the University of the Philippines

1 Economic and Political Aspects

As a result of the policies pursued by the Aquino and Ramos administrations the Philippine economy has undergone a profound restructuring and liberalisation. Overall, the Philippines has not attained its economic potential. However, the economy has recently enjoyed three years of growth, primarily led by exports and investment.

Whilst the Philippines economy was enjoying sustained growth, this was at the expense of a widening current account deficit. To counter this, exports were being encouraged and it was hoped that the liberalised business environment would promote foreign direct investment. This would help finance the deficit in the short term and improve the economy's ability to compete in the longer term.

There was a large disparity in incomes in the Philippines - the top 20 % had over ten times the income of the poorest 10 %. Whereas most of the other East Asian economies had seen a narrowing of income disparities, in the Philippines, the opposite had been the case. There was also a high level of regional inequality. The region around Manila accounted for one-third of the country's national income, with a GDP per head twice the national average.

The pace of economic growth had stabilised in the 1990s, following the volatility of the previous decade, and the improvement in economic performance saw a reduction in inflation to around 8 %. Meanwhile, the proportion of people below the poverty line fell from 59 % in 1991 to 39 % in 1996.

The population of the Philippines was relatively young, with over half of the population under the age of 20. The proportion of the population living in rural areas decreased from 70 % in 1960 to 56 % in 1992, whilst the rate of population growth slowed from an average of over 3 % in the 1960s, to around 2.5 % in 1996. The Philippines had also suffered from a high level of emigration, averaging at 64 000 per year in the 1990s.

2 Grid Electrification Status

The responsibility for centralised power generation plant belonged to the National Power Corporation (NPC or NAPOCOR). This state owned company was in the process of privatisation. There were three main companies operating in the energy sector: the NPC, the PNOC and the NEA. The remaining 140 companies and utilities were all investor or member owned.

Due to the geographic nature of the Philippines (i.e. an archipelago), the energy supply did not rely solely on centralised grid power sources, but on a mix of diesel-powered mini-grids and renewable energy sources.

Electricity was distributed by 26 private or municipal owned distribution utilities and 119 Rural Electric Co-operatives (RECs). The state-owned National Electrification Administration (NEA) was responsible for financing and providing related technical support to the 119 RECs, who bought power from the NPC or other generator and distributed it in their own grids.

RECs accounted for about 16 % of electricity sales, and were organisations through which the government intended to extend electrification. As of 1995, a total of 23 610 villages were supplied with electricity. This brought the electrification level to around 67 %. The government aimed to achieve 100 % electrification of all villages (totalling 35 213) by 2010 and connect all potential customers by 2018.

Energy production per capita in 1994 was 337 kWh and total national production was 29.7 GWh. Total installed capacity was estimated at 7 400 MW. Around 84 % of capacity was owned by the state-owned National Power Corporation. Demand for electricity was forecast to rise at 11.8 % per annum to 2005, and then at 9.5 % 2006 - 2010.

The capital cost for grid connection was around 700 USD per household. For families that would consume an average of perhaps 40 kWh per month, the prospects for grid connection are very low.

Typical monthly charges to a Philippine family for conventional energy was 2.5 USD for kerosene and 1 USD for dry cell batteries. Present commercial PV initiatives were charging 5.75 USD / month, which was expected to fall to around 4 USD as projects were commercialised.

3 PV Programme Experiences and Policy Issues

Photovoltaics had been in use in the Philippines for 20 years, although the total installed capacity was still only around 133 kWp. In 1991 the Office of Energy Affairs (OEA) - now the Department of Energy (DOE) estimated that, in conjunction with a five year plan, around 1 000 of the 13 667 unelectrified communities could be targeted for PV battery charging stations; that SHSs could eventually be introduced to about 10 % of the unelectrified rural households (c. 520 000 households), and that up to 1 000 small rural enterprises could be potential buyers of PV.

The goal of the DOE REPP (Renewable Energy Power Programme) provided for dissemination of technically and financially viable renewable energy projects; to provide an accommodating market environment for local / foreign implementation of such projects; to provide funding support and to assist in the national government's power development programme.

The Philippine-German Solar Energy Project, PG-SEP (1982 - 1988), was implemented under the Ministry of Energy, later the Office of Energy Affairs. Initially, a 13.3 kWp village plant was installed in Pulong Sampaloc, Bulacan, which supplied 60 households with electricity (70 % village power requirement). The purpose was to provide a training ground for PV engineers and to serve as a model for centralised village electrification. The project concentrated on the optimisation of the technical performance of the plant and showed that central PV plants were not yet economically feasible. The second phase of the project therefore focused more heavily on SHSs and communal battery charging stations. The project also demonstrated a commercialisation approach for remote island electrification in Burias Island.

The subsequent Special Energy Programme SEP (1987 - 1995), was the first co-operation of GTZ with the National Electrification Administration. This included the development of PV as well as mini-and micro-hydro plants. Based on these experiences, in 1991 the SEP started a nation-wide pilot implementation of 10 Rural PV Electrification projects. By the end of the programme around 1 700 households had been electrified and 41 RECs have since proposed follow-on RPE projects.

The Philippine – German PV Pumping Programme (1991 - 1995) aimed to prove the technical and economic viability of solar pumping systems in tropical developing countries. It involved close co-operation with national and local water and energy authorities, universities and manufacturers of PV pumping equipment. The Philippine project was initiated with the installation of five PV Pumping Stations in Cebu Province, followed by projects in Pilar, Camotes; Sablayan, Mindoro Occ.; and Limawasa, Leyte.

Preferred Energy Investments (PEI), an NGO which aimed to provide technical assistance and financing for the implementation of commercially viable renewable energy technologies. PEI was being implemented through a co-operative agreement between USAID and Winrock International, and was supported by the Environmental Enterprises Assistance Fund (EEAF) in the management of its capital investment fund. PEI ran the Philippine Renewable Energy Project Support Office (REPSO) in Manila as part of its dissemination and support activities.

The Consortium for Asian Renewable Energy (CARE) Philippines was a corporate joint venture founded in 1995 between Solar Resources Inc. (USA) and three Philippine companies. The aim of CARE was to remove institutional barriers which blocked acceptance of PV and the strategy included the establishment of local distribution, installation and servicing for village SHS systems.

The project included a 2 year feasibility study and 2 000 SHS installations as well as a smaller number of 500 Wp to 1000 Wp hotel systems (possibly PV-wind). The final stage of the project targeted long-term commercialisation of rural PV systems. The joint venture set a minimum annual installation goal of 3 000 SHS.

BP Solar Australia recently (April 1997) won a contract to design, supply and install 1 003 PV systems to provide electricity to 387 villages in the remote Visayas and Minanao regions, electrifying over 1 million people. One of the biggest solar projects world-wide, it will include provision of potable water pumping, electricity for hospitals, vaccine refrigerators, community centre lighting and TV and radio for schools' education. The project will be funded by a concessional loan from the Australian Export Finance and Insurance Corporation and a 13 MAUD government grant from AusAid. The installations were expected to be completed by mid-2000.

4 Domestic PV Industry

PV modules were imported whilst other electrical equipment was usually manufactured locally.

The National Non-conventional Energy (NCE) Act, 1991, implemented a number of measures to make the market more favourable for renewable energy applications. In particular, it initiated the Affiliated Noncon Energy Centres (ANEC) network, in order to raise awareness about RE in the remote provinces. It also exempted all imported RE equipment from import tax and duties, providing they were not manufactured locally; and lastly it instructed the state bank, DBP, to prioritise financing for individuals, enterprises and industry participating in the Non-conventional Energy Programme.

Commercialisation of PV systems was first introduced in the Burias Islands in 1987. There were at least 15 suppliers dealing in PV systems, supplying modules from most major PV manufacturers including BP Solar, Siemens, Kyocera, Solarex, Shell Solar and NAPS. The network of distributors and dealers was serviced mainly from the larger islands, with bases in Manila, Iloilo and Cebu.

5 Financing Options

The PGSEP Burias Island project encouraged the islanders to form the San Pascual Masbate Solar Power Inc. (SAPMASOPCO) co-operative, which negotiated with DBP to finance the initial order of 100 SHSs. SAPMASOPCO acted as the handling agent between users and the bank. Money was borrowed at 13 % and passed on at 16 %, compared to commercial bank interest rate of 21.5 %. The down-payment of 140 USD was 25 % followed by 36 monthly amortisation payments of 13 USD - equal to previous expenditure on kerosene and dry cells. Lastly, the end-user was entitled to a three month grace period to make the monthly payment and, in case of default, all previous payments were forfeited. Battery charging stations had also been tested, charging 0.40 USD to 1.10 USD per charge (equivalent to one week's electricity consumption). GTZ estimated such a business would need 5 700 USD in capital, recoverable over 6 - 7 years at 7 % interest.

The Rural PV Electrification programme of the Solar Energy Programme used the existing REC network to act as financial intermediaries. The RECs owned the solar generators, financed them on long term loans and offered them to consumers at low, yet cost covering fees. The SEP demonstrated and evaluated a variety of financing models, including Lease and Credit Concepts. One typical model was based on 25 % down-payment and 36 monthly instalments.

Financing of REC PV projects was arranged through the NEA and SEP. By end 1994, there were 10 RECs in three regions with 1500 SHSs. Financing involves a long term loan on long life cycle components with an up-front payment to cover installation, battery and lights (106 USD) amounting to less than the cost of connection to the grid. 50 % of costs were funded by GTZ, the balance by a loan from the NEA to the REC, charged at 12 %. Various mechanisms were tested for payment of the balance, monthly charges being around 7.50 USD. RECs obtain SHSs duty and VAT free.

The Department of Energy (DOE) established and funded a Renewable Energy Association of the Philippines (REAP), comprising private suppliers of such equipment. Financing for REAP products was available through the Development Bank of the Philippines (DBP) with 25 % of cost to be paid in advance and the balance paid in monthly fees over three, five, or seven years depending on the buyer's repayment capacity.

The Consortium for Asian Renewable Energy (CARE) had a project to support SHS and other community PV installations in Central Visayas. A total of 39 000, 48 Wp to 75 Wp SHS were to be installed over 8 years, continuing thereafter at 5 000 units a year. This was to be replicated in other areas. The project was to work through RECs and other community based organisations, renting out or leasing the systems to users but retaining ownership. Partner organisations would perform monthly payment collection and maintenance for a fee.

The Renewable Energy Financing and Technical Assistance Project (REFTA) was aprogramme financed by USAID as part of its commitment to the GEF. REFTA will expand the work of REPSO Philippines in identifying project opportunities and provide investment capital to be administered by the Environmental Enterprises Assistance Fund.

Preferred Energy Investments (PEI) provided both equity and financing for commercially viable RE projects. This assistance was available at 300 000 USD per project and leveraged against other funds if found insufficient. Co-financing with government financial institutions, private investors and other development institutions were also being pursued.

Senegal

Land Area	193 000 km^2
Population	9 million
GDP per capita	573 USD
Population Density	47 inhabs per km^2
Urban Population	44 %
Labour Force	2.5 million
Population Growth Rate (1980-1996)	2.7 %
Literacy Rate	38 %

General Data			
Insolation	5.8 kWh.m^{-2}.day^{-1}	Latitude	14°N
Population unelectrified	75 %	Terrain	Generally low rolling plains rising to foothills in south east.

PV Data	
PV power installed	800 kWp
Technical potential	43 MWp (based on 50 Wp SHS for 65 % of households currently without electricity, assuming 5 people per household.)
PV programmes committed	Unknown
Government policy	Government was actively promoting the use of renewable energy resources and equipment for all PV systems was exempt from VAT and import duties.
Utility programmes & strategies	Due to the low density of demand and the lack of economic viability of rural connections, the state owned utility, SENELEC, did not actively promote connections to the electricity distribution network. The company was evaluating opportunities for the implementation of solar energy and was willing to invest in independent power supplies.
Market sophistication	Low
Technical development	All PV system components were imported although Senegal manufactured automotive batteries.
Pricing structure	Limited credit available. Rural financing through informal revolving savings schemes.
Testing & Standards	The GTZ Project initiated a quality control, component and system standards to ensure quality safety and long-term reliability. SHS testing procedures were prepared as soon as 1995 in collaboration with Frauhofer Institut für Solare Energiesysteme. The Research Centre on Renewable Energy was set up with German funding to test PV components.

1 Economic and Political Aspects

Senegal's Gross Domestic Product (GDP) was estimated at 5 160 MUSD or approximately 573 USD per capita, with a growth rate of 1.8 %. In 1996, imports exceeded exports by 1.8 BUSD to 1.6 BUSD and the consumer price index was estimated to average 7.6 % between 1990 and 1996. The currency was devalued by 100 % in 1994 as part of an Economic Recovery Programme. The World Bank and International Monetary Fund responded favourably to the restructuring plans, and had supported the economy during the period of crisis.

Exports were reliant upon fishing, phosphate mining and groundnut cultivation. While groundnut cultivation was prone to failure through drought, agriculture remained the major source of income and employment, accounting for 18 % of GDP and 77 % of the labour force in 1996.

2 Grid Electrification Status

Electricity generating capacity was estimated at 230 MW, with annual generation of 900 GWh. Senegal was entirely dependent upon traditional thermal generation for primary electrical generation. Per capita consumption was estimated at 100 kWh. A National Electrification Programme had been instituted to run from 1995 to 2005. This programme provided for the electrification of 559 rural localities although funding had not been secured. Due to the low density of demand and the lack of economic viability of rural connections, the state owned utility, Societe Nationale d'Electricite (SENELEC) was not actively promoting connections to the electricity distribution network.

Senegal was in the process of selling 49 % of SENELEC to a private company. Plans existed to spend 200 MUSD boosting output over the next 5 years through rehabilitating existing plant and expanding capacity. The company was evaluating opportunities for the implementation of solar energy and was willing to invest in independent power supplies.

About 60 % of the population had no access to electricity (5.5 million people) with only about 150 of the 13 000 Senegalese villages (over 200 000 rural households) connected to the national grid. Even in electrified localities only 5-15 % of all households had access to the electricity network. This amounted to approximately 20 000 households in urban regions without access to electricity and with no prospect of being connected to grid in the foreseeable future.

3 PV Programme Experiences and Policy Issues

The photovoltaic industry in Senegal was entirely dependent upon aid projects. Installed capacity was estimated to be in the region of 800 kWp including solar home systems, health centres, village power stations and pumping units. More than 2 000 SHS had been installed, mainly with funding from the German Aid Agency, GTZ, in conjunction with central government under the Energie Solaire Photovoltaic project. The project was well received by users although the currency devaluation in 1994 meant that the cost of replacing broken or defective components became much higher. Nevertheless, the success of this project has meant that PV has been selected as one of the alternative options for rural electrification. The co-operatives that were formed to administer and maintain these systems merged to form Fopen-Solaire, a national organisation that now provides technical assistance and equipment.

A total of 36 village level battery charging stations had been installed since 1991, managed by the Centre d'Etudes et de Recherche sur les Energies Renouvelables de Dakar. Each station had 10-15 portable rechargeable lamps that were rented out with tariffs levied for each recharge. Some technical problems had been encountered but the lamps are rented 80 % of the time.

A number of projects have built on early experiences and experimented with different financial and organisational models. These project have been funded by a variety of different agencies:

- The Regional Solar Program funded by the European Union
- The Senegalese-German Solar-Energy Project funded by Germany
- The Senegalese-Nippon Project funded by Japan: this Project installed PV plants and PV-desalination facilities. This project also planned a programme for dissemination of SHS using an innovative financial and organisational system. Unfortunately, it could not be carried out because of the devaluation of CFA in1994.
- The APSPCS Project: Project for the equipment of Catholic Health Centre bases on a joint management of maintenance and financing through the sale of energy by the rental of portable lamps to villagers.
- The AISB Project: sales of electricity services, pricing scales based on consumption

Senegal had historically levied high import tariffs although tax free manufacturing zones permit the import of duty free manufacturing goods which could be assembled locally for regional distribution. However, the government was actively promoting the use of renewable energy resources and equipment for all PV systems was exempt from VAT and import duties.

Since 1987, GTZ Project provided training to the technicians of village organisations and to those of the private sector. The project developed two training manuals before transferring its training activities to two technical and professional training institutions: CNQP (National Centre for Professional Qualification) and CFPT Senegal/Japan (Professional and Technical training Centre). The trainers in charge of that program were trained by the Project which provided all the logistics necessary for the training program. As a result, Senegal is the only country of the region where professional schools offer PV training to installation and maintenance technicians.

4 Domestic PV Industry

Research and development capabilities in Senegal were limited although there were some existing research centres. However, the institutional linkages between the centres and the industrial/commercial sectors that could benefit from them were weak and they were not sufficiently exploited.

All PV system components were imported although attempts were made to set up local production of regulators. The facility was linked to the GTZ funded project described above so production ceased on closure of the project. Senegal did manufacture automotive batteries.

The private sector imports, assembles, and supplies SHSs to the village associations which take charge of installation and maintenance activities. To date there are in Senegal 10 private companies and 10 village associations marketing PV equipments.

5 Financing Options

Limited credit was available in Senegal with levels of interest which varied between 10 % and 24 %, but these were mainly for productive purposes and did not adapt well to the purchase of PV systems. Interest rates for bank loans were in the order of 6 % to 17 % and the term of the loan was usually between 24 and 48 months for consumer equipment and more than 10 years for housing.

The Caisse Nationale de Credit Agricole du Senegal (CNCAS), founded in 1984, extended credit exclusively through rural self-help co-operatives for agriculture and social purposes. It may be possible to extend this for financing SHS with CNCAS providing financing and the co-operatives managing the actual lending and administration. GTZ successfully tested a similar scheme on a pilot scale with a village co-operative.

The Agence de Credit pour l'Enterprise Privee (ACEP) had 19 branches and extended loans averaging 1 000 USD for small income generating activities. Loans to over 2 000 borrowers had typical terms of 12 months repayment and interest rates of 20 %. Only 3 % of loans were over three months in arrears. This scheme was considered to be both financially and operationally self-sufficient.

Credit Mutuel Senegal (CMS), a branch of the French bank, was managing guarantee funds for NGOs and development agencies. This meant that the French Aid Agency, Caisse Française de Developpement (CFD) could use this mechanism to guarantee loans to village committees.

The Catholic Relief Service (CRS) was also working with a banking system for the poorest groups, especially women. This had led to investment of the savings in services such as electricity, one project aimed to electrify 800 houses in the region of Kolda.

Rural financing was also available through informal revolving savings schemes which were widespread - these also included traditional money lenders and informal savings and loan associations (tontines).

South Africa

Land Area	1 220 000 km^2
Population	38 million
GDP per capita	3 324 USD
Population Density	31 inhabs. per km^2
Urban Population	50 %
Labour Force	15 million
Population Growth Rate (1980-1996)	2.0 %
Literacy Rate	76 %

General Data			
Insolation	5.5 kWh.m^{-2}.day^{-1}	Latitude	29°S
Population unelectrified	33 %	Terrain	Vast interior plateau rimmed by rugged hills and narrow coastal plain.
PV Data			
PV power installed	5 MWp to 6 MWp		
Technical potential	80 MWp (based on 50 Wp SHS for 65 % of households currently without electricity, assuming 5 people per household.)	Commercial potential	30 MWp by 2010
PV programmes committed	REFSA established and charged with developing PV SHS programme. Subsidy of 1 500 ZAR per system for approved pilot projects. ESKOM committed to manage the electrification of 16 400 schools that will not be connected to the grid under the RDP. 4 000 health clinics have been targeted for PV electrification		
Government policy	The National Electrification Forum aimed to increase dwellings connected to the grid from 45 % to 67 % by 2000 and 79 % by 2012.		
Utility programmes & strategies	ESKOM had electrification programme, with target of 400 000 connections per annum. ESKOM coverage had risen from 31 % to 45 % of households since 1992. RDP aimed to electrify 72 % of households by 2000.		
Market sophistication	Advanced		
Technical development	Manufactured all PV components from modules to BOS components.		
Pricing structure	REFSA provided a subsidy of 1 500 ZAR per PV for pilot PV SHS projects. ESKOM offered financing for SHSs at a concessional 3 % interest rate. Business plan to install 1 800 SHS on a cost recovery basis. SELF developed pilot scheme with 20 % deposit, 15 % interest, 3 year repayment.		
Testing & Standards	REFSA support standards to be developed by Global Accreditation Programme.		

1 Economic and Political Aspects

The political and economic landscape of South Africa was dominated by the collapse of apartheid, and attempts to redress the society through the Reconstruction and Development Programme (RDP). South Africa had entered a period of transition and transformation, with the realisation of the democratic government. At present, despite massive unemployment and high crime rates, the new administration had been able to maintain stability in the nation.

The country was divided into 9 provinces. The most densely populated of these was Guateng (in which Johannesburg was located) and the least densely populated Northern Cape (2.2 inhabitants per km^2). The population of South Africa was 38 million, greater than all its neighbours (Namibia, Botswana, Zimbabwe, Mozambique, Lesotho and Swaziland) together. Of the population, 26 % lived in shacks/informal dwellings/zozos and 17 % in traditional dwellings.

Gross Domestic Product was estimated at 126 BUSD, with a growth rate of 1.2 % and inflation of 10.4 %. South Africa had an export led economy, with exports of 24.3 BUSD and imports of 18.1 BUSD. The major recipients of South Africa's exports in 1994 were Switzerland (6.0 MZAR), United Kingdom (5.9 MZAR), USA (4.4 MZAR) and Japan (4.2 MZAR). Imports came mainly from Germany (13.0 MZAR), USA (12.5 MZAR) and the United Kingdom (9.0 MZAR)

2 Grid Electrification Status

Energy production per capita in 1995 was 4 916 kWh and total national production was 187 GWh. The vagaries of the apartheid system left an odd legacy, in that there was a greater percentage of the urban population without electricity than rural (76 % to 21 %). South Africa had an electricity generation capacity of about 40 GW with an extended national grid spanning some 239 000 km of high voltage transmission lines. This grid was interconnected with that of a number of its immediate neighbours. Maximum demand was about 25 GW, leaving South Africa with substantial excess capacity. Average tariff levels were 7.5c/kWh for domestic users, 4c/kWh for industrial users (1994 figures).

The electricity industry in South Africa was dominated by ESKOM, an independent, self financing, vertically integrated, utility, 100 % owned by the government. ESKOM was largest utility in Africa and generated 97 % of South Africa's electricity (over half of Sub-Saharan Africa's). The rest was generated by local authorities (2%) and industry (1%), who sold surplus electricity to ESKOM. ESKOM had a monopoly on transmission and sold 44% of its electricity to municipal distribution utilities with the remainder being distributed by ESKOM. The privatisation of ESKOM was considered unlikely as ESKOM is efficient, self funding, and “strategic”.

A major part of the South African population, an estimated 55-60%, were not connected to the national electricity grid and relied on wood, paraffin (kerosene) and coal (if close to the coal fields) for their basic energy needs. The National Electrification Forum (NELF) was established in 1993 to develop a strategy for accelerated grid extension. NELF aimed to increase the percentage of dwellings connected to the national grid from the present 45 % to 67 % by the year 2000 and

79 % by 2012. Taking population growth into account, this implied that some 2.5 million dwellings would still be without access to the electricity grid at that time.

ESKOM was leading a large electrification programme, with a target of 400 000 connections per annum, and was building a 4 GW coal fired station to come on stream 1996-2001. Both of these were being internally financed and managed, although there was a joint venture with EDF and East Midlands to electrify a township of 60 000 homes near Cape Town using pre-payment meters.

Renewables in 1995 covered 10.7 % of energy consumption. Grid extension was expensive (averaging 720 USD a service point). ESKOM coverage had risen from 31 % to 45 % of households since 1992 but this included the rapid growth of new housing in urban areas. A major component of the RDP was to bring electric power to 72 % of households by 2000.

3 PV Programme Experiences and Policy Issues

A GEF funded mission to evaluate the PV market was completed in early 1995. The value of the market was estimated as 800 MUSD in initial equipment sales. South Africa had yet to ratify the Climate Change Convention and was therefore not eligible for GEF funded projects.

There were three principal PV programmes being implemented in South Africa at the time of writing. In 1996, REFSA was established and charged with developing a national PV SHS programme. In April 1997 it announced a subsidy of 1 500 ZAR per system for approved pilot projects. ESKOM had committed itself to manage the non-grid electrification of the 16 400 schools that would not be connected to the grid under the RDP. Some 1 100 schools had been electrified with PV by ESKOM, although the installation rate had slowed. Approximately 4 000 health clinics which were without electricity had been targeted for PV electrification. IDT had electrified approximately 180 of these by early 1997.

The European Union supported a comprehensive study entitled ‘Scheme for large-scale implementation of solar home systems’ during 1995/96. The objectives of the project were to undertake a techno-economic analysis and develop a strategy for PV household electrification in South Africa. The E.U. was also supporting an energy specialist at DME to investigate opportunities for E.U. collaborative projects. The E.U. was also proposing to support the PV electrification of clinics and schools.

SELF were undertaking a small SHS pilot project in KwaZulu-Natal. REFAD, USA had supported training programmes at Peninsula Technikon. CASE Australia were investigating establishing a Centre for the Application of Solar Energy in South Africa.

The UNDP-SADC FINESSE programme appointed consultants to identify bankable PV projects. A 600 000 USD SHS project had been identified in KwaZulu-Natal for which further pre-investment studies were underway. DGIS, of the Netherlands, were considering providing some initial financing with the Triodos Bank for a SHS project.

4 Domestic PV Industry

All components of PV SHS were manufactured in South Africa including modules (manufactured by Africa Solar using imported cells). A second company, SunCorp, recently ceased production. Most major international module manufacturers had a distributor in South Africa. The principal suppliers of modules to the South African market were Siemens Solar, Solarex and Kyocera. There were between 50 and 80 companies in the South African PV Industry (mainly systems houses and distributors). Estimates of staff employed by the industry varied from 300 to 1 500. Companies active in South Africa include: Siemens, Franklin Electric, Africa Solar, First National Batteries (Solarex), Grinaker BP Solar, National Luna, Willard Battery and representatives of Photowatt and Total

Although South Africa had a well developed photovoltaic industry, this was developed internally during the apartheid era. It was estimated that present installed power is between 5 MWp and 6 MWp, with 34 000 to 50 000 Solar Home Systems, 2 400 to 4 000 solar pumping stations, and numerous schools, clinics, telecommunications and coastal navigation systems. Annual sales of PV for SHS was estimated as 160 kWp or around 4 000 systems per year in 1996.

The Energy and Development Group in their assessment of the potential market for PV systems for the FINESSE studies estimated annual sales of SHS rising to 40 000 systems per annum by 2010 for non-subsidised systems and 80 000 systems if a subsidy was continuously available. This would indicate an annual market of between 2 MWp and 4 MWp of PV for SHS by 2010 or a cumulative market of at least 25 MWp.

There were some 16 000 schools and 4 000 clinics to be electrified by PV. DME estimated that these would be electrified mainly before 2005 and peaking in 1999/2000. This represented a cumulative market of 4 MWp. DME had also indicated annual sales of PV pumps rising to 1 000 units by 2010 from negligible sales at present.

Potential barriers to the market included the lack of published rural electrification maps/plans coupled with an expectation of consumers to be eventually connected to the utility and the growing problem of theft of PV modules.

5 Financing Options

The government established a renewable energy development financing agency, Renewable Energy For South Africa.(REFSA). REFSA planned to promote the PV electrification of homes and was charged with establishing a National PV SHS programme. In May 1997, REFSA announced that a subsidy of 1 500 ZAR per PV SHS would apply for pilot PV SHS projects.

The majority of sales of PV systems were on a cash basis or short term dealer credits. While consumer credit facilities in urban areas were well established, they were virtually non-existent in rural areas. ESKOM, through a low income housing programme, offered financing for SHSs at a concessional 3 % interest rate.

South Africa was a participant in the SADC programme on Financing Energy Services for Small Scale Energy users (FINESSE). As part of this programme a business plan to install 1 800 SHS in KwaZulu-Natal had been developed on a cost recovery basis requiring 588 000 USD of financing. The project appeared financially viable - the average income in the region is about 90 USD per month. The Department of Minerals and Energy of the Government of South Africa was supporting continuation of pre-investment activities for FINESSE (which is primarily supported by The Netherlands Ministry of Foreign Affairs (DGIS) via UNDP).

SELF with US Department of Energy funding, developed a pilot covering 75 households (50 Wp SHSs and 200 Wp village centre) in KwaZulu-Natal. The KwaZulu Finance Corporation channelled financing to the local community based Electrification Committee for financing end-user credit (20 % deposit, 15 % interest, and three year repayment term).

In order to incorporate planned preventative maintenance into programmes and reduce initial down payments some PV marketing specialists were promoting the use of utility style schemes, leasing schemes or prepayment metering. There was however a tradition of non-payment of utility bills as a means of protest (not necessarily about energy matters) and repossession of systems was not always possible.

Tanzania

Land Area	884 000 km^2
Population	30 million
GDP per capita	195 USD
Population Density	33.9 inhabs per km^2
Urban Population	25 %
Labour Force	16 million
Population Growth Rate (1980-1996)	3.1 %
Literacy Rate	46 %

General Data			
Insolation	4.8 kWh.m^{-2}.day^{-1}	Latitude	6 00 S
Population unelectrified	96 %	Terrain	Coastal plains, a central plateau and highlands in the north and south

PV Data	
PV power installed	NA
Technical potential	190 MWp (based on 50 Wp SHS for 65 % of households currently without electricity, assuming 5 people per household.)
PV programmes committed	Unknown.
Government policy	Unknown.
Utility programmes & strategies	Extension of the utility grid into rural areas was not a high priority
Market sophistication	Low
Technical development	All components were imported although a small industry in photovoltaic system installation was developing.
Pricing structure	Systems purchased privately were not subsidised in any way. Lack of affordable finance.
Testing & Standards	The SADCC's Technical and Administrative Unit (TAU) was attempting to develop a regional code of practice covering system design, installation and performance.

1 Economic and Political Aspects

Tanzania is located on the East coast of Africa and had a population of 30 million and occupied an area of 884 000 km^2, giving a population density of 33.9 inhabitants per square kilometre.

The GDP was estimated to be 5 840 MUSD (1996 figures) equivalent to a GDP per capita of 195 USD. The GDP growth rate between 1990 and 1996 was 3.2 % and the rate of inflation for the same period was 26.8 %. Agriculture was the predominant occupation, employing 90 % of the workforce and contributing 57 % of the GDP.

There had been economic growth in Tanzania during the 1990s mainly due to increased agricultural production and funds provided by bilateral donors, the World Bank and the International Monetary Fund. Industrial production and mining of minerals had also seen an increase.

Tanzania exported agricultural produce and imported manufactured goods, oil and some foodstuffs. The total value of exports was 679 MUSD (1995) compared to total imports valued at 1.69 BUSD (1995) resulting in a considerable trade deficit of around 1 BUSD.

Politically, Tanzania was considered one of the more stable countries in the Southern Africa Development Co-ordination Conference (SADCC) region.

2 Grid Electrification Status

Electricity was supplied by a single utility, the Tanzania Electric Supply Company, which covered approximately 40 % of the country. Installed electricity generation capacity was estimated at 405 000 kW with an annual production of 1 800 GWh of which 86 % was generated from hydro sources and the remainder from thermal generation. The nominal electricity production per capita in 1995 was 60 kWh. The majority of the population, an estimated 19 million people, in Tanzania did not have access to electricity and the extension of the utility grid into rural areas was not a high priority.

3 PV Programme Experiences and Policy Issues

Unlike neighbouring Kenya, the majority of photovoltaic activity in Tanzania to date had been prompted by Aid organisations, in particular UNICEF, DANIDA, NORAD, SIDA, Oxfam, Norwegian Volunteers, Commonwealth Science Council, and Catholic Relief Services. Funding from these agencies had been used to install vaccine refrigerators, solar pumping stations, and telecommunications relay stations, usually through grants to the particular ministry concerned, for example the Ministry of Health for vaccine refrigerators. For these projects there had been no attempts made at cost recovery. NAPS Kenya, a subsidiary of NESTE of Finland and one of the PV firms active in the SADCC region, had been involved in the installation of many of the systems and was involved in the installation of microwave relay stations and satellite earth stations, as well as providing training to local technicians.

The SADCC's Technical and Administrative Unit (TAU) was attempting to develop a regional code of practice covering system design, installation and performance. Additional recommendations include encouragement of inter-regional trade in photovoltaic components; as almost none of the system components were manufactured in Tanzania, this could assist in accelerating the use of systems in the private sector. It should be noted that, while this would encourage the use of systems, it could be detrimental to the development of local production capacity.

4 Domestic PV Industry

A small but growing – estimated at 9 firms - private sector industry in photovoltaic system installation was developing in Tanzania, usually to install lighting systems. None of the components were manufactured locally but were imported from abroad, and systems purchased privately were not subsidised by the government in any way. Minor efforts were being made to research further photovoltaic applications and to assemble systems locally with the inclusion of some Tanzanian components, but these efforts had not matured.

5 Financing Options

The majority of the PV market in Tanzania was still linked with aid projects, which had generally been well received. Future projects had been planned using photovoltaic systems to develop a wider network providing basic electrification but these were dependent upon external funding. The opportunity existed for the private sector to develop, but the widespread application of photovoltaics would require either a breakthrough in the capital costs of systems or the provision of long term, low interest funding.

SADCC/TAU carried out an "Assessment of Applications and Markets for the Solar Photovoltaic Systems in the SADCC Region," which identified a lack of inter-regional co-operation, lack of affordable financial mechanisms and historical reliability problems as the primary barriers to the development of photovoltaic power systems in the SADCC area. Suggestions to alleviate the first and last of these barriers included the development of a code of practice to cover system performance, the development of an industry co-operative body to provide training and information concerning the design and installation of systems, and the removal of prejudicial tariffs seen as providing advantage to traditional generating systems. The provision of affordable financing mechanisms remains the most difficult barrier to overcome, as the necessary funds were not available at the national level and must be sought from international sources.

Thailand

Land Area	511 000 km^2
Population	60 million
GDP per capita	3 084 USD
Population Density	117.4 inhabs per km^2
Urban Population	20 %
Labour Force	34 million
Population Growth Rate (1980-1996)	1.6 %
Literacy Rate	94 %

General Data			
Insolation	4.8 kWh.m^{-2}.day^{-1}	Latitude	15°N
Population unelectrified	27 %	Terrain	Central plain, Khorat plateau in the East, mountains elsewhere.

PV Data	
PV power installed	2.5 MWp
Technical potential	105 MWp (based on 50 Wp SHS for 65 % of households currently without electricity, assuming 5 people per household.)
PV programmes committed	
Government policy	There was no distinct rural energy plan, but rural energy issues had a high priority under the rural development component of the National Economic and Social Development Plan.
Utility programmes & strategies	Main utility, EGAT has a programme to develop alternative energy sources.
Market sophistication	Medium
Technical development	Joint ventures in PV module assembly had been established and total local production capacity was put at 1MWp, but the domestic market did not generate sufficient demand to require capacity increases.
Pricing structure	Unknown
Testing & Standards	Unknown

1 Economic and Political Aspects

Located in Southeast Asia, Thailand encompasses a land area of 511 000 km^2, including numerous islands. The population was estimated at 60 million, with an estimated 20 % in urban centres; annual growth rate between 1990 and 1996 was estimated at 1.6 %. The population was well educated at the primary level, with a literacy rate estimated at 94 %. The labour force was estimated at approximately 34 million, of whom 57 % were engaged in rural agriculture: the unemployment rate was estimated at 2.6 % in 1996.

Thailand has been considered one of the "Tiger" economies of Asia and is usually listed as an emerging, rather than developing, market. Economic growth was led by cheap labour manufacturing labour-intensive export goods. Exports were valued at 57.3 BUSD in 1996 compared to imports of 72.4 BUSD. Increasing prosperity in the country, coupled with increased competition in the low-wage sector from China and Vietnam, had led to attempts to move to reliance upon more sophisticated manufacturing processes.

Recently, however the financial markets had collapsed and the local currency, the Baht, had been devalued considerably. More conservative fiscal policies suggested by the International Monetary Fund (IMF), required to qualify for a 16 BUSD loan to prevent a balance-of-payments crisis, were expected to lead to recovery, but there was question as to whether the political will existed to carry out these measures. Prior to the currency crises, Gross Domestic Product in 1996 was estimated at 185 BUSD, with a growth rate of 8.3 % between 1990 and 1996. Average annual inflation over this period was estimated at 4.8 %.

2 Grid Electrification Status

The installed electricity generation capacity of 10 GW produced approximately 80.1 TWh in 1995, equating to a per capita generation of 1 335 kWh. The majority of electricity was consumed by industrial loads and urban centres. Electricity generation was largely dependent on thermal generation from gas, oil and coal, which accounted for over 90 % of generation: the remainder being provided from hydro-electric schemes.

As Thailand is mainly composed of one main island, extension of the electricity grid was fairly easy. Figures for the extent of rural electrification vary, but grid availability appeared widespread with over 98 % of villages connected to the grid and between 70 % and 86 % of rural households electrified. Decentralised electricity needs were therefore restricted to isolated communities where village co-operatives tend to own any generating facilities with support from the Department of Public Works and the Department of Energy Development and Promotion.

The major organisation governing electricity generation and supply was the Electricity Generating Authority of Thailand (EGAT). EGAT had a programme to develop alternative energy sources, including wind, geothermal and fuel cells. The company had installed approximately 70 kWp of PV, mainly for commercial applications (e.g. communication repeaters and navigation aids), but was reportedly considering large scale PV installations (centralised PV power plants connected to a grid) in its future plans.

Thailand also had considerable hydropower potential – estimated at over 8 GW – but large-scale dam construction continued to prove controversial, making further hydro capacity expansion unlikely beyond that already planned. There was potential for some small hydro in the mountainous north, and some wind potential in southern coastal areas.

3 PV Programme Experiences and Policy Issues

National Energy Planning was the responsibility of the National Energy Policy Committee (NEPC), which governed strategies for electricity generation, energy conservation and development of alternative energy sources. The Department of Energy Development and Promotion (DEDP) was responsible for overall rural energy matters, although rural electrification was the responsibility of the Provincial Electricity Authority (PEA).

An energy Master Plan was prepared during the 1980s and subsequently developed under successive five-year plans. There was no distinct rural energy plan, but rural energy issues had a high priority under the rural development component of the National Economic and Social Development Plan.

There was a New & Renewable Energy Programme under the Energy Conservation Programme, which recognised that renewables are expected to play a major role in the future Thai energy economy. Under this programme, investment subsidies of between 20 % and 60 % were available to organisations for pilot projects, project preparation and management, programme marketing, training, and after-sales service and maintenance. The projects must satisfy the eligibility criteria which were based on a calculation of internal rates of return - projects with an internal rate of return of less than 9 % were not eligible for subsidy.

Most PV projects in Thailand were conducted independently by government Departments and as a result over 90 % of Thailand's installed PV capacity (estimated at 2.5 MWp) had been government funded. DEDP had utilised PV for battery charging centres in 300 remote villages between 1995-99, as well as for water pumping projects and domestic lighting systems. PWD administered a PV battery charging station programme under the sixth Five-year Plan and had committed itself to install PV in 50-100 villages per year. PWD had also undertaken some PV water pumping projects. The Ministry of Public Health, Ministry of Education, Royal Irrigation Department and Royal Agriculture Program had each used PV for various applications including water pumping, health care centres and schools. For example, the Ministry of Education had installed 20 kWp in remote primary schools using locally manufactured modules.

Donor activity for PV projects had been very limited, although the Thai government was encouraging involvement from international agencies in renewable energy production. The German Aid agency, GTZ, provided support for the Kenitra Special Energy Project between 1991 and 1993 to install 200 SHS. AUSAID had collaborated with Australia's Centre for Application of Solar Energy (CASE) and the

Provincial Electricity Authority (PEA) on four renewable energy pilot projects. These included the integration of 7.2 kWp of PV with an existing 90 kW mini-hydro system to provide electricity for lights, refrigeration and cooking for 90 households in a mountain village. A second project integrated 12 kWp of PV with existing diesel generators to provide power for 170 households, a temple, a school and clinic on a small island in the Gulf of Thailand. PEA also owns three PV power plants for village supply totalling 150 kWp which was funded by NEDO of Japan.

With regard to import duties and tariffs in Thailand, there was a measure to reduce import tax on raw materials for cell manufacture to lay the foundations for PV business in Thailand.

4 Domestic PV Industry

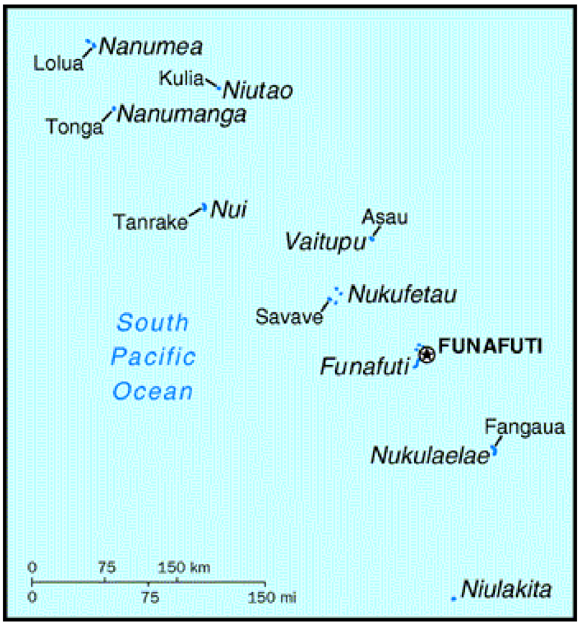
The industrial base in Thailand was extensive, and was capable of supplying all components for a photovoltaic system, including PV modules where there was some private sector involvement. A number of joint ventures in PV module assembly had been established and total local production capacity was put at 1MWp, but the domestic market did not generate sufficient demand to require capacity increases. BP Thai Solar imported cells and assembled modules locally; SolarTron had established a joint venture to import cells and assemble modules; Siam Solar was another joint venture (partner unidentified) importing cells and assembling modules and there was a local Solarex distributor.

There were also a number of Institutes involved in PV R&D including Semiconductor Device Research Laboratory (SDRL) which had been undertaking fundamental R&D since 1975, and had a complete crystalline silicon cell fabrication line. Some novel thin-film research was also undertaken. Chulalongkorn University had investigated PV applications for rural electrification and the Asian Institute of Technology (AIT) undertook some PV system design.

5 Financing Options

There was little available information on financing experience for PV systems. It appeared that the majority of systems installed to date had been supported by the government. Users of the battery charging stations paid cash to have their batteries recharged. The operators of the charging stations apparently received no salary for their services, but were eligible for free recharges. It was unclear where the income from the charging stations goes to – presumably it was repaid to the implementing government department.

Tuvalu



Land Area	26 km^2
Population	10 300
GDP per capita	800 USD (ppp)
Population Density	396.2 inhab per km^2
Urban Population	15 %
Labour Force	NA
Population Growth Rate (1980-1996)	1.45 %
Literacy Rate	NA

General Data			
Insolation	$kWh.m^{-2}.day^{-1}$	Latitude	8°S
Population unelectrified	NA	Terrain	Low-lying and narrow coral atolls

PV Data	
PV power installed	NA
Technical potential	NA
PV programmes committed	3 programmes had been initiated, installing over 300 more systems and funded by the E.U and French bilateral Aid
Government policy	After initial scepticism about the use of PV systems, the government was enthusiastic about their use.
Utility programmes & strategies	Unknown
Market sophistication	Low
Technical development	A local installation capability existed. The islands themselves lacked any facilities for manufacture of components or research into applications
Pricing structure	A co-operative venture, the Tuvalu Solar Electric Company, had been formed to provide photovoltaic systems and collect payments to provide funding for operation and maintenance
Testing & Standards	Unknown

1 Economic and Political Aspects

Tuvalu is a small, densely populated, island chain in the South Pacific, generally associated with French Polynesia. The total land area was estimated at 26 km^2, supporting a population of 10 300. The population was scattered across the nine islands of the chain, making centralised infrastructure untenable. The country had no known mineral resources and few exports: subsistence farming and fishing were the primary economic industries. The GDP (PPP) of Tuvalu was estimated at 7.8 MUSD with an estimated annual growth rate of 8.7 % and inflation of 2.9 %. Exports were estimated at 165 000 USD, and imports estimated at 4.4 MUSD. About 1 000 Tuvaluans work in Nauru in the phosphate mining industry sending remittances to relatives at home. Substantial income was received from an international trust fund established in 1987 by Australia, New Zealand and the United Kingdom.

2 Grid Electrification Status

Electrification of the main island was controlled by the Tuvalu Electricity Corporation, and did not extend to other islands in the chain. Capacity was estimated at 2 600 kW, with annual production of 3 GWh. The use of portable generators on the other islands was not considered cost effective due to the transportation cost of the fuels.

3 PV Programme Experiences and Policy Issues

The government of Tuvalu was initially sceptical about the use of photovoltaic systems but with the success of the first programme, which installed 160 Solar Home systems in 1983 (funded by the NGO, Save the Children), this attitude changed to one of enthusiasm. A further three programmes had been initiated, installing over 300 more systems and funded by the E.U, and through French bilateral Aid. The systems were seen as improving the quality of life in the islands by providing both domestic lighting and refrigeration, as well as contact with the outside world through radio.

A co-operative venture, the Tuvalu Solar Electric Company, was formed with the assistance of the South Pacific Institute for Renewable Energy (SPIRE) and GIE Soler, both based in Tahiti in French Polynesia. The co-operative provided the photovoltaic systems and collected payments to provide funding for operation and maintenance.

Future programmes intended to install a further 200 SHS and expand the system size to three modules per house.

4 Domestic PV Industry

Local technicians had been sent for training on the installation and maintenance of the systems at SPIRE in French Polynesia and a local installation capability existed. The islands themselves lacked any facilities for manufacture of components or research into applications, and relied upon the industry in French Polynesia for supplies.

5 Financing Options

Future programmes were planned, expanding the current electrification and increasing the number of modules provided for each consumer. This expansion was entirely dependent upon funding from external sources, as the local population were only able to pay for the upkeep of the systems and the co-operative, without providing a net income to fund expansion. Monthly payments into the credit schemes were typically 15 USD per month.

Uganda

Land Area	200 000 km^2
Population	20 million
GDP per capita	306 USD
Population Density	100 inhabs per km^2
Urban Population	13 %
Labour Force	10 million
Population Growth Rate (1980-1996)	2.7 %
Literacy Rate	48 %.

General Data			
Insolation	4.8 kWh.m^{-2}.day^{-1}	Latitude	1°N
Population unelectrified	95 %	Terrain	Mostly plateau with rim of mountains

PV Data	
PV power installed	150 kWp
Technical potential	120 MWp (based on 50 Wp SHS for 65 % of households currently without electricity, assuming 5 people per household.)
PV programmes committed	Funding had been secured for a 1.76 MUSD GEF funded PV for Rural Electrification Project. The project aimed to install 2,000 SHS and solar lanterns in rural communities.
Government policy	The NRSE (New & Renewable Sources of Energy) division within the Department of Energy in the Ministry of Energy and Mineral Development activities included facilitating the development of renewable sources of energy and this ensured government involvement.
Utility programmes	The Uganda Electricity Board is not involved in any PV programmes.
Market sophistication	Low
Technical development	System components were imported and assembled in country. There were a number of dealers and installation companies.
Pricing structure	The World Bank / GEF programme intended to assist in developing rural credit facilities to assist in the development of a sustainable market. PV system manufacturers will extend short term credit for private purchases.
Testing & Standards	Unknown

1 Economic and Political Aspects

Following independence in 1962 the economic prospects for Uganda were extremely good. However, by 1980, after almost a decade of chronic mismanagement by General Idi Amin and a damaging civil war, the economy lay in ruins. Only subsistence farming and the small-scale coffee sector survived in reasonable order.

The problem, since 1980, has been how best to rebuild the shattered economy. Strong remedial action of a conventional nature was introduced in 1981 by the government of Milton Obote, supported by an IMF stand-by arrangement. The plan principally involved floating the currency, removing price controls, increasing agricultural producer prices and imposing strict limits on government spending. The government hoped that these measures would encourage foreign aid and investment, and the Expropriated Properties Act was introduced to persuade the Asian community to return. The plan was successful initially, and the economy began to grow, but the improvements were only superficial. The government could not attract significant support from the donor community, and when the authorities failed to maintain budgetary discipline the IMF withdrew its support in 1984.

In 1987 the government published its definitive Economic Recovery Programme (ERP). The long-term goal was to create a viable and, as far as possible, self-sufficient economy. The immediate objectives of the programme were to rehabilitate the production sectors, in particular the critical infrastructure on which those sectors depended, to reduce inflation by tackling budget deficits and to address a crisis in the balance of payments which left the country with very low reserves and uncertain supplies of foreign exchange.

The recovery programme had been supported by the IMF, in a 175 MUSD three year Enhanced Structural Adjustment Facility (ESAF) approved in September 1994, and by credits from the World Bank’s soft-loan arm, the International Development Association (IDA). These re-established Uganda’s credentials with the aid organisations and donor countries of the West, and generated significant flows of funds in the form of balance-of-payments support and project assistance.

Economic output was dominated by agriculture, which was responsible for about 46 % of GDP including substantial non-monetary production. Most Ugandans owed their survival during the troubles of the 1970s and 1980s to the resilience of the informal agricultural sector, and most wage earners still used small plots for domestic food supplies. Food crop production was by far the most important economic activity, accounting for more than one-quarter of GDP, compared with only 5 % for cash crops. Manufacturing output contributed only about 7 % of GDP. It suffered badly from the decades of instability and failed to recover the position it held in the economy at independence. Most agricultural production took place in the south, where climatic conditions have always supported the densest rural populations.

The basis of regional economic variations in Uganda was partly climatic (the south favours agriculture much more than the north) but also historical in that the construction of the Uganda Railway during the colonial period laid down the infrastructure for subsequent urban developments. The contrast between a more prosperous south and less prosperous north also broadly coincided with the major ethnic division between a Bantu south and Nilotic north.

2 Grid Electrification Status

The electrical distribution system suffered through years of neglect and was plagued by failures. Electricity generation capacity was 172 MW, of which 168 MW was accounted for by a single hydroelectric plant. Annual generation in 1996 was 974 GWh, of which 262 GWh was exported to Kenya, leaving per capita consumption of less than 32 kWh. The Uganda Electricity Board (UEB) was responsible for all generation, transmission and distribution in Uganda. However, the government granted a licence in 1995 to a US and Ugandan consortium to construct a 250 MW hydroelectric plant although the plant was not expected to start generating until after 2004. The construction of a 60 MW thermal plant in Kampala, which was originally scheduled for completion in 1997, had been delayed by contractual difficulties. An agreement had also been reached with a Norwegian company for the construction of an underground electricity plant at Karuma Falls in Western Uganda. The first phase of the project will aim to improve distribution in northern and eastern Uganda.

National electricity requirements were 240 MW and were growing at an estimated 24% annually. The domestic energy sector was responsible for 80 % of total energy consumption, and 94 % of this was biomass, illustrating the poor state of the economy and low level of industrialisation. Commercial energy represented only about 10 % of total energy consumption, with most energy being met from fuelwood and charcoal. Between 3 % and 5 % of the population had access to electricity with only 1 % of the rural population with access.

Power shortages seriously affected manufacturing industry and were hampering growth (which reached 8.7 % in 1995 and could exceed 12 % with adequate electricity supplies).

3 PV Programme Experiences and Policy Issues

As of 1996, Uganda had an installed photovoltaic capacity of approximately 150 kWp, mostly in communications, refrigeration and domestic lighting systems. The Uganda Posts and Telecommunications Corporation and Uganda Railways Corporation have installed photovoltaic microwave repeater stations and radio call stations.

The Solar Electric Light Fund (SELF) in conjunction with Habitat for Humanity International (HHI) who build 10,000 homes a year world-wide mostly in unelectrified rural areas initiated a pilot project to install 100 PV SHS on HHI homes. The full cost of systems was 800 USD and a 50 % subsidy was provided by the US Department of Energy. It was planned that the financing mechanism would be developed into a revolving fund. The project included training of technicians and owners, as well as a public information work and training in additional economic activities. Systems were assembled in Uganda to minimise costs

In order to ensure that PV systems went to customers who were not likely to default on payments, only home owners would had completely repaid their mortgages were allowed to apply for a Solar Home System. Repayments were through a three year loan using the existing HHI credit system on house mortgages. The possibility of receiving a system appeared to encourage payment of mortgages (many of which were in arrears). For the pilot programme, payment was for 50 % costs (400 USD) with a 10 % down-payment followed by 36 monthly payments of 10 USD. The monthly payment was estimated to be equivalent to costs of kerosene, candles & dry cell batteries. There were no defaulters on payment therefore no repossessions. In fact, some loans were paid off early after the additional lighting enabled additional money generating activities.

The project appeared to have been very successful although it was unclear why it had not developed further. The project was to be developed into a revolving fund at full system cost but this had not happened due to ‘administrative problems’.

Funding had been secured for a 1.76 MUSD GEF funded PV for Rural Electrification Project. The project aimed to install 2,000 SHS and solar lanterns in rural communities. The project will act as a pilot using different financing schemes to assess their suitability. A key part of the financing schemes will be the use of NGOs already active in providing credit in the rural areas. The SHS will be installed on a full cost recovery basis but using development rates for loan interest.

Other planned projects included the installation of 360 solar home systems in dioceses of Church of Uganda which would be subsidised by 50 % by the Anglican church of USA. The Ministry of Health was planning to install more than 500 solar units and 117 solar refrigerators in health centres.

PV components were zero tax rated for import duties and until 1995, solar equipment was also exempt from VAT. However, in 1996 VAT was levied on solar equipment at 17 %. Certain educational/health goods are currently VAT exempt and NRSE (New & Renewable Sources of Energy, within the Department of Energy in the Ministry of Natural Resources) are pressing for PV to be included in this exemption.

The Uganda Renewable Energy Association (UREA), supported by the GEF, has more than 30 members and has been active co-ordinating awareness and in training activities.

The German funded Energy Advisory Project supports the Ministry of Energy in the development of an energy policy and a strategy for renewable energy which includes photovoltaics.

4 Domestic PV Industry

Uganda had very little manufacturing capability. System components must be imported, and assembled in country. There were nine companies in Uganda dealing with photovoltaic power systems, usually either selling systems to middle and upper income consumers, or working in conjunction with electrification projects.

The NRSE (New & Renewable Sources of Energy) Division within the Department of Energy and Mineral Development was an important institutional player in Uganda, providing support for private industry NRSEs major functions include facilitating the development of renewable sources of energy and this ensured government involvement in renewables. NRSE carried out a review of rural energy carried out and were instrumental in developing the GEF PV for Rural Electrification Project

5 Financing Options

The Uganda Commercial Bank had an extensive nation-wide network and was particularly active in supporting sub-sectoral and other small farmers' programmes. The Small Farmers' scheme developed into a semi-autonomous area of the bank's activities which had greatly extended the outreach of the bank. The Co-operative Bank managed to develop a viable rural banking system in parallel to the credit activities of producer and marketing co-operatives and the network of savings and credit co-operatives.

Several organisations tried to establish micro-lending programmes in the early 1990s but retreated because of widespread corruption and theft. Nonetheless, a village banking programme promoted by FINCA through local NGOs, which began in 1992, had proved a success, channelling 1.3 MUSD into the hands of low-income women over the last five years. By the end of 1996, 110 village banks had been established with over 3 300 members, almost all of whom were women. Average loans were small (120 USD) but significant in relation to income levels: recovery was put at 99 %.

In 1996, IFC provided a loan to Uganda Leasing Company (ULC), part owned by the Development Finance Company of Uganda. IFC had an equity stake in both organisations. ULC started operations in mid-1995 as the first dedicated leasing company in the country. The IFC loan was designed to enable ULC to undertake foreign currency denominated leases, largely for export oriented companies.

The World Bank / GEF programme was intended to assist in developing rural credit facilities to assist in the development of a sustainable market. PV system manufacturers would extend credit for private purchases although only for a maximum term of 45 days. System suppliers extended credit over same period or longer (4 months quoted from one supplier) to customers at zero interest rate.

In 1999 a GEF project put in place a guarantee fund with two local banks and started awareness raising campaigns in the regions of Mbale and Mbarara.

Vietnam

Land Area	325 000 km^2
Population	75 million
GDP per capita	311 USD
Population Density	231 inhab per km^2
Urban Population	19 %
Labour Force	38 million
Population Growth Rate (1980-1996)	2.1 %
Literacy Rate	94 %

General Data			
Insolation	4.9 $kWh.m^{-2}.day^{-1}$	Latitude	16°N
Population unelectrified	80 %, 6 million households without electricity	Terrain	Low flat delta in south and north, central highlands, hilly, mountainous in far north and northwest.

PV Data	
PV power installed	100 kWp
Technical potential	195 MWp (based on 50 Wp SHS for 65 % of the 6 million households without electricity)
PV programmes committed	The World Bank and DANIDA provided funding for a Rural Electrification Masterplan to identify regions to be supplied by the grid, and those which would be supplied by a variety of other energy sources, including micro-hydro and PV.
Government policy	The Government had played a major role in establishing PV industry and energy policy. The National Program for New and Renewable Sources of Energy (NRSE) was established by a government initiative to improve living conditions in rural areas.
Utility programmes & strategies	The state utility, Electricity of Viet Nam collaborated with the Institute of Energy for long term planning in the power sector, including rural electrification and renewable energy.
Market sophistication	Low
Technical development	Organisations involved in design, fabrication, supply and installation of PV systems and three dealers of international PV companies.
Pricing structure	The Solar Electric Light Fund collaborated with the Vietnam Women's Union on a pilot project to install SHS. Loans for rural electrification projects may be available through the Vietnam Bank of Agriculture. In addition, there is one private company involved in supply, installation and financing of PV systems.
Testing & Standards	Unknown

1 Economic and Political Aspects

Up until the early 1980s, Vietnam was a centrally planned economy. Since then a number of liberalising measures had been introduced through a reform programme begun in 1986 known as 'Doi Moi'. This dismantled collectives and returned the land to family farming, liberalised most pricing structures, encouraged new private businesses, and opened the trade and investment regime. This resulted in low inflation and an average growth rate of 8 % since 1991.

Although the average GDP of 311 USD per capita puts Vietnam amongst the poorer countries in the world, the country had many social characteristics of a much higher income, for example life expectancy of 68 years and adult literacy of 94 %. There was also clear evidence of a rapidly growing economy in the huge number of consumer goods in the shops and the surge in traffic in major towns. Investment capital, however, remained very scarce and was a major constraint on government and local authority spending.

Responsibility for energy lay with both the Ministry for Science and Technology and the Ministry of Industry. The Ministry of Planning and Investment (MPI) was in charge of all domestic and foreign investment affairs. All foreign investments must be licensed with MPI, and it could take 6 - 12 months for this process to be completed.

2 Grid Electrification Status

The World Bank and DANIDA provided funding for a Rural Electrification Masterplan, which had been developed by the Institute of Energy on behalf of the state utility, under the Ministry of Industry. This plan identified the regions to be supplied by the grid, and those which would be supplied by a variety of other energy sources, including micro-hydro and PV. This Masterplan was due to be completed in 1998.

New power plants and extension of transmission lines constructed as a result of economic reforms since 1986 greatly increased the implementation of rural electrification in Vietnam. However, the World Bank's power engineer for Vietnam estimated that it will be at least 20 years before the majority of rural households could be electrified.

Total national electricity generation was 16.4 TWh in 1996. Energy production at around 225 kWh per capita was low, although production was growing at 8 % per annum. The government aimed to increase capacity by about 15 % per annum to 2000, increasing capacity from 6.7 GW in 1996 to 9 GW in 2000.

The state utility, Electricity of Viet Nam (EVN), was responsible to the Ministry of Industry. It collaborated with the Institute of Energy for its long term planning in the power sector, including rural electrification and renewable energy. The projects were implemented by regional branches of EVN. At the time of writing, about 5 000 of the country's 9 000 communes were supplied by the grid.

The domestic tariff for electricity was around 0.04 USD/kWh. Around 6 million rural households remained without a grid connection, and little prospect of one in the next ten years. The degree of rural electrification coverage varied over the country. The highest coverage was in the Red River delta where a majority of homes were reported to have a supply. Coverage was considerably less in the central areas of the country and less still in the Mekong delta where lack of accessibility was a major obstacle. A recent World Bank ESMAP study of rural electrification in Vietnam was pessimistic about prospects for wide-spread electrification due to the lack of investment resources.

3 PV Programme Experiences and Policy Issues

The Government of Vietnam played a major role in establishing PV industry and energy policy, and was expected to continue to do so. Although the political environment was rapidly becoming more liberal, the government will still have a large influence over future economic and technical developments.

To date a total capacity of around 100 kWp of PV had been installed throughout the country, at least 70 % of which had been for telecommunications systems.

The National Program for New and Renewable Sources of Energy (NRSE) was established by a government initiative to improve living conditions in rural areas. Based at the Ho Chi Minh Polytechnic, the NRSE was focused on research, development and application of different types of NRSE for rural, mountain and island areas.

The ‘Solarlab’ research team at the Centre of Physics, Ho Chi Minh city, together with the French NGO, FONDEM collaborated in a project to construct and install several types of PV systems including village ‘solar stations’ of 300 Wp to 1200 Wp, telecommunication systems (1200 Wp), and hundreds of other smaller systems such as vaccine refrigerators, navigation flashlights and height indicators. Over 40 solar stations and cultural houses had been set up in rural areas with amenities for public battery charging, TV/video, kareoke, lighting and local radio broadcasting.

An analysis reported that the Vietnamese perceive advantages of solar stations over SHS including a reduction in installation costs, easier management, control and maintenance, and a high level of safety. Training of women as solar educators, technicians and entrepreneurs was seen as one of the benefits of this project. With good management capital investment was expected to be returned within 5 years through charges for battery-charging, video and kareoke ticket sales etc.

The Solar Electric Light Fund (SELF) a Washington DC-based non-profit organisation, and the Vietnam Women’s Union (VWU) representing 11 million women had collaborated to install 240 SHS, 5 community centre PV systems and street lights in two village markets. The project received financial and technical assistance from the Rockefeller Brothers Fund and Sandia National Laboratories (funded through the US-DoE).

Following on from this project, SELF and the VWU proposed a programme of one million SHS to be installed over the next 10 years (150 000 in 5 years) by establishing SELCO-Vietnam. SELCO-Vietnam was a 100 % foreign owned company providing financial and technical assistance for management, administration, training, consumer credit and marketing, while the VWU would be in charge of system installation, troubleshooting, service and revenue collection. SELCO-Vietnam would operate a range of cash, credit and leasing schemes through 40 'Solar Service Centres' around the country.

Photovoltaic related materials and equipment were listed as duty-free imports in Vietnam.

4 Domestic PV Industry

There were five Vietnamese organisations involved in design, fabrication, supply and installation of PV systems and three dealers of international PV companies. In addition, there was one established private company involved in supply, installation and financing of PV systems. All of the organisations in the first category had some capacity for manufacture of solar electronic components (charge controllers), and two were involved with small-scale PV module manufacture. Indigenous batteries were of poor quality and better products were imported from Korea.

There was still an element of government control and ownership in all of the Vietnamese organisations, but nevertheless, there was keen rivalry between the institutes.

Solarlab was founded as part of the National Centre for Science and Technology in 1989 and was the country's leading PV institute. Solarlab staff had designed and manufactured their own PV modules and a regulator-inverter apparatus called the 'solarstat'. They had installed a number of *Solarstat* battery charging stations, island power systems, and telecommunications systems under government and military contracts.

The Solar Electric Light Company (SELCO) was to begin electrifying the country's 6-7 million off-grid rural households with solar home systems (see below). SELCO-Vietnam expected to be manufacturing PV equipment in Vietnam towards the end of the decade.

5 Financing Options

The Solar Electric Light Fund (SELF) collaborated with the Vietnam Women's Union (VWU) on a pilot project (not fully cost recoverable) to install 130 SHS, completed in early 1995, and expanded to a further 110 in 1996. Individual families paid for their residential systems through a subsidised revolving loan fund established by SELF and operated by the VWU. Families made a 20 % down-payment and monthly payments over 4 years. Collection rates were around 95 %.

It was not clear whether the fund as actually managed to revolve due to unforeseen expenditure required to resolve early technical problems. In the next phase, SELF and VWU were planning a sustainable solar program based on full cost recovery, and funds had been requested from UNDP.

Loans for rural electrification projects were sometimes available through the Vietnam Bank of Agriculture (VBA) although their financial resources were limited. As well as the Vietnam Women's Union, the Vietnamese Farmers Union covered the whole country and may be a useful vehicle for PV sales/dissemination. It was co-operatives such as these that had the organisational structure to take SHSs into the rural areas.

In early 1997 the UNDP proposed a 350 000 USD plan for financing an additional 1 000 solar home systems on the SELF / VWU model, with the Vietnam Bank for Agricultural Development managing the revolving fund on behalf of the VWU.

Unfortunately historical factors and distrust of the banking sector had limited the extent of financial deepening even under transition of the economy and a large proportion of assets were held outside the banking system in the form of foreign currency, gold, precious stones and metals. In 1995 such hoarding was estimated at 2 BUSD.