

SMALL SCALE HYDRO POWER OPPORTUNITIES IN SRI LANKA

by

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Abstract

Sri Lanka has no identified indigenous fossil fuel resources. Therefore development of alternative energy resources is important to Sri Lanka. The governmental Policy Directions for Power Sector envisages that the hydropower generation potential of the country will be developed to its full potential as it is the major indigenous resource for power generation. Under this policy, all large-scale hydropower generation facilities are to remain under governmental control for the foreseeable future. Private sector financing will be utilized for power generation from small hydro power plants.

Several assessments of the hydropower potential have been done by various agencies. This paper briefly summarizes the results of these studies. The private sector participates in small hydropower projects in Sri Lanka under the three schemes. In grid-connected schemes, Ceylon Electricity Board purchases energy under a standardized power purchase agreement and a published tariff. The tariff calculation methodology is described here in detail.

Board of Investment of Sri Lanka offers a range of incentives to these infrastructure projects according to the size of the investment. Additionally, for smaller projects, credit facilities are available from Sri Lankan commercial banks under the World Bank's Energy Services Delivery Project.

1. Sources of Energy in Sri Lanka

Sri Lanka has no proven resources of fossil fuels. Hydro power and fuel wood (and other bio-mass) are Sri Lanka's only indigenous energy resources. All of the country's crude oil requirements, and from time to time some refined petroleum products such as gasoline, kerosene, LPG and diesel are imported. The estimated per capita energy consumption in the country is 0.332 TOE (1996 figures).

Energy consumption in the household sector dominates other sectors of the economy, accounting for over 60% of the gross energy demand. The Industrial sector consumes about 20 % of energy from all the sources, and is the largest consumer of electricity, accounting for 40% of the total electricity consumption. However, nearly 90% of the household energy comes from non-commercial fuel wood and other biomass. In Sri Lanka, only about 45% of the households are provided with main electricity. Though the countrywide average of households with main electricity is 53%, it is less than 30% in the rural areas. As in most developing countries of the region, the consumption of energy is rising at a high rate; annual demand growth is estimated to be around 10% for the next decade.

2. An Introduction to Ceylon Electricity Board

Ceylon Electricity Board (CEB) is a statutory body, fully owned by the Government of Sri Lanka. It was established under an act of the Parliament in 1969, and has the sole responsibility for generation and transmission of electricity, and for electricity distribution in most parts of the country. Lanka Electricity Company (LECO) is a fully government-owned company responsible for electricity distribution in the southwestern parts of the country. CEB holds a 57 % stake of equity of LECO. CEB has about 13,000 employees working in all parts of the country, of which about 400 are professional engineers.

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CEB serves about 1.4 million consumers, while LECO has a smaller consumer base compared to CEB, which is about 220,000. Average per capita electricity consumption in Sri Lanka is about 200 kWh, which figure is on the low side in comparison to other developing countries.

CEB Power System: Present

Sri Lanka's power system has been a hydro-dominated system. The total installed capacity in the CEB system is 1543 MW. There are 15 hydro power plants in operation, which accounts for 70% of the total installed capacity. The maximum demand recorded for 1998 is about 1150 MW, and the total gross generation was about 5700 GWh.

Major hydro plants in the system are located in the basins of the two of the longest rivers, Kelani and Mahaweli. Five hydro power stations in Laxapana Hydro Complex are operated in cascade along two main tributaries of the Kelani River, Kehelgamu Oya and Maskeliya Oya. The total installed capacity in Laxapana Complex is 335 MW, and they annually generate about 1575 GWh of Energy.

Six hydro power stations in Mahaweli Hydro Complex are operated in cascade along main Mahaweli River and on Kotmale Oya, a major tributary. The total installed capacity in Mahaweli Complex is 667 MW, and they annually generate about 2200 GWh of Energy. However, the power generation in the multi-purpose Mahaweli System, is subject to seasonal variation of down-stream irrigation requirements, and usually priority is given to irrigation needs.

Samanalawewa Hydro Power plant, located in Walawe River in southern Sri Lanka has a Capacity of 120 MW, but had generated about 335 GWh in 1998, despite restrictions in reservoir operation, while wet blanketing of the reservoir being done. In 1998, four small independent hydro plants have contributed 6.3 GWh to the system.

The thermal power plants provide about 405 MW of installed capacity. Kelanitissa oil-fired steam plant rated at 50 MW; Sapugaskanda diesels of an installed capacity of 120 MW and installed Gas Turbine capacity of 235 MW comprise of CEB's thermal capacity. They annually contribute about 1200 GWh to the system. Four independent thermal plants in operation contribute about 90 MW, and in 1998, they have contributed additional 414 GWh to the system.

A fully integrated grid system operates at 220 kV and 132 kV. Around 90% of the total 1800 km of the transmission network operate at 132 kV. CEB's distribution network consists of over 11,000 km of 33 kV and some 2000 km of 11 kV lines. The total length of its low voltage (400 V) distribution system exceeds 30,000 km. Three 220/132 kV substations connect the two transmission systems, and about forty 132/33 kV substations feed the distribution system.

CEB Power System: Future

Electricity demand in Sri Lanka has shown an annual growth rate of round 7.5% during the last twenty years. This high growth in electricity consumption could be attributed to the increasing degree of economic activity during the recent past.

Sri Lanka faces the challenge of meeting its growing demand for electricity as the demand for electricity is expected to grow at around 10% in to the next century. The country has already developed 1,135 MW of hydro capacity, which provides on average 4,000 GWh of energy a year. Among the remaining hydro resources identified, economically exploitable major hydro potential is limited. As a result, the thermal share of Sri Lanka's electricity generation capacity is likely to change with the proposed additions in the future. CEB is also looking into use of renewable energy resources, such as small hydro and wind to generate electricity. CEB also promotes demand side management measures as an alternative to committing to conventional electricity generation facilities.

CEB's Transmission Division annually produces a 15-year rolling plan for least cost expansion based on WASP III model and on the latest available demand forecasts. The expansion plan for 1998, with the demand growing at 8% per annum, is shown in Table 1. In addition, based on the data available from the Generation Expansion Studies, the Transmission Division prepares an annual Transmission expansion plan too. Initiatives towards fulfillment of the increasing need for power. The Long Term Generation Expansion Plan foresees additions of 40 MW of residual fuel diesel, 60 MW IPP of Fuel Oil-fired Barge, 450 MW of combined cycle, 220 MW hydro and 300 MW of coal plants during the coming decade. Statuses of these projects are shown in Table 1.

Table 1
Base Generation Expansion Plant Sequence
Source: Draft Generation Expansion Plan: CEB: 1998

Year	Hydro Additions	Thermal Additions	Present Status
2000		40 MW Residual Oil fired Diesel	Under Construction
		60 MW Barge	Project Agreements signed
2001		100 GT of Combined Cycle	Tenders invited
		165 MW Combined Cycle (BOOT)	LOI signed
2002		50 MW ST of Combined Cycle	Tenders invited
2003	70 MW Kukule		Under construction
		150 MW Combined Cycle	Feasibility study concluded
2004		300 MW Coal (West Coast)	Awaiting environmental clearance
2005		-	-
2006	150 MW Upper Kotmale		Awaiting environmental clearance

3. Power Sector Policy Directions

In August 1997, the Ministry of Irrigation and Power announced the Policy Directions for Power Sector, where the Private Sector is expected to play a key role in power sector development activities.

The Policy Directions for Power Sector envisages that Hydro Power generation potential of the country will be developed to its full potential as it is a major indigenous resource for power generation. All large scale hydro power generation facilities are to remain under Governmental control for the foreseeable future, due to multi-purpose nature of these projects. Private sector financing will be utilized for power generation from small hydro power plants.

CEB has already taken a decision to purchase electricity from such small hydro power plants and from other renewable and co-generation power projects. Power purchase is made on the basis of proposals on developer's initiative, and not on any Request for Proposal from the Ceylon Electricity Board.

In the meanwhile, as a part of these policy directions, the power sector will be restructured and the roles of the government as owner, regulator and operator will be clearly defined and separated. With the advent of Independent Power Producers, a separate regulatory authority will any way be needed, to regulate operational issues and purchase / sale tariffs.

4. Development of Small Hydro Projects

Broadly, CEB has identified three categories of Small Hydropower projects, which may be developed by private developers. They are:

- **Grid-connected Small Hydro power plants:**
 Connected to the integrated electricity distribution grid and deliver electricity exclusively to the grid
- **Self-generating Small Hydro power plants:**
 Connected to the integrated electricity distribution grid and while delivering electricity to the grid, a part of the energy generated is used by the developer

- **Off-Grid Small Hydro power plants:**
Operate in isolation without being connected to the integrated electricity distribution grid

These project categories are dealt with separately here.

Environmental Impacts

Although most small hydro schemes are run-of-river systems, which do not inundate large extents of land or cause social displacement, they are not without environmental problems. Most of the water courses in the central hills are subject to competing water uses, such as, irrigation, animal husbandry, drinking water and community bathing, all of which become critical during the typically dry period of February - April.

In addition to these primarily social issues, small hydro development could also bring about adverse impacts on fauna and flora, due to diversion of water. Such impacts are mostly present during dry weather when diversion could cause drying up of the entire stream between the weir and powerhouse. In some projects permitting a pre-determined quantity of water to flow into the stream mitigates this.

Environmental issues highlighted above do not pose insurmountable problems, nor have they caused significant impact on the project viability. Developers are legally required to address these issues by following the guidelines stipulated under the National Environment Act.¹

5. Project Identification

In either of the above project categories, project identification will be a responsibility of the developer. For a small hydropower project, there are several avenues of finding a suitable project location. They are:

- **CEB Generation Master Plan Study Reports***
These include a number of pre-feasibility study reports for certain potential hydropower sites in Sri Lanka. These reports are referred to as "Master Plan" in the following sections.
- **Data Bases maintained by local Consultancy firms**
Some local consultancy firms specialized in small-scale hydropower also maintain databases on potential small hydro power plants of capacities less than 5 MW.
- **Developer finding his own project site**
The developer may commission pre-feasibility at his own risk and cost, and identify a site and its power potential.

Medium-Scale Hydro Schemes identified in the Master Plan

The results of the hydro project analyses are reported in 41 individual project reports. Of the 41 projects, only 20 could produce power cheaper than US¢ 9 per kWh. The aggregate average generation of these 20 projects would be about 3200 GWh per year, which could be considered as the economic potential of untapped hydropower in Sri Lanka, at a crude oil price of US\$ 40 per barrel, as far as medium-scale projects are concerned.

The most promising projects are situated on Uma Oya, Upper Kotmale, Gin Ganga, Kelani Ganga, Belihul Oya, Kalu Ganga, Sudu Ganga and upper reaches of Mahaweli Ganga.

Small-Scale Hydro Schemes identified in the Master Plan

Similar studies were carried out for 12 selected small-scale hydro schemes. Eleven of the 12 projects could generate at less than US¢ 9 per kWh, but the variability in their output would be considerable in the absence of reservoir storage. The average aggregate generation of the economic small-scale hydro projects was established to be some 200 GWh per year.

The projects can broadly be divided into the following three categories:

- A. Those as at yet undeveloped sites.
- B. Those at existing irrigation projects, using the head from irrigation canals, irrigation tanks or reservoirs.
- C. Rehabilitation, upgrading or extension of existing small hydro projects.

A CEB survey of Category-A projects, carried out in the early 1980's, found 62 sites with a capacity of less than 5MW, as shown in Table 2 below.

The plant factor adopted for the survey has been 0.5. The average head is about 75 meters and the average capacity 0.5 MW. Several other projects of Category-A have been investigated on an individual basis and assuming at least 100 suitable sites, it would seem not unlikely that the overall potential of small hydropower plants (less than 5 MW) at undeveloped sites are about 50MW.

* These reports are available for purchase from the office of the Deputy General Manager (Generation Planning), Ceylon Electricity Board, Colombo 00200. Fax: +94-1-434866

Table 2
Small Scale Hydro Potential at Undeveloped Site
Source: Master Plan for the Electricity Supply of Sri Lanka: CEB: June 1989

Installed Capacity		No. of Sites
0 - 0.1 MW		29
0.1 - 0.5 MW		17
0.5 - 1.0 MW		10
1.0 - 5.0 MW		6
Total	30 MW	62

With respect to projects of Category-B, the Irrigation Department has compiled a list of existing major irrigation tanks and reservoirs. The list covers a total of 290 sites, the estimated potential of which is shown in the Table 3 below.

The computations for Table 3 were based on the assumption of an average release of 6 litres per second per hectare of irrigated land and an average operating head of 70% of the difference between full supply level and spill level of the sluice. The plant factor of 0.50 had been assumed. The average head computed was only about 3 meters, and the average plant capacity was 300 kW.

Table 3
Small Scale Hydro Projects at Irrigation Tanks and Reservoirs
Source: Master Plan for the Electricity Supply of Sri Lanka: CEB: June 1989

Installed Capacity		No. of Sites
0 - 0.1 MW		269
0.1 - 0.5 MW		19
0.5 - 1.0 MW		2
1.0 - 5.0 MW		0
Total	8 MW	290

In addition to the major tanks there are about 10,000 small village tanks. These have dikes of about 2 to 5 meters high. The average capacity of the micro hydro plants which could be developed at these low head dikes would be a mere 2.5 kW per tank, assuming a plant factor of 0.50 and 10 ha of double cropped

paddy per year. The average annual energy output would be only about 10,000 kWh per year. The report concludes that installation of such small hydro plants at village tanks would be ineffective and uneconomic.

Projects of Category-C, i.e. upgrading, rehabilitation or extension of existing small hydropower projects, are mainly found in tea and rubber estates. At least 100 such projects may have existed, but almost all were abandoned after the gradual connection of the estates to the national grid. The civil works of most projects of this category are reported to be in good order. But the electromechanical equipment would need replacement.

Provisional estimates show that 140 mini hydro schemes, which would need rehabilitation, exist in the plantations, and detailed studies for some of such projects have been concluded.

Extrapolation from the results of a Canadian Study² which evaluated 38 discussed projects in the area under the jurisdiction of then Sri Lanka State Plantations Corporation, indicated that the technical potential of Category C projects may be as shown in Table 4. The average plant factor of the projects shown in Table 4 is about 0.55, the average head is about 80 meters and the average capacity is about 350 kW.

Table 4
Potential Rehabilitation, Upgrading or Extension of Existing Small Scale Hydro Projects
Source: Master Plan for the Electricity Supply of Sri Lanka: CEB: June 1989

Installed Capacity		No. of Sites
0 - 0.1 MW		6
0.1 - 0.5 MW		28
0.5 - 1.0 MW		1
1.0 - 5.0 MW		3
Total	58 MW	38

The foregoing demonstrates that the greater contribution from small scale hydropower developments can be expected from projects of Categories A and C, and that in comparison the potential which can be expected from irrigation tanks and reservoirs is fairly minimal, except for the largest tanks.

Projects of Category-C, rehabilitation of existing schemes in the estates, are well covered by previous and ongoing studies and actual rehabilitation of several schemes was undertaken. These projects do not fall under the jurisdiction of CEB, and therefore were not covered by the Master Plan Study.

Projects of Category-A, as at yet undeveloped sites include a considerable number of projects in the 0.5-5 MW capacity range. Pilot studies were carried out for twelve such projects during an add-on phase to the Master Plan Study, which was intended to evaluate the attractiveness of typical small-scale hydro projects of Category-A. A summary of the findings and the project locations are given in Figure 1.

Data Bases maintained by local Consultancy firms

Intermediate Technology Development Group has done an assessment of the small hydro potential in Sri Lanka in 1998.³ The study has separately identified the small hydropower potential within the plantations (mainly tea estates) and elsewhere. The exploitable Small Hydro Potential estimated in this study (Table 5) is about 100 MW, excluding the Small Hydro Potential of 50 MW identified in the above Master Plan study conducted by Ceylon Electricity Board. This study does not cover the potential sites in the head range below 30 meters. It is based on average daily flow and not the optimum design flow for the particular site. Taking these factors too into account, the study estimates the total exploitable Small Hydro Potential in Sri Lanka to be 170 ~ 180 MW.

- The Power Purchase tariff is based on the Avoided Costs of CEB, and is announced each year
- The floor tariff over the term is 90% of the initial year Tariff. If during the term of this Agreement, the Tariff forecast for any year becomes less than 90% of the Tariff on the date of the execution of the Agreement, the Tariff applicable for that year will be equal to the Tariff applicable for the previous year.
- The cost of transmission interconnection has to be borne by the Developer

This Power Purchase Agreement should not be treated as a financeable one on conventional non-recourse financing means. However, the Participating Credit Institutions (four selected commercial banks in Sri Lanka) under the World Bank's Energy Services Delivery Project** require their credit applicants to secure the Letter of Support from the CEB in their project appraisals.

Procedural details of entering into a standardized power purchase agreement with CEB are described in Annex 1.

Table 5
Exploitable Small Hydro Potential

Source: An Assessment of the Small Hydro Potential in Sri Lanka Intermediate technology Development Group March 1998

Site Classification	Old Estate sites	New Estate sites	Non Estate sites	Total
Number of sites	137	71	49	257
Utilized Potential MW	6.12	-	-	
Exploitable Potential MW	23.7	20.7	53.0	97.4
Highest Site capacity kW	1665	1127	5192	
Lowest Site Capacity kW	5	8	44	

6. Development of Grid Connected Small Hydro Projects

Standardized Power Purchase Agreement

Ceylon Electricity Board will enter into a Standardized Small Power Purchase Agreement* with the developer. This Standardized Small Power Purchase Agreement has the following main features⁴:

- All energy produced by the Facility will be purchased by CEB
- The power plant is not subject to dispatch

Tariff

Avoided cost of energy represents the maximum value of generation avoided by CEB as a result of any purchase of energy from sources outside the CEB system. Ideally, this value should be the value of one unit of energy (kWh) displaced at the margin by a unit of energy purchased from such sources. According to

* Specimen Standardized Small Power Purchase Agreement is available from the office of the Deputy General Manager (Private Power Projects), Ceylon Electricity Board, Colombo 0020 Fax: +94-1-344774

** See Section 10

Projects eligible for Grid Connection

Small hydropower plants of Capacity not more than 10 MW will be eligible for connection to the Grid. The projects which are marginally above 10 MW, will be considered on a case by case basis, provided that the developer agrees to comply with the Tariff and the terms and conditions of the Standardized Power Purchase Agreement.

Procedure for Application

Developer to forward the Initial Proposal to Deputy General Manager (Private Power Projects) requesting formal approval from CEB to purchase electricity. Initial Proposal shall at least include the following information related to the project.

- Name and Address of the Developer
- Weir and Power House locations (longitude and latitude) (to be marked on a one inch survey map)
- Identification of the River/Stream/canal where the plant is located
- Head and flow involved, power capacity, annual energy generation
- Rainfall or river flow data available and the basis on which energy output has been estimated
- Availability and the ownership of the land for the project, i.e. whether government or privately owned.

The developer will be requested to deposit an Application Processing Fee.

Initial examination of the Proposal

The details of the project proposal are studied by CEB for reasonableness, any conflicts with other on going private or CEB Master Plan Projects and a tentative grid connection point at 33kV level is identified. In this process, CEB will establish that the project is prima facie technically viable.

CEB will grant initial approval for the project, in the form of a Letter of Support valid for a period of six (6) months, indicating its willingness to purchase electricity from the proposed project. This Letter of Support will facilitate approvals required from other agencies. No further Letters of Support will be issued to the same site, or if the project proposal conflicts with another proposal to which a Letter of Support is issued already.

Approvals

Principal approvals needed and the various approving authorities are as follows:

Environmental Clearance/Licence	Central Environmental Authority
Permission to use water resources, development of roads Construction of buildings and canals	Divisional Secretary/ Irrigation Engineer etc. or Pradeshiya Sabha
Electricity License to generate and sell electricity	Chief Electrical Inspector, Ministry of Irrigation & Power
Investment and tax Concessions	Board of Investment
Title to the Land or Permission to use the Land	Land owner or Divisional Secretary

In addition to the above, if any waterways or reserves coming under the jurisdiction of Mahaweli Authority of Sri Lanka are to be used, specific approval from Mahaweli Authority of Sri Lanka is required. Similarly if diversion of water for agricultural activities is involved, permission from Department of Agrarian Services is required.

Feasibility Study

Within six months from receipt of initial approval from CEB, a complete feasibility report needs to be forwarded to DGM (Private Power Projects) of Ceylon Electricity Board. Failure to carryout the feasibility studies within the stipulated period will result in cancellation of the Letter of Support. Within six (06) months from establishment of feasibility, construction of the facility should be started and the progress of the same should be informed quarterly to CEB. Construction of the interconnection line (33 kV) and the substation to be co-ordinated with CEB.

Interconnection Requirements

The power plant is required to be connected to the 33 kV distribution system. Ceylon Electricity Board will identify the interconnection point after the issuance of the Letter of Support. Under the Standardized Power Purchase Agreement, the developer will be required to bear the cost of interconnection.

Ceylon Electricity Board will provide an estimate of the cost of interconnection, if the developer opts CEB to construct the interconnection facility. Otherwise, the developer is required to construct the interconnection facility according to CEB Standard Specification No: CEB:DCS-4: Construction Standards for Medium Voltage Power Distribution Lines.

Testing

Once the construction of the plant is completed, grid connection tests should be co-ordinated with CEB and on satisfactory completion of tests, CEB will permit connection of the facility and to export power.

Activities regarding switching on/off of the interconnection during maintenance and all operations of the power plant as well as the interconnection line should be co-ordinated with the CEB. Meter readings are taken by CEB, jointly with a representative of the Power Plant.

ANNEX 2
TARIFF CALCULATION METHODOLOGY

The following method is used in the calculation of yearly Tariff:

- Step 1** To calculate the cost of a unit generated by each plant in operation using applicable fuel costs and other plant data such as heat rates. The applicable fuel cost will be determined on the basis of the fuel price calculation by the Ceylon Petroleum Corporation in its fuel sales to CEB. This formula, along with the plant data and the parameters used in the calculations are published in the "Calculation of Small Power Purchase Tariff", which is published separately for the respective year.
- Step 2** Compute the expected plant factors for each month in the year under consideration using projections prepared by CEB's System Control Centre.
- Step 3** Calculate the fraction of time that each plant operates in the margin during a given month using the expected monthly plant factors. These fractions are then used directly in estimating the overall monthly avoided cost.
- Step 4** Estimate the avoided costs for wet and dry seasons separately by taking the arithmetic average of the

months in each season. That is, the Dry Season tariff is the average of avoided costs calculated for months February, March and April and the Wet Season tariff is the average of those in the balance nine months. Allowances made on account of Station Losses, Transmission Losses and overheads incurred by CEB are as follows:

Allowance for	%
Station Losses	3.0
Transmission Losses	3.2
CEB Overheads	1.5

- Step 5** Estimating the Tariff offered to small power producers

The Tariff offered to the Seller each year shall be the arithmetic average of the following:

- (a) Avoided cost of generation for the year, calculated according to methodology described in Step 4, and;
- (b) Avoided costs of generation used for estimating the price offered to the Seller in the previous two years.

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ANNEX 3
INCENTIVES FOR LARGE SCALE INFRASTRUCTURE PROJECTS

Qualifying Criteria	Minimum Investment	Rs.500~1499 million	Rs.1499~2499 million	Rs.2499~4499 million	over Rs.5000 million
	Minimum new Employment	not applicable	not applicable	not applicable	not applicable
Incentives	Tax Holiday	10 years	12 years	15 years	20 years
	Concessionary Tax at 15 %	after the tax holiday as per Inland Revenue Laws	after the tax holiday as per Inland Revenue Laws	after the tax holiday as per Inland Revenue Laws	after the tax holiday as per Inland Revenue Laws
	Import duty Exemption	On Capital goods during the Project establishment period	On Capital goods during the Project establishment period	On Capital goods during the Project establishment period	On Capital goods during the Project establishment period
	Exemption from Exchange Control	Yes	Yes	Yes	Yes

Source: Bureau of Infrastructure Investment Sri Lanka (1998): Guidelines and Incentives for Private Sector Participation in Economic Infrastructure Development

this rather broad definition, the avoided cost of a unit of electricity comprises fuel and variable O&M costs of generation displaced at the margin by a unit purchased at a given instant. This is generally the cost of the most expensive unit being generated at that instant, since it is implied that different generators are dispatched in their merit order of costs, subject to availability.

For purchases of energy from the developer, the maximum price the CEB is willing to pay for energy is its avoided cost. The avoided generation cost is calculated separately for dry and wet seasons of the year. "Dry Season" each year is defined as the period commencing on the 1st February and ending on the 30th April. The balance period (i.e. 1st January to 31st January and 1st May to 31st December) is defined as the "Wet Season".

The tariff calculation methodology is described in detail in Annex 2.

The Present Status

Seven projects, whose capacity totaling to about 3.0 MW, are now in operation under the standardized power purchase agreements. In 1998, these projects have contributed 4.6 GWh to the system. Only four projects were in operation in 1998. CEB has issued Letters of Support in relation to further 28 projects. They are in various stages of implementation, and additional 4 projects will be commissioned during this year. A summary of these projects is given in Table 6.

Many developers have used the data sources, as identified above, as the base for their feasibility studies. Certain developers have incorporated cost-effective technical variations to some existing study results. In the case of Off-Grid Hydro Schemes, the villagers themselves have identified many Schemes.

However, the grid-connected developers do have concerns related to long-term stability of the power purchase tariffs, due to its almost full dependence on oil prices. On the other hand, the maximum price that CEB can offer is its avoided cost, seasonally differenti-

ated. At the present, the parties are making attempts to find a mutually acceptable solution to this problem.

7. Development of Self Generating Small Hydro Projects

Projects eligible for Self-Generation

If the Developer is a present customer of Ceylon Electricity Board and wishes to develop a small hydro facility and sell energy to CEB whilst consuming a part of the energy generated, he will be eligible for sale of energy subject to the following conditions:

- The Developer will be liable for conditionalities of stand-by tariff
- Developer's energy firm shall exceed his consumption
- Both the developer and the consumer shall be the same legal entity

Project identification

Project identification will be a responsibility of the Developer. However, the data bases mentioned in Section 5 above are available to guide the developers in selection of the projects.

Power Purchase Agreement

Ceylon Electricity Board will enter into the Standardized Small Power Purchase Agreement with the Developer, under the same terms and conditions applicable to Grid-Connected Projects. The same tariffs as described in Annex 2 will be applicable here.

Interconnection Requirements

The power plant may be connected to the consumer's existing LV Bus. Under the Standardized Power Purchase Agreement, the developer will be required to bear the cost of interconnection.

Table 6
A Summary of the Projects Implemented Under the Standardized PPA
Source: Ceylon Electricity Board Private Power Projects

Status	Number of Projects	Capacity MW	Expected Annual Energy GWh
In operation	7	3.0	12.0
Under construction	8	14.5	68.5
Pre-construction stage	22	60.5	286

8. Development of Off-Grid Small Hydro Projects

Demonstration of the viability of off-grid micro hydro schemes to provide the basic electricity needs of rural people was first undertaken by the Intermediate Technology Development Group (ITDG) in 1991. Since about 1993, there has been an increasing flow of state funding for such schemes from Provincial Councils.

The profile of an off-grid micro hydro scheme

The schemes are initiated, implemented and managed by an Electricity Consumers Society (ECS) comprising members of beneficiary households. A typical scheme is rated at about 5 kW-10 kW and its daily load is characterized by domestic lighting and appliances such as TV & radio. The household demand varies between 75W and 125W, which is sufficient to light three fluorescent lights and to power a black and white TV. During daytime, the surplus power is used in some schemes to charge automotive batteries of neighboring villages, and for operation of small industrial units such as rice mills, welding/carpentry workshops etc. CEB will assist Electricity Consumers Society in project preparation and for it to conform to a set of pre-determined technical standards

As an electricity distributor, the ECS will be required to obtain an electricity license as per requirements of Electricity Act No.19 of 1950. The Electricity Consumers Societies are presently not supervised and monitored by any particular state agency. Some ECS are

registered with the Divisional Secretary for the area, who oversees the ownership and management aspects of the ECS. Generally, the tariff adopted for this type of schemes is at the discretion of the ECS, and is normally based on the power consumed by the households.

The Present Status

About 75 such off-grid power projects have been successfully completed by the year 1998. These projects have a total of 400 kW, with individual project sizes ranging from 200 W-35 kW.

9. Incentives for Infrastructure Sector by the Board of Investment

The Government of Sri Lanka offers a wide range of incentives for investors through the Board of Investment.⁵ The incentives relevant to the infrastructure sector are outlined below. They broadly fall into two categories:

- Large scale projects where total project costs exceeds Rs.500 million. (Approx. US\$ 10 million)
- Small scale projects where total project cost is less than Rs.500 million (Table 7)

Incentives are conferred under the relevant Regulations of the BOI Act. This is reviewed on an annual basis and, in certain instances, amended on a case by case basis by the Minister of Finance through powers vested under the Act.

Table 7

Incentives for Non-Export Oriented Projects-Small Scale Infrastructure (Power)

Source: Bureau of Infrastructure Investment Sri Lanka (1998): Guidelines and Incentives for Private Sector Participation in Economic Infrastructure Development

Qualifying Criteria	Minimum Investment	Rs.50~499 million
	Minimum new Employment	not applicable
Incentives	Tax Holiday	none
	Concessionary Tax	7 years
	Import duty Exemption	On Capital goods during the Project establishment period
	Exemption from Exchange Control	No

Small Scale Infrastructure Projects

Infrastructure projects where total cost ranges from Rs.125 million to Rs.499 million would qualify for incentives under this Category. In the case of power and housing projects, the minimum project size to qualify for incentives is Rs.50 million.

Other benefits include exemption from import and excise duties on operational and construction machinery, equipment and construction materials during the project implementation period. Expatriate employees are eligible for a 15% reduced income tax for the first three years of the project.

Incentives for large scale infrastructure projects

New Enterprises with total project costs exceeding Rs.500 million are classified as Large Scale Projects eligible for tax holiday periods varying according to the size of the investment. The tax holiday period applicable for the respective schemes is shown below. Exemption from exchange control laws would also be available for such projects.

Exemption from import duties, turnover tax and excise duties on imports will be applicable only during the project implementation period as defined by the BOI. Projects anticipating expansion may submit applications for each expansion phase. These benefits are summarized in Annex 3.

10. Facilities Provided Under the Energy Services delivery Project

The Government of Sri Lanka has proposed the Energy Services Delivery Project to develop cost-effective renewable energy and demand side initiatives. In this World Bank/GEF project, the major component is the Energy Services Delivery Credit Program, which would provide medium and long-term financing to private sector firms and co-operatives for household solar photovoltaic electrification, village hydro schemes, grid-connected mini-hydro plants, and other renewable energy investments.

Funds for the ESD Credit Program and associated technical assistance would be made available under an IDA credit as well as a grant from the Global Environment Facility. The GEF funding would primarily support off-grid (photovoltaic and village hydro) subprojects. Credit Institutions, which meet specific eligibility criteria, have entered into an agreement with the Government to participate in the ESD Credit Program. The ESD Credit Program is administered the DFCC Bank in Colombo on behalf of the Government.

Eligible Projects

Private investment proposals by any private enterprise or co-operative operating in Sri Lanka are eligible for financing under the above credit to develop grid-connected mini-hydro power plants and off-grid village hydro systems (and also for solar home systems and other renewable energy investments), provided that:

The proposed subproject is below 5 MW in capacity, financially viable, environmentally sound, arid economically justifiable;

The subproject will be designed, constructed, operated and maintained in accordance with accepted safety codes and engineering standards, as well as environmental standards;

The sub-borrower meets the creditworthiness assessment of the participating Credit Institution; and

The sub-loans are re-financed on terms and conditions approved by IDA.

Four selected Sri Lankan commercial banks function as Participating Credit Institutions under this project.

11. Conclusions

Significant amount data is already available in the public domain about the hydropower potential of Sri Lanka. The healthy interest in small hydro development points us towards maximization of developed small hydro potential in the country. Significant correspondence between the power purchase tariff and the international oil prices has however affected viability of new projects, in the prevalent low oil price scenario. However, in the electricity utilities perspective, this is consonant with its objective of achieving the optimum fuel mix in its operations.

Board of Investment of Sri Lanka offers a range of incentives to these infrastructure projects according to the size of the investment. Additionally, for smaller projects, credit facilities are available from Sri Lankan commercial banks under the World Bank's Energy Services Delivery Project. Almost all the developers have taken advantage of these incentives.

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