1.1.3 Energy supply and demand

(1) Energy production and consumption

Energy supply

The gross energy supply in Sri Lanka amounted to 7.6 million barrels petroleum equivalent in 1994. This was supported by fuelwood, agricultural waste, unused animal parts and cellulose fiber materials supplying 4.6 million barrels or 61% of the total. Petroleum including LPG accounted for 25%, hydro electricity for 10%, and coal and coal products for 4%.

Energy consumption

Energy consumption by sector including biomass consists of 63% household, 16% transport, 17% industrial and 4% commercial and other uses. If biomass energy consumption is excluded, transport use accounts for 54% of the total energy use, followed by household for 17%, industrial uses for 19%, and commercial and other uses for 10%.

(2) Power supply and consumption

Power supply system

The national power system is divided into eleven areas: 1) Northern, 2) Northern Central, 3) Eastern, 4) North Western, 5) Central, 6) Uva, 7) Western North, 8) Western South, 9) Colombo City, 10) Sabaragamuwa, and 11) Southern. Boundaries of these areas are shown in Figure 1.1.

CEB operates at present 15 hydropower stations and three thermal power stations to feed the national grid operating at 220 kV and 132 kV (Figure 1.2).

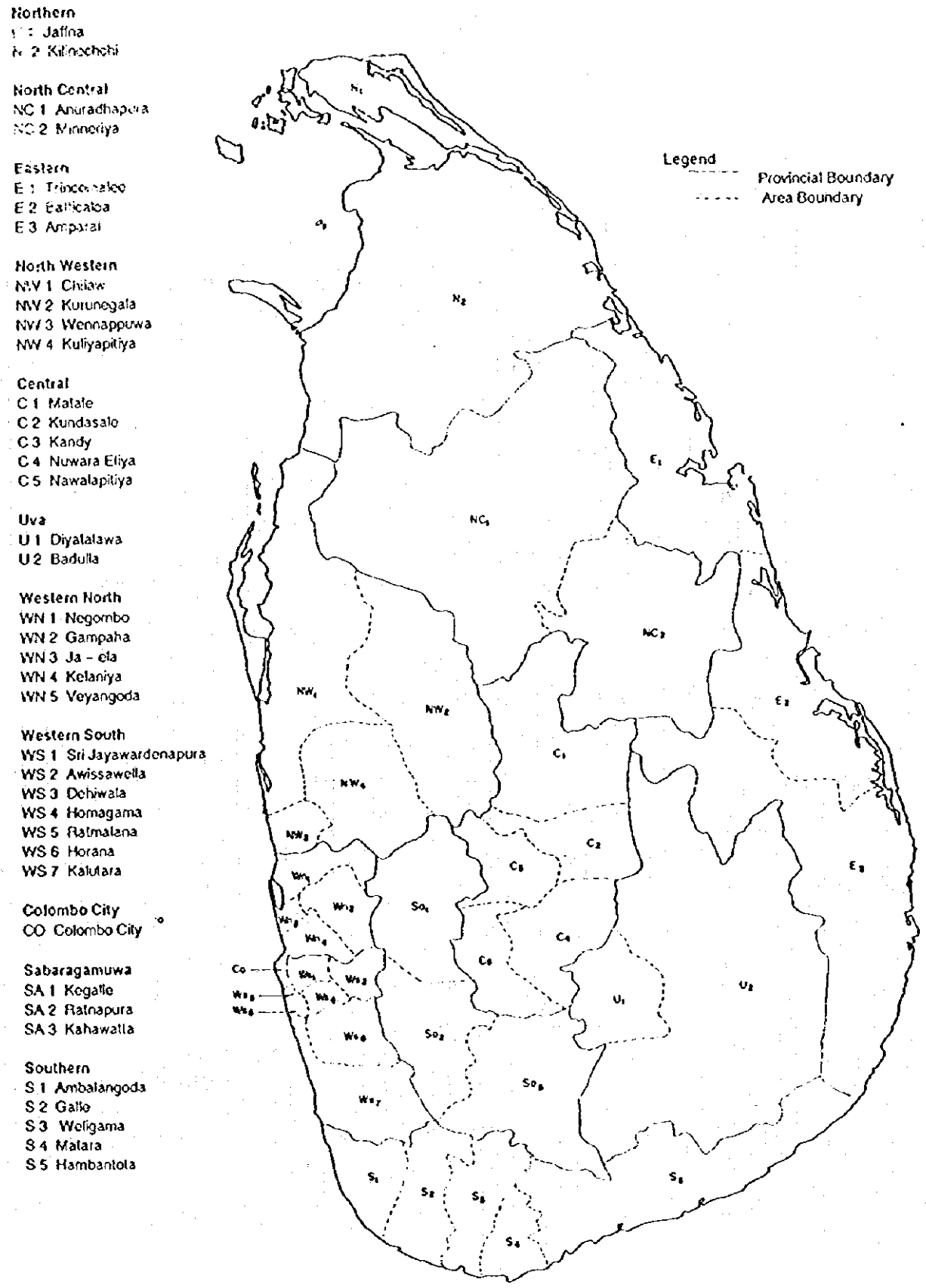

Figure 1.1 CEB Provincial Boundaries & Area Boundaries

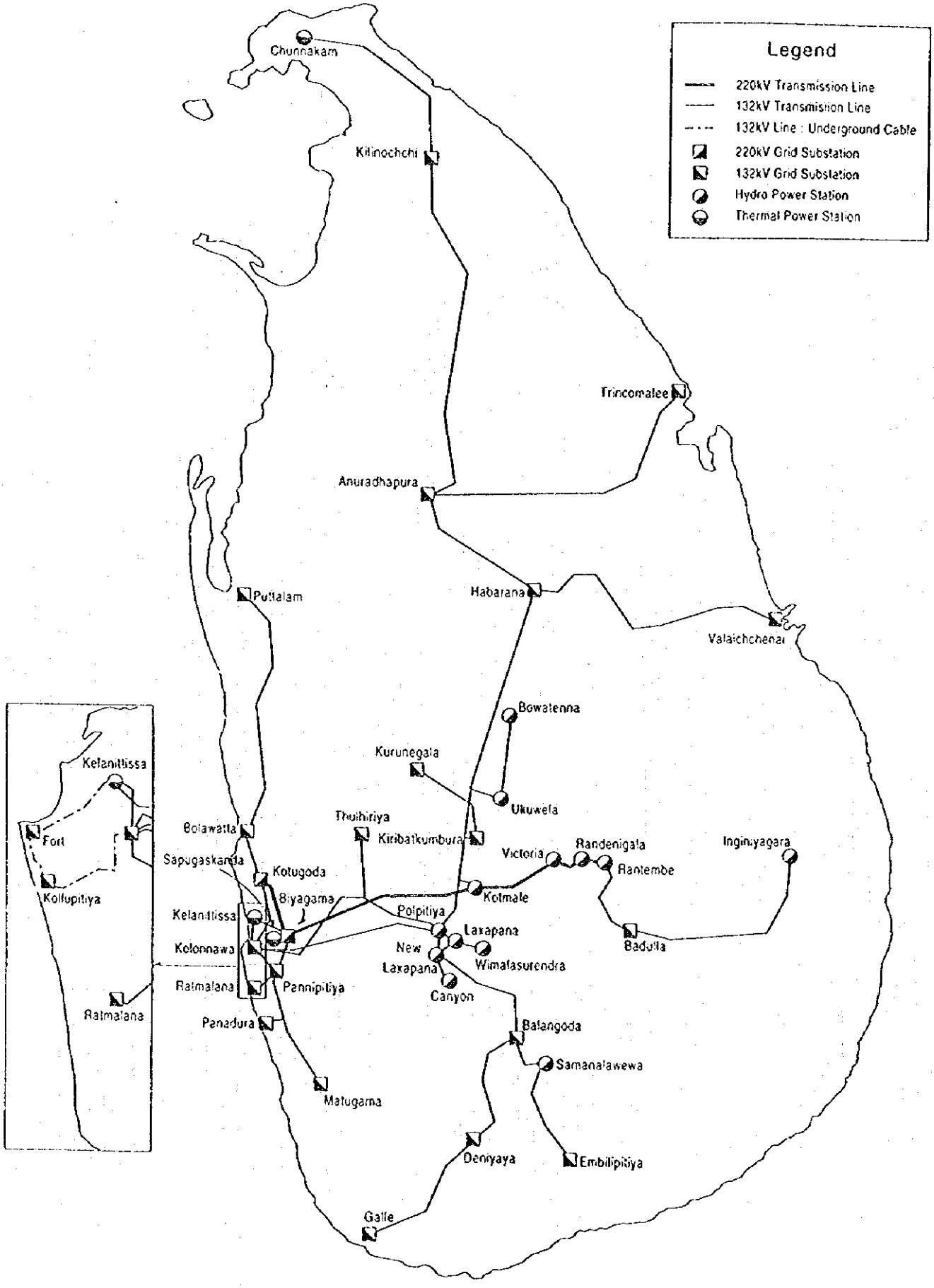

Figure 1.2 Power Transmission System of CEB (End-1995)

Power supply capacity

The total installed capacity for power generation in the Country (CEB grid) was 1,410 MW, but the effective capacity was 1,302 MW, consisting of 86.5% hydro, 3.3% steam-based thermal, 6.7% gas turbine and 3.5% diesel as shown in Table 1.1.

Table 1.1 Existing Power Stations in Sri Lanka

Hydro Power Station	Installed Capacity (MW)	Effective Capacity (MW)	% of Eff. Capacity
Laxapana Complex		335.00	25.8
Old Laxapana	50.00	50.00	
Wimalasurendra (Norton)	50.00	50.00	
Samanala (Polpitiya)	75.00	75.00	
Canyon	60.00	60.00	
New Laxapana	100.00	100.00	
Mahaweli Complex		659.00	50.6
Ukuwela	40.00	38.00	
Bowetanna	40.00	40.00	
Victoria	210.00	210.00	
Kotamale	201.00	201.00	
Randenigala	122.00	120.00	
Ratambe	49.00	50.00	
Samanalawewa Plant			
Samanalawewa	120.00	120.00	9.2
Minor Hydro		12.20	0.9
Inginiyagala	11.25	5.00	
Udawalawe	6.00	4.00	
Nilamba	3.20	3.20	
Total of Hydro	1,137.45	1,126.20	86.5
Thermal Power Station			
Chunnakam (Diesel)	14.00	NA	
Kelanitissa (Steam)	50.00	43.00	3.3
Kelanitissa (Gas)	120.00	87.50	6.7
Sapugaskanda (Diesel)	80.00	45.00	3.5
Cement Factory (Gas)	8.20	NA	
Total of Thermal	272.20	175.50	
Total	1409.65	1301.70	100

Source: "Annual Plan 1995" by Ministry of Irrigation, Power and Energy.

The total energy production from these plants was 4,365 GWh in 1994 within the CEB grid, consisting of 93.2% hydro, 2.0% steam, 2.3% gas turbine, 2.0% diesel and 0.5% self-generation as shown in Table 1.2.

The CEB facilities in the transmission and distribution system at the end of 1994 were classified as shown in Table 1.3. Transmission lines extend for the total length of 1,537 km, consisting of 89% line length operating at 132 kV and the rest at 220 kV.

Distribution lines are based on a primary system at 33 kV and a secondary system at 11 kV, and the low voltage distribution is operated at 400/230 V, three-phase, four-wire.

Table 1.2 Power Generation 1993/1994

	Unit	1993	% of Total	1994	% of Total	% Increase
Maximum Demand	MW	812.2	-	910.8	-	12.1
System Load Factor	%	55.92	-	54.7	-	-2.2
Annual Energy						
Hydro	GWh	3795.903	95.4	4089.217	93.2	7.7
Steam	GWh	87.589	2.2	86.862	2.0	-0.8
Diesel	GWh	82.759	2.1	86.311	2.0	4.3
Gas Turbine	GWh	12.347	0.3	102.242	2.3	728.1
Sub-total	GWh	3978.598	100.0	4364.632	99.5	9.7
Self Gener	GWh	-	-	22.18	0.5	-
Total	GWh	3978.598	100.0	4386.813	100.0	10.3

Source: Statistical unit, Load forecasting and tariff branch, CEB Colombo.
Note: There was self thermal generation during September, October and November 1994.

Table 1.3 Length of Transmission and Distribution Lines in the CEB Grid

Description	Unit	1993	1994	% Increase
220 kV route length	km	168	168	0.0
132 kV route length	km	1,369	1,369	0.0
66 kV route length	km	235	235	0.0
33 kV circuit length (overhead)	km	12,371	12,944	4.6
33 kV circuit length (underground)	km	62	59	-4.8
11 kV circuit length (overhead)	km	1,916	2,078	8.5
11 kV circuit length (underground)	km	630	638	1.3
Low voltage (overhead and underground)	km	33,470	38,698	15.6

Source: "Statistical Digest 1994" by CEB.

The number of the substations in the CEB grid was 9,421 at the end of 1994, of which 98% were distribution substations (Table 1.4).

Table 1.4 Number of Substations

Description	Unit	1993	1994	% Increase
Grid substation (220/33 kV & 132/33 kV)	No.	29	29	0.0
Primary substation (33 kV/11 kV & 33 kV/3.3 kV)	No.	136	144	5.9
Distribution substation (33 kV/LV & 11 kV/LV)	No.	8,750	9,248	5.7
Total	No.	8,915	9,421	5.7

Source: "Statistical Digest 1994" by CEB.

Power consumption

Total power consumption in Sri Lanka reached 3,565 GWh in 1994. The increase of electricity sales was at 7.6% per annum during the 1970s, reduced to 6.5% per annum in the 1980s, and accelerated to 7.8% per annum over 1990-94 (Table 1.5).

The power consumption by the domestic sector increased at higher rates to increase its share from 8.9% in 1971 to 25.5% in 1994, reflecting rural electrification efforts. The share of the industrial sector decreased from 51.7% in 1971 to 39.4% in 1994 of the total electricity sales. The commercial sector increased its share from 12.9% in 1971 to 16.3% in 1994 (Table 1.5).

Table 1.5 Peak Demand and Electricity Sales 1971—94

Year	Peak Demand (MW)	Total Sales (GWh)	Per Capita Sales (kWh)	Percentage of Sales by Tariff Group			
				Domestic	Industry	Commerce	Other
1971	-	722	57	8.9	51.7	12.9	26.5
1972	200	823	65	8.7	54.4	12.0	24.9
1973	200	867	66	9.5	53.8	12.4	24.3
1974	216	907	68	9.1	54.2	13.0	23.7
1975	219	965	71	9.0	54.3	12.4	24.3
1976	240	997	73	9.5	51.8	13.5	25.2
1977	261	1041	75	10.2	49.9	14.2	25.7
1978	291	1166	82	10.2	50.9	13.9	25.0
1979	329	1298	90	11.8	48.7	15.5	24.0
1980	369	1392	94	13.7	45.0	16.0	25.3
1981	413	1510	101	14.3	44.9	14.6	26.2
1982	431	1694	112	15.3	43.6	15.5	25.6
1983	437	1797	117	17.0	41.8	16.2	25.0
1984	487	1886	121	16.8	41.3	17.0	24.9
1985	515	2060	130	16.8	41.3	17.0	24.9
1986	540	2232	138	16.5	41.5	17.1	24.9
1987	570	2253	138	16.9	38.5	18.6	26.0
1988	594	2371	143	16.5	38.1	19.5	25.9
1989	618	2353	140	17.3	36.1	19.1	27.5
1990	640	2608	154	19.0	34.9	16.2	29.9
1991	685	2742	159	23.5	34.9	19.9	21.7
1992	742	2916	168	23.1	36.7	19.6	20.6
1993	812	3270	186	24.6	37.4	19.6	18.4
1994	911	3565	200	25.5	39.4	16.3	18.8

Source: "Report on Long Term Generation Expansion Planning Study 1995-2009" by CEB, October 1994.

Power consumption by province was composed of 0.16% Northern, 2.49% Northern Central, 4.06% Eastern, 7.44% North Western, 9.14% Central, 2.41 Uva, 21.07% Western North, 21.93% Western South, 17.5% Colombo City, 6.36% Sabaragamuwa and 7.34% Southern (Table 1.6).

The maximum demand in the CEB grid reached 910.8 MW in 1994 (Table 1.2). It grew at an average annual rate of 12.1% during 1993-1994 with the load factor of 54.7% (Table 1.2).

Per capita electricity consumption

Per capita electricity consumption of the Country stood at 200 kWh in 1994 as shown in Table 1.7. This may be compared with 6,300 kWh in Japan, 5,451 kWh in Singapore, 2,747 kWh in South Korea, 1,549 kWh in Malaysia, 895 kWh in Thailand and 213 kWh in Indonesia.

Ratio of electrified households

Electrification by CEB including LECO and LAs is 41.4% as of the end of 1994 as shown in Table 1.8.

1.1.4 Power tariff system

(1) Electricity tariffs

The complete monopoly system was established according to government regulations for electric power supply activities of CEB as an organization to provide basic infrastructure to the Nation. The system calls for power tariffs to be determined on a fair basis. The power tariffs are determined basically annually based on the estimated annual expenditure of the electricity supply plus eight percent return which is acknowledged by the World Bank and ADB as fair and reasonable. The annual expenditure calculation for tariff decision includes all operating and maintaining cost, repayment to borrowed loans and interest payment to them for generation and transmission projects, and construction costs of distribution and other facilities. The necessary income expected from power sales is allocated to all categories of consumers based on assigned tariffs and estimated sales. Thus, the actual tariffs are not based on the true costs for power supply to each consumer category. A tariff study under an ADB loan is underway to calculate tariffs based on actual costs.

Table 1.6 Electricity Consumption (Sales) by Province

Province	CEB's Area	1993 (GWh)	1994 (GWh)	%Increase 1993/1994	1993 %of National	1994 %of National
Northern	Jaffna	0.002	0.000	-100.0	0	0
	Kilinochchi	4.954	5.803	17.1	0.14	0.16
Sub-total		4.956	5.803	17.1	0.14	0.16
Northern Central	Anuradhapura	38.182	53.789	40.9	1.17	1.51
	Minneriya	30.459	34.930	14.7	0.93	0.98
Sub-total		68.641	88.719	29.3	2.10	2.49
Eastern	Trincomalee	75.348	67.950	-9.8	2.30	1.91
	Ampara	20.661	22.506	8.9	0.63	0.63
	Batticaloa	39.393	37.140	-5.7	1.20	1.04
	Kalmuni	15.003	17.023	13.5	0.46	0.48
Sub-total		150.405	144.620	-3.8	4.59	4.06
North Western	Kurunegala	50.550	56.071	10.9	1.55	1.57
	Wennappuwa	45.729	47.554	4.0	1.40	1.33
	Chilaw	109.117	109.670	0.5	3.34	3.08
	Kuliyapitiya	40.872	52.041	27.3	1.25	1.46
Sub-total		246.268	265.336	7.7	7.54	7.44
Central	Nortonbridge	60.984	62.062	1.8	1.86	1.74
	Kandy	94.830	99.825	5.3	2.90	2.80
	Nuwara Eliya	72.483	73.537	1.5	2.22	2.06
	Matale	37,176	41.810	12.5	1.49	1.17
	Kundasale	48.620	48.722	0.2	1.49	1.37
Sub-total		314.093	325.959	3.8	9.96	9.14
Uva	Badulla	45.023	45.095	0.2	1.38	1.27
	Diyatalawa	38.076	40.794	7.1	1.16	1.14
Sub-total		83.100	85.889	3.4	2.54	2.41
Western-North	Gampaha	59.490	61.733	3.8	1.82	1.73
	Veyangoda	46.292	51.898	0.12	1.42	1.46
	Negombo	176.568	193.562	0.10	5.40	5.43
	Kelaniya	273.106	323.167	0.18	8.35	9.07
	Ja-ela	106.962	120.651	0.13	3.27	3.38
Sub-total		662.418	751.010	0.13	20.26	21.07
Western-South	Ratmalana	243.421	287.211	18.0	7.44	8.06
	Homagama	43.555	51.471	18.2	1.33	1.44
	Sri Jayawardanapura	236.354	264.590	11.9	7.22	7.42
	Kalutara	28.845	29.146	1.0	0.88	0.82
	Dehiwela	73.580	77.125	4.8	2.25	2.16
	Awissawella	30.027	35.037	16.7	0.92	0.98
	Horana	31.906	37.604	17.9	0.98	1.05
Sub-total		687.689	782.182	13.7	21.02	21.93
Colombo City		601.918	627.123	4.2	18.41	17.59
Sabaragamuwa	Kegalle	103.057	112.504	9.2	3.15	3.16
	Ratnapura	42.974	47.362	10.2	1.31	1.33
	Kahawatta	65.034	66.689	2.5	1.99	1.87
Sub-total		211.066	226.555	7.3	6.45	6.36
Southern	Ambalangoda	35.144	41.147	17.1	1.07	1.15
	Galle	92.841	106.822	15.0	2.84	3.00
	Weligama	36.757	37.749	2.7	1.12	1.06
	Matara	45.031	43.850	-2.6	1.38	1.23
	Hambantota	29.776	32.063	7.7	0.91	0.90
Sub-total		239.549	261.631	9.2	7.32	7.34
National		3,270.103	3,564.818	9.0	100.00	100,00

Source: "Sales and Generation Data Book 1994" by CEB.

Table 1.7 Per Capita Electricity Consumption in 1994

Province	CEB's Area	Electricity Consumption (GWh)	Population Estimate (thousand)	kWh Per Capita	Land Area (sq. km)
Northern	Jaffna	0.000	893		984
	Kilinochchi	5.803			
		5.803			
North Central	Anuradhapura	53.789	753	71	7,034
	Minnerita	34.930	334	105	3,224
		88.719	1,087	82	10,258
Eastern	Trincomalee	67.950	328	207	2,631
	Ampara	22.506	509	44	4,318
	Batticaloa	37.140	440	84	2,686
	Kamunai	17.023			
		144.620			
North Western	Kurunegala	56.071	1,485	38	4,813
	Wennppuwa	47.554			
	Chilaw	109.670	627	175	3,013
	Kuliyapitiya	52.041			
		265.336			
Central	Nortonbridge	62.065			
	Kandy	99.825	1,289	77	1,906
	Nuwara Eliya	73.537	543	135	1,721
	Matale	41.810	436	96	1,993
	Kundasale	48.722			
		325.959			
Uva	Badulla	45.095	735	61	2,803
	Diyatalawa	40.794	367	111	5,546
		85.889	1,102	78	8,349
Western-North	Gampaha	61.733	1,580	39	1,387
	Veyangoda	51.898			
	Negombo	193.562			
	Kelaniya	323.167			
	Ja-ela	120.651			
		751.010			
Western-South	Ratmalana	287.211			
	Homagama	51.471			
	Sri Jayawardanapura	264.590			
	Kalutara	29.146	976	30	1,589
	Dehiwela	77.125			
	Avissawelle	35.037			
	Horana	37.604			
		782.182			
Colombo City		627.123	2,059	305	657
Sabaragamuwa	Kegalle	112.504	770	146	1,693
	Ratnapura	47.362	975	49	3,255
	Kahawatta	66.689			
		226.555			
Southern	Galle	147.959	986	150	1,636
	Matara	81.599	810	101	1,283
	Hambantota	32.063	539	59	2,579
Sub-total		261.621	2,335	112	5,498
National		3,564,818	17,824	200	64,455

Source: "Status of Electrification - 1994" by CEB for Population and Land Area.

Table 1.8 Ratio of Electrified Households by District
(As of 31 Dec. 1994)

District	Number of Households	Number of Consumers			Total No. of Electrified Households	Percentage Electrified Household
		CEB	LECO	LA		
Jaffna	178,600	20,928		30,000	50,928	28.5
Anuradhapura	167,442	49,089			49,089	29.3
Minnerita	76,535	22,781			22,781	29.8
Trincomalee	70,560	15,224			15,224	21.6
Ampara	125,143	19,069			19,069	15.2
Batticaloa	110,770	44,249			44,249	39.9
Kurunegala	332,220	81,953			81,953	24.7
Chilaw	145,748	60,803			60,803	41.7
Kandy	253,899	87,772		25,000	112,772	44.4
Nuwara Eliya	136,783	57,316			57,316	41.9
Matale	104,475	32,815			32,815	31.4
Badulla	173,763	58,361			58,361	33.6
Diyatalawa	82,057	10,200			10,200	12.4
Gampaha	371,488	199,740	66,241		265,981	71.6
Kalutara	222,706	61,996	73,246		135,242	60.7
Colombo	346,634	210,312	64,063		274,375	79.2
Kegalle	176,969	47,503			47,503	26.8
Ratnapura	200,897	51,172		7,144	58,316	29.0
Galle	211,417	68,797	31,386		100,183	47.4
Matara	175,443	76,720			76,720	43.7
Hambantota	121,543	28,594			28,594	23.5
Other	93,000	3,497			3,497	3.8
Total	3,878,092	1,308,891	234,936	62,144	1,605,971	41.4

Source: "Status of Electrification - 1994" by CEB.
Note: Other includes Vavuniya, Mannar, Kilinochchi and Mulathivu.

(2) Current tariff system

The current tariff system effective from 1 January 1996 is shown in Table 1.9. The overall average tariff is Rs. 4.15 per kWh. The electricity consumption charge is billed as the sum of monthly fixed charge and kWh charge based on monthly energy consumption. The country-wide uniform tariffs are applied covering the whole area of the Country for supplies by CEB, LECO and LAs.

1.2 Existing Energy Situation in Southern Area

1.2.1 Characteristics of energy situation

(1) Electricity consumption

The less developed status of Southern Areas is observed in its energy use. The electricity consumption in Southern Area was only 392 GWh or 11.0% of the total national consumption in 1994, much smaller than its population share. This consists of 262 GWh or 66.8 % in Southern province, 23 GWh or 5.8 % in Ampara, 41 GWh or 10.4% in Moneragala, and 67 GWh or 17.0 % in Kahawatta. Electricity consumption in Southern Area grew at a high rate of 7.8% during 1993-1994. Some consumption data are summarized in Table 1.10.

Per capita electricity consumption was 93 kWh in Southern Area and 112 kWh in Southern province, as compared with the national average of 200 kWh, both in 1994. Per capita electricity consumption varies among districts: 150 kWh in Galle, 101 kWh in Matara, 59 kWh in Hambantota, 44 kWh in Ampara, 111 kWh in Moneragala and 68 kWh in Kahawatta. Reference is given in Table 1.11.

Table 1.9 Electricity Tariffs

CEYLON ELECTRICITY BOARD
ELECTRICITY TARIFF
with effective from 01-01-1996

Domestic:-

First 30 kWh (Block 1)	Rs. 1.20 kWh
31 - 90 kWh (Block 2)	Rs. 2.40 kWh
91 -180 kWh (Block 3)	Rs. 4.50 kWh
Above 180 kWh (Block 4)	Rs. 5.60 kWh

Monthly Fixed Charge - Rs. 15.00 per month

Religious Purpose: -

First 90 kWh (Block 1)	Rs. 1.20 kWh
	Rs. 2.40 kWh
91 -150 kWh (Block 2)	Rs. 4.50 kWh
Above 150 kWh (Block 3)	

Monthly Fixed Charge - Rs. 15.00 per month

Other Categories: Monthly	General Purpose	Industrial	Industrial (Time of Day)
1) Supply at 400/230V (Contract demand less than 50 kVA)			
Energy Charge (Rs/kWh)	5.60	4.30	3.20 (off peak) 8.90 (peak 6 p.m. to 9 p.m.)
Fixed Charge (Rs/month)			
.Up to 10 kVA	15.00	15.00	15.00
.Above 10 kVA	205.00	205.00	205.00
2) Supply at 400/230V (Contract demand 50 kVA and above)			
Energy Charge (Rs/kWh)	5.50	4.10	3.80 (off peak) 9.00 (peak 6 P.m. to 9 p.m.)
Demand charge (Rs/kVA)	270.00	235.00	110.00
Fixed Charge (Rs/month)	435.00	435.00	435.00
3) Supply at 11/33/132 kV			
Energy Charge (Rs/kWh)	5.40	3.90	3.60 (off peak) 8.60 (peak 6 p.m. to 9 p.m.)
Demand charge (Rs/kVA)	250.00	210.00	100.00
Fixed Charge (Rs/month)	435.00	435.00	435.00
Bulk Supply to LECO/LA		Energy charge (Rs/kWh)	Demand charge (Rs/kVA)
L1: Supply at 400/230V		2.60	65.00
L2: Supply at 11kV and above:		2.25	47.50
Street Light		4.30 per kWh	

Notes: 1) Adoption of fixed energy charge or time differential energy charge for industrial consumers is consumer's choice.
2) Peak time 18 to 21 o'clock; off peak time is the rest of the day.

Source: CEB

Table 1.10 Electricity Consumption in Southern Area

Province	CEB's Area	1993 (GWh)	1994 (GWh)	% Increase 1993/1994	1994 % of Total	1994 % of National
Southern	Ambalangoda	35.144	41.147	17.1	10.5	1.2
	Galle	92.841	106.822	15.0	27.3	3.0
	Weligama	36.757	37.749	2.7	9.6	1.1
	Matara	45.031	43.850	- 2.6	11.2	1.2
	Hambantota	29.776	32.063	7.7	8.2	0.9
Sub-total		239.549	261.631	9.2	66.8	7.4
Eastern	Ampara	20.661	22.506	8.9	5.8	0.6
Uva	Moneragala	38.076	40.794	7.1	10.4	1.1
Sabaragamuwa	Kahawatta	65.034	66.689	2.5	17.0	1.9
Total of Southern Area		363.320	391.620	7.8	100.0	11.0
National		3,270.103	3,564.818	9.0	-	100.0

Source: "Sales and Generation Data Book 1994" by CEB.

Table 1.11 Per Capita Electricity Consumption in Southern Area

Province	CEB's Area	Electricity Consumption (GWh)	Population Estimate (thousand)	kWh Per Capita	Land Area (sq.km)
Southern	Galle	147.969	986	150	1,636
	Matara	81.599	810	101	1,283
	Hambantota	32.063	539	59	2,579
Sub-total		261.631	2,335	112	5,498
Eastern	Ampara	22.506	512	44	4,318
Uva	Moneragala	40.794	367	111	5,546
Sabaragamuwa	Kahawatta	66.689	975	68	3,255
Total of Southern Area		391.620 (11.0)	4,189 (23.5)	93	18,617 (28.9)
National		3,564,818	17,824	200	64,455

Source: "Status of Electrification - 1994" by CEB for Population and Land Area.

(2) Energy sources and supply

Southern Area has very limited energy sources. In addition to the existing hydropower plant of 6 MW at Udawalawe, only the Gin Ganga hydropower plant at Deniyaya in Matara district is a candidate project except for the multipurpose development by water diversion such as Uma Oya. Southern Area is provided electricity from the national grid through five substations at Matugama, Galle, Deniyaya, Embilipitiya and Balangoda for Southern province and Kahawatta, and three substations at Deniyaya, Badulla and Inginiyagala for Moneragala and Ampara.

(3) Electrification

Much expansion of electric distribution lines has been undertaken in Southern Area with assistance from various funding organizations: Asian Development Bank (ADB), the World Bank, Integrated Rural Development Projects (IRDPs) and various other international organizations.

The rate of electrified households was 32.0% in Southern Area and 40.4% in Southern province as of December 1994, lower than the national average 41.4%. The ratio varies among districts: 47.4% in Galle, 43.7% in Matara, 23.5% in Hambantota, 15.2% in Ampara, 12.4% in Moneragala and 29.0% in Kahawatta. Reference data are shown in Table 1.12.

Table 1.12 Ratio of Electrified Households in Southern Area

District	Number of Households	Number of Consumers			Total No. of Electrified Households	Percentage Electrified Household
		CEB	LECO	LA		
Galle	211,417	68,797	31,386		100,183	47.4
Matara	175,443	76,720			76,720	43.7
Hambantota	121,543	28,594			28,594	23.5
Sub-total	508,403	74,111	31,386		205,497	40.4
Ampara	125,143	19,069			19,069	15.2
Moneragala	82,057	10,200			10,200	12.4
Kahawatta	200,897	51,172		7,144	58,316	29.0
Total	916,500	254,552	31,386	7,144	293,082	32.0
National	3,878,092	1,308,890	234,936	62,144	1,605,970	41.4

Source: "Status of Electrification - 1994" by CEB.

1.2.2 Electricity supply

(1) Power supply system

Southern Area is covered by the national grid. Grid substations serving Southern province are the Matugama grid substation (SS) with available capacity of 10 MVA, Galle grid SS with 60 MVA, Deniyaya grid SS with 25 MVA, Embilipitiya grid SS with 15 MVA and Balangoda grid SS with 5 MVA. The total available capacity of 115 MVA covers the present system peak demand of 77.4 MVA. Reference is given in Table 1.13.

Table 1.13 Grid Substations in Southern Area

Grid Substation	Available Capacity (MVA)
Matugama	10 (31.5 x 2)
Galle	60 (30 x 3)
Deniyaya	25 (10 x 3)
Embilipitiya	15 (10 x 2)
Balangoda	5 (10 x 2)
Total	115

Source: "Analysis of MV Distribution Network in Southern Province" by CEB, June 1995.

Notes: Figures are capacities available for the province.
Total capacity is given in parentheses.
System Peak Demand 77.4 MVA
Firm Capacity Ratio 115/77.4 = 1.49

Moneragala and Ampara are supplied from three grid SSs (Balangoda, Badulla and Iginiyagala) and Kahawatta is covered by two grid SSs (Deniyaya and Embilipitiya). Construction of 132 kV transmission lines from the existing Embilipitiya grid SS with switchgear augmentation to a new Matara grid SS (132/33 kV, 63 MVA) started recently under the Transmission and Grid Substation Development Project (TGSDP) to be completed by the end of 1997. Also the 132 kV two-cct transmission line between Laxapana and Badulla, and the switchgear in Badulla grid SS were expanded under the Transmission System Augmentation and Development Project (TSADP) by July 1996.

(2) Distribution system

The primary substations are connected by 33 kV distribution lines to grid SSs and by 33 kV or 11 kV lines to distribution substations/bulk substations/bulk distribution. The number of distribution substations is 1,131 in Southern province, 88 in Moneragala and 427 in Kahawatta area as shown in Table 1.14.

Table 1.14 Distribution System in Southern Area

Item	Southern Province Nos./Capacity (MVA)	Moneragala District Nos./Capacity (MVA)	Ratnapura District Nos./Capacity (MVA)
Primary Substations	16/50	- / -	- / -
Distribution Substation (11 & 33 kV)	799/108	88/ -	427/ -
Bulk Substation (11 & 33 kV)	204/46	- / -	- / -
Bulk Distribution (11 & 33 kV)	112/26	- / -	- / -
Total	1131/230	88/ -	427/ -

Sources: "Analysis of MW Distribution Network in Southern Province" by CEB (Southern province).
"Project Report of Rural Electrification Ratnapura District" by CEB (Eheliyagoda).

The total length of 33 kV and 11 kV distribution lines amounts to 1,760 km in Southern province, 290 km in Moneragala and 1,065 km in Kahawatta as shown in Table 1.15.

Table 1.15 Distribution Lines in Southern Area

Item	Southern Province (km)	Moneragala District (km)	Ratnapura District (km)
LXNX Double Circuit Lines	36	-	-
LYNX Single Circuit Lines	41	-	-
Racoon Lines	814	-	-
Weasel Lines	860	-	-
Copper Lines	9	-	-
Total	1760	290	1065

Sources: "Analysis of MV Distribution Network in Southern Province" by CEB (Southern province).
"Project Report of Rural Electrification Ratnapura District" by CEB (Ehuliyagoda).

1.2.3 Non-conventional energy

(1) Solar energy

The National Housing Development Authority (NHDA) promoted during 1991-92 solar power and solar-powered water supply systems in Moneragala district. Objectives were to demonstrate the applicability of solar technology in rural areas remote from the national grid and to create an awareness among villagers on the benefits which can be drawn from the technology. The systems are to be handed over to the following organizations after one-year free maintenance by the contractor expires:

i) Divisional Secretariats/Pradeshiya Sabha,
ii) Health Department,
iii) Education Department, and
iv) National Water Supply and Drainage Board.

Solar power system

The solar power system consists of solar panel, control box, battery and charge indicator. The direct current (DC) generated by sunlight feeds a selected number of batteries starting from a 12 V supply. The energy stored in the batteries may then be used for DC lighting, refrigeration, or operating a small electrical appliance like a television set. The solar power system is in operation at 34 sites (at eight rural maternity clinics, nine school/temples, nine community/training centers, and 14 domestic and other users) in Moneragala.

Solar-powered water supply system

The solar-powered water supply system consists of solar panel, inverter, bore hole, water pump, flow switch, water tank, overflow control and water pipes. The energy of the solar panel may be converted to alternating current (AC) by the use of an inverter. Here no batteries are involved. The electricity generated is directly supplied to the pump. The solar-powered water pump is submerged in the bore hole and automatically starts pumping with day break. The water is collected in a storage tank. When the tank is full, a float switch mounted on top of the tank prevents further operation of the pump. As the water level recedes in the tank, the pump automatically becomes operative again. There is also a flow switch to prevent the pump running without water. The water supply system is in operation to supply drinking water only at 13 schools and communities in Moneragala.

(2) Mini hydro

There exist many mini-hydro power plants which were discarded but may be rehabilitated.

CHAPTER 2 CONSTRAINTS AND POTENTIALS

2.1 Issues and Constraints

Main issues in the energy and power sector at present are low power supply reliability due to power supply shortage and high system losses, acceleration of private sector participation, electricity tariffs and low penetration of energy conservation.

2.1.1 Power supply reliability

(1) Proper balance between hydro and thermal system

Past efforts for power development of Sri Lanka have been concentrated on the exploitation of hydropower potentials as clean and renewable indigenous energy resources. As seen in the historical generation record in Table 2.1, during the recent 21-year period a predominant portion of power generation (more than 90% in most years) was by hydropower. Thermal power has been generated only for supplementing deficiencies in the hydropower generation when available river flow is not enough to meet the demand.

Table 2.1 Historical Record of Hydro and Thermal Generation

	Hydro Generation		Thermal Generation		Gross Generation	
Year	GWh	Share(%)	GWh	Share(%)	GWh	Growth (%)
1974	997.4	98.6	14.3	1.4	1011.7	-
1975	1077.5	99.9	1.3	0.1	1078.8	6.6
1976	1108.5	97.9	24.3	2.1	1132.8	5.0
1977	1214.4	99.8	2.1	0.2	1216.6	7.4
1978	1365.8	98.6	19.3	1.4	1385.1	13.9
1979	1461.2	95.8	64.3	4.2	1525.6	10.1
1980	1479.4	88.7	188.9	11.3	1668.3	9.4
1981	1571.3	84.0	300.3	16.0	1871.6	12.2
1982	1608.1	77.8	457.6	22.2	2065.8	10.4
1983	1217.2	57.6	897.2	42.2	2114.4	2.4
1984	2090.7	92.5	170.0	7.5	2260.7	7.5
1985	2394.6	97.2	69.4	2.8	2394.6	9.0
1986	2645.3	99.8	6.5	0.2	2651.9	7.6
1987	2177.4	80.4	530.1	19.6	2707.5	2.1
1988	2597.0	92.8	201.7	7.2	2798.8	3.4
1989	2801.5	98.0	56.6	2.0	2858.1	2.1
1990	3144.6	99.8	5.1	0.2	3149.7	10.2
1991	3116.2	92.3	260.4	7.7	3376.7	7.2
1992	2900.1	81.9	639.8	18.1	3539.8	4.8
1993	3795.9	95.4	182.7	4.6	3978.6	12.4
1994	4089.2	93.7	275.4	6.3	4364.6	9.7

Source: Load Forecasting and Tariffs Branch, CEB.

Contribution of hydropower to total power generation recorded the minimum of 57.6% in 1983 due to the extremely dry weather worldwide, and recently 81.9% in 1992. Since 1992, new addition of generating capacity has not been realized and the total installed capacity of power generating facilities has been unchanged (1,135 MW in 1995). Then the peak demand (980 MW) of 1995 became 86.3% of the total hydro installation. The lack of generating capacity during the dry season is becoming serious and power shortage in a dry year is unavoidable after 1996 as experienced in April to July of the year.

In the first half of 1996, CEB experienced a severe electric power shortage due to unexpectedly little rain in the season. The possible annual generation of hydro energy in 1996 under different weather conditions had been estimated as follows, where the wet, medium and dry hydrological conditions are defined with the probability of occurrence at 15%, 40% and 85%, respectively: 4,315 GWh under the wet hydro conditions, 3,890 GWh under the medium hydro conditions, and 2,993 GWh under the dry hydro conditions.

The available annual energy generation of thermal power stations in 1996 was estimated as follows.

Kelanitissa steam	2 x 25 MW (derated to 2 x 22 MW)	274 GWh
Kelanitissa gas	6 x 20 MW (derated to 6 x 18 MW)	558 GWh
Sapugaskanda diesel	4 x 20 MW (derated to 4 x 18 MW)	354 GWh
Total		1,186 GWh

With the anticipated rate of growth of demand, the Sri Lanka power system badly requires considerable amount of additional contingency thermal generating capacities to meet power demand in dry years. For cheap thermal generation during very short annual operation hours, diesel and gas turbine generators with relatively low construction cost and short starting time are suitable. However, when demand grows further, base-load thermal stations of larger capacity would become appropriate.

(2) Large losses in transmission and distribution systems

The transmission and distribution (T&D) loss factor of the CEB system was 17.8% in 1994. This loss ratio does not include distribution losses in the distribution systems of LECO and LAs. The entire T&D loss ratio including the non-CEB systems is estimated to be around 20%. The breakdown of the entire transmission and distribution loss ratio is roughly estimated as follows.

220/132 kV system	3.5%
33/11 kV (MV) system	4.5%
230/400 V (LV) system	12.0%
Total	20.0%

The loss in the LV system includes non-technical loss comprising illegal use and metering and billing losses and is much larger than the losses in the transmission and MV distribution systems.

The 1994 T&D loss factor of Japanese power companies was 5.5%. The loss factor is generally high in developing Southeast Asian countries: smaller than 10% in China and Thailand, around 15% in Indonesia, around 20% in Vietnam, and exceeding 20% in India and Nepal according to available 1991 to 1993 records.

The loss reduction is a great concern to the Government and CEB, as it is equivalent to the construction of costly power stations. All measures to reduce losses result in smaller variations in the consumer supply voltage, that is, the power supply reliability.

2.1.2 Acceleration of private sector participation

The key long-term issue facing the power sector is to mobilize funds for rapid expansion of power supply up to 2015 which would need investments of US$ 2,579 million (CEB Long Term Generation Expansion Plan). Such a volume of investments is beyond the capacity of the Government and conventional funding available from donors. The Government has therefore taken the necessary policy initiative to create a conducive climate for the private sector investment in power production.

Several foreign private investors have submitted proposals for power development and are now carrying out investigation and studies for construction of several power generation plants in Sri Lanka under the BOO and BOT schemes.

The review of their proposals and negotiation are progressing. Until now, a contract has been concluded only for the KHD (Klökner Humboldt Deutz AG under the private sector of German-UK joint operation) diesel plant of 51 MW capacity. Beside, there are some examples to develop mini hydro plants.

2.1.3 Electricity tariffs

It is normal to determine each category of tariff based on the cost of supplying energy to the respective category of consumers. However, the current tariffs have been determined by allocating expenditures of CEB to all categories of consumption according to the government pricing policy without due regard to actual costs of supply.

Cross subsidy is applied in the tariff decision. The domestic sector is subsidized by the commercial and industrial sectors. The power tariffs of small consumers are generally lower than those of large consumers regardless of higher costs incurred and the tariff for MV receiving industries is slightly higher than that for LV consumers. This tendency is conspicuous for the domestic category. The energy tariff for domestic consumers of up to 30 kWh per month (lowest category) is only 21% of the tariff applicable to consumers exceeding 180 kWh per month (highest category).

In many countries (including Japan), relatively low tariffs are applied to the agricultural consumption. However, in Sri Lanka such preferential tariffs are not applied to the agricultural consumption.

Time-of-day differential tariffs are applied only to industrial consumers. There is no differential tariff according to seasons. For the dry season, however, there is a rule to purchase surplus power from self-generators to curtail the supply by CEB.

The actual tariff is not based on the true costs of power supply of each category, and under an ADB loan a study is going on to calculate tariff based on the actual costs.

2.1.4 Low penetration of energy conservation

The need and the urgency of energy conservation was not fully realized until recently. This is due to three reasons:

1) lack of commitment at the national level in the past,
2) absence of a governmentally laid down policy and a planned implementation strategy, and
3) slow adoption of renewable, environment-friendly and cost effective energy technology.

However, in the recent past, the Ministry of Energy Conservation has initiated action to lay down a policy for energy conservation to overcome these shortcomings.

The implementation of demand management and conservation programs has been very slow in the past, until the declaration of Energy Conservation Week, the major one of its kind. In order to maintain the same level of enthusiasm from both sides, users and suppliers, it is important to develop and implement a program of policy measures with Government involvement. The Government is now considering some of the required policy measures including financial assistance to industrialists to carry out energy conservation measures, financial assistance and policy guidance by the Government to carry out an efficient lighting program, especially for households, and to improve the main power and resource requirements for continuous monitoring of energy users.

In spite of the development and research of renewable energy technologies such as solar, wind and biogas at various institutions, these technologies have not sufficiently realized commercial scale operations.

2.2 Potentials for Energy Resources

2.2.1 Oil and gas

Although seismic surveys carried out in different areas of Sri Lanka indicated possibilities of oil and/or gas, drillings carried out have not shown positive results. The most promising area may be the offshore area close to the Cavery basin in India, where oil reserves were discovered.

2.2.2 Peat

Peat deposits have been identified at Muthurajawela with the estimated reserve of 3.14 million m^3 or 285,000 tons of dry matter. This quantity is inadequate to operate a medium-sized (100 MW) power plant even for two years. Another limiting factor is its high sulfur content of around 5%.

2.2.3 Fuelwood/biomass

The Forestry Master Plan for Sri Lanka (1986) estimated the availability of fuelwood and the demand for different periods as summarized in Table 2.2.

Table 2.2 Fuelwood's Availability and Demand

(Unit: million ton/year)

Period	Availability	Demand
1986-90	11.4	9.7
1991-95	11.6	10.4
1996-2000	11.0	11.0

The Plan proposed forest and fuelwood management programs to enable fuelwood supply to exceed demand by 10% up to the year 2020.

Most rural households use agro-wastes and other forms of biomass as a fuel for cooking. Annual potential biomass supply at present is estimated at 16.5 million tons, considerably larger than the present and medium-term demands.

2.2.4 Hydropower

A large number of potential hydropower generation sites still exist in Sri Lanka, but their economic viability varies depending on costs of generation as compared to alternative thermal. If low speed high efficiency diesel plants are taken as the alternative thermal, economically viable hydropower potentials are as in Table 2.3 below depending on the prices of diesel fuel.

Table 2.3 Economically Viable Hydropower Potentials

Oil price	Economic potentials of hydropower		Total no.
(US$/bbl)	Capacity (MW)	Energy generation (GWh/year)	of sites
20	340	1,430	10
30	624	2,639	16
40	782	3,300	22

If US$ 40 per barrel is considered an upper limit on oil prices, 782 MW and 3,300 GWh per annum may be taken as the remaining economic potential by large- and medium-scale hydropower developments. Additional 200 GWh per annum may be available in small hydropower sites.

The capacity in MW given above is on the basis of a plant factor at 48%. However, to meet the future peaking capacity with base-load thermal plants which appear necessary after the year 2000, hydropower plants may need to be designed for a plant factor of some 35%. Based on such a design, the annual energy generation of 3,300 GWh corresponds to 1,076 MW capacity, which is comparable to the existing hydropower capacity.

2.2.5 Non-traditional sources of energy

Wind energy has been used to a very limited extent mainly as mechanical energy for water pumping. An experimental 5 kW wind generator was installed at Pattiyapola in Hambantota more than 15 years ago. Investigation of wind energy potential was carried out by CEB at several sites.

Application of photo-voltaic technology is limited in Sri Lanka due mainly to costs and limited access to technology. Solar water heating is not popular either as most domestic hot water users prefer to use electricity.

Simple saw dust burning stoves are available for home use. Timber mills in and around Colombo now sell saw dust packed in bags. Paddy husk came into use as a fuel for domestic cooking and other purposes during the 1970s. Parboiling of paddy using paddy husk is now widely practiced. Use of coir dust for energy is more difficult due to the presence of moisture. Further research and development would be necessary to make coir dust into a common fuel source. Driving energy from municipal and other wastes is becoming more attractive. A small plant of about 5 MW may already be possible first for Colombo.

There are many mini-hydro power plants which were discarded 25 to 35 years ago with the advent of grid-electricity. Most of them may be rehabilitated viably. A few mini-hydro developments may become viable in the medium term.

2.3 Power Development Program

2.3.1 National demand forecast

According to a new national demand forecast prepared by CEB revising the 1994-2014 Power Demand Forecast made in 1994, the sales demand is expected to grow at 10% per annum up to 2000 and at 9.0% thereafter up to 2015. Generation and peak demands are estimated at 7,407 GWh and 1,481 MW in 2000, at 17,096 GWh and 3,365 MW in 2010 and at 26,304 GWh and 5,177 MW in 2015. The revised demand forecast for the Base Case is shown in Table 2.4.

Table 2.4 National Demand Forecast of CEB's System

Year	Energy Sales (GWh)	System Losses (%)	Generation (GWh)	Load Factor (%)	Peak Demand (MW)	Growth Rate Sales (%)	Growth Rate Gen. (%)
1994	3,587	18.3	4,364	54.7	910		
1995	3,946	17.9	4,806	55.1	996	10.0	10.1
1996	4,341	17.2	5,242	55.9	1,071	10.0	9.1
1997	4,775	16.5	5,718	56.2	1,161	10.0	9.1
1998	5,252	15.8	6,238	56.7	1,256	10.0	9.1
1999	5,777	15.1	6,805	56.9	1,365	10.0	9.1
2000	6,355	14.2	7,407	57.1	1,481	10.0	9.1
2001	6,927	13.6	8,017	57.3	1,597	9.0	8.8
2002	7,550	12.8	8,659	57.5	1,719	9.0	8.2
2003	8,230	12.2	9,373	57.7	1,854	9.0	8.0
2004	8,971	12.0	10,194	57.9	2,010	9.0	8.3
2005	9,778	12.0	11,111	58.0	2,187	9.0	8.8
2006	10,658	12.0	12,111	58.0	2,384	9.0	9.0
2007	11,617	12.0	13,201	58.0	2,598	9.0	9.0
2008	12,663	12.0	14,389	58.0	2,832	9.0	9.0
2009	13,802	12.0	15,684	58.0	3,087	9.0	9.0
2010	15,044	12.0	17,096	58.0	3,365	9.0	9.0
2011	16,398	12.0	18,635	58.0	3,668	9.0	9.0
2012	17,874	12.0	20,312	58.0	3,998	9.0	9.0
2013	19,483	12.0	22,140	58.0	4,358	9.0	9.0
2014	21,236	12.0	24,132	58.0	4,750	9.0	9.0
2015	23,148	12.0	26,304	58.0	5,177	9.0	9.0

Note: The above demand forecast has been modified by CEB for the Master Plan Study for Development of Transmission System on 1st January of 1996.

Source: Load Forecasting and Tariffs Branch, CEB, 1996-1-22.

2.3.2 Long-term generation expansion plan

To meet the projected demand, a long-term generation expansion plan has been prepared by CEB, as outlined in Table 2.5. Main features are summarized below.

(1) Short-term plan

The total capacity of existing generating facilities will become insufficient to meet the national demand in 1996 and thereafter while planned major base-load coal thermal power plants have yet to be commissioned. To meet such immediate needs of increasing generating capacity, CEB has plans to install in the Colombo area diesel engine, gas turbine and combined cycle generators with relatively short delivery and construction periods. The CEB plan up to the year 2000 comprises the following:

1) Diesel engine generators 130 MW,
2) Gas turbine generators 140 MW, and
3) Combined cycle generators 2 x 150 MW.

Table 2.5 Long-Term Generation Expansion Plan (1995 - Base Case)

Year	Hydro additions	Thermal additions	Thermal retirements
1996	-	-	Sapugas Diesel 2x18MW (for refurbishment)
1997	-	*Diesel 40MW (Sapugaskanda) Refurb Diesel 2x18MW (Sapugaskanda)	Sapugas Diesel 2x18MW (for refurbishment)
1998	-	Gas Turbine 140MW (Kelanitissa) Diesel 90MW (Sapugaskanda) Refurb Diesel 2x18MW	-
1999	-	Combine Cycle 150MW (Kelanitissa)	-
2000	-	Combine Cycle 150MW	-
2001	-	Gas Turbine 70MW	Kelanitissa Oil Steam 2 x 22MW
2002	Kukule 70MW	Coal 150MW (Site 1, Unit 1)	Gas Turbine 3x18MW (for refurbishment)
2003	-	Coal 150MW (Site 1, Unit 2) Refurb GT 3x20MW	Gas Turbine 3 x 18MW (for refurbishment)
2004	-	Coal 300MW (Site 1, Unit 3) Refurb GT 3x20MW	Sapugas Diesel 2x18MW
2005	-	Coal 300MW (Site 1, Unit 4)	-
2006	-	-	-
2007	-	-	-
2008	-	Coal 300MW (Site 2, Unit 1)Combine Cycle 300MW (Outside Colombo, Boosa)	- Sapugas Diesel 2x18MW
2009	-	Coal 300MW (Site 2, Unit 2)	-
2010	-	Coal 300MW (Site 2, Unit 3)	-
2011	-	Combined Cycle 300MW (Outside Colombo)	-
2012	-	Combined Cycle 300MW (Outside Colombo, Boosa) Coal 300MW (Site 2, Unit 4)	-
2013	-	Coal 300MW (Site 3, Unit 1)	-
2014	-	Coal 300MW (Site 3, Unit 2) Gas Turbine 35MW	-
2015	-	Combine Cycle 300MW (Outside Colombo) Gas Turbine 175MW (Outside Colombo)	-
Total PV Cost up to 2015			US$ 2,579 million

Notes:

(1) Assumed discount rate is 10%.

(2) Calculation of long-term average generation cost does not include energy contribution from the existing hydro plants, plant commissioning and retirement at the beginning of the year indicated.

(3) At the present stage, the first site conceived for development as coal thermal plant is Puttalam.

(4) * denotes committed projects.

Source: CEB

Of these projects, 40 MW (4 x 10 MW) diesel generators are under construction at

Sapugaskanda utilizing an ADB loan with target commissioning in August 1997. The second 40MW diesel plan with the same particulars as above is under negotiation to seek for a German loan. An installation plan of 51 MW diesel units has been signed with KHD (Klockner Humboldt Deutz AG) under the private sector of German-UK joint operation.

The 114 MW gas plant with single unit at Kelanitissa was tendered recently with CEB's own fund and is expected to be commissioned in March 1998. Details have not been finalized for addition of the remaining gas turbine plant.

Two sets of 150 MW combined cycle plants are planned to be installed. A loan from OECF of Japan was signed in June 1996 for the first plant at Kelanitissa with target completion of 100 MW gas turbine sets in 1998 and a succeeding 50 MW steam turbine set in 1999. The second 150 MW combined cycle plant will be located at Kelawalapitiya to the north of Kelanitissa. The site has already been arranged, but its financial arrangement has yet to be determined.

The existing refinery capacity at Sapugaskanda is adequate to provide residual fuel for about 290 MW of diesel plants to operate for base load. Naphtha, another by-product of the refinery, can also be used for firing gas turbines and is planned to be used for the 150 MW Kelanitissa combined cycle plant. This fuel has the advantage of less environmental impact. Heavy diesel fuel will be fired for the second combined cycle plant.

(2) Long-term plan

Hydropower development

Only the construction of the Kukule hydroelectric plant (70 MW) is under execution as of 1996 utilizing an OECF loan and is planned to be commissioned by 2002. The construction of the Upper Kotmale project (150 MW) was once committed for a loan from OECF but its execution has been suspended due to environmental concerns.

The total capacity of economically more promising hydro power projects available for development is estimated at approximately 400 MW. Candidate projects are Broadland (40 MW), Uma Oya (150 MW), Gin Ganga (49.6 MW), Bulihuloya (17 MW), Moragolla (27 MW) and Upper Kotmale (150 MW). Except for the Upper Kotmale Project, detailed feasibility studies have not yet been performed on these projects.

Thermal power development

As more economical hydro potentials are exhausted, CEB has to consider the construction of thermal plants as major developments. Currently conceived coal plant project sites are outlined below:

1) West coast site near Puttalam as Site 1 of coal plant Unit 1 (150 MW, 2002), Unit 2 (150 MW, 2003), Unit 3 (300 MW, 2004) and Unit 4 (300 MW, 2005),
2) Trincomalee site as Site 2 of coal plant Unit 1 (300 MW, 2007), Unit 2 (300 MW, 2009), Unit 3 (300 MW, 2010) and Unit 4 (300 MW, 2012), and
3) Southern coast site (Mawella) as Site 3 of coal plant Unit 1 (300 MW, 2013) and Unit 2 (300 MW, 2014).

Also conceived combined cycle plant sites are shown below:

1) Kelanittissa site for first unit (150 MW, 1999),
2) Kerawalapitiya site (north of Kelanitissa) for second unit (150 MW, 2000), fourth unit (300 MW, 2012) and sixth unit (300 MW, 2015), and
3) Boosa site (about 7 km to the northwest of Galle) for third unit (300 MW, 2008) and fifth (300 MW, 2011).

2.3.3 Demand forecast for Southern Area

To carry out long-term transmission system planning with foreign technical assistance, the Government of Sri Lanka officially requested technical cooperation to the Government of Japan for the Master Plan Study for the Development of Transmission System of CEB. Subsequently, a JICA team prepared area-wise power demand forecast as part of a transmission system extension plan up to 2015 (*Progress Report*, July 1996). The detailed demand forecast for Southern Area is shown in Table 2.6. Table 2.7 summarizes the forecast.

Table 2.6 (1/2)Sale Energy Demand Forecast for Southern Area (1994-2004)

Province/Area	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Sale Energy Demand Forecast by Area (GWh)											
Southern province	261.6	291.1	321.6	352.1	386.9	425.0	466.8	507.5	552.0	600.6	653.5
Galle	106.8	122.3	138.7	155.6	174.9	196.2	219.8	242.4	267.3	294.7	324.8
Ambalangoda	41.1	45.7	50.3	54.8	60.0	65.5	71.6	77.5	83.9	90.9	98.4
Hambantota	32.1	33.6	35.1	36.4	37.9	39.4	41.1	42.9	44.8	46.8	49.0
Matara	43.9	46.9	49.9	52.6	55.7	59.1	62.7	66.4	70.3	74.6	79.0
Weligama	37.7	42.6	47.6	52.7	58.4	64.7	71.6	78.3	85.6	93.6	102.2
Uva											
Moneragala	40.8	44.4	48.0	51.5	55.4	59.6	64.1	68.6	73.5	78.8	84.4
Sabaragamuwa											
Kahawatta	66.7	70.6	74.3	77.5	81.2	85.1	89.2	93.3	97.5	102.0	106.7
Eastern											
Ampara	22.5	23.8	25.0	26.0	27.2	28.5	29.9	31.2	32.6	34.1	35.6
Total	391.6	406.1	468.9	507.1	550.7	588.2	650.0	700.6	755.6	815.5	880.2
Annual Increase Rate of Demand (%)											
Southern province		11.28	10.48	9.48	9.88	9.84	9.83	8.72	8.77	8.80	8.81
Galle		14.49	13.43	12.21	12.39	12.17	12.01	10.29	10.27	10.26	10.22
Ambalangoda		10.97	10.10	9.06	9.37	9.28	9.23	8.29	8.29	8.30	8.28
Hambantota		4.94	4.36	3.58	4.07	4.15	4.27	4.42	4.45	4.50	4.51
Matara		6.97	6.33	5.49	5.94	5.99	6.07	5.92	5.96	6.00	6.01
Weligama		12.78	11.82	10.68	10.92	10.76	10.66	9.32	9.30	9.30	9.28
Uva											
Moneragala		8.88	8.14	7.20	7.58	7.56	7.58	7.09	7.11	7.13	7.13
Sabaragamuwa											
Kahawatta		5.89	5.21	4.34	4.76	4.77	4.82	4.56	4.58	4.61	4.61
Eastern											
Ampara		5.71	5.05	4.20	4.62	4.65	4.72	4.53	4.45	4.50	4.51

Table 2.6 (2/2)Sale Energy Demand Forecast for Southern Area (2005-2015)

Province/Area	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Sale Energy Demand Forecast by Area (GWh)											
Southern province	711	774	841	915	995	1081	1175	1276	1385	1503	1603
Galle	357.8	394.0	433.6	476.9	523.9	575.3	631.3	692.3	758.8	831.2	910.0
Ambalangoda	106.5	115.3	124.7	134.8	145.8	157.5	170.1	183.5	198.0	213.4	229.9
Hambantota	51.2	53.5	55.8	58.3	61.0	63.8	66.6	69.6	72.6	75.7	78.9
Matara	83.8	88.8	94.1	99.7	105.8	112.2	118.9	125.9	133.3	141.1	149.2
Weligama	111.7	121.9	133.1	145.1	158.2	172.3	187.7	204.2	222.1	241.4	262.2
Uva											
Moneragala	90.4	96.8	103.6	110.8	118.7	127.0	135.8	145.1	155.0	165.5	176.6
Sabaragamuwa											
Kahawatta	111.5	116.5	121.7	127.1	133.0	139.0	145.2	151.6	158.3	165.0	172.0
Eastern											
Ampara	37.2	38.9	40.6	42.4	44.4	46.4	48.5	50.6	52.8	55.1	57.4
Total	954.1	1026	1107	1195	1291	1394	1404	1623	1751	1888	2009
Annual Increase Rate of Demand (%)											
Southern province	8.80	8.86	8.66	8.80	8.74	8.64	8.70	8.60	8.54	8.52	6.65
Galle	10.17	10.11	10.05	9.99	9.86	9.80	9.73	9.67	9.61	9.54	9.48
Ambalangoda	8.25	8.21	8.16	8.12	8.11	8.05	7.99	7.92	7.86	7.79	7.74
Hambantota	4.50	4.49	4.46	4.44	4.60	4.54	4.48	4.42	4.36	4.29	4.24
Matara	6.01	5.99	5.97	5.94	6.11	6.05	5.99	5.93	5.86	5.80	5.74
Weligama	9.23	9.19	9.13	9.08	9.00	8.94	8.88	8.82	8.75	8.69	8.63
Uva											
Moneragala	7.10	7.08	7.04	7.00	7.06	7.00	6.94	6.88	6.82	6.75	6.69
Sabaragamuwa											
Kahawatta	4.50	4.49	4.46	4.44	4.60	4.54	4.48	4.42	4.36	4.29	4.24
Eastern											
Ampara	4.50	4.49	4.46	4.44	4.60	4.54	4.48	4.42	4.36	4.29	4.24

Table 2.7 Energy Demand Forecast for Southern Area (Summary)

CEB's Area	Base 1994 (GWh)	2000 (GWh)	2010 (GWh)	2015 (GWh)
Southern province	261.6	466.8	1,081.1	1,603.2
Moneragala	40.8	64.1	127.0	176.6
Kahawatta	66.7	89.2	139.0	172.0
Ampara	22.5	29.8	46.4	57.4
Southern Area	391.6	650.0	1,393.5	2,009.2

Source: Table 2.6.

2.3.4 Transmission line/grid substation development plan for Southern Area

The main objective of the transmission system planning is to connect power generating stations and demand centers to send necessary power of good quality with the minimum of interruption.

(1) Plans up to 2000

As the immediate power generation projects to be completed by 2000 are located mainly in the Colombo area, all the generated power will be delivered through the existing 220 kV-designed 132 kV lines in Colombo area converted to 220 kV operation as well as through the existing 132 kV system.

In Southern Area, the 1995-97 transmission system expansion plan will be newly started for the following:

- Capacity increase (2 x 31.5 MVA) by replacing existing transformers (2 x 10 MVA) with Korean funds at the Balangoda grid SS,
- Capacity increase (2 x 31.5 to 3 x 31.5 MVA) by additional transformer and feeder bays with ADB funds at the Matugama grid SS, and
- Augmentation (2 x 31.5 MVA from 2 x 10 MVA) with ADB funds at the Embilipitiya grid SS.

Also, the following transmission system expansion project up to 2000 is recommended:

1) New 132 kV transmission lines:

- Inginiyagara grid SS—Ampara grid SS 1-cct 20 km, and
- Matugama grid SS—New Galle grid SS 2-cct 50 km; and

2) New grid substations:

- Ampara grid SS 2 x 31.5 MVA by January 1998,
- Ratnapura grid SS 2 x 31.5 MVA by 2000, and
- New Galle grid SS 2 x 31.5 MVA by 2000.

The recommended transmission line system in 2000 is shown in Figure 2.1.

(2) Plans up to 2010

The transmission system expansion project up to 2010 in Southern Area is recommended as follows:

1) New 220/132 kV transmission lines:

- New Galle grid SS—Matara grid SS (132 kV) by 2005,
- Embilipitiya grid SS—Hambantota grid SS (132 kV by 2005,
- Hambantota grid SS—Tissamaharama grid SS (132 kV) by 2010,
- Boosa combined cycle—New Galle grid SS (132 kV) by 2010, and
- Boosa combined cycle—Pannipitiya grid SS (220 kV) by 2010; and

2) New grid substations:

- Ambalangoda grid substation 2 x 31.5 MVA by 2005,
- Hambantota grid substation 2 x 10.0 MVA by 2005, and
- Tissamaharama grid substation - by 2010.

The recommended transmission line system in 2010 is shown in Figure 2.2.

(3) Plans up to 2015

The transmission system expansion project up to 2015 in Southern Area is recommended as follows:

- 220 kV transmission line (Maxwella coal—Paduka grid SS), and
- 220 kV transmission line (Maxwella coal—Boosa combined cycle).

The recommended transmission line system in 2015 is shown in Figure 2.3.

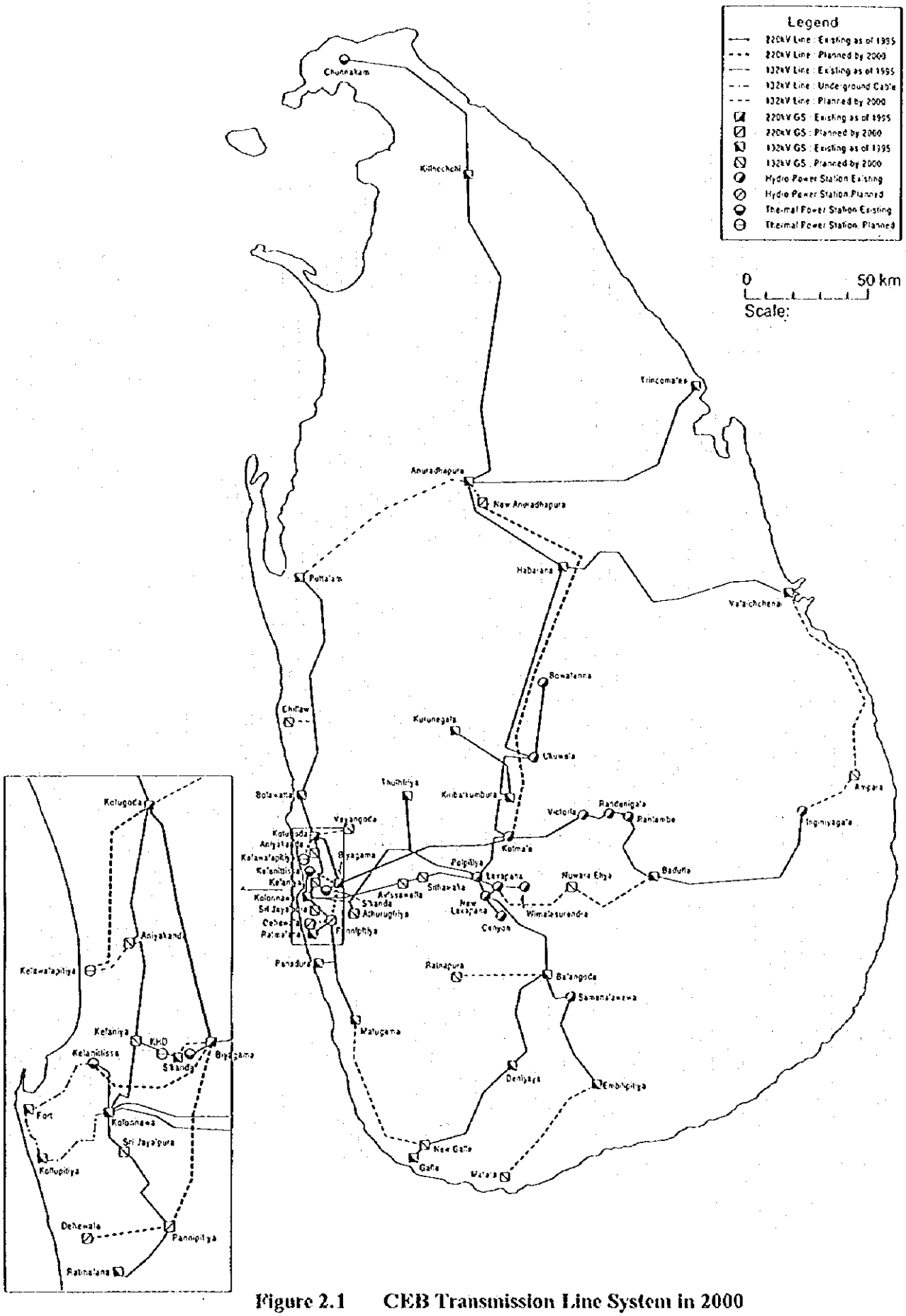

Figure 2.1 CEB Transmission Line System in 2000

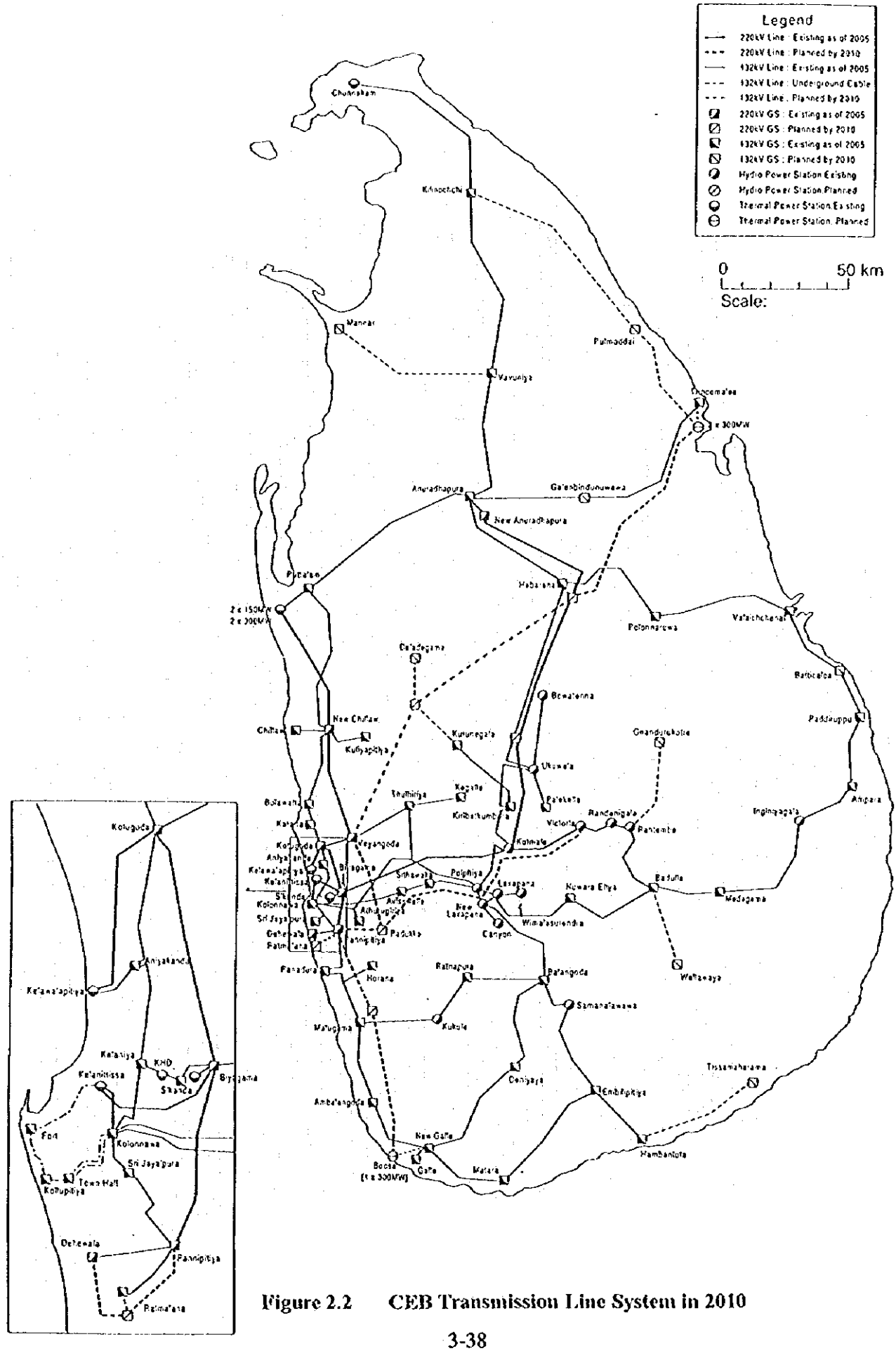

Figure 2.2 CEB Transmission Line System in 2010

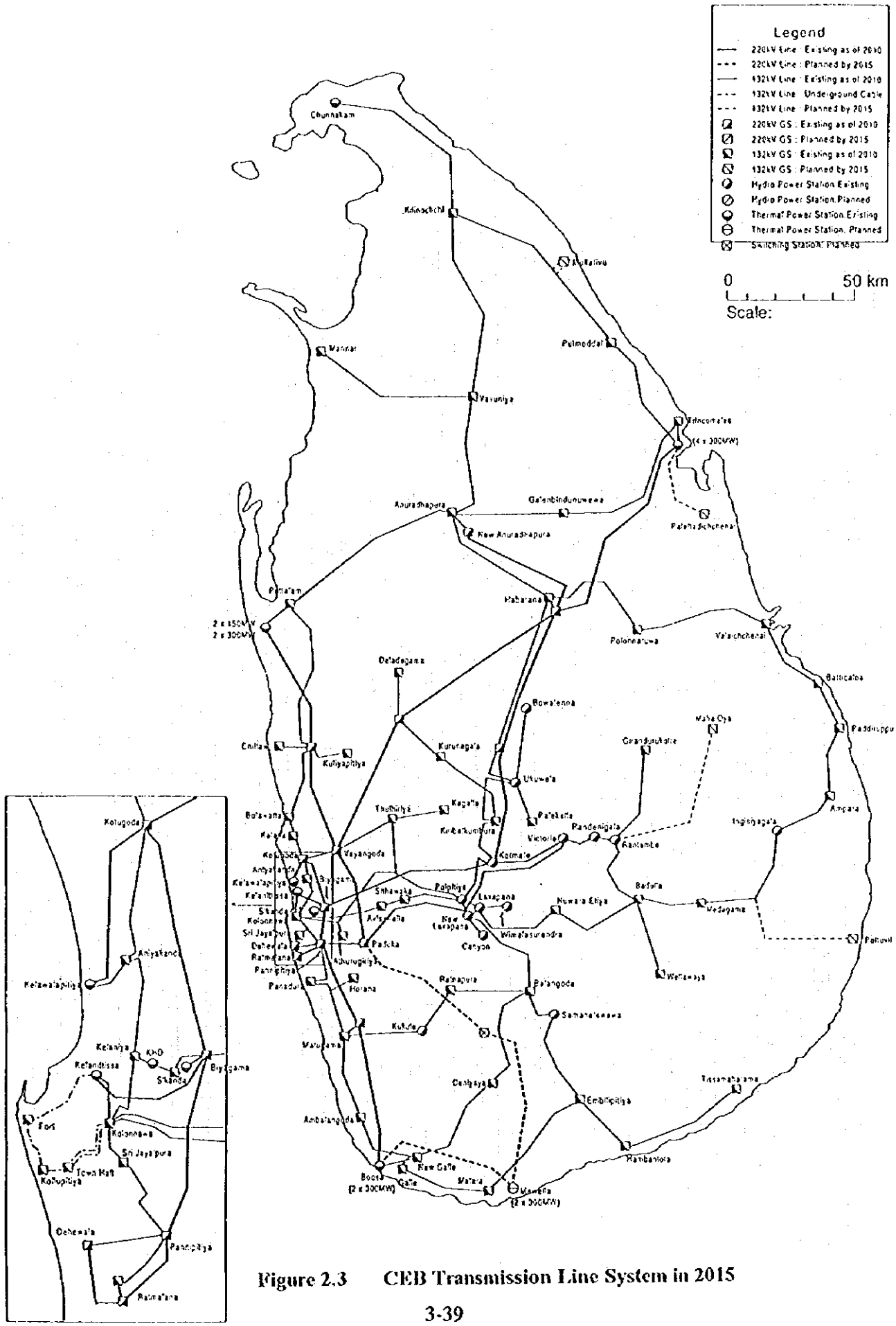

Figure 2.3 CEB Transmission Line System in 2015

CHAPTER 3 OBJECTIVES AND STRATEGY

3.1 Objectives

3.1.1 General objectives

Over the past years, expansion, development and improvement in the power sector have received high priority as a part of infrastructure development. These developments have been seen as one of the important prerequisites for a higher and steady economic growth.

General objectives for the power and energy sector apply equally to Southern Area and the Country. They are expressed as follows:

1) Rationalizing the power distribution system, improving reliability, minimizing power losses and reducing the cost to consumers;
2) Providing electricity to all villages by the end of the decade, through a combination of the expansion of the power distribution network and introduction of alternative sources of energy to very remote areas;
3) Expanding the power supply by implementing the least cost power generation plan; and
4) Implementing energy conservation by ensuring maximum utilization of available resources.

3.1.2 Specific objectives

More specifically, energy development in Southern Area should aim at the following:

1) To enhance the per capita electricity consumption and the ratio of electrified households in each district at least up to the current national level in order to uplift the living level of people in Southern Area and to support the income generating activities in rural areas;

2) To develop more than two major electric power projects using available energy resources within Southern Area to support higher industrialization/urbanization and anticipating that the demand for electricity may increase at about 12%; and

3) To provide the energy for basic human needs (light, fan, refrigerator, drinking water and TV) in rural areas having no access to electricity supplied by the national grid, utilizing the non-conventional energy sources.

3.2 Strategy

3.2.1 Overall strategy

(1) Extension of distribution network

Extension of distribution lines should be accelerated to realize 100% village electrification. Priority should be given to division capitals in Moneragala, Ratnapura and Ampara districts which are still deprived of electricity.

Electricity consumption in Southern province is expanding rapidly (9.2% during 1993-94), and even higher growth is expected with the Southern Area development program. To cope with this situation, the Distribution System Efficiency Improvement Program in Southern province should be promptly implemented by CEB.

(2) Development of major energy sources

Options for power development within Southern Area are: the 12 MW wind power plant, the Gin Ganga hydropower plant, the oil thermal associated with the second oil refinery, the coal thermal planned at Mawella, and the Uma Oya multi-purpose project. The wind power plant should be implemented as a pilot scheme to secure a future option.

Other power schemes may involve serious social and environmental issues. The oil thermal plant is subject to the national policy to establish a second oil refinery for security reasons. In the absence of such a policy, the coal thermal power may be a better option on economic ground. The location should be carefully decided from an environmental point of view.

The Uma Oya multi-purpose project will open up a new horizon in the dry zone of Southern Area. A feasibility study should be undertaken urgently, including a comparative study of alternative diversion routes, environmental inventory and impact assessment of all the related river basins, and examination of water use options. Strong

government initiatives would be indispensable for better planning and early implementation of the Uma Oya as well as the Gin Ganga schemes.

(3) Non-conventional energy

Possible sources of non-conventional energy in Southern Area are bio-mass energy, mini-hydro and solar energy. The bio-mass consumption in Southern Area is comparatively higher at 70% of the total than the national average of 61%. Bio-mass is used mainly for cooking. In addition, a significant demand for heat energy for the tea industry and brick making is also currently satisfied with this source. Bio-mass supplies are adequate to cater to the demand until the year 2000, but shortages may occur locally. In the short term, a program for the introduction of efficient fuel wood stoves should be accelerated for the domestic sector while tea plantations should be encouraged to provide their own fuel wood crops to serve their individual requirements. In the long term, use of bio-mass may be expanded including cassava, sugarcane by-products, lucaena and other energy crops.

As mentioned above, wind energy can be considered as a future renewable source for grid-connected power generation together with hydropower. However, it has not been established that it is more desirable and economical to electrify rural areas with wind and hydro energy.

Solar energy application may be expanded for various uses as demonstrated by the Project for the Installation of Solar Power in Rural Villages of Uva Province, if people are guided properly. Solar water heaters can be introduced first to public facilities such as hospitals, schools and hotels. The use can be expanded to other purposes such as cleaning of public markets and fishery facilities, industrial process heat and domestic uses. Photo voltaic technology can be applied to rural electrification in general, and for pumping water, electric fencing against wild animals, and telecommunication purposes in particular.

3.2.2 Phasing strategy

The Southern Area development is divided into three phases: Phase I 1997-2000, Phase II 2001-2010 and Phase III 2010-2015. Power and energy development expected in each phase in line with the objectives defined above is outlined.

(1) Phase I: 1997-2000

In this phase, key infrastructure development should take place mainly in large growth centers, Galle and Matara. As part of it, integrated improvement of the distribution system in Southern province should be promoted to maintain stable and reliable power supply to consumers and reduce distribution system losses.

Rural electrification should be accelerated with the extension of power distribution lines and the introduction of alternative sources. Most electricity-deprived areas in Moneragala and Ratnapura districts should be given the first priority.

(2) Phase II: 2001-2010

Electricity consumption in Southern Area may increase rapidly to sustain a growth rate of around 10% per annum over the planning period. It is not allowed to maintain a stable and reliable power supply to consumers in Southern Area only with power generated in other regions. Based on the results of a comprehensive water resource study expected to be undertaken in Phase I, some developments with hydropower generation reformulated for several purposes such as the Uma Oya project should proceed to execution in this phase under strong government initiative. A coal thermal power plant will provide a much needed base load for more reliable and stable power supply in the Country and particularly in Southern Area.

(3) Phase III: 2011-2015

Possible sources of non-conventional energy in Southern Area are wind, solar and bio-mass energy. Wind energy will be considered as a renewable source for grid-connected generation supplemental to major hydropower and thermal power.

CHAPTER 4 MEASURES

4.1 Stable/Reliable Power Supply and Electrification of Rural Areas

There are two directions for power development in the short term. One is an effort of integrated distribution system improvement for more stable and reliable power supply by Southern province, CEB. The other is further expansion of the distribution network for electrification of rural areas in Moneragala and Ratnapura districts by Badulla DGM's office and by Kahawatta DGM's office.

4.1.1 Stable and reliable power supply

Electricity consumption in Southern province expanded rapidly (9.2% during 1993-94). According to the *CEB Energy Demand Forecast by Area (1995-2015)*, energy demand is expected to grow at 9.8% per year until 2000. To cope with this situation, an integrated distribution system improvement program in Southern province will need to be promptly implemented in Phase I.

In Sri Lanka, power supply is required to be kept within the range of the rated value ±6%. As on-load tap changers are provided with substation transformers, the 33 kV bus voltage is kept at a control level. However, the receiving end voltage drops in the long MV and LV distribution lines as static capacitors are mostly not provided in the distribution system. It is noted that the following typical measures to reduce voltage drop coincide with measures to reduce line losses:

1) Raising line voltage,
2) Use of large conductors, and
3) Improvement of power factor.

All measures to limit variation of the consumer supply voltage result in reduction of line losses.

The entire 33 kV and 11 kV network of Southern province was studied in June 1995 by the provincial planning unit of CEB Southern province and the distribution planning branch of CEB to determine the present level of system losses and to plan and design present and future networks to operate on minimal loss criteria. The study has revealed that the present level of energy losses in the 33 kV and 11 kV network is in the region of

3.6%. This figure could be brought down to 2.3% by the implementation proposal recommended under Case 1 - Case 3 of the study. This would save Rs. 60 million per year.

Case 1: Installation of new ABS, auto reclosors commissioning of new feeder bays and upgrading CTs at grid substations;

Case 2:

1) Construction of 8 km of new 33 kV lines,
2) Shifting of a primary substation,
3) Conversion of 90 km of 11 kV lines to 33 kV, and
4) Reconductoring 4 km of Weasel lines to Raccoon.

Case 3: Placement of 20 Nos Capacitor Banks equivalent to 7,800 kVA at selected locations on feeders for the entire province.

This integrated improvement of distribution system in Southern province should be strongly promoted to maintain stable and reliable power supply to consumers under the Southern Area development.

4.1.2 Expansion of distribution network

(1) Moneragala district

Moneragala district, due to its large land area, is poorly covered by public utilities, especially electricity supply. Electrification rates are 16.9% of 48,400 total households and 9.7% of 691 total villages.

CEB Badulla DGM's office in Uva province is carrying out operation of their distribution systems and power sales to consumers in four divisions, excluding Tanamalwila and Kataragama divisions which are included in the service area of Southern province. CEB Badulla prepared an extension plan of distribution lines and electrification of villages in Moneragala district, to be implemented by 2000 (Table 4.1).

Out of these, three projects are decided for execution by 1997 under the ADB-3 project. CEB Badulla is planning the implementation of the remaining seven projects under the Southern Area development by 2000. The projects will be instrumental in transforming the living standard and environment of the most electricity-deprived Siyambalanduwa division (3.5% household electrification), and the expansion in Wellawaya division will

facilitate future distribution extension to another electricity-deprived division of Tanamalwila (2.7%).

Table 4.1 Extension Plan by CEB Badulla

Implementing Agency/Fund	Project	Location (AGA Division)	Project cost (Rs.M)	Implementation schedule
CEB/ADB-3	1. Obbegoda-Liyangolla 33 kV line, 19 km	Siyambalanduwa	12	1997
CEB/ADB-3	2. Amunumulla-Horabokka 33 kV line, 13 km	Buttala and Badalkumbura	8	1997
CEB/ADB-3	3. Pelwatta-Hadapangala 33 kV line, 21 km	Wellawaya and Buttala	13	1997
No Funds	4. Weliara-Ulvita 33 kV line, 13 km	Wellawaya and Badalkumbura	8	2000
No Funds	5. Electrification of villages under item 1, 4 villages	Siyambalanduwa	12	2000
No Funds	6. Electrification of villages under item 2, 3 villages	Buttala and Badalkumbura	9	2000
No Funds	7. Electrification of villages under item 3, 4 villages	Wellawaya and Badalkumbura	12	2000
No Funds	8. Electrification of villages under item 4, 2 villages	Wellawaya and Badalkumbura	6	2000
No Funds	9. Electrification of villages between Telulla and Tanamalwila, 3 villages	Wellawaya	6	2000
No Funds	10. Electrification of villages between Kudaoya and Balaharuwa, 3 villages	Wellawaya	14	2000
	Total of item 4 to 10		67	

(2) Ratnapura district

In Ratnapura district, two divisions of Embilipitiya and Kolonne are included in Southern Area. CEB Kahawatta DGM's office in Sabaragamuwa province is carrying out operation of their distribution systems and power sales to consumers for Embilipitiya and Kolonne divisions, and prepared additional distribution requirements and additional fund estimated up to 2000, as summarized in Table 4.2.

CEB Kahawatta is planning to execute the above-mentioned 1996-2000 plan under the Southern Area development.

Table 4.2 Extension Plan by CEB Kahawatta

	1992 to 1995		1996 to 2000	
	Line Length (km)	Funds Requirement (Rs.M)	Line Length (km)	Funds Requirement (Rs.M)
Addl. Medium Voltage line length (km)	300	160	325	165
Addl. Low Voltage line length (km)	625	200	750	250
Addl. No. of distribution substation	150	50	150	60
Total Rs.M		410		475

(3) Introduction of alternative energy to very remote areas

In Moneragala, a minimum number of 30 consumers are required for each quarter mile coverage by low voltage lines to justify the high capital and operation costs. This requirement is not satisfied by many remote villages. In Ratnapura, 30% of households are located far from the national grid so that electrification by non-conventional energy is more economical than the extension of distribution lines.

The criterion will be revised in the near future with expansion of network step by step and the result of the tariff study under an ADB loan. Still, introduction of alternative energy to very remote areas must be hastened particularly for rural maternity clinics, schools, temples, community and training centers in electricity-deprived rural areas in Southern Area.

Generally, photo-voltaic and mini-hydro power plants including those plants to be rehabilitated after 25 to 35 years of neglect will be conceived as the alternative energy. There is a demonstration project for solar power in rural villages of Uva province. The project, under the direction of the Ministry of Housing and Construction, was carried out by the National Housing Development Authority during 1991/1992. The project was funded by Australian Food Aid Counterpart Fund of the Australian government as arranged with the Australian International Development Assistance Bureau (AIDAB). Under this project 84 sites in Uva province received solar power systems, whose total cost was Rs. 60 million.

Solar power system

The solar power systems have been installed at the following 84 sites in Uva province:

1) Rural maternity clinics (12 sites) and hospitals (eight sites); each maternity clinic or residential hospital of the area serves people across a wide radius;

- with no electricity, patients were requested to bring their own kerosene or candles to provide light in the dark nights of their stay.

2) Schools (18 sites), temples (eight sites), and vocational training centers (four sites); most of these centers are equipped with a solar-powered TV through which they may link up to the educational programs broadcast over available channels.

3) Community centers (34 sites); each remote village has been given a small building to serve as a community center equipped with solar power sufficient to operate a few lights and a solar-powered TV.

Solar water supply system

The solar-powered water supply system has been installed at 19 sites of schools, hospitals and community centers. At present water use is restricted to drinking only. Pipe borne water supply is also limited to a maximum of five taps clustered together. Nonetheless, it is still a better choice than walking a long distance in search of water.

Maintenance activities of both systems are limited to occasional cleaning of module glass surface and topping up of the batteries with distilled water twice a year. Tasks will be within the capacity of an average teenage child. If proper instructions are given, this project can also be introduced first to public facilities such as rural maternity clinics, schools and community centers in other electricity-deprived rural areas in Southern Area.

4.2 Power Generation Development

The installation of 570 MW thermal plants in the Colombo area during Phase I will establish proper balance between hydro and thermal generation. Of the estimated total hydro power potential of 2,000 MW in the Country, 1,135 MW (57% of total) has been exploited. As relatively large economically favorable sites have already been developed or in the stage of development with priority, attractive sites are going to be depleted in Phase II and Phase III. CEB will have to rely on thermal plants. Environmental problems and compensation for resettlement associated with large developments will become serious.

4.2.1 Thermal power development project

In the CEB long-term generation expansion plan, two major thermal power development projects are scheduled in Southern Area: the Boosa combined cycle project for

commissioning in 2008 and 2011 and the Mawella coal fired thermal plant project for commissioning in 2013 and 2014. Besides, one diesel power plant is listed as a candidate project.

(1) Boosa combined cycle project

This site is located about 7 km to the northwest of Galle and is considered as a suitable site for construction of combined cycle plants. As natural gas is free of polluting components such as sulfur and in view of the high percentage of hydrogen content, the Government is interested in utilizing natural gas for power generation by combined cycle or gas-fired plants. However, a lot of investment is required to construct facilities to import and utilize natural gas. World natural gas reserves are limited with respect to amount (at most 25 years) and locations. The project, therefore, may not be proposed under the Southern Area development at present.

(2) Mawella coal fired thermal plant project

A site at Mawella was studied at pre-feasibility level together with other thermal options (thermal generation option, Back and Veatch International, October, 1988). The study proposed a 300 MW development in two stages.

Though the coal plant at Mawella was considered only as a candidate due to high costs compared with the Trincomalee site and opposition from the environmental points of view, CEB considers the construction of the Mawella coal-fire thermal plant as the third economical thermal development following the Puttalam site and the Trincomalee site.

According the latest CEB's sale energy demand forecast (1994-2015), the sale energy demand in Southern province amounts to 1,385 GWh in 2013 and 1,603 GWh in 2015. The 2015 peak demand is calculated at 316 MW supposing that the load factor is 58%.

In order to ensure energy security while reducing the dependence on oil, it is essential to expand the use of coal. While it has such advantages as abundant reserves and relatively even geographical distribution, coal has disadvantages including inconvenience of handling and high contents of pollutants like sulfur. Since coal can be turned into a clean, easy-to-handle energy source through gasification or liquefaction, active efforts are under way in many countries to develop these technologies.

The type of the plant and its location will be determined from social and environmental points of view as well as on economic ground. It will provide a much needed base-load power plant for more reliable and stable power supply in the Country and particularly in Southern Area. This project should be promoted conditional on social and environmental requirements in areas under the Southern Area development.

(3) Generation by Hambantota oil refinery

There is a plan to construct a diesel power plant of 300 MW capacity as an IPP (private power investors) scheme by an investor for an oil refinery project. As its particulars are uncertain, this project could not be proposed under the Southern Area development.

The capacity of oil refinery at Sapugaskanda presently is 50,000 barrels per day which has to be increased to 80,000 barrels per day to meet the Country's needs by 2005. It is proposed to carry out a study to evaluate optimum capacity and the type of installation as a first step.

The oil installation at Kolonnawa and pipe lines have almost reached the full capacity utilization but cannot be expanded further due to lack of space and congestion on the transport system. It is proposed to build a second oil installation close to the refinery at Sapugaskanda. A feasibility study is in progress.

4.2.2 Hydropower development

In the CEB long-term generation expansion plan, two hydropower development projects in Southern Area are listed as candidate projects: the Uma Oya multi-purpose project and the Gin Ganga hydropower project.

(1) Uma Oya multi-purpose project

According to the CEB long-term generation expansion plan, only the Kukule hydro electric project (70 MW) is under execution as of 1996 utilizing an OECF loan and is planned to be commissioned by 2002. The total capacity of economically promising hydropower projects available for development is estimated at approximately 400 MW and the Uma Oya project is listed as one of these candidate projects.

Two main objectives of the Uma Oya project are to provide irrigation water in the Kirindi Oya basin with 4,000 ha land upstream of Lunugamwehera and to generate electric power. The expected install capacity of the power plant is 75 MW x 2 units with energy output of 456 GWh per year. The generated power is to be supplied to the national grid through the Badulla grid substation. One double circuit 220 kV transmission line is proposed to connect the power plant to the Badulla substation.

If this multi-purpose development is reformulated for several purposes as the result of a comprehensive water resource study expected to be undertaken in Phase I, the hydropower project should proceed to execution under the Southern Area development.

(2) Gin Ganga hydropower project

A dam site is located on the upper Gin Ganga near the Deniyaya town, about 1 km downstream of the confluence with a right tributary named Aranuwa Dola. A powerhouse is located some 9 river-kilometers downstream, at the end of a high gradient river stretch. With its small reservoir, the power station can regulate the river flow to only a limited extent.

The project has been planned with 2 x 24.8 MW installed capacity and 209 GWh annual energy generation. Main components will be a concrete gravity dam with 50 m height, 231 m length and 93,000 m^3 volume, 132 kV transmission line with 23 km to the Deniyaya grid substation and a new access road of 23 km. However, the scheme may involve serious issues of resettlement of 1,560 persons and inundation of 114 ha of forest and agricultural land.

CECB has drawn up an alternative proposal to divert water from the Gin Ganga to the Nilwala via a tunnel and hydropower station with a link reservoir and second tunnel to divert the water further to Kirama, Urubokka and Walawe. A study is required to investigate all these alternatives, taking into account actual needs in the Urubokka and Kirama basins, impact on downstream users of the Nilwala and impact of such diversions on the upper Nilwala catchment. Therefore, though CEB listed up as a candidate project, the initial study is proposed under the Southern Area development.

4.3 Non-Conventional Energy Development

Possible sources of non-conventional energy in Southern Area are wind, solar and bio-mass energy.

4.3.1 Wind power plant

Initial investigations have indicated the availability of wind energy resources particularly in the Hambantota area. A survey has been conducted by CEB on a limited scale and available data indicate that average wind speeds of around 6 meters per second can be expected. Although for commercial exploitation wind speeds around 8 meters per second are preferred, the available wind energy capacity should not be ignored.

The Energy Unit of CEB carried out a resource assessment study of wind potential in the southern lowland of Sri Lanka. The study revealed an overall wind potential of 8 MW/km^2 of open land area or an overall potential of approximately 200 MW in the southeastern quarter of the island. The southeast of the Country is exposed to both southwest and northeast monsoons and thus wind plants in this region can yield acceptable levels of plant factor.

The project is proposed to generate power through a number of windmills, using wind energy in Hambantota district. The plant will be located in the vicinity of the Bundala National Park and salterns. Several foreign private investors have submitted proposals for the project and CEB now is reviewing the proposals. This project should be supported by the Southern Area development program.

4.3.2 Other non-conventional energy development

As to other non-conventional energy sources, no concrete projects to utilize them have been proposed due to difficulty in fund arrangement.

4.4 Southern Area Energy Development Projects

The following seven projects are proposed in the power and energy sector for the Southern Area development:

1) Distribution System Efficiency Improvement Program,
2) Extension of 33 kV Distribution Lines and Electrification of 19 Villages,
3) Expansion Plan of Distribution Network (1996 to 2000),
4) Solar Power System/Solar Water Supply System,
5) Uma Oya Multi-Purpose Development (generation only),
6) Coal Thermal Power Plant, and
7) 12 MW Wind Power Plant.

4.4.1 Distribution System Efficiency Improvement Program

This is a project to operate the entire 33 kV and 11 kV distribution network of Southern province on minimal loss criteria and was prepared by Southern province and the Distribution Planning Branch, CEB. This integrated improvement of distribution system in Southern province will contribute to more stable and reliable power supply to consumers and to the reduction of distribution losses.

4.4.2 Extension of 33 kV Distribution Lines and Electrification of 19 Villages

The project is planned by Badulla DGM's office, CEB, to extend 33 kV distribution lines in Wellawaya division and electrify 19 villages in Buttala, Wellawaya and Siyambalanduwa divisions. This will be instrumental in transforming the economic structure of the most electricity-deprived Siyambalanduwa division (3.5% households electrified). The electrification extension in Wellawaya division will also facilitate future distribution extension to another electricity-deprived division of Tanamalwila (2.7%) in Moneragala district.

4.4.3 Expansion Plan of Distribution Network (1996 to 2000)

This project was prepared by Kahawatta DGM's office, CEB, and additional distribution requirements and additional fund for 1996-2000 are proposed. The project will be instrumental in transforming the society and environment of electricity-deprived areas in Kolonne and Embilipitiya divisions.

4.4.4 Solar Power System/Solar Water Supply System

The solar power and solar-powered water supply systems demonstrated by the "Project for the Installation of Solar Power in Rural Villages of Uva Province" will be introduced first to public facilities such as rural maternity clinics, schools and community centers in other electricity-deprived rural areas in Southern Area. Solar power systems are to be installed at rural maternity clinics, schools, temples, community and training centers. The system is very simple, consisting of a solar panel, a control box, a charging indicator and a battery. Solar-powered water supply systems are to be installed at schools and community centers to supply drinking water. This system is also simple, consisting of a solar panel, an inverter, a bore hole, a water pump, a flow switch, a water tank, an overflow control and water pipes.

4.4.5 Uma Oya Multi-Purpose Development

The Uma Oya multi-purpose development will be reformulated to serve additional purposes. On the power generation side, the expected installed capacity of the power plant is 75 MW x 2 units with energy output of 456 GWh per year. Generated power will be supplied to the national grid through the existing Badulla grid substation. This hydro generation may help to reduce CEB reliance on thermal generation in the long run and to supply stable and reliable power to consumers in Southern Area.

4.4.6 Coal Thermal Power Plant

This project is planned as the third base-load coal thermal plant following Puttalam and Trincomalee in the CEB long-term generation expansion plan. Unit 1 with 300 MW installed capacity is programmed for commissioning in 2013 and unit 2 with 300 MW in 2014. Its location will be determined somewhere between Matara and Tangalle from social and environmental points of view as well as on economic ground. It will provide a much needed base load power plant for more reliable and stable power supply in Sri Lanka and particularly in Southern Area.

4.4.7 Wind Power Plant

The project is to be implemented as currently planned. The best foreign private investors will be selected for implementation.