NO. 6

スリ・ランカ民主社会主義共和国
鉱工業プロジェクト選定確認調査
報　告　書

1999年1月

国際協力事業団
鉱工業開発調査部

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報告書目次

Ⅰ. 調 査 概 要

Ⅰ．調査概要

1．調査目的

鉱工業分野の開発調査を効率的に実施するため、既に我が国に正式要請の提出がなされている「ブロードランド水力発電計画」、「民間投資促進政策策定計画」及び今後要請提出が予想される「産業公害対策（工場排水処理）」の各案件について、その背景、目的、国家開発計画における位置づけ、調査概要等について調査し、今後の我が国の協力の可能性等を協議した。

2．調査期間

１９９８年7月２１日（火）から7月２８日（火）　８日間

3．調査団員構成（５名）

①団長・総括　：永江　勉（Tsutomu　NAGAE）
国際協力事業団鉱工業開発調査部計画課課長代理

②技術協力政策：馬杉　学治（Noriharu　MASUGI）
外務省経済協力局開発協力課研究調査員

③技術協力行政：十郎　正義（Masayoshi　JURO）
通産省通商政策局北西アジア課市場専門官

④工業開発　　：三木　常靖（Tsunenobu　MIKI）
国際協力事業団国際協力専門員（工業開発）

⑤調査・企画　：込山　誠一郎（Seiichiro　KOMIYAMA）
国際協力事業団鉱工業開発調査部計画課

4．全体調査日程

日順	月　日	曜	行　　事	宿泊先
1	7月21日	火	成田（11:00）発→バンコク（15:15）着（JL717） バンコク（18:25）発→コロンボ（20:35）着（CX701）	コロンボ
2	22日	水	ＪＩＣＡスリランカ事務所、 在コロンボ日本大使館、 ＯＥＣＦコロンボ事務所、 Depertment of External Resources、 Depertment of National Planning、 ＪＥＴＲＯコロンボ事務所、 訪問・打ち合わせ	コロンボ
3	23日	木	Ministry of Irrigation and Power、 Ministry of Housing and Urban Development、 Ministry of Industrial Development、 Ceylon Electricity Board、 訪問・打ち合わせ	コロンボ
4	24日	金	Ministry of Forestry and Environment、 Board of Investment、 Textile Training and Service Centre、 SIGIRI社、 VELONA社、 訪問・打ち合わせ	コロンボ
5	25日	土	資料整理日	コロンボ
6	26日	日	資料整理日	コロンボ
7	27日	月	Textile Training and Service Centre、 NAGINDAS社、 Ministry of Industrial Development、 訪問・打ち合わせ 在コロンボ日本大使館、 Depertment of External Resources、 ＪＩＣＡスリランカ事務所、 訪問・結果報告	
8	28日	火	コロンボ（02:45）発→バンコク（07:10）着（CX700） バンコク（09:40）発→成田（18:00）着（TG670）	

5．調査対象案件

①ブロードランド水力発電計画（実施機関：潅漑・電力省、セイロン電力庁）

(1)要請の背景・目的

スリランカにおいては、近年の経済成長に伴う電力需要が多く見込まれており、過去１５年の年平均で７％増加し、９５年には３９億kwhとなっている。一方、世界銀行はスリランカ政府の財政赤字削減のため、発電部門の民間セクター導入を1992年に勧告し、既に２件の民間事業が具体化している。しかしながら、セイロン電力庁（ＣＥＢ）としては、購入価格が自社電源に比べ高いことから、積極的な評価を行っていないのが現状となっている。

今後ＣＥＢとしては、火力発電所については、系統に接続・運転されている３火力発電のうち、設備の老巧化及びメインテナンス不足から定格出力を下回っている

２発電所について、今後１０年以内に廃止し、残る１発電所については、基本的に民間資本の導入による整備を行うこととし、今後は石炭炊き火力発電及びコンバインドサイクルをメインに電源開発計画をたてており、本年５月に開発調査が始まった「ケラワラピティヤ・コンバインドサイクル発電所」もその一つである。

一方、発電電力量の９３％をしめる水力発電については、水力発電体系の開発余地が残る箇所の可能性を検討しており、水力発電電力量のうち３０％程度を占めるラカパナ（Laxapana）流域にあるケラニ（Kelani）川上流に、流れ込み式の発電所（施設容量４０MW）を建設するためのＦ／Ｓ調査を、平成７年度に続き再度要請した。

(2)調査内容

・1986年にセイロン電力庁が作成（Ceylon Engeneering & Consultancy Bureau）したＦ／Ｓ調査の見直し

・経済性検討

電源構成が水力発電に圧倒的に片寄っているため、最大電力需要に対し、発電出力は十分であるものの、過去渇水年（近年では、９２、９６年）には大規模な電力不足を生じたところ。

ＣＥＢとしては、今後は火力をメインに電源構成を変更していく予定であり、長期電源開発計画における本案件の位置づけを良く確認する。

・環境影響評価等

近年、スリランカにおいては、環境問題に対し慎重に対処する必要がある。

水力案件の一例としては、８３年から８６年までＪＩＣＡがＦ／Ｓを実施し、引き続き９３年にＯＥＣＦがＥ／Ｓを実施した「アッパーコトマレ水力発電」計画が環境クリアランスを得られずに事業化が見送られている。最近では、９２年に運転開始した発電所以降、新規に運転はされていない。

因みに、火力発電についても近隣住民の反対により工程の遅延が生じている。

②民間投資促進政策策定計画（実施機関：工業開発省）

(1)要請の背景・目的

スリランカは８８年に世銀・ＩＭＦの勧告を受け入れ、民営化による公的部門の合理化及び民間部門の振興等を実施した結果、近年のＧＤＰ成長率は５％を示し、順調な経済成長を遂げている。

ス国の主要産業は農業であり、ＧＤＰの２４％を占めている（９６年）が、近年、製造業はス国経済の重要な位置を占めるまでに成長し、特に民間部門は国営企業の民営化が進んだことで、８０年代には年平均１０％以上の成長を遂げている。

製造業のなかでも繊維・衣料については、生産高では４１％、輸出に占める割合は４９％となっているが、原材料を輸入に頼っているため、付加価値率は２７％

に留まっている。

このようななかで、ス国政府は繊維産業に依存した産業構造から、バランスの取れた構造への脱却をめざし、将来の工業振興計画の策定をＪＩＣＡに要請越した。

(2)調査内容

・既存セクター毎の振興計画レビュー

９１年から９３年まで開発調査を実施した「工業分野開発振興計画」において、輸出振興と併せて投資促進策を策定している。これに対し、ＢＯＩが採った制度の改善等について確認する。

・将来の工業振興計画と問題点の解明等

③産業公害対策（工場排水処理）（実施機関：中央環境庁等）

(1)調査内容

スリランカ政府は公害発生元企業に対し厳しい環境規制を課し、環境団体等もこれを指示するなど環境保護に熱心である。このような現状において、中小企業は生き残りのため各種方策を検討中である。なかでも深刻な革なめし（重金属汚染等）及び繊維（染色排水）産業については、これまで無秩序に立地している工場をまとめて産業公害防止施設を整備した団地に移設させるなどの方策も考えられるが、これらを踏まえた、今後の開発調査の可能性を調査する。

6．主要面談者

・スリランカ側：

J.H.J.Jayamaha	: Director, Depertment of External Resources
P.Alailima	: Director General, Ministry of Finance and Planning National Planning Depertment
Jaliya Medagama	: Secretary, Ministry of Irrigation and Power
Mahinda.D.Bandusena	: Secretary, Ministry of Industrial Development
C.N.D.Perera	: Actg.Chairman, Ceylon Electricity Board
K.A.S.Gunasekera	: Secretary, Ministry of Forestry and Environment
L.J.Isaac	: Director, (Promotion) Board of Investment

・日本側：

杉山　洋二　：特命全権大使
川村　文洋　：一等書記官
狩野　良昭　：ＪＩＣＡスリランカ事務所長
古賀　竜太郎：ＯＥＣＦコロンボ事務所首席駐在員
谷川　克己　：ＪＥＴＲＯコロンボ事務所長

仲井　儀英　：ＪＩＣＡスリランカ繊維製品品質向上計画プロジェクトリーダー

7．調査結果

①ブロードランド水力発電計画

(1)スリランカ長期電源開発計画に関し、現在発電電力量の９０％強をしめる水力発電を、2010年を目途にピーク時発電用として主に利用することとし、ベースロードとしては火力発電にするよう転換計画を策定したところ。

(2)この計画に基づき、火力発電等については、現在調査を進めているケラワラピティヤコンバインドサイクル（150MW）を始め、西部石炭火力（300MW×3基）等、ほぼ毎年１基の割合で計画がされている。

(3)一方、水力発電計画については、環境問題から計画が中断していたアッパーコトマレ水力（150MW）が同クリアランスを得た模様であり、今後事業が順調に進捗するこが期待され、ククレ水力（70MW）はＯＥＣＦにより2002年完成を目途に事業が進捗している。この他、ウマオヤ水力（150MW）、サマナラウエア水力（120MW、１基増強）の可能性等が今回の調査で確認された。

(4)本件開発調査実施に当たっては、今後新たに環境Ｆ／Ｓの調査が必要であり、また、その規模（40MW）等から経済性等を慎重に判断する必要があると思料され、特に緊急性は感じられない。

②民間投資促進政策策定計画

(1)前回調査（工業分野開発振興計画）の提言に関し、工業団地開発は「Seethawaka」に建設中（今年度中に完成予定）。貿易振興策については、各種見本市に参加するなどし、金属加工に関しては「鋳造センター」を設立し、現在プロ技を実施するなど、提言が活用されていることが確認された。

(2)工業開発省は1996年から2006年まで「生産性向上の１０年」と定め、今後の振興業種として「ゴム」「電子」「宝石」「セラミクス」「エンジニアリング」の５業種を特定している。一方ＢＯＩは貿易振興及び投資促進について、免税措置等これまで積極的な政策等を実施し、今後の外資誘致の優先業種として、「電子産業」「鉱産物加工」「セラミクス・ガラス」「ゴム」「軽・重エンジニアリング」「パイオニア産業」を設定した。

(3)今後、スリランカにおける工業分野に係る国内外向け振興策については、SAFTA（南アジア自由貿易協定・2000年、遅くても2005年誕生予定）等を見据え、時期を踏まえた的確な政策を押し進める必要がある。

(3)開発調査実施に当たり、スリランカ側の希望業種を踏まえ、可能性のある業種を更に伸ばしていく（例えば、今後の繊維産業について、その方向性等について前回調査のアフターケアを実施する等）ための調査を行うことは時期を得たものと思料される。

③産業公害対策（工場排水処理）

(1)スリランカにおける環境の責任官庁は森林環境省であるが、環境の現状や情報について満足なデータがあるのか今一つ不明であった。

(2)今回の調査で、コロンボ南部の繊維工場を視察したが、排水については処理が一切行われず、そのまま川に流されている工場がある一方、インド製の処理設備（聞き取りベースで費用はRP 3.5 million）を取り付けている工場もあった。

(3)森林環境省では、繊維染色排水の処理が難しいことは認識されている一方、問題業種として製紙産業等が指摘された。今後開発調査を進めるに当たり、業種の選定はもちろん、現状等の正確なデータが必要である。

(4)今後は、ＪＩＣＡスリランカ事務所と業種等について調整したうえで、開発調査実施の可能性について検討していくことが適当である。

8．団長所感

①ブロードランド水力発電

本件については、調査前において得た情報によれば、同国では近年、気候条件に左右される不安定な水力発電から、発電コストが水力に比し割高であっても安定的に電力を供給できる火力発電に方針を転換したとの認識から、本件の発電計画における重要度は低いものと想定されていたが、今次調査において、灌漑エネルギー省側から「ベースロードの電源としては火力発電による対応を、また、水力発電については、今後の電力需要の伸び、特にピーク時への対応電源とするべく2010年を目途に計画している。また、それまでの間については、国内の資源を有効に活用でき、かつ、輸入に依存しない未だ開発の余地のある水力発電を政府の開発対象として重視したい。」との説明がなされ、その重要性が強調された。

しかしながら、同国における過去ほぼ２年間にわたる水力発電による電力の安定供給の実績や、近年燃料コストが低廉に落ち着いてることから、現状では電力供給上重大な問題が生じていないこと、ピーク対応に必要とされる電力量に比し、本件で対応可能な計画電力量が小さく、今後の発電計画における位置付け／重要度につきさらなる検討を要すること、また、４０MWという発電規模が経済性の点で成り立つのかどうか等につき慎重な判断が必要なこと、さらに、ブロードランド以外にアッパーコトマレ、ククレ、ウマオヤ、サマナラウェアなどの水力発電所の計画がなされていることから、先方においても、早急に取り組まねばならない緊急性の高い案件との認識はさほど感じられなかった。

従って、本要請案件については、今後のこれらの計画の進捗等を見極めつつ、開発調査の必要性も含め、その実施につき検討することが妥当なものと思料する。

②民間投資促進計画

ス国の経済は、過去５、６年間を見てもほぼ堅実に成長を遂げており、特にアジア各国

が経済不安にみまわれた昨年においても６％以上の経済成長をみせている。この中で、特に工業部門の伸びは著しいものがあり、現在ではＧＮＰの約２２％を製造業が占めている等、同国の経済成長の基礎をなしているものといえる。

しかしながら、同製造業の中心は繊維関連産業に依存していることから、繊維産業の成長を追風に、その他の産業を振興することで産業基盤の多様化を図り、確固たる産業構造の確立を目指す本開発調査の要請内容は、今後の同国の工業政策の実行に際し重要な役割を果たすことが期待される。

特に、同国においては、治安上の問題は無視できないが、質の高い労働力、堅調な経済成長、アセアン諸国や近隣国に比しても充実しているといえる投資制度など、比較的投資環境としては比較的整備されていることから、内外からの投資は伸びているとの現状がある。また、1993年の事業団の実施した工業分野開発振興計画のマスタープラン策定時からも、ほぼ安定的に経済成長を遂げていること、特に、昨年のアセアン諸国に端を発した経済不安は、アジア地域内における海外からの直接投資対象国としてのスリランカの位置付けに変化をもたらし、これらがセクターによっては同国に有利に働くであろうとの期待感を持っている。

折しも、当調査とほぼ時期を一にして、SAARC会議が開催されることになっているが、同会議においても話題となるであろうSAPTA/SAFTA等、今後推進される可能性の高い当地域における自由貿易化の動向を見据え、スリランカが将来の「工業化の促進」や「工業化の牽引車となる内外からの投資の促進」を図るための方策を検討することは必須のことと思料される。

先方の要請にある本調査の根幹となる有望振興業種の選定については、現時点では特定されてはいないものの、関連する情報として、工業省では、昨年秋に主として民間企業の代表から構成されるAdvisory Council of Industryの設置により、今後振興を図るべき産業として「ゴム」「電子」「宝石」「セラミクス」「エンジニアリング」の５業種を特定している一方、大蔵省投資委員会では今後の投資促進の対象として「電子」「鉱産物」「セラミクス・ガラス」「ゴム」「軽・重エンジニアリング」「パイオニア産業」を独自に選定しているという状況もあることから、今後、本件調査を実施するのであれば、両省庁はもとより関連する諸機関を構成員とする運営委員会などの設置を行い、各界の十分な意見調整を行う必要があろう。

以上を踏まえると、このようなスリランカを取り巻く周辺環境の変化に対応するべく、工業化促進／振興を目的とする今回の開発調査の要請は時宜を得たものであり、積極的に取り組む意義のある調査であると思料する。

③産業公害防止対策

産業公害対策としてのモデルプラントの導入を伴う発生源対策の新しい開発調査のスキームは、スリランカ政府関係機関にとって期待度の高いものとして歓迎される一方、単純

に無償で排水処理装置の設置が可能になるとの考えから、目先の問題を解決するための単なる機材供与と考えられがちであることも事実である。今次調査において、住宅都市開発省、森林環境省からそれぞれ「工場集積地の汚水処理」「製紙工場の排水対策」の提案がなされたが、いずれも、本スキームにはなじまないものであった。しかしながら、本調査期間中に、あわせて実施した繊維工場視察時に、工場排水を未処理で放流しているなどのいくつかの工場の実態に鑑み、本件の様な調査スキームに対するニーズは当国において高いものと感じられた。

今後は、専門家の協力を得ることが可能で、情報収集の行いやすい繊維工業分野を中心に本スキームの導入の可能性を検討していきたいと考えるが、本件は、早急に実施しようとすると相当の困難が予想されるところであり、繊維工業分野とあわせ、スリランカの産業公害の現状を把握するための情報収集等を行いつつ、最も効果的なプロジェクトを選定することが肝要である。

従って、本件については先方関係各機関の関心が非常に高い分野ではあるものの、具体的なプロジェクト対象の選定に至るまでには、まだ、時間をかけていく必要があるところ、引き続き、JICA事務所等を通じ調査実施の可能性を検討していきたい。

以　上

Ⅱ．主要協議議事録（要約）

在コロンボ日本大使館との協議議事録

日時：平成１０年7月２２日（水）１０：００～１０：４５
場所：日本大使館会議室
出席者：日本大使館：杉山洋二　　大使
　　川村文洋　　一等書記官
　　大岡新吾　　二等書記官
　　調査団及びJICAスリランカ事務所　米林所員

概要：

川村：調査団には、次に繋がるような調査を期待。
　　発電関係では、アッパーコトマレ水力発電に関し、先週環境クリアランスが認可された。残りはククレ発電所である。
　　政府目標としては、火力発電を５０％としている。水力は意義を感じるものの、調査実施後事業化に時間がかかり、足の速い調査を期待。

団長：発電は火力中心に移行と聞いており、（ブロードランドは）長期発電計画にも入っておらず、緊急性も感じられないことから、今すぐの調査開始は困難。できたとしても来年度以降ではないか。
　　投資調査については他に多くの前例があり、調査手法は問題ない。要は、投資側の志次第であり、治安は問題ないのではないか。ス国は、その産業構造から、繊維産業からの脱却がテーマと思料。調査として、有望であれば繊維も可能性があるが、その場合、５年前の調査のアフターケア調査といった方法もある。
　　環境については、情報収集調査を進めて行きたい。

川村：民間投資について、ス国は具体的な将来ビジョンが無いのではないか。他国の例を参考に勉強したいのでは。

大使：投資については、分野を絞るのが重要か。市場が自由化されているなかで、現在の競争力を生かすのは難しい。日本のこれまでの例は参考にならない。強いていえば台湾の例か。
　　ス国は市場金利が高く（１７～１８％）中小企業は必要資金が借りれないことをよく指摘すべき。これは、SAARC関係国のうち、ス国は貯蓄率が低い（１６％）のも影響しているのではないか。インドは２５％（９７年）程度。東南アジアは４０％程度。

川村：労使関係も問題有り。

大使：組合が強い。

団長：労使問題が関係すると投資にも影響する。
　　途上国は工場の実態把握を行っていないことが多い。足を運んで調査する手法も必要か。

大使：鋳造については、今後期待できるのではないか。電子部品にも応用可能。

セラミック（日系企業・ノリタケ）が成功したのは、原料及び会社の努力である。

団長：調査対象業種については、調査を実施しながら絞り込む方法もある。

以　上

ＯＥＣＦ（在コロンボ事務所）との協議議事録

日時：平成１０年７月２２日（水）１１：００～１２：００

場所：ＯＥＣＦ会議室

出席者：ＯＥＣＦ：古賀　主席駐在員

調査団及びJICAスリランカ事務所　米林所員

概要：

古賀：今後火力発電は民活と決まっているが、料金設定が高く（ｻﾌｶｽｶﾞﾝﾀﾞ･ﾃﾞｰｾﾞﾙ：7.3ｾﾝﾄ/１kwh）、ハブ火力（6.5ｾﾝﾄ/１kwh）でさえCEBは値下げ交渉中。民活ではPayしないのではないか。石炭火力及び水力はその値段から可能性有りか。
電力需要量は大きな伸び（昨年８％程度）で、今後毎年１５０MW程度設置する必要有り。

・UPPER KOTMALEについては環境クリアランス（ＣＥＡ担当）が厳しすぎたため、これに替わる機関を設置したことにより可能となった。滝（ｾﾝﾄｸﾚｱ､ﾃﾞﾎﾞﾝ）については１日５、６回程度放流することとした。

・SAMANALAWEWAは下流右岸から漏水中。以前から地質が複雑と指摘されており、事前にその対策は充分に行ってきたところ。現在貯水池に対策を施している。
更に１基追加（１２０MW）の予定あり。

・BROADLANDSについては（４０MWでは）小さいので、建設期間が長いと経済効果は薄いと思料。また流れ込み式は降水量による影響があるため将来計画が難しい。

・中小企業育成のための２ステップローンを昨年から実施。世銀及びＡＤＢも実施。

・世銀の２ステップは３回実施されたが、Conditionallityの問題（State Bank２行が不良債権を抱えており、民営化を条件）から、これ以降には行われていない。

・工業団地開発も積極的。AVISSAWELLAを売り出し中。外国企業の入居が少ないため、値段を安く（KATUNAYAKEの半分）したため引き合いは良好。日系企業は無し。工業団地全般にインフラ（道路、水、電気等）は充分とはいえない。

・投資関係では南西アジアで法整備が最も進んでいるのではないか。ＢＯＩは税優遇など策を講じているものの、それほどの効果が出ていないのが現状。

・通貨がインドルピーに連動していることから、影響も強い。貿易相手国は欧米がメインである。

・アジア通貨危機の影響で、今後切り下げの可能性も充分有り。インフレ率（7.9%）は下がっている。

・国内投資は増加しているので、今後は外国資本の出資が望まれる。ＮＴＴが来ており、通信ケーブルも繋がっている。今後は関係企業の出資等が期待できるのではないか。

以　上

Depertment of External Resourcesとの協議議事録

日時：平成１０年７月２２日（水）

１．ブロードランド水力発電計画について

・電力需要は年１０％ペースで上昇している。
・水力発電は火力に比べコストが低く優先度が高い。「ブ」もその一つである。
・各発電案件のプライオリティ付けはＣＥＢが行っている。
・水力発電については、今後政府主導で開発し、送配電も政府が行っていく。
・「アッパーコトマレ」については環境クリアランスが下りた。資金についてはＯＥＣＦ融資を期待している。
・「ブ」案件は緊急性がないものの、建設コストが安いので実現させたいと考えている。
・「ブ」についてもＯＥＣＦ融資を期待している。
・「ケラワラピチィア」については、ＢＯＯ又はＢＯＴでの事業化を考えている。

２．民間投資について

・今後製造業を強化し、国内外投資を重視していきたいと考えている。
・工業分野開発振興計画において提言された「衣料品」、「宝石」、「宝飾品」及び「ゴム製品」については現在発展している業種であり、政府も後押ししているところ。
・今後ハイテク産業について重視していきたい。

３．産業排水処理について

・政府として関心のある分野。
・排水処理は工業団地単位で検討したい。（調査団から、本スキームは工場単位を想定している旨説明）
・現在世銀が工業団地単位で開発調査を実施しているが、これは排水路（Water Network）建設について実施することとなっている。ただし、排水処理施設は含まれていないので、これを日本側で実施して欲しい。
・排水を垂れ流しているのは古くからの工場（50～60年代）であり、当時は環境基準は無かった。
・現在、新規に工場を建設するには環境クリアランスの取得を条件としている。

以　上

Depertment of National Planningとの協議議事録

日時：平成１０年７月２２日（水）

１．ブロードランド水力発電計画について

・「ブ」について４年前に民間に提示したが結果うまくいかなかった。過去に世銀に対しファイナンスを要請したこともある。政府としては是非建設したく今回要請した次第。

・水力発電については、水の管理が他省庁に跨りこれを民間ベースで解決するのは無理なので、今後は政府ベースで実施し、火力は民間ベースで推進したい。

・水力発電について、ポテンシャルがあるのは残り３～４ヶ所（アッパーコトマレ、ウマオヤ、ブロードランド）程度ではないか。

・（「ブ」についてス国長期電力開発計画に載っていないことを日本側から質問したのに対し）そんなはずはない。計画はＣＥＢが行っている。内容は毎年リバイスされており重要なプロジェクトの一つである。

・「ブ」案件は緊急性がないものの、建設コストが安いので実現させたいと考えている。

・「ブ」についてもＯＥＣＦ融資を期待している。

・「ケラワラピチィア」については、ＢＯＯ又はＢＯＴでの事業化を考えている。

２．民間投資について

・今後製造業を強化し、国内外投資を重視していきたいと考えている。

・工業分野開発振興計画において提言された「衣料品」、「宝石」、「宝飾品」及び「ゴム製品」については現在発展している業種であり、政府も後押ししているところ。

・今後ハイテク産業について重視していきたい。

３．産業排水処理について

・政府として関心のある分野。

・排水処理は工業団地単位で検討したい。（調査団から、本スキームは工場単位を想定している旨説明）

・現在世銀が工業団地単位で開発調査を実施しているが、これは排水路（Water Network）建設について実施することとなっている。ただし、排水処理施設は含まれていないので、これを日本側で実施して欲しい。

・排水を垂れ流しているのは古くからの工場（50～60年代）であり、当時は環境基準は無かった。

・現在、新規に工場を建設するには環境クリアランスの取得を条件としている。

以　上

ＪＥＴＲＯとの協議議事録

日時：平成１０年７月２２日（水）１６：００～１７：３０
場所：ＪＥＴＲＯ所長室
出席者：ＪＥＴＲＯ：谷川 克己　所長
　　安藤 智洋　所員
　　調査団５名

概要：

谷川：・スリランカ商工会は現在６３社加盟（JETRO、JICAを含む）うち、製造業は２３社。２カ月に１度会議を開催。
・９６年８月から投資問題対策特別委員会を設置。商工会及びＢＯＩが１０人づつ（大使館はオブザーバー）出席し、インフラや労働争議等について協議を実施。ＢＯＩの対応も良好である。
・投資環境はインド及びパキスタンと比べ条件はいいのではないか。地理的に欧州に近く、英語も話せることから同メーカーは期待している模様。
・日本のスリランカに投資するきっかけとしては、在日スリランカ人を帰国させ中小企業を起こす例が多い。しかしマネージメント等に問題があり、うまく行かないことが多い。ミッション等がきっかけになることは少ないのではないか。
・賃金は、インド、パキスタンに比べ低い。
・「ジョイン事業」を行った結果、アルミサッシ枠、温度ヒューズ、セラミックについて具体的な話が進んでいる。
・「対日輸出促進事業」として加工食品、プラスチック成形、電子部品産業について専門家を派遣し、可能性調査を実施した。９８年３月に報告書を作成。うち、電子部品について、専門家いわく、東南アジア程ではないものの、Catch upは可能ではないかと見解。
・コンピュータ部品について、対日輸出は5,000万ドル程度、全て外資。ローカルは１０社程度。規模が小さくアッセンブラーであり、全量国内市場向け。うち３、４社は品質管理の認識があり、適切な指導により可能性はあるのではないか。
傾向としては、ノックダウンより完成品輸入になりつつある。
・公的機関に新技術をリードしていくセクションがない（アッセンブラーの機械を修理している程度）ことから、政府は今後の具体的な戦略等を作成できないのが現状。
・長期の専門家を派遣するなどして、技術の向上を図るのが必要と思われる。

以　上

Ministry of Industrial Developmentとの協議議事録

日時：平成１０年7月２３日（木）１４：００～１５：３５

場所：Ministry of Industrial Development, Secretary室

出席者：Mahinda Bandusena, Secretary

W.E.Dheerach, Additional Secretary

M.Susiriwardane, Director

J.G.Keerthiratne　他４名

日本側

ＪＩＣＡミッションチーム５名他事務所から米林所員及びローカルスタッフ１名

概要：

１．「工業分野振興開発計画」提言に係る実施状況については以下のとおり。

・シータルカ（報告書では、アーサーフィールド）工業団地は現在建設中。今年度中に完工予定。

・輸出振興策については、各種見本市への参加等実施。

・金属加工については、鋳造センター（ＪＩＣＡプロ技実施中）の設立。

２．前回調査時との状況変化については、以下のとおり。

・製造業輸出は伸びているが、繊維製品に偏重している。

・失業率は下がったが、その結果、労働集約産業の利点が失われつつある。

・今後の関税率引き下げにより、競争力の強化が必要になってきている。

・東南アジアの経済危機により、各国通貨が切り下げられ、例えばゴムについて、マレイシアとの競争力を失いつつある。

３．Ministry of Industrial Developmentの優先業種

・ゴム、電子・情報技術産業、宝石、セラミックス、エンジニアリングの５業種への多様化を図る方針。

・上記以外に、アドヴァンスドテクノロジー、サポーティングインダストリーを重視し、前者については、特別のインセンティブ制度を設けている。後者については、世界市場への部品供給を狙うもの。

４．その他

・1996年～2006年を「生産性の１０年」と定め、生産性向上を図っている。これまでは、労働組合の理解を得ることに重点を置いていたが、今後は、企業レベルの取り組みを進めることとする。

・ＢＯＩとの業務分担は、ＭＩＤは国内市場向けの国内企業を指向している。

・ＭＩＤ次官はＢＯＩの理事を兼ねており、必要な調整を行える仕組みになっている。

以　上

Ceylon Electricity Boardとの協議議事録

日時：平成１０年７月２３日（木）１５：５０～１６：３０

場所：Ceylon Electricity Board　会議室

出席者：C.N.D.Rerera, Actg.Chairman

Shavindranath Fernando, Deputy General Manager（Generation Planning）他２名

日本側

ＪＩＣＡミッションチーム５名他事務所から米林所員

概要：

ス：９６年における水力発電のTotal Capacityは、１１３５MWであった。

ＣＥＢでは、１９９８年から２００２年までの長期電力計画を策定（９８年６月）したところ。

ブロードランド水力はケラニ川で発電所建設可能な最も下流に位置し、発電量は４０MWを予定。１９８５年に最初のＦ／Ｓを行い、140GW/hで建設費は900millionドルのコスト計算であったが、その後、計画見直し等により、60millionドルまでコストダウンが可能と判断された。環境問題も関係なく、良いプロジェクトと判断している。

日：ファイナンスは何を考えているのか。

ス：計画は３つのステージ（開発可能性調査、詳細設計、入札関係書類作成）に分かれており、詳細設計終了後はＯＥＣＦを考えている。

日：他の援助機関の状況は。

ス：世銀は発電所建設についてサポートしないこととしている。民活（ＢＯＯ又はＢＯＴ）がポリシー。

ＧＴＺ等他のヨーロッパ各国機関が、Ｆ／Ｓを実施したプロジェクトもある。

スリランカは今後、ベースロードの発電は火力発電をメインとし、水力発電についてはピークロードをメインにするよう転換する。

日：長期電力計画の中に、ブロードランド水力が見あたらないのは何故か。

ス：水力案件については、環境クリアランスが得られた案件を計画に盛り込む（現在ククレのみ）こととしている。今後、アッパーコトマレを新たに計画に盛り込む必要があるが、本件については同クリアランスが得られていないことから計画に入っていない。

ＪＩＣＡの開発調査には、環境評価と開発可能性調査（第１ステージ）をお願いしたい。環境評価に係るＴＯＲについて作成したので、本日お渡しする。

以　上

Ministry of Forestry and Environmentとの協議議事録

日時：平成１０年７月２４日（金）９：３０～１０：３０

場所：Ministry of Forestry and Environment　会議室

出席者：K.A.S.Gunasekera次官

J.G.Keerthiratne次官補　他４名

日本側

ＪＩＣＡミッションチーム５名他事務所からローカルスタッフ１名

概要：

日：従来のＪＩＣＡ開発調査スキームは、最終成果として報告書（レポート）を提出することにあるが、今回、排水処理設備をモデル工場に設置して、その成果をモニタリングし、その結果が他の工場に普及することを念頭に置いている。今回の調査では、ス国において、このＦ／Ｓ調査及び工業排水の実状を見極めることを念頭に置いている。

ス：環境公害に対しては、ス政府はコンサルタントを使ってデータ収集を行ってきた。１０年程前に関連法規が出来て、１９９０年頃から調査を開始した。水質汚染に対しては、民間企業は処理装置設置のため、そのスペース確保と資金の問題を抱えている。ウェスタンプロビンスでは、約１００の工場があるが、過去６年間で水質が１５％向上した。

UNIDO／UNDPは、Pollution Reduction Programを提案した。これは、処理装置の設置に対し、補助金を出すシステムである。（Installment Basis Pay Back System）しかし、民間企業にとって、コンサルタントから保証を取り付けることが困難となっている。

日：森林環境省の役割及び他省庁との関係は。

ス：全ての公害規制に関与。例えば、工業省等と開発計画作成時には連携をすることになっている。

日：環境関連の詳細なデータを入手したい。

ス：ス国の問題点として、産業セクターが政府系企業と民間企業に分かれており、これらに対する指導と対策資金調達力に大きな差が生じていることである。例えば、製紙及び石油精製等が政府系列。

日：産業公害の主要な原因は。

ス：（製紙も問題だが）繊維が問題か。何故なら処理技術が非常に複雑。

ス政府は対策を計画し、皮革産業は移転による集中化（資金が必要だが）を検討している。

日：今回のJICAスキームの最適産業は何か。ス側は、土地、ランニングコスト及び建設費の一部を負担することになるが。

ス：政府系製紙業が最大の産業か。今回のスキームで民間企業の排水処理改善状況を政府がモニターするのは制限を受けるので政府系企業が適当ではないか。

日：選ばれた企業は、制度の目的上モデル工場としての役割をしなければならず、その意

味から普及を念頭においており、ス国において製紙工場が多く存在する必要有り。

ス：（工場は多くないと発言の後）多くの工場があり、排水処理装置を持っていない古い工場が多い。新しい工場は全て処理装置を備えなければ操業出来ない。

新しい工業団地も前処理装置を設置し、３カ月に１度の程度でデータの提出を義務付けている。

本件調査とは直接関係ないが、環境対策担当エンジニアを育てる研究機関設立と、規制及び排水処理対策の現場指導を目的とした実地訓練の提案をしたい。

日：環境問題を起こしている工場に対し、強制的に操業を停止させる権限はどの機関か。

ス：森林環境省である。

以　上

Board of Investmentとの協議議事録

日時：平成１０年7月２４日（金）１１：３０～１２：００

場所：Board of Investment　会議室

出席者：L.J.Issac, Director（Investment Promotion）

日本側

ＪＩＣＡミッションチーム５名及び事務所からローカルスタッフ１名

概要：

１．この１年程で次のような優遇制度が導入された。

・Trust Indunstriesとして以下を育成する。
電子、鉱物、窯業・ガラス製品、ゴム製品、軽重エンジニアリング及びパイオニア産業。

・既存企業の遠隔地への移転促進。

・「５０縫製プログラム」（コロンボ以外への移転・ＭＩＤと共同）。

・繊維産業のリストラ、近代化。

・アドヴァンスド・テクノロジー育成（ＭＩＤ・ＭＯＦと共同）。

２．近年の投資傾向。

・投資が増加している業種は、ソフトウェア開発、窯業（壁タイル等）、インフラ開発（電力、港湾等）。

・９７年までの２、３年間はインフラ開発が上昇。

・９８年は東南アジアの経済危機により、マレイシアと韓国の投資が減少した。

・ＳＡＰＴＡ構想の反響として、東南アジア市場向けのゴムをベースとした自動車部品、金属製品に関しての問い合わせが増加している。

３．ＭＩＤとの関係

・ＭＩＤは国内企業、ＢＯＩは外国企業及び輸出指向企業に焦点をあてている。

・工業団地開発では、ＢＯＩがＦＴＺ、ＭＩＤが一般工業団地を主管している。

・優先業種の選定等でもＢＯＩはＭＯＦ以外の指導を受けず、独自に行っている。

以　上

Ⅲ. 資 料 集

SRI LANKA -
BUSINESS ENVIRONMENT
AND INVESTMENT INCENTIVES

MAKE IT. IN SRI LANKA

THE BOARD OF INVESTMENT

"Comparisons have shown that Sri Lanka offers one of the most liberal business environments in Asia."

Sri Lanka's economy recorded considerable growth in 1997 with Gross Domestic Product (GDP) expected to exceed 6 per cent (compared to an average of 5.0% per annum from 1994 to 1996). In brief, the salient features of the economy for 1997 are summarised below.

* Gross Domestic Capital formation increased to 26% of GDP (compared to 24% in 1996.) A significant decline in interest rates, where the prime lending rate declined to 12% from 18% one year ago, contributed to increased rates of investment.

* The external sector was bouyant. Total exports and industrial exports grew by 14% and 16% in US$ terms respectively. The current account deficit and the trade deficit declined to 4 per cent and 10.09 per cent of GDP respectively.

* Total foreign investments (including net foreign direct and portfolio investment and privatisation proceeds) reached US$ 550 million for 1997–the highest ever on record.

* The external debt service ratio was reasonable at 12.5% of exports in 1997. Short term foreign borrowings were less than 1% of total capital inflows, thus insulating Sri Lanka's economy against volatile capital transfers.

* The balance of payment recorded a surplus of over US$ 400 million (2.7% of GDP) and foreign reserves (US$ 2.8 billion) is adequate to cover over 5 months' imports.

INFRASTRUCTURE

Private and public investment programmes have been implemented to improve the country's basic infrastructure facilities, which today rank as the best available in South Asia.

Ports : Throughput at Colombo Port has grown at a compound annual rate of 20.3 % over the last five years to reach 1.68 million TEU's at present. Transhipment cargo accounts for 72% of throughput, positioning Colombo as a major shipping hub. Construction has already commenced to further expand capacity to 3 million TEUs within the next 3 years.

Telecom : Today Sri Lanka has multiple providers of Basic, (3 companies) Cellular (4 companies) and Pay (5 companies) telephone services, making the industry among the most competitive in Asia. The number of fixed telephone lines installed increased by 65 % in

1997 due to the entry of 2 wireless local loop operators and the privatisation of Sri Lanka Telecom.

Power: Sri Lanka has reduced its dependency on hydro energy to a great extent, thus virtually eleminating reliance on weather patterns for stable supply. In 1997, due to an accelerated public investment programme, thermal generation capacity installed as a percentage of total capacity increased to 29.1 % compared to 19.3 % in 1996. Additional thermal capacity will come on stream during 1998 and 1999.

Comparisons have shown that Sri Lanka offers one of the most liberal business environments in Asia. Total foreign ownership is welcome in most areas of the economy. While there are a few areas where foreign investment is limited, these are being minimised. There are no restrictions on the repatriation of earnings and capital.

The Sri Lankan government is business-friendly and is actively pursuing a policy of economic liberalisation with emphasis on private sector investment. The private sector plays a vital role in traditional areas of public investment such as telecommunications, energy and transport. So far, 15 enterprises are in the process of undergoing privatisation.

In the last 12 months, several landmark investments were approved and implemented in the infrastructure, manufacturing and service sectors. The most significant of these include:

- The largest ever privatisation was recently concluded with the purchase of 35 per cent in Sri Lanka Telecom by NTT of Japan for US$225 million.
- In late 1995, two licences were awarded to set up basic telecommunication services using wireless local loop technology to business groups led by Telia AB of Sweden and Transmarco of Singapore.
- A US$385 million investment by IMC Agrico, Freeport McMoran Resource Partners (both of the USA) and Tomen Corporation (Japan) for phosphate mining and processing of DAP fertiliser was approved and the Mineral Investment Agreement initialled. This is the largest single foreign direct investment in the manufacturing sector ever approved by the BOI.
- A concession was awarded to a consortium led by P&O of the United Kingdom and John Keells Holdings of Sri Lanka to expand the Port of Colombo.

"Sri Lanka is the logical location for manufacturing and service organisations that wish to establish a presence in what is fast becoming an economic powerhouse in the region."

- The first-ever power generation project on a BOO basis was successfully structured by the BOI. This US$62 million investment by the UK-based KHD Group has now been committed and the plant is under construction.

- Subsequent to the successful purchase of a majority shareholding in the recently privatised Ceylon Steel Corporation, Hanjung of Korea is embarking on a US$1 billion investment in the Southern region to set up an export oriented steel mill, 200MW power plant and an oil refinery.

THE LOCATION ADVANTAGE

Sri Lanka is *the* logical location for manufacturing and service organisations that wish to establish a presence in what is fast becoming an economic powerhouse in the region. The island is ideally located as the gateway to the vast Indian subcontinent - home to a quarter of the world's population.

In addition, trade barriers are falling throughout the region. The South- Asia Preferential Tariff Arrangement (SAPTA) came into force on December 7th, 1995. Already tariff concessions apply to 226 items. The seven countries which comprise the South Asia Association for Regional Cooperation (SAARC) have agreed to expand the list of items on a phased basis. SAARC member nations have further resolved that SAPTA should eventually progress towards the South-Asia Free Trade Arrangement (SAFTA).

INVESTMENT PROTECTION AND GUARANTEES

Sri Lanka has developed an enviable record of "political credibility" in the international arena. All major political parties are committed to free enterprise and individual freedom.

Bilateral investment agreements, supported by a constitutional guarantee, provide strong protection to foreign investment in Sri Lanka. **The safety of foreign investment is guaranteed through the acceptance by a two thirds majority of Parliament of the Constitutional Guarantee of Investment Protection Agreements.** Under Article 157 of the country's Constitution, the agreement enjoys the force of law and no legislative, executive or administrative action can be taken to contravene it.

Bilateral investment agreements are valid for 10 years. They are extended automatically unless terminated by either party. If the agreements are terminated, investments already made are protected for another 10

"The Safety of foreign Investment is guaranteed by the constitutional recognition of Investment protection agreements"

years. A clause in the Sri Lankan Constitution ensures the sanctity of the agreements.

These agreements provide for the following:

- Protection against nationalisation.
- Prompt and adequate compensation if required.
- Free remittance of earnings, capital and business fees.
- Settlement of disputes under the International Convention for the Settlement of Investment Disputes (ICSID).

Bilateral agreements exist between Sri Lanka and the following countries:
Belgium, China, Denmark, Egypt, Finland, France, Germany, Indonesia, India, Italy, Japan, Korea, Luxembourg, Malaysia, Netherlands, Norway, Romania, Singapore, Sweden, Switzerland, Thailand, the United Kingdom and the United States of America.

Sri Lanka is also a founding member of the Multilateral Investment Guarantee Agency (MIGA). This provides further safeguards against expropriation and non-commercial risk. Investors may also refer disputes for arbitration under the Rules of the International Chamber of Commerce.

INTELLECTUAL PROPERTY

The laws relating to copyright, industrial designs, patents, trade marks, service marks, trade names and unfair competition are covered by the Code of Intellectual Property Act of 1979 and subsequent amendments.

Protection for trade marks is based on registration in the Registry of Trade Marks. The classification used for this purpose follows the international grouping set by the Nice Agreement of the World Intellectual Property Organisation with 34 classes of goods and eight classes of services. Registration of a mark is valid for 10 years and renewable for additional periods of 10 years.

ARBITRATION

An Arbitration Centre has been established in Colombo for the settlement of commercial disputes expeditiously, economically and privately. A new law has already been enacted for this purpose. The Centre will be affiliated with the Arbitration Institute of the Stockholm Chamber of Commerce and will follow its standards and norms.

The Arbitration Act gives recognition to the New York Convention on the Recognition and Enforcement of Foreign Arbitral Awards.

REMITTANCE OF EARNINGS AND CAPITAL

By mid 1994, Sri Lanka had removed all foreign exchange restrictions on current account transactions. The monetary authorities are moving towards further liberalising exchange controls.

Within this liberal environment, foreign investors can freely remit dividends, capital or royalty payments through any commercial bank, as well as the sale proceeds of shares.

SKILLED WORKFORCE

According to data published by the World Bank, Sri Lanka has the highest life expectancy (71 years) highest literacy rate (89 per cent) and lowest infant and child mortality rates among the designated low income countries. Sri Lanka also has the lowest rate of population growth in the developing world (1.2 per cent). We also have the lowest urbanisation rate within this group, lessening the pressure on cities unlike the experience of other developing countries. This situation is the result of extensive investment in public education welfare by successive post-independence governments.

Today, investors will find an intelligent, educated and energetic workforce that is comfortable with modern production techniques and has a level of trainability that is among the best in the region.

In fact,we believe we have the best quality workforce available at this income and wage level.

LAND

A foreign investor can either purchase or lease land for any proposed enterprise. If land is purchased by a non-national, a tax payment of 100 per cent of the purchase price is required.

However, if a foreign investor incorporates a company in Sri Lanka under the Companies Act and buys the land in the name of the company, a tax payment is not required even though the shareholders of the company are foreign nationals.

INCENTIVES AVAILABLE UNDER BOI LAW - AT A GLANCE

	QUALIFYING CRITERIA			INCENTIVES							
						Import Duty Exemption		Exemption from turnover Tax			Exemption from Exchange Control
	Minimum Investment In Rs.mn	Minimum direct/indirect export requirement (% of output)	Minimum New Employment Required	Full Tax Holiday +	Concessionary Tax at 15%	On Capital Goods	On Raw Materials	On Capital Goods	On Raw Materials	On Sales Revenue	
1. THRUST INDUSTRY (a) A new export oriented enterprise	50-1499	90%	50	10 years	10 years after tax holiday	yes	yes, if utilized for export	yes	yes, if utilized for export	yes, on export sales	yes
	1500-2499	90%	50	12 years	8 years after tax holiday	yes	yes, if utilized for export	yes	yes, if utilized for export	yes, on export sales	yes
	2500-4999	90%	50	15years	5 years after tax holiday	yes	yes, if utilized for export	yes	yes, if utilized for export	yes, on export sales	yes
	Above 5000	90%	50	20 years	as per IR Law after tax holiday	yes	yes, if utilized for export	yes	yes, if utilized for export	yes, on export sales	yes
(b) Existing BOI enterprise	50	90%	None	10 yrs if no previous tax holiday	10 years after tax holiday	yes	yes, if utilized for export	yes	yes, if utilized for export	yes, on export sales	yes
	500-1499	90%	None	10 years	10 years after tax holiday	yes	yes, if utilized for export	yes	yes, if utilized for export	yes, on export sales	yes
	1500-2499	90%	None	12 years	8 years after tax holiday	yes	yes, if utilized for export	yes	yes, if utilized for export	yes, on export sales	yes
	2500-4999	90%	None	15 years	5 years after tax holiday	yes	yes, if utilized for export	yes	yes, if utilized for export	yes, on export sales	yes
	Above 5000	90%	None	20 years	As per IR Law after tax holiday	yes	yes, if utilized for export	yes	yes, if utilized for export	yes, on export sales	yes

	QUALIFYING CRITERIA			INCENTIVES							
						Import Duty Exemption		Exemption from turnover Tax			Exemption from Exchange Control
	Minimum Investment In Rs.mn -	Minimum direct/indirect export requirement (% of output)	Minimum New Employment Required	Full Tax Holiday +	Concessionary Tax at 15%	On Capital Goods	On Raw Materials	On Capital Goods	On Raw Materials	On Sales Revenue	
(c) Existing Non-BOI enterprise (Presently non-export oriented)	None	upto 49%	None	None	yes, on export income	yes	On Exports only.	yes	On Exports only.	yes, on export	No
	None	50-89% (within 5 yrs)	None	5 years	yes, on export income after tax holiday	yes	On Exports only. customs bonding	yes	On Exports only. customs bonding	yes, on export sales	FCBU only
	None	90% or more (within 5 yrs)	None	10 years	yes, on export income after tax holiday	yes	yes, if utilized for export	yes	yes, if utilized for export	yes, on export sales	yes
(d) Existing Non BOI export oriented enterprise	None	90%	None	None	Yes	Yes	yes, if utilized for export	yes	yes, if utilized for export	yes, on export sales	yes
	50 - 1499	90%	None	10 years	10 years after tax holiday	yes	yes, if utilized for export	yes	yes, if utilized for export	yes, on export sales	yes
	1500-5000 and above } Incentives as enumerated under (b) above shall apply										
2. DIRECT & INDIRECT EXPORTS (GENERAL) (a) Manufactured goods (new enterprise)	12.5	90%	None	None	20 years	yes	yes, if utilized for export	yes	yes, if utilized for export	yes, on export sales	yes
(b) Services (new enterprise)	None	70%	None	None	20 years	yes	yes, if utilized for export	yes	yes, if utilized for export	As per T.T. Act	yes

	QUALIFYING CRITERIA			INCENTIVES							
	Minimum Investment In Rs.mn -	Minimum direct/indirect export requirement (% of output)	Minimum New Employment Required	Full Tax Holiday +	Concessionary Tax at 15%	Import Duty Exemption		Exemption from turnover Tax			Exemption from Exchange Control
						On Capital Goods	On Raw Materials	On Capital Goods	On Raw Materials	On Sales Revenue	
3. EXPANSION/ RELOCATION OF EXISTING BOI & NON-BOI ENTERPRISES INTO DESIGNATED ZONES											
(a) Zones categorised as "difficult"	12.5	90% for apparels 50% other products	150	5 years (added to existing tax holiday)	yes, on export income after tax holiday	yes	yes, if utilized for export	yes	yes, if utilized for export	yes, on export sales	yes
(b) Zones categorised as "most difficult"	12.5	90% for apparels 50% other products	150	8 years (added to existing tax holiday)	yes, on export income after tax holiday	yes	yes, if utilized for export	yes	yes, if utilized for export	yes, on export sales	yes
4. EXPANSION OF ENTERPRISES IN "DIFFICULT" & "MOST DIFFICULT" AREAS											
(a) Existing BOI enterprise engaged in apparel export expanding to mfg apparel accessories or setting up specialised training centre in same locality	10	50%	100	5 years (added to existing tax holiday)	yes, on export income after tax holiday	yes	yes, if utilized for export	yes	yes, if utilized for export	yes, on export sales	yes
(b) New enterprise to mfg any itme other item than apparel	None	25%	75	5 years	yes, on export income after tax holiday	yes	yes, if utilized for export	yes	On exports only s.t. customs bonding	yes, on export sales	No

	QUALIFYING CRITERIA			INCENTIVES							
	Minimum Investment In Rs.mn	Minimum direct/indirect export requirement (% of output)	Minimum New Employment Required	Full Tax Holiday +	Concessionary Tax at 15%	Import Duty Exemption		Exemption from turnover Tax			Exemption from Exchange Control
						On Capital Goods	On Raw Materials	On Capital Goods	On Raw Materials	On Sales Revenue	
5. FIFTY GARMENT FACTORIES PROGRAMME (Applicable only to enterprises selected by Ministry of Industries	20	90%	250	5 years for "difficult" area 8 years for "most difficult" area	15 years after tax holiday 12 years after tax holiday	yes	yes, if utilised for export	yes	yes, if utilised for export	yes, on export sales	yes
6. TEXTILE & ANCILLARY INDUSTRIES INCL. THREAD YARN ETC. (Available to new and existing enterprises)	5	0-49% 50% or more (within 5 yrs)	None None	None 5 years	yes, on export income yes, on export income after tax holiday	yes yes	yes yes	yes yes	yes yes	yes yes	no no
7. EXISTING ENTERPRISES UNDERTAKING LARGE SCALE PROJECTS (Available only to mfg. of textile & ancillary industries cement and steel)	500-1499	None	None	10 years on total income	n.a.	Excluding textiles, establish-ment period 2 years	No, unless used for exports or textile mfg	Exluding textiles, establish-ment period	No, unless used for exports or textile mfg	No, excluding textiles and export sales	yes
	1500-2499	None	None	12 years on total income	n.a.	Excluding textiles, establish-ment period 2 years	No, unless used for exports or textile mfg	Excluding textiles, establish-ment period	No, unless used for exports or textile mfg	No, excluding textiles and export sales	yes

	QUALIFYING CRITERIA			INCENTIVES							
	Minimum Investment In Rs.mn	Minimum direct/indirect export requirement (% of output)	Minimum New Employment Required	Full Tax Holiday +	Concessionary Tax at 15%	Import Duty Exemption		Exemption from turnover Tax			Exemption from Exchange Control
						On Capital Goods	On Raw Materials	On Capital Goods	On Raw Materials	On Sales Revenue	
	2500-4999	None	None	15 years on total income	n.a.	Excluding textiles, establish-ment period 2 years	No, unless used for exports or textile mfg	Excluding textiles, establish-ment period	No, unless used for exports or textile mfg	No, excluding textiles and export sales	yes
	Above 5000	None	None	20 years on total income	n.a	Excluding textiles establish-ment period 2 years	No, unless used for exports or textile mfg	Excluding textiles establish-ment period	No, unless used for exports or textile mfg	No, excluding textiles and export sales	yes
8. NEW ENTERPRISES UNDERTAKING LARGE SCALE PROJECTS (a) Export oriented	500 - 1499	90%	100 for mfg only	10 years	10 years after tax holiday	yes	yes, if utilised for export	yes	yes, if utilised for export	yes, on export sales	yes
	1500 - 2499	90%	100 for mfg only	12 years	8 years after tax holiday	yes	yes, if utilised for export	yes	yes, if utilised for export	yes, on export sales	yes
	2500 - 4999	90%	100 for mfg only	15 years	5 years after tax holiday	yes	yes, if utilised for export	yes	yes, if utilised for export	yes, on export sales	yes
	Above 5000	90%	100 for mfg only	15 years	5 years after tax holiday	yes	yes, if utilised for export	yes	yes, if utilised for export	yes, on export sales	yes

	QUALIFYING CRITERIA			INCENTIVES							
	Minimum Investment In Rs.mn	Minimum direct/indirect export requirement (% of output)	Minimum New Employment Required	Full Tax Holiday +	Concessionary Tax at 15%	Import Duty Exemption		Exemption from turnover Tax			Exemption from Exchange Control
						On Capital Goods	On Raw Materials	On Capital Goods	On Raw Materials	On Sales Revenue	
(b) Other	500 - 1499	n.a.	100 for mfg only	10 years	as per IR Law after tax holiday	Excluding textiles, during project establishment period (2 yrs)	No, unless used for exports	Excluding textiles, during project establishment period (2 yrs)	No, unless used for exports or textile mfg	No, excluding textiles and export sales	yes
	1500 - 2499	n.a.	100 for mfg only	12 years	As per IR Law after tax holiday	Excluding textiles, during project establishment period (2 yrs)	No, unless used for exports	Excluding textiles, during project establishment period (2 yrs)	No, Unless used for exports or textile mfg	No, excluding textiles and export sales	yes
	2500 - 4999	n.a.	100 for mfg only	15 years	As per IR Law after tax holiday	Excluding textiles, during project establishment period (2 yrs)	No, unless used for exports.	Excluding textiles, during project establishment period (2 yrs)	No, unless used for exports or textile mfg	No, excluding textiles and export sales	yes
	Above 5000	n.a.	100 for mfg only	20 years	As per IR Law after tax holiday	Excluding textiles, during project establishment period (2 yrs)	No, unless used for exports	Excluding textiles, during project establishment period (2 yrs)	No, unless used for exports or textile mfg	No, excluding textiles and export sales	yes

	QUALIFYING CRITERIA			INCENTIVES							
	Minimum Investment In Rs.mn	Minimum direct/indirect export requirement (% of output)	Minimum New Employment Required	Full Tax Holiday +	Concessionary Tax at 15%	Import Duty Exemption		Exemption from turnover Tax			Exemption from Exchange Control
						On Capital Goods	On Raw Materials	On Capital Goods	On Raw Materials	On Sales Revenue	
9. SOFTWARE (a) Domestic market oriented	None	0 - 69%	25 technically qualified persons	5 years (extended to 8 yrs if 70% exported)	As per IR Law after tax holiday	yes	n.a.	yes	n.a.	As per TT Act	No
(b) Export oriented	None	More than 70%	25 technically qualified persons	8 years	12 years after tax holiday	yes	n.a.	yes	n.a.	As per TT Act	yes
10. GEMS, DIAMONDS & JEWELLERY (a) Manufacturing enterprise	10	70%	None	20 years	As per IR Law after tax holiday	yes	yes	yes	yes	yes	yes
(b) Trading enterprise	5	70%	None	20 years	As per IR Law after tax holiday	During establishment period (2 yrs)	yes	no	yes	yes	yes
11. HOUSING (a) Low cost housing	50-499 (min 100 units)	n.a.	None	7 years	n.a.	During establishment period (2 yrs)	no	no	no	no	no
(b) Other For investments greater than Rs. 500 mn, 8 (b) shall apply	100-499 (min 100 units)	n.a.	None	10 years	n.a.	During establishment period (2 yrs)	no	no	no	no	no

	QUALIFYING CRITERIA			INCENTIVES							
	Minimum Investment In Rs.mn	Minimum direct/indirect export requirement (% of output)	Minimum New Employment Required	Full Tax Holiday +	Concessionary Tax at 15%	Import Duty Exemption		Exemption from turnover Tax			Exemption from Exchange Control
						On Capital Goods	On Raw Materials	On Capital Goods	On Raw Materials	On Sales Revenue	
12. TOURISM & RECREATION For investments greater than Rs. 500 mn 8 (b) shall apply	10 - 499	n.a.	None	None	20 years	During establishment period (2 yrs)	no	yes	no	no	no
13. SMALL SCALE INFRASTRUCTURE (a) Power	50 - 499	n.a.	None	None	7 years	During establishment period (2 yrs)	no	no	no	no	no
(b) Other (ware houses and general infrastructure) For investment greater than Rs. 500 mn, 8 (b) shall apply	125 - 499	n.a.	None	None	7 - 10 years depending on investment	During establishment period (2 yrs)	no	no	no	no	no
14. REGIONAL OPERATING HEADQUARTERS	None	n.a.	None	5 years	As per IR Law After tax holiday	During establishment period (2 yrs)	no	no	no	no	FCBU only
15. TRAINING INSTITUTIONS	None	n.a.	Min 100 to be trained per yr	None	10 years	During establishment period (2 yrs)	no	no	no	no	no

	QUALIFYING CRITERIA			INCENTIVES							
						Import Duty Exemption		Exemption from turnover Tax			Exemption from Exchange Control
	Minimum Investment In Rs.mn	Minimum direct/indirect export requirement (% of output)	Minimum New Employment Required	Full Tax Holiday +	Concessionary Tax at 15%	On Capital Goods	On Raw Materials	On Capital Goods	On Raw Materials	On Sales Revenue	
16. SHIP REPAIR & BREAKING For investments greater than Rs. 500 mn, 8 (a) shall apply	10 - 499	70%	25	5 years	15 years after tax holiday	yes	yes	yes, if approved by Ministry of Finance	yes	no, as per TT Act	yes
17. WORKER TRANSPORT (a) New company servicing zones	10 forty seater buses	n.a.	n.a.	5 years	As per IR Law after tax holiday	yes	no	yes	no	no, as per TT Act	no
(b) Existing BOI approved company	2-5 forty seater buses depending on location	n.a.	n.a.	1 yr added existing tax holiday (income tax credit for others)	n.a.	yes	n.a.	yes	n.a.	n.a.	n.a.

NOTES

All investments where project cost exceeds Rs. 500 mn quality for BOI incentives under 'Large-scale Projects'

Turnover tax rates vary from 2% to 20%

Tax holiday effective from the commencement of business. Dividends declared out of tax exempt profits during the tax holiday and one year thereafter will be exempt from income tax in the hands of shareholders.

Concessionary tax rate runs from commencement of employment.

INVESTMENT TAX ALLOWANCE

Manufacturing companies which invest in a new plant, machinery or equipment between 6 November 1996 and 31 March 2000, are eligible for the following investment tax allowance.

Investments up to Rs 250 million (US$ 4.2 million) attract an investment allowance of 75 per cent of the capital, against a maximum of 50 per cent of the assessable income, in the year in which the acquisition and use of the plant, machinery or equipment occurs.

Investments exceeding Rs 250 million, or where the investment is undertaken in designated 'backward areas', attract an allowance of 100 per cent of the capital, against a maximum of 75 per cent of the assessable income.

Any unutilised allowance could be carried forward indefinitely for claim in subsequent years.

INCENTIVES UNDER 'NORMAL LAWS' - AT A GLANCE

	QUALIFYING CRITERIA			INCENTIVES							
						Import Duty Exemption		Exemption from turnover Tax			Investment Tax Allowance
	Minimum Investment In Rs.mn	Minimum direct/indirect export requirement	Minimum New Employment Required	Full Tax Holiday +	Concessionary Tax rate	On Capital Goods	On Raw Materials	On Capital Goods	On Raw Materials	On Sales Revenue	
1. ADVANCED TECHNOLOGY											
(a) New	4	N.A.	50	5 years	As per IR Law	Yes	None	Yes	No	No	Yes
(b) Existing	1	N.A.	50	5 years*	As per IR Law	Yes	None	Yes	No	No	Yes
2. AGRICULTURE & DAIRY											
(a) Large Scale	10	-	-	10 years	As per IR Law	Yes	Yes	Yes	Yes	No	Yes
(b) Fruit & Vegetables (Fresh Processed)	-	-	-	10 years •	As per IR Law	Yes	Yes	Yes	Yes	No	Yes
(c) Agri. Marketing	-	-	-	5 years	As per IR Law	Yes	No	Yes	No	No	Yes
3. TOURISM	None	None	None	None	15% for 1998/1999	yes for refurbishment of existing hotels if over Rs. 1 Mn upto 1998 November	No	Yes for refurbishment of existing hotels upto 1998 November	No	Room sales are exempt	Yes
4. GOLD, GEMS JEWELLERY	Nil	None	None	Open ended tax holiday	N.A.	Yes	Yes	Yes	Yes	Yes	Yes
5. TEXTILE Existing companies	5	None	None	5 years	As per IR Law	Yes	Yes	Yes	Yes	Yes	Yes
6. MEDICAL SERVICES	None	None	None	None	None	Yes	Yes	Yes	Yes	Yes	Yes
7. DAIRY PRODUCTS	-	-	-	5 years	As per IR Law	Yes	Yes	Yes	Yes	No	Yes

* incremental income

• subject to cultivation of minimum of 5 Acres

	QUALIFYING CRITERIA			INCENTIVES							
						Import Duty Exemption		Exemption from turnover Tax			
	Minimum Investment In Rs.mn	Minimum direct/indirect export requirement (% of output)	Minimum New Employment Required	Full Tax Holiday	Concessionary Tax rate	On Capital Goods	On Raw Materials	On Capital Goods	On Raw Materials	On Sales Revenue	Investment Tax Allowance
8. FISHERIES & LIVESTOCK		None	None	5 years	As per IR Law	Yes	Yes	Yes	Yes	No	Yes
9. SOFTWARE		N.A.		5 years	As per IR Law	Yes	N.A.	Yes	N.A.	As per TT Act	Yes
10. BUS ASSEMBLING	None	None	None	None	None	Yes	Yes	Yes	Yes	No	Yes

FOR MORE INFORMATION CONTACT THE BOARD OF INVESTMENT OF SRI LANKA, P.O. BOX 1768, WORLD TRADE CENTRE, COLOMBO 1, SRI LANKA.
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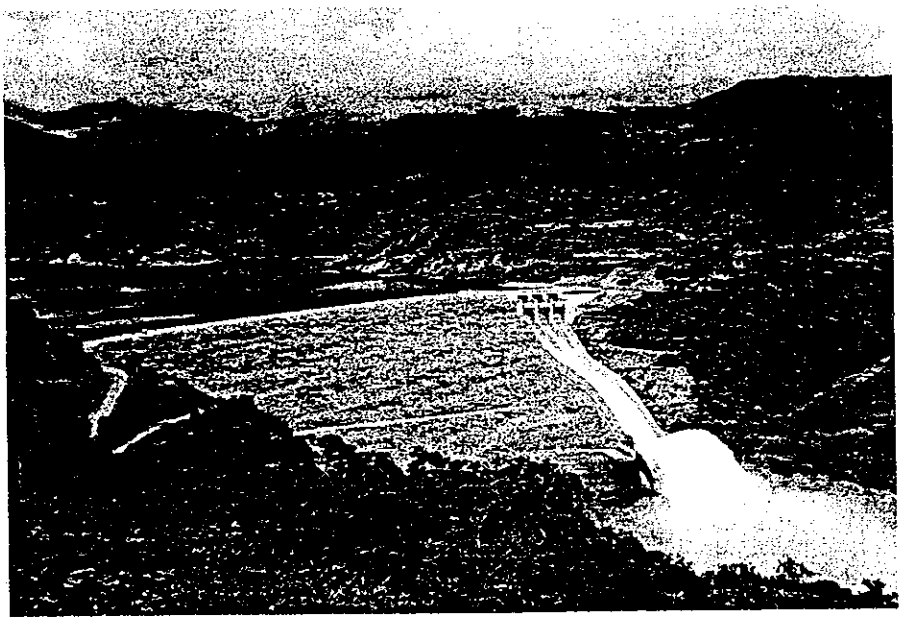
KEY ECONOMIC INDICATORS

	Units	1992	1993	1994	1995	1996	1997
Nominal GDP	SLRs.bn	387	453	523.3	598.3	696.0	805
Real GDP	SLRs.bn	141.0	150.8	159.3	168.0	174.3	184.8
Real GDP Growth	%YoY	4.3	6.9	5.6	5.5	3.8	6.0
Per Capita GDP	US$	557	588	656	719	760	814
Sector Growth Rates	% YoY						
Agriculture	%YoY	-1.6	4.9	3.3	3.3	-4.6	2.9
Construction	%YoY	8.1	6.5	6.0	4.9	3.4	5.5
Manufacturing	%YoY	8.8	10.5	9.1	9.2	6.5	8.9
Services	%YoY	5.3	6.3	5.2	5.1	5.8	6.1
Investment	% of GDP	24.3	25.6	27.0	25.1	24.2	25.8
Domestic Savings	% of GDP	15.0	16.0	15.2	15.3	15.5	17.0
GNP Deflator	%YoY	10.0	9.5	9.4	8.4	12.3	9.0
WA Prime Lending Rate	%	20.0	20.4	18.5	20.1	18.4	14.7
M2	SLRs.bn	131.6	162.4	194.4	131.7	253.2	288.6
	%YoY	17.4	23.4	19.7	19.2	10.8	14.0
Trade Balance	SDR Mn	-540	-825	-1089	-997	-909	1055
	%YoY	4.5	-15.3	-36.3	11.6	8.8	
Exports	SDR Mn	1745	2046	2235	2504	2822	3263
Imports	SDR Mn	2485	2872	3324	3501	3731	4318
	%YoY	12.4	19.8	19.4	8.3		
Current Account Balance	SDR Mn	-306	-280	-526	-425	-378	-400
	%YoY	11.5	7.8	-90.9	28.9		
Balance of Payments	SDR Mn	133	375	173	-62	-63	300
	%YoY	-10.2	136.4	-31.8	-126.6		
Foreign Reserves	Rs Mn	66236	105258	130340	138905	138408	161557
	% YoY	24.6	47.5	22.8	-1.4		
	Months of Imports	5.1	6.5	6.5	6.1	5.4	5.4
Budget Deficit	Rs Mn	(31192)	(42121)	(57730)	(64224)	(59931)	(34650)
	% of GDP	7.3	8.4	10.0	8.4	7.8	3.9
Total Government Debt	Rs Mn	405559	483909	550930	632045	708412	760530
	% of GDP	95.4	96.9	95.1	94.6	92.1	85.6
Debt Service Ratio	% of Export	17.1	13.8	13.3	13.9	15.1	13.3
Exchange Rate (Yr-end)	SLRs/US$	46.0	49.56	49.98	54.05	56.71	61.28
	%YoY	-8.03	-7.74	-0.84	-8.14		-7.5

CEYLON ELECTRICITY BOARD



REPORT ON

LONG TERM GENERATION EXPANSION PLANNING STUDIES

1998 - 2012

Generation Planning Branch
Ceylon Electricity Board
P.O. Box 540, Colombo
Sri Lanka

June 1998

EXECUTIVE SUMMARY

This report describes the Generation Expansion Planning Studies carried out by the Generation Planning Branch of the Ceylon Electricity Board for the period 1998-2012. Each plant sequence presented in this report is the least-cost sequence for a given scenario. The report also presents the investment and implementation plan for the proposed projects and recommends the adoption of the least cost plant sequence derived for the base case and also emphasises the need to implement the plan to avoid energy shortfalls.

The studies presented in this report were conducted under three different electrical energy demand growth scenarios; the base demand forecast, high demand forecast and low demand forecast. In these demand forecasts, it was assumed that the system transmission loss levels will reduce by 0.2% yearly and that the system load factor will improve to 58% by year 2007. The proposed hydroelectric plants at Broadlands, Gin Ganga, Uma Oya, Belihul Oya and Moragolla were considered as candidate for system expansion. The thermal plants considered were Coal, Combined Cycle and Gas Turbines. The Upper Kotmale Hydro Electric Plant was not considered as a candidate plant as the environmental clearance for the implementation has not been granted as yet.

The sensitivity of the recommended generating plant additions to the changes in fuel price forecast, cost of unserved energy and change of discount rate are all presented in the report. These are in addition to the three demand growth scenarios studied.

Kukule Hydro Electric plant has been fixed for commissioning in the year 2002 in accordance with the present implementation schedule. The 40 MW diesel plant at Sapugaskanda and 150 MW Combined cycle plant at Kelanitissa have been fixed to the years 1999 and 2000 respectively. The study with the base demand forecast reveals the need to develop gas turbine and combined cycle plants to a total capacity of 615 MW over the years 1998-2010. The coal plants should be developed for operation from year 2004 onwards.

As the minimum time requirement for implementation of small thermal plants is approximately two years, there is **absolutely no time for delay** in implementing 105 MW gas turbine plants required in January 2000. Combined Cycle power plants of capacity 300 MW need to be commissioned in 2001. As the soft loan OECF funds are already available for the 150 MW Combined Cycle power plant to be located at the Kelanitissa power station premises, utmost priority should be given to its implementation.

It should also be noted that a Request For Proposals has been made by Ministry of Irrigation and Power for a 150 MW Combined cycle power plant at Kelanitissa. The ongoing study to design and construct additional Combined Cycle power plant at Muthurajawela required in 2001 should be given priority. Urgent attention is also required for the timely implementation of the 300 MW Coal plant in the West coast for which studies are underway with OECF funding.

It is also emphasized that there is absolutely no time for any delay in implementation of the plan. Utmost effort and total commitment will be required on the part of the CEB and the Government to implement the plan in a timely manner to avoid any future crisis situations.

The major recommendations are;

1. Expedite the implementation of 40 MW of additional Diesel plant capacity to the Sapugaskanda Extension project for which the funding is available from the German Government.
2. Expedite the commissioning of the 150 MW Combined Cycle power plant at the Kelanitissa premises for which the funding from the OECF of Japan is available.
3. Expedite the implementation of the Kukule project for which the funding is available from the OECF of Japan.
4. Expedite the phase II of the engineering services of the Coal fired thermal power plant. Meantime seek funding for the construction and expedite the commissioning of the plant in 2004.
5. Once the environmental clearance for Upper Kotmale hydro power project is obtained, seek funds from OECF of Japan for the implementation of the project as they have once appraised this project for funding.
6. As soon as the feasibility study for Muthurajawela Combined cycle project is completed, seek funding for the implementation. Expedite the commissioning of the plant in 2001.
7. Implementation the 150MW Combined cycle power plant for which a Request For Proposals has been made for private sector participation.

CHAPTER 1
INTRODUCTION

Ceylon Electricity Board (CEB), established by an Act of Parliament in 1969, is the statutory body responsible for Generation, Transmission and most of the Distribution of electric power in Sri Lanka. Presently, CEB has 15 hydro power stations and 3 thermal power stations connected to the national grid which operates at 220 kV and 132 kV. The total installed capacity of all power stations owned and operated by CEB at the end of 1997 is 1540 MW. In addition a 22.5 MW plant built, owned and operated by Lakdanavi (Pvt) Ltd. was connected to the system in late 1997. In 1996, the Sri Lankan power system experienced the worst ever power curtailments. The total generation in 1996 including power purchases from Independent Power Producers (IPPs) and self generation amounted to 4530 GWh whereas the power curtailments were estimated to be around 381 GWh. The recorded maximum demand of 968 MW during the year 1996 was less than that of the previous year. The highest peak recorded during 1997 was 1037 MW (in December).

	1995	1996	1997
Generation (GWh)	4782	4530	5097
Peak (MW)	979	968	1037
Installed Capacity (MW)	1385	1386.4	1563.9

To meet the increasing demand for electrical energy and to replace the thermal plants due for retirement towards the end of the century, CEB needs to install new generating stations as and when required. If the demand for electricity grows according to the base forecast, it is estimated that the Sri Lankan Power System needs over 2325 MW of new generating capacity to be installed over the next 15 years (1998-2012).

1.1 The Background

CEB's normal practice is to revise the Long Term Generation Expansion Plan (LTGEP) every year. This plan, is the result of intensive studies conducted by the staff of the Generation Planning Branch of the CEB. A coordinating committee representing the Power Stations, System Operations, Generation Projects and other units in various divisions of the CEB meets during the study period to review the study inputs and the findings.

The demand forecast used in the studies is obtained from the Long Term Electricity Demand forecast prepared by the Tariff Branch (formerly the Load Forecasting and Tariff Branch) of CEB. Operating information about the existing generating plants are obtained from records maintained by the Generation Planning Branch and the individual power stations. Certain operational information and system limitations are obtained from the System Control Centre of CEB. Data pertaining to candidate thermal and hydro plants which are considered for system additions are obtained from pre-feasibility

and feasibility studies commissioned by the CEB in the recent past. In 1995 the cost data base used in the expansion studies was updated under the Thermal Generation Options Study [7] and again updated in 1997 during the review of the last year's least cost generation plan [13].

All these information are then used to derive a set of feasible generation expansion sequences using state of the art computer models widely used by many power utilities in the region. Each of the scenarios presented in Chapter 8 of this report is a least cost generation expansion sequence derived under a set of pre-defined input information and constraints.

Results of this study, together with the demand forecasts at the regional level are subsequently used in preparing the Long Term Transmission Plan.

1.2 Main Objectives

The main objectives of the generation planning studies conducted by the CEB are the following:

a) Conduct system simulation studies to determine the economically optimum mix of generating plants to meet the forecast demand and the acceptable reliability levels in the 20-year period ahead.

b) Investigate the robustness of the economically optimum plan by analyzing its sensitivity to changes in the key input parameters.

CHAPTER 2
BACKGROUND

2.1 Country Profile

Sri Lanka is an island situated in the Indian Ocean near the Southern tip of the Indian subcontinent. It has an area of 64,455 square kilometers and a population of 18.3 million (in 1996). Sri Lanka has tropical climatic conditions with two distinct rainy seasons fed from Southwest and Northeast Monsoons which are active from May to September and November to February respectively. There is only a small variation in temperature throughout the year due to Sri Lanka's close proximity to the equator. The average temperature varies between about 23 °C and 29 °C except in some parts of the central mountainous region, where the average is about 20 °C. A geographical map of Sri Lanka is shown in Figure 2.1, which shows the major rivers as well.

2.2 The Economy

Sri Lanka's Economy recovered from its weak performance in 1987-1989 to register a GDP growth rate of 6.2% in 1990 but declined again to 4.6% in 1991 and to 4.3% in 1992. It increased again to 6.9% in 1993 and to 5.6% in 1994 but has declined again to a recorded minimum of 3.8% in 1996. Table 2.1 shows the economic indicators over the past few years.

Table 2.1 Economic Indicators for Sri Lanka

Item	1989	1990	1991	1992	1993	1994	1995	1996
Rate of growth - GDP *	2.3	6.2	4.6	4.3	6.9	5.6	5.5	3.8
Rate of growth - GNP *	2.2	6.6	4.6	4.4	7.7	5.3	6.0	3.1
GDP Per Capita * Rs.	7,243	7,606	7,839	8,101	8,558	8,915	9,273	9,515
GDP Per Capita ** Rs.	13,575	17,102	19,563	22,235	25,716	29,292	33,035	37,998
** US$	377	427	473	507	533	593	645	687
*** US$	416	473	522	557	588	656	719	760

* Constant 1982 prices
** Current Factor cost Prices
*** Market Prices

Source: Annual Reports, Central bank of Sri Lanka [1]

As a major share of investment cost in power generation is foreign, the value of Sri Lankan Rupee (Rs) against the major currencies is of significance to the economy as well as to CEB. The variation in exchange rate against US Dollar (US$) during the last two decades is shown in Table 2.2. There has been a steady decline in the value of the Sri Lankan Rupee where its value against the US Dollar has almost halved over the last 10-12 years.

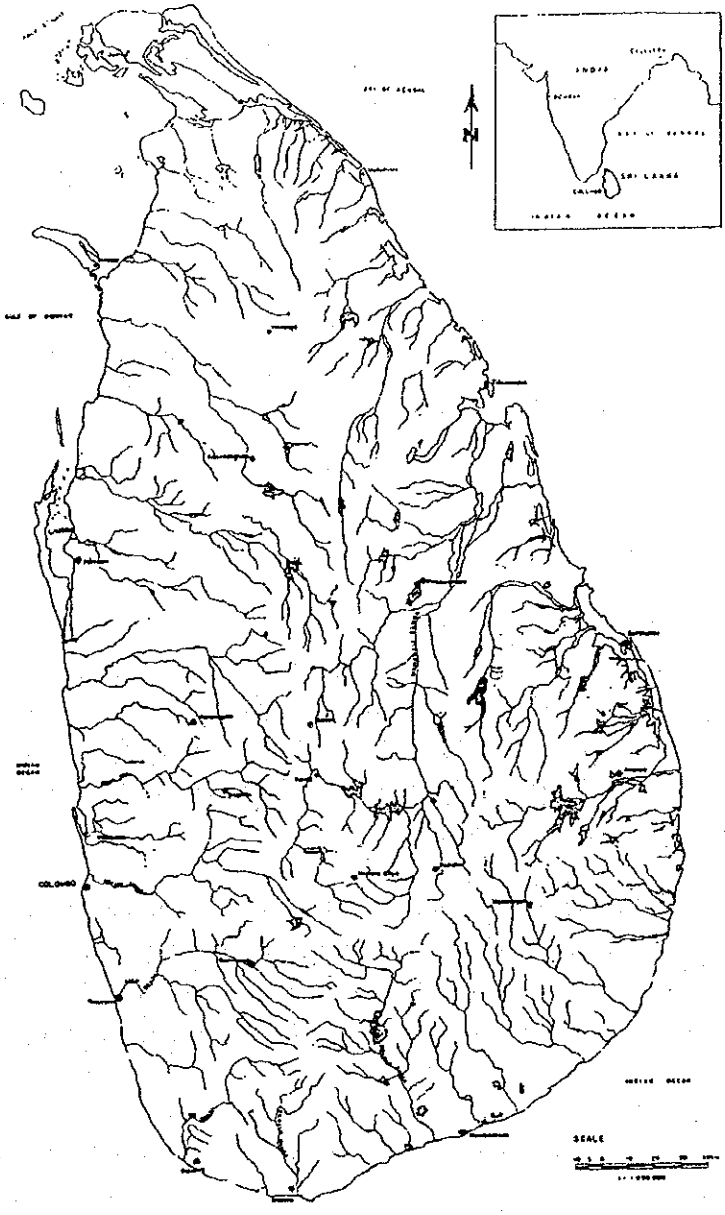


Figure 2.1 Geographical Map of Sri Lanka

Table 2.2 The Variation in Exchange Rate of Sri Lankan Rupee Against US Dollar

(average for each year)

Year	77	78	79	80	81	82	83	84	85	86
Rs/US$	15.56	15.51	15.45	18.00	20.55	21.32	25.00	26.28	27.41	28.52
Year	87	88	89	90	91	92	93	94	95	96
Rs/US$	30.76	33.0	36.05	40.06	41.37	43.83	48.25	49.42	51.25	55.27

Note : In November 1977 the Sri Lanka Rupee was officially devalued.

Source: Annual Reports, Central Bank of Sri Lanka [1]

2.2.1 Economic Projections

According to the Public Investment Program (PIP) of 1997, the GDP growth rate in 1998 is forecast to be 6.5% (in real terms). The growth rate is expected to increase in steps of 0.5% thereafter upto the year 2001 as shown in Table 2.3.

Table 2.3 Forecast of GDP Growth Rate in Real Terms

Item	1995*	1996*	1997	1998	1999	2000	2001
Forecast Rate of growth - GDP	5.5	3.8	6.0	6.5	7.0	7.5	8.0

* 1995 & 1996 are actual values

Source: Public Investment Programme, 1997-2001, Dept. of National Planning [8]

2.3 Energy Sector

2.3.1 Energy Supply

Hydro power is the main indigenous source of primary *commercial* energy in Sri Lanka with an estimated potential of about 2000 MW. More than half of this has already been harnessed and it is found that further exploitation of hydro resources may be increasingly difficult due to impacts on the environment and the eco-system of the country.

Sri Lanka has no proven reserves of fossil fuels and all fossil fuel requirements are imported. A small quantity of Peat has been located in the vast extent of marshy lands to the North of Colombo. However, a feasibility study conducted in 1989 [2] has indicated that the quality and extent of the reserve could not prove to be commercially viable for extraction and use as a source in power generation.

Therefore, the major indigenous primary energy sources (including both commercial and non-commercial sources) are;

(a) Hydro electricity, and
(b) Fuelwood and other biomass

Crude Oil is the main primary energy import while small quantities of coal and refined petroleum products, particularly diesel, and kerosene are also imported.

In 1995, the per capita consumption in terms of primary energy supplied to the country, including traditional non-commercial sources, was 0.353 toe per person (1 toe = 10 Gcal). There has been no appreciable change in the per capita consumption when compared with that of the previous year which amounted to 0.342 toe. The breakdown of the gross supply of primary energy is shown in Figure 2.2. Please note that hydro electricity is adjusted to reflect the energy input required in a thermal plant to produce the equivalent amount of electricity.

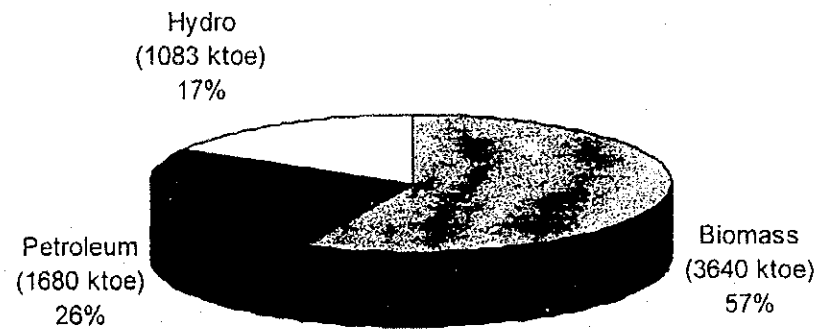


Figure 2.2 The Share of each Primary Source of Energy in the Gross Energy Supply in Sri Lanka (1995)

Source: Energy Conservation Fund, Sri Lanka [14]

Note: toe denotes tonnes of oil equivalent (1 toe = 10 GCal)
Contribution of coal (1.11 toe) was negligible in 1995

2.3.2 Energy Demand

The consumption of Energy by sectors is shown in Figure 2.3. It can be seen that when traditional sources are included, the household and commercial sector becomes the largest consuming sector of Energy consisting of fuelwood (3260 ktoe), kerosene (5 ktoe), electricity (187 ktoe) and Liquefied Petroleum Gas (LPG), (73 ktoe). Due to the poor conversion efficiency of fuelwood, the composition of the net (or useful) energy consumption in the domestic sector could be different from the above. On the other hand, fuelwood, being the cheapest and most easily accessible source of energy, dominates the domestic sector consumption.

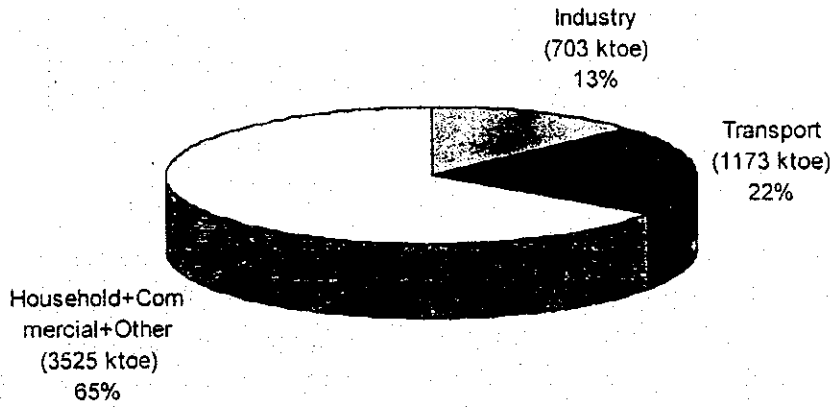


Figure 2.3 Gross Energy Consumption by Sectors Including Non-Commercial Sources (1995)

Note: toe denotes tonnes of oil equivalent, 1 ktoe = 10 Tcal

Crude oil which is imported is refined in the country's own refinery at Sapugaskanda. Electricity generated in the hydro and thermal plants is transmitted and distributed throughout the country by the national grid. Even though fuelwood is largely traded in urban and suburban areas it is still classified as a non-commercial form of energy.

2.4 Electricity Sector

Electrical energy requirement in the country has been growing at rates close to 10% in the recent years [9.7%(1994), 9.6%(1995)]. However, it has dropped to a recorded minimum of 2.7% (or -5.3% without adjusting for power cuts) in 1996 due to the worst ever power curtailments experienced by the system in that year. Table 2.4 shows the electricity generation and peak demand over the past ten years (1987-1996). Electricity generation has been growing at an average rate of 6.8% over the last 10 years.

Table 2.4 Electricity Generation, Peak Demand and Their Annual Growth Rates

Year	Actual Generation		Peak Demand	
	(GWh)	Growth	(MW)	Growth
1987	2707	2.1%	570	5.6%
1988	2800	3.4%	594	4.2%
1989	2858	2.1%	618	4.0%
1990	3149	10.2%	640	3.6%
1991	3376	7.2%	685	7.0%
1992	3540*	4.9%	742	7.7%
1993	3979	12.41%	812	9.4%
1994	4365	9.7%	910	12.1%
1995	4782	9.6%	980	7.7%
1996	4911**	2.7%	968	-1.2%
5 year average growth		8.5%		6.9%
10 year average growth		6.8%		6.0%

* Including estimated 46 GWh curtailed by power cuts in 1992

** Including estimated 381.3 GWh curtailed by power cuts in 1996

Figure 2.4 shows the growth rates of generation and peak demand over the last 21 years. The year 1983 and 1987-1989 period have very low growth rates both in generation and peak demand mainly due to the civil disturbances that prevailed during those years. Peak demand has the lowest recorded growth rate of -1.2% in 1996. The growth in electricity demand has a very similar pattern when compared to that of GDP as seen in Figure 2.5.

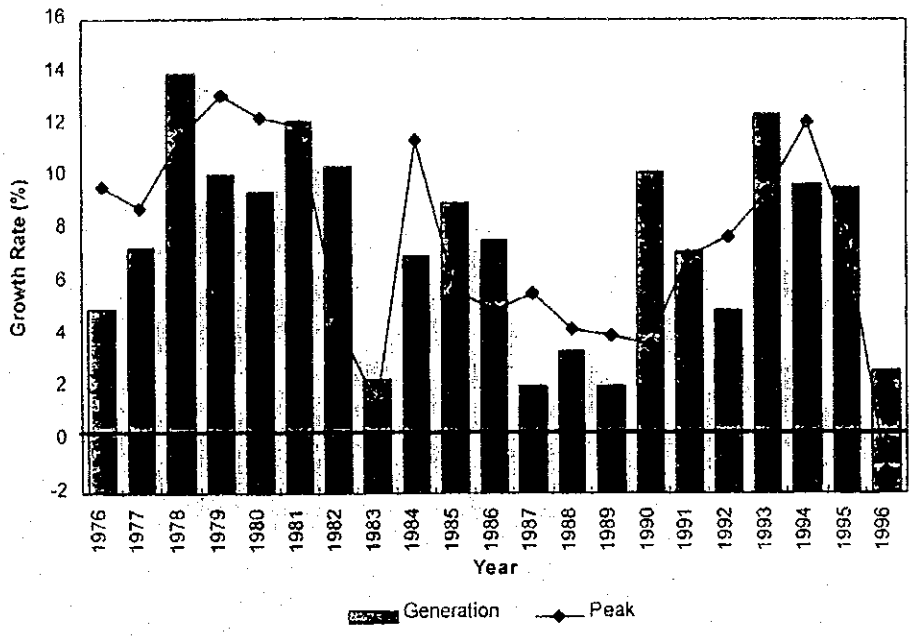
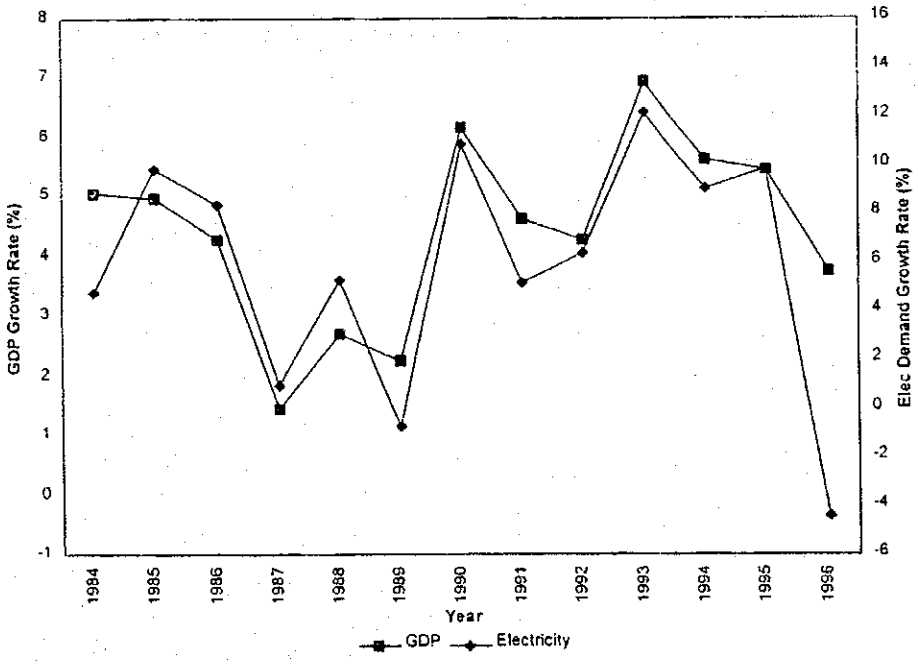


Figure 2.4 Growth Pattern of Electricity Generation and Peak Demand



Note: Two axes with different scales are used to show the relationship better.

Figure 2.5 Growth Rates of GDP and Electricity Sales in the Recent Past

2.4.1 Sectoral Consumption of Electricity

The distribution of sectoral electricity consumption for 1996 is shown in Figure 2.6. It should be noted that most of the electricity sold through Licencees (local authorities) such as Municipalities, city councils etc. was consumed in the domestic sector. It could be noted that the share of domestic consumption has risen significantly during the last few years. As explained in Chapter 4.1.2, this

apparently large increase in the share of domestic consumption (as shown in CEB's statistics) is partly due to the gradual transfer of the distribution systems managed by local authorities to CEB under the Local Authority Taking Over Project, and rapid rural electrification programs. This could also be seen by comparing the share of licensees in electricity sales during the recent years.

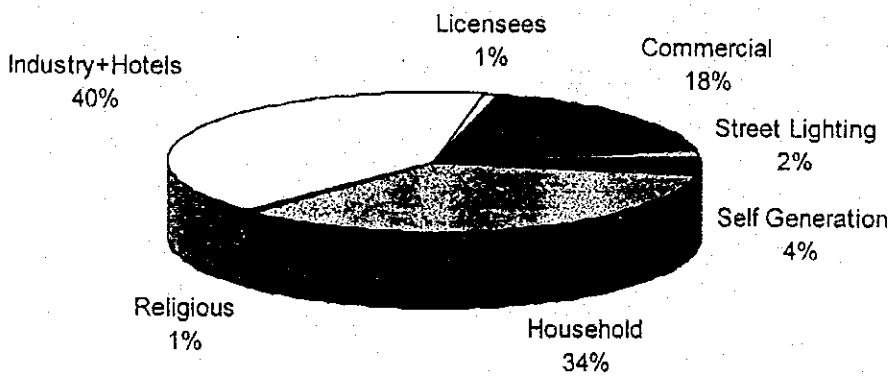


Figure 2.6 Sectoral Consumption of Electricity (1996)

Licensees = Local Authorities

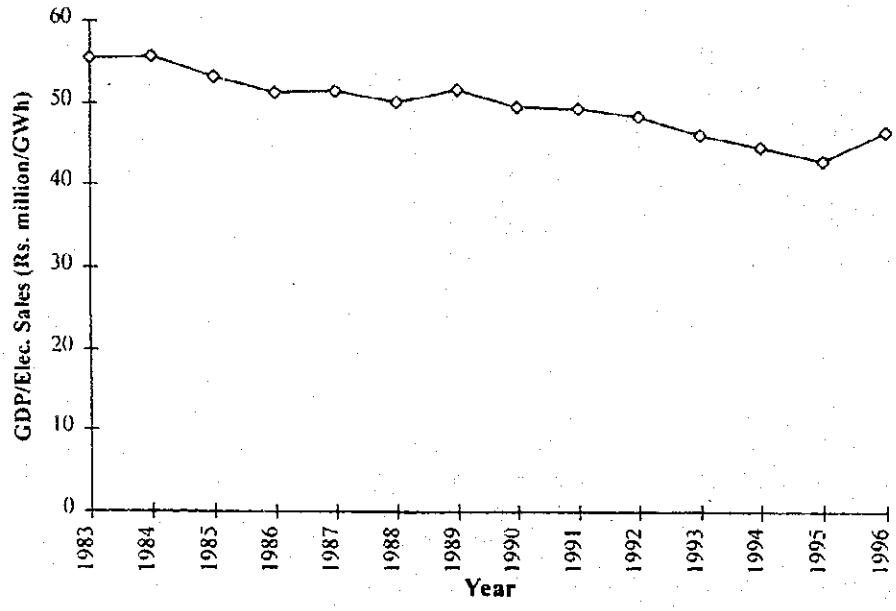


Figure 2.7 GDP-Electricity Index

GDP in constant 1982 terms

Electricity sold in GWh

The GDP-Electricity index has declined over the years as shown in Figure 2.7. The sudden increase in 1996 could most probably be due to the low value recorded for electricity sales in that year as a result of the power cuts.

CHAPTER 3

THE EXISTING GENERATING SYSTEM

Until 1996, Sri Lanka electricity demand was met by the CEB owned hydro and thermal generating plants. Since 1996, private sector too participated in power generation. Existing CEB power generating system is described below.

3.1 Hydro Generation

The CEB existing generating system is predominantly based on Hydro Power. Seventy four percent of the total system capacity (i.e. 1135 MW) is installed at 15 hydro power stations. In 1996, only 71.8% of the total energy demand was met by the hydro plants, compared to 94% in 1995[17] .

Table 3.1 summarizes the Electricity Generation during the last fifteen years and figure 3.1 shows the CEB hydro-thermal and Independent Power Producers (IPP) energy share graphically. It clearly shows the cyclic nature of the occurrence of the drought periods during the past few years. Details of the existing hydro system are given in Table 3.2, whereas the geographical locations of the Power Stations are shown in the Figure 3.2.

Table 3.1 - Electricity Generation 1982 – 1996

Year	Hydro Generation		Thermal Generation		Self Generation		Total
	GWh	%	GWh	%	GWh	%	GWh
1982	1608	77.8	458	22.2	-	-	2066
1983	1217	57.6	897	42.4	-	-	2114
1984	2091	92.5	170	7.5	-	-	2261
1985	2395	97.2	69	2.8	-	-	2464
1986	2645	99.7	7	0.3	-	-	2652
1987	2177	80.4	530	19.6	-	-	2707
1988	2597	92.8	202	7.2	-	-	2799
1989	2801	98.0	57	2.0	-	-	2858
1990	3144	99.8	5	0.2	-	-	3149
1991	3116	92.3	260	7.7	-	-	3376
1992	2900	81.9	640	18.1	-	-	3540
1993	3796	95.4	183	4.6	-	-	3979
1994	4089	93.2	275	6.3	22.2	0.5	4386
1995	4514	94.0	269	5.6	17	0.4	4800
1996	3249	71.8	1126	24.9	152	3.4	4527
10 year Average	3283	90.0	354.7	9.6	-	-	3612

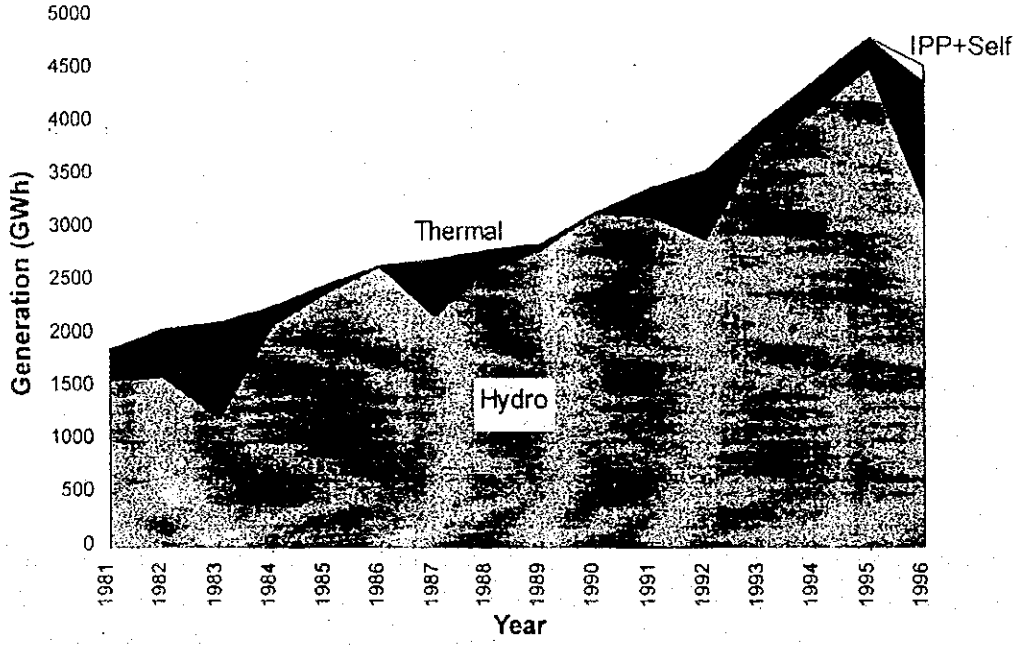


Figure 3.1 - Hydro-Thermal Share in the Recent Past

The major hydro power schemes already developed are associated with Kelani and Mahaweli river basins. Five hydro power stations with a total installed capacity of 335 MW have been built in two cascaded systems associated with the two main tributaries of Kelani River; Kehelgamu Oya and Maskeliya Oya (KM Complex). The five stations in this complex have no significant irrigation or other water requirements, hence they are primarily designed to meet the power requirements of the country. Castlereigh and Moussakelle are the major storage reservoirs under the KM hydro power complex. Castlereigh reservoir with a storage of 43.2 MCM feeds the Wimalasurendra Power Station of capacity 2 x 25 MW, while Canyon (2 x 30 MW) is fed from the Moussakelle reservoir of storage 120.5 MCM. Canyon, Norton and Laxapana ponds (so referred because of their smaller size) feed New Laxapana, Old Laxapana and Polpitiya power stations respectively.

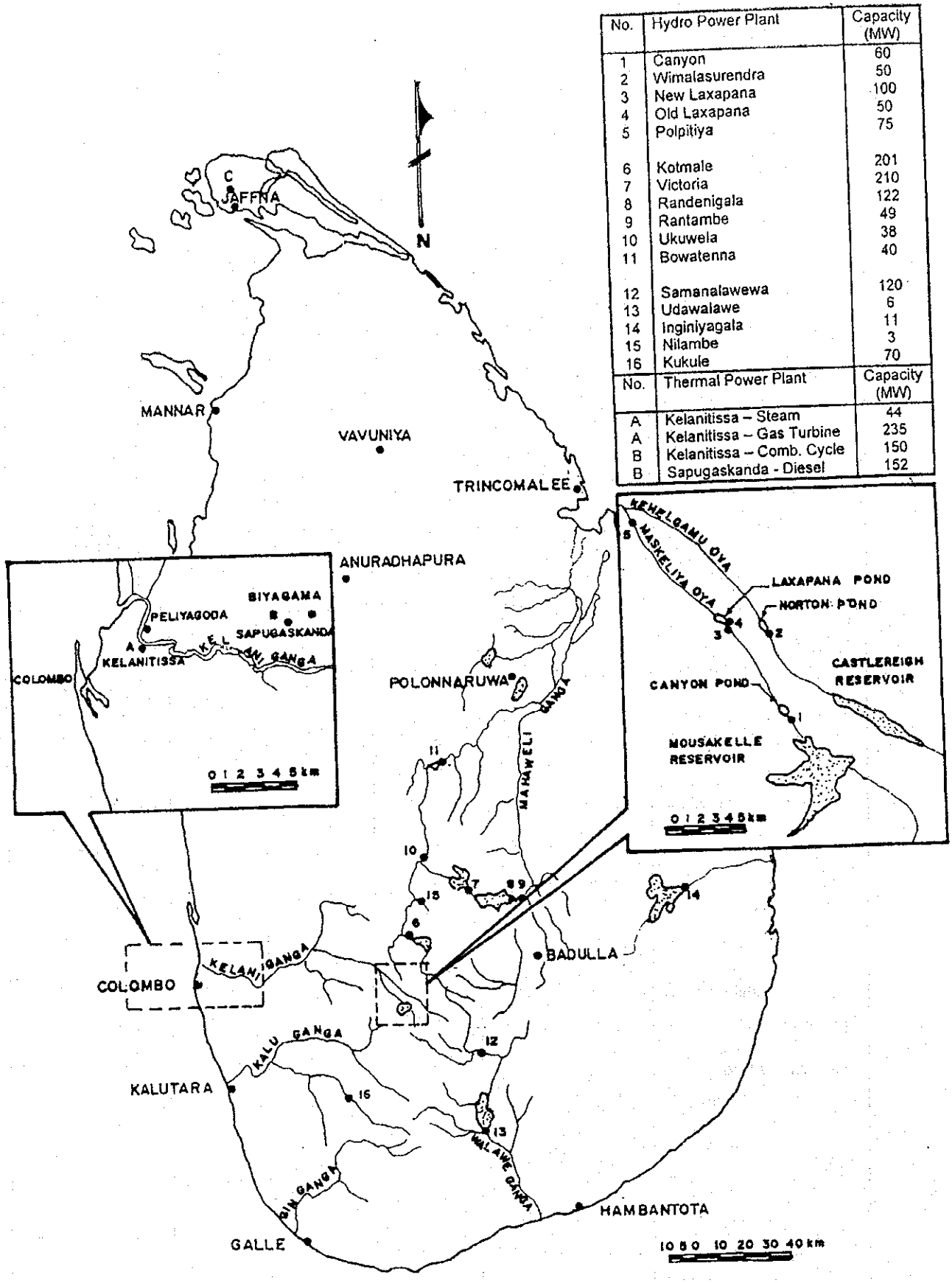
The development of the major hydro-power resources under the accelerated Mahaweli project added six hydro power stations (*Ukuwela, Bowatenna, Kotmale, Victoria, Randenigala and Rantambe*) to the national grid with a total installed capacity of 660 MW. Three major reservoirs, *Victoria, Kotmale and Randenigala*, were also built under the Mahaweli development program. Polgolla diversion weir (across Mahaweli Ganga), downstream of Kotmale and upstream of Victoria, diverts Mahaweli waters to irrigation systems via Ukuwela power station (38 MW). After generating electricity at Ukuwela power station the water is discharged to Sudu Ganga which carries water to Bowatenna reservoir. It then feeds both Bowatenna power station (40 MW) and Mahaweli System-H by means of separate water ways. Water discharged through Bowatenna power station goes to Elahera Ela and is available for diversion to Mahaweli systems D and G. The schematic diagram of the hydro reservoir network is shown in Figures 6.1 and 6.2 in Chapter 6.

Unlike the Laxapana cascade, the Mahaweli system is operated as a multi-purpose system. Hence power generation from the associated power stations is governed by the down-stream irrigation requirements as well. These requirements being highly seasonal constrain the operation of power stations during certain periods of the year.

Table 3.2 Existing and Committed Hydro Power Plants

HYDRO PLANT	INSTALLED CAPACITY (MW)		AVERAGE FLOW	ELECTRICITY GENERATION (GWh/year)		COMMISSIONING
	Units x Capacity		(m^3/s)	Average Historic	Long Term Expected	
Laxapana (KM) Complex						
Canyon	2 x 30	60	12.7	137.3	162	Unit 1 Mar 1983 Unit 2 1988
Wimalasurendra	2 x 25	50	7.6	122.1	113	Jan 1965
Old Laxapana	3 x 8.33 2 x 12.5	50	9.1	260.8	289	Dec 1950 Dec 1958
New Laxapana	2 x 50	100	16.2	465.8	481	Unit 1 Feb 1974 Unit 2 Mar 1974
Polpitiya	2 x 37.5	75	9.1	396.8	404	Apr 1969
Laxapana Total		**335**		**1382.8**	**1449**	
Mahaweli Complex						
Victoria	3 x 70	210	57.3	663.7 (1985-96)	735	Unit 1 Jan 1985 Unit 2 Oct 1984 Unit 3 Feb 1986
Kotmale	3 x 67	201	30.8	445.13 (1988-96)	495	Unit 1 Apr 1985 Unit 2 Feb 1988 Unit 3 Feb 1988
Randenigala	2 x 61	122	75.3	326.4 (1987-96)	381	Jul 1986
Ukuwela	2 x 19	38	34.1	164.4	164	Unit 1 Jul 1976 Unit 2 Aug 1976
Bowatenna	1 x 40	40	48.2	48.8 (1995-96)	50	Jun 1981
Rantambe	2 x 24.5	49	94.1	189.1 (1991-96)	223	Jan 1990
Mahaweli Total		**660**		**1745**	**2048**	
Samanalawewa	2 x 60	120	17.3	277.3 (1993-96)	361	Oct 1992
Small Hydro Plants						
Inginiyagala	2x2.475+2 x 3.15	11	n.a.	26.8	n.a.	Jun 1963
Uda Walawe	3 x 2	6	n.a.	7.6	n.a.	April 1969
Nilambe	2 x 1.6	3	n.a.	11.6 (1989-96)	n.a.	July 1988
Small Hydro Total		**20**				
Under Construction						
Kukule	2 x 35	70	30.4	-	306	Jan 2002
Total		**1205**			**4091**	

Note: - Historic average electricity is given for 1984-96, unless stated otherwise



No.	Hydro Power Plant	Capacity (MW)
1	Canyon	60
2	Wimalasurendra	50
3	New Laxapana	100
4	Old Laxapana	50
5	Polpitiya	75
6	Kotmale	201
7	Victoria	210
8	Randenigala	122
9	Rantambe	49
10	Ukuwela	38
11	Bowatenna	40
12	Samanalawewa	120
13	Udawalawe	6
14	Inginiyagala	11
15	Nilambe	3
16	Kukule	70

No.	Thermal Power Plant	Capacity (MW)
A	Kelanitissa – Steam	44
A	Kelanitissa – Gas Turbine	235
B	Kelanitissa – Comb. Cycle	150
B	Sapugaskanda - Diesel	152

Figure 3.2 Location of Existing and Committed Power Stations

Samanalawewa hydro power plant of capacity 120 MW was commissioned in 1992. Samanalawewa reservoir which is on Walawe river and with a storage of 278MCM feeds this power plant.

The contribution of the three small hydro plants (Inginiyagala, Uda Walawe and Nilambe) to the National Grid is small and dependent on irrigation water releases from the respective reservoirs.

Kukule power project for which the funds are available from Overseas Economic Cooperation Fund (OECF) of Japan is considered as committed in the present study. This project is run-of river type located on Kukule Ganga, a tributory of Kalu Ganga. Kukule power plant of capacity of 70 MW is expected to provide an average 306GWh of energy per year and is scheduled to be commissioned in 2002.

3.2 Thermal Generation

In 1996, thermal energy accounted for 24.9% of the total generation compared to 4.6%, 6.3% and 5.6% in 1993, 1994 and 1995 respectively. Kelanitissa 6 x 18 MW gas turbines are under rehabilitation. At the completion of the refurbishment in early 1998, the capacity of GT's will be increased to 6 x 20 MW. The refurbishment of 4 x 18 MW diesel plants at Sapugaskanda will also be completed in early 1998. The availability of the machines will be increased to 80% after the refurbishment. A gas turbine of capacity 115 MW was added to the power system in July 1997. This 115MW plant is the single largest unit now operating in the system. Diesel plant with 4 x 10MW, funded by the ADB was commissioned at Sapugaskanda in August 1997. With the addition of these two plants, thermal installed capacity of CEB has been increased to 405 MW.

Diesel power plant of 4 x 10 MW capacity funded by kfw of Germeny is expected to be commissioned in early 1999 at Sapugaskanda. A combined cycle power plant with capacity 150MW funded by OECF, will be added to the system in year 2000. This plant will be located at Kelanatissa. The gas turbine part of the combined cycle is expected to be commissioned in 1999. In the present study these two projects, diesel and combined cycle are considered as committed.

The CEB total installed thermal capacity, of 405 MW (name plate rating) is now derated to 391 MW and is made up of as follows.

Kelanitissa Gas Turbines	235 MW
Kelanitissa Steam	(originally 50 MW, now delivering only 44 MW) and
Sapugaskanda Diesel	(originally 120 MW, now derated to 112 MW)

Small thermal plants at Chunnakam (14 MW Diesel) and Kankesanturai (7 MW Gas Turbine) are not presently in operation. Details of the existing and committed thermal plants are shown in Table 3.3 whereas their technical specifications are given in the Annex 3.

Table 3.3 - Details of Existing and Committed Thermal Plants

Plant	Capacity	Commissioned		Remarks	Average Annual Plant Factor
	Units x MW	Unit	Date		
Kelanitissa Gas Turbines	6 x 20 (6 x 18 MW before refurbishment)	1	Nov 80	Recommissioned in 1998 after rehabilitation.	12.56 (1984 - 1996)
		2	Mar 81		
		3	Apr 81		
		4	Dec 81		
		5	Apr 82		
		6	Mar 82		
	1 x 115	1	Aug 97		-
Kelanitissa Steam	2 x 22 (originally 2 x 25 MW)	1	Jun 62	Recommissioned in 1991 after rehabilitation. To be retired by end 2000	29.63 (1991 - 1996)
		2	Sep 63		
Sapugaskanda Diesel	4 x 18 (originally 4 x 20 MW)	1	May 84	Recommissioned in 1991 after rehabilitation. To be retired by end 2004 and end 2008 2 units each year	15.23 (1984 - 1996)
		2	May 84		
		3	Sep 84		
		4	Oct 84		
Sapugaskanda Diesel Ext. (ADB)	4 x 10	5, 6, 7, 8	Sept 97	-	-
Sapugaskanda Diesel Ext. (kfw)	4 x 10	-	Early 1999	-	-
Kelanatissa Combined Cycle Plant	1 x 150	-	-	100MW GT part will be commissioned in 1999 and plant will be completed in 2000	-

3.3 Independent Power Producers (IPP)

An Independent Power Producer, Lakdhanavi (Pvt) Ltd. commissioned a diesel power plant in December 1997 on Build, Operate and Own (BOO) basis. This plant of capacity 22.5MW and with Minimum Guaranteed Energy per Annum (MEGA) 156 GWh runs on residual oil. Another private power plant by Asia Power (Pvt.) Ltd. (KHD), which is under construction, is scheduled to be commissioned in 1999. This plant with a MGEA of 330 GWh will also operate on BOO basis. In addition four other small power producers; Hydrotech Lanka Dickoya (Pvt.) Ltd., Talawakelle Tea Factory, Ritigala Tea Factory and Seethaeliya Tea Factory connected to the CEB system small/micro hydro plants in 1996 and 1997 with capacities of 960kW, 112kW, 112kW and 108kW respectively.

3.4 Transmission System

The Sri Lankan transmission system presently operates at voltages; 220kV and 132kV. The 90% of the total 1850 km of transmission lines will operate at 132kV and the balance operates at 220kV.

The 220kV system was constructed for the bulk transmission of Mahaweli power to the load centers in the Western coastal region. The main receiving station of Mahaweli Power is located at Biyagama in the suburbs of Colombo. Apart from the Biyagama - Kotugoda line, which operates at 220kV, rest of the outgoing lines from Biyagama operate at 132kV.

Kolonnawa Grid Sub Station, located close to the main load center (Colombo) is the main receiving station of power from the Laxapana Complex. These two main receiving stations are inter-connected through Pannipitiya and Kelanitissa grid sub stations for higher system reliability.

The locations of the existing and proposed grid sub stations and high voltage lines of the Sri Lankan power system are shown in Figure 3.3.

3.5 Summary of Existing Plant Data

Informations about existing and committed generating plants, as input to the 1997 Expansion Planning Studies, are summarized in Tables 3.4 and 3.5. The operation and maintenance costs of all hydro power plants is taken as 3.84 US$/kW per annum. The fuel costs of existing thermal plants, calculated using the prevailing market prices are given in Table 3.6.

Table 3.4 Characteristics of Existing and Committed Hydro Plants

Hydro Project	Installed Capacity (Units x MW)	Annual Energy Expected (GWh)	Storage (MCM)
Canyon	2 x 30	162	123.4
Wimalasurendra	2 x 25	113	44.8
New Laxapana	2 x 50	481	1.2
Old Laxapana	[3 x 8.33		
	2 x 12.5]	289	0.4
Polpitiya	2 x 37.5	404	0.4
Kotmale	3 x 67	494	172.6
Victoria	3 x 70	735	721.2
Randenigala	2 x 61	381	875.0
Rantambe	2 x 24.5	223	21.0
Ukuwela	2 x 19	164	1.2
Bowatenna	1 x 40	50	49.9
Samanalawewa	2 x 60	361	1.0
Kukule (committed)	2 x 35	306	1.7

Table 3.5 Characteristics of Existing and Committed Thermal Plants

Name of Plant	Units	Kelanitissa				Sapugaskanda	
		Gas Turbine 20MW Units	Gas Turbine 115MW Unit	Oil Steam	Combined Cycle Plant	Diesel	Diesel (Extension)
Number of Sets		6	1	2	1	4	8
Unit Capacity	MW	20	115	22	150	18	10
Heat Rate at Full Load	kCal/kWh	3588	2857	3094	1865	2346	1954
Fuel Type		Auto Diesel	Auto Diesel	Furnace Oil	Auto Diesel	Residual Oil	Residual Oil
Fuel Cost	USCts/GCal	1654	1654	1180	1654	943	943
Full Load Efficiency	%	24.0	30.1	27.8	46.1	36.7	44.0
Forced Outage Rate	%	20	8	20	8	10	15
Scheduled Maintenance	Days/Year	40	30	40	30	40	30
Fixed O&M Cost	$/kWmonth	0.254	0.38	1.017	0.351	0.593	1.598
Variable O&M Cost	USets/kWh	0.237	0.34	0.169	0.3	1.020	0.684

All costs are in January 1997 US$ border prices.

Note:

KELANITISSA (Gas Turbines) - Retirement of 20 MW units will not occur during planning period. 115 MW plant in operation from August 1997.

KELANITISSA (Steam sets) - to be retired by end of 2000.

SAPUGASKANDA (Diesel) - to be retired by end of 2004 and 2008, two units each year.

SAPUGASKANDA Diesel Ext. - 4 units commissioned in 1997 and other 4 units will be commissioned in early 1999.

Table 3.6 - Fuel Costs of Existing Thermal Plants

Plant Name	Unit Size MW	Fuel Type	Calorific Value (kCal/l)	Fuel Use at Full Load l/kWh	Actual Fuel Cost Rs/kWh
Kelanitissa Gas Turbines	20	Auto Diesel	9200	0.39	5.51
	115	Auto Diesel	9200	0.311	4.38
Kelanitissa Oil Steam	22	Furnace Oil 1000 s	9700	0.319	2.43
Sapugaskanda Diesel	18	Residual Oil 3500 s	9600	0.244	1.50
Sapugaskanda Diesel Ext. (ADB)	10	Residual Oil 3500 s	9600	0.204	-

Note :- The above costs are based on August 1997 market prices of fuel supplied by the Ceylon Petroleum Corporation.

CHAPTER 4
ELECTRICITY DEMAND

This chapter is devoted to the *long-term power and energy demand forecasts* used for the present studies; the data used to derive the forecasts are also described.

4.1 Economic Growth and Electricity Demand

4.1.1 Review of the Electricity Demand

In 1996, the unfavourable weather conditions that prevailed in the catchment areas had a negative impact on the Sri Lankan energy sector. The total electricity generation reduced to 3249GWh compared to 4514 GWh in 1995 and 4809 GWh in 1994.

The historic development of the electricity sales from 1977 to 1996 is given in Table 4.1. The share of electricity consumption in domestic sector served directly by the CEB steadily increased from 10.2% of total sales in 1977 to 28.6% of total sales in 1996. This can be attributed to extensive rural electrification work undertaken by the CEB and also the transfer of Local Authorities to CEB. The share of industrial consumption in the same period has dropped from 50 % of total sales to 38 % of total sales while consumption in the commercial sector has increased its share from 14.2% to 16.5%. From January 1994 most of the hotels consumption is included in the industrial sector. Further, Table 4.1 does not include the breakdown of consumption by categories in LECO and Local Authorities. Therefore, above sectoral consumption may not reflect the actual situation.

The electricity generation of CEB for the year 1996 was 4377 GWh, a decrease of 8.5% over the 1995 generation of 4783 GWh.

4.2 Load Forecast

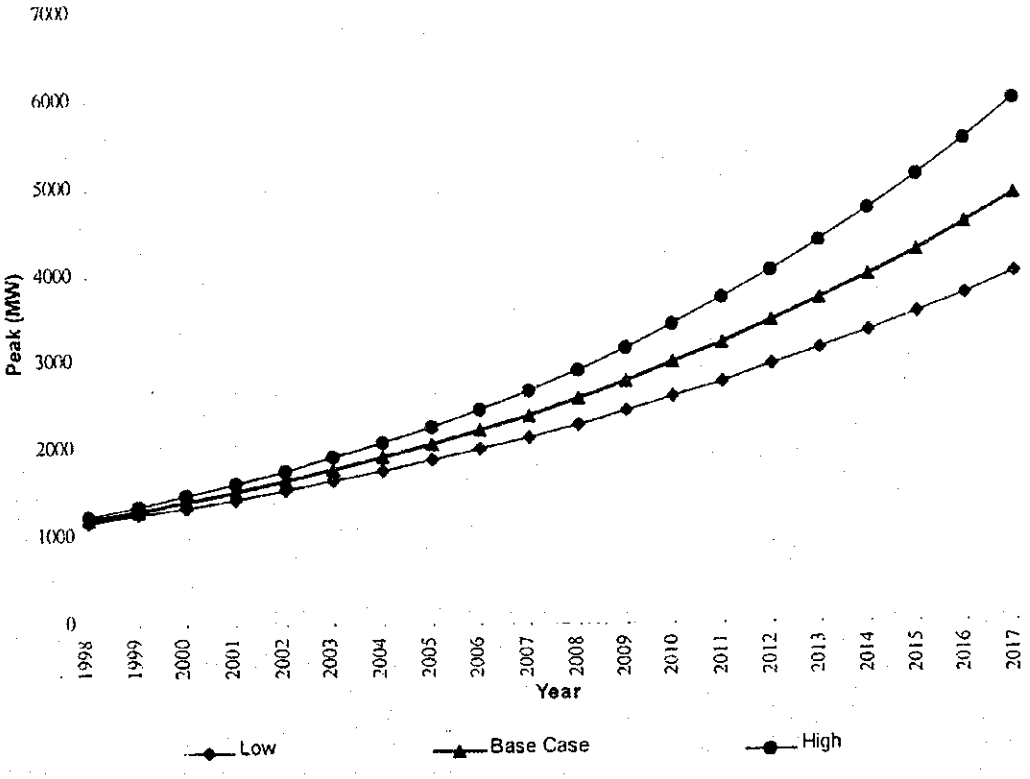
The base load forecast with an average growth of 8.1% prepared by the Load Forecasting and Tariff Branch of CEB [15] is used in the base case of the analyses. In order to analyse the effects of any variation in the demand forecast, two more demand forecasts were prepared with lower (7.1%) and higher (9.1%) growth rates. The base load forecast is tabulated in Tables 4.2, and low and high load forecasts are given in Annex 4. Figure 4.1 shows the graphical representation of the above three forecasts while a comparison of load forecasts prepared during the years 1993 to 1996 with the actual demand over 1987-96 is given in Figure 4.2.

Table 4.1: Electricity Sales in the Past Twenty Years

Year	Total Sales (GWh)	Per Capita Sales (kWh/Person)	Percentage of Energy Sales by Tariff Group			
			Domestic	Industry	Commerce	Other*
1977	1041	75	10.2	49.9	14.2	25.7
1978	1166	82	10.2	50.9	13.9	25.0
1979	1298	90	11.8	48.7	15.5	24.0
1980	1392	94	13.7	45.0	16.0	25.3
1981	1510	101	14.3	44.9	14.6	26.2
1982	1694	112	15.3	43.6	15.5	25.6
1983	1797	117	17.0	41.8	16.2	25.0
1984	1886	121	16.8	41.3	17.0	24.9
1985	2060	130	16.8	41.3	17.0	24.9
1986	2232	138	16.5	41.5	17.1	24.9
1987	2253	138	16.9	38.5	18.6	26.0
1988	2371	143	16.5	38.1	19.5	25.9
1989	2353	140	17.3	36.1	19.1	27.5
1990	2608	154	19.0	34.9	16.2	29.9
1991	2742	159	23.5	34.9	19.9	21.7
1992	2916	168	23.1	36.7	19.6	20.6
1993	3270	186	24.6	37.4	19.6	18.4
1994	3565	200	25.5	39.6**	16.9	18.0
1995	3915	216	25.9	39	16.1	19.0
1996	3588	204	28.6	37.9	16.5	17.0

* Includes bulk sales to Lanka Electricity Company and Local Authorities, some of which are gradually being taken over by CEB.

** Consumption by Hotels is included in the Industry from January 1994.



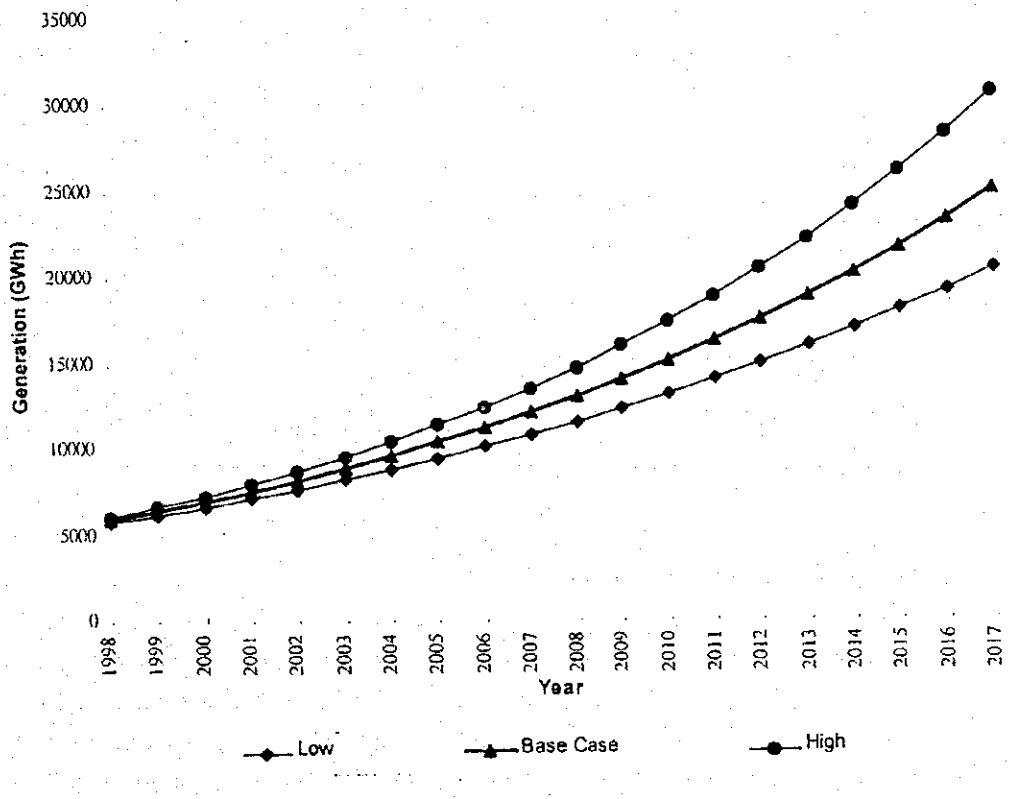


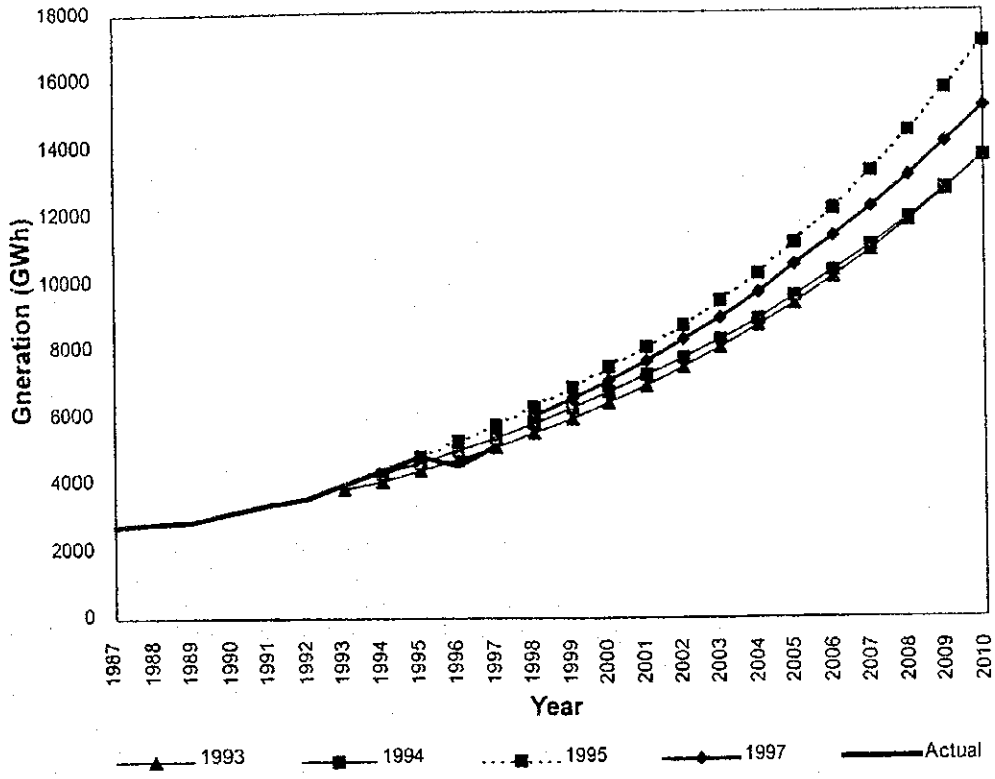
Figure 4.1 Peak Demand and Electricity Generation Forecasts 1997

Table 4.2 Base Case Scenario 1997
(Average annual growth rate = 8.1%)

Year	Sales (GWh)	Growth Rate (%)	System Losses (%)	Generation (GWh)	Load Factor (%)	Peak Demand (MW)
1998	4948	8.1	17.6	6005	56.3	1218
1999	5363	8.4	17.4	6493	56.5	1312
2000	5804	8.2	17.2	7010	56.7	1411
2001	6296	8.5	17.0	7586	56.9	1522
2002	6843	8.7	16.8	8225	57.1	1644
2003	7428	8.5	16.6	8906	57.3	1774
2004	8054	8.4	16.4	9634	57.5	1913
2005	8742	8.5	16.2	10432	57.7	2064
2006	9457	8.2	16.0	11258	57.9	2220
2007	10221	8.1	15.8	12139	58.0	2389
2008	11036	8.0	15.6	13076	58.0	2574
2009	11927	8.1	15.4	14098	58.0	2775
2010	12858	7.8	15.2	15163	58.0	2984
2011	13851	7.7	15.0	16295	58.0	3207
2012	14931	7.8	14.8	17525	58.0	3449
2013	16082	7.7	14.6	18831	58.0	3706
2014	17290	7.5	14.4	20199	58.0	3975
2015	18599	7.6	14.2	21677	58.0	4266
2016	19993	7.5	14.0	23248	58.0	4576
2017	21492	7.5	14.0	24991	58.0	4919

4.3 Load Duration Curve (LDC)

Load duration curves for the expansion analyses were developed using the half-hourly load data (generation figures) obtained from the System Control Centre of CEB. The normalised LDC[1] used in the present study (1997) is shown in Figure 4.3 and the monthly peak variation over the year is shown in Figure 4.4. It is assumed that monthly energy consumption is varied in proportion with the peak value, but the load factor remains the same throughout the year.



Note: See the effect of Power deficiencies in 1992 and 1996

Figure 4.2 Comparison of Past Demand Forecasts with Actual Demand

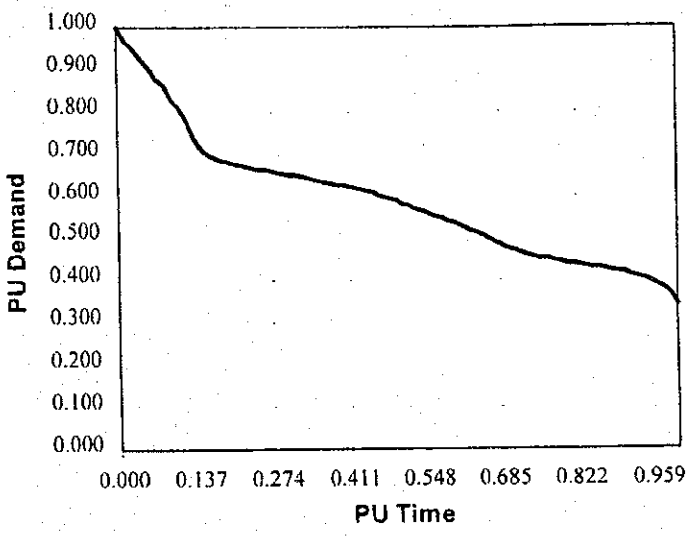


Figure 4.3 Normalised Load Duration Curve

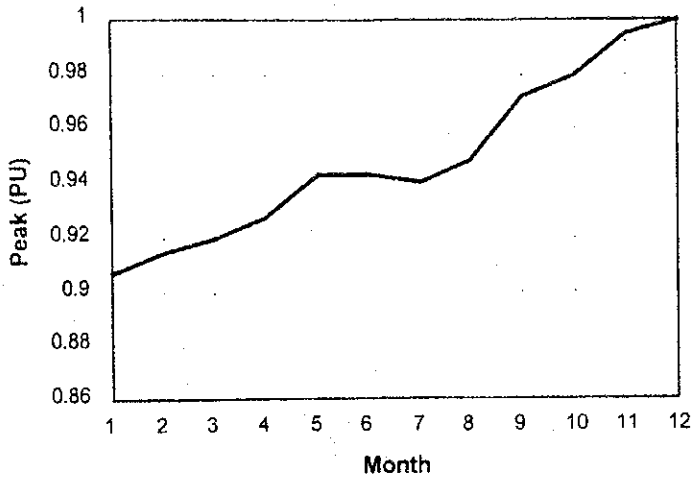
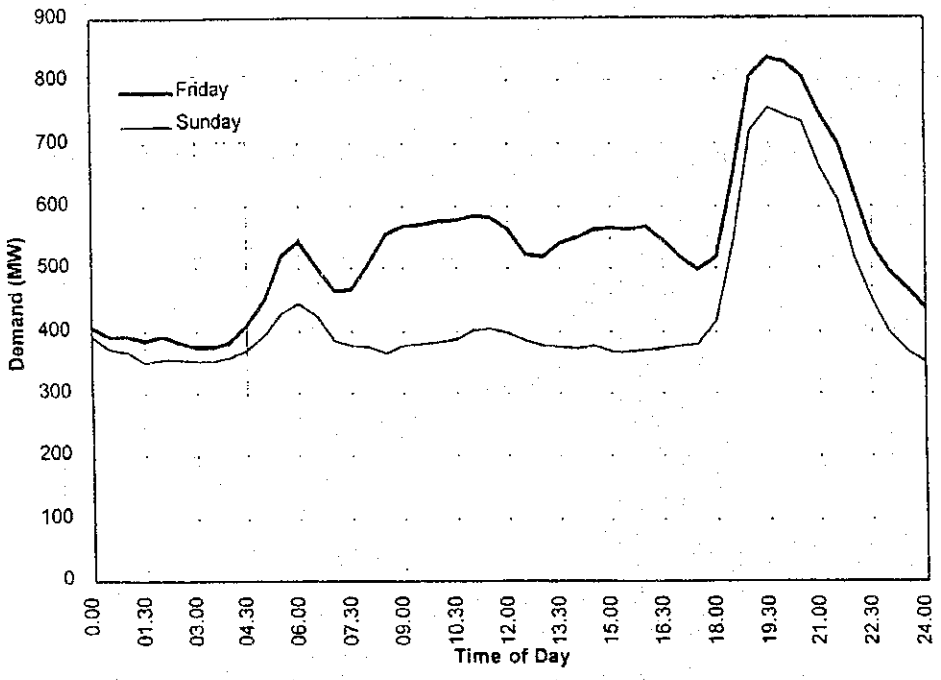


Figure 4.4 Peak Variation over the Months

Figure 4.5 shows Load Curves for a working day and a holiday, which gives an idea how the demand varies during different hours of the day.



Note: The curves were drawn using data before the time adjustment in 1996.

Figure 4.5 Load Curves for a Holiday and a Working day

Footnotes:

[1] First the half hourly load data for the year 1991 (8760x2 data points) are divided into twelve equal periods of 730 hours (having 1460 data points in each period). Then data in each period are arranged in the descending order and normalized curves were obtained by converting into per unit values. Out of each of those curves 74 equally spaced points were selected and averaged to get the *Normalized Monthly Average Load Duration Curve* which is normally referred to as Normalized LDC or the base LDC. This base LDC is then adjusted to have the required load factors in different years.

CHAPTER 5
FUTURE GENERATION OPTIONS

The following primary energy options could be considered in meeting the future electricity demand.

(a) Hydro
(b) Fossil fuel based thermal
(c) Nuclear based thermal
(d) New and Renewable

The suitability of these primary options are determined by a large number of factors, including,

(a) Costs of development and operation, and
(b) Technical considerations.

Each primary energy option available is discussed in this chapter. The costs and technical data of the Electric Power plants considered as candidates in the study are given in Table 5.3 and Table 5.4.

5.1 Hydro Options

5.1.1 The Background

Sri Lanka has developed 1115 MW of hydro capacity, capable of providing 3858 GWh of energy (on average) per year. This excludes the generation from small grid connected hydro stations at Inginiyagala, Uda-Walawe and Nilambe, contributing on average, 46.86 GWh per year.

Although, the country has over 100 river catchments, the climatic and topographical conditions are such that only seven of these have any significant hydro-electric potential. They are,

(i) Kelani Ganga and its tributaries
(ii) Mahaweli Ganga and its tributaries
(iii) Walawe Ganga
(iv) Kalu Ganga
(v) Gin Ganga
(vi) Nilwala Ganga
(vii) Maha Oya

The hydro potential of Kelani and Mahaweli river basins have already been developed but more potential remains to be developed, especially in Mahaweli, in its two major tributaries, Kotmala Oya and Uma Oya.

During a Masterplan Study [2] concluded in 1989, the remaining hydro potential in the country has been estimated. This is estimated to be approximately 870 MW in 27 sites capable of generating

electricity at a long-term average cost of less than 15 USCts/kWh (in 1988 prices). These new projects would be capable of generating 3680 GWh/year under average hydrological conditions.

5.1.2 Candidate Hydro Projects Considered

The expansion planning studies presented in this report have considered six prospective hydro projects as candidates. Locations of these candidate projects are given in Figure 5.1. The following criteria was adopted in selecting these hydro projects from the large number of hydro sites available.

(a) The candidate hydro projects identified and studied under the Masterplan Study, were taken as the basis for selection.

(b) Projects less than 15 MW were not considered as candidates.

(c) Whenever a feasibility study results are available for any prospective project, such results were used in preference to those of the Masterplan study. (Studies conducted under the Masterplan are considered to be at pre-feasibility level).

5.1.3 Available Studies on Hydro Potential

Following studies of selected prospective hydro sites have been completed.

(a) Feasibility study on the proposed *Upper Kotmale* Hydroelectric Power Development Project was completed in August 1987 with the assistance of the Japan International Cooperation Agency (JICA) [3]. The Engineering Services completed in June 1995 with the assistance of the Overseas Economic Cooperation Fund (OECF) [4] reviewed the 1987 study to select the best development strategy, prepared drawings and tender documents and also carried out the environmental impact assessment (EIA) study. The environmental clearance for the project is awaited.

(b) Feasibility study on the proposed *Broadlands* Hydroelectric Project was conducted in 1986 with the assistance of Central Engineering Consultancy Bureau (CECB) of Sri Lanka [5]. These cost estimates were subsequently updated by CECB in a special study in 1991 [5a].

(c) A Pre-feasibility study on *Uma Oya* Multi-purpose Project has been completed by the Central Engineering Consultancy Bureau of Sri Lanka in July 1991 [9] where the diversion of Uma Oya, a tributary of Mahaweli Ganga has been studied. The development proposed in the study is used as a candidate in the present expansion studies.

No.	Hydro Project	Master Plan Code	Capacity (MW)	Specific Cost (Rs/kWh)
1	Belihul Oya	BELI 015	17	4.55
2	Gin Ganga	GING 074	49	3.86
3	Morogolla	MAHW 235	27	5.72
4	Uma Oya	-	150	5.66
5	Broadlands	KELA 085	40	5.11

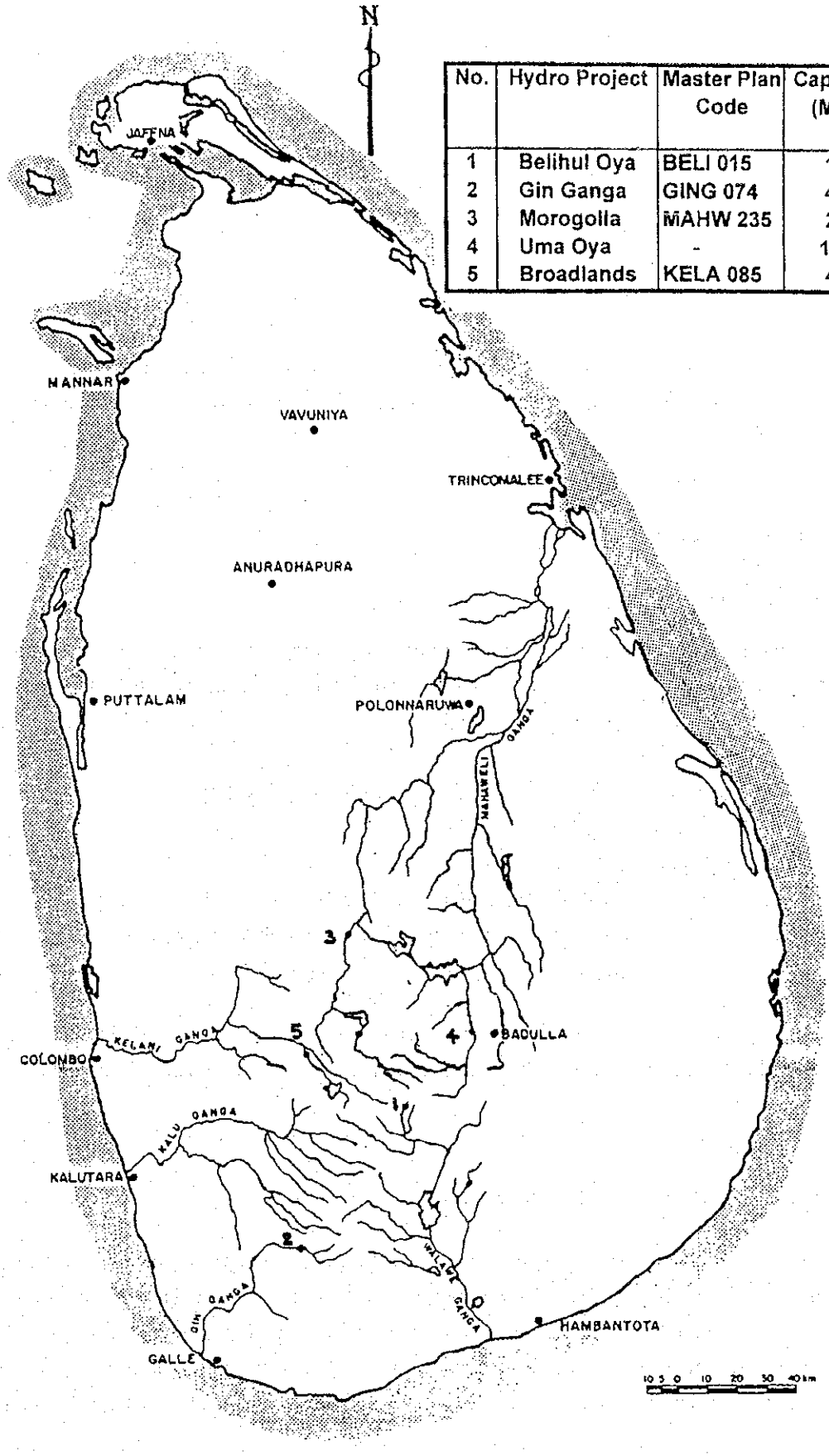


Figure 5.1 Locations of Hydro Power Candidates

The candidate hydro projects considered in the study are summarised below. [For details please see Annex 5.1]

(i)	40 MW Broadlands Project	-	Kelani River Basin
(ii)	49 MW Gin Ganga Project	-	Gin Ganga River Basin
(iii)	17 MW Belihul Oya Project	-	Walawe River Basin
(iv)	27 MW Moragolla Project	-	Mahaweli River Basin
(v)	150 MW Uma Oya Project	-	Mahaweli River Basin

The capacity and cost details of the candidate hydro projects considered in the expansion plan are given in Table 5.3 whereas Annex 5.2 provides information about the cost calculations of candidate hydro plants including adjustments made to their cost bases.

5.2 Thermal Options

5.2.1 The Background

Thermal plants play a major role in system additions in the future as most of the economical hydro potential has already been harnessed. Several studies had been conducted to assess the future thermal options for electricity generation in Sri Lanka.
These were,

a) Feasibility study on Trincomalee Thermal Power Project (1988) [6]
b) Thermal Generation Options (1988) [7]
c) Thermal Generation Options (1996) [12]
d) Special Assistance for Project Formulation (1996) [16]
e) Coal Fired Thermal Development Project – West Coast (1996 – underway)
f) Review of Long Term Generation Expansion Studies (1997) [13]

The data gathered during these studies were used for the present analysis. Following sections describe briefly the fuels and different technologies of thermal power plants considered as candidates in the present study.

5.2.2 Fuels Used for Electricity Generation

All fossil fuel-based thermal generation in Sri Lanka would continue to depend on oil imports. Ceylon Petroleum Corporation (CPC) presently provides all petroleum products required for thermal power stations. From mid 1996, the CPC ceased the production of heavy diesel and has substituted it with auto diesel. In general, the CPC refinery has a surplus of heavy oils and light distillates while the middle distillates, especially diesel, is in deficit, owing to heavy demand of diesel by the transport sector.

Natural Gas as a fuel option for the Gas Turbine and Combined Cycle plants was studied since it is more attractive in environmental perspective. However considering large infrastructure costs

involved in Liquified Natural Gas (LNG) transport, handling and storage facilities it was revealed that Sri Lanka does not have adequate level of demand to justify LNG as an economical fuel option.

5.2.2.1 Fuel Price Projections

World Bank fuel price projections of August 1997 was used in the analysis. These prices were based on 18.5 US$/bbl for crude oil and 37 US$/tonne for coal.

Tables 5.1 and 5.2 show respectively the basic oil price projections and input information used in the analyses.

Table 5.1 Forecast of Fuel Prices Used for the Study

Year	Crude oil Sing. ($/bbl)	Diesel ($/bbl)	Furnace oil ($/bbl)	Residual oil ($/bbl)	Coal Trinco ($/tonne)	Coal West Coast ($/tonne)
1998 - 2017	18.5	24.2	18.2	14.4	44.0	47.0

Based on the World Bank forecast of Aug.1997.

Table 5.2 Forecast of Fuel Prices Used for Studies (As input to the WASP analysis)

Year	Diesel (USets/GCal)	Furnace oil (USets/GCal)	Residual oil (USets/GCal)	Coal Trinco (USets/GCal)	Coal West Coast (USets/GCal)
1998 - 2017	1654	1180	943	698	746

(a) Auto Diesel heat content = 9200 kCal/l
(b) Residual oil heat content = 9600 kCal/l
(c) Furnace oil heat content = 9700 kCal/l
(d) Australian coal heat content = 6300 kCal/kg

5.2.3 Thermal Power Candidates

Following are the power generation technologies considered for the Planning Studies.

(i) Coal Fired Thermal Plants

(ii) Combined Cycle Power Plants

(iii) Gas Turbine Plants

(iv) Oil Fired Steam Plants

(v) Diesel Power Plants

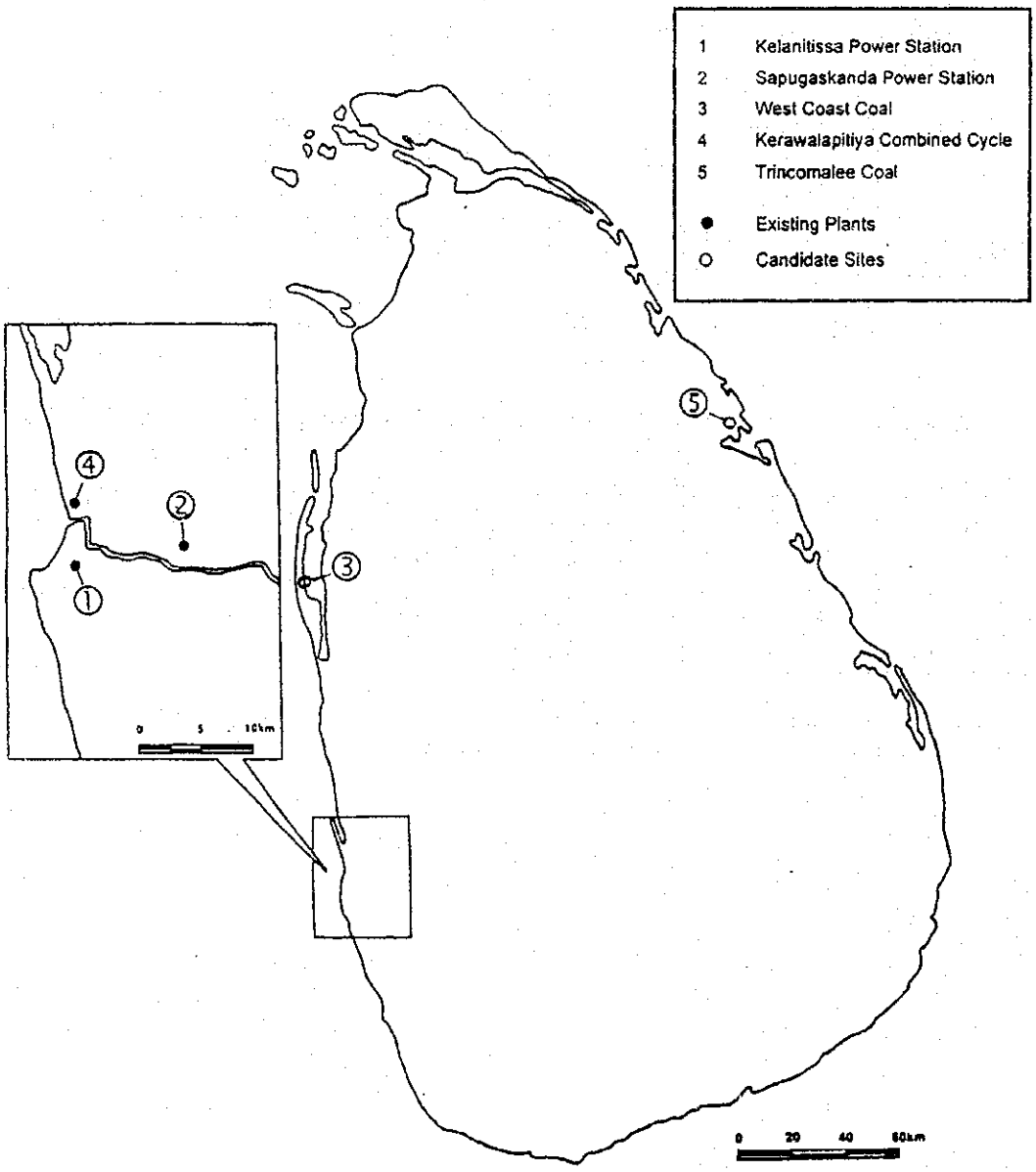


Figure 5.2 Siting of Thermal Power Stations

Thermal plant data base, updated by Electrowatt Engineering (EWE) during the Thermal Generation Options Study (1996) [8] and again during the Review of Long Term Generation Expansion Study (1997) [13], was extensively used during the studies.

Whenever feasibility study results are available for any prospective project, such results were used in preference to the above studies.

5.2.3.1 Candidates with Feasibility Studies

(a) Trincomalee Coal Power Project

The feasibility study on Trincomalee Coal-fired power station [6] considered a site capacity of 900 MW when fully developed (2 x 150 MW and 2 x 300 MW in a phased development). Site location is marked in Figure 5.2. The investment cost and other relevant parameters were reviewed during the 1995 Thermal Generation Options Study.

Coal used for this plant, to be imported and transported by ship, is assumed to be of low sulphur content (less than 1%). Thus, no flue gas de-sulphurisation equipment have been considered in plant capital and recurrent cost calculations.

(b) West Coast Coal Power Development Project

Feasibility study and engineering services on West Coast coal power plant commenced in November 1996 with the assistance of Overseas Economic Cooperation Fund (OECF) of Japan. This project which is on the Kalpitiya penisula (Figue 5.2) will be developed in 3 phases with an ultimate planned capacity of 900 MW. The first phase covers the installation of the first 300 MW generating unit together with coal handling system, site infrastructure and power transmission system.

(c) Muthurajawela Combined Cycle Power Project

Feasibility study on Muthurajawela Combined Cycle plant commenced in December 1997 with the assistance of Japanese International Cooperation Agency (JICA). This plant will be located in the reclaimed land area at Kerawalapitiya (Figure 5.2). Capacity to which the site could be developed further in the future will also be determined during the feasibility study. The study is expected to be completed by August 1998.

A summery of capital costs and economic lifetimes of candidate plants is shown in Table 5.3 as input to the present studies. Operating characteristics of these plants are shown in Table 5.4.

5.2.4 *Screening of Generation Options*

In comparing alternative plants with varying capital investments, operation costs, maintenance and repair costs and life times etc., it is necessary to employ an indicator common for all plants. Specific generation costs (expressed in US cts/kWh) calculated at different plant factors for all available thermal plants (using economic costs/prices) were used to screen or eliminate the uneconomical options before carrying out detailed expansion planning studies.

The methodology employed is illustrated in Annex 5.4

Specific generation costs calculated for various plants are shown in Figure 5.3 and Table 5.5 for a discount rate of 10%. The specific generation cost for selected thermal plants, calculated for 6% and 12 % discount rates, are also provided in Annex 5.4. It can be seen that with a lower discount rate, plants with high investment and low operating costs are more economical than other plants and vise versa.

5.2.5 *Thermal Power Candidates after Screening*

Thermal Power candidate plants listed under section 5.2.3 were subjected to further analysis to investigate constraints such as fuel limitations etc; after the initial screening.

Following are the plants considered for the present study after the initial investigations.

Plant	Capacity (MW)	
Coal	150	300
Combined Cycle	150	300
Gas Turbine	35	105

Since the quantity of the residual oil produced by the refinery is utilised by the existing and committed diesel plants running on residual oil diesel plants were not considered as candidates during the present study.

Screening analysis indicated that the oil fired steam plants are not competitive when compared with other thermal plants. Hence, such plants were not considered as candidates in the present study.

The detailed characteristics of the selected candidate plants are given in Annex 5.3.

Table 5.3 Capital Cost Details of Expansion Candidates Considered in the Study

Plant	Capacity	Pure Construction Cost US$/kW		Total Cost	Const Period	IDC at 10% (as % of	Const. Cost as Input to Analysis incl. IDC (US$/kW)		Economic Life
	(MW)	Local	Foreign	(US$/kW)	(yrs)	pure costs)	Local	Foreign	(Years)
THERMAL									
Coal Trinco	300	158.7	773.9	932.6	3.5	16.00	184.1	897.7	30
Coal West Coast	150	210.9	1022.9	1233.8	3.5	16.00	244.6	1186.6	30
Unit - 1	300	188.8	897.7	1086.5	3.5	16.00	219.0	1041.3	30
Unit - 2 & 3	300	162.2	771.6	933.9	3.5	16.00	188.0	895.8	30
Gas Turbine	35	66.9	447.8	514.7	1.5	6.51	71.3	476.9	20
Gas Turbine	105	45.5	304.5	350.0	1.5	6.51	48.5	324.3	20
Combined Cycle	150	151.8	538.2	690.1	3	13.54	172.4	611.1	30
	300	122.9	435.4	558.2	3	13.54	139.4	494.2	30
Combined Cycle	150	178.4	601.8	780.2	3	13.54	202.4	683.2	30
Outside Colombo	300	136.1	467.0	603.0	3	13.54	154.5	530.2	30
HYDRO									
Gin Ganga	49	419.8	1920.5	2127.6	4	18.53	497.5	2276.4	50
Belihuloya	17	383.8	2262.5	2405.7	4	18.53	454.9	2681.8	50
Broadlands	40	565.0	2034.6	2548.6	4	18.53	669.7	2411.6	50
Umaoya	150	426.2	1834.2	2152.7	5	23.78	527.5	2270.3	50
Moragolla	27	440.2	2862.8	3002.8	4	18.53	521.8	3393.3	50

All costs are in January 1997 border prices. Exchange rate US$ 1 = Rs. 59

IDC = Interest during Construction

Table 5.4 Characteristics of Generating Plants Considered as Expansion Candidates

(a) Thermal Plants

Name of Plant	Capacity (MW)	Heat Rate (kCal/kWh)		Fuel Cost USets/GCal)	Full Load Efficiency (%)	FOR (%)	Scheduled Maint. (Days/yr)	O&M Cost (Fixed) S/kW month	O&M Cost (Variable) USets/kWh
		MIN LOAD	AVG. INCR						
West Coast - 900 MW									
COAL	150	2819	2247	746.0	36.0	12.0	35	0.761	0.417
COAL	300	2687	2162	746.0	37.5	11.0	40	0.645	0.354
Trinco									
COAL	300	2687	2162	698.0	37.5	11.0	40	0.645	0.354
GAS TURBINE	35	3060	3060	1654.0	28.1	8.0	30	0.463	0.371
GAS TURBINE	105	4134	2322	1654.0	30.1	8.0	30	0.350	0.278
Sites Near Colombo									
COMBINED CYCLE	150	2614	1462	1654.0	46.1	8.0	30	0.351	0.301
COMBINED CYCLE	300	2457	1427	1654.0	48.6	8.0	30	0.265	0.227
Sites outside Colombo									
COMBINED CYCLE	150	2614	1462	1654.0	46.1	8.0	30	0.351	0.301
COMBINED CYCLE	300	2457	1427	1654.0	48.6	8.0	30	0.265	0.227

(b) Hydro Plants

Project	Installed Capacity (MW)	Annual Energy (GWh)	Storage (MCM)
Gin Ganga	49	212	17.5
Belihul Oya	17	71	5.8
Broadlands	40	145	0.2
Uma Oya	150	447	18.0
Moragolla	27	111	5.0

All Costs are in January 1997 US$ border prices.
Hydro operation and maintenance costs are taken as 3.84 US$/kW year

5.2.6 *Specific Cost Comparison*

Table 5.5 Specific Cost of Generation of Candidate Plants Used in the Present Study

PROJECT/PLANT	CAPACITY (MW)	SPECIFIC COST (in 1997 border prices)	
		USCts/kWh	Rs/kWh
HYDRO			
Gin Ganga	49	6.55	3.86
Belihul Oya	17	7.71	4.55
Broadlands	40	8.66	5.11
Uma Oya	150	9.60	5.66
Moragolla	27	9.70	5.72
THERMAL			
Coal - West C (80% PF)	150	4.39	2.59
Coal - West C (79% PF)	300	3.83	2.26
Coal - Trinco (79% PF)	300	3.63	2.14
Combined Cycle (84% PF)	150	3.91	2.31
Combined Cycle (84% PF)	300	3.54	2.09
Gas Turbine (30% PF)	35	8.09	4.77
Gas Turbine (30% PF)	105	5.94	3.50

Note : The specific cost of generation of Coal plants and Combined Cycle plants were calculated assuming base load operation and that all Energy can be dispatched.
PF = Annual plant factor.
(1 US$ = 59.00 SL Rs.)

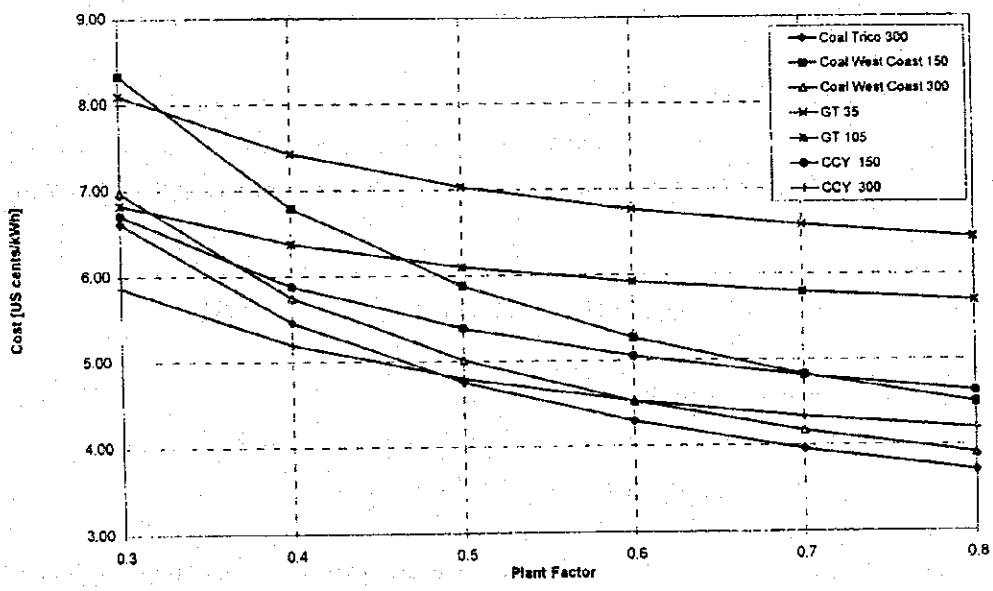


Figure 5.3 Specific Costs of Candidate Plants – Based on Economic Costs (Discount Rate = 10%)

5.3 Renewable Sources

Sri Lanka, being a country in the tropical belt has an abundance of renewable sources of energy. Solar, wind, hydro and biomass are some of the resources that can be considered to deliver useful energy.

5.3.1 Wind

The Pre-Electrification Unit of Ceylon Electricity Board carried out a resource assessment study of solar and wind potential in 1992 [11]. This study reveals an overall wind potential of 8MW/sqkm 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 monsoonal winds and hence wind plants in this region can yield acceptable levels of plant factor. A study on the integration of wind energy in the system indicates that a wind energy project of 10 MW commissioned in the year 2000 would provide a benefit/cost ratio of about 0.5 at a discount rate of 10%. Thus it is apparent that wind energy can only be considered as a future energy option in economic terms. Furthermore, system constraints would have other technical limitations of large scale introduction of wind plants to the system in the immediate future. Thus, Wind being the most promising option of the available renewable sources for grid connected power generation, CEB has initiated a 3 MW pilot scale wind plant which will be commissioned shortly to analyse the associated techno-economical parameters. This project is located in the southern coast near Hambanthota.

5.3.2 Micro Hydro

Harnessing of hydro resources in major projects are dealt with elsewhere in the report while certain aspects of small and micro hydro potential in the country is discussed here.

Well over 400 micro hydro sites have been reported in the country especially in the central hilly areas. Most of these sites are now abandoned and studies have revealed that only about 140 such sites could be developed to generate useful energy. Sixty of such sites are already rehabilitated and are in operation.

The master plan studies carried out in 1988 reveals that there is potential for,

a) Development of new sites
b) Harnessing the head from irrigation canals, tanks and reservoirs
c) Rehabilitation, upgrading or extension of existing sites.

It is estimated that 30 MW of small hydro potential exists in about 60 undeveloped sites while further 8 MW exist in about 290 irrigation tanks and reservoir sites. Another 50 MW of small hydro potential can be tapped in about 140 sites, which can either be rehabilitated or re-developed. Therefore

development of these small, mini and micro hydro potential could contribute significantly in satisfying future electricity demand of the country.

5.3.3 Solar

Solar energy with its characteristic high cost of development can only be considered as a decentralised source of power to meet basic lighting requirements of remote rural households which are far away from the national grid.

5.3.4 Other

Use of biomass in Dendro thermal plants have also been proposed but no conclusive studies have been made. Other forms of energy such as Wave, OTEC (Ocean Thermal Energy Conversion) and other solar thermal applications for large scale power generation are either not developed for commercial scale application or have high development costs. Hence they do not warrant serious consideration at this stage.

This study does not take any of the renewable sources of energy into consideration, as they are not expected to contribute considerably to the national electrical energy requirement.

However, renewable sources of energy will continue to play an important role in decentralised applications, in meeting electrical energy needs of rural and remote communities.