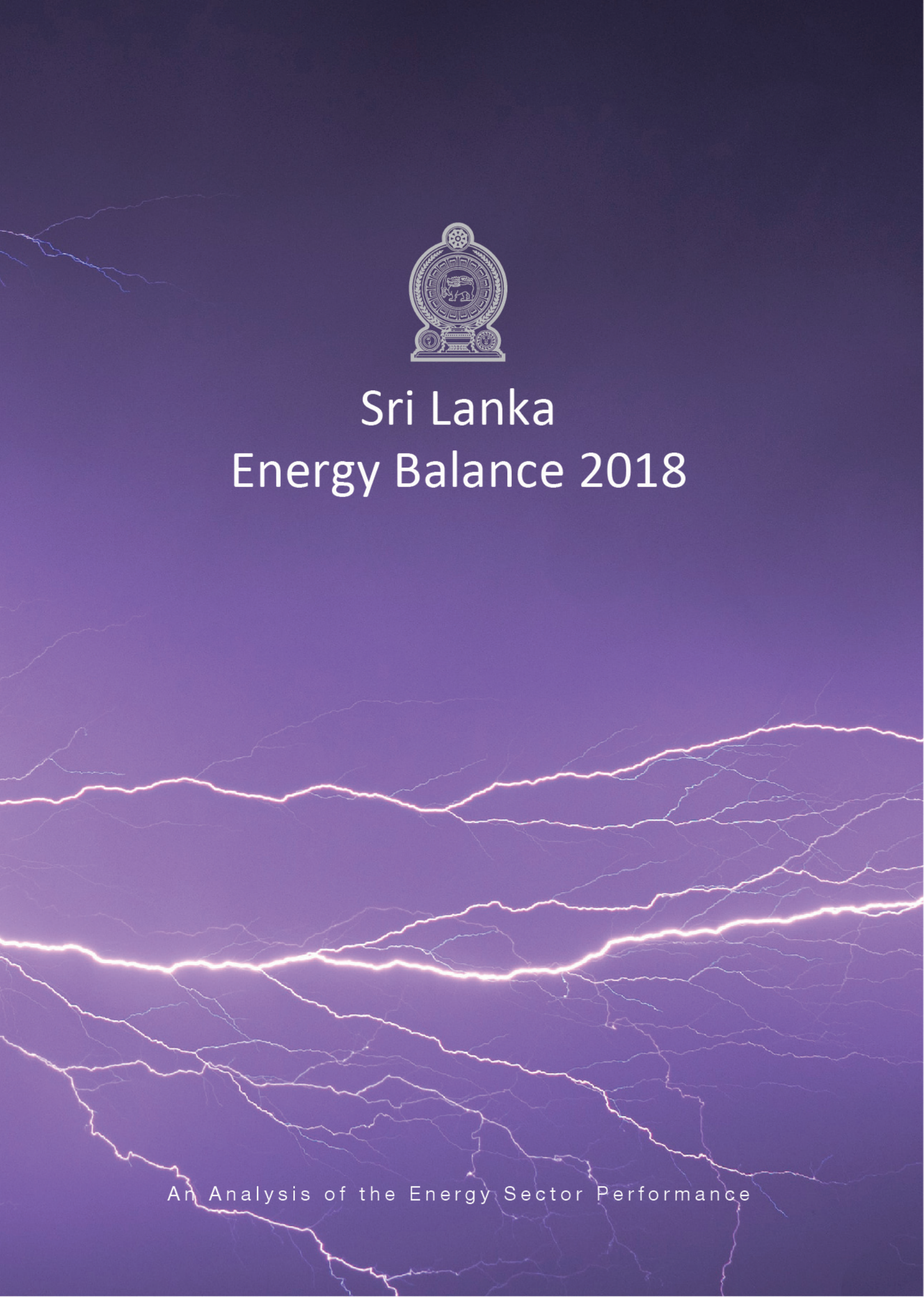

Sri Lanka
Energy Balance 2018

An Analysis of the Energy Sector Performance

Sri Lanka

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Sri Lanka Sustainable Energy Authority
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ISSN: ISSN 2386-172X

First Printed in Sri Lanka 1976

Anthropologists of the world agree on one fact, the role played by *Fire* in the human civilisation. We chose the second element of the five states of existence; Apo, Thejo, Wayo, Patavi and Okasa as understood by the oriental scholars many millennia ago. Thejo, which in old ages simply meant *Fire*, has now has a bigger meaning encompassing all aspects of energy.

Exact day of making a productive use of *Fire* by human civilisation is often disputed. Some anthropologists suggest that it happened a million years ago in Africa and certain others indicate that frequent use of *Fire* happened In Israel. Evidence of extensive and repeated use of *Fire* between 420,000 and 200,000 years ago were found in Qesem Cave a Middle Pleistocene site close to the capital Tel Aviv of Israel. Indications of recrystallisation of wood ash at this site clearly points out to habitual use of *Fire* for preparation of meats as a primary source of nutrition. It is proposed that the mankind managed to preserve a *Fire* caused most probably by lightning strikes by propagating flames to dried animal dung or woody biomass for later use.

Fire is also symbolic of the darker side of our civilisation, as it is the single most harmful action which has started to cause irreparable damage to the planet earth. Year 2018 marks a significant milestone in this sense, which saw the simultaneous wildfires ravaging the forests in several countries. Many rushed to name the phenomenon as the 'Planet on Fire' hinting at the global warming catastrophe, launched by the incessant burning of fossil fuel. Global warming has caused longer and pronounced droughts and warmer weather, the necessary ingredients for frequent wildfires.

Our cover page adorns a spectacular lighting strike, captured by Bas van der Horst of Denmark. Even though less phenomenal than the one that started the *Fire* that the mankind managed to tame long time ago, the same electrical energy, when properly managed has the power to take this troubled human civilisation to a whole new level.

Just like the fateful lighting strike that ignited the passion of our ancestors along with large swaths of forests, electrical energy can drive humanity to douse the 'Planet on Fire' when electricity generated from renewable energy resources are efficiently used to power the civilisation. It opens up a new development paradigm which can steer humanity away from burning more fossil fuel, which cause irreversible climate change.

We at SEA are hopeful that the day we find electricity as the primary energy vector in the world is not far away.

Executive Summary

In 2018, Total Primary Energy Supply (TPES) increased to 536 PJ, after a lower value in previous year. Petroleum fuels continued to dominate TPES, with a share of 40%, followed by biomass with a share of 36%. Coal and hydropower accounted for 10% slices of the TPES each, whilst new renewable energy accounted for 4%. Energy demand increased to 414.2 PJ as electricity demand growth made up for reduced demand for petroleum products. Per capita electricity use increased in 2018, reaching 651.6 kWh/person, whilst the consumption of petroleum fuels (other than coal) reduced to 214.4 kg/person in 2018. Commercial energy intensity of economy remained in the same league reporting 0.42 TJ/LKR million of GDP.

Demand for crude oil increased due to improved performance of the refinery which processed 1,675,337 tonnes of crude oil to produce 1,594,167 tonnes of refined products. Overall, the demand for petroleum products showed a marginal decrease in 2018. International oil prices rose sharply, resulting in the Brent index climbing from 54.76 USD/bbl to 71.76 USD/bbl and average cost of imports to reach 76.25 USD/bbl in 2018. This caused a serious impact on the balance of payment, as the fuel import bill enlarged from approximately 1/4th to 1/3rd of the total non-petroleum export earnings. The impact of increasing costs and stagnant retail prices saw the loss incurred by the Ceylon Petroleum Corporation passing the 100 LKR billion mark in 2018. Its sole competitor Lanka Indian Oil Corporation too suffered a loss of 637 LKR million. Exploration tasks undertaken by the Petroleum Resources Development Secretariat continued in 2018, with more studies and surveys.

The active fleet of vehicles serving the transport sector grew to 4,879,468 vehicles, where more than half of the fleet was motor cycles and more than 1/5th was three wheelers. This unhealthy trend is seen as a result of steady deterioration of the public transport services in the country.

Electricity generation increased by a margin of 7.9% in 2018, registering a 16,197.8 GWh of gross generation. The residential electricity consumer accounts passed the six million mark in 2018, taking the total number of electricity users close to seven million, growing at a 3% rate. Total generation capacity increased to 4,186.78 MW, with main contribution from new renewable energy (NRE) plants. Composition of generation capacity stood at 49% thermal, 33% major hydro and 17% NRE. After serving the full life cycle of twenty years, the first wind power plant of 3MW capacity owned and operated by CEB was decommissioned in 2018. With increased rainfall, NRE share in the generation rose to 11% after remaining under 10% level in the last two years.

Electricity demand increased to 14,119.6 GWh, without a major change in shares of demand by different sectors. Combined turnover of the two utilities reached 244 LKR billion with an average sales tariff of 16.79 LKR/kWh.

Legal impediments which have virtually crippled the development of NRE projects in the country since 2012 continued in 2018. Rooftop capacity increased to 154 MW in 2018 and contributed to generate approximately 215 GWh. Competitive bidding for NRE capacity produced good results, almost halving the purchase price of solar and wind electricity. Construction of the first two wind power plants thus procured commenced in the Northern sector, after a lengthy and painful struggle to secure land resources for the projects. Changing the course of wind energy development in the country, CEB inked the agreements to procure EPC services from a leading wind turbine manufacturer. This turnkey contract is expected to establish the first large scale wind park in the country in the Mannar island with a capacity of 100MW in 2020. CEB also took steps to expedite the work related to the development of the remaining hydropower plants.

On the demand side management front, CEB invested 200 LKR million in a first of a ten-fold energy efficiency improvement and conservation (EEI&C) programme developed by the Presidential Taskforce on Energy Demand Side Management to distribute a million LED lamps among the low user residences on a hire purchase scheme. The programme, executed by the Sri Lanka Sustainable Energy Authority is expected to be enlarged to cater to medium level users, if the first phase proves to be successful.

On the environmental front, the grid emission factors for 2018 were reported as: Operating Margin - 0.7044 $kgCO_2$/kWh, Build Margin - 0.8786 $kgCO_2$/kWh and Combined Margin - 0.7915 $kgCO_2$/kWh. Average emission factor for grid power generation for 2018 was reported as 0.4694 $kgCO_2$/kWh.

After several attempts over the last five years, the National Energy Policy & Strategies of Sri Lanka was finalised, incorporating more than 300 comments received during the lengthy period of public review. It is expected that the policy will be declared in early 2019.

Key Energy Statistics

Primary Energy (PJ)	2017	2018
Biomass	192.9	193.8
Petroleum	214.7	215.4
Coal	56.9	55.0
Major hydro	30.9	51.9
New Renewable Energy	16.2	19.9
Total	**511.6**	**536.0**

Imports (kt)	2017	2018
Crude Oil	**1,499.4**	**1,763.0**
Coal	**2,527.0**	**2,166.0**
Finished Products	**4,139.9**	**4,085.7**
LPG	387.0	413.0
Gasoline	1,097.4	1,128.5
Avtur	282.2	461.0
Auto Diesel	1,763.2	1,482.6
Fuel Oil	581.2	553.3
Avgas	0.2	0.1
Bitumen	19.7	28.2
Mineral Gas Oil	9.0	19.0

Refined Products (kt)	2017	2018
Crude Input	1,646.0	1,675.3
Naphtha	141.7	140.7
Petrol	164.6	165.4
Avtur	236.4	237.3
Kerosene	59.8	35.2
Diesel	506.0	567.6
Furnace Oil	430.8	424.4
Solvents	0.6	1.6
Total Output	**3,185.9**	**3,247.4**

Grid Capacity (MW)	2017	2018
Major Hydro	1,391.4	1,398.9
Thermal Power	2,046.0	2,046.0
New Renewable Energy	562.5	588.4
Micro Power Producers (µPP)	93.7	153.5
Total	**4,093.6**	**4,186.8**

Gross Generation (GWh)	2017	2018
Major Hydro	3,075.2	5,168.7
Thermal (Oil)	5,212.6	3,760.9
Thermal (Coal)	5,120.6	5,309.4
New Renewable Energy	1,464.4	1,743.7
Micro Power Producers (µPP)	129.7	215.1
Total	**15,002.4**	**16,197.8**

Average electricity price (LKR/kWh)	16.7	16.8
Net oil imports as % of non petroleum exports	29.5	33.7

Total Demand (PJ)	2017	2018
Biomass	191.1	191.4
Petroleum	172.1	170.0
Coal	1.8	2.0
Electricity	48.3	50.8
Total	**413.3**	**414.2**

Demand by Sector (PJ)	2017	2018
Industry	103.2	108.8
Transport	143.0	135.8
Household & Commercial	167.1	169.6
Total	**413.2**	**414.2**

Industry Demand (PJ)	2017	2018
Biomass	78.3	81.3
Petroleum	7.2	9.0
Coal	1.8	2.0
Electricity	15.7	16.6
Total	**103.2**	**108.8**

Transport Demand (PJ)	2017	2018
Petroleum	143.0	135.8
Total	**143.0**	**135.8**

HH, Comm, Other (PJ)	2017	2018
Biomass	112.7	110.1
Petroleum	21.8	25.2
Electricity	32.6	34.3
Total	**167.1**	**169.6**

Electricity Demand (GWh)	2017	2018
Domestic	5,063.7	5,230.9
Religious	88.6	93.9
Industrial	4,371.5	4,597.9
Commercial	3,834.6	4,066.4
Streetlighting	130.3	130.6
Total	**13,488.8**	**14,119.6**

Grid Emission Factors (t-CO_2/MWh)	2017	2018
Operating Margin	0.6993	0.7044
Build Margin	0.9224	0.8786
Combined Margin	0.8108	0.7915

Average Emission Factor	2017	2018
(kg-CO_2/kWh)	0.5865	0.4694

GDP at 1982 factor cost prices (million LKR)	511,631	528,004
Commercial Energy Intensity (TJ/LKR million)	0.43	0.42
Electricity Sold (kWh/person)	629.0	651.6
Petroleum Sold (kg/person)	224.6	214.4

Acknowledgement

Sri Lanka Sustainable Energy Authority wishes to express its sincere thanks to the following institutions for their valuable cooperation in the compilation of the "Sri Lanka Energy Balance 2016" and the Analysis of Energy Sector Performance.

Ministry of Power and Renewable Energy

Ministry of Petroleum Resources Development

Ceylon Electricity Board

Lanka Electricity Company (Pvt) Ltd.

Ceylon Petroleum Corporation

Petroleum Resources Development Secretariat

Sri Lanka Railways

Department of Motor Traffic

Department of Census and Statistics

Central Bank of Sri Lanka

State Timber Corporation

All institutions, which responded positively to our request to provide relevant data

Sri Lanka Energy Balance 2018 was compiled by the
Sri Lanka Sustainable Energy Authority

List of Abbreviations

C&F	Cost and Freight
CEB	Ceylon Electricity Board
CHP	Combined Heat and Power
CPC	Ceylon Petroleum Corporation
DG	Distributed Generation
ECF	Energy Conservation Fund
ESCO	Energy Service Company
FOB	Free On Board
GCal	Giga calorie
GDP	Gross Domestic Product
GEF	Grid Emission Factor
GWh	Giga Watt hour
IPP	Independent Power Producer
kCal	kilo calorie
kg	kilo gram
kJ	kilo Joule
kVA	kilo Volt Ampere
LA	Local Authority
LECO	Lanka Electricity Company
LIOC	Lanka Indian Oil Company
LKR	Sri Lankan Rupees
LNG	Liquid Natural Gas
LPG	Liquid Petroleum Gas
µPP	Micro Power Producer
MT	Metric Tonnes
MW	Mega Watt
NERD Centre	National Engineering Research and Development Centre
NRE	New Renewable Energy
NREL	National Renewable Energy Laboratory of United States
OE	Oil Equivalent
PJ	Peta Joule
RDA	Road Development Authority
RERED Project	Renewable Energy for Rural Economic Development Project
SEA	Sri Lanka Sustainable Energy Authority
SCADA	Supervisory control and data acquisition
SLSI	Sri Lanka Standards Institute
SPP	Small Power Producer
SPPA	Standardised Power Purchase Agreement
toe	Tonnes of Oil Equivalent
ToU	Time of Use
TJ	Tera Joule
VET	Vehicle Emissions Testing

Contents

List of Tables

List of Figures

1 Introduction to the Energy Sector

1.1 Highlights of 2018

2018 passed as an uneventful period for the energy sector, with a few developments. Oil prices started to climb up, leaving the petroleum industry stressed as the Government kept the reduced retail prices of products, driving demand increases. Compared to 2017, oil imports decreased by 1.3% from 4,139.9 tonnes to 4,085.7 tonnes in 2018.

Petroleum prices continued to climb up in 2018, signalling a stressful period ahead for the energy sector. On average, the average international crude oil price (Brent) was 31% higher at USD 71.76 per barrel in 2018, compared to USD 54.76 in 2017. The average price of crude oil imported by the CPC increased by 31.9% to USD 76.25 per barrel in 2018 from the average price of USD 57.79 per barrel of 2017. Facing such a sharp increase in unit price and a marginal decrease of import volumes of petroleum products continued to impact the economy negatively.

Sri Lanka spent 33.69% of all non-petroleum export earnings on fossil fuel imports in 2018. Considering the increasing oil prices which characterised 2018, this is seen as a significant trend. Continuation of this trend, in the context of the sensitive issue of local pricing is painting a bleak future for the petroleum sector and a dire warning on the foreign reserves.

Formulation of a comprehensive energy policy resumed with the appointment of a committee and the work progressed well, with the active support of the sector entities. The draft document was opened for public comments and attracted a large volume of comments from the concerned parties.

Exploration activities in the Mannar and Cauvery basins are expected to recommence after the decision to extend invitations to appraise the discoveries in the Block M2 and conduct further explorations in the Blocks M1 and C1. Interest in the use of natural gas for power generation and the extensive work on developing a natural gas policy for the country signals a positive outlook for the gas sector.

The lost momentum in new renewable energy development due to legal impediments was somewhat recovered by the rooftop solar project, with the availability of low cost debt from the Asian Development Bank. Construction of the last large hydropower projects continued in 2018, with Moragahakanda hydropower plant becoming operational. Agreement on procuring EPC services for the Mannar 100MW wind power project too was inked in 2018, passing a milestone.

1.2 Sector Governance and Organisations

1.2.1 Energy Sector Governance

The two Ministries, the Ministry of Power and Renewable Energy and the Ministry of Petroleum Resource Development continued to govern the energy sector. Biomass sector continued to operate independently and informally, with very little interaction with the energy sector governing structure.

In addition to the involvement of the government, private organisations and the general public are also stakeholders of the energy sector. Public Utilities Commission of Sri Lanka (PUCSL) is responsible for regulatory oversight of sector operations, presently with powers to monitor and regulate electricity

industry operations. Tariff filing by the six electricity sector licensees were carried out as required, but no end user tariff revision was contemplated by the PUCSL during 2018. With the increasing price of fossil fuels on one side and an end use tariff which saw a 25% reduction in 2014 and no further revisions for four more years on the other, financial health of the entire electricity sector suffered heavily.

The PUCSL granted conditional approval for the base case generation expansion plan for 2018 - 2037 submitted by the CEB in June 2018. The government assigned a generous 30% share of the generation mix in the latest government policy for natural gas, in anticipation of speedy delivery of new generation capacity from the ongoing procurement efforts.

On the demand side management front, several measures were taken by SEA to improve energy efficiency and conservation. With the intention of saving energy, an LED lamp distribution scheme named 'Shakthi' was developed by the SEA, under the Presidential Task Force on Energy Demand Side Management. Efficient LED lamps will be distributed among low user households at a price less than one third of the market price, which will be recovered on a 24 months instalment basis without interest. Procurement of a million LED lamps was concluded in 2018.

1.2.2 Public Sector Institutions

Ministry of Power and Renewable Energy

The Ministry of Power and Renewable Energy of Sri Lanka is responsible for the power sector and sustainable energy.

The Ministry of Power and Renewable Energy is the main body responsible for the management of the power sector. The Ministry comprises several divisions, discharging its functions in planning, and in the supervision of sub-sectoral state institutions. From time to time, the subject of Energy has been combined with others such as Irrigation and Lands, in the establishment of the Ministry. The following state-owned energy institutions presently operate under the supervision of Ministry of Power and Renewable Energy.

Sri Lanka Sustainable Energy Authority (SEA)

The Sri Lanka Sustainable Energy Authority (SEA) established in 2007 by enacting the Sri Lanka Sustainable Energy Authority Act No. 35 of 2007, comes under the purview of the Ministry of Power and Renewable Energy. The SEA continued to consolidate gains realised in the sustainable energy sector, in both renewable energy and energy efficiency spheres in 2018. With the strong commitment of the Government, towards sustainable energy, the SEA undertook to develop two major thrusts on developing renewable energy and increasing energy efficiency.

Ceylon Electricity Board (CEB)

Established in 1969, the CEB is empowered to generate, transmit, distribute and supply electricity in the country. The Electricity Act of 2009 caused CEB's businesses of (i) generation, (ii) transmission and bulk supply operations and (iii) distribution and supply to be separately licensed. In 2018, CEB generated about 77% of electrical energy supplied through the national grid, while the balance was generated by private power plants. The moves to build new generation capacity using LNG as the fuel continued to be delayed due to complex issues in the procurement process.

The entire 220 kV, 132 kV and 33 kV network is owned and operated by the CEB. CEB directly serves about 92% of gird connected electricity consumers in the country. It operated 2,914 km of transmission lines and 176,936 km of distribution lines at the end of 2015, serving a total of 6,193,131 customers.

Lanka Electricity Company (Pvt) Ltd (LECO)

The LECO is an institution established in 1983 to distribute electricity in areas previously served by Local Authorities (Municipal Councils etc.). LECO receives electricity from CEB at 11 kV and distributes in LECO franchise areas. LECO serves about 8% of the electricity customers in the country. LECO's franchise area steadily expanded from 1983 to 1990, and the company implemented a major rehabilitation program in the newly acquired distribution networks, which has reduced losses substantially. It served 560,786 customers by end-2018, through a 4,796 km of distribution lines.

Ministry of Petroleum and Petroleum Resources Development

The following Departments and Statutory Institutions are presently operational under the supervision of the Ministry of Petroleum and Petroleum Resources Development.

- Ceylon Petroleum Corporation
- Ceylon Petroleum Storage Terminal Ltd.
- Petroleum Resources Development Secretariat

While the role of Ceylon Petroleum Corporation is quite significant in the present context, the other three institutions perform facilitating roles to the petroleum supply and exploration ventures recently initiated by the government.

Ceylon Petroleum Corporation (CPC)

Established in 1961, CPC imports, refines and distributes petroleum products in the country. CPC owns and operates the only refinery in Sri Lanka, with a daily throughput of 50,000 barrels. The demand for petroleum products has significantly increased, with the sale of all petroleum products for all sectors recording an increase from 4,669.3 kt in year 2016 to 5,361.1 kt in 2017.

Lanka Coal Company (LCoC)

With the commissioning of the first coal plant in Puttalam in 2011, a new company was established under the Ministry of Power and Energy to streamline the supply of coal required for the plant. This new organisation continues supplying coal to the 900 MW power plant, with a supply of 2,086.5 thousand tonnes in 2017. In a major incident related to procurement of coal, the board of management of the company was removed in early 2017.

Ceylon Petroleum Storage Terminals Limited (CPSTL)

With the liberalisation of the petroleum industry in 2002 and the entry of Lanka Indian Oil Company, a necessity was felt to share storage infrastructure among downstream vendors. At the time there was an expectation of a third player entering the downstream petroleum business. A company was incorporated with equal share holdings of CPC, LIOC and the Treasury. CPSTL is now managing a major part of storage, pipeline and distribution facilities including two major terminals in Kollonnwa and Muthurajawela.

Petroleum Resources Development Secretariat (PRDS)

This Secretariat was established in 2003 to manage the petroleum exploitation activities of the country. PRDS has successfully attracted oil exploring company to explore the Petroleum resources in the Mannar offshore region. This Secretariat was assigned to the Ministry of Petroleum Resources Development on 21 September 2015 after the upstream development activities were placed within the purview of this Ministry.

1.2.3 Private Sector Organisations

There are numerous private sector organisations participating in the supply, distribution and sale of electricity, petroleum and biomass. The private sector organisations in the electricity sector include Independent Power Producers (IPPs) supplying electricity to the CEB for resale and Small Power Producers (SPPs) producing power using renewable technologies. Annex 1 provides a list of all IPPs and SPPs operational by end 2018.

In the petroleum sector, in addition to the CPC, several private companies distribute and sell petroleum products, lubricants and LP gas. Details of these companies are given in *Annex I*.

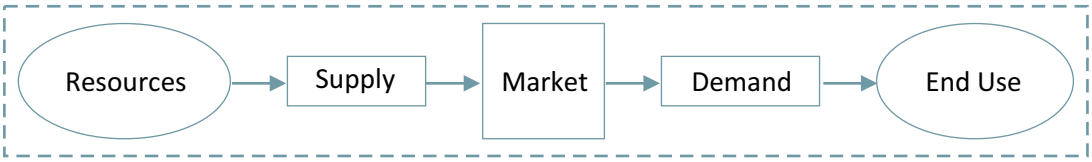
Stages in Energy Flow

Energy used in a country is found in different forms at different stages of its flow from the raw form found in nature to the actual end use form. Broadly, these stages can be categorised as;

- Energy Resources
- Energy Supply including conversion/production and distribution
- Energy Demand
- End Use

Energy sector is the combination of all the above stages of different energy forms which are interrelated, as illustrated below.

Energy Sector Composition



The above flow diagram explains that, owing to various end uses of energy, a demand exists in the market, which is fulfilled by the energy supply using the available resources. This follows the basic demand supply economic model valid for any scarce resource.

Energy Resources

A natural resource is considered an energy resource, if it can be converted to a usable form of energy. There are numerous forms of energy sources in the world and different countries use different resources, primarily selected on economic principles. However, environmental and political reasons also influence the selection of a country's energy portfolio.

Availability, either locally or globally, is not necessarily the only factor considered for using a particular resource as an energy supply source. More importantly, the use must be economical compared with other available sources. Hence, the technology available for converting the resource to a more usable form is important in the selection of an energy resource for energy supply. Change of technology and availability of resource over time can change the economics of using the resource for energy supply. Therefore, the resources used by a country for energy requirements also change with time.

Indigenous Resources

Attributed to geo-climatic settings, Sri Lanka is blessed with several types of renewable energy resources. Some of them are widely used and developed to supply the energy requirements of the country. Others have the potential for development when the technologies become mature and economically feasible for use. Following are the main renewable resources available in Sri Lanka.

- Biomass
- Hydro Power
- Solar
- Wind

In addition to the above indigenous renewable resources, the availability of petroleum within Sri Lankan territory is being investigated.

Global Resources

In the international market, many forms of energy sources are available for Sri Lanka to import and use for its energy needs. However, up to now, Sri Lanka has been largely using only petroleum fuels for this purpose. Increasing petroleum prices have prompted Sri Lanka to examine the feasibility of using other sources such as coal and Liquefied Natural Gas (LNG) to replace liquid petroleum in certain applications. Following are the most common energy sources globally available for energy supply on a commercial scale.

- Petroleum
- Coal
- Natural Gas
- Nuclear Energy

More recently, new energy supply technologies such as biofuels and energy carriers such as hydrogen and electricity storage have emerged as alternatives to the above conventional technologies and transfer options. However, use of these technologies for energy supply purposes is still limited in Sri Lanka.

Energy Supply

To understand the status of the energy sector of a country, what is more important is not the availability of different energy resources, but the extent of use of these resources. As explained earlier, mere availability of a resource within a country does not enable its utilisation. Therefore, it is more important to analyse the resources which are actually being used to meet the energy demand of the country. Following are the four main energy supply forms in Sri Lanka.

- Biomass
- Petroleum
- Coal
- Electricity

Energy supply is essentially the conversion of energy resources from one form to a more usable form. However, this conversion can vary from producing electricity from the potential energy in a hydro reservoir to refining crude oil into gasoline or diesel.

Transmission/Distribution

For each energy supply source, there must be a distribution mechanism through which it can be served to the points of end use. From the production or storage facilities of the energy supply system, the distribution system transports energy to the end user.

The biomass distribution network is quite simple, and in the case of most users, a formal network does not exist. The majority use of biomass is in households, where the source and the point of use, both are within the same home garden. Even in industrial use, distribution is a one-to-one arrangement, which links the source to the user through a direct biomass transport.

In the case of petroleum, distribution is from the petroleum storage facilities up to end user points such as vehicles, power plants and industries, channelled through regional storage facilities and filling stations.

For electricity, distribution starts from the generating station (power plant) and ends at consumer points such as households and industries. The high voltage transmission network, medium voltage regional networks and low voltage local distribution networks are collectively considered as the energy distribution system of electricity.

Demand

For the energy sector, demand drives the market. Demand arises owing to energy needs of households, industries, commercial buildings, etc. According to the needs of the user, the supply of energy has to take different forms. For example, the energy demand for cooking is in the form of biomass in rural areas, while it is in the form of either LP gas or electricity in urban areas. Therefore, not only the quantity of energy, even the quality and the form it is delivered, is determined by the demand.

In this report, the demand is categorised in terms of end-use sectors and is not based on the actual usage or the application of energy at appliance level.

2 Energy Resources

2.1 Indigenous Energy Resources

2.1.1 Biomass

Large quantities of firewood and other biomass resources are used for cooking in rural households and to a lesser extent, in urban households. Even though a large portion of energy needs of the rural population is fulfilled by firewood, there are possibilities to further increase the use of biomass for energy in the country, especially for thermal energy supply in the industrial sector. Furnace oil prices have been maintained without subsidies since 2012, and continue to be expensive at LKR 80.00 per litre, even after a downward revision at the beginning of 2015. Therefore, the business case for large industrial thermal plants to be operational on biomass continued in 2018, further consolidating the supply chains. With no sign of new fuel wood plantations, the biomass supply chain of industrial thermal plants continued to grow. Biomass energy supplies continued to consolidate with a large number of thermal energy installations switching to fuelwood. Petroleum continued to surpass the volume of biomass in primary energy in 2018. Figure 2.1 indicates cumulative capacity additions of biomass power plants in Sri Lanka.

2.1.2 Hydro

Hydro power is a key energy source used for electricity generation in Sri Lanka. A large share of the major hydro potential has already been developed and delivers valuable low cost electricity to the country. Currently, hydro power stations are operated to supply both peaking and base electricity generation requirements. A substantial number of small hydro power plants which operate under the Standardised Power Purchase Agreement (SPPA) and many more are expected to join the fleet during the next few years. The momentum gained by the small hydropower industry from the streamlined approval process was somehow lost due to legal impediments to approve new projects. Figure 2.2 indicates SPP hydro cumulative capacities by district.

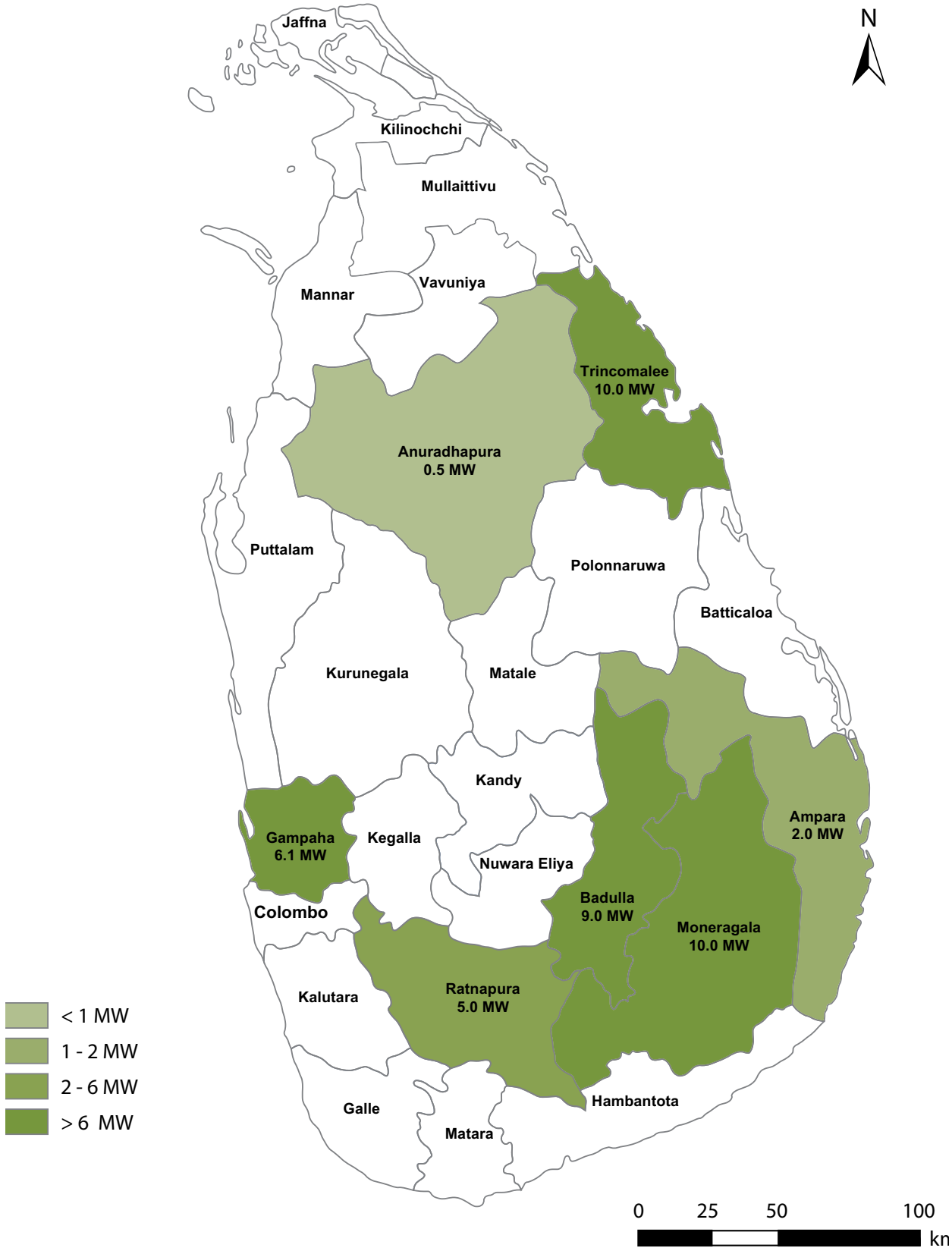


Figure 2.1 – Cumulative Capacity Additions of Biomass (2018)

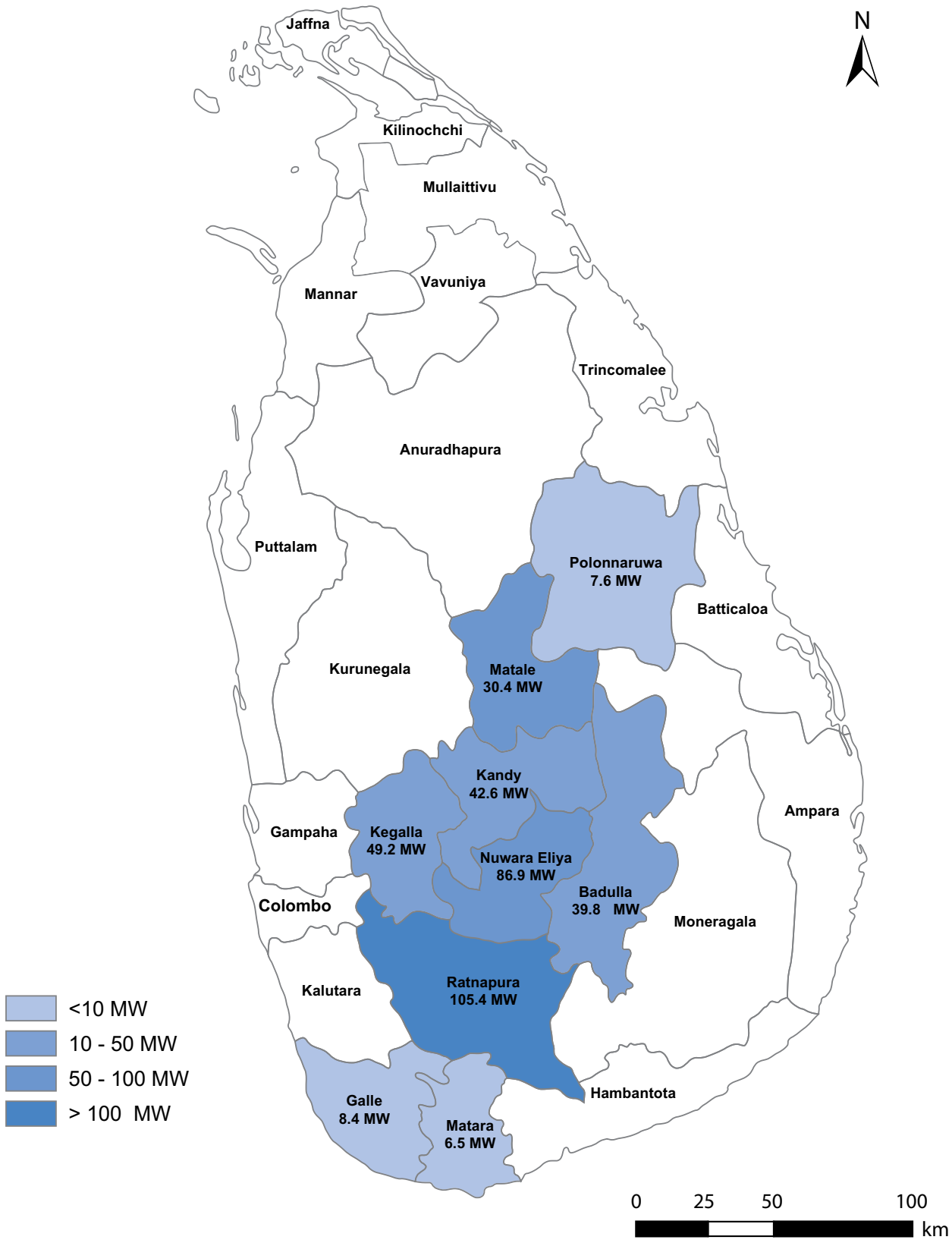


Figure 2.2 – Cumulative Capacity Additions of SPP Hydro (2018)

2.1.3 Solar

The two pilot projects operated by SEA realised annual plant factors of The two pilot projects operated by SEA realised annual plant factors of 7.76% for the 737 kW plant and 9.24% for the 500 kW plant, in 2018. The lower than expected plant factors resulted from the failure of some key components in the power plant.

The first five commercial scale solar power plants completed their first full year of operations in 2018, supplying 97GWh energy to the national grid. The capacity additions produced impressive results yielding an aggregate plant factor of 22.21%. The energy yields and monthly plant factors are given in figure 2.3 below.

The lower than expected plant factors resulted from the failure of some key components in the power plant. In the commercial development sphere, the first commercial scale solar power plant which commenced operations on December 21, 2016 was joined by four more 10MW power plants in 2017. The capacity additions produced impressive results yielding an aggregate plant factor of 19.23%. However, the plant factor can be expected to reach 22.75% if the total 50MW capacity was available from the beginning of 2017. The capacity additions, energy yields and monthly plant factors are given in figure 2.3 below.

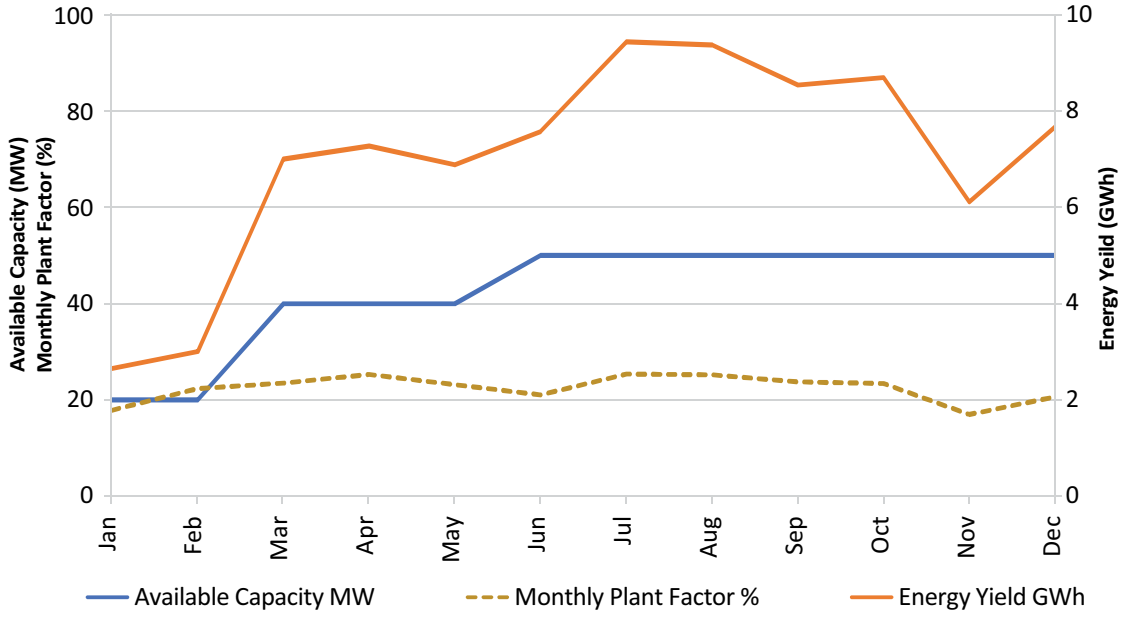


Figure 2.3 – Solar Power Generation

With the introduction of the Sooryabala Sangramaya scheme in 2016, the installation of solar rooftop PV systems gathered momentum, and by end 2018, a total of 19,164 systems were in operation, with a total capacity of 154 MW generating 215 GWh. Generation statistics were estimated based on average energy yields expected in a Typical Meteorological Year (TMY).

2.1.4 Wind

100 MW wind power plant in Mannar progressed well after clearing numerous obstacles, and passed the important milestone of awarding the EPC contract to a global player in wind turbine manufacturing. The project also secured all land resources required for project implementation and site access, which might expedite the erection of wind turbine generators and related site work.

The first two 10 MW projects offered on competitive basis by CEB. The tough competition managed to discover the true cost of wind electricity, which was lower than the feed-in-tariff by nearly 40%. The LCoE of power plants stood at 13.20 LKR/kWh

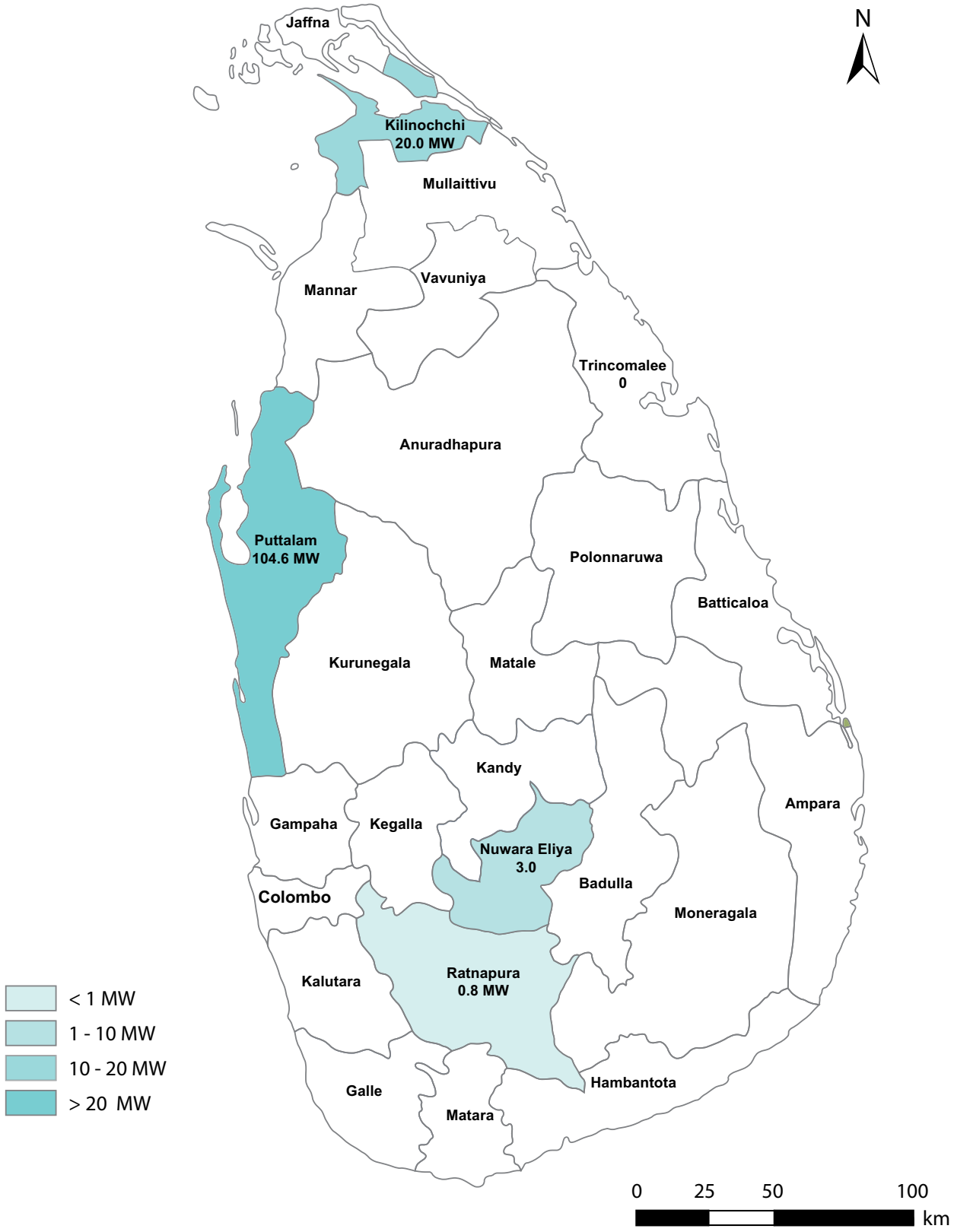


Figure 2.4 – Cumulative Capacity Additions of Wind (2018)

The capacity of 128.45 MW supplied 317 GWh energy to the national grid, yielding an aggregate plant factor of 28.18% in 2018, a much lower value than 2017. The energy yields and monthly plant factors are given in Figure 2.5 below. The energy yields and monthly plant factors are given in Figure 2.5 below

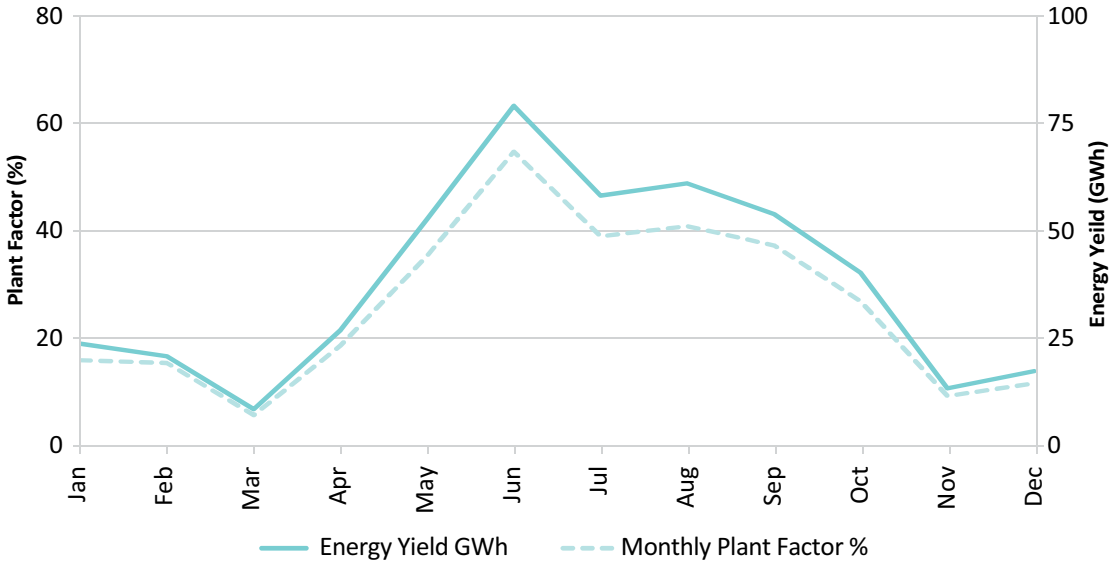


Figure 2.5 – Wind Power Generation

2.1.5 Oil/Gas Exploration

Exploration of fossil fuels in the territory of Sri Lanka and the exclusive economic zone received due attention of the government, leading to an initiative to formulate a national gas policy. This initiative was made with a view to introducing natural gas into Sri Lanka's economy across all sectors to meet the demand for imported petroleum fuels.

The Petroleum Resources Development Secretariat (PRDS) continued to support oil and gas exploration activities in 2018. In May 2018, the GoSL entered into a contractual Umbrella Multi-Client Agreement with a subsidiary of a global oil field service, to enhance the off-shore exploration data repository capacity of the country. The survey operations under the Agreement were completed in 2018 with the detailed data acquisition of a 5,000 km line, 250 km line, 500 km line and 2,500 km line in blocks of the Cauvery Basin, Lanka Basin and Mannar Basin. In 2018, the Cabinet of Ministers granted approval to float a bid round to identify the most suitable entity for commercial production of Liquefied Natural Gas (LNG) in Block M2 of the Mannar basin. Accordingly, the bid round will be floated in 2019 and the contract will be awarded if a successful bidder is identified.

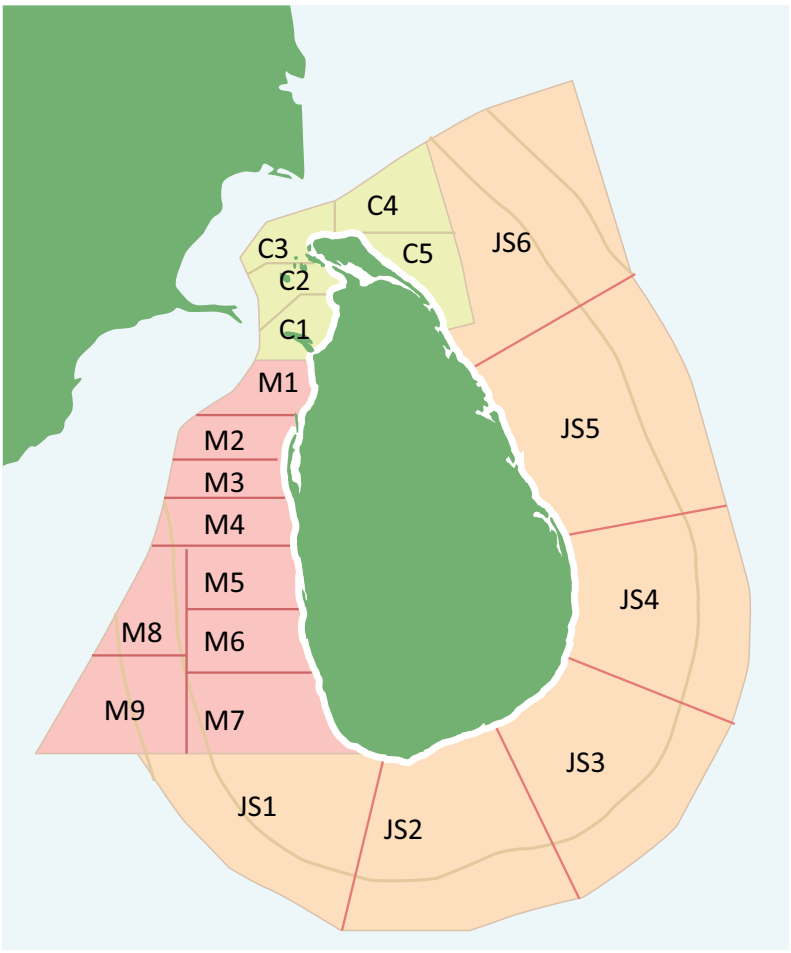


Figure 2.6– Petroleum Resources of Sri Lanka

Encouraged by the outcome of the interest shown by the oil companies, a decision was taken to launch a mini-bid round and formal bid documents were prepared to call an internal mini-bid round for the entire Block. PRDS is currently engaged in preparing the fiscal provisions to initiate discussions with the power sector for possible off-take assurance. Discussions and preparatory work are underway to offer four more exploration blocks in the Mannar and Cauvery basins M1, C1, C2 and C3 as shown in Figure 2.6 above.

PRDS continued the Joint Study with the French Major Total, to explore two ultra-deep water blocks JS5 and JS6 off the East coast of Sri Lanka for hydrocarbon prospects. It is expected to conduct a 5,000 km of 2D seismic survey covering those blocks in 2018.

Several 2D seismic surveys in the offshore region around Sri Lanka including two joint study blocks JS5 and JS6 off the eastern coast on multi-client basis will be undertaken shortly. Plans were also made to carry out a Multi-Client Airborne Geophysical Survey in both Mannar and Cauvery Basins. It is expected to start this survey in 2018.

2.1.6 Indigenous Resources in Sri Lanka

Table 2.1 - Indigenous Primary Sources of Energy in Sri Lanka

Indigenous Energy Source	Typical User Groups	Typical Applications	Scale of Use by End 2017
Biomass	Household	Cooking	Widespread
	Commercial	Hotels, Bakeries	Widespread
	Industry	Process heat for tea drying, brick and tile	Growing number of installations
	Private power plant	For sale to utility	10 power plants
		Own consumption	Several villages and factories
Hydro Power	Electricity utility owned large multipurpose systems	For retail to customers	Major power plants
	Commercial grid-connected	For sale to utility	182 power plants
	Village-level off-grid electricity	Household use	A few plants operating in the grid-connected mode, however, many now in disuse
	Industrial off-grid electricity	Tea industry	A few power plants
	Industrial mechanical drives	Tea Industry	Negligible, one or two remaining
Solar Power	Solar photovoltaic	Net-metering	About 11,882 installations
		Household lighting	No longer reported in large numbers
	Grid connected PV	For sale to utility	8 power plants
	Solar Thermal	Hot water systems in commercial and domestic sectors	Widespread
	Informal use	Household and agricultural use	Widespread
Wind Power	Grid Connected Wind	For retail to customers	15 power plants
	Off-grid power plants	For residential use	A few dozens, most in disuse
	Water pumping	Agriculture	A few dozens, one or two in operation

2.2 Global Energy Resources

As explained previously, petroleum, coal, natural gas and nuclear energy are the four main energy sources used in other countries. However, in Sri Lanka, petroleum and coal are imported in large scale to the country as a source of energy while the use of other sources is still being at lower levels. The use of refined petroleum products and coal is described in Table 2.2.

Table 2.2 – Use of Global Energy Resources in Sri Lanka

Imported Energy Source	Typical User Groups	Typical Applications	Scale of use at Present
Crude Oil and refined products including LPG	Household	Lighting, cooking	Widespread
	Commercial	Hotels, bakeries	Widespread
	Industry	Furnaces, kilns, boilers	Widespread
	Power generation	Combined cycle, gas turbine, diesel engines, steam turbines	A number of thermal power plants
	Transport	Rail, road, air and sea	Widespread
Coal	Railways	Rail	Negligible
	Industry	Kilns	Cement industry and foundries
		Boiler	Two or more
	Power Generation	Boiler	3 units of 300 MW (900 MW)

3 Energy Supply

Energy needs of the country are fulfilled either directly by primary energy sources such as biomass and coal, or by secondary sources such as electricity produced using petroleum, biomass, hydro power and refined petroleum products.

3.1 Supply from Primary Energy Sources

3.1.1 Evolution of Energy Supply

The primary energy supply of Sri Lanka consists of biomass, petroleum, coal, major hydro and new renewable energy. Table 3.1 summarises the contribution of supply energy forms by source.

Table 3.1 – Primary Energy Supply by Source

PJ	2005	2010	2015	2016	2017	2018
Biomass	195.5	207.4	202.2	196.3	192.9	193.8
Petroleum	179.6	185.1	202.6	239.3	214.7	215.4
Coal	2.7	2.5	51.9	54.9	56.9	55.0
Major hydro	32.4	50.1	49.3	35.0	30.9	51.9
New Renewable Energy	3.0	7.5	15.3	12.6	16.2	19.9
Total	**413.1**	**452.7**	**521.4**	**538.0**	**511.6**	**536.0**
%						
Biomass	47.3	45.8	38.8	36.5	37.7	36.2
Petroleum	43.5	40.9	38.9	44.5	42.0	40.2
Coal	0.7	0.6	9.9	10.2	11.1	10.3
Major hydro	7.8	11.1	9.5	6.5	6.0	9.7
New Renewable Energy	0.7	1.7	2.9	2.3	3.2	3.7

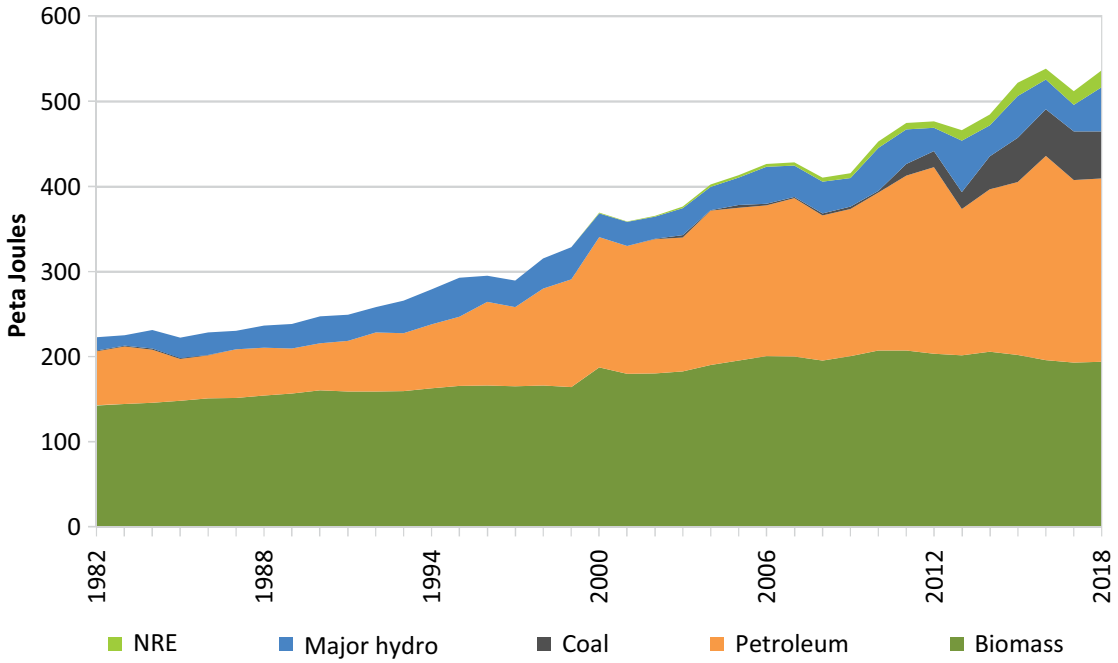


Figure 3.1 – Evolution of Energy Supply Forms

In early years (1970's, at which the earliest comprehensive energy accounts are available), the primary energy supply was dominated by biomass and petroleum. By end 2018, the share of biomass in the primary energy supply was 36.2%, whilst the share of petroleum was 40.2%. The contribution of NRE has increased marginally, while the share of major hydro, however, has increased from 6.0% to 9.7% owing to the favourable climatic conditions experienced in 2018. Figure 3 2 shows the variation on percentage shares of the Primary Energy Supply.

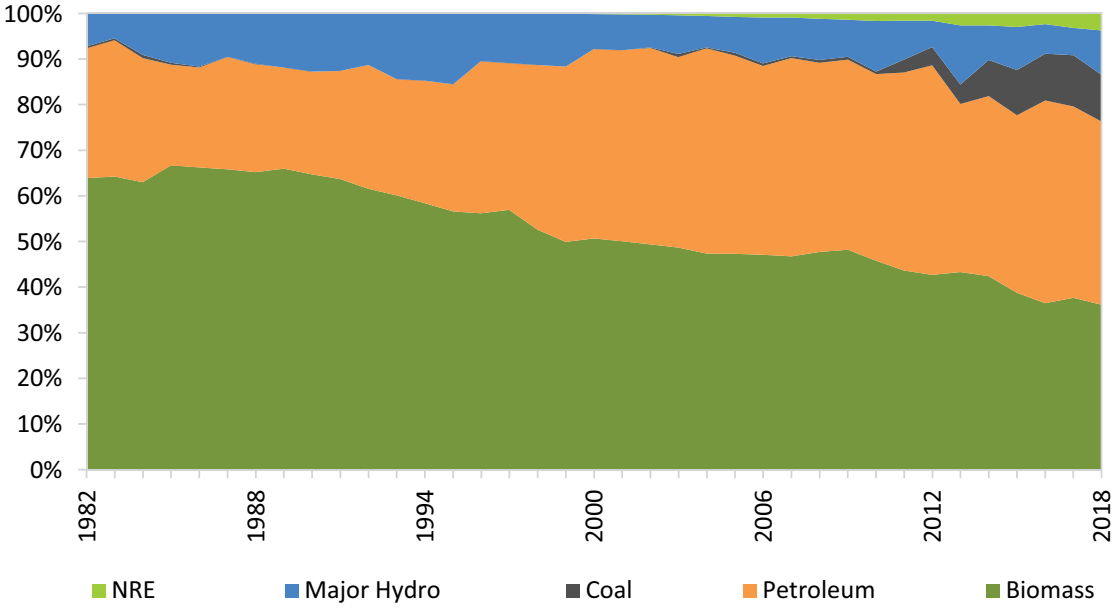


Figure 3.2 – Percentage Share of Primary Energy Supply

Biomass is the most widely available source of energy supply in the country, of which the largest use is in the domestic sector for cooking purposes. Due to the abundant availability, only a limited portion of the total biomass use is channelled through a commodity market and hence the value of the energy sourced by biomass is not properly accounted. However, this situation is fast changing with many industries switching fuel to reduce the cost of thermal energy. There is a growing demand from the users to regularise the biomass market by way of introducing quality traceability and sustainability assurance schemes. With the successful completion of the project Promoting Sustainable Biomass Energy Production and Modern Bio-Energy Technologies by SEA and UNDP in 2018, the biomass industry can look forward to a better future with most of the regulatory instruments now available for adoption in Sri Lanka.

Sources of Production of Biomass

Biomass comes in different forms. Following are the most common forms of biomass available in Sri Lanka.

- Fuel wood (unprocessed logs)
- Fuel wood (processed chips)
- Municipal Waste
- Industrial Waste
- Agricultural Waste

General biomass conversions are given in Table 3.2

Table 3.2 – Biomass Conversions

Primary Source	Conversions
Firewood (natural yield, home gardens, dedicated woodlots)	Thermal energy for boilers to generate steam for industry uses and electricity generation and combustible gases to drive Internal Combustion engines for electricity generation
Coconut Shell	Charcoal, activated carbon; mostly for export as a non-energy product
Bagasse	Thermal energy to generate steam for boiler-turbine units used for electricity generation
Wood	Charcoal; mostly for the hotels and household markets

3.1.2 Energy Supply from Petroleum

As a country with no proven indigenous petroleum resources yet, Sri Lanka totally depends on petroleum imports, both in the form of crude oil and as finished products. Table 3 3 summarises the imported petroleum products.

Table 3.3 – Importation of Petroleum Products

kt	2005	2010	2015	2016	2017	2018
Crude Oil Import	**2,008.4**	**1,819.4**	**1,676.8**	**1,685.0**	**1,499.4**	**1,763.0**
Product Imports	**2,018.6**	**2,495.8**	**2,995.3**	**3,658.7**	**4,139.9**	**4,085.7**
LPG	149.1	137.1	277.0	345.0	387.0	413.0
Gasoline	288.5	451.8	899.0	956.7	1,097.4	1,128.5
Avtur	200.8	222.8	270.8	337.0	282.2	461.0
Kerosene	45.5	-	-	-	-	-
Auto Diesel	1,054.8	1,199.2	1,288.8	1,574.4	1,763.2	1,482.6
Fuel Oil	270.8	423.0	203.3	349.6	581.2	553.3
Avgas	0.1	0.3	0.1	0.1	0.2	0.1
Bitumen	8.9	44.7	32.2	71.0	19.7	28.2
Mineral Gas Oil	-	16.9	24.1	24.9	9.0	19.0
Solvents	0.2	-	-	-	-	-

The importation of crude oil has increased in 2018 compared to 2017, whereas the importation of finished petroleum products has decreased marginally. The importation of crude oil had increased by 15%, whereas the importation of finished products had decreased by 1.3% in 2018.

3.1.3 Energy Supply from Coal

The demand for coal decreased marginally in 2018 as the primary demand for coal is from the power generation sector, which was dominated by the increased hydropower generation due to the favourable rains which caused increased hydropower generation in 2018. (Figure 3 3 and Table 3 4).

Table 3.4 – Importation of Coal

kt	2005	2010	2015	2016	2017	2018
Coal Imports	92.7	108.1	1,881.5	**2,404.6**	**2,527.0**	**2,166.0**

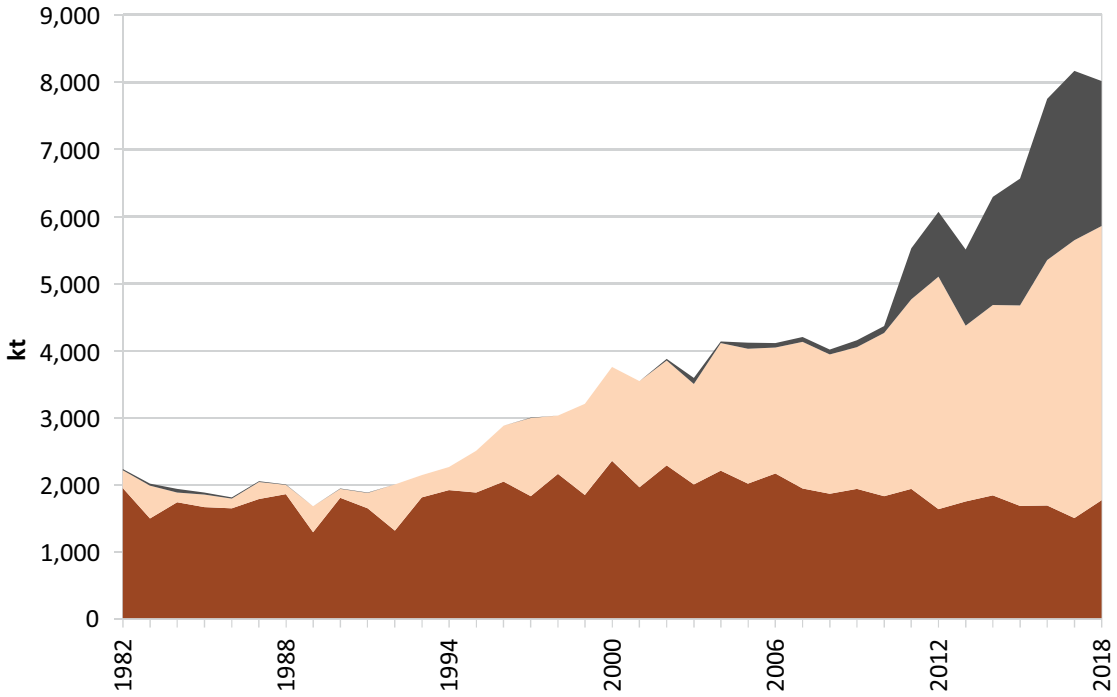


Figure 3.3 – Importation of Petroleum Products

3.1.4 Supply from Major Hydro

The topography of the country provides an excellent opportunity to harness the energy stored in river water which flows from the central hills of the country to the Indian Ocean surrounding the island. The contribution of hydro as an energy supply source is always through its secondary form, which is electricity. Having an early start in the hydro electricity generation, Sri Lanka has nearly exhausted the hydro power potential in its river systems. With the commissioning of the remaining four projects under construction the era of major hydropower development will come to an end. Three of these projects progressed in 2018, and it is expected that the Broadlands project in the Kelani river system will add 35 MW in 2020 and the Uma Oya project in the Badulla district will add 122 MW by 2020. Procurement work related to the Moragolla hydropower plant of the Mahaweli river system recommenced and it is expected that this project will progress and yield 30.2MW capacity by 2023. Moragahakanda project, the last project in the Mahaweli river system started to generate electricity in 2018, adding 25MW of capacity to the national grid.

3.1.5 Supply from New Renewable Energy

The development of New Renewable Energy (NRE) commenced with the commissioning of the first hydro plant (Dickoya) in 1996, with an installed capacity of 0.96 MW. The NRE industry however, was stagnant with an average capacity addition of 0.5% per annum, till about 2007. This situation changed for better with the establishment of the Sri Lanka Sustainable Energy Authority in 2007, which is an apex institution established for the purpose promoting indigenous energy resources. At present, NRE is seen in many forms such as small hydro, solar, wind and biomass power plants. The Small Power Producers for hydro plants are typically 'run-of-the-river' type.

Legal issues continued to keep 33 projects in abeyance denying the country of 49.67MW of clean power capacity. Legal action by various lobby groups contributed to delay the implementation of large number of renewable energy projects in the country.

By end 2018, eight solar power plants were commissioned. Apart from the large scale orthodox use of solar energy in drying and crop processing, large scale deployment of solar hot water systems are seen in new home construction. Also, the interest in solar roof top systems is seen to be increasing at a rapid rate. By end 2018, there were about 265 service providers actively engaged in this trade.

The wind development by the private sector which added 128.5 MW of capacity to the national grid, delivered 325 GWh of energy during 2018. The two 10MW wind projects in the Northern sector, the first projects which came up under the competitive bidding process failed to progress as expected. Land acquisition for these projects has turned out to be a complex and time consuming task.

The contribution of major hydro and NRE to the primary energy supply is depicted in Table 3.1, Figures 3.1 and 3.2 above.

3.2 Petroleum Refinery Operations

3.2.1 Refinery Product Output

The country's petroleum product requirements are met partly by direct import of finished products and partly by processing imported crude oil. The only refinery in Sri Lanka, located in Sapugaskanda, converts imported crude oil to refined products to supply approximately half of the petroleum demand of the country. The refinery produces its output at a rate of 2.3 million tonnes per year (50,000 bbl/stream day) and the refinery process flow is illustrated in Figure 3.4.

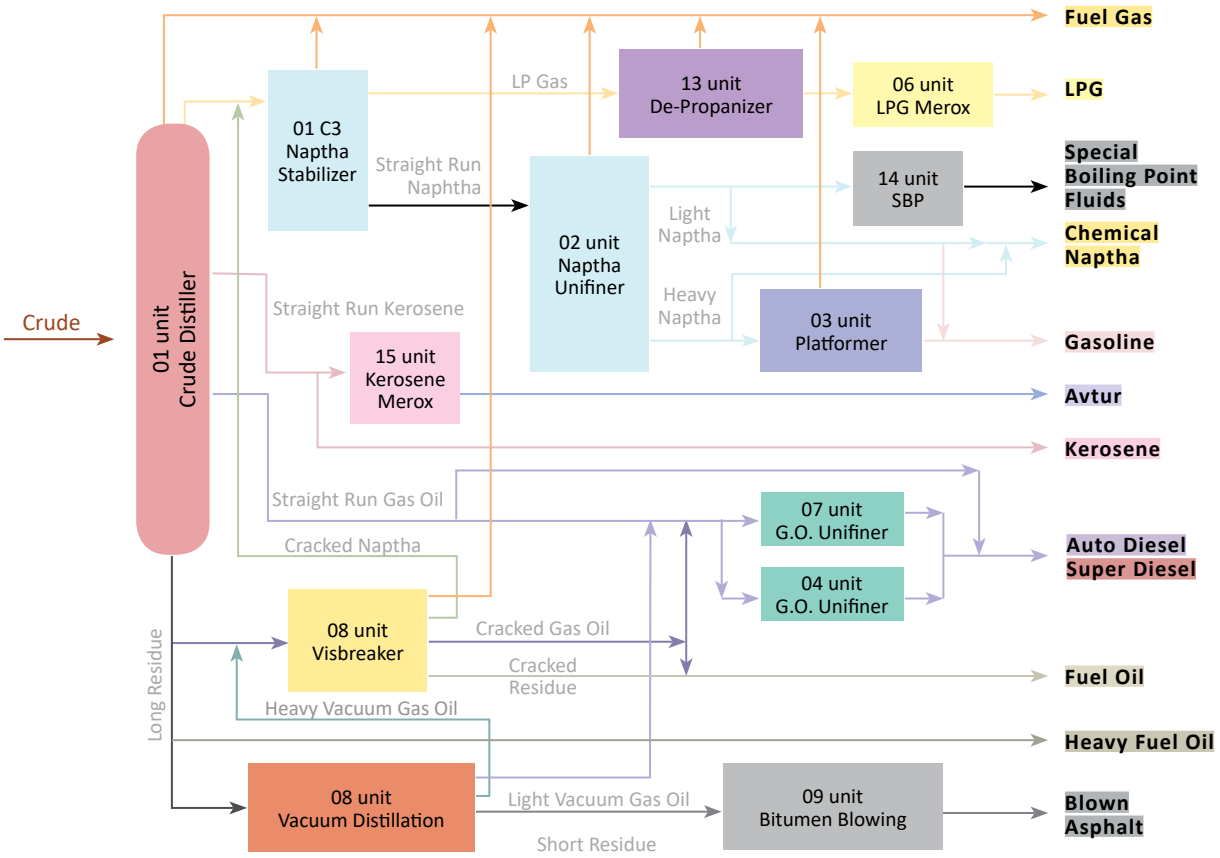


Figure 3.4 – Sapugaskanda Refinery Process Flow Diagram

The refinery operations were dominated by the processing of Murban Crude oil in 2018. In addition, Saharan Blend Crude was also processed at the Sapugaskanda refinery. Details of crude refined are given in Table 3 5. The CPC had to look for new sources of crude, owing to the on-going embargo which prevented any Iranian Light crude from reaching the refinery. This affected the throughput and process efficiency of the refinery.

Table 3.5 - Types of Crude Oil Refined at Sapugaskanda Refinery

kt	2005	2010	2015	2016	2017	2018
Arabian light	182.22	134.61	-	-	-	-
Iranian light	1,380.95	1,618.10	-	-	-	-
Miri Light	414.58	-	-	-	-	-
Upper zakum	-	-	-	93.75	-	-
Oman Crude	-	-	304.30	6.69	-	-
Dubai Crude	-	-	-	-	-	-
Murban Crude	-	-	1,387.77	1,557.95	1,404.23	1,570.25
DAS	-	-	-	87.79	95.17	-
Saharan Blend Crude	-	-	-	-	-	93.14
Total	**1,977.75**	**1,752.72**	**1,692.07**	**1,746.18**	**1,499.40**	**1,663.39**

The refinery maximum throughput is far less than the country requirement for petroleum products. Besides, its production slate differs from the mix of product demand. Although the refinery is operated at maximum design capacity to meet the demand for middle distillates, petrol, kerosene, Jet A-1 and diesel are still in deficit with a need for supplementary imports. All petroleum products had to be imported to supplement refinery production in 2018. Details of refinery output are given in Table 3 6 and Figure 3.5.

Table 3.6 - Refined Products from the Refinery

kt	2005	2010	2015	2016	2017	2018
Crude Input	**1,977.75**	**1,752.72**	**1,692.07**	**1,746.18**	**1,646.04**	**1,675.34**
LPG	13.05	22.93	9.65	8.84	19.42	22.08
Chemical Naphtha	113.31	84.29	136.56	144.24	141.69	140.66
Naphtha Total	**113.31**	**84.29**	**136.56**	**144.24**	**141.69**	**140.66**
Super Petrol	160.68	-	-	-	-	-
Regular Petrol	-	157.97	154.24	165.82	164.56	165.43
Petrol Total	**160.68**	**157.97**	**154.24**	**165.82**	**164.56**	**165.43**
Avtur	113.83	126.41	154.57	147.53	236.36	237.27
Kerosene	142.09	92.78	75.23	104.24	59.78	35.20
Auto Diesel	571.17	441.55	516.65	583.42	506.05	567.58
Super Diesel	7.19	-	-	-	-	-
Diesel Total	**578.36**	**441.55**	**516.65**	**583.42**	**506.05**	**567.58**
Furnace Oil 500'	20.58	-	-	-	-	-
Furnace Oil 800'	37.41	47.92	336.28	478.72	430.81	424.39
Furnace Oil 1000'	68.05	-	-	-	-	-
Furnace Oil 1500'	336.27	396.03	204.85	-	-	-
Furnace Oil 3500'	236.75	241.93	11.37	-	-	-
Furnace Oil Total	**699.06**	**685.88**	**552.50**	**478.72**	**430.81**	**424.39**
S.B.P.	4.04	2.73	1.51	0.63	0.62	1.56
Solvents Total	**4.04**	**2.73**	**1.51**	**0.63**	**0.62**	**1.56**
Bitumen	51.79	34.94	-	-	-	-
Total Output	**1,876.21**	**1,649.47**	**1,600.91**	**1,633.44**	**1,559.28**	**1,594.17**
Crude Input	1,885	1,753	1,692	1,746	1,646	1,675
Own Use and Losses (kt)	123	101	92	107	101	98
Own Use & loss as Percentage of Input	6.5%	5.8%	5.5%	6.1%	6.2%	5.8%

In 2018, the total refinery output increased to 1,594 kt from 1,559 kt in 2017.

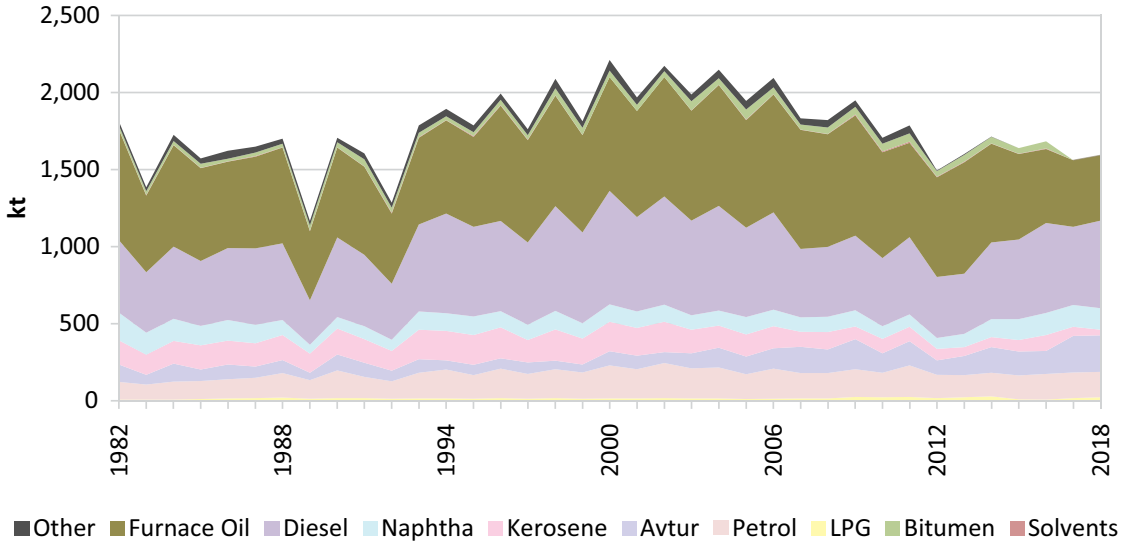


Figure 3.5 - Refined Product Output

3.2.2 Export of Surplus Products

Surplus production of the refinery is exported by the CPC, but the exported quantities are negligible in comparison with the imports. Table 3 7 summarises re-exported products, and naphtha and fuel oil were re-exported in 2018.

Table 3.7- Surplus Exports of Petroleum Products

kt	2005	2010	2015	2016	2017	2018
Naphtha	-	26.69	22.39	33.54	-	65.00
Fuel Oil	-	-	184.56	55.67	-	26.00
Total re-exported	**-**	**26.69**	**206.95**	**89.21**	**-**	**91.00**

4 Energy Conversion

4.1 Grid Electricity Generation

As far as the supply from secondary energy sources is concerned, conversion of primary energy in the form of hydro potential or petroleum to electricity is the most prominent. However, the conversion of petroleum fuel to steam which is used as an energy source in industries for their thermal application can also be considered a secondary form of energy. Though widely used, the quantum of steam generated, the quality and the end use is not recorded properly, which causes the discussion on supply from secondary energy sources to be limited to electricity.

Electricity generation in the country which was broadly divided into two parts based on whether they are connected to the national grid or whether they run isolated. Sri Lanka has a national grid, which now covers the whole country. It is very unlikely that further development of the off-grid sector will take place in the near term. However, the scope for the off-grid sector remains open in areas where grid electricity cannot be provided, such as the few inhabited islands.

Grid connected generation comprises of the following genre.

(i) CEB hydro power plants

(ii) CEB non-conventional power plants (only wind power at present)

(iii) CEB thermal power plants (oil fired and coal powered)

(iv) Independent Power Producers (IPPs) (presently oil-fired thermal power plants)

(v) Small Power Producers (SPPs) (presently mini hydro, one CHP plant, one solar power plant, wind power plants and biomass based power plants, all embedded in the distribution network)

(vi) Micro power producers (µPP), small scale power generators connected at the customer location, through one of the three schemes on offer.

Due to the significance of the grid supply compared with the diminishing role of off-grid supply, most of the analyses presented in the report will be for grid connected electricity supply.

4.1.1 Grid Connected Power Plants

As explained above, the electricity supply in Sri Lanka flows through the national grid and a brief description of the national grid is given in this section. Off-grid electricity generation is described in the next section.

Both CEB and private power producers generate electricity and supply to the national grid. All the large-scale hydro power plants in the country are owned by the CEB. Oil-fired thermal power plants and the coal power plant as well are owned by CEB. In addition to its own power plants, CEB as the single buyer of electricity, purchases electricity to the national grid from private Independent Power Producers (IPPs) who have entered into contracts with the CEB. All large IPPs are oil fired, while the mechanism to purchase electricity from renewable based power plants has enabled many Small Power Producers (SPPs) to generate and sell hydro power to the national grid. With the increase of electricity demand and delays

in construction of CEB's own power plants, the contribution from private power plants has increased significantly in the recent years.

Different Categories of Power Plants in the National Grid

CEB Power Plants

As the sole operator of the Sri Lankan power system, until 1997, the CEB owned and operated almost all the power plants in the national grid.

Independent Power Producers

Starting from 1997, many IPPs entered the electricity market, supplying electricity to the national grid. IPPs operate by entering into long term agreements with CEB. These contracts are individually executed under different terms and conditions. By 2018, six IPPs were in operation.

Small Power Producers

The number of small power producers increased rapidly over the period, under the enabling environment created by the Government, and implemented by the SEA through its facilitation of the project development through the newly introduced transparent resource allocation process. These power plants are operated by private sector investors and the installed capacity is limited to 10 MW since the plants are non dispatchable. Attractive tariffs offered through the cost-based, technology-specific tariff scheme, a policy intervention of the Ministry of Power and Renewable Energy and the flow of commercial financing provided by commercial banks contributed to the development of the industry.

However, the great strides made by the industry caused several issues, which in turn re-affected the industry. Most of the small hydropower developers were cautioned by activists opposing these projects on environmental and social grounds. This caused the environmental approval processes to become stricter, resulting in considerable delays. These delays affected the projects as most other time-restricted approvals realised by them expired before gaining the environmental approval. Lobbying against renewable energy projects escalated to legal action in 2018, causing more delays in project approval cycle.

On the regulatory front, suspension of purchase of electricity from producers at pre-determined feed-in-tariffs by CEB continued and no Standardised Power Purchase Agreements were signed in 2018. The Government is making strenuous efforts to resolve these issues and it is expected that a new regulatory mechanism will be designed and operated in the near future.

Net-metered Projects or micro power producers (µPP)

The net-metering scheme, which was introduced in 2010 continued to serve the solar PV rooftop industry with large scale implementation across the country. However, it failed to encourage other renewable energy projects as envisaged. By end 2018, 19,164 systems were connected to the national grid, adding 154 MW of capacity.

Rooftop Solar PV Proramme under the theme 'Sooryabala Sangramaya' launched in 2016 progressed as expected. In this scheme, excess energy exported to the grid can either be carried forward (as originally done in the net-metering scheme) or encashed (this scheme is identified as net-accounting), at a tariff

of LKR 22.00 per kWh during the first seven years and LKR 15.50 per kWh during the remaining thirteen years. The programme attempts to encourage institutional users through a third scheme, known as the micro power producers scheme, where all generation is exported through a separate export meter without making any change to the electricity users metering method.

With the significant reduction of cost of solar PV components, the service providers have quickly moved to tap large industrial customers who own large buildings with good roofs for solar PV systems. The scheme will receive a significant boost with the launch of a concessionary loan of USD 50 million granted by the Asian Development Bank in 2018.

Table 4.1 summarises the total grid connected capacity by type of power plant

Table 4.1 - Total Installed Capacity

MW	**2005**	**2010**	**2015**	**2016**	**2017**	**2018**
Major Hydro	1,207.5	1,207.5	1,377.0	1,383.9	1,391.35	1,398.85
Thermal Power Producers (CEB+IPP+Hired)	1,114.5	1,389.5	2,028.0	2,052.8	2,046.00	2,046.00
CEB Wind	3.0	3.0	3.0	3.0	3.00	3.00
New Renewable Energy	85.8	217.6	452.0	511.8	559.54	585.43
Micro Power Producers	-	-	27.7	50.4	93.72	153.50
Total Installed Capacity	**2,410.8**	**2,817.6**	**3,887.6**	**4,001.9**	**4,093.62**	**4,186.78**
%						
Major Hydro	50.1	42.9	35.4	34.6	34.0	33.4
Thermal Power Producers (CEB+IPP+Hired)	46.2	49.3	52.2	51.3	50.0	48.9
CEB Wind	0.1	0.1	0.1	0.1	0.1	0.1
New Renewable Energy	3.6	7.7	11.6	12.8	13.7	14.0
Micro Power Producers	-	-	0.7	1.3	2.3	3.7

Figure 4.1 depicts the total installed capacities serving the grid by type of power plant.

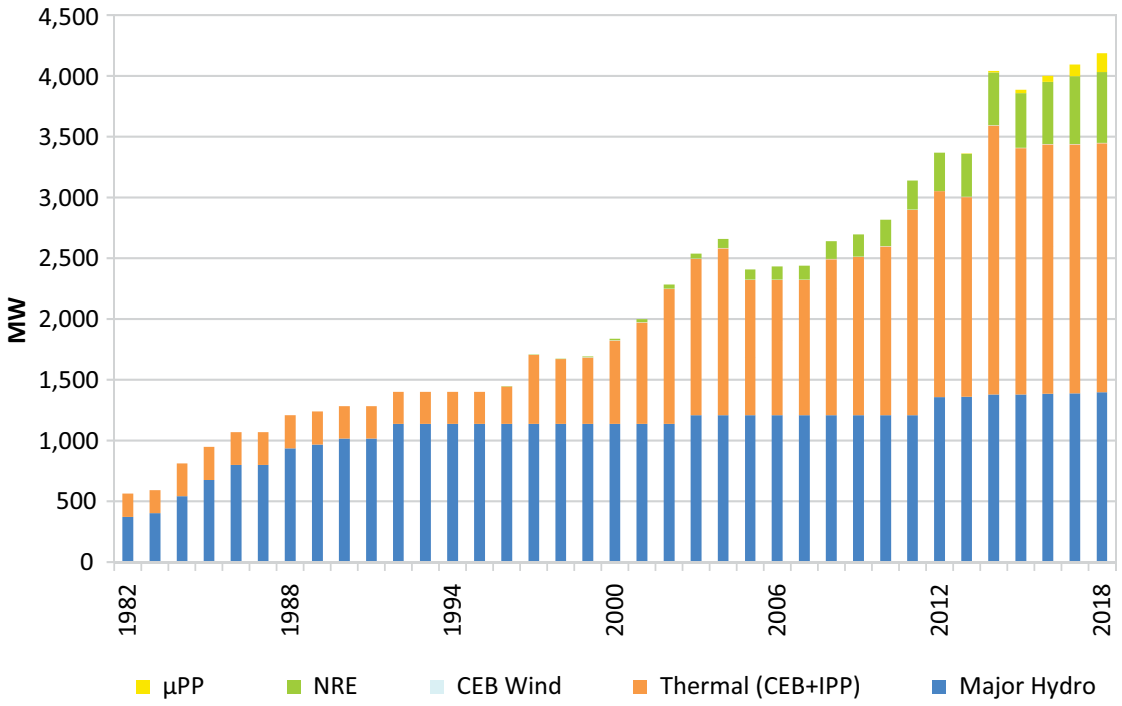


Figure 4.1 - Total Installed Capacity by Type of Power Plant

In the early stages, major hydro played a dominant role in power generation and continued until about 1996. Once the economically feasible major hydro schemes reached their saturation, the share of thermal plants in power generation increased. At present, 56% of power generation is from thermal power.

4.1.1.1 Major Hydro

Sri Lanka has two main hydro power complexes; namely Laxapana and Mahaweli, each consisting of several power plants. Laxapana complex is based on Kelani River while Mahaweli complex is based on Mahaweli River. Other than these major schemes, there are two independent large scale hydro power stations, namely Samanalawewa and Kukule Ganga while small scale power plants such as Inginiyagala and Uda Walawa are also generating hydropower using their respective reservoir storages. For administrative purposes, these smaller hydropower plants are grouped together as a single complex identified by the CEB as the 'Other Hydro' Complex, although these plants are located in different river systems.

Table 4.2 provides a list of major hydro power plants and their corresponding water storage capacities.

Table 4.2 - Storage Capacities and Generation of Major Hydro Power Stations

Name of Hydro Power Station	Plant Capacity (MW)	Name of the Reservoir	Reservoir Live Storage (million m^3)	Generation in 2018 (GWh)	Share in Generation (%)
Laxapana Complex					
Wimalasurendra	50	Castlereigh Reservoir	44.8	154.6	3.0
Canyon	60	Maussakelle Reservoir	123.4	170.7	3.3
Laxapana	53.5	Norton Pond	0.4	347.3	6.7
Samanala	75	Laxapana Pond	0.4	340.8	6.6
New Laxapana	116	Canyon Pond	1.2	546.3	10.6
Mahaweli Complex					
Kotmale	201	Kotmale Reservoir	172.6	578.3	11.2
Nilambe	3.2	-	-	12.6	0.2
Ukuwela	40	Polgolla Barrage	-	195.8	3.8
Bowatenna	40	Bowatenna Reservoir	49.9	83.4	1.6
Victoria	210	Victoria Reservoir	721.2	863.8	16.7
Randenigala	122	Randenigala Reservoir	875.0	418.4	8.1
Rantembe	49	Rantembe Pond	21.0	201.7	3.9
Upper Kotmale	150	Upper Kotmale	0.8	549.7	10.6
Other Hydro Complex					
Inginiyagala	11.25	Inginiyagala Reservoir	-	10.1	0.2
Uda Walawa	6	Uda Walawa	-	17.6	0.3
Samanalawewa	120	Samanalawewa Reservoir	278.0	356.2	6.9
Kukule Ganga	70	-	-	321.4	6.2
Total	**1,377**	**-**	**-**	**5,168.7**	**100.0**

By the end of 2018, a total of seventeen hydro power plants were in operation under the ownership of CEB.

4.1.1.2 Thermal Power

There are six oil-fired thermal power plants and three coal-fired plants that operate under the CEB, whereas four IPPs operate in private capacity.

Table 4.3 summarises thermal power generation in 2018.

Table 4.3 - Installed Capacities and Generation of Thermal Power Plants

Name of Power Station	Technology Type	Fuel Type	Capacity (MW)	Gross Generation (GWh)	Share in Generation (%)
CEB					
Kelanitissa Power Station	Gas Turbine (stg 2)	Auti Diesel	115	208.9	2.3
Kelanitissa Power Station	Gas Turbine (stg 3)	Auto Diesel	100	13.2	0.1
Sapugaskanda Power Station	Diesel Engine	Auto Diesel	80	13.3	0.1
		HSFO 380 cst (FO 3500)		222.7	2.5
Sapugaskanda Power Station Extension	Diesel Engine	Auto Diesel	80	11.9	0.1
		HSFO 380 cst (FO 3500)		397.6	4.4
Kelanitissa Power Station	Combined Cycle	Auto Diesel	165	248.5	2.7
		Naphtha		386.2	4.3
Uthuru Janani	Diesel Engine	HSFO 180 cst (FO 1500)	24	73.6	0.8
Barge Mounted Power Plant	Diesel Engine	HSFO 180 cst (FO 1500)	60	367.0	4.0
Puttalam Coal Power Station	Steam	Auto Diesel	900	10.1	0.1
		Coal		5,299.3	58.4
IPP					
Asia Power	Diesel Engine	HSFO 380 cst (FO 3500)	51	56.9	0.6
Ace Power Matara	Diesel Engine	HSFO 180 cst (FO 1500)	18	19.5	0.2
AES - Kelanitissa	Combined Cycle	Auto Diesel	163	301.0	3.3
	Steam Turbine		100	362.8	4.0
Ace Power Embilipitiya	Diesel Engine	HSFO 180 cst (FO 1500)	60	37.2	0.4
Yugadhanavi-Kerawalapitiya	Combined Cycle	LSFO 180 cst	270	1,040.4	11.5
Total			**2,046**	**9,070.3**	**100.0**

The oil-fired CEB power plants generated 1,943.0 GWh, while the coal-fired power plant generated 5,309.4 GWh. The contribution of the coal power plant to generation is 58.5%. The six IPPs generated 1,817.9 GWh in total.

4.1.1.3 CEB Wind Power

The first grid connected wind power plant, reached the end of its usable life, with some turbines developing gear box problems. The wind park area is to be taken over by a new investor of the Magampura Port, and plans were afoot to remove the turbines from the wind park to make way for future development of the location. Table 4 4 gives the capacity and generation of the wind power plant.

Table 4.4 - Installed Capacity and Generation of CEB Wind Power Plant

Name of the Power Station	Plant Capacity (MW)	Capacity of Turbines (kW)	Number of Turbines	Generation in 2018 (GWh)
Hambantota Wind Power Plant	3	600	5	1.3

4.1.1.4 New Renewable Energy

New Renewable Energy power plants are operated by private sector investors and the installed capacity is limited to 10 MW since the plants are non dispatchable. The first Small Power Producer Plant (Dik Oya) was commissioned in 1996, turning a new leaf in the New Renewable Energy industry. At present, the number and variety of SPPs have increased by several folds, and is scattered countrywide. Table 4 5 summarises the installed capacities and generation of SPPs contributing to the NRE industry.

Table 4.5 - Installed Capacities and Generation of NRE Power Plants by end 2018

Type of Power Station	Number of Plants	Total Installed Capacity (MW)	Generation in 2018 (GWh)	Share in Generation (%)
Hydro	194	368.5	1,232.0	70.7
Biomass	12	37.1	87.1	5.0
Solar	8	51.4	98.2	5.6
Wind	15	128.5	325.0	18.7
Total	**229**	**585.5**	**1,742.4**	**100.0**

Twelve SPP hydro plants and two biomass plants were commissioned in 2018, with installed capacities of 14.9 MW and 11 MW, respectively. There were no capacity additions in wind and solar in 2018. Figure 4 2 depicts the cumulative capacity additions and number of SPPs up to end 2018.

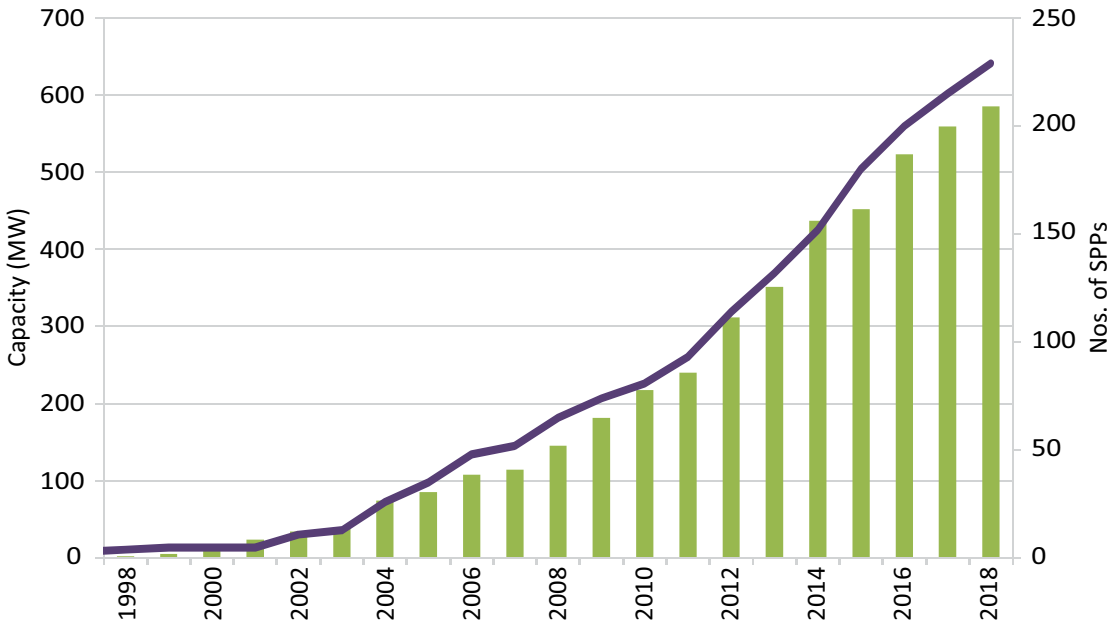


Figure 4.2 - Cumulative Capacity Additions and Number of SPPs

4.1.1.5 Micro Power Producers

By end 2018, 154 MW of µPP were in operation, generating approximately 215.1 GWh.

Table 4.6 - Cumulative Capacities and Generation of Net-metered Projects

Type of Net-metered Project	Number of Projects	Cumulative Capacity (MW)	Generation in 2018 (GWh)
Solar	11,882	154	215.1

4.1.2 Gross Generation of Grid Connected Power Plants

The total generation from major hydro plants, thermal plants, new renewable energy plants and net-metered project in 2018 was 16,197.8 GWh. Compared with the gross generation of 2017, which was 15,002.5 GWh, the generation in 2018 marks an increase of 7.9% as indicated in Table 4.7.

Table 4.7 - Gross Generation to the CEB Grid

GWh	2005	2010	2015	2016	2017	2018
Major Hydro	3,222.5	4,988.5	4,904.4	3,481.9	3,075.2	5,168.7
Thermal (Oil)	5,339.3	5,063.3	2,339.2	4,563.1	5,212.6	3,760.9
Thermal (Coal)	-	-	4,457.2	5,066.9	5,120.6	5,309.4
CEB Wind	2.4	3.0	1.1	2.1	2.2	1.3
New Renewable Energy	279.7	728.5	1,466.0	1,157.8	1,462.2	1,742.4
Micro Power Producers	-	-	38.8	70.7	129.7	215.1
Gross Generation to CEB Grid	**8,844.0**	**10,783.2**	**13,206.8**	**14,342.6**	**15,002.5**	**16,197.8**
Year-on-year growth rate	9.6%	8.2%	2.9%	8.6%	4.3%	7.9%

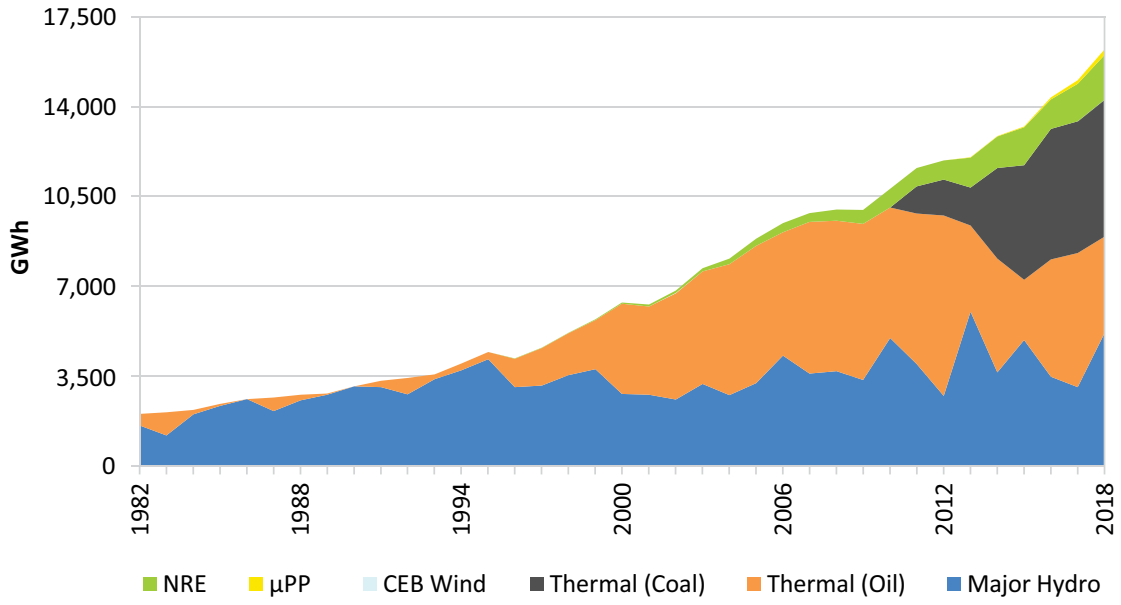


Figure 4.3 - Gross Generation to CEB Grid

In early stages, the energy mix included only major hydro plants and oil-fired thermal plants. The generation mix started diversifying from 1996 and the trend continues to date. At present however, the thermal share is dominant and it would continue to remain with the entry of coal power plants as base load generators.

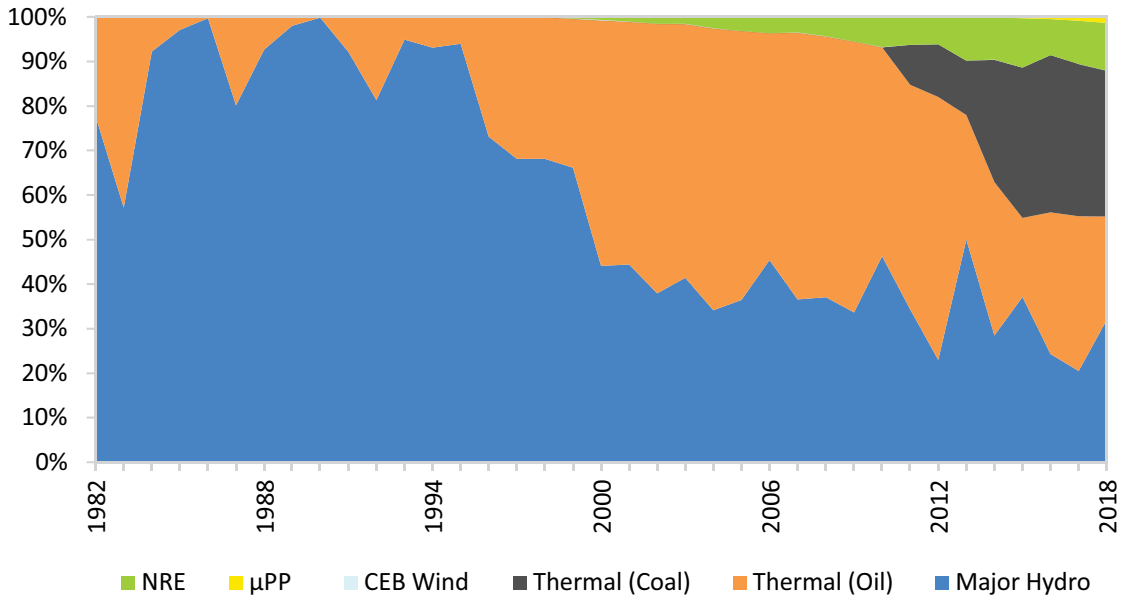


Figure 4.4 - Evolution of Generation Mix: 1981 to 2015

The NRE industry, which commenced in 1996 has progressed expeditiously, increasing in capacity each year. Figure 4 5 depicts the growth of the industry since inception to date.

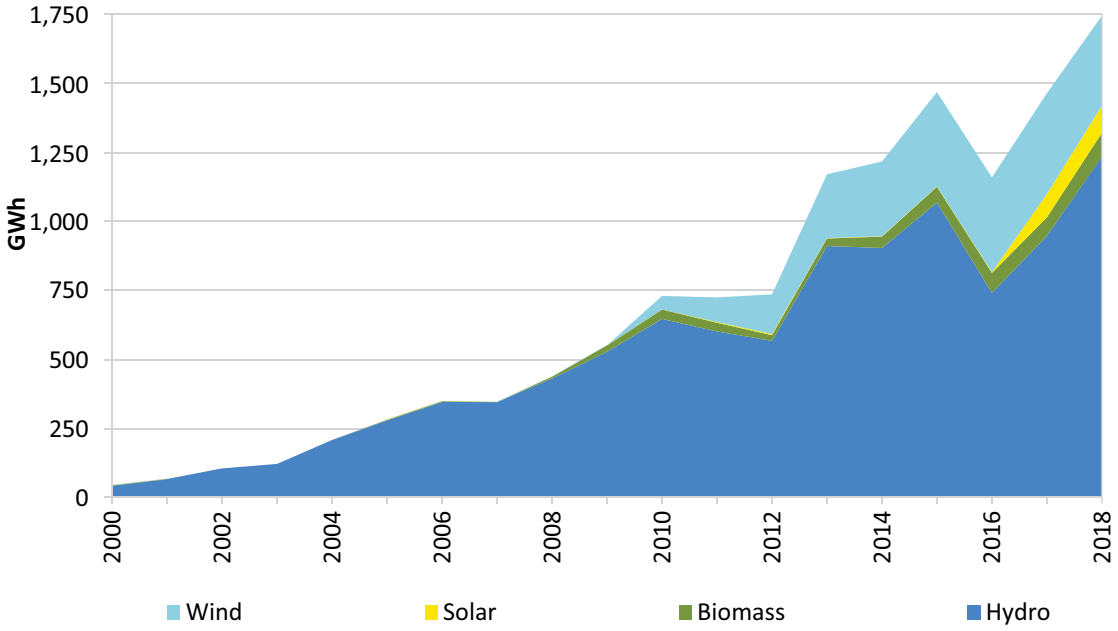


Figure 4.5 - Gross Generation of New Renewable Energy Power Plants

The share of NRE generation was 10.76% in the total gross generation to the CEB grid in 2018. There is a marked increase in hydro power generation as indicated in Figure 4 5, sanctioned by the favourable weather conditions that prevailed in 2018.

4.1.3 Different Technologies used by Power Plants in the National Grid

Table 4.8 - Grid Connected Power Plant Capacities (MW) by Technology Type

Technology	2005	2010	2015	2016	2017	2018
CEB Power Plants						
Major Hydro	1,207	1,207	1,377	1,384	1,391	1,399
CEB Wind	3	3	3	3	3	3
Steam, Fuel Oil	-	-	-	-	-	-
Steam, Coal	-	-	900	900	900	900
Sub total, Steam	**-**	**-**	**900**	**900**	**900**	**900**
Diesel Engine, Residual Oil	160	160	160	160	160	160
Diesel Engine, Fuel Oil	-	-	24	24	24	24
Diesel Engine, Diesel Oil	8	8	-	-	-	-
Sub total, Diesel Engines	**168**	**168**	**184**	**184**	**184**	**184**
Gas Turbines, Diesel Oil	215	215	195	195	195	195
Sub total, Gas Turbines	**215**	**215**	**195**	**195**	**195**	**195**
Combined Cycle, Naphtha, Diesel	165	165	165	165	165	165
Sub total, Combined Cycle	**165**	**165**	**165**	**165**	**165**	**165**
IPP						
Diesel Engine, Residual Oil	51	51	51	51	51	51
Diesel Engine, Fuel Oil	323	343	100	100	118	118
Diesel Engine, Diesel Oil	30	15	-	-	-	-
Combined Cycle, Diesel, Fuel Oil	163	433	433	433	433	433
Sub total IPP	**567**	**842**	**584**	**584**	**602**	**602**
SPP						
Hydro	84	175	306.7	337.9	353.6	368.5
Combined heat and power	0.1	0.1	-	-	-	-
Solar	-	-	1.4	21.4	51.4	51.4
Biomass	2	12	20.1	24.1	26.1	37.1
Wind	-	30	123.9	128.5	128.5	128.5
Sub total SPP	**86**	**218**	**452**	**512**	**560**	**585**
µPP						
Solar	**-**	**-**	27.7	50.4	93.7	153.5
Sub total µPP	**-**	**-**	**28**	**50**	**94**	**154**

Table 4.9 - Fuel Usage and Generation by Technology Type

Technology Type	2005	2010	2015	2016	2017	2018
CEB Gross Generation (GWh)						
Steam, Coal	-	-	4,447.2	5,054.5	5,112.0	5,299.3
Steam, Diesel	-	-	10.0	12.3	8.7	10.1
Diesel Engine, Residual Oil	849.2	830.9	271.9	763.9	674.0	620.4
Diesel Engine, Fuel Oil	-	-	87.9	469.3	533.7	440.6
Diesel Engine, Diesel	6.9	16.8	22.5	20.9	18.7	25.2
Gas Turbines, Diesel Oil	299.2	53.3	25.1	308.5	401.0	222.0
Combined Cycle, Diesel Oil	333.7	255.7	119.5	128.4	267.4	248.5
Combined Cycle, Naphtha	673.0	237.6	540.3	669.2	702.1	386.2
CEB Fuel Use (million litres)						
Steam, Coal (million kg)	-	-	1,880.0	2,004.0	2,086.5	2,009.1
Steam, Diesel	-	-	3.0	5.8	4.1	3.9
Diesel Engine, Residual Oil	188.7	184.9	60.6	169.7	150.8	137.4
Diesel Engine, Fuel Oil	-	-	19.3	102.3	116.7	95.9
Diesel Engine, Diesel	6.9	5.3	6.7	6.7	6.2	7.7
Gas Turbines, Diesel Oil	106.1	21.6	9.2	112.1	147.5	81.0
Combined Cycle, Diesel Oil	74.6	59.3	26.7	28.9	65.7	56.6
Combined Cycle, Naphtha	179.6	78.0	144.7	180.0	203.6	102.2
IPP Gross Generation (GWh)						
Diesel Engine, Residual Oil	362.4	325.0	101.1	130.2	119.4	56.9
Diesel Engine, Fuel Oil	2,228.1	2,245.1	235.5	374.9	598.9	382.4
Diesel Engine, Fuel Oil (LSFO 180 cst)	-	-	-	-	167.0	37.2
Diesel Engine, Diesel Oil	111.1	87.8	-	-	-	-
Combined Cycle, Diesel Oil	475.8	464.1	264.0	1,116.6	472.0	301.0
Combined Cycle, Fuel Oil (LSFO 180 cst)	-	547.1	671.4	581.2	1,193.6	1,040.4
Combined Cycle, Fuel Oil (HSFO 180 cst)	-	-	-	-	27.3	-
IPP Gross Fuel Use (million litres)						
Diesel Engine, Residual Oil	81.3	72.6	23.0	29.5	28.5	13.1
Diesel Engine, Fuel Oil	499.7	490.7	51.5	85.7	114.5	85.6
Diesel Engine, Diesel Oil	25.8	24.9	-	-	43.7	9.8
Diesel Engine, Fuel Oil (LSFO 180 cst)	-	-	-	-	-	-
Combined Cycle, Diesel Oil	96.3	99.1	56.0	242.1	107.2	55.3
Combined Cycle, Fuel Oil (LSFO 180 cst)	-	120.5	152.3	139.4	253.2	229.9
Combined Cycle, Fuel Oil (HSFO 180 cst)	-	-	-	-	10.0	-

4.1.4 Fuel Usage and Conversion Efficiency in Thermal Power Generation

Thermal power plants operating in Sri Lanka primarily use petroleum fuels such as diesel, fuel oil, residual oil and naphtha. Table 4.10 details the total quantities of common fuels used in power generation by thermal power plants.

Table 4.10 - Total Petroleum Fuels Used in Power Generation

	2005	2010	2015	2016	2017	2018
Fuel Oil (HSFO 180 CST, FO 1500) - (million litres)	503.6	490.7	70.8	188.0	241.2	181.6
Coal (million kg)	-	-	1,880.0	2,004.0	2,086.5	2,009.1
Residual Oil (HSFO 380 CST, FO 3500) (million litres)	270.1	257.5	83.6	199.3	179.3	150.5
Diesel (million litres)	311.8	210.2	98.6	389.9	370.3	210.4
LSFO 180 CST (million litres)	-	120.5	152.3	139.4	253.2	229.9
Naphtha (million litres)	179.6	78.0	144.7	180.0	203.6	102.2

The consumption of liquid petroleum fuels has generally decreased in 2018, compared to 2017. The major share of thermal power generation was borne by coal power. At present, the types of fuel used in power generation have increased in variety, owing to the large share of thermal power, as shown in Figure 4 6. Liquid fuels have been converted into corresponding weights at 30 0C (ambient temperature).

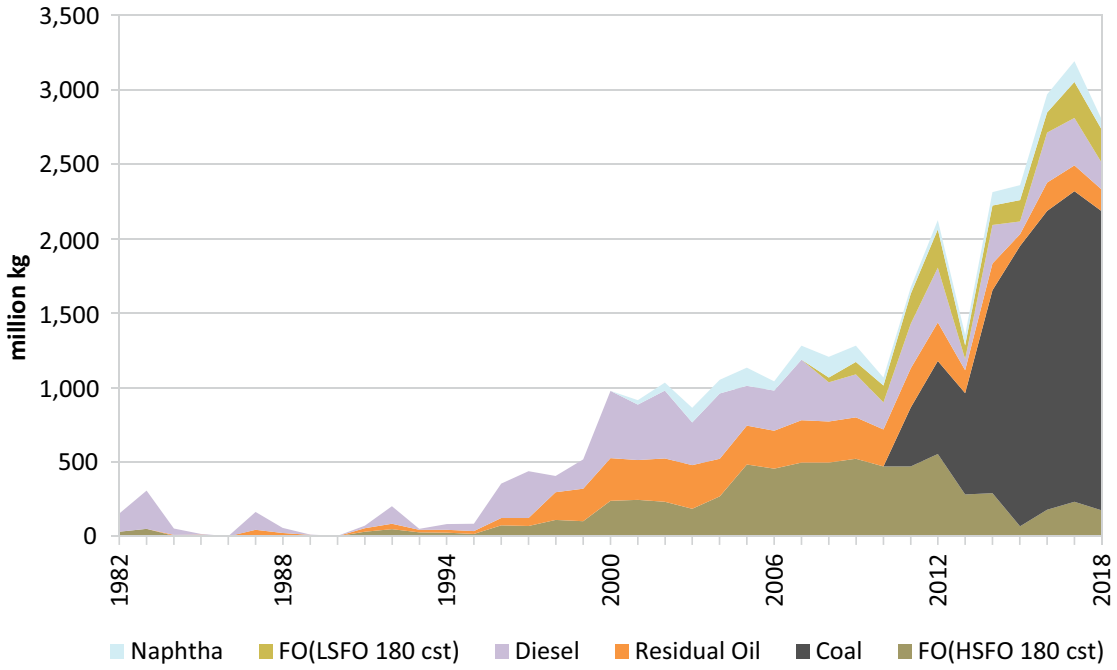


Figure 4.6 - Fuel Consumption in Thermal Power Generation by Type

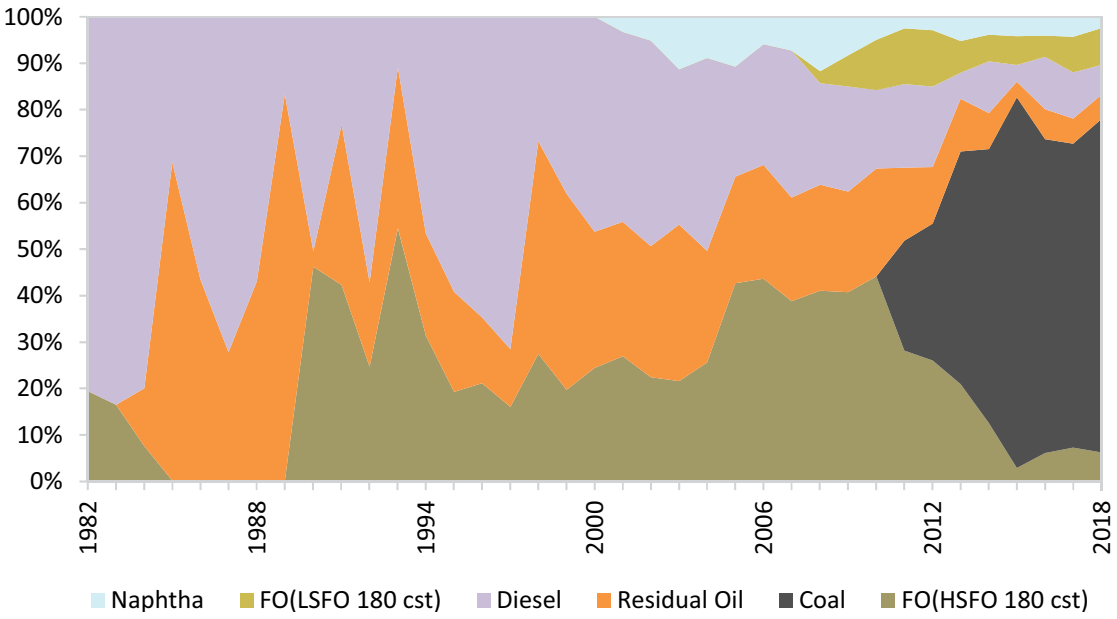


Figure 4.7 - Percentages of Fuel Mix in Thermal Power Generation

Table 4.11 summarises the efficiencies of thermal power plants by technology type.

Table 4.11 – Thermal Power Plant Efficiencies

Power Plant Efficiencies	2005	2010	2015	2016	2017	2018
CEB						
Steam, Coal	-	-	35.5%	37.8%	36.7%	39.6%
Steam, Diesel	-	-	31.4%	20.2%	19.9%	24.3%
Diesel Engine, Residual Oil	39.5%	39.5%	39.4%	39.5%	39.3%	39.7%
Diesel Engine, Fuel Oil	-	-	40.0%	40.3%	40.2%	40.4%
Diesel Engine, Diesel	21.9%	29.8%	31.9%	29.5%	28.7%	30.8%
Gas Turbines, Diesel Oil	26.7%	23.4%	25.8%	26.1%	25.8%	26.0%
Combined Cycle, Diesel Oil	42.4%	40.9%	42.5%	42.2%	38.6%	41.6%
Combined Cycle, Naphtha	41.5%	33.7%	41.3%	41.2%	38.2%	41.8%
CEB Gross Thermal Generation (Gcal)	1,859,282	1,199,040	4,750,977	6,387,301	6,637,076	6,237,052
CEB Fuel Energy Input (Gcal)	4,909,253	3,198,724	13,074,230	16,894,212	18,157,111	15,918,569
CEB Power Plant Efficiency	**37.9%**	**37.5%**	**36.3%**	**37.8%**	**36.6%**	**39.2%**
IPP						
Diesel Engine, Residual Oil	39.1%	39.3%	38.6%	38.7%	36.7%	38.2%
Diesel Engine, Fuel Oil	39.2%	40.2%	40.2%	38.4%	45.9%	39.2%
Diesel Engine, Diesel Oil	40.8%	33.4%	-		36.2%	36.0%
Combined Cycle, Diesel Oil	46.8%	44.4%	44.7%	43.7%	41.8%	51.6%
Combined Cycle, Fuel Oil (LSFO 180 cst)	-	39.9%	38.4%	36.3%	41.0%	39.4%
Combined Cycle, Fuel Oil (HSFO 180 cst)	-	-	-	-	24.0%	-
IPP Net Thermal Generation (Gcal)	2,732,531	2,684,904	516,533	1,394,647	1,167,263	619,813
IPP Fuel Energy Input (Gcal)	6,796,878	6,639,385	1,237,795	3,324,129	2,769,632	1,426,187
IPP Power Plant Efficiency	**40.2%**	**40.4%**	**41.7%**	**42.0%**	**42.1%**	**43.5%**

The highest efficiencies are reported in the combined cycle power plants of the CEB. These plants use diesel, fuel oil and naphtha and they have a higher overall efficiency and other operational advantages compared with the diesel engine power plants.

4.2 Off-Grid Electricity Generation

Isolated power generating facilities are available in some locations owing mainly to the unavailability of the national grid. In addition, standby power supplies are also available in most industries and commercial facilities, although their generation is very minimal due to the short-term nature of operation. The capacities and energy converted at these standby generators are not accounted for in this report.

Three main contexts in which off-grid electricity is used are as follows.

(i) Diesel generators are maintained only as a standby option and run only for short durations during grid failures, periodic testing and during generator servicing.

(ii) Renewable energy systems, such as small hydro (for industries and households), wind and solar photovoltaic systems for households are also operated off-grid due to unavailability of grid and technical reasons.

(iii) Four northern islands are provided with diesel generators, and utility level services are provided to customers by CEB, although the availability may not be round the clock. Integration of renewable energy to these island grids commenced with the Eluvaithivu Island.

The non-conventional off grid energy systems such as village and estate hydro plants and household solar photovoltaic systems are discussed separately in this report. Off-Grid generation broadly comprises the following genre.

(i) Self-Generation: Using own generating plants, even if the grid is available. Only a few locations, and they too are used sparingly.

(ii) Off-grid (Industrial): Industries using their own generation either as a matter of policy, keeping the grid supply only as backup or owing to non-availability of the grid in close proximity. Only a few locations, and they too are used sparingly.

(iii) Off-grid (non-industrial): Mostly rural systems of small micro hydro, wind, solar and other renewable energy based systems.

With the rapid expansion of the national grid, the role of off-grid electrification continued to diminish in 2017. Further activities in this area are expected through solar PV based DC micro grids in coming years.

4.3 Total Generation

The bulk of electricity generation in Sri Lanka is from grid-connected power plants. Table 4.12 gives the summary of electricity generation from grid-based and off-grid, conventional and non-conventional sources.

Table 4.12 – Total Gross Generation in Sri Lanka

GWh	2005	2010	2015	2016	2017	2018
Major Hydro Power	3,222.5	4,988.5	4,904.4	3,481.9	3,075.2	5,168.7
Thermal Power	5,339.3	5,063.3	6,796.4	9,630.0	10,295.7	9,070.3
CEB Wind Power	2.4	3.0	1.1	2.1	2.2	1.3
New Renewable Energy	279.7	728.5	1,466.0	1,157.8	1,462.2	1,742.4
Micro Power Producers	-	-	38.8	70.7	129.7	215.1
Off-grid Non-Conventional (Off-grid Renewables)	13.7	17.5	18.8	18.8	18.8	18.8
Gross Generation	**8,897.7**	**10,800.7**	**13,225.5**	**14,361.3**	**14,983.7**	**16,216.6**
%						
Major Hydro Power	36.2	34.2	37.1	24.2	20.5	31.9
Thermal Power	60.0	46.9	51.4	67.1	68.7	55.9
CEB Wind Power	0.0 3	0.03	0.01	0.01	0.0	0.0
New Renewable Energy	3.1	6.7	11.1	8.1	9.8	10.7
Micro Power Producers	-	-	0.3	0.5	0.9	1.3
Off-grid Non-Conventional (Off-grid Renewables)	0.2	0.2	0.1	0.1	0.1	0.1

5 Energy Distribution and Pricing

Energy sources and energy demand are separated by vast swaths of time and space. Therefore, to provide a sound energy supply, vast transport/transmission network, storage and transaction elements are required. The supply of energy includes generation/conversion and distribution to end users. Distribution is the process of delivering energy from its source to the ultimate end use. For convenience, the terminal points of distribution are considered to be from the measuring point at generation/conversion to the measuring point at the end user.

5.1 Electricity Distribution and Prices

Distribution of electrical energy is through the transmission and distribution network, the main difference between the two being the voltage at which the power is delivered. Transmission is at voltages 132 kV and 220 kV, whereas distribution is done at 33 kV, 11 kV and 400V.

5.1.1 Transmission and Distribution Networks

5.1.1.1 Electricity Transmission Network

Sri Lanka has a single transmission network spanning the whole country with the exception of four small inhabited islands in the Northern Province. The national grid consists of overhead transmission lines interconnecting large scale power plants scattered mostly in the central region and the Western province, and grid substations where the distribution networks spread from. Apart from the most common transmission lines carrying power at 132 kV, a limited number of 220 kV transmission lines are also available in the network. These 220 kV transmission lines strengthen the network, especially between nodes having heavy power flows, such as Kotmale-Biyagama and Kotmale-Anuradhapura.

5.1.1.2 Electricity Distribution Network

Electricity distribution and sales in Sri Lanka is the responsibility of the following organisations;

- Ceylon Electricity Board (CEB)
- Lanka Electricity Company (Pvt) Ltd. (LECO)

At grid substations, the high voltage electricity in the transmission network is converted to 33 kV to be distributed within the locality. In some instances, the electricity at 33 kV is again converted to 11 kV at primary substations and then distributed to consumers. Distribution networks operated by LECO use 11 kV as the distribution voltage. However, both CEB and LECO step down the distribution voltage again to 400 V prior to delivering power to small scale consumers such as households and commercial buildings. For a limited number of industrial and commercial establishments, electricity is provided and metered at the distribution voltage itself. The distribution responsibility ends at the consumer metering point up to which the maintenance work is carried out by the corresponding service provider (*i.e.* CEB or LECO).

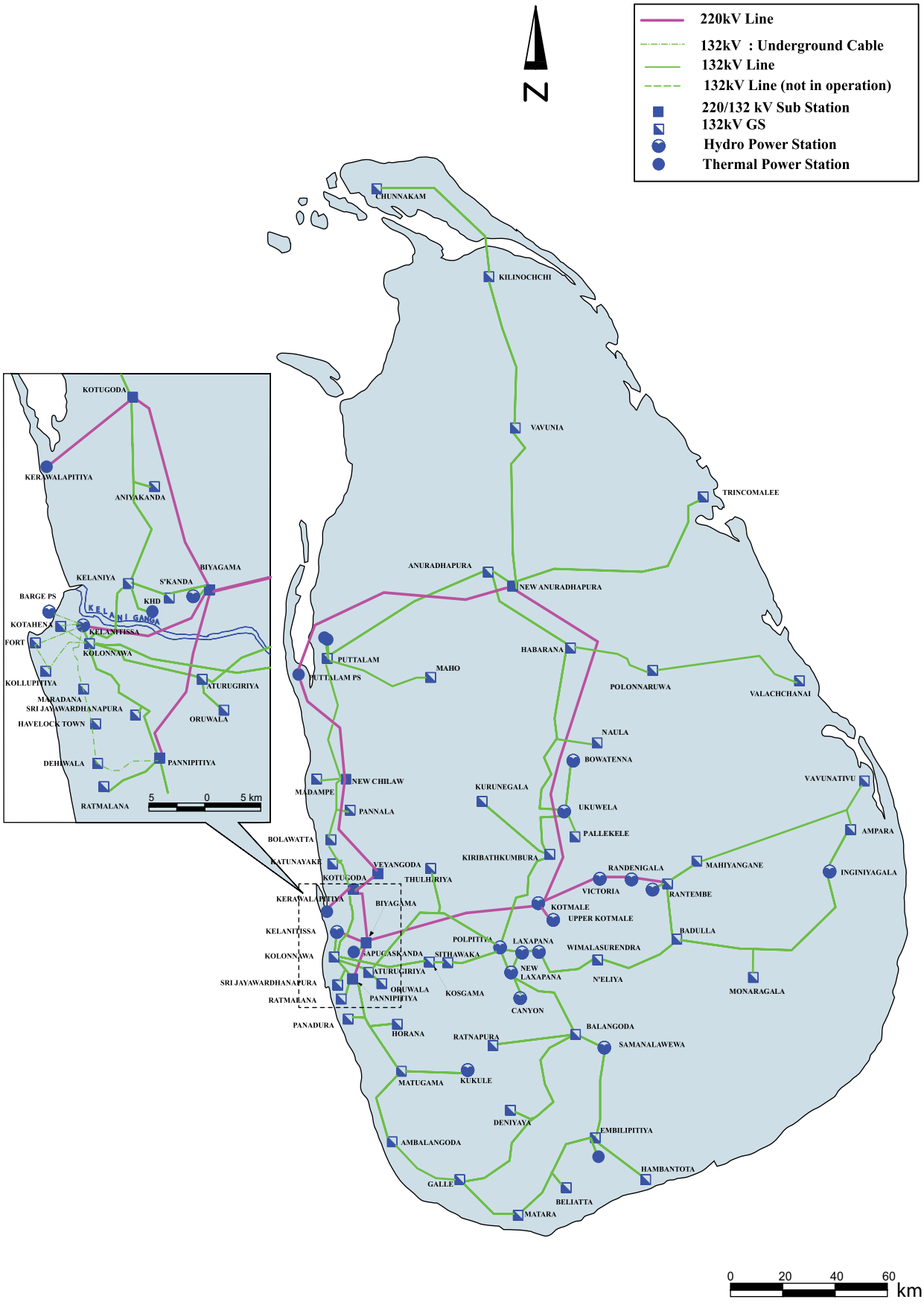


Figure 5.1 – Electricity Transmission Network (2017)

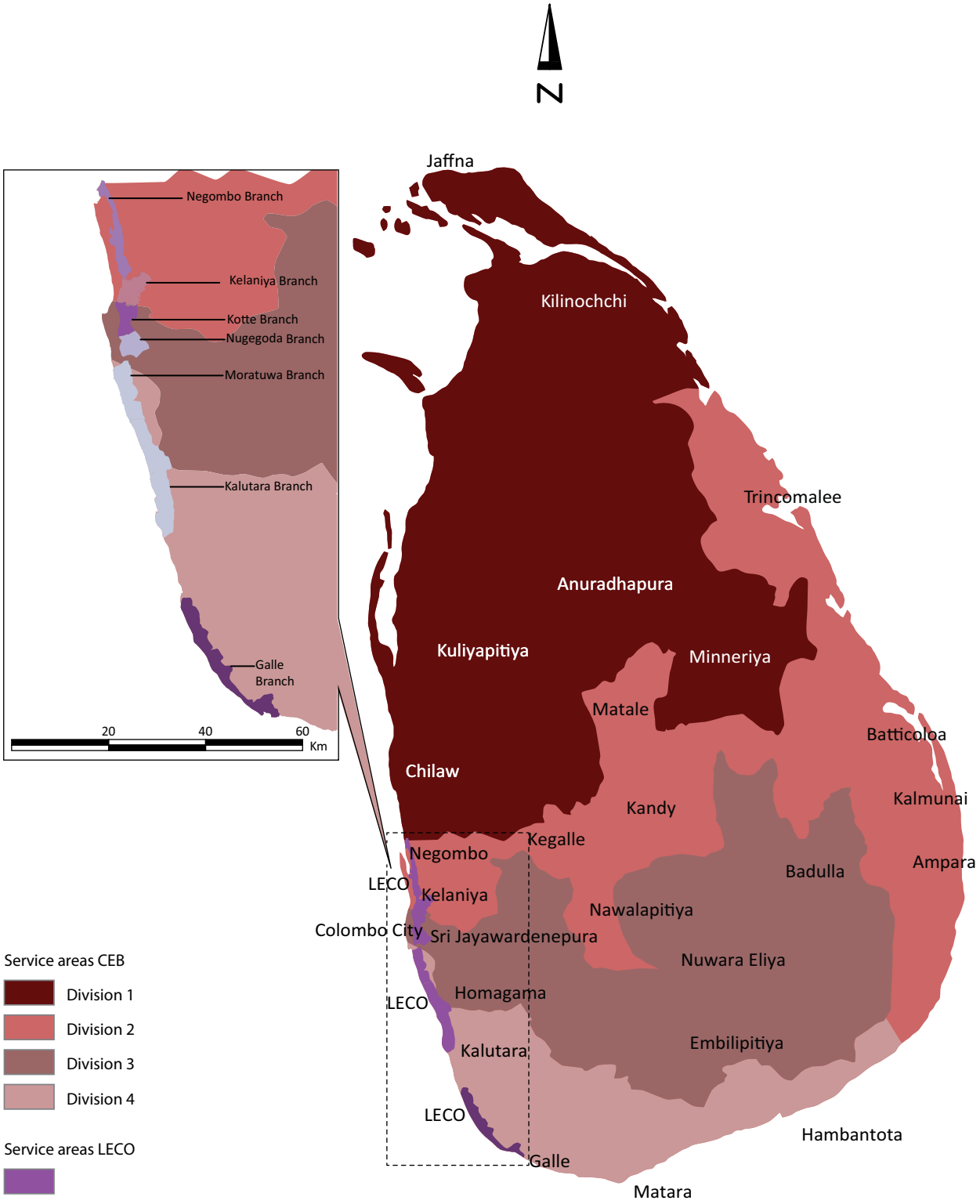


Figure 5.2 – Service Areas of the CEB and LECO

5.1.2 Electrification

All the categories of grid electricity consumers increased in number in 2018. While Table 5.1 shows the number of electricity consumers in the grid, Table 5 2 shows the share of electricity consumers of CEB and LECO separately.

Table 5.1 – Electricity Consumers Served by the Grid

Total Number of Consumer Accounts	2005	2010	2015	2016	2017	2018
Domestic	3,338,859	4,363,324	5,408,644	5,691,821	5,881,998	6,010,765
Religious	22,287	29,050	37,201	37,368	40,554	42,001
Industrial	38,299	48,461	59,820	62,051	63,783	65,648
Commercial	403,602	514,292	666,475	704,972	750,721	793,760
Streetlighting	4,050	2,931	3,065	2,756	2,770	2,892
Total	**3,807,097**	**4,958,058**	**6,175,205**	**6,498,968**	**6,739,826**	**6,915,066**

The number of total accounts served by the grid has increased by 3% in 2018 compared with 2017.

Table 5.2 – Electricity Consumers in the Grid, CEB and LECO

Total Number of Consumer Accounts	2005	2010	2015	2016	2017	2018
CEB						
Domestic	2,988,223	3,958,829	4,967,395	5,243,433	5,425,060	5,543,137
Religious	20,365	26,763	34,710	36,382	37,999	39,422
Industrial	34,020	45,059	56,681	58,381	60,694	62,570
Commercial	353,401	449,733	590,344	625,996	669,376	709,150
Streetlighting	1	1	1	1	1	1
Sub total CEB	**3,396,010**	**4,480,385**	**5,649,131**	**5,964,193**	**6,193,130**	**6,354,280**
LECO						
Domestic	350,636	404,495	441,249	448,388	456,938	467,628
Religious	1,922	2,287	2,491	986	2,555	2,579
Industrial	4,279	3,402	3,139	3,670	3,089	3,078
Commercial	50,201	64,559	76,131	78,976	81,345	84,610
Streetlighting	4,049	2,930	3,064	2,755	2,769	2,891
Sub total LECO	**411,087**	**477,673**	**526,074**	**534,775**	**546,696**	**560,786**

Note: CEB considers street lighting as one account, while LECO counts the street lighting systems individually as separate accounts.

The total number of accounts of the CEB and the LECO increased by 3% in 2018.

5.1.3 Electricity prices

A major role in electricity generation is played by the CEB while the IPPs and the SPPs play supportive roles. Unlike generation, CEB has a monopoly over electricity transmission. The distribution business is shared by CEB and LECO. Hence, the role of the CEB in the electricity industry in Sri Lanka is significant. As a result, analysis of the electricity sector financial performance is dominated by its main player; the CEB. Being a subsidiary of CEB and having a key presence in electricity sales, LECO financial performance is also important. Table 5 3 shows the sales and revenue of the two electricity utilities CEB and LECO, their annual revenue and average selling prices.

Table 5.3 – Average Electricity Sales, Selling Prices and Revenue of CEB and LECO

	2005	2010	2015	2016	2017	2018
CEB						
Sales (GWh)	6,228	8,067	10,340	11,232	11,835	12,451
Revenue from sales (LKRM)	49,735	105,710	165,741	182,396	193,268	204,078
Other Revenue (LKRM)	2,518	3,063	9,679	10,838	7,444	9,374
Total revenue (LKRM)	52,253	108,773	175,420	193,234	200,712	213,452
Average Selling price (LKR/kWh)	7.99	13.10	16.03	16.24	16.33	16.39
LECO						
Sales (GWh)	973	1,124	1,382	1,464	1,517.58	1,549.93
Revenue from sales (LKRM)	8,175	14,035	26,194	32,144	29,966.31	30,947.01
Total revenue (LKRM)	8,175	14,035	26,194	32,144	29,966.31	30,947.01
Average Selling price (LKR/kWh)	8.04	13.03	18.95	21.96	19.75	19.97

The national average selling price of electricity is given in Table 5 4 and the growth of the price is depicted in Figure 5.4.

Table 5.4 – National Average Selling Price of Electricity

	2005	2010	2015	2016	2017	2018
Average Selling price (LKR/kWh)	8.04	13.03	16.37	16.90	16.72	16.79

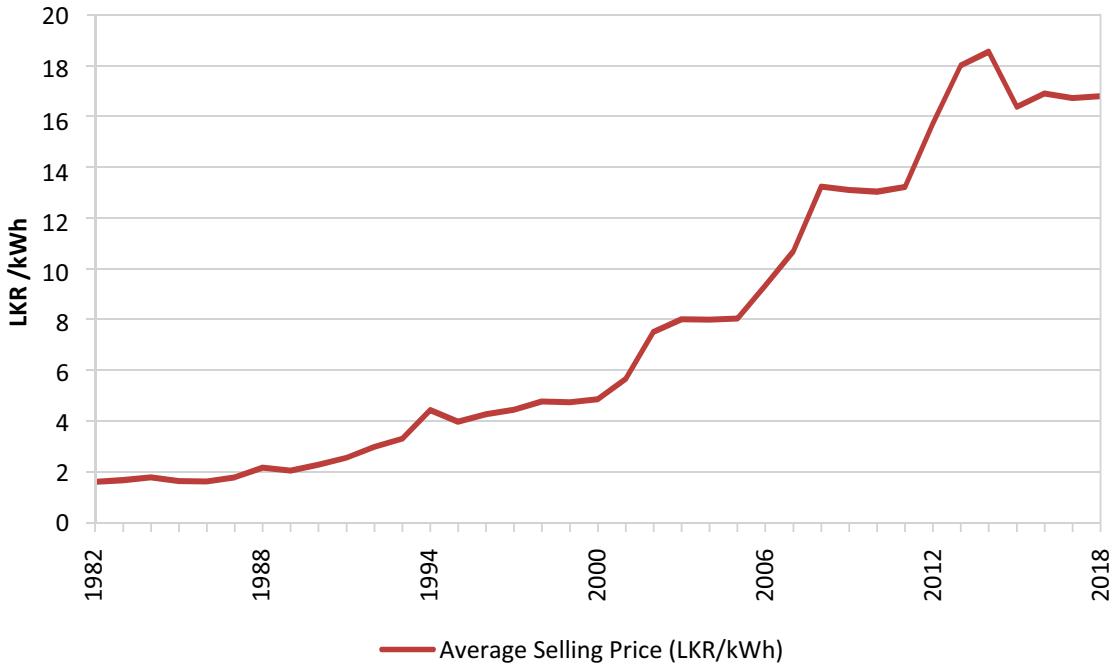


Figure 5.3 – National Average Selling Price of Electricity

The average selling price of electricity per kWh depends on the tariff structure and the sales to different consumer categories.

5.1.4 Electricity Tariff

As illustrated in Figure 5 4, the average selling price of an electricity unit in Sri Lanka increased over the time. Only around 200 customers migrated to the Time of Use (ToU) tariff offered to encourage at specific electricity use, as the peak time tariff was quite high. Nevertheless, this offer will continue to benefit electric vehicle users in future.

Effective date:

Domestic – September 16, 2014

Non-domestic categories – November 15, 2014

ToU for domestic category – September 15, 2015

Table 5.5 – Electricity Prices in Year 2017

	Unit Rate (LKR/Unit)	Fixed Charge (LKR)
Domestic		
Usage 0 – 60 kWh/month		
Block 1 – First 30 units	2.50	30.00
Block 2 – 31 – 60 units	4.85	60.00
Usage above 60 kWh/month		
Block 1 - First 60 units	7.85	N/A
Block 2 - 61 - 90 units	10.00	90.00
Block 3 - 91 - 120 units	27.75	480.00
Block 4 - 121 - 180 units	32.00	480.00
Block 5 - Above 180 units	45.00	540.00
Religious and Charitable Institutions		
Block 1 – First 30 units	1.90	30.00
Block 2 – 31 – 90 units	2.80	60.00
Block 3 – 91 – 120 units	6.75	180.00
Block 4 – 121 – 180 units	7.50	180.00
Block 5 – Above 180 units	9.40	240.00

Time of Use Electricity Tariff for Domestic Consumers

The following optional Electricity Tariffs based on Time of Use (TOU) for Domestic Consumers who are connected with 3 -phase 30A or above.

Time of Use (ToU)	Energy Charge (LKR/kWh)	Fixed Charge (LKR/month)
Peak (18.30-22.30)	54.00	540.00
Day (5.30-18.30)	25.00	
Off-peak (22.30-05.30)	13.00	

	General Purpose	Government (Schools, hospitals, ..etc	Industrial	Hotels
Rate - 1 Supply at 400/230 V				
Contract Demand < or = 42 kVA Unit Charge (LKR/unit) Fixed Charge (LKR/month)	GP1-1 For≤300 kWh/month 18.30 + 240.00 GP1-2 For>300 kWh/month 22.85 + 240.00	14.65 + 600.00	12.50 + 600.00	22.00 + 600.00
Rate – 2 Supply at 400/230 V				
Contract Demand above 42 kVA Unit Charge (LKR/unit) Demand Charge (LKR/kVA) Fixed Charge (LKR/month)	Day 20.80 (5.30 am – 6.30 pm) Peak 26.60 (6.30 pm – 10.30 pm) Off-peak 14.50 (10.30 pm – 5.30 am) + 1,100.00 + 3,000.00	14.55 + 1,100.00 + 3,000.00	Day 11.00 (5.30 am – 6.30 pm) Peak 20.50 (6.30 pm – 10.30 pm) Off-peak 6.85 (10.30 pm – 5.30 am) + 1,100.00 + 3,000.00	Day 14.65 (5.30 am – 6.30 pm) Peak 23.50 (6.30 pm – 10.30 pm) Off-peak 9.80 (10.30 pm – 5.30 am) + 1,100.00 + 3,000.00
Rate – 3 Supply at 11 kV and above				
Unit Charge (LKR/unit) Demand Charge (LKR/kVA) Fixed Charge (LKR/month)	Day 19.50 (5.30 am – 6.30 pm) Peak 24.00 (6.30 pm – 10.30 pm) Off-peak 13.50 (10.30 pm – 5.30 am) + 1,000.00 + 3,000.00	14.35 + 1,000.00 + 3,000.00	Day 10.50 (5.30 am – 6.30 pm) Peak 24.00 (6.30 pm – 10.30 pm) Off-peak 6.00 (10.30 pm – 5.30 am) + 1,000.00 + 3,000.00	Day 14.00 (5.30 am – 6.30 pm) Peak 23.00 (6.30 pm – 10.30 pm) Off-peak 9.00 (10.30 pm – 5.30 am) + 1,000.00 + 3,000.00
Street Lighting	at LKR 17.00 per Unit			

Note: 1. No Fuel adjustment charge is applicable for the above Tariff Structure.

2. Tariff for Religious & Charitable Institutions is not revised.

Road map for the implementation of ToU tariffs to industrial, general and hotel customers in the retail category by 2013, got further delayed in 2018 with no sign of any tangible progress. The cost of electricity supply depicted below deviated from the tariffs, prominently in the case of domestic sector (Figure 5 5).

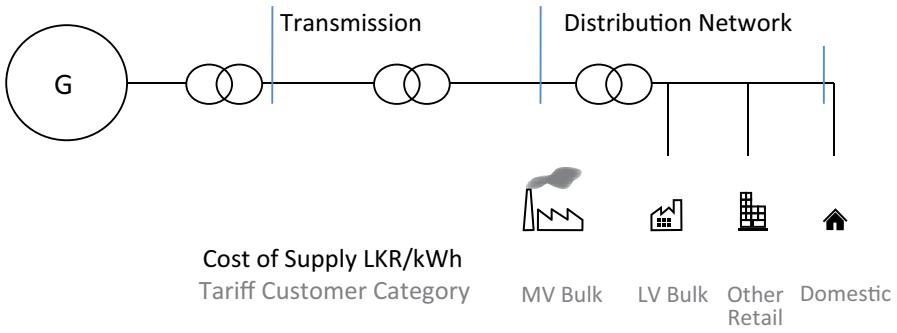


Figure 5.4 – Cost of Electricity Supply Diagram

5.2 Petroleum Distribution and Prices

As described previously, Sri Lanka meets the country petroleum demand entirely by imported petroleum brought in as either crude oil or refined products. Since the processing capacity of the CPC-owned refinery is not sufficient to meet the country demand, considerable amounts of petroleum products have to be imported and directly sold in the local market.

5.2.1 Distribution Structure

Until 2002, CPC was responsible for all aspects of petroleum supply, with the exception of retail marketing of LPG. By 2002, CPC owned and operated the refinery, all the import, storage and distribution terminals, and about 350 filling stations. In addition, there were about 700 privately-owned filling stations.

The refinery located in Sapugaskanda consists of 50,000 barrels/day processing plant and a 540,000 tonne crude oil tank farm. The refinery gets crude oil either directly from the Single Point Buoy Mooring (SPBM) facility installed about 10 km offshore or from the four crude oil storage tanks of 40,000 tonnes (each), located in Orugodawatta. Part of the refinery output is stored at Sapugaskanda storage facility for distribution and the balance is pumped to the Kolonnawa storage facility. The Sapugaskanda tank farm (mini-distribution facility) receives products only from the refinery. This has a total storage capacity of 60,000 tonnes in twelve tanks for diesel, kerosene and fuel oil.

The aging pipeline transport system was to be improved through a new pipeline installation in 2018. After a prolonged and successful effort to evict the illegal squatters on the pipeline trace, the procurement process was initiated to retain a contractor to perform the much needed upgrade. However, the launch of the project got further delayed due to a commercial dispute related to the contract award.

The Muthurajawela tank farm commenced operations in 2004. With the construction of this tank farm, Sri Lanka's storage capacity for finished petroleum products increased by 250,000 tonnes. Muthurajawela tank farm consists of 21 tanks of 10,000 m3 capacity and 8 tanks of 5,000 m3 capacity. These tanks store and distribute diesel and kerosene. Along with the tanks, CPC installed a new SPBM system, where 60,000 DWT (deadweight tonnage) ships could use the buoy for discharging imported finished products direct

from sea to tanks via a submarine pipeline. This terminal includes a loading facility to distribute products by road tankers. However, rail transportation of petroleum products stored in the Muthurajawela tank farm is constrained due to the absence of a railway line. A dual pipeline transport systems named the 'cross country pipeline' with a length of 6.5km is expected to link Muthurajawela tank farm with the Supugaskanda facility in the near future.

Petroleum supply for retail sale is done at the following storage/distribution facilities

1. Muthurajawela
2. Kolonnawa
3. Sapugaskanda mini distribution facility
4. China Bay storage facility
5. 13 regional depots.

Of the thirteen regional depots, Kurunagala depot added a new fire pump house and a distribution gantry to its assets in 2017, expanding its capabilities further.

Lanka Marine Services (LMS) located at Bloemandhal in Colombo receives imported products directly as well as from the Kolonnawa terminal via pipelines, and provides bunker fuel to ships via pipelines connected to Dolphin pier and also from South jetty. LMS terminal has a storage capacity of 23,000 tonnes of fuel oil and 6,800 tonnes of diesel.

Some amount of LPG is produced at the CPC refinery for local consumption. However, most of the country's LPG requirement is met through direct imports. LPG is imported through the Colombo Port, and also via a conventional buoy mooring system (CBM) for Litro Gas Lanka Limited facilities at Muthurajawela.

Residual oil (heavy furnace oil) is transferred directly from the refinery to the 160 MW Sapugaskanda power plant owned by the CEB and to the 51 MW residual oil power plant owned by Asia Power to produce electricity for the national grid. The refinery LPG production is delivered to the private distributor by means of road tankers and then filled into bottles for onward distribution to consumers.

As previously explained in this report, Sri Lanka meets all its petroleum demand by imported petroleum brought in as crude oil or refined products. Since the refining capacity of the CPC-owned refinery is not sufficient to meet the country demand, considerable amounts of petroleum products have to be imported and directly sold in the local market. Whether locally refined or directly imported, petroleum is channelled through the same distribution network which consists of several tank farms located in Kolonnawa, Sapugaskanda and Trincomalee and the local depots and the distribution stations (filling stations) spread all around the country.

5.2.2 Petroleum Prices

5.2.2.1 Prices of Crude Oil and Imported Finished Products

Crude oil imports increased in 2018 compared with 2017 as shown in Table 5.6.

Table 5.6 – Costs of Crude Oil Imports

Crude Oil Import Price Movements (F.O.B, Freight and C&F)	2005	2010	2015	2016	2017	2018
Quantity (kt)	2,008.41	1,819.43	1,676.76	1,685.03	1,499.40	1,763.00
Quantity (million bbl)	14.76	13.38	13.00	12.87	11.48	13.53
Crude Oil Import Unit Price (USD/bbl)						
F.O.B. Price	50.57	78.27	-	-	-	-
Freight Rate	1.30	0.97	-	-	-	-
C&F Price	51.87	79.24	55.81	45.25	56.99	75.69
Crude Oil Import Unit Price (LKR/bbl)						
F.O.B. Price	5,202.65	8,924.69	7,548.03	6,802.81	-	-
Freight	130.08	109.99	-	-	-	-
C & F Price	5,332.74	9,020.68	7,677.67	6,678.00	-	-

The import prices of finished petroleum products increased in 2018 compared with 2017. Details of costs of crude oil and other product imports are given in Table 5.7.

Table 5.7 – Finished Product Import Price Variation

Product Import Price Variation (F.O.B)	2005	2010	2015	2016	2017	2018
Mogas 92 Unl (USD/bbl)	61.08	86.23	71.15	58.2	69.85	81.56
Mogas 95 Unl (USD/bbl)	34.74	88.40	74.36	60.53	73.07	85.06
Naphtha (USD/bbl)	50.74	-	44.35	-	-	-
Kerosene (USD/bbl)	67.64	90.18	-	-	-	-
Gas Oil 0.05% S (USD/bbl)	-	90.35	68.49	54.68	67.17	87.68
Gas Oil 0.25% S (USD/bbl)	46.46	89.97	-	-	-	-
Gas Oil 0.5% S (USD/bbl)	-	89.55	68.27	-	-	-
Gas Oil 1.0% S (USD/bbl)	67.45	-	-	-	-	-
Gas Oil 0.001% S (USD/bbl)	-	-	-	56.95	68.88	88.72
FO 180Cst (USD/t)	264.10	470.28	-	49.56	54.47	-
FO 380Cst (USD/t)	254.10	462.59	-	-	-	-
LSFO (US$/t)	-	-	-	-	-	450.86
HSFO (US$/t)	-	-	-	-	-	491.89
LPG (USD/t)	538.00	714.46	-	-	-	-
Jet A-1 (USD/bbl)	-	-	69.66	55.99	67.30	87.13

5.2.2.2 Petroleum Product Prices in the Local Market

Table 5.8 summarises the price variations of locally sold petroleum products.

Month	Petrol (LKR/l)		Kerosene (LKR/l)		Diesel (LKR/l)		Furnace Oil (LKR/l)		LPG LKR/kg	
	90 Oct	95 Oct	Industrial	Domestic	Super	Auto	800 sec	1500 sec	Litro	Laugfs
2017-end Price	117.00	128.00	88.00	44.00	110.00	95.00	82.20	80.00	114.48	110.00
2018 Prices										
April 28										245.00
May 11	148.00	137.00	110.00	101.00	119.00	109.00				
June 13				70.00						
June 29									134.08	138.00
July 11	155.00	145.00			129.00	118.00				
August 11	157.00				130.00					
September 11	161.00	149.00			133.00	123.00				
September 27									123.04	195
October 11	169.00	155.00			141.00					
November 2		145.00				116.00				
November 16	164.00	140.00			136.00	111.00				
December 1	159.00	135.00			131.00	106.00				
December 22	149.00	125.00			121.00	101.00				
December 31									138.64	

Table 5.8 – Price Variation of Locally Sold Petroleum Products (Colombo Spot)

The prices of kerosene and LP gas were revised in 2017.

Figure 5.5 depicts the historical price changes of common petroleum products. The price indicated in the graph is the weighted average of monthly price revisions for a given year. The price of LPG is the average price of both Litro and LAUGFS.

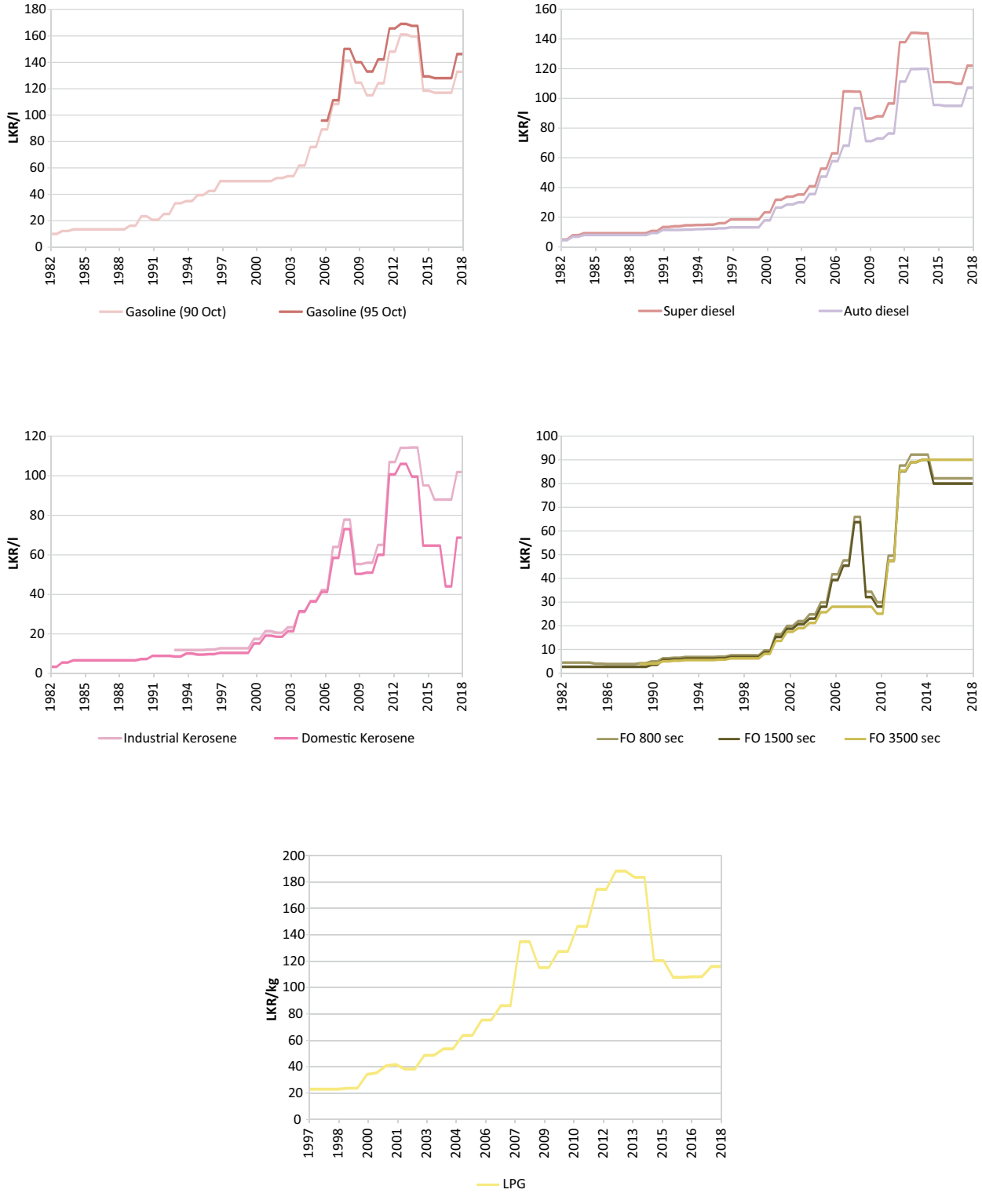


Figure 5.5 – Historical Price Variations of Petroleum Products

5.3 Coal Imports and Prices

The total quantities of coal imported are given in Table 5.9. Coal consumption has increased over time, with the commissioning of new coal power plants in 2014.

Table 5.9 – Coal Imports and Prices

	2010	2015	2016	2017	2018
Imported Qty (t)	108,116	1,881,462	2,404,574	2,527,000	2,165,987
Imported price (LKRM)	1,277	21,542	28,549	39,493	38,660
Price (LKR/kg)	11.82	11.45	11.87	15.63	17.85

5.4 Biomass Distribution and Prices

Biomass meets more than a third of the energy demand of the country. Abundant availability, especially in rural areas where the usage is most common, has simplified the distribution of biomass. The actual value of biomass is often misrepresented by its discounted price due to the simplified sourcing options. In terms of the cost of alternate fuels avoided, biomass has a significantly higher value to the economy.

With the increased household income levels, fuelwood used in cooking is reducing in volume. However, without a survey of the residential sector, the actual trends remain unreported. In contrast, with the advent of formal supply chains, biomass use in industrial thermal energy use is gaining rapid grounds, due to cost benefits. Table 5 10 gives the quantity of firewood produced and sold for industries.

Given the situation of increased use of biomass in industrial thermal applications, an attempt will be made to devise a consolidated set of data with the inclusion of both, major suppliers and major users in data collection efforts in by 2019.

Table 5.10 – Firewood Production and Sale for Industries

Firewood (m^3)	2005	2010	2015	2016	2017	2018
Quantity Produced	168,216	118,544	87,159	125,225	126,861	101,172
Quantity Sold	83,411	129,502	83,041	121,226	119,669	95,680

Early signs of an organised biomass industry became visible in 2016, with several major suppliers setting up fuelwood pre-processing facilities in close proximity to end-user facilities. It is estimated that around 500 - 700 tonnes/day of chipped fuelwood is used by individual thermal energy users in the export processing zones.

6 Energy Demand

Energy is a vital building block for economic growth, and energy demand provides vital signs for better management of an economy. Supply of energy discussed up to now is a direct consequence of the demand for energy, which is analysed in detail in this chapter. This chapter presents the analyses of energy demand from electricity, petroleum and biomass.

6.1 Electricity Demand

6.1.1 The System Demand

Electricity demand has two aspects. The first being the energy demand where the cumulative electrical energy requirement is met by the supply system. The peak demand is the other criterion to be fulfilled in meeting the national electricity demand. The generating system needs to be able to meet the peak demand of the national grid. Since the national demand profile has an evening peak, the capability of the supply system in meeting the demand during the evenings (i.e. peak period) is important. Figure 6 1 shows the hourly demand profiles of May 1, 2018, the day the system recorded the maximum peak.

In spite of being equipped with state of the art supervisory control and data acquisition (SCADA) systems, even the newly connected wind and solar power plants are not reporting realtime data to the system control centre. Accordingly, the demand estimates are continued to be based on monthly energy data provided by the small power producers.

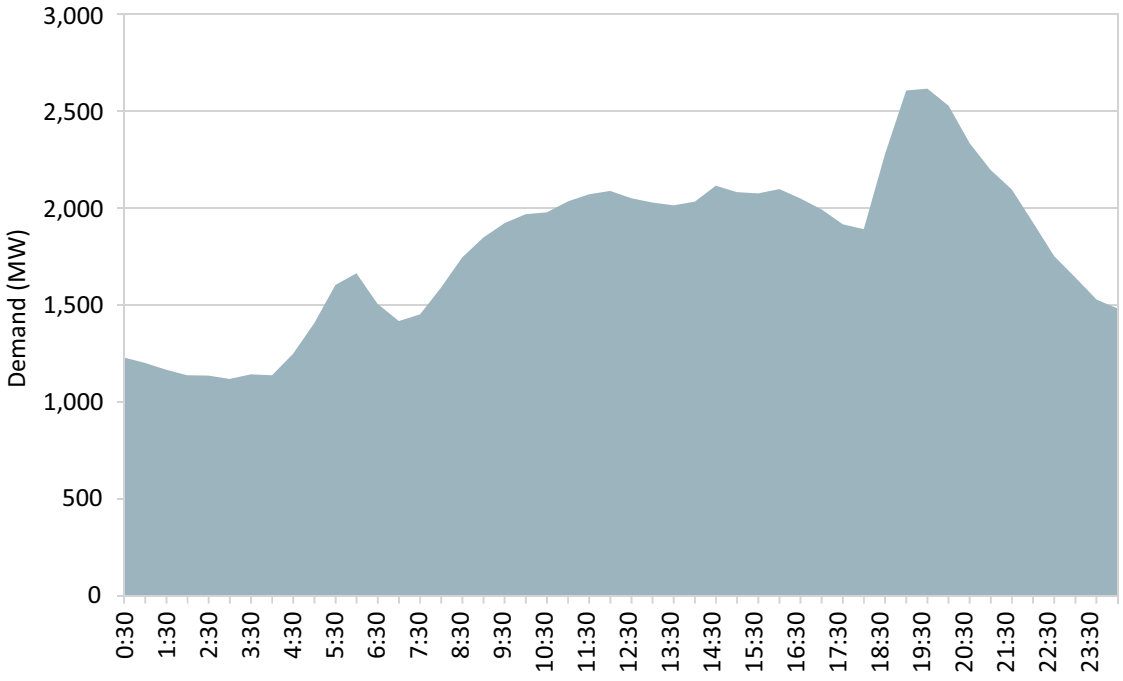


Figure 6.1 – System Demand Profile on 1 May 2018

Table 6.1 shows the development of the system peak demand over the years.

Table 6.1 - The Growth in System Capacity and Demand

System Parameters	2005	2010	2015	2016	2017	2018
Total Gross Generation (GWh)	8,897.7	10,800.7	13,226.6	14,361.3	15,021.2	16,131.3
Total Grid Connected Capacity (MW)	2,420.8	2,817.6	3,888.4	4,013.0	4,093.6	4,186.8
Maximum Demand (MW)	1,748.2	1,954.7	2,283.4	2,452.9	2,523.0	2,616.0
Reserve Capacity	672.6	862.9	1,605.0	1,560.1	1,570.6	1,570.8
System Load Factor	57.3%	63.0%	66.0%	66.7%	67.7%	70.3%
System Reserve Margin	37.9%	44.1%	70.3%	63.6%	62.3%	60.0%

System load factors in the range 55%-65% are typical of a customer mix dominated by households with a high demand for electricity used for lighting in the evening. The peak demand in 2018 was 2,616 MW. The system reserve margin declined by 2.2% in 2018. Figure 6 2 depicts the development of the system load factor, reserve margin and peak demand from 1979 to present.

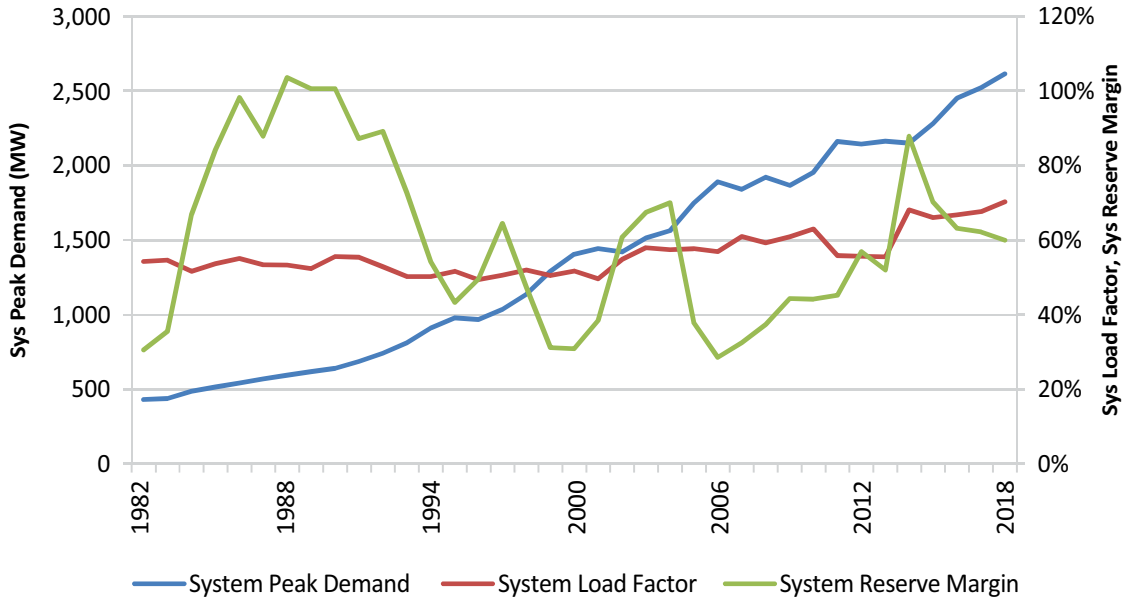


Figure 6.2 – Development of System Load Factor, Reserve Margin and Peak Demand

Figure 6.3 depicts the historic growth of the load curve.

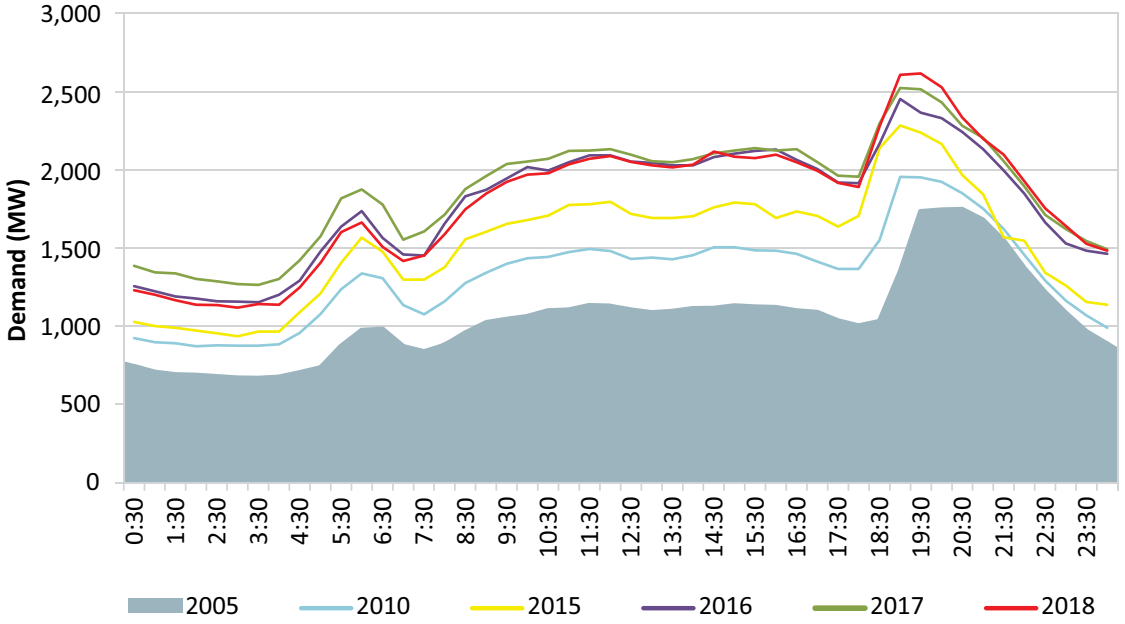


Figure 6.3 – The Growth in System Peak Demand

6.2 Petroleum Demand

6.2.1 Demand for Different Petroleum Products

The demand for different petroleum products vary primarily on their potential usage. For instance, auto diesel is widely used for transportation and power generation; in contrast to kerosene, which is used only for rural household energy needs, some industrial applications, agriculture and fisheries. Therefore, the demand for auto diesel is substantially higher than for kerosene. The refinery production process is adjusted to produce more of the high demand products while some products are directly imported to bridge the gap between refinery output and the demand.

The demand for petroleum products decreased in 2018 compared with 2017, owing to the decreased consumption in power generation. Table 6 2 summarises the demand for different petroleum products.

Table 6.2 – Demand for Different Petroleum Products

kt	2005	2010	2015	2016	2017	2018
LPG	165.0	187.5	293.4	356.0	412.0	435.0
Naphtha	124.9	54.1	97.2	174.3	139.3	69.4
Gasoline	463.0	616.5	1,009.0	1,463.1	1,276.8	1,358.7
Kerosene	209.0	165.1	130.2	172.4	159.0	209.5
Auto Diesel	1,665.3	1,696.8	1,996.0	2,148.8	1,922.1	1,766.3
Super Diesel	16.0	12.2	46.4	86.6	91.5	101.2
Furnace Oil	972.8	994.5	441.0	268.2	724.8	623.3
Total	**3,616.0**	**3,726.7**	**4,355.6**	**4,669.4**	**4,725.5**	**4,563.4**

Figure 6.4 depicts the evolution of the demand for different petroleum products through time. The demand for transport fuels like auto diesel, gasoline is on the rise and power generation fuels like auto diesel and furnace oil have increased over time. The demand for LPG has also increased, owing probably due to low prices maintained. Although a gradual reduction for kerosene demand was expected with the complete electrification of the country, the surge in demand for kerosene continued in 2018, driven most likely by the much lower price compared to transport fuels.

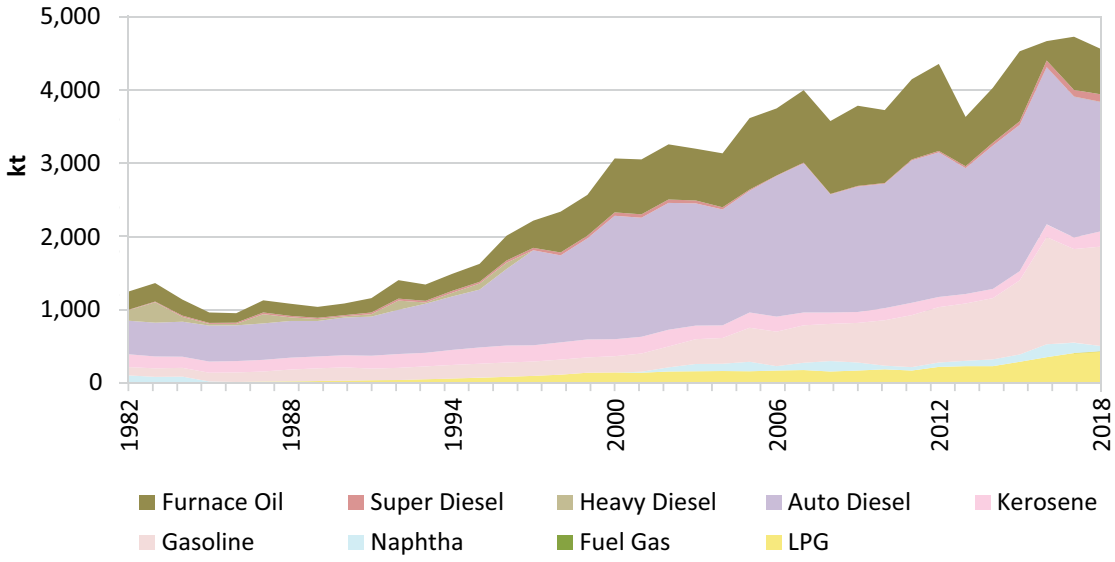


Figure 6.4 – Evolution in the Demand for Different Petroleum Products

6.2.2 Demand for Petroleum by District

Table 6.3 details the district-wise retail and consumer sales of petroleum products, of the CPC and LIOC in 2017. Figure 6.5 depicts the distribution of the petroleum demand by district in ktoe.

Table 6.3 – Demand for Petroleum by District

District Sales (kl)	Petrol (90 Octane)	Auto diesel	Super diesel	Kerosene	Industrial kerosene	Petrol (95 Octane)	Fuel oil 800 sec	Fuel oil 1500 sec (HS)	Fuel oil 1500 sec (Low)
Kandy	88,975	135,516	6,356	6,392	26	12,718	1,115	-	-
Matale	32,954	48,216	2,086	4,438	-	2,501	172	-	-
Nuwara Eliya	18,688	44,140	1,538	3,551	-	1,716	3,377	13	-
Batticaloa	27,466	34,319	799	6,989	-	871	-	-	-
Ampara	38,815	51,980	733	5,323	13	1,525	238	-	-
Trincomalee	21,427	50,774	653	10,299	-	561	620	-	-
Anuradhapura	64,237	87,182	1,901	8,359	198	3,973	40	-	-
Polonnaruwa	28,766	54,193	997	2,459	7	1,551	-	-	-
Jaffna	30,339	44,764	726	14,302	-	1,082	-	21,107	-
Mannar	5,640	11,507	191	7,088	-	119	-	-	-
Mulalativu	7,026	11,319	59	6,458	-	106	-	-	-
Vavuniya	10,714	27,911	535	4,458	-	541	-	-	-
Killinochchi	7,019	15,404	178	4,257	-	277	515	-	-
Kurunegala	128,462	184,060	5,940	11,652	7	10,903	6,501	264	-
Puttalam	53,008	85,348	3,947	19,523	7	4,732	1,848	-	-
Ratnapura	58,493	93,037	3,821	4,604	1,861	6,646	2,152	-	-
Kegalle	42,781	55,704	2,620	2,822	106	4,508	218	-	-
Galle	68,433	90,893	5,182	5,614	343	9,603	2,614	13	-
Matara	46,840	92,949	2,660	5,495	-	4,818	224	13,794	-
Hambantota	38,686	93,832	2,528	4,630	-	2,462	-	-	-
Badulla	37,082	65,891	1,907	2,716	7	3,300	13	-	-
Moneragala	27,162	51,850	1,096	2,633	-	1,630	2,732	53	-
Colombo	293,965	744,393	38,376	22,575	573	95,680	282,223	26,357	253,217
Gampaha	213,756	320,414	19,205	22,816	413	39,917	192,039	2,614	-
Kalutara	84,150	104,528	4,732	9,247	2,921	11,847	1,478	13	-
Total	**1,474,884**	**2,600,122**	**108,765**	**198,699**	**6,481**	**223,588**	**498,119**	**64,228**	**253,217**

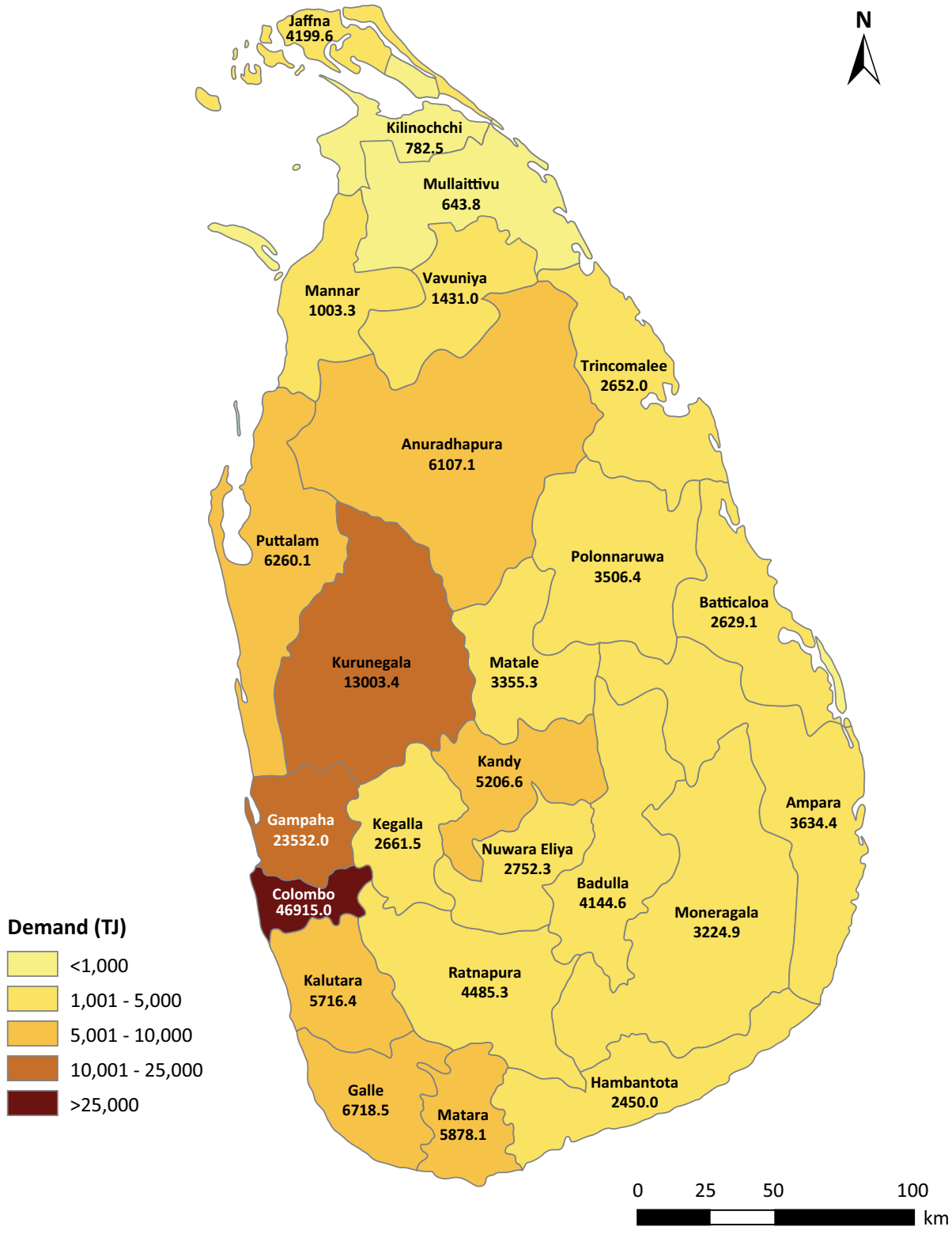


Figure 6.5 – Districtwise Demand for Petroleum (ktoe) - 2018

The highest demand for petroleum fuels is in the Colombo district, whereas the least demand was from the Mannar district.

6.3 Coal

Coal is an energy resource used in industries and power generation. With the commissioning of two new coal power plants in 2014, the demand for coal was on the rise (Table 6 4). Due to favourable hydropower generation in 2018, coal use experienced a marginal reduction.

Table 6.4 – Demand for Coal

kt	2005	2010	2015	2016	2017	2018
Total Consumption	92.7	95.1	1,966.6	2,081.9	2,156.6	2,084.1

6.4 Biomass

As the most significant primary energy supply source in the country, biomass has a widespread demand for both commercial and non-commercial applications. However, the informal nature of supply, mainly through users' own supply chains, has prevented accurate and comprehensive usage data being compiled for biomass. Therefore, estimation methods are used to develop reasonable information based on available data. Mid-year population data and LPG consumption are used to estimate household firewood consumption. Meanwhile, industrial biomass consumption is estimated based on the industrial production data and surveys. Most of the information on biomass presented in this report is based on estimates and sample surveys. There is an urgent necessity to conduct a census of biomass energy industry to derive a better understanding of the situation. Table 6 5 summarises the total usage of sources biomass.

Table 6.5 – Demand for Biomass

kt	2005	2010	2015	2016	2017	2018
Firewood	11,841.2	12,828.3	12,406.1	11,959.1	11,808.0	11,815.7
Bagasse	210.9	137.8	196.4	241.1	190.3	203.0

Bagasse is the waste form of sugar cane, which is used in sugar factories for combined heat and power generation. By 2018, the bagasse production was 203.6 kt, generated from the Pelawatta and Sevanagala sugar factories. Charcoal is produced mainly from coconut shell and wood. A major portion of the production of coconut shell charcoal is exported as a non-energy product.

6.5 Sectoral Demand

6.5.1 Electricity Demand by Different End Use Categories

Based on the usage type, electricity consumers are separated into the following categories.

- Domestic
- Religious purpose
- Industrial
- Commercial
- Street Lighting

Amounts of electricity used by different customer categories are given in Table 6 6, which also includes off-grid electricity generation using conventional and non-conventional sources. Although the electrical energy demand of different end users is established using electricity sales data, individual power demand of different categories cannot be established due to the lack of a monitoring system or regular load research. Nevertheless, by analysing the typical load profiles of different user categories, it is visible that the domestic category is most influential in the morning and evening peaks and the consequent low load factor of the system.

Table 6.6 – Electricity Sales by End Use Category

GWh	**2005**	**2010**	**2015**	**2016**	**2017**	**2018**
Domestic	2,865.5	3,651.4	4,444.7	4,810.6	5,063.7	5,230.9
Religious	49.2	55.0	76.4	84.2	88.6	93.9
Industrial	2,731.8	3,148.1	3,880.1	4,149.1	4,371.5	4,597.9
Commercial	1,465.1	2,224.0	3,178.9	3,535.5	3,834.6	4,066.4
Streetlighting	141.3	130.0	160.7	135.7	130.3	130.6
Total	**7,252.8**	**9,208.5**	**11,740.9**	**12,715.1**	**13,488.8**	**14,119.6**
%						
Domestic	39.5	39.7	37.9	37.8	37.5	37.0
Religious	0.7	0.6	0.7	0.7	0.7	0.7
Industrial	37.7	34.2	33.0	32.6	32.4	32.6
Commercial	20.2	24.2	27.1	27.8	28.4	28.8
Streetlighting	1.9	1.4	1.4	1.1	1.0	0.9

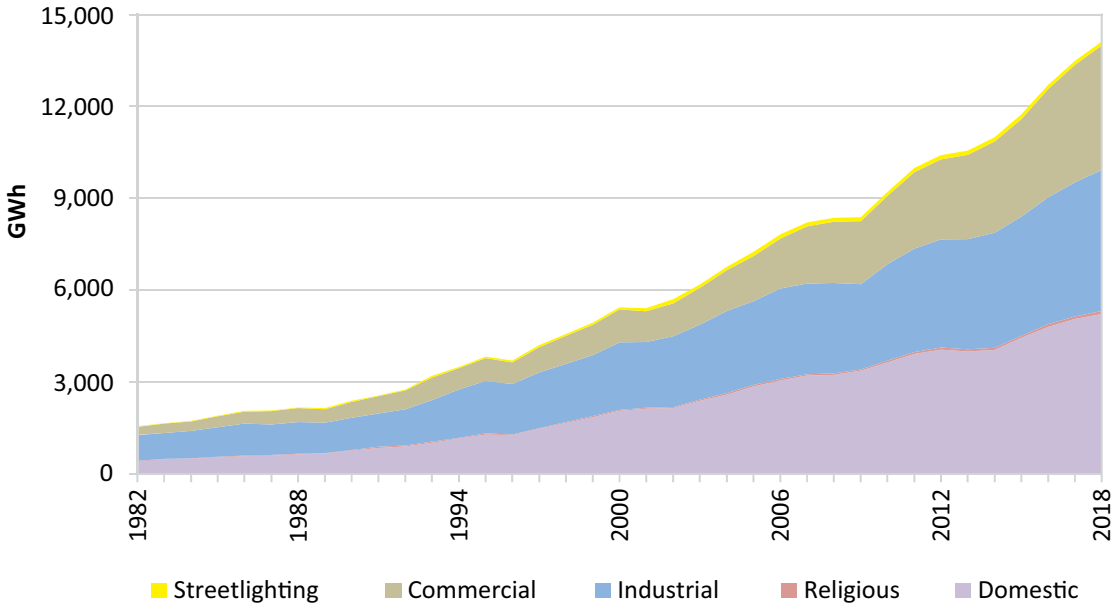


Figure 6.6 - Electricity Sales by Consumer Category

Table 6.6 indicates that the sales to the domestic and streetlighting customers have decreased marginally, while the sales to the industrial and commercial customers have increased marginally.

6.5.2 Petroleum Demand in Different Sectors

Petroleum has a wide range of applications as a convenient energy source. Transport, power generation, industrial thermal applications, domestic lighting and cooking are the most common uses of petroleum in Sri Lanka. In addition, due to the strategically important geographic location of Sri Lanka in terms of maritime and aviation movements, foreign bunkering and aviation fuel sales also create a demand for petroleum in the country. Petroleum demand to meet the non-domestic needs such as bunkering and aviation fuel is discussed separately in this report.

6.5.2.1 Transport Sector

Transport is the most important sector as far as petroleum is concerned. The majority of vehicles in Sri Lanka are powered by either diesel or gasoline. With the reversal of the significantly lower import duty on electric vehicles, the rapid growth of the fleet of electric vehicles slowed down in 2017. However, a better tax structure which was introduced in late 2017 continued in 2018. Worries about reduced range resulting from aging batteries, and the apparent absence of any mechanism for cost effective replacement somewhat dampened the market interest of electric vehicles. Both, road and rail transport are entirely fuelled by liquid petroleum fuels. In the distant past, rail transport was fuelled by coal, and today, only a single coal powered rail is operated as a tourist attraction. The Internal Combustion (IC) engines in all these vehicles intrinsically introduce considerable energy wastage in terms of conversion efficiency from petroleum energy to motive power. Use of electricity to at least energise the train transportation can be an efficient and economical alternative to burning petroleum fuels in the transport sector. Table 6 7 summarises the demand for fuels in the transport sector.

Table 6.7 – Transport Fuel Demand by Type

kt	2005	2010	2015	2016	2017	2018
Gasoline	463.0	616.5	1,009.0	1,463.1	1,276.8	1,358.7
Auto Diesel	1,325.1	1,433.8	1,815.1	1,902.6	1,605.3	1,568.4
Super Diesel	15.0	11.5	46.1	86.6	91.5	101.1

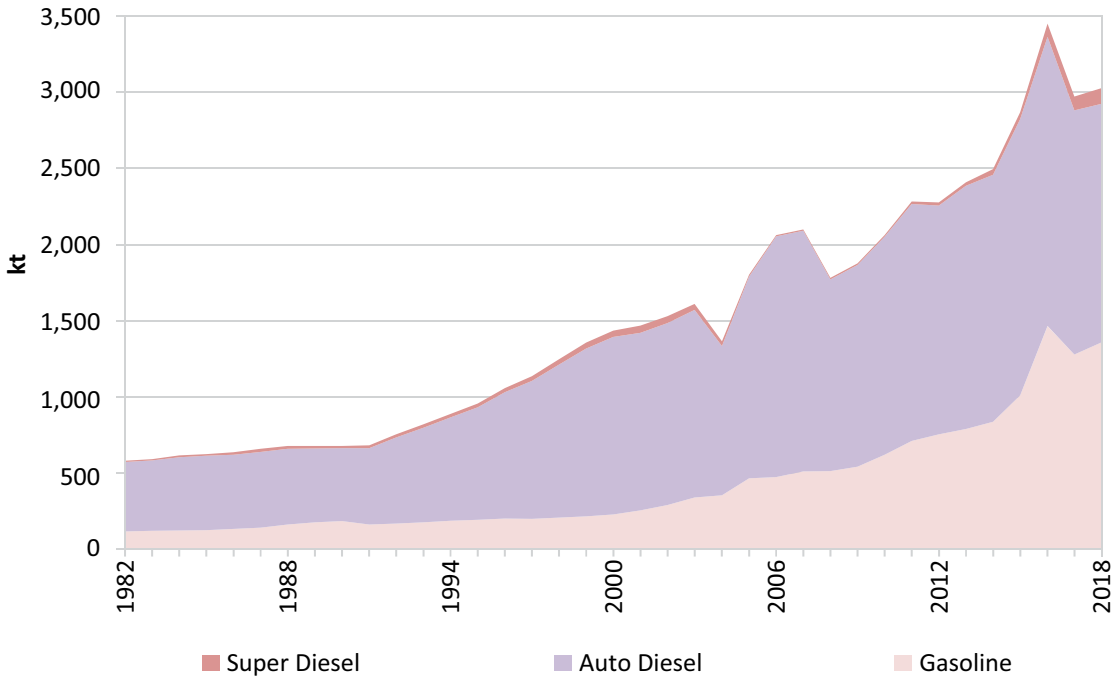


Figure 6.7 – Transport Demand by Fuel Type

Table 6.8 summarises the auto diesel demand in road transport and rail transport.

Table 6.8 – Auto Diesel Demand in Road and Rail Transport

kt	2005	2010	2015	2016	2017	2018
Road Transport	1,337.1	1,419.7	1,815.1	1,902.6	1,658.5	1,636.7
Rail Transport	25.9	26.2	38.4	39.2	38.3	32.8
Total	**1,362.9**	**1,445.9**	**1,853.5**	**1,941.7**	**1,696.8**	**1,669.5**
%						
Road Transport	98.1	98.2	97.9	98.0	97.7	98.0
Rail Transport	1.9	1.8	2.1	2.0	2.3	2.0

Only a marginal share of 2% of the total transport diesel demand is consumed by rail transport. The transport fuel mix is dominated by auto diesel. The demand for transport fuels has marginally decreased in 2018, compared with 2017. The demand for super diesel is growing in the transport fuel mix.

Figure 6.8 gives a snapshot of the cumulative vehicle fleet. Motor cycles and three wheelers account for the highest number of registrations each year. The registration of motor cars too show an increasing trend.

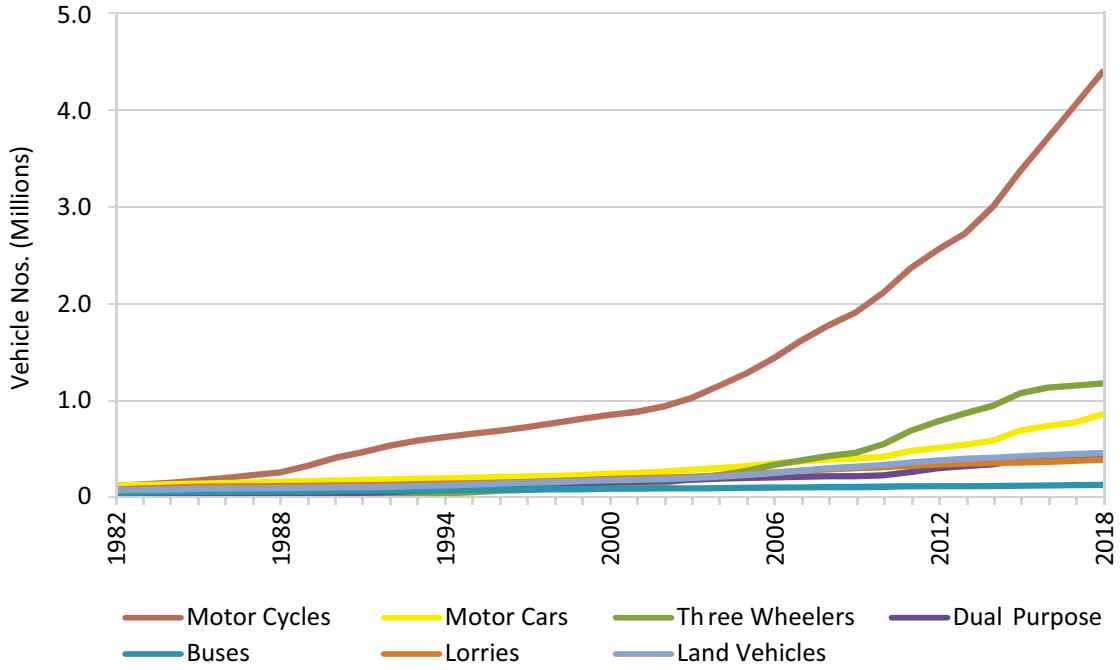


Figure 6.8 – Growth Pattern of Road Vehicle Fleet

The active vehicle fleet is reported by the Air Resource Management Centre (Air-MAC) of the Ministry of Environment and Renewable Energy, using information from the Vehicle EmissionTest (VET) programme (Figure 6.9).

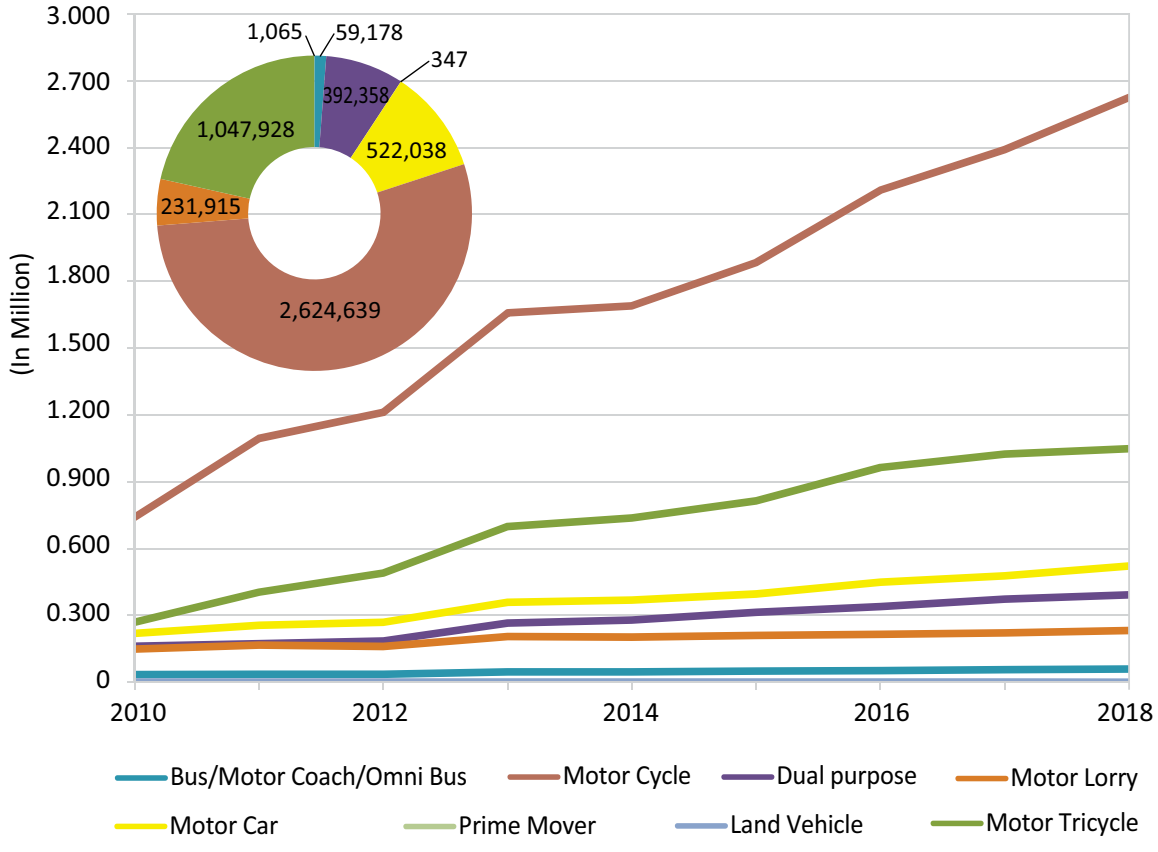


Figure 6.9 – Active Vehicle Fleet

Sri Lanka's active fleet in 2018 was 4,879,468 vehicles. It is characterised by an increased population of motor cycles (53.8%) and motor tricycles (21.5%). The share of public transport is very low (1.2%). Undoubtedly, this is a clear sign of worsening public transport services in the country, which must be arrested early, to avoid a severe transport crisis in the medium term.

6.5.2.2 Petroleum Usage in Other Sectors

Transport and power sector are the largest petroleum consuming sectors. Fuel consumption of the power sector by type, technologies and quantities has been detailed in Chapter 4, under energy conversions in thermal power plants.

Domestic sector petroleum consumption is limited to kerosene and LPG. However, with the increased use of LPG, especially in urban households for cooking purposes, the demand for petroleum by the domestic sector has also become significant. Industrial sector petroleum usage is mostly for thermal applications where diesel and fuel oil is used to fire industrial steam boilers and air heaters. LPG usage is also increasing in industrial thermal applications where the quality and control of heat generation is important for the industry operation. LPG fired kilns in the ceramic industry is one such example. The commercial sector including the service sector organisations such as hotels also contribute to the national petroleum demand, but to a lesser degree than the above-mentioned high volume petroleum consumers.

Table 6.9 details LPG demand by sector. The total LPG demand has increased over the years, and 2018 shows an increase in total consumption.

Table 6.9 – Demand for LPG by Sector

kt	2005	2010	2015	2016	2017	2018
Household, Commercial and Other	143.9	159.8	234.5	284.8	338.7	366.9
Industries	22.1	24.8	57.6	70.2	72.5	76.6
Transport	3.7	0.1	1.2	1.1	0.5	0.2
Total	**169.8**	**184.8**	**293.4**	**356.0**	**411.6**	**443.7**

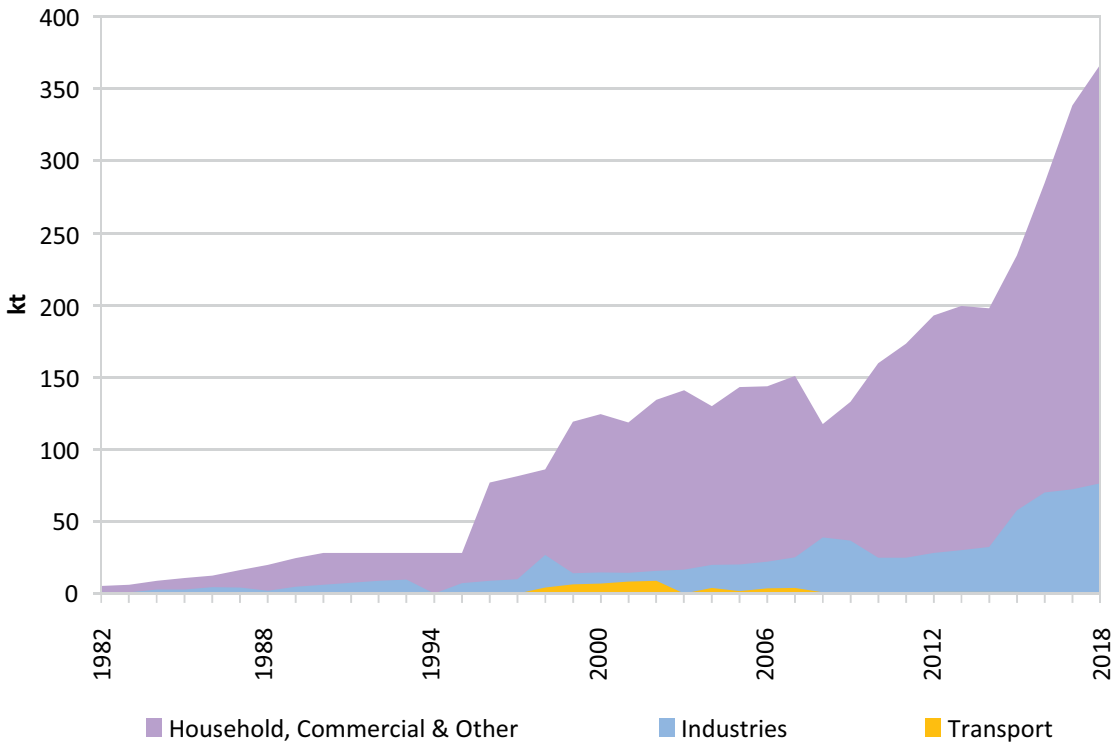


Figure 6.10 - LPG Demand by Sector

The domestic demand for LPG is increasing rapidly. This is often attributed to the improved per capita income levels. If the prices of LPG remain at low levels, many high temperature industries might switch back to LPG, to better control their processes.

Agriculture based petroleum demand in Sri Lanka is reported as considerably low, despite the fact that it is broadly an agricultural economy. This is also attributed to the difficulty in separating fuel dispersed for agricultural purposes and transport, as they are done through the same fuel station. Estate sector is one division which shows a fair usage of petroleum for drying purposes, but its energy consumption is accounted under industrial usage.

Kerosene used in fisheries is another substantial consumer category with regard to petroleum demand. Engine powered boats commonly used in the fishing industry are fuelled by either diesel or kerosene. It is therefore, important to understand that kerosene, which is a subsidised petroleum product in Sri Lanka, is not entirely used by the poorest segment of the society as envisaged in petroleum pricing policies. Table 6 10 summarises the kerosene consumption.

Table 6.10 – Demand for Kerosene by Sector

kt	2005	2010	2015	2016	2017	2018
Industrial	14.5	20.2	8.0	5.7	4.0	5.9
Household, Commercial and Other	194.5	144.9	122.2	166.7	155.1	203.6

Figure 6 11 indicates that the household kerosene consumption generally follows a declining trend, mainly owing to the deeper penetration of the national grid. Kerosene in the domestic sector is mainly used as a lighting fuel. However, when kerosene is sold at subsidised prices, substantially lower than transport fuels, a large scale surge in demand appears to reverse this declining trend. This surge in demand is mostly attributed to adulteration of auto diesel with cheaper kerosene.

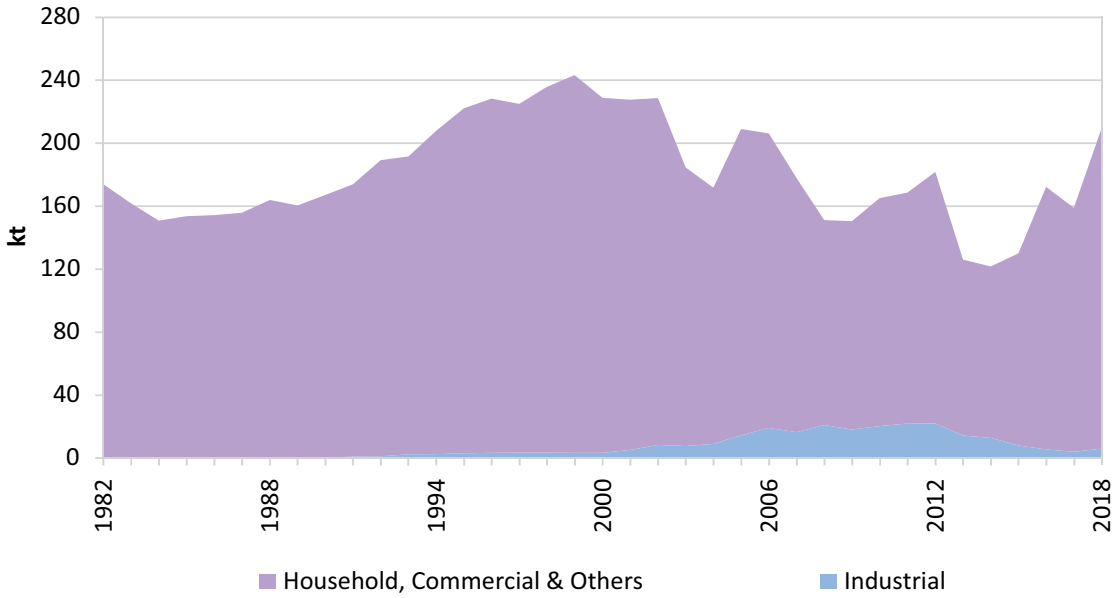


Figure 6.11 – Demand for Kerosene by Sector

In the early stages, the demand for kerosene has been only in the household and commercial sector. However since the 2000s, the demand for kerosene in the industrial sector has gradually increased, but is in a decreasing trend at present.

6.5.2.3 Bunkering and Aviation Sales

Local and foreign bunkering and aviation fuel sales are also contributing to the national petroleum demand. Although it is arguable that the real use may not occur within the country, the transaction of purchasing the product happens within the country and therefore, the national petroleum supply needs to cater to this demand as well. Upto about 2009, the bunkering sales were not properly reported, owing to the difficulty in collecting data from numerous bunkering operators islandwide. Table 6.11 presents a summary of bunkering fuel quantities and aviation fuel usage.

Table 6.11 – Bunkering and Aviation Sales

kt	2005	2010	2015	2016	2017	2018
Domestic Bunkers						
Furnace Oil	-	22.1	40.1	66.0	62.6	67.0
Marine Lubricants	-	0.2	0.1	-	-	-
Sub total	**-**	**28.5**	45.3	66.0	62.6	67.0
Foreign Bunkers						
Marine Gas Oil	-	55.3	46.7	11.5	45.7	47.2
Furnace Oil	-	199.0	360.6	594.0	563.7	603.3
Marine Lubricants	-	1.8	0.9	0.2	-	-
Sub total	**-**	**256.1**	**408.1**	**605.6**	**609.5**	**650.5**
Domestic Aviation						
Jet A1	170.8	169.5	2.4	2.7	9.5	9.3
Avgas	0.1	0.2	0.1	0.1	-	-
Sub total	**170.9**	**169.7**	**2.6**	**2.9**	**9.5**	**9.3**
Foreign Aviation						
Avtur	129.6	111.0	370.5	523.4	539.8	501.4
Avgas	0.1	-	-	-	-	-
Naphtha	-	26.7	-	-	-	-
Sub total	**129.7**	**137.7**	**370.5**	**523.4**	**539.8**	**501.4**

6.5.3 Coal Demand in Different Sectors

In the past, the total demand for coal had been in the transport sector or industries. But with the commissioning of coal power plants, there has been an increased demand for coal in power generation. In 2018, the demand for coal in power generation alone was 96%.

The total coal demand is given in Table 6.12.

Table 6.12 – Demand for Coal by Sector

kt	2005	2010	2015	2016	2017	2018
Industries	92.60	95.13	86.58	77.90	70.10	75.00
Power Generation	-	-	1,880.01	2,004.02	2,086.52	2,009.06
Total Consumption	**92.74**	**95.13**	**1,966.59**	**2,081.92**	**2,156.62**	**2,084.06**
%						
Industries	100.0	100.0	4.4	3.7	3.3	3.6
Power Generation	-	-	95.6	96.3	96.7	96.4

6.5.3.1 Coal Demand in Industries

The coal demand in industries declined marginally as given in Table 6.13.

Table 6.13 – Coal Demand in Industries

kt	2005	2010	2015	2016	2017	2018
Industries	92.6	95.1	86.6	77.9	70.1	75.0

6.5.3.2 Coal Demand in Power Generation

The demand for coal in the power generation in 2017 was 2,009.06 thousand tonnes.

6.5.4 Biomass Demand in Different Sectors

6.5.4.1 Biomass Demand in Industries

The demand bagasse has increased, whereas the demand for firewood has remained more or less the same.

Table 6.14 – Biomass Demand in Industries

kt	2005	2010	2015	2016	2017	2018
Firewood	3,505.0	3,788.5	4,535.7	4,513.2	4,723.3	4,895.8
Bagasse	210.9	137.8	196.4	241.1	190.3	203.6

6.5.4.2 Biomass Demand in Household, Commercial and Other Sector

Firewood is a main source of cooking fuel in many parts of the country. Table 6 15 gives the total firewood requirement in the household and commercial sector. A marginal increase in firewood consumption was reported in 2018, compared to 2017.

The total bagasse generated by the sugar plants was 203.0 kt in 2018, which was used in a captive generation plant for industrial purposes, amounting to a capacity of 4.5 MW generating 12,855 MWh.

Table 6.15 – Demand for Firewood in Household, Commercial and Other Sector

kt	2005	2010	2015	2016	2017	2018
Firewood	8,336.2	9,039.7	7,870.3	7,446.0	7,084.7	6,919.9

The consumption of firewood in the household, commercial and other sector has decreased over the years. The consumption of 2018 has decreased, compared with that of 2017.

6.6 Total Energy Demand

Table 6.16 summarises the total energy demand by source.

Table 6.16 – Total Energy Demand by Energy Source

PJ	2005	2010	2015	2016	2017	2018
Biomass	191.9	206.5	200.7	194.3	191.1	191.4
Petroleum	116.7	126.0	158.1	183.2	172.1	170.0
Coal	2.7	2.5	2.3	2.1	1.8	2.0
Electricity	26.1	33.2	42.3	45.8	48.3	50.8
Total	**337.4**	**368.1**	**403.3**	**425.4**	**413.3**	**414.2**
%						
Biomass	56.9	56.1	49.8	45.7	46.2	46.2
Petroleum	34.6	34.2	39.2	43.1	41.6	41.0
Coal	0.8	0.7	0.6	0.5	0.4	0.5
Electricity	7.7	9.0	10.5	10.8	11.7	12.3

The petroleum demand figures presented are only in terms of final energy use and this does not include the fuels consumed in electricity generation. The share of biomass consumption in the total energy demand was 46.2% in both years, whereas the share of petroleum has marginally decreased in 2018, compared with 2017.

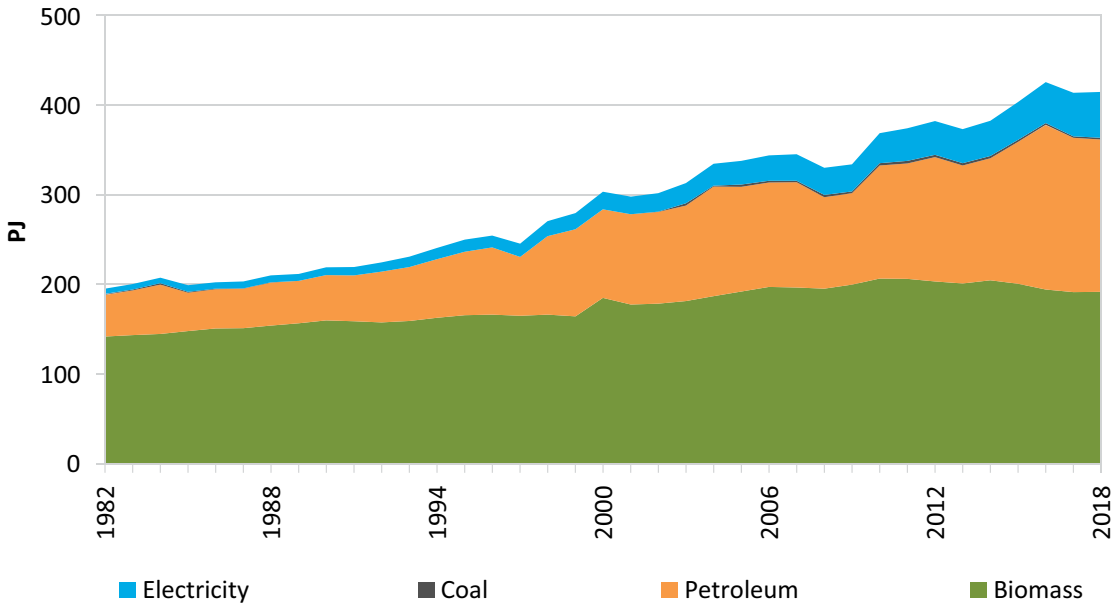


Figure 6.12 – Total Energy Demand by Energy Source

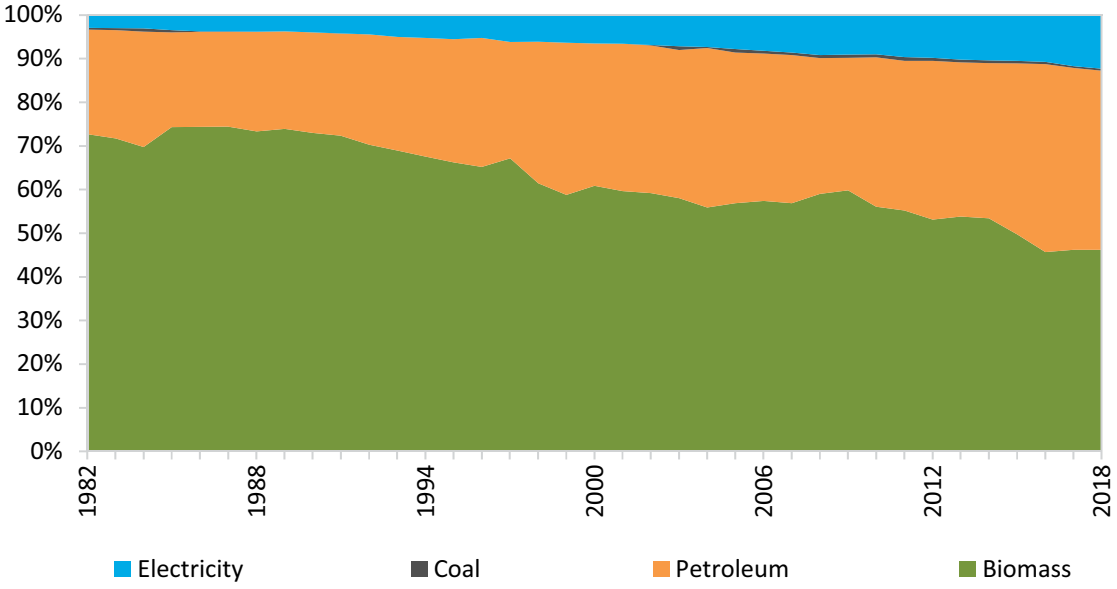


Figure 6.13 – Evolution of Energy Demand by Energy Source

As can be expected from any growing economy, the share of biomass in the energy demand portfolio is on a decreasing trend, while the share of electricity is on an increasing trend. With the economic development of the country, these trends will further accentuate in the medium term.

6.6.1 Total Industrial Energy Demand

Table 6.17 – Total Energy Demand of Industries by Energy Source

PJ	2005	2010	2015	2016	2017	2018
Biomass	59.3	62.7	75.5	75.8	78.3	81.3
Petroleum	12.4	10.2	14.6	8.9	7.2	9.0
Coal	2.7	2.5	2.3	2.1	1.8	2.0
Electricity	9.8	11.3	14.0	14.9	15.7	16.6
Total	**84.2**	**86.8**	**106.3**	**101.7**	**103.2**	**108.8**
%						
Biomass	70.4	72.3	71.0	74.6	75.9	74.7
Petroleum	14.7	11.8	13.7	8.7	7.0	8.2
Coal	3.2	2.9	2.1	2.0	1.8	1.8
Electricity	11.7	13.1	13.1	14.7	15.3	15.2

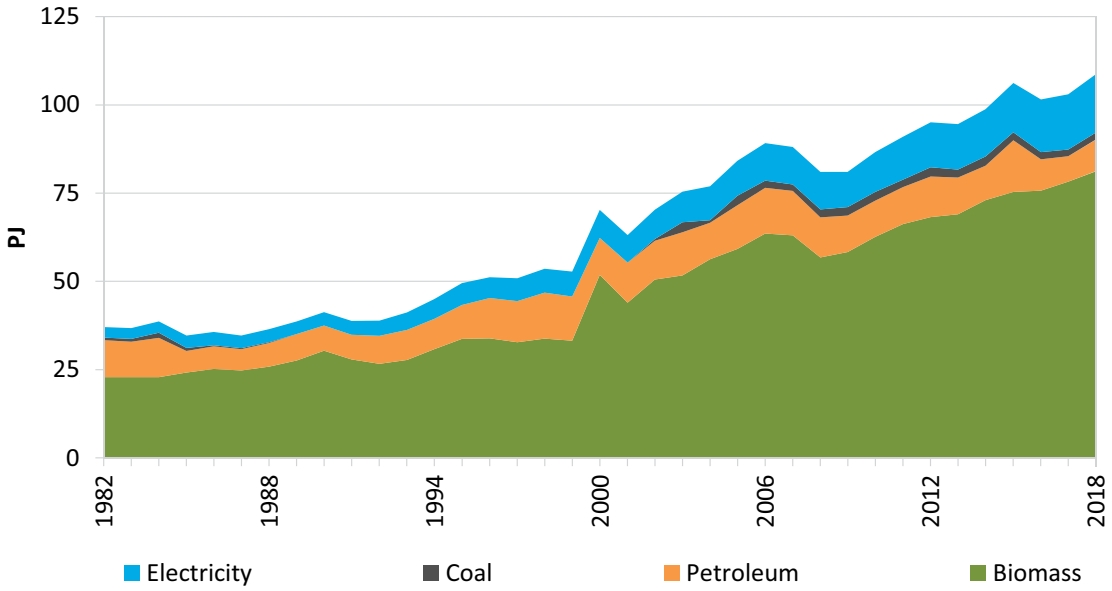


Figure 6.14 – Total Energy Demand of Industries by Energy Source

6.6.2 Total Transport Energy Demand

This much awaited railway electrification project took off in 2016, with the leadership of the Ministry of Transport and Civil Aviation. Under this project, the Kelani Valley line will be electrified first and the Veyangoda – Panadura main line will be implemented next.

The lower taxation on hybrid and electric vehicles was reintroduced with changes in late 2017. This change may help to regain the market confidence for electric vehicles, presently dented mainly due to battery replacement issues. Electricity used in transport is not reported, and a survey of the available fleet is necessary to estimate the usage levels

Table 6.18 – Total Transport Energy Demand by Energy Source

PJ	2005	2010	2015	2016	2017	2018
Petroleum	88.6	100.4	127.7	154.4	143.0	135.8

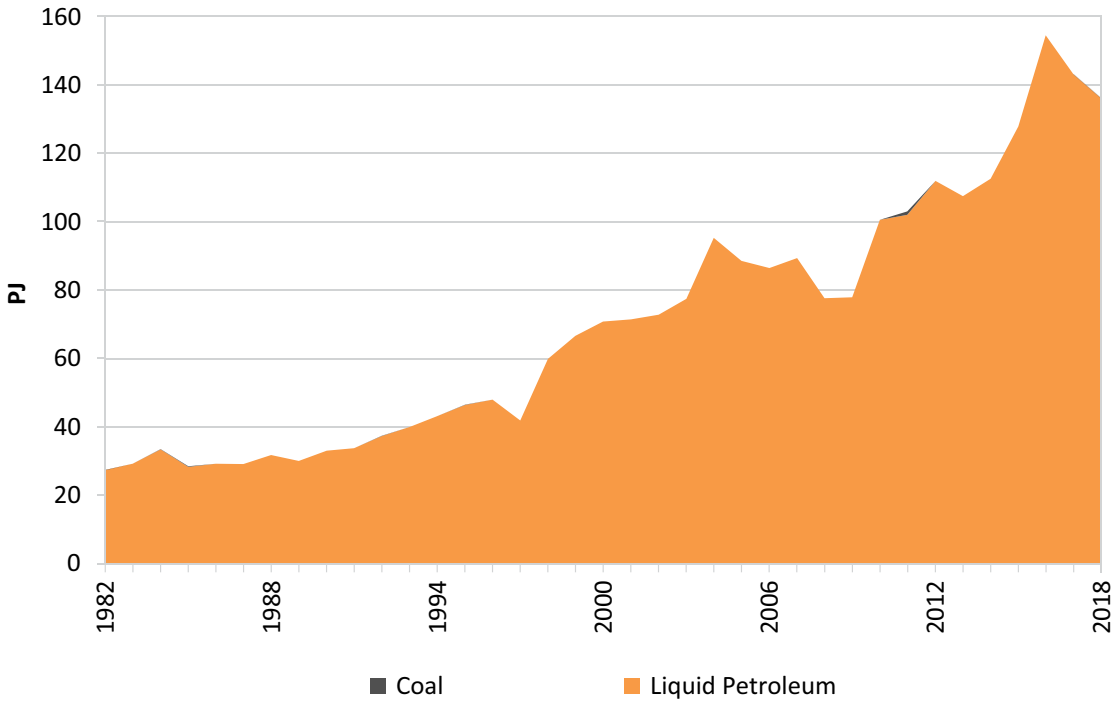


Figure 6.15 – Total Energy Demand of Transport by Energy Source

6.6.3 Total Energy Demand in Household, Commercial and Other Sectors

Table 6.19 – Total Energy Demand in Household, Commercial and Other Sectors by Energy Source

PJ	2005	2010	2015	2016	2017	2018
Biomass	132.6	143.8	125.2	118.5	112.7	110.1
Petroleum	15.1	14.9	15.8	20.0	21.8	25.2
Electricity	16.3	21.8	28.3	30.8	32.6	34.3
Total	**164.0**	**180.6**	**169.3**	**169.3**	**167.1**	**169.6**
%						
Biomass	80.8	79.6	74.0	70.0	67.4	64.9
Petroleum	9.2	8.3	9.3	11.8	13.1	14.9
Electricity	9.9	12.1	16.7	18.2	19.5	20.2

Biomass accounts for approximately 64.9% of the total household, commercial and other sector's energy demand. The share of biomass indicates a marginal decrease, whereas petroleum has shown a marginal increase. The share of electricity also shows an increase. The expansion of the electricity share could be attributed to the growth of households served by the grid and the tariff which remained unchanged since 2014.

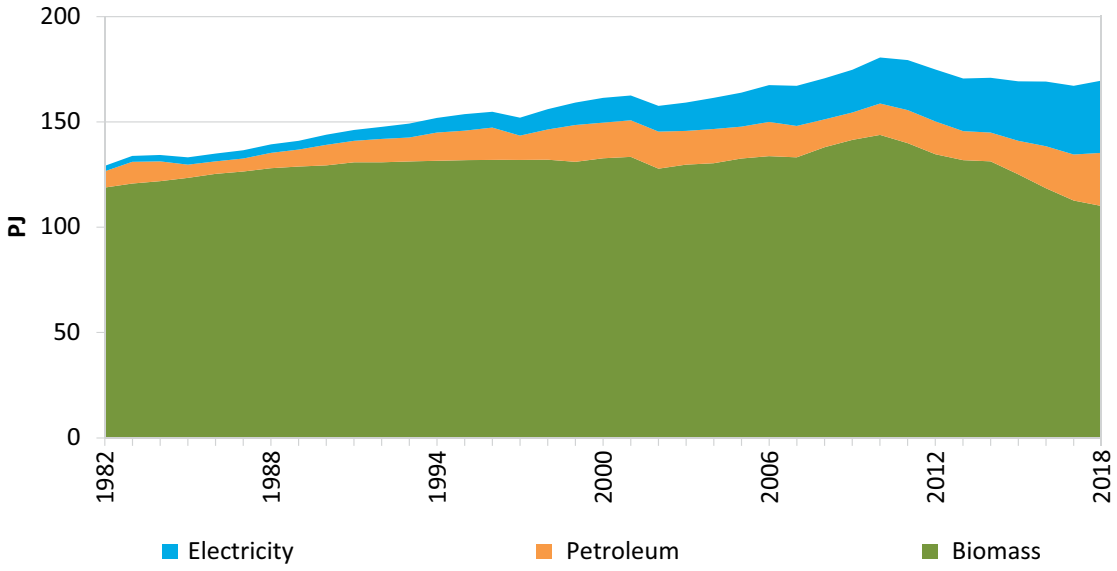


Figure 6.16 – Total Energy Demand of Household, Commercial and Other Sector by Energy Source

6.6.4 Total Energy Demand by Sector

Table 6.20 – Total Energy Demand by Sector

PJ	2005	2010	2015	2016	2017	2018
Industry	84.2	86.8	106.3	101.7	103.2	108.8
Transport	88.6	100.4	127.7	154.4	143.0	135.8
Household, Commercial & Others	164.0	180.6	169.3	169.3	167.1	169.6
Total	**336.8**	**367.7**	**403.3**	**425.4**	**413.2**	**414.2**
%						
Industry	25.0	23.6	26.4	23.9	25.0	26.3
Transport	26.3	27.3	31.7	36.3	34.6	32.8
Household, Commercial & Others	48.7	49.1	42.0	39.8	40.4	40.9

In 2017, households, commercial and other sectors accounted for the largest share of energy being 40.9%. The transport and industry sector accounted for 32.8% and 26.3%, respectively.

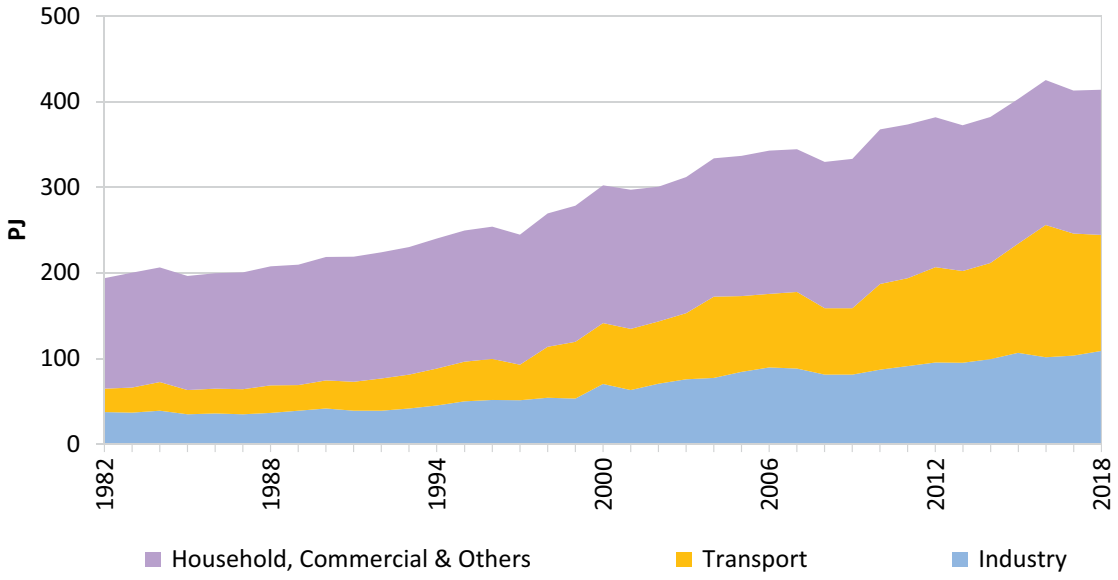


Figure 6.17 – Total Energy Demand by Sector

Figure 6.21 depicts the growth of energy demand in the three main Sectors.

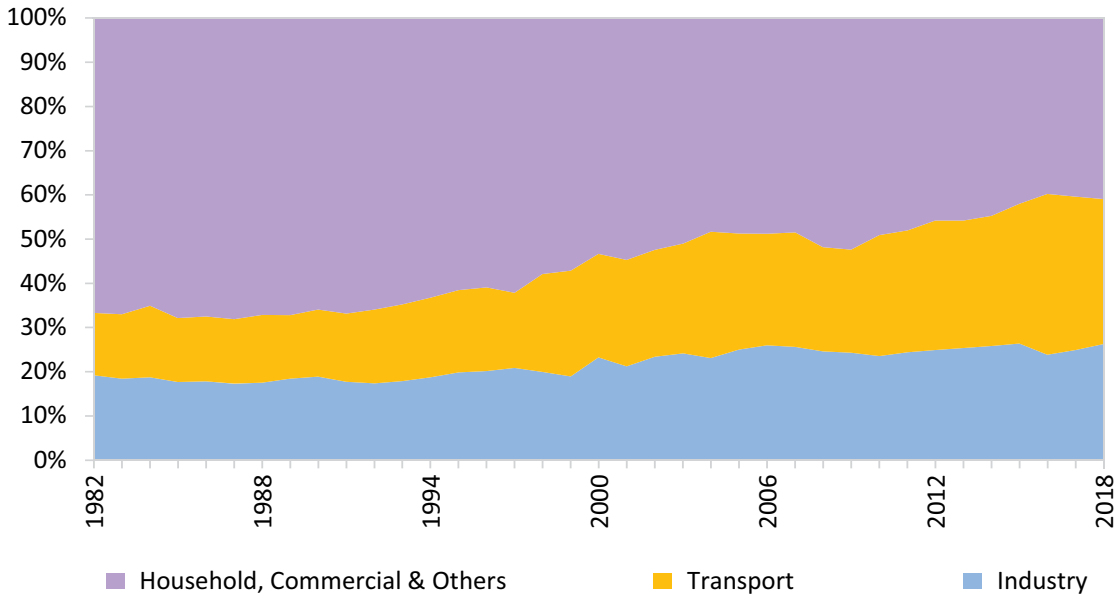


Figure 6.18 – Evolution of Total Energy Demand by Sector

Compared with 2017, the energy demand has marginally increased in 2018.

7 Energy Balance

The performance of the entire energy sector is summarised in the National Energy Balance shown in the following pages, in original commodity units and in SI Units of PJ (Peta Joules). The Energy Balance illustrates the energy supply, energy conversion, losses and energy consumption (demand) within the year. Figure 7 1 gives the Energy Balance for 2018 in PJ. Relevant conversion factors are given in *Annex II*.

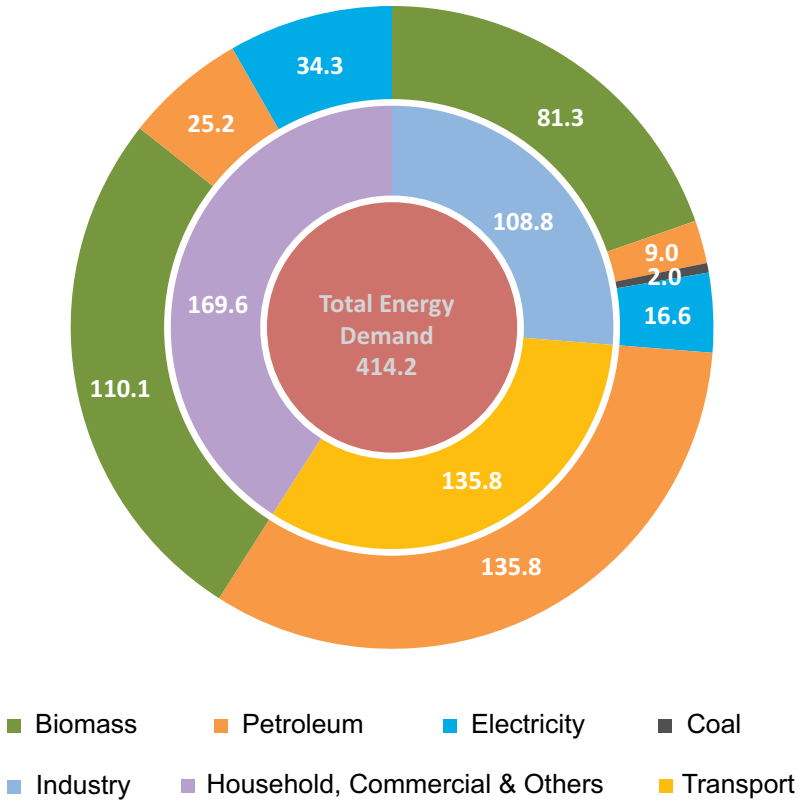


Figure 7.1 – Energy Balance 2017 (in PJ)

The total energy demand of the household, commercial and other sector was 169.6 PJ, out of which 110.1 PJ came from biomass, 25.2 PJ came from petroleum and 34.3 PJ came from electricity. The total energy demand in the industrial sector was 108.8 PJ. Biomass accounted 81.3 PJ, petroleum for 9.0 PJ, coal for 2.0 PJ and electricity accounted 16.6 PJ. In the transport sector, the total demand of 135.8 PJ was sourced by petroleum.

Table 7.1 – Sri Lanka Energy Balance: 2018 (in original units)

	Renewables (GWh)	Electricity (GWh)	LPG (kt)	Gasoline (kt)	Naptha (kt)	Av. Gas (kt)	Kerosene (kt)
Supply							
Primary Energy	4,725.0	-	-	-	-	-	-
Imports	-	-	205.3	1,097.4	-	0.2	-
Direct Exports	-	-	-	-	-	-	-
Foreign Bunkers	-	-	-	-	-	-	-
Stock Change	-	-	186.9	226.9	61.9	-0.2	99.3
Total Energy Supply	**4,725.0**	**-**	**392.2**	**1,324.3**	**61.9**	**-**	**99.3**
Energy Conversion							
Petroleum Refinery	-	-	19.4	164.6	141.7	-	59.8
Conventional Hydro Power	(3,075.2)	3,075.2	-	-	-	-	-
Thermal Power Plants	-	10,295.7	-	-	(203.6)	-	-
Small Hydro Power	(945.4)	945.4	-	-	-	-	-
Wind Power	(364.6)	364.6	-	-	-	-	-
Biomass Power	(67.0)	67.0	-	-	-	-	-
Solar Power	(85.2)	85.2	-	-	-	-	-
Waste Heat	-	-	-	-	-	-	-
Net-metered Power Plants	(131.4)	131.4	-	-	-	-	-
Self Generation by Customers	(37.5)	37.5	-	-	-	-	-
Off-grid Conventional	-	-	-	-	-	-	-
Off-grid Non-Conventional	(18.8)	18.8	-	-	-	-	-
Charcoal Production	-	-	-	-	-	-	-
Own Use	-	(646.1)	-	-	-	-	-
Conversion Losses	-	-	-	-	-	-	-
Losses in T&D	-	(533.1)	-	-	-	-	-
Non Energy Use	-	-	-	-	-	-	-
Total Energy Conversion	**(4,725.0)**	**13,841.5**	**19.4**	**164.6**	**(61.9)**	**-**	**59.8**
Energy Use							
Agriculture	-	-	-	-	-	-	-
Industries	-	4,330.3	72.5	-	-	-	4.0
Road Transport	-	-	0.5	1,488.9	-	-	-
Rail Transport	-	-	-	-	-	-	-
Domestic Aviation	-	-	-	-	-	-	-
Household, Commercial & Other	-	9,041.4	338.7	-	-	-	155.1
Total Energy Use	**-**	**13,371.7**	**411.6**	**1,488.9**	**-**	**-**	**159.0**

Table 7.1 – Sri Lanka Energy Balance: 2018 (in original units)

Jet A1 (kt)	Diesel (kt)	Fuel Oil (FO 1500) (kt)	Residual Oil (kt)	Solvents (kt)	Coal (kt)	Baggase Agro Residues (kt)	Firewood (kt)	Charcoal (kt)	Crude Oil (kt)
-	-	-	-	-	-	190.3	11,810.1	-	-
282.2	1,763.2	581.2	-	-	2,527.4	-	-	-	1,499.4
-	-	-	-	-	-	-	-	-	-
(539.8)	-	(563.7)	-	-	-	-	-	-	-
30.7	94.9	120.6	179.3	1.2	(370.8)	109.8	-	-	(57.8)
(226.9)	**1,858.1**	**138.1**	**179.3**	**1.2**	**2,156.6**	**300.1**	**11,810.1**	**-**	**1,441.6**
236.4	506.0	431.6	-	0.6	-	-	-	-	(1,646.0)
-	-	-	-	-	-	-	-	-	-
-	(407.8)	(494.4)	(179.3)	-	(2,086.5)	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	(109.8)	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	13.8	
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-		(101.5)
-	-	-	-	-	-	-	-	-	-
-	-	-	-	(1.8)	-	-	-	(13.8)	-
236.4	**98.2**	**(62.8)**	**(179.3)**	**(1.2)**	**(2,086.5)**	**(109.8)**	**-**	**-**	**(1,747.5)**
-	-	0.1	-	-	-	-	-	-	-
-	17.1	75.2	-	-	70.1	190.3	4,724.5	-	-
-	1,900.9	-	-	-	-	-	-	-	-
-	38.3	-	-	-	-	-	-	-	-
9.5	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	7,085.7	-	-
9.5	**1,956.3**	**75.3**	**-**	**-**	**70.1**	**190.3**	**11,810.1**	**-**	**-**

Table 7.2 – Sri Lanka Energy Balance: 2018 (in Tera Joules)

	Renewables	Electricity	LPG	Gasoline	Naptha	Av. Gas	Kerosene	Jet A1
Supply								
Primary Energy	47,478.7	-	-	-	-	-	-	-
Imports	-	-	9,113.2	50,078.8	-	9.4	-	12,406.5
Direct Exports	-	-	-	-	-	-	-	-
Foreign Bunkers	-	-	-	-	-	-	-	(23,732.2)
Stock Change	-	-	8,293.3	10,356.5	2,826.7	(9.4)	4,363.3	1,350.9
Total Energy Supply	**47,478.7**	**-**	**17,406.5**	**60,435.3**	**2,826.7**	**-**	**4,363.3**	**(9,974.9)**
Energy Conversion								
Petroleum Refinery	-	-	861.7	7,510.1	6,466.1	-	2,628.1	10,390.7
Conventional Hydro Power	(30,900.8)	11,072.8	-	-	-	-	-	-
Thermal Power Plants	-	37,071.2	-	-	(9,292.7)	-	-	-
Small Hydro Power	(9,500.2)	3,404.2	-	-	-	-	-	-
Wind Power	(3,663.3)	1,312.7	-	-	-	-	-	-
Biomass Power	(673.0)	241.2	-	-	-	-	-	-
Solar Power	(855.8)	306.6	-	-	-	-	-	-
Waste Heat	-	-	-	-	-	-	-	-
Net-metered Power Plants	(1,320.0)	473.0						
Self Generation by Customers	-	-	-	-	-	-	-	-
Off-grid Conventional	-	-	-	-	-	-	-	-
Off-grid Non-Conventional	(188.6)	67.6	-	-	-	-	-	-
Charcoal Production	-	-	-	-	-	-	-	-
Own Use	-	(2,326.5)	-	-	-	-	-	-
Conversion Losses	-	-	-	-	-	-	-	-
Losses in T&D	-	(1,919.5)	-	-	-	-	-	-
Non Energy Use	-	-	-	-	-	-	-	-
Total Energy Conversion	**(47,101.6)**	**49,703.1**	**861.7**	**7,510.1**	**(2,826.7)**	**-**	**2,628.1**	**10,390.7**
Energy Use								
Agriculture	-	-	-	-	-	-	-	-
Industries	-	15,591.9	3,215.5	-	-	-	174.1	-
Road Transport	-	-	20.6	67,945.4	-	-	-	-
Rail Transport	-	-	-	-	-	-	-	-
Domestic Aviation	-	-	-	-	-	-	-	415.8
Household, Commercial & Other	-	32,554.8	15,032.2	-	-	-	6,817.3	-
Total Energy Use	**-**	**48,146.7**	**18,268.2**	**67,945.4**	**-**	**-**	**6,991.4**	**415.8**

Table 7.2 – Sri Lanka Energy Balance: 2018 (in Tera Joules)

Diesel	Fuel Oil (FO 1500)	Residual Oil	Solvents	Coal	Baggase Agro Residues	Firewood	Charcoal	Crude Oil	Total
-	-	-	-	-	3,186.8	187,897.5	-	-	238,563.0
77,510.8	23,848.2	-	-	66,666.0	-	-	-	64,660.0	304,292.8
-	-	-	-	-	-	-	-	-	-
-	(23,130.2)	-	-	-	-	-	-	-	(46,862.5)
4,174.1	4,948.7	7,358.4	43.7	(9,781.3)	1,839.5	-	-	(2,493.6)	33,270.8
81,684.8	**5,666.6**	**7,358.4**	**43.7**	**56,884.8**	**5,026.3**	**187,897.5**	**-**	**62,166.3**	**529,264.1**
22,246.5	17,707.8	-	23.1	-	-	-	-	(70,983.9)	(3,150.0)
-	-	-	-	-	-	-	-	-	(19,828.0)
(17,929.0)	(20,286.2)	(7,358.4)	-	(55,035.7)	-	-	-	-	(74,395.2)
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	(1,839.5)	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	374.2	-	374.2
-	-	-	-	-	-	-	-	-	(2,326.5)
-	-	-	-	-	-	-	-	(4,375.0)	(4,375.0)
-	-	-	-	-	-	-	-	-	(1,919.5)
-	-	-	(66.8)	-	-	-	(374.2)	-	(441.0)
4,317.5	**(2,578.4)**	**(7,358.4)**	**(43.7)**	**(55,035.7)**	**(1,839.5)**	**-**	**-**	**(75,359.0)**	**(106,061.1)**
-	3.6	-	-	-	-	-	-	-	3.6
753.1	3,084.6	-	-	1,849.1	3,186.8	75,165.6	-	-	103,020.6
83,566.8	-	-	-	-	-	-	-	-	151,532.7
1,682.5	-	-	-	-	-	-	-	-	1,682.5
-	-	-	-	-	-	-	-	-	415.8
-	-	-	-	-	-	112,731.8	-	-	167,136.1
86,002.3	**3,088.2**	**-**	**-**	**1,849.1**	**3,186.8**	**187,897.5**	**-**	**-**	**423,791.4**

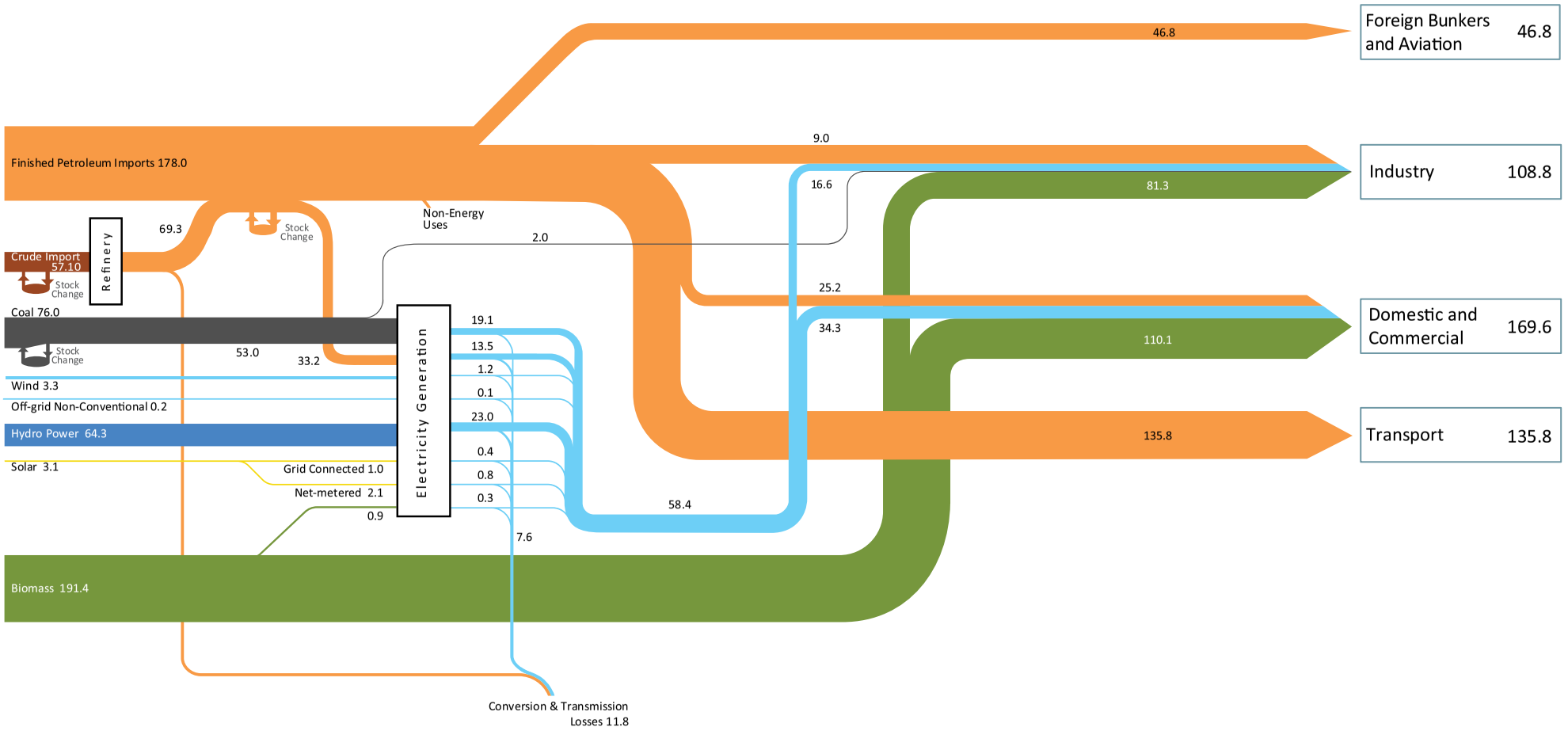


Figure 7.2 – Energy Flow Diagram - 2018(PJ)

8 Energy and Economy

8.1 Electricity Sector Financial Performance

The year 2018 recorded poor financial performance for the CEB, and the return on assets (RoA) was negative for the third consecutive year and stood at -2.7%. The LECO recorded a financial performance of an RoA of 6.6%. Table 8 1 summarises the financial performance of CEB and LECO.

Table 8.1 – Financial Performance of CEB and LECO

	2005	2010	2015	2016	2017	2018
CEB						
Net assets in Operation (LKRM)	256,120	378,207	616,154	703,416	722,877	747,049
Return on assets (%)	(1.15)	0.1	2.0	(1.4)	(4.3)	(2.7)
LECO						
Net assets in Operation (LKRM)	5,119	8,420	10,911	11,000	11,264	12,885
Return on assets (%)	9.0	(1.9)	4.5	7.0	6.8	6.6

8.2 Financial Performance of the Petroleum Sector

8.2.1 Impact on Macro Economy

The price of petroleum in the world market continued to increase in 2018. The net petroleum import bill was USD 4,418 million. With the demand for petroleum increasing over the past years, expenditure on oil imports as a percentage of non petroleum exports was 33.7% in 2018. Table 8 2 shows the historic trends of the petroleum import costs.

Table 8.2 – Petroleum Import Costs and its Impact on the Macro Economy

million USD	2005	2010	2015	2016	2017	2018
Total Exports	6,347	8,626	10,546	10,310	11,360	11,890
Total Imports	8,863	13,451	18,935	19,400	20,980	22,233
Petroleum Imports	1,730	3,183	2,864	2,647	3,660	4,418
Petroleum Re-exports	131	263	374	287	434	622
Net Oil Imports	1,599	2,920	2,490	2,360	3,226	3,796
Non Petroleum Exports	6,216	8,363	10,172	10,023	10,926	11,268
Net Oil Imports as % of Non Petroleum Exports	25.7	34.9	24.5	23.5	29.5	33.7

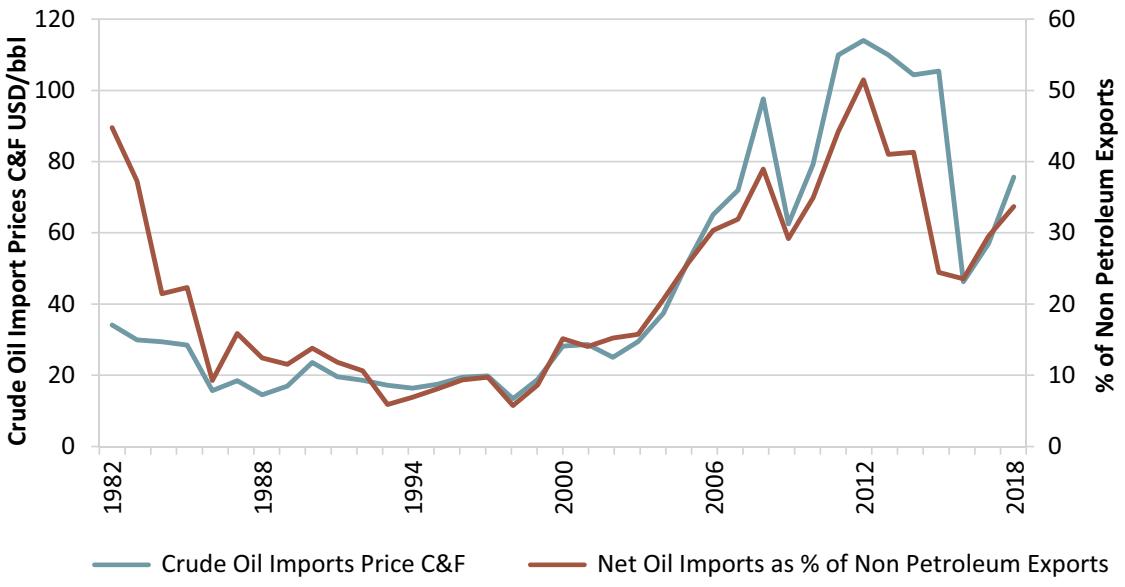


Figure 8.1 - Net Oil Imports as a Percentage of Exports

The impact of oil import bill on the national economy is clearly presented in the above graph, as the cost of net oil Imports as a percentage of all non-petroleum export earnings. This has two important points in history, first being in 1982, where it climbed to 44.8% and more recently in 2012 when it reached the highest ever value of 51.5%. This figure, which dropped to 23.5% in 2016, has climbed steadily over three consecutive years to 33.7% and is to be taken as a warning of an impending balance of payment crisis.

8.2.2 Petroleum Sector Financial Performance

Ceylon Petroleum Corporation (CPC) dominates the petroleum sector of the country. However, the role of Lanka Indian Oil Company (LIOC) and the LP Gas companies also have a reasonable bearing on the overall sector performance. Several bunkering companies were also active in the petroleum sector. Table 8 3 presents financial performance details of the CPC and LIOC.

Table 8.3 – CPC and LIOC Financial Performance

LKR million	2005	2010	2015	2016	2017	2018
CPC						
Total Revenue	177,323	277,084	423,741	487,014	528,512	605,955
Total Cost	169,722	(304,007)	444,422	443,981	527,816	711,006
BTT/GST/VAT	12,703	20,222	37,761	51,990	71,325	71,286
Income Tax	2,129	-	634	26,632	1,932	22
Estimated Tariff Cost	31	-	-	-	-	-
Crude & Product Import Cost	145,163	(265,604)	337,119	326,441	417,905	523,982
Estimated other Cost	9,695	(18,181)	68,908	38,918	36,654	115,716
Profit/ Loss	**7,601**	**(26,923)**	**(20,681)**	**43,033**	**696**	**(105,051)**
LIOC *						
Total Revenue		51,423	68,728	79,107	87,872	91,608
Total Cost		(49,376)	69,114	73,836	89,176	92,245
VAT, ESC, Debit,Payee & other taxes		(998)	134	222	45	164
Income Taxes		(17)	286	989	219	6
Import Duty		N/A	-	-	-	-
Product Cost		N/A	65,986	69,306	86,157	88,830
Estimated other costs		N/A	2,709	3,319	2,754	3,246
Profit/ Loss		**1,032**	**(386)**	**5,217**	**(1,304)**	**(637)**

Prices of petroleum fuels remained mostly unchanged except a substantial price reduction of domestic kerosene on January 11 and a slight increase of price of LPG on September 26.

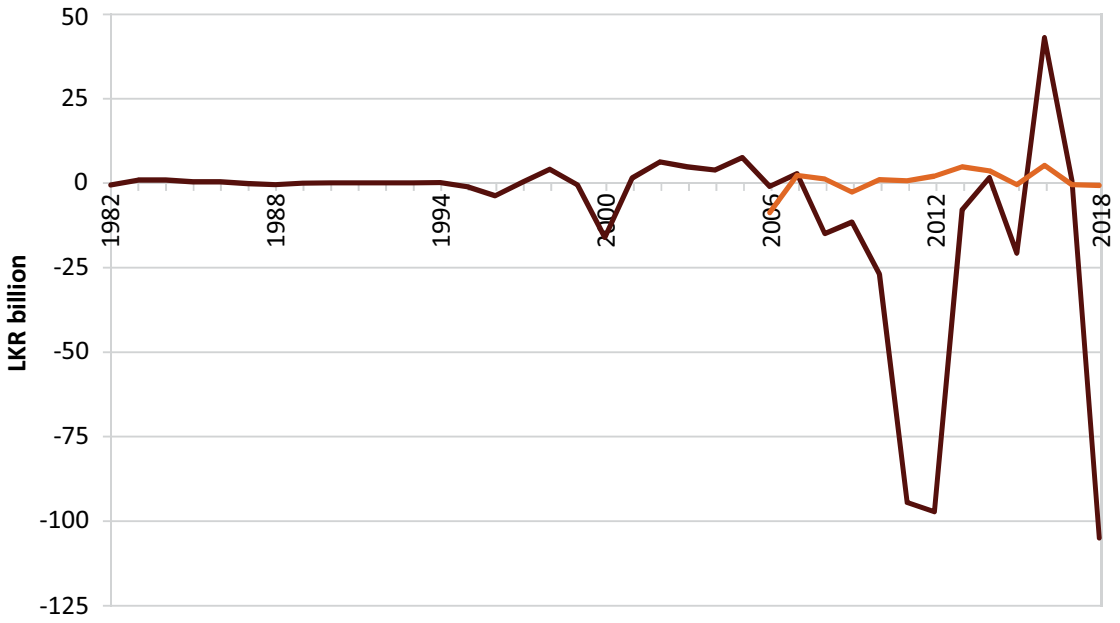


Figure 8.2 – Profit/Loss of CPC and LIOC

With the steady upward climb of petroleum prices and static local selling prices, chances of reviving the industry appears to be limited in the short term. However, improved supply conditions can reverse this to benefit the local petroleum sector, if a prudent pricing policy is implemented.

8.3 Energy-Economy Indicators

Commercial energy (petroleum, electricity and coal) intensity is an indicator of a country's energy utilisation with respect to the national output (measured in terms of Gross Domestic Product-GDP). The commercial energy intensity marginally decreased from 0.43 TJ/GDP million LKR in 2017 to 0.42 TJ/GDP million LKR in 2018. The success of policies and action taken by the relevant authorities as well as the energy users in making their energy use more productive than ever, combined with the structural change of the economy where growth is largely in the services sector is presumed to have arrested the growth of energy intensity to a larger extent.

Table 8.4 – Sri Lanka Energy Indices

	2005	2010	2015	2016	2017	2018
Electricity (TJ)	26,115.0	33,156.4	42,274.8	45,782.1	48,295.2	50,839.9
Petroleum (TJ)	116,657.3	125,958.2	171,363.1	183,238.4	172,055.6	170,011.6
Coal (TJ)	2,717.9	2,509.2	2,283.7	2,054.7	1,849.1	1,978.3
Total commercial energy (TJ)	**145,490.2**	**161,623.9**	**215,921.5**	**231,075.1**	**222,199.8**	**222,829.8**
GDP at 1982 factor cost prices (million LKR)	259,885	352,878	473,954	494,808	511,631	528,004
Commercial Energy Index	2.32	2.58	3.44	3.68	3.54	3.55
GDP Index (Index 1984=1.0)	2.49	3.38	4.54	4.74	4.90	5.06
Commercial Energy Intensity (TJ/LKR million)	**0.56**	**0.46**	**0.46**	**0.47**	**0.43**	**0.42**
Commercial Energy Intensity Index (1984=1.0)	0.93	0.76	0.71	0.78	0.72	0.70

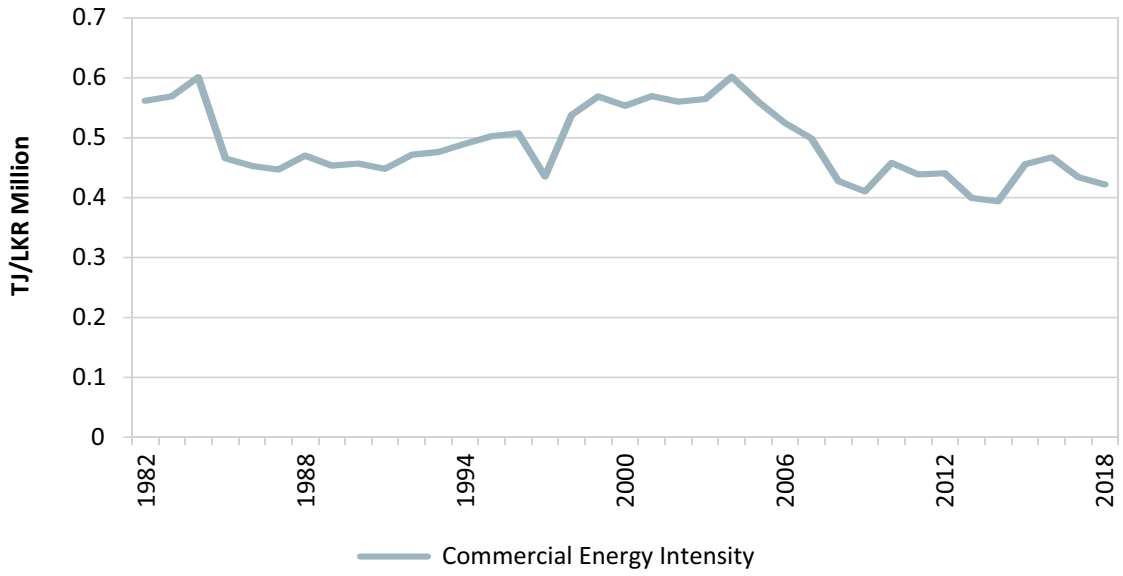


Figure 8.3 – Commercial Energy Intensity

9 Environmental Impacts

9.1 Grid Emission Factor

From year 2016 onwards, this publication will present a new emission factor, named the 'Average Emission Factor (AEF)' mainly for reporting carbon footprint of electricity users. This emission factor is calculated by dividing the total emissions from the power sector from the total units of electricity used in the country in a given year. If the emission reductions due to any sustainable energy intervention are to be calculated, the appropriate emission factor would be the Grid Emission Factor (GEF).

Table 9.1 – Average Emission Factor

	2005	2010	2015	2016	2017	2018
Emission Factor (kg CO_2/kWh)	0.3451	0.3158	0.4753	0.5684	0.5865	0.4694

The GEF indicates the amount of CO2 avoided, if a specific intervention is made either through the introduction of a renewable energy project to a grid or through the introduction of an energy saving project in the grid. The GEF also represents the quantity of CO2 emitted by a power system during a year. The GEF pivots on three factors, viz., Operating Margin, Build Margin and Combined Margin. 'Margin' refers to the happenings of renewable energy based power or an energy saving project.

The Grid Emission Factor for 2018 was calculated using the Methodological Tool 07 'Tool to calculate the emission factor for an electricity system' (Version 07.0).

9.1.1 Operating Margin

The Operating Margin (OM) is a concept which includes all power plants which can have reduced outputs due to a project. It specifically excludes 'low cost, must run' power plants, implying that with or without the project, such generation will continue. Table 9 1 gives the Simple Operating Margin (OM).

Table 9.2 – Operating Margin

	2015	2016	2017	2018
Emissions from Power Plants (t-CO_2)	1,551,881.9	3,114,853.6	3,438,963.6	2,529,709.6
Net Electricity Generation (GWh) excluding low-cost must run power plants	2,276.3	4,460.6	4,854.9	3,579.2
Operating margin CO_2 emission factor (t-CO_2/MWh)				
Three-year generation based weighted average	0.6896	0.6987	0.6993	0.7044

9.1.2 Build Margin

The Build Margin (BM) is a concept which attempts to foretell the happenings of a generation system in future, during the crediting period of a project, considering the recent additions to a generation system.

Table 9.3 – Build Margin

	Unit	2015	2016	2017	2018
Emissions of power plants considered for the BM	tonnes of CO_2	3,717,903.7	4,203,018.6	3,595,191.6	3,508,911.2
Generation of power plants considered for the BM	GWh	3,693.3	4,467.1	3,897.9	3,993.6
Build margin emission factor	t-CO_2/MWh	1.0067	0.9409	0.9224	0.8786

9.1.3 Combined Margin

The Combined Margin (CM) is a weighted average of OM and BM and is commonly known as the Grid Emission Factor (Table 9.4).

Table 9.4 – Combined Margin

	2015	2016	2017	2018
For solar, wind Projects	0.7689	0.7593	0.7550	0.7480
All other Projects; 1st crediting period	0.8481	0.8199	0.8108	0.7915
All other Projects; 2nd - 3rd crediting period	0.9274	0.8803	0.8666	0.8351

The OM, BM and CM are required for the assessment of CO_2 emission reductions for projects claiming carbon credits under UNFCC guidelines. The GEF is indicated in Figure 9.1.

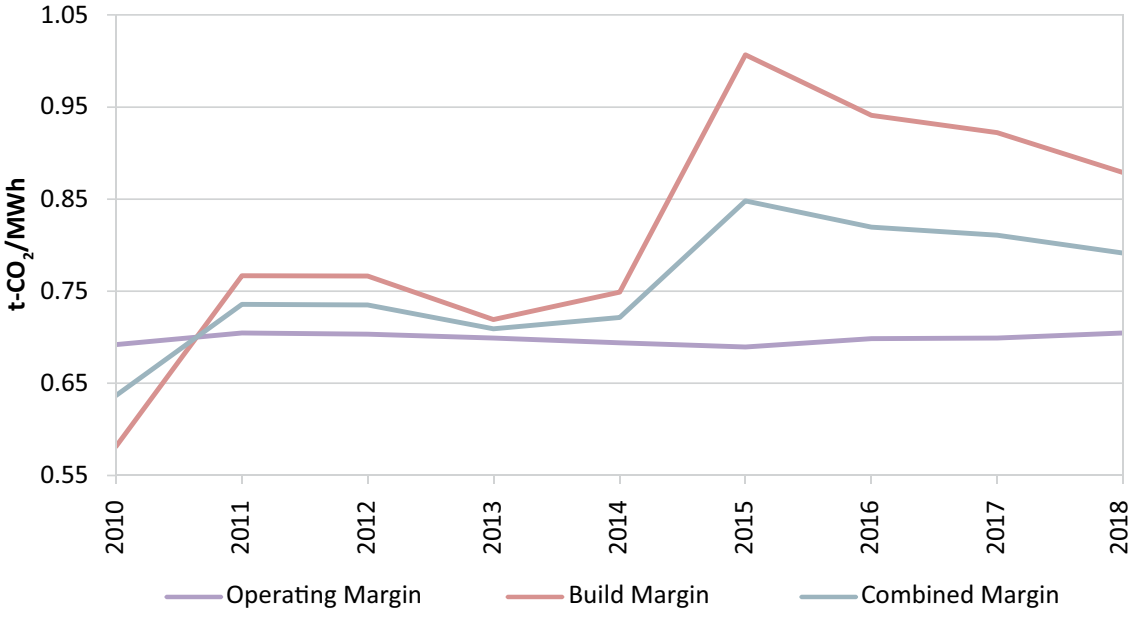


Figure 9.1 – Grid Emission Factors

With the commissioning of the coal power plants, with a capacity of 300 MW each, therefore, the emissions of CO_2 increased, as indicated in Figure 9.2.

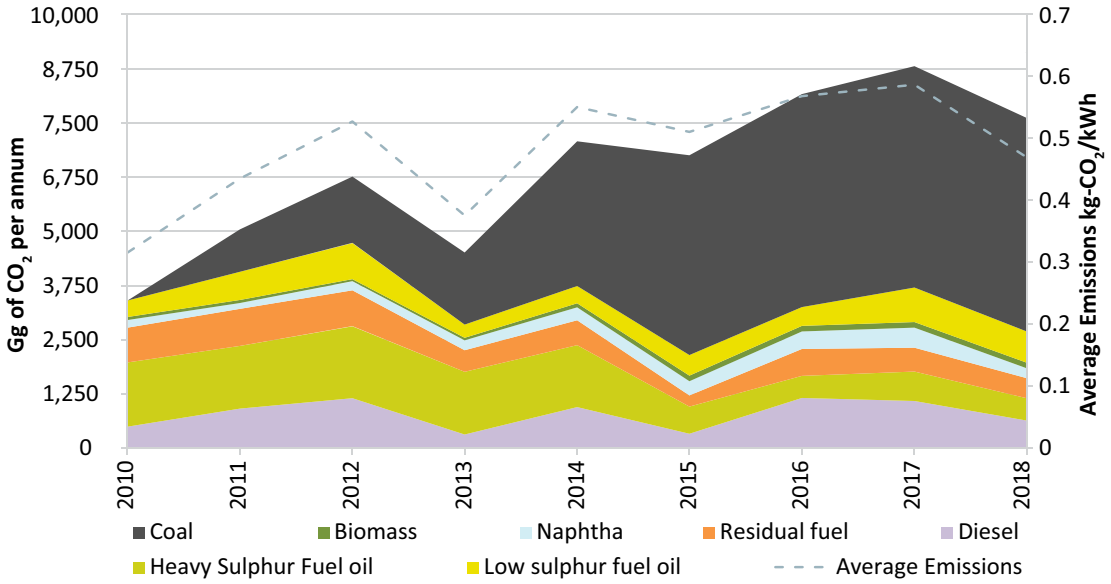


Figure 9.2 – Emissions from Power Plants by Type of Fuel

10 Energy Sector Performance and Future Outlook

The focus of the government on sustainable energy, especially energy efficiency and conservation was seen as a positive development. Supply side woes continued with major power plant construction getting delayed due to issues related to procurement. Capacity additions in NRE too suffered due to the legal impediments and lobbying by various interest groups against NRE projects. However, the rooftop solar sector continued to grow, as the prices of equipment continued to fall.

10.1 Electricity

The total electricity generation of the country increased by 7.6% to 16,216.6 GWh in 2018, from 14,983.7 GWh of the preceding year. The electricity generation continued to expand in 2018, supported by a significant growth in hydropower generation. Compared with 2017, the hydropower generation in 2018 increased by 37%, while oil based power decreased by 13.5%.

The coal power generation declined marginally by 4%, however, this was mainly due to certain issues at the Norochcholai coal power plant. The generation by new renewable energy too increased by 15%, which is mainly ascribed to the increased hydropower generation.

The overall transmission and distribution loss of the electricity system continued to decline as in the previous year, owing to measures taken to mitigate such losses through improved distribution efficiency. Compared with 2017, the electricity sales increased by 4.5% in 2018. Sales of the religious, industrial and commercial categories have increased by 5.6%, 4.9% and 5.7 in 2018, compared with the previous year. The sales of the domestic sector increased by 3.2%, while the sales in the streetlight category have increased only marginally (0.2%).

The financial performance of the CEB remained weak in 2018 as well. Although hydropower generation had improved considerably in this year, it was not sufficient to offset the losses incurred by the high cost of thermal power generation. The low fuel oil requirement for power generation, driven by increased availability of hydropower, reduced the CEB's cost on fuel significantly. Ascribed to this, the overall average cost of electricity at the selling point reduced to LKR 16.79 per kWh. The overall average tariff as at end December 2018 was LKR 16.30 per kWh, compared to LKR 16.49 per kWh in 2017.

The weak financial position of the CEB and the considerable strain it has on the on the balance sheet of the state banks, highlight the need for the implementation of plans for the expansion of power generation through less costly sources without delay. Further, it is also necessary to introduce a cost-reflective pricing mechanism for electricity.

The PUCSL granted conditional approval for the base case LCLTGEP for 2018 - 2037 submitted by the CEB in June 2018, subject to the accommodation of Cabinet-approved 'Government to Government' LNG power plants and the latest government policy on the electricity generation mix. Accordingly, as per the Cabinet approval, the national policy on the energy mix to be met by 2030 consists of 30% by LNG or indigenously available natural gas, 30% by high-efficient coal, 25% by major hydro and 15% by both furnace oil – a by-product from the refineries – and new renewable energy.

The construction work of several large scale hydropower projects was in progress in 2018. The Moragahakanda hydropower project was commissioned in 2018 with a total capacity of 25 MW. Construction

work of the Uma Oya hydropower project and the Moragolla hydropower projects were in progress and these power plants are expected to add an installed capacity of 120 MW and 30.2 MW, respectively, to the national grid by 2019 and 2022, respectively. In addition to this, the Broadlands hydropower project, with a capacity of 35 MW, is expected to be commissioned by end 2019. Further, the 15 MW Thalpitigala hydropower plant will be completed by 2020, while the 20 MW of Seethawaka hydropower plant will be added to the national grid also by end 2019. In addition, the SEA plans to establish a solar power park in Siyambalanduwa and a solar-wind hybrid park in Pooneryn.

The Ministry of Power and Renewable Energy drafted a new version of the National Energy Policy and Strategies, and is now under scrutiny of major stakeholder ministries and agencies coming under those ministries. It is expected that this policy will be presented before the parliament in early 2019.

In 2018, numerous demand side management measures were taken to improve energy efficiency and conservation. With the intention of saving energy, a LED lamp distribution scheme named 'Shakthi' was developed by the SEA. This programme plans to distribute 10 million LED lamps among 3.9 million households, which is expected to reduce the peak demand by 304 MW, saving 432 GWh on an annual basis. Under this scheme, it is expected to carry out a bulk purchase of LED lamps, which are more efficient than both Incandescent Filament Lamps (IFL) and Compact Florescent Lamps (CFL), and supply at a price less than one third of the market price to be recovered on a 24 months instalment basis without interest. Procurement of LED lamps was concluded and the distribution will be carried out during the early parts of 2019.

10.1.1 New Renewable Energy Development

The Government envisioned generating 10% of power from new renewable energy sources by 2016, which was successfully achieved by contributing 11.01% to generation by end-2015. At present, electricity generation from new renewable energy contributes 10.79% to the total generation. This includes small power producers and micro-power producers, mainly the rooftop solar projects. Out of the new renewable energy projects, 70.2% was contributed by small hydro, while the second highest percentage of 19.0% was contributed by wind. Biomass and solar contributed by 5.1% and 5.7%, respectively.

The Government continued to focus on the development of new renewable energy in 2018 as well, with the long term view of enhancing energy sustainability. The 'Soorya Bala Sangramaya' programme, which was launched in 2016, continued with added rigor in 2017. This programme alone contributed by adding 154 MW and thereby generating a total of 215.1 GWh. The 'Rivi Bala Savi' concessionary loan scheme to promote rooftop solar plants also continued in 2018 as well.

The approvals required for the Mannar Wind Power Project (100 MW) such as development permits and energy permit, were secured during 2018.

10.2 Petroleum

The global crude oil (Brent) prices recorded a notable increase during 2018, before it declined again in the last two months of the year. Brent prices showed an upward trend from mid-2017 until end May 2018 when prices fell over the expectations that the Organisation of the Petroleum Exporting Countries (OPEC) could wind down the output deal, which was in place since the beginning of 2017. However, supply concerns in relation to US trade sanctions on Iran resulted in an uptick in oil prices from mid-August to early-October 2018. Brent prices reached a peak of USD 86 on October 4, 2018, which was its highest level since October 2014. Subsequently, from November 2018, Brent prices followed a declining trend due to the build-up of global inventories and record levels of oil production from the world's three largest producers, i.e. the US, Russia and Saudi Arabia. Further, the uncertainties of the future global demand growth, particularly with the slowdown of China and several advanced economies also contributed to this. Accordingly, the average crude oil (Brent) price that stood at USD 80.93 per barrel in October 2018 declined to USD 58.16 per barrel in December 2018. However, on average, Brent price was 31% higher at USD 71.76 per barrel in 2018, compared to USD 54.76 in 2017.

The average price of crude oil imports of the CPC moved in line with global crude oil prices. Consequently, the average price of crude oil imported by the CPC increased by 31.9% to USD 76.25 per barrel in 2018 from the average price of USD 57.79 per barrel in the preceding year. The domestic retail prices of petroleum products were revised periodically during 2018, with the implementation of a cost reflective pricing formula in May 2018. However, petroleum products sales decreased in 2018 with the decline in the demand for fuels from the power generation sector.

Financial performance of the CPC deteriorated substantially during 2018, amidst rising global oil prices, depreciation of the rupee against the USD and the non-adjustment in domestic retail petroleum prices until May 2018. The CPC reported an operational loss of LKR 105 billion in 2018. Depreciation of the rupee against the US dollar resulted in a loss of LKR 82.7 billion to the CPC during 2018, while lower demand from the power generation sector also contributed to the reduction in revenue of the CPC.

Large losses incurred by the CPC deem the need to strengthen its financial viability on a sustainable basis. Accumulated financial losses of the CPC continued to burden the fiscal situation of the government, while higher borrowings by the CPC to cover its financial deficit affected the banking sector as well. The sharp depreciation of the rupee against the US dollar also generated significant losses to the CPC on top of its legacy debt. Therefore, measures are needed to ensure the CPC's financial viability while taking measures to reduce its vulnerability to exchange rate fluctuations. On the other hand, although the demand for kerosene should have declined with the total electrification of the country, the consumption of kerosene has continued to increase since 2015. This is because kerosene is sold at a subsidised price with the aim of supporting low-income households and the fisheries sector but misuse of kerosene by unintended subsidy beneficiaries also contributed to the erosion of the financial performance of the CPC. Therefore, the conversion of the kerosene price subsidy to a targeted cash subsidy could partly reduce the financial burden of the CPC. Furthermore, with the support of private sector investments, the country's oil refinery capacity needs to be improved to enhance the domestic supply of refined petroleum products. Hence, up scaling of the capacity of the Sapugaskanda refinery and discharge lines as well as investment in refining of low grade crude oil to high value petroleum products are needed to strengthen energy security of the country.

List of Small Power Producers

hydro solar biomass/dendro wind waste heat

Annex I

Independent Power Producers (IPPs)

Starting from 1997, many IPPs entered the electricity market, supplying electricity to the national grid. CEB has separate power purchase agreements with these private sector companies.

1. Asia Power (Pvt) Ltd
2. Colombo Power (Pvt) Ltd
3. AES Kelanitissa (Pvt) Ltd
4. ACE Power Embilipitiya (Pvt) Ltd
5. Yughadhanavi (Pvt) Ltd

The IPPs Heladhanavi (Pvt.) Ltd., and Northern Power retired from the national grid in 2015, upon reaching the end of their contracts. Colombo Power (Pvt) Ltd operated under the CEB in 2015.

Small Power Producers

Many new small power producers came into existence as a result of the attractive tariffs offered by the CEB and the lending facilities provided by the RERED project. A total of 200 SPPs were operational by the end of 2016. CEB has signed Standardised Small Power Purchase Agreements (SPPAs) with these companies.

List of Small Power Producers

hydro solar biomass/dendro wind waste heat

	Name of Power Plant	Yr commissioned	Capacity (MW)	Generation (GWh)
1	Dik Oya	1996	0.96	-
2	Seetha Eliya	1996	0.07	-
3	Ritigaha Oya	1997	0.80	
4	Rakwana Ganga	1999	0.76	-
5	Kolonna	1999	0.78	2.0
6	Ellapita Ella	1999	0.55	1.7
7	Carolina	1999	2.50	10.7
8	Wedamulla	1999	0.20	-
9	Delgoda	2000	2.65	11.8
10	Mandagal Oya	2000	1.28	3.9
11	Glassaugh	2000	2.53	10.3
12	Minuwan Ella	2001	0.64	2.2
13	Kabaragala	2001	1.50	-

List of Small Power Producers

hydro solar biomass/dendro wind waste heat

	Name of Power Plant	Yr commissioned	Capacity (MW)	Generation (GWh)
14	Bambarabotu Oya	2001	3.20	-
15	Galatha Oya	2001	1.20	-
16	Hapugastenna I	2001	4.60	-
17	Belihul Oya	2002	2.50	10.5
18	Watawala (Carolina II)	2002	1.30	-
19	Niriella	2002	3.00	2.8
20	Hapugastenna II	2002	2.30	-
21	Deyianwala	2002	1.50	-
22	Hulu Ganga 1	2003	6.50	5.2
23	Ritigaha Oya -II	2003		2.8
24	Sanquhar	2003	1.60	5.2
25	Karawila Ganga	2004	0.75	2.4
26	Brunswick	2004	0.60	1.2
27	Sithagala	2004	0.80	3.1
28	Vey Ganga	2004	8.93	23.3
29	Alupola	2004	2.52	10.0
30	Rath Ganga	2004	3.00	13.2
31	Waranagala	2004	9.90	42.0
32	Nakkawita	2004	1.01	2.0
33	Walakada	2004	4.21	18.5
34	Miyanawita Oya	2004	0.60	1.8
35	Atabage Oya	2004	2.20	6.9
36	Batalagala	2004	0.10	0.1
37	Hemingford	2005	0.18	0.6
38	Kotapola	2005	0.60	2.2
39	Wee Oya	2005	6.00	18.6
40	Radella	2005	0.20	0.8
41	Kumburuteniwela	2005	2.80	9.6
42	Asupini Ella	2005	4.00	14.0
43	Kalupahana	2005	0.80	2.5
44	Upper Korawak Oya	2005	1.50	5.0
45	Badalgama (Biomass)	2005	1.00	0.8
46	Delta Estate	2006	1.60	6.4
47	Gomala Oya	2006	0.80	3.7
48	Gurugoda Oya	2006	4.48	11.9
49	Coolbawn	2006	0.75	2.5
50	Henfold	2006	2.60	8.7
51	Dunsinane	2006	2.70	11.6
52	Nilambe oya	2006	0.75	0.8
53	Kolapathana	2006	1.10	2.4
54	Guruluwana	2006	2.00	8.2

List of Small Power Producers

hydro solar biomass/dendro wind waste heat

	Name of Power Plant	Yr commissioned	Capacity (MW)	Generation (GWh)
55	Kuda Oya	2006	2.00	6.0
56	Labuwewa	2006	2.00	6.1
57	Forest Hill	2006	0.30	0.6
58	Batatota	2007	2.60	11.4
59	Kehelgamu Oya	2007	3.00	8.9
60	Kotankanda	2007	0.15	0.6
61	Lower Neluwa	2007	1.45	6.1
62	Barcaple	2008	2.00	7.1
63	Kadawala I	2008	4.85	13.1
64	Blackwater	2008	1.65	3.2
65	Koswatta ganga	2008	2.00	5.0
66	Kadawala II	2008	1.32	3.8
67	Loggal Oya	2008	4.00	13.6
68	Manelwala	2008	2.40	9.1
69	Somerset	2008	0.80	4.8
70	Sheen	2008	0.56	2.3
71	Palmerston	2008	0.60	3.4
72	Giddawa	2008	2.00	8.8
73	Magal Ganga	2008	9.93	40.8
74	Soranathota	2008	2.50	3.3
75	Tokyo Cement	2008	10.00	10.9
76	Lower Atabage	2009	0.45	1.1
77	Halathura Ganga	2009	1.30	4.5
78	Nugedola	2009	0.50	1.2
79	Pathaha Oya	2009	1.50	4.7
80	Badulu Oya	2009	5.80	22.4
81	Amanawala	2009	1.00	4.2
82	Adavikanda	2009	6.50	19.2
83	Bogandana	2009	5.00	13.0
84	Gangaweraliya	2009	0.30	1.1
85	Watakalle	2010	1.50	4.9
86	Ganthuna Udagama	2010	1.20	3.3
87	Aggra Oya	2010	1.50	4.3
88	Mampoori I	2010	10.00	21.3
89	Seguwanthivu	2010	10.00	23.6
90	Vidatamunai	2010	10.00	24.9
91	Willpita	2010	0.85	0.8
92	Denawak Ganga	2011	1.40	5.9
93	Maduru Oya	2011	5.00	15.1
94	Laymasthota	2011	1.30	4.2
95	Kalupahana Oya (Pahala)	2011	2.50	4.3

List of Small Power Producers

hydro solar biomass/dendro wind waste heat

	Name of Power Plant	Yr commissioned	Capacity (MW)	Generation (GWh)
96	Bowhill	2011	1.00	4.7
97	Kirk Oswald	2011	4.00	21.1
98	Kiriwan Eliya	2011	4.65	15.4
99	Gonnoruwa II	2011	0.50	0.4
100	Thirappane	2011	0.12	-
101	Gonnoruwa I	2011	0.74	0.5
102	Nirmalapura	2011	10.00	24.0
103	Watawala B	2012	0.44	1.9
104	Denawak Ganga MHP	2012	7.20	23.2
105	Waltrim	2012	2.00	8.3
106	Branford	2012	2.50	9.9
107	Upper Ritigaha Oya	2012	0.64	1.9
108	Koladeniya	2012	1.20	5.5
109	Upper Magalganga	2012	2.40	7.1
110	Kokawita I	2012	1.00	2.8
111	Upper Hal Oya	2012	0.80	1.9
112	Kalugala Pitawala	2012	0.80	0.8
113	Bambarabotuwa III	2012	4.00	11.2
114	Nandurana Oya	2012	0.35	0.9
115	Kaduruwan Dola Athuraliya	2012	0.02	0.1
116	Barcaple II	2012	4.00	16.5
117	Bopekanda	2012	0.35	1.3
118	Falcon Valley	2012	2.40	5.2
119	Indurana	2012	0.06	0.1
120	Punagala	2012	3.00	8.3
121	Ambewala	2012	3.00	3.4
122	Madurankuliya	2012	10.00	34.3
123	Uppudaluwa	2012	10.00	17.9
124	Kalpitiya	2012	9.80	22.6
125	Green Energy	2013	0.25	1.3
126	Rakwana Ganga	2013	1.00	4.2
127	Wembiyagoda	2013	1.30	5.0
128	Pathanahenagama	2013	1.80	1.5
129	Wellawaya	2013	1.20	5.0
130	Lenadora	2013	1.40	7.0
131	Mulgama	2013	2.80	11.7
132	Rajjammana	2013	6.00	31.0
133	Kandadola	2013	0.18	0.8
134	Waverly	2013	1.20	6.3
135	Bambatuwa Oya	2013	3.00	6.7
136	Barandah	2013	0.36	1.0

List of Small Power Producers

hydro solar biomass/dendro wind waste heat

	Name of Power Plant	Yr commissioned	Capacity (MW)	Generation (GWh)
137	Gampola	2013	1.00	1.7
138	Gonagamuwa	2013	0.75	1.3
139	Kadurugal Dola	2013	1.20	3.5
140	Werapitiya	2013	2.00	6.5
141	Madugeta	2013	2.50	9.2
142	Malpel	2013	0.01	0.00
143	Dunsinane cottage	2013	0.90	1.8
144	Mille Oya	2013	1.20	3.3
145	Maduru Oya II	2013	2.00	6.0
146	Mul Oya	2013	3.00	7.4
147	Embilipitiya (Dendro)	2013	1.50	0.6
148	Erumbukkudal	2013	4.80	12.0
149	Stellenberg	2014	1.00	3.4
150	Devituru	2014	1.20	5.0
151	Bulathwaththa	2014	3.80	11.6
152	Ranmudu Oya	2014	0.50	1.8
153	Monara Ella	2014	1.80	5.6
154	Lower Kothmale Oya	2014	4.30	20.1
155	Gammaduwa	2014	0.90	3.4
156	Ritigaha Oya I	2014	0.40	2.2
157	Ross Estate	2014	4.55	21.5
158	Maa Oya	2014	2.00	5.4
159	Maha Oya	2014	3.00	10.9
160	Bowhill	2014	0.60	1.3
161	Kudawa Lunugalahena	2014	0.05	0.2
162	Bathalayaya (Dendro)	2014	5.00	38.4
163	Ninthavur	2014	2.00	1.8
164	Mampoori II	2014	10.00	25.1
165	Mampoori III	2014	10.00	25.6
166	Puloppalai	2014	10.00	31.9
167	Vallimunai	2014	10.00	31.9
168	Owala	2015	2.80	15.2
169	Naya Ganga	2015	3.00	6.0
170	Rideepana	2015	1.75	6.6
171	Thebuwana	2015	1.00	2.5
172	Maduru Oya II	2015	0.60	2.1
173	Demodara	2015	1.00	2.0
174	Lower Atabage Oya II	2015	1.25	5.0
175	Kehelwatta	2015	1.00	5.2
176	Theberton	2015	1.30	4.1
177	Ranmudu Oya	2015	0.55	1.6

List of Small Power Producers

hydro solar biomass/dendro wind waste heat

	Name of Power Plant	Yr commissioned	Capacity (MW)	Generation (GWh)
178	Andaradeniya	2015	0.80	2.6
179	Jannet Valley	2015	0.95	2.7
180	Batugammana (Dendro)	2015	0.02	-
181	Musalpetti	2015	10.00	25.7
182	Gawaragiriya	2016	0.99	2.9
183	Samanalawewa	2016	1.20	5.4
184	Upper Lemastota	2016	1.00	3.3
185	Kurundu Oya Ella	2016	4.65	20.1
186	Maskeli Oya	2016	2.00	10.8
187	Hittaragewela	2016	0.46	9.7
188	Ginigathhena Thiniyagala	2016	0.80	1.2
189	Dolekanda	2016	0.55	1.5
190	Gomale Oya	2016	1.40	2.7
191	Mawanana	2016	4.30	13.7
192	Ethamala Ella	2016	2.00	9.1
193	Upper Waltrim	2016	2.60	13.3
194	Urubokka	2016	1.00	5.1
195	Ebbawala	2016	4.00	4.8
196	Hulkiridola	2016	0.75	1.4
197	Dambulu Oya	2016	3.25	12.1
198	Saga Solar	2016	10.00	18.8
199	Solar One Ceylon Power	2016	10.00	20.7
200	Loluwagoda DPP	2016	4.00	25.8
201	Kiruwana Ganga MHP	2017	0.63	2.4
202	Ruhunu MHP	2017	0.35	1.1
203	Winsor Forest MHP	2017	0.40	1.4
204	Nahalwathura MHP	2017	0.40	2.4
205	Hapugahakumbura MHP	2017	1.60	4.6
206	Padiyapelella MHP	2017	3.50	21.1
207	Moragaha Oya MHP	2017	1.50	5.7
208	Campion MHP	2017	1.00	4.9
209	Demodara MHP	2017	1.60	6.7
210	Berannawa MHP	2017	0.50	1.1
211	Loggal Oya DPP	2017	2.00	7.7
212	Iris (Baruthankanda) SPP	2017	10.00	17.9
213	Anorchi Lanka (Baruthankanda) SPP	2017	10.00	19.3
214	Nedunkulam SPP	2017	10.00	20.5
215	Udawela MHP	2018	1.40	4.1
216	Mossville Estate MHP	2018	0.90	3.2

	Name of Power Plant	Yr commissioned	Capacity (MW)	Generation (GWh)
217	Loggal Oya MHP - Phase I	2018	1.60	4.5
218	Bambarapana MHP	2018	2.50	10.1
219	Manakola MHP	2018	2.50	10.4
220	Muruten Ela MHP	2018	0.50	0.6
221	Polgaswaththa MHP	2018	1.00	0.8
222	Maliyadda MHP	2018	0.90	1.2
223	Ankanda MHP	2018	1.20	6.3
224	Thannewatha MHP	2018	1.00	0.6
225	Ranwala Oya MHP	2018	0.70	-
226	Binathura Ela MHP	2018	0.70	-
227	Panamure DPP	2018	0.99	1.2
228	Kalawa Aragama DPP	2018	10.00	-
Total			**584.9**	**1,713.8**

Litro Gas Lanka Limited.

Liquefied Petroleum Gas (LPG) industry was privatised in 1995, when Shell Gas purchased a stake in the previously Government-owned Gas Company, under a five-year concession. Over 1995-2000, Shell Gas purchased LPG available in the CPC refinery and also imported LPG, and marketed in Sri Lanka. The monopoly status ended in late 2000. The Company markets LPG to all customer segments, in all provinces of the country.

The full ownership of Shell Gas Lanka (Pvt) Ltd was handed over to the Government in November 2010, forming Litro Gas Lanka Limited (LGLL). Sri Lanka depends on imported LPG to bridge the growing gap between demand and the limited local production by Ceylon Petroleum Corporation's (CPC) Refinery in Sapugaskanda. To meet this demand, the Government also took steps to purchase the Shell owned LPG Storage Terminal situated in Kerawalapitiya. The LPG Storage Terminal was re-named Litro Gas Terminal Lanka (Private) Limited (LGTLL). Litro Gas also owns a modernised LPG bottling plant situated in Mabima, Sapugaskanda which is one of the largest in the region and a fleet of modernised LPG tanker trucks.

LAUGFS Gas PLC

Established in the year 1995, LAUGFS Holdings is a Sri Lankan diversified business conglomerate covering most of the commercial spectrum of industries. LAUGFS Gas PLC is a subsidiary of Laugfs Holdings Limited. It plays a key role in the importation, storage filling, distribution and sale of Liquefied Petroleum Gas (LPG) for domestic, industrial and auto gas users. LAUGFS hold one of the state-of-art storage and filling facility at Mabima, with a storage capacity of 2,500 tonnes, equipped with a strong dealer network in the country.

Lanka Indian Oil Company (LIOC)

LIOC is a subsidiary of Indian Oil Company, which is owned by the government of India. It operates about 150 petrol and diesel stations in Sri Lanka, and has a very efficient lube marketing network. Its major facilities include an oil terminal at Trincomalee, Sri Lanka's largest petroleum storage facility and an 18,000 tonnes per annum capacity lubricants blending plant and state-of-the-art fuels and lubricants testing laboratory at Trincomalee.

Annex II

Conversion to Uniform Energy Units

For comparison, energy products expressed in their respective units used for ordinary transactions need to be converted to a common equivalent unit. Similar to most other countries, Sri Lanka used tonnes of oil equivalent (toe) as the common denominator for this purpose (1 toe = 10 GCal = 41868000 kJ). Sri Lanka is contemplating using Joules as the common unit in future. Shown below are the conversion factors used for converting each energy product to equivalent toe. After two more years, this publication will cease to report toe as the common energy denominator.

Conversion Factors and Calorific Values

Primary Energy	toe/t	kJ/t
Bagasse	0.40	16,747,200
Charcoal	0.65	27,214,200
Coal	0.70	29,307,600
Crude Oil	1.03	43,124,040
Fuel wood	0.38	15,909,840
Hydro electricity (thermal equivalent) (toe/GWh)	240.00	10,048,320,000

Products	toe/t	kJ/t
Aviation Gasoline	1.06	44,380,080
Aviation Turbine Fuel	1.05	43,961,400
Ethane	1.18	49,404,240
Fuel Oil	0.98	41,030,640
Gas Oil /Diesel Oil	1.05	43,961,400
Kerosene	1.05	43,961,400
LPG	1.06	44,380,080
Motor Gasoline (Petrol)	1.09	45,636,120
Naphtha	1.09	45,636,120
Refinery gas	1.15	48,148,200
Residual Oil	0.98	41,030,640
Solvent	0.89	37,262,520

Electricity	kJ/kWh
Electricity	3,600

Compiled by

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ISSN 2386-172X