Biomass energy policy perspectives of Sri Lanka: A review

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Abstract: Nearly 69% of Sri Lankan household depend on biomass to meet their energy needs, while biomass meets 36% of country's energy supply. The users of biomass can be classified as households, institutions, industries, and power generation. There is a slow shift away from using biomass as a cooking fuel in the household sector adhering to the fuel stacking phenomena, as they tend to retain the practice of using biomass for cooking irrespective of using modern modes. Biomass use in industries is increasing and becoming more formalized and organized. Biomass based power generation is very minimal. The national policy related to biomass is encouraging. It emphasises on increasing growing biomass, supply chains, value addition, and conversion efficiencies. Some technological improvements on devices have taken place historically, while Sri Lanka has established national standards on improved biomass cook stoves and sustainably sourced fuelwood. The private sector has initiated to meet their entire thermal energy needs from biomass. Sri Lanka Sustainable Energy Authority and Ceylon Electricity Board have planned to add power generation capacity from biomass powerplants. Biomass sector could contribute significantly towards commitments on Sri Lanka's Nationally Determined Contributions (NDCs) as well as achievement of Sustainable Development Goals (SDGs) while ensuring energy security and reducing draining of foreign exchange on importation of fuels.

Key words: Energy, Biomass, Policy, Sri Lanka

Introduction

Biomass is the second largest energy supply source in Sri Lanka. It meets more than a third of the energy demand of the country satisfying a greater portion of the cooking energy requirements of the domestic sector. Biomass comes in different forms, and the most common forms of biomass available in Sri Lanka are fuelwood (unprocessed logs and processed chips), and municipal, industrial and agricultural waste. However, due to the abundant availability, only a limited portion of the total biomass used is channeled through a commodity market. During 2017, the share of biomass in the primary energy supply and total energy demand were 36.5% (out of 528.9 PJ) and 45.1% (out of 423.8 PJ) respectively (SLSEA, 2019)

Biomass sector operate independently and informally over the history, with very little interaction with the energy sector governing structure (SLSEA, 2019). At the macro level, the users of biomass in Sri Lanka can predominantly be classified into 4 groups, the households, institutions, industries, and power generation.

The biomass supply and distribution network is quite simple, and in the case of most users, a formal network does not exist (SLSEA, 2019). The supply chains comprise of a large number of small suppliers. Few of them supply biomass to large-scale suppliers some of whom own delivery trucks or lorries. The commodities they transport alternate between biomass such as firewood and sawdust, and others such as rice, cement, sand, and bricks according to the varying demands, profits, and the seasonality. There are few bulk biomass suppliers who liaise with companies that demand for large quantities of biomass. They source them from small-scale suppliers. As the preference of some companies is the processed forms of biomass such as wood chips and split-wood, some of the medium or larger-scale suppliers add value by processing their supplies (SLSEA, 2016). Also, biomass generated in a province may not necessarily be used in the same province; for instance, all saw dust from central province are exported to eastern province while a significant portion of biomass remains underutilised by households within the province (Musafer et al., 2011).

Biomass use in Household Sector

In the formal publication Sri Lanka Energy Balance, the values related to biomass are presented for the household, commercial, and other sectors (which include the institutions) together, and these sectors accounted for 67% of the country's energy

demand in 2017 which was 112.7 Petajoules (PJ) out of the total of 167.1 PJ. Abundant availability, especially in rural areas where the biomass usage is most common, has simplified the distribution of biomass in the country. For them, energy demand for cooking is in the form of biomass while it is in the form of either Liquefied Petroleum (LP) gas or electricity in the urban areas (SLSEA, 2019). The households who use biomass, use multiple fuel-wood sources and most widely used fuel-wood sources are from their own land, land which don't belong to them and fuel-wood bought commercially at markets. Other sources providing fuel-wood include private land, state-owned land and road side vegetation. Branch-wood and twigs are some widely used fuel-wood types (Wickramasinghe, 2013). For majority of the households, both the source and the point of use are within the same home garden. With the increase of household income levels, fuelwood used in cooking is reducing in volume (SLSEA, 2019).

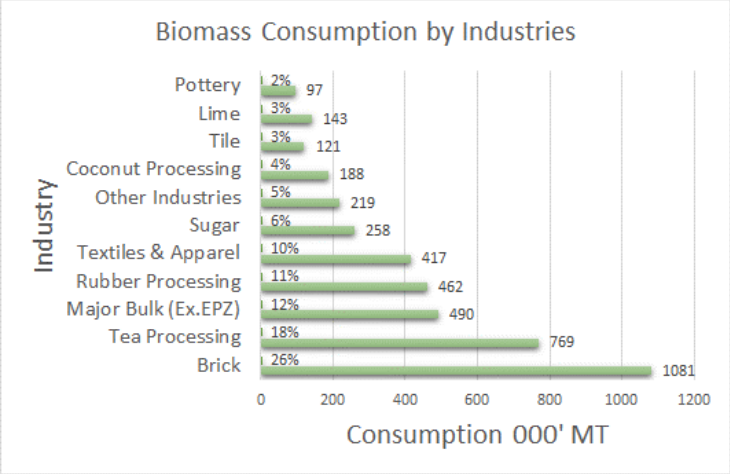
Stoves are used to cook from biomass. Different institutions contributed in the design, promotion, and commercialization of improved cookstoves in Sri Lanka since 1972 (Amarasekara & Atukorala). As per the national energy policy and strategies, the penetration of efficient, low soot and smoke biomass cook stoves are to be increased to 10% of households by 2022, while the processed, commercialized biomass based fuels used in such stoves will be made widely available across the retail market by creating an enabling environment (NEPS, 2019). The Sri Lanka Standard Institute released national standard SLS 1475: 2013 on two pot biomass clay cook stoves, which is for improved cook stoves (SLS, 2013) resulting in less soot and smoke. The National Engineering Research & Development Centre of Sri Lanka introduced two types of wood gasifier stoves which are more efficient, one a forced draft stove with a small electrically operated blower connected to it, and the other, a natural draft stove (Musafer, 2013), having a combustion efficiency of about 35% when compared with less than 8% in traditional 3-stone cook stove (Joseph, 2011).

The energy ladder hypothesis holds for Sri Lanka as opined by Rajmohan & Weerahewa (2010). This is a model used by resource economists to describe how households would advance to more 'sophisticated' domestic fuels with the improvements in their economic conditions, where the underlying premise behind this theory is that as households' economic status improves, they move up the energy ladder, replacing biomass fuels with the sophisticated fuels, and conversely they will move down the ladder as their economic status decreases (Maconachie et al., 2009). Sri Lanka is moving towards modern fuels such as liquefied petroleum gas (LPG) and electricity, the urban sector proceeding much faster than the rural sector (Rajmohan & Weerahewa, 2010). In 2016, 77% of the rural houses and 25% of the urban houses used firewood as their cooking fuel. This contributed to nearly 69% of the houses in Sri Lanka. In 2009/2010, 81% of houses used firewood as cooking fuel while use of gas increased to 29% of the houses in 2016 from 16% in 2009/2010 (CBSL, 2020). Further, the budget elasticity values of firewood demonstrate to be negative in the urban sector, indicating that they are inferior goods while LPG and electricity demonstrating positive budget elasticity values indicating that they are normal goods (Rajmohan & Weerahewa, 2010). However, there is a greater potential for a transition from traditional cooking stoves fuelled by firewood burning to improved stoves, but switching to cleaner energy will not be immediate due to the strangeness of non-income determinants where a mere increase in household income will not reduce the demand for biomass from the society. Most believe that the use of LPG for cooking is very costly compared to biomass (Damayanthi, 2018). This imply that Sri Lankans too disagree with the notion of complete fuel substitution given that most households tend to have a mix of energy sources for their activities (Adamu et al., 2020), being in line with the phenomena of fuel stacking (multiple resource use).

Biomass use in the Industrial Sector

The total energy demand in the industrial sector in 2017 was 103 PJ of which biomass accounted for 76% (78.4 PJ). In industrial use of biomass, distribution is a one-to-one arrangement, which links the source to the user through a direct biomass transport. However, with the advent of formal supply chains, biomass use in industrial thermal energy use is gaining rapid grounds, due to cost benefits (SLSEA, 2019). Due to disparity of prices between furnace oil and biomass, there is a business case for large industrial thermal plants to adopt fuel-switching and to be operational on biomass, further consolidating the biomass supply chains. This can result in further increase of the use of biomass for energy in the country, especially for thermal energy supply in the industrial sector (SLSEA, 2019).

From the industries sector, the largest biomass (all forms) consumption is observed from the brick industry, followed by tea processing industries and bulk consumers such as industries from the export processing zones (EPZ) as depicted in the figure. When firewood, saw dust, paddy husk, are singled out, the biggest consumers of firewood are the tea, textiles, and brick industries respectively in Sri Lanka (SLSEA, 2016). It is also encouraging to note the initiatives taken by some private sector players to meet their thermal energy demands from biomass; for instance Elpitiya Plantations PLC targets at meeting 100% of thermal energy requirements from their estate grown sustainable biomass sources (EPP, 2020).



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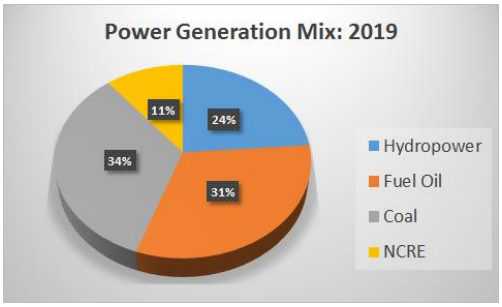
Early signs of organised biomass industry was witnessed in 2016, with some major fuelwood suppliers setting up pre-processing facilities that are in close proximity to end-user facilities. In the Export Processing Zones alone, it is estimated that about 500 - 700 tonnes of chipped fuelwood is used per day by individual thermal energy users. The first biomass energy terminal came into commercial operations in 2017 assisted by a development agency (SLSEA, 2019). There are around 400 biomass boilers operating around Sri Lanka consuming about 3,200 metric tons of biomass (Arachchige & Sandupama, 2019).

Biomass use in Power Generation



Sri Lanka's had a national electricity grid of 4,217 MW of installed capacity, with a maximum demand of 2,669 MW in 2019. The country generated 15,879 GWh during this year. Her electricity sector is heavily reliant on carbon intensive primary energy sources, which contributed 66% of the total electricity generation in 2019, as depicted in Figure. The other sources are hydropower and Non-Conventional Renewable Energy (NCRE) which include Solar, Wind, Small Hydro, and Biomass. Sri Lanka imports all her coal & oil. In 2019, 45.4% of petroleum in Sri Lanka was used for power generation. Heavy dependency on imported fossil fuel for electricity generation has a major bearing on the trade balance and the exchange rate. In 2019, the country reported a minus trade balance of US$ million 7,997 with exports and imports of US$ million 11,940 and 19,937 respectively while the average exchange rate of LKR: US$ was 178.78 (CBSL, 2020). Similarly, the Carbon Dioxide emission factor (total emissions of the power sector divided by the total number of units of electricity produced during the year) from electricity grid was 585g CO_2/kWh in 2017, (an increase by 85% within seven years) which translates into 8.6 million metric tonnes of CO_2 emissions by the electricity sector during the year (SLSEA, 2019). Power generation form biomass, being an indigenous renewable resource, shall ease the country with her trade balance, stabilizing the exchange rate, and reduce corresponding greenhouse gas emissions too.

Biomass Power Sector Economics

Sri Lanka's power generation is dominated by the state owned Ceylon Electricity Board (CEB) supported by the Independent Power Producers (IPPs). The installed capacity of the system in 2018 was 4,046 MW of which 72% was owned by the state owned utility CEB). Generating electricity using fuel oil is the most expensive source for CEB while price of electricity purchased from the IPPs exceed the average tariff charged from the consumers substantially as shown in the following tables.

Price, Cost, Tariff	Average Price, Cost, Tariff / kWh	
	LKR	US$ Cents
Purchase price from IPPs	26.47	14.81
Cost at selling point	23.29	13.03
Consumer tariff	16.62	9.30

Average purchase price, cost and tariff (2019)
Source: CBSL, 2020

Source	Average Cost / kWh	
	LKR	US$ Cents
Hydro	2.49	1.39
Coal	10.48	5.86
Fuel Oil	31.93	17.89

Average cost to CEB to generate 1 kWh (2019)
Source: CBSL, 2020

Sector	Average Tariff / kWh	
	LKR	US$ Cents
Domestic (Households)	14.11	7.89
General Purpose (Ex. Offices)	23.91	13.37
Government Establishments	18.19	10.17
Industrial	14.72	8.23
Hotels	17.75	9.93

Average electricity tariff (2019)
Source: CBSL, 2020

By the year 2017, there were 10 grid connected biomass powerplants in the country with an installed capacity of 26 MW (CEB, 2018a). There were 14 Standardized Power Purchasing Agreements signed as at end of 2018 for biomass projects with a total capacity of 71 MW (CEB 2018a). The power generation from biomass in 2018 was 16 GWh (CEB, 2018a). The energy value of biomass directed for power generation was 0.67PJ (SLSEA, 2019). The performance of the biomass related power plants in the year 2018 of the country are given below. All of these powerplants are privately owned and operated.

#	Powerplant	Commissioned Date	Installed Capacity (MW)	Power Generation (GWh)	Average Unit Price (LKR / kWh)
Dendro (generation of electricity from sustainably grown biomass - fuel wood)					
1	Kottamurichchana	Sep 2011	0.50	0.000	-
2	Embilipitiya	Feb 2013	1.50	0.592	20.70
3	Batalayaya	May 2014	5.00	38.370	20.70
4	Batugammana	Aug 2015	0.02	0.000	-
5	Loluwagoda	Oct 2016	4.00	25.821	24.34
6	Loggaloya	Sep 2017	2.00	7.673	23.83
7	Panamure	May 2018	0.99	1.170	23.44
8	Kalawa Aragama	Dec 2018	10.0	0.000	-
Total / Overall of Dendro			**24.01**	**73.626**	**22.35**
Biomass					
1	Badalgama	Jul 2005	1.00	0.813	13.47
2	Tokyo (Trincomalee)	Dec 2008	10.00	10.858	8.57
3	Ninthawur	Feb 2014	2.00	1.830	14.25
4	Dikkanda (Biogas)	Sep 2015	0.08	0.000	-
Total / Overall of Biomass			**13.08**	**13.501**	**9.63**
Total of Dendro & Biomass			**37.09**	**87.130**	N/A

Dendro & Biomass Installed Capacity, Power Generation, and average unit price in 2018
Source: CEB, 2019

Under the given backdrop, the average price electricity is purchased from privately owned oil based powerplants is exorbitantly high (LKR 31.93 in 2019) compared to the average tariff charged (LKR 16.62 in 2019) from the consumers. The power purchased form biomass and dendro powerplants at the average price of LKR 9.63 & LKR 22.35 respectively (CBSL, 2020) would ease the CEB, but again, purchasing from dendro powerplants is also higher than the aforementioned average tariff charged from consumers, which would impact the CEB in making a trade loss.

Biomass & Energy Policy

Ministry of Plantation Industries submitted a memorandum to Cabinet of Ministers in June 2005 and obtained approval to designate Gliricidia sepium as the 4th National Plantation Crop; Tea, Rubber and Coconut being the other plantation crops in Sri Lanka (Joseph, 2011). However, no major energy plantations are found in Sri Lanka. In the year 2008, National Policy and Strategies on Energy was gazetted, and this was subsequently superimposed by a new National Energy Policy and Strategies in 2019. This document presents how the country is planning to meet the challenge of developing and managing her energy sector to ensure delivery of reliable, cost-effective, and competitively priced energy services from diverse sources to fuel the social market economy. This policy has many favourable aspects pertaining to the promotion of biomass as a source of energy. It goes to the extent of claiming that biomass is probably the most important energy resource, and it will play a valuable role as a convenient fuel for the households and a dependable thermal energy supply for the industries. Under the implementing strategies, on enhancing self-reliance, it states 'availability of biomass will be enhanced by establishing dedicated energy plantations or plantations with residue as a potential fuel, in prescribed biomass energy development areas'. This policy encourages the commercial availability of biomass and biomass-based fuel products to be used in industrial thermal applications and household use, and to nurture fuel source supply chains with processed biomass with an efficient collection, processing, value addition, storage, and distribution system. Further, improved biomass conversion devices such as cook stoves, similar to experiences of commercial fuel-based cooking devices (smoke and soot free, and convenient to use) will be introduced and promoted for household use. This strategy is expected to help to retain the share of biomass as a fuel used for cooking applications and to discourage migration to petroleum fuels (NEPS, 2019).

Sri Lanka Sustainable Energy Authority (SLSEA) is to develop indigenous energy resources to the optimum levels to minimise dependence on imported resources, and it targets at prescribing a minimum of 10,000 hectare of unproductive land as biomass energy development areas, and lease them to developers for 5 years to transform them into commercial timber cum fuel wood plantations as a measure of enhancing self-reliance. Further, to ensure access to reliable, equitable, convenient, quality, and affordable energy services for citizens to enhance their living standards and to engage in gainful economic activities, it is expected to double the commercial supply of biomass and biomass-based fuel products through the establishment of 20,000 hectares of biomass plantations within the period 2020-2023. Soft financing and other fiscal incentives will be offered to businesses that provide fuel wood including dedicated energy plantations and other commercial plantations in this regard. It is also to support biomass supply chains in five regions by a pilot project through improved collection of biomass residues, mixed cropping, and certification of sustainable extraction for three years (until their commercialisation) by 2020. SLSEA shall ensure that fiscal incentives are provided to entrepreneurs who are engaged in the manufacture and distribution of equipment using technologies such as improved cook stoves and mini gasifiers by the end of 2020, towards ensuring a minimum 5% penetration of improved stoves that use commercialized biomass fuels by 2021 (NEPS, 2019).

Biomass & Forestry

Logging in natural forests has been banned in Sri Lanka since 1990 (Premakantha et al., 2008). SLSI considers a naturally regenerated forest to include areas of agricultural land that are expected to reach a canopy cover of at least 10% and tree height of at least 5m; and forests with a mix of naturally regenerated trees and planted or seeded trees where the naturally regenerated trees are expected to constitute more than 50% of the growing stock at stand maturity whether or not they are legally protected (SLSI, 2016). Sri Lanka meets its timber and fuelwood demand mainly from tree resources outside the forests (Premakantha et al., 2008).

National Standards on Sustainably Grown Fuelwood

This standard aims to promote the sustainable production of biomass to be adopted voluntarily by producers or users who are concerned about the sustainability of their fuelwood supply, and seek a sustainability certification auditable by an independent third party. This standard looks at trees coming out of the ground, and not what happens to them afterwards, and does not cover sustainability of the technology used in the industrial processes. For the certification, this standard describes the sustainability requirements for the production of fuelwood including basic chain of custody or traceability through the supply chain where their transport and pre-preparation also considered. Fuelwood from home gardens and trees used in agriculture systems such as intercropping, alley cropping and the support trees can be considered for certification. From the existing plantations such as tea and rubber, the uprooted tea trees, shade trees, or their branches and rubber plantations including intercropping systems can be considered. From the coconut plantations, the fuelwood intercrops, husks and other coconut by-products that can be used as fuel can also be requested for certification. Other specific plantations such as for timber, agro-energy plantations like Gliricidia, and dedicated fuelwood plantations also could be candidates. From the export agricultural crops, the woody agricultural by-products such as cinnamon sticks can be considered. The invasive species removed through sanitation programs, although may not be continuously supplied from the same locations can also be considered (SLSI, 2016).

National Standards on Improved Biomass Cook Stoves

The national standards on two pot clay cook stoves provides guidelines for the manufacture of the stoves specifying their general, dimensional, physical, mechanical, and marking requirements used for domestic purposes. This standards further specifies the methods for inspection of general requirements, determination of dimensional, physical and mechanical requirements, and the criteria for conformity with the specification (SLSI, 2013).

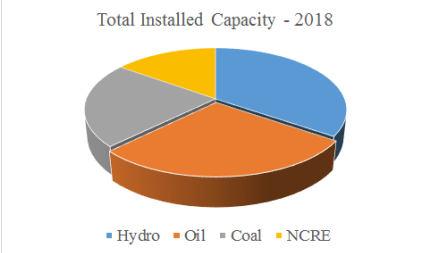
Discussion

The demand for biomass from the households, industries, and power generation were 112.7 PJ, 103.0 PJ, and 0.67 PJ respectively in 2017. Therefore, biomass based power generation from the demand perspectives is negligible.

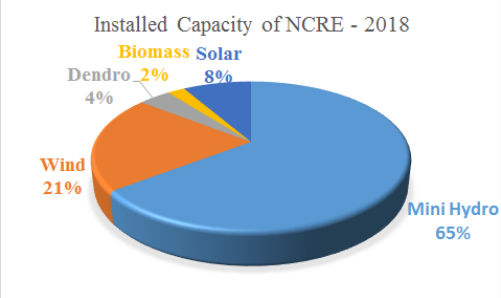
The details of the total installed power generation capacity and installed capacities of each non-conventional renewable energy (NCRE) sources during the year 2018 were as follows. The NCRE installed capacity is 15% of the total while biomass and dendro together make only 6% of the installed capacity of the NCRE. Accordingly, biomass is not a significant contributor to the power generation in the country too.

Source	Installed Capacity (MW)
Hydro	1,399
Oil	1,137
Coal	900
NCRE	610
Total	4,046

Total Installed Capacities of powerplants in 2018
Source: CEB, 2019



Source	Installed Capacity (MW)
Mini Hydro	394
Wind	128
Dendro	24
Biomass	13
Solar	51
Total	610



Installed Capacity of NCRE in 2018
Source: CEB, 2019

According to the Renewable Energy Development Plan Phase I: 2019-2025 of the SLSEA, 56 MW of biomass powerplants are planned to be added between 2019-2025 giving priority to the areas with high biomass energy resource potential as identified in the renewable energy resource inventory, including from the waste to energy projects. This plan considers designation of a 25 km radius around a 10 MW power plant as the prospective land area for biomass plantations in the determination of renewable energy resource development locations (SLSEA, 2019_b). Further, Long Term Generation Expansion Plan (2020-2039: Draft) of the CEB recognises biomass to be a renewable energy based firm energy source, and it envisages the cumulative capacity from biomass to be 144 MW by 2039, providing for higher shares of renewable energy sources with the expectation of maximising the utilization of indigenous natural resources (CEB, 2020). Because biomass is a renewable source of indigenous firm power, it has a high potential to be a contributor to reduce greenhouse gas emissions and thereby contributing to climate change mitigation facilitation the nationally determined commitments (NDCs) and achievement of Sustainable Development Goals (SDGs), especially the 7th goal on ensuring access to affordable, reliable, sustainable and modern energy for all.

Limitations

The actual value of biomass is often misrepresented by its discounted price due to the simplified sourcing options (SLSEA, 2019). Accordingly, there can be a considerable tolerance of the data presented. The latest data used in this review include the Energy Balance for 2017, power generation and sales values for the year 2018, and overall power sector data for 2019. Although older data could have been used to make the comparison more justifiable, latest data were included in the review to reflect the most current scenario. Accordingly, the readers may find it some difficulty in absolute comparisons. The details of the surveys included in this review have been carried out in 2015, thus current situation may have undergone some changes.

Conclusions

Biomass makes a significant contribution to the primary energy and energy demand in the country. The users of biomass can predominantly be classified as households, institutions, industries, and power generation. There is a shift towards use of LP gas for cooking in the household sector, but the rate at which this transformation takes place is slow and the way how it happens deviates from the phenomena of the energy ladder, but adheres to energy stacking or using of multiple source of energy concurrently. The use of biomass in the industries sector is increasing and getting more formalized and organized. The stake of biomass in the power generation sector is very minimal, despite it being a firm source of indigenous renewable energy contributing positively towards energy security and reduction of greenhouse gas emissions.

The national policy perspectives related biomass is quite positive paying attention to increasing of biomass supply by way of dedicating land, encouraging energy plantations, proposing for fiscal incentives, and streamlining supply chains and channels with interim value additions from one hand and on the improvement of energy efficiency and reduction of emissions from other hand. This is supported by some technological improvements taken place historically and establishment of national standards on improved cook stoves and sustainably sourced fuelwood. The private sector has taken their own initiatives to target for higher proportions of biomass to meet their thermal energy requirements. As for increasing power generation from biomass, both SLSEA and CEB have incorporated capacity additions from biomass in their planning horizons. Accordingly, it is very likely for biomass to remain as a main source of energy in Sri Lanka in the foreseeable future.

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