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Green Energy Finance in Sri Lanka: A review

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Green Energy Finance in Sri Lanka: A Review

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1. Introduction

The chapter introduces the analysis of green energy finance in Sri Lanka. As a country located on an island close to the equator in the Indian Ocean, there is abundant diversity in energy sources. While hydropower and thermal sources currently dominate, there is enormous potential for developing other renewable energy sources with the help of green finance.

Despite the availability of various energy resources in the country, the selection of an energy portfolio is influenced by environmental and political factors. The primary criteria for assessing the energy portfolio are its economic, environmental, and social impacts for sustainability. Sri Lanka is blessed with several types of renewable energy resources based on its geo-climatic settings. Some energy resources have been developed to meet current energy requirements, while others have the potential for development as technologies mature and become economically feasible. The development plan for the power and energy sector is aligned with the country's overall development goals. It aims to provide affordable, high-quality, and reliable energy for all citizens while conserving the country's precious natural environment. The plan prioritizes indigenous energy sources and seeks to minimize regional disparities in energy service delivery. The vision for the power and energy sector is to fully harness the potential of all renewable and other indigenous resources, making Sri Lanka a nation that is self-sufficient in energy.

In a nutshell, total population of the country is approximately 20 million, while total households are 5.3 million. On grid commercial entities are 400,000; on grid government institutions are 134,000; on grid Hotels are 546; on grid industries are 43,000; Per capita energy consumption (toe) – 0.478; (Lower middle-income country average of 1.02 toe); Per capita CO_2 emissions (tons/y) – 0.62. The total energy requirement of the country was around 16125 ktoe in 2015, and the primary energy supply mainly consisted of 4,814 ktoe of biomass, 4,582 ktoe of fossil fuels, and 1,442 ktoe of hydro. Accordingly, 56% of total energy consumption is from indigenous (biomass and hydro), and Sri Lanka has to import fossil fuels to meet the balance. This requires importing 02 MMT of crude oil, 04 MMT of refined petroleum products and 2.25 MMT of coal to the country annually, costing approximately USD 5 billion in foreign exchange (Sustainable Energy Authority, 2015). Sri Lanka has already achieved a grid connectivity of 98%, which is commendable by South Asian standards. Current total installed power generation capacity of the country is approximately 4,050 MW, consisting of 900 MW of coal power, 1,335 MW of oil burning thermal power, 1,375 MW of hydro-power and 442 MW of non-conventional renewable energy sources such as wind, mini hydro, biomass and solar power plants (Sustainable Energy Authority, 2015). The annual total electricity demand is about 10,500 GWh, comprising of 38% from domestic consumers, 39% from industries and 20% from commercial enterprises, with the balance coming from other sectors such as religious organizations and street lighting. The overall annual demand for electricity is 4-6 %by high prices. The annual total electricity demand is about 10,500 GWh,

comprising of 38% from domestic consumers, 39% from industries and 20% from commercial enterprises, with the balance coming from other sectors such as religious organizations and street lighting (Sustainable Energy Authority, 2015).

In this context, it is clear that a strategic balance between national energy demand and supply must be maintained with a long-term perspective to support steady economic growth. The development plan for the human capital sector in a knowledge-based economy has primarily evolved to meet energy demand through renewable and other indigenous energy resources. It emphasizes the potential of a "green" economy, energy conservation measures for sustainability, actions for energy security, financially and economically justifiable pricing policies for electricity and petroleum products, research and development initiatives, and, importantly, management and good governance practices for the sector. Sri Lanka is one of the countries with a high rate of electrification, leading to a high demand for energy. Despite having various energy sources and diversifying the energy mix to cater to the demand for renewable energy, considerations are made in line with the global trend towards green energy. Biomass, hydropower, solar, and wind are the main renewable resources available in Sri Lanka. More recently, new energy supply technologies such as biofuels and energy carriers like hydrogen have emerged as alternatives. However, the use of these technologies for energy supply purposes is still limited in Sri Lanka. Currently, the government has proposed a "battle for solar energy," the harvesting of wind power and wave energy from the ocean, in addition to the use of renewable sources like geothermal and hydropower.

Nevertheless, the renewable energy sector faces numerous constraints, including those related to green energy finance. Despite the high potential for the green energy sector, improving existing renewable energy sources is considered the best option for sustainability. There have been low attempts to increase green energy sources to mitigate the financial risks of energy development. However, current trends in energy resources are moving towards the better use of clean energy for electricity generation, promoting the sustainable development of the economy in the long run. These green initiatives aim to ensure that consumers and businesses are not unduly vulnerable to external market factors, and the economy can benefit from a secure and affordable energy supply.

Sri Lanka aims to become a regional hub by increasing refinery capacity and utilizing gas and condensate discoveries to create and meet domestic demand through green finance. Large-scale deployment of renewable energy, such as a wind farm and a widespread network of fuel wood exchanges, are planned green initiatives to increase the resilience of Sri Lanka's energy supply. The power and energy sector of Sri Lanka is working towards achieving energy self-sufficiency by 2050, and therefore, the green financial sector is a crucial consideration in ensuring the sustainability of green energy initiatives. While Sri Lanka's potential for the green energy sector is extremely high and diverse, there is a low level of initiative observed for its promotion. To create a catalytic and drastic change in the green energy sector in Sri Lanka, unlocking green financing with incentive schemes for private sector involvement in green energy projects is essential. Many renewable energy resources are currently wasted without producing energy capacities.

Given this context, the chapter elaborates on the Sri Lankan energy mix (current and outlook), green energy in Sri Lanka, barriers for green financing, government strategies, incentives, and solutions for mitigating financial barriers, impacts of financing flows and diffusion of renewables, and concludes with policy recommendations.

2. Context

2.1 Sri Lanka Energy Mix (Current and Outlook)

The Sri Lankan energy sector comprises five major sources: coal, hydro, wind, bio-thermal, and oil. Electricity in Sri Lanka is generated using three primary sources: thermal power (including energy from biomass, coal, and all other fuel-oil sources), hydropower (including small hydro), and other Non-Conventional Renewable Energy (NCRE) sources (solar power and wind power). According to the latest data, the country's total electricity generation increased by 5.7% to 8,675 GWh during the first eight months of 2015 from 8,207 GWh in the corresponding period of 2014. Hydropower generation (excluding mini hydro generation) during the first eight months of the year increased by 57.8% to 2,908 GWh.

Increased rainfall during the first few months of 2015 raised the share of hydropower in total power generation, although some decline in the share of hydropower was observed during the middle of the year with drought conditions prevailing in the main reservoir areas. The key utility provider was planning to re-connect decommissioned private plants either through extensions of power purchase agreements or outright purchase to boost standby capacity. Three Independent Power Producers (IPPs) are now considered, including ACE Embilipitiya (100MW), Heladanavi (100MW), and Lakdhanavi (22), whose terms had expired in 2012 and 2015 but were not renewed.

Coal power generation increased substantially by 72.5% to 3,328 GWh during the first eight months, reflecting the enhanced capacity of the Norochcholai coal power plant. The cumulative effect of increased hydro and coal power generation helped to limit power generation through fuel oil by 59.0% to 1,541 GWh during the first eight months of the year. Meanwhile, the generation of electricity through non-conventional renewable energy (NCRE) sources, including mini hydro generation, increased by 31.9% to 899 GWh. Accordingly, the share of hydro, fuel oil, coal, and green power generation during the first eight months of 2015 stood at 34%, 18%, 38%, and 10%, respectively.

Sri Lanka's electricity demand per year is estimated to be 2300 megawatts, with the island's present generating capacity being around 3900 megawatts. Electricity consumption in the domestic, industrial, general purpose (including government), and hotel sectors increased by 9.5%, 3.8%, 5.7%, and 10.0%, respectively, during the first eight months of 2015, reflecting the continued growth of economic activity. Thus, the total electricity sales increased by 6.4% to 7,781 GWh during the first eight months of 2015 from 7,314 GWh in comparison to the corresponding period of 2014. Further, the transmission and distribution losses, as a percentage of total generation, stood at 10.3%. Meanwhile, the financial position of Ceylon Electricity Board (CEB) has reportedly improved significantly during the period as a result of the favorable power

generation mix (CBSL, 2015). The CEB has reportedly made a profit of Rs.22 billion in 2015 and is expected to increase its profit to Rs.30 billion this year.

The energy sector transactions entered a new phase, with the green energy chains dominated by large-scale suppliers and numerous users changing form to value chains operated by a large number of small-scale suppliers dealing with a large number of users. These changes occurred mainly in onsite power generation using solar PV rooftop in the residential sector and large volumes of industrial thermal energy usage moving away from centrally supplied fossil fuels to widely sourced fuel wood supplies. These emerging complexities will continue to affect the timely reporting of energy sector transactions.

The energy sector of Sri Lanka experienced certain unexpected events during 2015, starting from relatively low petroleum prices after a long spell and also some low probability high-impact events in the electricity sector. Apart from these events, positive trends observed in renewable energy development continued during 2015, in a mature market form. Energy demand-side management garnered the attention of policymakers, causing the government to establish a Presidential Task Force on Energy Demand Side Management, which prepared a five-year plan to tackle the growing demand in the most economic way. Coal power gained its firm position as the base load generator, relieving the country to a great extent from the burden of expensive power generation from liquid fossil fuel. Coal power generation met 34% of the total electricity generation in the country in 2015.

The following figure 1 shows the total energy generation in Sri Lanka. Figure 2 provides the energy demand and supply in 2013.

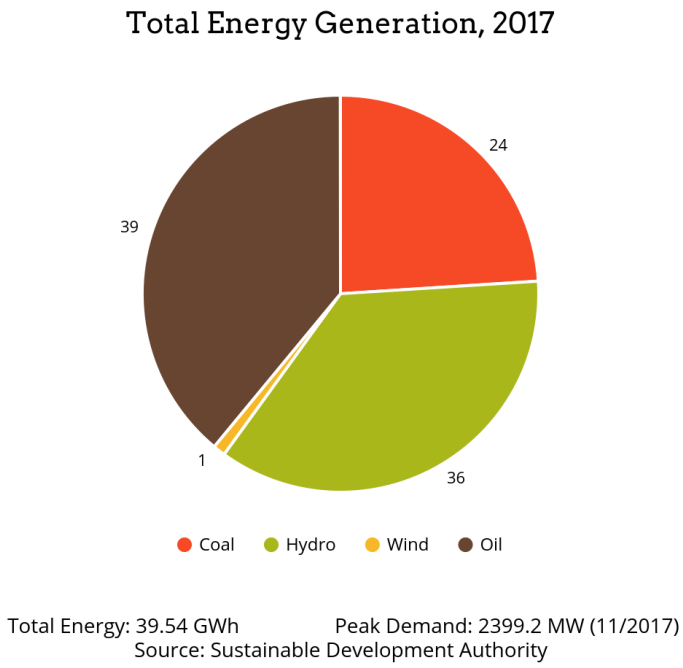


Figure 1: Renewable energy in Sri Lanka

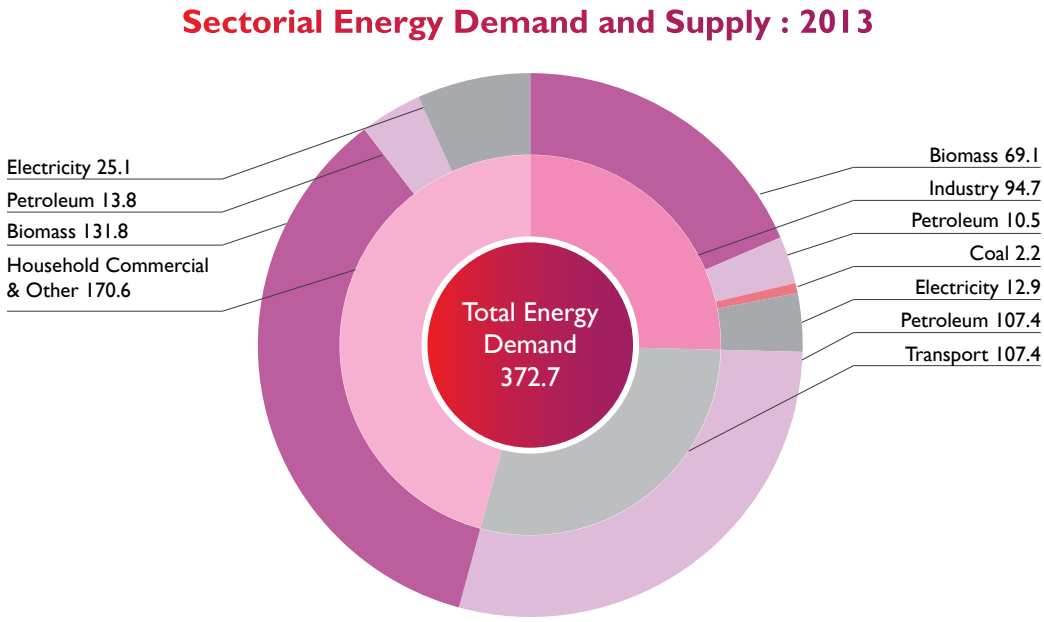
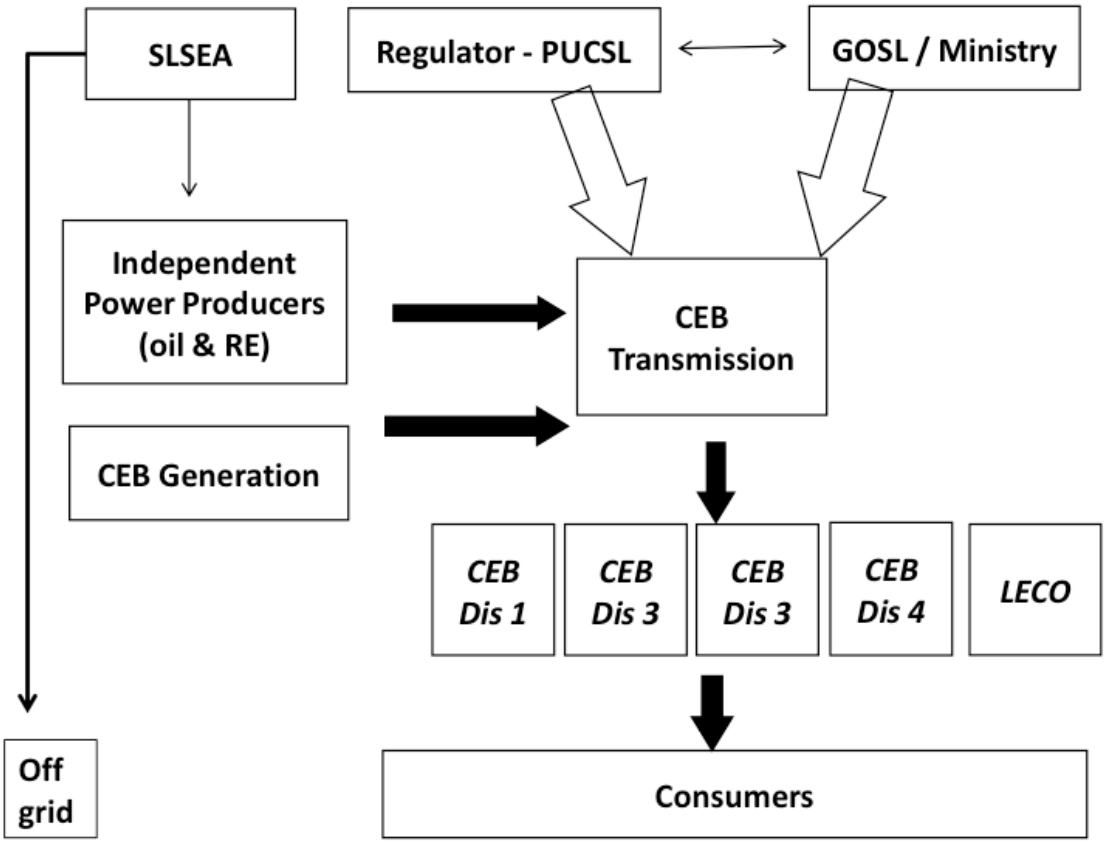


Figure 2: Energy demand and supply
Source: Sustainable Energy Authority



SLSEA – Sri Lanka Sustainable Energy Authority; PUCSL – Public Utility Commission of Sri Lanka; LECO – Lanka Electricity Company (Private) Limited, GOSL – Government of Sri Lanka; Dis - Districts

Figure 3: Context of Sri Lankan Energy Framework
Source: Ceylon Electricity Board (CEB)

The figure 3 provides the position of renewable energy in the context of Sri Lankan framework.

2.2 Green Energy in Sri Lanka

Locating in a favorable geo-climatic environment, Sri Lanka is blessed with diversity of green energy sources. In order to achieve clean energy goals with sustainable development, green energy is promoted in the world. However, the trend is towards promotion of clean energy with the green financing.

2.2.1 Renewable Energy Resources

A natural resource is considered an energy resource if it can be converted into a usable form of energy. Green energy refers to a type of energy resource that is replenished by a natural process at a rate equal to or faster than the rate at which the resource is being converted into other usable forms, such as electricity. Due to its geo-climatic conditions, Sri Lanka is fortunate to possess various forms of energy resources. As an island located in the tropics and surrounded by the Indian Ocean, Sri Lanka features central highlands, lowland mountain ranges, flat terrains, and plateaus, all of which influence cloud formation. The annual mean rainfall on the island ranges from 750 to 5000mm, resulting in high plant density.

Biomass, as a result, is abundantly available. Being situated in the equatorial belt, Sri Lanka receives consistent solar irradiation throughout the year. The tropical temperatures and the island's oceanic location create distinct wind regimes. These geographical and climatic features collectively provide the country with a rich green energy resource base.

Some of these renewable energy resources are extensively utilized and developed to meet the country's energy requirements, while others hold potential for development as technologies mature and become economically feasible. The main green resources available in Sri Lanka include:

- Biomass
- Hydropower
- Solar
- Wind

Sri Lanka's electricity sector relies heavily on hydropower, which has been developed over a long period to supply electricity to the grid. These hydropower schemes, considered 'conventional' power generation projects, have been in existence for a significant time, and their capacity has almost been exhausted. Consequently, mechanisms have been designed to explore alternative means of power generation, with a focus on small hydros, wind power generation schemes, and solar projects. These technologies are referred to as non-conventional renewable energy (NCRE) technologies, as they were not traditionally used in grid power generation. All renewable energy technologies, excluding large-scale hydropower from storage reservoirs, are now collectively termed as green energy.

Green Energy Resource Potential

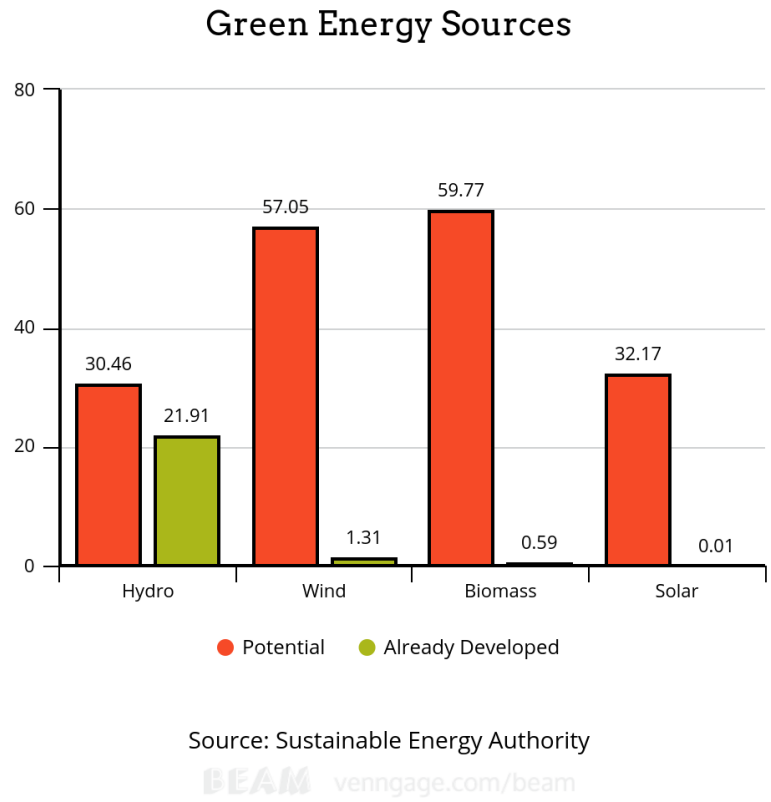


Figure 4: Gap between potential and already developed levels in 2016.
Source: Author calculation

Capacity Addition of the green energy sources

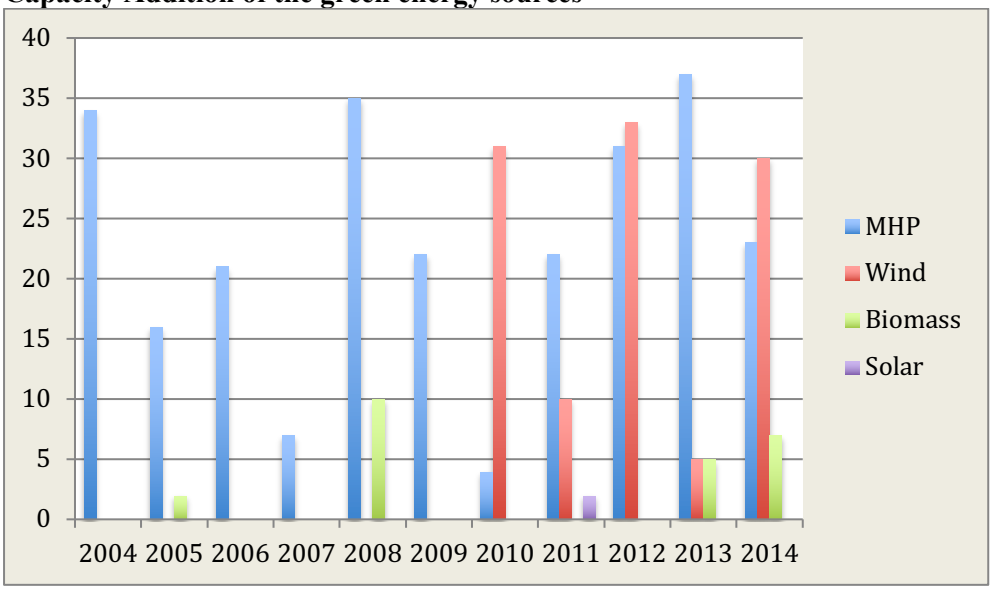


Figure 5: capacity addition of each energy sources from 2004 to 2014
MHP- Mini-Hydro Project
Source: Sustainable Energy Authority

The above graph shows that the mini-hydro power (MHP), wind, biomass, and solar energy evolution over 2004 to 2014. A number of attempts are made for the improvement of use of solar energy for the sustainable growth. The graph shows that

wind energy was introduced in 2010, while solar energy was introduced in 2011. The Table1 provides the statistics of small green energy power plants in Sri Lanka.

Table 1: Renewable energy power plants

	Biomass		Mini-Hydro		Solar		Wind		All REPs	
	No	**MW**	**No**	**MW**	**No**	**MW**	**No**	**MW**	**No**	**MW**
Commissioned	3	13	87	189	4	1	4	31	98	234
Under construction	15	74	112	211			10	99	137	384
Valid provisional approval	7	81	37	41	1	10			46	142
Total Commitment at Present	25	167	236	441	5	11	14	130	281	759
Wind farm							1	100	1	100
Solar Farm							1	100	1	100

Total – committed at present 2000 GWh/yr – 13% by 2016
Total – with parks – 2430 – 16% by 2016
Geo Thermal – PA – 10MW; Applied – 109 MW
Sea Wave –Applied 3 MW

Source: Small Renewable Energy Power Report

Table 2: Estimated Green Energy Potential

Sources	**Potential**
Hydro Power Potential	1960 MW at 40% pf
Dendro Power Potential	900 MW at 70% pf
Wind Power Potential	3000 MW at 30% pf
Solar Power Potential	4.5 to 6.0 kWh/m2/day at 16% pf
Wave Power Potential	200 MW at 65% pf
Geothermal Potential	30 MW
OTEC Potential	OTEC Potential – Trincomalee Canyon

Source: Green Energy Report

Table 2 provides the estimated green energy potential for Sri Lanka.

2.2.2 Hydro Power

Hydropower is the energy generated from the force of falling water and running water, which can be harnessed for electricity generation. It involves converting the energy in falling water into electricity, with the quantity of electricity generated determined by the volume of water flow and the head created by the dam. In Sri Lanka, a significant portion of the major hydro potential has been developed, delivering valuable low-cost electricity to the country. Hydroelectricity generation has played a major role in power generation in Sri Lanka since the commissioning of the first large hydroelectric power plant in 1950.

The geo-climatic settings in Sri Lanka are particularly conducive to harnessing hydro resources. The country features a highland mass situated in the south-center, surrounded by an intermediate zone of upland ridges and valleys lying at lower elevations. The climate of Sri Lanka is largely determined by the meteorological

conditions caused in the Indian subcontinent due to tropical circulation, resulting in distinct seasonal rains. Given the favorable rainfall conditions and hilly terrain, the highlands of Sri Lanka offer excellent opportunities to harness hydropower for electricity generation. Mini-hydro projects also contribute to the main grid's power generation as a green energy resource based on the level of energy generation.

2.2.3. Solar Power

Recently, grid-connected solar power has been introduced as a green energy source in Sri Lanka. The only operational commercial-scale solar-powered facility is the Buruthakanda Solar Park, boasting a capacity of 1.2 MW and operated by the Sri Lanka Sustainable Energy Authority (SLSEA).

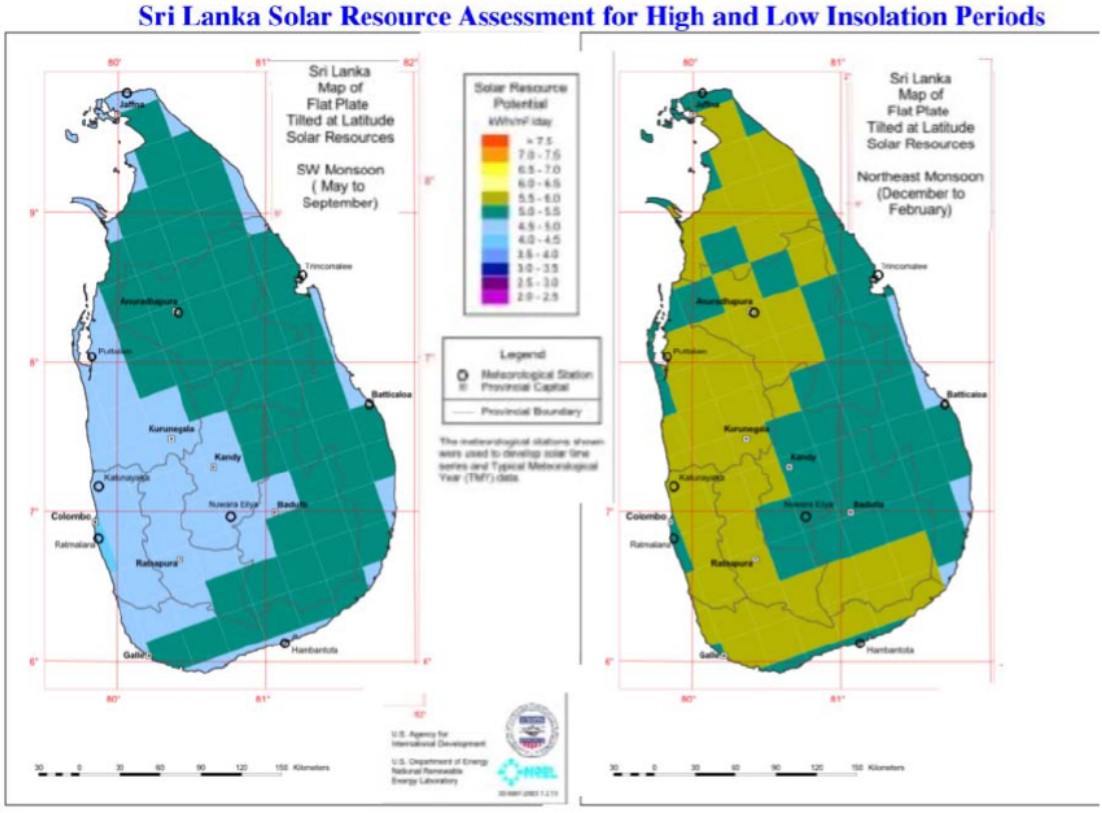


Figure 6: the maps show the potential for solar energy for Sri Lanka

Sri Lanka, being a tropical country, experiences relatively consistent solar radiation throughout the year without marked variations. The flat dry zones of the island receive solar radiations ranging from 4.0 to 4.5 kWh/m2/day. Although the total solar energy usage, primarily for non-commercial purposes, has not been accurately quantified, the Ceylon Electricity Board pioneered the introduction of solar PV technology during the early 1980s.

Solar Potential

Due to its proximity to the equator, Sri Lanka enjoys an abundant and consistent supply of solar radiation year-round. While solar radiation does not exhibit significant

seasonal variation over the island, noticeable spatial differences exist between the lowlands and mountain regions. According to estimates from the solar resource map developed by the National Renewable Energy Laboratory (NREL) of the USA, the flat dry zone, covering two-thirds of the land area, experiences solar radiation levels ranging from 4.0 to 4.5 kWh/m2/day. In contrast, solar radiation levels are lower at 2.0 to 3.5 kWh/m2/day over the high plains of Nuwara Eliya due to significant cloud cover throughout most parts of the day. Consequently, there exists substantial potential for harnessing solar energy in the dry zone of Sri Lanka.

Solar Energy Targets

Sri Lanka Sustainable Energy Authority has identified the following capacity additions of Solar PV are required in order to meet our renewable energy targets.

1. Under 20% renewable energy by 2020 Scenario: solar PV capacity addition under 20% renewable energy by 2020 scenario
2. Under 100% renewable energy by 2035 Scenario: solar PV capacity addition under 100% renewable energy by 2035 scenario

Table 3: Cumulative solar addition

Year	Solar PV Capacity Addition (MW)	Cumulative Solar (PV) Addition (MW)
2014		1.38
2015		1.38
2016		1.38
2017	41.13	42.51
2018	31.13	73.64
2019	41.13	114.77
2020	21.13	135.90
2021-2025	267.10	403.00
2026-2030	241.14	644.14
2031-2035	241.14	885.28

Source: Annual Report Sustainable Energy Authority

Indicated capacity additions in Table 3 have been estimated with already issued Energy Permits (EP) and Provisional Approvals (PA). Table 4 shows the capacity approximations are made based on the target to achieve ambitious goal of 100 % green energy.

Table 4: Commissioned Solar Projects

Name of Facility	**Capacity (MW)**	**Date of Grid Connection**	**Area**
Solar PV System	0.018	2002	Sri J'Pura
Gonnoruwa Phase II SPP	0.500	2011	Hambantota
Tirappane SPP	0.123	2011	Kekirawa
Gonnoruwa Phase I SPP	0.737	2011	Hambantota

Source: Annual Report Sustainable Energy Authority

2.2.4 Wind Power

Wind Power Development: Sri Lanka possesses a moderate wind energy potential of 300-400 W per m2 at 50m, particularly in the coastal and central regions. The hilly areas exhibit excellent wind potential, exceeding 800 W per m2. Despite this potential, Sri Lanka has yet to harness wind energy to a significant extent. An estimated 5,000 Km2 of windy areas with good potential are available, constituting about 6% of the total land area of 65,600 Km2. With an assumption of 5 MW per Km2 of wind energy, it is estimated that about 20,000 MW of wind potential exists.

The first grid-connected wind power plant, a pilot project with a capacity of 3 MW, was commissioned by the Ceylon Electricity Board (CEB) in 1999 in a 17 Ha land at Hambantota. This plant comprises five wind turbine generators of 600 KW each. Several proposals from private investors under Standardized Power Purchase Agreements (PPAs) have been received by CEB to develop wind power plants in the Kalpitiya area, known for its excellent wind power density of more than 800 W per m2. At the end of 2007, a 50 MW wind power plant was under consideration.

Sri Lanka could follow the example of neighboring India and conduct an in-depth study on wind potential. In India, the total installed wind power capacity reached 12,276 MW in 2010, with an expected target of 24,026 MW by 2020. The cumulative grid-connected wind power target set by the Government of Sri Lanka (GOSL) by 2015 is 85 MW. Wind power projects often face high upfront costs, making Private Public Partnerships (PPPs) or Build Operate and Transfer (BOT) models the most suitable.

The first commercial grid-connected wind farm in Sri Lanka is the 3 MW Hambantota Wind Farm. Unlike other power sources, wind power developments encounter numerous challenges during their development timeline. The government policy limiting wind projects to 10 MW per project also significantly reduces economies-of-scale, posing further challenges to such developments. Wind turbines remain the most common method for generating wind energy.

Wind Potential

As an island nation, Sri Lanka boasts substantial wind energy resources, primarily due to its latitude position. The country's wind climate is influenced by two monsoon wind patterns known as the Southwestern (SW) and Northeastern (NE) Monsoons. The SW Monsoon, the stronger of the two, lasts from May to October, while the NE Monsoon occurs from December to February.

The National Renewable Energy Laboratory (NREL) identified three major regions with good-to-excellent wind resources in 2003:

- The northwestern coastal region from the Kalpitiya Peninsula north to the Mannar Islands and the Jaffna Peninsula.
- The central highlands located in the interior of the country, largely within the Central Province.
- Parts of the Sabaragamuwa and Uva Provinces.

According to this study, there are nearly 5,000 km2 of windy areas with good-to-excellent wind resource potential, with approximately 4,100 km2 of this area located on land. This windy land represents about 6% of Sri Lanka's total land area of 65,600 km2. Assuming a conservative estimate of 5 MW per km2, the windy land could support over 20,000 MW of potential installed capacity. Additionally, windy lagoon areas cover an estimated 700 km2 with a potential installed capacity of 3,500 MW.

Currently, additional studies are underway to accurately assess the wind electric potential, taking into account factors such as existing transmission grid availability and accessibility, as well as socio-economic considerations.

Table 5: Commissioned Wind Projects

Name of Facility	Capacity (MW)	Year of Grid Connection	Area
Mampuri WPP	10.000	2010	Puttalam
Seguwantivu WPP	10.000	2010	Puttalam
Vidatamunai WPP	10.000	2010	Puttalam
Willpita WPP	0.850	2010	Kahawatta
Nirmalapura WPP	10.000	2011	Puttalam
Ambewela WPP	3.000	2012	Nuwara Eliya
Uppudaluwa WPP	10.000	2012	Puttalam
Madurankuliya WPP	10.000	2012	Puttalam
Kalpitiya WPP	9.800	2012	Puttalam
Erumbukkudal WPP	4.800	2013	Puttalam
Mampuri II WPP	10.000	2014	Puttalam
Mampuri III WPP	10.000	2014	Puttalam
Puloppalai WPP	10.000	2014	Kilinochchi
Vallimunai WPP	10.000	2014	Kilinochchi

Source: Annual Report Sustainable Energy Authority

Table 5 provides the statistics of commissioned wind projects for Sri Lanka.

2.2.5 Dendro Power:

Biomass-based electricity generation contributes to socio-economic development through non-energy benefits, requiring incentive pricing to attract private investors. The Government of Sri Lanka (GOSL) has granted a cost-based, technology-specific three-tiered tariff for biomass power generation. Currently, two projects with a capacity of 2 MW each are in operation, and seventeen projects, each with a capacity of 18.55 MW, have been developed.

Biomass energy encompasses energy derived from organic materials, categorized as virgin wood, energy crops, agricultural residues, and waste. Under proper management, biomass offers a wide range of benefits, with a focus on sustainability and environmentally sound technologies. Biomass technology is considered environmentally friendly, particularly in terms of net carbon emissions. Additionally, biomass can provide economic benefits and contribute to retaining national wealth.

Biomass Potential

The exploitation of biomass for electricity generation holds significance in Sri Lanka. While biomass is the most common energy source in the country, with a major portion used in the domestic sector for cooking, only a limited share is channeled through the market, and the value of energy sourced from biomass is not accurately accounted for. Common forms of biomass in Sri Lanka include fuel wood, municipal waste, industrial waste, and agricultural residues.

The potential power generation capacity from residues of major crops like paddy, tea, rubber, and coconut is substantial. Municipal Solid Waste (MSW) is also considered a renewable energy source falling under the biomass category. However, a comprehensive assessment of bioresources, along with figures and statistics on their quantities and points of origin on an island-wide basis, is needed. Establishing a supply chain for biomass, identifying supply nodes, recipients, establishing retail centers, and determining quantities and respective storage options are crucial aspects of the biomass energy sector.

Geothermal Power

Although geothermal power is under research in Sri Lanka, no operational power stations of this type currently exist.

3. Barriers for Green Financing in Sri Lanka

As many developing countries face challenges in green financing, Sri Lanka also encounters similar constraints in promoting green energy financing. However, the government has allocated LKR 350 million to cover policy costs from the budget in the parliament. This allocation aims to bridge the gap between subsidiary costs and reduce the loans for green finance.

3.1 Policy Barriers

- Low priority given to renewable energy financing in national planning and a weak implementation framework for such planning.
- Weak environmental regulations for assessing the impacts and abatement costs.
- Fossil fuel subsidies that hinder the use of green energy sources.
- Absence of a feed-in tariff (FIT) structure to encourage green finance.
- Lack of incentives for private sector involvement and inconsistent policies.
- Limited priority in politics and policy concerns despite proposed strategies for promoting green energy.
- Policy and strategy gaps in the promotion of solar energy, energy mix diversity, and ocean waves.
- Coordination issues among relevant institutes for green energy and financing.

3.2 Economic Barriers

- Small economies of scale and long payback periods.

- High perceived risks and uncertainties associated with green financing.
- High installation costs at the end-user level.
- Lack of access to credit and insufficient government financial support.
- Limited knowledge of the market potential for green financing.
- High initial capital requirements discouraging smallholding companies from involvement in renewable energy sectors.
- Unavailability of various models for projects, such as all-equity finance and Public-Private Partnerships (PPPs).
- Lack of green funds raised through Sri Lanka and foreign capital markets.

3.3 Technical and Measurement Barriers

- Lack of standardized technology for green energy.
- Limited local manufacturing of specialized equipment.
- Limited technical and financial capacity for designing, installing, operating, managing, and maintaining renewable-based modern energy services.
- Limited funds for technological constraints for reliable and comprehensive mapping of green energy distribution.
- Financing for technological capacity and Research & Development (R&D) due to limited know-how.
- Little focus of green finance on increasing energy efficiency through green technologies.

3.4 Process and Information Barriers

- Lack of quality information about green resources, technologies, equipment suppliers, and potential financiers.
- Inadequate training and capacity building for green funds and bonds.
- Insufficient information available on green finance for policymaking and mobilizing civil society.
- Limited bank involvement and diversity of financial mechanisms without International Finance Corporation (IFC) assistance.
- Challenges in the process of green financing services.
- Time taken to approve loans.
- High and uncertain project development costs.
- Lack of long-term financing for projects to be sustainable.

3.5 Administrative and Institutional Barriers

- Financial administrative issues and government involvement affecting the rules and regulations for finance in a conducive business environment for green services.
- Insufficient expertise in green technologies and financing.
- Limited capacity for green energy data collection, analysis, and project development for funding approvals.
- Lack of expertise and services in the system design, installation, operation, and maintenance of green technologies.
- Lack of partnerships to guarantee feasible and plausible green finance initiatives, hindering private investor entry into the green energy sector.

- Institutional capacity in the green finance market is still low due to the lack of competition and lower demand, even though the trend is growing.
- Lack of human resources, technical experts, skills, and capacity.

3.6 Environmental Barriers

- Lack of equity financing for conducive green energy sector development.
- Attitude of users/customers still favoring conventional wisdom, viewing green energy as unsustainable.
- Lack of incentives and investments in the private sector challenging green finance.
- Lack of innovative green financial mechanisms like green bonds.

4. Government Strategies, Incentives and Solutions for Mitigating Financial Barriers

4.1 Renewable Energy Policies

The Government of Sri Lanka (GOSL) has initiated a program called the "Battle for Solar Energy," designed to maximize the use of solar energy throughout the country. Further, the approval procedure for the private sector to enter into the market is facilitated with laws, rules and regulations, fostering a conducive business environment with incentives.

Renewable energy policies in Sri Lanka	
Planning and Strategy	**Official targets for renewable energy**
2010	40% renewables (large hydro)
2016	60% demand increase
2016	38% renewables (large hydro+ NCRE- 10%)
2020	100% demand increase
Demand side management	10%
2020	43% renewables (large hydro+ NCRE- 20%)
Statements of intend	Carbon neutral growth by 2020 Start carbon reduction by 2030

The government of Sri Lanka has put forward the green energy plan to achieve 100% in renewable energy by 2050. Sri Lankan vision of achieving 100% renewable electricity, which is a 100% green energy target, will change the way of utilities operation.

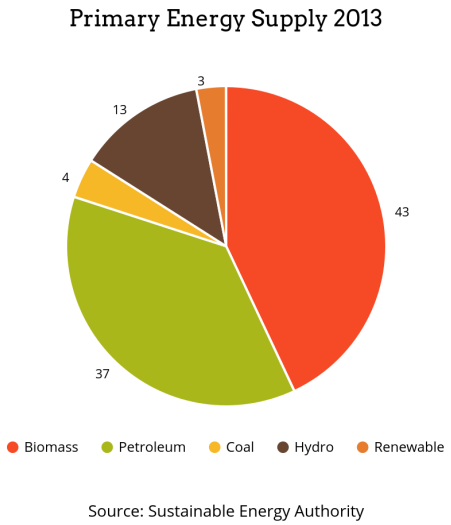


Figure 7: Energy Supply in 2013

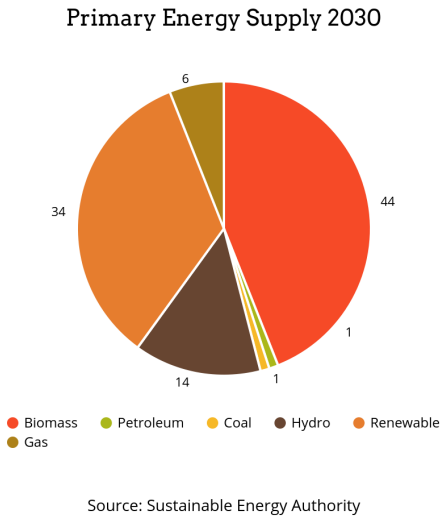


Figure 8: Energy Supply in 2030

Figure 7 and 8 provide the mid term goal of changing the energy supplying sources.

4.2 Government Targets and Strategies

Despite the challenge of gaining experience in designing innovative renewable energy solutions at the national scale, it creates new business models for a new generation of utilities and inspires ideas for existing utilities. However, these solutions can be easily replicated in countries throughout Asia and beyond with similar renewable energy ambitions, encouraging more countries to join the green transformation.

Targets:

- Make Sri Lanka an energy self-sufficient nation by 2030.
- Increase the share of electricity generation from renewable energy sources from 50% in 2014 to 60% by 2020 and finally meet the total demand from renewable and other indigenous energy resources by 2030.
- Increase the electricity generation capacity of the system from 4,050 MW to 6,400 MW by 2025.
- Generate a minimum of 1,000 MW of electricity using indigenous gas resources discovered in the Mannar basin by 2020.
- Increase the generation capacity of low-cost thermal power plants fueled by natural gas and biomass to 2,000 MW to reduce generation costs and diversify the generation mix by 2020.
- Provide affordable electricity coverage to 100% of the people of the country on a continuous basis before the end of 2015.
- Reduce the technical and commercial losses of the electricity transmission and distribution network from 11% to 8% by 2020.
- Reduce annual energy demand growth by 2% through conservation and efficient use.
- Reduce petroleum fuel use in the transport sub-sector by 5% by introducing alternative strategies such as efficient modes of transport and electrification of transport by 2020.

- Produce the total petroleum product demand of the country through our own refinery by 2025.
- Upgrade the quality of Gasoline and Diesel to EURO IV and EURO III, respectively, by 2018.
- Further enhance the quality and reliability of electricity and fuel supply.
- Broaden energy sector investment windows to include bonds, debentures, public-private partnerships, and other such novel financial instruments.
- Reduce the carbon footprint of the energy sector by 5% by 2025.

Direction	Key Programs	Strategies
1. Cleaner Production		
The vast renewable energy resource base of Sri Lanka will be developed to increase the dominance of indigenous energy in both electricity and thermal energy supplies. This initiative will cover the whole value chain of the electricity sector from electrification of remote locations through off-grid solutions to large scale infrastructure development to absorb wind, solar, remaining hydro and other renewable energy resources based power generation to the national grid. Investment climate will be improved to encourage and develop the markets for small scale green energy systems for SMEs and state sector and also to ensure a stable market for fuel wood through a guaranteed price.	• Establishment of a fuel wood exchange • Rehabilitation/ refurbishment old hydro power plants • Establishment of a natural gas processing facility in Norochcholei • Development of grid connected large scale wind and solar power	• Develop the renewable energy portfolio in the generation mix to an optimum level • Establish a competitive bidding process for large scale wind and solar power generation projects • Promote grid connected small renewable based power generation through net-metering. • Promote use of biomass by elevating its use as a modern, convenient energy source • Promote off-grid renewable energy applications for small/medium scale applications • Integrate the environmental protection and climate change issues with the energy sector development plans • Reduce the carbon footprint of energy sector to address global warming and climate change impacts
2. Finance for diverse energy sector		
The financial health of the energy sector will be improved through efficient treasury operations by restructuring debt portfolios of the sector entities using innovative mechanisms and tools ranging from trade debtors and public private partnerships in investments.	• Issuance of debentures and institutional bonds (CPC bonds – USD 2 billion and CEB debentures – USD 500 million) for restructuring of debt portfolios • Financial restructuring of CEB and CPC • Introduce concessionary loan schemes for low income electricity customers • Introduce concessionary financing for small renewable energy systems • Introduce loan schemes for	• Explore and adopt Innovative means of energy infrastructure financing • Introduction of efficient treasury operations, reducing the cost of finance by introduction of new financing tools such as issuance of Bonds/Debentures/shares etc.. , reviewing existing credit policy, restructuring CEB/CPC loan portfolio, competitive financing markets Implementation of Asset Management policy effectively. • Implementation of Asset Management policy effectively.

	large and medium scale renewable power development	
3. Investment in R&D for cutting- edge product development		
Available opportunities in product development and service delivery will be exploited to develop home grown technologies in energy conversion, storage, delivery, metering and billing to enhance the stake of renewable energy, carbon emissions avoidance and efficiency in the energy systems.	• Peaceful applications in Nuclear Energy for Agriculture, Human health, Environment and Industry • Electricity charging stations • Smart Meters and ICT solutions for energy sector transactions • Develop local capacity in renewable energy technologies and energy efficiency improvement technologies	• Establishment of a consultancy arm for energy sector projects • Encourage developing standard high-tech instruments

4.4 Incentives

A number of efforts for motivating the private sector to involve with the renewable energy has been introduces through flat tariff structure.

Table 7: Flat tariff for renewable energy

Technology	All inclusive rate for years 1-20	
	(LKR/kWh)	(USD Cts/kWh)
Mini-hydro	13.04	11.54
Mini-hydro-Local	13.32	11.79
Wind	19.43	17.19
Wind – Local	19.97	17.67
Biomass (Dendro)	20.70	18.32
Biomass (Agricultural and Industrial waste	14.53	12.86
Municipal waste	22.02	19.49
Waste Heat Recovery	6.64	5.88
Other	20.7	18.32

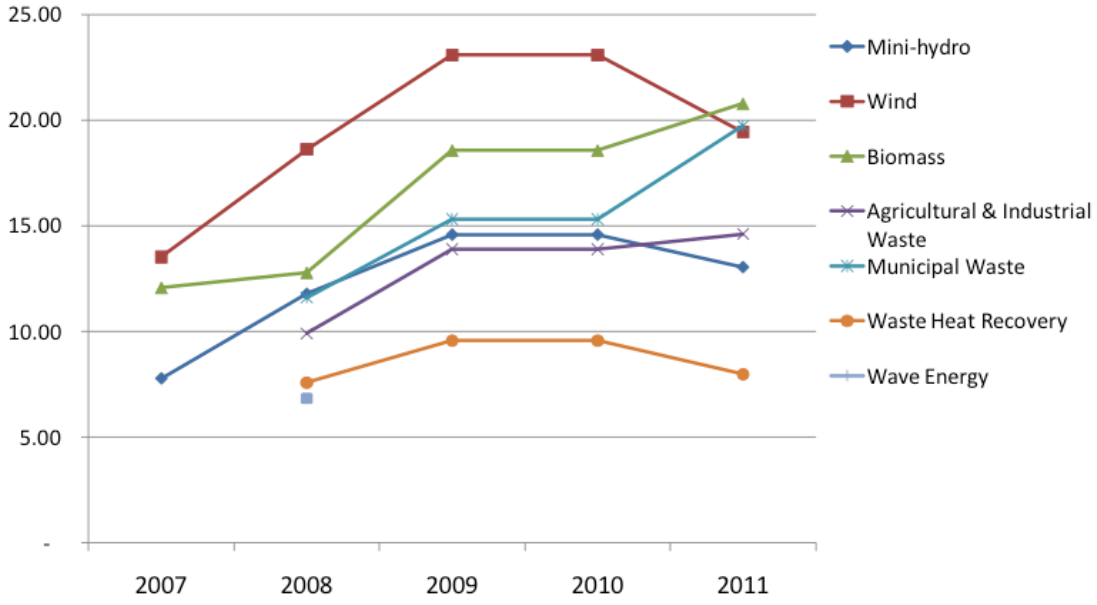


Figure 9: FIT in Sri Lanka – flat tariff all-inclusive rate for years 1-20 (LKR/kWh)

The state of play of renewable energy policy and generation-based incentives in Sri Lanka.

Feed-in-tariffs (FITs) in Sri Lanka	**FIT and its basic features**
• Avoided generation cost – early 1990 • Generated enthusiasm for mini-hydro power • Lack of transparency in calculating the actual avoided cost • Hidden subsidies given to fossil fuel • Technology specific financial cost reflective tariff (Flat and 3 tier) – 2007 • Generated enthusiasm for mini-hydro and wind power • No way to meet the additional cost – Above 25 MW – should have government share – Between 10 MW- 25 MW --- negotiated price – private companies – Less than 10 MW --- First come first serve basis - private companies	• First come first serve • Standardize • Non-negotiable • Cost-based • Sources – specific • Technology – specific • Either a three-tier tariff or a flat tariff • Valid for period of 20 years • Extendable by mutual consent

Other Incentives

Under the new scheme, the projects were introduced to commission, prior to 2007, were allowed to switch to cost based tariff or to continue with the avoided cost tariff. The projects, which are still continuing with the avoided cost principle, are offered a dry-season tariff and a wet-season tariff where the dry season tariff is higher than the wet season tariff. The Board of Investment (BOI) registered investors with a capital investment of over USD 3 million, get an Import Duty exemption and Corporate Tax

holidays for a 5-year period.

Green Financing Incentives

The Government of Sri Lanka, in collaboration with the World Bank, introduced a lending scheme under its Energy Services Delivery Project (ESDP) and Renewable Energy for Rural Economic Development (RERED) from 1997 to 2010. Under these projects, the World Bank provided a soft loan to the Government of Sri Lanka (GOSL). The projects were designed to lend funds through intermediaries (Participating Credit Institutions (PCIs)) to sub-borrowers undertaking renewable energy projects. Any private enterprise, non-governmental organization (NGO), cooperative, or individual operating in Sri Lanka was considered an eligible enterprise.

Once the loan was approved, PCIs forwarded a completed loan Refinance Application (RA) form requesting a commitment for a maximum of 80% of the approved loan amount. The release of grant funds by the Administrative Unit of the World Bank project was based on evidence of work done. The GOSL released these loans at the Weighted Average Cost of Capital (WACC) through registered financial institutions to the project developers. The Administrative Unit of the World Bank-funded project annually calculated the WACC. However, this financing mechanism ended in 2011, and there is a need to establish a follow-up financing mechanism as new ambitious targets have been set for the renewable energy sector.

5. Impact: Financing Flows and Diffusion of Renewables

Sri Lanka, as a country with ambitions to achieve green energy targets, has commendably embraced the trend of expanding the energy sector through the supply of green energy sources. Consequently, the increased usage of the energy sector will drive the demand for green finance to achieve green energy generation and diffusion targets. The positive impact of enhancing renewable energy growth in the country will contribute to the development of the sector and support the diffusion of renewable energy sources in Sri Lanka.

Despite the current lower level of green finance in Sri Lanka, there is enormous potential to finance green energy projects. A limited number of banks have provided loans to initiate green energy projects, and some banks have secured loans from the International Financial Corporation (IFC) to finance such projects. A case study illustrating such an investment in green financing is the funding for green energy finance by the Commercial Bank of PLC.

Figure 4: Options to estimate the green share of finance for loans

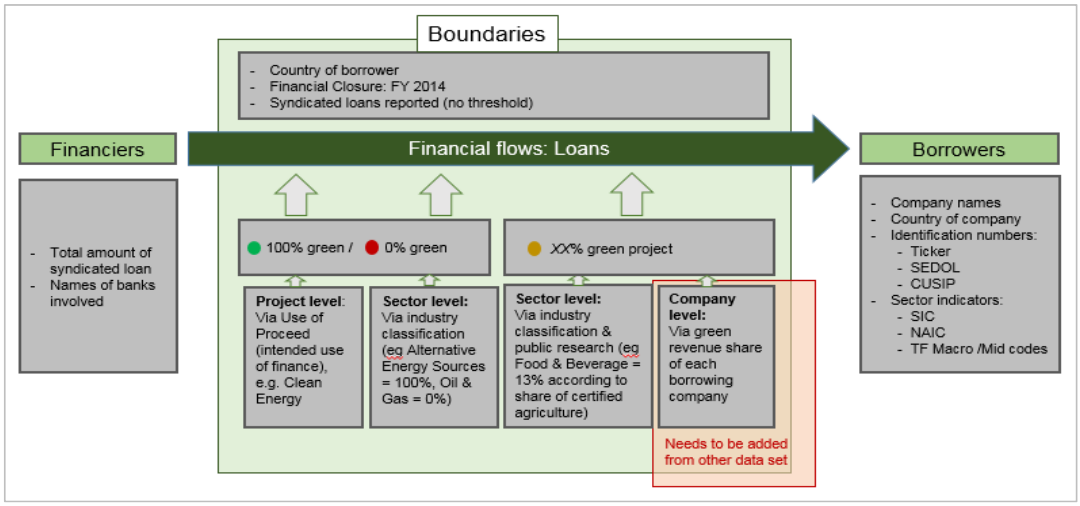


Figure 9: Green share of finance for loans

Designing the green finance flow is challenging since the green energy sector is not developed up to the potential because of lower competition among the banks. However, it is capable to identify the flows of green finance in the energy sector.

Model for Green Energy Financial Flow

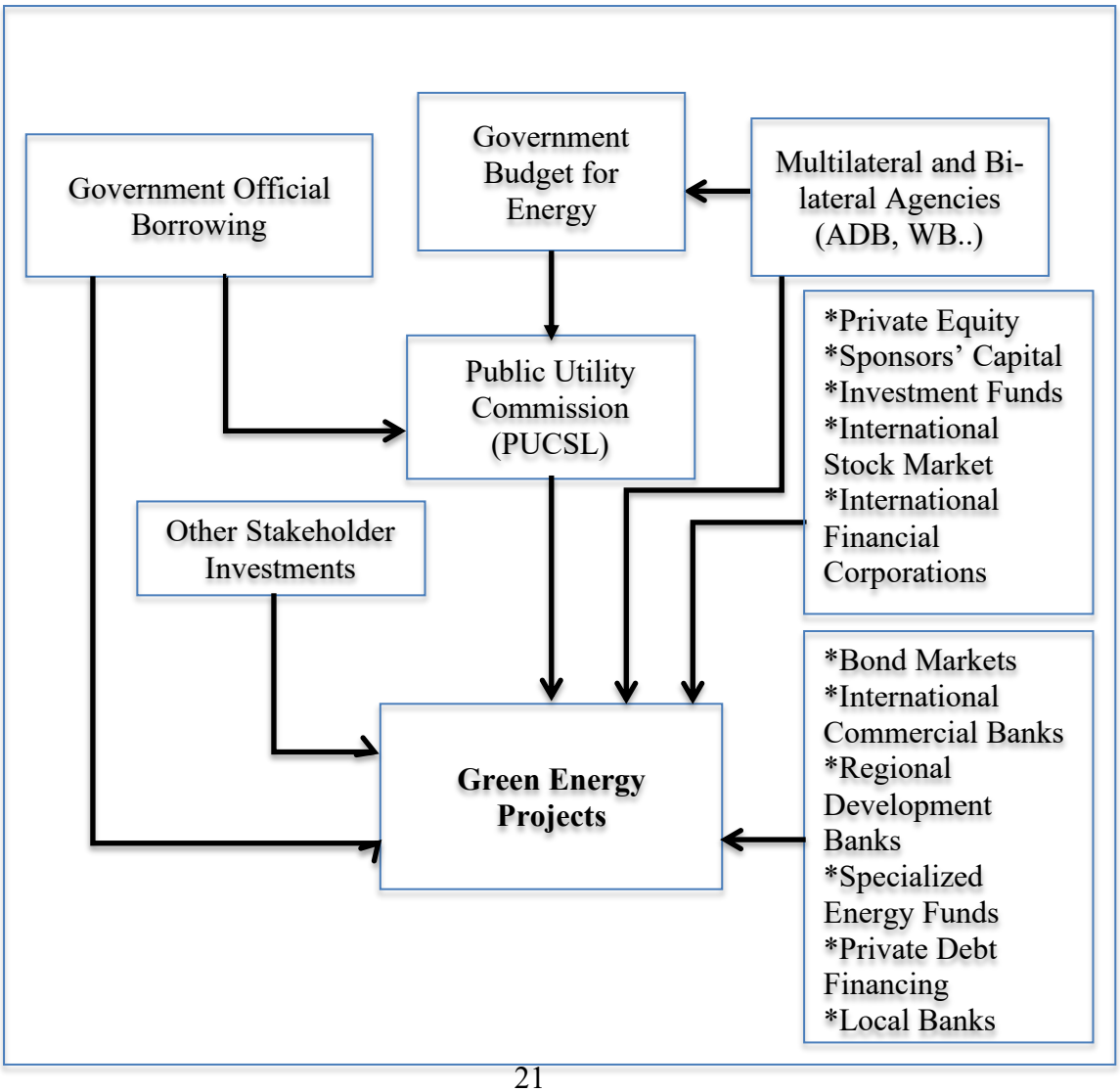


Chart 1: Green financing flow for green energy projects
Source: Author's design

The above model outlines the financial flow for green energy projects, detailing the types of entities responsible for green finance and the various financial resources flowing through these institutes. According to the desk review conducted with the Sustainable Energy Authority (SEA), green finance is an emerging market in Sri Lanka, marked by high competition among bankers and other stakeholders involved in green financing projects. New green energy sources and financing mechanisms are also emerging in the country, indicating that the Sri Lankan green financial sector is expected to flourish within the next five years. The following case provides evidence of the initiation of green finance for stakeholders involved in green energy projects, facilitated under the patronage of the International Financial Corporation (IFC).

Case Study: Green Finance Initiative in Commercial Bank PLC

Initiation:
The commercial Bank PLC is a public limited liability company, founded in 1920, which is leading commercial banks with 250 branches in Sri Lanka. Sri Lanka being a country with high electrification coverage, up to 70 percent of the country's power requirement is met by thermal power. Tapping into increasingly feasible renewable energy sources will help minimize overdependence on fossil fuel sources.

Context of financing:
Under the green financing services, International Financial Corporation (IFC), a member of the World Bank Group, is partnering with Sri Lanka's Commercial Bank of Ceylon (CBC) to help the bank increase investments in local companies focusing on renewable energy and energy efficiency projects. IFC's Green Finance Program is a global program that aims to increase private sector investments in green projects, including energy efficiency and renewable energy, by increasing banks' capacities and confidence to lend to green projects through investment and advisory support. Over the last 15 years, IFC has worked with more than 125 financial institutions in 35 countries, to provide over $20 billions of private sector financing.

The approaches for the financing:
Under the International Finance Corporation (IFC), the CBC develop a green finance business an emerging field in which banks provide credit to support a broad range of projects covering energy efficiency and renewable energy, cleaner production, green buildings, and resource efficiency, among others, according to an IFC approaches. The release said the CBC has been in the forefront of promoting green finance facilities and offers special terms for both businesses and consumers on investments made on green projects.

Impacts of the financing:
IFC and Commercial Bank to improve access to green financing in Sri Lanka. "There is substantial untapped potential in Sri Lanka for investments in green energy projects," said CBC Managing Director. He further explained, "this work is part of our broader strategy to help clients mitigate climate change risks and contribute to a cleaner, more sustainable environment." Not only investments in energy and resource efficiency are good for the environment, they are also good for business since they help reduce energy consumption, drive down costs, and make businesses more competitive. Besides, IFC Country Manager elaborated, "We continue to strengthen our partnership with the Commercial Bank as we partner with them on an initiative to build their green finance portfolio," Thus the impacts of the green energy financing is just initiating at the Sri Lankan context with competitive banking innovations. As a priority country for IFC's committed portfolio, Sri Lanka covers projects across a range of sectors, including renewable energy, and finance. IFC also provides advisory services to promote sustainable growth under the green energy sector

development.

The Sri Lankan green financial sector has been recognized for its positive impacts extending beyond the climate environment. With the consideration of achieving 100% renewable energy generation targets, the positive impacts are not limited to the climate but extend to various aspects. Sri Lanka has taken substantial steps to implement a comprehensive pathway toward its 2050 renewable energy target. The UNDP and ADB have collaborated to develop a structured approach for assessing current and future energy scenarios, technical solutions, and financial implications associated with this new target. The detailed assessments for several CFV member countries with ambitious renewable energy targets have provided valuable lessons learned.

It is crucial to emphasize a common understanding that the transformation to 100% renewable energy generation will bring positive impacts beyond climate and the environment. This shift will contribute to overall socio-economic development. The move towards renewable energy aligns with several Sustainable Development Goals (SDGs), including:

• Reducing air pollution from conventional energy sources such as coal, thereby alleviating the burden on the public health system (SDG 3) and enhancing climate resilience (SDG 13).
• Adoption of renewable energy technologies creating more opportunities for quality vocational training for youth (SDG 4).
• Development of robust ancillary industries, boosting economic productivity, and creating job opportunities (SDG 8).
• Facilitating international and national collaboration among renewable energy market players (SDG 17), enabling Sri Lanka to advance technologically and encouraging research on state-of-the-art renewable energy technologies (SDG 9).

6. Conclusions

The chapter is developed to unlock financing for the green energy sector in Sri Lanka. It provides context on Sri Lanka's energy mix, both current and future outlook, green energy resources, and finance. The chapter then outlines barriers to green financing, followed by government strategies, incentives, and solutions to mitigate financial barriers and assess the impacts of financing flows on the diffusion of renewables. Green energy financing is a priority area for the Sri Lankan government in its pursuit of sustainable development goals.

The renewable energy sector in Sri Lanka comprises mini-hydro, solar, biomass, and wind. However, this study indicates that the potential for the green energy sector is evident due to geo-climatic reasons. Currently, green finance is at a primary level, with financing mainly coming from international financial institutions collaborating with local banks. The impact of financing is reflected in the case study provided as evidence, initiating green finance for green energy projects under the patronage of the International Financial Corporation (IFC).

The context of Sri Lanka's green energy sector is evolving, with many green energy resources being utilized to create the energy mix. Over 98% of the population is already connected to the grid, and there is a high potential for using green energy sources. The development of green energy sources aligns with the interests of the people and decision-makers.

Sri Lanka's energy mix is primarily concerned with five major sources: hydro, geothermal, coal, wind, and oil. However, these patterns have changed over time, with a diverse shift towards green energy sources due to sustainability concerns. The potential for solar energy, wind energy, biomass, and hydropower has improved, and the capacity addition of green energy sources is continuously growing in Sri Lanka. However, barriers to green financing are discussed, including policy, economic, technical and measurement, process and information, administrative and institutional, and environmental barriers, which are the main priorities for green energy financing in Sri Lanka.

The government of Sri Lanka has developed green energy goals to achieve sustainability, along with strategies, incentives, and solutions for overcoming financial barriers. New renewable energy policies have been implemented, and explicitly stated government targets and strategies have been introduced. While targets and strategies are strengthened with incentives, such as Feed-In Tariffs (FIT), recently, these FIT packages have been removed. The chapter also introduces the green share of finance for loans and outlines a model for green energy financial flow. An exemplary case study has been presented, showcasing the existing initiative of green finance through the Commercial Bank PLC. The main concerns of green financing in Sri Lanka are addressed in the chapter, including minimum knowledge and technical gaps, addressing financial barriers, using modern technologies for sector growth, capacity building for green energy employees, and introducing mechanisms for firms to improve green finance and banks in Sri Lanka.

7. Policy Recommendations

Policy Instruments to Improve Green Energy Financial Sector

(i) **Incentives for private investments:** Introducing incentive packages for investors in green energy projects is vital for the budding projects to achieve sustainability. The Board of Investment (BoI) can guide these projects, supporting provincial councils, local authorities, and local banks to provide incentives that catalyze private engagement.

(ii) **Inclusion of green energy projects as BOI projects:** Supporting the involvement of the private sector involves providing tax concessions to promote investment. Therefore, the BoI can govern these projects to facilitate services and act as a catalyst for other investors to engage in the sector.

(iii) **Technological advancement of renewable energy projects:** Green energy processes have advanced significantly with innovative technologies. Importing these new technologies for efficient energy production is imperative to secure private capital for building green energy projects.

(iv) **Market for green energy:** Many green energy projects offer environmentally friendly solutions. However, certain conditions, such as environmentally destructive mini-hydro projects, need to be addressed. Banning such projects and replacing them with available green energy alternatives creates demand, ensuring the security of private capital under government policies and regulations. This allows the government to improve renewable energy in alignment with plans and policies to achieve sustainability by 2050, supporting the Sustainable Development Goals.

(v) **Technical expertise and knowledge:** Lack of technical knowledge and expertise in advisory services for the implementation of energy projects is a hindrance to securing private investments. Therefore, the government can increase advocacy through capacity building for green energy projects, providing technical expertise and knowledge to build sustainable plants.

(vi) **Return on investment:** Introducing green energy to consumers increases the use of green energy, enhancing the return on investment for private capital. Therefore, creating demand for renewable energy projects and encouraging consumers to use green energy are crucial for the long-term viability of projects.

(vii) **Government involvement in negotiation and agreements:** To regulate private services of green energy projects, the government can negotiate and sign agreements to provide better quality services to customers. One of the major roles of the government is to provide the policy framework and agreements that share the investment while securing private capital for green energy projects.

8. References

1. Sri Lanka Sustainable Energy Authority. (2015). Sri Lanka Energy Balance 2015 (Annual Report). Colombo.
2. Sri Lanka Sustainable Energy Authority. (2016). Sri Lanka Energy Balance 2016 (Annual Report). Colombo.
3. Sri Lanka Sustainable Energy Authority. (2017). Sri Lanka Energy Balance 2017 (Annual Report). Colombo.
4. Sri Lanka Sustainable Energy Authority. (2018). Sri Lanka Energy Balance 2018 (Annual Report). Colombo.
5. CBSL, Central Bank of Sri Lanka. (2015). (Annual Report). Colombo.
6. Ceylon Electricity Board (CEB), 2015. Annual Report of CEB. Colombo
7. OECD. (2007). Innovation and Growth Rationale for Innovation Strategy.
8. OECD. (2012). Linking renewable energy to rural development. Paris: OECD. (Organization for Economic Co-operation and Development).
9. OECD. (2016). OECD business and finance outlook 2016. Paris: OECD.
10. Public Utilities Commission of Sri Lanka. (2011). Achievements of Renewable Energy Targets in Sri Lanka 2011.
11. Public Utilities Commission of Sri Lanka. (2011). Achievements of Renewable Energy Targets in Sri Lanka (Rep.).
12. Public Utilities Commission of Sri Lanka. (2012). Regulation for renewable energy development: Lessons from Sri Lanka experience (Rep.). Colombo.