

Energy for Sustainable Development of Sri Lanka

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1. Introduction

The UN Secretary General's Advisory Group on Energy and Climate Change (AGECC) has identified two goals for attaining the Millennium Development Goals (MDG), which will enable the poorest of the poor to escape poverty; that is, access to modern energy services and increased energy efficiency¹. It has recommended that people need to have access to modern energy services while minimizing the impact of this increased energy consumption on global warming through improved energy efficiency and a transition to a stronger reliance on cleaner sources of energy, including renewable energy (RE) and low-GHG emitting fossil fuel technologies, such as a shift from coal to natural gas. Further, the recent IPCC Report on Renewable Energy Sources and Climate Change Mitigation has identified that the integration of RE policies and measures in SD strategies can

¹UN, New York, 2009



overcome existing barriers and create opportunities for RE deployment in line with SD goals².

Most people in developing countries still depend on biomass for many of their energy needs including cooking and low-tech industries. Heat extraction from biomass for cooking in most instances takes place at very low efficiencies, not more than 10%, thus providing opportunities to introduce measures for improving the efficiency of biomass utilization particularly in households. In fact the ratio of biomass energy a country consumes to the other forms of commercial energy it consumes is an indicator of non-development. Higher is this ratio, the poorer is the country. In Sri Lanka too, dependence on biomass is high, being about 45%. Incidentally, Sri Lanka's Human

Development Index (HDI) of 0.691 for 2011 ranks mid-way (97th) out of 187 countries with the HDI ranging from 0.943 (Norway) to 0.286 (Congo). The present paper discusses the current activities as well as potential measures that need to be undertaken by Sri Lanka in the energy sector in achieving sustainable development which includes shifting to modern energy services.

2. Energy Consumption During 2001-2010

The primary total energy supply (TPES) of Sri Lanka for the decade 2001-2010 has been in the range 369 – 474 PJ, showing an average annual growth of 2.17%. The energy mix in 2010 comprises of oil (51.3%), biomass (45.2%)³, hydro (3.2%)⁴ and coal 0.4% as shown in Fig. 1. Sri Lanka has only one petroleum refinery and it could meet only about 46% of the national requirements of about 4,300 kt annually, averaged during 2006 - 2010. The balance refined products are imported on short term contracts. The annual bill on importing oil is in the range USD 2.1-3.0 billion during 2006 – 2010, which is about 20% – 22% of the total import bill⁵. Petroleum products are used for generating energy in the power, transport, industry, commercial and domestic sub-sectors. The highest consumption of oil has been in the transport sector (38.3%), followed by the industry (34.7%), power (20.5%) and household & commercial (6.5%) sub-sectors. The consumption by the domestic sector has been little as they depend heavily on biomass. Fig. 2 shows the distribution of oil consumption in 2010.

²IPCC, 2011

³Since biomass is not traded commercially, these estimates could be in error by at least $\pm 10\%$.

⁴GWh from hydro are converted to PJ using 3.6 TJ/GWh relationship.

⁵Annual Report 2010, CBSL

The consumption of oil for the generation of electricity depends on the amount of electricity that could be generated from hydropower, which is limited by the availability of water. On an average during 2001 and 2010, the ratio of electricity generation from oil to hydro has been 55:45. The fuels consumed in the transport sector are mostly diesel and gasoline, their consumption in 2010 being 1,446 kt and 616 kt, respectively. The growth rates in the transport sector was estimated over the period 2006-2010 rather than the entire decade to be less dependent on historical situation, and there were 11% for diesel and 3% for gasoline. Their growth pattern is shown in Fig. 3.

The total contribution of petroleum and biomass in the industrial and household & commercial subsectors during the decade 2001 – 2010 is shown in Fig. 4. The averages of oil contribution in these two sub-sectors had been 17% and 10%, respectively. However, during the decade, consumption of oil in the industrial sub-sector shows an average of 0.4% decline while that in the household and commercial sub-sector shows only an average of 0.2% growth. On the other hand, biomass consumption shows an average growth of 3% in the industrial sub-sector and 1% growth in the HH and Commercial sub-sector for the same period.

3. Government Initiatives for Developing NCER Sources

With a view to develop sustainable and renewable energy resources, the government in 2007 established the Sri Lanka Sustainable Energy Authority (SLSEA). This was the successor to the Energy Conservation Fund which took the initiative to promote the development of NCRE sources from late nineties. The SLSEA has a wider mandate which included the following:

- Identify and declare renewable energy development areas including resource mapping.
- Implement energy efficiency initiatives and energy labeling schemes commencing from CFLs and progressively widen to other appliances.
- Conduct conservation programmes and energy audits through certified auditors.
- Promote energy security, reliability and cost effectiveness in energy delivery and information management.
- Introduce energy efficient building code initially applicable on a voluntary basis and later making it mandatory for new construction.
- Encourage appointment of an energy manager in high electricity consuming organizations who will be responsible for energy reporting and implementation of energy efficiency measures.
- Establish benchmarks for most of the industries making it mandatory for such industries to reporting their energy consumption.

SLSEA is also responsible for maintaining a database on all energy supply and consumption in all sectors and publish annually the Energy Balance Statement of Sri Lanka.

4. National Strategy for Sustainable Development

In pursuant to the commitments under the World Summit on Sustainable Development(SD) held in 1992, the government had developed an Action Plan 2008-2012 – Caring for the Environment – Path to Sustainable Development, in 2008 (MENR 2008). The government has also established a National Council for Sustainable Development (NCSD) chaired by H.E. the President with 22 ministers in charge of major economic development programmes serving in the Council. The objective of the NCSD is to function as a national platform to launch and promote the process of achieving sustainable development,

and to oversee and guide the implementation of its Action Plan, referred to as the Haritha (Green) Lanka Programme (HLP). Following the Action Plan (2008-12) prepared in 2008, the NCSD after further deliberations, prepared the HLP, the second Action Plan covering the period 2009-2016 (NCSD 2009).

The 2009-2016 Action Plan has developed 10 broad mission areas and strategies with a set of targets to achieve within the time period of concern. Among these are several strategies pertaining to Energy which have been included in the Mission Areas "Clean Air Everywhere" and "Meeting the Challenges of Climate Change". These strategies are:

- Shift towards cleaner fuels.
- Monitor emissions of power plants and high polluting industries.
- Monitor and reduce vehicle emissions.
- Promote the use of economically viable, environmental friendly, renewable energy resources, with emphasis on non-conventional energy resources.
- Optimize energy consumption through energy efficiency in enterprises and promoting substitution of fossil fuels by renewable energies in economic and production sectors.
- Promote supply side and end use energy efficiency.
- Develop and adopt energy saving technologies in agriculture.

The NAP (2009-16) is to be coordinated by the Ministry of Environment and its progress monitored by the Ministry of Plan Implementation.

5. Policy Document of the National Planning Department - Mahinda Chintana II

The National Planning Department has published in 2009 a policy document based on the vision of the President for the development of the country during the next 20 years⁶. The document has included several initiatives to be taken within the Energy sector and among these are the following.

- Build additional 600 MW coal power plant at Puttalam by the end of 2012.
- Build another 500 MW coal power plant at Trincomalee by 2014.
- Increase the capacity of electricity generation to 6367 MW by 2020.
- Replace the high cost oil fired thermal power plants with LNG power plants.
- Build new power plants using LNG technology.
- Conduct a feasibility study for establishing a nuclear power plant in the country.
- Reduce the system losses to 13 percent by 2016 and to 12 percent by 2020.
- Generate about 20 percent of electricity supply by renewable energy sources.
- Invest on wind, dendro, solar and mini hydro power plants to achieve a minimum of 20% contribution to the national grid from NCRE sources.
- Solar power parks and wind power parks to be established for generating renewable energy.
- Popularize the use of energy efficient bulbs and electrical appliances.
- Encourage the application of energy saving designs in building construction.
- Ensure application of energy efficiency in all new construction.
- Curtail energy waste in industrial and commercial sectors.
- Replace existing street lights with LED light systems.

In addition, the policy document has recommended the following initiatives in the Industry sector which have a bearing on the energy sector.

⁶Mahinda Chintana, NPD 2010

- Establish high-tech industrial parks with requisite modern physical infrastructure facilities.
- Increase the country's raw rubber production by twofold by 2020 for value-added production.
- Set up factories assembling electric and electronic appliances at high tech industrial estates.
- Manufacture locally by 2020, minimum of 70 percent of the requirement of electric appliances.
- Establish a dedicated industrial estate for heavy industries at Trincomalee.
- Establish a value added production facility for minerals at Trincomalee for use in the production of electronic products and titanium.

The 12 existing industrial zones operated by the Board of Investment (BOI) will be transformed into model zones improving their standards in regard to environment, infrastructure, employee relations and technology improvements. New dedicated zones will also be established with private investments in IT parks and knowledge based service centers, to generate exports and technology, and knowledge-based economic activities and provided with modern energy services. Further, cleaner production technology will be introduced to all industries to exercise environmental care and social responsibility.

6. Current Status of Non-Conventional Renewable Energy (NCRE)

Energy from non-conventional renewable sources has been introduced in Sri Lanka since late nineties beginning with a 3 MW wind power plant installed near the south-eastern coast and a few mini-hydro plants in the central hill country. With funding made available from the Global Environmental Facility (GEF) through the World Bank there has been a rapid growth in the installation of NCRE systems including solar home systems (SHS) and small hydro systems. The latter included⁷ :

- Over 131,500 SHS in the range 20–60 Wp and total capacity of 5.79 MW and 174 community based mini-hydro systems with overall capacity of 2.12 MW installed during 1997– 2011.
- Another 192 MW of grid-connected mini-hydro systems from 90 projects, mostly in the range 1 – 10 MW and another 87 projects with total capacity of 164 MW are under construction.
- Five wind plants with total capacity of 33 MW commissioned and another 9 plants with total capacity of 90 MW are under construction.
- Three grid-connected biomass plants with total capacity of 11.5 MW commissioned and another 13 plants with total capacity of 70 MW are under construction.

In addition three grid-connected solar PV plants with capacity 1.36 MWp are installed with funding from Japan and Korea.

With a total of 245 MW of NCRE projects installed and another 325 MW of projects under construction, the total contribution from NCRE sources will then reach about 20% to the grid having a total installed capacity of about 2,800 MW. One shortcoming in the data on solar energy is the absence of any record of a large number of solar flat plate collectors installed in residential and commercial buildings for hot water supply, currently estimated to be about 68,000 m² of collectors providing an equivalent of 50 MWth, based on information from suppliers.

⁷SLSEA 2012

7. Potential for Developing NCRE Sources

Wind Energy: It is estimated that there is nearly 5000 km² of windy areas with good-to-excellent wind resource potential in Sri Lanka, out of which about 4100 km² is on land. The land with wind potential represents about 6% of the total land area (65,600 km²), where winds with mean annual speeds in the range 6-7 m/s are found⁸. The windy lagoon areas are estimated to encompass 700 km² with a potential installed capacity of 3500 MW. The meteorological potential of all promising wind sites in Sri Lanka is a staggering 25,000MW, according to a US aided study⁹. But due to the poor condition of the national grid, only 200MW of this is technically feasible to be developed though it is economically feasible to connect about 1,800 MW¹⁰. However, it provides opportunities for the development of stand-alone systems for use in the electrolysis of water to generate hydrogen with potential application in fuel-cell systems, the future source of energy. However, in the utilization of hydrogen for energy generation, it is necessary to surmount many issues including its storage and distribution.

Solar Energy: Being a country close to the equator, solar insolation over Sri Lanka does not show a marked seasonal variation, though a significant spatial difference is exhibited between dry-zone low lands and the wet-zone hill country due to the high cloud cover over the hills. The average annual insolation in the dry zone is in the range 16-18 MJ/m² while over the central hills it is about 8-9 MJ/m². In the two arid zones lying in the extreme NW and SE regions of the country offer higher insolation making them suitable for the generation of electricity using high capacity grid-connected solar concentrator thermal systems. Already, in a SE site, a solar PV system of 900kW capacity has been installed with overseas funding. A few companies have installed large PV systems within their premises to feed the excess electricity generated to the national grid. This scheme has potential to grow if adequate incentives are given to consumers.

Biomass: Currently, Sri Lanka has consumed 13,150kt of biomass in the domestic and industrial sectors amounting to 51% of the total energy consumed. Of this, 9,000kt has been consumed in the domestic sector for cooking mostly in the traditional style which is no more than 10% efficient. There are however biomass stoves available today yielding around 30% combustion efficiency as revealed in a recent CDM project carried out in Nigeria. If such stoves could be popularized in Sri Lanka, it could result in the saving of about 67% of the biomass currently utilized in the domestic sector. In the industrial sector, a number of industries have switched from petroleum to biomass to generate thermal energy through gasification of biomass at a high efficiency. Removal of subsidies on petroleum will encourage more industries adopting this technology and the biomass saved from the domestic sector could be used to replace oil consumption from the industries altogether.

Biofuels: In view of the limited land extent (65,600 km²) and the high population density (326 persons per km² - 2009), the potential for producing biofuels to blend with petroleum fuels in significant quantities is not that high. Out of the various options of producing biofuels viz. ethanol from sugar or starch, biodiesel from vegetable oils and syngas from biomass for synthesizing liquid hydro-carbons, the highest yield per unit land area could be obtained from the third option¹². Several years ago, government appointed an Inter-Ministerial Committee on Biofuels to identify the barriers and promote the implementation of bio-fuels in the country. However, the report has not been made public or any action taken to implement its recommendations. Also, there has been no record of any commercial level plantation of crops for the purpose of bio-fuel production, though reports on pilot level plantations have appeared in the media from time to time.

⁸SLSEA 2012, ⁹SWERA 2010, ¹⁰ESMAP 2003, ¹¹WB, ¹²Ratnasiri, 2009

8. Gaps in National Level Implementation

The government has taken many initiatives towards achieving SD through the adoption of RE sources and energy efficiency strategies, but there has been no prompt action taken to implement these initiatives. The National Action Plan (NAP) for Haritha (Green) Lanka Programme (HLP) prepared by the NCSD covering the period 2009-2016 has recommended the following measures among others:

- Shift towards cleaner fuels.
- Monitor emissions of power plants and high polluting industries.
- Monitor and reduce vehicle emissions.

While the first measure suggests shifting to cleaner fuels, the main electric utility in the country has proposed building several coal power plants without even considering seriously the other options. For example, if natural gas is used to fire plants using combined cycle gas turbine, carbon dioxide emissions could be reduced by about 50% while eliminating other pollutants. Even in the case of power plants and industries, there is no regular programme to monitor their emissions and taking any action to limit any high emissions. In fact, there are no standards on emissions from power plants and industries gazetted to make them mandatory. There is an on-going vehicle emission testing programme, but the standards are based on static measurements rather than on dynamic measurements as practiced in most other countries.

The MahindaChintana II document described in Section 5 has outlines many initiatives to be taken both in the short term and long term. Though the document was prepared several years ago, the progress made in implementing even the short term measures appear to be too slow.

9. Measures for Immediate Implementation

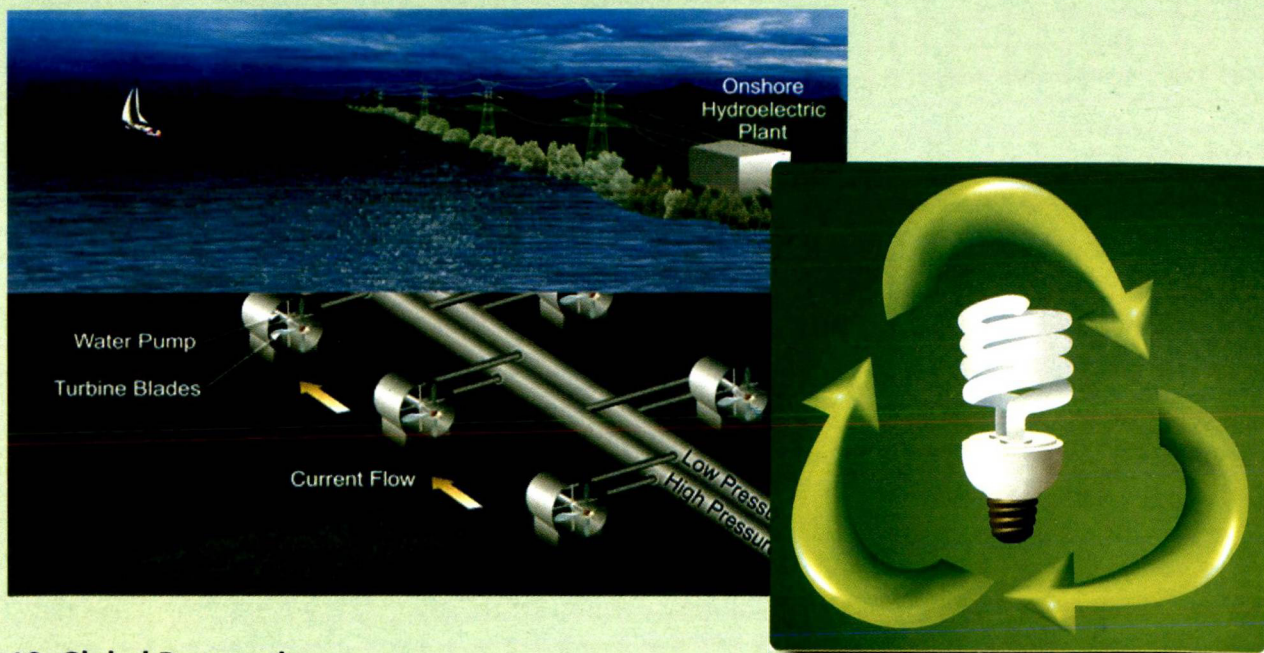
There are certain measures that could be implemented immediately through appropriate policy recommendations that would help in the reduction of CO₂ emissions. Some of these are described below.

Electric Vehicles: Currently, the highest emission of CO₂ is from the transport sector. Electric vehicles operate at much higher efficiencies than internal combustion (IC) engine driven vehicles. If electricity is generated at higher efficiency than in IC engines, a shift to electric vehicles could reduce CO₂ and other emissions. Today, electric vehicles suitable for short distance running are available overseas at comparable prices. Their use could be encouraged with suitable tax incentives, as they would reduce not only the emissions affecting the global environment, but also emissions affecting the local environment such as carbon monoxide, particularly in the cities.

Residential RE Installations: In order to get a larger segment of the society investing on RE projects on an individual basis, government could extend the present tax concessions given to tax payers who contribute towards identified government development projects to any person investing on residential RE installations. Further, rebates on the capital expenditure may also be given because people generating energy at the resident itself would reduce the burden on the utilities. The electricity utilities have recently introduced net-metering system enabling individual consumers including the corporate sector to participate in the generation of electricity in an environmentally friendly manner and contribute to the national development. Without such concessions, companies undertake these projects as part of their corporate social responsibility and to improve their carbon foot-print.

Biomass gasification and distribution: Though several parties have introduced single stoves operating on gasification principle, they are not popular among working housewives. Today, central gasification systems are available which could serve syngas to households as a substitute for LPG through a local piping network. This eliminates generation of CO₂ through combustion of fossil fuel and that consumed in its transport island-wide. Such systems are suitable for installation in urban housing schemes comprising about 50 – 100 houses particularly in areas where biomass is available freely¹³. A grant received recently by Sri Lanka recently from GEF to introduce new technologies for the efficient utilization of biomass and establish the supply chains could be used to demonstrate the feasibility of these schemes.

LNG for power generation: The Ministry of Power and Energy has been attempting to introduce LNG over the last few years for operating power plants in the western coast without any progress. The import of LNG requires port facilities with adequate depth. With the development of the deep Colombo South harbour, LNG receiving terminals could be built to import natural gas to meet the requirements of not only the power sector, but also those of the transport, industrial and commercial sectors in the Colombo District. The use of natural gas reduces CO₂ emission by half and eliminates altogether other pollutants such as carbon monoxide, sulphur dioxide and particulates. LNG could also be imported through Trincomalee or Hambantota harbours for distribution to power plants and other end users in the proposed industrial and commercial centres at these two future metropolis areas. A large scale terminal built at Trincomalee could even dispatch the gas to South India through a pipeline, which India is now planning to obtain from Myanmar. These terminals could be built by investors on BOOT basis without any burden on the government.



10. Global Perspectives

The historical growth of economies in developed countries has shown that economic development has been closely associated with increasing energy consumption. There exists a strong correlation between per capita energy, specifically electricity consumption, and levels of human development, with a minimum consumption of 4,000 kWh/capita required in order for a “decent” level of HDI = 0.9 to be attained, according to the ADB report on Energy for All¹⁴. The corresponding average for the G8 countries (excluding the Russian Federation) is over 11,000 kWh/capita. The UN AGECC report cites

¹³ Bhattacharya, ¹⁴ADB, 2007

the minimum energy required to benefit from modern energy services as 2,000 kWh/capita. However, Sri Lanka's per capita electricity consumption during 2008-2010 has been around 500 kWh/year, which is inadequate for people to live out of abject poverty. Thus, under both threshold levels identified for comfortable living, Sri Lanka's electricity consumption has been very low.

Even in the case of TPES with a per capita consumption of 23 GJ in 2010, Sri Lanka's position is far below the world average of 76 GJ (2008)¹⁵ and Europe's average of 143 GJ (2008). On the other hand, recent decisions taken at the Conference of Parties to UNFCCC require all countries to undertake voluntary reduction of greenhouse gas (GHG) emissions. In almost all countries, emissions are linked to energy generation from fossil fuel combustion, which is still the key source of energy. Thus any attempt to reduce GHG emissions would affect energy development plans. These decisions taken by UNFCCC without giving any consideration for low energy consuming countries, puts these countries in a dilemma.

While the multi-lateral organizations recommend that all countries increase their electricity consumption for a better living, UNFCCC puts constraints on them to reduce consumption in the short term. Presently, fossil fuels such as coal combustion is the most economical means of electricity generation, and until such time technology is developed to meet the countries' energy requirements from RE sources, countries will have to continue use fossil fuels possibly at an increasing rate to meet the thresholds cited by AGECC and ADB reports. This will eventually cause a rapid increase in the GHG emissions, without being able to comply with UNFCCC requirements.

11. Proposed Strategies to Fill the above Gaps

The two topics relevant to the present paper are energy and sustainable development, which come under the purview of at least three ministries; one on Energy and Power, second on transport and the third on Environment. The lack of coordination and a dialogue between these ministries appear to be the main constraint and barrier in implementing policies that had been adopted by the government. A high level body – the NCSD, has been established to ensure implementation of SD policies and the associated action plan. Yet, the progress has been slow in implementing the recommended measures, probably due to low priority and low funding allocated to this sub-sector.

The UNFCCC has adopted decisions at its recent meetings to grant financial assistance to developing countries to implement programmes that will reduce their emissions. In order to benefit from these funding sources, it is essential to prepare sound project proposals conforming to UNFCCC guidelines which require certain amount of capacity in the country.

Another problem has been the lack of appreciation of environmental issues by energy professionals. It is the general understanding that when a project is conceived, environmental issues need to be taken into account from the beginning rather than at the end of the pipeline, but this does not seem to happen. It is important that professionals working on various development projects including power projects address associated environmental issues with concern and internalize them.

The manner in which environmental issues are addressed by energy professionals is evident in a recent report prepared by a team of consultants on "Environmental Issues in the Power Sector in Sri Lanka" for submission to the World Bank¹⁶. Instead of providing a comprehensive analysis of environment issues affecting the power sector and recommend remedial measures, the report only makes an attempt to justify the proposed proliferation of coal power plants in the country.

¹⁵ESCAP, 2011, ¹⁶WB, 2010



12. Way Forward

The high level National Council on Sustainable Development (NCSD) has been mandated to promote the process of achieving sustainable development, and to oversee and guide the implementation of its . The Ministry of Environment as its convener needs to initiate a discussion on the progress of the implementation of HLP in consultation with the Ministry of Plan Implementation. It has been observed that various initiatives have been made in respect of RE projects but these have not been pursued with vigour. The NCSD needs to take a count on such projects and accelerate their progress, with adequate funding allocated if necessary.

Currently, whatever the progress made in the RE sector, has been achieved with the initiative shown by private sector investors. However, these appear to have been implemented in an ad-hoc manner. In order to achieve sustainable development through efficient systems and low or zero-carbon energy generation, it is necessary to have a clear long term plan or a road map for the generation of energy in a sustainable manner in the long term. This needs to be drawn up not only by energy specialists, but also with the involvement of economists, social scientists and environmental specialists, representing the three pillars of sustainable development. A concerted effort needs to be made to benefit from various funding sources available for promoting sustainable energy generation.