Chapter 3

SEA's investment on NCRE tariff

One of the main objectives of setting up of SEA is to increase the utilization of available renewable resources for grid connected electricity generation. As a result, SEA came up with new cost based, technology specific tariff structure to attract more private investors to invest on these projects, which was mainly restricted to mini hydro development under previous CEB's avoided cost tariff. Since, CEB's avoided cost tariff is source neutral tariff system all the renewable sources are given the same tariff. This makes only the mini hydro plants economically feasible for private investors. Due to this reason, since the opening of opportunities for private investors to implement small-scale renewable power plants, development had been limited to mini hydro power plants.

This new SEA's cost based tariff scheme is very much different to CEB's avoided cost tariff. Also SEA's 3-tier tariff scheme offer higher tariff rates during initial years, which is more than the present avoided cost tariff. On the other hand, as a separate commercial entity, CEB is only willing to pay their avoided cost for renewable energy. Therefore, to implement this new tariff scheme SEA has to invest on NCRE tariff. Amount of investment, SEA has to be made will largely depend on available renewable mix and the CEB's avoided cost.

3.1 New Cost based Tariff Structure

SEA's new cost based tariff structure has designed to encourage private investors to invest on renewable resources, especially sources likes Wind, Biomass and Municipal waste. In this new tariff structure, investors have two options; either they can go for 3-tier tariff structure or flat tariff option.

In 3 –tier tariff system, escalable amounts will be calculated based on five –year average of Colombo Consumer Price Index (CCPI) and the average LKR / USD rates of change. Therefore, tariff will be adjusted every year depending on this escalable percentage. Table 3-1 shows the basis of 3-tier tariff calculation for different sources [25].

Table 3-1: SEA, 3 – Tier SPP Tariff Option (April 2009)

Technology	Escalable Base O&M Rate (Rs.)	Escalable Base Fuel Rate (Rs.)	Non-escalable Fixed Rate (Rs.)		Escalable Year 16+ Base Rate (Rs.)	Royalty to Govt. paid direct by the power purchaser Year 16+
			Year 1 - 8	Year 9 - 15		
Mini - Hydro	1.55	none	14.18	5.16	1.62	10% of total tariff
Wind	2.46	none	22.53	8.19	1.62	10% of total tariff
Biomass (Dendro)	1.24 (1 -15 Years) 1.55 (16^{th} year onwards)	7.14	8.50	3.09	1.62	No Loyalty
Agricultural & Industrial Waste	1.24 (1 -15 Years) 1.55 (16^{th} year onwards)	3.56	8.50	3.09	1.62	No Loyalty
Municipal waste	3.13	none	12.26	4.46	1.62	No Loyalty
Waste Heat Recovery	0.49	none	10.15	3.69	1.62	No Loyalty
Wave Energy	1.01	none	6.58	2.48	1.3	10% of total tariff

Table 3-2 shows the flat tariff rates for different renewable sources. In flat tariff option, there is no escalable part in the tariff. Hence, same tariff will be paid without change for 20 years of operational period [25].

Table 3-2: SEA, Flat Tariff option (April 2009)

Technology	All inclusive Rate (Rs./kWh) for Years 1 - 20
Mini - Hydro	14.58
Wind	23.07
Biomass	18.56
Agricultural & Industrial Waste	13.88
Municipal waste	15.31
Waste Heat Recovery	9.55

Since avoided cost tariff was calculated based on constant terms (0% escalation) only 3 – tier tariff option can be used for this analysis. Because in flat tariff option, tariff is calculated by taking estimated escalation into account, therefore flat tariff option can't be compared with projected CEB avoided cost tariff, which was calculated under constant terms.

Table 3-3: SEA, 3 – Tier SPP Tariff under Constant Terms (0% escalation)

Year	Mini Hydro Rate (Rs. / kWh)	Biomass Rate (Rs. / kWh)	Wind Rate (Rs. / kWh)
1 to 8	15.73	16.88	24.99
9 to 15	6.71	11.47	10.65
16 to 20	2.85	10.31	3.67
>20	2.85	10.31	3.67
Avg. Rate for 20 years	9.02	13.16	14.10

Under constant terms, 3 – tier tariff can be presented as shown in table 3-3 for different renewable sources. Here, only Mini hydro, Biomass and Wind power plants are considered, since implementations of other forms of renewable sources are not expected to be significant during this study period.

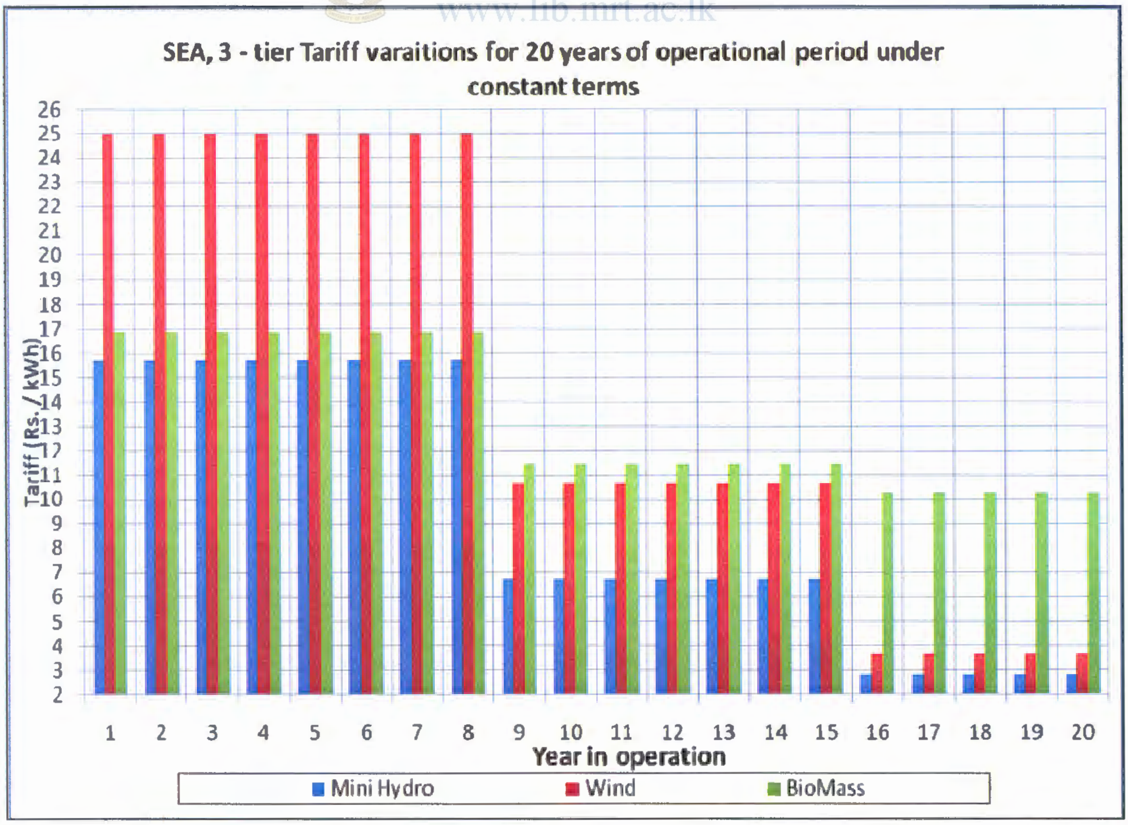

Figure 3-1: Tariff projection as per SEA, 3 – tier option under constant terms

Figure 3-1, further illustrate the projected variation in Mini hydro, Biomass and Wind energy plant's 3 –tier tariff under constant terms. As per figure 3-1, it is clear that Wind and Biomass plants will cost more for SEA than Mini hydro power plants. Also, all the sources are expecting to get higher tariff during their initial years to ease the burden on developer's cash flow, and will get lesser tariff during 2nd and 3rd tiers. Therefore, SEA is basically expecting to recover their investment on tariff during 2nd and 3rd tiers.

At the moment almost all of mini hydro power plants in operation have signed SPPA with CEB for 15 years. Therefore, until it lapses tariff for those power plants will be purely based on CEB avoided cost tariff principle. After completion of contract period of those SPPAs all the plants will have to operate under new SEA, 3 –tier tariff structure under 3rd category (from 16 +).

3.2 Non Conventional Renewable Energy Sources

Over the years, Sri Lanka has exploited large conventional hydro power resources to almost its maximum economical potential. Non conventional renewable energy has become a prime potential source of energy for the future due to the low impact on environment compared with conventional power plants. As far as Non conventional renewable energy sources, which can be utilized for grid integration, following proven options are available in Sri Lanka,

A) Mini Hydro power plants,
B) Wind power plants
C) Biomass power plants
D) Waste heat power plants
E) Others like Solar, Wave energy and ocean thermal power plants

However, this category doesn't include conventional renewable energy sources, such as large scale hydro power plants. Under the present CEB SPP regulations, capacities of these power plants have to be limited to a maximum of 10 MW. Therefore, these non conventional power plants are connected to medium voltage distribution system of the CEB to integrate with national grid as embedded generators.

As of May 2010 around 195 MW of embedded renewable power plants are being connected to the national grid. Out of this, most are mini hydro power plants and there are few other power plants, including recently commissioned 10MW Wind power plant in Puttalam under SEA's tariff scheme. Apart from these grid connected power plants, there are several off grid micro hydro power plants, wind plants, Dendro plants and Solar PV plants available to fulfill basic electricity needs at village level.

As far as Grid connected NCRE power plants are being concerned, all the developments are being done through private investments except CEB wind power plant in Hambanthota and one mini hydro power plant in Nilambe.

3.2.1 Mini Hydro Power Potential

At the moment, Mini hydro power plants are the dominant non conventional renewable form of energy source used for utility scale power production. Presently it accounts for more than 170 MW grid connected capacity. This development of grid connected mini hydro power plants have been started since 1996 after CEB allows private small scale power plants to connect to national grid. Also, mini hydro power is the only source out of renewable, identified as economically and technologically feasible under CEB's avoided cost principle. Topographical nature and relatively high rainfall in Sri Lanka, especially in hill country provide ideal opportunities to develop small scale hydro power plants without much disturbance to the Nature. In addition to that, this is the oldest form of renewable power generating method in Sri Lanka, going back to colonial era as well; therefore there is enough local expertise in this sector.

In addition to already implemented projects, there are considerable untapped potential in the country which can be used for utility scale projects. This includes,

A) Untapped hydro Potential available specially in eastern slopes of hill country.
B) Harnessing the head from irrigation canals, tanks and reservoirs
C) low head projects

As per present SEA statistics, in addition to already commissioned mini hydro power plants initial approval has been given for another 210 MW capacity. These statistics are based on the applications received by SEA for mini hydro power developments. However, study has to be done to identify the actual, economically viable potential available in mini hydro sector for future development.

Development of all those sites will largely depend on availability of infrastructure, mainly availability of grid, economic feasibility and investor's interest.

3.2.2 Wind Electric Potential

Several studies are being done regarding the wind power potential in our island nation by various organizations and individuals. Out of that, studies conducted by Ceylon Electricity Board and National Energy Laboratory of USA are paramount. CEB took the initiative to carry out a detailed wind-monitoring program in the south-eastern part of the country in 1988. The study revealed that the total potential of wind power generation in the South-eastern part of the country to be 200 MW. This excludes the land area for wild life reserves and agriculture.

There are several locations in Sri Lanka that show near-term potential for cost-effective utility scale wind power development given the current economic climate and infrastructure status [18]. The most promising sites identified, in order of potential feasibility, are

- Kalpitiya Peninsula
- National Livestock Board cattle farm near Ambewela
- Southeast coastal areas from Hambantota to Buthawa.
- Several other locations such as Mannar Island

And Jaffna District has favorable wind resource potential. However, the lacks of infrastructure pose significant barriers to near-term development.

Until commissioning of 10MW Wind plant in Puttalam in March 2010, only CEB developed 3 MW wind plant connected to the national grid located in Hambantota on the south-eastern coast. It was planned as a pilot plant for CEB to get hands-on experience and also to study the implications of integrating wind power into the grid system. Compared to mini hydro development, utility scale wind plants are still in its early stages of development. But several private parties have already taken initiatives to harness wind potential in Sri Lanka. With the advancements in technology in wind power plants, wind power has now become the world's fastest growing renewable form of energy.

SEA has already issued initial clearance to develop around 95 MW of wind capacity. Even though there is a huge un-tapped wind potential in Sri Lanka, implementation of these projects are hindered due to network and other infrastructure bottle necks.

3.2.3 Biomass potential

Biomass energy had always been the major source of primary energy in Sri Lanka. At present it accounts for nearly 50% of the total primary energy requirements [19]. For the past many decades, a substantial part of the biomass came from agricultural residues such as rubber plantations, cinnamon crop, coconut plantations, homesteads, fuel wood plantations established by the Forest Departments and some of the tea plantations. A significant quantity also came from unsustainable forest clearings.

There is great potential in Sri Lanka to utilize biomass for utility scale power production. Use of firewood from Short Rotational Coppicing (SRC), sugar cain residue and municipal waste are the most prominent sources of biomass, which can be use for utility scale energy generation. Out of above biomass options, use of firewood from short rotational crops considers to be the most potential source of biomass for electricity generation.

Several studied are being done by the Ministry of Science & Technology with many partner organizations including Coconut Research Institute, many tree species have been tested to be used in Dendro power production. Among them, *Gliricidia sepium, Acacia auriculiformis, Calliandra calothrysus, Leucaena leucocephala* have proven to be successful. The assessment was primarily based on the wood yield, ease of establishment and the ability to withstand frequent coppicing. Further, additional benefits such as rate of leaf decomposition, which leads to the improved nutrient status of the soil, were noted. Based on these results, *Gliricidia sepium* was selected as the best for a major proportion of the country [20].

As per present estimates, SRC can produce around 15 - 20 ton / year. The total extent of degraded marginal lands suitable for energy plantation in Sri Lanka is estimated at 1.6 million hectares. Hence the national potential for Dendro power in Sri Lanka is estimated as 4000 MW annually generating over 24 TWh [20]. This is more than total hydropower potential in this country. As per above statistics, Dendro potential in our country is adequate to meet our electrical energy demand for many decades.

Dendro power provides a significant potential to contribute to national economic growth and employment generation in rural areas, as well as local and global environmental management. With modern technologies, wood and other biomass can provide a competitive and sustainable fuel for processing and conversion into electricity in many situations. This position is expected to develop considerably when more expertise is gained with using biomass as a modern energy carrier.

Even though there is massive potential in sector to develop, only two plants has commissioned in commercial scale up to now. Unlike other renewable sources like mini hydro & Wind power plants, source of energy is not freely available, so maintaining proper supply of firewood is the biggest challenge in this sector.

3.3 Possible Technological Options to Reach the Target

Mini Hydro, Wind and Biomass are the main feasible non-conventional renewable energy generation potentials available for near term utility scale renewable energy developments. As per table 2-19, up to now only around 525 GWh of electric energy is being contributed from these non-conventional forms of energy per annum. To reach the envisaged NCRE contribution by year 2015, this value has to be increased to more than 1700 GWh. That means nearly 3 times the present contribution from the sector.

This is definitely a daunting task to be achieved. Even though there are enough renewable resources to reach this target; successful implementation of these projects will depend on several factors. Here government is only expected to play the facilitation role, such as providing the infrastructure facilities and policy frame work to fast track the implementation of renewable projects through private investments.

Since private investors are involved in development in renewable sector, it is difficult to pin point the exact amount and combination of renewable sources in operation in a particular year. It will largely depend on their interest and opportunities to develop these projects.

There can be several technological options to reach the year 2015 renewable target. Following table shows one possible combination of renewable sources to reach the target by taking into account feasible potential available from each source as per present studies.

Table 3-4: Possible addition of NCRE plants to reach envisaged generation by 2015

Year	Mini Hydro (MW)	Biomass (MW)	Wind (MW)
2010	24	3	10
2011	49	6	11
2012	49	11	9
2013	16	12	10
2014	16	16	18
2015	25	17	14

As shown in table 3-4, envisaged 2015 NCRE generation can be met with above combination. This means another 179 MW of Mini hydro, 65 MW of biomass and 62 MW of wind plants have to be added to the national grid by end of year 2015.

3.3.1 Required Energy contribution from each sector

Table 3-5 shows the possible additional contribution expected from each of these sectors in each year, if plants are implemented according to schedule mentioned in table 3-4. Here, it is assumed that, plant factors of mini hydro, biomass and wind power plants as 42%, 80% and 32% respectively [12].

Table 3-5: Required Additional Energy Contribution from each Sector

Year	Mini Hydro (GWh)	Biomass (GWh)	Wind (GWh)
2010	83	22	30
2011	171	40	28
2012	171	80	25
2013	57	83	28
2014	57	113	50
2015	89	120	40

3.4 Forecasting of SEA Investment on Non-conventional Renewable Sources to meet the Targeted Contribution

SEA cost-based tariff structure has been designed to alleviate the problems of negative cash flow experienced by many SPPs during the period of loan repayment, when the tariff was technology neutral and based on avoided costs to CEB. This means during initial period SEA has to make additional contribution to pay for SPPs with the available CEB's avoided cost tariff.

Amount of investment, SEA has to make on renewable energy tariff when reaching year 2015 non-conventional renewable electricity generation target will depend on several variables. These variables can be mainly categorized into two categories, such as actual combination of renewable energy sources and CEB avoided cost.

Table 3-6 shows one possible combination of non-conventional renewable sources expect to implement under new SEA tariff structure to meet envisaged renewable energy generation. Here, the only difference with table 3-5, which gives the overall plant implementation schedule, is that the part of the mini hydro contribution is not being included for year 2010 in case of table 3-6, since these plants are expected to be commissioned in year 2010 under CEB SPP agreements.

Table 3-6: Possible NCRE Combination comes under SEA's Tariff Structure

Year	Mini Hydro (GWh)	Biomass (GWh)	Wind (GWh)
2010	23	22	30
2011	171	40	28
2012	171	80	25
2013	57	83	28
2014	57	113	50
2015	89	120	40
Total contribution (GWh)	566	458	201
Percentage contribution (%)	46%	37%	17%

As per table 3-6, 46%, 37% and 17% of new renewable energy to be contributed from mini hydro sector, biomass and wind power sources respectively. If the above contribution changes, it will affect net revenue of SEA, since SEA's tariff is source-based. For instance, if the contribution from wind and biomass increases, then overall cost on SEA will increase since average tariff of those plants are higher than mini hydro tariff.

Table 3-7: Comparison of Average Source based Tariff and Forecasted Avoided Cost Tariff

SEA long Term Average Tariff (Rs./kWh)			Average CEB Tariff (Rs./kWh)		
Mini Hydro	Biomass	Wind	With Sep. 08' fuel prices	With Mar. 09' fuel prices	With Sep. 10' fuel prices
9.02	13.16	14.1	12.32	6.50	7.63

Table 3-7 shows the average 3-tier tariff for each main renewable source during their operational period and respective average avoided cost calculated with different fuel prices based on 2005 LGEP. This indicates, average SEA cost based tariff for mini hydro, biomass and wind power plants are more than the average CEB's avoided cost tariff calculated with September 2010 and March 2009 fuel prices. However, avoided cost average tariff calculated with September 2008 fuel prices is higher than the cost based SEA's tariff for mini hydro. Therefore, depending on fuel prices there is a possibility to SEA to cross subsidize wind and biomass projects with mini hydro plants.

SEA's net revenue for each year has been calculated based on estimated CEB's avoided cost tariff and SEA's 3-tier tariff commitments to reach year 2015, envisaged electricity generation from renewable sources. Since, this study concentrate on reaching year 2015 renewable electricity generation target, expected new renewable plants after year 2015 has not been taken into consideration.

Even though non conventional renewable addition is considered only up to year 2015, SEA's net revenue has been estimated until all those renewable plants complete their allotted period. Thus, it will help to evaluate net revenue of SEA, if those renewable plants implemented to meet specified renewable electricity generation target. Since, SEA offer higher tariff at the initial years and expect to recover during 2nd and 3rd tiers, it is very much important to continue this evaluation until all those plants complete their allotted period. Therefore SEA's net revenue from these new NCRE additions up to 2015 has been calculated until year 2034, where the plants implemented in year 2015 will complete their contract period.

Since, latest published LGEP (2008) contains data only up to year 2022, avoided cost for year 2023 to 2034 are assumed as the average avoided cost of last 3 years (2020 – 2022).

In addition to new renewable plants, which are expecting come up under SEA's cost based tariff system, all the present mini hydro plants, which presently operate under CEB's avoided cost tariff, will come under SEA's purview after completion of their allotted 15 years. Absorption of these old mini hydro power plants will commence from year 2012 onwards. Those existing mini hydro power plants will get 3rd tier tariff for another 15 years after expiring of their present SPPA with CEB.

Table 3-8 shows, sector vise and overall SEA's expected net income, when implementing their cost based 3-tier tariff scheme to meet National Energy Policy targets. As per the figures, SEA will need to subsidize, especially until 2026 to meet their tariff commitments. From year 2026 onwards they will have a surplus of income, since most of the implemented plants (up to 2015) are in 2nd or 3rd tier at that time.

Table 3-8: Net Income Calculation Summary of SEA with Sep. 2010 Fuel Prices and 2005 LGEP

Year	Expected New Energy addition from each sector under SEA tariff system (GWh)			Required total allocation to meet SEA 3 - tier Tariff (Rs. Millions)				Net Revenue From each sectors (Rs. Millions)			Net Revenue for SEA (Rs. Millions)
	Mini Hydro	Biomass	Wind	Mini Hydro Energy cost	Biomass Energy cost	Wind Energy cost	Energy cost of old plants	Mini Hydro	Biomass	Wind	
2010	23	22	30	362	371	750	0	(97)	(118)	(404)	(619)
2011	171	40	28	3,052	1,047	1,449	0	(846)	(342)	(790)	(1,978)
2012	171	80	25	5,741	2,397	2,074	20	(1,857)	(886)	(1,191)	(3,880)
2013	57	83	28	6,638	3,798	2,774	60	(2,218)	(1,441)	(1,611)	(5,110)
2014	57	113	50	7,535	5,705	4,023	110	(3,203)	(2,649)	(2,568)	(8,181)
2015	89	120	40	8,935	7,731	5,023	190	(4,330)	(4,018)	(3,393)	(11,391)
2016	0	0	0	8,935	7,731	5,023	270	(4,842)	(4,431)	(3,575)	(12,437)
2017	0	0	0	8,935	7,731	5,023	370	(5,066)	(4,612)	(3,654)	(12,818)
2018	0	0	0	8,727	7,612	4,593	490	(5,033)	(4,633)	(3,286)	(12,325)
2019	0	0	0	7,185	7,396	4,191	630	(3,535)	(4,453)	(2,900)	(10,099)
2020	0	0	0	5,642	6,963	3,833	780	(1,962)	(3,995)	(2,530)	(7,496)
2021	0	0	0	5,128	6,514	3,431	950	(1,453)	(3,551)	(2,131)	(5,931)
2022	0	0	0	4,614	5,902	2,714	1,150	(946)	(2,944)	(1,416)	(3,853)
2023	0	0	0	3,811	5,253	2,141	1,250	(137)	(2,290)	(840)	(1,683)
2024	0	0	0	3,811	5,253	2,141	1,480	(139)	(2,292)	(841)	(1,398)
2025	0	0	0	3,723	5,228	1,931	1,629	(51)	(2,267)	(632)	(887)
2026	0	0	0	3,063	5,181	1,736	1,629	610	(2,220)	(436)	18
2027	0	0	0	2,403	5,089	1,561	1,610	1,269	(2,127)	(262)	918
2028	0	0	0	2,184	4,992	1,366	1,570	1,489	(2,031)	(67)	1,379
2029	0	0	0	1,964	4,861	1,017	1,520	1,709	(1,900)	282	2,016
2030	0	0	0	1,621	4,722	738	1,440	2,052	(1,761)	562	2,676
2031	0	0	0	1,621	4,722	738	1,360	2,052	(1,761)	562	2,575
2032	0	0	0	1,621	4,722	738	1,260	2,052	(1,761)	562	2,448
2033	0	0	0	1,621	4,722	738	1,140	2,052	(1,761)	562	2,296
2034	0	0	0	1,621	4,722	738	1,000	2,052	(1,761)	562	2,119

3.4.1 Scenario Study of SEA's Financial Performances

SEA's net revenue of each year will basically depend on their tariff commitments and CEB's avoided cost. Here, their tariff commitments can vary each year depending on total renewable electricity generation as well as available renewable electricity generation mix. On the other hand, CEB's avoided cost can basically vary, with expected generation mix and fuel price.

A scenario study will be carried out to examine the variation of net revenue of the SEA under different circumstances. As per both, 2005 LGEP and 2008 LGEP, expected electricity generation is around 17500 GWh by year 2015. Therefore, expected electricity generation from NCRE can be kept as it is irrespective of LGEP when reaching NCRE generation endeavor by year 2015. Still, NCRE mix can vary to meet the same targeted renewable energy generation, which can change the tariff commitments of the SEA. As explained in section 3.3 optimum combination of NCRE addition is considered for initial study by considering identified NCRE sources, thus variation in NCRE energy mix has not been taken into account in this scenario study.

On the other hand SEA's main income, which is CEB's avoided cost, can drastically vary based on fuel prices as well as CEB generation mix, which also differs from 2005 LGEP to 2008 LGEP. Therefore, scenario study will be done under following different conditions to examine the net income of the SEA by keeping SEA's tariff commitments as it is.

A) Sep. 2008 fuel prices (with 2005 LGEP & 2008 LGEP)
B) Mar. 2009 fuel prices (with 2005 LGEP & 2008 LGEP)
C) Sep. 2010 fuel prices (with 2005 LGEP & 2008 LGEP)

Table 3-9 shows the net revenue of SEA in each of those scenarios, which involve 3 different fuel prices (Sep. 2008, Mar. 2009 & Sep. 2010) and 2 LGEPs (2005 LGEP and 2008 LGEP). As per the figures in the table, it is clear that a subsidy need to be provided by SEA with 2008 LGEP is more than 2005 LGEP due to its low avoided cost.

Table 3-9 : Summary of Net Revenue of SEA, without Carbon Credit in Different Scenarios

Year	Net Revenue of SEA (Rs. Millions)					
	Sep. 2010 fuel prices		Mar. 2009 fuel prices		Sep. 2008 fuel prices	
	With 2008 LGEP	With 2005 LGEP	With 2008 LGEP	With 2005 LGEP	With 2008 LGEP	With 2005 LGEP
2010	(619)	(619)	(619)	(619)	(619)	(619)
2011	(1,872)	(1,978)	(2,107)	(2,305)	(929)	(1,078)
2012	(3,091)	(3,880)	(3,989)	(4,991)	519	(667)
2013	(4,888)	(5,110)	(6,374)	(7,087)	1,134	882
2014	(8,952)	(8,181)	(10,466)	(10,191)	(2,683)	(1,360)
2015	(14,662)	(11,391)	(15,976)	(13,363)	(8,924)	(3,672)
2016	(14,891)	(12,437)	(16,138)	(13,992)	(9,328)	(5,490)
2017	(14,885)	(12,818)	(16,134)	(14,192)	(9,263)	(6,168)
2018	(13,983)	(12,325)	(15,282)	(13,686)	(8,153)	(5,824)
2019	(11,664)	(10,099)	(13,013)	(11,497)	(5,617)	(3,504)
2020	(9,092)	(7,496)	(10,515)	(8,955)	(2,755)	(668)
2021	(7,663)	(5,931)	(9,123)	(7,445)	(1,127)	1,221
2022	(5,622)	(3,853)	(7,153)	(5,434)	1,101	3,585
2023	(3,492)	(1,683)	(5,059)	(3,300)	3,341	5,920
2024	(3,308)	(1,398)	(4,946)	(3,092)	3,665	6,582
2025	(2,844)	(887)	(4,534)	(2,632)	4,000	7,326
2026	(1,941)	18	(3,631)	(1,727)	4,904	8,233
2027	(1,036)	918	(2,718)	(820)	5,778	9,102
2028	(558)	1,379	(2,228)	(346)	6,198	9,497
2029	98	2,016	(1,556)	308	6,780	10,055
2030	788	2,676	(839)	995	7,352	10,587
2031	718	2,575	(883)	921	7,164	10,357
2032	629	2,448	(938)	829	6,929	10,071
2033	523	2,296	(1,005)	718	6,646	9,727
2034	400	2,119	(1,083)	588	6,316	9,325

3.4.2 Carbon credit for SEA NCRE Projects

Electricity generated from grid connected non-conventional renewable energy sources, replaces the generation from conventional thermal power stations, thus preventing the emissions of greenhouse gases, including carbon and Sulphur dioxides.

Sri Lanka is a United Nations Framework Convention on Climate Change (UNFCCC) member, has signed the agreement and the ratification was given on the 3rd September 2002. The Clean Development Mechanism (CDM) is a win-win proposition: it allows industrialized countries or their authorized private entities to earn emission credits at a cheaper price through projects that contribute to the sustainable development of developing countries [20].

According to the Kyoto Protocol, gas emission reductions generated by CDM project activities must be additional to those that otherwise would occur. Additionality test checks whether the CDM project would have happened anyway or whether it needed the CDM to go ahead. Credits for GHG emission reduction were only be granted for the projects which are additional, that is credits were only granted for the projects which would not have taken place in the absence of the crediting procedure or Implication of Carbon Credits. So in order to obtain credits for a CDM project one must show that the project is impossible without the credits for GHG emission reduction.

Since SEA is offering higher Tariff to promote implementation of renewable energy sources for power generation, there is a strong argument for SEA to claim Carbon credit for energy generation from renewable sources, which are implemented under new SEA Tariff structure. Therefore, in addition to expected revenue from renewable energy income from CEB, SEA is expecting to generate some revenue through CDM as well. Since, NCRE energy to substitute fossil fuel energy generation and in line with all other criteria's of CDM, these plants are eligible to claim for CDM funds. These funds defiantly help to reduce the burden on SEA due to their tariff commitments, especially during initial periods.

Like any other market, purchasing price rate of carbon credit is very much volatile; also it varies from place to place as well. In year 2006 it went even up to 50 US $ per ton of carbon, now it is trading around 20 US $ [21]. Presently, European Union Emission

Trading Scheme (EU ETS) is the largest market for CDM projects. In addition to that, there are several other trading floors, likes of Chicago Climate Exchange (CCX), New South Wales Greenhouse Gas Abatement Scheme (NSW GGAS) and some voluntarily trading schemes.

3.4.3 Scenario study with carbon credit income

Scenario study can be continued with possible carbon credit income for SEA. Table 3-10; illustrate net income of the SEA in each year from renewable electricity sales with carbon credit. As per studies, each kWh of renewable electricity generation can reduce 0.75 kg of carbon emission [21]. Since SEA has large volume of carbon credit, it will be in a better position to get an attractive rate for its carbon credit. However, in this study, it is assumed that rate of carbon credit sales at 20 US$ per ton of carbon (present market price of EU ETS). This means around Rs. 1.68 / kWh additional income can be generated from carbon credit sales for SEA in addition to CEB avoided cost tariff.

Table 3-10: Summary of Net Revenue of SEA, with Carbon Credit in Different Scenarios

Year	Net Revenue of SEA with Carbon Credit (Rs. Millions)					
	Sep. 2010 fuel prices		Mar. 2009 fuel prices		Sep. 2008 fuel prices	
	With 2008 LGEP	With 2005 LGEP	With 2008 LGEP	With 2005 LGEP	With 2008 LGEP	With 2005 LGEP
2010	(493)	(493)	(493)	(493)	(493)	(493)
2011	(1,345)	(1,450)	(1,579)	(1,778)	(401)	(551)
2012	(2,088)	(2,877)	(2,986)	(3,988)	1,522	335
2013	(3,579)	(3,801)	(5,066)	(5,778)	2,443	2,191
2014	(7,245)	(6,473)	(8,758)	(8,483)	(976)	347
2015	(12,488)	(9,218)	(13,803)	(11,190)	(6,751)	(1,499)
2016	(12,671)	(10,216)	(13,918)	(11,772)	(7,108)	(3,270)
2017	(12,605)	(10,539)	(13,855)	(11,912)	(6,984)	(3,889)
2018	(11,634)	(9,975)	(12,932)	(11,336)	(5,803)	(3,474)
2019	(9,231)	(7,667)	(10,581)	(9,065)	(3,185)	(1,072)
2020	(6,572)	(4,975)	(7,995)	(6,435)	(234)	1,853
2021	(5,042)	(3,310)	(6,503)	(4,824)	1,493	3,841
2022	(2,884)	(1,115)	(4,414)	(2,696)	3,957	6,323
2023	(695)	1,114	(2,262)	(503)	6,304	8,717
2024	(375)	1,535	(2,014)	(159)	6,951	9,515
2025	177	2,134	(1,513)	389	7,727	10,347
2026	1,080	3,039	(610)	1,294	8,631	11,254
2027	1,973	3,927	291	2,189	9,493	12,111
2028	2,428	4,364	758	2,640	9,890	12,483
2029	3,054	4,972	1,401	3,264	10,443	13,011
2030	3,697	5,585	2,070	3,905	10,968	13,496
2031	3,580	5,437	1,979	3,784	10,733	13,220
2032	3,432	5,251	1,865	3,632	10,438	12,874
2033	3,256	5,029	1,727	3,450	10,085	12,459
2034	3,050	4,769	1,567	3,238	9,673	11,976

3.4.4 Additional Funds need to Fulfill Tariff Commitments

As per table 3-9 and table 3-10, it is clear that in all considered scenarios, SEA will need external funds to fulfill its tariff commitments, if NCRE plants implemented to reach year 2015 envisaged electricity generation. As per those tables, SEA will mainly need those funds from year 2013 to 2023.

Since SEA is a government authority and trying to promote renewable electricity generation by providing higher tariff in initial years, they will be able to secure soft loan schemes from international donor agencies to subsidize renewable energy tariff. Since, it is expected to be a soft loan, in this study it is assumed that the rate of interest as 4 %. By assuming those conditions net present value of SEA's overall income during concern period has been calculated for all the considered scenarios.

Table 3-11: Summary of SEA's NPV of Income for Different Scenarios

Fuel price (crude oil – US $ / Barrel)	LGEP	NPV of cumulative income with 4% Discount rate (Rs. Millions)	
		Without carbon credit	With carbon credit
Sep. 2010 - 75	2005	(66,395)	(32,749)
	2008	(88,005)	(54,359)
Mar. 2009 - 37	2005	(88,954)	(55,307)
	2008	(108,154)	(74,508)
Sep. 2008- 137	2005	31,087	64,734
	2008	(2,967)	34,224

As per table 3-11, except with September 2008 fuel prices in all the other considered scenarios, SEA's net overall income is in negative terrain. This means, in all those other considered scenarios, government of Sri Lanka need to subsidize renewable energy sector, when reaching the 2015 envisaged renewable electricity generation.

This scenario study data has been used to analyze the NPV of SEA's net income with variation in crude oil prices. Figure 3-2 shows the variation of NPV of SEA's net income due to their tariff commitments against crude oil prices.

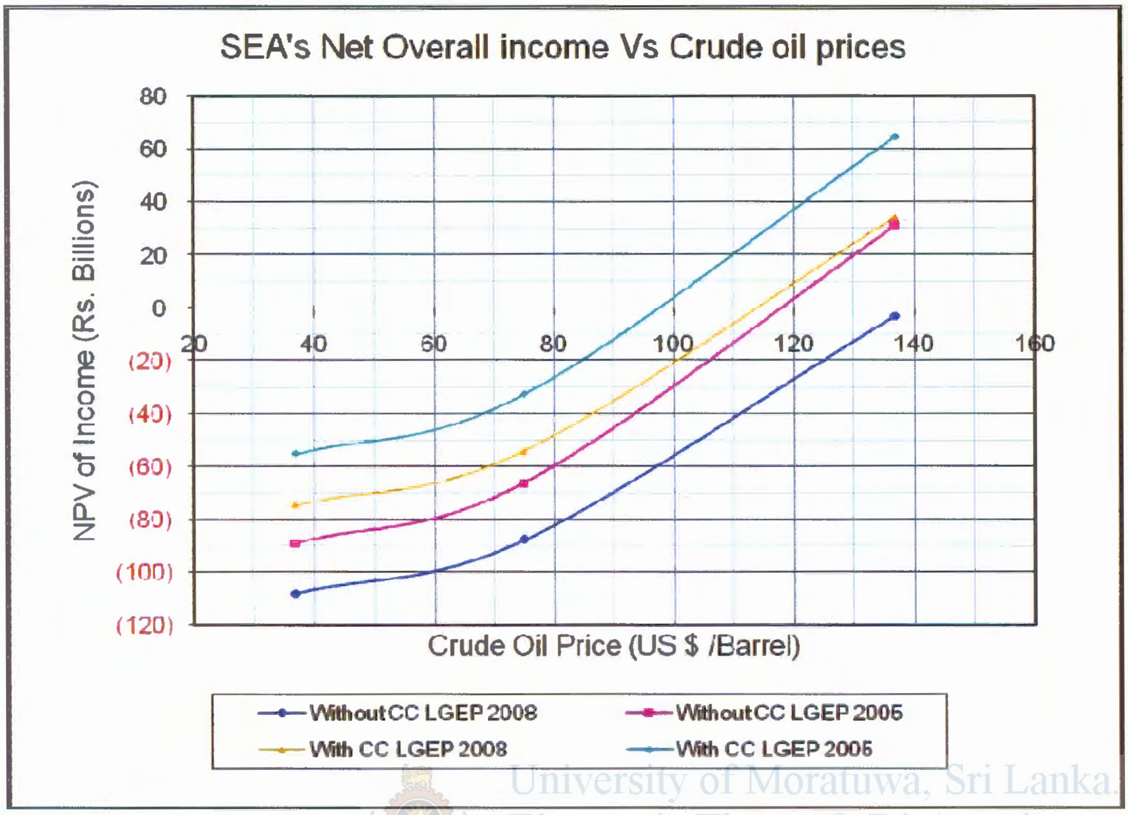

Figure 3-2: SEA's NPV of net income variation with crude oil prices in different scenarios

As per figure 3-2, SEA's investment on NCRE tariff will become breakeven, if the average crude oil prices stabilize within 100 – 120 $ per barrel. And if the price of crude oil goes below that range, government has to subsidize SEA to meet its tariff commitments. On the other hand if the average crude oil prices increases more than 100 – 120 $/ barrel then SEA will be able to make a profit out of their investment.