CHAPTER 5

5. CONCLUSION

Cost reflective tariff methodology signals the actual cost of developing and maintaining the power system while diminishing the risk of market operation. The research mainly focused on the study and analyzes the transmission pricing methodologies practicing in various power market models in the world and finally proposes a suitable methodology for the Sri Lanka power system. A study reveals that the common principal of almost all pricing methodologies are based on the cost recovery option. The key step of such methodologies is to clearly find out all the costs associate with the operation and maintenance of the network and enhancing the network services and allocation of the identified cost to the customers. When it comes to the customers connected in different voltage levels, it has to be considered the transmission loss factors too.

The research carried out studies on the transmission pricing methodologies, (i) embedded cost based, (ii) marginal cost based and (iii) composite cost based methodologies, and describes the real time transmission pricing methodologies applying in West Africa Power Pool, National Energy Market in Australia and Northern Ireland which operates in a competitive wholesale market model, and Thailand which operates in single buyer market model. Three main transmission pricing methodologies were analyzed while identifying cost components in each methodology relates to the Sri Lanka power system. Further the pricing models with respective to each methodology were developed and transmission tariff components were calculated, obtained results as in Table 4-19. Marginal/Incremental and Composite cost based pricing methodology options which are based on future expansion cost in determining transmission service prices results high capacity charges compared to the existing tariff. Marginal energy charges are the highest among three options calculated. Most suitable transmission tariff methodology was selected based on criteria that the tariff should be able to recover the costs of existing system and future expansions while not imposing additional burden to its customers

Analysis of data based on criteria above, the most appropriate methodology for calculation the transmission tariff for Sri Lanka is the embedded cost based method. According to the calculations, the tariff components are as Table 5-1.

Table 5-1 Proposed tariff components

	Proposed Methodology - Embedded Cost Based Method
	LKR/kVA/Month
Capacity Charge	2,991.20
Energy Charge	LKR/kWh
Day	10.02
Peak	12.93
Off-peak	6.57

Further analyses showed that in the year of 2015, the utility Ceylon Electricity Board had the total revenue of million LKR 415.66 while this would be increased to million LKR 618.97 if the proposed tariff was charged.

5.1 Recommendations

Proposed tariff methodology is using the transmission loss factors at 132kV/220kV and 33kV voltage levels based on assumptions. So a further study is needed to be done to figure out the actual transmission loss applied in different voltage levels. In addition energy component of the tariff is calculated based on forecast generation schedule and this shall be reconciled based on actual generation at each consecutive tariff period and adjusted.

5.2 Study Limitation and Suggestions for Future work

Time of use energy tariff in marginal/increment pricing methodology in 4.2 was calculated based on the power plants operated in the margin in each year of the period of analysis but without considering the power plants operated in the time period of the day (Day, Peak, Off-peak). So it’s recommended to calculate time of

use marginal energy prices by considering power plants operated at margin of the day in each time interval of the day.

Further suggests proposing a cost reflective retail by studying principles of pricing for retail tariffs and retail tariff methodologies in different power market structures in the world.

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Appendix I: Estimation of asset shares in different voltage levels.

		2015			Asset allocation factors				Cost of Assets			
	Life-time	Gross value million LKR	Acc. Dep	Net value	220kV	132kV	33kV	Sum	220kV	132kV	33kV	Sum
Buildings & land		**1,621**	**402**	**1,218**					**122**	**366**	**731**	**1218**
Land	N/A	66		66	10%	30%	60%	100%	7	20	40	66
Buildings	30	891	156	735	10%	30%	60%	100%	74	221	441	735
Civil structures	30	663	246	417	10%	30%	60%	100%	42	125	250	417
Network Switching & Operation		**5,830**	**1,168**	**4,662**					**875**	**1100**	**2687**	**4662**
Civil structures	30	1,224	245	978	20%	30%	50%	100%	196	294	489	978
220 kV lines	30	850	170	679	100%	0%	0%	100%	679	0	0	679
132 kV lines	30	773	155	618	0%	100%	0%	100%	0	618	0	618
33 kV lines	30	636	127	508	0%	0%	100%	100%	0	0	508	508
Substations (including all Transformers, switching & control equipment)	30	2,345	470	1,875	0%	10%	90%	100%	0	188	1688	1875
Meters & Communication Equip	10	2	0	2	10%	30%	60%	100%	0	1	1	2

Vehicles			**230**	**134**	**96**						**10**	**29**	**58**	**96**
	Heavy vehicles	10	230	134	96		10%	30%	60%	100%	10	29	58	96
	Light vehicles	10	-	-	-		10%	30%	60%	100%	0	0	0	0
Office equipment			**649**	**340**	**309**						**31**	**93**	**186**	**309**
	Computers & accessories	6.7	239	125	114		10%	30%	60%	100%	11	34	68	114
	Printers	6.7	-	-	-		10%	30%	60%	100%	0	0	0	0
	Photocopiers	6.7	-	-	-		10%	30%	60%	100%	0	0	0	0
	Overhead projectors	6.7	-	-	-		10%	30%	60%	100%	0	0	0	0
	Software	5	188	98	90		10%	30%	60%	100%	9	27	54	90
	Telecoms	10	139	73	66		10%	30%	60%	100%	7	20	40	66
	Other office equipment	10	39	21	19		10%	30%	60%	100%	2	6	11	19
	Furniture & fixtures	10	44	23	21		10%	30%	60%	100%	2	6	12	21
Tools			**173**	**90**	**82**						**8**	**25**	**49**	**82**
	Tools	10	136	71	65		10%	30%	60%	100%	6	19	39	65
	Electrical equipment	10	37	19	18		10%	30%	60%	100%	2	5	11	18
TOTAL			**8,502**	**2,135**	**6,368**						**1046**	**1612**	**3710**	**6368**

Appendix II: Proposed model of tariff calculation for the embedded cost based method

				Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16
			Loss %	MW	MW	MW	MW	MW	MW
Generation				1,981.20	1,923.41	1,911.72	2,101.40	2,119.41	2,314.84
Transmission	at 132 kV/220k V			1,981.20	1,923.41	1,911.72	2,101.40	2,119.41	2,314.84
		132kV loss	2.0%	39.62	38.47	38.23	42.03	42.39	46.30
		input to 132kV		1,941.58	1,884.94	1,873.48	2,059.37	2,077.02	2,268.55
		consumption		8.87	8.35	10.72	6.23	8.71	11.53
	33kV	input to 33kV		1,932.70	1,876.59	1,862.77	2,053.14	2,068.31	2,257.01
		tr loss	1.0%	19.33	18.77	18.63	20.53	20.68	22.57
				1,913.38	1,857.83	1,844.14	2,032.61	2,047.63	2,234.44

Oct-15

	Allocation of Gen Cost		Allocation of Tr Cost		Allocation of BSOB		Total Cost
	LKR/Month	LKR/MW	LKR	LKR/MW	LKR	LKR/MW	LKR/MW
Generation	4,268,638,106.31	2,154,570.83					
Transmission							
Cost at 220/132 kV		2,198,541.66	292,026,489.72	150,406.85	579,621,739.13	298,531.41	**2,647,479.92**
			290,691,929.76		576,972,869.95		
			438,039,734.58		869,432,608.70		
Cost at 33kV	4,249,130,446.12	2,220,749.16	728,731,664.34	380,861.51	1,446,405,478.65	755,943.78	**3,357,554.45**

Nov-15

	Allocation of Gen Cost LKR/Month	LKR/MW	Allocation of Tr Cost LKR	LKR/MW	Allocation of BSOB LKR	LKR/MW	Total Cost LKR/MW
Generation	4,247,983,153.82	2,208,565.12					
Transmission							
Cost at 220/132 kV		2,253,637.88	292,026,489.72	154,925.75	363,933,102.50	193,073.61	**2,601,637.23**
			290,732,782.28		362,320,841.36		
			438,039,734.58		545,899,653.75		
Cost at 33kV	4,229,164,150.74	2,276,401.89	728,772,516.87	392,271.16	908,220,495.11	488,861.34	**3,157,534.40**

Dec-15

	Allocation of Gen Cost LKR/Month	LKR/MW	Allocation of Tr Cost LKR	LKR/MW	Allocation of BSOB LKR	LKR/MW	Total Cost LKR/MW
Generation	4,273,678,106.31	2,235,517.26					
Transmission							
Cost at 220/132 kV		2,281,140.07	292,026,489.72	155,873.54	579,621,739.13	309,381.83	**2,746,395.44**
			290,356,304.77		576,306,712.77		
			438,039,734.58		869,432,608.70		
Cost at 33kV	4,254,629,446.18	2,317,435.98	728,396,039.35	394,978.55	1,445,739,321.47	783,963.66	**3,496,378.19**

Jan-16

	Allocation of Gen Cost		Allocation of Tr Cost		Allocation of BSOB		Total Cost
	LKR/Month	LKR/MW	LKR	LKR/MW	LKR	LKR/MW	LKR/MW
Generation	4,796,044,452.38	2,282,312.22					
Transmission							
Cost at 220/132 kV		2,328,890.02	401,179,526.68	194,806.99	363,933,102.50	176,720.67	**2,700,417.67**
			399,966,463.54		362,832,662.91		
			611,798,778.18		545,899,653.75		
Cost at 33kV	4,781,542,454.24	2,352,414.16	1,011,765,241.72	497,766.34	908,732,316.66	447,076.40	**3,297,256.89**

Feb-16

	Allocation of Gen Cost		Allocation of Tr Cost		Allocation of BSOB		Total Cost
	LKR/Month	LKR/MW	LKR	LKR/MW	LKR	LKR/MW	LKR/MW
Generation	4,737,960,616.12	2,235,512.09					
Transmission							
Cost at 220/132 kV		2,281,134.79	401,179,526.68	193,151.58	363,933,102.50	175,218.95	**2,649,505.32**
			399,497,311.63		362,407,068.14		
			601,769,290.02		545,899,653.75		
Cost at 33kV	4,718,093,528.88	2,304,176.56	1,001,266,601.64	488,988.83	908,306,721.89	443,589.99	**3,236,755.37**

Mar-16

	Allocation of Gen Cost		Allocation of Tr Cost		Allocation of BSOB		Total Cost
	LKR/Month	LKR/MW	LKR	LKR/MW	LKR	LKR/MW	LKR/MW
Generation	4,788,610,131.24	2,068,655.38					
Transmission							
Cost at 220/132 kV		2,110,872.84	401,179,526.68	176,844.42	363,933,102.50	160,425.78	**2,448,143.04**
			399,140,439.81		362,083,329.12		
			601,769,290.02		545,899,653.75		
Cost at 33kV	4,764,270,923.03	2,132,194.79	1,000,909,729.83	447,945.67	907,982,982.87	406,357.37	**2,986,497.82**

	LKR/MW/Month	*LKR/MVA/ Month*
Capacity cost at 132kV	2,632,263.10	2,991,208.07

Note: Capacity Cost is allocated for 132kV level based on the share of asset base.

Power loss - assumed

Appendix III: TOU Energy cost calculation for Composite based Method

	Annual Energy Generation (Thermal)						
	Unit	**Apr-16**	**May-16**	**Jun-16**	**Jul-16**	**Aug-16**	**Sep-16**
	GWh	866	661	581	604	526	435

Average Generation Energy cost							
	Unit	**Apr-16**	**May-16**	**Jun-16**	**Jul-16**	**Aug-16**	**Sep-16**
Generation Energy cost	SLR/kWh	11.74	12.37	6.48	7.51	6.14	8.67

Apr-16				
Block	**Energy generated (GWh)**	**Block Factor**	**Adjusted Factor**	**Charge (LKR/kWh)**
Day	492.15	1.00	0.99	11.68
Peak	196.69	1.25	1.24	14.60
Offpeak	177.63	0.75	0.75	8.76

Total Average cost	Mn. LKR	10173.97
Total Block cost	Mn. LKR	10173.97
Difference	Mn. LKR	0.00
Adjustment factor		0.99

May-16				
Block	**Energy generated (GWh)**	**Block Factor**	**Adjusted Factor**	**Charge (LKR/kWh)**
Day	375.71	1.00	0.99	12.30
Peak	150.15	1.25	1.24	15.38
Offpeak	135.60	0.75	0.75	9.23

Total Average cost	Mn. LKR	8181.98
Total Block cost	Mn. LKR	8181.98
Difference	Mn. LKR	0.00
Adjustment factor		0.99

Jun-16				
Block	**Energy generated (GWh)**	**Block Factor**	**Adjusted Factor**	**Charge (LKR/kWh)**
Day	329.82	1.00	0.99	6.44
Peak	131.81	1.25	1.24	8.05
Off-peak	119.04	0.75	0.75	4.83

Total Average cost	Mn. LKR	3776.57
Total Block cost	Mn. LKR	3776.57
Difference	Mn. LKR	0.00
Adjustment factor		0.99

Jul-16				
Block	**Energy generated (GWh)**	**Block Factor**	**Adjusted Factor**	**Charge (LKR/kWh)**
Day	343.11	1.00	0.99	7.47
Peak	137.12	1.25	1.24	9.34
Off-peak	123.83	0.75	0.75	5.61

Total Average cost	Mn. LKR	4539.27
Total Block cost	Mn. LKR	4539.27
Difference	Mn. LKR	0.00
Adjustment factor		0.99

Aug-16				
Block	**Energy generated (GWh)**	**Block Factor**	**Adjusted Factor**	**Charge (LKR/kWh)**
Day	298.85	1.00	0.99	6.11
Peak	119.44	1.25	1.24	7.64
Offpeak	107.86	0.75	0.75	4.58

Total Average cost	Mn. LKR	3231.67
Total Block cost	Mn. LKR	3231.67
Difference	Mn. LKR	0.00
Adjustment factor		0.99

Sep-16				
Block	**Energy generated (GWh)**	**Block Factor**	**Adjusted Factor**	**Charge (LKR/kWh)**
Day	247.31	1.00	0.99	8.63
Peak	98.84	1.25	1.24	10.78
Offpeak	89.26	0.75	0.75	6.47

Total Average cost	Mn. LKR	3776.57
Total Block cost	Mn. LKR	3776.57
Difference	Mn. LKR	0.00
Adjustment factor		0.99