ATTACHMENT

Attachment 11-1 Standard Unit Prices of 66 kV Facilities (1/1)

Type : Substation (2x30 MVA TR, 2x T/L bay, 2x5 Mvar SC) unit : US$1,000

Equipment		unit	Qty	Unit Cost		Total Cost	
Item	Spec.			F/C	I/C	F/C	I/C
TR	20MVA Transformer			211		0	0
	30MVA Transformer		2	235		470	0
	40MVA Transformer			312		0	0
	50MVA Transformer			396		0	0
	Earthing 20/0.4kV		1	18		18	0
	Fire Protection		1	125		125	0
	Subtotal					613	0
66kV	Tr bay		2	78		156	0
	Outgoing bay		2	95		190	0
	Bus coupler			67		0	0
	Measuring		1	22		22	0
	Busbar Syatem & Sec		1	65		65	0
	Connection to 20kV		2	7		14	0
	Equipment for reserve		1	13		13	0
	Subtotal					460	0
20kV	Incoming		2	34		67	0
	Outgoing		20	30		600	0
	Measuring		1	10		10	0
	Sectionaizer		1	58		58	0
	Capacitar bank		2	30		60	0
	Subtotal					794	0
C,M,P	Tr bay		2	22		43	0
	Outgoing bay		2	23		46	0
	Bus coupler			7		0	0
	Measuring		1	5		5	0
	Relay testing equip.		1	41		41	0
	Control for 20kV		26	1		31	0
	Aux.equip.		1	167		167	0
	Subtotal					332	0
S.C	5 Mvar		2	38		77	0
	10 Mvar			70		0	0
	Subtotal					77	0
Spare part & tool		lot	1			455	0
Material : CIF	Total					2,732	0
Inland tras.							34
Erection						137	341
Civil works							250
Site prepa.							46
Land acqui.							0
Grand Total	Total					2,868	672

Attachment 11-1 Standard Unit Prices of 66 kV Facilities (2/7)

Type : Substation (2x30 MVA TR, 3x T/L bay, 2x5 Mvar SC) unit : US$1,000

Equipment		unit	Qty	Unit Cost		Total Cost	
Item	Spec.			F/C	I/C	F/C	I/C
TR	20MVA Transformer			211		0	0
	30MVA Transformer		2	235		470	0
	40MVA Transformer			312		0	0
	50MVA Transformer			396		0	0
	Earthing 20/0.4kV		2	18		36	0
	Fire Protection		2	125		250	0
	Subtotal					**756**	**0**
66kV	Tr bay		2	78		156	0
	Outgoing bay		3	95		284	0
	Bus coupler			67		0	0
	Measuring		1	22		22	0
	Busbar Syatem & Sec		1	65		65	0
	Connection to 20kV		2	7		14	0
	Equipment for reserve		1	13		13	0
	Subtotal					**554**	**0**
20kV	Incoming		2	34		67	0
	Outgoing		20	30		600	0
	Measuring		1	10		10	0
	Sectionaizer		1	58		58	0
	Capacitar bank		2	30		60	0
	Subtotal					**794**	**0**
C,M,P	Tr bay		2	22		43	0
	Outgoing bay		3	23		68	0
	Bus coupler			7		0	0
	Measuring		1	5		5	0
	Relay testing equip.		1	41		41	0
	Control for 20kV		26	1		31	0
	Aux.equip.		1	167		167	0
	Subtotal					**355**	**0**
S.C	5 Mvar		2	38		77	0
	10 Mvar			70		0	0
	Subtotal					**77**	**0**
Spare part & tool		lot	1			**507**	**0**
Material : CIF	**Total**					**3,044**	**0**
Inland tras.							**38**
Erection						**152**	**381**
Civil works							**279**
Site prepa.							**51**
Land acqui.							**0**
Grand Total	**Total**					**3,196**	**748**

Attachment 11-1 Standard Unit Prices of 66 kV Facilities (3/7)

Type : Substation (2x30 MVA TR, 4x T/L bay, 2x5 Mvar SC) unit : US$1,000

Equipment		unit	Qty	Unit Cost		Total Cost	
Item	Spec.			F/C	I/C	F/C	I/C
TR	20MVA Transformer			211		0	0
	30MVA Transformer		2	235		470.4	0
	40MVA Transformer			312		0	0
	50MVA Transformer			396		0	0
	Earthing 20/0.4kV		2	18		36	0
	Fire Protection		2	125		250	0
	Subtotal					756	0
66kV	Tr bay		2	78		156	0
	Outgoing bay		4	95		379.2	0
	Bus coupler			67		0	0
	Measuring		1	22		22	0
	Busbar Syatem & Sec		1	65		65	0
	Connection to 20kV		2	7		14	0
	Equipment for reserve		1	13		13	0
	Subtotal					649	0
20kV	Incoming		2	34		67.2	0
	Outgoing		20	30		600	0
	Measuring		1	10		10	0
	Sectionaizer		1	58		58	0
	Capacitar bank		2	30		60	0
	Subtotal					794	0
C,M,P	Tr bay		2	22		43	0
	Outgoing bay		4	23		91	0
	Bus coupler			7		0	0
	Measuring		1	5		5	0
	Relay testing equip.		1	41		41	0
	Control for 20kV		26	1		31	0
	Aux.equip.		1	167		167	0
	Subtotal					378	0
S.C	5 Mvar		2	38		77	0
	10 Mvar			70		0	0
	Subtotal					77	0
Spare part & tool		lot	1			531	0
Material : CIF	Total					3185	0
Inland tras.							40
Erection						159	398
Civil works							292
Site prepa.							53
Land acqui.							0
Grand Total	Total					3345	783

Attachment 11-1 Standard Unit Prices of 66 kV Facilities (4/7)

Type : Substation (3x40 MVA TR, 4x T/L bay, 2x5 Mvar SC) unit : US$1,000

Equipment		unit	Qty	Unit Cost		Total Cost	
Item	Spec.			F/C	I/C	F/C	I/C
TR	20MVA Transformer			211		0	0
	30MVA Transformer			235		0	0
	40MVA Transformer		3	312		936	0
	50MVA Transformer			396		0	0
	Earthing 20/0.4kV		3	18		54	0
	Fire Protection		3	125		374	0
	Subtotal					1,364	0
66kV	Tr bay		3	78		234	0
	Outgoing bay		4	95		379	0
	Bus coupler			67		0	0
	Measuring		1	22		22	0
	Busbar Syatem & Sec		1	65		65	0
	Connection to 20kV		3	7		22	0
	Equipment for reserve		1	13		13	0
	Subtotal					734	0
20kV	Incoming		3	34		101	0
	Outgoing		39	30		1,170	0
	Measuring		1	10		10	0
	Sectionaizer		2	58		115	0
	Capacitar bank		2	30		60	0
	Subtotal					1,456	0
C,M,P	Tr bay		3	22		65	0
	Outgoing bay		4	23		91	0
	Bus coupler			7		0	0
	Measuring		1	5		5	0
	Relay testing equip.		1	41		41	0
	Control for 20kV		47	1		56	0
	Aux.equip.		1	167		167	0
	Subtotal					425	0
S.C	5 Mvar		2	38		77	0
	10 Mvar			70		0	0
	Subtotal					77	0
Spare part & tool		lot	1			811	0
Material : CIF	Total					4,867	0
Inland tras.							61
Erection						243	608
Civil works							446
Site prepa.							81
Land acqui.							0
Grand Total	Total					5,111	1,197

Attachment 11-1 Standard Unit Prices of 66 kV Facilities (5/7)

Type : Substation (2x20 MVA TR, 2x T/L bay, 2x5 Mvar SC) unit : US$1,000

Equipment		unit	Qty	Unit Cost		Total Cost	
Item	Spec.			F/C	I/C	F/C	I/C
TR	20MVA Transformer		2	211		422	0
	30MVA Transformer			235		0	0
	40MVA Transformer			312		0	0
	50MVA Transformer			396		0	0
	Earthing 20/0.4kV		1	18		18	0
	Fire Protection		1	125		125	0
	Subtotal					565	0
66kV	Tr bay		2	78		156	0
	Outgoing bay		2	95		190	0
	Bus coupler			67		0	0
	Measuring		1	22		22	0
	Busbar Syatem & Sec		1	65		65	0
	Connection to 20kV		2	7		14	0
	Equipment for reserve		1	13		13	0
	Subtotal					460	0
20kV	Incoming		2	34		67	0
	Outgoing		16	30		480	0
	Measuring		1	10		10	0
	Sectionaizer		1	58		58	0
	Capacitar bank		2	30		60	0
	Subtotal					674	0
C,M,P	Tr bay		2	22		43	0
	Outgoing bay		2	23		46	0
	Bus coupler			7		0	0
	Measuring		1	5		5	0
	Relay testing equip.		1	41		41	0
	Control for 20kV		22	1		26	0
	Aux.equip.		1	167		167	0
	Subtotal					328	0
S.C	5 Mvar		2	38		77	0
	10 Mvar			70		0	0
	Subtotal					77	0
Spare part & tool		lot	1			421	0
Material : CIF	Total					2,524	0
Inland tras.							32
Erection						126	316
Civil works							231
Site prepa.							42
Land acqui.							0
Grand Total	Total					2,651	621

Attachment 11-1 Standard Unit Prices of 66 kV Facilities (6/7)

Type : T/L OH 66 kV Overhead line unit : US$1,000

		unit	Qty	Unit Cost F/C	Unit Cost I/C	Total Cost F/C	Total Cost I/C
Transmission line	OH ACSR 240 sqmm	km	1	30		30	0
Material:CIF	Total					30	0
Inland tras.							0
Erection						2	4
Civil works							10
Site prepa.							1
Land acqui.							0
Grand Total	Total					32	15

Type : T/L UG 66 kV Underground line unit : US$1,000

		unit	Qty	Unit Cost F/C	Unit Cost I/C	Total Cost F/C	Total Cost I/C
Transmission line	UG cable 300 sqmm	km	1	108		108	0
Material:CIF	Total					108	0
Inland tras.							1
Erection						5	14
Civil works							36
Site prepa.							2
Land acqui.							0
Grand Total	Total					113	53

Type : T/L UG 66 kV Underground line unit : US$1,000

		unit	Qty	Unit Cost F/C	Unit Cost I/C	Total Cost F/C	Total Cost I/C
Transmission line	UG cable 630 sqmm	km	1	180		180	0
Material:CIF	Total					180	0
Inland tras.							2
Erection						9	23
Civil works							60
Site prepa.							3
Land acqui.							0
Grand Total	Total					189	88

Type : 20kV Circuit Breaker unit : US$1,000

Item		unit	Qty	Unit Cost F/C	Unit Cost I/C	Total Cost F/C	Total Cost I/C
20kV	Circuit breaker		1	18		18	0
Spare part & tool		lot				2	0
Material : CIF	Total					20	0
Inland tras.							0
Erection						1	2
Civil works							2
Site prepa.							0
Land acqui.							0
Grand Total	Total					21	5

Type : 66kV Circuit Breaker unit : US$1,000

Item		unit	Qty	Unit Cost F/C	Unit Cost I/C	Total Cost F/C	Total Cost I/C
66kV	Circuit breaker		1	31		31	0
Spare part & tool		lot				3	0
Material : CIF	Total					34	0
Inland tras.							0
Erection						2	4
Civil works							3
Site prepa.							1
Land acqui.							0
Grand Total	Total					36	8

Attachment 11-1 Standard Unit Prices of 66 kV Facilities (7/7)

Type : line bay Extension of 1x 66 kV T/L bay unit : US$1,000

Item		unit	Qty	Unit Cost F/C	Unit Cost I/C	Total Cost F/C	Total Cost I/C
66kV	Outgoing bay		1	95		95	0
C,M,P	Outgoing bay		1	23		23	0
Spare part & tool		lot				12	0
Material : CIF	Total					129	0
Inland tras.							2
Erection						6	16
Civil works							12
Site prepa.							2
Land acqui.							0
Grand Total	Total					136	32

Type : SW1 20 kV Switchgear for 2x30 MVA TR unit : US$1,000

Equipment Item	Spec.	unit	Qty	Unit Cost F/C	Unit Cost I/C	Total Cost F/C	Total Cost I/C
20kV	Incoming		2	34		67	0
	Outgoing		20	30		600	0
	Measuring		1	10		10	0
	Sectionaizer		1	58		58	0
	Capacitar bank		2	30		60	0
	Subtotal					794	0
C,M,P	Tr bay			22		0	0
	Outgoing bay			23		0	0
	Bus coupler			7		0	0
	Measuring			5		0	0
	Relay testing equip.			41		0	0
	Control for 20kV		26	1		31	0
	Aux.equip.			167		0	0
	Subtotal					31	0
Spare part & tool		lot	1			165	0
Material : CIF	Total					991	0
Inland tras.							12
Erection						50	124
Civil works							91
Site prepa.							17
Land acqui.							0
Grand Total	Total					1040	244

Type : SW2 20 kV Switchgear for 3x30 MVA TR unit : US$1,000

Equipment Item	Spec.	unit	Qty	Unit Cost F/C	Unit Cost I/C	Total Cost F/C	Total Cost I/C
20kV	Incoming		3	34		101	0
	Outgoing		30	30		900	0
	Measuring		1	10		10	0
	Sectionaizer		1	58		58	0
	Capacitar bank		2	30		60	0
	Subtotal					1128	0
C,M,P	Tr bay			22		0	0
	Outgoing bay			23		0	0
	Bus coupler			7		0	0
	Measuring			5		0	0
	Relay testing equip.			41		0	0
	Control for 20kV		37	1		44	0
	Aux.equip.			167		0	0
	Subtotal					44	0
Spare part & tool		lot	1			234	0
Material : CIF	Total					1407	0
Inland tras.							18
Erection						70	176
Civil works							129
Site prepa.							23
Land acqui.							0
Grand Total	Total					1477	346

Attachment 11-2 Standard Unit Prices of 20 kV and Low Voltage Facilities

Items	Specification	Unit	FC (US$)	LC (S £)	LC (US$)	Total (US$)
1. 20kV Distribution Facilities						
A. Construction, Reinforcement and Replace of 20kV Lines						
(a) 20kVUnderground Cables	C185AL, 3Phase1Circuit	km	18,326	722,504	15,707	34,033
(b) Reinforcement of 20kV Overhead Lines	120AS、3Phase1Circuit	km	10,804	259,726	5,646	16,450
(c) Construction of 20kV Lines	120AS、3Phase1Circuit	km	9,822	236,115	5,133	14,955
(d) Reinforcement of 20kV Overhead Cables	185AL、3Phase1Circuit	km	34,651	684,450	14,879	49,530
(e) Construction of 20kVOverhead Cables Construction of 20kV Overhead Service	185AL、3Phase1Circuit	km	31,501	622,227	13,527	45,028
(f) Wires		km	7,379	169,951	3,695	11,074
B. Rehabilitation of 20kV System Configuration			0	0	0	
(a) Installation of 20kV Fault Detecting Installation of Vacuum Switches for	20kV 20kV400A		2,500	58,883	1,280	3,780
(b) Distribution Automation System	F.Making31.5kA		29,167	456,167	9,917	39,084
(c) Installation of On-Load Switches	20kV400A		8,333	150,116	3,263	11,596
(d) Installation of Fault Section Indicators	20kA		1,000	15,640	340	1,340
(e) Installation of Reclosing Relay	20kA		1,667	26,067	567	2,234
(f) Installation of 20kV/100V Transformers	Grounded on High voltage sides		4,000	62,560	1,360	5,360
2. Installation of 20/0.4kV Transformers			0	0	0	
(a) City 200kVA	3 Phases Ground Mounted		12,345	490,030	10,653	22,998
(b) City 400kVA	3 Phases Ground Mounted		14,752	527,665	11,471	26,223
(c) City 630kVA	3 Phases Ground Mounted		19,267	598,287	13,006	32,273
(d) City 1000kVA	3 Phases Ground Mounted		29,383	756,505	16,446	45,829
(e) City 1600kVA	3 Phases Ground Mounted		53,888	1,139,762	24,777	78,665
(f) Rural 50kVA	3 Phases Ground Mounted		4,584	94,925	2,064	6,648
(g) Rural 100kVA	3 Phases Ground Mounted		5,160	103,934	2,259	7,419
(h) Rural 200kVA	3 Phases Ground Mounted		6,816	131,536	2,859	9,675
(i) Rural 400kVA	3 Phases Ground Mounted		11,545	319,738	6,951	18,496
(j) Rural 630kVA	3 Phases Ground Mounted		19,267	598,287	13,006	32,273
(k) Rual 1000kVA	3 Phases Ground Mounted		29,383	756,505	16,446	45,829
(l) Rural 1600kVA	3 Phases Ground Mounted		53,888	1,139,762	24,777	78,665
3. Low Voltage Distribution Facilities			0	0	0	
A. Construction, Reinforcement and Replacement of 0.4kV Lines			0	0	0	
(a) Reinforcement of 0.4kV Lines to 120AL	120AL,3Phase1Circuit	km	9,651	218,052	4,740	14,391
(b) Construction of 0.4kV Lines of 120AL Reinforcement of LV Overhead Lines to	120AL,3Phase1Circuit PVC Covered 120AL、	km	8,774	198,229	4,309	13,083
(c) PVC Covered Wires with 120AL Construction of LV Underground Cables	3Phase1Circuit	km	10,617	227,047	4,936	15,553
(d) with 120C	120AL,3Phase1Circuit	km	18,183	574,382	12,487	30,670
(e) Construction of LV Overhead Service Construction of LV Underground Service	50C,3Phase1Circuit	km	7,708	132,753	2,886	10,594
(f) Wires	50C,3Phase1Circuit	km	7,708	132,753	2,886	10,594
B. Meters and Meter Boxes			0	0	0	
(a) Installation of meters			16,000	330,240	7,179	23,179
(b) Installation of meter boxes			80,000	1,801,200	39,157	119,157
C. Miscellaneous Works			0	0	0	
(a) Proper Installation of Underground Cables Installation of Protective Pipes to Rising			225	7,519	163	388
(b) Cables Providing Door Locks for 20/0.4kV			200	5,128	111	311
(c) Transformer Stations			0	700	15	15
(d) Repairing of 20/0.4kV Transformer			0	2,000	43	43
(e) Repairing of LV Branch Boxes			0	1,700	37	37
(f) Installation of LV Proper Fuses			0	700	15	15
(g) Cleaning of 20/0.4kV Transformer Removal of Unnecessary Junk Equipment			0	1,400	30	30
(h) in and around 20/0.4kV Transformer			0	1,400	30	30

Attachment 11-3(1) Construction Cost for 66/20 kV Substation

Subprojects for Augmentation and Extension	Financing source	Comm. year	Cost Estimate F/C (US$1,000)	Cost Estimate I/C (US$1,000)
(1) Construction of 66/20kV Kafersuseh Substation		1999		
(a) Kafersuseh(2x30MVA)	PEDEEE	1999	2,868	671
(b) Kafersuseh-Al Jamhaa UG line(1 cct. 2.2km)	PEDEEE	1999	249	116
(c) Ersal-Midan 1 UG line from Al Jamhaa(1 cct. 0.5km)	PEDEEE	1999	57	26
(d) Ersal-Midan 1 UG line from Kafersuseh(1 cct. 0.5km)	PEDEEE	1999	57	26
(e) Al Jamhaa (two 66kV UG line bays)	PEDEEE	1999	272	64
Total		1999	3,503	904
(2) Construction of 66/20kV Harash Substation		1999		
(a) Harash(2x30MVA)	PEDEEE	1999	2,868	671
(b) pi-connection for Mazzrha-Amaween UG line(2 cct. 0.5km)	PEDEEE	1999	113	53
Total		1999	2,981	724
(3) Construction of 66/20kV Khan Al Shih Substation		1999		
(a) Khan Al Shih (2x20MVA)	PEDEEE	1999	2,651	621
(b) Kisweh -Khan Al Shih 66kV OH line (1 cct.18km)	PEDEEE	1999	567	263
(c) Kisweh(1x 66kV OH line bay)	PEDEEE	1999	136	32
Total		1999	3,354	916
Total 1999		1999	9,838	2,543
(4) Construction of 66kV Barzeh substation		2001		
(a) Barzeh (2x30MVA)	IDB	2001	2,868	671
(b) pi-conection of Qaboon II-Mazzrha UG line(2x0.5km)	PEDEEE	2001	189	88
Total		2001	3,057	759
(5) Construction of 66kV Qsoor substation		2001		
(a) Qsoor (2x30MVA)	IDB	2001	2,868	671
(b) pi-conection of Qaboon II-Mazzrha UG line(2x0.5km)	PEDEEE	2001	189	88
Total		2001	3,057	759
(6) Construction of 66kV Ibn Al Nafis substation		2001		
(a) Ibn Al Nafis (2x30MVA)	IDB	2001	2,868	671
(b) pi-conection of Qaboon II-Mazzrha UG line(2x0.5km)	PEDEEE	2001	189	88
Total		2001	3,057	759
(7) Construction of 66kV Zablatani substation		2001		
(a) Zablatani (2x30MVA)	IDB	2001	2,868	671
(b) pi-connection of Bab Sharki-Dawar Al Matar UG line (2x1.5km)	PEDEEE	2001	567	263
Total		2001	3,435	935
(8) Construction of 66kV Jalaa substation		2001		
(a) Jalaa (2x30MVA)	IDB	2001	2,868	671
(b) pi-connection of Al Jamhaa-Fursan OH line (2x0.5km)	PEDEEE	2001	32	15
Total		2001	2,899	686
(9) Construction of 66kV Hosh Blas substation		2001		
(a) Hosh Blas (2x30MVA)	IDB	2001	2,868	671
(b) pi-connection of Midan II-Kisweh OH line (2x0.5km)	PEDEEE	2001	32	15
Total		2001	2,899	686
(10) Construction of 66kV Shekh Hassan substation		2001		
(a) Shekh Hassan (2x30MVA)	IDB	2001	2,868	671
(b) Shekh Hassan-Dawar Al Matar 66kV UG line (1 cct. 1.6km)	PEDEEE	2001	302	140
(c) Dawar Al Matar (one 66kV UG line bay for Shekh Hassan)	IDB	2001	136	32
Total		2001	3,306	844
(11) Construction of 66kV Jaramana substation		2001		
Jaramana (2x30MVA)	IDB	2001	2,868	671
Jaramana-Bab Sharki 66kV OH line (1 cct. 2.0km)	PEDEEE	2001	63	29
Bab Sharki (one 66kV OH line bay for Jarmana)	IDB	2001	136	32
Jaramana-Izaa 66kV OH line (1 cct. 20km)	PEDEEE	2001	630	293
Izaa (one 66kV OH line bay for Jaramana)	IDB	2001	136	32
Total		2001	3,833	1,057
Total 2001		2001	25,543	6,485
(12) Construction of 66kV New Ersal substation		2002		
(a) Ersal(3x40MVA)		2002	5,111	1,197
(13) Construction of 66kV Al Feigha substation		2002		
(a) Al Feigha(2x20MVA)		2002	1,326	310
(b) pi-connection of Al Hameh-Dimas OH line (2x0.5km)	PEDEEE	2002	32	15
Total		2002	6,468	1,521
Total 2002		2002	6,468	1,521

Attachment 11-3(1) Construction Cost for 66/20 kV Substation

Subprojects for Augmentation and Extension	Financing source	Comm. year	Cost Estimate F/C (US$1,000)	Cost Estimate L/C (US$1,000)
(14) Construction of 66kV Jededat Artouz substation		2003		
(a) Jededat Artouz (2x30MVA)	Sauji	2003	2,868	671
(b) Jededat Artouz-Fursan 66kV OH line (1 cct. 7.5km)	PEDEEE	2003	236	110
(c) Fursan (one 66kV OH line bay for Jededat Artouz)	Sauji	2003	136	32
Total		2003	3,240	813
(15) Construction of 66kV Bludan substation		2003		
(a) Bludan (2x30MVA)	Sauji	2003	2,868	671
(b) Bludan-Zabadani 66kV OH line (1 cct. 6.5km)	PEDEEE	2003	205	95
(c) Zabadani (one 66kV OH line bay for Bludan)	Sauji	2003	136	32
Total		2003	3,209	798
(16) Construction of 66kV Yalda substation		2003		
(a) Yalda (2x30MVA)	Sauji	2003	2,868	671
(b) pi-connection of AlHAA-Bab Sharki OH line(2x 1.0km)	PEDEEE	2003	63	29
Total		2003	2,931	701
Total 2003		2003	9,379	2,312
(17) Construction of 66/20kV Al Tal substation		2006		
(a) Al Tal (2x30MVA TR,3x66kV OH line bays)	EU	2006	3,197	748
(b) Al Tal-Al Faihaa 66kV OH line (1 cct. 5.5km)	PEDEEE	2006	173	80
(c) Al Faihaa (1x66kV OH line bay)	EU	2006	136	32
(d) pi-connection of Sydanaya-Al Faihaa (2x0.5km)	PEDEEE	2006	32	15
Total		2006	3,537	875
(18) Construction of 66/20kV Yabroud substation		2006		
(a) Yabroud (2x30MVA TR,4x66kV OH line bays)	EU	2006	3,344	783
(b) double pi-connection of Nabek-Kotaifa (4x0.5km)	PEDEEE	2006	63	29
Total		2006	3,407	812
(19) Construction of 66/20kV Harasta substation		2006		
(a) Harasta (2x30MVA TR,2x66kV OH line bays)	EU	2006	2,868	671
(b) Harasta-Erbeen 66kV OH line (1 cct. 3.5km)	PEDEEE	2006	110	51
(c) Erbeen (1x66kV OH line bay)	EU	2006	136	32
(d) Harasta-Al Faihaa 66kV OH line (2 cct. 6km)	PEDEEE	2006	378	176
(e) Al Faihaa (2x66kV OH line bay)	EU	2006	272	64
Total		2006	3,764	994
(20) Construction of 66/20kV Nashabieh substation		2006		
(a) Nashabieh (2x30MVA TR,2x66kV OH line bays)	EU	2006	2,868	671
(b) pi-connection of Izaa-Jaramana (2x0.5km)	PEDEEE	2006	32	15
Total		2006	2,899	686
(21) Construction of 66/20kV Meleha substation		2006		
(a) Meleha (2x30MVA TR,2x66kV OH line bays)	EU	2006	2,868	671
(b) pi-connection of Izaa-Jaramana (2x0.5km)	PEDEEE	2006	32	15
Total		2006	2,899	686
(22) Construction of 66/20kV Kudsia-1 substation		2006		
(a) Kudsia-1 (2x30MVA TR,2x66kV OH line bays)	EU	2006	2,868	671
Total		2006	2,868	671
(23) Construction of 66/20kV Kudsia-2 substation		2006		
(a) Kudsia-2 (2x30MVA TR,2x66kV OH line bays)	EU	2006	2,868	671
(b) Kudsia 2-Kudsia 166kV OH line (1 cct. 2.0km)	PEDEEE	2006	63	29
(c) Kudsia 1 (1x66kV OH line bay)	EU	2006	136	32
(d) Kudsia 2-Dimas 66kV OH line (1 cct. 11km)	PEDEEE	2006	347	161
(e) Dimas (1x66kV OH line bay)	EU	2006	136	32
Total		2006	3,549	925
(24) Construction of 66/20kV Darea substation		2006		
(a) Darea (2x30MVA TR,2x66kV OH line bays)	EU	2006	2,868	671
(b) Darea-Midan II 66kV OH line (1 cct. 7km)	PEDEEE	2006	221	102
(c) Midan II (1x66kV OH line bay)	EU	2006	136	32
(d) Darea-Fursan 66kV OH line (1 cct. 4km)	PEDEEE	2006	126	59
(e) Fursan (1x66kV OH line bay)	EU	2006	136	32
Total		2006	3,486	896
Total 2006		2006	26,411	6,546
Grand Total			77,639	19,408
			Total FC+LC	97,046

Attachment 11-3(2) Increase of Transformer Capacity

Subprojects for Augmentation and Extension		Financing source	Comm. year	Cost Estimate F/C (US$1,000)	Cost Estimate I/C (US$1,000)
(1) Midan II	80 to 120MVA (1x20+2x30 to 4x30)	PEDEEE	2000	844	198
(2) Ersal	40 to 60 MVA (2x20 to 2x30)	PEDEEE	2000	844	198
(3) Fursan	60 to 90 MVA (2x30 to 3x30)	PEDEEE	2000	422	99
(4) Al maarad	40 to 60 MVA (2x20 to 3x30)	PEDEEE	2000	1,265	296
Total 2000			**2000**	**3,376**	**790**
(1) Mazzriha	60 to 70 MVA (3x20 to 2x20+1x30)		2002	422	99
(2) Al Ashmar	40 to 80 MVA (2x20 to 2x40)		2002	1,037	243
(3) Qaboon II	50 to 60 MVA (1x30+1x20 to 2x30)		2002	422	99
(4) Dummer	40 to 60 MVA (2x20 to 3x20)		2002	170	40
(5) Duma	50 to 90 MVA (1x30+1x20 to 3x30)		2002	844	198
(6) Adra II	20 to 60 MVA (1x20 to 3x20)		2002	340	80
(7) Kotaifa	10 to 20 MVA (1x10 to 1x20)		2002	170	40
(8) Nabek	40 to 70 MVA (2x20 to 2x20+1x30)		2002	422	99
(9) Al Hameh	40 to 90 MVA (2x20 to 3x30)		2002	1,265	296
(10) Zabadani	40 to 60 MVA (2x20 to 2x30)		2002	844	198
(11) Kisweh	40 to 70 MVA (2x20 to +2x20+1x30)		2002	422	99
(12) Dimas	20 to 40 MVA (1x20 to 2x20)		2002	170	40
(13) Kudseia	10 to 40 MVA (1x10 to 2x20)		2002	340	80
(14) Erbeen	40 to 60 MVA (2x20 to 3x20)		2002	170	40
(15) Dawar Al Matar	40 to 60 MVA(2x20 to 3x20)		2002	170	40
(16) Adra I	50 to 80 MVA(2x20+1x10 to 1x20+2x30)		2002	844	198
(17) Al Matar	30 to 60 MVA(2x5+1x20 to 2x5+1x20+1x30)		2002	422	99
(18) Izaa	40 to 60 MVA(2x20 to 3x20)		2002	392	92
(19) Al Faihaa	40 to 60 MVA(2x20 to 3x20)		2002	392	92
(20) Khan Al Shih	20 to 40 MVA(1x20 to 2x20)		2002	392	92
(21) Al Maarad	60 to 120 MVA(2x30 to 3x40)		2002	1,556	364
Total 2002			**2002**	**11,208**	**2,624**
(1) Amaween	60 to 80 MVA(3x20 to 1x20+2x30)		2005	844	198
(2) Al Hajer Al Aswad	60 to 90 MVA (2x30 to 3x30)		2005	422	99
(3) Dummer	60 to 90 MVA (3x20 to 3x30)		2005	1,265	296
(4) Kafersuseh	60 to 100 MVA(2x30 to 2x50)		2005	1,249	292
(5) Harash	60 to 100 MVA(2x30 to 2x50)		2005	1,249	292
(6) Adra I	80 to 110 MVA(1x20+2x30 to 1x20+3x30)		2005	422	99
(7) Sydanaya	40 to 60MVA (2x20 to 3x20)		2005	170	40
(8) Erbeen	60 to 80 MVA(3x20 to 1x20+2x30)		2005	350	82
(9) Zabltani	60 to 100 MVA(2x30 to 2x50)		2005	1,249	292
(10) Kotaifa	20 to 40 MVA(1x20 to 2x20)		2005	170	40
Total 2005			**2005**	**7,390**	**1,730**
(1) Mazzriha	70 to 90 MVA(2x20+1x30 to 3x30)		2007	844	198
(2) Amaween	80 to 120 MVA(1x20+2x30 to 3x40)		2007	1,556	364
(3) Mazzhe	60 to 80 MVA(3x20 to 1x20+2x30)		2007	350	82
(4) Midan I	60 to 80 MVA(3x20 to 1x20+2x30)		2007	350	82
(5) Al Ashmar	80 to 100 MVA(2x40 to 2x40+1x20)		2007	170	40
(6) Thawra	90 to 120 MVA(3x30 to 3x40)		2007	1,556	364
(7) Dawar Al Matar	60 to 80 MVA(3x20 to 1x20+2x30)		2007	350	82
(8) Qsoor	60 to 100 MVA (2x30 to 2x50)		2007	1,249	292
(9) Hosh Blas	60 to 90 MVA(2x30 to 2x40)		2007	1,037	243
(10) Zabadani	60 to 90 MVA(2x30 to 3x30)		2007	170	40
(11) Khan Al Shih	40 to 60 MVA(2x20 to 3x20)		2007	170	40
(12) Al jamha	40 to 60 MVA(2x20 to 2x30)		2007	350	82
(13) Al Matar	60 to 70 MVA(2x5+1x20+1x30 to 2x5+2x30)		2007	422	99
(14) New Ersal	120 to 160 MVA(3x40 to 4x40)		2007	519	122
Total 2007			**2007**	**9,095**	**2,129**
(1) Adra I	90 to 120 MVA(3x30 to 4x30)		2009	422	99
(2) Kisweh	70 to 90 MVA(2x20+1x30 to 3x30)		2009	844	198
(3) Erbeen	80 to 90 MVA(1x20+2x30 to 3x30)		2009	422	99
(4) Harasta	60 to 90 MVA(2x30 to 3x30)		2009	422	99
Total 2009			**2009**	**2,111**	**494**
(1) Duma	90 to 120 MVA(3x30 to 4x30)		2010	422	99
(2) Al Hameh	90 to 120 MVA(3x30 to 4x30)		2010	422	99
Total 2010			**2010**	**844**	**198**
	Grand Total			**33,178**	**7,768**
				Total FC+LC	**40,946**

Attachment 11-3(3) Replacement of 20 kV Switchgear

Subprojects for Augmentation and Extension		Financing source	Comm. year	Cost Estimate F/C (US$1,000)	Cost Estimate I/C (US$1,000)
(1) Replacement of 20kV Circuit Breaker					
(a) Midan I	28 nos. of 20kV CB	PEDEEE	1999	529	124
(b) Ersal	35 nos. of 20kV CB	PEDEEE	2000	662	155
(c) Qaboon I	10 nos. of 20kV CB	PEDEEE	2000	189	44
Total 2000			**2000**	**1,380**	**323**
(a) Midan II	47nos. of 20kV CB		2002	888	208
(b) Duma	16 nos. of 20kV CB		2002	302	71
(c) Adra I	8 nos. of 20kV CB		2002	151	35
(d) Adra II	11 nos. of 20kV CB		2002	208	49
Total 2002			**2002**	**1,550**	**363**
(a) Qaboon I	52 nos. of 20kV CB		2005	983	230
(b) Mazzhe	10 nos. of 20 kV CB		2005	189	44
(c) Amaween	25 nos. of 20kV CB		2005	473	111
(d) Kotaife	12 nos. of 20kV CB		2005	227	53
(e) Qaboon II	18 nos. of 20 kV CB		2005	340	80
Total 2005			**2005**	**2,211**	**518**
	Subtotal (1)			**5,141**	**1,204**
(2) Replacement of Complete set of 20kV Switchgear			2000		
(a) Ashmar	Complete 20kV switchgear	PEDEEE	2000	1,041	244
(b) Thawra	Complete 20kV switchgear	PEDEEE	2000	2,953	691
Total 2000			**2000**	**3,994**	**935**
(a) Mazzrha	Complete 20kV switchgears		2005	1,477	346
(b) Bab Sharki	Complete 20 kV Switchgears		2005	1,477	346
(c) Nabek	Complete 20kV switchgears		2005	1,477	346
(d) Al Hameh	Complete 20kV switchgears		2005	1,477	346
(e) Al Matar	Complete 20kV switchgears		2005	1,041	244
Total 2005			**2005**	**6,948**	**1,627**
(a) Al Hajer Al Aswad	Complete 20kV swtichgears		2010	1,477	346
(b) Al Jamha	Complete 20kV switchgears		2010	1,041	244
(c) Dummer	Complete 20kV switchgears		2010	1,477	346
(d) Sydanaya	Complete 20kV switchgears		2010	1,041	244
(e) Zabadani	Complete 20kV switchgears		2010	1,477	346
(f) Fursan	Complete 20kV switchgears		2010	1,477	346
(g) Izaa	Complete 20kV switchgears		2010	1,041	244
(h) Kisweh	Complete 20kV switchgears		2010	1,477	346
(i) Al Maarad	Complete 20kV switchgears		2010	1,477	346
(j) Al Faihaa	Complete 20kV switchgears		2010	1,041	244
Total 2010			**2010**	**13,023**	**3,049**
	Subtotal (2)			**23,965**	**5,611**
	Grand Total			**29,106**	**6,815**
				Total FC+LC	**35,921**

Attachment 11-3(4) Reinforcement of 66 kV Network

Subprojects for Augmentation and Extension	Financing source	Comm. year	Cost Estimate F/C (US$1,000)	Cost Estimate L/C (US$1,000)
(1) 66kV connection to 230,66kV Zahera substation		2001		
(a) Shekh Hassan-Zeherar 66kV UG line (1 cct. 1.7km 630sqmm)	PEDEEE	2001	321	149
(b) Zahera -Al Ashmar 66kV UG line (1cct.3.0km)	PEDEEE	2001	567	263
(c) Al Ashmar(one 66kV UG line bay for Zahera)	PEDEEE	2001	136	32
(d) Connection of Midan II-DAM UG line (Midan II side only,0.5km)	PEDEEE	2001	95	44
(e) Zahera -Dawar Al Matar 66kV UG line (1cct., 630sqmm, 2.5 km)	PEDEEE	2001	473	219
(f) Zahera -Bab Sharki 66kV UG line (1cct.3.8km 630sqmm)	PEDEEE	2001	718	333
(g) Zahera -AlHAA 66kV OH line (1cct.3.6km)	PEDEEE	2001	113	53
(h) Bab Sharki(one 66kV UG line bay for Zahera)	PEDEEE	2001	136	32
(i) Al Hajar Al Aswad (one 66kV OH line bay for Zahera)	PEDEEE	2001	136	32
Total		2001	2,695	1,157
Total 2001		2001	2,695	1,157
(1) Upgrading of existing cables		2005		
(a) Midan II-AlHAA UG line (1 cct.630sqmm,2.8km)	PEDEEE	2005	529	246
Total		2005	529	246
(2) Construction of new 66kV UG line		2005		
(a) Mazzrha-Ersal (1 cct.3km 630sqmm)	PEDEEE	2005	567	263
(b) Mazzrha (one 66kV UG line bay)	PEDEEE	2005	136	32
(c) Ersal (one 66kV UG line bay)	PEDEEE	2005	136	32
Total		2005	839	327
(3) Construction of 66kV 2nd OH line		2005		
(a) Kotaifa-Sydanaya (23.8km)	PEDEEE	2005	750	348
(b) Kotaifa-Adra II (19.2km)	PEDEEE	2005	290	135
(c) Adra I-Adra II (2.3km)	PEDEEE	2005	72	34
(d) Qaboon II-Duma (10.6km)	PEDEEE	2005	334	155
(e) Kotaifa (two 66kV OH line bay)	PEDEEE	2005	272	64
(f) Sydanaya (one 66kV OH line bay)	PEDEEE	2005	136	32
(g) Arda I (one 66kV OH line bay)	PEDEEE	2005	136	32
(h) Arda II (two 66kV OH line bays)	PEDEEE	2005	272	64
(i) Qaboon II (one 66kV OH line bay)	PEDEEE	2005	136	32
(j) Duma (one 66kV OH line bay)	PEDEEE	2005	136	32
Total		2005	2,534	926
(4) Construction of new 66kV OH line		2005		
(a) Kisweh-Al Maarad (1cct, 24km)	PEDEEE	2005	76	35
(b) Kisweh (one 66 kV OH line bay)	PEDEEE	2005	136	32
(c) Maarad (one 66 kV OH line bay)	PEDEEE	2005	136	32
Total		2005	348	99
Total 2005		2005	4,251	1,598
(1) Upgrading the existing cables		2006		
(a) Mazzrha-Thawra UG line (1 cct. 630sqmm, 3km)	PEDEEE	2006	567	263
Total		2006	567	263
(2) Construction of 2nd OH line		2006		
(a) Kotaifa-Nabek OH line (34.8km)	PEDEEE	2006	1,096	509
(b) Kotaifa(1x66kV OH line bay)	PEDEEE	2006	136	32
(c) Nabek (1x66kV OH line bay)	PEDEEE	2006	136	32
Total		2006	1,368	573
Total 2006		2006	1,935	836
(1) Construction of 2nd OH line		2008		
(a) Dimas-Switching Station OH line (10km)	PEDEEE	2008	315	146
(b) Dimas(1x66kV OH line bay)	PEDEEE	2008	136	32
(c) Switching Station(1x66kV OH line bay)	PEDEEE	2008	136	32
Total		2008	587	210
(2) 66kV line connectio to 230/66kV Saiedeh Zinab substation		2008		
(a) Saiedeh Zinab-Yalda 66kV OH line (1 cct. 2.5km)	PEDEEE	2008	79	37
(b) Yalda (1x66kV OH line bay)	PEDEEE	2008	136	32
(c) pi-connection of Al Maarad-Kisweh (2x1.5km)	PEDEEE	2008	95	44
(d) Saiedeh Zinab - . J Maarad OH line (2nd cct, 4 km)	PEDEEE	2008	126	59
(e) Al Maarad (1 x 66kV OH line bay)	PEDEEE	2008	136	32
Total		2008	571	203
(3) 66kV line connection to 230/66kV Baramekha substation		2008		
(a) pi-connection of Al Jamhaa-Ersal UG line(2x0.5km)	PEDEEE	2008	189	88
(b) pi-connection of Al Jamhaa-Kafersuseh UG line(2x0.6km)	PEDEEE	2008	227	105
(c) Baramekha-Ersal UG line(1 cct.6km)	PEDEEE	2008	1,134	527
(d) Baramekha-Midan I UG line(1 cct.2.5km)	PEDEEE	2008	473	219
(e) Ersal (1x66kV UG line bay)	PEDEEE	2008	136	32
(f) Midan I (1x66kV UG line bay)	PEDEEE	2008	136	32
Total		2008	2,294	1,003
Total 2008		2008	3,453	1,415
Grand Total			12,334	5,006
			Total FC+LC	17,340

Attachment 11-3(5) Installation of Static Capacitors

Subprojects for Augmentation and Extension		Financing source	Comm. year	Cost Estimate F/C (US$1,000)	Cost Estimate I/C (US$1,000)
(a) Bab Sharki	(3 x 5MVar)	PEDEEE	1999	121	28
(b) Ersal	(2 x 5MVar)	PEDEEE	1999	81	19
(c) Mazzrha	(3 x 5MVar)	PEDEEE	1999	121	28
(d) Ashmar	(2 x 5 MVar)	PEDEEE	1999	81	19
(e) Thawra	(2 x 10 MVar)	PEDEEE	1999	146	34
(f) Midan I	(3 x 5 MVar)	PEDEEE	1999	121	28
(g) Al Hajer	(2 x 10 MVar)	PEDEEE	1999	146	34
(h) Duma	(1 x 5 +1 x 10 MVar)	PEDEEE	1999	113	27
(i) Al Nabek	(2 x 5 MVar)	PEDEEE	1999	81	19
(j) Midan II	(2 x 10 +1x5 MVar)	PEDEEE	1999	186	44
(k) Maarad	(2 x 10MVar)	PEDEEE	1999	146	34
Total 1999			**1999**	**1,343**	**314**
(a) Sydanaya	(3x5MVar)		2002	121	28
(b) Al Faihaa	(2x10MVar)		2002	146	34
(c) Qaboon I	(3 x 10 MVar)		2002	219	51
Total 2002			**2002**	**486**	**114**
(a) Dummar	2x5 Mvar		2005	81	19
(b) Dimas	2x5 Mvar		2005	81	19
(c) Fursan	2x10 Mvar		2005	146	34
(d) Kisweh	2x5 Mvar		2005	81	19
(e) Adra I	2x5 Mvar		2005	81	19
(f) Erbeen	2x5 Mvar		2005	81	19
(g) Al Matar	2x5 Mvar		2005	81	19
(h) Zabadani	2x5 Mvar		2005	81	19
(i) Al Hameh	2x5 Mvar		2005	81	19
(j) Amaween	3x5 Mvar		2005	81	19
(k) Al Jamhaa	2x5 Mvar		2005	81	19
(l) Mazzhe	3x5 Mvar		2005	81	19
(m) Dawar Al Matar	2x5 Mvar		2005	81	19
(n) Adra II	2x5 Mvar		2005	81	19
(o) Qaboon II	2x5 Mvar		2005	81	19
Total 2005			**2005**	**1,275**	**299**
(a) Kotaifa	2x5 Mvar		2008	81	19
(b) Izaa	2x5 Mvar		2008	81	19
(c) Adra 2	2x5 Mvar		2008	81	19
(d) Qaboon 2	2x10 Mvar		2008	146	34
(e) Kisweh	2x5 Mvar		2008	81	19
(f) Zabadani	1x5 Mvar		2008	40	9
(g) Mazzrha	3x5 Mvar		2008	121	28
(h) Ersal	2x5 Mvar		2008	81	19
(i) Al Maarad	1x10 Mvar (2x10 to 3x10Mvar)		2008	73	17
Total 2008			**2008**	**784**	**183**
	Grand Total			**3,888**	**910**
				Total FC+LC	**4,799**

Attachment 11-3(6) Replacement of 66 kV Circuit Breaker

Subprojects for Augmentation and Extension		Financing source	Comm. year	Cost Estimate F/C (US$1,000)	Cost Estimate I/C (US$1,000)
(a) Mazzrha	9 nos. of 66kV CB		2002	295	69
(b) Amaween	9 nos. of 66kV CB		2002	295	69
(c) Midan I	6 nos. of 66kV CB		2002	197	46
Total 2002			**2002**	**786**	**184**
(a) Mazzhe	5 nos. of 66kV CB		2005	164	38
(b) Qaboon II	13 nos. of 66kV CB		2005	426	100
(c) Al Hajar Al Aswed	6 nos. of 66kV CB		2005	197	46
(d) Fursan	6 nos. of 66kV CB		2005	197	46
Total 2005			**2005**	**983**	**230**
(a) Adra II	9 nos. of 66kV CB		2010	295	69
(b) Al Hameh	2 nos. of 66kV CB		2010	66	15
Total 20010			**2010**	**360**	**84**
	Grand Total			**2,129**	**499**
				Total FC+LC	**2,628**

Attachment 11-4(1) Reinforcement of 20 kV Distribution Feeders

Subprojects for Augmentation and Extension	Type	Qty	unit	Comm. year	Cost Estimate F/C (US$1,000)	Cost Estimate I/C (US$1,000)
(1) For Damascus City Distribution Company						
(a) Reinforcement of 20 kV underground lines	C185AI, 1CCT	164	km	2002	3,005	2,576
(b) Construction of 20 kV underground lines	C185AI, 1CCT	60	km	2002	1,100	942
(c) Construction of service connection by 20 kV underground lines	C185AI, 1CCT	4	km	2002	73	63
(d) Replacement of Oil-cable to XLPE cable	C185AL, 1CCT	174	km	2002	3,189	2,733
Total					7,367	6,314
(2) For Damascus Rural Distribution Company						
(a) Reinforcement of 20 kV overhead lines	120AS, 1 CCT	229	km	2002	2,474	1,293
(b) Reinforcement of 20 kV underground lines	C185AL, 1CCT	35	km	2002	641	550
(c) Reinforcement of 20 kV overhead cable lines	C185AL, 1CCT	15	km	2002	520	223
(d) Construction of 20 kV overhead lines	120AS, 1 CCT	77	km	2002	756	395
(e) Construction of 20 kV underground lines	C185AL, 1CCT	12	km	2002	220	188
(f) Construction of 20 kV overhead cable lines	C185AL, 1CCT	3	km	2002	95	41
(g) Construction of service connection by 20 kV overhead lines	120AS, 1 CCT	140	km	2002	1,033	517
(h) Replacement of Oil-cable to XLPE cable	C185AL, 1CCT	34	km	2002	623	534
Total					6,362	3,741
Total for 2002				2002	13,729	10,056
(1) For Damascus City Distribution Company						
(a) Reinforcement of 20 kV underground lines	C185AL, 1CCT	164	km	2005	3,005	2,576
(b) Construction of 20 kV underground lines	C185AL, 1CCT	60	km	2005	1,100	942
(c) Construction of service connection by 20 kV underground lines	C185AL, 1CCT	4	km	2005	73	63
Total					4,178	3,581
(2) For Damascus Rural Distribution Company						
(a) Reinforcement of 20 kV overhead lines	120AS, 1 CCT	229	km	2005	2,474	1,293
(b) Reinforcement of 20 kV underground lines	C185AL, 1CCT	35	km	2005	641	550
(c) Reinforcement of 20 kV overhead cable lines	C185AL, 1CCT	15	km	2005	520	223
(d) Construction of 20 kV overhead lines	120AS, 1 CCT	77	km	2005	756	395
(e) Construction of 20 kV underground lines	C185AL, 1CCT	12	km	2005	220	188
(f) Construction of 20 kV overhead cable lines	C185AL, 1CCT	3	km	2005	95	41
(g) Construction of service connection by 20 kV overhead lines	120AS, 1 CCT	140	km	2005	1,033	517
Total					5,739	3,207
Total for 2005				2005	9,917	6,789
(1) For Damascus City Distribution Company						
(a) Reinforcement of 20 kV underground lines	C185AL, 1CCT	273	km	2010	5,003	4,288
(b) Construction of 20 kV underground lines	C185AL, 1CCT	100	km	2010	1,833	1,571
(c) Construction of service connection by 20 kV underground lines	C185AL, 1CCT	7	km	2010	128	110
Total					6,964	5,969
(2) For Damascus Rural Distribution Company						
(a) Reinforcement of 20 kV overhead lines	120AS, 1 CCT	278	km	2010	3,004	1,570
(b) Reinforcement of 20 kV underground lines	C185AL, 1CCT	10	km	2010	183	157
(c) Reinforcement of 20 kV overhead cable lines	C185AL, 1CCT	7	km	2010	243	104
(d) Construction of 20 kV overhead lines	120AS, 1 CCT	208	km	2010	2,043	1,068
(e) Construction of 20 kV underground lines	C185AL, 1CCT	32	km	2010	586	503
(f) Construction of 20 kV overhead cable lines	C185AL, 1CCT	6	km	2010	189	81
(g) Construction of service connection by 20 kV overhead lines	120AS, 1 CCT	200	km	2010	1,476	739
Total					7,724	4,221
Total for 2010				2010	14,687	10,190
Grand Total					38,334	27,034
					Total FC+LC	65,368

Attachment 11-4(2) Reinforcement of 20 kV System (Applying Auto-fault Detecting Switches)

Subprojects for Augmentation and Extension	Type	Qty	unit	Comm. year	Cost Estimate F/C (US$1,000)	Cost Estimate I/C (US$1,000)
B. Improvement of 20 kV Sytem by applying auto-fault detecting swithes						
(1) For Damascus City Distribution Company						
(a) 20 kV auto-fault detecting device	20 kV	283		2002	708	362
(b) Vacuum type load break switches	20 kV	63		2002	1,838	625
(c) Load break switch for interconnection	20 kV	283		2002	2,358	923
(d) Fault section indicators	20 kV	126		2002	126	43
(e) Reclosing relay	20 kV	126		2002	210	71
(f) 20 kV/100V trasformers	Grounded at 20 kV	283		2002	1,132	385
Total					6,371	2,410
(2) For Damascus Rural Distribution Company						
(a) 20 kV auto-fault detecting device	20 kV	262		2002	655	335
(b) Vacuum type load break switches	20 kV	54		2002	1,575	536
(c) Load break switch for interconnection	20 kV	262		2002	2,183	855
(d) Fault section indicators	20 kV	104		2002	104	35
(e) Reclosing relay	20 kV	104		2002	173	59
(f) 20 kV/100 V trasformers	Grounded at 20 kV	262		2002	1,048	356
Total					5,739	2,176
Total for 2002				**2002**	**12,110**	**4,586**
(1) For Damascus City Distribution Company						
(a) 20 kV auto-fault detecting device	20 kV	283		2005	708	362
(b) Vacuum type load break switches	20 kV	63		2005	1,838	625
(c) Load break switch for interconnection	20 kV	283		2005	2,358	923
(d) Fault section indicators	20 kV	126		2005	126	43
(e) Reclosing relay	20 kV	126		2005	210	71
(f) 20 kV/100 V trasformers	Grounded at 20 kV	283		2005	1,132	385
Total					6,371	2,410
(2) For Damascus Rural Distribution Company						
(a) 20 kV auto-fault detecting device	20 kV	262		2005	655	335
(b) Vacuum type load break switches	20 kV	54		2005	1,575	536
(c) Load break switch for interconnection	20 kV	262		2005	2,183	855
(d) Fault section indicators	20 kV	104		2005	104	35
(e) Reclosing relay	20 kV	104		2005	173	59
(f) 20 kV/100 V trasformers	Grounded at 20 kV	262		2005	1,048	356
Total					5,739	2,176
Total for 2005				**2005**	**12,110**	**4,586**
(1) For Damascus City Distribution Company						
(a) 20 kV auto-fault detecting device	20 kV	204		2010	510	261
(b) Vacuum type load break switches	20 kV	45		2010	1,313	446
(c) Load break switch for interconnection	20 kV	204		2010	1,700	666
(d) Fault section indicators	20 kV	92		2010	92	31
(e) Reclosing relay	20 kV	92		2010	153	52
(f) 20 kV/100 V trasformers	Grounded at 20 kV	204		2010	816	277
Total					4,584	1,734
(2) For Damascus Rural Distribution Company						
(a) 20 kV auto-fault detecting device	20 kV	248		2010	620	317
(b) Vacuum type load break switches	20 kV	45		2010	1,313	446
(c) Load break switch for interconnection	20 kV	248		2010	2,067	809
(d) Fault section indicators	20 kV	98		2010	98	33
(e) Reclosing relay	20 kV	98		2010	163	56
(f) 20 kV/100 V trasformers	Grounded at 20 kV	248		2010	992	337
Total					5,252	1,999
Total for 2010				**2010**	**9,836**	**3,733**
Grand Total					**34,056**	**12,905**
					Total FC+LC	**46,961**

Attachment 11-4(3) Installation of 20/0.4 kV Transformers

Subprojects for Augmentation and Extension	Type	Qty	unit	Comm. year	Cost Estimate F/C (US$1,000)	Cost Estimate I/C (US$1,000)
(1) For Damascus City Distribution Company						
(a) 200 kVA Transformer	Oil Insulated	18		2002	222	192
(b) 400 kVA Transformer	Natural Air Cooled	134		2002	1,977	1,537
(c) 630 kVA Transformer	Three Phase	507		2002	9,768	6,594
(d) 1,000 kVA Transformer		18		2002	529	296
(e) 1,600 kVA Transformer		9		2002	485	223
Total					12,981	8,842
(2) For Damascus Rural Distribution Company						
(a) 50 kVA Transformer	Oil Insulated	8		2002	37	17
(b) 100 kVA Transformer	Natural Air Cooled	36		2002	186	81
(c) 200 kVA Transformer	Three Phase	223		2002	1,520	638
(d) 400 kVA Transformer		398		2002	4,595	2,766
(e) 630 kVA Transformer		330		2002	6,358	4,292
(f) 1,000 kVA Transformer		28		2002	823	460
(g) 1,600 kVA Transformer		13		2002	701	322
Total					14,219	8,576
Total for 2002				**2002**	**27,200**	**17,418**
(1) For Damascus City Distribution Company						
(a) 200 kVA Transformer	Oil Insulated	9		2005	111	96
(b) 400 kVA Transformer	Natural Air Cooled	89		2005	1,313	1,021
(c) 630 kVA Transformer	Three Phase	231		2005	4,451	3,004
(d) 1,000 kVA Transformer		18		2005	529	296
Total					6,404	4,417
(2) For Damascus Rural Distribution Company						
(a) 50 kVA Transformer	Oil Insulated	2		2005	9	4
(b) 100 kVA Transformer	Natural Air Cooled	26		2005	134	59
(c) 200 kVA Transformer	Three Phase	98		2005	668	280
(d) 400 kVA Transformer		180		2005	2,078	1,251
(e) 630 kVA Transformer		125		2005	2,408	1,626
(f) 1,000 kVA Transformer		6		2005	176	99
(f) 1,600 kVA Transformer		6		2005	323	149
Total					5,797	3,467
Total for 2005				**2005**	**12,201**	**7,885**
(1) For Damascus City Distribution Company						
(a) 200 kVA Transformer	Oil Insulated	9		2010	111	96
(b) 400 kVA Transformer	Natural Air Cooled	142		2010	2,095	1,629
(c) 630 kVA Transformer	Three Phase	347		2010	6,686	4,513
(d) 1,000 kVA Transformer		36		2010	1,058	592
Total					9,949	6,830
(2) For Damascus Rural Distribution Company						
(a) 50 kVA Transformer	Oil Insulated	8		2010	37	17
(b) 100 kVA Transformer	Natural Air Cooled	49		2010	253	111
(c) 200 kVA Transformer	Three Phase	243		2010	1,656	695
(d) 400 kVA Transformer		379		2010	4,376	2,634
(e) 630 kVA Transformer		347		2010	6,686	4,513
(f) 1,000 kVA Transformer		28		2010	823	460
(g) 1,600 kVA Transformer		11		2010	593	273
Total					14,422	8,702
Total for 2010				**2010**	**24,372**	**15,532**
Grand Total					**63,773**	**40,835**
					Total FC+LC	**104,608**

Attachment 11-4(4) Reinforcement of Low Voltage Distribution Feeders

Subprojects for Augmentation and Extension	Type	Qty	unit	Comm. year	Cost Estimate F/C (US$1,000)	Cost Estimate I/C (US$1,000)
A. Reinforcement and construction of 0.4 kV feeders						
(1) For Damascus City Distribution Company						
(a) Reinforcement of 0.4 kV overhead lines	120Al, 1 CCT	154	km	2002	1,486	730
(b) Construction of 0.4 kV overhead lines	120Al, 1CCT	29	km	2002	254	125
(c) Reinforcement of 0.4 kV overhead lines by vynil covered conductor	120Al, 1CCT	6	km	2002	64	30
(d) Construction of 0.4 kV underground lines	120C, 1CCT	43	km	2002	782	537
(e) Construction of service connection with overhead lines	50C, 1CCT	113	km	2002	871	326
(f) Construction of service connection with underground lines	50C, 1CCT	48	km	2002	370	139
Total					3,827	1,886
(2) For Damascus Rural Distribution Company						
(a) Reinforcement of 0.4 kV overhead lines	120Al, 1 CCT	175	km	2002	1,689	830
(b) Construction of 0.4 kV overhead lines	120Al, 1CCT	59	km	2002	518	254
(c) Reinforcement of 0.4 kV overhead lines by vynil covered conductor	120Al, 1CCT	7	km	2002	74	35
(d) Construction of 0.4 kV underground lines	120C, 1CCT	9	km	2002	164	112
(e) Construction of service connection with overhead lines	50C, 1CCT	251	km	2002	1,935	724
(f) Construction of service connection with underground lines	50C, 1CCT	13	km	2002	100	38
Total					4,479	1,993
B. Meters and Meter Protection Boxes						
(1) For Damascus City Distribution Company						
(a) Meters		32	1,000	2002	512	230
(b) Meter Protection Boxes		6	1,000	2002	480	235
Total					992	465
(2) For Damascus Rural Distribution Company						
(a) Meters		53	1,000	2002	848	380
(b) Meter Protection Boxes		11	1,000	2002	880	431
Total					1,728	811
C. Miscellaneous Works						
(1) For Damascus City Distribution Company						
(a) Cable laying		378		2002	85	62
(b) Protection of cables		881		2002	176	98
(c) Installation of key locks		378		2002	0	6
(d) Repairing of transformer station		566		2002	0	24
(e) Repairing of Low voltage distribution panels		441		2002	0	16
(f) Ireplacement of fuses with the adequate size		944		2002	0	14
(g) Cleaning of facilities		1,384		2002	0	42
(h) Removal of un-used materials/equipment		1,259		2002	0	38
Total					261	299
(2) For Damascus Rural Distribution Company						
(a) Cable laying		793		2002	178	129
(b) Protection of cables		974		2002	195	108
(c) Installation of key locks		108		2002	0	2
(d) Repairing of transformer station		938		2002	0	40
(e) Repairing of Low voltage distribution panels		757		2002	0	28
(f) Ireplacement of fuses with the adequate size		1,154		2002	0	17
(g) Cleaning of facilities		1,046		2002	0	31
(h) Removal of un-used materials/equipment		901		2002	0	27
Total					373	383
Total for 2002				2002	11,661	5,837
A. Reinforcement and construction of 0.4 kV feeders						
(1) For Damascus City Distribution Company						
(a) Reinforcement of 0.4 kV overhead lines	120Al, 1 CCT	20	km	2005	193	95
(b) Construction of 0.4 kV overhead lines	120Al, 1CCT	42	km	2005	369	181
(c) Reinforcement of 0.4 kV overhead lines by vynil covered conductor	120Al, 1CCT	6	km	2005	64	30
(d) Construction of 0.4 kV underground lines	120C, 1CCT	19	km	2005	345	237

Attachment 11-4(4) Reinforcement of Low Voltage Distribution Feeders

Subprojects for Augmentation and Extension	Type	Qty	unit	Comm. year	Cost Estimate F/C (US$1,000)	Cost Estimate L/C (US$1,000)
(e) Construction of service connection with overhead lines	50C, 1CCT	153	km	2005	1,179	442
(f) Construction of service connection with underground lines	50C, 1CCT	66	km	2005	509	190
Total					2,659	1,175
(2) For Damascus Rural Distribution Company						
(a) Reinforcement of 0.4 kV overhead lines	120Al, 1 CCT	28	km	2005	270	133
(b) Construction of 0.4 kV overhead lines	120Al, 1CCT	73	km	2005	641	315
(c) Reinforcement of 0.4 kV overhead lines by vynil covered conductor	120Al, 1CCT	7	km	2005	74	35
(d) Construction of 0.4 kV underground lines	120C, 1CCT	7	km	2005	127	87
(e) Construction of service connection with overhead lines	50C, 1CCT	326	km	2005	2,513	941
(f) Construction of service connection with underground lines	50C, 1CCT	17	km	2005	131	49
Total					3,756	1,559
B. Meters and Meter Protection Boxes						
(1) For Damascus City Distribution Company						
(a) Meters		44	1000	2005	704	316
(b) Meter Protection Boxes		9	1000	2005	720	352
Total					1,424	668
(2) For Damascus Rural Distribution Company						
(a) Meters		69	1000	2005	1,104	495
(b) Meter Protection Boxes		14	1000	2005	1,120	548
Total					2,224	1,044
Total for 2005				2005	10,063	4,446
A. Reinforcement and construction of 0.4 kV feeders						
(1) For Damascus City Distribution Company						
(a) Reinforcement of 0.4 kV overhead lines	120Al, 1 CCT	46	km	2010	444	218
(b) Construction of 0.4 kV overhead lines	120Al, 1CCT	45	km	2010	395	194
(c) Reinforcement of 0.4 kV overhead lines by vynil covered conductor	120Al, 1CCT	10	km	2010	106	49
(d) Construction of 0.4 kV underground lines	120C, 1CCT	35	km	2010	636	437
(e) Construction of service connection with overhead lines	50C, 1CCT	300	km	2010	2,312	866
(f) Construction of service connection with underground lines	50C, 1CCT	129	km	2010	994	372
Total					4,888	2,136
(2) For Damascus Rural Distribution Company						
(a) Reinforcement of 0.4 kV overhead lines	120Al, 1 CCT	85	km	2010	820	403
(b) Construction of 0.4 kV overhead lines	120Al, 1CCT	105	km	2010	921	452
(c) Reinforcement of 0.4 kV overhead lines by vynil covered conductor	120AL, 1CCT	11	km	2010	117	54
(d) Construction of 0.4 kV underground lines	120C, 1CCT	15	km	2010	273	187
(d) Construction of service connection with overhead lines	50C, 1CCT	671	km	2010	5,172	1,937
(d) Construction of service connection with underground lines	50C, 1CCT	35	km	2010	270	101
Total					7,573	3,134
B. Meters and						
(1) For Damascus City Distribution Company						
(a) Meters		86	1000	2010	1,376	617
(b) Meter Protection Boxes		17	1000	2010	1,360	666
Total					2,736	1,283
(2) For Damascus Rural Distribution Company						
(a) Meters		141	1000	2010	2,256	1,012
(b) Meter Protection Boxes		28	1000	2010	2,240	1,096
Total					4,496	2,109
Total for 2010				2010	19,693	8,663
Grand Total					41,417	18,945
					Total FC+LC	60,362

Attachment 11-5 (1) Sensitivity Analysis (Construction Cost : 10% up)

(Alt-1)
Cost + 10%

Year	Capital Investment (US$1,000)	Increment O&M Cost (US$1,000)	Increment Energy Purchased (MWh)	Increment Energy Cost (US$1,000)	Increment Total cost (US$1,000)	Increment Energy Sold (MWh)	Increment Revenue (US$1,000)	Net Benefit (US$1,000)
1999	28,086	0	0	0	28,086	0	0	-28,086
2000	68,785	562	-2,133	-82	69,265	81,826	5,286	-63,979
2001	62,138	1,937	554	21	64,097	193,049	12,471	-51,625
2002	49,124	3,180	4,047	155	52,459	326,099	21,067	-31,392
2003	36,367	4,163	8,452	323	40,853	484,405	31,294	-9,560
2004	44,801	4,890	17,286	662	50,352	714,813	46,178	-4,174
2005	54,361	5,786	47,649	1,823	61,970	900,697	58,187	-3,784
2006	45,231	6,873	129,639	4,961	57,065	1,183,143	76,433	19,368
2007	31,660	7,778	293,067	11,215	50,653	1,532,311	98,990	48,337
2008	30,620	8,411	577,157	22,087	61,118	1,962,936	126,810	65,692
2009	31,426	9,023	988,570	37,832	78,281	2,477,983	160,083	81,802
2010	28,369	9,652	1,512,522	57,883	95,904	3,073,117	198,530	102,626
2011	0	10,219	1,512,522	57,883	68,102	3,073,117	198,530	130,427
2012	0	10,219	1,512,522	57,883	68,102	3,073,117	198,530	130,427
2013	0	10,219	1,512,522	57,883	68,102	3,073,117	198,530	130,427
2014	0	10,219	1,512,522	57,883	68,102	3,073,117	198,530	130,427
2015	0	10,219	1,512,522	57,883	68,102	3,073,117	198,530	130,427
2016	0	10,219	1,512,522	57,883	68,102	3,073,117	198,530	130,427
2017	0	10,219	1,512,522	57,883	68,102	3,073,117	198,530	130,427
2018	0	10,219	1,512,522	57,883	68,102	3,073,117	198,530	130,427
2019	0	10,219	1,512,522	57,883	68,102	3,073,117	198,530	130,427
2020	0	10,219	1,512,522	57,883	68,102	3,073,117	198,530	130,427
2021	0	10,219	1,512,522	57,883	68,102	3,073,117	198,530	130,427
2022	0	10,219	1,512,522	57,883	68,102	3,073,117	198,530	130,427
2023	0	10,219	1,512,522	57,883	68,102	3,073,117	198,530	130,427
2024	0	10,219	1,512,522	57,883	68,102	3,073,117	198,530	130,427
2025	0	9,658	1,512,522	57,883	67,540	3,073,117	198,530	130,989
2026	0	8,282	1,512,522	57,883	66,165	3,073,117	198,530	132,365
2027	0	7,039	1,361,270	52,094	59,134	2,765,805	178,677	119,543
2028	0	6,057	1,210,018	46,306	52,363	2,458,494	158,824	106,461
2029	0	5,329	1,058,765	40,518	45,847	2,151,182	138,971	93,123
2030	0	4,433	907,513	34,730	39,163	1,843,870	119,118	79,955
2031	0	3,346	756,261	28,941	32,287	1,536,559	99,265	66,977
2032	0	2,441	605,009	23,153	25,595	1,229,247	79,412	53,817
2033	0	1,808	453,757	17,365	19,173	921,935	59,559	40,386
2034	0	1,196	302,504	11,577	12,772	614,623	39,706	26,933
2035	0	567	151,252	5,788	6,356	307,312	19,853	13,497
Sum	510,968	255,484	34,583,511	1,323,476	2,089,928	75,929,278	4,905,183	2,815,255
NPV(DR9%)	319,007	62,669	6,330,325	242,255	623,932	15,865,145	1,024,920	400,988
Energy purchase cost (USC/kWh)			3.83					
Energy sales cost (USC/kWh)			6.46				EIRR(%)	19.92%

Attachment 11-5 (2) Sensitivity Analysis (Sales Energy as of year 2010 : 10% down)

(Alt-2)
Sales - 10%

Year	Capital Investment (US$1,000)	Increment O&M Cost (US$1,000)	Increment Energy Purchased (MWh)	Increment Energy Cost (US$1,000)	Increment Total cost (US$1,000)	Increment Energy Sold (MWh)	Increment Revenue (US$1,000)	Net Benefit (US$1,000)
1999	25,533	0	0	0	25,533	0	0	-25,533
2000	62,532	511	-2,092	-80	62,963	80,166	5,179	-57,784
2001	56,489	1,761	711	27	58,278	178,266	11,516	-46,761
2002	44,658	2,891	4,293	164	47,713	292,982	18,927	-28,786
2003	33,061	3,784	8,467	324	37,169	426,187	27,533	-9,637
2004	40,728	4,445	14,131	541	45,714	580,837	37,523	-8,191
2005	49,419	5,260	25,181	964	55,643	760,870	49,154	-6,489
2006	41,119	6,248	54,231	2,075	49,443	973,334	62,879	13,437
2007	28,782	7,071	123,338	4,720	40,573	1,228,211	79,345	38,772
2008	27,836	7,646	250,337	9,580	45,063	1,533,075	99,040	53,977
2009	28,569	8,203	465,502	17,814	54,586	1,899,410	122,706	68,119
2010	25,790	8,775	778,397	29,788	64,353	2,329,868	150,514	86,161
2011	0	9,290	778,397	29,788	39,079	2,329,868	150,514	111,435
2012	0	9,290	778,397	29,788	39,079	2,329,868	150,514	111,435
2013	0	9,290	778,397	29,788	39,079	2,329,868	150,514	111,435
2014	0	9,290	778,397	29,788	39,079	2,329,868	150,514	111,435
2015	0	9,290	778,397	29,788	39,079	2,329,868	150,514	111,435
2016	0	9,290	778,397	29,788	39,079	2,329,868	150,514	111,435
2017	0	9,290	778,397	29,788	39,079	2,329,868	150,514	111,435
2018	0	9,290	778,397	29,788	39,079	2,329,868	150,514	111,435
2019	0	9,290	778,397	29,788	39,079	2,329,868	150,514	111,435
2020	0	9,290	778,397	29,788	39,079	2,329,868	150,514	111,435
2021	0	9,290	778,397	29,788	39,079	2,329,868	150,514	111,435
2022	0	9,290	778,397	29,788	39,079	2,329,868	150,514	111,435
2023	0	9,290	778,397	29,788	39,079	2,329,868	150,514	111,435
2024	0	9,290	778,397	29,788	39,079	2,329,868	150,514	111,435
2025	0	8,780	778,397	29,788	38,568	2,329,868	150,514	111,946
2026	0	7,529	778,397	29,788	37,317	2,329,868	150,514	113,197
2027	0	6,399	700,557	26,810	33,209	2,096,881	135,463	102,254
2028	0	5,506	622,718	23,831	29,337	1,863,894	120,411	91,074
2029	0	4,845	544,878	20,852	25,697	1,630,908	105,360	79,663
2030	0	4,030	467,038	17,873	21,903	1,397,921	90,308	68,405
2031	0	3,042	389,199	14,894	17,936	1,164,934	75,257	57,321
2032	0	2,220	311,359	11,915	14,135	931,947	60,206	46,071
2033	0	1,644	233,519	8,937	10,580	698,960	45,154	34,574
2034	0	1,087	155,679	5,958	7,045	465,974	30,103	23,058
2035	0	516	77,840	2,979	3,495	232,987	15,051	11,557
合計	464,516	232,258	17,679,635	676,582	1,373,356	58,045,500	3,749,855	2,376,499
NPV(DR9%)	290,007	56,972	3,209,620	122,829	469,808	12,300,493	794,636	324,829

Energy purchase cost (USC/kWh) 3.83

Energy sales cost (USC/kWh) 6.46

EIRR(%) 18.91%

Attachment 11-5 (3) Sensitivity Analysis (Purchase Price : 20% up)

(Alt-3)
HV Supply Price :+20%

Year	Capital Investment (US$1,000)	Increment O&M Cost (US$1,000)	Increment Energy Purchased (MWh)	Increment Energy Cost (US$1,000)	Increment Total cost (US$1,000)	Increment Energy Sold (MWh)	Increment Revenue (US$1,000)	Net Benefit (US$1,000)
1999	25,533	0	0	0	25,533	0	0	-25,533
2000	62,532	511	-2,133	-98	62,945	81,826	5,286	-57,659
2001	56,489	1,761	554	25	58,276	193,049	12,471	-45,804
2002	44,658	2,891	4,047	186	47,735	326,099	21,067	-26,668
2003	33,061	3,784	8,452	388	37,233	484,405	31,294	-5,940
2004	40,728	4,445	17,286	794	45,967	714,813	46,178	211
2005	49,419	5,260	47,649	2,188	56,867	900,697	58,187	1,320
2006	41,119	6,248	129,639	5,953	53,321	1,183,143	76,433	23,113
2007	28,782	7,071	293,067	13,458	49,311	1,532,311	98,990	49,679
2008	27,836	7,646	577,157	26,505	61,987	1,962,936	126,810	64,823
2009	28,569	8,203	988,570	45,398	82,170	2,477,983	160,083	77,913
2010	25,790	8,775	1,512,522	69,459	104,024	3,073,117	198,530	94,506
2011	0	9,290	1,512,522	69,459	78,750	3,073,117	198,530	119,780
2012	0	9,290	1,512,522	69,459	78,750	3,073,117	198,530	119,780
2013	0	9,290	1,512,522	69,459	78,750	3,073,117	198,530	119,780
2014	0	9,290	1,512,522	69,459	78,750	3,073,117	198,530	119,780
2015	0	9,290	1,512,522	69,459	78,750	3,073,117	198,530	119,780
2016	0	9,290	1,512,522	69,459	78,750	3,073,117	198,530	119,780
2017	0	9,290	1,512,522	69,459	78,750	3,073,117	198,530	119,780
2018	0	9,290	1,512,522	69,459	78,750	3,073,117	198,530	119,780
2019	0	9,290	1,512,522	69,459	78,750	3,073,117	198,530	119,780
2020	0	9,290	1,512,522	69,459	78,750	3,073,117	198,530	119,780
2021	0	9,290	1,512,522	69,459	78,750	3,073,117	198,530	119,780
2022	0	9,290	1,512,522	69,459	78,750	3,073,117	198,530	119,780
2023	0	9,290	1,512,522	69,459	78,750	3,073,117	198,530	119,780
2024	0	9,290	1,512,522	69,459	78,750	3,073,117	198,530	119,780
2025	0	8,780	1,512,522	69,459	78,239	3,073,117	198,530	120,291
2026	0	7,529	1,512,522	69,459	76,988	3,073,117	198,530	121,541
2027	0	6,399	1,361,270	62,513	68,913	2,765,805	178,677	109,764
2028	0	5,506	1,210,018	55,567	61,073	2,458,494	158,824	97,750
2029	0	4,845	1,058,765	48,621	53,466	2,151,182	138,971	85,504
2030	0	4,030	907,513	41,676	45,706	1,843,870	119,118	73,412
2031	0	3,042	756,261	34,730	37,772	1,536,559	99,265	61,493
2032	0	2,220	605,009	27,784	30,003	1,229,247	79,412	49,409
2033	0	1,644	453,757	20,838	22,482	921,935	59,559	37,077
2034	0	1,087	302,504	13,892	14,979	614,623	39,706	24,727
2035	0	516	151,252	6,946	7,462	307,312	19,853	12,391
Sum	464,516	232,258	34,583,511	1,588,172	2,284,946	75,929,278	4,905,183	2,620,238
NPV(DR9%)	290,007	56,972	6,330,325	290,706	637,685	15,865,145	1,024,920	387,235

Energy purchase cost (USC/kWh) 4.596

Energy sales cost (USC/kWh) 6.46

EIRR(%) 20.87%

Attachment 11-5 (4) Sensitivity Analysis (Sales Price : 20% down)

(Alt 4)

I.V Sales Price :-20%

Year	Capital Investment (US$1,000)	Increment O&M Cost (US$1,000)	Increment Energy Purchased (MWh)	Increment Energy Cost (US$1,000)	Increment Total cost (US$1,000)	Increment Energy Sold (MWh)	Increment Revenue (US$1,000)	Net Benefit (US$1,000)
1999	25,533	0	0	0	25,533	0	0	-25,533
2000	62,532	511	-2,133	-82	62,961	81,826	4,229	-58,732
2001	56,489	1,761	554	21	58,272	193,049	9,977	-48,295
2002	44,658	2,891	4,047	155	47,704	326,099	16,853	-30,851
2003	33,061	3,784	8,452	323	37,169	484,405	25,034	-12,135
2004	40,728	4,445	17,286	662	45,835	714,813	36,942	-8,893
2005	49,419	5,260	47,649	1,823	56,502	900,697	46,548	-9,954
2006	41,119	6,248	129,639	4,961	52,329	1,183,143	61,145	8,816
2007	28,782	7,071	293,067	11,215	47,068	1,532,311	79,190	32,122
2008	27,836	7,646	577,157	22,087	57,570	1,962,936	101,445	43,875
2009	28,569	8,203	988,570	37,832	74,604	2,477,983	128,062	53,458
2010	25,790	8,775	1,512,522	57,883	92,447	3,073,117	158,819	66,371
2011	0	9,290	1,512,522	57,883	67,173	3,073,117	158,819	91,646
2012	0	9,290	1,512,522	57,883	67,173	3,073,117	158,819	91,646
2013	0	9,290	1,512,522	57,883	67,173	3,073,117	158,819	91,646
2014	0	9,290	1,512,522	57,883	67,173	3,073,117	158,819	91,646
2015	0	9,290	1,512,522	57,883	67,173	3,073,117	158,819	91,646
2016	0	9,290	1,512,522	57,883	67,173	3,073,117	158,819	91,646
2017	0	9,290	1,512,522	57,883	67,173	3,073,117	158,819	91,646
2018	0	9,290	1,512,522	57,883	67,173	3,073,117	158,819	91,646
2019	0	9,290	1,512,522	57,883	67,173	3,073,117	158,819	91,646
2020	0	9,290	1,512,522	57,883	67,173	3,073,117	158,819	91,646
2021	0	9,290	1,512,522	57,883	67,173	3,073,117	158,819	91,646
2022	0	9,290	1,512,522	57,883	67,173	3,073,117	158,819	91,646
2023	0	9,290	1,512,522	57,883	67,173	3,073,117	158,819	91,646
2024	0	9,290	1,512,522	57,883	67,173	3,073,117	158,819	91,646
2025	0	8,780	1,512,522	57,883	66,662	3,073,117	158,819	92,156
2026	0	7,529	1,512,522	57,883	65,412	3,073,117	158,819	93,407
2027	0	6,399	1,361,270	52,094	58,494	2,765,805	142,937	84,443
2028	0	5,506	1,210,018	46,306	51,812	2,458,494	127,055	75,243
2029	0	4,845	1,058,765	40,518	45,363	2,151,182	111,173	65,810
2030	0	4,030	907,513	34,730	38,760	1,843,870	95,291	56,531
2031	0	3,042	756,261	28,941	31,983	1,536,559	79,409	47,426
2032	0	2,220	605,009	23,153	25,373	1,229,247	63,527	38,155
2033	0	1,644	453,757	17,365	19,009	921,935	47,646	28,637
2034	0	1,087	302,504	11,577	12,664	614,623	31,764	19,100
2035	0	516	151,252	5,788	6,304	307,312	15,882	9,578
Sum	464,516	232,258	34,583,511	1,323,476	2,020,250	75,929,278	3,924,025	1,903,775
NPV(DR9%)	290,007	56,972	6,330,325	242,255	589,234	15,865,145	819,911	230,677
Energy purchase cost (USC/kWh)			3.83					
Energy sales cost (USC/kWh)			5.17				EIRR(%)	16.53%

Attachment 11.6 Analysis of Long-Run Average Incremental Cost (LRAIC)

1. Introduction

For the economic analysis of the improvement plans, the Long Run Average Incremental Cost (LRAIC) approach is applied to determine the energy purchase unit cost at the HV transmission outlet and the energy sales unit cost at the LV distribution network outlet. Long-Run Average Incremental Cost (LRAIC) is one of the alternative calculation methods to approximate the Long-Run Marginal Cost (LRMC). LRMC is the marginal cost (incremental cost) of optimum adjustments in the electric system expansion and electric system operations to meet small increments of demand, which is sustained into the long-run in the future.

The calculation for LRAIC for the economic evaluation under this study was conducted in consistency with the following preceding studies, which discussed LRAIC of the Syrian electric system.

(i) ESSP Generation and Transmission Master Plan, Technical Report No.3 "Generation Expansion Plan" and Technical Report No.4 "Transmission Expansion Plan", March and April 1997

(ii) Energy Power Efficiency Study, UNDP/World Bank, September 1988

2. Losses and Load Factors

For the computation of LRAIC, losses and load factors at various voltage levels are assumed as shown on the following table:

	Loss (%)	Load Factor (%)
Generation	5	80
HV Transmission	4	70
MV Primary Distribution	2.6	65
LV Secondary Distribution	8	60

It is noted that HV transmission, MV primary distribution and LV secondary distribution mean 400kV and 230kV transmission systems, 66kV and 20kV transmission systems and 0.4 kV distribution system respectively.

3. Long-Run Marginal Capacity Cost (LRMCC) at Generation Level

To obtain LRMCC (US$/kW-year) at generation level, the following power plants are considered according to the PEEGT's generation expansion plan in 1995-2005.

	Investment Cost (US$/kW)	Plant Life (Years)
Aleppo ST 5x200MW	650	25
Zezon GT 3x120MW	450	20
Zara ST 3x200 MW	600	25
Jandar CC 2x300 MW	650	20
Other CC 2x330MW	650	20

The weighted average investment cost and plant life of the above power plants are calculated at US$ 602.8/kW and 22.5 years respectively. Taking into account these average investment cost and plant life, annuitized capital cost per kW is calculated with a discount rate of 9 % as shown below:

$$\text{Annuity factor} = r/1-(1+r)^{(-n)} = 0.105$$

Where, r = discount rate, 9 %
n = equipment life, 22.5 years

Therefore, annuity per kW is computed at US$ 63.4 /kW-a. (US$ 602.8 x 0.105)

Then, considering the de-rating factor of 20% and auxiliary station consumption of 5%, the resulting Long-run Marginal Capacity Cost (LRMCC) is computed at US$ 83.2/kW-a (US$ 63.4/0.8x1.05) at the outlet of generation.

The marginal cost of energy per kWh at the generation level is calculated from the above LRMCC at US¢ 1.19 /kWh, taking into account the load factor of 80 % (i.e. 7008 operating hours per year).

US$ 83.2 /kW-a +7008 hrs = US¢ 1.19 /kWh

4. Operation and Maintenance (O&M) Cost of generation

The fixed O&M cost for generation per year is assumed at 3 % of the investment cost per year as follows:

US$ 602.8 /kW x 0.03 +7008 = US¢ 0.26 /kWh

5. Marginal Energy Cost

To determine the long-run marginal energy cost of the Syrian power system, three different types of power plants and the related fuel costs were taken into consideration. According to the statistic of power generation in 1998, base and intermediate loads generation, which shared 80 % of the total generated energy, was produced by conventional type steam thermal plants burning HFO and combined cycle thermal plants burning Natural Gas (NG). Out of the total generation for base and intermediate requirement, steam thermal plants (HFO) produced 38 % and combined cycle plants produced 62 %. Gas turbine thermal plants burning Distillated Oil (DO) were also used as peak load generating facilities for producing the remaining 20 % of the total generation.

The average net heat consumption per kWh is assumed as follows, based on the actual fuel consumption in 1998.

	Ave. Net Heat Consumption (kcal/kWh)	Net Efficiency
Base and intermediate loads (Steam thermal and Combined Cycle)	2,557	0.336
Peak load generation (Gas Turbine)	2,646	0.325

Note: The above values were measured at the outlet of step-up transformer, which included energy losses in step-up transformers and station use for auxiliary equipment.

Calorific values of HFO, NG and DO are 9,600 kcal/kWh, 9,400 kcal/Nm^3 and 10,200 kcal/kg respectively. Costs for fuels are assumed at US$ 80/ton for HFO, US$ 2.2/mmBTU (British Thermal Unit, 3412BTU = 1kWh =860 kcal) for NG and US$ 160/ton for DO.

Based on the above assumption, the marginal energy cost was calculated at US¢ 2.58 /kWh.

The details of calculation for marginal energy cost is shown below:

(1) Share of Incremental energy output by type of power plants

Steam and Combined cycle	:	80 %
Gas turbine	:	20 %

(2) Ave. Calorific values consumed for production of 1 kWh

HFO	:	2,557 kcal/kWh x 0.38 x 0.8 = 777.33 kcal
NG	:	2,557 kcal/kWh x 0.62 x 0.8 = 1,268.75 kcal
DO	:	2,646 kcal/kWh x 0.2 = 529.2 kcal

(3) Fuel cost required for production of 1 kWh

HFO	:	777.33/ 9,600 x 80/1,000 x 100 = US¢ 0.65
NG	:	1,268.75 x 3412/860x2.2/10^6x100 = US¢ 1.11
DO	:	529.2/10200/1000x160x100 = US¢ 0.83

(4) Thus, the resulting total energy (fuel) cost per 1 kWh is calculated at US¢ 2.58/kWh by summing up the above fuel costs (0.65+1.11+0.83=2.58).

(5) Total LRAIC at the generation level (at step-up transformer outlet) is calculated as follows:

Capital cost	US¢ 1.19 /kWh
O&M cost	US¢ 0.26 /kWh
Fuel cost	US¢ 2.58 /kWh
Total	US¢ 4.03 /kWh

6. Transmission and Distribution

The average investment costs for HV transmission, MV primary distribution and LV distribution facilities are assumed at US$ 26.6/kW-a, US$ 73.0/kW-a and US$ 46.0/kW-a respectively, based on the Technical Reports of Generation & Transmission Master Plan Study under ESSP.

LRMCCs (US$/kW-a) at different voltage levels are calculated as follows, taking into account the estimated loss ratios and load factors described in the above 2.

(1) HV Transmission

(83.2 + 26.6) x 1.04 = US$ 114.2/kW-a

(2) MV Distribution

(114.2+73.00) x 1.026 = US$ 192.0/kW-a

(3) LV Distribution

(192.0+46) x 1.08 = US$ 257.1/kW-a

Based on load factors at each voltage level, marginal energy costs (LRAIC) at different voltage levels are calculated as follows:

Yearly operating hours corresponding to load factors at each voltage level are calculated at 6,132, 5,694, and 5,256 hours for HV, MV and LV levels respectively.

(1) HV Transmission

US$ 83.2/kW-a /7008x1.04x100+26.6x1.04/6132x100 = US¢ 1.69/kWh

(2) MV Distribution

1.69*1.026+73/5694*100 = US¢ 3.04/kWh

(3) LV Distribution

3.04*1.08+46/5256*100 = US¢ 4.23/kWh

Annual O&M costs for transmission and distribution facilities are assumed at 1.5 % of investment cost for HV transmission, and 2 % for MV and LV distribution facilities. Plant life for transmission and distribution facilities was considered at 25 years and, therefore, the annuity factor was calculated at 0.101806 with a discount rate of 9 %. The marginal energy costs for operation and maintenance for various voltage levels were obtained as follows:

(1) HV Transmission

US¢ 0.26/kWh x 1.04 +US$ 26.6/kW-a /0.101806 x 0.015/6132 x 100 = US¢ 0.33 /kWh

(2) MV Distribution

US¢ 0.33/kWh x 1.026+US$ 73/kW-a /0.101806 x 0.02/5694 x 100 = US¢ 0.59 /kWh

(3) LV Distribution

US¢ 0.59/kWh x 1.08+US$ 46/kW-a /0.101806 x 0.02/5256 x 100 = US¢ 0.81 /kWh

The marginal cost for fuel consumption at each voltage level are as follows.

(1) HV Transmission US¢ 2.58 /kWh x 1.04 = US¢ 2.69 /kWh

(2) MV Distribution US¢ 2.69 /kWh x 1.026 = US¢ 2.76 /kWh

(3) LV Distribution US¢ 2.76 /kWh x1.08 = US¢ 2.98 /kWh

7. Resulting LRAICs based on LRMCC, O&M Cost and Energy Cost

The resulting LRAICs at each voltage level were summarized as shown in the following table based on the LRM capacity cost, O &M cost and fuel cost as discussed above.

(Unit : US¢ /kWh)

	(a) Generation Level	(b) HV Level	(c) MV Level	(d) LV Level
Capital Cost	1.19	1.69	3.04	4.23
O & M Cost	0.26	0.33	0.59	0.81
Energy Cost	2.58	2.69	2.76	2.98
Total	4.03	4.71	6.40	8.02

CHAPTER XII

PROCUREMENT OF PROJECT FUND

Chapter 12 Financing Plan

The total project costs of the proposed improvement plan during years 1999 through 2010 are as mentioned in Section 11.1. Prior to discussing a financing plan of the proposed improvement plan, attention is paid to the following situation. Namely, the improvement plan has already included some on-going sub-projects for which financing arrangement has been provided by foreign financing institutions and also another project for which financing arrangement is under negotiation with a foreign financing institution. These projects are mentioned in Chapter 6. Accordingly, financing plan should be discussed for the remaining sub-projects for which financing arrangements need to be provided.

Below are principles and criteria of the Team's proposed financing plan.

(1) Construction of the planned 66kV facilities includes on-going sub-projects financed by PEDEEE's own budget. The proposed financing plan for the 66 kV facilities excludes financing for these sub-projects.

(2) 66 kV transmission lines have traditionally been constructed by PEDEEE's own budget. Based on understanding that this tradition will remain unchanged in future, our proposed plan excludes financing for this item.

(3) In expansion of 20 kV and low voltage facilities, PEDEEE has been using own budget following their 5-year plan. The team's plan proposes based on understanding that PEDEEE's own fund will be provided to those facilities in future in similar extent of past financing.

From the above principles, it is considered that new facilities corresponding to demand increase will be constructed by PEDEEE's own budget. The budget for rehabilitation, reinforcement and introduction of newly developed technologies will be included in the scope of the proposed financing plan.

The team's financing plan based on the above policies and criteria is shown in Table 12-1 and summarized below.

Table 12-2 Summary of Financing Plan (Unit : US$1,000)

		Foreign Portion	Local Portion	Total
A	Total Investment cost	441,423	292,229	733,652
B	Projects under construction or scheduled to implement			
(1)	Eight substations in Damascus City	30,435	14,898	45,333
(2)	Three substations in Damascus Rural	11,746	6,458	18,204
(3)	Ten substations in Damascus Rural	35,605	17,587	53,192
(4)	Projects under construction by PEDEEE's own finance	22,891	10,788	33,679
	Sub-total	100,677	49,731	150,408
C	Balance (Finance to be prepared)	340,746	242,498	583,244
(1)	Projects to be implemented by PEDEEE's own finance	156,137	115,954	272,091
(2)	Projects to be funded by International Financing Institutions	184,609	126,544	311,153

As seen in the table, PEDEEE's fund required for the project till the year 2010 is US$ 272 million. This amount seems to be appropriate considering the past records invested for expansion projects of the distribution facilities under the PEDEEE's own fund.

In summary, the implementation of the proposed improvement plan needs the additional financing amount of US$ 311 million equivalent comprising US$ 185 million for foreign expenditures and US$ 126 million equivalent for local expenditures. However, local expenditures for import duties and interest during construction should be provided by PEDEEE's own budget.

Implementation stages of sub-projects are divided into three groups which will be completed in 2002, 2005, and 2010. Financing amounts for each stage will be as follows:

Table 12-3 Fund Required in Each Development Stage

(Unit: US$1,000)

Items	till 2002		2003 - 2005		2006 -2010	
	F/C	L/C	F/C	L/C	F/C	L/C
1. Construction Cost	53,523	23,643	32,037	12,595	42,316	17,845
2. Consulting Services	2,676	–	1,602	–	2,116	–
3. Contingencies - Physical	2,676	1,182	1,602	630	2,116	892
4. - Price	3,394	1,379	6,600	5,577	18,545	7,643
5. Import Duty	–	13,706	–	9,255	–	14,486
Subtotal (1 to 5)	62,269	39,910	41,841	25,057	65,093	40,866
6. Interest during Construction	5,097	6,981	3,296	4,084	7,013	9,646
Total (1 to 6)	67,366	46,891	45,136	29,141	72,107	50,512

It is reported that international institutions financed to PEDEEE for the study and development of its distribution networks are European Investment Bank, UNDP, Islamic Development Bank, Saudi Bank of Development, Kuwait Fund, etc. For the power sector of Syria, OECF financed for development of three thermal power plants.

It is proposed to prepare the financing plan to realize the proposed improvement plans of the distribution facilities, taking into account those institutions as a financing source or financing sources to the Project.

Table 12-1 Cost Estimate and Financing Plan

(Unit : US$1,000)

Work Item	Cost Estimate (1999 - 2010)			8 Substations in Damascus City (Islamic Investment Bank)			3 Substations in Damascus Rural (Saudi Bank)			10 Substations in Damascus Rural (European Investment Bank)			Rehabilitation Project to be financed by International Financing Institutions			Projects under execution by PEDEEE's finance			Other Projects to be financed by PEDEEE's own fund		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
1. Improvement on 66 kV Facilities																					
(a) Construction of new 66/20 kV Substations	77,639	19,408	97,047	25,543	6,485	32,028	9,379	2,312	11,691	26,411	6,546	32,957	5,111	1,197	6,308	9,838	2,543	12,381	1,357	325	1,682
(b) Increase of Transformer capacity	33,178	7,768	40,946										11,208	2,624	13,832	3,376	790	4,166	18,594	4,354	22,948
(c) Replacement of 20 kV Switchgears	29,106	6,815	35,921										23,732	5,557	29,289	5,374	1,258	6,632			
(d) Reinforcement of 66 kV Network	12,334	5,006	17,340																12,334	5,006	17,340
(e) Installation of Static Capacitors	3,888	910	4,798													1,343	314	1,657	2,545	596	3,141
(f) Replacement of 66 kV Circuit Breakers	2,129	499	2,628										2,129	499							
Sub-total	**158,274**	**40,406**	**198,680**	**25,543**	**6,485**	**32,028**	**9,379**	**2,312**	**11,691**	**26,411**	**6,546**	**32,957**	**42,180**	**9,877**	**52,057**	**19,931**	**4,905**	**24,836**	**34,830**	**10,281**	**45,111**
2. Improvement of 20 kV Facilities																					
(a) Reinforcement, construction, replacement of 20 kV feeders																					
Damascus City	18,509	15,864	34,373										3,189	2,733	5,922				15,320	13,131	28,451
Damascus Rural	19,861	11,202	31,063										5,348	3,197	8,545				14,513	8,005	22,518
(b) Improvement of 20 kV system by applying auto-fault detecting switches																					
Damascus City	17,326	6,553	23,879										17,326	6,553	23,879						
Damascus Rural	16,730	6,352	23,082										16,730	6,352	23,082						
Sub-Total	**72,426**	**39,971**	**112,397**										**42,593**	**18,835**	61,428				**29,833**	**21,136**	50,969
3. Increase of 20/0.4 kV transformers																					
Damascus City	29,334	20,089	49,423										7,744	5,286	13,030				21,590	14,803	36,393
Damascus Rural	34,439	20,746	55,185										17,099	10,315	27,414				17,340	10,431	27,771
Sub-Total	**63,773**	**40,835**	**104,608**										**24,843**	**15,601**	40,444				**38,930**	**25,234**	64,164
4. Improvement of Low voltage facilities																					
(a) Reinforcement and construction of 0.4 kV feeders																					
Damascus City	11,374	5,197	16,571										5,138	2,862	8,000				6,236	2,335	8,571
Damascus Rural	15,809	6,686	22,495										5,688	2,897	8,585				10,121	3,789	13,910
(b) Meters and Meter Protection Boxes																					
Damascus City	5,152	2,416	7,568										2,560	1,253	3,813				2,592	1,163	3,755
Damascus Rural	8,448	3,963	12,411										4,240	2,075	6,315				4,208	1,888	6,096
(c) Other Miscellaneous Works																					
Damascus City	261	299	560										261	299	560						
Damascus Rural	373	383	756										373	383	756						
Sub-total	**41,417**	**18,944**	**60,361**										**18,260**	**9,769**	**28,029**				**23,157**	**9,175**	**32,332**
Total	**335,890**	**140,156**	**476,046**	**25,543**	**6,485**	**32,028**	**9,379**	**2,312**	**11,691**	**26,411**	**6,546**	**32,957**	**127,876**	**54,082**	**181,958**	**19,931**	**4,905**	**24,836**	**126,750**	**65,826**	**192,576**
Consulting Services	16,500		16,500	1,277		1,277	469		469	1,321		1,321	6,394		6,394	997		997	6,042		6,042
Contingency																					
Physical Contingency	16,795	7,008	23,803	1,277	324	1,601	469	116	585	1,321	327	1,648	6,394	2,704	9,098	997	245	1,242	6,337	3,292	9,629
Price Contingency	46,883	20,243	67,126	885	225	1,110	828	742	1,570	4,331	1,074	5,405	28,539	11,600	40,139	282	70	352	12,018	6,532	18,550
Tax and Duties		91,900	91,900		6,372	6,372		2,455	2,455		7,374	7,374		37,447	37,447		4,878	4,878		33,374	33,374
Total Project Cost	**416,068**	**259,307**	**675,375**	**28,982**	**13,406**	**42,388**	**11,145**	**5,625**	**16,770**	**33,384**	**15,321**	**48,705**	**169,203**	**105,833**	**275,036**	**22,207**	**10,098**	**32,305**	**151,147**	**109,024**	**260,171**
Interest during Construction	25,355	32,922	58,277	1,453	1,492	2,945	601	833	1,434	2,221	2,266	4,487	15,406	20,711	36,117	684	690	1,374	4,990	6,930	11,920
Grand Total required for Financing	**441,423**	**292,229**	**733,652**	**30,435**	**14,898**	**45,333**	**11,746**	**6,458**	**18,204**	**35,605**	**17,587**	**53,192**	**184,609**	**126,544**	**311,153**	**22,891**	**10,788**	**33,679**	**156,137**	**115,954**	**272,091**

Table 12-4 Financing Plan of Improvement Plans to be Financed by International Donors

Subprojects for Augmentation and Extension	Comm. year	1999 F/C	1999 L/C	2000 F/C	2000 L/C	2001 F/C	2001 L/C	2002 F/C	2002 L/C	2003 F/C	2003 L/C	2004 F/C	2004 L/C	2005 F/C	2005 L/C	2006 F/C	2006 L/C	2007 F/C	2007 L/C	2008 F/C	2008 L/C	2009 F/C	2009 L/C	2010 F/C	2010 L/C	Total F/C	Total L/C
Base Cost																											
Up to 2002																											
I 66kV Facilities																											
1 Construction of New Substations																											
Construction of 66kV New Ersal substation	2002			1,022	239	2,044	479	2,044	479																	5,111	1,197
2 Increase of Transformer Capacity																										0	0
Transformer capacity up to 2000	2000																									0	0
Transformer capacity up to 2002	2002			2,242	525	4,483	1,050	4,483	1,050																	11,208	2,624
3 Replacement of 20kV Switchgear																											
20kV Circuit Breaker up to 2000	2000																									0	0
20kV Circuit Breaker up to 2002	2002			310	73	620	145	620	145																	1,550	363
Complete set of 20kV Switchgear up to 2000	2000																									0	0
4 Reinforcement of 66kV Network																											
66kV connection to 230/66kV Zahera substation	2001																									0	0
5 Installation of Static Capacitor																											
Stayic capacitor up to 1999	1999																									0	0
Stayic capacitor up to 2002	2002																									0	0
6 Replacement of 66kV Circuit Breakers																											
66kV circuit breakers up to 2002	2002			157	37	314	74	314	74																	786	184
II 20kV Facilities																											
1 Reinforcement of 20kV feerders																											
Damascus city	2002			3,189	2,733	0	0	0	0																	3,189	2,733
Damascus rural	2002			1,084	794	461	260	461	260																	2,005	1,314
2 Improvement of 20kV system																											
Damascus city	2002			2,134	807	2,119	801	2,119	801																	6,371	2,409
Damascus rural	2002			1,924	730	1,880	714	1,877	713																	5,680	2,157
III Increase of 20/0.4kV Transformer																											
Damascus city	2002			1,186	803	1,186	803	1,186	803																	3,558	2,410
Damascus rural	2002			2,371	1,430	2,335	1,411	2,335	1,411																	7,040	4,252
IV Low Voltage Facilities																											
1 Reinforcement of low voltage feerders																											
Damascus city	2002			884	487	856	470	847	465																	2,586	1,421
Damascus rural	2002			831	418	811	408	802	404																	2,445	1,231
2 Meters and meter protection boxes																											
Damascus city	2002			160	78	160	78	160	78																	480	235
Damascus rural	2002			320	157	320	157	240	117																	880	431
3 Other miscellaneous works																											
Damascus city	2002			261	299	0	0	0	0																	261	299
Damascus rural	2002			373	383	0	0	0	0																	373	383
Total for 2000 - 2002		0	0	18,446	9,993	17,588	6,849	17,488	6,800																	53,523	23,643
Up to 2005																											
I 66kV Facilities																											
1 Construction of New Substations																											
2 Increase of Transformer Capacity																											
transformer capacity up to 2005	2005																									0	0
3 Replacement of 20kV Switchgear																											
20kV circuit breaker up to 2005	2005									442	104	885	207	885	207											2,211	518
20kV switchgear up to 2005	2005									1,390	325	2,779	651	2,779	651											6,948	1,627
4 Reinforcement of 66kV Network																											
5 Installation of Static Capacitor																											
Static Capacitor up to 2005	2005																									0	0
6 Replacement of 66kV Circuit Breakers																											
66kV Circuit breakers up to 2005	2005									197	46	393	92	393	92											983	230
II 20kV Facilities																											
1 Reinforcement of 20kV feerders																											
Damascus city	2005																									0	0
Damascus rural	2005									461	260	461	260	461	260											1,382	780
2 Improvement of 20kV system																											
Damascus city	2005									2,134	807	2,119	801	2,119	801											6,372	2,409
Damascus rural	2005									1,924	730	1,880	714	1,877	713											5,681	2,157
III Increase of 20/0.4kV Transformer																											
Damascus city	2005									555	382	555	382	540	371											1,651	1,136
Damascus rural	2005									971	581	971	581	945	565											2,886	1,726
IV Low Voltage Facilities																											
1 Reinforcement of low voltage feerders																											
Damascus city	2005									339	191	321	178	311	174											971	543
Damascus rural	2005									402	207	355	181	355	181											1,112	569
2 Meters and meter protection boxes																											
Damascus city	2005									240	117	240	117	240	117											720	352
Damascus rural	2005									400	196	400	196	320	157											1,120	548
3 Other miscellaneous works																											
Damascus city	2005									0	0	0	0	0	0											0	0
Damascus rural	2005									0	0	0	0	0	0											0	0
Total for 2003 - 2005										9,454	3,946	11,358	4,360	11,225	4,288											32,037	12,595
Up to 2010																											
I 66kV Facilities																											
1 Construction of New Substations																											
2 Increase of Transformer Capacity																											
transformer up to 2007	2007																									0	0
transformer up to 2009	2009																									0	0
3 Replacement of 20kV Switchgear																											
20kV switchgear up to 2010	2010																	2,605	610	5,209	1,220	5,209	1,220			13,023	3,049
4 Reinforcement of 66kV Network																											
5 Installation of Static Capacitor																											
Static capacitor up to 2008	2008																									0	0
6 Replacement of 66kV Circuit Breakers																											
66kV Circuit breakers up to 2010	2010																	72	17	144	34	144	34			360	84
II 20kV Facilities																											
1 Reinforcement of 20kV feerders																											
Damascus city	2010																									0	0
Damascus rural	2010															413	229	413	229	378	214	378	214	378	214	1,961	1,102
2 Improvement of 20kV system																											
Damascus city	2010															921	349	921	349	919	348	919	348	902	342	4,582	1,736
Damascus rural	2010															1,087	412	1,087	412	1,087	412	1,069	406	1,040	396	5,370	2,038
III Increase of 20/0.4kV Transformer																											
Damascus city	2010															521	358	521	358	502	345	502	345	490	334	2,536	1,740
Damascus rural	2010															1,449	875	1,449	875	1,449	875	1,415	857	1,410	855	7,172	4,338
IV Low Voltage Facilities																											
1 Reinforcement of low voltage feerders																											
Damascus city	2010															324	183	314	179	314	179	314	179	314	179	1,581	898
Damascus rural	2010															435	223	424	218	424	218	424	218	424	218	2,131	1,097
2 Meters and meter protection boxes																											
Damascus city	2010															320	157	320	157	240	117	240	117	240	117	1,360	666
Damascus rural	2010															480	235	480	235	480	235	400	196	400	196	2,240	1,096
3 Other miscellaneous works																											
Damascus city	2010															0	0	0	0	0	0	0	0	0	0	0	0
Damascus rural	2010															0	0	0	0	0	0	0	0	0	0	0	0
Total for 2006 - 2010																5,950	3,022	5,930	3,012	8,470	3,571	11,015	4,134	10,952	4,105	42,316	17,845
Base Cost Total		0	0	18,446	9,993	17,588	6,849	17,488	6,800	9,454	3,946	11,358	4,360	11,225	4,288	5,950	3,022	5,930	3,012	8,470	3,571	11,015	4,134	10,952	4,105	127,876	54,082
Physical Contingency		0	0	922	500	879	342	874	340	473	197	568	218	561	214	297	151	296	151	424	179	551	207	548	205	6,394	2,704
Price Contingency		0	0	384	208	1,119	436	1,892	736	1,461	610	2,302	884	2,837	1,084	1,814	921	2,129	1,082	3,519	1,484	5,222	1,960	5,861	2,196	28,539	11,600
Duty and Tax		0	0	0	4,543	0	4,505	0	4,658	0	2,619	0	3,272	0	3,363	0	1,854	0	1,922	0	2,855	0	3,861	0	3,994	0	37,447
Consultancy Services		0	0	922		879		874		473		568		561		297		296		424		551		548		6,394	0
Total		0	0	20,675	15,244	20,466	12,132	21,128	12,535	11,860	7,373	14,796	8,735	15,184	8,950	8,359	5,949	8,652	6,166	12,836	8,088	17,339	10,162	17,907	10,501	169,203	105,833
Interest During Construction								5,097	6,981					3,296	4,084									7,013	9,646	15,406	20,711
Grand Total								67,366	46,891					45,136	29,141									72,107	50,512	184,609	126,544

CHAPTER XIII

CASE STUDY FOR IMPROVEMENT OF LOW TENSION DISTRIBUTION SYSTEMS

Chapter 13 Case Studies on Low Voltage Distribution Feeders

13.1 Low Voltage Overhead Distribution Feeders

13.1.1 Selection of Feeders

Low voltage overhead distribution feeders for the case study were selected from the Damascus Rural Distribution network through discussion with PEDEEE. Two 20/0.4 kV distribution transformers in Duma district were selected, at first, to be in an average operational condition in the whole study area. Then, all low voltage feeders connected to the transformers are considered to be those for the case study.

In the actual operation of low voltage network, partial load of overloaded transformers or feeders are shifted to other adjacent feeders for preventing overloading fault or more efficient operation of the transformers and feeders.

For simulation of such feeder operation, the selected model feeders for this study were presently operated each other in adjacent area. Figure 13.1-1 shows the selected overhead low voltage feeders.

13.1.2 Method of Case Study

(1) Configuration of the Model Feeders

The system configuration for this study is as the existing feeders including number and capacity of transformer units, kind and length of conductors, location and number of section terminals, and others, which were provided to the Team by the Damascus Rural Distribution Company and confirmed the survey results of the Team.

(2) Estimation of the Loads

The actual phase current of each feeder used for the study was assumed being converted from those actual values measured by the Team to the estimated peak values in a day of December 1998. The current values of each feeder in future were estimated in accordance with demand growth forecasted in Chapter 4. Load distribution on a feeder was assumed to be uniform along the feeder. Accordingly, in case that the growing load on a feeder will be divided from the existing feeder into several feeders in future, the future load will be distributed in proportion to the length of new feeder. While, the future load to each transformer was assumed to be sum of load on each feeder connected to the transformer.

Load shifting among adjacent transformers is normally conducted in the actual operation of the network. In this study, the same load shifting operation was limited to that between the selected two (2) transformers for preventing complicated examination.

(3) Reinforcement of Facilities

Based on the facility standards described in Chapter 7, the facilities were examined for expansion to meet the growing demand. The timing of additional installation of new transformers is basically set to be done in the year when the facility is predicted to be overloaded.

It was estimated in the detailed examination that the selected two transformers would be overloaded in the year 2001, but their operation rates would reach to 100% in the year 2000 without any allowance for load demand in the supply area. The low voltage distribution feeders will also be overloaded even if conductor sizes would have been increased to the standard 120AL because of insufficient current carrying capacity of the upgraded conductors. Therefore, additional three (3) transformers should be individually installed at three different places on the feeder during 2000.

Upgrade of conductor size should be completed over the whole section related before the current carrying capacity of the existing conductor would reach its limit. In case that overloading of the feeder would not be solved by application of the larger conductors, new feeders are to be constructed in the section.

Routes of those new feeders are aligned so as not to duplicate with the existing feeders referring to the drawings provided by the Damascus Rural Distribution Company. It is assumed that load will uniformly distribute along the new feeders.

13.1.3 Result of Case Study

The single line diagrams of the expansion plan formulated in the method mentioned above are shown in Figures 13.1-2 to 13.1-7. Table 13.1-1 shows the required quantities of transformers and conductors in each development stage.

Table 13.1-1 Required Quantities of Facilities by Each Stage

Development Stage		2000	2005	2010
Additional transformers	(kVA)	1,660	400	1,660
	(Nos.)	3	1	3
Upgrade of existing conductors to AL 120 mm^2	(m)	521	196	331
	(Nos.)	6	3	4
New feeder construction (AL 120 mm^2)	(m)	0	321	260

Table 13.1-2 shows the facility index after the implementation planned in Table 13.1-1 would have been completed.

Table 13.1-2 Facility Index in Each Year

			1998	2000	2005	2010
Transformers	Total capacity	(kVA)	2,060	3,720	4,120	5,780
	Number of station	(Nos.)	2	5	6	9
	Average capacity/station	(kVA)	1,030	744	687	642
Low Voltage Feeders	120mm²	(m)	146	667	1,184	1,775
	Smaller than 120mm²	(m)	2,424	1,903	1,707	1,376
	Total	(m)	2,570	2,570	2,891	3,151
	Percentage of 120mm²	(%)	6	26	41	56
	Total Nos. of feeders	(Nos.)	10	17	23	34
	Average feeder Length	(m)	257	151	126	93
	Average feeder current	(A)	252	171	186	185

13.1.4 Loss and Expenses of Facilities

Energy losses in the case study for the selected low voltage overhead feeders discussed above are estimated in Table 13.1-3. It is found out that % loss at peak demand in 2010 will be reduced to one third of the % loss in 1998. It is noted that those values contain losses of transformers. (Details are referred to Attachment 13-1.)

Table 13.1-3 Losses in the Case Study (at Peak Demand)

1998 (1,573.6 kW)	2000 (1,817.6 kW)		2005 (2,611.6 kW)		2010 (3,847.8 kW)	
Before improvement	Before improvement	After improvement	Before improvement	After improvement	Before improvement	After improvement
121.1 kW	156.1 kW	67.4 kW	144.4 kW	89.8 kW	197.3 kW	97.5 kW
7.7%	8.6%	3.7%	5.5%	3.4%	5.1%	2.5%

( ) : Power at delivering point

Annual expenses of all low voltage distribution facilities and annual losses in the selected feeders have been computed as shown in Table 13.1-4. Unit prices of facilities are referred to those described in Chapter 11. Annual expenses ratio of facility are supposed to be 10% of the construction cost. KWh unit price is assumed at 0.0646$/kWh as LRMC. Total annual loss is worked out in the manner of peak loss×8,760 hours×0.42. Factor of 0.42 is obtained from the load curve in Chapter 4.

Table 13.1-4 Annual Expenses of Facility and Losses in the Case Study (Unit : US$)

			1998	2000	2005	2010
Annual expenses of whole facility in the model system	Transformers :	630 kVA	6,455	12,909	12,909	19,364
		400 kVA	5,245	7,867	10,489	13,112
	Low voltage feeders :	120 mm²	2,101	9,599	17,040	25,546
		Less than 120 mm²	2,568	2,016	1,808	1,458
	Sub total		16,368	32,392	42,247	59,479
	Annual expenses of losses		28,783	16,019	21,343	23,173
	Total Annual Expenses		45,151	48,411	63,590	82,652

Both annual expenses of facility and of loss in the Table increase in proportion to the increase of power

demand. The expenses per kWh obtained from the total annual expenses divided by annual sales energy in this area are shown in Table 13.1-5 supposing the load factor to be 0.65.

Table 13.1-5 Annual Expenses of Facilities and Losses per kWh

(unit : US$/kWh/1,000)

	1998	2000	2005	2010
Expenses of facilities	1.98	3.25	2.94	2.79
Expenses of losses	3.48	1.61	1.49	10.9
Total annual expenses	5.46	4.86	4.43	3.87

In 2010, expenses of facilities per kWh increase in comparison with those in 2008. But, due to large decrease of the expenses of losses, it is found out that the total expenses per kWh decrease.

13.2 Low Voltage Underground Distribution Feeders

13.2.1 Selection of Feeders

The low voltage underground feeder (with three transformers) in the Central area in Damascus City that has average characteristics of low voltage underground network in the study area was selected as the model feeder for case study through the discussion with PEDEEE.

13.2.2 Method of Case Study

(1) Configuration of the Model Feeders

The feeder configuration for this study is as the existing feeders including number and capacity of transformer units, kind and length of cables, and others, which were provided to the Team by the Damascus City Distribution Company and confirmed the survey results of the Team.

The case study area is densely covered by tall buildings. The actual network configuration in the area was physically impossible to confirm during the Team's survey. Information about the kind of cables or cross-section for any part of the underground feeders was not available. Therefore, the Team was obliged to suppose some underground feeder routes based on the load measurement data.

(2) Estimation of the Loads

The actual phase current of each feeder used for the study was assumed being converted from those actual values measured by the Team to the estimated peak values in a day of December 1998. The currents of each feeder in future were estimated in accordance with demand growth forecasted in Chapter 4. Most of underground cable feeders are constructed in a radial formation in the area, and loads are not connected in its midway but connected at the end of feeder as a concentrated load.

Accordingly, in examination of the growing load along the feeders, three (3) cases are assumed; (1) load growing area, (2) no-load growing area and (3) new load area. Those three areas were assumed to be randomly connected to the feeders so as total load of the feeders to be the forecasted load. Loads are expressed in capacity (kVA) but not in current (A).

(3) Reinforcement of Facilities

Addition of transformer facilities is planned in accordance with the facility standards described in Chapter 7. The timing of additional installation of new transformers is basically set to be done in the year when the facility is predicted to be overloaded.

Since information about the existing cables and their loading conditions are not available, it was assumed that the existing cables will be reinforced when the load of the feeder will reach 1.5 times the present (the year 1998) load. Newly installed cables were selected for their carrying capacities depending on the forecasted loads. New underground cables except for installation in buildings are aligned under the roads in consideration of future configuration of the low voltage system.

13.2.3 Result of Case Study

The single line diagrams of the expansion plan formulated under the method mentioned above are shown in Figures 13.2-2 to 13.2-7. Table 13.2-1 shows the required quantities of facilities by year. In this case study, only numbers of feeders are estimated because of insufficient information about accurate feeder lengths or cable specifications.

Table 13.2-1 Required Quantities of Facilities by Each Stage

		2000	2005	2010
New transformers	(kVA)	1,000	1,630	1,000
	(Nos.)	1	2	1
New feeders	(Nos.)	3	11	7

Table 13.2-2 shows the facility index after the reinforcement planned in Table 13.2-1 would have been completed.

Table 13.2-2 Facility index in Each Year

			1998	2000	2005	2010
Transformers	Total capacity	(kVA)	2,630	3,630	5,260	6,260
	Station	(Nos.)	3	4	6	7
	Average capacity	(kVA)	877	908	877	894
LV Feeders	Total numbers of feeders	(Nos.)	21	24	35	42
	Average feeder number	(Nos.)	7	6	6	6
	Average feeder current	(A)	169	161	147	167

From system maps of the underground low voltage distribution network in the central area, average length of

underground feeder is estimated at about 100 meters. Length of low voltage feeder is in proportion to the square root of the supply area of the transformer. The average lengths of underground feeders in each stage thus obtained are shown in Table13.2-3.

Table 13.2-3 Average Length of Underground Feeder

			1998	2000	2005	2010
Low voltage feeders	Average feeder length	(m)	100	87	71	65

13.3 Unit Capacity of 20/0.4 kV Transformers

Unit capacity of installed 20/0.4 kV transformers are to be selected so as to be appropriate for a district in particular consideration of its demand density, voltage drops and energy losses. In this study, the optimum unit capacity of 20/0.4 kV transformers is examined in both Damascus City and Damascus Rural areas taking into account construction cost and loss. The way of examination and selection of optimum unit capacity of transformers is detailed in Attachment 7-3. Attachment 13-2 details a concrete example of the examination. Losses in the examination contain copper and iron losses of transformers, and only resistance portion is considered in computation of losses of low voltage feeders. Conditions of the model feeder taken in this study are supposed as follows.

Table 13.3-1 Conditions of the Optimum Model Feeder

Power factor	0.90
Operation ratio of 20/0.4 kV transformers	100 %
Area of the ideal model	10 km^2
Load distribution in the area	Uniform distribution
Conductors of low voltage feeders	Underground system in City : 120C Overhead system in Rural : 120AL
Number of feeders from a 20/0.4 kV transformer	Fixed for each capacity of transformer in extent of 1 to 12 so as to make feeders current about 200 A
Annual energy losses	Loss at peak load × 8760hours × 0.42

Determination of the optimum capacity of transformers is made through following examinations;

(a) To apply various unified unit capacities in a model area to supply power for demand

(b) To analyze and compare annual expenses of facilities and losses of each unit of transformer applied

(c) To select the most economical unit capacity from the comparison

Unit prices of facilities are described in Chapter 11. Annual expenses of the facility are supposed to be 10% of total construction cost. KWh unit price is assumed to be 0.0646$/kWh as LRMC for the low voltage.

Optimum unit capacity examination resulted in those shown in Tables 13.3-2 to 13.3-4. Details of the examination can be referred to Attachment 13-3 and Attachment 13-4.

Table 13.3-2 Optimum Unit Capacities of Transformer for Underground System
(In case pole mounted transformers are applicable.)

Demand density (MW/km^2)	Type of transformers
Less than 3	400 kVA ground mounted type
4 - 70	630 kVA ground mounted type
More than 80	1,000 kVA ground mounted type

Table 13.3-3 Optimum Unit Capacities of Transformer for Overhead System
(In case both pole mounted type and ground mounted type are applicable.)

Demand density(MW/km^2)	Type of transformers
Less than 0.6	100 kVA Pole mounted type
0.7 - 60	200 kVA Pole mounted type
More than 70	400 kV Pole mounted type

Table 13.3-4 Optimum Unit Capacities of Transformer in Overhead System
(In case ground mounted type only is applicable.)

Demand density (MW/km^2)	Type of transformers
Less than 1	200 kVA ground mounted type
2 - 4	400 kVA ground mounted type
More than 5	630 kVA ground mounted type

The result mentioned above depends on such conditions as increase or decrease of unit prices of facilities, expenses of energy losses and situations of the installed locations. The result indicates only approximate unit capacities. Examples for low voltage system in this report are shown in Table 13.3-5. In comparison with the optimum unit capacities analyzed above, three (3) cases are assumed. One-step-larger transformers are installed in case A, one-step-smaller transformers are partly installed in case B and one-step-larger transformers are partly installed in case C. Although there are some deviations observed in this classification, unit capacities in each existing case can be considered to be generally consistent with the results mentioned above. Also it is found out that there might be few cases of change of unit capacities in case of double existing demand density, because wide range of demand density is suitable for one unit capacity. However, some transformer stations have two (2) transformers, and this duplicated installation way is not desirable for the system from the viewpoints of reduction of loss and voltage drop.

Table 13.3-5 Demand Densities and Unit Capacities in the Model Systems

Case	Reference	Type of system	Existing demand density (MW/km^2)	Type of transformers
A	Attachment 7.7.1	Overhead system Corresponding to Table 13.3-3	0.4	One 200 kVA pole mounted transformer
B	Chapter 13	Overhead system Corresponding to Table 13.3-4	8	Two 400 kVA ground mounted transformers and two 630 kVA ground mounted transformers
C	Chapter 13	Underground system Corresponding to Table 13.3-2	40	One 630 kVA ground mounted transformer and two 1,000 kVA ground mounted transformers

13.4 Selection of Optimum Conductor Size of Low Voltage Feeders

Optimum conductor size for low voltage feeders is usually determined in such a way that the conductor under given feeder current condition brings the sum of the annual expense of construction costs and the annual energy loss cost of the feeder to be minimum.

(1) Low Voltage Overhead Feeder

For overhead feeder, the same conductor is supposed to be applied over the whole section between a transformer and the end of feeder taking into account the facts that overhead low voltage feeders are frequently modified in their network configurations. Annual expenditure is assumed to be 10% of the total construction cost.

The construction cost was estimated referring to the recent construction cost in Syria as follows:

New feeder with Aluminum 185 mm2 : US$ 24,499 /km
New feeder with Aluminum 120 mm2 : US$ 15,891 /km
New feeder with Aluminum 70 mm2 : US$ 10,023 /km

Annual loss was analyzed under following conditions:

(a) The load on the feeder is uniformly distributed along the feeder. (The loss amount in this case is one third of the case of the concentrated load at the end of the feeder.)

(b) The monthly load variation on the feeder is assumed to be in proportion to the load duration curve given in Figure 3.2-10. Thus, annual energy loss is estimated to be 0.42 times the annual peak load loss.

(c) Unbalance currents between phases are assumed to be 10%.

(d) Only resistance of conductors at 70°C is taken into account and those values of various conductors are as follows:

- Aluminum 185mm^2 : 0.19224 Ω/km
- Aluminum 120mm^2 : 0.295569 Ω/km
- Aluminum 70mm^2 : 0.526257 Ω/km

The loss cost consists of kW-cost and kWh-cost. However, kWh loss shares most of the system loss, and therefore in this study, the kWh loss only is considered with the unit rate of US$ 0.0646 /kWh.

Based on these conditions, total annual cost C_{Tot}(US$/Year) for each conductor is estimated as follows:

$$C_{Tot} = 0.001 \times 3.1 \times (1/3) R L I^2 \times 8760 \times 0.42 \times C_e + C_c L \times 0.1$$

Where, R : resistance of the conductor (Ω/km)

L : feeder length (km)

I : feeder peak current (A)

C_e : loss cost (US$/kWh)

C_c : construction cost of the feeder (US$/km)

Table 13.4-1 shows the result of the estimate

Table 13.4-1 Annual Cost of Conductors in Each Feeder Current (OH feeder)

(unit : US$/year)

Current (A)	Type of Conductors		
	AL-70mm²	AL-120mm²	AL-185mm²
0	100	159	245
10	102	160	245
20	105	162	247
30	112	165	249
40	121	171	253
50	133	177	257
60	147	185	262
70	164	194	268
80	183	205	275
90	205	218	283
100	229	232	292
110	257	247	302
120	286	263	313
130	319	282	325
140	354	301	338
150	391	322	351
160	431	345	366
170	474	369	381
180	**519**	**394**	**398**
190	567	421	415
200	617	449	434
210	670	479	453
220	726	510	474
230	784	543	495
240	845	577	517
250	908	613	540

Results of the case study show that the average feeder peak current in the year 2000 after the improvement is around 180 A and then the optimum conductor is 120mm² with a slight advantage over 185mm². Accordingly, taking into account the standard conductor size in Syria, 120mm² conductor is selected for the optimum conductor for the model area.

(2) Low Voltage Underground Cable

For underground cables, optimum cable is selected in the same principle as that for the overhead conductors. For selection of the optimum underground cable, the following conditions are applied:

(a) Feeder loss is assumed to be 5/8 of that of the concentrated load at its end, because the load

distribution on an underground feeder is considered to be between uniform load distribution along the feeder and the end concentrated load.

(b) Average peak feeder current is supposed to be 140 A that is the average peak current of the underground feeder in the model area.

The construction cost of underground feeder is estimated as follows:

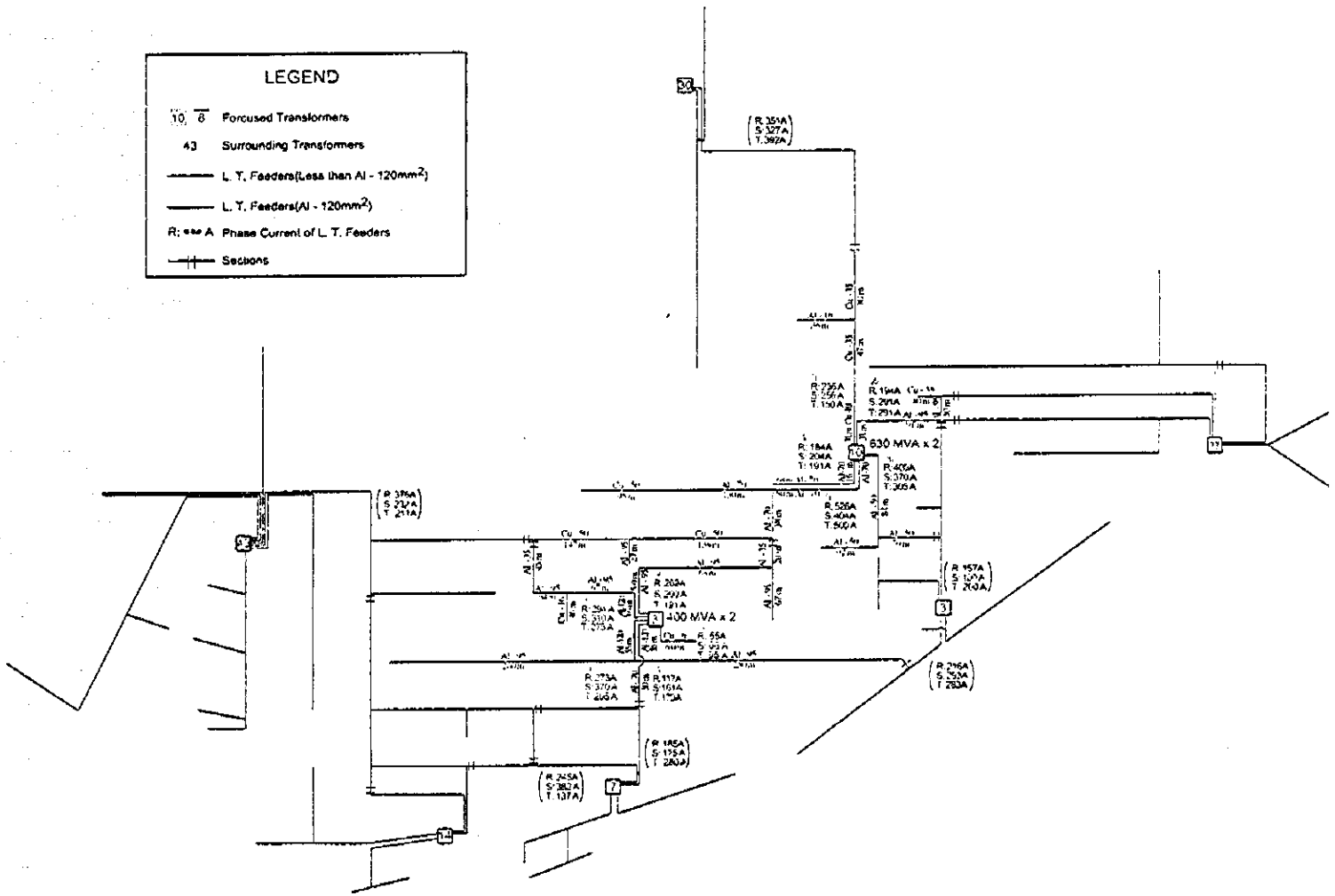
New feeder with Aluminum 240mm^2 : US$ 34,184 /km
New feeder with Aluminum 185mm^2 : US$ 27,795 /km
New feeder with Aluminum 70mm^2 : US$ 14,511 /km

As resulted in Table 13.4-2, aluminum conductor 185mm^2 cable is selected as the optimum cable for the model area. However, some defects on low voltage aluminum conductor cables have been reported, the causes of the defects are under investigation by PEDEE, and new installation of the aluminum cables is suspended at the present. Under such a situation in Syria, copper conductor cable 120 mm^2 is selected as the standard cable for the model area. If the aluminum cables will be permitted in the future, aluminum conductor 185mm^2 cable should be considered as the optimum cable for the area.

Table 13.4-2 Annual Cost of Cables in Each Feeder Current (UG feeder)

(unit : US$/year)

Current (A)	Type of Conductor		
	AL-240mm^2	AL-185mm^2	AL-70mm^2
0	513	417	218
10	514	418	221
20	517	422	232
30	522	429	250
40	529	438	276
50	538	450	309
60	549	465	349
70	562	482	396
80	577	502	450
90	593	524	512
100	612	550	581
110	633	578	658
120	656	608	741
130	681	641	832
140	**708**	**677**	**930**
150	737	716	1,036
160	768	757	1,148
170	801	801	1,268
180	835	847	1,395
190	872	896	1,530
200	911	948	1,672
210	952	1,003	1,821
220	995	1,060	1,977
230	1,040	1,119	2,141



Public Establishment for Distribution and Exploitation of Electrical Energy (PEDEEE)	Japan International Cooperation Agency (JICA) Joint Venture Nippon Koei Co., Ltd. & Tokyo Electric Power Services Co., Ltd	The Feasibility Study on The Rehabilitation Project of Damascus and Damascus Rural Distribution Network	Figure 13.1-1 Title Selected Low Tension Overhead Distribution Feeders for the Case Study (as of yera 1998)

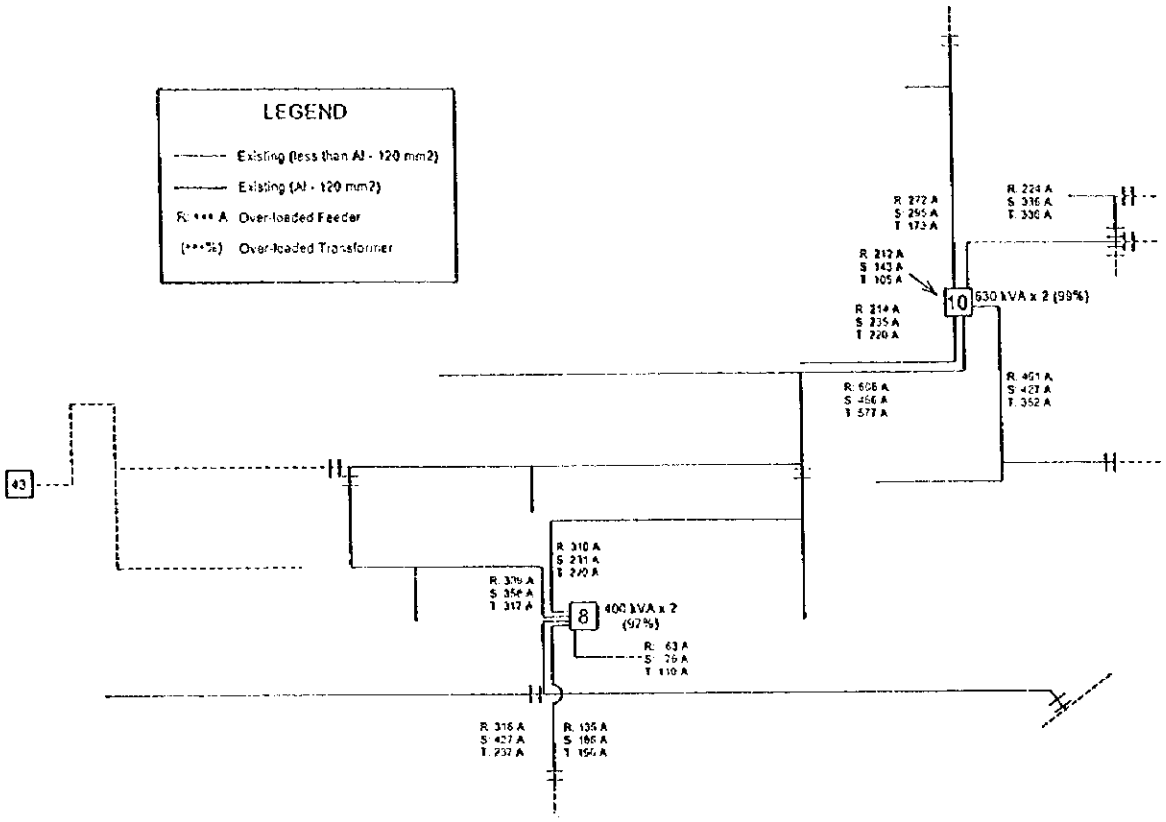


Figure 13.1-2 Situation in 2000 without Countermeasure

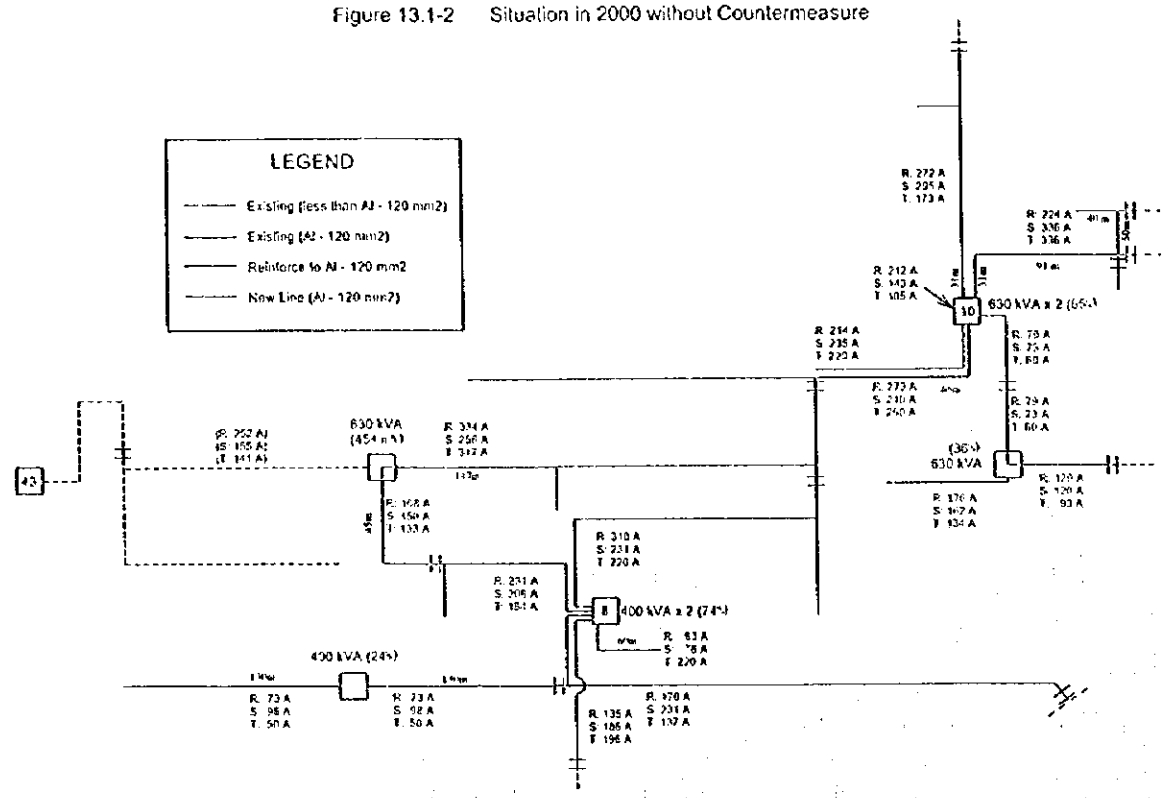


Figure 13.1-3 Situation in 2000 after Countermeasure

Public Establishment for Distribution and Exploitation of Electrical Energy (PEDEEE)	Japan International Cooperation Agency (JICA)	The Feasibility Study on The Rehabilitation Project of Damascus and Damascus Rural Distribution Network	Figure
	Joint Venture Nippon Koei Co., Ltd. & Tokyo Electric Power Services Co., Ltd		Title

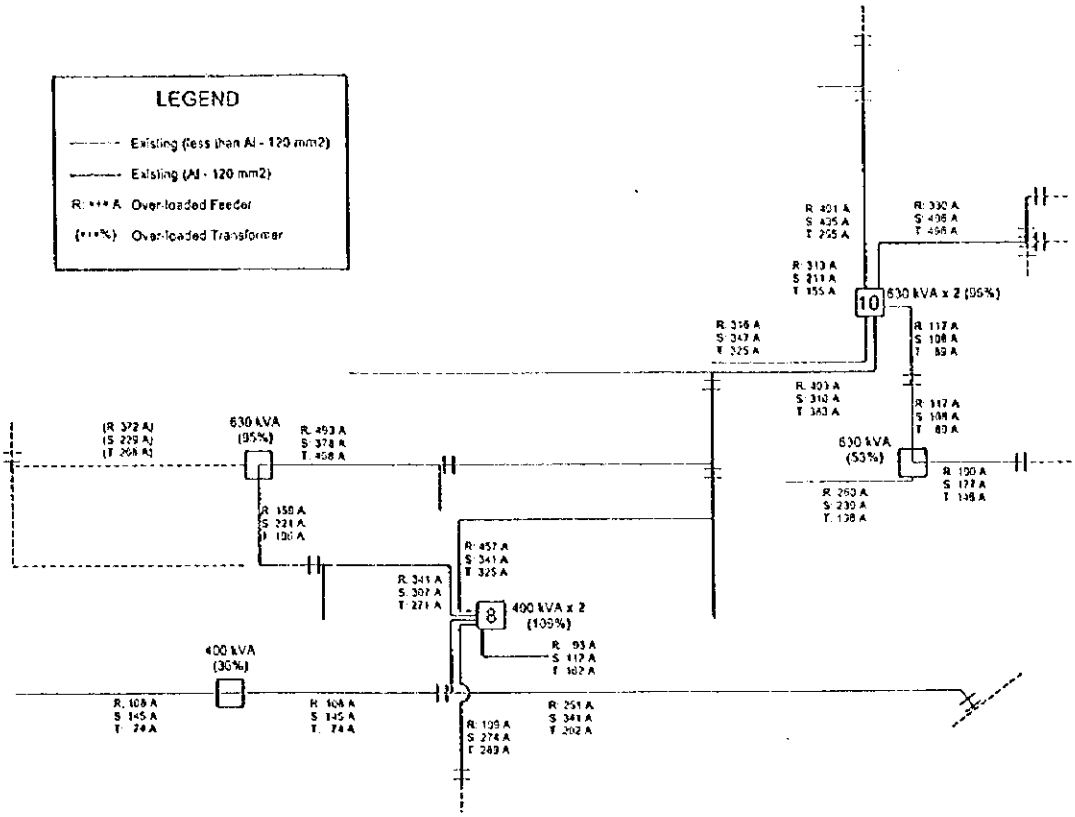


Figure 13.1-4 Situation in 2005 without Countermeasure

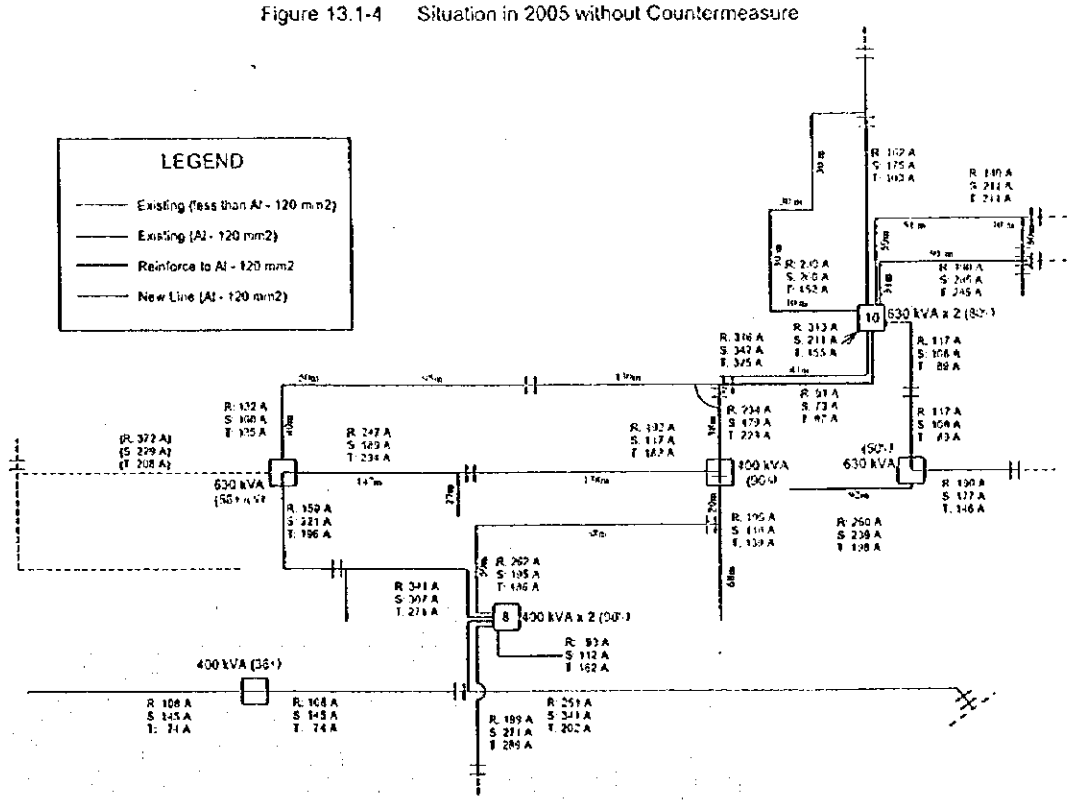


Figure 13.1-5 Situation in 2005 after Countermeasure

Public Establishment for Distribution and Exploitation of Electrical Energy (PEDEEE)	Japan International Cooperation Agency (JICA)	The Feasibility Study on The Rehabilitation Project of Damascus and Damascus Rural Distribution Network	Figure
	Joint Venture Nippon Koei Co., Ltd. & Tokyo Electric Power Services Co., Ltd		Title

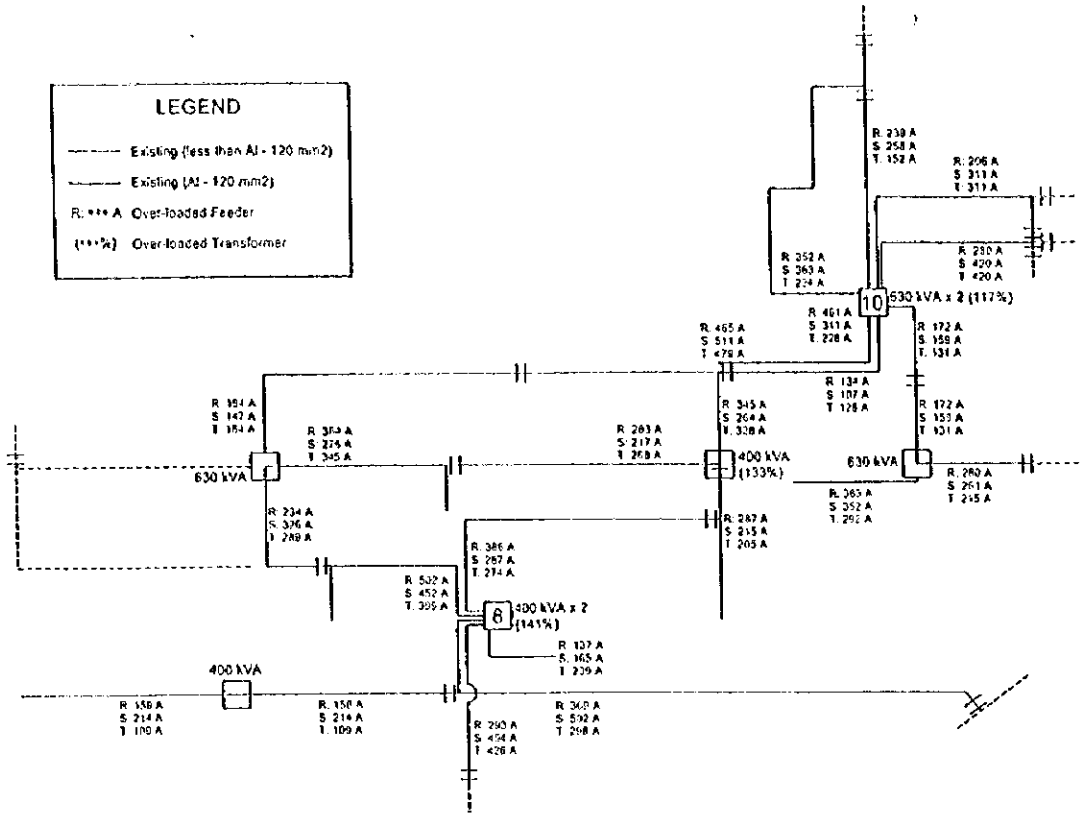


Figure 13.1-6 Situation in 2010 without Countermeasure

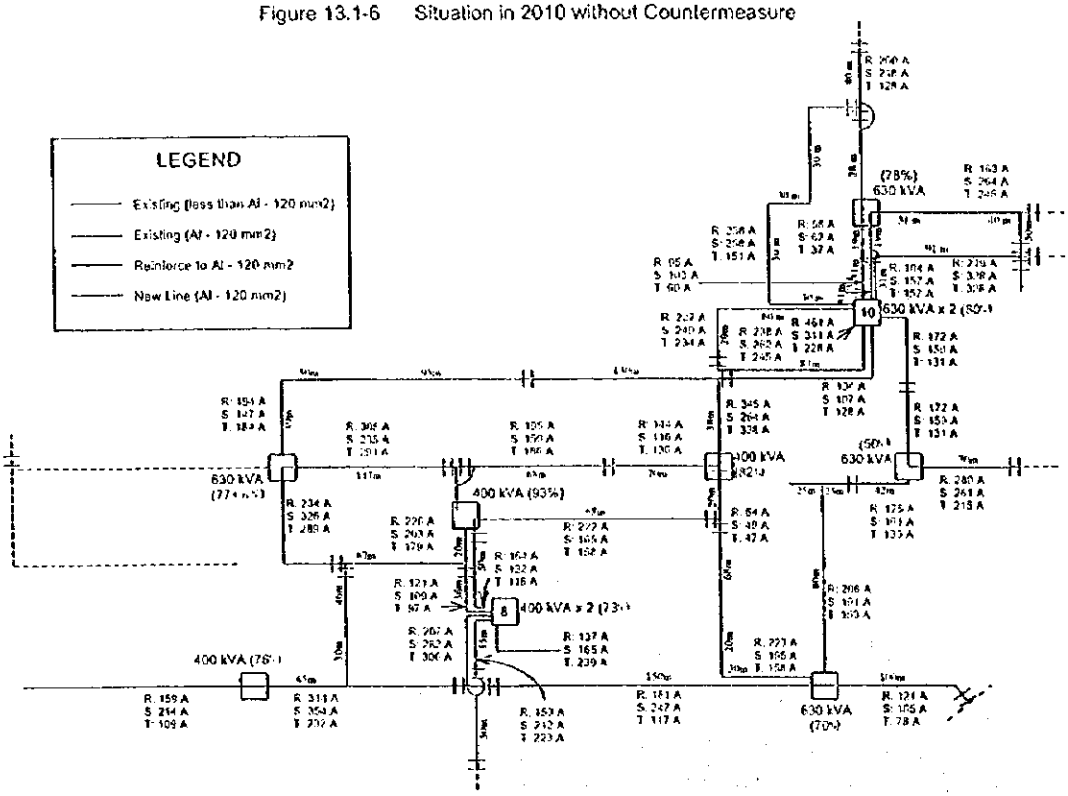
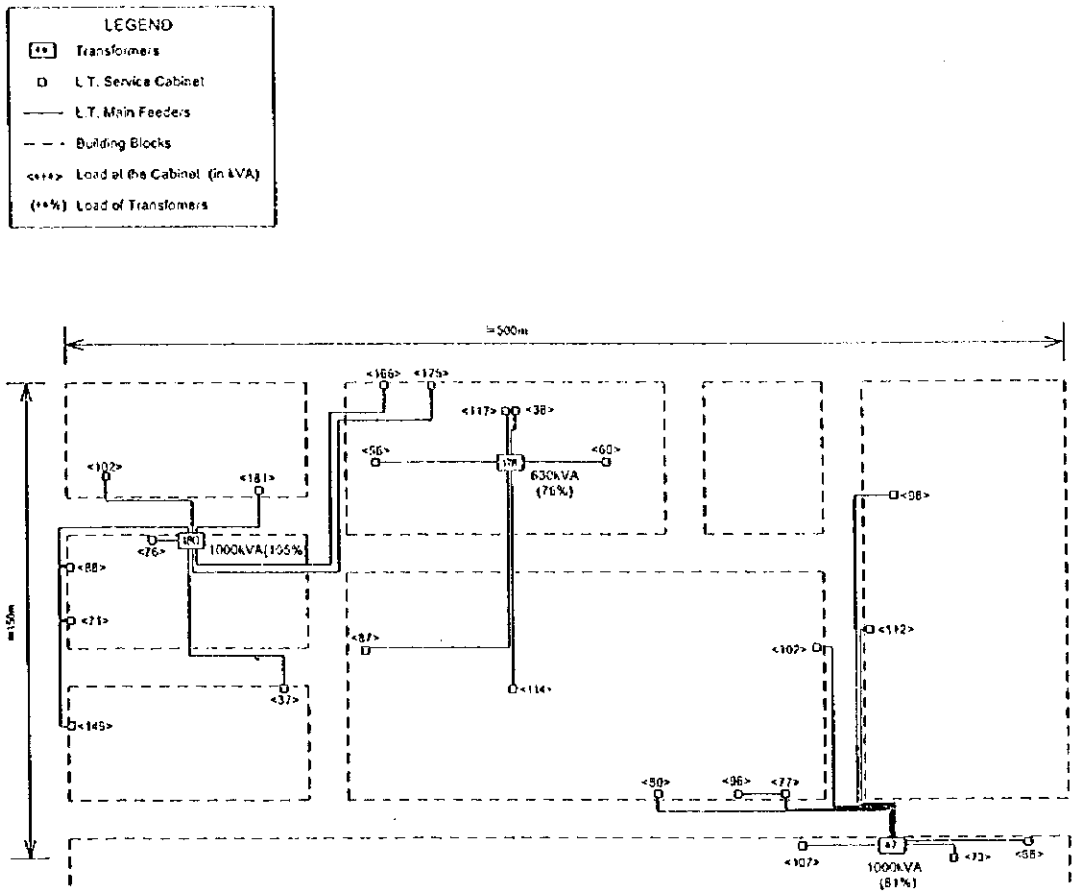


Figure 13.1-7 Situation in 2010 after Countermeasure

Public Establishment for Distribution and Exploitation of Electrical Energy (PEDEEE)	Japan International Cooperation Agency (JICA)	The Feasibility Study on The Rehabilitation Project of Damascus and Damascus Rural Distribution Network	Figure
	Joint Venture Nippon Koei Co., Ltd. & Tokyo Electric Power Services Co., Ltd		Title



Public Establishment for Distribution and Exploitation of Electrical Energy (PEDEEE)	Japan International Cooperation Agency (JICA)	The Feasibility Study on The Rehabilitation Project of Damascus and Damascus Rural Distribution Network	Figure 13. 2-1
	Joint Venture Nippon Koei Co., Ltd. & Tokyo Electric Power Services Co., Ltd		Title: Selected Low Tension Underground Distribution Feeders for the Case Study (as of yera 1998)

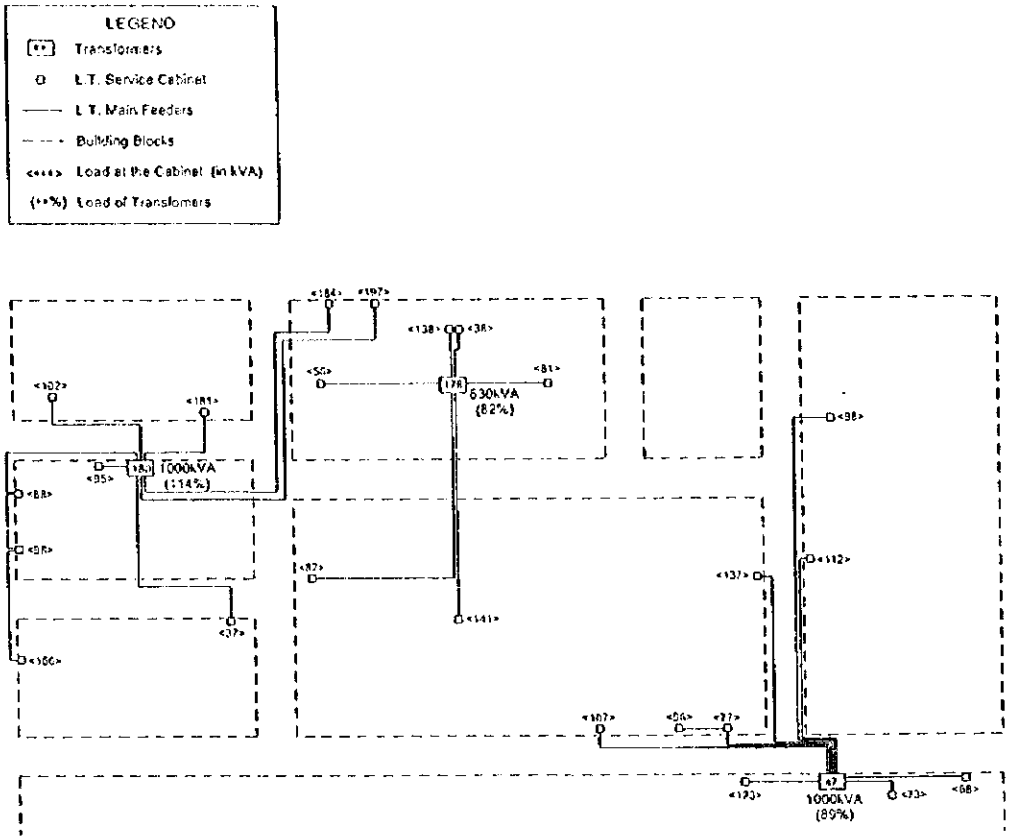


Figure 13.2-2 Situation in 2000 without Countermeasure

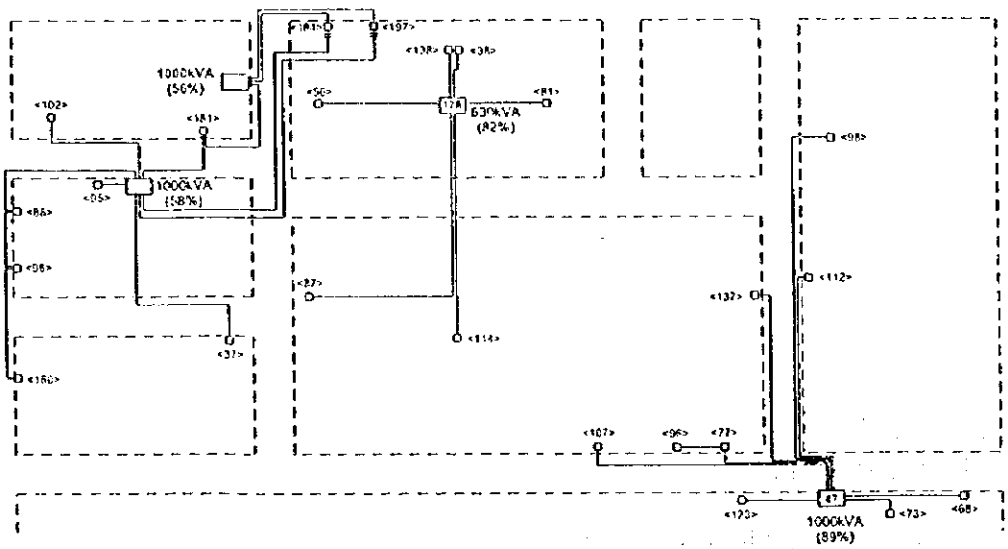


Figure 13.2-3 Situation in 2000 after Countermeasure

Public Establishment for Distribution and Exploitation of Electrical Energy (PEDEE)	Japan International Cooperation Agency (JICA) Joint Venture Nippon Koei Co., Ltd. & Tokyo Electric Power Services Co., Ltd	The Feasibility Study on The Rehabilitation Project of Damascus and Damascus Rural Distribution Network	Figure No. Title

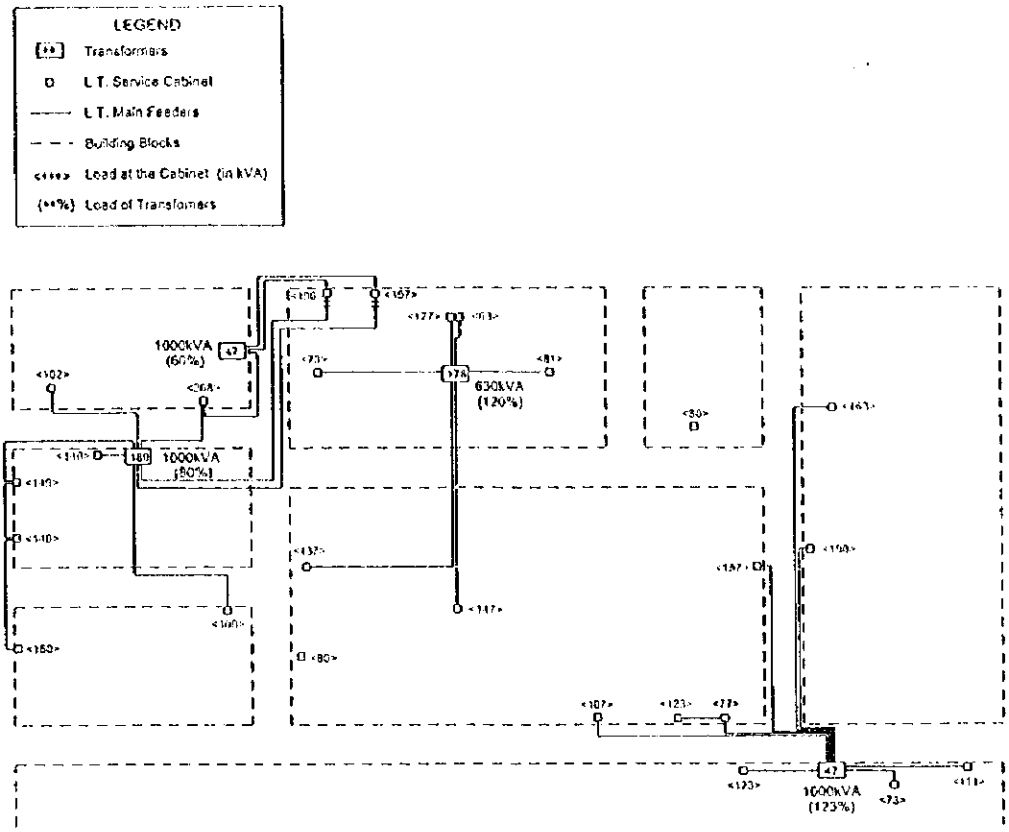


Figure 13.2-4 Situation in 2005 without Countermeasure

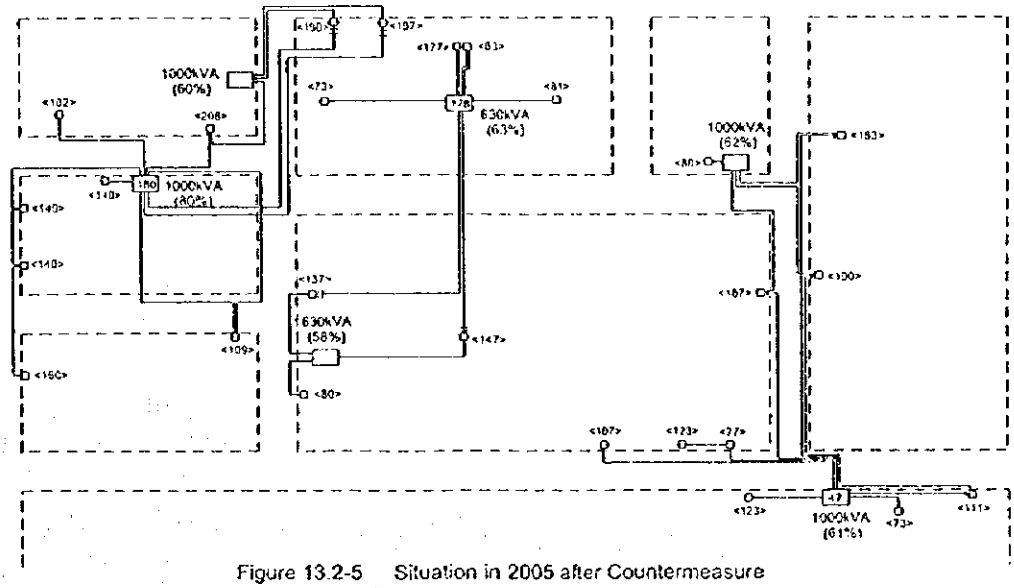


Figure 13.2-5 Situation in 2005 after Countermeasure

Public Establishment for Distribution and Exploitation of Electrical Energy (PEDEEE)	Japan International Cooperation Agency (JICA)	The Feasibility Study on The Rehabilitation Project of Damascus and Damascus Rural Distribution Network	Figure No.
	Joint Venture Nippon Koei Co., Ltd. & Tokyo Electric Power Services Co., Ltd		Title

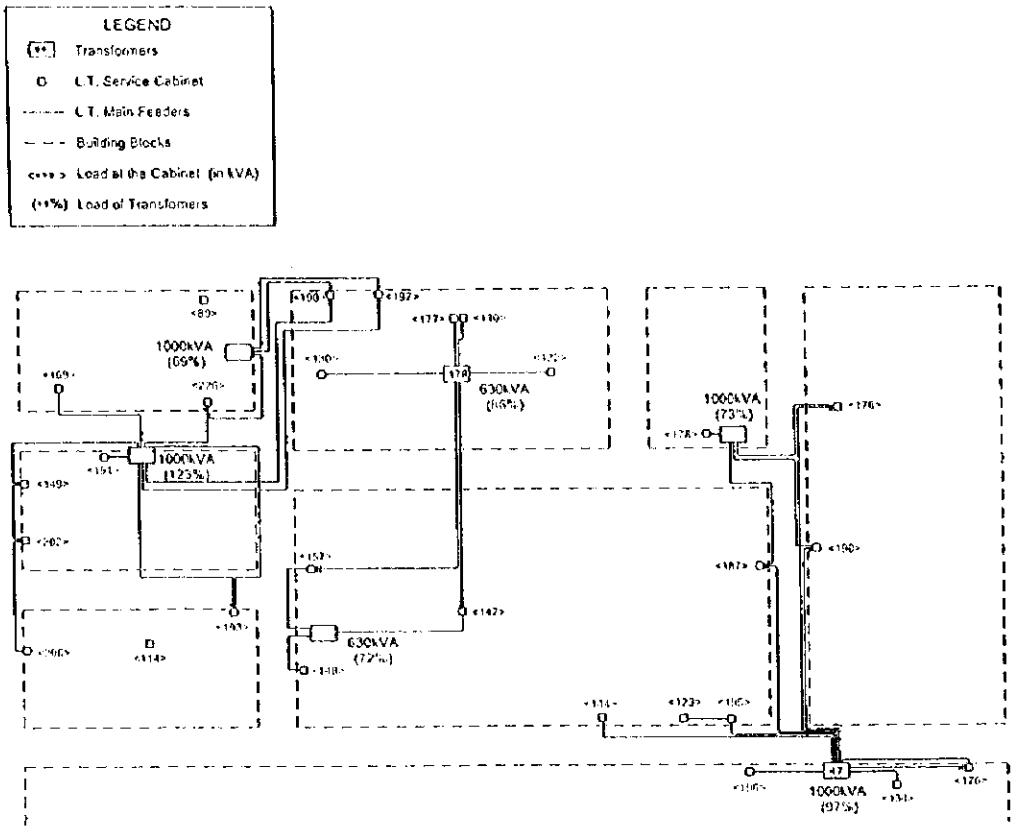


Figure 13.2-6 Situation in 2010 without Countermeasure

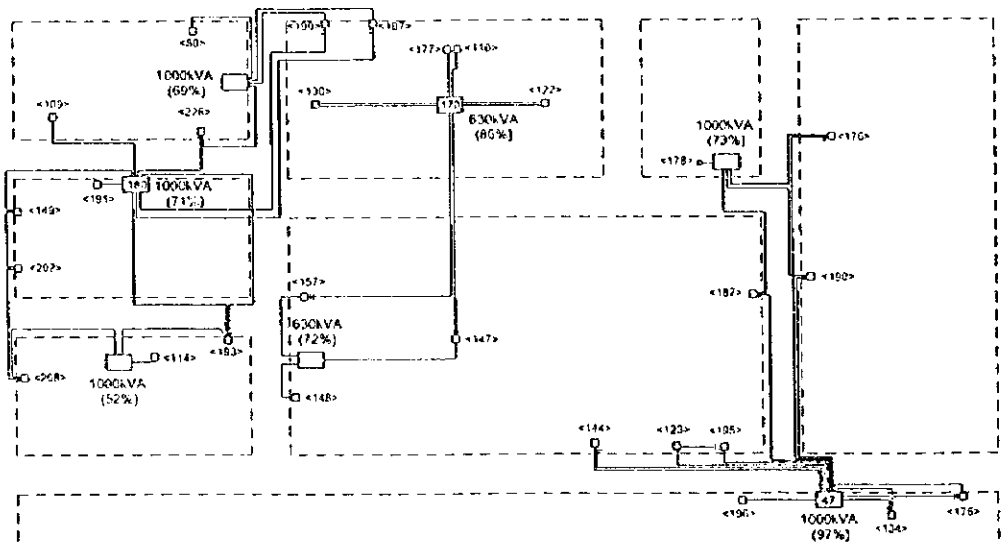


Figure 13.2-7 Situation in 2010 after Countermeasure

Public Establishment for Distribution and Exploitation of Electrical Energy (PEDEE)	Japan International Cooperation Agency (JICA) Joint Venture Nippon Koei Co., Ltd. & Tokyo Electric Power Services Co., Ltd	The Feasibility Study on The Rehabilitation Project of Damascus and Damascus Rural Distribution Network	Figure No. Title

ATTACHMENT

Attachment 13-1 Losses at Peak Time before and after Countermeasures in Sample Low Voltage Systems

	SS	Capacity (kVA)	Feeders' Main Number	Feeders' Sub Number	1998 Before Countermeasures Power at Delivering Point (kW)	1998 Before Countermeasures Loss (kW)	2000 Before Countermeasures Power at Delivering Point (kW)	2000 Before Countermeasures Loss (kW)	2000 After Countermeasures Power at Delivering Point (kW)	2000 After Countermeasures Loss (kW)	2005 Before Countermeasures Power at Delivering Point (kW)	2005 Before Countermeasures Loss (kW)	2005 After Countermeasures Power at Delivering Point (kW)	2005 After Countermeasures Loss (kW)	2010 Before Countermeasures Power at Delivering Point (kW)	2010 Before Countermeasures Loss (kW)	2010 After Countermeasures Power at Delivering Point (kW)	2010 After Countermeasures Loss (kW)
Loss of Low Voltage Systems	8		1	1	183.2	6.75	211.3	8.98	129.8	2.38	191.5	5.17	191.5	5.17	282	11.22	68.2	0.13
	8																126.7	1.22
	8			2					81.5	0.18	49.6	0.4	49.6	0.4	73.1	0.87	73.1	0.87
	8		2	1	137.6	2.95	158.6	3.92	158.6	3.92	234	8.54	134	1.31	197.4	2.85	83.8	0.19
	8																113.6	0.94
	8			2									100	1.55	147.4	3.35	33.3	0.02
	8																114.1	1.86
	8		3	1	45	0.88	51.9	1.18	51.9	0.16	76.5	0.35	76.5	0.35	112.8	0.76	112.8	0.76
	8		4	1	176.1	8.09	204.3	10.84	112.1	4	165.5	8.72	165.5	8.72	243.6	18.88	165.7	2.6
	8																113.6	2.7
	8																75.9	0.8
	8			2					46.1	0.36	68.2	0.8	68.2	0.8	100.5	1.73	100.5	1.73
	8			3					46.1	0.36	68.2	0.8	68.2	0.8	100.5	1.73	187.6	1.73
	8		5	1	93.4	0.82	107.8	1.09	107.8	1.09	158.8	2.38	158.8	2.38	234.1	5.17	122.6	0.71
					635.3	19.49	733.9	26.01	733.9	12.45	1012.3	27.16	1012.3	21.48	1491.4	46.56	1491.5	16.26
						3.1%		3.5%		1.7%		2.7%		2.1%		3.1%		1.1%
	10		1	1	133.8	11.92	154.2	15.83	154.2	5.69	227.4	12.37	91.7	0.74	135.3	1.6	53.8	0.09
	10																32.7	0.12
	10												135.7	5.92	199.9	12.84	113.8	1.86
	10																134.8	2.95
	10		2	1	161.7	6.34	186.7	8.45	186.7	8.45	275.5	14.13	158.4	2.71	233.4	5.89	182.4	3.24
	10												117.1	2.71	172.6	5.88	136.5	2.34
	10																87.1	0.21
	10		3	1	224.1	18.23	259.3	24.41	44.2	0.16	65.4	0.35	65.4	0.35	96.3	0.75	96.3	0.75
	10			2					44.2	0.16	65.4	0.35	65.4	0.35	96.3	0.75	96.3	0.75
	10			3					72.5	0.71	106.9	1.54	106.9	1.54	157.6	3.35	157.6	1.4
	10			4					98.4	1.72	145.3	3.76	145.3	1.57	214.1	3.4	97.8	0.32
	10																116.3	1.33
	10		4	1	298	36.61	343.9	48.75	154.9	7.44	228.6	16.22	52.3	0.14	77.1	0.31	77.1	0.31
	10												74.4	0.99	109.4	2.15	109.4	2.15
	10			2					189	9.9	278.9	21.54	108.6	2.06	160.1	4.47	64	0.21
	10																128	1.56
	10												139.6	2.72	205.7	5.91	173.8	3.59
	10												132.6	4.18	195.3	9.07	195.3	5.09
	10		5	1	120.7	1.66	139.6	2.22	139.6	2.22	205.9	4.84	205.9	2.72	303.3	5.89	303.3	5.89
					938.3	74.76	1083.7	99.66	1083.7	36.45	1599.3	75.1	1599.3	28.7	2356.4	62.26	2356.3	34.14
						8.0%		9.2%		3.4%		4.7%		1.8%		2.6%		1.4%
Loss of Transformers	8	400				3.4596		3.7636		2.1904		4.7524		3.6864		7.9524		2.1316
	8	400				3.4596		3.7636		2.1904		4.7524		3.6864		7.9524		2.1316
		400								0.2304		0.5184		0.5184		1.1236		2.3104
		400												3.24		7.0756		2.6896
		400																3.4596
					635.3	6.9192	733.9	7.5272	733.9	4.6112	1012.3	10.0232	1012.3	11.1312	1491.4	24.104	1491.5	12.7228
						1.1%		1.0%		0.6%		1.0%		1.1%		1.6%		0.9%
	10	630				3.0276		3.9204		1.69		3.6864		1.9044		5.4756		2.56
	10	630				3.0276		3.9204		1.69		3.6864		1.9044		5.4756		2.56
		630								0.5184		1.1236		1.1236		2.43679258		1.3924
		630								0.81		3.61		1.2544		2.71845318		2.3716
					938.3	19.9044912	1083.7	22.9054564	1083.7	13.9370831	1599.3	32.1627014	1599.3	28.4601959	2356.4	64.3306078	2356.3	34.3381302
						2.1%		2.1%		1.3%		2.0%		1.8%		2.7%		1.5%
Total					1573.6	121.1	1817.6	156.1	1817.6	67.4	2611.6	144.4	2611.6	89.8	3847.8	197.3	3847.8	97.5
						7.7%		8.6%		3.7%		5.5%		3.4%		5.1%		2.5%

Attachment 13-2 Unit Capacity of Transformers and Annual Expense Ratio including Loss and Construction Cost

Power Factor	PF			0.90
Unit Capacity of Transformers	C	kVA		400.00
Operation Ratio of Transformers	U	%		100.00
Electrical Demand in a Model Area	P	kW		700,000.00
An Area of a Model	A	km2		10.00
Number of LV Feeders at a Transformer	F			3.00
Voltage of LV System	V	V		380.00
Resistance of a LV Line	R	Ω		0.29557
Loss of a Transformer at a Rated Current	TRLossRated	kW		4.00
Construction Cost for MV Lines(Annual expenses ratio)	MVCost	US$/km		1,645
Construction Cost for LV Lines(Annual expenses ratio)	TRCost	US$		1849.5
Construction Cost for Transformers(Annual expenses ratio)	LVCost	US$/km		1,439
Expenses of Loss for kWh		US$/kWh		0.06
Ratio of Loss				0.42
↓				
Resistance of Transformers	RT	Ω	TRLossRated*1000/(C*(U/100)*1000/√3*V)^2	0.01
Demand Density	D	kW/km2	P/A	70,000.00
An Area of a Transformer	S	km2	A/N	0.01
Length of a LV Feeder	L	km	√S	0.07
Current of a LV Feeder	I	A	(C*(U/100))*1000/F/(√3*V)	202.58
Loss of a LV Feeder	LVLoss	kW	√S*R*I^2/1000	0.87
Loss of a Transformer	TRLoss	kW	RT*(F*I)^2/1000	4.00
Length of MV Lines in a Model Area		km	√S*N	139.44
Number of Transformers in a Model Area	N		P/((C*(U/100))*PF)	1,944.44
Length of LV Lines in a Model Area		km	√S*F*N	418.33
Loss of Transformers in a Model Area		kW	TRLoss*N	7,777.78
Loss Ratio of Transformers in a Model Area				0.01
Loss of LV Lines in a Model Area		kW	LVLoss*F*N	5,074.19
Loss Ratio of LV Lines in a Model Area				0.01
Construction Cost of MV Lines in a Model Area (Annual Expenses Ratio)		US$		229,384.29
Construction Cost of Transformers in a Model Area (Annual Expenses Ratio)		US$		3,596,250.00
Construction Cost of LV Lines in a Model Area (Annual Expenses Ratio)		US$		602,060.56
Annual Expenses of Loss of Transformers in a Model Area		US$		1,848,593.60
Annual Expenses of Loss of LV Lines in a Model Area		US$		1,206,015.38
Total of Annual Expenses		US$		7,482,303.83

Attachment 13-3

Annual Expenses Ratio classified by Demand Densities and Applied Transformer Unit Capacities in a Model System (Overhead System in Damascus Rural)

(Evaluated in expenses of all facility and loss)

1.Condition:Overhead System in Rural

Power Factor	0.90		PF
Operation Ratio of Transformers	100.00		P
An Area of a Model	10.00	km^2	A
Voltage of LV System	380.00	V	V
Resistance of a LV Line	0.29557	Ω	R
Construction Cost for MV Lines (Annual Expenses)	1,645	US$/km/Y	MVCost
Construction Cost for LV Lines (Annual Expenses)	1,439	US$/km/Y	LVCost
Expenses of Loss for kWh	0.06460	US$	
Ratio of Annual Loss to Peak Loss	0.42		

2.Results

(Unit:US$/Year)

Demand Density (MW/km^2)	In case of having possibility of installation of Pole Mounted Transformers				In case of application of Ground Mounted Transformers				
	50 kVA	100 kVA	200 kVA	400 kVA	200 kVA	400 kVA	630 kVA	1,000 kVA	1,600 kVA
0.01	18,297	16,854	19,161	25,130	19,901	25,345	29,624	37,493	45,336
0.30	145,513	120,946	125,900	156,718	148,105	163,158	181,558	223,028	266,572
0.60	238,246	191,563	193,064	235,302	237,474	248,182	270,596	328,070	390,070
0.70	266,926	212,975	212,969	258,194	264,781	273,221	296,364	358,097	425,189
1.00	349,207	273,626	268,503	321,307	342,520	342,773	367,080	439,776	520,356
2.00	602,051	455,364	429,770	499,961	577,803	542,894	565,241	664,142	779,497
4.00	1,067,825	780,781	707,886	798,180	1,003,953	884,047	891,593	1,023,649	1,189,582
5.00	1,291,363	934,575	836,542	933,452	1,206,625	1,040,785	1,038,383	1,182,505	1,369,284
10.00	2,367,253	1,663,683	1,433,297	1,547,922	2,173,464	1,762,589	1,699,050	1,883,339	2,154,475
60.00	12,356,538	8,220,906	6,544,408	6,553,330	10,985,408	7,841,330	6,956,639	7,171,286	7,920,180
70.00	14,305,686	9,485,903	7,512,425	7,482,304	12,693,592	8,984,970	7,922,770	8,119,990	8,941,282
100.00	20,115,539	13,245,051	10,374,645	10,213,579	17,776,312	12,360,245	10,755,274	10,882,074	11,902,695
110.00	22,042,883	14,489,257	11,318,398	11,110,274	19,460,231	13,471,608	11,683,185	11,782,037	12,864,692

Attachment 13-4

Annual Expenses Ratio classified by Demand Densities and Applied Transformer Unit Capacities in a Model System (Underground System in Damascus City)

(Evaluated in expenses of all facility and loss)

1.Condition:Underground system in City

Power Factor	0.90		PF
Operation Ratio of Transformers	100.00		P
An Area of a Model	10.00	km^2	A
Voltage of LV System	380.00	V	V
Construction Cost for MV Lines (Annual Expenses)	0.18671	Ω/km	R
Construction Cost for MV Lines (Annual Expenses)	3,403	US$/km/Y	MVCost
Construction Cost for LV Lines (Annual Expenses)	3,067	US$/km/Y	LVCost
Expenses of Loss for kWh	0.06460	US$	
Ratio of Annual Loss to Peak Loss	0.42		

2.Results

(Unit:US$/Year)

Demand Density (MW/km^2)	In case of having possibility of installation of Pole Mounted Transformers				In case of application of Ground Mounted Transformers				
	50 kVA	100 kVA	200 kVA	400 kVA	200 kVA	400 kVA	630 kVA	1,000 kVA	1,600 kVA
1.00	501,791	366,588	358,527	378,913	432,544	400,380	435,559	488,485	591,612
2.00	817,837	586,833	557,084	581,429	705,117	624,362	662,084	733,027	880,269
3.00	1,103,324	783,000	729,322	754,923	951,372	819,323	854,219	937,434	1,119,082
4.00	1,372,992	966,705	887,935	913,394	1,184,002	999,261	1,028,551	1,121,065	1,332,094
10.00	2,849,765	1,957,655	1,717,980	1,730,091	2,458,146	1,944,758	1,915,599	2,037,368	2,379,807
20.00	5,112,154	3,452,532	2,930,087	2,902,364	4,410,420	3,331,697	3,170,176	3,303,320	3,801,585
30.00	7,277,906	4,871,271	4,058,966	3,982,861	6,279,466	4,626,861	4,315,998	4,442,356	5,065,743
40.00	9,393,634	6,250,597	5,144,763	5,015,853	8,105,429	5,874,519	5,405,525	5,515,694	6,248,311
50.00	11,477,394	7,604,737	6,203,028	6,018,485	9,903,861	7,091,818	6,459,076	6,547,049	7,378,739
60.00	13,538,447	8,940,986	7,241,736	6,999,552	11,682,736	8,287,552	7,487,072	7,548,580	8,472,130
70.00	15,582,293	10,263,679	8,265,625	7,964,278	13,446,791	9,466,945	8,495,704	8,527,514	9,537,456
80.00	17,612,516	11,575,638	9,277,781	8,916,067	15,199,114	10,633,400	9,489,005	9,488,557	10,580,563
100.00	21,641,377	14,174,671	11,274,891	10,789,648	18,676,557	12,936,315	11,440,061	11,369,159	12,615,258