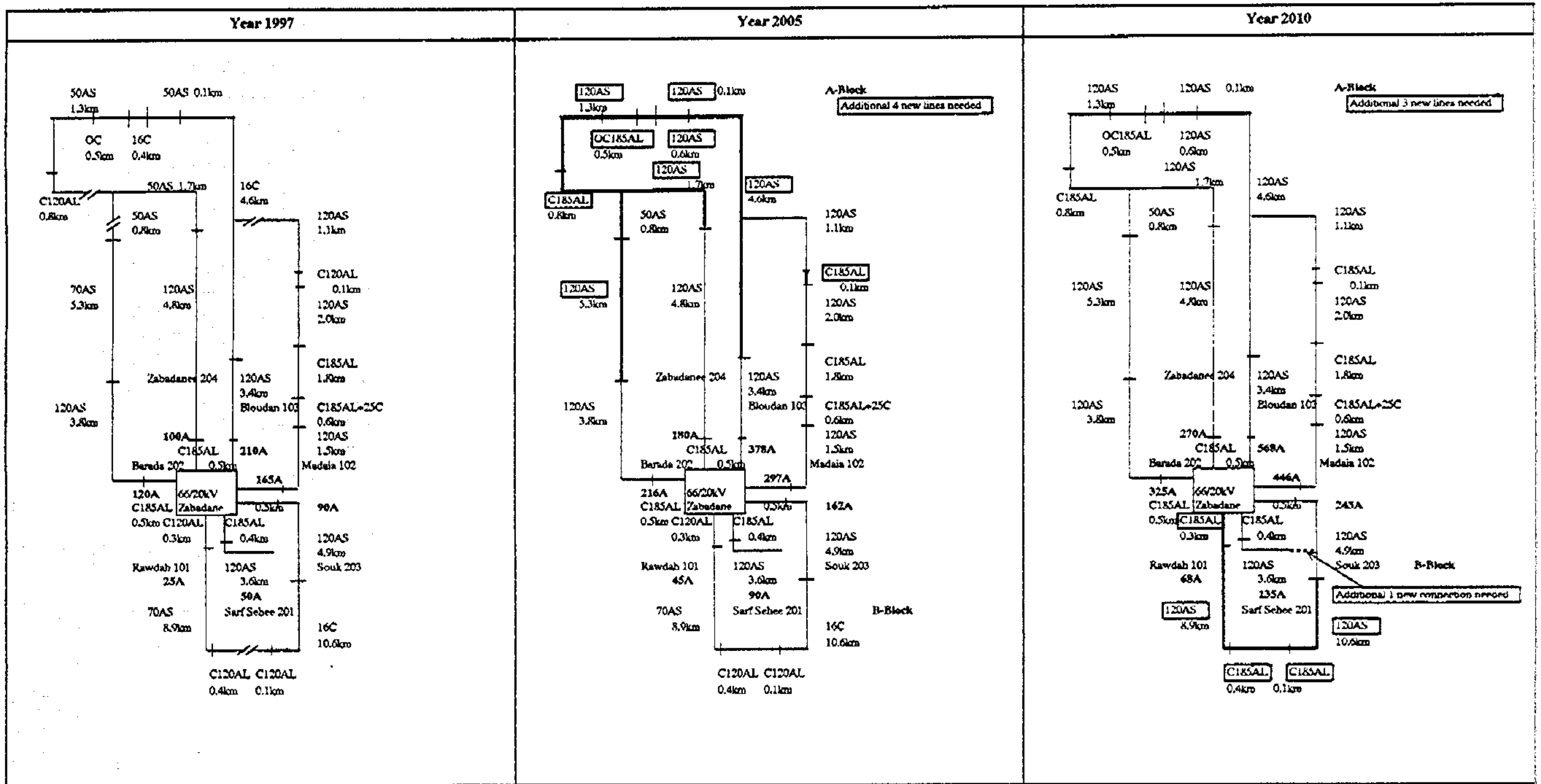
Figure 8.2-1 (1) Construction schedule on some 20 kV feeders from 66/20 kV Zabadani S/S

(Only main lines shown. Not including installation of switches)

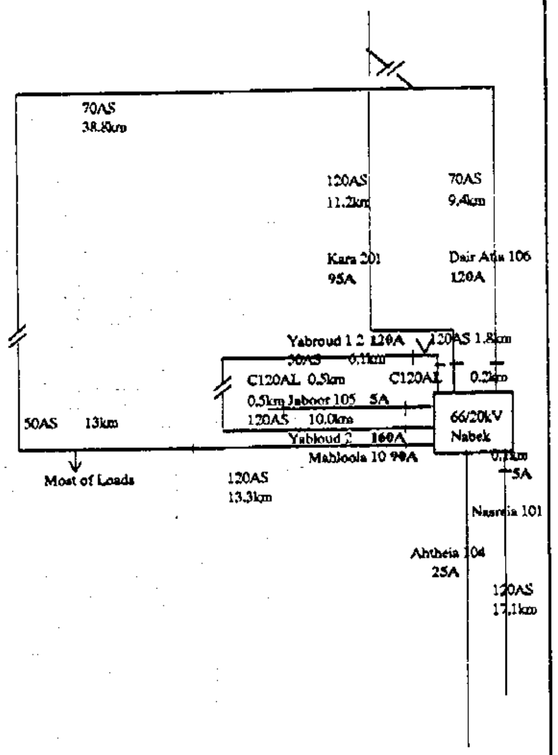


	Year 1997		Year 2005		Year 2010	
			Reinforcement	Construction	Reinforcement	Construction
			120AS 14.2km+12km(Branches)	120AS 12km	120AS 19.5km+9km(Branches)	120AS 9km+2km(Connections)
			C185AL 0.9km+0.4km(Branches)	C185AL 2.5km	C185AL 0.8km+0.3km(Branches)	C185AL 1.5km
			OC185AL 0.5km+0.4km(Branches)	OC185AL 0.5km	OC185AL 0.3km(Branches)	OC185AL 0.3km
	A	B	A	B	A	B
Number of feeder connected	4	2	4+4(New) = 8	2	8+3(New) =11	(2+1)(Connection) = 3
Total Current	100A+120A+210A+165A = 595A	90A+25A = 115A	180A+216A+378A+297A = 1071A	162A+45A = 207A	325A+270A+568A+446A =1609A	68A+135A+243A=446A
Average	149A	58A	134A	104A	146A	149A

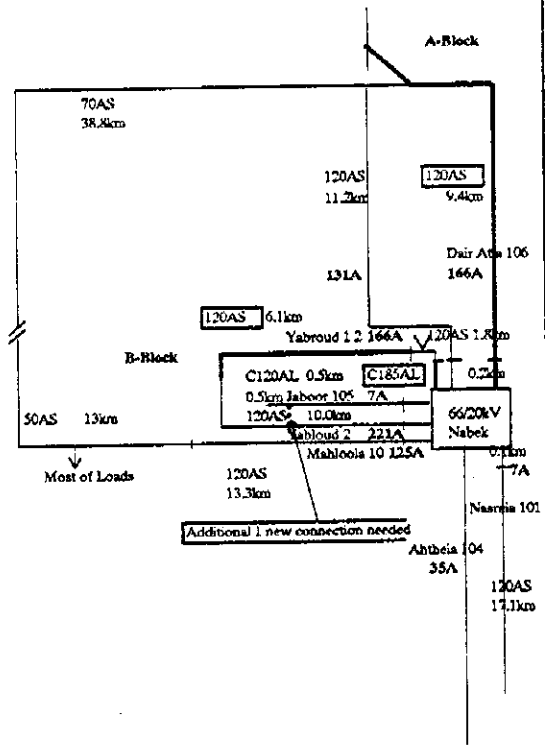
Figure 8.2-1 (2) Construction schedule on some 20 kV feeders from 66/20 kV Nabek S/S
(Only main lines shown. Not including installation of switches)

Year 1997	Year 2005	Year 2010

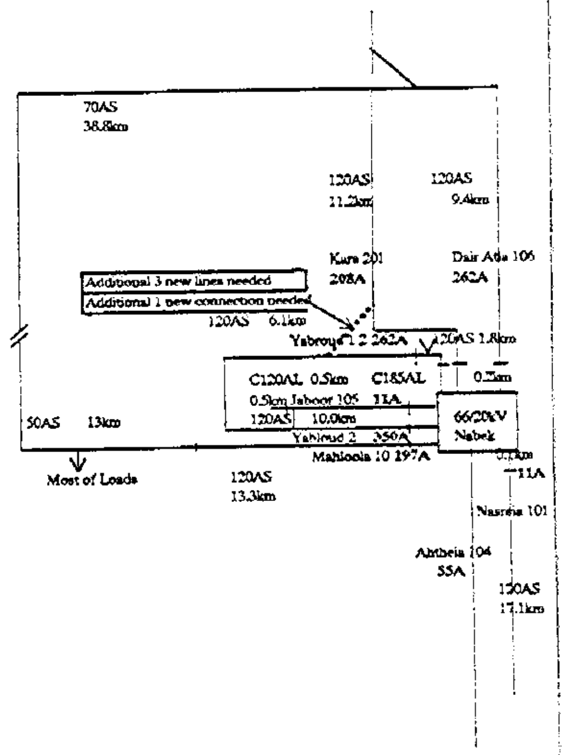
Year 1997



Year 2005



Year 2010



Year 2005

Reinforcement		Construction	
120AS	15.5km	120AS	2km(Connections)
C185AL	1.2km	C185AL	0km
OC185AL	0km	OC185AL	0km

Year 2010

Reinforcement		Construction	
120AS	9km(Branches)	120AS	9km+2km(Connections)
C185AL	0km+0.3km(Branches)	C185AL	1.5km
OC185AL	0km+0.3km(Branches)	OC185AL	0.3km

Year 1997

	A	B
Number of feeder connected	2	2
Total Current	215A	280A
Average	108A	140A

Year 2005

	A	B
Number of feeder connected	2	2+1(Connections)
Total Current	297A	394A
Average	149A	132A

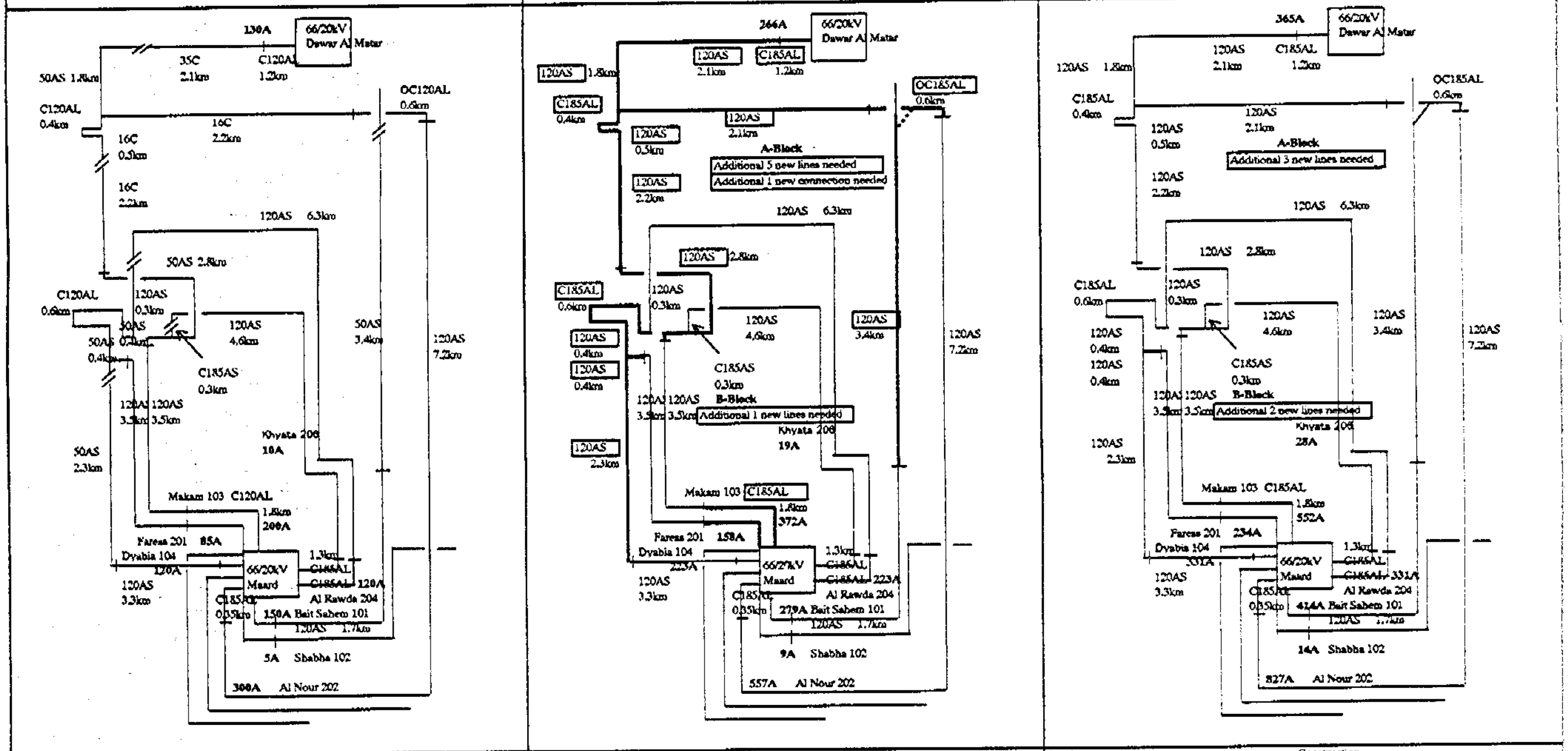
Year 2010

	A+B
Number of feeder connected	(2+3)(Connection)+3(New)
Total Current	197A+350A+11A+262A+208A+262A = 1290A
Average	161A

Figure 8.2-1 (3) Construction schedule on some 20 kV feeders from 66/20 kV Maarad S/S

(Only main lines shown. Not including installation of switches)

Year 1997	Year 2005	Year 2010



	Year 1997	Year 2005	Year 2010
Reinforcement		120AS 17.9km+18km(Branches) C185AL 6.1km+0.6km(Branches) OC185AL 0.6km+0.6km(Branches)	120AS 18km(Branches) C185AL 0km+0.6km(Branches) OC185AL 0km+0.6km(Branches)
Construction		120AS 18km+2km(Connections) C185AL 3km OC185AL 0.6km	120AS 18km C185AL 3km OC185AL 0.6km

Year 1997

	A	B
Number of feeder connected	4	3
Total Current	130A+200A+300A+10A = 640A	85A+120A+120A =325A
Average	160A	109A

Year 2005

	A	B
Number of feeder connected	(4+1)(Connection)+5(New)= 10	3+1(New)=4
Total Current	372A+19A+266A+279A+557A = 1493A	223A+158A+223A
Average	149A	151A

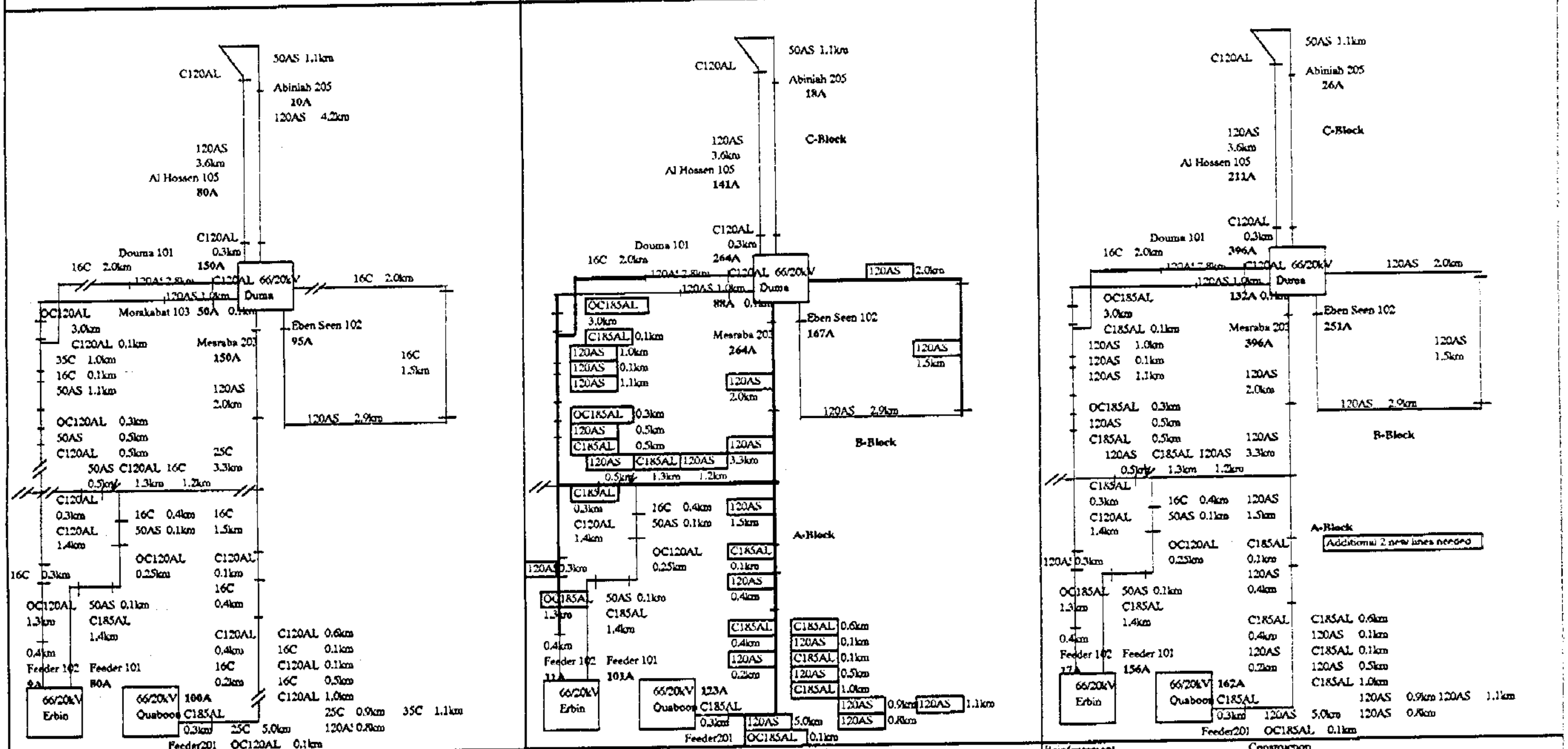
Year 2010

	A	B
Number of feeder connected	10+4(New)	4+2(New)=6
Total Current	365A+552A+28A+414A+827A = 2052A	331A+234A+331A = 896A
Average	156A	149A

Figure 8.2-1 (4) Construction schedule on some 20 kV feeders from 66/20 kV Duma S/S

(Only main lines shown. Not including installation of switches)

Year 1997	Year 2005	Year 2010



	Year 2005		Year 2010	
	Reinforcement	Construction	Reinforcement	Construction
120AS	23.7km	0km	6km(Branches)	6km
C185AL	6.2km	0km	0km+0.2km(Branches)	1.0km
OC185AL	4.7km	0km	0km+0.2km(Branches)	0.2km

Year 1997

	A	B	C
Number of feeder connected	6	2	2
Total Current	150A+50A+150A+9A+80A+100A = 539A	80A+10A	95A
Average	90A	45A	48A

Year 2005

	A	B	C
Number of feeder connected	6	2	2
Total Current	264A+88A+264A+11A+101A+123A = 850A	141A+18A	167A
Average	141A	80A	89A

Year 2010

	A	B	C
Number of feeder connected	6+2(New)	2	2
Total Current	396A+132A+396A+17A+156A+162A = 1259A	211A+26A	251A
Average	157A	119A	126A

ATTACHMENT

Attachment 8-1(1) Subprojects up to year 2002 : 66 kV Facilities (1/3)

Subprojects for Augmentation and Extension		Financing Source	Commissioning Year
1. Construction of New Substation			
(1)	Construction of 66/20 kV Kafersuseh Substation		
	a) Kafersuseh(2x30 MVA)	PEDEEE	2000
	b) Kafersuseh-Al Jamhaa UG line(1 cct. 2.2 km)	PEDEEE	2000
	c) Ersal-Midan 1 UG line from Al Jamhaa(1 cct. 0.5 km)	PEDEEE	2000
	d) Ersal-Midan 1 UG line from Kafersuseh(1 cct. 0.5 km)	PEDEEE	2000
	e) Al Jamhaa (two 66 kV UG line bays)	PEDEEE	2000
(2)	Construction of 66/20 kV Harash Substation		
	a) Harash(2x30MVA)	PEDEEE	2000
	b) pi-connection for Mazzrha-Amaween UG line(2 cct. 0.5 km)	PEDEEE	2000
(3)	Construction of 66/20 kV Khan Al Shih Substation		
	a) Khan Al Shih (1x20MVA)	PEDEEE	2000
	b) Kisweh -Khan Al Shih 66 kV OH line (1 cct.18 km)	PEDEEE	2000
	c) Kisweh(one 66 kV OH line bay)	PEDEEE	2000
(4)	Construction of 66 kV Barzeh substation		
	a) Barzeh (2x30MVA)	IDB	2001
	b) pi-conection of Qaboon II-Mazzrha UG line(2x0.5 km)	PEDEEE	2001
(5)	Construction of 66 kV Qsoor substation		
	a) Qsoor (2x30MVA)	IDB	2001
	b) pi-conection of Qaboon II-Mazzrha UG line(2x0.5 km)	PEDEEE	2001
(6)	Construction of 66 kV Ibn Al Nafis substation		
	a) Ibn Al Nafis (2x30MVA)	IDB	2001
	b) pi-conection of Qaboon II-Mazzrha UG line(2x0.5 km)	PEDEEE	2001
(7)	Construction of 66 kV Zablatani substation		
	a) Zablatani (2x30MVA)	IDB	2001
	b) pi-connection of Bab Sharki-Dawar Al Matar UG line (2x1.5 km)	PEDEEE	2001
(8)	Construction of 66 kV Jalaa substation		
	a) Jalaa (2x30MVA)	IDB	2001
	b) pi-connection of Al Jamhaa-Fursan OH line (2x0.5 km)	PEDEEE	2001
(9)	Construction of 66 kV Hosh Blas substation		
	a) Hosh Blas (2x30MVA)	IDB	2001
	b) pi-connection of Midan II-Kisweh OH line (2x0.5 km)	PEDEEE	2001
(10)	Construction of 66 kV Shekh Hassan substation		
	a) Shekh Hassan (2x30MVA)	IDB	2001
	b) Shekh Hassan-Dawar Al Matar 66 kV UG line (1 cct. 1.6 km)	PEDEEE	2001
	c) Dawar Al Matar (one 66 kV UG line bay for Shekh Hassan)	IDB	2001
(11)	Construction of 66 kV Jaramana substation		
	a) Jaramana (2x30MVA)	IDB	2001
	b) Jaramana-Bab Sharki 66 kV OH line (1 cct. 2.0 km)	PEDEEE	2001
	c) Bab Sharki (one 66 kV OH line bay for Jarmana)	IDB	2001
	d) Jaramana-Izaa 66 kV OH line (1 cct. 20 km)	PEDEEE	2001
	e) Izaa (one 66 kV OH line bay for Jaramana)	IDB	2001
(12)	Construction of 66 kV New Ersal substation		
	a) Ersal (3x40MVA)		2002
(13)	Construction of 66 kV Al Feigha substation		
	a) Al Feigha (2x20MVA)		2002
	b) pi-connection of Al Hameh- Dimas OH line (2x0.5 km)	PEDEEE	2002

Subprojects for Augmentation and Extension		Financing Source	Commissioning Year
2. Increase of Transformer Capacity			
Midan II	80 to 120MVA (1x20+2x30 to 4x30)	PEDEEE	2000
Ersal	40 to 60 MVA (2x20 to 2x30)	PEDEEE	2000
Fursan	60 to 90 MVA (2x30 to 3x30)	PEDEEE	2000
Al maarad	40 to 90 MVA (2x20 to 3x30)	PEDEEE	2000
Mazzrha	60 to 70 MVA (3x20 to 2x20+1x30)		2002
Al Ashmar	40 to 80 MVA (2x20 to 2x40)		2002
Qaboon II	50 to 60 MVA (1x30+1x20 to 2x30)		2002
Dummer	40 to 60 MVA (2x20 to 3x20)		2002
Duma	50 to 90 MVA (1x30+1x20 to 3x30)		2002
Adra II	20 to 60 MVA (1x20 to 3x20)		2002
Kotaifa	10 to 20 MVA (1x10 to 1x20)		2002
Nabek	40 to 70 MVA (2x20 to 2x20+1x30)		2002
Al Hameh	40 to 90 MVA (2x20 to 3x30)		2002
Zabadani	40 to 60 MVA (2x20 to 2x30)		2002
Kisweh	40 to 70 MVA (2x20 to +2x20+1x30)		2002
Dimas	20 to 40 MVA (1x20 to 2x20)		2002
Kudseia	10 to 40 MVA (1x10 to 2x20)		2002
Erbeen	40 to 60 MVA (2x20 to 3x20)		2002
Dawar Al Matar	40 to 60 MVA(2x20 to 3x20)		2002
Adra I	50 to 80 MVA(2x20+1x10 to 1x20+2x30)		2002
Al Matar	30 to 60 MVA(2x5+1x20 to 2x5+1x20+1x30)		2002
Izaa	40 to 60 MVA(2x20 to 3x20)		2002
Al Faihaa	40 to 60 MVA(2x20 to 3x20)		2002
Khan Al Shih	20 to 40 MVA(1x20 to 2x20)		2002
Al Maarad	60 to 120 MVA(2x30 to 3x40)		2002
3. Replacement of 20 kV Switchgear			
(1) Replacement of 20 kV Circuit Breaker			
(a) Midan I	28 nos. of 20 kV CB	PEDEEE	2000
(b) Ersal	35 nos. of 20 kV CB	PEDEEE	2000
(c) Qaboon I	10 nos. of 20 kV CB	PEDEEE	2000
(d) Midan II	47nos. of 20 kV CB		2002
(e) Duma	16 nos. of 20 kV CB		2002
(f) Adra I	8 nos. of 20 kV CB		2002
(g) Adra II	11 nos. of 20 kV CB		2002
(2) Replacement of Complete set of 20 kV Switchgear			
(a) Ashmar	Complete 20 kV switchgear	PEDEEE	2000
(b) Thawra	Complete 20 kV switchgear	PEDEEE	2000
4. Reinforcement of 66 kV Network			
(1) 66 kV connection to 230/66 kV Zahera substation			
(a) Shekh Hassan-Zeherar 66 kV UG line (1 cct. 1.7 km 630sqmm)		PEDEEE	2001
(b) Zahera -Al Ashmar 66 kV UG line (1cct.3.0 km)		PEDEEE	2001
(c) Al Ashmar(one 66 kV UG line bay for Zahera)		PEDEEE	2001
(d) Connection of Midan II-Dawal Al Matar UG line (Midan II side only, 0.5 km)		PEDEEE	2001
(e) Zahera -Dawar Al Matar 66 kV UG line (1cct., 630sqmm, 2.5 km)		PEDEEE	2001
(f) Zahera -Bab Sharki 66 kV UG line (1cct.3.8 km 630sqmm)		PEDEEE	2001
(g) Zahera -Al Hajar Al Aswad 66 kV OH line (1cct. 3.6 km)		PEDEEE	2001
(h) Bab Sharki(one 66 kV UG line bay for Zahera)		PEDEEE	2001
(i) Al Hajar Al Aswad (one 66 kV OH line bay for Zahera)		PEDEEE	2001
5. Installation of Static Capacitors			
(1) Under installation		PEDEEE	1999
(a) Bab Sharki	(3 x 5MVar)	PEDEEE	1999
(b) Ersal	(2 x 5MVar)	PEDEEE	1999
(c) Mazzrha	(3 x 5MVar)	PEDEEE	1999
(d) Ashmar	(2 x 5 MVar)	PEDEEE	1999

Attachment 8-1(1) Subprojects up to year 2002 : 66 kV Facilities

Subprojects for Augmentation and Extension		Financing Source	Commissioning Year
(e) Thawra	(2 x 10 MVar)	PEDEEE	1999
(f) Midan I	(3 x 5 MVar)	PEDEEE	1999
(g) Al Hajer	(2 x 10 MVar)	PEDEEE	1999
(h) Duma	(1 x 5 +1 x 10 MVar)	PEDEEE	1999
(i) Al Nabek	(2 x 5 MVar)	PEDEEE	1999
(j) Midan II	(2 x 10 +1x5 MVar)	PEDEEE	1999
(k) Maarad	(2 x 10MVar)	PEDEEE	1999
(2) **New Installation**			
(a) Sydanaya	(3x5MVar)		2002
(b) Al Faihaa	(2x10MVar)		2002
(c) Qaboon I	(3 x 10 MVar)		2002
6. Replacement of 66 kV circuit breakers			
(1) Mazzeha	9 nos. of 66 kV CB		2002
(2) Amaween	9 nos. of 66 kV CB		2002
(3) Midan I	6 nos. of 66 kV CB		2002

Attachment 8-1(2) Subprojects up to year 2005 : 66 kV Facilities (1/2)

Subprojects for Augmentation and Extension	Financing Source	Commissioning Year
1. Construction of New Substation		
(1) Construction of 66 kV Jededat Artouz substation		
a) Jededat Artouz (2x30MVA)	Saudi or Abu Dhabi*	2003
b) Jededat Artouz-Fursan 66 kV OH line (1 cct. 7.5 km)	PEDEEE	2003
c) Fursan (one 66 kV OH line bay for Jededat Artouz)	Saudi or Abu Dhabi*	2003
(2) Construction of 66 kV Bludan substation		
a) Bludan (2x30MVA)	Saudi or Abu Dhabi*	2003
b) Bludan-Zabadani 66 kV OH line (1 cct. 6.5 km)	PEDEEE	2003
c) Zabadani (one 66 kV OH line bay for Bludan)	Saudi or Abu Dhabi*	2003
(3) Construction of 66 kV Yalda substation		
a) Yalda (2x30MVA)	Saudi or Abu Dhabi*	2003
c) pi-connection of Al Hajar Al Aswad-Bab Sharki OH line(2x 1.0 km)	PEDEEE	2003
2. Increase of Transformer Capacity		
(1) Amaween 60 to 80 MVA(3x20 to 1x20+2x30)		2005
(2) Al Hajer Al Aswad 60 to 90 MVA (2x30 to 3x30)		2005
(3) Dummer 60 to 90 MVA (3x20 to 3x30)		2005
(4) Kafersuseh 60 to 100 MVA(2x30 to 2x50)		2005
(5) Harash 60 to 100 MVA(2x30 to 2x50)		2005
(6) Sydanaya 40 to 60MVA (2x20 to 3x20)		2005
(7) Erbeen 60 to 80 MVA(3x20 to 1x20+2x30)		2005
(8) Zabltani 60 to 100 MVA(2x30 to 2x50)		2005
(9) Kotaifa 20 to 40 MVA(1x20 to 2x20)		2005
(10) Adra I 80 to 110 MVA(1x20+2x30 to 1x20+3x30)		2005
3. Replacement of 20 kV Switchgear		
(1) **Replacement of 20 kV Circuit Breakers**		
(a) Qaboon I 52 nos. of 20 kV CB		2005
(b) Mazzhe 10 nos. of 20 kV CB		2005
(c) Amaween 25 nos. of 20 kV CB		2005
(d) Kotaife 12 nos. of 20 kV CB		2005
(e) Qaboon II 18 nos. of 20 kV CB		2005
(2) **Replacement of Complete set of 20 kV Switchgear**		
(a) Mazzrha Complete 20 kV switchgears		2005
(b) Bab Sharki Complete 20 kV switchgears		2005
(c) Nabek Complete 20 kV switchgears		2005
(d) Al Hameh Complete 20 kV switchgears		2005
(e) Al Matar Complete 20 kV switchgears		2005
4. Reinforcement of 66 kV Network		
(1) Upgrading of existing cables		
(a) Midan II-Al Hajar Al Aswad UG line (1 cct.630sqmm,2.8 km)	PEDEEE	2005
(2) Construction of new 66 kV UG line		
(a) Mazzrha-Ersal (1 cct.3 km 630sqmm)	PEDEEE	2005
(b) Mazzrha (one 66 kV UG line bay)	PEDEEE	2005
(c) Ersal (one 66 kV UG line bay)	PEDEEE	2005
(3) Construction of 66 kV 2nd OH line		
(a) Kotaifa-Sydanaya (23.8 km)	PEDEEE	2005
(b) Kotaifa-Adra II (19.2 km)	PEDEEE	2005
(c) Adra I-Adra II (2.3 km)	PEDEEE	2005
(d) Qaboon II-Duma (10.6 km)	PEDEEE	2005
(e) Kotaifa (two 66 kV OH line bay)	PEDEEE	2005
(f) Sydanaya (one 66 kV OH line bay)	PEDEEE	2005

Attachment 8-1(2) Subprojects up to year 2005 : 66 kV Facilities

Subprojects for Augmentation and Extension		Financing Source	Commissioning Year
(g) Arda I (one 66 kV OH line bay)		PEDEEE	2005
(h) Arda II (two 66 kV OH line bays)		PEDEEE	2005
(i) Qaboon II (one 66 kV OH line bay)		PEDEEE	2005
(j) Duma (one 66 kV OH line bay)		PEDEEE	2005
(4) Construction of new 66 kV OH line			
(a) Kisweh-Al Maarad (1cct, 24 km)		PEDEEE	2005
(b) Kisweh (one 66 kV OH line bay)		PEDEEE	2005
(c) Maarad (one 66 kV OH line bay)		PEDEEE	2005
5. Installation of Static Capacitors			
(a) Dummar	2x5 Mvar		2005
(b) Dimas	2x5 Mvar		2005
(c) Fursan	2x10 Mvar		2005
(d) Kisweh	2x5 Mvar		2005
(e) Adra I	2x5 Mvar		2005
(f) Erbeen	2x5 Mvar		2005
(g) Al Matar	2x5 Mvar		2005
(h) Zabadani	2x5 Mvar		2005
(i) Al Hameh	2x5 Mvar		2005
(j) Amaween	3x5 Mvar		2005
(k) Al Jamhaa	2x5 Mvar		2005
(l) Mazzhe	3x5 Mvar		2005
(m) Dawar Al Matar	2x5 Mvar		2005
(n) Adra II	2x5 Mvar		2005
(o) Qaboon II	2x5 Mvar		2005
6. Replacement of 66 kV circuit breakers			
(1) Mazzhe	5 nos. of 66 kV CB		2005
(2) Qaboon II	13 nos. of 66 kV CB		2005
(3) Al Hajar Al Aswed	6 nos. of 66 kV CB		2005
(4) Fursan	6 nos. of 66 kV CB		2005

Note: * under discussion

Attachment 8-1(3) Subprojects up to year 2010 : 66 kV Facilities (1/2)

Subprojects for Augmentation and Extension		Financing Source	Commissioning Year
1. Construction of New Substation			
(1)	Construction of 66/20 kV Al Tal substation		
	a) Al Tal (2x30MVA)	EU*	2006
	b) Al Tal-Al Faihaa 66 kV OH line (1 cct. 5.5 km)	PEDEEE	2006
	c) Al Faihaa (1x66 kV OH line bay)	EU*	2006
	d) pi-connection of Sydanaya-Al Faihaa (2x0.5 km)	PEDEEE	2006
(2)	Construction of 66/20 kV Yabroud substation		
	a) Yabroud (2x30MVA)	EU*	2006
	b) double pi-connection of Nabek-Kotaifa (4x0.5 km)	PEDEEE	2006
(3)	Construction of 66/20 kV Harasta substation		
	a) Harasta (2x30MVA)	EU*	2006
	b) Harasta-Erbeen 66 kV OH line (1 cct. 3.5 km)	PEDEEE	2006
	c) Erbeen (1x66 kV OH line bay)	EU*	2006
	d) Harasta-Al Faihaa 66 kV OH line (2cct. 6 km)	PEDEEE	2006
	e) Al Faihaa (2x66 kV OH line bay)	EU*	2006
(4)	Construction of 66/20 kV Nashabieh substation		
	a) Nashabieh (2x30MVA)	EU*	2006
	b) pi-connection of Izaa-Jaramana (2x0.5 km)	PEDEEE	2006
(5)	Construction of 66/20 kV Meleha substation		
	a) Meleha (2x30MVA)	EU*	2006
	b) pi-connection of Izaa-Jaramana (2x0.5 km)	PEDEEE	2006
(6)	Construction of 66/20 kV Kudseia 1 substation		
	a) Kudseia 1 (2x30MVA)	EU*	2006
(7)	Construction of 66/20 kV Kudseia-2 substation		
	a) Kudseia-2 (2x30MVA)	EU*	2006
	b) Kudseia 2-Kudseia 1 66 kV OH line (1 cct. 2.0 km)	PEDEEE	2006
	c)Kudseia 1 (1x66 kV OH line bay)	EU*	2006
	d) Kudseia 2-Dimas 66 kV OH line (1 cct. 11 km)	PEDEEE	2006
	e) Dimas (1x66 kV OH line bay)	EU*	2006
(8)	Construction of 66/20 kV Darea substation		
	a) Darea (2x30MVA)	EU*	2006
	b) Darea-Midan II 66 kV OH line (1 cct. 7 km)	PEDEEE	2006
	c)Midan II (1x66 kV OH line bay)	EU*	2006
	d) Darea-Fursan 66 kV OH line (1 cct. 4 km)	PEDEEE	2006
	e) Fursan (1x66 kV OH line bay)	EU*	2006
2. Increase of Transformer Capacity			
(1) Mazzrha	70 to 90 MVA(2x20+1x30 to 3x30)		2007
(2) Amaween	80 to 120 MVA(1x20+2x30 to 3x40)		2007
(3) Mazzhe	60 to 80 MVA(3x20 to 1x20+2x30)		2007
(4) Midan I	60 to 80 MVA(3x20 to 1x20+2x30)		2007
(5) Al Ashmar	80 to 100 MVA(2x40 to 2x40+1x20)		2007
(6) Thawra	90 to 120 MVA(3x30 to 3x40)		2007
(7) Dawar Al Matar	60 to 80 MVA(3x20 to 1x20+2x30)		2007
(8) Qsoor	60 to 100 MVA (2x30 to 2x50)		2007
(9) Hosh Blas	60 to 90 MVA(2x30 to 2x40)		2007
(10) Zabadani	60 to 90 MVA(2x30 to 3x30)		2007
(11) Khan Al Shih	40 to 60 MVA(2x20 to 3x20)		2007
(12) Al jamha	40 to 60 MVA(2x20 to 2x30)		2007
(13) New Ersal	120 to 160 MVA(3x40 to 4x40)		2007
(14) Al Matar	60 to 70 MVA(2x5+1x20+1x30 to 2x5+2x30)		2007
(15) Kisweh	70 to 90 MVA(2x20+1x30 to 3x30)		2009

Subprojects for Augmentation and Extension		Financing Source	Commissioning Year
(16) Erbeen	80 to 90 MVA(1x20+2x30 to 3x30)		2009
(17) Harasta	60 to 90 MVA(2x30 to 3x30)		2009
(18) Duma	90 to 120 MVA(3x30 to 3x40)		2010
(19) Al Hameh	90 to 120 MVA(3x30 to 3x40)		2010
3. Replacement of 20 kV Switchgear			
(1) **Replacement of Complete set of 20 kV Switchgear**			
(a) Al Hajer Al Aswad	Complete 20 kV swtichgears		2010
(b) Al Jamha	Complete 20 kV switchgears		2010
(c) Dummer	Complete 20 kV switchgears		2010
(d) Sydanaya	Complete 20 kV switchgears		2010
(e) Zabadani	Complete 20 kV switchgears		2010
(f) Fursan	Complete 20 kV switchgears		2010
(g) Izaa	Complete 20 kV switchgears		2010
(h) Kisweh	Complete 20 kV switchgears		2010
(i) Al Maarad	Complete 20 kV switchgears		2010
(j) Al Faihaa	Complete 20 kV switchgears		2010
4. Reinforcement of 66 kV Network			
(1) Upgrading the existing cables			
(a) Mazzrha-Thawra UG line (1 cct. 630sqmm, 3 km)		PEDEEE	2006
(2) Construction of 2nd OH line			
(a) Kotaifa-Nabek OH line (34.8 km)		PEDEEE	2006
(b) Kotaifa(1x66 kV OH line bay)		PEDEEE	2006
(c) Nabek (1x66 kV OH line bay)		PEDEEE	2006
(d) Dimas-Switching Station OH line (10 km)		PEDEEE	2008
(e) Dimas(1x66 kV OH line bay)		PEDEEE	2008
(f) Switching Station(1x66 kV OH line bay)		PEDEEE	2008
(3) 66 kV connection to 230/66 kV Saiedeh Zinab substation			
(a) Saiedeh Zinab-Yalda 66 kV OH line (1 cct. 2.5 km)		PEDEEE	2008
(b) Yalda (1x66 kV OH line bay)		PEDEEE	2008
(c) pi-connection of Al Maarad-Kisweh (2x1.5 km)		PEDEEE	2008
(d) Saiedeh Zinab - Al Maarad OH line (2nd cct, 4 km)		PEDEEE	2008
(e) Al Maarad (1 x 66 kV OH line bay)		PEDEEE	2008
(4) 66 kV connection to 230/66 kV Baramekha substation			
(a) pi-connection of Al Jamhaa-Ersal UG line(2x0.5 km)		PEDEEE	2008
(b) pi-connection of Al Jamhaa-Kafersuseh UG line(2x0.6 km)		PEDEEE	2008
(c) Baramekha-Ersal UG line(1 cct.6 km)		PEDEEE	2008
(d) Baramekha-Midan I UG line(1 cct.2.5 km)		PEDEEE	2008
(e) Ersal (1x66 kV UG line bay)		PEDEEE	2008
(f) Midan I (1x66 kV UG line bay)		PEDEEE	2008
5. Installation of Static Capacitors			
(1) Kotaifa	2x5 Mvar		2008
(2) Izaa	2x5 Mvar		2008
(3) Adra 2	2x5 Mvar		2008
(4) Qaboon 2	2x10 Mvar		2008
(5) Kisweh	2x5 Mvar		2008
(6) Zabadani	1x5 Mvar		2008
(7) Mazrrha	3x5 Mvar		2008
(8) Ersal	2x5 Mvar		2008
(9) Al Maarad	1x10 Mvar (2x10 to 3x10Mvar)		2008
6. Replacement of 66 kV Circuit Breakers			
(1) Adra II	9 nos. of 66 kV CB		2010
(2) Al Hameh	2 nos. of 66 kV CB		2010

Note: * under negotiation

Attachment 8-2(1) Subprojects up to year 2002 : 20 kV and Low Voltage Facilities (1/2)

Subprojects for Augmentation and Extension		Q'ty	Financing Source	Commissioning Year
1. Improvement of 20 kV Facilities				
A. Reinforcement and Construction and Replacement of 20 kV Feeders				
(1) For Damascus City Distribution Company				
(a) Reinforcement of 20 kV underground lines	C185AL, 1CCT	164 km		2002
(b) Construction of 20 kV underground lines	C185AL, 1CCT	60 km		2002
(c) Construction of service connection by 20 kV underground lines	C185AL, 1CCT	4 km		2002
(d) Replacement of Oil-cable to XLPE cable	C185AL, 1CCT	174 km		2002
(2) For Damascus Rural Distribution Company				
(a) Reinforcement of 20 kV overhead lines	120AS, 1 CCT	229 km		2002
(b) Reinforcement of 20 kV underground lines	C185AL, 1CCT	35 km		2002
(c) Reinforcement of 20 kV overhead cable lines	C185AL, 1CCT	15 km		2002
(d) Construction of 20 kV overhead lines	120AS, 1 CCT	77 km		2002
(e) Construction of 20 kV underground lines	C185AL, 1CCT	12 km		2002
(f) Construction of 20 kV overhead cable lines	C185AL, 1CCT	3 km		2002
(g) Construction of service connection by 20 kV overhead lines	120AS, 1 CCT	140 km		2002
(h) Replacement of Oil-cable to XLPE cable	C185AL, 1CCT	34 km		2002
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 sets		2002
(b) 20 kV Vacuum type load break switches	20 kV	63 sets		2002
(c) 20 kV Load break switch for interconnection	20 kV	283 sets		2002
(d) 20 kV Fault section indicators	20 kV	126 sets		2002
(e) 20 kV Reclosing relay	20 kV	126 sets		2002
(f) 20 kV/100V trasformers	Grounded at 20 kV	283 sets		2002
(2) For Damascus Rural Distribution Company				
(a) 20 kV auto-fault detecting device	20 kV	262 sets		2002
(b) 20 kV Vacuum type load break switches	20 kV	54 sets		2002
(c) 20 kV Load break switch for interconnection	20 kV	262 sets		2002
(d) 20 kV Fault section indicators	20 kV	104 sets		2002
(e) 20 kV Reclosing relay	20 kV	104 sets		2002
(f) 20 kV/100 V trasformers	Grounded at 20 kV	262 sets		2002
2. Installation of 20/0.4 kV Transformers				
(1) For Damascus City Distribution Company				
(a) 200 kVA Transformer	Oil Insulated	18 sets		2002
(b) 400 kVA Transformer	Natural Air Cooled	134 sets		2002
(c) 630 kVA Transformer	Three Phase	507 sets		2002
(d) 1000 kVA Transformer		18 sets		2002
(e) 1600 kVA Transformer		9 sets		2002
(2) For Damascus Rural Distribution Company				
(a) 50 kVA Transformer	Oil Insulated	8 sets		2002
(b) 100 kVA Transformer	Natural Air Cooled	36 sets		2002
(c) 200 kVA Transformer	Three Phase	223 sets		2002
(d) 400 kVA Transformer		398 sets		2002
(e) 630 kVA Transformer		330 sets		2002
(f) 1000 kVA Transformer		28 sets		2002
(g) 1600 kVA Transformer		13 sets		2002

Subprojects for Augmentation and Extension		Q'ty	Financing Source	Commissioning Year
3. Improvement of Low Voltage Facilities				
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
(b) Construction of 0.4 kV overhead lines	120AL, 1CCT	29 km		2002
(c) Reinforcement of 0.4 kV overhead lines by vynil covered conductor	120AL, 1CCT	6 km		2002
(d) Construction of 0.4 kV underground lines	120C, 1CCT	43 km		2002
(e) Construction of service connection with overhead lines	50C, 1CCT	113 km		2002
(f) Construction of service connection with underground lines	50C, 1CCT	48 km		2002
(2) For Damascus Rural Distribution Company				
(a) Reinforcement of 0.4 kV overhead lines	120AL, 1 CCT	175 km		2002
(b) Construction of 0.4 kV overhead lines	120AL, 1CCT	59 km		2002
(c) Reinforcement of 0.4 kV overhead lines by vynil covered conductor	120AL, 1CCT	7 km		2002
(d) Construction of 0.4 kV underground lines	120C, 1CCT	9 km		2002
(e) Construction of service connection with overhead lines	50C, 1CCT	251 km		2002
(f) Construction of service connection with underground lines	50C, 1CCT	13 km		2002
B. Meters and Meter Protection Boxes				
(1) For Damascus City Distribution Company				
(a) Meters		32,000 pcs		2002
(b) Meter Protection Boxes		6,000 pcs		2002
(2) For Damascus Rural Distribution Company				
(a) Meters		53,000 pcs		2002
(b) Meter Protection Boxes		11,000 pcs		2002
C. Miscellaneous Works				
(1) For Damascus City Distribution Company				
(a) Cable laying		378 loc.		2002
(b) Protection of cables		881 loc.		2002
(c) Installation of key locks		378 loc.		2002
(d) Repairing of transformer station		566 loc.		2002
(e) Repairing of Low voltage distribution panels		441 loc.		2002
(f) Replacement of fuses with the adequate size		944 loc.		2002
(g) Cleaning of facilities		1,384 loc.		2002
(h) Removal of un-used materials/equipment		1,259 loc.		2002
(2) For Damascus Rural Distribution Company				
(a) Cable laying		793 loc.		2002
(b) Protection of cables		974 loc.		2002
(c) Installation of key locks		108 loc.		2002
(d) Repairing of transformer station		938 loc.		2002
(e) Repairing of Low voltage distribution panels		757 loc.		2002
(f) Replacement of fuses with the adequate size		1,154 loc.		2002
(g) Cleaning of facilities		1,046 loc.		2002
(h) Removal of un-used materials/equipment		901 loc.		2002

Note: "loc." means " locations".

Attachment 8-2(2) Subprojects up to year 2005 : 20 kV and Low Voltage Facilities (1/2)

Subprojects for Augmentation and Extension		Q'ty	Financing Source	Commissioning Year
1. Improvement of 20 kV Facilities				
A. Reinforcement and Construction and Replacement of 20 kV Feeders				
(1) For Damascus City Distribution Company				
(a) Reinforcement of 20 kV underground lines	C185AL, 1CCT	164 km		2005
(b) Construction of 20 kV underground lines	C185AL, 1CCT	60 km		2005
(c) Construction of service connection by 20 kV underground lines	C185AL, 1CCT	4 km		2005
(2) For Damascus Rural Distribution Company				
(a) Reinforcement of 20 kV overhead lines	120AS, 1 CCT	229 km		2005
(b) Reinforcement of 20 kV underground lines	C185AL, 1CCT	35 km		2005
(c) Reinforcement of 20 kV overhead cable lines	C185AL, 1CCT	15 km		2005
(d) Construction of 20 kV overhead lines	120AS, 1 CCT	77 km		2005
(e) Construction of 20 kV underground lines	C185AL, 1CCT	12 km		2005
(f) Construction of 20 kV overhead cable lines	C185AL, 1CCT	3 km		2005
(g) Construction of service connection by 20 kV overhead lines	120AS, 1 CCT	140 km		2005
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 sets		2005
(b) 20 kV Vacuum type load break switches	20 kV	63 sets		2005
(c) 20 kV Load break switch for interconnection	20 kV	283 sets		2005
(d) 20 kV Fault section indicators	20 kV	126 sets		2005
(e) 20 kV Reclosing relay	20 kV	126 sets		2005
(f) 20 kV/100 V trasformers	Grounded at 20 kV	283 sets		2005
(2) For Damascus Rural Distribution Company				
(a) 20 kV auto-fault detecting device	20 kV	262 sets		2005
(b) 20 kV Vacuum type load break switches	20 kV	54 sets		2005
(c) 20 kV Load break switch for interconnection	20 kV	262 sets		2005
(d) 20 kV Fault section indicators	20 kV	104 sets		2005
(e) 20 kV Reclosing relay	20 kV	104 sets		2005
(f) 20 kV/100V trasformers	Grounded at 20 kV	262 sets		2005
2. Installation of 20/0.4 kV Transformers				
(1) For Damascus City Distribution Company				
(a) 200 kVA Transformer	Oil Insulated	9 sets		2005
(b) 400 kVA Transformer	Natural Air Cooled	89 sets		2005
(c) 630 kVA Transformer	Three Phase	231 sets		2005
(d) 1000 kVA Transformer		18 sets		2005
(e) 1600 kVA Transformer				2005
(2) For Damascus Rural Distribution Company				
(a) 50 kVA Transformer	Oil Insulated	2 sets		2005
(b) 100 kVA Transformer	Natural Air Cooled	26 sets		2005
(c) 200 kVA Transformer	Three Phase	98 sets		2005
(d) 400 kVA Transformer		180 sets		2005
(e) 630 kVA Transformer		125 sets		2005
(f) 1000 kVA Transformer		6 sets		2005
(g) 1600 kVA Transformer		6 sets		2005

Attachment 8-2(2) Subprojects up to year 2005 : 20 kV and Low Voltage Facilities

Subprojects for Augmentation and Extension		Q'ty	Financing Source	Commissioning Year
3. Improvement of Low Voltage Facilities				
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
(b) Construction of 0.4 kV overhead lines	120AL, 1CCT	42 km		2005
(c) Reinforcement of 0.4 kV overhead lines by vynil covered conductor	120AL, 1CCT	6 km		2005
(d) Construction of 0.4 kV underground lines	120C, 1CCT	19 km		2005
(e) Construction of service connection with overhead lines	50C, 1CCT	153 km		2005
(f) Construction of service connection with underground lines	50C, 1CCT	66 km		2005
(2) For Damascus Rural Distribution Company				
(a) Reinforcement of 0.4 kV overhead lines	120AL, 1 CCT	28 km		2005
(b) Construction of 0.4 kV overhead lines	120AL, 1CCT	73 km		2005
(c) Reinforcement of 0.4 kV overhead lines by vynil covered conductor	120AL, 1CCT	7 km		2005
(d) Construction of 0.4 kV underground lines	120C, 1CCT	7 km		2005
(e) Construction of service connection with overhead lines	50C, 1CCT	326 km		2005
(d) Construction of service connection with underground lines	50C, 1CCT	17 km		2005
B. Meters and Meter Protection Boxes				
(1) For Damascus City Distribution Company				
(a) Meters		44,000 pcs		2005
(b) Meter Protection Boxes		9,000 pcs		2005
(2) For Damascus Rural Distribution Company				
(a) Meters		69,000 pcs		2005
(b) Meter Protection Boxes		14,000 pcs		2005

Attachment 6-2(3) Subprojects up to year 2010 : 20 kV and Low Voltage Facilities

Subprojects for Augmentation and Extension		Q'ty	Financing Source	Commissioning Year
1. Improvement of 20 kV Facilities				
A. Reinforcement and Construction and Replacement of 20 kV Feeders				
(1) For Damascus City Distribution Company				
(a) Reinforcement of 20 kV underground lines	C185AL, 1CCT	273 km		2010
(b) Construction of 20 kV underground lines	C185AL, 1CCT	100 km		2010
(c) Construction of service connection by 20 kV underground lines	C185AL, 1CCT	7 km		2010
(2) For Damascus Rural Distribution Company				
(a) Reinforcement of 20 kV overhead lines	120AS, 1 CCT	278 km		2010
(b) Reinforcement of 20 kV underground lines	C185AL, 1CCT	10 km		2010
(c) Reinforcement of 20 kV overhead cable lines	C185AL, 1CCT	7 km		2010
(d) Construction of 20 kV overhead lines	120AS, 1 CCT	208 km		2010
(e) Construction of 20 kV underground lines	C185AL, 1CCT	32 km		2010
(f) Construction of 20 kV overhead cable lines	C185AL, 1CCT	6 km		2010
(g) Construction of service connection by 20 kV overhead lines	120AS, 1 CCT	200 km		2010
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	204 sets		2010
(b) 20 kV Vacuum type load break switches	20 kV	45 sets		2010
(c) 20 kV Load break switch for interconnection	20 kV	204 sets		2010
(d) 20 kV Fault section indicators	20 kV	92 sets		2010
(e) 20 kV Reclosing relay	20 kV	92 sets		2010
(f) 20 kV/100 V trasformers	Grounded at 20 kV	204 sets		2010
(2) For Damascus Rural Distribution Company				
(a) 20 kV auto-fault detecting device	20 kV	248 sets		2010
(b) 20 kV Vacuum type load break switches	20 kV	45 sets		2010
(c) 20 kV Load break switch for interconnection	20 kV	248 sets		2010
(d) 20 kV Fault section indicators	20 kV	98 sets		2010
(e) 20 kV Reclosing relay	20 kV	98 sets		2010
(f) 20 kV/100V trasformers	Grounded at 20 kV	248 sets		2010
2. Installation of 20/0.4 kV Transformers				
(1) For Damascus City Distribution Company				
(a) 200 kVA Transformer	Oil Insulated	9 sets		2010
(b) 400 kVA Transformer	Natural Air Cooled	142 sets		2010
(c) 630 kVA Transformer	Three Phase	347 sets		2010
(d) 1000 kVA Transformer		36 sets		2010
(e) 1600 kVA Transformer				2010
(2) For Damascus Rural Distribution Company				
(a) 50 kVA Transformer	Oil Insulated	8 sets		2010
(b) 100 kVA Transformer	Natural Air Cooled	49 sets		2010
(c) 200 kVA Transformer	Three Phase	243 sets		2010
(d) 400 kVA Transformer		379 sets		2010
(e) 630 kVA Transformer		347 sets		2010
(f) 1000 kVA Transformer		28 sets		2010
(g) 1600 kVA Transformer		11 sets		2010

Attachment 8-2(3) Subprojects up to year 2010 : 20 kV and Low Voltage Facilities (2/2)

Subprojects for Augmentation and Extension		Q'ty	Financing Source	Commissioning Year
3. Improvement of Low Voltage Facilities				
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
(b) Construction of 0.4 kV overhead lines	120AL, 1CCT	45 km		2010
(c) Reinforcement of 0.4 kV overhead lines by vynil covered conductor	120AL, 1CCT	10 km		2010
(d) Construction of 0.4 kV underground lines	120C, 1CCT	35 km		2010
(e) Construction of service connection with overhead lines	50C, 1CCT	300 km		2010
(f) Construction of service connection with underground lines	50C, 1CCT	129 km		2010
(2) For Damascus Rural Distribution Company				
(a) Reinforcement of 0.4 kV overhead lines	120AL, 1 CCT	85 km		2010
(b) Construction of 0.4 kV overhead lines	120AL, 1CCT	105 km		2010
(c) Reinforcement of 0.4 kV overhead lines by vynil covered conductor	120AL, 1CCT	11 km		2010
(d) Construction of 0.4 kV underground lines	120C, 1CCT	15 km		2010
(e) Construction of service connection with overhead lines	50C, 1CCT	671 km		2010
(d) Construction of service connection with underground lines	50C, 1CCT	35 km		2010
B. Meters and Meter Protection Boxes				
(1) For Damascus City Distribution Company				
(a) Meters		86,000 pcs		2010
(b) Meter Protection Boxes		17,000 pcs		2010
(2) For Damascus Rural Distribution Company				
(a) Meters		141,000 pcs		2010
(b) Meter Protection Boxes		28,000 pcs		2010

CHAPTER IX

EFFECT OF IMPROVEMENT PLAN

Chapter 9 Effect of Development Plan

9.1 Improvement of Power Supply Situation

The situation of power supply to consumers is evaluated with the quantity of supply, quality of supply, and reliability of supply.

- Quantity of power supply to consumers is evaluated with power supply capability to meet consumers' requirement.
- Quality of power supply to consumers is evaluated with supply of qualified power to consumers, i.e. power at specified frequency and voltage, to consumers.
- Reliability of power supply to consumers is evaluated with continuity of supply, in other words, continuous supply under a minimum interruption.

(1) Quantity of Power Supply

This subject is attained by proper operation of power generating facilities and adequate capacities of transmission and distribution facilities. Of which, the demand – supply balance of power system has been improved by recent commissioning of new power stations, and at present the Syrian power system has enough generation capacity to satisfy the demand in the coming several years.

While, the power transfer capacity of the distribution system in the study area is not sufficient; there are many transformers of both 66/20 kV and 20/0.4 kV, and distribution feeders overloaded at present. The present situation will worsen if the demand in the area further increases in future.

Such situation will be improved by execution of the distribution system rehabilitation project planned in this study, which comprises addition of transformer capacities and reinforcement of distribution feeders to meet current needs taking into account demand growth to the year 2010. For formulating the reinforcement plan of distribution network, the Standards for 66 kV Substations and Transmission Lines and for 20/0.4 kV Distribution Facilities recommended by the Study Team as discussed in Chapter 7 are referred to.

Based on the procurement schedule of 66/20 kV transformers discussed in Clause 8.1.2, improvement of transformer overload at N-1 criteria at major substations in Damascus City is shown in Attachment 9-1. An example of improvement in cases of "with" and "without" the procurement is shown in Attachment 9-2.

(2) Quality of Power Supply

The power system frequency is controlled by the power generating stations, under the joint operation of central load dispatching center for generation control and power stations. Thus, the system frequency is out of control for a distribution system.

In the existing distribution network, the drop of consumer end voltage is significant due to (1) relatively low operating voltage of the 66 kV and 20 kV buses at 66/20 kV substations and (2) sharp voltage drop in 20/0.4 kV networks. The insufficient capacity of transformers is also a cause of the low voltage operation of substation buses. Power consumption increases exceeding the available capacity of transformers if the bus voltage is kept normal. Thus, for lessening load shedding, the problem of insufficient transformer capacity is currently being solved by keeping the system voltage low and reducing actual load.

Situation of voltage drop will be much improved by execution of the distribution network rehabilitation, based on criteria mentioned in the Standards for Planning Distribution Facilities formulated by the study team. The increase of supply capacity mentioned in the above (1) will also contribute to avoid excessive voltage drop.

(3) Reliability of Power Supply

The reliability of power supply is usually evaluated by continuity of supply. In this study, the Team proposed to adopt the deterministic criteria expressed as 'N-1' criterion (single outage contingency) as mentioned in Clause 7.2.2.

At present there is no criterion or clear idea in Syria regarding the reliability of power supply to consumers, and the reliability problems are not properly managed. For example, in the planning of substation transformers, the quantity and unit capacity of 66/20 kV transformers have been decided from the peak demand only, but without consideration of the supply reliability. Therefore, many transformers are having nearly 100% load of transformer rated capacity and sometimes overloaded. Under such situation, if one unit of transformer becomes out of service, the remaining transformer/transformers are not possible to take over the interrupted loads, and accordingly the interruption of power supply to consumers may prolong until the faulted transformer returns to the operation.

The 'N-1' criterion requires ensuring continuity of power supply even when any one component of power network is out of operation. In this study, the rehabilitation plans of the distribution facilities are prepared to satisfy the requirement of the "N-1" criterion as far as applicable, for the design of not only 66/20kV transformers but also 66kV transmission lines, 20 kV feeders, 20/0.4kV transformers, etc. Thus, the system reliability problem will be significantly improved.

(4) Indirect effect by improvement of power supply situation

The following indirect effects are expected from the above improvement in quantity, quality and reliability of power supply:

(a) As the distribution facilities will have a sufficient power supply capacity by the rehabilitation project, the scheduled power cuts to consumers during peak load time, which had been imposed in the past frequently, will disappear.

(b) As the significant improvements in the excessive voltage drop and low frequency will raise the quality of electric power, most of consumers will be satisfied with the power supply of high quality.

(c) The time duration for un-served energy due to outages will be shortened remarkably through the improvement of power supply reliability and accordingly the consumers will receive more dependable power supply.

In the past, the relatively large power consumers, e.g. factories, office buildings, shops and others, have been obliged to equip expensive diesel generators and/or un-interrupted power supply facilities to protect them from frequent power failures. These expensive power supply facilities will become out of necessity by the significant improvements in quality, quantity and reliability of power supply as mentioned above. This will solve financial constraints for peoples who intend to start economic activities, since high initial investment costs for these facilities can be eliminated from their planning. Accordingly, this will contribute a lot to revitalization of the economy.

Furthermore, the same effects are expected in the ordinary domestic customers by the stable power supply of high quality, which will improve the living standard of the public.

9.2 Improvement of Energy Loss and Voltage Drop

(1) Effect of Loss Reduction and Improvement of Voltage Drop in the 20 kV Distribution System

As mentioned in Chapter 7, the Team proposed to adopt one line circuit with multi-divided and multi-connected systems for 20 kV systems in order to improve system reliability. This system needs the standardized large cross-section of conductors in main lines, which should have enough current capacity to cover power supply to the consumers in the fault section by switching operation. Further, the adoption of standardized large cross section of conductor will reduce loss and voltage drops in 20 kV lines. In order to evaluate effect of loss reduction and improvement of voltage drops, power flow analysis for the several sample feeders of Damascus Rural area were carried out as shown in Table 9.2-2.

In the power flow analysis, it is supposed that capacity of 20/0.4 kV transformer is sufficient to meet the peak load and its power factor is 0.9 at primary side. 20/0.4 kV transformer's loss which is estimated at about 1% is neglected and admittance of aluminum conductor is assumed to be 0.1%/km/cct at 20 kV and 1 MVA base in the computation. Line constant of each type of conductors/cables are shown in Table 5.3-1.

The results of power flow analysis for each case are shown on Fig. 9.2-1 to Fig. 9.2-4 and the summary is shown in Table 9.2-1.

Table 9.2-1 Loss Reduction in Improved 20 kV System in Damascus Rural

Names of 20 kV feeders	Present 20kv System			Improved 20kv System			Effect
	Power (kW)	Loss (kW) (a)	Loss Ratio	Power (kW)	Loss (kW) (b)	Loss ratio	(a - b) / a
Maarad Al Nour	10,164	1,278	12.6%	9,707	821	8.5%	35.8%
Zabadane Bloudan	7,487	1,267	16.9%	6,780	560	5.5%	55.8%
Zabadane Barada	3,690	136	3.7%	3,656	102	2.8%	25.0%
Nabek Dair Atia	3,653	99	2.7%	3,613	58	1.6%	41.4%
Total	24,993	2,780	11.1%	23,755	1,542	6.5%	44.5%

Effect of loss reduction in these sample feeders is calculated at 44.5% in total. The effect of loss reduction in the whole 20 kV feeders of the study area is not possible to be calculated, because detailed data of all 20 kV feeders such as lengths, cross sections of conductors, load distribution, branch lines, etc. are not available to the Team. However, according to the result of power flow analysis on the sample feeders, it is roughly estimated that the effect of loss reduction by applying standardized larger size of conductor to all main lines in Damascus Rural will be more than 30 %.

In Damascus City area, 2 types of cross section of 20 kV cables are mainly used. Type, cross section and resistances of conductors are shown in Table 9.2-2. As detailed data of 20 kV feeders are not available to the Team, it is difficult to estimate the effect of loss reduction for Damascus City at the present. In case that 30% of all conductors in Damascus City area are supposed to be replaced with C185AL, the effect of loss reduction is estimated at approximately 10% from the following formula.

$0.3 \times (0.253 - 0.164) / 0.253 = 11\%$ (Losses increase in proportion to resistance of cable.)

Table 9.2-2 Main Conductor and Resistance

Conductor	Resistance at 70°C (Ω/km)
C120AL	0.253
C185AL	0.164

The effect of improvement in voltage drops for sample 20 kV feeders was also examined through the power flow analysis in case of adoption of standardized large cross section of conductors to main lines in Damascus Rural area.

Table 9.2-3 Effect of Improvement of Voltage Drops

Names of 20 kV feeders	Present System			Improved System		
	Voltage at 66/20 kV substation	Voltage at largest voltage drop point	Voltage drop ratio	Voltage at 66/20 kV substation	Voltage at largest voltage drop point	Voltage drop ratio
Maarad Al Nour	19.0 kV	15.9 kV	16.2%	19.0 kV	16.8 kV	11.4%
Zabadane Bloudan	19.0 kV	13.8 kV	27.6%	19.0 kV	15.8 kV	17.0%
Zabadane Barada	19.0 kV	18.1 kV	4.9%	19.0 kV	18.2 kV	4.0%
Nabek Dair Atia	19.0 kV	18.2 kV	4.3%	19.0 kV	18.4 kV	2.9%

As seen in the above table, voltage drops in the above 20 kV feeders are improved by applying larger cross section to the sample feeders, but in the 20 kV feeders of Maarad Al Nour and Zabadane Bloudan, the voltage drops are still in the higher level. To solve the large voltage drops in such feeders, the construction of a new 20 kV feeder from a new substation or connection to other 20 kV feeder is necessary. For example, 66/20 kV Bloudan substation is planned to be constructed at the north of Zabadani and new 20 kV outgoing feeders from the substation will be constructed to take over the loads of those feeders. Thus, the large voltage drops in the 20 kV feeders will be solved.

(2) Effect of Loss Reduction and Improvement of Voltage Drops Applying to Standard Capacity of 20/0.4 kV Transformers

As discussed in Section 7.7.1, the same capacities of transformers with existing transformers are recommended to be installed in order to improve large voltage drops in the low voltage system. Loss ratio may vary in proportion to $\sqrt{(C/D)}$, where C is transformers capacity and D is demand density. Therefore, supposing that C is considered constant, loss ratio will increase in proportion to $\sqrt{(1/D)}$. According to power demand forecast, the peak demand in 2010 will increase to 2.4 times of that in 1997. Where the demand density in 2010 is supposed to increase to twice of demand density in 1997, the loss in 2010 will be reduced to about 70% of loss in 1997. It is therefore concluded that the effect of loss reduction during next ten years is estimated at more than 30 % by the improvement plan to install additional 20/0.4 kV transformers with the same capacities of existing transformers according to the growth of demand density. The following table shows the differences of losses calculated for various capacities of 20/0.4 kV transformers under the two different cases, where demand density is assumed at 500 kW/km^2 and 1000 kW/km^2.

Table 9.2-4 Loss of Low-Tension Feeders by Demand Density in an Ideal Model (unit: kW)

Applied Trans. Capacity	50 kVA	100 kVA	200kVA	400 kVA	630kVA	1,000 kVA	630×2 kVA
500 kW/km^2	1,577.9	2,231.5	3,155.8	4,462.9	5,600.9	7,056.5	7,920.9
Demand = 50 MW	(3.2%)	(4.5%)	(6.3%)	(8.9%)	(11.2%)	(14.1%)	(15.8%)
1,000 kW/km^2	2,231.5	3,155.8	4,462.9	6,311.5	7,920.9	9,979.4	11,201.8
Demand = 100 MW	(2.2%)	(3.2%)	(4.5%)	(6.3%)	(7.9%)	(10.0%)	(11.2%)

An area = 100 km^2, Conductor =120AS, Current at a low voltage line =200 A, Voltage = 380 V

Voltage drops will also vary in proportion to $\sqrt{(C/D)}$ which also relates to the length of a low voltage feeder according to Attachment 7-3 in Chapter 7. Therefore, the effect of improvement in voltage drops is approximately the same as that of loss reduction. The following table shows the equivalent lengths of low tension feeders from the 20/0.4 kV transformers in the area covered by one unit of 20/0.4 kV transformer for the demand density of 500 kW and 1,000 kW respectively and calculated in an ideal model feeder. It shows that voltage drop may increase with the increase of length of feeder.

Table 9.2-5 Length of Low-tension Feeders by Demand Density Calculated in an Ideal Model

Applied Trans. Capacity	50 kVA	100 kVA	200 kVA	400 kVA	630 kVA	1,000 kVA	630x2 kVA
500 kW/km^2 Demand=50 MW	320 m	450 m	630 m	890 m	1,120 m	1,410 m	1,590 m
1,000 kW/km^2 Demand=100 MW	220 m	320 m	450 m	630 m	790 m	1,000 m	1,120 m

An area = 100 km^2, Conductor = 120AS, Current at a low voltage line = 200 A, Voltage = 380 V

(3) Effect of Loss Reduction and Improvement of Voltage Drops by Reinforcement of 0.4 kV Feeders

Introducing of large size of conductor 120Al to the 0.4 kV feeders will contribute to the loss reduction in 0.4 kV system effectively, as discussed in the recommended Standard. According to Table 5.7-2, the effect of loss reduction by reinforcement of 0.4 kV feeders with 120Al conductors is roughly estimated at 60-70%.

As discussed above, by introducing conductors of larger cross section to the existing distribution lines, the effect of loss reduction and voltage drops in the low voltage network is estimated at about 30 to 40 %.

(4) Summary of Loss Reduction on 20 kV and 0.4 kV Systems

During the study period up to 2010, 66/20kV substations are planned to be constructed at 21 locations in the study area. The construction of new substations reduces the average length of 20 kV feeders and also to reduce the average loads per feeder. Thus, the construction of 66/20 kV substations reduces losses and improve voltage drops effectively. Supposed that the effect of loss reduction in the 20 kV network by the construction of substations is same as the effect of loss reduction in 0.4 kV network by adding new 20/0.4 kV transformers, the effect by the construction of new substations up to 2010 is estimated at about 30% in loss reduction in the 20 kV network.

Taking into account the effect of loss reduction by the construction of substations, it is concluded for the effect of loss reduction due to the rehabilitation and improvement plans on 20 kV and 0.4 kV distribution network as mentioned below.

(a) In the 20 kV network, losses can be reduced to about 60% of the existing level. (Losses will be reduced to 70% by the construction of new substations and to 80 % by the reinforcement of 20 kV main lines, i.e. 90% in Damascus City and 70% in Damascus Rural area.)

(b) In the 0.4 kV distribution network, losses can be reduced to 40% of the existing. (Losses will be reduced to 70% by installation of 20/0.4 kV transformers and to 60% by the reinforcement of 0.4 kV main lines)

As described in Chapter 13, from the result of the detailed study on the selected 0.4 kV model feeders, it was found that losses in 2010 were reduced to 32 % of the existing level. Thus, the study on effect of loss reduction in the model feeders of 0.4 kV network has proved the above effects.

9.3 Improvement of Supply Reliability

As mentioned in Chapter 5, the followings are major problems in the existing 20 kV systems in terms of supply reliability.

(1) Some 20 kV feeders can be considered not to have enough capacity to supplement another load for diverting energy supply in case one 20 kV feeder faults.

(2) In case one 20 kV feeder faults, the restoration work is at present performed manually by substation operators and maintenance personnel. Electricity supply for all transformers installed on the other sections of feeder other than the fault section is restored normally within one to three hours in the present system. The detail of restoration procedures is referred to the Section 5.7.3.

In order to improve the situation mentioned above, the rehabilitation plan for 20 kV feeders by applying the multi-divided and multi-connected system to 20kV feeders is recommended as discussed in Chapter 7 and 8 to secure the supply reliability of the system. In case the rehabilitation plans for 20 kV feeders are applied, the situation on 20 kV system reliability will be improved as follows:

- All the loads supplied from this feeder are once shed.
- The location of fault point in the feeder can be found within several ten seconds by auto-fault detecting devices.
- Electricity supply for transformers in the sections of the feeder from the substation up to the section except fault point can be restored within relatively short period by delayed auto-reclosing at the substation.
- After the fault point is found, the section switches on both ends of the fault section will be opened, and the sections from fault point to the end of the main feeder can be connected with another feeder by hand operation under the on-load condition.
- Electricity supply for all transformers installed on the other sections of feeder except the fault point section can be restored as above in a relatively short period.

As stated above, the recommended rehabilitation plan for 20 kV network will improve the reliability of 20 kV system through enhancing the ability of switching operation and shortening the time for restoration of supply. Effect in reduction of un-served energy due to the fault can be determined quantitatively as mentioned hereunder. (Reference is made to Fig. 9.3-1.)

(a) It normally takes about two hours in average to find a fault-point where the multi-divided and multi-connected system is not applied.

(b) In case that the load switches with auto fault detecting devices are employed to the feeder which is divided into three sections by the switches,

- Electricity supply to the sections except the fault section from the substation can be restored within 2 minutes after the fault occurred by the auto switches with auto-fault detecting devices. Approximately one-third of all loads on the feeder can be restored, although it may change depending on the location of fault point.

- Then, within about 40 minutes after the fault occurred, power supply to the sections after the fault section to the end of feeder can be restored by connecting the sections with other feeders by closing terminal interconnecting switch by hand under on-load condition. Approximately one-third of all loads in average can be restored.
- The remaining one-third of all loads on the feeder are connected to the fault section. As the fault section is already known by auto-fault detecting device, the time required for clearing the fault from the feeder can be reduced to within one hour.

As stated above, in case that auto switches with auto-fault detecting devices are applied to the 20 kV feeder which is divided into three section by the switches, the un-served energy due to fault is possible to reduce to 30 % of the existing situation.

The improvement of all the 20 kV feeders in the study area to the multi-divided and multi-connected system is planned to start from the year 2000 and complete by the year 2010. Accordingly, the ratio of un-served energy to the total energy consumption, which was recorded at 1.68 % in 1997 in the study area, is able to decline to 0.5 % in 2010.

9.4 Environmental Effects

The global warming due to emission of greenhouse gas represented by carbon dioxide (CO_2) is a global issue to be taken care in the world.

The execution of rehabilitation plans recommended in the reports is expected to contribute to reduction of power loss in the distribution network, and will finally result in reduction of power generation. Reduction of generation at thermal power station will result in reduction of greenhouse gas emission produced by thermal generation.

As discussed in Section 9.3, technical losses of the distribution network in the study area are able to be reduced as seen in Table 9.4-1.

Table 9.4-1 Reduction of Technical Losses in the Study Area

	Whole Syria (1994)	Study area (1999)	Study area (2010)	Remarks
66 kV network	1.5 %	1.19 %	0.6 %	According to Power flow analysis
20 kV network	4.0 %	3.18 %	1.9 %	Reduced to 60 % of 1999 level
Low voltage network	14.0 %	11.14 %	5.1 %	1 % as losses in the transformer, the remaining portion to be reduced to 40 %.
Total	19.5 %	15.51 %	7.6 %	

Note: The breakdown of technical losses in 1999 of the study area were obtained by analyzing the estimated technical losses of 15.51 % in the power demand forecast in accordance with the breakdown of each voltage level for whole Syria in 1994 known to the Team by PEDEEE.

Quantity of technical loss reduction in every year is shown in the Table 9.4-2, in which the quantity of technical loss reduction in case of "With Project" is calculated when compared with the baseline case (reference case). It is supposed in the baseline case that the existing distribution facilities are to be extended or augmented to the minimum requirements for supplying growing power demand according to the demand forecast, and the rate of technical loss will remain in the same level as of 1999 and constant during the period of 1999 to 2010. As seen in this table, in the year 2010 when the improvement project is completed, the reduction of technical loss will amount to 990 GWh per annum compared with the baseline case. This loss reduction in electric energy is considered as the same effect with a reduction of 174 MW in peak load, assuming a load factor of 0.65. In other words, taking into account the fact that major part of technical losses is produced during peak load time, this loss reduction is regarded as having an effect worthy to eliminate one peaking thermal power station of 200 MW generating capacity.

In the power system of Syria, majority of thermal power plant is natural gas fired combined cycle. The above loss reduction results in the reduction of power generation by natural gas fired combined cycle, and finally reduce the greenhouse gas emission produced by natural gas fired combined cycle power plants.

The greenhouse gases include carbon dioxide(CO_2), methane(CH_4), carbon monoxide(CO), nitrogen oxides (NOx), nitrous oxide(N_2O), etc. The reduction in each gas emission is calculated as shown in the Table 9.4-3. As combined cycle or gas turbine units burning natural gas produce negligible sulfur oxide (SOx), reduction of SOx emission is not considered in this table.

As seen in the table, the reduction of CO_2 emission will amount to 460 thousand tonnes/year and that of NOx will amount to 1,500 tonnes/year in the year 2010 when the improvement project is completed. Furthermore, the reduction of all greenhouse gases emissions are converted into units of carbon dioxide-equivalent (tonnes CO_2 equivalent) by means of the global warming potentials. The total weight of reduction in greenhouse gas emissions in unit of CO_2-equivalent will reach to 520 thousand tonnes CO_2-equivalent per year in the year 2010.

Thus, the execution of the proposed improvement plans will reduce a large amount of greenhouse gas emissions, and accordingly this will make considerable contribution to the protection of global warming.

Table 9.4-2 Reduction of Techincal Loss

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Damascus plus Damscus Rural													
Total Sale (MWh)	4,244,580	4,573,070	4,963,380	5,387,051	5,847,035	6,346,633	6,889,467	7,479,513	8,121,140	8,819,147	9,578,807	10,404,345	
Distribution Loss (MWh)	1,689,658	1,727,883	1,777,947	1,826,742	1,873,852	1,918,822	1,961,130	2,000,183	2,035,303	2,065,718	2,090,551	2,108,648	
Total Consumption (MWh)	5,934,237	6,300,953	6,741,327	7,213,793	7,720,888	8,265,455	8,850,597	9,479,696	10,156,443	10,884,865	11,669,357	12,512,993	105,730,624
With Project													
Technical Losses in %	15.51	14.80	14.08	13.36	12.64	11.92	11.20	10.48	9.76	9.04	8.32	7.60	
Techinical Losses (MWh)	920,682	932,240	948,889	963,487	975,662	985,005	991,055	993,291	991,123	983,888	970,835	950,987	11,607,144
Baseline (Reference case)													
Technical Losses in %	15.51	15.51	15.51	15.51	15.51	15.51	15.51	15.51	15.51	15.51	15.51	15.51	
Techinical Losses (MWh)	920,682	977,577	1,045,900	1,119,201	1,197,876	1,282,364	1,373,147	1,470,750	1,575,746	1,688,759	1,810,471	1,941,359	16,403,832
Reduction in techincal loss (MWH)	0	45,337	97,011	155,715	222,214	297,359	382,092	477,460	584,623	704,871	839,636	990,371	4,796,688

Table 9.4-3 Reduction in GHG (Greehouse Gas) Emission

Reduction in Power Generation	(kWh/year)	990,371	Equivalent to loss reduction
Net Heat Rate per kWh	(J/kWh)	3,600,000	
Plant Conversion Efficiency		0.43	Combined cycle burning natural gas
Reduction of fuel consumption	(GJ/year)	8,291,478	

Emission Factors of greenhouse gases			
CO_2	(g/GJ)	55,820	56,100 g/GJ x 0.995
CO	(g/GJ)	32	
CH_4	(g/GJ)	6	
NOx	(g/GJ)	187	
N_2O	(g/GJ)	0	

Reduction in GHG Emissions per year		
CO_2	(t/year)	462,826
CO	(t/year)	265
CH_4	(t/year)	51
NOx	(t/year)	1,551
N_2O	(t/year)	0

Convert to units of carbon dioxide-equivalent emissions

			GWP
CO_2	(tCO_2)	462,826	1
CO	(tCO_2)	796	3
CH_4	(tCO_2)	1,062	21
NOx	(tCO_2)	62,020	40
N_2O	(tCO_2)	0	290
Total	(tCO_2)	526,705	

Note:
(1) Source of Emission factor : Greenhouse Gas Assesement Handbook, World Bank, September 1998
(2) GWP means Global Warming Potential of time horizon of 100 years.

Figure 9.2-1 Result of Power Flow Calculation for 20 kV Network improvement Plan (Maarad Al Nour)

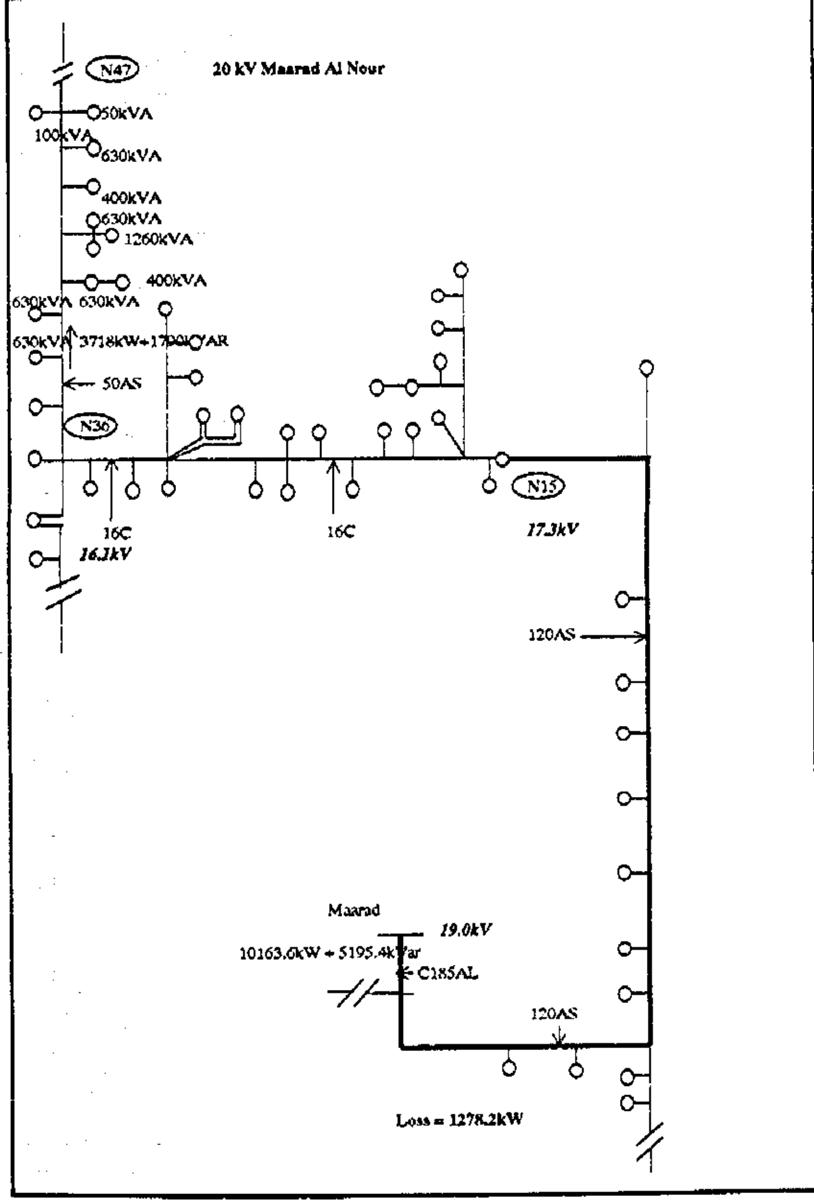
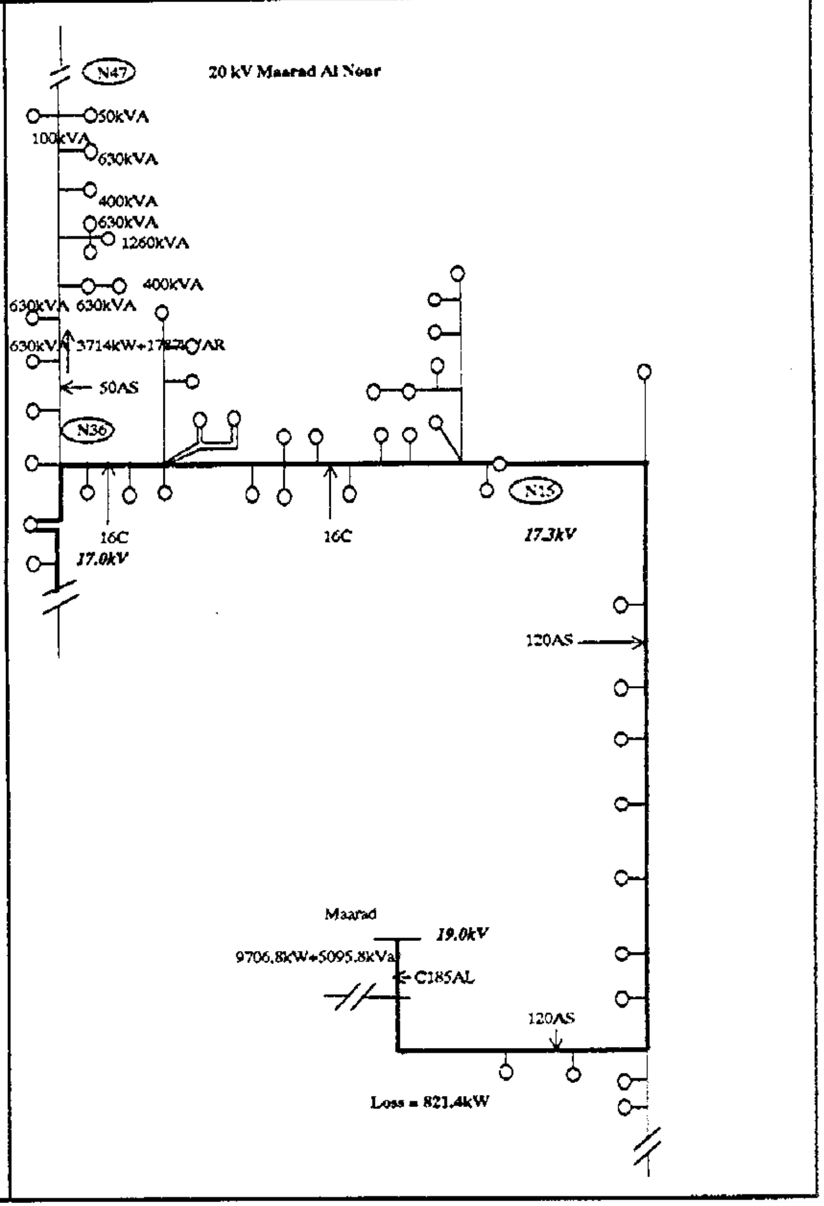
Present System	Improved System
	

Figure 9.2-2 Result of Power Flow Calculation for 20 kV Network improvement Plan (Zabadani Bloudan)

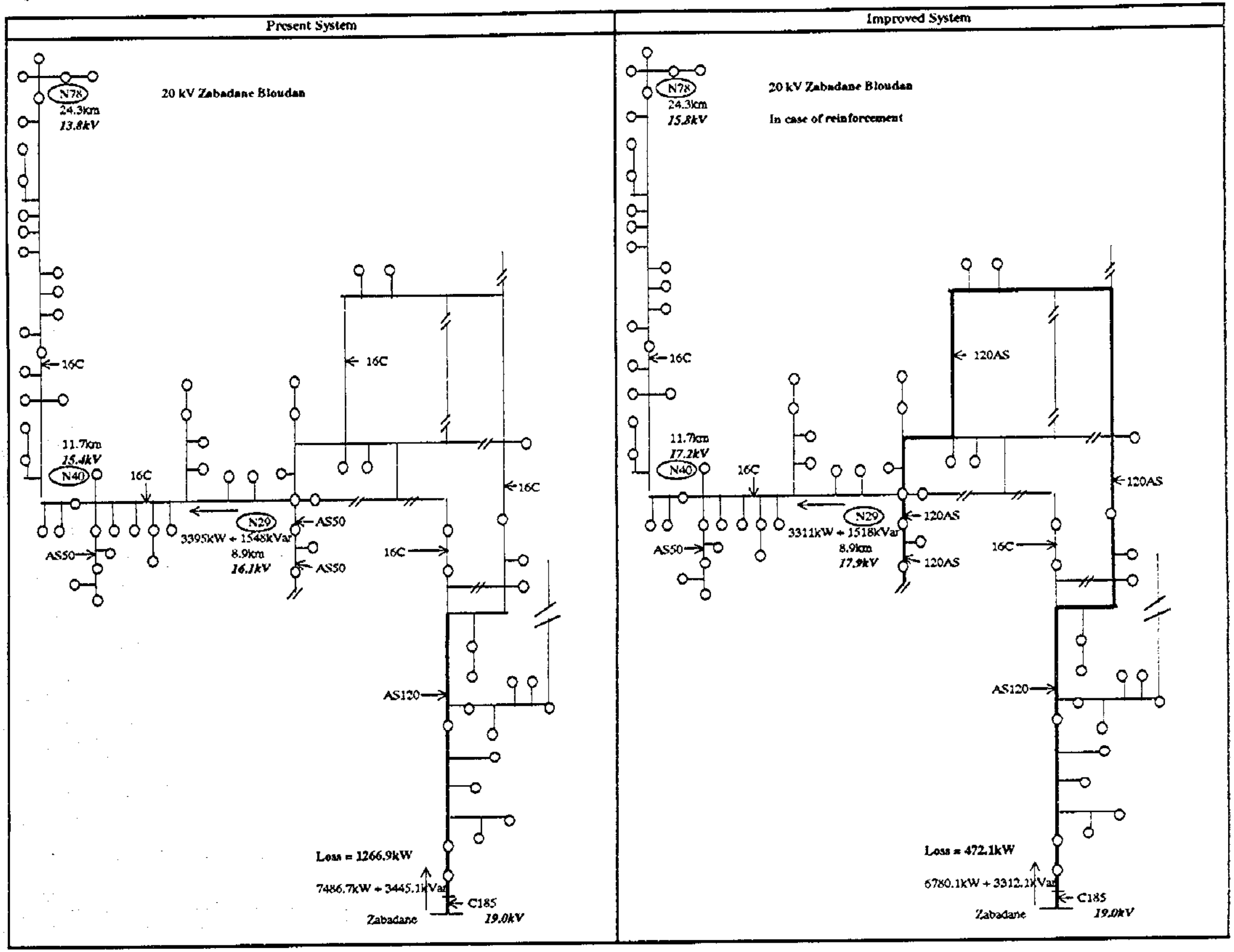


Figure 9.2-3 Result of Power Flow Calculation for 20 kV Network improvement Plan (Zabadani Barada)

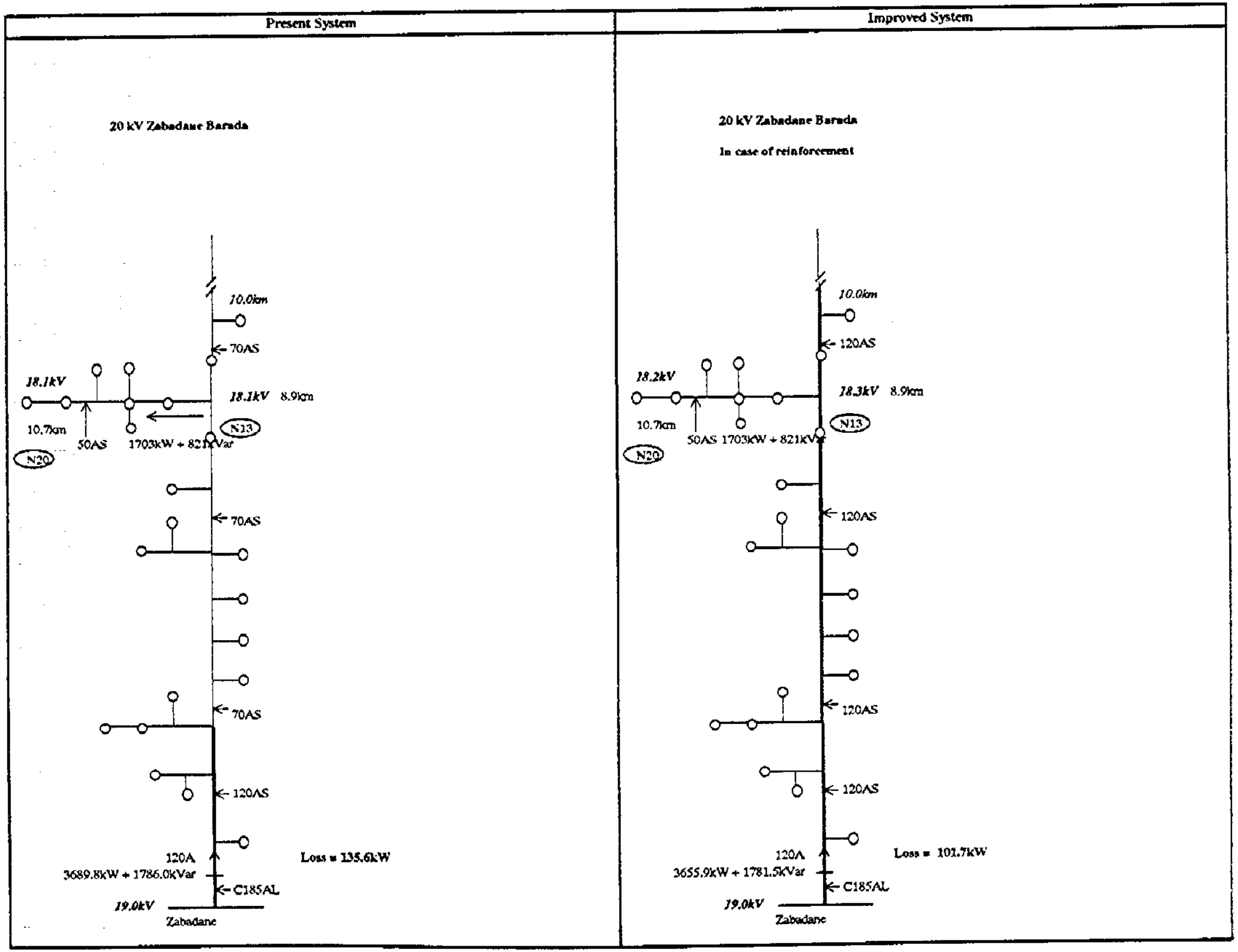
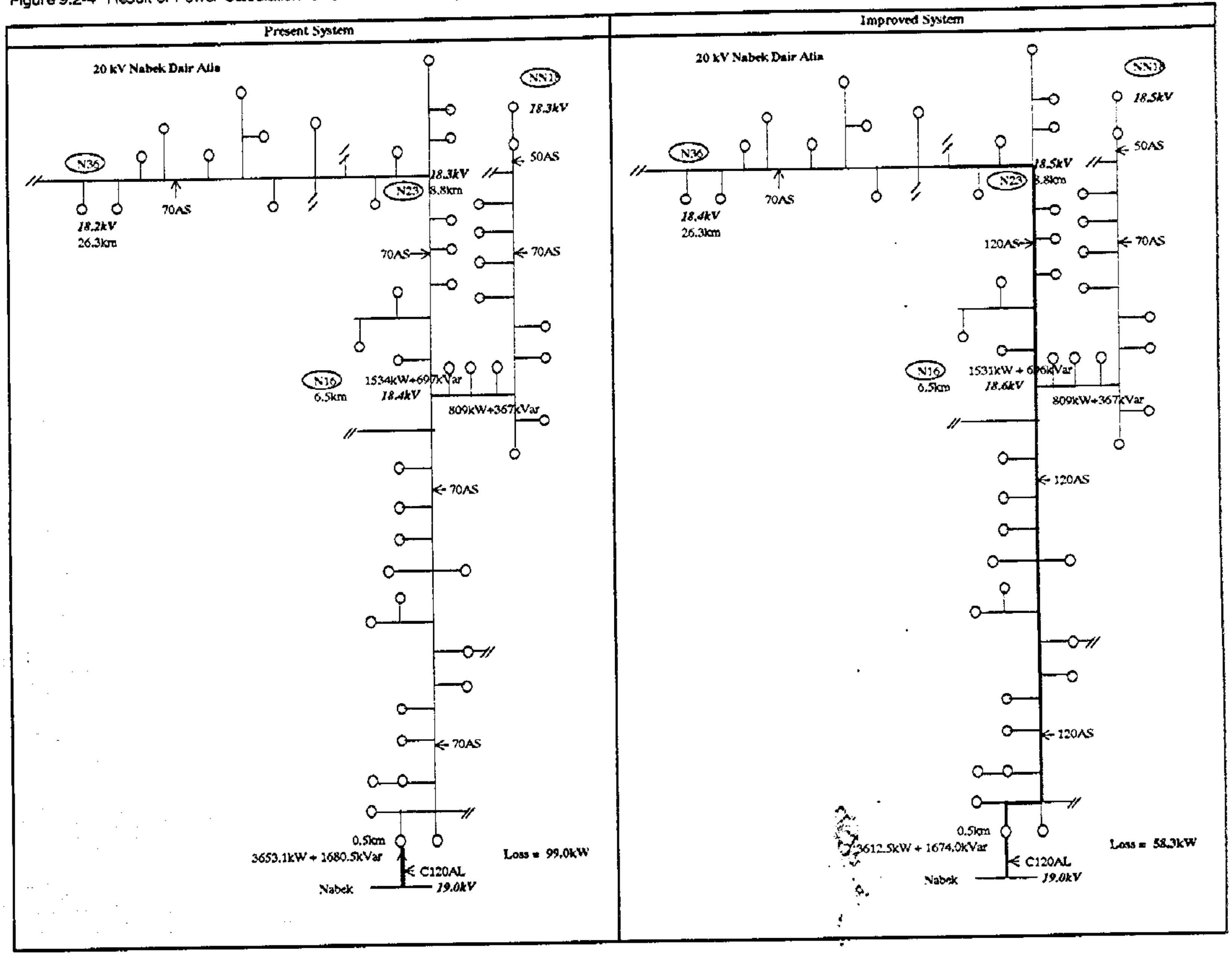
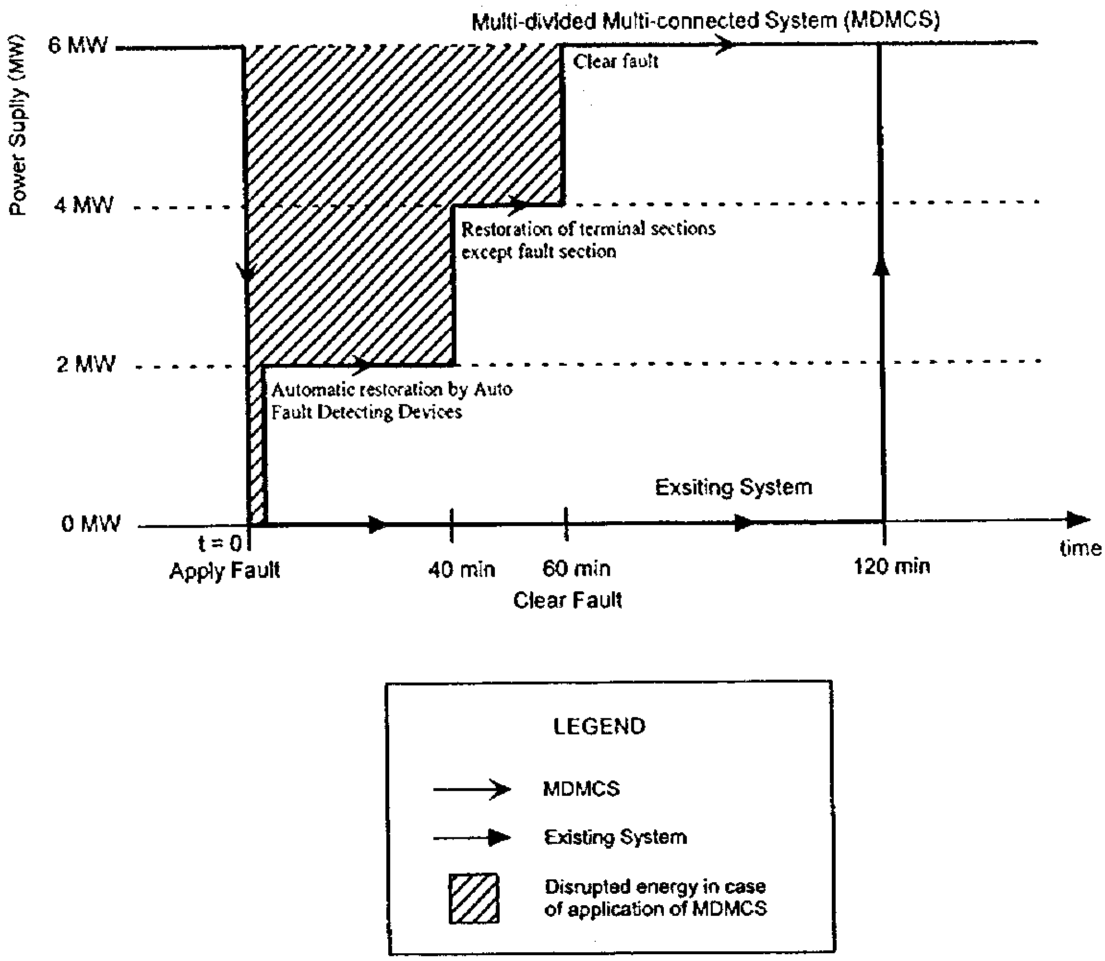


Figure 9.2-4 Result of Power Calculation for 20 kV Network improvement Plan (Nabek Dair Atia)





Disrupted Energy

Existing System 6 MW x 120 min = 720 MW · min

After Countermeasures 2 MW x 2 min + 2 MW x 40 min +2 MW x 60 min = 204 MW · min

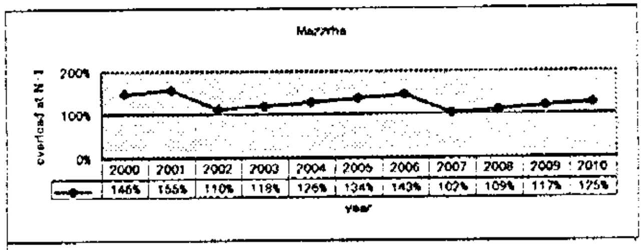
(* Compared with existing system, disrupted energy is reduced to 28.3% .)

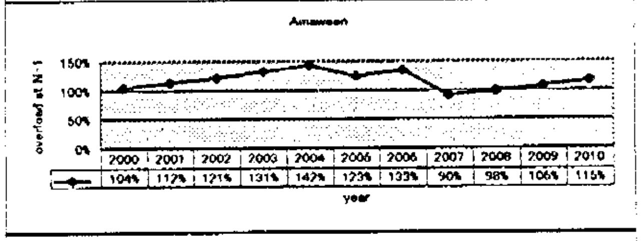
Public Establishment for Distribution and Exploitation of Electrical Energy (PEDEEE)	Japan International Cooperation Agency (JICA) Joint Venture Nippon Koei Co., Ltd. & Tokyo Electric Power Services Co., Ltd	The Feasibility Study on The Rehabilitation Project of Damascus and Damascus Rural Distribution Network	Figure 9.3 - 1 Title Example of Reduction of Disrupted Energy with Multi-divided Multi-connected System

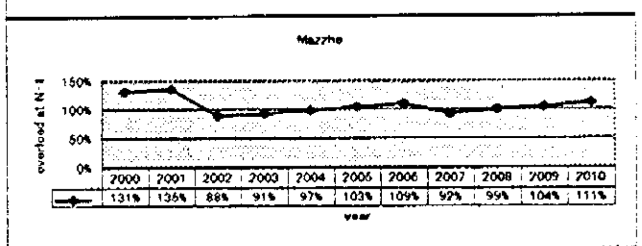
ATTACHMENT

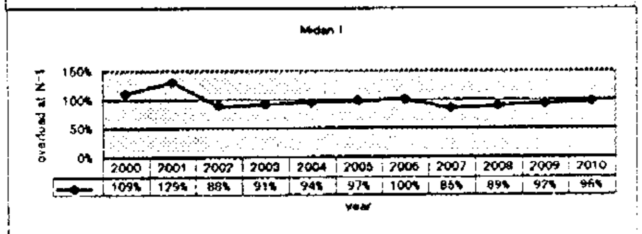
Attachment 9-1 (1/4) Procurement Schedule of 66/20 kV Transformer in Damascus City

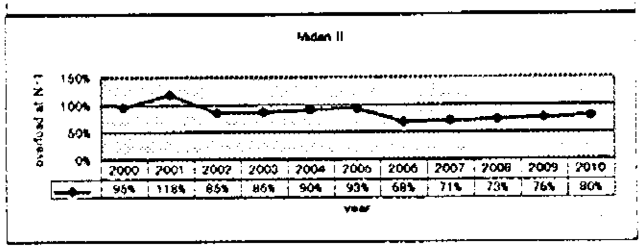
Substation		existing	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1 Mazzha	Peak (MW)	47	50	53	38	40	43	46	49	52	56	60	64
	Peak (MVA)	55	58	62	44	47	50	54	57	61	66	70	75
	TR capa.												
	1	20	20	20	30	30	30	30	30	30	30	30	30
	2	20	20	20	20	20	20	20	20	30	30	30	30
	3	20	20	20	20	20	20	20	20	30	30	30	30
	4												
	total	60	60	60	70	70	70	70	70	90	90	90	90
	Reserve	5	2	-2	26	23	20	16	13	29	24	20	15
	Balance at N-1	-15	-18	-22	-4	-7	-10	-14	-17	-1	-6	-10	-15
	Overload at N-1	138%	146%	155%	110%	118%	126%	134%	143%	102%	109%	117%	125%
2 Amaween	Peak (MW)	33	35	38	41	45	48	52	57	61	67	72	78
	Peak (MVA)	39	42	45	49	53	57	62	67	72	78	85	92
	TR capa.												
	1	20	20	20	20	20	20	30	30	40	40	40	40
	2	20	20	20	20	20	20	30	30	40	40	40	40
	3	20	20	20	20	20	20	20	20	40	40	40	40
	4												
	total	60	60	60	60	60	60	80	80	120	120	120	120
	Reserve	21	18	15	11	7	3	18	13	48	42	35	28
	Balance at N-1	1	-2	-5	-9	-13	-17	-12	-17	8	2	-5	-12
	Overload at N-1	97%	104%	112%	121%	131%	142%	123%	133%	90%	98%	106%	115%
3 Mazzhe	Peak (MW)	42	44	46	30	31	33	35	37	39	42	44	47
	Peak (MVA)	49	52	54	35	36	39	41	44	46	49	52	55
	TR capa.												
	1	20	20	20	20	20	20	20	20	30	30	30	30
	2	20	20	20	20	20	20	20	20	30	30	30	30
	3	20	20	20	20	20	20	20	20	20	20	20	20
	4												
	total	60	60	60	60	60	60	60	60	80	80	80	80
	Reserve	11	8	6	25	24	21	19	16	34	31	28	25
	Balance at N-1	-9	-12	-14	5	4	1	-1	-4	4	1	-2	-5
	Overload at N-1	124%	131%	135%	88%	91%	97%	103%	109%	92%	99%	104%	111%
4 Midan I	Peak (MW)	28	37	44	30	31	32	33	34	36	38	39	41
	Peak (MVA)	33	44	52	35	36	38	39	40	42	45	46	48
	TR capa.												
	1	20	20	20	20	20	20	20	20	30	30	30	30
	2	20	20	20	20	20	20	20	20	30	30	30	30
	3	20	20	20	20	20	20	20	20	20	20	20	20
	4												
	total	60	60	60	60	60	60	60	60	80	80	80	80
	Reserve	27	16	8	25	24	22	21	20	38	35	34	32
	Balance at N-1	7	-4	-12	5	4	2	1	0	8	5	4	2
	Overload at N-1	82%	109%	129%	88%	91%	94%	97%	100%	85%	89%	92%	96%
5 Midan II	Peak (MW)	55	73	90	65	66	69	71	52	54	56	58	61
	Peak (MVA)	65	86	106	76	78	81	84	61	64	66	68	72
	TR capa.												
	1	20	30	30	30	30	30	30	30	30	30	30	30
	2	30	30	30	30	30	30	30	30	30	30	30	30
	3	30	30	30	30	30	30	30	30	30	30	30	30
	4		30	30	30	30	30	30	30	30	30	30	30
	total	80	120	120	120	120	120	120	120	120	120	120	120
	Reserve	15	34	14	44	42	39	36	59	56	54	52	48
	Balance at N-1	-15	4	-16	14	12	9	6	29	26	24	22	18
	Overload at N-1	129%	95%	118%	85%	86%	90%	93%	68%	71%	73%	76%	80%





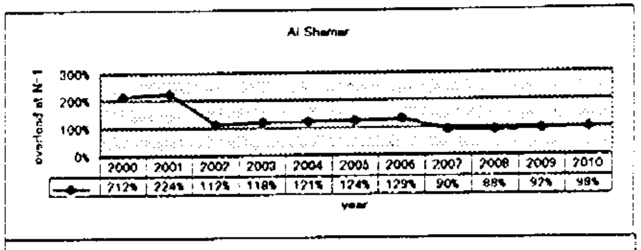


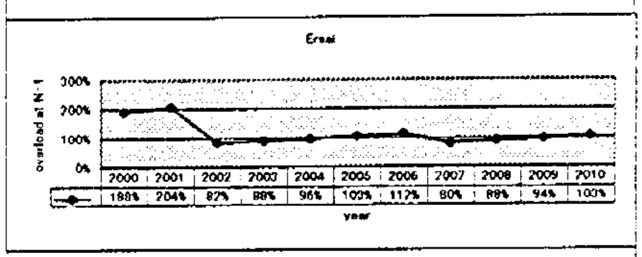


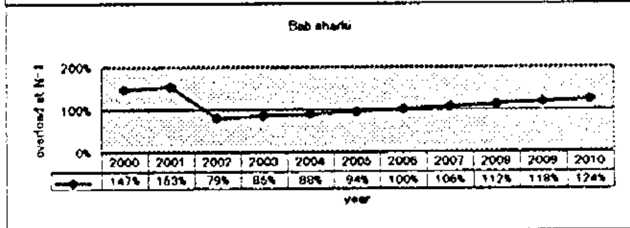


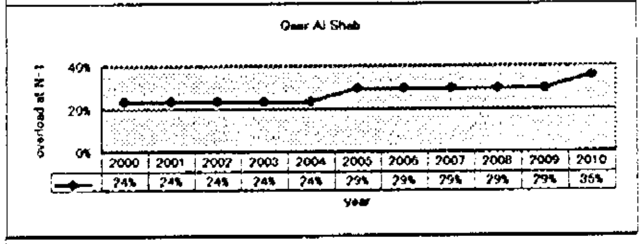
Attachment 9-1 (2/4) Procurement Schedule of 66/20 kV Transformer in Damascus City

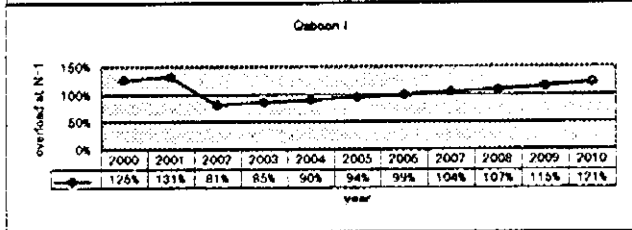
Substation		existing	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
6 Al Ashumar	Peak (MW)	37	36	38	38	40	41	42	44	46	45	47	50
	Peak (MVA)	44	42	45	45	47	48	49	52	54	53	55	59
	TR capa.												
	1	20	20	20	40	40	40	40	40	40	40	40	40
	2	20	20	20	40	40	40	40	40	40	40	40	40
	3									20	20	20	20
	4												
	total	40	40	40	80	80	80	80	80	100	100	100	100
	Reserve	-4	-2	-5	35	33	32	31	28	46	47	45	41
	Balance at N-1	-24	-22	-25	-5	-7	-8	-9	-12	6	7	5	1
	Overload at N-1	218%	212%	224%	112%	118%	121%	124%	129%	90%	88%	92%	98%
7 Ersal	Peak (MW)	50	48	52	56	60	65	70	76	82	90	96	105
	Peak (MVA)	59	56	61	66	71	76	82	89	96	106	113	124
	TR capa.												
	1	20	30	30	40	40	40	40	40	40	40	40	40
	2	20	30	30	40	40	40	40	40	40	40	40	40
	3				40	40	40	40	40	40	40	40	40
	4									40	40	40	40
	total	40	60	60	120	120	120	120	120	160	160	160	160
	Reserve	-19	4	-1	54	49	44	38	31	64	54	47	36
	Balance at N-1	-39	-26	-31	14	9	4	-2	-9	24	14	7	-4
	Overload at N-1	294%	188%	204%	82%	88%	96%	103%	112%	80%	88%	94%	103%
8 Bab Sharki	Peak (MW)	48	50	52	27	29	30	32	34	36	38	40	42
	Peak (MVA)	56	59	61	32	34	35	38	40	42	45	47	49
	TR capa.												
	1	20	20	20	20	20	20	20	20	20	20	20	20
	2	20	20	20	20	20	20	20	20	20	20	20	20
	3	20	20	20	20	20	20	20	20	20	20	20	20
	4												
	total	60	60	60	60	60	60	60	60	60	60	60	60
	Reserve	4	1	-1	28	26	25	22	20	18	15	13	11
	Balance at N-1	-16	-19	-21	8	6	5	2	0	-2	-5	-7	-9
	Overload at N-1	141%	147%	153%	79%	85%	88%	94%	100%	106%	112%	118%	124%
9 Qasr Al Shab	Peak (MW)	4	4	4	4	4	4	5	5	5	5	5	6
	Peak (MVA)	5	5	5	5	5	5	6	6	6	6	6	7
	TR capa.												
	1	20	20	20	20	20	20	20	20	20	20	20	20
	2	20	20	20	20	20	20	20	20	20	20	20	20
	3												
	4												
	total	40	40	40	40	40	40	40	40	40	40	40	40
	Reserve	35	35	35	35	35	35	34	34	34	34	34	33
	Balance at N-1	15	15	15	15	15	15	14	14	14	14	14	13
	Overload at N-1	24%	24%	24%	24%	24%	24%	29%	29%	29%	29%	29%	35%
10 Qaboon I	Peak (MW)	81	85	89	55	58	61	64	67	71	73	78	82
	Peak (MVA)	95	100	105	65	68	72	75	79	84	86	92	96
	TR capa.												
	1	40	40	40	40	40	40	40	40	40	40	40	40
	2	40	40	40	40	40	40	40	40	40	40	40	40
	3	40	40	40	40	40	40	40	40	40	40	40	40
	4												
	total	120	120	120	120	120	120	120	120	120	120	120	120
	Reserve	25	20	15	55	52	48	45	41	36	34	28	24
	Balance at N-1	-15	-20	-25	15	12	8	5	1	-4	-6	-12	-16
	Overload at N-1	119%	125%	131%	81%	85%	90%	94%	99%	104%	107%	115%	121%





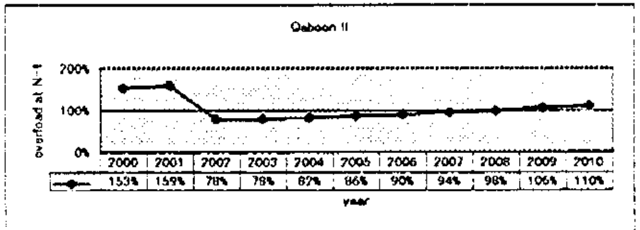


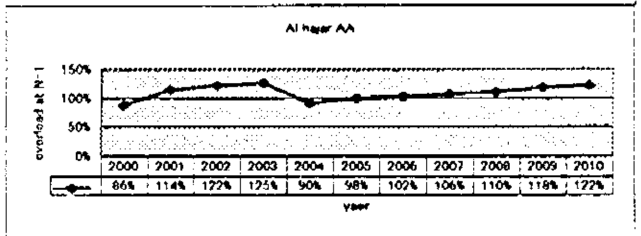


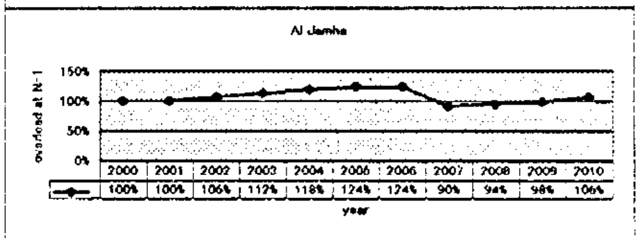


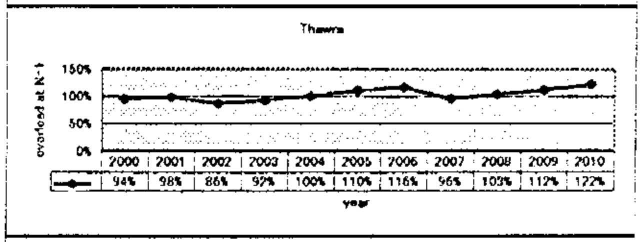
Attachment 9-1 (3/4) Procurement Schedule of 66/20 kV Transformer in Damascus City

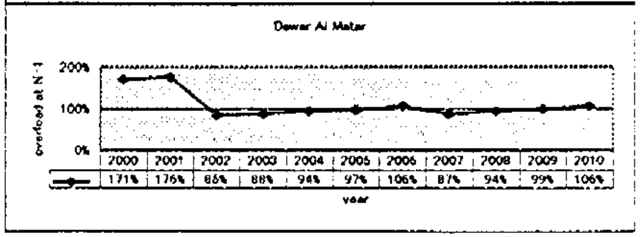
Substation		existing	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
11 Qaboon II	Peak (MW)	25	26	27	20	20	21	22	23	24	25	27	28
	Peak (MVA)	29	31	32	24	24	25	26	27	28	29	32	33
	TR capa.												
	1	30	30	30	30	30	30	30	30	30	30	30	30
	2	20	20	20	30	30	30	30	30	30	30	30	30
	3												
	4												
	total	50	50	50	60	60	60	60	60	60	60	60	60
	Reserve	21	19	18	36	36	35	34	33	32	31	28	27
	Balance at N-1	-9	-11	-12	6	6	5	4	3	2	1	-2	-3
	Overload at N-1	147%	153%	159%	78%	78%	82%	86%	90%	94%	98%	106%	110%
12 Al Hajar AA	Peak (MW)	21	22	29	31	32	23	25	26	27	28	30	31
	Peak (MVA)	25	26	34	36	38	27	29	31	32	33	35	36
	TR capa.												
	1	30	30	30	30	30	30	30	30	30	30	30	30
	2	30	30	30	30	30	30	30	30	30	30	30	30
	3												
	4												
	total	60	60	60	60	60	60	60	60	60	60	60	60
	Reserve	35	34	26	24	22	33	31	29	28	27	25	24
	Balance at N-1	5	4	-4	-6	-8	3	1	-1	-2	-3	-5	-6
	Overload at N-1	82%	86%	114%	122%	125%	90%	98%	102%	106%	110%	118%	122%
13 Al Jamha	Peak (MW)	16	17	17	18	19	20	21	21	23	24	25	27
	Peak (MVA)	19	20	20	21	22	24	25	25	27	28	29	32
	TR capa.												
	1	20	20	20	20	20	20	20	20	30	30	30	30
	2	20	20	20	20	20	20	20	20	30	30	30	30
	3												
	4												
	total	40	40	40	40	40	40	40	40	60	60	60	60
	Reserve	21	20	20	19	18	16	15	15	33	32	31	28
	Balance at N-1	1	0	0	-1	-2	-4	-5	-5	3	2	1	-2
	Overload at N-1		100%	100%	106%	112%	118%	124%	124%	90%	94%	98%	106%
14 Thawra	Peak (MW)	44	48	50	44	47	51	56	59	65	70	76	83
	Peak (MVA)	52	56	59	52	55	60	66	69	76	82	89	98
	TR capa.												
	1	30	30	30	30	30	30	30	30	40	40	40	40
	2	30	30	30	30	30	30	30	30	40	40	40	40
	3	30	30	30	30	30	30	30	30	40	40	40	40
	4												
	total	90	90	90	90	90	90	90	90	120	120	120	120
	Reserve	38	34	31	38	35	30	24	21	44	38	31	22
	Balance at N-1	8	4	1	8	5	0	-6	-9	4	-2	-9	-18
	Overload at N-1	86%	94%	98%	86%	92%	100%	110%	116%	96%	103%	112%	122%
15 Dawar Al Matar	Peak (MW)	27	29	30	29	30	32	33	36	37	40	42	45
	Peak (MVA)	32	34	35	34	35	38	39	42	44	47	49	53
	TR capa.												
	1	20	20	20	20	20	20	20	20	30	30	30	30
	2	20	20	20	20	20	20	20	20	30	30	30	30
	3				20	20	20	20	20	20	20	20	20
	4												
	total	40	40	40	60	60	60	60	60	80	80	80	80
	Reserve	8	6	5	26	25	22	21	18	36	33	31	27
	Balance at N-1	-12	-14	-15	6	5	2	1	-2	6	3	1	-3
	Overload at N-1	159%	171%	176%	85%	88%	94%	97%	106%	87%	94%	99%	106%





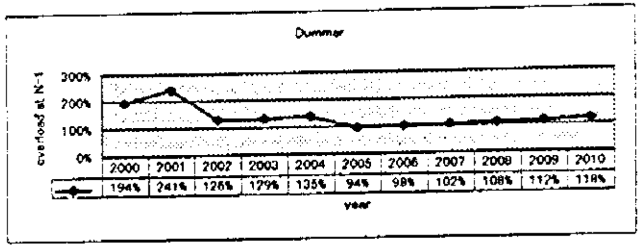






Attachment 9-1 (4/4) Procurement Schedule of 66/20 kV Transformer in Damascus City

Substation		existing	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
16 Dummar	Peak (MW)	26	33	41	43	44	46	48	50	52	55	57	60
	Peak (MVA)	31	39	48	51	52	54	56	59	61	65	67	71
	TR capa.												
	1	20	20	20	20	20	20	30	30	30	30	30	30
	2	20	20	20	20	20	20	30	30	30	30	30	30
	3				20	20	20	30	30	30	30	30	30
	4												
	total	40	40	40	60	60	60	90	90	90	90	90	90
	Reserve	9	1	-8	9	8	6	34	31	29	25	23	19
	Balance at N-1	-11	-19	-28	-11	-12	-14	4	1	-1	-5	-7	-11
	Overload at N-1	153%	194%	241%	126%	129%	135%	94%	98%	102%	108%	112%	118%



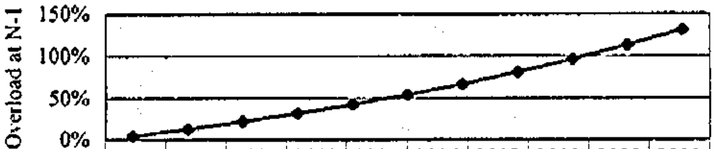
Attachment 9-2 Effect of Improvement of 66/20 kV Transformer Capacity (with N-1Criteria)

Under existing capacity

Mazzrha

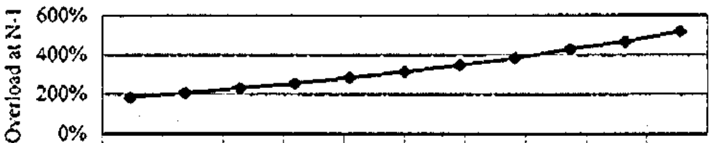
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
—◆—	46%	55%	10%	18%	26%	34%	43%	53%	64%	76%	88%

Amaween



	2000	2001	2002	2003	2004	2006	2007	2008	2009	2010
—◆—	4%	12%	21%	31%	42%	67%	81%	96%	113	131

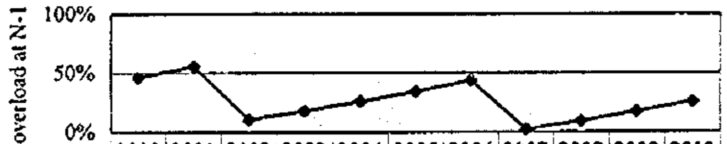
Ersal



	2000	2001	2002	2003	2004	2006	2007	2008	2009	2010
—◆—	182	206	229	253	282	347	382	429	465	518

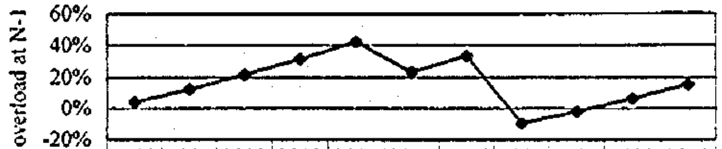
After Improvement

Mazzrha



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
—◆—	46%	55%	10%	18%	26%	34%	43%	2%	9%	17%	25%

Amaween



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
—◆—	4%	12%	21%	31%	42%	23%	33%	-10	-2%	6%	15%

Ersal

	2000	2001	2002	2003	2004	2006	2007	2008	2009	2010
—◆—	88%	104	-18%	-12%	-4%	12%	-20%	-12%	-6%	3%

Note: Parsentage in the graphs means overloaded ratio against rated capacity of transformer.

CHAPTER X

FEASIBILITY DESIGN OF IMPROVEMENT PLAN

Chapter 10 Feasibility Design of Improvement Plan

10.1 Standards to be applied

66 kV, 20 kV and low voltage distribution facilities proposed in the improvement plans will be reviewed and designed based on the standards for the distribution system described in Chapter 7. International Electro-technical Committee (IEC) standard, which is widely used in the field of electric power equipment through the world, is applied to technical specifications of each equipment. The IEC standard is recommended to apply as a standard of electrical equipment in Syria, since other international standards such as British Standard (BS) or German Standard (DIN) are also referring to the IEC standard. In case of Japan, Japanese standard has been also reviewed and revised to comply with the IEC standard.

10.2 66 kV Facilities

10.2.1 66/20 kV Substation

(1) Components

66/20 kV substation is composed of the following major components.

(a) 66/20 kV Transformer
(b) 66 kV Switchgear
(c) 20 kV Switchgear
(d) Supervisory and Control System
(e) Protective Relay System
(f) Station Service Power Supply System

Feasibility design for the above components to be applied in the proposed improvement plan is summarized below.

(2) 66/20 kV Transformer

30 MVA three phase transformer with on-load tap changer is recommended as a standard capacity. According to the results of power demand forecast, a larger size of transformer such as 40 MVA or 50MVA will be used in some substations where needs more capacity to cover its power demand. Technical particulars of main transformer are shown below.

(a) Rated voltage 66/20 kV

(b) Voltage group Ynd 11

(c) Rated impedance 10 %

(d) Cooling methods ONAF/ONAN

Unit capacity and number of transformers will be decided taking into consideration of N-1 criteria, that means sound transformers can fully cover power load at failure of one transformer without any interruption. It is, however, noted that, in the improvement plan, transformer capacity is selected in the assumption that 120% load is an allowable overload capacity by the following reasons;

(a) Unit capacity will unpractical increase due to limitation of bay extension, if 100% load is applied.

(b) According to typical daily load duration curve, it is judged that period of peak load is relatively short and approximately 80% of peak load is assumed as a base load of the substation.

(c) Transformer is allowed to operate under 120% loading condition during a short period.

In the improvement plan, it is also proposed to utilize removed transformers mainly 20 MVA or 30 MVA in other substations unless a particular trouble is found.

(3) 66 kV Switchgear

Typical component of 66 kV switchgear is shown below.

(a) 66 kV bus and bus section

(b) 66 kV line bay

(c) Transformer bay

(d) Bus coupler bay

Single bus system with ratings of 1,600 A and 31.5 kA is proposed to apply as a standard 66 kV bus in the improvement plan, however, double bus system is recommended in major or larger substations. The double bus system has a bus coupler bay composing of circuit breaker for the purpose of bus connection.

66 kV lines are connected to the 66 kV bus through line bay which is composing of circuit breaker, disconnecting switch, earthing switch, current transformer and voltage transformer. Lightning arrester is recommended to install at the entrance of overhead line to protect 66 kV switchgear from an abnormal surge such as lightning surge or switching surge.

Transformer is connected with 66 kV bus via transformer bay which is composing of circuit breaker, disconnecting switch and current transformer, and at the secondary side of transformer, circuit breaker is also installed to completely isolate it during trouble or maintenance. Lightning arrester is recommended to install at the primary side of transformer to protect the transformer from a abnormal surge such as lightning surge or switching surge.

The rated short circuit current of 66 kV circuit breaker is proposed to be 31.5 kA to cover every fault current at 66 kV bus in 2010.

(4) 20 kV Switchgear

Typical component of 20 kV switchgear is shown below.

(a) 20 kV bus and bus section
(b) 20 kV feeder bay
(c) Transformer bay
(d) Static condenser bay

Single bus system with ratings of 1,600 A and 25 kA is proposed to apply as a standard 20 kV bus in the improvement plan, however, double bus system is recommended in major or larger substations.

SF6 gas insulated type of 20 kV circuit breaker with rated short circuit current of 25 kA is proposed in order to cover fault current in 2010. Vacuum type or SF6 gas type circuit breaker is widely used in 20 kV switchgear. In the improvement plan, SF6 gas type is recommended in consideration of maintenance and availability of spare parts because PEDEEE is going to replace the existing circuit breakers with SF6 gas type.

Number of 20 kV feeders per one transformer is decided by the standards of distribution system described in Chapter 7, that is, 8 feeders for 20 MVA and 10 feeders for 30 MVA which correspond to 2.5 to 3 MVA capacity for one feeder.

2 sets of static condenser with unit capacity of 5 MVar are connected to 20 kV bus to maintain stable voltage in 66 kV system.

(5) Supervisory and Control System

Supervisory and control panels are installed in the control room to operate switchgear, monitor and record system conditions under central supervised system. Major supervisory items are as follows;

(a) Main transformers	(i) Oil and winding temperature
	(ii) Oil level
	(iii) On-load tap changer position
(b) 66 kV switchgear	(i) Circuit breaker operation and indication
	(ii) Disconnecting switch operation and indication
	(iii) Earthing switch operation and indication
	(iv) Bus voltage
	(v) Bus frequency

(vi) 66 kV line voltage
(vii) 66 kV line current
(viii)66kV line load

(c) 20 kV switchgear
(i) Circuit breaker operation and indication
(ii) Disconnecting switch operation and indication
(iii) Bus voltage
(iv) 20 kV feeder voltage
(v) 20 kV feeder current

Measuring panel is installed in the control room for measurement of power energy at 66 kV lines and 20 kV feeders.

(6) Protective Relay System

Protective relay panels are installed in the control room, which contains protective relays for main transformer, 66 kV lines, 20 kV feeders and station service for the purpose of protection of equipment and to isolate a fault area without interruption of sound areas.

Protective relays for major equipment are as follows;

(a) Main transformer
(i) Differential protection relay
(ii) Overcurrent relay
(iii) Buchholz relay
(iv) Oil and winding temperature relay

(b) 66 kV line
(i) Distance relay with multi-stages for main protection
(ii) Overcurrent relay and directional earth fault relay for backup protection

(c) 20 kV feeder
(i) Overcurrent relay
(ii) Earth fault relay

(d) 66 kV Bus coupler
(i) Overcurrent relay

For the above relays, static type digital protective relay is recommended in place of electromechanical type.

(7) Station Service Power Supply System

Station service power supply system is composed of direct current (DC) and alternative current (AC) system as power source of control, indication, lighting etc. for the substation.

AC power supply with 400/230 V is provided by station service transformer to be connected to the secondary side of main transformer. DC power supply is provided through battery in case of power failure. One set of diesel engine generator is installed in the substation for an emergency purpose.

(8) General Layout and Single Line diagram of 66/20 kV Substation

Based on the above feasibility design, typical general layout and single line diagram of 66/20 kV substation is shown in Figures 10.2-1 and 10.2-2.

10.2.2 66 kV Line

(1) 66 kV Overhead Line

At present 66 kV network, overload of overhead lines appears as increase of power demand in certain areas. This is caused by the reason that PEDEEE has adopted only one standard design for all 66 kV overhead lines in Syria. Considering this situation, construction of 2nd line in addition to the existing one is proposed in the improvement plan, which will result in increasing reliability of power supply.

The standard design for 66 kV overhead line applied in the improvement plan is as follows;

(a)	Standard voltage	66 kV	
(b)	Number of circuit	one (triangular arrangement) or two (vertical arrangement)	
(c)	Type and size of conductor	ACSR of 240/40 mm2 or 450/40 mm2	
(d)	Overhead earthwire	one, Galvanized Steel Stranded Wire of 50 mm^2	
(e)	Insulators	Suspension porcelain insulator discs or toughened glass insulator discs	
(f)	Characteristics of insulator string set		
		Lightning impulse withstand voltage	325 kV
		Power frequency withstand voltage	140 kV
(g)	Tower	Self-supporting latticed steel tower	
(h)	Types of tower	Three or four types for suspension, right angle and heavy angle towers and dead-end tower	

It is reported that there has been considerably large numbers of insulation breakdown in 230 kV and 66 kV lines, especially fault rate of 66 kV lines is extraordinarily high. To solve this problem, it is necessary to increase leakage distance of insulator string and for that purpose two ideas are considered, one is use of fog-type discs instead of normal type and the other is increase of number of disc. In the improvement plan, the fog-type disc is recommended in some polluted area because it has an advantage that the standard tower design can be applied without design change.

(2) 66 kV Underground Line

PEDEEE has adopted one standard design for 66 kV underground line as well as 66 kV overhead lines. The standard type and size is CV cable with sectional area of 300 mm^2. In the improvement plan, construction of new underground lines with sectional area of 630 mm^2 is proposed to increase transmission capacity.

This type of cable (CV cable 630 mm²) is planned to be installed for the section between Midan II and Al Hajar Al Aswad. The standard design for 66 kV underground line applied in the improvement plan is as follows;

(a)	Type of Cable	Cross-Linked Polyethylene (XLPE) Insulated Polyvinyl Chloride Sheathed Cable (CV cable)
(b)	Size	Cu, 300 mm^2 or 630 mm^2
(c)	Nos, of core	Single core
(d)	Installation method	Buried directly in the ground
(e)	Others	Steel wire or steel tape Armored

10.3 Basic Design for 20 kV and LT Distribution Facility

The equipment that is generally applied to the existing system is basically applied to the formulation of the rehabilitation plan, except those that are newly introduced to the system by this plan. Each facility is designed according to Attachment 7-3 "Standard for 20 kV and 0.4 kV Distribution Facilities" and the following basic specifications.

10.3.1 20 kV Distribution Lines

(1) 20 kV Overhead Distribution Feeders

(a) Concrete poles (single pole 12 m) shall be applied to straight sections of distribution lines with condition that the pole shall have enough strength, and latticed steel poles (13 m high) shall be applied to the heavy angle points or terminal.

(b) Aluminum Conductor Steel Reinforced (ACSR) of cross section 120mm^2 is basically applied to main feeders.

(c) Cross Linked Polyethylene Insulated (XLPE) cable with messenger wires (aluminum conductor triplex cables, 185 mm^2) are applied to overhead cable feeders.

(d) Two nos. of suspension insulator disc shall be used for tension insulator set and pin type insulators of two nos. of suspension insulator discs for suspension points,

(e) Single circuit in horizontal arrangement as a standard arrangement of conductors with two tension insulators or suspension insulators is basically applied.

(2) 20 kV Underground Distribution Feeders

(a) 20 kV Cross Linked Polyethylene Insulated (XLPE) cables shall be used. Main specifications are as follows.

- Type of cable — Cross Linked Polyethylene Insulated Vinyl Sheathed Cable
- Conductors — Aluminum conductor, 185 mm^2
- Number of cores — Single core or triplex
- Withstand voltage — Lightning impulse 210 kV; Power frequency 45 kV
- Others — Steel armored, directly buried in the ground

(b) Standard installation depth shall be 1.2 m and cables are protected by pipes.

10.3.2 Improvement of 20 kV System Configuration

(1) 20 kV Switches

(a) Vacuum type load break switches shall be applied at the end of 20 kV main feeders for interconnection with other feeders. The major ratings shall be as follows:

- Nominal voltage : 20 kV
- Rated voltage : 24 kV
- Rated normal current : 400 A
- Rated frequency : 50 Hz

(b) Section switches shall be of vacuum type automatic load break switches with short circuit making capacity. The major specifications are as follows.

- Nominal voltage : 20 kV
- Rated voltage : 24 kV
- Rated normal current : 400 A
- Short-circuit making current : 31.5 kA
- Rated frequency : 50 Hz
- Control source: Single phase, AC 110 V/50 Hz

(2) Auto-fault Detecting Device

(a) Control device having the auto-fault detecting function as shown in Attachment 10-1 is used to control the automatic section switches. Control device shall be accommodated in the weather-proofed cabinet to be mounted on the poles.

(3) 20 kV/0.11 kV Transformers for Auto-fault Detecting Device

(a) Two units of 20 kV/0.11 kV, single phase transformers with the capacity of 0.5 kVA are used for control source of the auto-fault detecting devices.

(4) **Re-closing relays**

(a) Re-closing relay for 20 kV circuit breaker installed on the outgoing feeder at substation shall be suitable for two times re-closing and shall be reset automatically after successful re-closing operation.

(5) **Fault section indicators**

(a) Fault section indicators shall be installed on the control panel or 20 kV switchgear cubicle in combination with the auto-fault detecting devices and re-closing relays to indicate the fault section when successful re-closing is made. Fault section indicators shall be reset automatically after the successful re-closing.

10.4 Low Voltage Distribution Facilities

(1) **20/0.4 kV Transformers**

(a) 20//0.4 kV distribution transformers shall be of three phase, oil immersed ONAN type, regardless of the installation type.

- Rated voltage:	Primary	20 kV
	Secondary	380-220 V (3-phase 4-wire system)
- Vector group:	Dyn11	
- Off-load tap changing changer:		± 2 x 2.5 %
- Rated frequency:	50 Hz	
- Cooling type:	ONAN	

(b) Standard installation types are steel latticed tower/pole mounted type as shown on Photo 10-1 or ground mounted type as shown on Photo 10-2 and Figure 10.4-1.

(c) Cutout fuses and disconnectors shall be installed on the primary side of transformers and low voltage circuit breakers on the secondary side. Fuses shall be installed on every feeder at the low tension distribution panel. Capacities of those fuses are listed in Attachment 7-3.

(d) Lightning arresters shall be installed at the primary dropping wire in case of the pole mounted transformers. Lightning arresters shall have the following characteristics:

- Type	outdoor pole mounted type
- Rated voltage	24 kV, 50 Hz
- Rated current	5 kA
- Power frequency spark-over voltage	39.6 kV

(2) LT Overhead Distribution Feeders

(a) Concrete poles (single pole, 10 m high) shall be used at the straight section of line so far as the strength permits, and latticed steel poles (11 m, high) shall be applied to the angle or terminal points of lines.

(b) Bare hard drawn stranded aluminum conductor (AAC) 120 mm² shall be applied as a standard conductor for main line. Vinyl insulated type conductors of Aluminum 120 mm² shall be also used where it is considered necessary to prevent illegal connection by consumers and from the viewpoint of safety.

(c) Standard arrangement of conductors is of single circuit in vertical formation

(3) LT Underground Distribution Feeders

(a) Cross linked polyethylene insulated PVC sheathed (XLPE) copper conductor 120 mm² cables (four core) shall be applied to underground cable feeders.

(b) Standard installation depth is 1.2m below ground level. Cables shall be protected by steel or iron pipes.

(4) LT Service Wires/Cables

(a) Vinyl insulated cables with copper conductor (four cores x 50 mm²) shall be used for low voltage service wires/cables for connection to consumers.

(5) Watt-hour Meter

(a) Watt-hour meter shall be of AC single phase or three phase use and of weather-proof type.

- Rated voltage 380 - 220 V
- Rated frequency 50 Hz
- Rated current 10 - 30 A
- Power factor 0.7 - 0.98
- Integral digits 6 nos.

(6) Aggregating Meter Box

(a) The aggregating meter boxes for single-phase consumer shall be designed to be mounted on a wall at the entrance hall of consumer building. The meter box shall be able to accommodate 3 to 6 nos. of single-phase watt-hour meter.

10.5 Implementation Schedule

The improvement plan up to 2010 presented in Chapter 8 contains the following subprojects.

(a) Subprojects under construction

(b) Subprojects with fund

(c) Subprojects under negotiation with donor

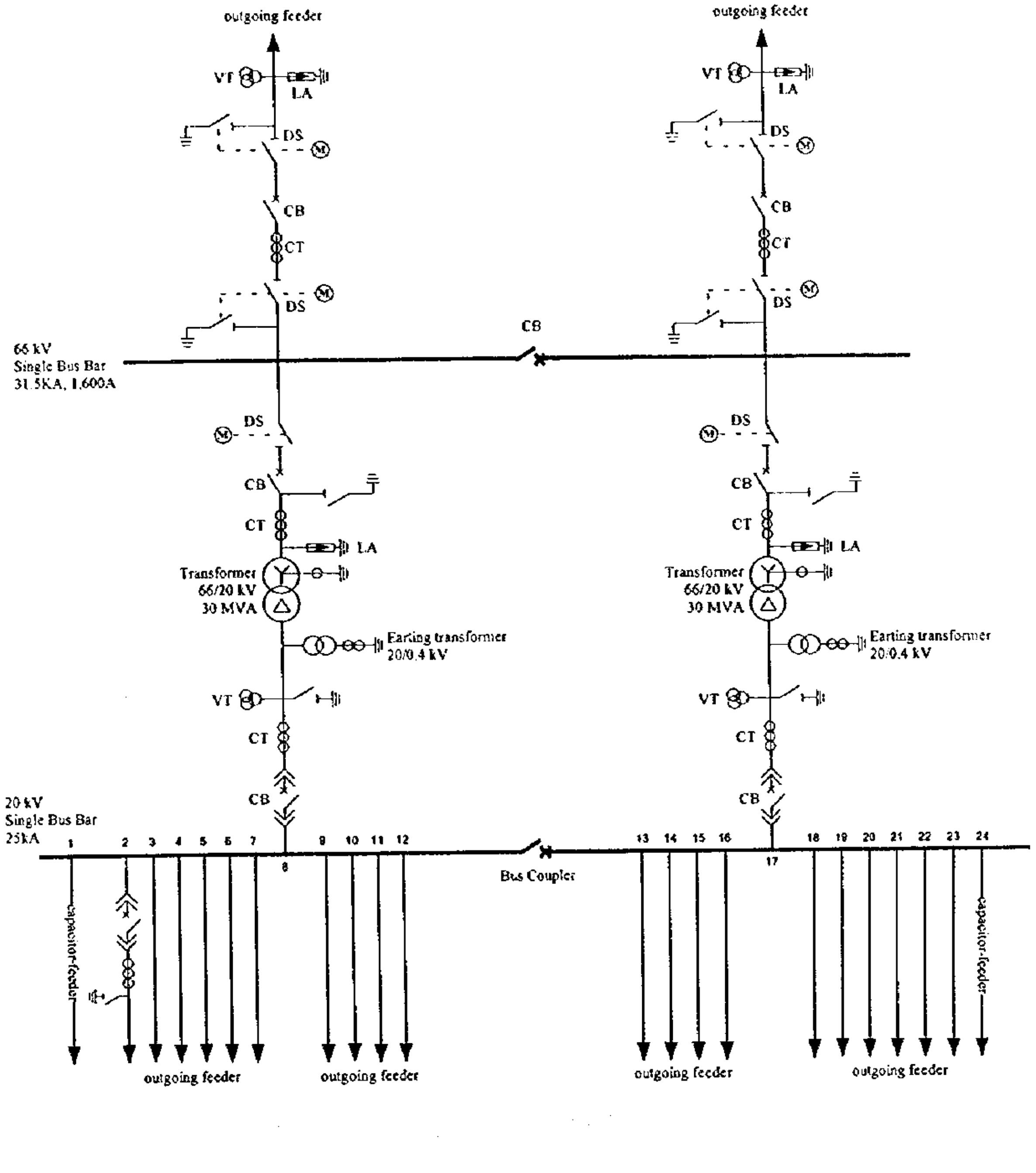
(d) Subprojects not yet funded

Subproject lists attached in Chapter 8 includes all the above subprojects and the list is shown with name of substation and components and its commissioning year at 3 stages, that is, up to 2002, 2003 to 2005 and 2006 to 2010.

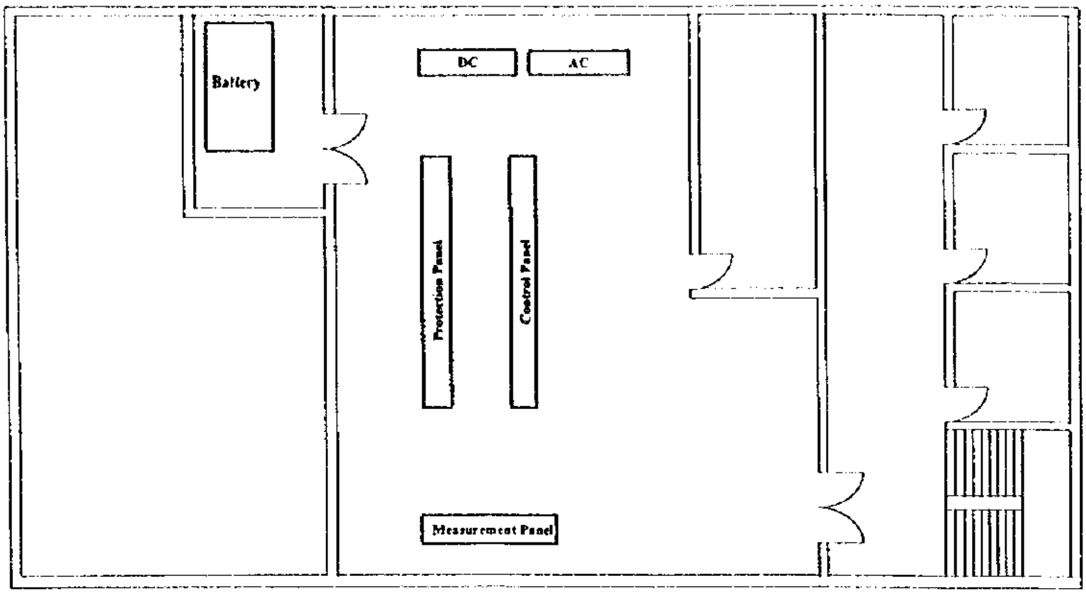
Based on the subproject lists, the implementation schedule at the 3 stages is shown in Figure 10.5-1. Construction period of the subprojects is assumed as follows.

(a) Construction period of 66 kV facilities is assumed at 3 years taking into consideration of the past similar projects although construction periods for substation and transmission line are slightly different.

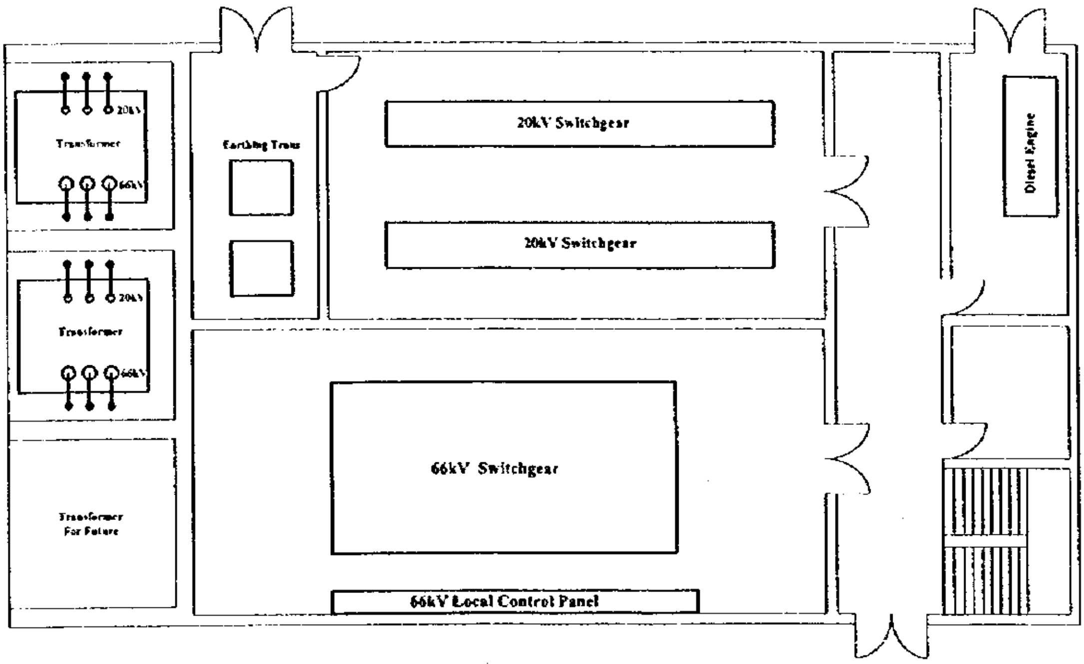
(b) As for 20 kV and Low voltage facilities, construction is assumed to be continued up to the project commissioning year at a yearly base.



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 10.2-1 Title Typical Single Line Diagram of 66/20 kV Substation



First Floor



Ground Floor

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 10.2-2 Title Typical Layout of 66/20 kV Substation

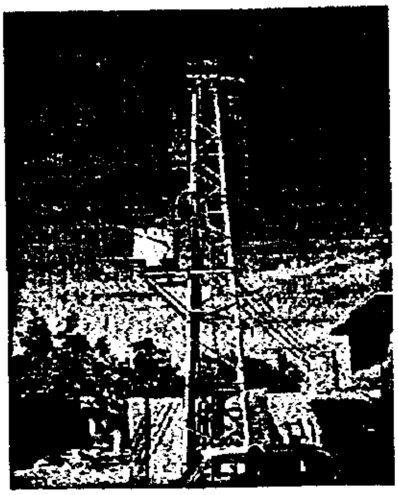


Photo 10-1 Pole Mounted Transformer

Photo 10-2 Ground Mounted Transformer

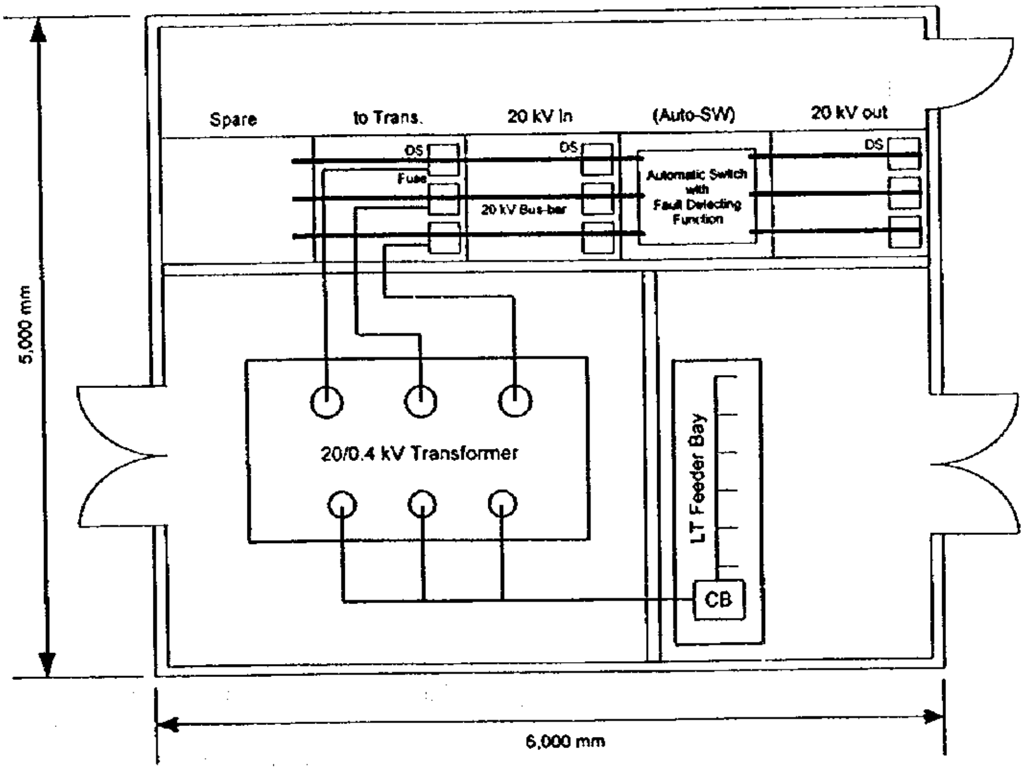


Figure 10.4-1 Typical Layout of Ground Mounted 20/0.4 kV Transformer

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 Title

Figure 10.5-1 Implementation Schedule for Improvement Plan

	Subprojects		Commissioning year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2002	**I 66 kV Facilities**														
	1 New substation	:Kafersuseh/Harash/Khan Al Shih	1999												
		: Barzeh/Qsoor/Ibn Al Nafis/Zablatani	2001												
		: Jaraa/Hosh Blas/Shekh Hassan/Jaraman	2001												
		: New Ersal	2002												
	2 Transformer	: 4 substations	2000												
		: 21 substations	2002												
	3 20 kV Switchgear	: 5 substations	2000												
		: 4 substations	2002												
	4 66 kV Network	: 66 kV connection to Zahera	2001												
	5 Static Condensor	: 11 substations	1999												
		: 3 substations	2002												
	6 66 kV CB	: 3 substations	2002												
	II 20 kV Facilities														
	1 Section switches														
	2 Upgrade of feeders														
	3 New feeders														
	4 Replace of OF cable														
	III Low Voltage Facilities														
	1 New and Upgrade of feeders														
	2 Distribution transformers														
	3 Meters and Meter Boxes														
	4 Other Works														
2003-2005	**I 66 kV Facilities**														
	1 New substation	: Jededat Artouz/Bludan/Yalda	2003												
	2 Transformer	: 10 substations	2005												
	3 20 kV Switchgear	: 10 substations	2005												
	4 66 kV Network	: new UG&OH lines/2nd OH lines	2005												
	5 Static Condensor	: 15 substations	2005												
	6 66 kV CB	: 4 substations	2005												
	II 20 kV Facilities														
	1 Section switches														
	2 Upgrade of feeders														
	3 New feeders														
	III Low Voltage Facilities														
	1 New and Upgrade of feeders														
	2 Distribution transformers														
	3 Meters and Meters Boxes														
2006-2010	**I 66 kV Facilities**														
	1 New substation	: Al Tal/Yabroud/Harasta/Nashabieh	2006												
		: Meleha/Kudseia 1/Kudseia 2/Darea	2006												
	2 Transformer	: 14 substations	2007												
		: 4 substations	2009												
	3 20 kV Switchgear	: 10 substations	2010												
	4 66 kV Network	: Upgrade UG lines/2nd OH lines	2006												
		: 66 kV connection to Saiedeh Zinab	2008												
		: 66 kV connection to Baramekha	2008												
	5 Static Condensor	: 9 substations	2008												
	6 66 kV CB	: 2 substations	2010												
	II 20 kV Facilities														
	1 Section switches														
	2 Upgrade of feeders														
	3 New feeders														
	III Low Voltage Facilities														
	1 New and Upgrade of feeders														
	2 Distribution transformers														
	3 Meters and Meters Boxes														

Attachment 10-1 Time-delay Fault Detecting System

The time-delay fault detection system designed to function in collaboration with the re-closing relay in the substation is a kind of the time relay which function with time for detection and elimination the faulty section of the distribution line and used in combination with the automatic switches installed on the distribution line.

1. Outline of fault detection

When the fault has occurred in the distribution line, the fault is detected by the relay in the substation to cause the circuit breaker for the distribution feeder line to be tripped, thereby causing the power transmission to be discontinued. Then, after 60 seconds, the circuit will be closed to resume the power transmission.

When the transmission of the power is resumed, the time-delay fault detector causes the automatic switches to be closed sequentially based on the X-time interval (time interval for closing). When the power is transmitted to the faulty section, the relay of the substation detects the fault again to cause the circuit breaker to be re-tripped. At this point, the time-delay fault detector set to Y-time interval (time interval for detection) is closed and locked in order to prevent it from causing the automatic switch to be closed again. Then, the circuit breaker will be closed again after 60 seconds from the re-tripping of the circuit breaker to energize all the sound sections preceding the faulty section, which will be separated.

2. Operation characteristics of time-delay fault detector

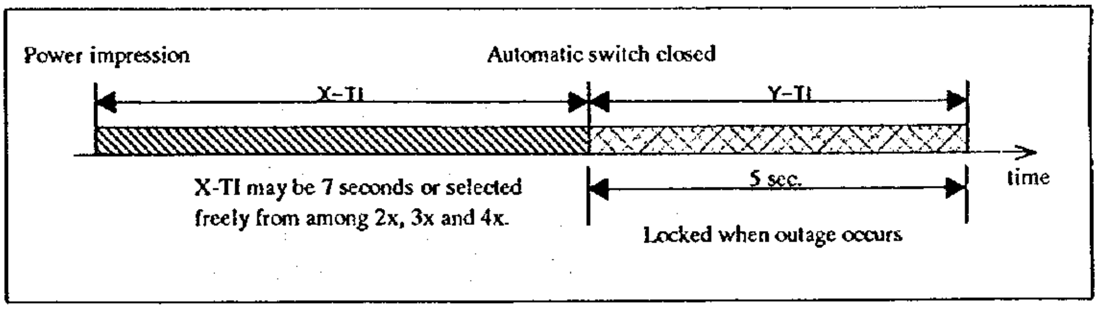
- X-time interval (Time limit for closing, X-TI)

  The time required from the charging of detector to the closing of automatic switch.

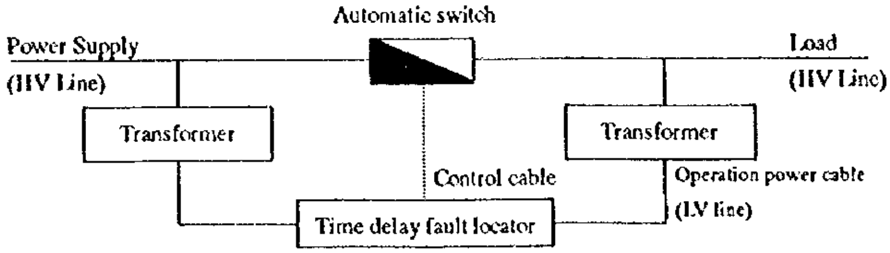
- Y-time interval (Time limit for detection, Y-TI)

  Represents the time elapsed from the closing of the automatic switch. When the outage has occurred during this time interval, the circuits of the fault detector relay for closing on the automatic switch is locked regarding that the faulty section is detected, and the switch is kept opened. When there is no outage during this time interval, the fault detector will be initialized.

- Time chart of X-time and Y-time interval



3. Connection of the time-delay fault locator and automatic switch

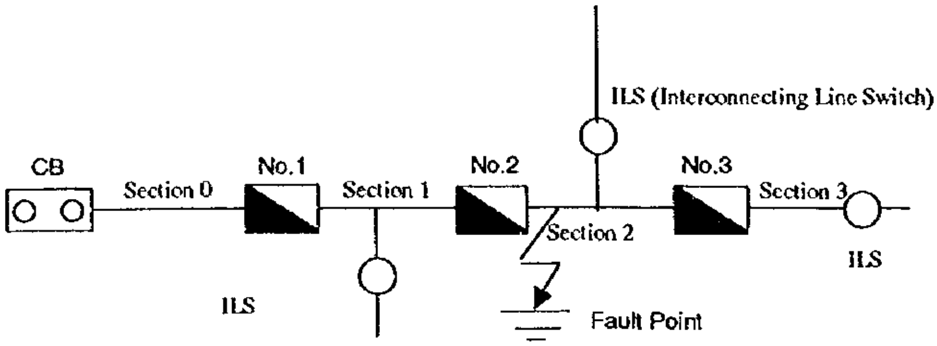


* function of automatic switch

To close by being impressed operation voltage from the time-delay fault locator, and to open when operation voltage is off.

4. Example of fault location and separation by the time-delay fault locator

The following figure shows the flow of fault location and separation when a distribution fault occurs.



1) A fault occurs in the section 2.
   a. The protective device at substation detects the distribution line fault, and the distribution circuit breaker opens. (Distribution line is suspended.)
   b. All the automatic switches in the distribution line are open as a result of losing operation power.
2) The distribution circuit breaker at the substation is closed in 60 seconds. (re-transmission)
   a. Re-transmission (charging) in the section 0.
   b. The operation power is supplied to the time-delay fault locator at the automatic switch No.1. In seven seconds (X-time setting time) the automatic switch is closed (section 1 is charged).
3) Automatic switch is closed sequentially every X-time setting time. (each section is charged)
4) Distribution fault occurs again when the section with the fault point is charged.
   a. The protective device at substation detects the distribution fault again and the distribution circuit breaker opens. (Distribution line is suspended.)
   b. The time-delay fault locator that charged the fault section (In this case, fault locator No.2) makes the automatic switch being kept open by the lock function (Y-time lock).
5) In 60 seconds the distribution circuit breaker at the substation is closed for the second time (2nd re-transmission).
   a. Transmission (charging) in the section 0.
   b. The operation power is supplied to the time-delay fault locator at the automatic switch No.1. In seven

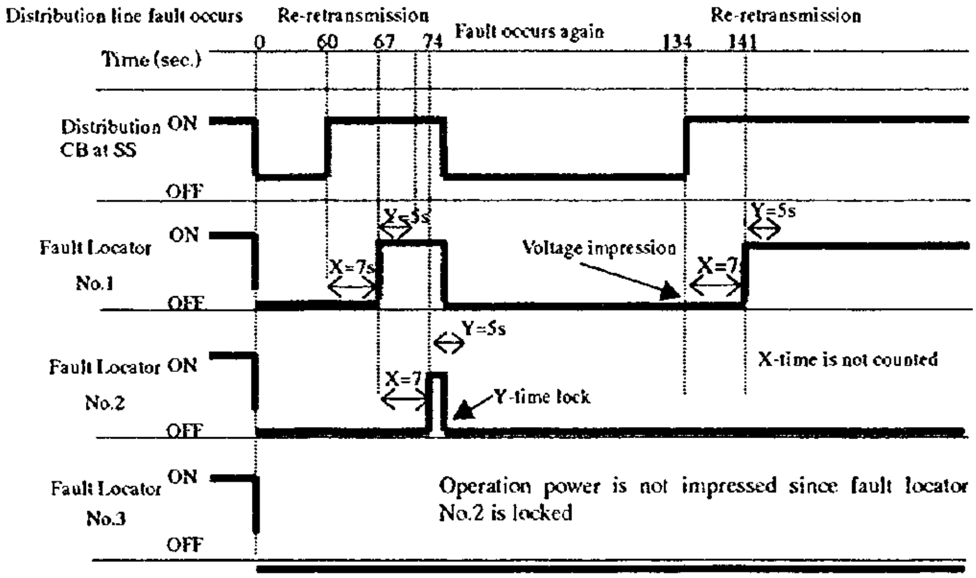
seconds (X-time setting time) the automatic switch is closed (section 1 is charged).

6) Automatic switch is closed sequentially every X-time setting time. (each section is charged)

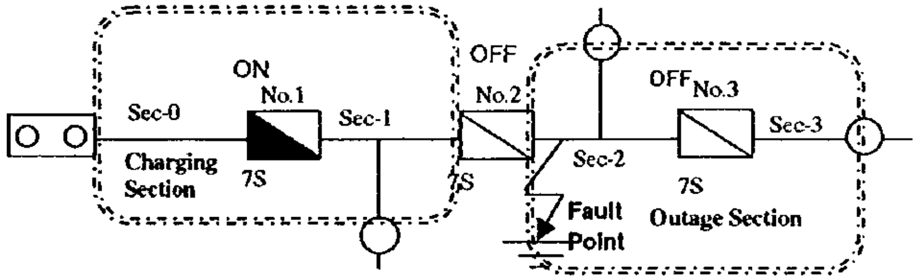
a. The fault section is separated by not re-closing the automatic switch (In this case, switch No.2) that is locked by the lock function of the time-delay fault locator.

> The fault section is detected and separated by two sets of closing operations (re-closing and 2nd re-closing) and time fault location function.

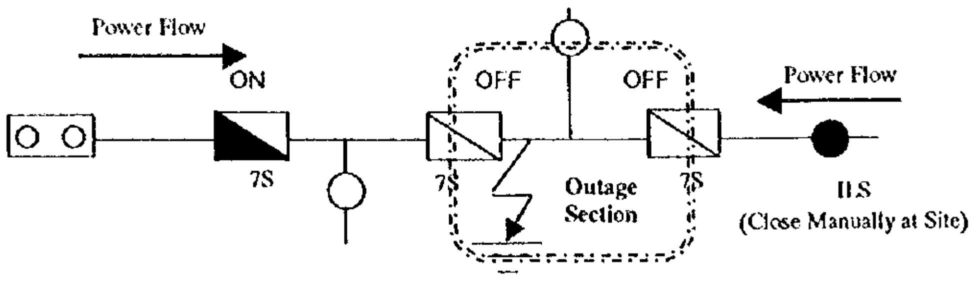
5. Time chart of fault section location and separation with the time-delay fault locator.



6. Distribution line after fault location and separation



7. Transmission into the sound section



a. Automatic switch No.2 maintains open by Y-time lock function.

b. Automatic switch No.3 maintains open by reverse transmission lock function.

* Reverse transmission lock function:

  The function that makes the automatic switch keep open while the operation power of the time-delay fault locator is supplied from the reverse direction.

CHAPTER XI

ECONOMIC AND FINANCIAL EVALUATION OF IMPROVEMENT PLAN

Chapter 11 Economic and Financial Evaluation of Improvement Plan

11.1 Investment Cost and Investment Schedule

(1) Investment Cost

Based on the improvement plans presented in Chapter 8 and the feasibility design in Chapter 10, quantities of components/materials required for all the subprojects of improvement plans for 66 kV, 20 kV and Low voltage facilities were estimated. The construction cost for each sub-project was calculated based on these quantities of materials/equipment and the standard unit prices.

The Team prepared standard unit prices referring to the recent contract prices for the construction of distribution facilities in Syria and various data owned by the Team. The standard unit prices of 66 kV facilities for the cost estimate are shown in Attachment 11-1 and those of 20 kV and low voltage facilities in Attachment 11-2.

As a normal practice for construction of the distribution facilities in Syria, PEDEEE procures only main equipment and materials from abroad, and the installation and related civil works are executed by local contractors. The construction costs estimated by the Team in the report were worked out in the same way.

The total investment cost required for the improvement plans is sum of the construction costs and the following various expenses necessary to accomplishing the plans.

(a)	Consultancy services		5 % of foreign portion of the construction costs
(b)	Contingency	- Physical	5 % of foreign portion of the construction costs 5 % of local portion of the construction costs
		- Price	2.5 % inflation rate for foreign portion[1] 8 % inflation rate for local portion[2]
(c)	Tax and duty for imported goods		Weighted average import duty rate: 23% of CIF[3]
(d)	Interest during construction period		4 % for foreign portion, 8 % for local portion

The total investment cost thus estimated is shown in Table 11.1-1, and the summary is given in Table 11.1-2. The breakdown of construction costs for 66 kV facilities and 20 kV/Low Voltage facilities is shown in Attachment 11-3 and Attachment 11-4 respectively.

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[1] Inflation rate in foreign currency portion is estimated at 1.4 % in 1999 and 2.5 % after 2000.

[2] Estimated from the past records of inflation in Syria.(Refer to Chapter 2.2.1)

[3] Power transformers: 8 %, High voltage switchgears (switches, arresters, condenser, etc.): 28 %, High voltage power cable:29 %, Distribution transformers: 10 %, Low voltage equipment: 32 %, Towers: 49% (Source: PEDEEE and List of import duties in Syria, 1995)

Table.11.1-2 Total Investment Cost (unit : US$ 1,000)

	Facilities	Foreign	Local	Total
1.	66 kV Facilities	158,274	40,406	198,680
2.	20 kV Facilities	72,426	39,971	112,397
3.	20/0.4kV Transformer	63,773	40,835	104,608
4.	Low voltage feeders	41,417	18,944	60,361
	Subtotal	335,890	140,156	476,046
5.	Consultancy service	16,500	-	16,500
6.	Contingency - Physical	16,795	7,008	23,803
	- Price	46,883	20,243	67,126
7.	Tax and duty	-	91,900	91,900
	Total Construction Cost	416,068	259,307	675,375
8.	Interest during Construction	25,355	32,922	58,277
	Total	441,423	292,229	733,652

(2) Investment Schedule

Investment Schedule of the improvement plans was prepared taking into account the implementation schedule of the subprojects discussed in Section 10.5 and shown in Table 11.1-3.

As seen in the table, it was considered that the improvement plans would be implemented through three stages, i.e. (1) urgent sub-projects to be implemented by 2002, (2) sub-projects to be implemented in the middle term basis to meet the power demand in 2005, and (3) sub-projects to be implemented in the long-term basis to meet the power demand in 2010. The construction of 66 kV facilities was supposed to take three to four years for tendering, manufacturing, transport, installation and commissioning. While, the procurement of components/materials and installation works for 20 kV and low voltage facilities are supposed to be completed every year for immediate operation, for which annual investment will be required.

11.2 Benefits

Benefits brought by the implementation of improvement plans are considered as follows:

(a) Incremental energy sales

(b) Reduction of technical-losses

(c) Reduction of non-technical losses

(d) Reduction of un-served energy due to outage by improvement of supply reliability

Considering two cases, e.g. "With Project" where the Project is to be implemented and "Without Project" where the Project is not to be implemented, yearly streams of sales energy, energy losses and un-served energy were studied to obtain net benefit of the project.

(1) Assumptions when the Project is to be implemented (With Project)

(a) The sales energy estimated in the power demand forecast would be secured by the improved and expanded distribution facilities.

(b) Reduction of technical and non-technical losses would be achieved by the improved facilities as follows:

Table 11.2-1 Reduction of Technical and non-technical losses (Unit : %)

		1997	2000	2010
Damascus City	Technical losses	16.00	14.94	11.40
	Non-technical losses	12.31	10.27	3.50
Damascus Rural	Technical losses	16.50	15.32	11.40
	Non-technical losses	16.18	14.06	7.00

(c) The un-served energy due to outage would be remarkably reduced. As discussed in the Clause 10.3, most of un-served energy took place in 20kV network. Owing to improvement of 20kV network, the time for un-served energy will be much reduced. The un-served energy is estimated to be reduced to nearly 30 % of the existing amount.

(2) Assumptions when the Project is not to be implemented (Without Project)

(a) The existing distribution facilities remain unchanged by 2010. After the peak load reaches to the limited capacity of the existing facilities, the power supply above the existing distribution capacity could not be delivered.

The total capacity of all the 66/20 kV substations in 1998 was 1,720 MVA (approx. 1,460 MW with power factor of 0.85). The total of individual peak loads of substations is normally higher than the system peak load by about 10 % (non-simultaneous peak loads at substations). The maximum power to be distributed through the existing facilities, therefore, is considered at approximately 1,300 MW. The energy below 1,300 MW peak is the maximum energy to be supplied, accordingly. In the load duration curves on Fig. 11.2-1, peak loads exceeding 1,300 MW is unable to be delivered by the existing facilities.

(b) Technical losses will increase in proportion to the square of current increase, in case of same cross-section of conductor. The current will increase in proportion to the power growth. Accordingly, technical losses will increase in proportion to the square of increase rate of total energy consumption per annum.

(c) Non-technical losses will continue to stay in the same level as of 1999.

(d) Supply reliability remains in the low level till 2010. The ratio of un-served energy to the total energy sale in 1999 will remain unchanged till 2010.

Being computed under the above assumptions, yearly streams of energy sales, losses, un-served energy, energy purchased from PEEGT and net benefits are shown in Table 11.2-2 and Fig. 11.2-2.

Non-technical losses do not influence to the national product from a view point of national economy.

Therefore, the energy which would be shifted from non-technical losses to sales energy shall not be considered in both energy sales and energy purchase from PEEGT in case of "With Project".

11.3 Economic and Financial Analysis

(1) General

The economic and financial analysis of the project assesses incremental costs, revenues and benefits reflecting comparison of "With Project" that the project is to be implemented and "Without Project" that the project is not to be implemented.

The analysis seeks net benefits computed from investment costs and incremental revenues, profitability of the project and Economic and Financial Internal Rate of Return (EIRR and FIRR) to confirm viability of the project. The project is focused on the distribution network improvement in Damascus City and Damascus Rural Distribution Companies during years 1999-2010.

Furthermore, sensitivity analysis against foreseeable adverse risks such as deviations in investment cost overrun, decreases in power demand forecasting, increase in energy purchase unit cost and decrease in energy sales unit cost are conducted to confirm how internal rates of return will be affected with such risks and also to confirm viability of the project.

(2) Economic Analysis

For the economic analysis, economic prices (shadowed prices) are used. All foreign costs are measured using border prices (CIF prices). Local prices are expressed in terms of equivalent border prices using conversion factors. The energy purchase unit cost at the HV transmission outlet and the energy sales unit cost at the LV distribution network outlet are obtained from Long Run Average Incremental Costs (LRAIC) which is one of calculation methods of the Long Run Marginal Costs (LRMC)[4].

To confirm the economic viability of the project, the economic internal rate of return (EIRR) is computed on the basis of the incremental economic costs, revenues and benefit streams in comparison between "with and without projects", as mentioned in Section 11.2. The incremental cost streams comprise: (a) capital investment costs under the projects during 1999-2010; and (b) the incremental operation, maintenance and administrative costs; and (c) cost of incremental energy purchased from PEEGT, evaluated in terms of long

[4] 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. As a complimentary tool to detailed long-run optimization of system expansion, the marginal cost can be a handy yardstick to resolve planning problems at the margin of the least-cost program. LRAIC, simply based on the discounted total system expansion investment and recurrent cost streams, distributed over the discounted stream of incremental kWh sales, is one of alternative calculation methods to approximate the LRMC.

run average incremental cost (LRAIC) of energy supply at the HV transmission outlet. The incremental revenues are estimated based on the incremental sales of electricity.

The EIRR was computed on the following basis:

(i) Cost referring to prices at the mid-1999.

(ii) Economic life of the project to be 25 years.

(iii) Border prices (CIF prices) for imported equipment and materials. Duties and taxes excluded.

(iv) Local costs (for equipment, materials and labor) are adjusted by conversion factors to reflect border prices. Conversion factors for local goods, materials and labor forces are as follows.

- Goods and materials: 0.8
- Labor force: 0.8
- Standard conversion factor: 0.8

(v) Discount Rate to be 9%

(vi) Electricity purchase unit cost at HV transmission outlet from PEEGT and sales unit cost at LV distribution network outlet for consumers were estimated using LRAIC[5]. The results of the analysis were shown in Table 11.3-1 and summarized below.

- Unit purchase cost from PEEGT: US¢ 4.71/kWh
- Weighted average sales unit cost for consumers: US¢ 8.02/kWh

Based on the above, the project EIRR was computed at about 26 %. Detailed calculation is shown in Table 11.3-2. This indicates that the project has a sufficient economic profitability.

(3) Financial Analysis

In the financial analysis, financial (actual) prices are used. The actual price includes, as mentioned in Section 11.1, base cost, physical and price contingencies, import duties, etc. Energy purchase unit price of SP 0.6385/kWh is used at HV transmission line outlet based on the determined price between PEEGT and PEDEEE in 1997. The electricity tariff list shown in Table 3.2-8 in Chapter 3 which is currently prevailing is applied for energy sales price for consumers. The weighted average sales unit price of the two distribution companies in 1997 was SP 0.868/kWh.

Based on the above, yearly cost and benefit streams were analyzed. The result of the analysis is shown in Table 11.3-3. As seen in the table, the present worth value of net benefit (B) with a discount rate of 9 % was

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[5] This calculation was conducted on the basis of the following preceding studies which discussed LRAIC of the Syrian electricity network.

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

(ii) Energy Power Efficiency Study, UNDP/World Bank, September 1988 computed at less than the present worth value of total cost (C). This result was caused by the extremely low energy sales tariffs to consumers in Syria compared with the average energy sales tariffs applied in the world.

LRAIC based on the financial analysis which is the present worth value of total cost divided by the present worth value of the total energy sales will be at SP 1.586/kWh. This means that if the energy sales unit price will be increased to SP 1.586/kWh, the present worth value (NPV) of the net benefit will become to be zero and FIRR will be 9 %. Detailed analysis is shown in Table 11.3-4.

11.4 Sensitivity Analysis

The economic internal rate of return (EIRR) of the improvement project was tested against adverse assumptions associated with project risks for the following four cases: (a) 10% increase in the investment cost; (b) 10% decrease in total energy sales amount in 2010; (c) 20% increase in energy purchase unit cost; and (d) 20% decrease in energy sales unit cost. The results of calculations are shown in Attachment 11-5 and summarized in the following table.

Table 11.4-1 Result of Sensitivity Analysis

	Variations in assumed conditions	EIRR (%)
(i)	10% increase in investment cost	24.3 %
(ii)	10% decrease in total energy sales amount in 2010	23.1 %
(iii)	20% increase in enegry purchase unit cost (LRAIC)	25.5 %
(vi)	20% decrease in energy sales unit cost (LRAIC)	20.6 %

The above analysis indicates that the proposed improvement plan has sufficient profitability against any of those adverse conditions.

11.5 Economic Evaluation Compared with Reference Case

The economic and financial evaluation of the improvement plans proposed in this report was analyzed in consideration of two cases of "With Project" and "Without "Project" as described in the foregoing sub-clauses. However, the assumptions under the case of "Without Project" seems impractical, where the distribution facilities in the study area will remain unchanged without any extension or augmentation until 2010. Energy consumption in the study area will be increasing as estimated in the power demand forecast and the distribution facilities required for growing demand will be extended and/or augmented accordingly by PEDEEE under any circumstance. An alternative case is, therefore, considered in which the extension and/or augmentation of distribution facilities in the study area is supposed to be executed by PEDEEE with his own budget to the minimum requirements for supplying the growing power demand. Economic evaluation for the case of "With Project" compared with the above alternative case was conducted for reference purpose. The following conditions are assumed in the reference case:

(i) To supply the energy demand as estimated in the power demand forecast to the consumers, the extension and augmentation of the distribution facilities in the study area will be executed by PEDEEE to the extent of the minimum requirements. Energy sales will be the same as those of "With Project" during the period of 1999 to 2010.

(ii) Rates of technical losses and non-technical losses and the level of supply reliability of the distribution facilities will remain in the same level as of 1999 during the period of 1999 to 2010.

(iii) The incremental construction cost required to realize the improvement proposed in this report from the reference case is equivalent to the cost for the projects to be funded by International Financing Institutions as described in the Chapter 12 "Financing Plans".

Benefits in the case of "With Project" against the reference case are the same with those stated in the sub-clause 11.2. The breakdown of benefits is shown on the Table 11.5-1 and shown on the Fig. 11.5-1. Other conditions in the economic evaluation are the same with those mentioned in the sub-clause 11.3.

As a result of economic analysis on the "With Project" compared with the reference case, economic internal rate of return (EIRR) was calculated at 17.9 % as shown on the table 11.5-2. Thus, this indicates that, even if improvement works only of the existing distribution facilities, not including expansion or augmentation of the facilities to meet the growing power demand, are taken into consideration, the proposed improvement plans in this report are found economically feasible as well.

Table 11.1-1 Summary of Construction Cost

(Unit: 1,000 x US$)

Work Item	FC (US$)	LC (US$)	Total (US$)
1. Improvement on 66kV Facilities			
(a) Construction of new 66/20kV Substations	77,639	19,408	97,047
(b) Increase of Transformer capacity	33,178	7,768	40,946
(c) Replacement of 20kV Switchgears	29,106	6,815	35,921
(d) Reinforcement of 66kV Network	12,334	5,006	17,340
(e) Installation of Static Capacitors	3,888	910	4,798
(f) Replacement of 66kV Circuit Breakers	2,129	499	2,628
Sub-total	**158,274**	**40,406**	**198,680**
2. Improvement of 20kV Facilities			
(a) Reinforcement, construction, replacemnt of 20kV feeders			
Damascus City	18,509	15,864	34,373
Damascus Rural	19,861	11,202	31,063
(b) Improvement of 20kV system by applying auto-fault detecting swithes			
Damascus City	17,326	6,553	23,879
Damascus Rural	16,730	6,352	23,082
Sub-Total	**72,426**	**39,971**	**112,397**
3. Increase of 20/0.4kV transformers			
Damascus City	29,334	20,089	49,423
Damascus Rural	34,439	20,746	55,185
Sub-Total	**63,773**	**40,835**	**104,608**
4. Improvement of Low voltage facilities			
(a) Reinforcement and construction of 0.4kV feeders			
Damascus City	11,374	5,197	16,571
Damascus Rural	15,809	6,686	22,495
(b) Meters and Meter Protection Boxes			
Damascus City	5,152	2,416	7,568
Damascus Rural	8,448	3,963	12,411
(c) Other Miscellaneous Works			
Damascus City	261	299	560
Damascus Rural	373	383	756
Sub-total	**41,417**	**18,944**	**60,361**
Total	**335,890**	**140,156**	**476,046**
Consulting Services	16,500		16,500
Contingency			
Physical Contingency	16,795	7,008	23,803
Price Contingency	46,883	20,243	67,126
Tax and Duties		91,900	
Total Project Cost	**416,068**	**259,307**	**675,375**
Interest during Construction	25,355	32,922	58,277
Grand Total required for Financing	**441,423**	**292,229**	**733,652**

Table 11.1-3 Investment Schedule (unit: US$ 1,000)

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 66/20kV Kafersuseh Substation	1999	3,503	904																							3,503	904
Construction of 66/20kV Harash Substation	1999	2,981	724																							2,981	724
Construction of 66/20kV Khan Al Shih Substation	1999	3,354	916																							3,354	916
Construction of 66kV Barzeh substation	2001	611	152	1,223	304	1,223	304																			3,057	759
Construction of 66kV Qsoor substation	2001	611	152	1,223	304	1,223	304																			3,057	759
Construction of 66kV Ibn Al Nafis substation	2001	611	152	1,223	304	1,223	304																			3,057	759
Construction of 66kV Zablatani substation	2001	687	187	1,374	374	1,374	374																			3,435	935
Construction of 66kV Jalaa substation	2001	580	137	1,160	274	1,160	274																			2,899	686
Construction of 66kV Hosh Blas substation	2001	580	137	1,160	274	1,160	274																			2,899	686
Construction of 66kV Sheikh Hassan substation	2001	661	169	1,322	337	1,322	337																			3,306	844
Construction of 66kV Jaramana substation	2001	767	211	1,533	423	1,533	423																			3,833	1,057
Construction of 66kV New Ersal substation	2002			1,022	239	2,044	479	2,044	479																	5,111	1,197
Construction of 66kV Al Feigha substation	2002			271	65	543	130	543	130																	1,357	325
2 Increase of Transformer Capacity																											
Transformer capacity up to 2000	2000	1,688	395	1,688	395																					3,376	790
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	690	162	690	162																					1,380	323
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	1,997	468	1,997	468																					3,994	935
4 Reinforcement of 66kV Network																											
66kV connection to 230/66kV Zahera substation	2001	539	231	1,078	463	1,078	463																			2,695	1,157
5 Installation of Static Capacitor																											
Stayic capacitor up to 1999	1999	1,343	314																							1,343	314
Stayic capacitor up to 2002	2002			97	23	195	46	195	46																	486	114
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			4,600	3,942	1,393	1,194	1,374	1,178																	7,367	6,314
Damascus rural	2002			2,573	1,631	1,921	1,075	1,886	1,051																	6,380	3,757
2 Improvement of 20kV system																											
Damascus city	2002			2,134	807	2,119	801	2,119	801																	6,372	2,409
Damascus rural	2002			1,924	730	1,880	714	1,877	713																	5,681	2,157
III Increase of 20/0.4kV Transformer																											
Damascus city	2002			4,332	2,951	4,332	2,951	4,317	2,940																	12,981	8,842
Damascus rural	2002			4,805	2,891	4,715	2,847	4,699	2,838																	14,219	8,576
IV Low Voltage Facilities																											
1 Reinforcement of low voltage feerders																											
Damascus city	2002			1,300	643	1,272	625	1,255	618																	3,827	1,886
Damascus rural	2002			1,517	675	1,489	662	1,473	655																	4,479	1,992
2 Meters and meter protection boxes																											
Damascus city	2002			336	157	336	157	320	150																	992	464
Damascus rural	2002			608	286	608	286	512	240																	1,728	812
3 Other miscellaneous works																											
Damascus city	2002			261	299																					261	299
Damascus rural	2002			373	383																					373	383
Total for 1999 - 2002		21,204	5,411	44,532	20,437	39,559	16,291	28,031	13,107																	133,326	55,246
Up to 2005																											
I 66kV Facilities																											
1 Construction of New Substations																											
Construction of 65kV Jedeidat Artouz substation	2003					648	163	1,296	325	1,296	325															3,240	813
Construction of 66kV Bludan substation	2003					642	160	1,283	319	1,283	319															3,209	798
Construction of 66kV Yalda substation	2003					586	140	1,172	280	1,172	280															2,931	701
2 Increase of Transformer Capacity																											
transformer capacity up to 2005	2005									1,478	346	2,956	692	2,956	692											7,390	1,730
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																											
Construction of 66kV OH,UG lines up to 2005	2005									850	320	1,700	639	1,700	639											4,251	1,598
5 Installation of Static Capacitor																											
Static Capacitor up to 2005	2005									255	60	510	119	510	119											1,275	299
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									1,411	1,209	1,393	1,194	1,374	1,178											4,178	3,581
Damascus rural	2005									1,950	1,097	1,911	1,070	1,886	1,051											5,747	3,218
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									2,139	1,476	2,139	1,476	2,125	1,465											6,403	4,417
Damascus rural	2005									1,944	1,163	1,944	1,163	1,909	1,142											5,797	3,468
IV Low Voltage Facilities																											
1 Reinforcement of low voltage feerders																											
Damascus city	2005									902	401	883	389	874	384											2,659	1,174
Damascus rural	2005									1,289	539	1,241	513	1,226	507											3,756	1,559
2 Meters and meter protection boxes																											
Damascus city	2005									480	225	480	225	464	218											1,424	668
Damascus rural	2005									768	361	768	361	688	322											2,224	1,044
3 Other miscellaneous works																											
Damascus city	2005																										
Damascus rural	2005																										
Total for 2002 - 2005						1,876	462	3,752	925	23,304	10,133	23,981	10,306	23,765	10,181											76,678	32,008
Up to 2010																											
I 66kV Facilities																											
1 Construction of New Substations																											
Construction of 66/20kV Al Tal substation	2006											707	175	1,415	350	1,415	350									3,537	875
Construction of 66/20kV Yabroud substation	2006											681	162	1,363	325	1,363	325									3,407	812
Construction of 66/20kV Harasta substation	2006											753	199	1,506	397	1,506	397									3,764	994
Construction of 66/20kV Nashabieh substation	2006											580	137	1,160	274	1,160	274									2,899	686
Construction of 66/20kV Meleha substation	2006											580	137	1,160	274	1,160	274									2,899	686
Construction of 66/20kV Kudsia-1 substation	2006											574	134	1,147	269	1,147	269									2,868	671
Construction of 66/20kV Kudsia-2 substation	2006											710	185	1,420	370	1,420	370									3,549	925
Construction of 66/20kV Darea substation	2006											697	179	1,395	358	1,395	358									3,486	896
2 Increase of Transformer Capacity																											
transformer up to 2007	2007													1,819	426	3,638	852	3,638	852							9,095	2,129
transformer up to 2009	2009																	422	99	844	198	844	198			2,111	494
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																											
Construction of 66kV OH,UG lines up to 2006	2006											387	167	774	334	774	334									1,935	836
Construction of 66kV OH,UG lines up to 2008	2008															691	283	1,381	566	1,381	566					3,453	1,415
5 Installation of Static Capacitor																											
Static capacitor up to 2008	2008															157	37	313	73	313	73					784	183
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															1,411	1,209	1,411	1,209	1,393	1,194	1,374	1,178	1,374	1,178	6,963	5,968
Damascus rural	2010															1,610	878	1,578	864	1,525	834	1,515	828	1,505	823	7,733	4,227
2 Improvement of 20kV system																											
Damascus city	2010															921	349	921	349	919	348	919	348	904	342	4,584	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															2,036	1,396	2,007	1,380	1,973	1,355	1,973	1,355	1,961	1,344	9,950	6,830
Damascus rural	2010															2,959	1,779	2,905	1,754	2,886	1,741	2,845	1,719	2,828	1,710	14,423	8,703
IV Low Voltage Facilities																											
1 Reinforcement of low voltage feerders																											
Damascus city	2010															987	432	977	427	977	427	977	427	970	424	4,888	2,137
Damascus rural	2010															1,529	633	1,511	625	1,511	625	1,511	625	1,511	625	7,573	3,133
2 Meters and meter protection boxes																											
Damascus city	2010															608	286	592	279	512	240	512	240	512	240	2,736	1,285
Damascus rural	2010															944	443	928	436	928	436	848	397	848	397	4,496	2,109
3 Other miscellaneous works																											
Damascus city	2010																										
Damascus rural	2010																										
Total for 2005 - 2010												5,669	1,476	13,157	3,379	29,916	11,941	19,672	9,325	18,927	9,076	19,741	8,974	18,806	8,732	125,888	52,904
Base Cost Total		21,204	5,411	44,532	20,437	41,435	16,754	31,783	14,031	23,304	10,133	29,650	11,783	36,922	13,560	29,916	11,941	19,672	9,325	18,927	9,076	19,741	8,974	18,806	8,732	335,892	140,157
Physical Contingency		1,060	271	2,227	1,022	2,072	838	1,589	702	1,165	507	1,483	589	1,846	678	1,496	597	984	460	946	454	987	449	940	437	16,795	7,010
Price Contingency		156	40	1,247	572	2,277	921	2,625	1,159	2,584	1,124	4,149	1,649	6,264	2,301	5,988	2,390	4,552	2,158	4,986	2,391	5,849	2,659	6,205	2,881	46,882	20,245
Duty and Tax			5,157		11,041		10,530		8,279		6,222		8,115		10,357		8,602		5,798		5,717		6,113		5,969		91,900
Consultancy Services				1,650		1,650		1,650		1,650		1,650		1,650		1,650		1,650		1,650		1,650				16,500	
Grand Total		22,420	10,879	49,656	33,072	47,434	29,043	37,647	24,171	28,703	17,986	36,932	22,136	46,682	26,896	39,050	23,530	26,858	17,747	26,509	17,638	28,227	18,195	25,951	18,019	416,069	259,312

Table 11.2-2 Benefits of Improvement Plan

Damascus City + Rural (With Project)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Sale	4,244,580	4,573,070	4,963,380	5,387,051	5,847,035	6,346,633	6,889,467	7,479,513	8,121,140	8,819,147	9,578,807	10,404,345
Growth (%)	7.72	7.74	8.53	8.54	8.54	8.54	8.55	8.56	8.58	8.59	8.61	8.62
Distribution Loss (MWh)	1,689,658	1,727,883	1,777,947	1,826,742	1,873,852	1,918,822	1,961,130	2,000,183	2,035,303	2,065,718	2,090,551	2,108,648
Technical Loss (MWh)	920,682	954,101	995,660	1,038,523	1,082,684	1,128,141	1,174,883	1,222,889	1,272,128	1,322,551	1,374,095	1,426,481
Non-technical Loss (MWh)	768,976	773,781	782,287	788,219	791,168	790,681	786,247	777,293	763,175	743,167	716,456	682,167
Total Loss in %	28.47	27.42	26.37	25.32	24.27	23.21	22.16	21.10	20.04	18.98	17.91	16.85
Technical Loss in %	15.51	15.14	14.77	14.40	14.02	13.65	13.27	12.90	12.53	12.15	11.78	11.40
Non-technical Loss in %	12.96	12.28	11.60	10.93	10.25	9.57	8.88	8.20	7.51	6.83	6.14	5.45
Total Consumption	5,934,237	6,300,953	6,741,327	7,213,793	7,720,888	8,265,455	8,850,597	9,479,696	10,156,443	10,884,865	11,669,357	12,512,993
Interrupted Power Supply (MWh)	71,473	77,004	78,244	78,773	78,757	78,101	76,699	74,431	71,162	66,738	60,986	53,999
% to the Demand	1.68	1.68	1.58	1.46	1.35	1.23	1.11	1.00	0.88	0.76	0.64	0.52
Actual Energy Sale (Total sale - Interrupted power supply)	4,173,107	4,496,066	4,885,136	5,308,278	5,768,278	6,268,532	6,812,768	7,405,081	8,049,978	8,752,409	9,517,821	10,350,346
Actual Energy Received from PEEGT	5,862,764	6,223,949	6,663,083	7,135,019	7,642,131	8,187,354	8,773,898	9,405,264	10,085,281	10,818,127	11,608,372	12,458,994
Total Energy Received from PEEGT (excl. non-Tech. Loss)	5,093,788	5,450,167	5,880,796	6,346,801	6,850,963	7,396,674	7,987,651	8,627,971	9,322,105	10,074,960	10,891,916	11,776,827
Peak Load (MW)	1,042	1,107	1,184	1,267	1,356	1,452	1,554	1,665	1,784	1,912	2,049	2,198
Load Factor	0.65	0.650	0.65	0.65	0.65	0.65	0.650	0.650	0.650	0.650	0.650	0.650
Sales Energy shifted from Non-tech. Losses		42,714	91,274	146,566	209,327	280,381	360,639	451,113	552,927	667,325	795,694	939,303
	12.96											
Net Energy Sale excl. energy shifted from non-tech. Losses.		4,453,351	4,793,862	5,161,712	5,558,951	5,988,151	6,452,128	6,953,968	7,497,051	8,085,084	8,722,127	9,411,043
Net Energy received from PEEGT		5,407,453	5,789,522	6,200,235	6,641,635	7,116,292	7,627,011	8,176,857	8,769,179	9,407,634	10,096,222	10,837,524

Damascus City + Rural (Without Project)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Sale by Demand Forecast	4,244,580	4,573,070	4,963,380	5,387,051	5,847,035	6,346,633	6,889,467	7,479,513	8,121,140	8,819,147	9,578,807	10,404,345
Growth (%)	7.72	7.74	8.53	8.54	8.54	8.54	8.55	8.56	8.58	8.59	8.61	8.62
Total Consumption in Demand Forecast	5,934,237	6,300,953	6,741,327	7,213,793	7,720,888	8,265,455	8,850,597	9,479,696	10,156,443	10,884,865	11,669,357	12,512,993
Unserved Energy (over 1300MW)					341	5,825	33,626	120,900	301,086	619,290	1,082,943	1,675,026
Available Energy		6,300,953	6,741,327	7,213,793	7,720,547	8,259,630	8,816,971	9,358,796	9,855,357	10,265,575	10,586,414	10,837,967
Distribution Loss (MWh)	1,689,658	1,854,556	2,061,716	2,295,360	2,559,089	2,895,976	3,170,460	3,489,134	3,788,458	4,038,573	4,235,327	4,391,492
Technical Loss (MWh)	920,682	1,038,060	1,188,155	1,360,575	1,558,638	1,825,669	2,027,931	2,276,394	2,511,372	2,708,329	2,863,508	2,987,076
Non-technical Loss (MWh)	768,976	816,496	873,561	934,784	1,000,451	1,070,307	1,142,529	1,212,740	1,277,086	1,330,243	1,371,819	1,404,416
Technical Loss in %	15.51	16.47	17.62	18.86	20.19	22.10	23.00	24.32	25.48	26.38	27.05	27.56
Non-technical Loss in %	12.96	12.96	12.96	12.96	12.96	12.96	12.96	12.96	12.96	12.96	12.96	12.96
Total Consumption	5,934,237	6,300,953	6,741,327	7,213,793	7,720,547	8,259,630	8,816,971	9,358,796	9,855,357	10,265,575	10,586,414	10,837,967
Total Energy sales	4,244,580	4,446,396	4,679,612	4,918,433	5,161,458	5,363,655	5,646,511	5,869,662	6,066,899	6,227,002	6,351,088	6,446,476
Interrupted Power Supply (MWh)	71,473	74,871	78,798	82,820	86,912	90,317	95,080	98,837	102,158	104,854	106,944	108,550
% to the Demand	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68
Actual Energy Sale (Total sale - Interrupted power supply)	4,173,107	4,371,525	4,600,813	4,835,613	5,074,546	5,273,338	5,551,431	5,770,825	5,964,740	6,122,148	6,244,144	6,337,926
Actual Energy Received from PEEGT	5,862,764	6,226,081	6,662,529	7,130,973	7,633,635	8,169,314	8,721,891	9,259,959	9,753,198	10,160,721	10,479,471	10,729,417
Total Energy Received from PEEGT (excl. non-Tech. Loss)	5,093,788	5,409,585	5,788,968	6,196,189	6,633,184	7,099,007	7,579,362	8,047,218	8,476,112	8,830,477	9,107,652	9,325,002
Peak Load (MW)	1,042	1,107	1,184	1,267	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300

For Economical Analysis												
Incremental Energy Sales		81,826	193,049	326,099	484,405	714,813	900,697	1,183,143	1,532,311	1,962,936	2,477,983	3,073,117
Incremental Energy received from PEEGT		-2,133	554	4,047	8,452	17,286	47,649	129,639	293,067	577,157	988,570	1,512,522
For Financial Analysis												
Incremental Energy Sales		124,541	284,323	472,664	693,733	995,195	1,261,336	1,634,257	2,085,238	2,630,261	3,273,677	4,012,420
Incremental Energy received from PEEGT		-2,133	554	4,047	8,496	18,041	52,006	145,306	332,082	657,406	1,128,901	1,729,577

Tables 11.3-1 LRAICs at HV Outlet and at LV Outlet

Average Generation Expansion Plan

1995-2000	Inv. Cost	Plant Life
Aleppo ST (5 x 200MW)	$600/kW	25 years
Zezon GT (3 x 120 MW)	$450/kW	20 years
Zara ST (3 x 200 MW)	$600/kW	25 years
Jandar CC (2 x 300 MW)	$650/kW	20 years
Other CC (2 x 330 MW)	$650/kW	20 years
Weighted Average	$602.8/kW	22.5 years

Av. Gen.Investment Cost (US$/kW)		602.8
Discount Rate (Discount Rate)		9.0 %
Av. Equipment life		22.5 years
Annuitized capital cost		
AF: Annuity Factor=r/1-(1+r)^(-n)		0.105145
Where: r: discount rate: 9%; n: years: 22.5		
Annuitized capital cost =602.8*AF	($/kW-y)	63.4
Derating: 20%		0.2
LRMCC at Generating Plant Outlet	($/kW-y)	79.2

LRM Capacity Costs (LRMCC)

		Generation	Transmission (HV)	Primary Distribution (MV)	Secondary Distribution (LV)
Ave. Equipment Life	(years)	22.5	25	25	25
Annuity Factor		0.105145	0.101806	0.101806	0.101806
Estimated Investment Cost	(US$/kW-year)	79.2	26.6	73	46
Losses coeff.	(%)	5.0	4.0	2.6	8.0
Global LRMCC	(US$/kW-year)	83.2	114.2	192.0	257.1

LRAIC (USC/kWh)

		Generation	Transmission (HV)	Primary Distribution (MV)	Secondary Distribution (LV)
Load Factor (%)		80.0	70.0	65.0	60.0
Operating Hour/year (hrs)		7,008	6,132	5,694	5,256
Capital cost (US cent)		1.19	1.69	3.04	4.23
O&M cost (% of Capital Cost)		3.0 %	1.5 %	2.0 %	2.0 %
O&M cost (US cent)		0.26	0.33	0.59	0.81
Energy(Fuel) cost (US cent/kWh)					
HFO	0.65				
NG	1.11				
DO	0.83				
Total	2.58				
Energy (Fuel) cost (USC/kWh)		2.58	2.69	2.76	2.98
LRAIC (USC/kWh)		**4.03**	**4.71**	**6.40**	**8.02**

Note: (1) Share of generation by type of power plant : 80% by ST and CC, 20% by GT.

(2) Type of fuel: HFO (80% x 0.38), NG (80% x 0.62), DO (20%)

(3) Fuel cost : HFO (US$80/ton), NG (US$2.2/mmBTU), DO (US$160/ton)

(4) Cal. Value : HFO (9600kcal/kg), NG (9400kcal/Nm^3), DO (10200kcal/kg)

(5) Heat consumption: ST and CC (Weighted Ave. 2557kcal/kWh), GT (2646kcal/kWh)

Table 11.3-2 Economic Internal Rate of Return (EIRR)

(Base Case)

Year	Capital Investment (US$ 1,000)	Incremental O&M Cost (US$ 1,000)	Incremental Energy Purchased (MWh)	Incremental Energy Cost (US$ 1,000)	Incremental Total Cost (US$ 1,000)	Incremental Energy Sold (MWh)	Incremental 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	-100	62,942	81,826	6,562	-56,380
2001	56,489	1,761	554	26	58,276	193,049	15,483	-42,794
2002	44,658	2,891	4,047	191	47,740	326,099	26,153	-21,587
2003	33,061	3,784	8,452	398	37,243	484,405	38,849	1,606
2004	40,728	4,445	17,286	814	45,988	714,813	57,328	11,340
2005	49,419	5,260	47,649	2,244	56,923	900,697	72,236	15,313
2006	41,119	6,248	129,639	6,106	53,473	1,183,143	94,888	41,415
2007	28,782	7,071	293,067	13,803	49,656	1,532,311	122,891	73,235
2008	27,836	7,646	577,157	27,184	62,667	1,962,936	157,427	94,761
2009	28,569	8,203	988,570	46,562	83,334	2,477,983	198,734	115,400
2010	25,790	8,775	1,512,522	71,240	105,804	3,073,117	246,464	140,660
2011	0	9,290	1,512,522	71,240	80,530	3,073,117	246,464	165,934
2012	0	9,290	1,512,522	71,240	80,530	3,073,117	246,464	165,934
2013	0	9,290	1,512,522	71,240	80,530	3,073,117	246,464	165,934
2014	0	9,290	1,512,522	71,240	80,530	3,073,117	246,464	165,934
2015	0	9,290	1,512,522	71,240	80,530	3,073,117	246,464	165,934
2016	0	9,290	1,512,522	71,240	80,530	3,073,117	246,464	165,934
2017	0	9,290	1,512,522	71,240	80,530	3,073,117	246,464	165,934
2018	0	9,290	1,512,522	71,240	80,530	3,073,117	246,464	165,934
2019	0	9,290	1,512,522	71,240	80,530	3,073,117	246,464	165,934
2020	0	9,290	1,512,522	71,240	80,530	3,073,117	246,464	165,934
2021	0	9,290	1,512,522	71,240	80,530	3,073,117	246,464	165,934
2022	0	9,290	1,512,522	71,240	80,530	3,073,117	246,464	165,934
2023	0	9,290	1,512,522	71,240	80,530	3,073,117	246,464	165,934
2024	0	9,290	1,512,522	71,240	80,530	3,073,117	246,464	165,934
2025	0	8,780	1,512,522	71,240	80,019	3,073,117	246,464	166,445
2026	0	7,529	1,512,522	71,240	78,769	3,073,117	246,464	167,695
2027	0	6,399	1,361,270	64,116	70,515	2,765,805	221,818	151,303
2028	0	5,506	1,210,018	56,992	62,498	2,458,494	197,171	134,673
2029	0	4,845	1,058,765	49,868	54,713	2,151,182	172,525	117,812
2030	0	4,030	907,513	42,744	46,774	1,843,870	147,878	101,104
2031	0	3,042	756,261	35,620	38,662	1,536,559	123,232	84,570
2032	0	2,220	605,009	28,496	30,715	1,229,247	98,586	67,870
2033	0	1,644	453,757	21,372	23,016	921,935	73,939	50,923
2034	0	1,087	302,504	14,248	15,335	614,623	49,293	33,958
2035	0	516	151,252	7,124	7,640	307,312	24,646	17,007
合計	464,516	232,258	34,583,511	1,628,883	2,325,657	75,929,278	6,089,528	3,763,871
NPV(DR9%)	290,007	56,972	6,330,325	298,158	645,137	15,865,145	1,272,385	627,247

Energy purchase cost (LRAIC, USC/kWh	4.71		
Energy sales cost (LRAIC, USC/kWh)	8.02	EIRR(%)	26.41%

Table 11.3-3 Financial Internal Rate of Return (FIRR)

(Base Case)

Year	Capital Investment (SP1,000)	Incremental O&M Cost (SP1,000)	Incremental Energy Purchased (MWh)	Incremental Energy Cost (SP1,000)	Incremental Total Cost (SP1,000)	Incremental Energy Sold (MWh)	Incremental Revenue (SP1,000)	Net Benefit (SP1,000)
1999	1,551,481	0	0	0	1,551,481	0	0	-1,551,481
2000	4,005,066	31,030	-2,133	-1,362	4,034,734	124,541	108,102	-3,926,632
2001	3,896,712	111,131	554	354	4,008,197	284,323	246,792	-3,761,404
2002	3,312,998	189,065	4,047	2,584	3,504,647	422,664	366,872	-3,137,775
2003	2,629,122	255,325	8,496	5,425	2,889,872	693,733	602,160	-2,287,712
2004	3,505,489	307,908	18,041	11,519	3,824,916	995,195	863,829	-2,961,086
2005	4,602,654	378,017	52,006	33,206	5,013,877	1,261,336	1,094,840	-3,919,038
2006	4,116,246	470,070	145,306	92,778	4,679,094	1,634,257	1,418,535	-3,260,559
2007	3,077,196	552,395	332,082	212,034	3,841,626	2,085,238	1,809,987	-2,031,639
2008	3,204,386	613,939	657,406	419,754	4,238,079	2,630,261	2,283,067	-1,955,012
2009	3,548,678	678,027	1,128,901	720,803	4,947,508	3,273,677	2,841,552	-2,105,957
2010	3,593,551	749,001	1,729,577	1,104,335	5,446,886	4,012,420	3,482,781	-1,964,106
2011	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	3,482,781	1,557,574
2012	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	3,482,781	1,557,574
2013	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	3,482,781	1,557,574
2014	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	3,482,781	1,557,574
2015	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	3,482,781	1,557,574
2016	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	3,482,781	1,557,574
2017	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	3,482,781	1,557,574
2018	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	3,482,781	1,557,574
2019	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	3,482,781	1,557,574
2020	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	3,482,781	1,557,574
2021	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	3,482,781	1,557,574
2022	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	3,482,781	1,557,574
2023	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	3,482,781	1,557,574
2024	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	3,482,781	1,557,574
2025	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	3,482,781	1,557,574
2026	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	3,482,781	1,557,574
2027	0	738,784	1,556,619	993,901	1,732,686	3,611,178	3,134,503	1,401,817
2028	0	656,697	1,383,662	883,468	1,540,165	3,209,936	2,786,224	1,246,059
2029	0	574,610	1,210,704	773,034	1,347,645	2,808,694	2,437,946	1,090,302
2030	0	492,523	1,037,746	662,601	1,155,124	2,407,452	2,089,668	934,544
2031	0	410,436	864,789	552,167	962,603	2,006,210	1,741,390	778,787
2032	0	328,349	691,831	441,734	770,083	1,604,968	1,393,112	623,030
2033	0	246,261	518,873	331,300	577,562	1,203,726	1,044,834	467,272
2034	0	164,174	345,915	220,867	385,041	802,484	696,556	311,515
2035	0	82,087	172,958	110,433	192,521	401,242	348,278	155,757
Sum	41,043,579	21,163,776	39,530,612	25,240,295	87,447,650	99,672,255	86,515,517	-932,133
NPV(DR9%)	23,956,176	4,752,256	7,230,843	4,616,893	33,325,325	21,002,519	18,230,187	-15,095,138

Energy purchase cost (SP/kWh) 0.6385

Energy sales cost (SP/kWh) 0.868

FIRR(%) -0.17%

Table 11.3-4 Energy Sales Cost (FIRR 9%)

(Alt. Case)

Sales price SP 1.586/kWh

Year	Capital Investment (SP1,000)	Incremental O&M Cost (SP1,000)	Incremental Energy Purchased (MWh)	Incremental Energy Cost (SP1,000)	Incremental Total Cost (SP1,000)	Incremental Energy Sold (MWh)	Incremental Revenue (SP1,000)	Net Benefit (SP1,000)
1999	1,551,481	0	0	0	1,551,481	0	0	-1,551,481
2000	4,005,066	31,030	-2,133	-1,362	4,034,734	124,541	197,612	-3,837,121
2001	3,896,712	111,131	554	354	4,008,197	284,323	451,142	-3,557,054
2002	3,312,998	189,065	4,047	2,584	3,504,647	422,664	670,652	-2,833,996
2003	2,629,122	255,325	8,496	5,425	2,889,872	693,733	1,100,764	-1,789,108
2004	3,505,489	307,908	18,041	11,519	3,824,916	995,195	1,579,101	-2,245,815
2005	4,602,654	378,017	52,006	33,206	5,013,877	1,261,336	2,001,394	-3,012,484
2006	4,116,246	470,070	145,306	92,778	4,679,094	1,634,257	2,593,117	-2,085,978
2007	3,077,196	552,395	332,082	212,034	3,841,626	2,085,238	3,308,700	-532,926
2008	3,204,386	613,939	657,406	419,754	4,238,079	2,630,261	4,173,501	-64,578
2009	3,548,678	678,027	1,128,901	720,803	4,947,508	3,273,677	5,194,426	246,918
2010	3,593,551	749,001	1,729,577	1,104,335	5,446,886	4,012,420	6,366,608	919,721
2011	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	6,366,608	4,441,401
2012	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	6,366,608	4,441,401
2013	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	6,366,608	4,441,401
2014	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	6,366,608	4,441,401
2015	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	6,366,608	4,441,401
2016	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	6,366,608	4,441,401
2017	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	6,366,608	4,441,401
2018	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	6,366,608	4,441,401
2019	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	6,366,608	4,441,401
2020	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	6,366,608	4,441,401
2021	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	6,366,608	4,441,401
2022	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	6,366,608	4,441,401
2023	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	6,366,608	4,441,401
2024	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	6,366,608	4,441,401
2025	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	6,366,608	4,441,401
2026	0	820,872	1,729,577	1,104,335	1,925,206	4,012,420	6,366,608	4,441,401
2027	0	738,784	1,556,619	993,901	1,732,686	3,611,178	5,729,947	3,997,261
2028	0	656,697	1,383,662	883,468	1,540,165	3,209,936	5,093,286	3,553,121
2029	0	574,610	1,210,704	773,034	1,347,645	2,808,694	4,456,626	3,108,981
2030	0	492,523	1,037,746	662,601	1,155,124	2,407,452	3,819,965	2,664,841
2031	0	410,436	864,789	552,167	962,603	2,006,210	3,183,304	2,220,701
2032	0	328,349	691,831	441,734	770,083	1,604,968	2,546,643	1,776,561
2033	0	246,261	518,873	331,300	577,562	1,203,726	1,909,982	1,332,420
2034	0	164,174	345,915	220,867	385,041	802,484	1,273,322	888,280
2035	0	82,087	172,958	110,433	192,521	401,242	636,661	444,140
合計	41,043,579	21,163,776	39,530,612	25,240,295	87,447,650	99,672,255	158,152,479	70,704,828
NPV(DR9%)	23,956,176	4,752,256	7,230,843	4,616,893	33,325,325	21,002,519	33,325,227	-98

Energy purchase cost (SP/kWh) 0.6385

Energy sales cost (SP/kWh) 1.5867 LRAIC(SP/kWH) 1.587 FIRR(%) 9.00%

Table 11.5-1 Benefit of Improvement Plans When Compared with Reference Case

Damascus City + Rural (With Project)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Sale	4,244,580	4,573,070	4,963,380	5,387,051	5,847,035	6,346,633	6,889,467	7,479,513	8,121,140	8,819,147	9,578,807	10,404,345
Growth (%)	7.72	7.74	8.53	8.54	8.54	8.54	8.55	8.56	8.58	8.59	8.61	8.62
Distribution Loss (MWh)	1,689,658	1,727,883	1,777,947	1,826,742	1,873,852	1,918,822	1,961,130	2,000,183	2,035,303	2,065,718	2,090,551	2,108,648
Technical Loss (MWh)	920,682	954,101	995,660	1,038,523	1,082,684	1,128,141	1,174,883	1,222,889	1,272,128	1,322,551	1,374,095	1,426,481
Non-technical Loss (MWh)	768,976	773,781	782,287	788,219	791,168	790,681	786,247	777,293	763,175	743,167	716,456	682,167
Total Loss in %	28.47	27.42	26.37	25.32	24.27	23.21	22.16	21.10	20.04	18.98	17.91	16.85
Technical Loss in %	15.51	15.14	14.77	14.40	14.02	13.65	13.27	12.90	12.53	12.15	11.78	11.40
Non-technical Loss in %	12.96	12.28	11.60	10.93	10.25	9.57	8.88	8.20	7.51	6.83	6.14	5.45
Total Consumption	5,934,237	6,300,953	6,741,327	7,213,793	7,720,888	8,265,455	8,850,597	9,479,696	10,156,443	10,884,865	11,669,357	12,512,993
Interrupted Power Supply (MWh)	71,473	77,004	78,244	78,773	78,757	78,101	76,699	74,431	71,162	66,738	60,986	53,999
% to the Demand	1.68	1.68	1.58	1.46	1.35	1.23	1.11	1.00	0.88	0.76	0.64	0.52
Actual Energy Sale (Total sale - Interrupted power supply)	4,173,107	4,496,066	4,885,136	5,308,278	5,768,278	6,268,532	6,812,768	7,405,081	8,049,978	8,752,409	9,517,821	10,350,346
Actual Energy Received from PEEGT	5,862,764	6,223,949	6,663,083	7,135,019	7,642,131	8,187,354	8,773,898	9,405,264	10,085,281	10,818,127	11,608,372	12,458,994
Total Energy Received from PEEGT (excl. non-Tech. Loss)	5,093,788	5,450,167	5,880,796	6,346,801	6,850,963	7,396,674	7,987,651	8,627,971	9,322,105	10,074,960	10,891,916	11,776,827
Peak Load (MW)	1,042	1,107	1,184	1,267	1,356	1,452	1,554	1,665	1,784	1,912	2,049	2,198
Load Factor	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650
Sales Energy shifted from Non-tech. Losses		42,714	91,274	146,566	209,327	280,381	360,639	451,113	552,927	667,325	795,694	939,303
	12.96											
Net Energy Sale excl. energy shifted from non-tech. Losses		4,453,351	4,793,862	5,161,712	5,558,951	5,988,151	6,452,128	6,953,968	7,497,051	8,085,084	8,722,127	9,411,043
Net Energy received from PEEGT		5,407,453	5,789,522	6,200,235	6,641,635	7,116,292	7,627,011	8,176,857	8,769,179	9,407,634	10,096,222	10,837,524

Damascus City + Rural (Reference Case)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Sale by Demand Forecast	4,244,580	4,573,070	4,963,380	5,387,051	5,847,035	6,346,633	6,889,467	7,479,513	8,121,140	8,819,147	9,578,807	10,404,345
Growth (%)	7.72	7.74	8.53	8.54	8.54	8.54	8.55	8.56	8.58	8.59	8.61	8.62
Distribution Loss (MWh)	1,689,658	1,820,421	1,975,794	2,144,446	2,327,554	2,526,431	2,742,519	2,977,401	3,232,816	3,510,675	3,813,076	4,141,701
Technical Loss (MWh)	920,682	991,934	1,076,595	1,168,492	1,268,267	1,376,633	1,494,378	1,622,363	1,761,537	1,912,940	2,077,716	2,256,782
Non-technical Loss (MWh)	768,976	828,487	899,199	975,953	1,059,287	1,149,798	1,248,141	1,355,038	1,471,279	1,597,734	1,735,359	1,884,919
Total Loss in %	28.47	28.47	28.47	28.47	28.47	28.47	28.47	28.47	28.47	28.47	28.47	28.47
Technical Loss in %	15.51	15.51	15.51	15.51	15.51	15.51	15.51	15.51	15.51	15.51	15.51	15.51
Non-technical Loss in %	12.96	12.96	12.96	12.96	12.96	12.96	12.96	12.96	12.96	12.96	12.96	12.96
Total Consumption	5,934,237	6,393,491	6,939,174	7,531,497	8,174,589	8,873,064	9,631,986	10,456,914	11,353,956	12,329,822	13,391,882	14,546,046
Interrupted Power Supply (MWh)	71,473	77,004	83,577	90,711	98,456	106,869	116,009	125,945	136,749	148,502	161,294	175,195
% to the Demand	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68
Actual Energy Sale (Total sale - Interrupted power supply)	4,173,107	4,496,066	4,879,804	5,296,340	5,748,579	6,239,765	6,773,458	7,353,568	7,984,391	8,670,644	9,417,512	10,229,150
Actual Energy Received from PEEGT	5,862,764	6,316,487	6,855,597	7,440,786	8,076,133	8,766,196	9,515,976	10,330,969	11,217,207	12,181,319	13,230,588	14,370,851
Total Energy Received from PEEGT (excl. non-Tech. Loss)	5,093,788	5,487,999	5,956,399	6,464,833	7,016,846	7,616,398	8,267,835	8,975,931	9,745,928	10,583,585	11,495,229	12,485,931
Peak Load (MW)	1,042	1,123	1,219	1,323	1,436	1,558	1,692	1,836	1,994	2,165	2,352	2,555

Benefit For Economical Analysis

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Reduction of Technical Losses (MWh)		37,833	80,935	129,969	185,582	248,492	319,495	399,474	489,410	590,390	703,621	830,300
Reduction of Interruped Power Supply (MWh)		0	5,333	11,937	19,699	28,768	39,310	51,513	65,587	81,765	100,308	121,196
Total Incremental Energy Sales(MWh)		0	5,333	11,937	19,699	28,768	39,310	51,513	65,587	81,765	100,308	121,196
Incremental Energy received from PEEGT		-37,832	-75,602	-118,032	-165,883	-219,724	-280,185	-347,961	-423,823	-508,625	-603,313	-709,104

Benefit For Financial Analysis

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Reduction of Technical Losses (MWh)		37,833	80,935	129,969	185,582	248,492	319,495	399,474	489,410	590,390	703,621	830,300
Reduction of Non-technical Losses (MWh)		56,706	116,912	187,735	268,119	359,117	461,894	577,744	708,104	854,567	1,018,904	1,202,752
Reduction of Interruped Power Supply (MWh)		0	5,333	11,937	19,699	28,768	39,310	51,513	65,587	81,765	100,308	121,196
Total Incremental Energy Sales (mWh)		0	5,333	11,937	19,699	28,768	39,310	51,513	65,587	81,765	100,308	121,196
Incremental Energy received from PEEGT		-92,538	-192,514	-305,766	-434,002	-578,841	-742,079	-925,705	-1,131,927	-1,363,192	-1,622,216	-1,911,856

(Note) In the reference case, the minimum investment required to maintain the power supply to the consumers according to the demand forecast is executed by the PEDEEE's own finance. However, ratios of technical and non-technical losses against the supplied energy from PEEGT and ratio of un-served energy against total sales energy will remain constant with at the same level as of 1999.

Table 11.5-2 Economic Internal Rate of Return When Compared with Reference Case (EIRR)

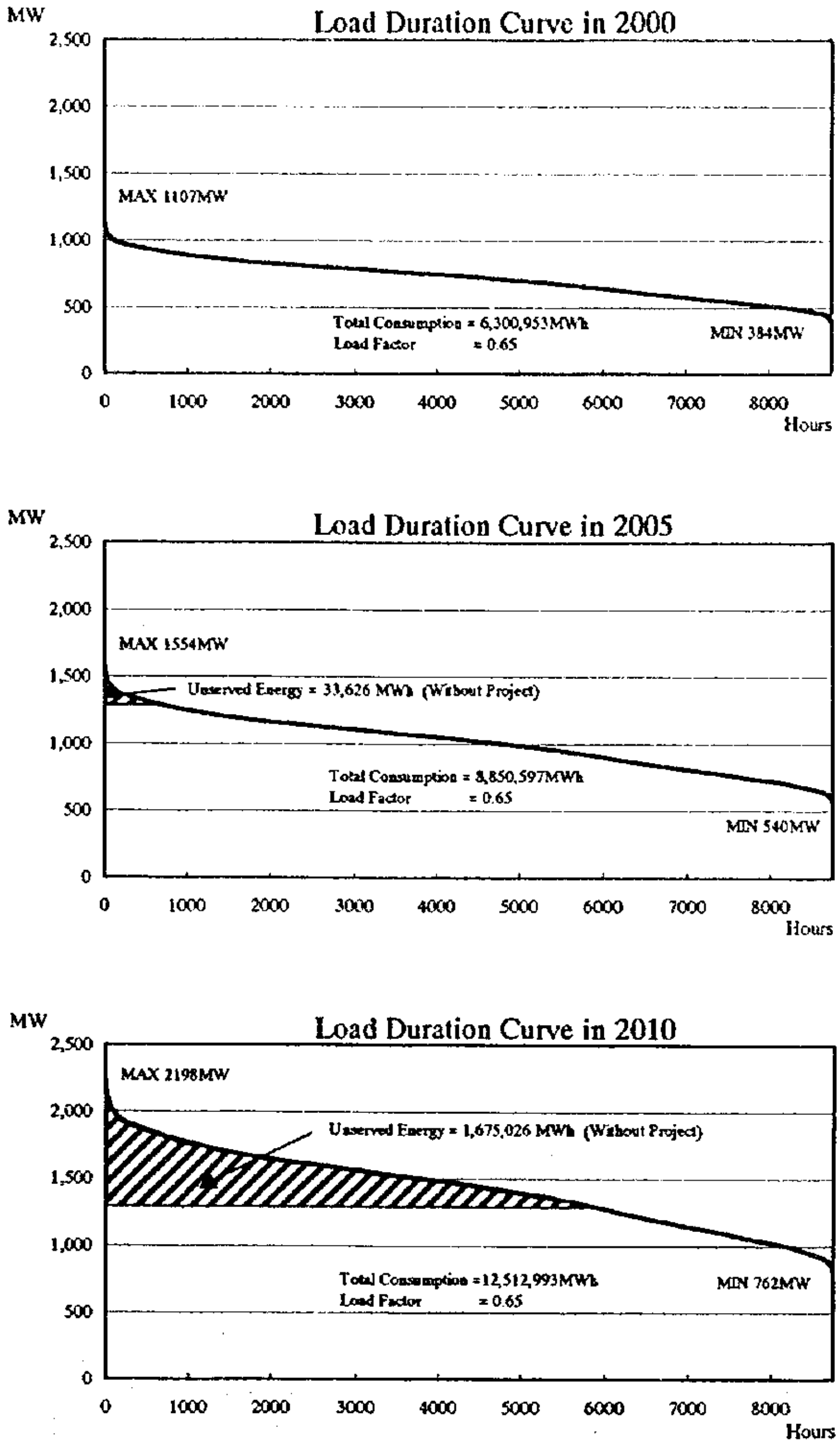
(Base Case)

Year	Capital Investment (US$ 1,000)	Incremental O&M Cost (US$ 1,000)	Incremental Energy Purchased (MWh)	Incremental Energy Cost (US$ 1,000)	Incremental Total Cost (US$ 1,000)	Incremental Energy Sold (MWh)	Incremental Revenue (US$ 1,000)	Net Benefit (US$ 1,000)
1999	0	0	0	0	0	0	0	0
2000	27,365	0	-37,832	-1,782	25,583	0	0	-25,583
2001	23,949	547	-75,602	-3,561	20,935	5,333	428	-20,507
2002	23,802	1,026	-118,032	-5,559	19,269	11,937	957	-18,312
2003	13,085	1,502	-165,883	-7,813	6,774	19,699	1,580	-5,194
2004	15,415	1,764	-219,724	-10,349	6,830	28,768	2,307	-4,523
2005	15,218	2,072	-280,185	-13,197	4,093	39,310	3,153	-940
2006	8,664	2,377	-347,961	-16,389	-5,348	51,513	4,131	9,479
2007	8,635	2,550	-423,823	-19,962	-8,777	65,587	5,260	14,037
2008	11,750	2,723	-508,625	-23,956	-9,484	81,765	6,558	16,042
2009	14,872	2,958	-603,313	-28,416	-10,587	100,308	8,045	18,631
2010	14,785	3,255	-709,104	-33,399	-15,359	121,196	9,720	25,079
2011	0	3,551	-709,104	-33,399	-29,848	121,196	9,720	39,568
2012	0	3,551	-709,104	-33,399	-29,848	121,196	9,720	39,568
2013	0	3,551	-709,104	-33,399	-29,848	121,196	9,720	39,568
2014	0	3,551	-709,104	-33,399	-29,848	121,196	9,720	39,568
2015	0	3,551	-709,104	-33,399	-29,848	121,196	9,720	39,568
2016	0	3,551	-709,104	-33,399	-29,848	121,196	9,720	39,568
2017	0	3,551	-709,104	-33,399	-29,848	121,196	9,720	39,568
2018	0	3,551	-709,104	-33,399	-29,848	121,196	9,720	39,568
2019	0	3,551	-709,104	-33,399	-29,848	121,196	9,720	39,568
2020	0	3,551	-709,104	-33,399	-29,848	121,196	9,720	39,568
2021	0	3,551	-709,104	-33,399	-29,848	121,196	9,720	39,568
2022	0	3,551	-709,104	-33,399	-29,848	121,196	9,720	39,568
2023	0	3,551	-709,104	-33,399	-29,848	121,196	9,720	39,568
2024	0	3,551	-709,104	-33,399	-29,848	121,196	9,720	39,568
2025	0	3,551	-709,104	-33,399	-29,848	121,196	9,720	39,568
2026	0	3,003	-709,104	-33,399	-30,395	121,196	9,720	40,115
2027	0	2,524	-638,194	-30,059	-27,534	109,076	8,748	36,282
2028	0	2,048	-567,283	-26,719	-24,671	96,957	7,776	32,447
2029	0	1,787	-496,373	-23,379	-21,592	84,837	6,804	28,396
2030	0	1,478	-425,462	-20,039	-18,561	72,718	5,832	24,393
2031	0	1,174	-354,552	-16,699	-15,525	60,598	4,860	20,385
2032	0	1,001	-283,642	-13,360	-12,359	48,478	3,888	16,247
2033	0	828	-212,731	-10,020	-9,192	36,359	2,916	12,107
2034	0	593	-141,821	-6,680	-6,087	24,239	1,944	8,031
2035	0	296	-70,910	-3,340	-3,044	12,120	972	4,016
Sum	177,538	88,769	-18,026,716	-849,058	-582,751	3,009,934	241,397	824,148
NPV(DR9%	108,714	21,357	-3,944,156	-185,770	-55,698	631,003	50,606	106,305

Energy purchase cost (USC/kWh) 4.710

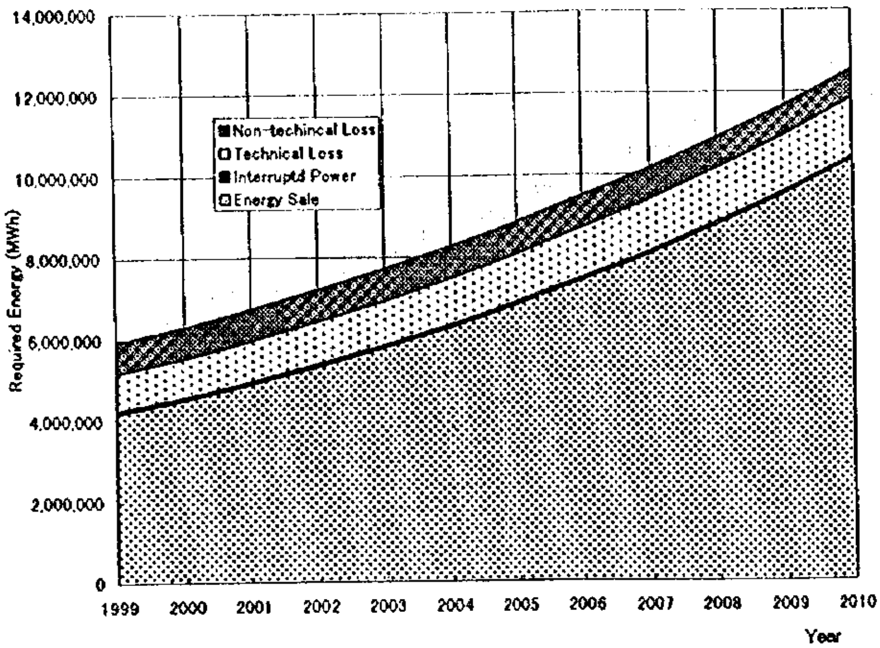
Energy sales cost (USC/kWh) 8.020

EIRR(%) 17.94%

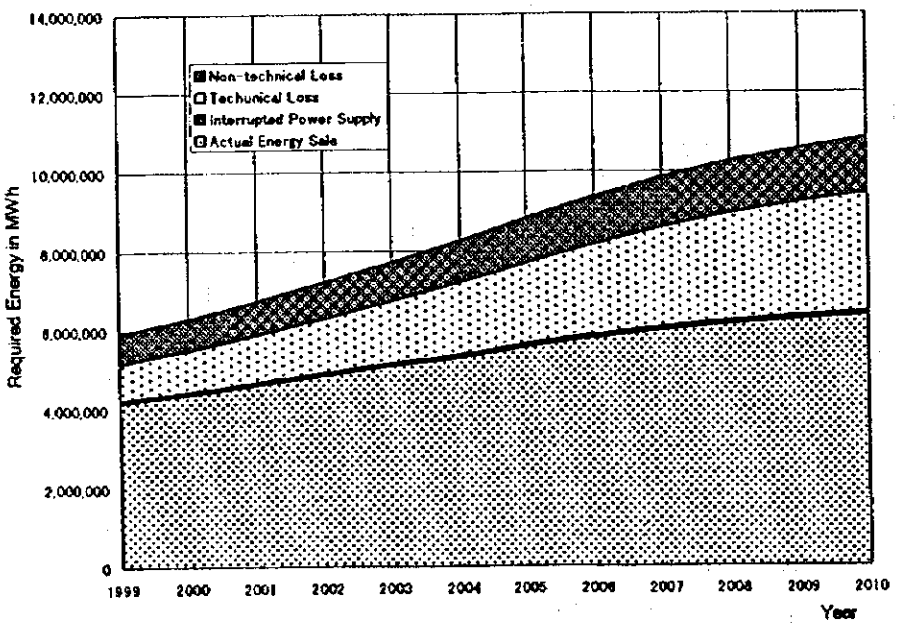


Public Establishment for Distribution and Exploitation of Electrical Energy (PEDEEE)	Japan International Cooperation Agency (JICA) Joint Venture Nippon Koei Co., Ltd. & Tokyo Electric Power Services Co., Ltd	The Feasibility Study on The Rehabilitation Project of Damascus and Damascus Rural Distribution Network	Figure 11.2-1 Title Load Duration Curve

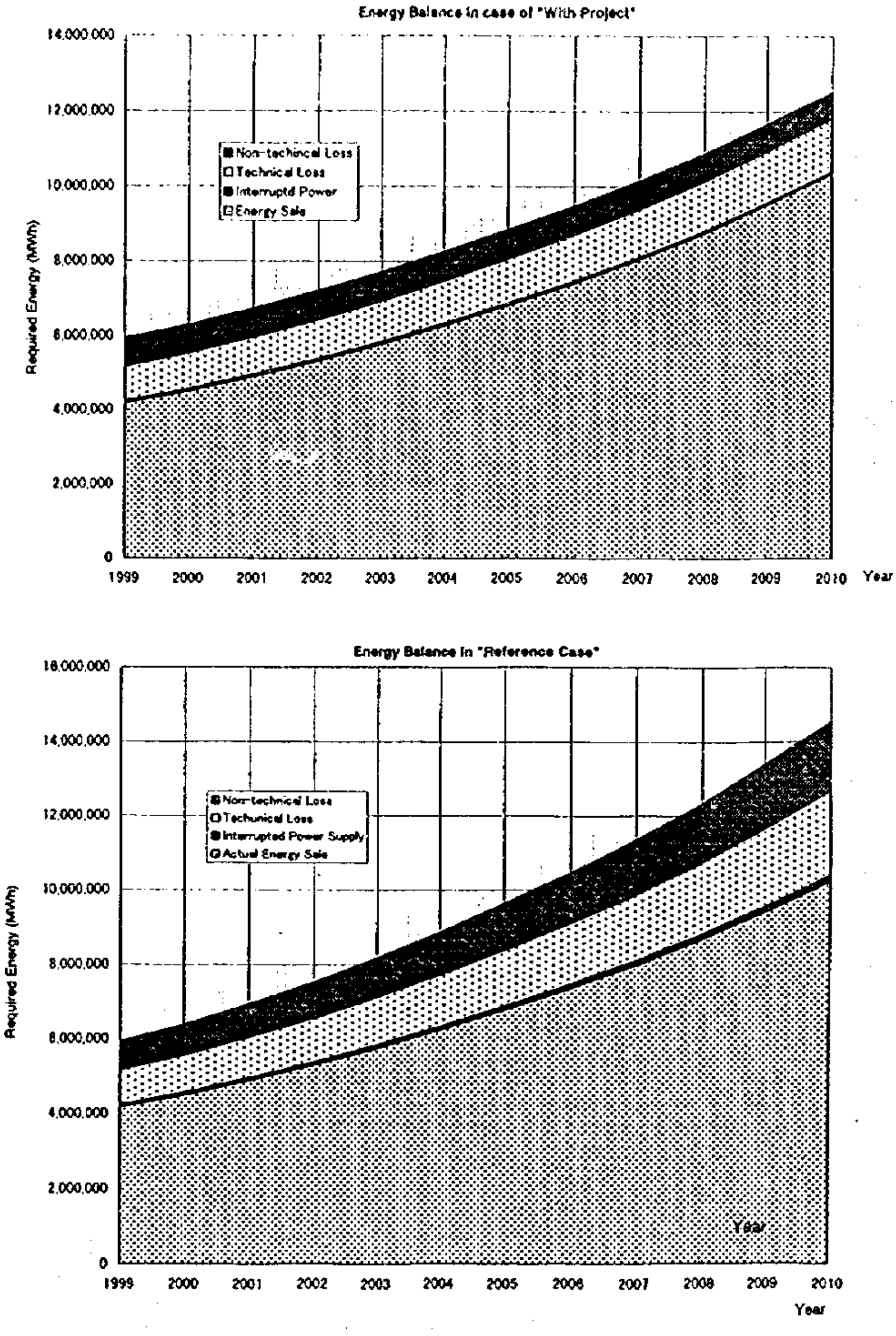
Energy Balance in case of "With Project"



Energy Balance in case of "Without Poriect"



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 11.2-2 Title Energy Balance in case of with Project and without Project



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 11.5-1 Title Energy Balance in case of With Project and Reference Case