4) Natural and cultural protected areas

1. UNESCO World Heritage sites
There are many cultural assets in and around the model areas. Moreover, as shown below, three of the six UNESCO World Heritage sites in Egypt are located near the model areas.

Table 1 UNESCO World Heritage Sites Near Model Areas

Name	UNESCO Criteria	Property	Year	Description
Abu Mena	(iv)	182.72 ha	1979	The church, baptistry, basilicas, public buildings, streets, monasteries, houses and workshops in this early Christian holy city were built over the tomb of the martyr Menas of Alexandria, who died in A.D. 296.
Historic Cairo (1979)	(i)(v)(vi)	523.66 ha	1979	Tucked away amid the modern urban area of Cairo lies one of the world's oldest Islamic cities, with its famous mosques, madrasas, hammams and fountains. Founded in the 10th century, it became the new centre of the Islamic world, reaching its golden age in the 14th century.
Memphis and its Necropolis – the Pyramid Fields from Giza to Dahshur (1979)	(i)(iii)(vi)	16358.52 ha	1979	The capital of the Old Kingdom of Egypt has some extraordinary funerary monuments, including rock tombs, ornate mastabas, temples and pyramids. In ancient times, the site was considered one of the Seven Wonders of the World.

2. Natural protectorates
27 natural protectorates are designated based on Law 102 of 1983 in Egypt. One of the protectorates, El Bourollus, covers a part of the North Delta DC area. Some protectorates are located near the model areas.

Table 2 Natural Protectorates Near Model Areas

Name	Designation	Year	Size	IUCN Category[1]	Notes
Ashtum El Gamel	Habitat/Species Management Area	1998	17,116 hectares	VI (Managed Resource Protected Area)	Part of lake Manzala, the largest and most productive of the Nile Delta wetlands. Previously recorded as "Ashtum El Gamil."
El Bourollus	Habitat/Species Management Area	1998	91,083 hectares	VI (Managed Resource Protected Area)	Site also called "Lake Burullus (Wetlands of International Importance (Ramsar))."
El Omayed	Managed Resource Protected Area	1986	69,010 hectares	IV (Habitat/Species Management Area)	(UNESCO-MAB Biosphere Reserve)
Petrified Forest	Natural Monument	1989	604 hectares	V(Protected Landscape/Seascape)	Contains well preserved petrified remains of a 35-million-year-old forest. It is the only remaining site within the bounds of greater Cairo where desert wilderness can be seen. Previously recorded as "Maadi Petrified Forest."

[1] Definitions of the categories are shown in Appendix 4.1-2

3. Important Bird Areas
Important Bird Areas (IBAs) are designated by Bird Life International. There are four IBAs near the model area.

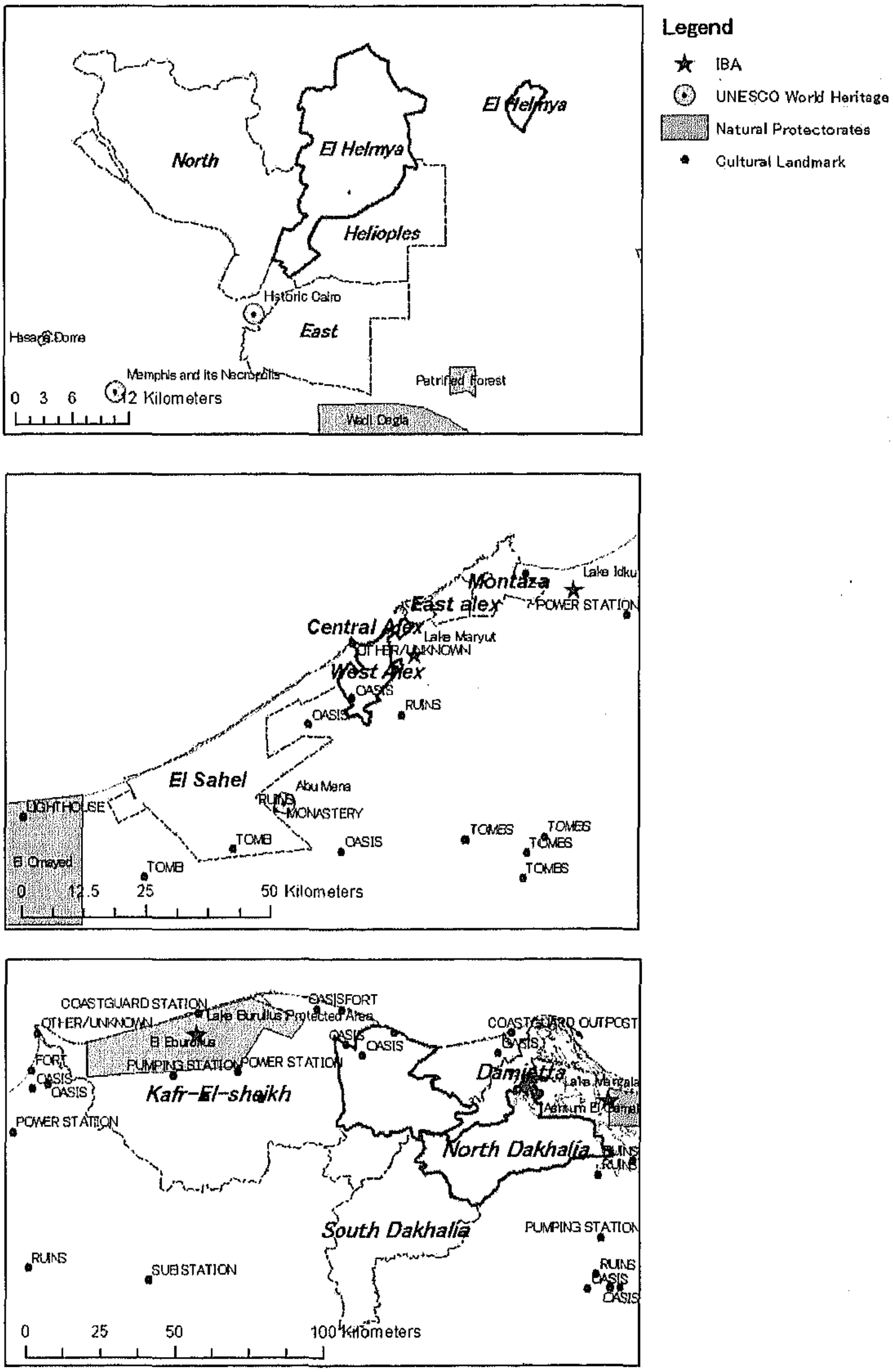
Table 3 IBAs Near Model Areas

Name	Area	Category[2]	Issue
Lake Maryut	6000 ha	A4i	Lake Maryut has been reduced by more than 75% from its original area, and is still shrinking.
Lake Idku	7000 ha	A4iii	Lake Idku suffers from drainage, land claim, pollution, disturbance, and waterbird catching.
Lake Burullus Protected Area	46000 ha	A1, A4i, A4iii	It is anticipated that Burullus will be further reduced in area as a result of landward migration of coastal sandbars.
Lake Manzala	77000 ha	A1, A4i, A4iii	The pollution problem here, caused by many factors, is very severe. Municipal wastewater is perhaps the most serious source of pollution, as much of the raw and treated sewage from Cairo, Port Said and Damietta ends up in Manzala.

5) Sediment contamination

The contamination of sediments in the Alexandria Harbor by PCBs, DDTs and chlordanes appeared to be high on a worldwide basis (Assem O. Barakat, 2002)[3]. PCB concentrations in surface sediments of Alexandria Harbor were one to two orders of magnitude higher than most of the riverine and estuaries systems. The usage of PCBs in Egypt is not well established, but the use of PCBs in transformers, electrical equipment, and other industries is common.

[2] Definitions of the categories are shown in Appendix 4.1-3.
[3] Assem O. Barakat, Moonkoo Kim, Yoarong Qian, Terry L. Wade., 2002. Organochlorine pesticides and PCB residues in sediments of Alexandria Harbour, Egypt. Marine Pollution Bulletin, Volume 44, Issue 12, December 2002, pages 1426-1434.



Source: Bird Life international (IBA); World Commission on Protected Areas (Natural Protectorates); UNESCO (UNESCO World Heritage)

Fig. 5 Protected Natural Areas and Cultural Heritages

Appendix 4:

Appendix 4.1-2 UNESCO World Heritage Cultural Criteria

Appendix 4.1-2 UNESCO World Heritage Cultural Criteria

Selection criteria:

i. to represent a masterpiece of human creative genius;

ii. to exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design;

iii. to bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared;

iv. to be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history;

v. to be an outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change;

vi. to be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance. (The Committee considers that this criterion should preferably be used in conjunction with other criteria);

Appendix 4:

Appendix 4.1-3 *IUCN Protected Area Management Categories*

Appendix 4.1-3 IUCN Protected Area Management Categories

CATEGORY Ia: Strict Nature Reserve: protected area managed mainly for science
Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.

CATEGORY Ib: Wilderness Area: protected area managed mainly for wilderness protection
Large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.

CATEGORY II: National Park: protected area managed mainly for ecosystem protection and recreation
Natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.

CATEGORY III: Natural Monument: protected area managed mainly for conservation of specific natural features
Area containing one, or more, specific natural or natural/cultural feature which is of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance.

CATEGORY IV: Habitat/Species Management Area: protected area managed mainly for conservation through management intervention
Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.

CATEGORY V: Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation
Area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.

CATEGORY VI: Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural ecosystems
Area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.

Appendix 4:

Appendix 4.1-4 Global IBA Criteria

Appendix 4.1-4 Global IBA Criteria

A1. Globally threatened species

The site qualifies if it is known, estimated or thought to hold a population of a species categorized by the IUCN Red List as Critically Endangered, Endangered or Vulnerable. In general, the regular presence of a Critical or Endangered species, irrespective of population size, at a site may be sufficient for a site to qualify as an IBA. For Vulnerable species, the presence of more than threshold numbers at a site is necessary to trigger selection. Thresholds are set regionally, often on a species by species basis. The site may also qualify under this category if holds more than threshold numbers of other species of global conservation concern in the Near Threatened, Data Deficient and, formerly, in the no-longer recognised Conservation Dependent categories. Again, thresholds are set regionally.

A2. Restricted-range species

The site forms one of a set selected to ensure that, as far as possible, all restricted-range species of an EBA or SA are present in significant numbers in at least one site and, preferably, more. The term 'significant component' is intended to avoid selecting sites solely on the presence of one or more restricted range species that are common and adaptable within the EBA and, therefore, occur at other chosen sites. Sites may, however, be chosen for one or a few species that would, e.g. because of particular habitat requirements, be otherwise under-represented.

A3. Biome-restricted species

The site forms one of a set selected to ensure, as far as possible, adequate representation of all species restricted to a given biome, both across the biome as a whole and, as necessary, for all of its species in each range state. The 'significant component' term in the category definition is intended to avoid selecting sites solely on the presence of one or a few biome-restricted species that are common, widespread and adaptable within the biome and, therefore, occur at other chosen sites. Additional sites may, however, be chosen for the presence of one or a few species which would, e.g. for reasons of particular habitat requirements, be otherwise under-represented.

A4. Congregations

i. This applies to 'waterbird' species as defined by Delaney and Scott (2002) 'Waterbird Population Estimates' Third Edition, Wetlands International, Wagenigen, The Netherlands, and is modelled on criterion 6 of the Ramsar Convention for identifying wetlands of international importance. Depending upon how species are distributed, the 1% thresholds for the biogeographic populations may be taken directly from Delaney & Scott, they may be generated by combining flyway populations within a biogeographic region or, for those for which no quantitative thresholds are given, they are determined regionally or inter-regionally, as appropriate, using the best available information.

ii. This includes those seabird species not covered by Delaney and Scott (2002). Quantitative data are taken from a variety of published and unpublished sources.

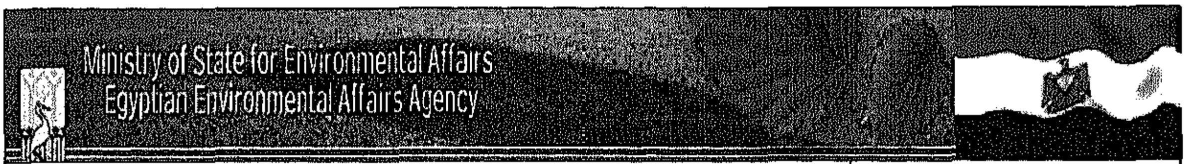
iii. This is modelled on criterion 5 of the Ramsar Convention for identifying wetlands of international importance. Where quantitative data are good enough to permit the application of A4i and A4ii, the use of this criterion is discouraged.

iv. The site is known or thought to exceed thresholds set for migratory species at bottleneck sites. Thresholds are set regionally or inter-regionally, as appropriate.

Appendix 4:

Appendix 4.1-5 Environmental Effect Assessment Principles and Procedures Guide

Appendix 4.1-5 Environmental Effect Assessment Principles and Procedures Guide



Ministry of State for Environmental Affairs
Egyptian Environmental Affairs Agency
Environmental Sector

Arab Republic of Egypt
Egyptian Cabinet

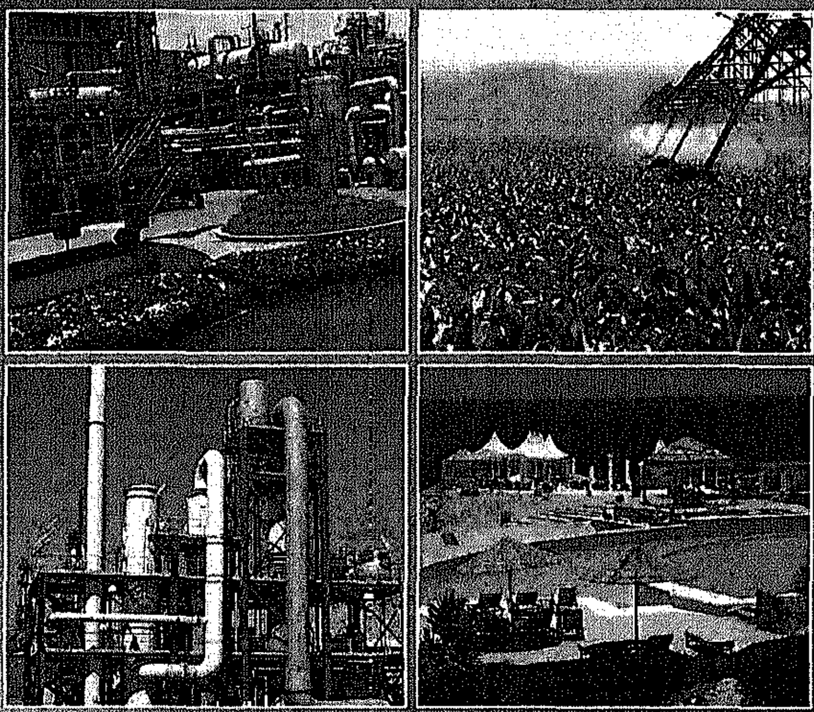
Environmental Effect Assessment Principles and Procedures Guide

Issue 2 – January 2009

جمهورية مصر العربية
رئاسة مجلس الوزراء

وزارة الدولة لشئون البيئة
جهاز شئون البيئة
قطاع الإدارة البيئية

دليل
أسس وإجراءات تقييم التأثير البيئي



الإصدار الثاني - يناير ٢٠٠٩

Appendix 4:

Appendix 4.1-6 Feeder Load balance by Upgrading DMS (DAS)

Appendix 4.1-6 Feeder Load balance by Upgrading DMS (DAS)

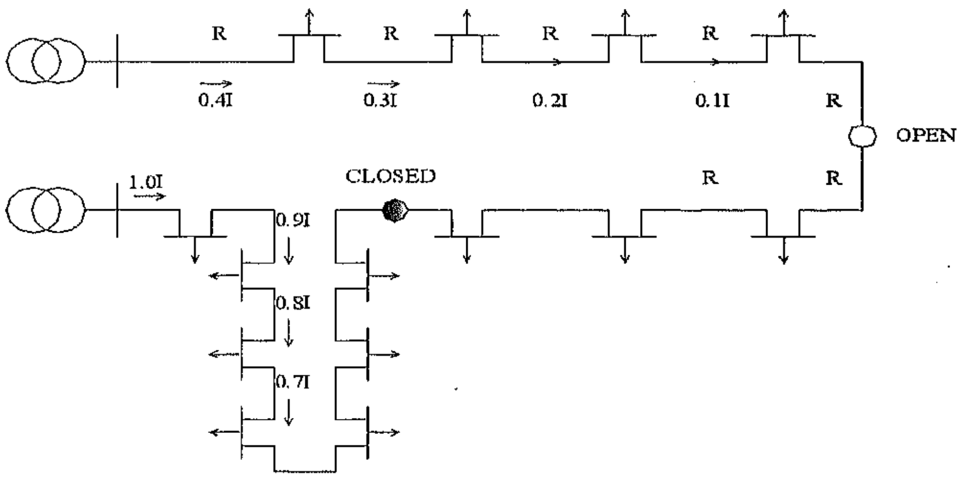
Example Calculation>

The effect of Upgrading DMS (DAS) on loss reduction could be substatial .Its value depends on the value and distribution of loads, network parameters and network configuration before applying Upgrading DMS (DAS) .An example based on some assumptions is given in order to describe the effect of Upgrading DMS (DAS).

Assumptions:

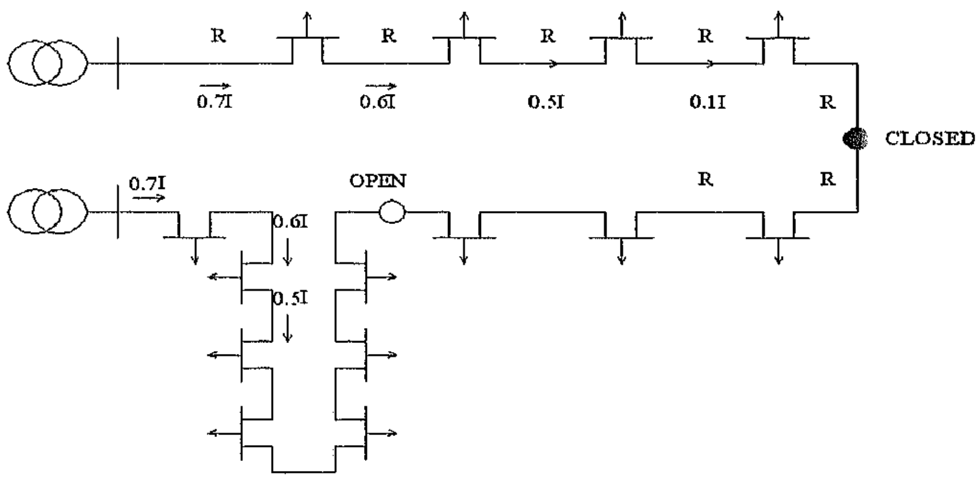
v. Rtaed current of each feeder =I
vi. Value of load at each node=0.1I
vii. Resistance between sections are equal having value equals R

(1) Before application of DAS



Total losses $= (0.4I)^2.R+(0.3I)^2.R+(0.2I)^2.R+(0.1I)^2.R+$
$(1.0I)^2.R+(0.9I)^2.R+(0.8\ I)^2.R+......+(0.1I)^2.R$
$= 4.15\ I^2.R$

(2) After installation of Upgrading DMS (DAS)



Total losses $= 2((0.7I)^2.R+(0.6I)^2.R+......+(0.1I)^2.R)$
$= 2.76\ I^2.R$

Effect of DAS $= (4.15-2.76)*(100)/(4.15)$
$= 33.4\%$

Appendix 4:

Appendix 4.1-7 Improvement of Power Factor by capacitor control

Appendix 4.1-7 Improvement of Power Factor by capacitor control

Capacitors installed in 66/11kV substation and/or distribution feeder can be controlled by DAS which can monitor the power factor in real time and control the automatic LBS for the capacitor.
The principal of loss reduction by capacitor control is explained as follows.
The relationship among Reactive power Q, Active power P and Apparent power S is shown in Fig 5-1. In this example case, it is defined that one feeder is loaded at 40 percent rate, and the other is loaded by 100 percent, which means there exists an unbalanced load rate.

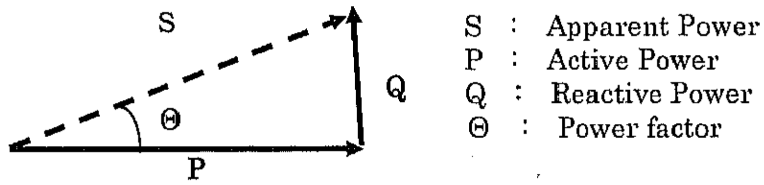


Fig 5-1 Relationship among S, P and Q

When a reactive power Q becomes larger by using motor load, the active power P will reduce and the load current will increase in case of requirement of the same power P such as motor loads, so that the loss by increasing the load current will increase.
Q is normally a lagging reactive power Q1/Q2 whose load consists of motor, light and so on. Therefore, if a leading reactive power Qc such as capacitors is added to the load side, the Q1 can be reduced to Q2, so that the loss can be reduced as shown in Fig 5-2.

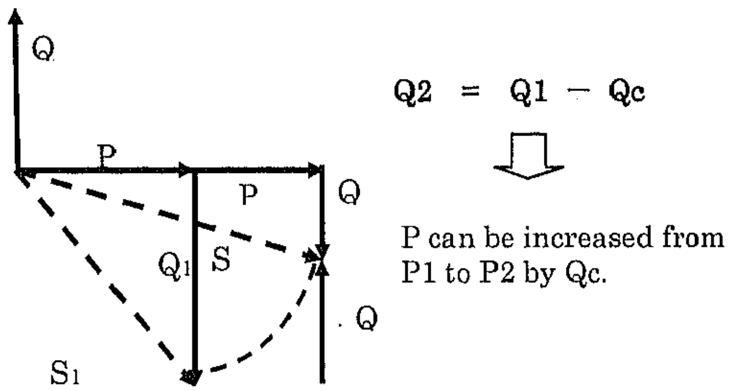
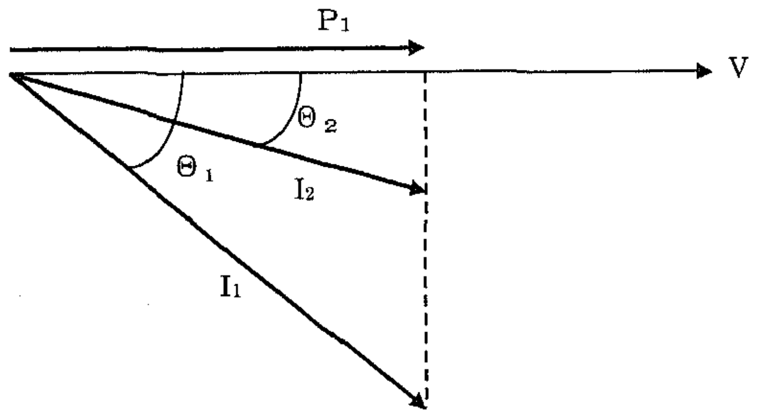


Fig 5-2 Improvement of Power factor by leading reactive power



Loss reduction $= I_1^2 \cdot R - I_2^2 \cdot R = (P_1 / V \cdot \mathrm{Cos}\ \theta_1)^2 \cdot R -$
$(P_1 / V \cdot \mathrm{Cos}\ \theta_2)^2 \cdot R$
$= (P_1^2 / V^2) \cdot R\ (1/\cos^2\theta_1 - 1/\cos^2\theta_2)$

R: Resistance of distribution line
V: Voltage between phases

In case that power factor can be improved from 0.8 to 0.95 by DAS, 30% (←29.1%)of loss can be reduced

DAS can control the capacitors installed in substations and overhead distribution networks in accordance with the real time monitoring of the power factor, so that the loss can be reduced up to around 30%.

Appendix 4:

Appendix 4.2-1 Fault Detecting, Isolating and Restoration (FDIR)

Appendix 4

Appendix 4.2-1 Fault Detecting, Isolating and Restoration (FDIR)

<Methods of FDIR>

For fault sensing system, there are two methods, namely voltage sensing method and current sensing method. The features of the two methods are explained as follows.

a) Voltage Sensing Method
Upgrading DMS (DAS) system configuration of voltage sensing method is shown below. Voltage sensing method can perform FDIR by only feeder equipment because Fault Detecting Relay (FDR) function of RTU can identify the faulty section by the voltage existence of the feeder. The features of the necessary equipment for voltage sensing system are as follows.

- ✓ FDR is assembled in RTU
- ✓ Regarding operating mechanism of automatic LBS, LBS will be automatically opened when the feeder voltage is lost, and automatically closed when the feeder voltage is supplied
- ✓ Switch Power Supply (SPS) transformer is required for supplying power to FDR *built-in RTU* and for *sensing feeder voltage of both side of automatic LBS*

The voltage sensing method has one more unique feature, that is, "Simplified Upgrading DMS (DAS)" which doesn't require Upgrading DMS (DAS) computer system, substation equipment and communication system as shown in Fig 4-3-4, and can perform the automatic FDIR function just by feeder equipment. The "Simplified Upgrading DMS (DAS) " might be applicable for the outskirt area.

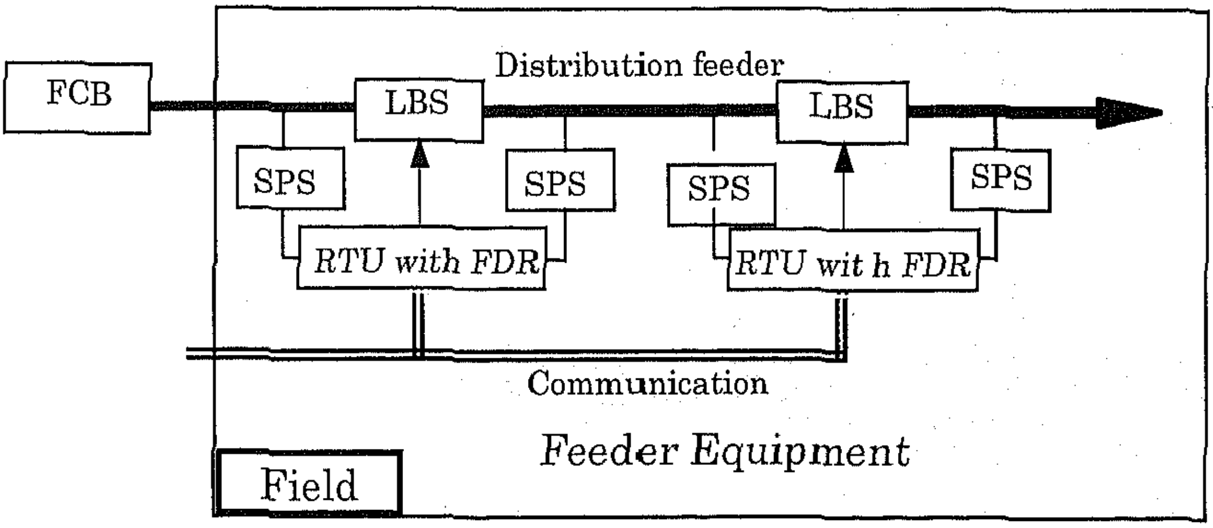
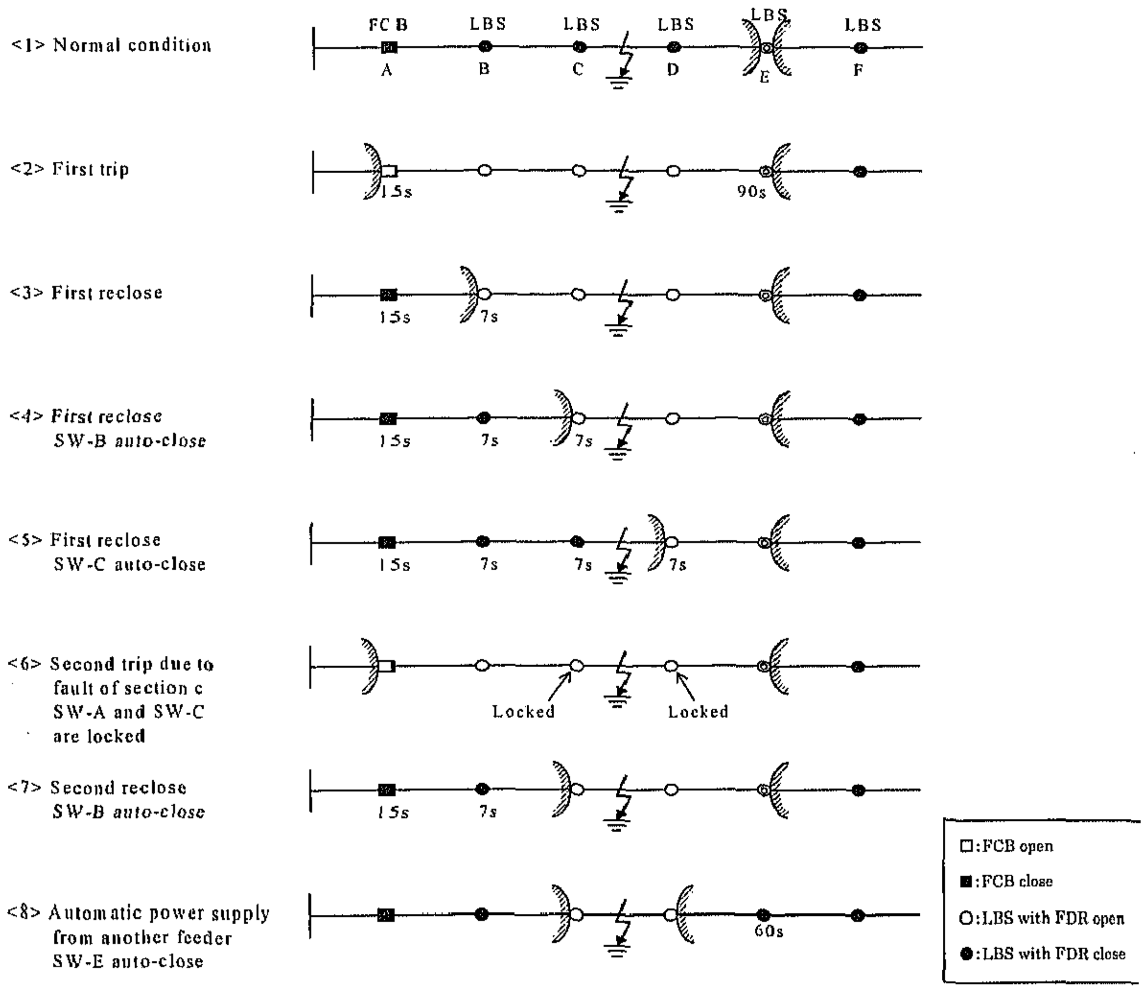


Fig. 4-3-5 Configuration of Voltage Sensing Method

Schematic diagram for voltage sensing method is shown in Fig 4-3-6. The diagram is given in the assumption of a loop system.



<1> At normal operating condition without any fault, FCB and LBSs except for SW-E, which is located at the loop point, are in closed state.

<2> When a fault occurs in section c, FCB trips and the voltage is cut off. At the same time, all LBSs are opened automatically by the function of FDRs.

<3> FCB recloses, and the power supply to section a is restored.

<4> After X-time of LBS-B, which is 7 second in this case, LBS-B is closed, and the power supply to section b is restored.

<5> After X-time of LBS-C, which is 7 second in this case, LBS-C is closed, and the power supply to section c is restored.

<6> In case that a fault remains in section c, FCB trips again and LBSs are opened. And LBS-C is locked in the state of opening, based on the judgement of the FDR for the LBS-C that a voltage drop occurred within a preset lapse of time (Y-time), which is 5 second in this case, after the restoration of the power supply. LBS-D is also locked in the state of opening as FDR for LBS-D detects faulty voltage (30% of the rated voltage or more during 150 msec. or more).

<7> FCB recloses again, and the power supply to section a and section b is restored in the same way as step <3> and <4>. Since LBS-C is locked by FDR in the state of opening, LBS-C is not closed.

<8> LBS-E is closed XL-time after the first tripping of FCB, and the power supply form another feeder is achieved. XL-time, which is a preset lapse time, is 90 second in this case.Because LBS-D is locked out, power is not supplied to faulty section c.

Fig. 4-3-6 Schematic Diagram for Voltage Sensing Method (Loop System)

b) Current Sensing Method
Upgrading DMS (DAS) system configuration of current sensing method is shown in Fig 4-3-7. This current sensing method can be performed by FDIR function of Upgrading DMS (DAS) computer system. So Upgrading DMS (DAS) computer system, substation equipment and communication system are required for this method. In addition, the following devices are required for feeder equipment.

- ✓ Over Current (OC) / Over Current Grounding (OCG) relay for detecting the faulty current
- ✓ Battery and Battery-charger for operation of automatic LBS under outage

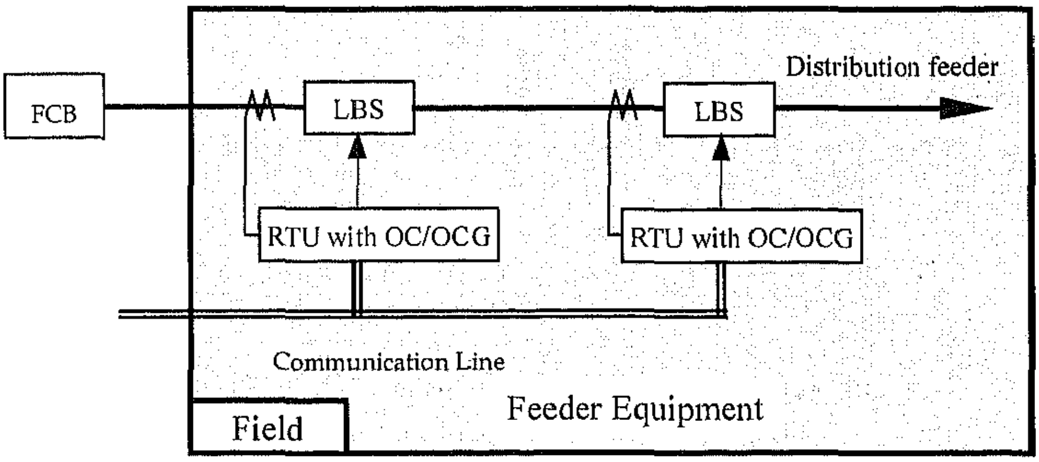
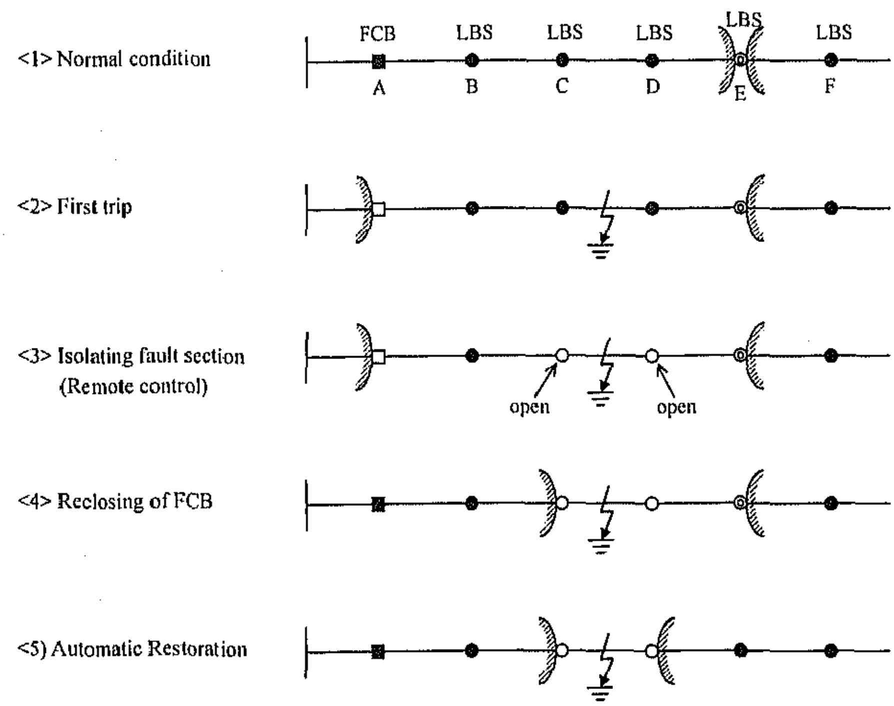


Fig. 4-3-7 Configuration of Current Sensing Method

Schematic diagram for current sensing method is shown in Fig 4-3-8. The diagram is given with the assumption of a loop system.



<1> At normal condition of the network, power is supplied from the substation Feeder Circuit Breaker (FCB) and automatic Load Break Switch (LBS) attached to the distribution feeder line, which all FCB and LBSs are on a closed state. At the loop point, LBS-E is open state.

<2> When a fault occurs in section c, FCB in the substation trips and the voltage is cut off.

<3> The DAS computer system identifies section c as the faulty section, based on the fault current information from the remote terminal units (RTUs). The system then commands the RTUs to open LBS-B and LBS-C, so that the faulty section is isolated.

<4> The FCB is closed, and the power is supplied to section a and b.

<5> The computer system commands the RTU in the LBS-E to close the LBS-E, and power supply to section d from another feeder is restored.

Fig. 4-3-8 Schematic Diagram for Current Sensing Method

c) Comparison of the Sensing Methods

Major features of voltage sensing and current sensing method are as follows.

(i) Voltage Sensing Method

- Automatic detection of faulty section is performed only by local (feeder) equipment.
- Number of reclosing of FCB in substation will be 2 times.
- Automatic LBS is automatically opened in case where the power supply is lost.

(ii) Current Sensing Method

- Automatic detection of faulty section is performed by DAS computer system.
- Number of reclosing of FCB in substation will be 1 time.
- Automatic LBS is latch type, which is kept closed in case where the power supply is lost. Stage is suitable for applied distribution network.

Comparison of these methods is summarized as shown in Table 4-3-9.

Table 4-3-9 Comparison between Current Sensing and Voltage Sensing Method

		Current Sensing Method	***Voltage Sensing Method***
FCB Operation		1 time action	2 times action
Fault Detection		Have difficulties of detecting high impedance faults just only by OC relays.	Detectable in all cases
Maintenance		Replacement of battery is required every 2 years. Easy fieldwork of battery replacement is required, especially in case of overhead network because pole work is troublesome.	Maintenance-free
Redundancy		If DAS Computer System and Communication system have some troubles, the faulty section can not be detected automatically.	Feeder equipment can detect the faulty section even if DAS Computer System or Communication System is unavailable.
Operator work		Operator should judge the fault section and supply the power up to the source side of the faulty section by remote control.	The fault section is isolated and the power is supplied up to the source side of the faulty section automatically.
Cost	Computer / Communication System	Computer System and Communication system should be needed	Computer System and Communication system are not required only for simplified Upgrading DMS (DAS).
	Feeder Equipment	Battery and battery charger will be required. Relay/CT for fault detection is needed. SPS is not required.	Battery, battery charger and relay are not required. SPS is required.

<Recommendation on Sensing Method>

Fault detecting procedure/method would be recommended in order to avoid the following difficulties.

- ✓ Maintenance work is not easy in the field. Because the working place is always high on pole.
- ✓ Most of faults in OH network are temporary one.

Accordingly, there are many benefits for voltage and current sensing method as shown in Table 4-3-9. Also the reclosing function/relay would be effective.

Advantage of voltage sensing method:
Voltage sensing method has a few advantages in comparison with current sensing method for OH network.

- ✓ It is not necessary to change the battery on pole.
- ✓ Automatic reclosing function is acceptable for OH network, so that the voltage sensing method could be applied.

In addition to the above benefits, the followings are effective:

- ✓ Quantity of work for operator can be reduced by the automatic fault detection.
- ✓ Power can be supplied to the end of the section where is the adjacent to the fault section.
- ✓ Investment cost for simplified Upgrading DMS (DAS), which can be applied for rural area, would be low.

On the other hand, UG network has the following features.

- ✓ Maintenance works is easy in field because working place is not high. UG facilities are installed on the pedestrian road.
- ✓ Most of faults in UG network are permanent one. Therefore, the reclosing function is not effective.

Advantage of current sensing method:
Current sensing method has a few advantages in comparison with voltage sensing method for UG network.

- ✓ The periodical change of battery is required but the work can be easily carried out.
- ✓ Automatic reclosing function is not acceptable for UG network. Therefore, voltage sensing method using reclosing function would not be recommendable.

In addition to the above benefits, existing RMU can be modified so that the automatic operation of current sensing method could be applied. Consequently, the investment cost can be reduced.

<Remarks>
The distribution network applied with Upgrading DMS (DAS) will be based on 3 sections and 3 looped points (normal open point). In case that the looped points will be lacked, the new construction will be required.

Appendix 4:

Appendix 4.2-2 Communication network

Appendix 4.2-2 Communication network

(1) Backbone communication network

The backbone communication system for Upgrading DMS (DAS) data is roughly classified into a wired system and a wireless system. The wired system is further classified into a fiber optic system and Power Line Communication (PLC) system. These four systems have respectively advantages and disadvantages, and should be selected in consideration of the circumstances involved.
For selecting the communication system to be applied, the following three points have to be fully taken into account, (i) communication technology specifications required by Upgrading DMS (DAS), (ii) high priority items and (iii) peculiarities of the Egyptian Distribution Company.

<Comparison of Communication Systems>

Comparison of each communication system is shown in Table 1.

Table 1 Comparison of Communication Systems

	Fiber Optic System	**PLC**	**Radio wave**	**Mobile Phone**
1.Transmission System	Direct intensity modulation	PLC/ground return	VHF/UHF (Digital)	GPRS
2.Transmission Capacity	Several Gbps	200~600 bps	~ Several kbps	~ Several kbps
3. Reliability	Very High	Transmission loss for 11kV line is large due to DT/connection, so the reliability is not so good.	Low	Low
4. Congestion	No problem	No problem	No problem	Congestion should be considered in case of outage and disaster
5. Security	No problem because of special line	No problem because of special line	Security had better be considered.	Security should be considered because of public network
6. Cost	High	Low	Not low	Low
7.Expansion (New business)	Transmission capacity is enough for communication business	No margin for transmission capacity	Transmission capacity is not enough	Transmission capacity is not enough

The above table shows that any of these communication systems satisfies all the requirements for communication technology specifications, but it can be found that they are not necessarily appropriate in some points.

PLC system is used in TEPCO. However, PLC system for HV (11kV) is not appropriate for Egypt due to the following reasons.

- ✓ Loss of transmission signals becomes large due to transformers (DT) and capacitors.
- ✓ In terms of transmission distance, as the total length of feeders is longer because the medium distribution voltage in Egypt is 11 kV compared with 6 kV in Japan, the transmission loss becomes further larger at the time of arrival at RTU.
- ✓ Reliability of PLC is not so good due to cable connection problems, standing wave etc.
- ✓ It is necessary to carry out verification for every distribution system. Because of a long period of time required for such verification and consequent cost, its advantage of low cost is offset.

In case of General Packet Radio Service (GPRS), the investment is low because the public network constructed by Tele-communication company can be used for Upgrading DMS (DAS) and AMR/DSM. However, for use of the public network, it generally has two major problems which are security and congestion. It is necessary for the communication system using GPRS to design the countermeasure for security and the high priority against congestion. In addition, we should consider to pay the connection fee to the Tele-communication company every use/day/month/year.

As for fiber optic system, the transmission capacity, contingency and reliability of power security are excellent. However, the cost of fiber optic system is slightly higher than other systems, but the future potential and upgrade ability of the former is much higher.

As for Digital UHF/VHF, the reliability and transmission capacity is lower than Fiber Optic system, but the investment is lower and the installation work is more easy.

<Recommendation for backbone Communication System>

As for the back-bone communication network among MCC, substation and RTU, Digital UHF/VHF is recommendable due to low cost and easy installation.
However, the characteristics of Fiber Optic is the best as backbone network, so it is recommended that Fiber optic will be installed in cables when new distribution feeder will be constructed in order to apply in future.

(2) Branch (Last one mile) communication network

There are 4 candidates as branch communication network for AMR which are of PLC for LV line, GPRS, WiMAX and ZigBee.
The rough comparison is shown in the following table.

	PLC	GPRS (Public)	WiMAX (Private)	ZigBee
Bandwidth	- 450 kHz 4 – 28MHz	850 – 1900 MHz	2 – 11 GHz	868 – 870 MHz 902 - 928 MHz 2.4 GHz
Distance	△	◎ by Public network	◎ (2-10km, 50km max)	○ (30m x N)
Baudrate	△ 2.4kbps (for LV)	○ 28kbps	◎ 74Mbps (at 20MHz band)	○ 20kbps (868M) 40kbps (915M) 250kbps (2.4G)
Reliability	X	○	○	○
Security	○	X By Public use	○ (3DES)	○
Collision / Congestion	○	X By Public use	○	○ (CSMA/CA)
Power consumption	△	○	△	◎
Initial Cost	○	◎	△	◎
Maintenance Cost	○	X	○	○
Standard	△ (CEPCA etc)	○	○ (IEEE 802.16) (WiMAX Forum)	○ (IEEE 802.15.4) (Zigbee Alliance)

PLC for LV (400V) line is suitable for the communication for AMR/DSM on consumer side because the high reliability is not required and the investment is low.
However, there are a lot of reliability problems as follows.

- ✓ Loss of transmission signals happens due to a lot of connection points, noise by electric household devices and so on.
- ✓ Leakage electric magnetic wave is occurred by the LV line as the function of antenna
- ✓ Reliability of PLC is not so good due to cable connection problems, standing wave etc.

Therefore, PLC is not recommendable.

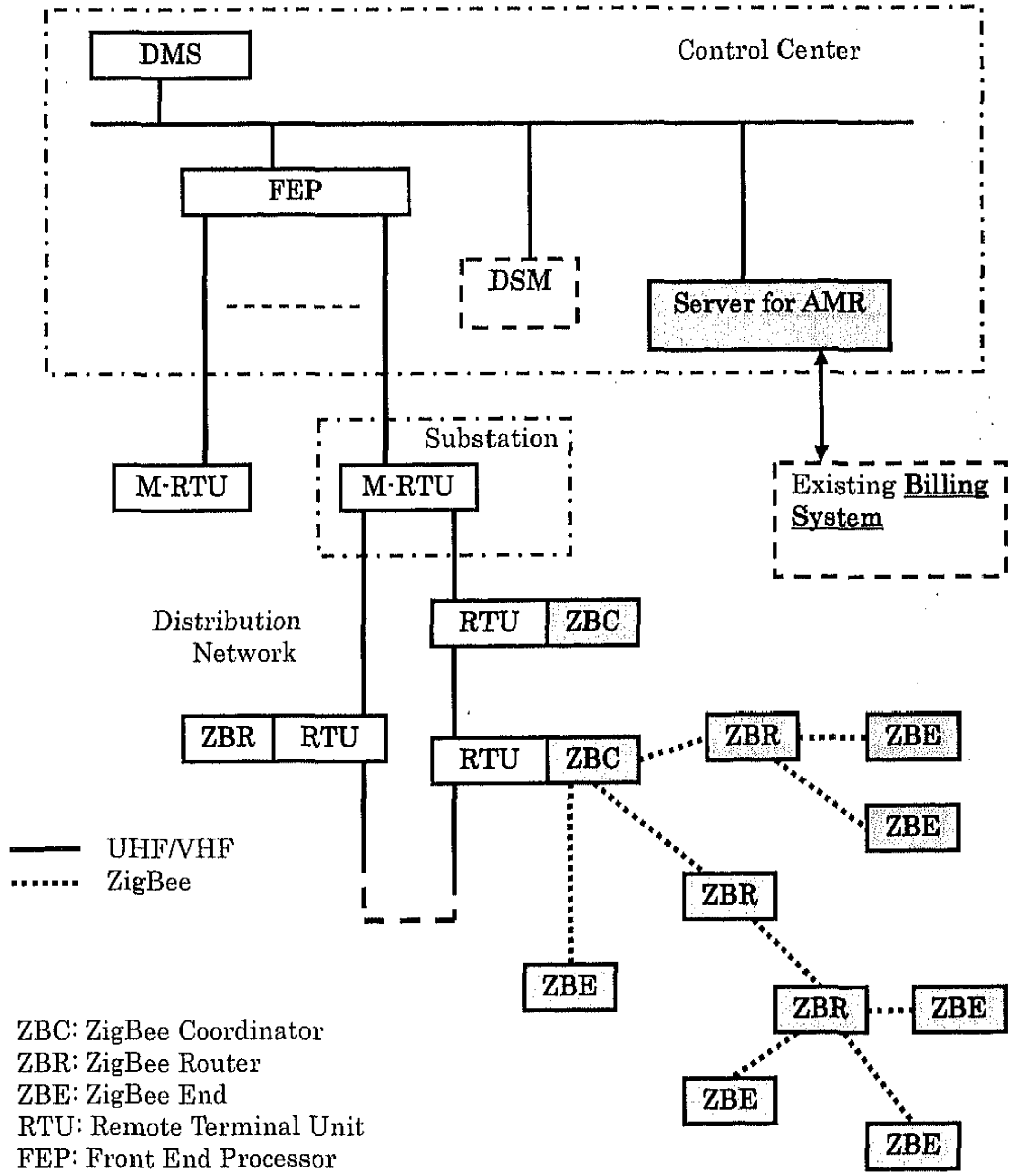
As for GPRS under Public network, GPRS is fascinated due to the low investment. However, the maintenance cost is large because a lot of communication is required for AMR which means to pay huge money to Telecommunication Company.
In addition, the security and the congestion should be considered in the design of communication system using GPRS.
As for the branch communication network between RTU and AWHM on consumer side, GPRS is not recommendable.

As for WiMAX, the characteristics are excellent but the initial cost and power consumption are large as compared with ZigBee.
As for ZigBee, the characteristics are not so good as compared with WiMAX but are enough in application to AMR.
The cost is inexpensive and the power consumption is very small, so that AWHM assembled the device can attain small size and low cost.
Therefore, ZigBee is recommendable as the branch communication.

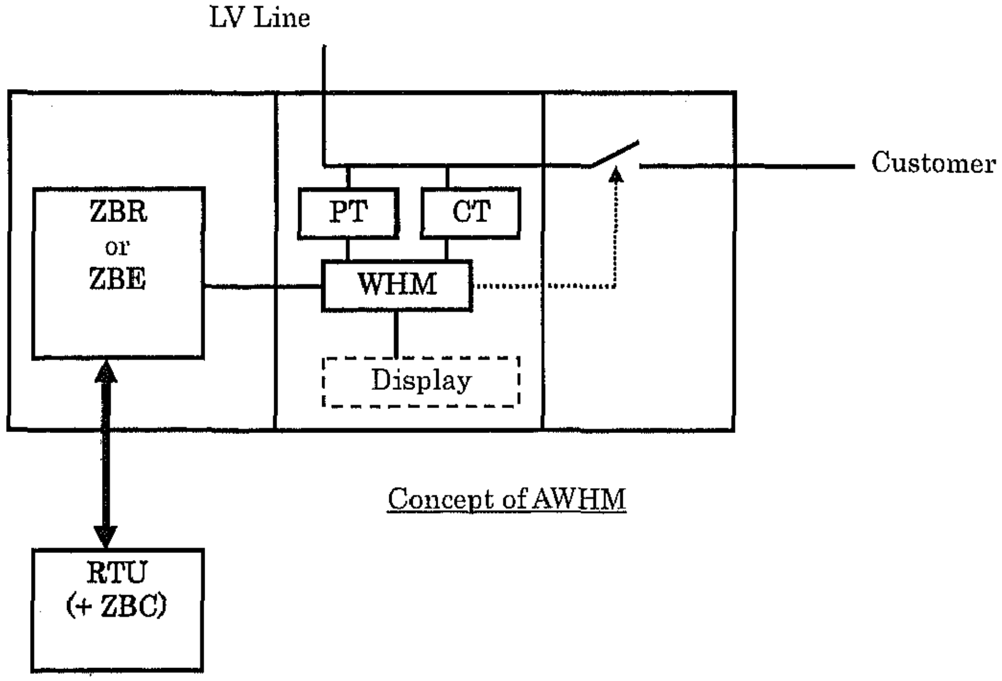
Appendix 4:

Appendix 4.2-3 System configuration idea for AMR

Appendix 4.2-3 System configuration idea for AMR



ZBC: ZigBee Coordinator
ZBR: ZigBee Router
ZBE: ZigBee End
RTU: Remote Terminal Unit
FEP: Front End Processor
AMR: Auto Meter Reading system
DMS: Distribution Management System



Concept of AWHM

< Major feature of AMR >

(1) WHM can store the consumption data for more than One month.
When the control center requests to send the data, the accumulated data in WHM can be sent through ZigBee communication network
(2) Display in AWHM is simple in order to achieve low price.
(3) SW can be assembled in AWHM in order to implement DSM in future.

Appendix 4:

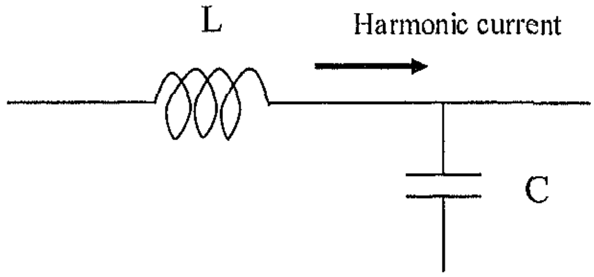
Appendix 4.2-4 Problems and Consideration in case of installation of capacitor to LV line

Appendix 4.2-4 Problems and Consideration in case of installation of capacitor to LV line

It is necessary to check the following problems in case of installing LV capacitor.

(1) Harmonic current problem
When capacitor is installed to LV line, it has to examine series resonance which is caused by combination of impedance of LV line and capacitor.
Because almost all of impedance of LV line is occupied by reactance, total impedance of LV line, to which capacitor is connected, is calculated as follows,

$$Z = j\omega L + 1/j\omega C$$



Regarding the above mentioned Z, put Z=0 and get $\omega = 1/\sqrt{LC}$, which is series resonance of this LV line.

Generally, harmonic current, which is caused by electrical equipment such as inverter, flows on LV line. When the frequency of the harmonic current of LV line is equal to the series resonance of this LV line, over-current flow into the capacitor, which is connected to this LV line, and cause the damage to this capacitor.

Therefore, in case of the design about connection of capacitor to LV line, it will be needed to examine impedance of LV line and capacity of capacitor.

(2) Other problem
In case of LV capacitor, cheaper cost is required due to a lot of quantity, so that the following problems should be checked.

- Lack of capacity (Enough margin is required.)
- Lack of withstanding voltage against LV voltage including switching surge and lightning surge.
- Lack of withstanding voltage under long term-use
- Deterioration by using long term under high temperature condition

Appendix 4:

Appendix 4.2-5 Contents of project cost

Appendix 4.2-5 Contents of project cost

< West Alex in AEDC >

Location of Loss	Project	Quantity	Foreign MUS$	Local MUS$ (MLE)	Reason of Cost 1US$=5.5LE
(1) 11kV feeder	①Construction of 11kV feeder	180 feeder	-	56.2 (309)	9157km / 1873 feeder = 4.9km/feeder 350kLE / km 4.9km x 0.35MLE x 180 = 309MLE
	②Installation of new Capacitor	100 units (New) 175 units (existing)	5.6	0.4 (2.2)	288 UG feeder + 3 OH feeder = 291 1) Existing capacitor; 49(Distributor) + 126(Kiosk) = 175 units (Old) 175 x 9kUS$ → 1.6MUS$ 2) New capacitor; 291- 175 = 116 units → 100 units 100 x 40kUS$ = 4000 → 4MUS$ [40kUS$; 300KVAR Capacitor + RTU + Auto LBS(VS)] 3) Adaptation work in site; 8kLE x 275 = 2200kLE
	③Improvement of Load unbalance	600 units	18.0	1.8	Load unbalance can be improved by DAS including control center, RTU and SW. The control center and RTU are included in item 3, so SW is calculated as project cost in order to avoid the overwrapping of cost. Necessary SW: 720 units (288 feeder x 2.5 = 720) Existing Kiosk: 126 units (→modified to automatic type) 126 x 15kLE = 1890 → 1.9 MLE 720 -126 = 594→ 600 units (2 way: Automatic + 2way: Manual) 600 x 30kUS$ = 18000→ 18MUS$
(2) DT	Replacement of low loss DT Large capacity DT to improve overload	970 units	30.0	3.0	Existing old DT: 970 units The DT will be replaced to low loss and 1000KVA DT. 970 x 0.17MLE = 1649MEGP
(3) LV line	Improvement of phase unbalance by Upgrading DMS (DAS)	1 system 8 SS 2000units	13.5	1.3	Load current of LV phases at DT are monitored by Upgrading DMS (DAS) with RTU and control center. The necessary facilities are of 1 system of control center, M-RTU for Substation (8 SS), RTU for Kiosk (720-126 units) and RTU for DT (1059). → 2000 units (RTU) for considering expansion Existing M-RTU will be applied. 1 system x 3.5 MUS$ + 2000 x 0.005 MUS$ = 13.5 → 13.5 MUS$ These RTU and communication network can be used for AMR to reduce non-technical loss and Upgrading DMS (DAS) to improve the reliability. These facilities can also be used for future plan of DSM (peak cut) and communication business.
(4) Meter	Replacement to electrical meter	200,000 units	24.0	1.2	For all of consumers (200,000 consumers) 120US$ x 200,000 = 24000000 → 24MUS$
<Sub-Total>			91.1	7.7	
(5) Non - technical loss	By AMR system	1 system	2.0	0.2	Meter cost is included in (4). Communication (RTU) and parts of control center are included in (3).
< Total >			93.1	7.9	

<Remarks> The distribution network applied with Upgrading DMS (DAS) will be based on 3 sections and 3 looped points (normal open point). In case that the looped points will be lacked, the new construction will be required.

< North Dahkalia >

Location of Loss	Project	Quantity	Foreign MUS$	Local MUS$ (MLE)	Reason of Cost 1US$=5.5LE
(1) 11kV feeder	①Construction of 11kV feeder	140 feeder		50.2 (276)	UG: 812km/160feeder=5.1km OH: 2162km/122feeder=17.7km 5.1x0.3x60feeder(UG)+17.7x0.13x80 feeder(OH) = 276MLE 276/5.5= 50.2MUS$
	②Installation of new Capacitor	70	4.0	0.4	OH: 122 feeders → 70 feeders (Bad Pf) 300kVA capacitor for OH with RTU and Auto LBS(Vacuum type). 70 x 57kUS$ = 3990 → 4.0 MUS$
	③SVR	150	4.0	0.4	OH: 122 feeders → Assumption of Voltage drop: 50 feeders, 3units/feeder 500 KVA SVR: 24kUS$ 50 x 3 x 26kUS$ = 3900 → 4.0MUS$
	④Improvement of Load unbalance	LBS: 550 units RTU: 965 units	12.5	3.0 (16.6)	Load unbalance can be improved by Upgrading DMS (DAS) including control center, RTU and SW. The control center and RTU are included in item 3, so SW is calculated as project cost in order to avoid the overwrapping of cost. Necessary SW; 550 units for OH (122 feeder x 4.5 = 549 → 550) OH: 550 unitsx0.008 = 4.4 MUS$ UG: using existing Kiosk:2893 The necessary automatic Kiosk: 415 (166 x 2.5 = 415), 415 x 40kLE = 16600 → 16.6MLE for modification of Kiosk RTU, Arr and Tr for OH: 0.004 MUS$ RTU, battery etc for UG: 0.008 MUS$ 550 x 0.004 + 415 x 0.008 = 5.52 MUS$ 4.4 + 5.52 = 9.92 → 10 MUS$ Control center: 2.5 MUS$
(2) DT	Replacement of low loss DT	600 (UG)	10.2	1.1	Old DT: 2289 units UG: 600 units for 500kVA will be replaced as assumption to keep the budget. 600x0.093MLE=55.8MLE → 10.2MUS$
(3) LV line	Shortening LV line by DT of small capacitor	200 units	3.2	0.3	LV line of OH can be reduced by replacing to small capacity (100KVA) DT as mentioned item (2). 200 units x 0.088MLE = 17.6 MLE (3.2MUS$)
(4) Meter	Replacement to electrical meter	600,000 Units	72.0	7.2	For all of consumers (600,000 consumers). 120US$ x 600,000 = 72,000,000 US$
	Upgrading Communication	1	1.0	0.1	
<Sub-Total>			94.4	9.5	
(5) Non - technical loss	By AMR system	1 system	2.0	0.2	Meter cost is included in (4). Communication (RTU) and parts of control center are included in item (1)④.
< Total >			96.4	9.7	

<Remarks>The distribution network applied with Upgrading DMS (DAS) will be based on 3 sections and 3 looped points (normal open point). In case that the looped points will be lacked, the new construction will be required.

<Helmya sector in NCEDC >

Location of Loss	Project	Quantity	Foreign MUS$	Local MUS$ (MLE)	Reason of Cost 1US$=5.5LE
(1) 11kV feeder	①Construction of 11kV feeder	200 feeder	-	47.5 (261)	Necessary new feeder: 200 feeders 2.9km x 0.45MLE x 200 = 261MLE
	②Installation of new Capacitor	424(new) +42(old)	17.4	0.7	Existing feeder: 565 feeders (UG), 0 feeder (OH) 1) Existing Capacitor: 42 units (11kV, 300KVA) 42 x 9KUS$ = 378 →0.4 MUS$ 2) New Capacitor: 565feeder x 3/4 → 424 feeders for Bad Pf as assumption to keep budget. 424 x 40kUS$ = 16960 → 17.4 MUS$ 3) Adaptation work; 8KLE x 466 = 3728→ 0.7 MUS$
	③Improvement of Load unbalance	1400 units	7.0	0.7	Load unbalance can be improved by Upgrading DMS (DAS) including control center, RTU and SW. The control center and RTU are included in item 3, so SW is calculated as project cost in order to avoid the overwrapping of cost. Necessary SW: 1413 units → 1400 (565 feeder x 2.5 = 1413) Existing Kiosk: 2795 units 565x2.5 = 2283 (Kiosk) → No need for new SW Modification to automatic type: 1400 x 27.5kLE = 38500 → 7 MUS$
(2) DT	Replacement of high loss DT Large capacity DT to improve overload	1500 units	32.0	3.2	Existing old DT; 2285 units The DT will be replaced to low loss and 1000KVA DT (from 500KVA). 2285 → 1500 units 1500 x 0.12 = 180MLE → 32 MUS$
(3) LV line	Improvement of phase unbalance by Upgrading DMS (DAS)	1 system 14 SS 2285units	16.2	1.6	Load current of LV phases at DT are monitored by Upgrading DMS (DAS) with RTU and control center. The necessary facilities are of 1 system of control center, M-RTU for Substation (14 SS), RTU for Kiosk (2795 units) and RTU for DT (2285), RTU for existing distributor (42) 1 system x 2.5 MUS$ + 14 SS x 0.15 MUS$ + 42 x 0.005 + 2285 x 0.005 MUS$ = 16.2 MUS$ These RTU and communication network can be used for AMR to reduce non-technical loss and DAS/SCADA to improve the reliability. These facilities can also be used for future plan of DSM (peak cut) and communication business.
(4) Meter	Replacement to electrical meter	600,000 units	72.0	3.6	For all of consumers (600,000 consumers) for El Helmya zone as 1st step.
(5) Others	Communication upgrading	1	7.0	0.7	
<Sub-Total>			144.6	9.8	
(5) Non-technical loss	By AMR system	1 system	2.0	0.1	Meter cost is included in (4). Communication (RTU) and parts of control center are included in (3).
< Total >			146.6	9.9	

<Remarks>The distribution network applied with Upgrading DMS (DAS) will be based on 3 sections and 3 looped points (normal open point). In case that the looped points will be lacked, the new construction will be required.

Appendix 4:

Appendix 4.3-1 Calculation Sheets for West Alex, AEDC

Appendix 4.3-1 Calculation Sheets for West Alex, AEDC

West Alex

Sales Energy forecast in the project area up to the commissioning year

No.	Year	Electricity Consumption (GWh)	Loss Rate	Sales Energy (GWh)	Growth Rate	Note
1	2008/2009	999	13.76%	862		
2	2009/2010	-	-	930	8.0%	
3	2010/2011	-	-	1,005	8.0%	
4	2011/2012	-	-	1,085	8.0%	
5	2012/2013	-	-	1,172	8.0%	
1	2013/2014	-	-	1,266	8.0%	

Note: Further energy growth was assumed until 2028 by 8% of annual growth rate for calculation of benefit.

Benefit by the Project

No.	Year	*Reduction of Outage Duration*		*Reduction of Technical loss*		*Reduction of Non-Technical loss*	
		Reduced Duration (hour)	*Benefit (GWh)*	*Reduced Value (%)*	*Benefit (GWh)*	*Reduced Value (%)*	*Benefit (GWh)*
1	2013	1.93	0.3	3.73	55	4.09	60
2	2014	1.93	0.3	3.73	59	4.09	65
3	2015	1.93	0.3	3.73	64	4.09	70
4	2016	1.93	0.4	3.73	69	4.09	76
5	2017	1.93	0.4	3.73	74	4.09	82
6	2018	1.93	0.4	3.73	80	4.09	88
7	2019	1.93	0.4	3.73	87	4.09	95
8	2020	1.93	0.5	3.73	94	4.09	103
9	2021	1.93	0.5	3.73	101	4.09	111
10	2022	1.93	0.6	3.73	109	4.09	120
11	2023	1.93	0.6	3.73	118	4.09	130
12	2024	1.93	0.7	3.73	128	4.09	140
13	2025	1.93	0.7	3.73	138	4.09	151
14	2026	1.93	0.8	3.73	149	4.09	163
15	2027	1.93	0.8	3.73	161	4.09	176
16	2028	1.93	0.9	3.73	174	4.09	190
17	2029	1.93	0.9	3.73	174	4.09	190
18	2030	1.93	0.9	3.73	174	4.09	190
19	2031	1.93	0.9	3.73	174	4.09	190
20	2032	1.93	0.9	3.73	174	4.09	190
21	2033	1.93	0.9	3.73	174	4.09	190
22	2034	1.93	0.9	3.73	174	4.09	190
23	2035	1.93	0.9	3.73	174	4.09	190
24	2036	1.93	0.9	3.73	174	4.09	190
25	2037	1.93	0.9	3.73	174	4.09	190
26	2038	1.93	0.9	3.73	174	4.09	190
27	2039	1.93	0.9	3.73	174	4.09	190
28	2040	1.93	0.9	3.73	174	4.09	190
29	2041	1.93	0.9	3.73	174	4.09	190
30	2042	1.93	0.9	3.73	174	4.09	190

Tariff & Purchase Price

Year	Tariff (cent/kWh)	Purcahce Price (cent/kWh)
2009	3.41	2.16
2013	3.93	2.49
2014	4.10	2.60
2015	4.27	2.70
2016	4.44	2.81
2017	4.61	2.92
2018	4.61	2.92
2019	4.61	2.92
2020	4.61	2.92
2021	4.61	2.92
2022	4.61	2.92
2023	4.61	2.92
2024	4.61	2.92
2025	4.61	2.92
2026	4.61	2.92
2027	4.61	2.92
2028	4.61	2.92
2029	4.61	2.92
2030	4.61	2.92
2031	4.61	2.92
2032	4.61	2.92
2033	4.61	2.92
2034	4.61	2.92
2035	4.61	2.92
2036	4.61	2.92
2037	4.61	2.92
2038	4.61	2.92
2039	4.61	2.92
2040	4.61	2.92
2041	4.61	2.92
2042	4.61	2.92

Financial Analysis

Financial Analysis for the Project in AEDC

Project

Target Area	West Alex, AEDC			
Project Life	2 years construction + 30 years operation			
Averaged Tariff	0.188 LE/ kWh	=	3.415	US cent/kWh
Averaged Purchase Price	0.119 LE/kWh	=	2.164	US cent/kWh
Exchange Rate	0.182 US$/LE	=	5.5	LE/US$

Financial Cost

Financial Cost	121.6 million US$	
Spare Parts (every 5 years)	3.6 million US$	(3 % of the above)
Replacement of RTU in 20th year	15.0 million US$	

FIRR 5.9%

Unit: Million US$

No.	Year	Activities	Cost (C) Construction	O&M	Total Cost (1)	Benefit (B) Reduction of Outage Duration	Reduction of Losses	Total Benefit (2)	B-C Net (2)-(1)
1	2011	Construction period	60.8		60.8			-	(60.8)
2	2012		60.8		60.8			-	(60.8)
1	2013	Operation period		1.5	1.5	0.004	4.5	4.5	3.0
2	2014			1.5	1.5	0.005	5.1	5.1	3.6
3	2015			1.5	1.5	0.005	5.7	5.7	4.2
4	2016			1.5	1.5	0.006	6.4	6.4	4.9
5	2017			5.1	5.1	0.006	7.2	7.2	2.1
6	2018			1.5	1.5	0.007	7.8	7.8	6.3
7	2019			1.5	1.5	0.007	8.4	8.4	6.9
8	2020			1.5	1.5	0.008	9.1	9.1	7.6
9	2021			1.5	1.5	0.009	9.8	9.8	8.3
10	2022			5.1	5.1	0.009	10.6	10.6	5.5
11	2023			1.5	1.5	0.010	11.4	11.4	10.0
12	2024			1.5	1.5	0.011	12.3	12.3	10.9
13	2025			1.5	1.5	0.012	13.3	13.3	11.9
14	2026			1.5	1.5	0.013	14.4	14.4	12.9
15	2027			5.1	5.1	0.014	15.5	15.5	10.4
16	2028			1.5	1.5	0.015	16.8	16.8	15.3
17	2029			-	-	0.015	16.8	16.8	16.8
18	2030			-	-	0.015	16.8	16.8	16.8
19	2031			-	-	0.015	16.8	16.8	16.8
20	2032			18.6	18.6	0.015	16.8	16.8	(1.9)
21	2033			-	-	0.015	16.8	16.8	16.8
22	2034			-	-	0.015	16.8	16.8	16.8
23	2035			-	-	0.015	16.8	16.8	16.8
24	2036			-	-	0.015	16.8	16.8	16.8
25	2037			3.6	3.6	0.015	16.8	16.8	13.1
26	2038			-	-	0.015	16.8	16.8	16.8
27	2039			-	-	0.015	16.8	16.8	16.8
28	2040			-	-	0.015	16.8	16.8	16.8
29	2041			-	-	0.015	16.8	16.8	16.8
30	2042			-	-	0.015	16.8	16.8	16.8
Total			121.6	56.8	178.4	0.351	393.1	393.4	215.0

Economic Analysis

Economic Analysis for the Project in AEDC

Project

Target Area	West Alex, AEDC		
Project Life	2 years construction + 30 years operation		
Averaged Tariff	0.188 LE/ kWh	=	3.415 US cent/kWh
Averaged Purchase Price	0.119 LE/kWh	=	2.164 US cent/kWh
Exchange Rate	0.182 US$/LE	=	5.5 LE/US$
Cost of alternative thermal plant (Gas)			6.95 US cent/kWh
Un-Served Energy value			2000 $/MWh

Economic Cost

Economic Cost	111.5 million US$	
Spare Parts (every 5 years)	3.3 million US$	(3 % of the above)
Replacement of RTU in 20th year	15.0 million US$	

EIRR	**9.3%** %	
NPV	**-8.1** million US$	(at 10% Discount Rate)
B/C	**0.9**	(at 10% Discount Rate)

Unit: Million US$

No.	Year	Activities	Cost (C) Construction	O&M	Total Cost (1)	Benefit (B) Reduction of Outage Duration	Reduction of Losses	Total Benefit (2)	Net (2)-(1)
1	2011	Construction Period	55.8		55.8			-	(55.8)
2	2012		55.8		55.8			-	(55.8)
1	2013	Operation		1.5	1.5	0.6	6.2	6.7	5.2
2	2014			1.5	1.5	0.6	6.8	7.4	5.9
3	2015			1.5	1.5	0.7	7.4	8.1	6.6
4	2016			1.5	1.5	0.7	8.1	8.8	7.4
5	2017			4.8	4.8	0.8	8.9	9.7	4.9
6	2018			1.5	1.5	0.8	9.7	10.5	9.0
7	2019			1.5	1.5	0.9	10.4	11.3	9.8
8	2020			1.5	1.5	1.0	11.3	12.2	10.7
9	2021			1.5	1.5	1.0	12.2	13.2	11.7
10	2022			4.8	4.8	1.1	13.1	14.2	9.4
11	2023			1.5	1.5	1.2	14.2	15.4	13.9
12	2024			1.5	1.5	1.3	15.3	16.6	15.1
13	2025			1.5	1.5	1.4	16.5	17.9	16.5
14	2026			1.5	1.5	1.5	17.9	19.4	17.9
15	2027			4.8	4.8	1.6	19.3	20.9	16.1
16	2028			1.5	1.5	1.8	20.8	22.6	21.1
17	2029			-	-	1.8	20.8	22.6	22.6
18	2030			-	-	1.8	20.8	22.6	22.6
19	2031			-	-	1.8	20.8	22.6	22.6
20	2032			18.3	18.3	1.8	20.8	22.6	4.3
21	2033			-	-	1.8	20.8	22.6	22.6
22	2034			-	-	1.8	20.8	22.6	22.6
23	2035			-	-	1.8	20.8	22.6	22.6
24	2036			-	-	1.8	20.8	22.6	22.6
25	2037			3.3	3.3	1.8	20.8	22.6	19.3
26	2038			-	-	1.8	20.8	22.6	22.6
27	2039			-	-	1.8	20.8	22.6	22.6
28	2040			-	-	1.8	20.8	22.6	22.6
29	2041			-	-	1.8	20.8	22.6	22.6
30	2042			-	-	1.8	20.8	22.6	22.6
Total			111.5	55.3	166.8	41.8	489.8	531.6	364.8
				NPV (at 10% Discount Rate)	112.2			104.1	(8.1)

(1) Cost Data of Alternative Thermals

Items	unit	Description	Remark
1	Fuel cost	7.00 $/MMBTU	
2	Thermal efficiency	40%	
3	Calorific value	8.530E+03 (BTU/kWh)	

(2) Computation of Adjustment Coefficients for Losses:

Items		Description	Remark
1	Total System Losses	14.1%	Assumed
2	Overall operation efficier	85.9%	

(3) Computation of reduced fuel cost

Items		Description	Remark
1	Fuel cost per kWh	0.060 $/kWh	
2	Adjustment factor	1.16	
3	Cost per kWh (after adju	6.95 C/kWh	

Appendix 4:

Appendix 4.3-2 Calculation Sheets for North Dakhalia, NDEDC

Appendix 4.3-2 Calculation Sheets for North Dakhalia, NDEDC

North Dakhalia

Sales Energy forecast in the project area up to the commissioning year

No.	Year	Electricity Consumption (GWh)	Loss Rate	Sales Energy (GWh)	Growth Rate	Note
1	2008/2009	1,986	12.00%	1,748	-	
2	2009/2010	-	-	1,847	5.7%	
3	2010/2011	-	-	1,953	5.7%	
4	2011/2012	-	-	2,064	5.7%	
5	2012/2013	-	-	2,182	5.7%	
1	2013/2014	-	-	2,306	5.7%	

Benefit by the Project

No.	Year	*Reduction of Outage Duration*		*Reduction of Technical loss*		*Reduction of Non-Technical loss*	
		Reduced Duration (hour)	*Benefit (GWh)*	*Reduced Value (%)*	*Benefit (GWh)*	*Reduced Value (%)*	*Benefit (GWh)*
1	2013	-	-	1.95	51	4.03	106
2	2014	-	-	1.95	51	4.03	106
3	2015	-	-	1.95	51	4.03	106
4	2016	-	-	1.95	51	4.03	106
5	2017	-	-	1.95	51	4.03	106
6	2018	-	-	1.95	51	4.03	106
7	2019	-	-	1.95	51	4.03	106
8	2020	-	-	1.95	51	4.03	106
9	2021	-	-	1.95	51	4.03	106
10	2022	-	-	1.95	51	4.03	106
11	2023	-	-	1.95	51	4.03	106
12	2024	-	-	1.95	51	4.03	106
13	2025	-	-	1.95	51	4.03	106
14	2026	-	-	1.95	51	4.03	106
15	2027	-	-	1.95	51	4.03	106
16	2028	-	-	1.95	51	4.03	106
17	2029	-	-	1.95	51	4.03	106
18	2030	-	-	1.95	51	4.03	106
19	2031	-	-	1.95	51	4.03	106
20	2032	-	-	1.95	51	4.03	106
21	2033	-	-	1.95	51	4.03	106
22	2034	-	-	1.95	51	4.03	106
23	2035	-	-	1.95	51	4.03	106
24	2036	-	-	1.95	51	4.03	106
25	2037	-	-	1.95	51	4.03	106
26	2038	-	-	1.95	51	4.03	106
27	2039	-	-	1.95	51	4.03	106
28	2040	-	-	1.95	51	4.03	106
29	2041	-	-	1.95	51	4.03	106
30	2042	-	-	1.95	51	4.03	106

Tariff & Purchase Price

Year	Tariff (cent/kWh)	Purcahce Price (cent/kWh)
2009	3.71	2.65
2013	4.27	3.05
2014	4.45	3.19
2015	4.64	3.32
2016	4.82	3.45
2017	5.01	3.58
2018	5.01	3.58
2019	5.01	3.58
2020	5.01	3.58
2021	5.01	3.58
2022	5.01	3.58
2023	5.01	3.58
2024	5.01	3.58
2025	5.01	3.58
2026	5.01	3.58
2027	5.01	3.58
2028	5.01	3.58
2029	5.01	3.58
2030	5.01	3.58
2031	5.01	3.58
2032	5.01	3.58
2033	5.01	3.58
2034	5.01	3.58
2035	5.01	3.58
2036	5.01	3.58
2037	5.01	3.58
2038	5.01	3.58
2039	5.01	3.58
2040	5.01	3.58
2041	5.01	3.58
2042	5.01	3.58

Financial Analysis

Financial Analysis for the Project in the NDEDC

Project

Target Area	North Dakhalia, NDEDC	
Project Life	*2 years construction + 30 years operation*	
Averaged Tariff	0.204 LE/ kWh	= 3.709 US cent/kWh
Averaged Purchase Price	0.146 LE/kWh	= 2.655 US cent/kWh
Exchange Rate	0.182 US$/LE	= 5.5 LE/US$

Financial Cost

Financial Cost	127.5 million US$	
Spare Parts (every 5 years)	3.8 million US$	(3 % of the above)

FIRR **3.5%**

Unit: Million US$

No.	Year	Activities	Cost (C)			Benefit (B)			B-C
			Construction	O&M	Total Cost (1)	Reduction of Outage Duration	Reduction of Losses	Total Benefit (2)	Net (2)-(1)
1	2011	Construction period	63.7		63.7			-	(63.7)
2	2012		63.7		63.7			-	(63.7)
1	2013	Operation period		-	-	-	6.7	6.7	6.7
2	2014			-	-	-	7.0	7.0	7.0
3	2015			-	-	-	7.3	7.3	7.3
4	2016			-	-	-	7.6	7.6	7.6
5	2017			3.8	3.8	-	7.8	7.8	4.0
6	2018			-	-	-	7.8	7.8	7.8
7	2019			-	-	-	7.8	7.8	7.8
8	2020			-	-	-	7.8	7.8	7.8
9	2021			-	-	-	7.8	7.8	7.8
10	2022			3.8	3.8	-	7.8	7.8	4.0
11	2023			-	-	-	7.8	7.8	7.8
12	2024			-	-	-	7.8	7.8	7.8
13	2025			-	-	-	7.8	7.8	7.8
14	2026			-	-	-	7.8	7.8	7.8
15	2027			3.8	3.8	-	7.8	7.8	4.0
16	2028			-	-	-	7.8	7.8	7.8
17	2029			-	-	-	7.8	7.8	7.8
18	2030			-	-	-	7.8	7.8	7.8
19	2031			-	-	-	7.8	7.8	7.8
20	2032			3.8	3.8	-	7.8	7.8	4.0
21	2033			-	-	-	7.8	7.8	7.8
22	2034			-	-	-	7.8	7.8	7.8
23	2035			-	-	-	7.8	7.8	7.8
24	2036			-	-	-	7.8	7.8	7.8
25	2037			3.8	3.8	-	7.8	7.8	4.0
26	2038			-	-	-	7.8	7.8	7.8
27	2039			-	-	-	7.8	7.8	7.8
28	2040			-	-	-	7.8	7.8	7.8
29	2041			-	-	-	7.8	7.8	7.8
30	2042			-	-	-	7.8	7.8	7.8
Total			127.5	19.1	146.6	-	232.4	232.4	85.8

Economic Analysis

Economic Analysis for the Project in the NDEDC

Project

Target Area	North Dakhalia, NDEDC	
Project Life	2 years construction + 30 years operation	
Averaged Tariff	0.204 LE/ kWh	= 3.709 US cent/kWh
Averaged Purchase Price	0.146 LE/kWh	= 2.655 US cent/kWh
Exchange Rate	0.182 US$/LE	= 5.5 LE/US$
Cost of alternative thermal plant (Gas)		6.95 US cent/kWh
Un-Served Energy value		2000 $/MWh

Economic Cost

Economic Cost	116.9 million US$	
Spare Parts (every 5 years)	3.5 million US$	(3 % of the above)
Replacement of RTU in 20th year	million US$	

EIRR 5.4% %

NPV -38.3 million US$ (at 10% Discount Rate)

B/C 0.6 (at 10% Discount Rate)

Unit: Million US$

No.	Year	Activities	Cost (C) Construction	O&M	Total Cost (1)	Benefit (B) Reduction of Outage Duration	Reduction of Losses	Total Benefit (2)	Net (2)-(1)
1	2011	Construction Period	58.5		58.5			-	(58.5)
2	2012		58.5		58.5			-	(58.5)
1	2013	Operation		-	-	-	8.1	8.1	8.1
2	2014			-	-	-	8.2	8.2	8.2
3	2015			-	-	-	8.4	8.4	8.4
4	2016			-	-	-	8.6	8.6	8.6
5	2017			3.5	3.5	-	8.8	8.8	5.3
6	2018			-	-	-	8.8	8.8	8.8
7	2019			-	-	-	8.8	8.8	8.8
8	2020			-	-	-	8.8	8.8	8.8
9	2021			-	-	-	8.8	8.8	8.8
10	2022			3.5	3.5	-	8.8	8.8	5.3
11	2023			-	-	-	8.8	8.8	8.8
12	2024			-	-	-	8.8	8.8	8.8
13	2025			-	-	-	8.8	8.8	8.8
14	2026			-	-	-	8.8	8.8	8.8
15	2027			3.5	3.5	-	8.8	8.8	5.3
16	2028			-	-	-	8.8	8.8	8.8
17	2029			-	-	-	8.8	8.8	8.8
18	2030			-	-	-	8.8	8.8	8.8
19	2031			-	-	-	8.8	8.8	8.8
20	2032			3.5	3.5	-	8.8	8.8	5.3
21	2033			-	-	-	8.8	8.8	8.8
22	2034			-	-	-	8.8	8.8	8.8
23	2035			-	-	-	8.8	8.8	8.8
24	2036			-	-	-	8.8	8.8	8.8
25	2037			3.5	3.5	-	8.8	8.8	5.3
26	2038			-	-	-	8.8	8.8	8.8
27	2039			-	-	-	8.8	8.8	8.8
28	2040			-	-	-	8.8	8.8	8.8
29	2041			-	-	-	8.8	8.8	8.8
30	2042			-	-	-	8.8	8.8	8.8
Total			116.9	17.5	134.5	-	263.1	263.1	128.7
				NPV (at 10% Discount Rate)	105.8			67.5	(38.3)

Appendix 4:

Appendix 4.3-3 Calculation Sheets for El Helmya, NCEDC

Appendix 4.3-3 Calculation Sheets for Helmya, NCEDC

Helmya

Sales Energy forecast in the project area up to the commissioning year

No.	Year	Electricity Consumption (GWh)	Loss Rate	Sales Energy (GWh)	Growth Rate	Note
1	2008/2009	4,538	17.80%	3,730	-	
2	2009/2010			3,851	3.25%	
3	2010/2011	-	-	3,977	3.25%	
4	2011/2012	-	-	4,106	3.25%	
5	2012/2013	-	-	4,239	3.25%	
1	2013/2014	-	-	4,377	3.25%	

Benefit by the Project

No.	Year	*Reduction of Outage Duration*		*Reduction of Technical loss*		*Reduction of Non-Technical loss*	
		Reduced Duration (hour)	*Benefit (GWh)*	*Reduced Value (%)*	*Benefit (GWh)*	*Reduced Value (%)*	*Benefit (GWh)*
1	2013	6.12	3.1	5.30	282	2.13	113
2	2014	6.12	3.1	5.30	282	2.13	113
3	2015	6.12	3.1	5.30	282	2.13	113
4	2016	6.12	3.1	5.30	282	2.13	113
5	2017	6.12	3.1	5.30	282	2.13	113
6	2018	6.12	3.1	5.30	282	2.13	113
7	2019	6.12	3.1	5.30	282	2.13	113
8	2020	6.12	3.1	5.30	282	2.13	113
9	2021	6.12	3.1	5.30	282	2.13	113
10	2022	6.12	3.1	5.30	282	2.13	113
11	2023	6.12	3.1	5.30	282	2.13	113
12	2024	6.12	3.1	5.30	282	2.13	113
13	2025	6.12	3.1	5.30	282	2.13	113
14	2026	6.12	3.1	5.30	282	2.13	113
15	2027	6.12	3.1	5.30	282	2.13	113
16	2028	6.12	3.1	5.30	282	2.13	113
17	2029	6.12	3.1	5.30	282	2.13	113
18	2030	6.12	3.1	5.30	282	2.13	113
19	2031	6.12	3.1	5.30	282	2.13	113
20	2032	6.12	3.1	5.30	282	2.13	113
21	2033	6.12	3.1	5.30	282	2.13	113
22	2034	6.12	3.1	5.30	282	2.13	113
23	2035	6.12	3.1	5.30	282	2.13	113
24	2036	6.12	3.1	5.30	282	2.13	113
25	2037	6.12	3.1	5.30	282	2.13	113
26	2038	6.12	3.1	5.30	282	2.13	113
27	2039	6.12	3.1	5.30	282	2.13	113
28	2040	6.12	3.1	5.30	282	2.13	113
29	2041	6.12	3.1	5.30	282	2.13	113
30	2042	6.12	3.1	5.30	282	2.13	113

Tariff & Purchase Price

Year	Tariff (cent/kWh)	Purcahce Price (cent/kWh)
2009	3.64	2.71
2013	4.18	3.12
2014	4.36	3.25
2015	4.55	3.39
2016	4.73	3.52
2017	4.91	3.66
2018	4.91	3.66
2019	4.91	3.66
2020	4.91	3.66
2021	4.91	3.66
2022	4.91	3.66
2023	4.91	3.66
2024	4.91	3.66
2025	4.91	3.66
2026	4.91	3.66
2027	4.91	3.66
2028	4.91	3.66
2029	4.91	3.66
2030	4.91	3.66
2031	4.91	3.66
2032	4.91	3.66
2033	4.91	3.66
2034	4.91	3.66
2035	4.91	3.66
2036	4.91	3.66
2037	4.91	3.66
2038	4.91	3.66
2039	4.91	3.66
2040	4.91	3.66
2041	4.91	3.66
2042	4.91	3.66

Financial Analysis

Financial Analysis for the Project in NCEDC

Project

Target Area	Helmya		
Project Life	*2 years construction + 30 years operation*		
Averaged Tariff	0.200 LE/ kWh	=	3.636 US cent/kWh
Averaged Purchase Price	0.149 LE/kWh	=	2.709 US cent/kWh
Exchange Rate	0.182 US$/LE	=	5.5 LE/US$

Financial Cost

Financial Cost	185.7 million US$	
Spare Parts (every 5 years)	5.6 million US$	(3 % of the above)
Replacement of RTU in 20th year	30.0 million US$	

FIRR **8.2%**

Unit: Million US$

No.	Year	Activities	Cost (C)			Benefit (B)			B-C
			Construction	O&M	Total Cost (1)	Reduction of Outage *Duration*	Reduction of Losses	Total Benefit (2)	Net (2)-(1)
1	2011	Construction period	92.8		92.8			-	(92.8)
2	2012		92.8		92.8			-	(92.8)
1	2013	Operation period		-	-	0.03	16.5	16.6	16.6
2	2014			-	-	0.03	17.3	17.3	17.3
3	2015			-	-	0.04	18.0	18.0	18.0
4	2016			-	-	0.04	18.7	18.7	18.7
5	2017			5.6	5.6	0.04	19.4	19.5	13.9
6	2018			-	-	0.04	19.4	19.5	19.5
7	2019			-	-	0.04	19.4	19.5	19.5
8	2020			-	-	0.04	19.4	19.5	19.5
9	2021			-	-	0.04	19.4	19.5	19.5
10	2022			5.6	5.6	0.04	19.4	19.5	13.9
11	2023			-	-	0.04	19.4	19.5	19.5
12	2024			-	-	0.04	19.4	19.5	19.5
13	2025			-	-	0.04	19.4	19.5	19.5
14	2026			-	-	0.04	19.4	19.5	19.5
15	2027			5.6	5.6	0.04	19.4	19.5	13.9
16	2028			-	-	0.04	19.4	19.5	19.5
17	2029			-	-	0.04	19.4	19.5	19.5
18	2030			-	-	0.04	19.4	19.5	19.5
19	2031			-	-	0.04	19.4	19.5	19.5
20	2032			35.6	35.6	0.04	19.4	19.5	(16.1)
21	2033			-	-	0.04	19.4	19.5	19.5
22	2034			-	-	0.04	19.4	19.5	19.5
23	2035			-	-	0.04	19.4	19.5	19.5
24	2036			-	-	0.04	19.4	19.5	19.5
25	2037			5.6	5.6	0.04	19.4	19.5	13.9
26	2038			-	-	0.04	19.4	19.5	19.5
27	2039			-	-	0.04	19.4	19.5	19.5
28	2040			-	-	0.04	19.4	19.5	19.5
29	2041			-	-	0.04	19.4	19.5	19.5
30	2042			-	-	0.04	19.4	19.5	19.5
Total			185.7	57.9	243.5	1.134	575.171	576.3	332.8

Economic Analysis

Economic Analysis for the Project in NCEDC

Project

Target Area	Helmya			
Project Life	2 years construction + 30 years operation			
Averaged Tariff in 2009	0.200	LE/ kWh	=	3.636 US cent/kWh
Averaged Purchase Price in 2009	0.149	LE/kWh	=	2.709 US cent/kWh
Exchange Rate	0.182	US$/LE	=	5.5 LE/US$
Cost of alternative thermal plant (Gas)			6.95	US cent/kWh
Un-Served Energy value			2000	$/MWh

Economic Cost

Economic Cost	170.3	million US$	
Spare Parts (every 5 years)	5.1	million US$	(3 % of the above)
Replacement of RTU in 20th year	30.0	million US$	

EIRR 16.1% %
NPV 84.6 million US$ (at 10% Discount Rate)
B/C 1.5 (at 10% Discount Rate)

Unit: Million US$

No.	Year	Activities	Cost (C)			Benefit (B)			
			Construction	O&M	Total Cost (1)	Reduction of Outage Duration	Reduction of Losses	Total Benefit (2)	Net (2)-(1)
1	2011	Construction Period	85.2		85.2			-	(85.2)
2	2012		85.2		85.2			-	(85.2)
1	2013	Operation		-	-	6.1	24.3	30.5	30.5
2	2014			-	-	6.1	24.6	30.7	30.7
3	2015			-	-	6.1	24.8	30.9	30.9
4	2016			-	-	6.1	25.0	31.1	31.1
5	2017			5.1	5.1	6.1	25.2	31.3	26.2
6	2018			-	-	6.1	25.2	31.3	31.3
7	2019			-	-	6.1	25.2	31.3	31.3
8	2020			-	-	6.1	25.2	31.3	31.3
9	2021			-	-	6.1	25.2	31.3	31.3
10	2022			5.1	5.1	6.1	25.2	31.3	26.2
11	2023			-	-	6.1	25.2	31.3	31.3
12	2024			-	-	6.1	25.2	31.3	31.3
13	2025			-	-	6.1	25.2	31.3	31.3
14	2026			-	-	6.1	25.2	31.3	31.3
15	2027			5.1	5.1	6.1	25.2	31.3	26.2
16	2028			-	-	6.1	25.2	31.3	31.3
17	2029			-	-	6.1	25.2	31.3	31.3
18	2030			-	-	6.1	25.2	31.3	31.3
19	2031			-	-	6.1	25.2	31.3	31.3
20	2032			35.1	35.1	6.1	25.2	31.3	(3.8)
21	2033			-	-	6.1	25.2	31.3	31.3
22	2034			-	-	6.1	25.2	31.3	31.3
23	2035			-	-	6.1	25.2	31.3	31.3
24	2036			-	-	6.1	25.2	31.3	31.3
25	2037			5.1	5.1	6.1	25.2	31.3	26.2
26	2038			-	-	6.1	25.2	31.3	31.3
27	2039			-	-	6.1	25.2	31.3	31.3
28	2040			-	-	6.1	25.2	31.3	31.3
29	2041			-	-	6.1	25.2	31.3	31.3
30	2042			-	-	6.1	25.2	31.3	31.3
Total			170.3	55.5	225.8	183.4	753.1	936.5	710.7
				NPV	157.7			242.3	84.6

(at 10% Discount Rate)

Appendix 5:

Appendix 5.1 Inception Presentation PP

JICA Project Formation for Energy Efficiency of Power Supply in Egypt

Outline of Working Plan

1. *Background*
2. *Purpose*
3. *Terms of Reference*
4. *Approach & Methodology*
5. *Team members*
6. *Schedule*
7. *Requirement*

Japan International Cooperation Agency (JICA)
Tokyo Electric Power Services Co., Ltd. (TEPSCO)

1. Background

Background

- Energy consumption in Egypt has increased 7.1% /year since 1996.
- Generators including renewable energy and nuclear will be constructed.
- In parallel, improvement of energy efficiency is expected
  - to reduce supply-demand gap of power
  - to reduce growth of emission of GHG
- Support using Japanese ODA Loan is desired for the energy efficiency of generation / transmission / distribution / demand management.
- Improvement in energy efficiency and reliability of power contributes to economic development in Egypt.

2

2. Purpose

Purpose

Future candidate projects by Japanese ODA Loan in energy efficiency of Egypt Power Sector will be proposed and formulated.

< For Example >

- Rehabilitation of old power station / Construction of high-efficiency power station
- Distribution Automation System (DAS) with Demand Side Management (DSM) and Automatic Meter reading (AMR)
- Conversion to high-voltage system and augmentation for transmission / Distribution system
- Application of new battery

3

Terms of Reference (TOR1)

TOR1: To confirm the current effort to improvement in energy efficiency for power sector in Egypt

1. Outline of Power Sector
   - Electrical Power Demand (Forecast and supply-demand balance)
   - National Development Strategy
   - 6th five year plan
   - Power Sector Reform
2. Current Energy Consumption in Egypt
3. Plan and activity of Egypt regarding improvement of energy efficiency in Power Sector
4. Plan and activity of other donors regarding energy efficiency projects in Power Sector

4

Terms of Reference (TOR2)

TOR2: To confirm potential of improvement in energy efficiency of power sector in Egypt and propose the candidates of Japanese ODA loan project

1. Confirmation of Potential / Problem / Countermeasure regarding improvement of energy efficiency in Power Generation / Transmission / Distribution / Demand Management
2. Long List of candidate projects regarding improvement in energy efficiency
   - Power Generation/Transmission/Distribution/Demand Management
3. Propose the candidates of Japanese ODA loan project.

5

Terms of Reference (Long List)

Sector	Sub-sector	Expected Project
Power Generation	Energy Efficiency of Generation	-Rehabilitation of old power generation -High-Efficiency Power Station
Transmission	Transmission Loss	-High Voltage -Augmentation
Distribution	Distribution Loss	-New construction of Substation and MV feeder -Distribution Automation System (DAS) -Low loss transformer -New Battery
	Reliability	-DAS -Upgrade Feeder Structure(Loop, Section SW)
Demand Side	Peak Cut / Shift	-DAS + DSM -New Battery
	Energy Efficiency	-AMR -DSM

6

Terms of Reference (TOR3)

TOR3: Model project in power distribution based on Japanese ODA loan

1. *To perform the preliminary feasibility study*
   - Outline of Distribution Power Company for model project
   - Analyze the current condition and activities for energy efficiency
   - Scope of model project :
     (System configuration / Project size / Schedule / Packaging / Tariff / Capacity Development etc)
   - System and Technical comparison
     (Communication / Fault detecting procedure / new battery)
   - Calculation of project cost
   - Economical Evaluation (Project benefit, IRR etc)
   - Issue for Social and Environmental problems

7

Terms of Reference (TOR4)

TOR4: Workshop to accelerate the project based on this project formulation

1. Workshop will be held during 3rd Investigation after the preparation of Draft Final Report.
2. **Invite the related persons.**

8

Approach & Methodology for TOR1

Items	Methodology
1. Progress and current situation of energy efficiency in power *sector* 2. Current energy consumption 3. Plan and activity of Energy Efficiency in Egypt 4. Plan and activity of Energy efficiency by other donors	**1. Review of the latest documents and the project proposal** **2. Data collection and interview based on our questionnaire** **3. Visit and interview on Generation, Transmission, Distribution, Demand Management and Energy efficiency project** **4. Literature survey and review** **5. Review of existing plans**

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Approach & Methodology for TOR2

Items	Methodology
1. Confirmation of Potential / Problems / Countermeasure in *energy efficiency* •Power generation •Transmission • Distribution •Demand Management 2. Long List of the candidate projects in power sector 3. Propose Japanese ODA loan projects	**1. Survey and Discuss with the related institution such as EEHC, *EETC, Distribution Companies* etc** **2. Review of other existing plans** **3. Data collection and interview based on our questionnaire** **4. Literature survey and site survey** **5. Review and Discuss about criteria, so that the ODA projects will be recommended.**

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Approach & Methodology for TOR3

Items	Methodology
1 Model Project - Outline of Distribution Company - Analyze the current condition and activities - Project scope - Project Cost - Procurement packages - Implementation schedule - Economical Evaluation (Effect and IRR) 2. Capacity Development 3 Environmental and social consideration	**1. Data collection, interview and survey for the following data and information:** • Survey of existing distribution network and facilities •data correction for SAIDI, loss, Supply power, Demand, power factor, etc • Survey of construction / installation cost • Operation / Maintenance organization and the cost • Discussion for scope, packaging, schedule, etc • Data collection required for IRR calculation and environmental / social consideration **2. Data collection and survey for load** • Survey for daily load •Survey and Estimate the type of load in peak demand

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Specific points for environmental and social consideration (TOR 3)

- Institutional aspects in terms of environmental and social consideration (e.g. relevant laws and agencies)
- Environmental and social considerations in the project site (e.g. socio-economic statistics
- Environmental review using JICA environmental checklist (e.g. permits to fell trees, relocation, etc.)

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Approach & Methodology for TOR4

Items		Methodology
Workshop to accelerate the project based on this study 1. Workshop will be held during 3rd Investigation. 2. Invite the related persons. 3. Study the possibility of expansion for the model project which means show-window.	⇨	**1. Prepare the Draft final report and explain the summarized power point documents** **2. Interview to confirm expectation to Japanese assistance** **3. Discuss and Confirm problems to proceed the model project based on Japanese ODA loan** **4. Interview and Study possibility of expansion for the model project**

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Team Members

Team Leader/ Distribution Specialist:	A. Fujisawa
Power planning and generation Specialist:	H. Shinohara
Power Distribution Specialist:	K. Kuwahara
Energy Efficiency Specialist for Demand Side:	K. Akakura
Transmission and Substation Specialist:	H. Tujita
Power system planning and analysis Specialist:	M. Kittaka
Environmental and social Specialist:	A. Urago
Economy and Management Specialist:	K. Takasawa

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Schedule

1. First Mission: July 14 – August 11
   - *Collection and interviewing for required data and information, and site visits*
2. Submission Interim Report: End of September
3. Second Mission: Middle of October (3 weeks)
   - *Follow up Interim Report*
4. Submission Draft Final Report: Middle of December
5. Third Mission : Middle of December (1 week)
   - *Follow up Draft Final Report and hold Workshop*
6. Submission of Final Report :End of January

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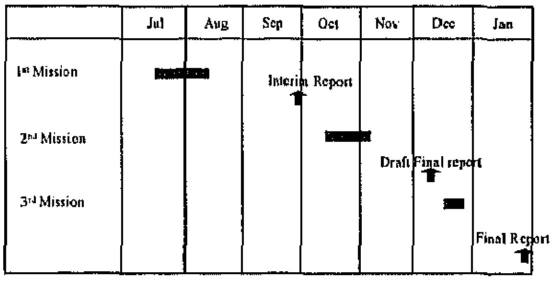
Schedule



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Detailed Schedule for 1st mission

Date	Team Leader A. Fujisawa	Power planning / Generation H. Shinohara	Distribution K. Kuwahara	Transmission H. Tujita	Power System M. Kittaka	Demand Management K. Akakura
7/20 Mon	Move to Alexandria Meeting with Alexandria					
21 Tue	Site survey and meeting in Alexandria					
22 Wed	Wrap up meeting in Alexandria					
23 Thu	Preliminary day in Alexandria					
25 Sat	Site survey and meeting in North Delta					
27 Mon	Site survey and meeting in Cairo North					
28 Tue	Follow up for pending in North Delta					
29 Wed	Follow up for pending in Cairo North					Follow up for pending in Cairo North
30 Thu	Meeting with NREA					Meeting with NREA

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For Official Use Only

Detailed Schedule for 1st mission

Date	Team Leader A. Fujisawa	Power planning / Generation H. Shinohara	Distribution K. Kuwahara	Transmission H. Tujita	Power System M. Kittaka	Demand Management K. Akakura
8/2 Sun	Meeting with Donor					
3 Mon	Meeting with Donor					
4 Tue	Meeting with Distribution Company					
5 Wed	Meeting with EEHC					
6 Thu	AM Wrap up Meeting					
9 Sun	Follow up for pending Report to JICA					
10 Mon	Leave for Japan					
11 Tue	Arrive at Narita					

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Undertaking for the Expert Team of project formulation by Egyptian side

< EEHC >

1. To arrange counterpart of EEHC for JICA expert team
2. To arrange counterparts for the following project formulation
   1) Power Generation Plan
   2) Transmission Development Plan
   3) Distribution Development Plan
   4) Demand Side Development Plan
3. To answer questionnaires and provide material/data/information required by the Expert team

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Undertaking for the Expert Team by Egyptian side

< Distribution Company >

1. To arrange counterparts of each distribution Company
2. To support the site survey schedule in Distribution Company
3. To answer questionnaires and provide material / data / information required by the Expert team
4. To accompany the Expert team to the site visit in model area if possible.

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The End

Thank you for your attention

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Appendix 5:

Appendix 5.2 Interim report and Wrap up PP

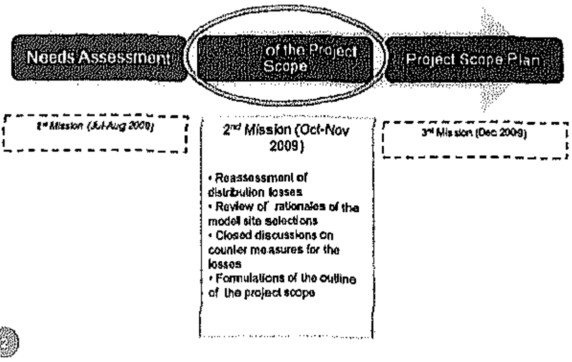
Wrap up meeting:
Energy Efficiency Projects for Egyptian Electricity Distribution Companies

Nov, 2009

Tokyo Electric Power Services Co., Ltd. (TEPSCO)
JICA Project Formulation Expert Team

1

Where are we now ?



2

Aim of Today's Presentation

- JICA project formation team visited 3 distribution companies (AEDC, NDEDC, CNEDC) during 2nd mission and intensively discussed with them.
- As a result, we could more clearly grasp distribution losses and rationale of selection of the pilot areas in each distribution company.
- Here, we are reporting the result of such examinations and, based on them, we are proposing a couple of options of the project scope.
- We would like to get your observations on such options. Based on them, we will finalize our team's recommendations on the project scope for the Egyptian government, JICA and the Japanese government.

3

1. Alexandria Electricity Distribution Company (AEDC)

4

1. Alexandria Electricity Distribution Company (AEDC)

1) Rationale of the Pilot Area Selection

	Montaza	East Alex	Central Alex	West Alex	El Sahel	Total
Technical loss	8.14	7.97	8.05	8.38	7.97	8.15
Non-technical loss	5.27	5.32	5.49	5.38	5.23	5.39
Total	13.20	13.16	13.54	13.76	13.20	13.54

<Why West Alex?>
- ◆The highest technical loss
- ◆ Potentials of loss reduction(longest distribution lines and several overloaded DTs)
- ◆ Importance of the area (Industrial zone and growing new residences)

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1. Alexandria Electricity Distribution Company (AEDC)

2) Breakdown of Distribution loss in West Alex

	Location of loss occurrence	West Alex in AEDC
Technical loss	11kV feeder	0.32%
	11kV DT	5.36%
	LV line	2.19%
	Meter	*0.51%*
	Sub Total	8.38%
Non-Technical loss	Meter problem theft	5.38%
	Total	13.76%

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1. Alexandria Electricity Distribution Company (AEDC)

3) Counter Measures: Option 1 [Full Option]

	Location	Loss Rate (a)	Item	Investment (b)(MUS$)	Loss Reduction (c)	Investment Efficiency (a)x(c)/(b)
Technical Loss	11kV feeder	0.32	New construction of 11kV feeder	56	Δ34%	0.19
			Capacitor	6	Δ16%	0.86
			Improvement of Load unbalance	18	Δ4%	0.07
	11kV DT	5.36	Low loss and large capacity DT	21	Δ50%	12.8
	LV line	2.19	Improvement of phase unbalance	21	Δ30%	6.9
	Meter (WHM)	0.51	Low loss WHM for AMR	24	Δ60%	1.28
	Sub Total	8.38	-	146	~ Δ45% (3.81)	
Non- Technical Loss		5.38	AMR	(24)+2	Δ70% (3.77)	14.5
TOTAL		13.76	-	[illegible]	[illegible]	[illegible]

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1. Alexandria Electricity Distribution Company (AEDC)

4) Counter Measures: Option 2 [High Investment Efficiency Portion only]

	Location	Loss Rate (a)	Item	Investment (b)(MUS$)	Loss Reduction (c)	Investment Efficiency (a)x(c)/(b)
Technical Loss	11kV feeder	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
			[illegible]	[illegible]	[illegible]	[illegible]
			[illegible]	[illegible]	[illegible]	[illegible]
	11kV DT	5.38	Low loss and large capacity DT	21	Δ50%	12.8
	LV line	2.19	Improvement of phase unbalance	21	Δ30%	6.9
	Meter (WHM)	0.51	Low loss WHM for AMR	24	Δ60%	1.28
	Sub Total	8.38	-	66	~ Δ43% (3.64)	
Non- Technical Loss		5.38	AMR	(24)+2	Δ70% (3.77)	14.5
TOTAL		13.76	-	[illegible]	[illegible]	[illegible]

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1. Alexandria Electricity Distribution Company (AEDC)

5) Counter Measures: Option 3 [1000 unit of AMR only (Others: Same as Option 2)]

	Location	Loss Rate (a)	Item	Investment (b)(MUS$)	Loss Reduction (c)	Investment Efficiency (a)x(c)/(b)
Technical Loss	11kV feeder	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
			[illegible]	[illegible]	[illegible]	[illegible]
			[illegible]	[illegible]	[illegible]	[illegible]
	11kV DT	5.36	Low loss and large capacity DT	21	Δ50%	12.8
	LV line	2.19	Improvement of phase unbalance	21	Δ30%	6.9
	Meter (WHM)	0.51	Low loss WHM for AMR	0.12	Δ0.3%	1.28
	Sub Total	*8.38*	-	*42.12*	*~ Δ40% (3.34)*	
Non- Technical Loss		5.38	AMR	(0.12)+2	Δ0.35% (0.02)	0.94
TOTAL		13.76	-	[illegible]	[illegible]	[illegible]

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2. North Delta Electricity Distribution Company (NDEDC)

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2. North Delta Electricity Distribution Company (NDEDC)

1) Rationale of the Pilot Area Selection

	Domitta	Kafr El-Shiekh	South Dakhalia	North Dakhalia	Total
Technical loss	4.1	4.9	3.5	6.7	4.8
Non-technical loss	1.9	3.1	2.7	5.3	3.25
Total	6.0	8.0	6.2	12.0	8.05

<Why North Dakhalia?>

- ◆The highest technical loss
- ◆ Potentials of loss reduction(high ratio of OH, long distribution lines and growing demands)
- ◆ Importance of the area (the concentration of industries and commercial activities and growing new residences)

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2. North Delta Electricity Distribution Company (NDEDC)

2) Breakdown of Distribution loss in North Dakhalia

	Location of loss occurrence	North Dakhalia in NDEDC
Technical loss	11kV feeder	4.0%
	11kV DT	1.2%
	LV line	1.1%
	Meter	*0.4%*
	Sub Total	6.7%
Non-Technical loss	Meter problem theft	5.3%
Total		12.0%

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2. North Delta Electricity Distribution Company (NDEDC)

3) Counter Measures: Option 1 [Full Option]

	Location	Loss Rate (a)	Item	Investment (b)(MUS$)	Loss Reduction (c)	Investment Efficiency (a)x(c)/(b)
Technical Loss	11kV feeder	4.0	New construction of 11kV feeder	84	Δ30%	1.43
			Capacitor	6	Δ16%	10.67
			SVR for OH	7	Δ6%	3.42
			Improvement of Load unbalance	12	Δ4%	1.33
	11kV DT	1.2	Low loss DT	30	Δ30%	2.30
	LV line	1.1	Shortening LV line by small DT		Δ30%	
	Meter (WHM)	0.4	Low loss WHM for AMR	60	Δ60%	0.40
	Sub Total	6.7	-	199	~ Δ47% (3.17)	
Non- Technical Loss		5.3	AMR	(60)+2	Δ70% (3.71)	5.98
TOTAL		12.0	-	[illegible]	[illegible]	[illegible]

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2. North Delta Electricity Distribution Company (NDEDC)

4) Counter Measures: Option 2 [High Investment Efficiency Portion only]

	Location	Loss Rate (a)	Item	Investment (b)(MUS$)	Loss Reduction (c)	Investment Efficiency (a)x(c)/(b)
Technical Loss	11kV feeder	4.0	[illegible]	[illegible]	[illegible]	[illegible]
			Capacitor	6	Δ16%	10.67
			SVR for OH	7	Δ6%	3.42
			[illegible]	[illegible]	[illegible]	[illegible]
	11kV DT	1.2	Low loss DT	30	Δ30%	2.30
	LV line	1.1	Shortening LV line by small DT		Δ30%	
	Meter (WHM)	0.4	Low loss WHM for AMR	60	Δ60%	0.40
	Sub Total	6.7	-	103	~ Δ27% (1.81)	
Non- Technical Loss		5.3	AMR	(60)+2	Δ70% (3.71)	5.98
TOTAL		12.0	-	[illegible]	[illegible]	[illegible]

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2. North Delta Electricity Distribution Company (NDEDC)

5) Counter Measures: Option 3 [1000 unit of AMR only (Others: Same as Option 2)]

	Location	Loss Rate (a)	Item	Investment (b)(MUS$)	Loss Reduction (c)	Investment Efficiency (a)x(c)/(b)
Technical Loss	11kV feeder	4.0	[illegible]	[illegible]	[illegible]	[illegible]
			Capacitor	6	Δ16%	10.67
			SVR for OH	7	Δ6%	3.42
			[illegible]	[illegible]	[illegible]	[illegible]
	11kV DT	1.2	Low loss DT	30	Δ30%	2.30
	LV line	1.1	Shortening LV line by small DT		Δ30%	
	Meter (WHM)	0.4	Low loss WHM for AMR	0.12	Δ0.12%	0.40
	Sub Total	6.7	-	43.12	~ Δ24% (1.57)	
Non- Technical Loss		5.3	AMR	(0.12)+2	Δ0.14% (0.007)	0.37
TOTAL		12.0	-	[illegible]	[illegible]	[illegible]

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2. North Delta Electricity Distribution Company (NDEDC)

6) Counter Measures: Option 4 [AMR only]

	Location	Loss Rate (a)	Item	Investment (b)(MUS$)	Loss Reduction (c)	Investment Efficiency (a)x(c)/(b)
Technical Loss	11kV feeder	4.0	[illegible]	[illegible]	[illegible]	[illegible]
			[illegible]	[illegible]	[illegible]	[illegible]
			[illegible]	[illegible]	[illegible]	[illegible]
			[illegible]	[illegible]	[illegible]	[illegible]
	11kV DT	1.2	[illegible]	[illegible]	[illegible]	[illegible]
	LV line	1.1	[illegible]		[illegible]	
	Meter (WHM)	0.4	[illegible]	[illegible]	[illegible]	[illegible]
	Sub Total	6.7	[illegible]	[illegible]	[illegible]	[illegible]
Non- Technical Loss		5.3	AMR	(60)+2	Δ70% (3.71)	5.98
TOTAL		12.0	-	[illegible]	[illegible]	[illegible]

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3. Cairo North Electricity Distribution Company (CNEDC)

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3. Cairo North Electricity Distribution Company (CNEDC)

1) Rationale of the Pilot Area Selection

Sector	Heliopies	North	Helmya	East	Total
Technical loss	9.37	7.09	12.2	5.61	6.08
Non-technical loss	4.31	3.26	5.6	2.58	5.57
Total	13.7	10.4	17.8	8.19	11.65

<Why Helmya?>
◆ The highest technical loss
◆ Potentials of loss reduction(old and overloaded DTs)
◆ Importance of the area (governmental buildings, hospitals, concentration of industries, commercial activities and residences)
◆ Relatively longer outrage time

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3. Cairo North Electricity Distribution Company (CNEDC)

2) Breakdown of Distribution loss in Helmya

	Location of loss occurrence	Helmya in CNEDC
Technical loss	11kV feeder	1.8%
	11kV DT	7.2%
	LV line	2.3%
	Meter	0.9%
	Sub Total	12.2%
Non-Technical loss	Meter problem theft	5.6%
Total		17.8%

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3. Cairo North Electricity Distribution Company (CNEDC)

3) Counter Measures: Option 1 [Full Option]

	Location	Loss Rate (a)	Item	Investment (b)(MUS$)	Loss Reduction (c)	Investment Efficiency (a)x(c)/(b)
Technical Loss	11kV feeder	1.8	New construction of 11kV feeder	48	Δ30%	1.13
			Capacitor	18	Δ16%	1.60
			Improvement of Load unbalance	4	Δ4%	1.80
	11kV DT	7.2	Low loss and large capacity DT	31	Δ50%	11.6
	LV line	2.3	Improvement of phase unbalance	30	Δ30%	2.3
	Meter (WHM)	0.9	Low loss WHM for AMR	72	Δ60%	0.75
	Sub Total	12.2	-	203	~ Δ47% (6.7)	
Non- Technical Loss		5.6	AMR	(72)+2	Δ70% (3.92)	5.4
TOTAL		17.8	-	[illegible]	[illegible]	[illegible]

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3. Cairo North Electricity Distribution Company (CNEDC)

4) Counter Measures: Option 2 [High Investment Efficiency Portion only]

	Location	Loss Rate (a)	Item	Investment (b)(MUS$)	Loss Reduction (c)	Investment Efficiency (a)x(c)/(b)
Technical Loss	11kV feeder	1.8	New construction of 11kV feeder	48	Δ30%	1.13
			Capacitor	18	Δ16%	1.60
			Improvement of Load unbalance	4	Δ4%	1.80
	11kV DT	7.2	Low loss and large capacity DT	31	Δ50%	11.6
	LV line	2.3	Improvement of phase unbalance	30	Δ30%	2.3
	Meter (WHM)	0.9	Low loss WHM for AMR	72	Δ60%	0.75
	Sub Total	12.2	-	133	~ Δ40% (4.83)	
Non- Technical Loss		5.6	AMR	(72)+2	Δ70% (3.92)	5.4
TOTAL		17.8	-	[illegible]	[illegible]	[illegible]

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3. Cairo North Electricity Distribution Company (CNEDC)

5) Counter Measures: Option 3 [1000 unit of AMR only (Others: Same as Option 2)]

	Location	Loss Rate (a)	Item	Investment (b)(MUS$)	Loss Reduction (c)	Investment Efficiency (a)x(c)/(b)
Technical Loss	11kV feeder	1.8	New construction of 11kV feeder	48	Δ30%	1.13
			Capacitor	18	Δ16%	1.60
			Improvement of Load unbalance	4	Δ4%	1.80
	11kV DT	7.2	Low loss and large capacity DT	31	Δ50%	11.6
	LV line	2.3	Improvement of phase unbalance	30	Δ30%	2.3
	Meter (WHM)	0.9	Low loss WHM for AMR	0.12	Δ0.1%	0.75
	Sub Total	12.2	-	61.12	~ Δ36% (4.29)	
Non- Technical Loss		5.6	AMR	(0.12)+2	Δ0.12% (0.007)	0.34
TOTAL		17.8	-	[illegible]	[illegible]	[illegible]

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4. Summary: Proposed Options of the Project Scope Outline

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4. Proposed Option of the Project Scope Outline

1) Option 1 [Full Option]

Distribution Company	Estimated Investment* (MUS$)	Distribution Loss (Before the Project)	Loss Reduction	Distribution Loss (After the Project)
Alexandria (AEDC)	148	13.76 (TL:8.38+NTL:5.38)	7.58 (TL:3.81+NTL:3.77)	6.18 (TL:4.57+NTL:1.61)
North Delta (NDEDC)	201	12.0 (TL:6.7+NTL:5.3)	6.88 (TL:3.17+NTL:3.71)	5.12 (TL:3.53+NTL:1.59)
Cairo North (CNEDC)	205	17.8 (TL:12.2+NTL:5.6)	9.62 (TL:5.7+NTL:3.92)	8.18 (TL:6.5+NTL:1.68)
Total	554			

*) Contingency, Price Escalation, Administration cost and Engineering Service are NOT included.

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4. Proposed Option of the Project Scope Outline

2) Option 2 [High Investment Efficiency Portion only]

Distribution Company	Estimated Investment* (MUS$)	Distribution Loss (Before the Project)	Loss Reduction	Distribution Loss (After the Project)
Alexandria (AEDC)	68	13.76 (TL: 8.38+NTL: 5.38)	7.41 (TL:3.64+NTL:3.77)	6.35 (TL:4.74+NTL:1.61)
North Delta (NDEDC)	105	12.0 (TL:6.7+NTL:5.3)	5.52 (TL:1.81+NTL:3.71)	6.48 (TL:4.89+NTL1.59)
Cairo North (CNEDC)	135	17.8 (TL:12.2+NTL:5.6)	8.75 (TL:4.83+NTL:3.92)	9.05 (TL:7.37+NTL:1.68)
Total	308			

*) Contingency, Price Escalation, Administration cost and Engineering Service are NOT included.

4. Proposed Option of the Project Scope Outline

3) Option 3 [1000 unit of AMR only (Others: Same as Option 2)]

Distribution Company	Estimated Investment* (MUS$)	Distribution Loss (Before the Project)	Loss Reduction	Distribution Loss (After the Project)
Alexandria (AEDC)	44.12	13.76 (TL: 8.38+NTL: 5.38)	3.36 (TL:3.34+NTL:0.02)	10.4 (TL:5.04+NTL:5.36)
North Delta (NDEDC)	*45.12*	*12.0* (TL:6.7+NTL:5.3)	*1.58* (TL:1.57+NTL:0.007)	*10.42* (TL:5.13+NTL:5.29)
Cairo North (CNEDC)	63.12	17.8 (TL:12.2+NTL:5.6)	4.30 (TL:4.29+NTL:0.007)	13.5 (TL:7.91+NTL:5.59)
Total	152.36			

*) Contingency, Price Escalation, Administration cost and Engineering Service are NOT included.

4. Proposed Option of the Project Scope Outline

4) Option 4 [Non-Tech Loss Only in NDEDC (Others: Same as Option 2)]

Distribution Company	Estimated Investment* *(MUS$)*	Distribution Loss (Before the Project)	Loss Reduction	Distribution Loss (After the Project)
Alexandria (AEDC)	68	13.76 (TL: 8.38+NTL: 5.38)	7.41 (TL:3.64+NTL:3.77)	6.35 (TL:4.74+NTL:1.61)
North Delta (NDEDC)	62	12.0 (TL:6.7+NTL:5.3)	3.71 (TL:0+NTL:3.71)	8.29 (TL:6.7+NTL1.59)
Cairo North (CNEDC)	135	17.8 (TL:12.2+NTL:5.6)	8.75 (TL:4.83+NTL:3.92)	9.05 (TL:7.37+NTL:1.68)
Total	265			

*) Contingency, Price Escalation, Administration cost and Engineering Service are NOT included.

5. Next Step

3rd Mission

Needs Assessment → Outline of the Project Scope → Project Scope Plan

1) 3rd mission: 12/17-12/27

2) Updated and scrutinized Project Scope Plan will be proposed in the Workshop*

(*) Workshop
- Date (candidate): 23 or 24 December, 2009.
- Place: EEHC conference room
- Attendant: Key persons (Chairman and key staff) in EEHC, AEDC, NDEDC,CNEDC

3) Draft Final Report will be submitted during the 3rd mission

4) Final Report will be submitted by the end of January, 2009

Appendix 5:

Appendix 5.3 Final work shop PP

Workshop:
Energy Efficiency Projects
for Egyptian Electricity Distribution Companies

Dec, 2009

Tokyo Electric Power Services Co., Ltd.
(TEPSCO)
JICA Project Formulation Expert Team

Today's Topics

1. Framework of JICA Experts Activities
2. Summary of the Activities 1
   (Step 1: Needs Assessment (EE needs in the Egyptian Electricity Sector))
3. Summary of the Activities 2
   (Step 2: Pilot Projects (the Egyptian Distribution Sector))
4. Next Step

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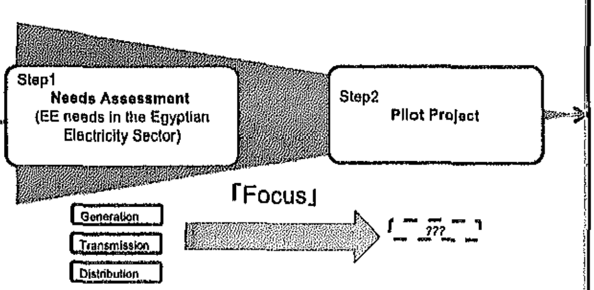
1. Framework of JICA Expert's Activities

Examination Framework



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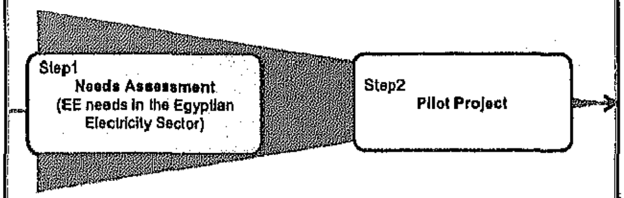
2. Summary of the Activities 1

(Step 1: **Needs Assessment**
(EE needs in the Egyptian Electricity Sector))



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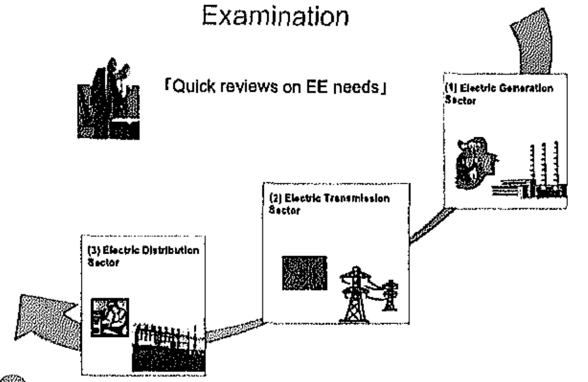
2. Summary of Activities 1 (Needs Assessment)

Examination



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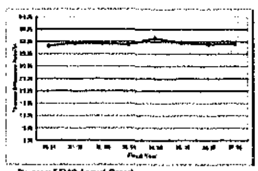
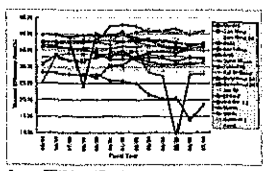
2. Summary of Activities 1 (Needs Assessment)

(1) EE needs on Electric Generation



Sources: EEHC Annual Report
Fig. 2(1)-1 Yearly Thermal Efficiency in Egypt



Sources: EEHC Annual Report
Fig. 2(1)-2 Yearly Record of ST Thermal Efficiency by Plant

<Observation>

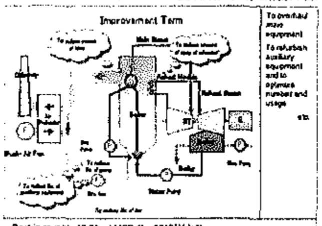
• As a whole, Energy Efficiency(EE) rate seems to be high mainly due to the nature of Egyptian power generation, that is heavily relying on natural gas.
• However <u>It is important to note that there are some plants that EE rate is low such as Matroh, El-Seluf and Damanhour</u>.
• Enhancing EE of such power plants can be an option to cheaply strengthen power generation capacity.

2. Summary of Activities 1 (Needs Assessment)

(2) Potential Projects in Electric Generation

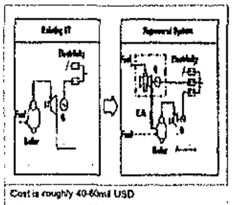
<Potential EE Projects>

- The followings are potential EE projects in Electric Generation sector.
  - ✓ Retrofitting in efficient power plant
  - ✓ Combining existing plant with new gas turbine
- The both option can cheaply enhance power generation capacity.
- The challenge is the necessity of stopping power plant to be renewed.



Cost is roughly 10-30mil USD (for 60MW Unit)

Fig. 2(2)-1 Retrofitting in efficient power plant



Cost is roughly 40-60mil USD
(for combination of 100MW GT unit)

Fig. 2(2)-2 Combining existing plant with new GT

2. Summary of Activities 1 (Needs Assessment)

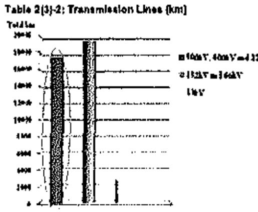
(3) EE needs on Electric Transmission

Table2(3): Transmission Loss in Egypt

Transmission	3.78	3.72	3.73	3.71	3.89
(c.f.) Generation	3.63	3.64	3.43	3.25	3.13

(Source) EEHC

Table 2(3)-2: Transmission Lines (km)



<Observation>

- Needs for EE project seem not to be so high since transmission loss is low.
- Low transmission loss is seemingly due to the factors such as introduction of high voltage lines (500kv) in massive consuming area and appropriate choice of equipment in substations.
- Indeed, there are some methods to further reduce transmission losses, but cost effectiveness of such EE investments for transmission might be limited.
- EE should be enhanced mainly in the course of regular development plan.

2. Summary of Activities 1 (Needs Assessment)

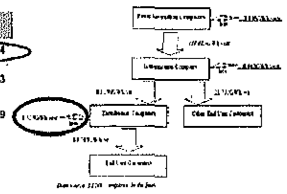
(4) EE needs on Electric Distribution

Table2(4): Distribution Loss in Egypt

Distribution	10.38	10.26	9.38	9.24	9.14
(c.f.) Generation	3.63	3.64	3.43	3.25	3.13
(c.f.) Transmission	3.78	3.72	3.73	3.71	3.89

(Source) EEHC

Table 2(4)-2: Electric Energy Power Flow (2007/8)



<Observation>

- By its nature and as usual, distribution is the sector those loss is the highest.
- We confirmed that Egyptian distribution companies have already tackled with losses very intensively through a couple of counter-measures.
- But, in our view, with some more sophisticated techniques and technologies, there still remain many rooms to further reduce distribution losses.
- Our team recommends that the highest priority should be given to this sector and examines the concrete measures as a pilot in the following chapter.

2. Summary of Activities 1 (Needs Assessment)

(5) EE needs on DSM

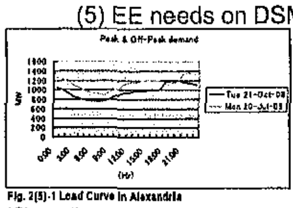


Fig. 2(5)-1 Load Curve in Alexandria

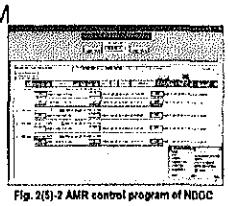


Fig. 2(5)-2 AMR control program of NDCC

<Observation>

- Power demand is growing with GDP growth. However demand curve seems to be relatively flatter than other countries in Egypt, meaning that the difference of peak and off-peak is not so big now. (System load factor is kept at over 70% level in Egypt)
- Peak demand appears in night, which implies that peak demand comprises of lightning, heating water, cooking and so on.
- Comparing peak (summer) and off-peak (autumn) demand, there are differences, implying that AC may make peak demand bottom-up.
- DSM seems to be a future task for Egypt. The more widespread AC becomes, the more precisely you need to scrutinize the factors of escalating demand during peak time. In that time, AMR and DAS will be useful tools for monitoring and controlling peak demands

2. Summary of Activities 1 (Needs Assessment)

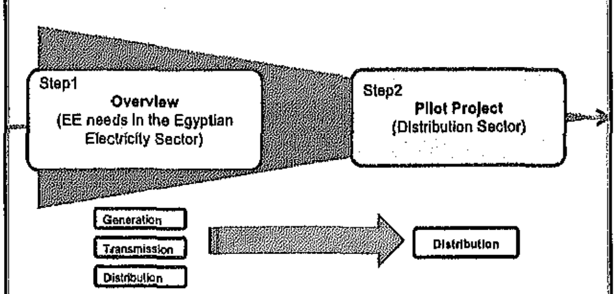
(6) Sum: Needs of Actions in Detail

Priority Evaluation Criterion
1) Costs (A : Small, B : Medium, C : Large)
2) Impacts (A : Very high, B : High, C : Medium)
3) Implementation period (A : Short, B : Medium, C : Long)
4) Affects for Reliability of Existing Operations during constructions (A : Non, B: Minor Little, C : Significant)
5) Necessity of Additional Technical Examination (A : A Few, B : Some, C : Much)
6) Urgency (A: Urgent, B: Medium, C: Moderate)

	Project	Total costs	E/C	Imp. period	Impact to Reliability	Necessity of tech study	Urgency	Total
Gene.	Retrofitting & rehabilitation for inefficient power plants	A	A	A	C	C	B	B
	Combining existing plant with new GT	A	A	C	C	C	B	C
Trans.	Newly-built high voltage transmission line	C	C	B	A	B	C	C
	Reduction of load factor by increasing the number of parallel lines	C	C	B	A	B	C	C
	Augmentation of transmission line (heavy lining, usage of multiple …)	C	C	B	A	B	C	C
	Reduction of in-house power of substations	B	C	A	B	B	C	C
	Reduction of load factor by expansion of transformers	B	C	A	B	B	C	C
	Installation of automatic power factor adjusting device	B	C	A	B	B	C	C
	Installation of automatic voltage regulator	B	B	A	B	B	C	B
	Utilization of transformer waste heat	B	C	B	A	C	C	C
Dist.	New construction of HV feeders	A	A	A	A	B	A	A
	Shortening LV line by installing small size DT	A	A	A	A	B	A	A
	Replace old DT to new low loss DT	A	A	A	A	B	A	A
	Improvement of power factor by installing capacitor	A	A	A	A	B	A	A
	Balancing distribution feeder load	A	B	A	A	B	A	A
	Install Step Voltage Regulators (SVR) to improve of voltage drop	A	B	A	A	B	A	A
DSM	Efficiency Improvement by DSM targeting on AC	A	B	A	A	C	C	C
	DSM by AMR	A	A	A	A	B	B	A

3. Summary of the Activities 2

(Step 2: **Pilot Projects** (the Egyptian Distribution Sector))



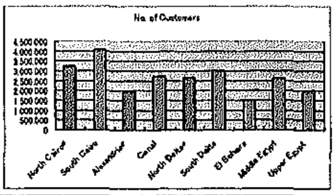
3. Summary of Activities 2 (Pilot Projects for Distribution)

(1)Where are we now?

Needs Assessment	Outline of the Project Scope	
1st mission (July-Aug 2009)	2nd mission (Oct-Nov 2009)	3rd mission (Dec 2009)
		-Feedback of JICA expert team's examinations -Discussion on the Pilot Project in Egyptian Distribution Sector

3. Summary of Activities 2 (Pilot Projects for Distribution)

(2) Model Project Area Selection



No. of Customers of Model Distribution Company

(EEHC Annual Report 07/08)

As a result of discussion bet EEHC and JICA, three companies were chosen in terms of EE needs, willingness to EE activities, regional balance and so forth.

< Model Project Area >
- West Alex zone in AEDC
- *North Dakhalla Sector in NDEDC*
- El Helmia zone in NCEDC

3. Summary of Activities 2 (Pilot Projects for Distribution)

(3) Rationale of the Pilot Area Selection

Alexandria Electricity Distribution Company (AEDC)

	Montaza	East Alex	Central Alex	West/Alex	El Sahel	Total
Technical loss	8.14	7.97	8.05	8.38	7.97	8.16
Non-technical loss	5.27	5.32	5.49	5.38	5.23	5.39
Total	13.41	13.29	13.54	13.76	13.20	13.54

<Why West Alex?>
◆The highest technical loss
◆ Potentials of loss reduction(longest distribution lines and several overloaded DTs)
◆ Importance of the area (Industrial zone and growing new residences)

3. Summary of Activities 2 (Pilot Projects for Distribution)

(3) Cont. Rationale of the Pilot Area Selection

North Delta Electricity Distribution Company (NDEDC)

	Domitta	Kafr El-Shiekh	South Dakhalla	North Dakhalla	Total
Technical loss	4.1	4.9	3.5	6.7	4.8
Non-technical loss	1.9	3.1	2.7	5.3	4.25
Total	6.0	8.0	6.2	12.0	8.05

<Why North Dakhalla?>
◆The highest technical loss
◆ Potentials of loss reduction(high ratio of OH, long distribution lines and growing demands)
◆ Importance of the area (the concentration of industries and commercial activities and growing new residences)

3. Summary of Activities 2 (Pilot Projects for Distribution)

(3) Cont. Rationale of the Pilot Area Selection

Cairo North Electricity Distribution Company (CNEDC)

Sector	Helioples	North	Helmya	East	Total
Technical loss	9.37	7.09	12.2	5.61	6.08
Non-technical loss	4.31	3.26	5.6	2.58	5.57
Total	13.7	10.4	17.8	8.19	11.65

<Why Helmya?>
◆The highest technical loss
◆ Potentials of loss reduction(old and overloaded DTs)
◆ Importance of the area (governmental buildings, hospitals, concentration of industries, commercial activities and residences)
◆ Relatively longer outrage time

3. Summary of Activities 2 (Pilot Projects for Distribution)

(4) Breakdown of Dist. Loss in the Pilot Areas

	Location of loss occurrence	West Alex in AEDC	North Dakhalia in NDEDC	Hekmya in CNEDC
Technical loss	11kV feeder	0.32%	4.0%	1.6%
	11kV DT	5.36%	1.2%	7.2%
	LV line	2.19%	1.1%	2.3%
	Meter	0.51%	0.4%	0.9%
	Sub Total	8.38%	6.7%	12.2%
Non-Technical loss	Meter problem theft	5.38%	5.3%	5.6%
Total		13.76%	12.0%	17.8%

Target losses to be reduced

Losses to be reduced associated with target loss reduction activities

3. Summary of Activities 2 (Pilot Projects for Distribution)

(5) Model Project Components

	Location of loss occurrence	West Alex in AEDC	North Dakhalia in NDEDC	Helmya in CNEDC
Technical loss	11kV feeder	-Improving Load Unbalance by DAS	-Capacitor -SVR for OH	-Improving Load Unbalance by DAS
	11kV DT	-Low Loss and Large Capacity DT		
	LV line	-Improving Phase Unbalance by DAS	-Shortening LV line by Small DT	-Improving Phase Unbalance by DAS
	Meter	-AMR with Low Loss WHM		
Non-Technical loss	Meter problem theft	-AMR with Low Loss WHM -DAS		

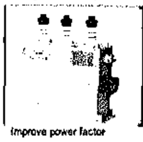
3. Summary of Activities 2 (Pilot Projects for Distribution)

(6) Model Project Component 1

Capacitor and SVR for OH (applied for NDEDC only)

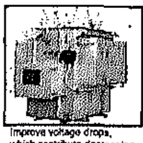
<Current Situation> <Project Component> <Expected Outcome>

Low Power Factor: 0.86



Power Factor ↑ 0.95

Voltage drop frequently occurs due to long distance line



Voltage Drop ↓

3. Summary of Activities 2 (Pilot Projects for Distribution)

(7) Model Project Component 2

Low loss and Large Capacity Distribution Transformer(DT)

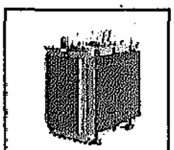
<Current Situation> <Project Component> <Expected Outcome>

1) Ratio of old DT is high

	West Alex	North Dakhalia	Helmya
New DT	89	714	728
Old DT	970	2,289	1,555
Total	1,059	3,003	2,285

2) High Iron and Copper loss

3) Lots of overloaded 500KVA DT



-Replacing to low loss and large capacity *(1000KVA) DT*

Technical Loss ↓ by 50%

3. Summary of Activities 2 (Pilot Projects for Distribution)

(8) Model Project Component 3

Shortening LV line by Small DT (applied for NDEDC only)

<Current Situation> <Project Component> <Expected Outcome>

	West Alex	North Dakhalia	Helmya
OH	[illegible]	[illegible]	0
UG	[illegible]	[illegible]	[illegible]

1)In NDEDC, Share of OH is high.

2)LV line is long (some reached around 15km) and Enough space for installation of DT on pole.

100/160/200KVA of OH DT will be replaced by 50KVA DT

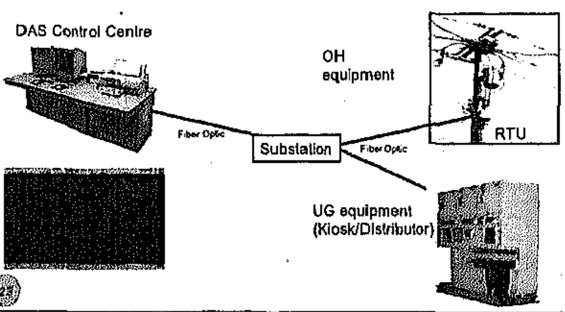
Shortening LV line, Technical Loss ↓ by 30%

3. Summary of Activities 2 (Pilot Projects for Distribution)

(9) Model Project Component 4

Improving Load and Phase Unbalance by DAS

< Concept of DAS >



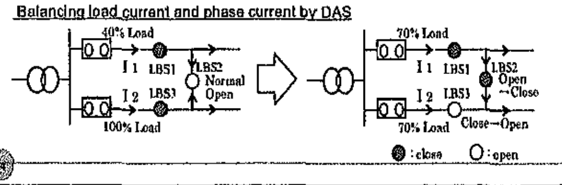
3. Summary of Activities 2 (Pilot Projects for Distribution)

(9) Cont, Model Project Component 4

Improving Load and Phase Unbalance by DAS

	Current Situation	DAS functions / facilities	Outcome
1	Loss by load unbalance	Switching LBS of looped point	Loss reduction of 11kV feeder
2	Loss by phase unbalance of LV line	Monitoring of DT phase current on LV side → DAS make the report with recommendation for customer connection	Loss reduction of LV line

Balancing load current and phase current by DAS

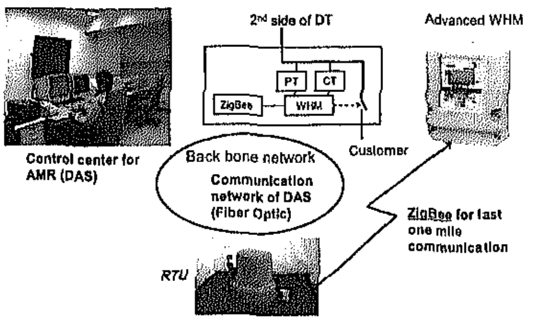


3. Summary of Activities 2 (Pilot Projects for Distribution)

(10) Model Project Component 5

AMR with Low Loss WHM

< Concept of AMR >



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3. Summary of Activities 2 (Pilot Projects for Distribution)

(10) Cont, Model Project Component 5

AMR with Low Loss WHM

Improvement of non technical loss by Auto Meter Reading (AMR)

	Current Situation	AMR functions	Expected Outcomes
1	Non performing / under performing WHM	Checking the performance in real time by AMR	Non performing WHM can be quickly replaced.
2	Defects of circuit in CT / PT	CT / PT are assembled inside AWHM. Alarm occur when the cover will open.	Circuit of CT / PT can not be changed, so that non technical loss can be reduced.
3	*Mistake of meter reader*	*Digital data of meter send to control center through communication network.*	*There are no mistake due to digital implementation.*
4	Pilferage by manipulation of meter	Alarm occurs when the cover is opened, so that the alarm is sent to control center in real time.	The cover has to be opened in order to manipulate the WHM, so that the theft can be found out by the alarm.
5	Energy theft by direct tapping	ditto	The cover has to be opened in order to change the tapping, so that the theft can be found out by the alarm.
6	Direct connection without meter	Alarm occurs when the voltage-drop happen. Control center can get the DT data and the accumulated WHM data.	In case the voltage-drop happens by the direct connection, the theft can be found out by the alarm. The difference between DT and the accumulated WHM data can be checked, so that the theft customer can be found out.

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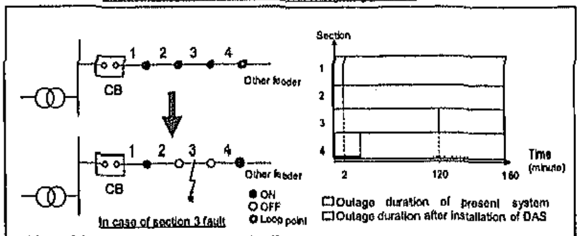
3. Summary of Activities 2 (Pilot Projects for Distribution)

(Ref.1) Additional Project Outcomes

Enhancement of Reliability by DAS



DAS can detect and isolate the faulty section (3 section).
DAS can restore non-faulty sections (1 / 2 / 4 sections) after isolation of the faulty section.

	Outage duration (SAIDI) before DAS	Outage duration (SAIDI) after DAS
West Alex	116 min / year	10 min / year
North Dakhalia	124 min / year	48 min / year
Helmya	162 min / year	93 min / year

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3. Summary of Activities 2 (Pilot Projects for Distribution)

(Ref.1) Cont, Additional Project Outcomes

Enhancement of Reliability by DAS

	Current Situation	DAS functions / facilities	Outcomes
1	Long outage duration	Automatic fault detection, *isolation and restoration*	Reduction of outage *duration → Customer* satisfaction
2	Blindness for distribution network	Monitoring in real time for substation, distribution network and the equipment	Quick response → Customer satisfaction
3	Maintenance work for long outage duration, many workers and mistake	Making report for maintenance work and implementing the switching procedure	Reduction maintenance crews Customer satisfaction
4	Overload of engineer Bad records of diverse data	*Making report for distribution construction plan, outage, etc*	*Improvement of office work* Systematic recording
5	No chance for future function and business	DAS communication network using Fiber optic, RTU etc	Expansion for AMR / DSM (Peak cut) / telecom business

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3. Summary of Activities 2 (Pilot Projects for Distribution)

(Ref.2) Communication Network for DAS/AMR

- **Backbone network: Fiber optic (recommendation)**

	PLC	UHF/VHF	GPRS (Mobile)	Fiber Optic
Speed/Capacity	x	x	○	◎
Reliability	x	△	○	◎
Security	○	○	△	◎
Expansion (AMR, new business)	x	x	○	◎
Initial investment	◎	○	◎	△
Operation Cost	◎	○	x	◎

< Solution >
Installation of Fiber Optic shall be limited to main feeder for RTU (Not blanch line).
Installation of fiber Optic for existing UG network is difficult.
UG cable is old, so replace the old cable to new cable with Fiber Optic before completion of projects.

- **Last one mile network: ZigBee (recommendation)**

	PLC	GPRS	WiMAX	ZigBee
Speed/Capacity	x	○	◎	[illegible]
Distance	△	◎	○	[illegible]
Reliability	x	○	○	[illegible]
Security	○	△	○	[illegible]
Power Consumption	△	○	△	[illegible]
Initial investment	○	◎	△	[illegible]
Operation cost	◎	x	◎	[illegible]

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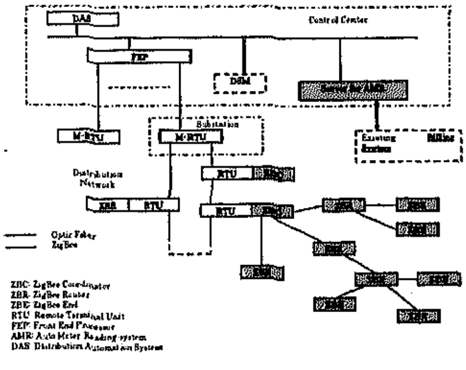
3. Summary of Activities 2 (Pilot Projects for Distribution)

(Ref.2) Cont, Communication Network for DAS/AMR



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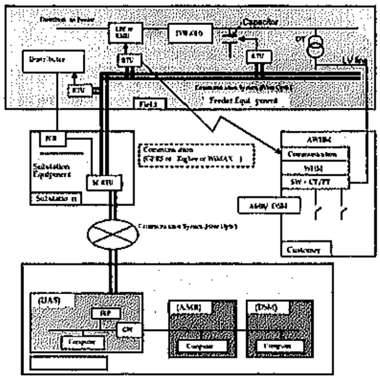
3. Summary of Activities 2 (Pilot Projects for Distribution)

(Ref.3) Potential of Future Applications of DAS

- Peak cut by DSM using communication network and AWHM.
- Telecommunication business by using communication network
- Interactive communication for Home Automation (HA) by using communication network and AWHM
- Monitor and Control for renewable energy such as Fuel cell and Solar power, which are connected to distribution network, by using communication network and AWHM in order to;
  - avoid to rise the voltage near the renewable energy
  - avoid to supply the power to outage areas when CB in the feeder trips
- Application for power storage of electric car

3. Summary of Activities 2 (Pilot Projects for Distribution)

(12) System Configuration



3. Summary of Activities 2 (Pilot Projects for Distribution)

(13) Role of Each Distribution Company

- It is important to note that, while many distribution losses will be systemically reduced due to these new system introductions, some losses will remain to be unsolved merely with such system introductions.
- In this regard, sophisticated usage of the system by each distribution company is indispensable and prompt reactions to the warnings made by the new system are also quite essential.
- JICA will consider the possibility of technical assistance to support such distribution companies' activities. This topic will be discussed in the course of JICA's appraisal.

3. Summary of Activities 2 (Pilot Projects for Distribution)

(12) Project Cost 1 Alexandria Electricity Distribution Company (AEDC)

	Location	Loss Rate (a)	Item	Investment (b) MUS$ ( ):Local Cost	Loss Reduction (c)	Investment Efficiency (a)x(c)/(b)
Technical Loss	11kV feeder	0.32	Improvement of load unbalance	18	Δ10%	0.18
	11kV DT	5.36	Low loss and large capacity DT	21 (21)	Δ50%	12.8
	LV line	2.19	Improvement of phase unbalance	15	Δ30%	6.9
	Meter (WHM)	0.51	Low loss WHM for AMR	24	Δ60%	1.28
	Sub Total	8.38	-	78 (21)	~ Δ44% (3.68)	
Non- Technical Loss		5.38	AMR	2	Δ70% (3.77)	14.5
Consultancy				4 (1)	-	-
Price Escalation & Contingencies				8 (3)	-	-
Tax				9 (3)	-	-
TOTAL		13.76	-	[illegible]	[illegible]	[illegible]

*) Foreign Currency : 73mil US$, Local Currency: 28mil US$

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3. Summary of Activities 2 (Pilot Projects for Distribution)

(13) Project Cost 2 North Delta Electricity Distribution Company (NDEDC)

	Location	Loss Rate (a)	Item	Investment (b) MUS$ ( ): Local Cost	Loss Reduction (c)	Investment Efficiency (a)x(c)/(b)
Technical Loss	11kV feeder	4.0	Capacitor	6	Δ16%	10.67
			SVR for OH	7	Δ6%	3.42
			Improvement of Load unbalance	15 (3)	Δ10%	2.67
	LV line	1.1	Shortening LV line by small DT	15 (15)	Δ30%	2.28
	Meter (WHM)	0.4	Low loss WHM for AMR	60	Δ60%	0.40
	Sub Total	6.7	-	103 (18)	~ Δ28% (1.85)	
Non- Technical Loss		5.3	AMR	2	Δ70% (3.71)	5.98
Consultancy				4 (1)	-	-
Price Escalation & Contingencies				10 (3)	-	-
Tax				11 (2)	-	-
TOTAL		12.0	-	[illegible]	[illegible]	[illegible]

*) Foreign Currency : 106mil US$, Local Currency: 24mil US$

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3. Summary of Activities 2 (Pilot Projects for Distribution)

(14) Project Cost 3 Cairo North Electricity Distribution Company (CNEDC)

	Location	Loss Rate (a)	Item	Investment (b) MUS$ ( ): Local Cost	Loss Reduction (c)	Investment Efficiency (a)x(c)/(b)
Technical Loss	11kV feeder	1.8	Improvement of Load unbalance	4 (4)	Δ10%	4.5
	11kV DT	7.2	Low loss and large capacity DT	32 (32)	Δ50%	11.0
	LV line	2.3	Improvement of phase unbalance	30	Δ30%	2.3
	Meter (WHM)	0.9	Low loss WHM for AMR	72	Δ60%	0.75
	Sub Total	12.2	-	138 (36)	~ Δ41% (5.01)	
Non- Technical Loss		5.6	AMR	2	Δ35% (1.96)	2.6
Consultancy				4 (1)	-	-
Price Escalation & Contingencies				14 (6)	-	-
Tax				14 (4)	-	-
TOTAL		17.8	-	[illegible]	[illegible]	[illegible]

*) Foreign Currency : 125mil US$, Local Currency: 47mil US$

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