Palestinian Authority
Palestinian Water Authority
Palestinian Energy and National Resources Authority
Coastal Municipalities Water Utility
Gaza Electricity Distribution Company

DATA COLLECTION SURVEY ON GAZA RECONSTRUCTION IN WATER AND ENERGY SECTOR IN PALESTINE

FINAL REPORT

Volume II Energy Sector

September 2017

Japan International Cooperation Agency (JICA)
NJS Consultants Co., Ltd.
Yachiyo Engineering Co., Ltd.

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Currency Exchange Rate (As of July 2017)

USD1.00 = JPY 112.185

EUR1.00 = JPY 127.430

NIS1.00 = JPY 31.965

JOD1.00 = JPY 158.585

Volume Ⅱ

Energy Sector

DATA COLLECTION SURVEY ON GAZA RECONSTRUCTION IN WATER AND ENERGY SECTOR IN PALESTINE
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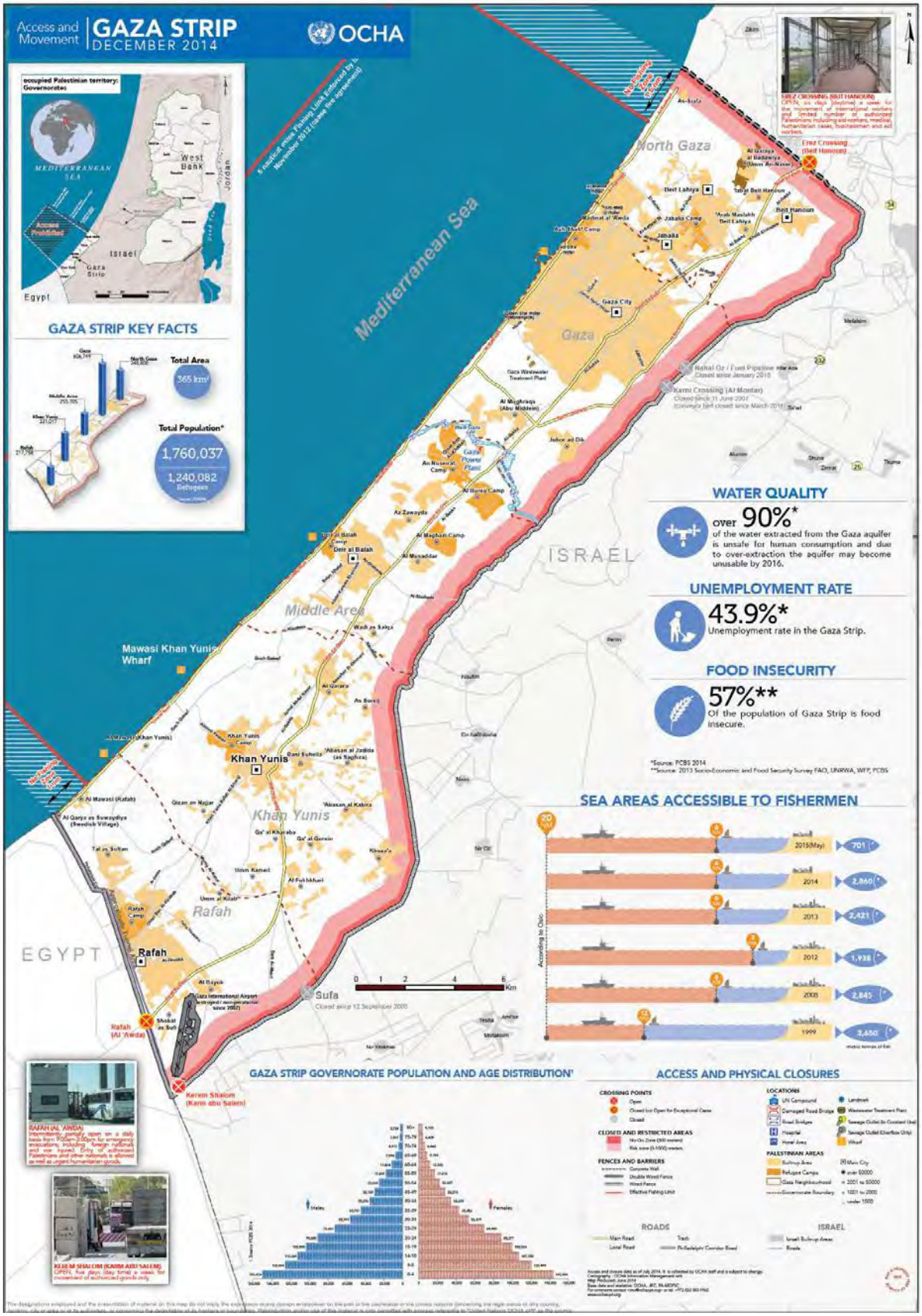
【Abbreviations】

AAC	All Aluminium Conductor
AAAC	All Aluminium Alloy Conductor
ABC	Aerial Bundled Cable
AC	Alternate Current
ACSR	Aluminum Cable Steel Reinforced
ADSS	All Dielectric Self-Supporting
AutoCAD®	Auto Computer-Aided Design
COGAT	Coordination of Government Activities in the Territories
DAR	Damage Assessment Report
DC	Direct current
DISCO	Distribution Company
ETAP™	Electrical Power System Analysis Software
GDP	Gross Domestic Product
GEDCO	Gaza Electricity Distribution Company
GIS	Geographic Information System
GN-S/S	Gaza North Substation
GM-S/S	Gaza Middle Substation
GoI	Government of Israel
GPP	Gaza Power Plant
GPGC	Gaza Power Generating Company
GPS	Global Positioning System
GRM	Gaza Reconstruction Mechanism
GS-S/S	Gaza South Substation
GW-S/S	Gaza West Substation
GWh	Gigawatt-hour
HEPCO	Hebron Electric Power Company
HV	High Voltage
ICRC	International Committee of the Red Cross
ICU	Intensive Care Unit
IEC	Israel Electricity Corporation
IsDB	Islamic Development Bank
IT	Information Technology
JDECO	Jerusalem District Electricity Co., Ltd.
JICA	Japan International Cooperation Agency
JOD	Jordan Dinar
JPY	Japanese Yen

JST	JICA Survey Team
km	Kilometer
kV	Kilovolt
kVA	Kilovolt Ampere
kW	Kilowatt
kWh	Kilowatt-hour
kWp	Kilowatt Peak
LED	Light Emitting Diode
LV	Low Voltage
MDLF	Municipal Development & Lending Fund
MV	Medium Voltage
MVA	Mega Volt Ampere
MW	Mega Watt
NCC	Palestinian National Load Control & Dispatch Center
NEDCO	North Electricity Distribution Company
NIS	New Israel Shekel
OCHA	UN Office for the Coordination of Humanitarian Affairs
OCR	Overcurrent relay
O.H.T.L.	Overhead Transmission Line
OJT	On-the-Job Training
OVR	Overvoltage relay
PA	Palestinian Authority
PEC	Palestinian Electricity Company
PEA	Palestinian Energy Authority
PENRA	Palestinian Energy and National Resources Authority
PETL	Palestinian Electricity Transmission Company
PLC	Programmable Logic Controller
PMU	Project Management Unit
PP	Power Plant
PQ	Pre-Qualification
PV	Photovoltaic system
SCADA	Supervisory Control And Data Acquisition
S/S	Substation
TEDCO	Tubas Electricity Distribution Company
TOT	Training of the trainers
UNDP	United Nations Development Programme
UNMAS	United Nations Mine Action Service

UNRWA	The United Nations Relief and Works Agency Special Purpose Company
UNSCO	United Nations Office of Special Coordinator for the Middle East Peace Process
USD	United States Dollars
UVR	Under voltage relay
V	Volt
VAT	Value Added Tax
WB	The World Bank



Source: OCHA Humanitarian Atras 2015

Location Map

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Meeting with PENRA (Ramallah)
(7 May 2015)</td>
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Presentation of reconstruction needs by PENRA
(13 May 2015)</td>
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Conducting assessment of the situation

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Meeting with Gaza Power Plant (26 May 2015)

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Conducting assessment of the situation

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Temporary fuel tank of Gaza Power Plant (The building of lower left)</td>
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Photovoltaic system of Shifa Hospitals</td>
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Photovoltaic system of Al Faloja School</td>
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The site situation of completed or ongoing projects

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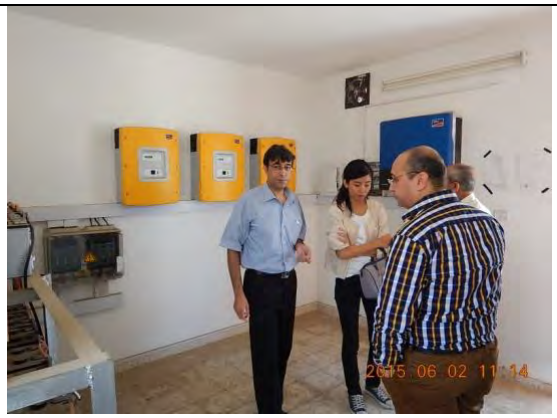
<td> 

Photovoltaic system of Al Faloja School</td>
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Street lighting with Photovoltaic system of Gaza Port</td>
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Transformer repair factory</td>
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Gaza North Substation (Construction is suspended)</td>
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Temporary repaired cable (Beit Hanoun)</td>
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Temporary repaired cable (Beit Hanoun)</td>
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Temporary repaired cable (Alshejaia)</td>
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Black smith of transformer repair</td>
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The site situation of completed or ongoing projects

 Pilot Project (Khan Younis)	 Pilot Project (Khan Younis)
 Pilot Project (Khan Younis)	 Pilot Project (Khan Younis)
 Pilot Project (Khan Younis)	 Pilot Project (Khan Younis)
 Pilot Project (Khan Younis)	 Pilot Project (Khan Younis)

The site situation of Pilot project

Summary

The Gaza Strip was completely dependent on the Israeli Electricity Corporation (IEC) for its electrical power supply. In 1995, the Palestinian Energy Authority (PEA) was established to oversee the development of the electrical sector in Palestine, make it more reliable, efficient and less dependent on the IEC and a master plan was implemented by PEA. The generation project involved constructing the 140MW combined-cycle Gaza Power Plant (GPP), which was completed and put into commercial operation by a private entity, the Gaza Power Generating Company, in March 2003. In terms of transmission work, although the first stage of the Palestinian transmission system was constructed in Gaza, it has since been suspended due to the contractor leaving without completing the commissioning, citing security conditions in Gaza. As a distribution project, meanwhile, deteriorated existing distribution networks have been rehabilitated and expanded and a commercially oriented distribution company, the Gaza Electricity Distribution Corporation Ltd. (GEDCO), was established. The Gaza Strip is currently fed by three different sources, namely IEC via old overloaded radial 22kV feeders with power peaking at 120MW, the GPP with maximum a power of 60MW and Egypt through three 22kV feeders with a maximum power of 28MW. Regional interconnection of 220 and 161kV supply lines is also planned. However, the networks have not yet been improved for the following reasons:

1) The available energy in the Gaza Strip to feed the loads is insufficient, with an energy deficit rate of around 75 ～85% as of July 2017.
2) The energy sources are unstable.
3) The isolation of the Gaza Strip due to the fact that it is surrounded by Israel causes long-term difficulties with securing necessary materials and supplies. Therefore, GEDCO must operate using only items for which procurement is possible.

The Gaza Strip is prone to frequent blackouts due to significant deficits in the electricity supply and restrictions imposed by Israel and Egypt. Consequently, Electricity is supplied for 2 to 4 hours only a day as of July 2017. The GPP is also usually operated at less than half capacity given the excessive fuel cost due to tax. Moreover, since the electricity infrastructure in Gaza Strip was significantly damaged following an Israeli attack in 2014, under these circumstances, a pilot electricity restoration project was implemented as part of this survey and the results of the project were reflected in future medium-term assistance. Medium-term assistance has been examined and taking into account the difficulty of implementing a large-scale project due to political issues between Israel and Palestine as well as logistical constraints, the recommended Medium-term Assistance Plan is listed as follows:

1) GEDCO skill development a means to help restore distribution networks and reduce electricity loss
2) Supply of protective equipment, meters, tools and lights required to restore the distribution network
3) Procurement of bucket trucks for maintenance & installation work and detecting theft of electricity
4) Maintaining service at medical and educational institutions using solar power
5) Introduction of solar-powered street lights
6) Introduction of solar-powered generating system for low-income group
7) Capacity development

Chapter 1

Current Status of the Gaza Strip

Chapter 1 Current Status of the Gaza Strip

1-1 The Status of Energy Sector

1-1-1 The Story of the Energy Sector

The Gaza Strip was completely dependent on the Israeli Electricity Corporation (IEC) for its electrical power supply via nine old and overloaded 22KV radial feeders. In 1995, the Palestinian Energy Authority (PEA)[1] was founded to oversee the development of the electrical sector in Palestine and make it more reliable, efficient and less dependent on the IEC. With this in mind, a master plan was implemented by PEA; assisted by Donors as follows:

1) Generation

A 140MW combined-cycle power plant, Gaza Power Plant (GPP) was constructed for the Gaza Strip which has been operated commercially by a private entity, the Gaza Power Generating Company, since construction completed in March 2003.

2) Transmission

The initial stage involved constructing the Palestinian transmission system in the Gaza Strip, which was funded by the Swedish Government via the Swedish International Development Cooperation Agency as follows:

- The 220/22kV Gaza West Substation (GW-S/S) was constructed in GPP and commercial operation commenced after construction completed.
- Construction of the 220/161/22kV Gaza North Substation (GN-S/S) was almost complete in October 2002 when the Swedish contractor left prematurely, citing security conditions in the Gaza Strip.
- A 220kV overhead transmission line connecting between GW-S/S and GN-S/S has been remained in incomplete due to the security conditions.
- The Palestinian Electricity Transmission Company (PETL) was established.
- The Palestinian National Load Control & Dispatch Center (NCC) was planned

3) Distribution

Deteriorated existing distribution networks have been rehabilitated and expanded, and a commercially oriented distribution company, the Gaza Electricity Distribution Corporation Ltd. (GEDCO), was established.

4) Regional Interconnection

The Gaza Strip is currently fed by three different sources, namely IEC through old and overloaded radial 22kV feeders with power peaking at 120MW, GPP with a maximum power of 60MW and Egypt through three 22kV feeders with maximum power of 28MW. The regional interconnection is planned as below.

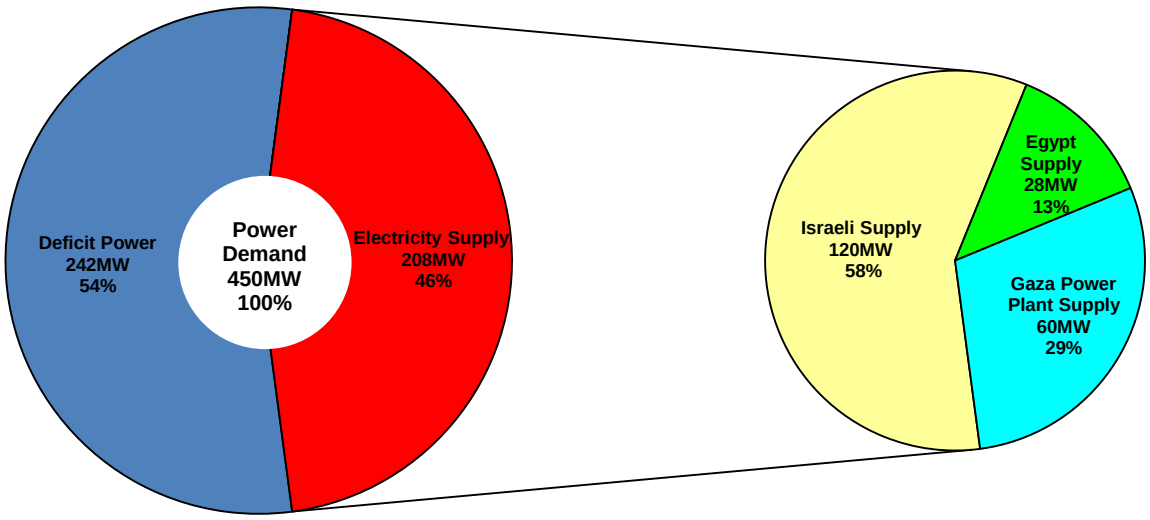
- A 220 kV interconnection with the Egyptian Transmission Grid.
- A 161 kV interconnection with the Israeli Transmission Grid.

[1] The Palestinian Energy and National Resources Authority (PENRA) was renamed in 2009 from PEA to PENRA.

1-1-2 The Status of Development and Damage of the Related Infrastructure

(1) Status of electricity Supply

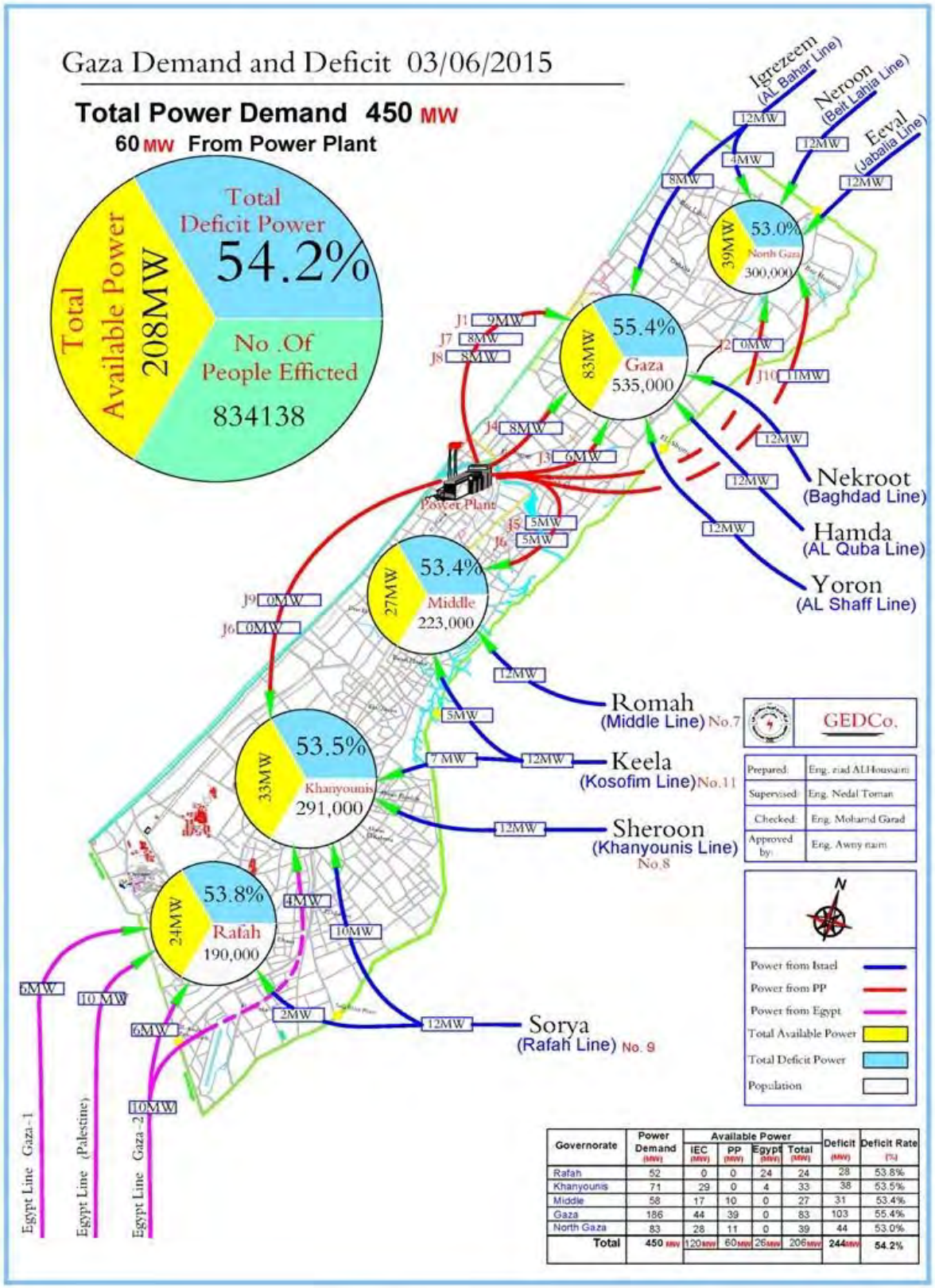
As of June 2015, the electricity demand in the Gaza Strip is estimated at 450MW, however, the electricity supply capacity remains only about 208MW, approximately 46% of the demand. The electricity supply from Israel is approximately 120MW, the power from the GPP peaks at 60MW and Egypt supplies approximately 28MW. Frequent blackouts in the Gaza Strip occur due to the significant deficit in the electricity supply and the restrictions imposed by Israel and Egypt. Therefore these supply capacities are all unstable. Consequently, GEDCO implements planned outages (i.e. supplying electricity for 8 hours followed by electricity cuts for 8 hours, repeated over this schedule) and equating to an average of 12 hours' outage per day. When GPP stops operation, the duration of outage becomes longer (i.e. 4 hours turn-on, 12 hours turn-off, 4 hours turn-on, repeated over this schedule), which means 16 hours outage. Moreover the outage duration as of July 2017 is over 20 hours. Figure 1-1 shows the demand, deficit and supply of electricity in the Gaza Strip. Each part of power supply lines from Israel and from Egypt are often suspended due to maintenance and other reasons, and operation is sometimes suspended at the GPP due to limitation of fuel procurement. Hence, the actual electricity supply is lower than 208MW shown in Figure 1-1 and it also fluctuates.



Source: GEDCO, Gaza Demand and Deficit 2015/6/3

Figure 1-1 Electricity Supply and Deficit in the Gaza Strip (As of June 2015)

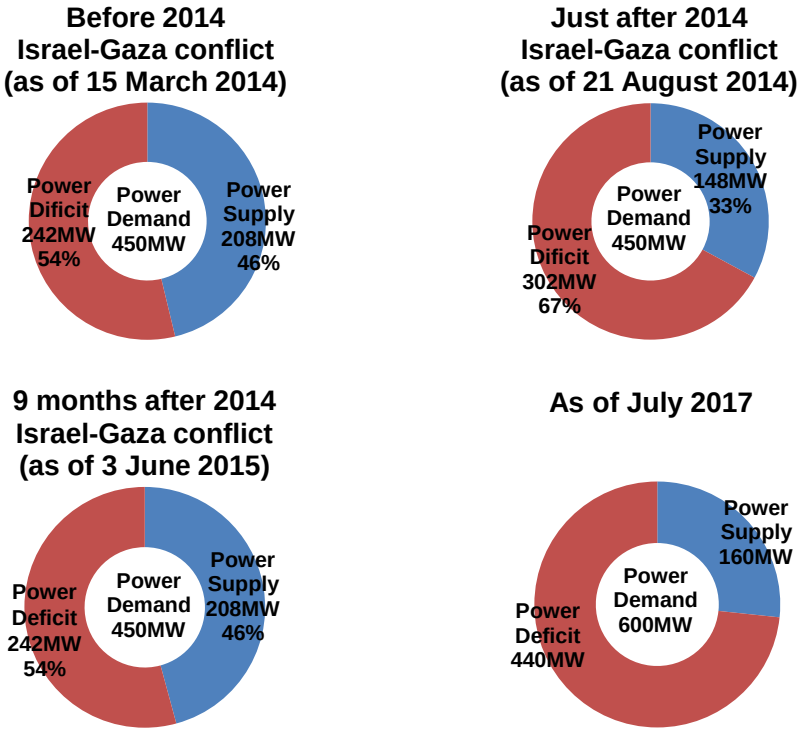
Figure 1-2 shows the status of electricity supply in the Gaza Strip as of June 2015



Governorate	Power Demand (MW)	Available Power IEC (MW)	PP (MW)	Egypt (MW)	Total (MW)	Deficit (MW)	Deficit Rate (%)
Rafah	52	0	0	24	24	28	53.8%
Khanyounis	71	29	0	4	33	38	53.5%
Middle	58	17	10	0	27	31	53.4%
Gaza	186	44	39	0	83	103	55.4%
North Gaza	83	28	11	0	39	44	53.0%
Total	450 MW	120MW	60MW	26MW	206MW	244MW	54.2%

Source: GEDCO Gaza Demand and Deficit 03/06/2015

Figure 1-2 Status of Electricity Transmission in the Gaza Strip



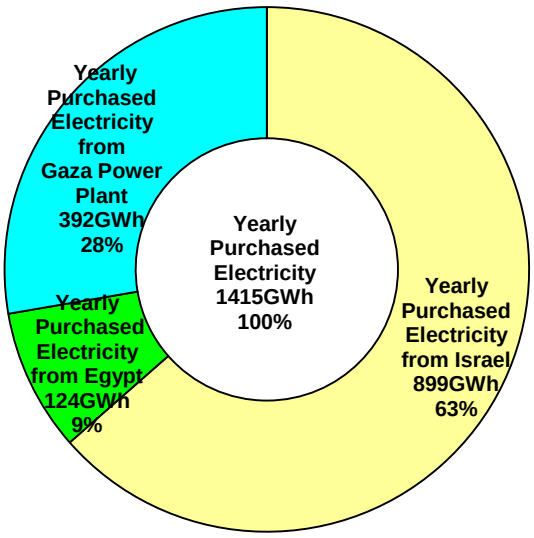
Source: OCHA The Humanitarian Impact of Gaza's electricity and Fuel Crisis March 2014, OCHA Gaza Initial Rapid Assessment 27 August 2014, GEDCO Gaza Demand and Deficit 03/06/2015, Data provided by GEDCO

Figure 1-3 Power demand and supply before and after 2014 Israel-Gaza conflict

Figure 1-3 shows power deficit and supply before, just after and 9 months after 2014 Israel-Gaza conflict. Just after 2014 Israel-Gaza conflict as of 21th August 2014, the operation of GPP supplying 60MW stopped because equipment and fuel tank of GPP were damaged by the Israeli attack. As a result, the power supply decreased from 208MW (46% of the demand) to 148MW (33% of the demand). After that, the damaged equipment was repaired and the operation of GPP was resumed. As of 21 August 2014, power supply resumed up to level before 2014 Israel-Gaza conflict. The changes in the electricity supply and demand in the Gaza Strip are apparent in the beginning of July 2017, the level of electricity supplied from the Israeli side via ten feeders was reduced from 120MW to 70MW coinciding with the complete or partial shutdown of the GPP due to a lack of fuel and the recurrent breakdown of the Egyptian feeders. Electricity demand in the Gaza Strip reached 600MW in July 2017 while the level of electricity currently available is between 70 and 160MW. In summary the Israeli feeding lines only supply 70MW to the Gaza Strip following Israeli reductions, the GPP is operated at partial capacity to generate between 23 and 60MW due to a lack of fuel and the Egyptian feeding lines supply to the Rafah Governorate with 20MW, but are prone to frequent breakdowns. This has increased the deficit to between 75 and 85%, meaning the current electricity supply in July 2017 for each part of the Gaza Strip operates for between two and four hours per day.

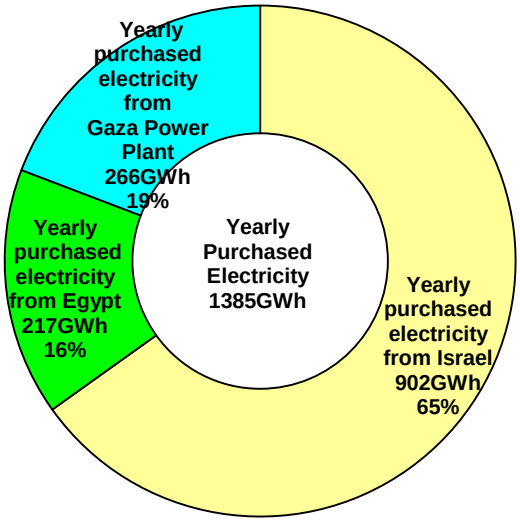
Figure 1-4 and Figure 1-5 show yearly purchased electricity by sources in 2012 before the 2014 Israel-Gaza conflict and in the year of the conflict. In 2012 before the conflict, three-fifths of the purchased electricity was from Israel and two-fifths was from GPP and Egypt. In 2014 in the year of the conflict, the amount of electricity

generated by GPP decreased by shutdown due to the damage of the conflict.



Source: West Bank and Gaza Assessment and Action Plan to improve payment for electricity services in the Palestinian Territories (World Bank Report No. ACS9393, November 25, 2014)
Note: According to GEDCO, the quantities of electricity purchased from Israel and Egypt in the above figure for 2012 were estimated, since no further Israeli and Egyptian bills had been received since 2009

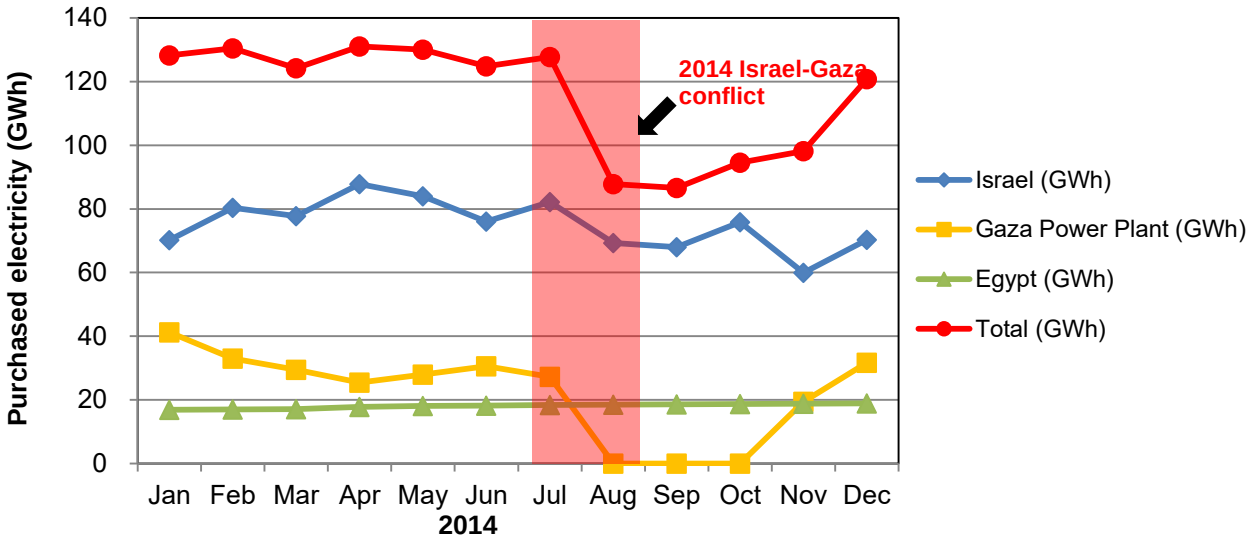
Figure 1-4 Yearly purchased electricity before 2014 Israel-Gaza conflict (2012)



Source: Data provided by GEDCO
Note: According to GEDCO, the quantities of electricity purchased from Israel and Egypt in the above figure for 2012 were estimated, since no further Israeli and Egyptian bills had been received since 2009

Figure 1-5 Yearly purchased electricity in the year of 2014 Israel-Gaza conflict (2014)

Figure 1-6 shows monthly purchased electricity by source in 2014, the Israel-Gaza conflict year. GPP did not operate for three months.



Source: Data provided by GEDCO

Figure 1-6 Monthly purchased electricity by source in 2014

Table 1-1 shows yearly electricity consumption of all customers in the Gaza Strip from 2006 to 2014. The growth of electricity consumption is almost flat after 2007. Currently, the Israeli and Egyptian power supply to the Gaza Strip, and capacity of GPP to be generated are limited up to 120MW, 28MW and 60MW respectively, therefore, the electricity consumption has not been increased year by year. This has results in stagnation of economic development.

Table 1-1 Yearly electricity consumption of all customers in Gaza Strip

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Electricity consumption of all customers (GWh)	858	1,031	1,074	1,088	1,081	1,234	1,149	1,210	1,038

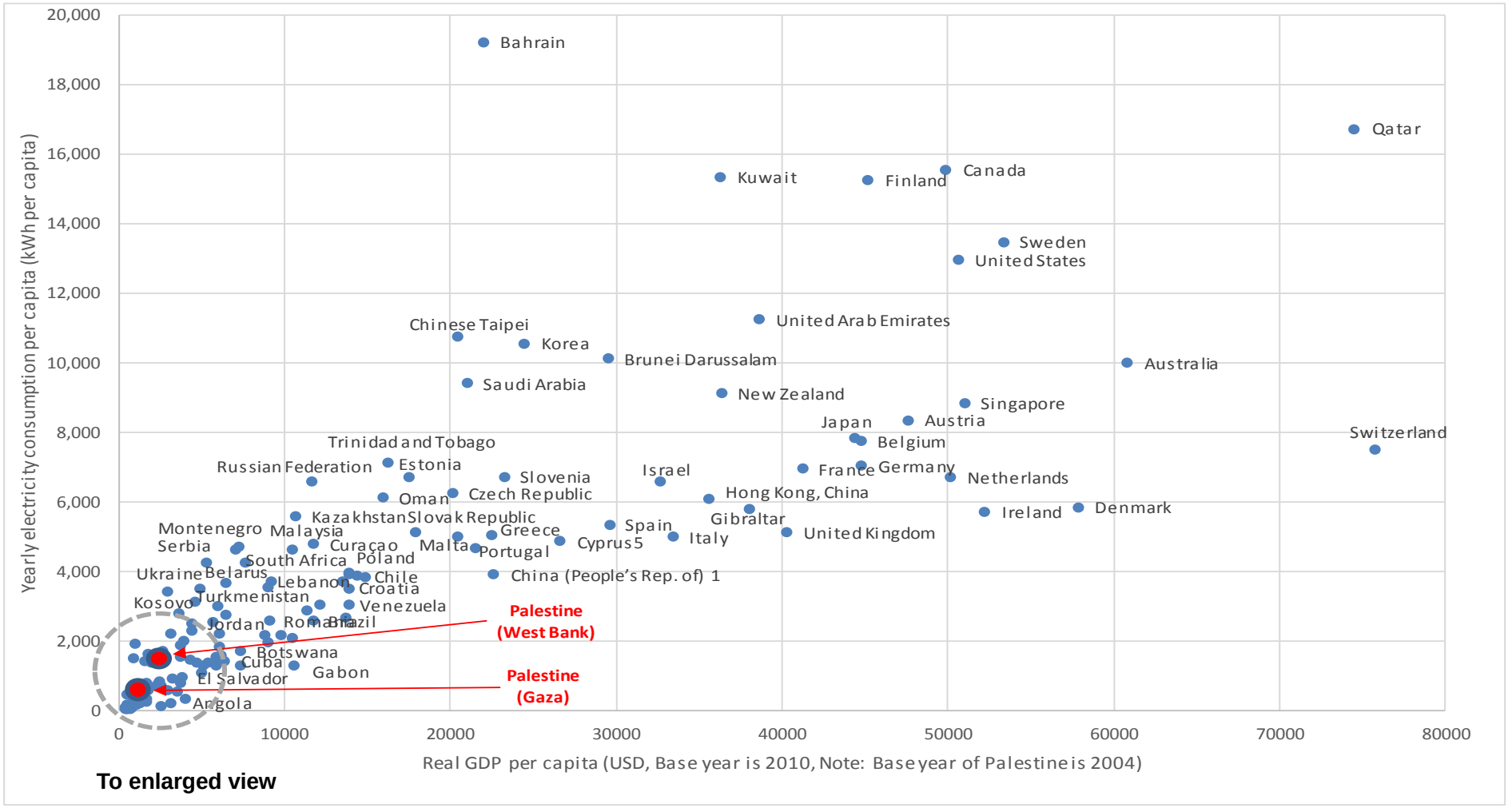
Source: 1. Project Appraisal Document on a Proposed Grant from the Trust Fund for Gaza and West Bank in the amount of USD 8 million equivalent to the Palestine Liberation Organization Gaza Electricity Network Rehabilitation Project (Report No: 66412-GZ)
2. West Bank and Gaza Assessment and Action Plan to improve payment for electricity services in the Palestinian Territories (World Bank Report No. ACS9393, November 25, 2014)

Table 1-2 shows yearly electricity consumption per capita in the Gaza Strip (kWh) in 2014. Figure 1-7 and Figure 1-8 show yearly electricity consumption per capita by real GDP with international comparison. Yearly electricity consumption per capita and real GDP in the Gaza Strip is very low in comparison with developed countries and semi-developed countries, it is also lower than West Bank. However, it is close to Pakistan and Zimbabwe among other developing countries. This shows that the electricity consumption and economic activity in the Gaza Strip is extremely low.

Table 1-2 Yearly electricity consumption per capita in the Gaza Strip (kWh) in 2014

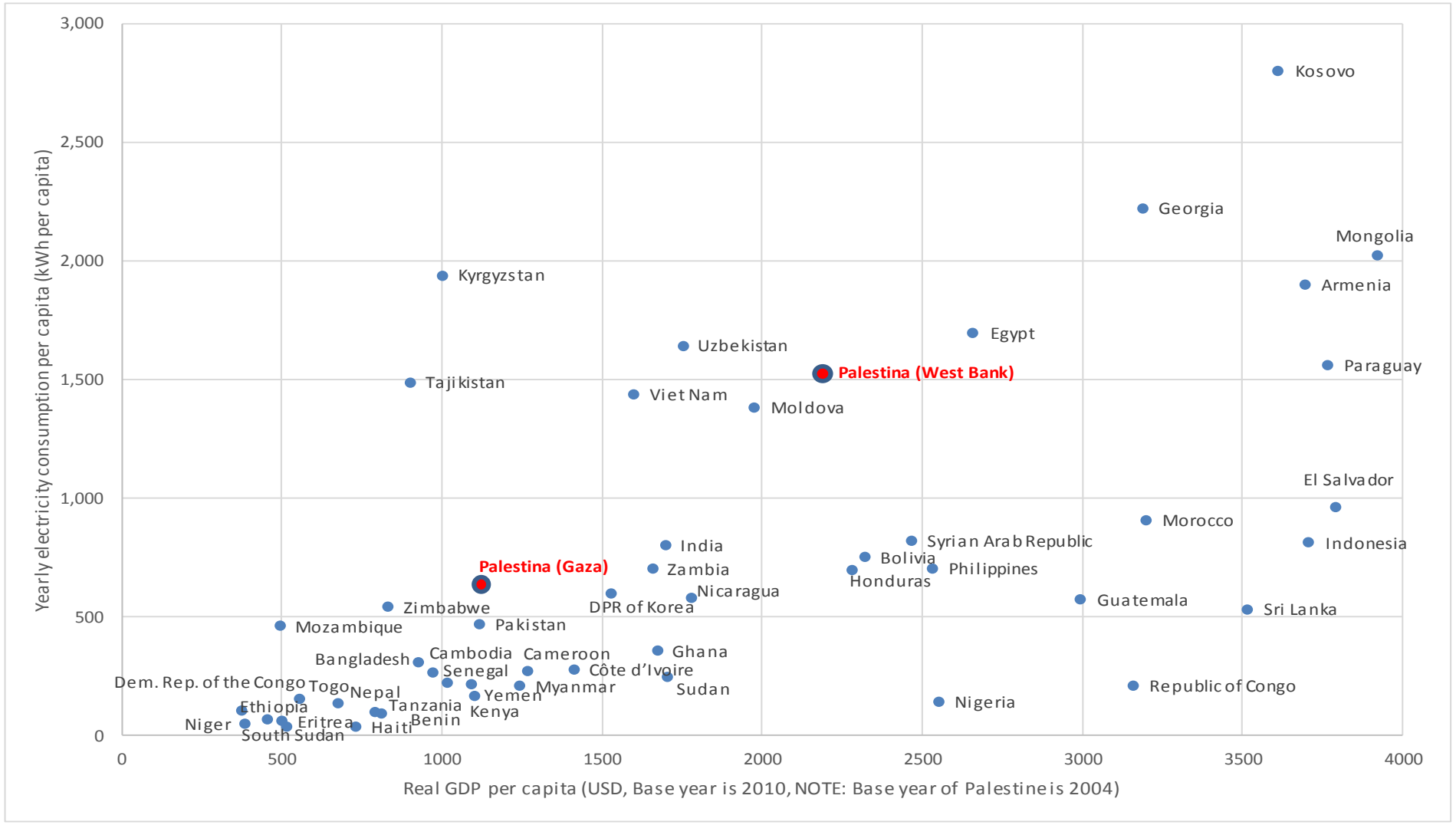
Population of Gaza Strip ※GEDCO’s estimation (2014)	Yearly electricity consumption in 2014 (kWh)	Yearly electricity consumption per capita in Gaza Strip in 2014 (kWh)
1,850,000	1,038,608,619	**561**

Source: Data provided by GEDCO



Source: 2014 International Energy Agency Key World Energy Statistics, 2016 UNSCO Socio-Economic Report Overview of the Palestinian Economy in Q1 - Q4/2016, OCHA Humanitarian Atras 2015, Palestinian Central Bureau of Statistics Imported Energy in Palestine by Type of Energy and Region, 2015, JST

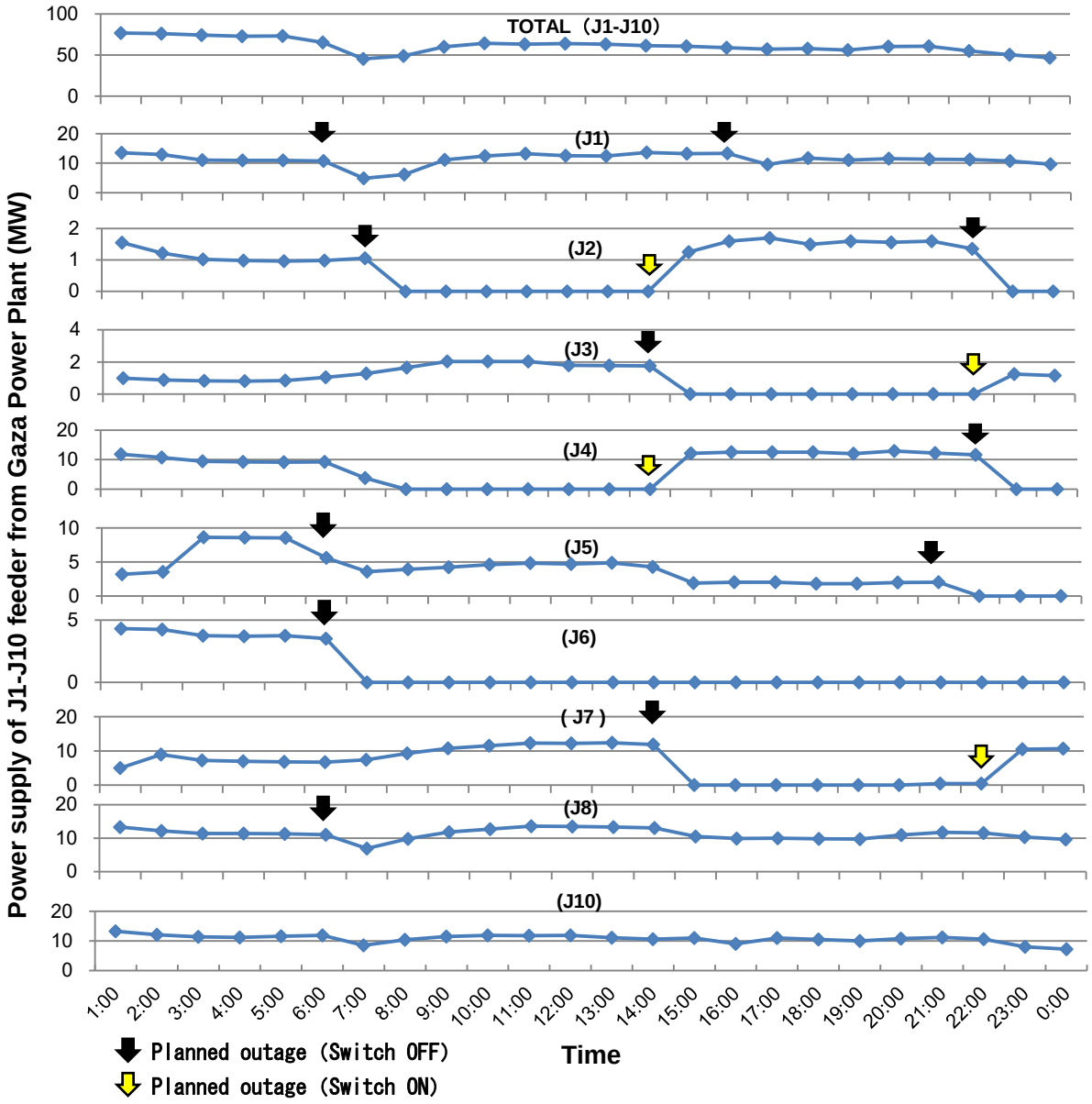
Figure 1-7 International comparison of yearly electricity consumption per capita and real GDP



Source: 2014 International Energy Agency Key World Energy Statistics, 2016 UNSCO Socio-Economic Report Overview of the Palestinian Economy in Q1 - Q4/2016, OCHA Humanitarian Atras 2015, Palestinian Central Bureau of Statistics Imported Energy in Palestine by Type of Energy and Region, 2015, JST

Figure 1-8 International comparison of yearly electricity consumption per capita and real GDP (Enlarged view)

Planned outages are manually triggered by hundreds of workers turning the MV disconnectors on and off every eight hours, three times daily in 2015. Figure 1-9 shows a planned outage of power supply of J1-J10 feeder from GPP (on 12 August 2015) as an example. Planned outage is controlled by switches so that the demand does not exceed the supply limit.



Source: Data provided by GEDCO, JST

Figure 1-9 Planned outage of power supply of J1-J10 feeder from GPP on 12 August 2015 (Example)

(2) Power Generation Facility

The GPP, the only one in the Gaza Strip, is a combined-cycle plant with nominal capacity of 140MW. The plant comprises two identical power blocks, each with capacity of 70MW. Each power block comprises two gas turbines (each of 23MW) and one steam turbine (24MW). The 2014 Israel-Gaza conflict completely destroyed the fuel tanks and fuel treatment equipment, damaged the generator in the first block and the steam turbine in the second block, which meant the destroyed fuel tank in the GPP was forced to shut down at the end of July 2014. The power plant was then repaired by local contractors except for the fuel storage and fuel treatment system and went back into operation at the end of October 2014. The currently available fuel storage system is 1,200 cubic meters instead of the 20,000 cubic meters originally installed, which has led to restrictions being imposed on operating the plant on days when the border with Kerem Shalom gate is closed, Kerem Shalom gate is a passing point of fuel tank lorry for power generation. Moreover, restrictions are also imposed on the fuel, which must be of high quality. The destroyed fuel processing facilities have not been repaired, so fuel cannot be upgraded. Therefore, the GPP uses automotive diesel oil rather than industrial diesel. The power plant is usually operated in a single block and with a nominal output of 60MW, because it is operating on very costly liquid fuel, which makes it financially infeasible to secure the amount of fuel to operate the plant at full capacity. The high cost of fuel is mainly due to the high taxes imposed by Israel, where the final cost per liter is around triple the ex-refinery price[2]. To offset the overwhelming electricity shortage, there is a need to expand the GPP and receive transmissions from outside the Gaza Strip. The Palestinian Energy and Natural Resources Authority (PENRA) has been planning a 161kV transmission system to receive 150MW of electricity transmission from Israel, but it has yet to be implemented due to the lack of political agreement.

Figure 1-10 Destroyed Fuel tank of GPP

(3) Electricity Distribution Facility

A 22kV medium voltage network has been established in all of the 5 governorates in the Gaza Strip. Additionally, the network is connected to the GPP, which is the electricity supply source, and also to the distribution lines from the Israeli side and Egyptian side.

As of June 2015, the distribution system has 10 feeders (120MW in total) connected to the Israeli grid, 10 feeders (60MW in total) connected to GPP and 3 feeders (28MW in total) connected to the Egyptian grid. 1,479 transformers are installed on the 22kV medium-voltage network, and 22kV is transformed into 0.4kV by the transformers and the 0.4kV is distributed to customers by low voltage network. Table 1-3 shows outline of distribution network in Gaza Strip. Regarding medium voltage network, there are route drawing, quantity and specification under GEDCO's management; however, drawings of low voltage network, quantity and specification are not available. Table 1-4 shows outline of transformers in Gaza Strip. In general, to minimize

[2] Oil refinery shipping value

transformer load, operations are usually conducted with distribution generators running at less than 60% of capacity. Jerusalem District Electricity Co., Ltd. (JEDCO), the only electric power distribution company on Palestine's West Bank, also sets a target of 60% or less. However, half of the transformers have exceeding 60% Load factor[3], and there are a lot of high load transformers in Gaza Strip. Especially, the transformer which exceed 100% of load factor is necessary to rehabilitate. The varieties of transformer capacities in Gaza Strip are available at 160, 250, 400, 630, 800, 1,250, and 1,600kVA but almost all of available transformers in the Gaza Strip are 400kVA or 630kVA, on the other hand, the capacity of transformers is almost 50kVA in Japan. Therefore the capacity of transformers in the Gaza Strip is comparatively higher than that of Japan[4]; therefore, each transformer has a lot of customers. This causes the low voltage distribution line between transformer and customer to be longer, resulting in high electricity loss since low voltage and long-distance distribution line makes electricity loss high. Electricity loss increases in proportion to the decrease in distribution voltage. It thus appears that electricity losses are being exacerbated by transmitting power over long-distances at low voltage.

Table 1-3 Outline of distribution network in the Gaza Strip

Distribution network	Unit	Governorate					Total
		North	Gaza	Middle	Khan Younis	Rafah	
Medium Voltage line length (Estimation)	km	90	193	77	110	80	550
Number of Medium Voltage Steel Tower (Estimation)	No.	990	1,700	1,000	1,170	880	5,740
Number of Medium Voltage Concrete Poles (Estimation)	No.	70	115	130	175	85	575
Number of Medium Voltage Wooden Poles (Estimation)	No.	70	85	90	100	70	415
Low Voltage line length (Rough Estimation)	km	-	-	-	-	-	7,000

Source: Data provided by GEDCO

Table 1-4 Outline of transformer in the Gaza Strip

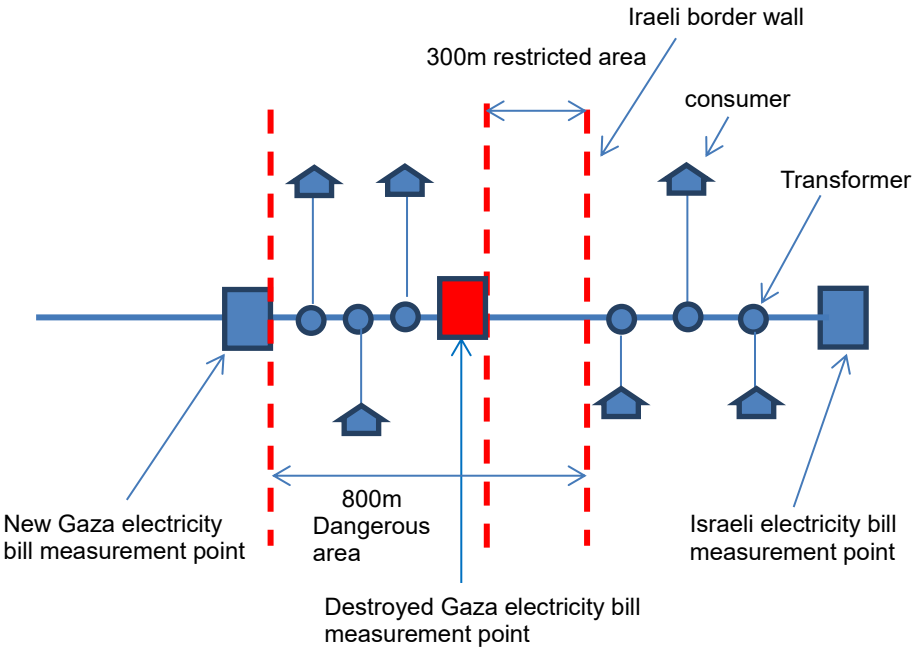
Transformer	Unit	Governorate					Total
		North	Gaza	Middle	Khan Younis	Rafah	
Number of transformers	No.	266	538	259	244	172	1479
Capacity of transformers	MVA	163	372	137	137	102	911
Number of transformers with over 60% load factor	% of total	177	260	101	110	91	739
		67%	48%	39%	45%	53%	50%
Number of transformer over 100% Load factor	%of total	52	32	7	18	25	134
		20%	6%	3%	7%	15%	9%

Source: Data provided by GEDCO

As for the payment method to Israel, the price charged is based on the amount of electricity measured at the point on the Israeli side where bills are measured, as shown in Figure 1-11. GEDCO had had its own measurement point located at 300m from the dividing wall between Israel and the Gaza Strip, but since this was destroyed during the 2014 Israel-Gaza conflict, GEDCO re-installed at 800m from the wall, since the previous location closer to the wall posed a danger to GEDCO workers. There are also some consumers among metering points of Israel and the Gaza Strip (consuming an unknown quantity of electricity), which GEDCO is unable to confirm their consumptions. Consequently, GEDCO assumes the electricity consumption in the stretched are,

[3] Load factor: Maximum load of transformer/Capacity of transformer
[4] The varieties of transformer capacity in the Japanese distribution network of Tokyo Electric Company are 10, 20, 30, 50, 75 and 100kVA in single phase 6.6kVA/210-105V, and almost all transformers are 50kVA.

although the actual value may be different. GEDCO has been paying the electricity charge to the Israel without knowing the exact electricity consumption, so the installation of a watt-hour meter at each measurement point is being planned with a donor assistance.



Source: Interview with GEDCO, JST

Figure 1-11 Measurement of electricity from Israel

Regarding the 148MW (Israel: 120MW, Egypt: 28MW) electricity supply from Israel and Egypt, the voltage at the power receiving point is lower than allowable range due to voltage drop, affecting the appliances of customers negatively. Especially, voltage at the receiving point from Egypt is considerably low. The Egypt supplies approximately 28MW of power through a distribution system consisting of three lines. Since the substation on the Egyptian side is 35 km far from Rafah Governorate in the south of Gaza Strip, voltage drop (from 22kV to 17kV) and electricity loss occur often in Rafah Governorate. Thus, the electric supply services to general households as well as operation of hospitals has been impacted greatly. Generally, when a voltage drop occurs, the electric current drawn by induction motors (i.e. various motor driven machines, pumps, etc.) and inverter control devices (i.e. air conditioners, refrigerators, compressors, construction tools, etc.) increases, causing an increase in electricity loss. This also causes decreased output in electric heaters, decreased luminance and lifespan in fluorescent lamps, and failure in control devices. As for actual harm caused by this, various problems are occurring such as the outflow of untreated sewage into the sea due to malfunctioning pumps at sewage treatment plant, and issues with inadequate water supply caused by malfunctioning groundwater pumps.

(4) Implementation Agency

1) The Palestinian Energy and Natural Resources Authority (PENRA)

PENRA is responsible for enterprises related to the electric power system (electricity generation, transmission, distribution and transformation, including renewable energy) in the Palestinian Authority. In the Gaza Strip, PENRA supplies fuel to the Palestinian Electricity Company (PEC) in GPP centrally.

Headquarters of PENRA is located at West Bank and it had branch office in Gaza Strip is located at Gaza city. As for staffing levels, there are approximately 100 staff at PENRA in the Gaza Strip, and approximately 10 staff in the Project Management Unit (PMU)[5] at PENRA in Ramallah.

2) Palestinian Electricity Company (PEC)

PEC was established in 1999 in accordance with Palestinian laws, to establish and operate power generating plants in Palestinian territories. PEC is a public owned company whereby the public shareholders represent 33% and the private shareholders represent 67%.

3) Gaza Power Generating Company (GPGC)

PEC owns GPGC, GPGC was established as GPP's operational arm of GPP which is the sole Palestinian supplier of power in Palestine in order to fulfill the electricity needs of the Gaza Strip. The number of employees is 170.

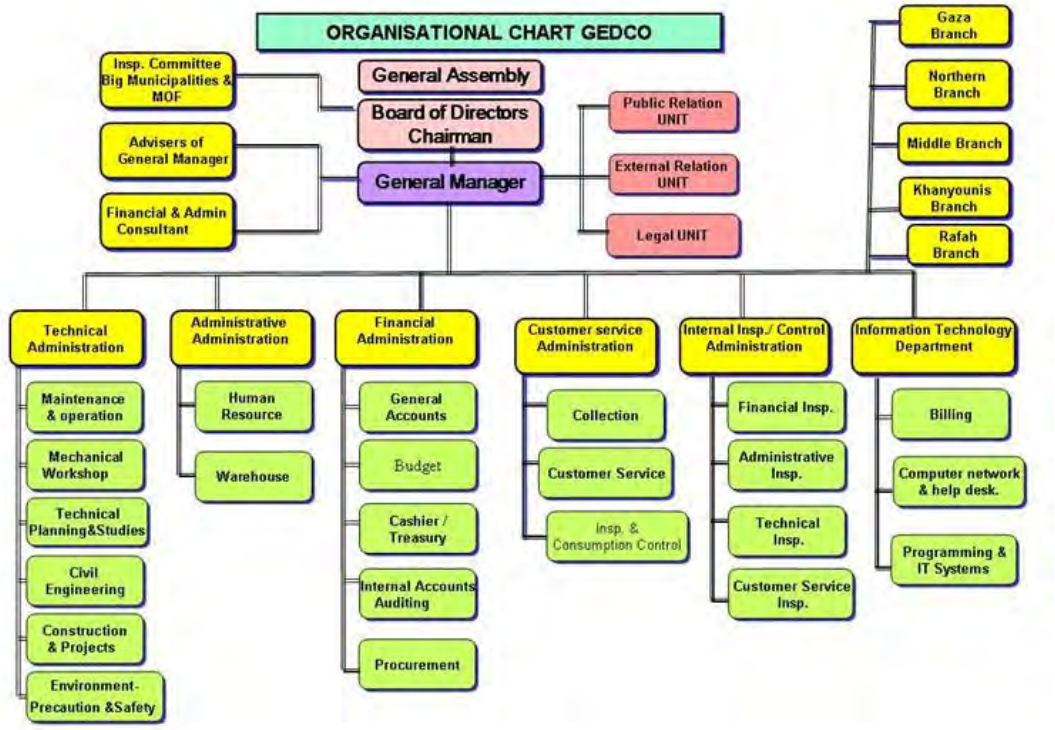
4) Gaza Electricity Distribution Company (GEDCO)

The implementation body for the energy sector (especially distribution) in the Gaza Strip is GEDCO, established in 1998, performs electricity distribution, maintenance and management of electricity distribution facilities, and electricity fee collection in the Gaza Strip. It possesses 5 offices in the Gaza Strip, and in the entire distribution area of Gaza where 1,760,000 people inhabit; the number of customer is 221,792. Distribution voltage is set to be at 22kV, and it is stepped down to 0.4kV by distribution transformer to supply low voltage to consumers.

- GEDCO's responsibilities
  - Ensure power distribution service to all customers (home, industry, commerce, public agencies) based on the technical standards
  - Improvement of quality and ensuring stability of power distribution services
  - Renovation and replacement of deteriorated power distribution networks
  - Installation of new transformers and maintenance of existing transformers
  - Establishment of a future power distribution plan corresponding to increasing of power demand
  - Development of hazard prediction, safe distribution network and environmental consideration
  - Development of Information Technology (IT) in all operational aspects
  - Focus on training and creative work to meet customer needs for optimal distribution services
  - Repair and restoring of failures and damages on the distribution network due to Israeli attacks, and also improvement of electricity losses caused by the damage
  - Establishment of necessary elements for the future planning for expansion of the entire distribution network

Figure 1-12 shows the organization chart of GEDCO.

[5] PMU is responsible for handling all aspects of financial and procurement issues related to project.



Source: Data provided by GEDCO

Figure 1-12 Organizational Chart of the Gaza Electricity Distribution Company (GEDCO)

- GEDCO's technical standards

In recent years, GEDCO has been occupied with dealing with repairing of distribution networks that have been destroyed by the conflict, blackout due to shortage of power supply and electricity theft.

GEDCO aims at centrally controlling the distribution network. Nonetheless, currently GEDCO has been forced to implement planned outage as it faces a big shortage of construction material, machinery for maintenance and management, test devices, restriction of electricity supply from outside of the Gaza Strip, etc. Thus, it has been operating planned outage by turning on and off the switches of 1,430 transformers manually.

According to the interviews with PENRA and GEDCO, as well as result of the analysis of the collected materials, GEDCO is considered to have a certain level of technical capacity that is required for maintenance and management of the distribution network. In terms of human resource development of technician, the number of young expert to shoulder the next generation is not enough and training course in Gaza Strip is insufficient. Participation in training in other countries is the most expected, however training in other countries is difficult there due to the political situation with Israel as of 2017. Thus, it is necessary to pay attention when planning training.

- GEDCO's financial performance

Table 1-5 shows the financial performance of GEDCO according to its financial record from 2006 to 2014. GEDCO's income from collecting electricity charges is listed under income. Expenditures consist of electricity purchases, labor cost, repairs, etc. GEDCO has not received invoices for electricity purchased from Israel and Egypt since 2009 and does not have a grasp on accurate information such as the amount of electricity purchased,

etc. Therefore, the electricity purchase amounts in Table 1-5 show an estimated values of total energy purchase amounts and loss (estimates). Although electricity loss has been calculated by subtracting electricity sales from purchases, it is impossible to determine accurately due to energy purchases being estimates. In light of this, it is considered necessary for GEDCO to gain a thorough understanding of electricity purchase amounts in developing measures against electricity loss. According to the agreement between GEDCO and PENRA, the unit price of electricity purchased from Israel and electricity purchased from the GPP are the same. Also, according to a World Bank report entitled "West Bank and Gaza Assessment and Action Plan to improve payment for electricity services in the Palestinian Territories," GEDCO has not paid electricity purchase fees to Israel nor Egypt. Electricity fees paid to Israel are deducted by the Israeli Ministry of Finance from the value-added tax (16%) levied by the Palestinian government on goods imported to the Gaza Strip, and are paid to Israel as net lending. In addition, electricity fees collected by GEDCO are supplied through PENRA to Gaza Power Plant to purchase the fuel necessary for operation.

Table 1-5 Financial Performance of GEDCO According to Financial Records

: Estimated values

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Power purchase amount (GWh)	1,129	1,483	1,439	1,554	1,544	1,762	1,641	1,729	1384
Power sales amount (GWh)	858	1,031	1,074	1,088	1,081	1,234	1,149	1,210	1038
Electricity loss (%)	24	30	25	30	30	30	30	30	25
Average electricity purchase price from Israel and Gaza Power Station (NIS/kWh)	0.34	0.33	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Average electricity purchase price from Egypt (NIS/kWh)	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.27
Average unit price for electricity purchases (NIS/kWh)	0.34	0.33	0.38	0.38	0.38	0.38	0.38	0.38	0.37
Average unit price for electricity sales (NIS/kWh)	0.40	0.42	0.42	0.42	0.42	0.44	0.47	0.46	0.55
Energy purchase cost (Million NIS)	381	487	544	588	583	670	623	652	511
Staffing, repair, and other costs (Million NIS)	38.0	42.0	58.0	49.0	45.0	51.9	54.8	52.6	51.3
Expenditures (Million NIS)	419	529	602	637	628	722	678	705	562
Revenues (Million NIS)	342	431	449	455	452	549	540	555	567
Profit (Million NIS)	-65	-93	-122	-157	-171	N/A	N/A	N/A	N/A
Depreciation/Nonperforming loans/Other provisions (Million NIS)	19.0	19.0	19.0	20.0	20.0	20.7	18.9	12.6	13.9
Uncollected money (Million NIS)	1,017	1,297	1,628	1,954	2,223	2,452	2,663	2,854	3104
Electricity bill collection rate (%)	28	35	34	41	52	65	66	67	60

Source: Data provided by GEDCO

Table 1-6 shows electricity consumption by customer type and tariff structure in Gaza Strip in 2014. Electricity consumption of domestic is seven-tenth of the total, while that of industrial, commercial, agricultural makes only one-tenth of the total.

Table 1-6 Electricity consumption by customer type and Tariff structure (2014) in Gaza Strip

Customer type	Domestic	Industrial	Commercial	Agricultural	Public institution	Temporary	Municipalities	Total
Number of customers	195,871	3,992	12,421	3,498	3,183	2,110	717	221,792
Number of customers (%)	88.3%	1.8%	5.6%	1.6%	1.4%	1.0%	0.3%	100%
Electricity consumption (GWh)	725.2	49.7	70.74	32.4	50.2	4.1	106.2	1,038.54
Electricity consumption (GWh)	69.8%	4.8%	6.8%	3.1%	4.8%	0.4%	10.2%	100%
Electricity sales tariff (NIS/kWh)	0.50 (Single /Three phase, Classified domestic) 0.60 (Multi use domestic and commercial)	0.60 (Three phase or power use)	0.50 (Single phase) 0.60 (Three phase) 0.6 (Single/three phase, Communications)	0.50 (Single phase) 0.60 (Three phase)	0.50 (Single phase) 0.60 (Three phase)	0.65 (Single phase) (Three phase)	0.55 (Street lighting) 0.60 (Other facilities)	0.52 *2013 year

Source: Data provided by GEDCO

Table 1-7 shows cost of purchased electricity and electricity sales tariff of each electricity supplier in 2012. The GPP has the highest electricity purchase tariff, while electricity purchase tariff of Egypt is half of that of GPP and Israel. The high electricity purchase tariff makes financial status of GEDCO poor. As Table 1-6 shows, electricity tariff is set at 0.52NIS/kWh in total, and it is almost same as 0.50NIS/kWh of the purchasing cost, therefore the tariff structure is unprofitable. It seems that the high electricity purchasing cost is causing GEDCO's financial status to worsen.

Table 1-7 Cost of purchased electricity by electricity supplier (2012)

Electricity supplier	Israel	Egypt	GPP	Total
Cost of purchased electricity (NIS)	443,846,085	29,137,992	254,972,224	727,956,301
Unit Cost(NIS/kWh)	0.49	0.23	0.65	0.50

Source: West Bank and Gaza Assessment and Action Plan to improve payment for electricity services in the Palestinian Territories (World Bank Report No. ACS9393, November 25, 2014)

- Low electricity bill collection rate

Table 1-8 shows the collection percentage of electricity charges by GEDCO, all regions of the West Bank, and each electricity distribution company NEDCO, TEDCO, JEDCO, HEPCO) in the West Bank. The collection ratio of GEDCO is lower than that of companies in the West Bank. However, it is gradually improved and the highest figure, 71% was marked in 2013. It is considered that this occurred because the system to deduct the electricity charges directly from the salary of public workers was introduced since 2008. The total payment by

the public workers summed up to NIS 134 million, 30% of the collected total amount. Effective impact of the new system on improvement of the collection ratio was recognized. Common causes for this include high electricity charges, low income, poor service, and low ability of fare collectors to follow up with customers. In addition, 5,000 prepaid meters were installed in the same year. This also had a positive impact on the improvement of the collection rate.

Table 1-8 Average yearly collection for DISCO (Distribution company) 2009−2013

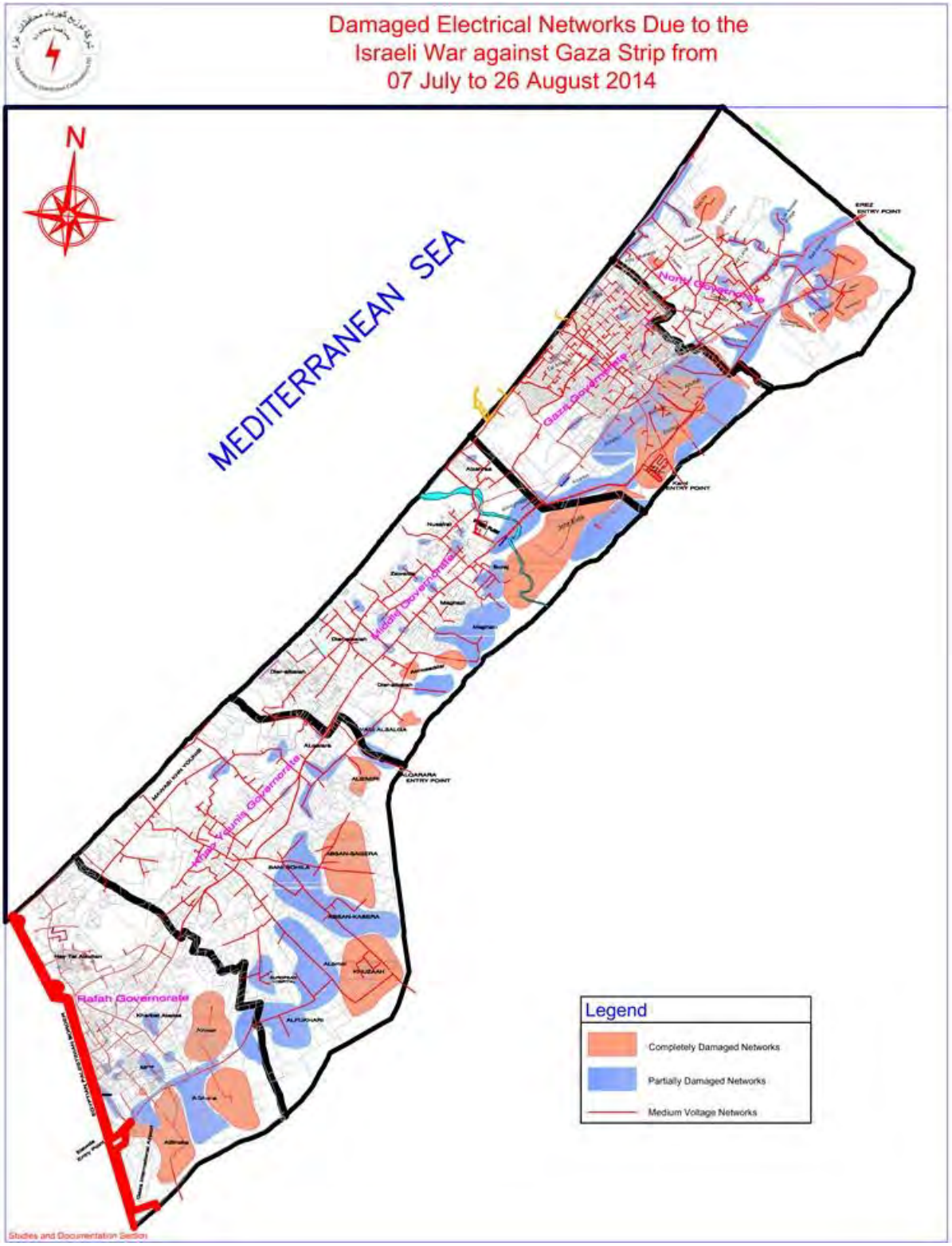
Year	NEDCO	TEDCO	JDECO	HEPCO	West Bank	GEDCO
2009		93%	96%	81%	93%	47%
2010	81%	117%	92%	80%	90%	59%
2011	79%	97%	96%	74%	90%	65%
2012	70%	105%	97%	74%	89%	68%
2013		97%	83%	70%	81%	71%

Source: West Bank and Gaza Assessment and Action Plan to improve payment for electricity services in the Palestinian Territories (Report No. ACS9393, November 25, 2014)

1-1-3 Damage of 2014 Israel-Gaza Conflict

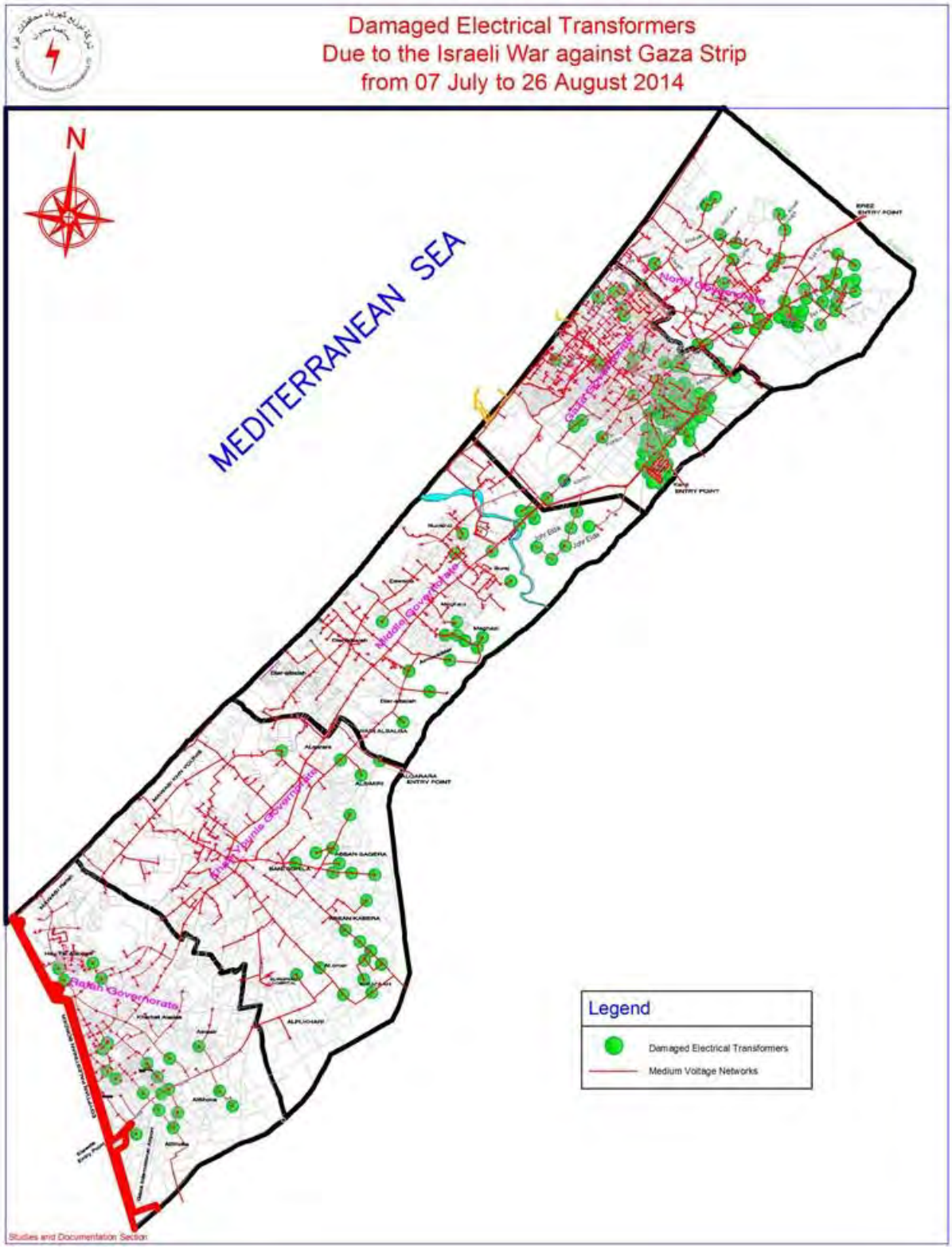
(1) Reconstruction status

Figure 1-13 and Figure 1-14 show electrical networks, and electrical transformers damaged by the 2014 Israel-Gaza conflict. The distribution facilities in east side of the Gaza Strip have been greatly damaged by the Israeli army attack. Some distribution facilities have been temporarily reconstructed by the GEDCO. However, the shortage of construction material and the temporary treatment increase the danger of electrical accidents including electric shock. Therefore, prompt reconstruction is desired.



Source: Damages Assessment Report, Electricity Distribution Sector, Israeli War against Gaza Strip (07 JULY-26 AUGUST 2014)

Figure 1-13 Electrical networks damaged by 2014 Israel-Gaza conflict



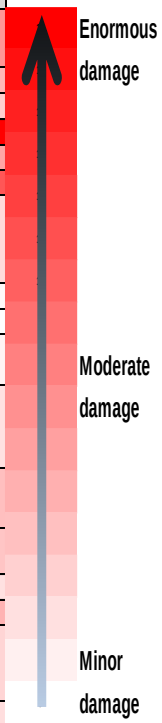
Source: Damages Assessment Report, Electricity Distribution Sector, Israeli War against Gaza Strip (07 JULY-26 AUGUST 2014)

Figure 1-14 Damaged electrical transformers due to 2014 Israel-Gaza conflict

Table1-9 shows details on damage to power facilities by each municipality, while Table1-10 shows the damage assessment cost for facilities by each municipality. There is severe damage in Alshejaia and different zones (regions other than Alshejaia and Alzayton) of the Gaza Governorate, followed in severity by Beit Honoun and Beit Lahia of the North Governorate. Thirdly, there is prominent damage in Khuzaah and Alfukhari, and Abasan Al Kabera in the Khan Younis Governorate, as well as Alshoka in Rafah Governorate.

Table1-9 Damage to Power Facilities by Municipality

Governorate	Municipal	Steel Materials and Wooden Poles (US$)	Transformers (US$)	Switches, Switchgears and Distribution Boards (US$)	Wires , Cables and M.V Cables Accessories (US$)	Fuse Holders, Insulators and Accessories (US$)	Concrete for Steel Bases (US$)	Total (US$)
North	Beit Hanoon	290,349	346,080	151,353	432,987	142,665	36,600	**1,400,034**
	Beit Lahia	225,309	184,660	115,662	413,574	99,399	26,400	**1,065,003**
	Jabalia	150,998	177,900	74,353	314,679	78,466	30,200	**826,596**
Gaza	Alshejaia	638,010	749,520	316,059	865,538	224,816	111,150	**2,905,092**
	Alzayton	345,474	112,620	56,177	533,328	139,672	63,200	**1,250,470**
	Different Zones	471,650	329,920	213,015	791,283	190,126	46,450	**2,042,444**
Middle	Johr Aldik, Almoghraga and Alzahra	206,743	142,020	45,235	219,162	77,163	25,300	**715,624**
	Almaghazi	86,958	97,920	27,765	134,820	49,776	9,200	**406,439**
	Alburayij	99,779	14,700	20,235	137,844	50,483	9,650	**332,691**
	Alnusairat and Alzawayde	88,996	76,740	33,588	194,773	56,673	9,300	**460,071**
	Deir Albalah, Amosadar and Wadi Alsalga	179,539	62,040	31,882	269,350	84,580	16,600	**643,992**
Khan Younis	Khuzaah and Alfukhari	312,895	130,560	69,529	322,113	112,632	36,550	**984,279**
	Abasan Al Kabera	255,874	140,560	82,529	303,393	102,687	35,650	**920,694**
	Different Zones	151,883	112,920	47,294	235,961	74,145	15,750	**637,953**
Rafah	Al Shoka	322,505	124,380	88,559	418,099	120,839	31,800	**1,106,181**
	Alnasir and Kherbet Aladas	241,689	79,980	39,412	283,424	84,542	29,800	**758,846**
	Different Zones	161,198	124,380	49,000	249,355	70,592	21,100	**675,625**
Total (US$)		**4,229,849**	**3,006,900**	**1,461,647**	**6,119,683**	**1,759,256**	**554,700**	**17,132,035**



Source: Damages Assessment Report Electricity Distribution Sector Israeli War against Gaza Strip (07 JULY-26 AUGUST 2014)

Table1-10 Damage Assessment Cost for Facilities by Municipality

Governorate	Municipal	Steel Materials and Wooden Poles					Transformers	Switches, Switchgears and Distribution Boards				Wires , Cables and M.V Cables Accessories				Fuse Holders, Insulators and Accessories					Concrete for Steel Bases	Total (US$)
		Steel Poles	Wooden Poles	Steel Bases	Steel Arms	Steel Accessories		M.V Switches	L.V Switches	Switchgears	Distribution Boards	Wires	L.V Cables	M.V Cables	M.V Cables Accessories	Surge Arrestors Fuse holders and Accessories	Insulators and Accessories	Overhead lines Accessories	L.V Cables Accessories	Another Accessories	Concrete	
		No.	No.	No.	No.	US $	No.	No.	No.	No.	No.	km	km	km	No.	No.	No.	No.	No.	US $	m3	US $
North	Beit Hanoon	118	660	41	584	9453	22	19	88	2	0	66	39	1	12	98	754	1,247	11,088	16,389	366	1,400,034
	Beit Lahia	82	404	27	845	6055	11	11	45	3	1	31.9	31.4	1.5	21	70	370	1,140	8,559	8,869	264	1,065,003
	Jabalia	51	270	32	382	3906	11	16	44	0	0	47.2	20	1.45	30	68	386	1,188	5,543	9,192	302	826,596
Gaza	Alshejaia	261	1109	100	1637	17078	47	37	192	4	1	89.9	60.2	9.6	72	127	1,071	2,395	15,662	35,143	1,112	2,905,092
	Alzayton	116	508	51	1130	8061	7	14	32	0	0	51.4	47.4	3.2	36	77	526	1,636	11,653	9,573	632	1,250,470
	Different Zones	164	1000	70	1315	13233	20	38	89	2	3	84	52.5	5.6	93	223	899	3,037	12,897	20,081	465	2,042,444
Middle	Johr Aldik, Almoghraga and Alzahra	96	393	32	444	5613	9	11	24	0	0	32	24	0	0	48	424	650	6,604	8,418	253	715,624
	Almaghazi	44	170	7	193	2658	6	8	12	0	0	10.2	16	0	0	29	210	582	4,475	5,426	92	406,439
	Alburayij	38	240	9	249	3298	1	8	4	0	0	9.08	17	0.05	8	19	282	564	4,689	4,468	97	332,691
	Alnusairat and Alzawayde	34	190	11	300	3132	5	9	16	0	0	23.5	15	1.05	54	29	286	823	4,272	6,455	93	460,071
	Deir Albalah, Amosadar and Wadi Alsalga	61	444	15	388	5998	4	10	12	0	0	43.1	24	0.5	21	32	528	1,040	6,412	7,043	166	643,992
Khan Younis	Khuzaah and Alfukhari	132	760	36	631	9683	8	12	32	1	0	43.4	33	0	0	98	605	1,108	8,774	7,608	366	984,279
	Abasan Al Kabera	134	424	29	533	6627	8	13	28	2	0	33.3	30	0	0	82	497	1,103	8,546	7,046	357	920,694
	Different Zones	80	260	15	379	4266	7	12	24	0	0	33.3	18	1.5	33	72	355	1,240	5,114	6,016	158	637,953
Rafah	Al Shoka	132	860	32	685	11168	8	11	28	2	1	63.3	38	0.5	36	101	645	1,026	9,473	7,904	318	1,106,181
	Alnasir and Kherbet Aladas	125	524	28	442	7168	5	10	20	0	0	29.1	29	0	0	75	330	833	7,525	5,380	298	758,846
	Different Zones	84	270	31	445	3692	8	11	28	0	0	36.9	19	1.5	18	73	348	1,032	4,731	6,522	211	675,625
Total		1,752	8,486	566	10,582	121,089	187	250	718	16	6	727	514	27	434	1,321	8,516	20,644	136,017	171,533	5,550	17,132,034

Source: Damages Assessment Report Electricity Distribution Sector Israeli War against Gaza Strip (07 JULY-26 AUGUST 2014)

1-1-4 Progress of repair work

(2) Repair work

Although the assistance of donors for reconstruction has been implemented, the restriction and monitoring imposed by the Israeli side for security reason is making the delivery of the materials to the Gaza Strip difficult. As a result, the reconstruction and assistance process has been taking time.

As seen in Figure 1-15, distribution lines are temporarily repaired with whatever equipment and materials are on hand. Temporary repairs on transformers are made in GEDCO's repair shop, but as these are all makeshift repairs there are significant voltage drops and the electricity losses, and power quality seems to be getting worse than it was before the invasion of the Gaza Strip. One of the factors in electricity loss is that, if the contact area is too small when connecting severed wires together, electricity loss increases due to larger contact resistance. In the field, some cases have been seen in which power wires are connected by twisting them together. Electricity loss occurs in such cases due to inadequate twisting (see Figure 1-16) which unravels when vibration or tension is applied the power wire, causing an increase in contact resistance. As seen in Figure 1-17, sometimes PG clamps are used in the field to connect ABC cables, but generally PG clamps are meant to be used in areas not under tension (connecting jumper wires, etc.). If they are used in areas under tension (lines between utility poles) in this manner, bolts can loosen over time from vibration or tension, also causing an increase in contact resistance. Also, since PG clamps are conductors, an interphase short circuit can occur if PG clamps come into contact with each other. Consequently, the current temporary repairs are not considered suitable as permanent solutions and it needs permanent repair.

Figure 1-15 Temporary repair of 22kV distribution line

Figure 1-16 Temporary repair of 0.4kV distribution line

Figure 1-17 Temporary repair using PG clamps

Table 1-11 shows damage status and reconstruction status of distribution line as of 2015. As of 2015, the 22kV medium-voltage distribution network has been affected significantly, and 46 % of the total network has been damaged. Moreover, 187 transformers for electricity distribution (about 13% of all districts) have been damaged and become unusable due to the Israeli attack, and half of the damaged transformers have been temporarily repaired since then.

Only a small percentage of permanent repairs funded by donors, such as distribution networks and new transformer replacement, have been completed, resulting in almost no progress in permanent reconstruction. One of the principal causes was the destruction of GEDCO's warehouse during Israeli attacks in 2014, which resulted in loss of equipment and materials needed for maintenance and distribution network operation. GEDCO needs new equipment for repairing the distribution network and to replace transformers that have been temporarily repaired.

Table 1-11 Damage status and reconstruction status of distribution line

					Unit	%
Medium Voltage Line	Total line length			550	km	**100**
	Damage Status	Damaged line length	All Governorate	251	km	**46**
			North Governorate	49	km	**9**
			Gaza Governorate	81	km	**15**
			Middle Governorate	40	km	**7**
			Khan Younis Governorate	37	km	**7**
			Rafah Governorate	44	km	**8**
		Non-damaged line length		299	km	**54**
	Reconstruction Status	Permanently repaired line length		16	km	**3**
		Temporarily repaired line length		210	km	**38**
		Non-repaired line length		25	km	**5**
Low Voltage Line	Total line length			7000	km	**100**
	Damage Status	Damaged line length	All Governorate	514	km	**7**
			North Governorate	90	km	**1**
			Gaza Governorate	160	km	**2**
			Middle Governorate	96	km	**1**
			Khan Younis Governorate	81	km	**1**
			Rafah Governorate	86	km	**1**
		Non-damaged line length		6486	km	**93**
	Reconstruction Status	Permanently repaired line length		68	km	**1**
		Temporarily repaired line length		395	km	**6**
		Non-repaired line length		51	km	**1**
Transformer	Total number			1430	No.	**100**
	Damage Status	Number of damaged	All Governorate	187	No.	**13**
			North Governorate	44	No.	**3**
			Gaza Governorate	74	No.	**5**
			Middle Governorate	25	No.	**2**
			Khan Younis Governorate	23	No.	**2**
			Rafah Governorate	21	No.	**1**
		Number of non-damaged		1243	No.	**87**
	Reconstruction Status	Number of permanently repaired		14	No.	**1**
		Number of temporarily repaired		115	No.	**8**
		Number of non-repaired		58	No.	**4**

Source: Damages Assessment Report Electricity Distribution Sector Israeli War against Gaza Strip (07 JULY-26 AUGUST 2014), PENRA/GEDCO
Data provided by PENRA / GEDCO, JST

(3) Maintenance Status of Distribution Networks

Table1-12 shows the maintenance status of each region's distribution network in 2015. International Committee of the Red Cross (ICRC) provides partial assistance for maintenance, which consists of preventive maintenance work, reconstruction work, rehabilitation works, and emergency maintenance. Also, the maintenance cost in Rafah is somewhat low compared with Figure 1-10's Damage Assessment Cost. Figure 1-18 shows distribution network maintenance costs. Reconstruction work and emergency maintenance account for

60% of the total, indicating that the distribution network is inadequate.

Table1-12 Maintenance Status of Distribution Networks in Each Region (2015)

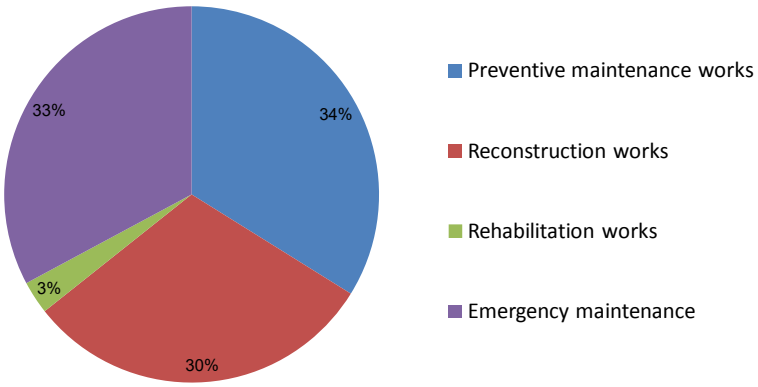
Contents of maintenance	Preventive maintenance works						Reconstruction works				Rehabilitation works				Emergency maintenance	Maintenance Cost Total	Damage Assessment Cost Total	Maintenance Cost / Damage Assessment Cost
	Materials of preventive maintenance	Enlarge transformers	Efficiency works and remove danger				Reconstruction projects				Rehabilitation of low voltage networks				Materials of urgent maintenance			
Source of fund			ICRC Grant		GEDCO		ICRC Grant		GEDCO		ICRC Grant		GEDCO					
	NIS	NIS	No.	NIS	No.	NIS	No.	NIS	No.	NIS	No.	NIS	No.	NIS	NIS	NIS	NIS	%
North	73,748	269,330	3	37,724	30	216,752	19	283,230	29	348,108	1	5,902	3	18,904	1,037,881	2,291,663	12,421,932	18
Gaza	510,348	328,078	5	48,248	83	1,003,583	17	128,170	57	639,259	7	52,384	7	67,543	1,348,144	4,125,931	23,389,973	18
Middle	30,353	125,499	0	0	32	295,135	17	402,595	18	135,684	1	15,604	12	132,940	334,966	1,472,856	9,656,438	15
Khan Younis	99,085	357,582	1	7,977	30	190,386	17	649,171	27	703,573	1	4,217	6	34,032	630,091	2,676,196	9,596,469	28
Rafah	117,407	181,083	0	0	6	50,465	6	186,160	2	73,000	0	0	0	0	471,967	1,080,096	9,587,887	11
Total	830,942	1,261,572	9	93,949	181	1,756,321	76	1,649,325	133	1,899,623	10	78,106	28	253,419	3,823,049	11,646,742	64,652,699	

High maintenance cost

Mudium maintenance cost

Low maintenance cost

Source: Data provided by GEDCO

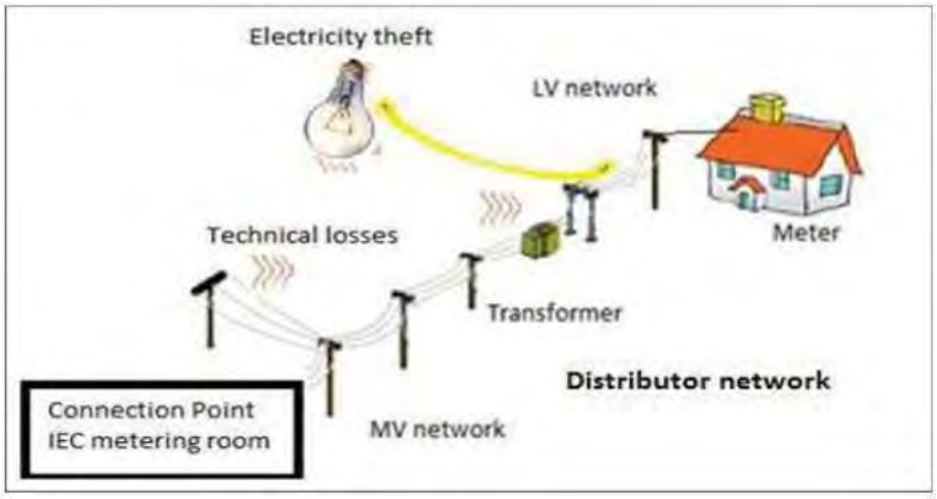


Source: Data provided by GEDCO

Figure 1-18 Distribution Network Maintenance Cost as Percentages

(4) High electricity loss (technical loss) due to temporarily repaired distribution network

Technical loss, as shown in Figure 1-19, is the loss of electricity caused by electric resistance of the power line, transformer, cables, etc. The electricity loss in the West Bank is measured by comparing the electricity measured at the connecting point of the IEC supply side with the sum of electricity that is measured at each customer. The difference between these two is the electricity loss, which also contains non-technical loss.



Source: World Bank, West Bank and Gaza Assessment and Action Plan to improve payment for electricity services in the Palestinian Territories (Report No. ACS9393, November 25, 2014)

Figure 1-19 Electricity losses

Table 1-13 shows the electricity loss (Technical Loss + Non-technical loss) by each electricity distribution company from 2010 to 2013 in Palestine. The loss by GEDCO is the highest, 30%. After 2014, the loss may have risen to over 30% since the distribution networks that were destroyed remain unrepaired as of 2015. For reference, the electricity loss in Jordan is 13%.

Table 1-13 Percentage of electricity losses for DISCO

Year	NEDCO	TEDCO	JDECO	HEPCO	West Bank	GEDCO
2009			28%	22%	26%	30%
2010	18%	5%	26%	20%	23%	30%
2011	20%	4%	28%	22%	26%	30%
2012	18%	16%	27%	19%	24%	30%
2013	N/A	16%	26%	20%	25%	30%

Source: World Bank, West Bank and Gaza Assessment and Action Plan to improve payment for electricity services in the Palestinian Territories (Report No. ACS9393, November 25, 2014)

Chapter 2

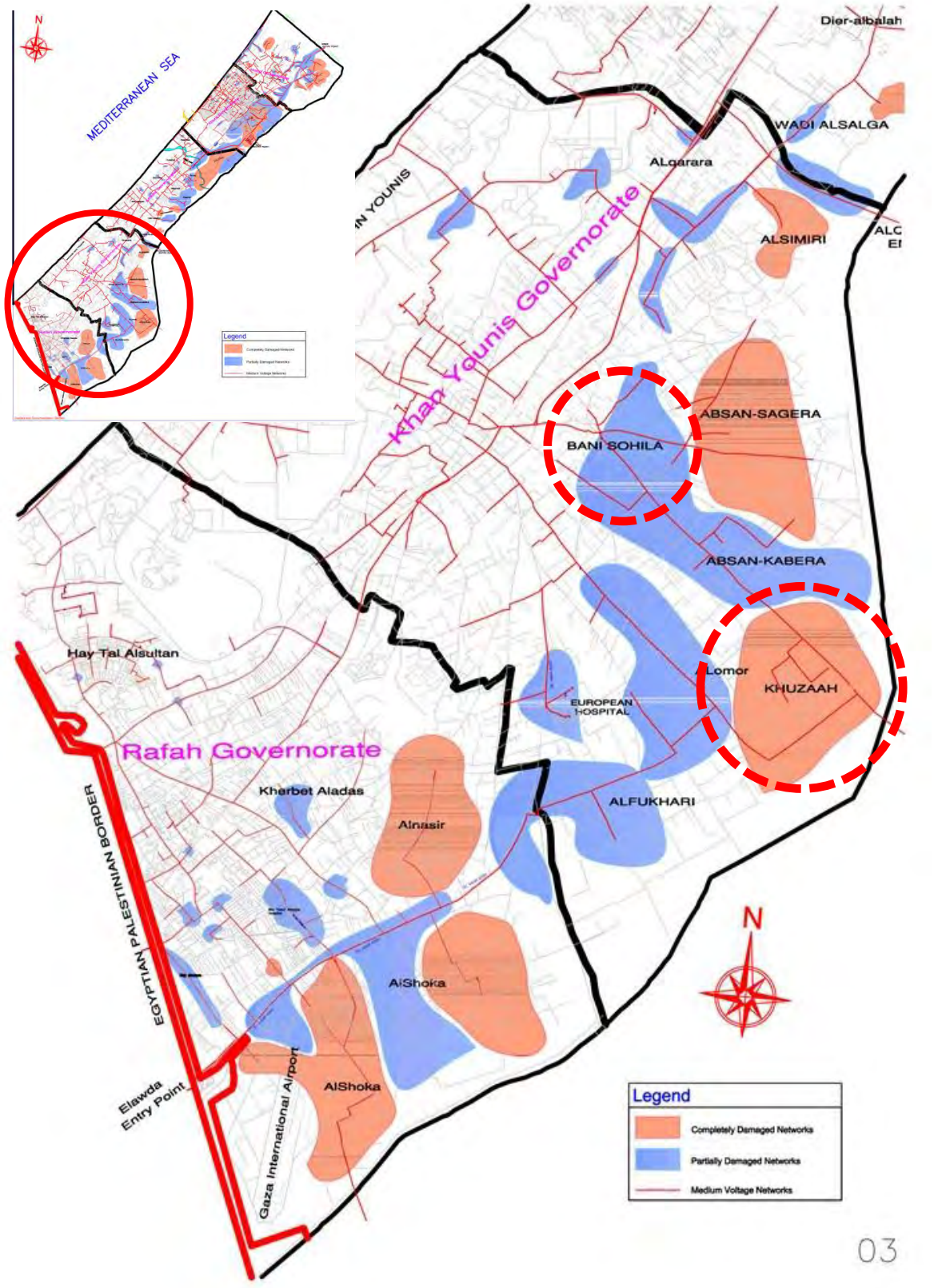
Pilot Project

Chapter 2 Pilot Project

2-1 Background and outline of Pilot Project

2-1-1 Background of Pilot Project

The electricity infrastructure has been damaged greatly by the Israeli attack in 2014. Especially, after the power equipment warehouse of GEDCO was destroyed, reconstruction of the electricity supply system in the Gaza Strip became difficult since necessary equipment for repair and maintenance of the transmission network became insufficient. As of 2015, about 10% of the population is unable to receive the electricity supply, and 90% of population suffer recurrent outage. The shortage of electricity led to a variety of social unrest in the Gaza Strip, malfunction of water supply and sewage infrastructure, shrinkage of industry as well as worsening unemployment rate. Under these circumstances, GEDCO submitted a "Proposal on Pilot Project Candidate" to JICA. This electricity restoration pilot project targets about 3,700 electricity consumers in Khuzaah and Bani Sohila of Khan Younis Governorate. The objective of the project is to connect the electricity distribution network to the electricity consumers, to restore electricity distribution network that has been only temporary repaired, to decrease the loss of electricity, to improve electricity supply, and to protect electric appliances of electricity customers. The implementation of the project aims to increase the number of people who can receive electricity to improve their livelihoods that have been worsened by electricity shortage, improve the efficiency ratio of electricity transmission, improve maintenance, and reduce blackouts. The pilot project site has been selected because it is in the area that is greatly damaged by the Israeli attack and also it is one of the areas where the most severely destroyed electricity infrastructures in the Gaza Strip are found. Therefore, the implementation of the project at this site is judged to contribute greatly to achieve the objective of the project as well as the reconstruction of the region. Thus, the site was selected for the pilot project.



Source: Damages Assessment Report, Electricity Distribution Sector, Israeli War against Gaza Strip (07 JULY-26 AUGUST 2014)

Figure 2-1 Location of Khuzaah and Bani Sohila pilot project sites

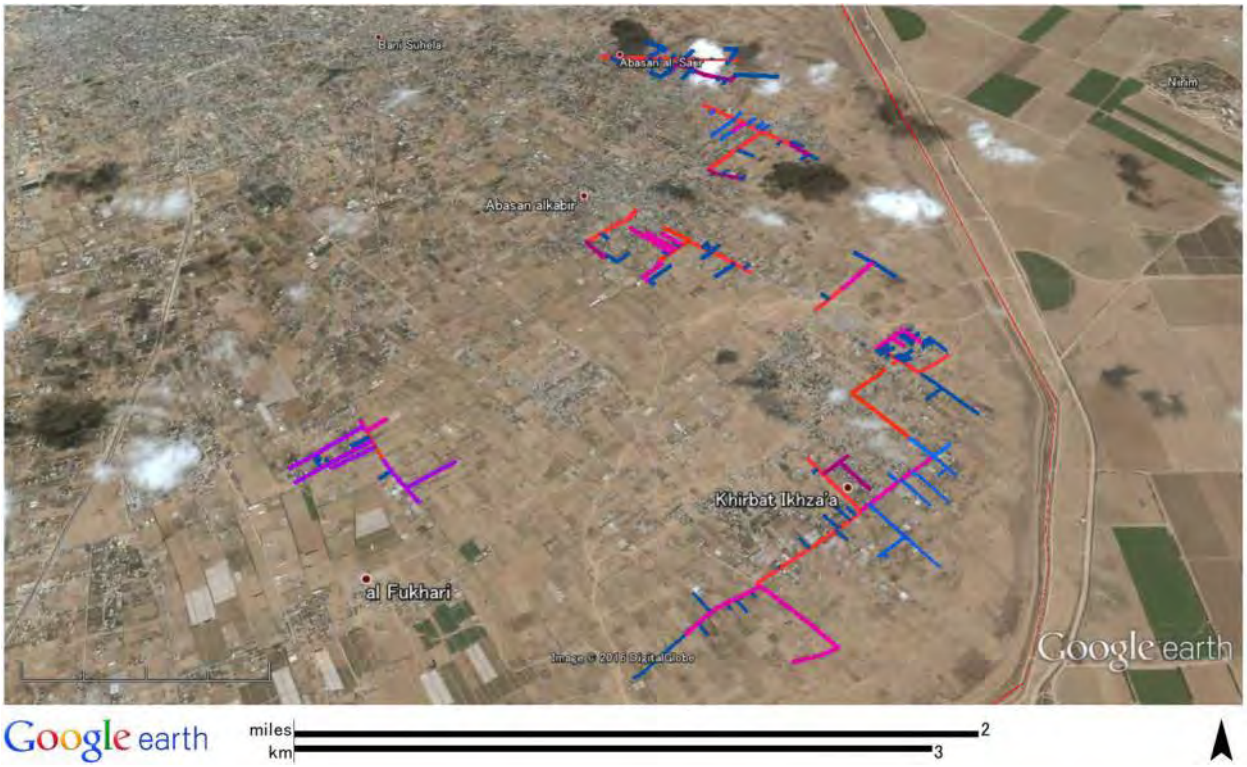
2-1-2 Outline of Pilot Project

The pilot project targets 16 areas in Khuzaah and Bani Suhila. Based on the distribution route map, the specifications and approximate quantity of wood poles and electric cables are confirmed, and a list of materials to be ordered is finalized as shown in Table 2-1 (prepared by GEDCO).

Figure 2-2 shows a map of the entire distribution route.

Table 2-1 List of Equipment for the Pilot Project of restoring electricity distribution in Khan Younis Governorate

Material	Specifications	Quantity
Wooden poles	Length 8.5m, Diameter of the pole end 150-180mm	154
Electrical distribution line	ABC Cable, 0.6/1kV, Aluminum stranded wire ,3×150mm^2, 1×95mm^2, 2×25mm^2	8.0km
Electrical distribution line	ABC Cable, 0.6/1kV, Aluminum stranded wire 4×95mm^2	9.0km
Electrical distribution line	ABC Cable, 0.6/1kV, Aluminum stranded wire 4×50mm^2	9.5km



Source: Data provided by GEDCO

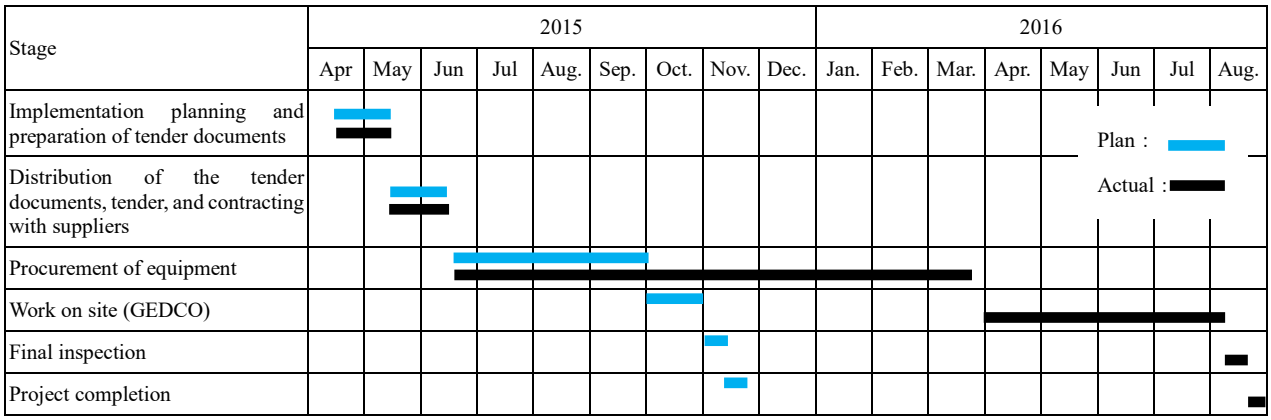
Figure 2-2 Distribution route drawing

2-2 Lessons from Pilot Project

2-2-1 Lessons from procurement

The planned and actual implementation schedules of the pilot project are shown in Figure 2-3. Although the project was initially anticipated to take roughly six months from contract agreement to the completion of work, it actually took 14 months to completion it, as shown in Figure 2-3.

The tax exemption and customs clearance procedures necessary for the project were processed via Coordination of Government Activities in the Territories (COGAT), and not through Gaza Reconstruction Mechanism (GRM)[6]. Time was needed for pre-shipment tax exemption, customs clearance and security checks in Israel (Port of Ashdod), as well as security checks at the Kerem Shalom crossing into the Gaza Strip. An increased tension between Israel and the Gaza Strip also delayed the equipment procurement. The procurement of equipment was initially expected to take three months, but it ended up taking nine months. The problem and measures are mentioned below.



Source: JST

Figure 2-3 Implementation schedule of the pilot project in the electricity sector and its outcome

(1) Problem

When goods are transported into the Gaza Strip, Israeli approval of tax exemption and security clearance is required, and it usually takes a few months and in some cases half a year to get the approval. It is the main reason of project delay.

A follow-up project of JICA was completed in Beit Hanoun. The follow-up project is to supply materials (ABC cables and ACSR wires) into Beit Hanoun. Tax exemption was applied in February 2015. Although the tax exemption is usually approved in 2 to 3 months, the tax exemption of the follow-up project was not approved within 2 to 3 months. COGAT who is responsible of the tax exemption in Israel replied in May 2015 requesting the following additional information:

- Detail of the intended use of the materials while referring to the specific projects for which the materials will be used as well as the precise location of the projects;

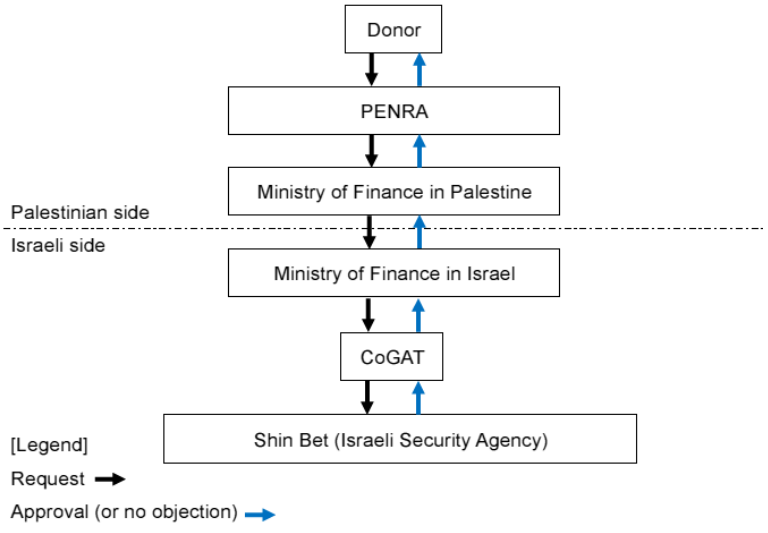
[6] GRM: A pact made between the Palestinian and Israeli governments following the invasion of Gaza in 2014, to authorize the large-scale import of supplies to the Gaza strip, which can be used by both military and civilian organizations, provided they are used for the purpose of restoration work in Gaza.

- Specification of the exact materials required for each of the projects; and
- Specification of the entities/organization/contractors which will be executing said projects.

In response, JICA submitted the information listed below to COGAT in June 2015:

- ✓ Entity of project implementation
- ✓ Purpose of materials, location of installation (GPS coordination and Google Earth™ map indicating the location)
- ✓ Bill of material (specification, quantity and photos)
- ✓ Supplier and contractor

COGAT did not respond to the approval request even after over two months after the submission of detail information. Therefore, JICA inquired COGAT about the progress, and COGAT answered that Shin Bet refused the tax exemption due to security concerns and the approval in the case of donor assistance takes longer time than that of the normal procedure. However, the tax exemption was approved just after this inquiry. It was also identified that JICA is not well known by COGAT. The same goes for support from other donors. In the case of support from the Islam Development Bank (IsDB), tax exemption permits were not granted for supplies (power lines, etc.) even after eight months. This pilot project also uses the same supply (power line) procurement, so receiving the tax exemption took a great deal of time. In the case of the assistance project of Islamic Development Bank, the tax exemption request for some electricity materials (wires) has not been approved even though it is now 8 months since the approval request has been made. Therefore, pilot project was also delayed by the tax exemption and security clearance process. Figure 2-4 shows the flow of approval of tax exemption.



Source: JST

Figure 2-4 Flow of tax exemption without GRM (Without a GRM Application)

(2) Measures

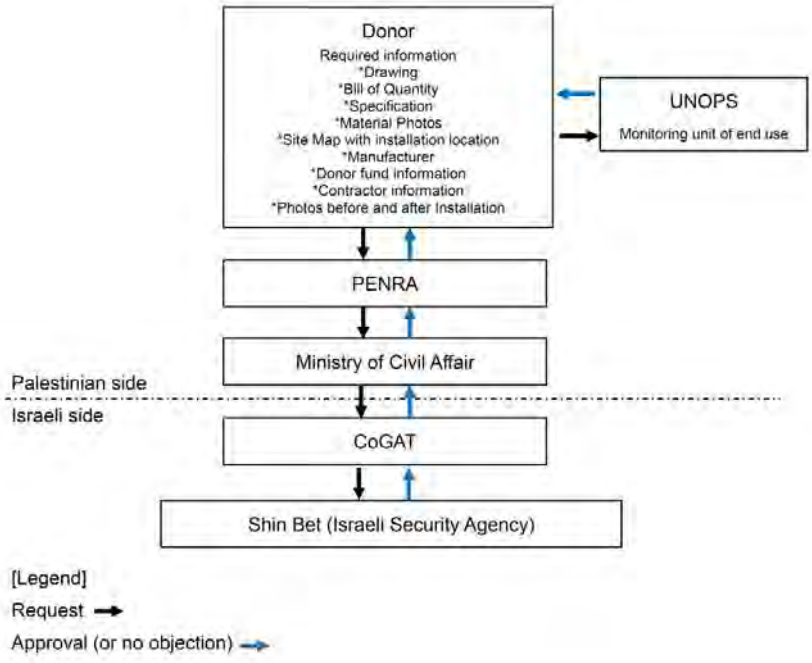
To avoid the problems mentioned above in the pilot project, detail information on the project should be submitted in advance to COGAT. This will shorten the approval time since Shin Bet will be able to issue the approval. The detail information that should be submitted is follows:

- ✓ Entity of project implementation

- ✓ Purpose of materials, location of installation (GPS coordinates and Google Earth™ map indicating the location)
- ✓ Bill of material (specification, quantity and photos)
- ✓ Supplier and contractor

As for future project in the Gaza Strip, explanation of imported materials will be needed before the application of tax exemption; information required for tax exemption and security clearance should be confirmed and then this information should be submitted with the tax exemption application. These measures will shorten the approval duration.

To shorten the approval time of the tax exemption and security clearance mentioned above, it is GRM. Figure 2-5 shows the flow of tax exemption of GRM. Because tax exemption and customs clearance in the project's procurement process were not undertaken via GRM, time was spent for customs clearance, for the security check in the port of Ashdod in Israel and the security check at the Kerem Shalom crossing into the Gaza Strip. The procurement was left substantially behind schedule. According to previous cases reported by PENRA, omitting tax exemption of VAT (Value Added Tax), using GRM can shorten the time required for procurement.



Source: JST

Figure 2-5 Tax Exemption Flow in GRM-Applicable Cases

2-2-2 Lessons during construction

(3) Implementation schedule

An implementation schedule serves as a compass that indicates a sequence of tasks and time required in the entire work process, and it is typically presented in the following manners.

Bar chart: Horizontal lines show a sequence and duration of tasks with planned start and end times for each, specified with months and dates.

Network diagram: Relationships between tasks, sequences, and days required for completion are

represented articulately.

Figure 2-6 shows a part of the implementation schedule submitted by GEDCO. GEDCO's implementation process flow chart is not a bar chart or a network. Furthermore, it contains no plans or performance records, so the progress of construction cannot be ascertained. GEDCO thus needs to revise the way the implementation schedule is composed.

Item	2016/4/4	2016/5/4	2016/6/4	2016/7/4	2016/9/4	2016/10/4	2016/11/4	2016/12/4	13/4/2016
Location	Mazarea	Mazarea	Mazarea	Mazarea	Mazarea	Mazarea	Mazarea	Mazarea	Mazarea
Wooden Pole (8.5 m Long, Top Diameter: 150-180 mm)	22					15			
ABC Cable, Al Conductor, 0.6/1 kV, 3x150+1x95+2x25 mm2				400	447				
ABC Cable, Al Conductor, 0.6/1 kV, 4x95 mm2				205	203	501			
ABC Cable, Al Conductor, 0.6/1 kV, 4x50 mm2		727	752						
Remove the old network									
Connecting the customers on the new Network									

Source: Data provided by GEDCO

Figure 2-6 Implementation schedule submitted by GEDCO

The detailed work schedule submitted by GEDCO includes the followings:

1) A design engineer conducts an on-site survey.
2) Design drawings and bill of materials (BOM) are prepared.
3) A technical manager approves the design drawings and BOM.
4) An official request is filed to relevant local government bodies to notify about project sites and locations of electrical poles.
5) Before starting the work, written approval is obtained from relevant local government bodies, CMWU, and communication network providers etc. to confirm that they do not own any properties on the project sites.
6) GEDCO's survey section examines the site conditions to determine the depth of pole holes.
7) Equipment and materials are transferred from the warehouse to an on-site working team in accordance with the approved design drawings and BOM, when all the necessary approvals are obtained.
8) The site manager cross-checks the site conditions with the design drawings.
9) The site manager controls logistics related to transport and acceptance of the equipment and materials necessary for the construction work.
10) Before starting the work, the site manager ensures safety and risk-prediction measures for all the workers and vehicles on site in accordance with the work procedures and schedule.
11) Pole locations, once determined, are excavated manually to preliminarily check for any underground obstacles (such as pipes, communication lines, and cables). When no problems are identified, holes are subsequently drilled with a heavy machine.
12) Heavy machines and other machines are used according to the site conditions.
13) Excavated excess soil is removed after pole installation

14) Electric cables undergo tension stringing in accordance with applicable operation standards.
15) Appropriate ancillary parts are fixed according to types of poles and cables.
16) Cable terminals are sealed with end caps.
17) Newly installed distribution network is connected with the existing grid.
18) Power supplied to customers is checked with applicable requirements.
19) All the necessary drawings are prepared and sent to supervisors on GEDCO, upon completion of installation.
20) A delivery test committee evaluates the project and modifies any adjusting points.
21) New distribution network is documented and included in GEDCO' assets.
22) In the case of restoration work, blackouts resulting from the work are avoided by carrying out work during planned outages (a cycle of 8 hours of power supply, 12 hours of power outage, and 8 hours of power supply).

It is recommended that GEDCO prepare more specific work procedures developed on this schedule to become more capable of managing construction work.

(4) Construction management

In general, for any modification of a design drawing in a construction phase, the contractor has to revises it and obtains the approval of the client (design engineer) before starting the work. For this reason, the completion drawing will correspond to the actual distribution network, and even if there should be any discrepancy, it will be insignificant. Given the urgent needs of network rehabilitation, on the other hand, GEDCO often revises a drawing after the work is completed, resulting in substantial differences. The resulting outcome is an electricity distribution plan developed in an ad-hoc manner, and it appears as though appropriate planning is not being carried out. It is therefore recommended that construction be managed with proper procedures.

The work procedures of GEDCO describe task components, cautions, names of workers, duration of work, the number of vehicles used, and a list of equipment and materials. Although requested, GEDCO did not submit written work procedures in Pilot Project. It is recommended that construction be managed with written work procedures.

(5) Safety control

On March 20, 2016, a training session by United Nations Mine Action Service (UNMAS)'s was provided for GEDCO's work team on the handling of unexploded shells to help the team in identify them during work and take appropriate precautions to prevent accidental explosions.

Training session on unexploded shells

Learning material on unexploded shells

Source: UNMAS

Figure 2-7 Risk mitigation training on unexploded shells

An extract of Safety guidelines for operators obtained from GEDCO are shown in Figure 2-8. The guidelines, which are covered by 29 pages, describe precautions which must be taken for different types of works. Evidently, GEDCO prescribes safety measures, although, as shown in Figure 2-9, neither outriggers (toppling-prevention measures) nor safety belts are in use, so currently, safety measures are not being fully implemented on site. The project thus guided the need of revising the safety measures, making suggestions in accordance with the "Guidance for the Management of Safety for Construction Works in Japanese ODA Projects (September 2014)."

Source: GEDCO, Safety handbook of GEDCO

Figure 2-8 Safety guidelines of GEDCO for operators (selected pages)

Figure 2-9 Dangerous elevated work with a bucket truck (without a safety belt and outrigger)

2-2-3 Lessons from completion inspection

A completion inspection verified that procured wood poles were all installed. Some of the installed poles and cables were located at points different from the completion drawing. The project discussed corrections needed in a meeting with GEDCO held after the completion inspection. After the corrections needed were indicated, GEDCO revised the completion drawing to indicate the actual installation locations and quantities. Subsequently, accurate locations for the distribution route were updated in GPS, mapping GPS coordinates. GEDCO made corrections immediately after they were pointed out. This implies that corrective action will be taken promptly in response to future capacity development efforts and that the effect of improvements is high.

Results of the completion inspection indicate that GEDCO does not properly pursue data collection on the distribution network, drawing administration, distribution planning, quality control, and construction management. Consequently, it is considered that a substantial electricity loss is occurring. A priority mitigation measure is to implement sound and proper data collection on the distribution network, drawing administration, distribution planning, quality control, and construction management. Measures to prevent electricity loss include reducing loss in LV distribution network (by changing the LV network to MV, shortening the LV distribution distance, and lowering high electricity current). On these measures, the project proposes a medium- and long-term assistance plan in this report, including a strategy to develop GEDCO's managerial capacity. The corrections items described below were identified in a discussion with GEDCO over the results of the completion inspection.

(1) Appropriate data management, drawing administration, and distribution planning

On the whole, quantities and locations of the installed wood poles and cables differ from those shown in the drawings. Electricity loss increases as the cable distance gets longer and more cable routes are included. Therefore, distribution planning must accurately identify the network location, which should be reflected in the drawings. This is essential for the optimal distribution planning minimizing electricity loss. GEDCO's distribution planning, on the other hand, is modified on ad hoc basis during construction depending on the number of customers, their requests, and road plans. This has resulted in discrepancies between the drawings and output of the construction work. Consequently, electricity distribution is not planned on the basis of accurate

data and drawings. Although provided with GPS (satellite positioning system) and GIS (geographic information system), GEDCO is not able to fully utilize GIS for several reasons. They do appear to making good use of GPS, by obtaining location information and plotting using Google Earth™. To create the optimal distribution plan with less electricity loss, it is recommended that GPS and GIS be used for accurate data management and drawing administration.

(2) Reduction of loss in the LV distribution network

On the whole, the LV distribution distance from the 22/0.4kV transformer to the customer is long (1km or more). According to GEDCO, measured electric current in the LV network is approximately 300A at maximum. Electricity loss is supposed to be substantial there, because it considerably increases when a large electric current flows through long LV cables. (e.g. When 300A flows in ABC cable of 150mm^2 at a low voltage, the electricity loss adds up to approximately 21kW; about 10% of distributed electricity). The pilot project sites measured the amount of electricity current on respective LV network cables (ABC cable of 150mm^2, ABC cable of 95mm^2, and ABC cable of 50mm^2) to estimate the losses. Electricity loss in each site is calculated as shown in Table 2-2, Table 2-3 and Table 2-4. Considerable electricity loss is generated in ABC cable of 150mm^2 used for a trunk line in the LV distribution network, followed by ABC cable of 95mm^2. ABC cable of 50mm^2 is generating relatively small electricity loss, as it is used for terminal branches with short cable distance, passing low current. The electricity loss in all the pilot project sites is 225kW, equivalent to roughly 3% of the electricity supplied (7,136kW). On the basis of cable type, however, many of the ABC cables of 150mm^2 are generating more than a 6% loss (indicated in yellow in the below table). Measures to reduce electricity losses are required in the future, including dual cabling. Thus Medium-term Assistance Plan, together with distribution network restoration is proposed in 3-3-4.

Table 2-2 Electricity loss in the pilot project sites (ABC cable 150 mm^2)

Site No.	Cable length (m)	Current measurement (A)	Power (kW)	**Power loss (kW)**	Power loss (%)
IIDB150109_ABC_150	349	380	237	**13.1**	5.5
IIDB150253_ABC_150	646	284	177	**12.9**	7.3
IIDB150254_ABC_150	561	210	131	**5.9**	4.5
IIDB150256_ABC_150	243	220	137	**2.8**	2.0
IIDB150278_ABC_150	537	360	224	**17.9**	8.0
IIDB150453_ABC_150	520	345	215	**15.8**	7.3
IIDB150454_ABC_150	318	150	94	**1.6**	1.7
IIDB150493_ABC_150	468	265	165	**8.1**	4.9
IIDB150493_ABC_150	170	200	125	**1.6**	1.3
IIDB150580_ABC_150	774	300	187	**17.4**	9.3
IIDB150581_ABC_150	407	280	175	**7.9**	4.5
IIDB150582_ABC_150	440	280	175	**8.5**	4.9
IIDB150583_ABC_150	285	180	112	**2.2**	2.0
IIDB150584_ABC_150	495	308	192	**11.8**	6.1
IIDB150585_ABC_150	485	200	125	**4.6**	3.7
IIDB150586_ABC_150	675	265	165	**11.7**	7.1
Total	**7,373**		**2,636**	**143.8**	**5.5**

Source: Data provided by GEDCO

Table 2-3 Electricity loss in the pilot project sites (ABC cable 95 mm^2)

Site No.	Cable length (m)	Current measurement (A)	Power (kW)	**Power loss (kW)**	Power loss (%)
IIDB150108_ABC_95	256	60	37	**0.3**	0.8
IIDB150109_ABC_95	276	90	56	**0.8**	1.4
IIDB150109_ABC_95	385	80	50	**0.9**	1.8
IIDB150109_ABC_95	311	65	41	**0.5**	1.2
IIDB150109_ABC_95	481	80	50	**1.1**	2.2
IIDB150109_ABC_95	485	60	37	**0.6**	1.6
IIDB150253_ABC_95	290	150	94	**2.4**	2.6
IIDB150254_ABC_95	144	100	62	**0.5**	0.8
IIDB150256_ABC_95	181	120	75	**0.9**	1.2
IIDB150256_ABC_95	54	135	84	**0.4**	0.5
IIDB150278_ABC_95	271	110	69	**1.2**	1.7
IIDB150278_ABC_95	390	107	67	**1.6**	2.4
IIDB150278_ABC_95	269	90	56	**0.8**	1.4
IIDB150278_ABC_95	194	85	53	**0.5**	0.9
IIDB150453_ABC_95	240	124	77	**1.3**	1.7
IIDB150454_ABC_95	305	200	125	**4.7**	3.8
IIDB150454_ABC_95	434	250	156	**10.7**	6.9
IIDB150493_ABC_95	380	150	94	**3.2**	3.4
IIDB150493_ABC_95	100	100	62	**0.4**	0.6
IIDB150580_ABC_95	1,221	100	62	**4.4**	7.1
IIDB150581_ABC_95	185	115	72	**0.9**	1.3
IIDB150582_ABC_95	208	160	100	**2.0**	2.0
IIDB150582_ABC_95	237	80	50	**0.5**	1.0
IIDB150583_ABC_95	347	120	75	**1.8**	2.4
IIDB150587_ABC_95	615	165	103	**6.3**	6.1
IIDB150587_ABC_95	146	100	62	**0.5**	0.8
Total	**8,405**		**1,868**	**49.2**	**2.6**

Source: Data provided by GEDCO

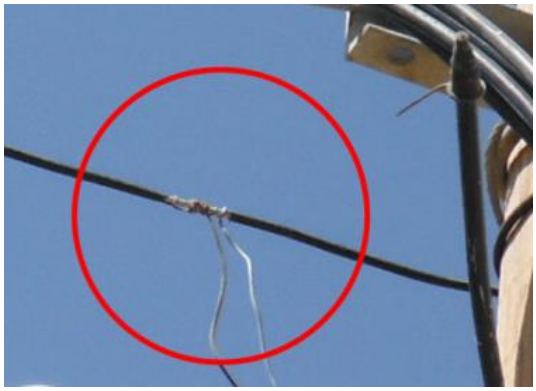
Table 2-4 Electricity loss in the pilot project sites (ABC cable 95 mm^2)

Site No.	Cable length (m)	Current measurement (A)	Power (kW)	**Power loss (kW)**	Power loss (%)
IIDB150109_ABC_50	40	60	37	**0.1**	0.3
IIDB150109_ABC_50	81	50	31	**0.1**	0.3
IIDB150109_ABC_50	60	65	41	**0.2**	0.5
IIDB150109_ABC_50	100	35	22	**0.1**	0.5
IIDB150109_ABC_50	121	80	50	**0.6**	1.2
IIDB150253_ABC_50	76	60	37	**0.2**	0.5
IIDB150253_ABC_50	59	32	20	**0.0**	0.0
IIDB150253_ABC_50	145	64	40	**0.4**	1.0
IIDB150254_ABC_50	113	64	40	**0.3**	0.8
IIDB150254_ABC_50	113	65	41	**0.3**	0.7
IIDB150254_ABC_50	110	32	20	**0.1**	0.5
IIDB150254_ABC_50	157	80	50	**0.7**	1.4
IIDB150254_ABC_50	118	75	47	**0.5**	1.1
IIDB150254_ABC_50	300	75	47	**1.2**	2.6
IIDB150254_ABC_50	72	32	20	**0.1**	0.5
IIDB150256_ABC_50	95	53	33	**0.2**	0.6
IIDB150256_ABC_50	107	59	37	**0.3**	0.8
IIDB150256_ABC_50	101	65	41	**0.3**	0.7
IIDB150256_ABC_50	72	32	20	**0.1**	0.5
IIDB150278_ABC_50	266	70	44	**0.9**	2.1
IIDB150278_ABC_50	65	81	51	**0.3**	0.6
IIDB150278_ABC_50	54	76	47	**0.2**	0.4
IIDB150453_ABC_50	207	65	41	**0.6**	1.5
IIDB150453_ABC_50	82	78	49	**0.4**	0.8
IIDB150580_ABC_50	346	64	40	**1.0**	2.5
IIDB150580_ABC_50	77	64	40	**0.2**	0.5
IIDB150580_ABC_50	139	64	40	**0.4**	1.0
IIDB150580_ABC_50	45	64	40	**0.1**	0.3
IIDB150580_ABC_50	90	64	40	**0.3**	0.8
IIDB150580_ABC_50	76	64	40	**0.2**	0.5
IIDB150580_ABC_50	121	48	30	**0.2**	0.7
IIDB150580_ABC_50	164	52	32	**0.3**	0.9
IIDB150580_ABC_50	73	64	40	**0.2**	0.5
IIDB150580_ABC_50	77	70	44	**0.3**	0.7
IIDB150580_ABC_50	40	32	20	**0.0**	0.0
IIDB150580_ABC_50	16	32	20	**0.0**	0.0
IIDB150581_ABC_50	276	80	50	**1.3**	2.6
IIDB150581_ABC_50	173	85	53	**0.9**	1.7
IIDB150581_ABC_50	80	32	20	**0.1**	0.5
IIDB150581_ABC_50	219	64	40	**0.6**	1.5
IIDB150581_ABC_50	504	85	53	**2.7**	5.1
IIDB150581_ABC_50	206	64	40	**0.6**	1.5
IIDB150581_ABC_50	38	32	20	**0.0**	0.0
IIDB150581_ABC_50	75	64	40	**0.2**	0.5
IIDB150582_ABC_50	40	32	20	**0.0**	0.0
IIDB150583_ABC_50	350	60	37	**0.9**	2.4
IIDB150583_ABC_50	74	32	20	**0.1**	0.5
IIDB150584_ABC_50	200	40	25	**0.2**	0.8
IIDB150584_ABC_50	199	76	47	**0.8**	1.7
IIDB150584_ABC_50	60	61	38	**0.2**	0.5
IIDB150584_ABC_50	60	102	64	**0.5**	0.8
IIDB150584_ABC_50	60	67	42	**0.2**	0.5
IIDB150585_ABC_50	300	80	50	**1.4**	2.8
IIDB150585_ABC_50	27	69	43	**0.1**	0.2
IIDB150585_ABC_50	163	80	50	**0.8**	1.6
IIDB150585_ABC_50	70	32	20	**0.0**	0.0
IIDB150586_ABC_50	448	100	62	**3.3**	5.3
IIDB150586_ABC_50	169	85	53	**0.9**	1.7
IIDB150586_ABC_50	147	73	46	**0.6**	1.3
IIDB150586_ABC_50	80	32	20	**0.1**	0.5
IIDB150586_ABC_50	39	32	20	**0.0**	0.0
IIDB150586_ABC_50	122	64	40	**0.4**	1.0
IIDB150587_ABC_50	382	80	50	**1.8**	3.6
IIDB150587_ABC_50	174	80	50	**0.8**	1.6
IIDB150587_ABC_50	83	64	40	**0.2**	0.5
IIDB150587_ABC_50	40	32	20	**0.0**	0.0
IIDB150587_ABC_50	266	66	41	**0.8**	1.9
IIDB150587_ABC_50	39	32	20	**0.0**	0.0
IIDB150587_ABC_50	41	32	20	**0.0**	0.0
IIDB150587_ABC_50	97	50	31	**0.2**	0.6
IIDB150587_ABC_50	38	32	20	**0.0**	0.0
Total	**9,317**		**2,632**	**32.1**	**1.2**

Source: Data provided by GEDCO

(3) Work quality control

Work quality varies among the project sites, and the executed work is low quality as a whole. The project indicated problems identified in the completion inspection to GEDCO. Corrections were made where possible (see Figure 2-10). The main causes of low quality are a lack of materials and equipment as well as illegal conduct of customers. However, it is also supposedly attributable to GEDCO as it has not submitted necessary documents and drawings such as a work plan, work procedures, and a testing plan. This implies that the work quality is not standardized properly. GEDCO partly submitted work procedures on ABC cables (Installation standard for ABC cables), wood poles (Installation standard for Impregnated Wood poles), and branch cables (Stay wires). They are, however, deemed insufficient for work quality control. Apart from material procurement, it is recommended that the work quality be controlled in accordance with a work plan, work procedures, and a testing plan.

Left (Low Quality Installation)	Right (After Correction)
 Very loose cables	 Loose cable (after correction)
 No isolation in a cable connection on a road light (Connection with road lights is under jurisdiction of a local government body)	 No isolation in a cable connection on a road light (after correction)

Left (Low Quality Installation)	Right (After Correction)
	
Unfixed branch terminal	Unfixed branch terminal (after correction)
	
No terminal isolation of isolated cables	No terminal isolation of isolated cables (after correction)
	
Unsecured cable suspension	Unsecured cable suspension (after correction)

Left (Low Quality Installation)	Right (After Correction)
 Barbed wires around a wood pole	 Barbed wires around a wood pole (after correction)
The others of low Quality Installation	
 Largely sloping wood pole	 Fixed with lead-in wires tied on metal parts
 Contact of lead-in wires with other cables	 Brach cable fixed with a residence

Figure 2-10 Low work quality and corrections made after problem identification

Chapter 3

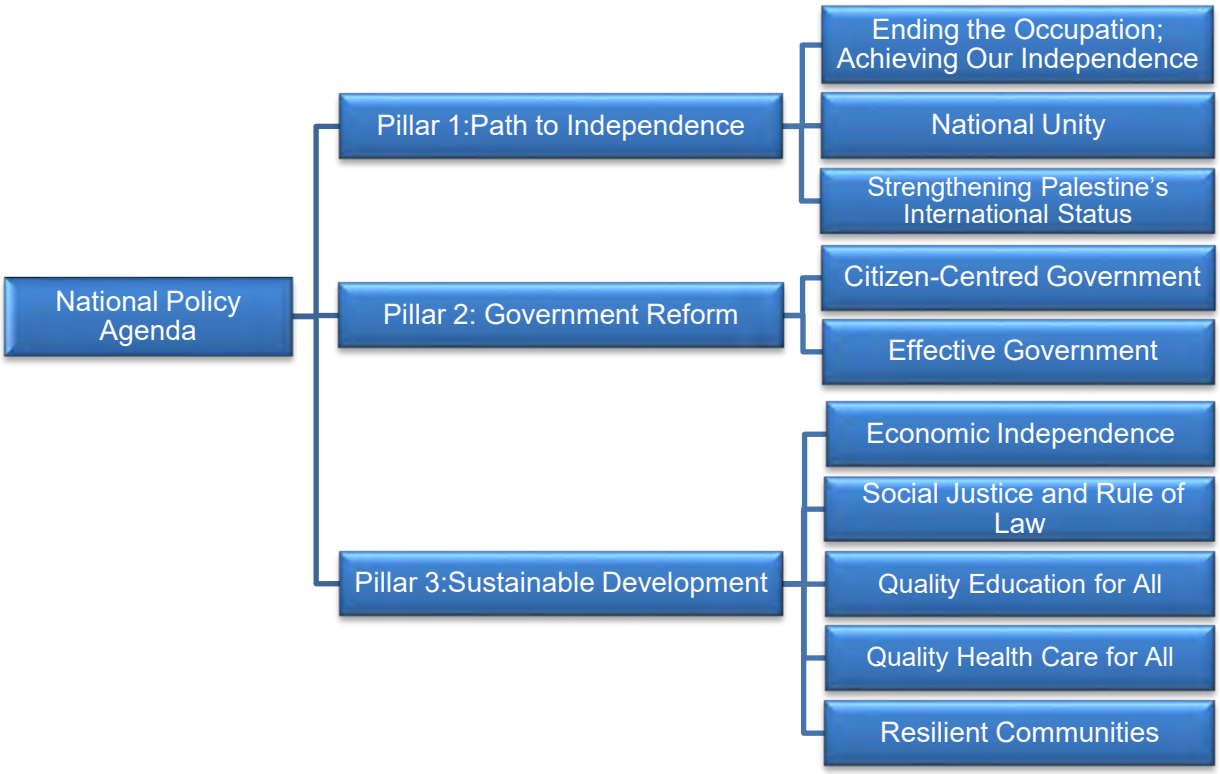
Medium-Term Cooperation Plan

Chapter 3 Medium-Term Cooperation Plan

3-1 Development Plans in Energy Sector

3-1-1 National Policy Agenda

"Sustainable Development," which is one of the three pillars of the National Policy Agenda (2017-2022), namely, (1) Path to Independence, (2) Government Reform, and (3) Sustainable Development shown in Figure 3-1 sets forth 5 national priorities and 20 national policies as described in Table 3-1.



Source: State of Palestine (December, 2016) "National Policy Agenda 2017-2022 Putting Citizens First"

Figure 3-1 National Policy Agenda (2017-2022)

Table 3-1 National Priorities and 20 National Policies in the "Sustainable Development" Pillar of the National Policy Agenda

National Priority		National Policy
1	Economic Independence	➢ Building Palestine's Future Economy ➢ Creating Job Opportunities ➢ Improving Palestine's Business Environment ➢ Promoting Palestinian Industry
2	Social Justice and Rule of Law	➢ Escaping Poverty ➢ Strengthening Social Protection ➢ Improving Access to Justice ➢ Gender Equality and Women's Empowerment ➢ Our Youth; Our Future
3	Quality Education for All	➢ Early Childhood Education and Preschool Education ➢ Improving Student Enrollment and Retention ➢ Improving Primary and Secondary Education ➢ From Education to Employment

National Priority		National Policy
4	Quality Healthcare for All	➢ Better Healthcare Services ➢ Improve Citizens' Health and Well-being
5	Resilient communities	➢ Ensuring Community and National Security, Public Safety and the Rule of Law ➢ Meeting the Basic Needs of Our Communities ➢ Ensuring a Sustainable Environment and Adapting to Climate Change ➢ Revitalizing Agriculture and Strengthening Our Rural Communities ➢ Preserving Our National Identity and Cultural Heritage

Source: State of Palestine (December 2016) "National Policy Agenda 2017-2022 Putting Citizens First"

Individual policy interventions have been established in the National Policy Agenda (2017-2022) for the national priorities and policies listed above. The following table describes policy interventions that relate to the power sector. Policy interventions for the power sector are vital in achieving the National Policy Agenda.

Table3-2 Policy Interventions for National Policies in the "Sustainable Development" Pillar of the National Policy Agenda, and Their Relevance to the Power Sector

National Policy	Policy Intervention	Relevance to the Power Sector
Building Palestine's Future Economy	● Rebuild Palestine's productive sectors, focusing on manufacturing, agriculture, tourism and restoring Gaza's industrial base ● Plan and invest in strategic infrastructure (water, electricity, transportation and telecom networks, airports, seaport and industrial parks)	● A stable supply of power to industrial areas is necessary for Gaza's industry reconstruction ● Plan and invest in critical infrastructure (power)
Creating Job Opportunities	● Ensure a safe work environment through application of health and occupational safety standards	● Ensures the safety of the working environments in power sector construction
Improving Primary and Secondary Education	● Reform and modernize primary and secondary school curricula ● Develop of e-learning programs ● Upgrade educational facilities to ensure a safe, healthy learning environment	● Electric power is necessary to use computers as part of modernizing curriculum ● E-learning courses require power to use computers ● Power is needed as dark learning environments from outages are not considered healthy learning environments
Better Healthcare Services	● Improve the quality of healthcare services (infrastructure, equipment, drugs, IT, training of health care workers, standards)	● An uninterrupted power supply is necessary to improve the quality of medical equipment and IT
Meeting the Basic Needs of Our Communities	● Expand community access to clean water and sanitation ● Expand community access to reliable energy ● Improve public transportation and road safety	● Electric power is necessary to provide clean water ● Reliable energy use is a function of expanding community access to reliable energy ● Electric power is necessary for the street lights that provide road safety
Ensuring a Sustainable Environment and Adapting to Climate Change	● Reduce and effectively control pollution and greenhouse gas emissions ● Expand solid waste management and recycling ● Manage, protect and promote sustainable use and conservation of natural resources (land,	● Use of renewable energy functions as a measure against environmental pollution ● Electricity is required for the management, treatment, and recycling of solid waste

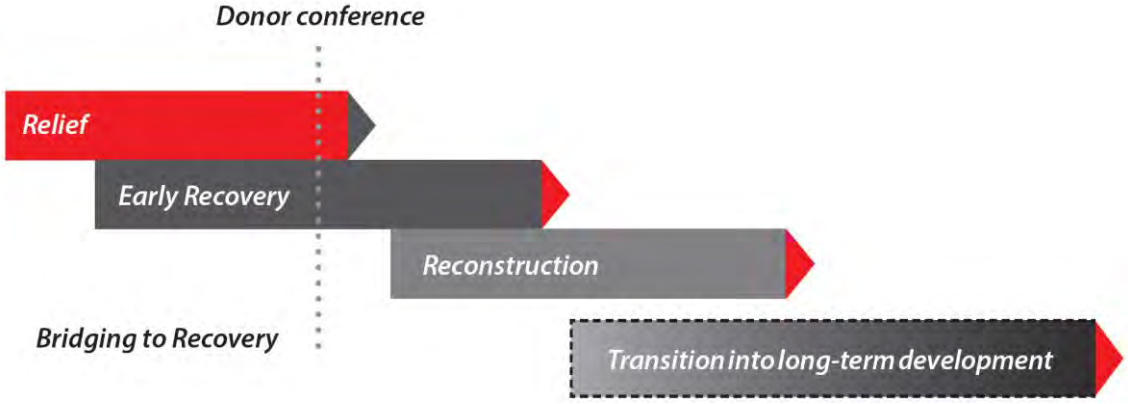
National Policy	Policy Intervention	Relevance to the Power Sector
	water and energy) ● Increase energy efficiency and reliance on renewable energy	● Use of renewable energy functions as natural resource use ● Reduction of electricity loss as an energy efficiency improvement

Source: State of Palestine (December 2016) "National Policy Agenda 2017-2022 Putting Citizens First"

3-1-2 National Early Recovery and Reconstruction Plan for Gaza Strip

The National Early Recovery and Reconstruction Plan formulated by the Palestinian Authority in October 2014 has identified three phases of interventions to respond to the complex, and large-scale needs of the Gaza Strip and its population:

- ✧ Relief: Immediate – Month 6
- ✧ Early Recovery: Month 1 – Month 12
- ✧ Reconstruction: Month 6 – Ongoing



Source: State of Palestine (Oct.2014) "The National Early Recovery and Reconstruction Plan for Gaza"

Figure 3-2 Three phases of recovery and reconstruction in Gaza Strip

Beyond the first two response phases, the plan comprises a major reconstruction effort across all sectors in order to restore the Gaza Strip to "normalcy." The entire reconstruction effort will be underpinned by the aspiration to "build back better." A mere rebuilding of the status quo or filling gaps left by the assault will not suffice. In this sense, the reconstruction provides an opportunity to revisit the needs of the Gaza Strip residents as they stand today, not as they stood yesterday.

In the energy sector, an initial repair of the GPP has been completed to make it operational. In addition, planned early recovery will see the restoration of the main power lines for supply from Israel and the provision of electrical materials to repair networks. In parallel, the possibility of increasing the electricity supply from Egypt through existing lines is being explored. Other potential short-term alternatives are being evaluated. However, the pre-existing energy deficit requires more than an attempt to avoid returning to the cost-inefficient status quo. In the long-term, Palestine Authority will promote the cost-saving through conversion of the GPP from industrial diesel generation to natural gas generation by the private sector.

3-1-3 Solar Energy Action Plan for Gaza Strip

An action plan for introducing solar power in the Gaza Strip, called the Solar Action Plan, was formulated in 2014 in order to implement the National strategy for solar energy use. The main goals of the plan are as follows:

- Achieve 3MW of new production capacity of solar energy in the Gaza Strip by 2014
- Provide local markets with the greatest amount of clean energy
- Decrease rates of diseases caused by pollution
- Increase environmental awareness and interest in the use of renewable energy
- Improve energy efficiency and energy conservation in the Gaza Strip
- Create a new green jobs and new industrial skills in the Gaza Strip
- Enhance the geographical and national integration in the energy market between the home parts

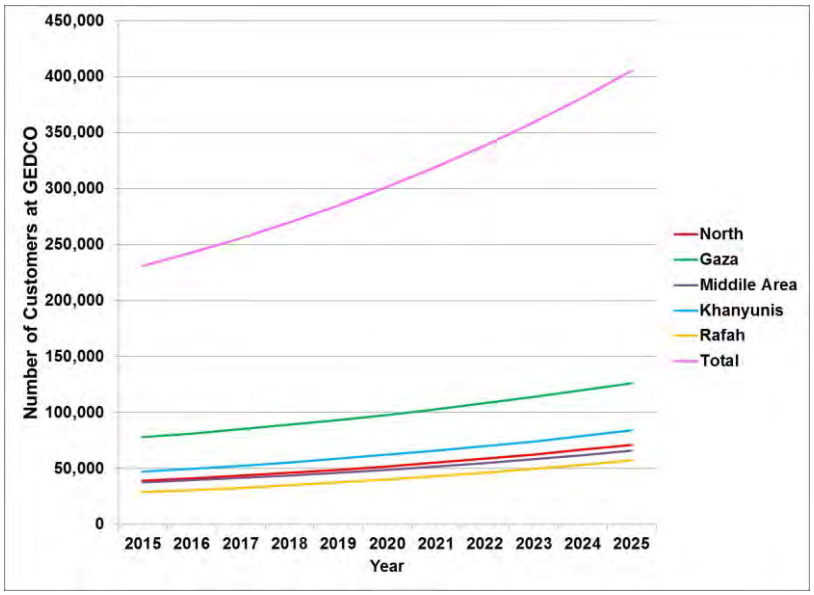
To achieve success in the pursuit of the above goals, the Plan adopts a staged approach, introducing 2MWp at the first stage and 1MWp at the second stage. The list of proposed projects is shown in **Appendix A.**

The first stage includes the construction of solar power projects in the capacity range of not exceeding 50kWp. This is to be done by supplying electricity to some of the urgently needed institutions such as those in the health and educations sectors. The water sector is also of a great importance where providing some public wells of the municipalities, specially the public wells under the municipalities in the border areas.

The second stage includes the construction of solar plants having a capacity of 300–350kWp connected to the electricity grid. Three locations, the North, Middle and South Gaza, are proposed to install one plant in each area.

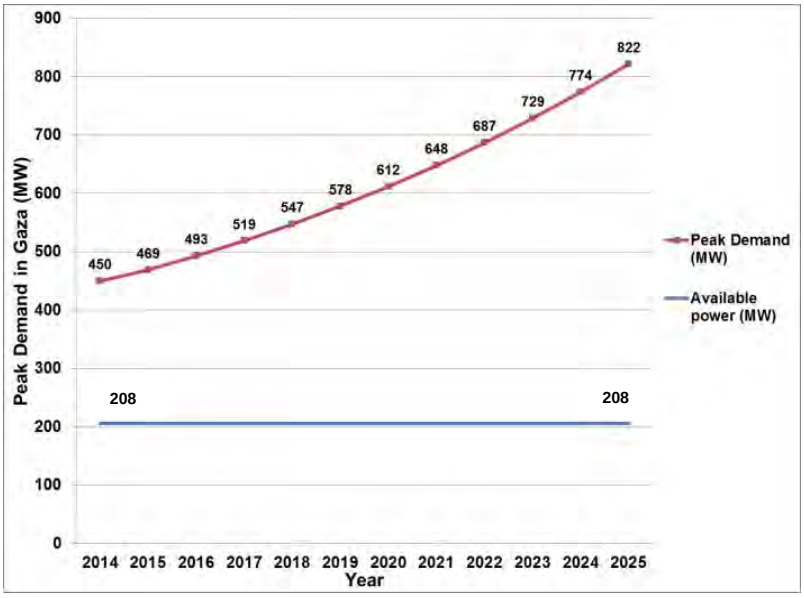
3-1-4 Power Demand Forecast in Gaza Strip

GEDCO has forecast the growth of its consumers from 222 thousands in 2014 to 302 thousands (1.36 times compared to 2014) in 2020, which will further increase to 405 thousands (1.83 times compared to 2014) in 2025. Based on this consumer growth, peak demand in the Gaza Strip will increase from 450MW in 2014 to 612MW in 2020 and 822MW in 2025. If the current 206MW power supply does not increase, considerably large share of power demand will not be satisfied in the near future; 2/3 of the demand in 2020 and 3/4 of the demand in 2025 will not be met. Thus, power supply situation in the Gaza Strip will be severely worsened.



Source: Data provided by GEDCO

Figure 3-3 Growth forecast of number of consumers in the Gaza Strip



Source: JST

Figure 3-4 Peak demand forecast for the Gaza Strip

3-2 The Status of the Assistance by Other Donors

3-2-1 The World Bank

The World Bank has been implementing "Gaza Electricity Network Rehabilitation Project", in collaboration with the Islamic Development Bank since 2012 in Gaza Strip. The project covers the rehabilitation of medium- and low-voltage distribution networks, procurement of vehicles, equipment and tools, installation of 12,000 prepaid meters, financial auditing service[7], formulation of power system master plan for the Gaza Strip, and procurement of GIS and power system analysis software and related trainings.

In addition to the ongoing project, the World Bank has provided additional financing of USD15million for "Gaza Emergency Response for Electricity Network Rehabilitation Project", to urgently rehabilitate distribution network in five governorates and storage facilities damaged by the Israel's assault in 2014. Necessary materials, tools and equipment are procured under this project.

[7] External accounting auditor who is approved internationally audits Annual financial report of project cost in accordance with international accounting standards and Technical auditor audits technical report. Technical support and capacity building for GEDCO is implemented through the project and Manual of financial procedure is produced.

Table 3-3 World Bank's assistance in energy sector

PROJECT NAME	DONOR	COMPONENTS		TERM	BUDGET
Gaza Electricity Network Rehabilitation Project (US$16M) **Project ID: P116199**	World Bank	Network Rehabilitation and Expansion	Rehabilitation of Medium and Low Voltage Networks	2012 to Sep 2013	US$4.5M
			Network Supply Improvement	2012 to Aug 2015	
		Utility Capacity Building and Technical Assistance to PENRA	Collection Improvement	2012 to Nov 2015	US$3.5M
			Supply of Vehicles and IT System to GEDCO	2012 to Oct 2015	
			Technical Assistance to PENRA- Formulation of Power System Master Plan and Financial Audit	2012 to Nov 2015	
	Islamic Development Bank	Network Rehabilitation and Expansion	Three new 22 kV underground feeders from the Gaza Power Plant (GPP) to load centers in Gaza city	To be informed	US$8.0M
			Reconfiguration and Expansion of Medium and Low Voltage Networks of the existing distribution networks in Gaza's five governorates	2012 to 2015	
Gaza Emergency Response for Electricity Network Rehabilitation (Additional fund 15MUS$) **Project ID: P152411**	World Bank	Electricity Network Reconstruction, Rehabilitation and Expansion	North Gaza Governorate MV and LV Reconstruction	Short to Medium Term (2014 to 30th Jun 2017)	US$14.42M
			Gaza Governorate MV and LV Reconstruction		
			Middle Governorate MV and LV Reconstruction		
			Khan Younis Governorate MV and LV Reconstruction		
			Rafah Governorate MV and LV Reconstruction		
			Goods and Materials Supply for main warehouse such as wires and cables, steel and wooden poles, transformers, switches, etc.	Short Term (2014 to Sep 2015)	
		GEDCO Capacity Building and Technical Assistance to PENRA and PMU	Supply of Tools and Equipment	Short Term (2014 to May 2015)	US$0.58M
			Provision of Warehouse Space	To be informed	
			Support for Operating Costs	To be informed	

Source: Data provided by PENRA and GEDCO

3-2-2 Other Donors

Since 2014, Islamic Development Bank (USD0.3M), OCHA-UNDP (USD0.3M), ICRC (USD1.0M) and Turkey (USD0.64) have been assisting the procurement of distribution materials and transformers necessary for rehabilitating the damaged distribution network. Qatar granted USD10 million for the procurement of fuel for GPP. Table 3-4 shows the list of project assisted by donors other than the World Bank.

Appendix B, **C, D** and **E** show the status of the assistance by donors.

Table 3-4 Assistance from other donors in energy sector

PROJECT NAME	DONOR	COMPONENTS		TERM	COST(US$)
Replacement of destroyed equipment in installed electrical network	Islamic Development Bank	Supply of reconstruction materials for LV and MV networks damaged by the 2014 Israeli war	- Clamps - Tap Connector - Compression Joint - Black Tape - Straight Joint for Cable - Heat Shrinkable Outdoor Termination Kit for Cable - Terminal Lug for Conductor - Tension Compression Joint for Wire - Cables - Insulators - Wires - Wooden Pole	2014 to 2014	0.3M
Replacement of destroyed equipment in installed electrical network	OCHA-UNDP	Reconstruction of LV and MV networks damaged by the 2014 Israeli war	- Wooden poles - Wires - L.V Cables - Termination Kits and Straight Joints - Compression Lugs - Insulators - Clamps - Fuse Holder , Fuses	2014 to 2015	0.3M
Replacement of destroyed equipment in installed electrical network	ICRC	Reconstruction of LV and MV Networks due to Israeli war 2014	- Transformers - Wires - Cables - Termination Kits for Cable - Heat Shrinkable Joint for Cable - Switches - Switchgear and Short Circuit Current Ring Main Unit	2014 to 2015	1M
Replacement of destroyed equipment in installed electrical network	Turkish Grant	Reconstruction of LV and MV Networks due to Israeli war 2014	- Wooden Poles - Switches - Wires - Cables - Termination Kits for Cable - Joints for Cable - Fuse Holders - Insulators - Clamps - Socket Eyes - Joint for Wire - Terminal Lug - Fuse - Knife Blade	2014 to 2015	0.64M
Qatari-donated fuel supplies	Qatar	Cost of Tax exemption of fuel of Gaza Power Plant		Dec 2014	10M

Source: Data provided by PENRA and GEDCO

3-2-3 Assistance by Japan

Table 3-5 shows the support provided by Japan to the energy sector up until the present day. As part of the power distribution network restoration project, power lines were provided to Beit Hanoun City to replace those that were damaged in the 2014 Israel-Gaza conflict. In addition, a solar power generation system was installed at the Al-Shifa Hospital, making intensive care possible even during blackouts.

Table 3-5 Japanese Support to the energy Sector

PROJECT NAME	DONOR	COMPONENTS		TERM	BUDGET	LOCATION
Replacement of destroyed equipment in installed electrical network	JICA	Reconstruction of LV and MV Networks due to Israeli war 2014 in Bait Hanoun	- ACSR Wire Rabbit (According BS215 PART 2): 20km - ACSR 150/25 mm2 Conductor (According German Sizes DIN 48204): 20km - 0.6/1 kV ABC Cable with Stranded Aluminium Conductor 3x150+1x95+2x25 mm2: 8km - 0.6/1 kV ABC Cable with Stranded Aluminium Conductor 3x95+1x54.6+2x25 mm2: 5km - 0.6/1 kV ABC Cable with Stranded Aluminium Conductor 4x95+2x25 mm2: 5km	2014 to 2016 (Completed)	0.19M	Beit Hanoun
Electrification of ICU alshifa hospital	JICA	Photovoltaic system	- Type of system is grid Interactive (AC-coupling) - Installed capacity is 30kWp	2014 (Completed)	0.19M	Alshifa hospital

Source: Data provided by JICA

3-2-4 Solar Power Generation

UNDP, Italy, Islamic Relief and Islamic Development Bank are assisting solar power projects equipped with battery system for the urgently needed institutions such as medical and health clinics to supply electricity to such important facilities without frequent interruptions. Donor-assisted solar projects are shown in **Appendix E**.

Lead-acid batteries are applied to the above-mentioned system. Usually, the life of batteries depends on the depth of discharge (DOD) and number of charge/discharge cycles. If a battery is used in deep DOD condition (nearly exhausted), the life of the battery will be shorter than that observed under normal condition. The above-mentioned donor assisted project apply European-made batteries having a capability of 1,000 charge/discharge cycles at 50% DOD. However, most of the batteries, which can be used for five years in a normal condition, need to be replaced in two to three years due to over discharged operation under frequent power interruption (a blackout of more than 20 hours occurred in July 2017) in the Gaza Strip. Replacement cost for batteries is a challenge for solar power projects in the Gaza Strip.

To address this, we recommend a long-life Valve Regulated Lead Acid battery (VRLA battery) provided by the Japanese manufacturers. As opposed to the 1,000 cycle at DOD 70% (temp. 25°C) lifespan of other overseas VRLA batteries, Japanese-made VRLA batteries have a lifespan of 4,200 cycles. This makes the batteries usable for roughly 10 years and when factoring in the cost of replacement, and there is little difference in the overall cost. Moreover, since they are also maintenance free (Not necessary of water refilling), these storage batteries are considered to be well-suited as solar batteries for the Gaza Strip.

3-3 Needs of Assistance

3-3-1 Proposed needs of assistance

The electricity infrastructure in the Gaza Strip was damaged catastrophically by the conflict in 2014. In respond to this, the Palestinian Authority created a list of needs for reconstruction assistance in 2015 (refer to Table 3-6). In addition, PENRA as well as GEDCO listed reconstruction needs as shown in Table 3-7 and Table 3-8. The reconstruction needs include the rehabilitation of distribution network in the short-term as well as the enhancement of power supply capacity to the Gaza Strip to be achieved in the medium- to long-term. In addition, even in 2017, the lack of supplies is dire. There is no change in the need for support, but PENRA has also indicated a need for solar power generation systems for the low-income group.

In the current situation, the political conflict between Palestine and Israel makes it difficult to implement large projects other than the rehabilitation of the distribution network.

Appendix F and **G** show the detail of the needs.

Table 3-6 List of Needs for Reconstruction Assistance provided by Palestine (2015)

Code	Sector	Sub-Sector	Phase	Damage	Required Intervention	Budget (USD)	Institution	Remarks
2.2.1.	Infrastructure	Energy	Relief	0	0	–	0	0
2.2.2.	Infrastructure	Energy	Early Recovery	Grid damages	Restoration of main power lines for electricity purchases from Israel	1,400,000	PENRA	
2.2.2.	Infrastructure	Energy	Early Recovery	Grid damages	Provision of electrical material to repair networks	20,765,768	PENRA	
2.2.2.	Infrastructure	Energy	Early Recovery	Damage to spare equipment and storage facilities	Rental of temporary storage facilities for electrical equipment	100,000	PENRA	
2.2.2.	Infrastructure	Energy	Early Recovery	Destruction of Gaza Power Plant	Operation of temporary short-term alternatives to Gaza Power Plant, including infrastructure to connect the ship power plant , this depends on israeli approval for the ship power plant project	10,000,000	PENRA	
2.2.3.	Infrastructure	Energy	Reconstruction	Grid damages	Installation of 220kV transmission systems and upgrade of relevant substations between Gaza and Egypt that secure an additional 150MW to the Gaza Strip in its first phase. Eventually the supply could be increased to 300MW.	58,000,000	PENRA	USD 32.5 million was secured from the Islamic Development Bank. However, the project is currently on hold due to the political and security situation.
2.2.3.	Infrastructure	Energy	Reconstruction	Damage to spare equipment and storage facilities	Construction of new main storage facility for electrical equipment	15,076,814	PENRA	
2.2.3.	Infrastructure	Energy	Reconstruction	Destruction of Gaza Power Plant – Compensation for loss of electricity and for general electricity shortage	Establishment of new transmission system to procure an additional 150MW from the Israeli Electricity Company	30,000,000	PENRA	Based on existing infrastructure on the Israeli side the Israeli grid would be connected to the Gaza North substation
2.2.3.	Infrastructure	Energy	Reconstruction	Damage to Gaza North substation	Installation of two transformers, switchyards, equipment, and 220 KV switch gear	10,000,000	PENRA	To be implemented only if additional connection is established with Israeli grid as per the above intervention
2.2.3.	Infrastructure	Energy	Reconstruction	Destruction of Gaza Power Plant	Rehabilitation of Gaza Power Plant	10,000,000	PENRA	Rehabilitation to full capacity of 140 MW, with potential for additional 140 MW
2.2.3.	Infrastructure	Energy	Reconstruction	Destruction of Gaza Power Plant	Restoration of Gaza West substation to its original 220 KV design and connection to Gaza Middle substation;	40,000,000	PENRA	Currently, production cost of 1.7 NIS/KWh significantly exceeds the electricity tariff of 0.5 NIS/KWh; the modified plant would be able to produce at 0.35 NIS/KWh and contribute to fiscal sustainability. This restoration of Gaza West substation from 66KV to 220 KV will depend on connection to the Egyptian grid, which runs on 220 KV. The Gaza West substation was damaged by Israel in 2006 and subsequently restored with lower capacity as high capacity transformers were not available.

Source: Document distributed by JICA

Table 3-7 Reconstruction Needs of PENRA (2015)

Needs	Short Term (0 to 12 months) Cost (USD)	Status	Priority	Medium Term (1 to 2years) Cost (USD)	Status	Priority	Long Term (over 2years) Cost (USD)	Status	Priority	Total Cost (USD)
Rental of temporary storage facility	100,000	On going	High	100,000	Fund not secured	Middle				**200,000**
Finalize repairs to Israeli lines; urgent maintenance for other lines	1,400,000	Completed	High							**1,400,000**
Construction of new main warehouse; repair of GEDCO branches				1,764,706	Fund not secured	Middle				**1,764,706**
Replacement of destroyed equipment In Installed electrical network	8,620,000	Fund secured	High	4,500,000	Fund not secured	Middle	4,011,593	Fund not secured	Low	**17,131,593**
Replacement of equipment destroyed In main warehouse	4,140,000	On going	High	6,500,000	Fund not secured	Middle	2,555,087	Fund not secured	Low	**13,195,087**
Installation costs for replacement of electrical network assets	2,000,000	On going	High	1,000,000	Fund not secured	Middle	456,407	Fund not secured	Low	**3,456,407**
Repair and upgrade Gaza North Substation including construction of distribution networks	26,000,000	Fund not secured	High							**26,000,000**
Repair damage of Gaza Power Plant	5,000,000	Fund not secured	High	5,000,000	Fund not secured	Middle				**10,000,000**
Upgrading KARMIA substation on Israel side, procure and installing transmission and distribution networks on Israel and Palestinian sides (26 MW additional)	10,000,000	Fund not secured	High							**10,000,000**
Construction of new transmission system for additional 160MW from Israel	10,000,000	Fund not secured	High							**10,000,000**
Construction ANSAR substation including transmission networks and distribution networks				40,000,000	Fund not secured	Middle				**40,000,000**
Switch Gaza Power Plant from industrial diesel fuel to natural gas				40,000,000	Fund not secured	Middle				**40,000,000**
Restoration of Gaza West Substation to 220KV design; connection to Gaza Middle Substation				40,000,000	Fund not secured	Middle				**40,000,000**
Upgrade of substations between Gaza and Egypt to support increased supply							58,000,000	Fund not secured	Low	**58,000,000**
Identification of land for establishment of renewable energy infrastructure							1,000,000	Fund not secured	Low	**1,000,000**
Exploration and study of Gaza marine territory for natural gas supplies							5,000,000	Fund not secured	Low	**5,000,000**
Total Cost (USD)	**67,260,000**			**138,864,706**			**71,023,087**			**277,147,793**

Source: Data provided by PENRA

Table 3-8 Needs for Reconstruction Assistance by GEDCO (2015)

Reconstruction Needs						
Needs	**Total Losses**	**Short-Term (0 to 12 months)**	**Medium-Term (1 to 2 years)**	**Long-Term (over 2 years)**	**Total Secured**	**Total Unsecured**
		High Priority	**Medium Priority**	**Low Priority**		
Rental of temporary storage facility	200,000	100,000	100,000	0	100,000	100,000
		100,000 USD Secured World Bank	100,000 USD Unsecured			
Replacement of equipment destroyed in main warehouse	13,195,087	4,140,000	6,500,000	2,555,087	4,810,000	8,385,087
		500,000 USD Secured PENRA				
		230,000 USD Secured OCHA	670,000 USD Secured World Bank			
		3,410,000 USD Secured World Bank	5,830,000 USD Unsecured	2,555,087 USD Unsecured		
Replacement of destroyed equipment in installed electrical network	17,131,593	8,620,000	4,500,000	4,011,593	10,731,171	6,400,422
		200,000 USD Secured Islamic Bank				
		639,998 USD Secured Turkey				
		911,173 USD Secured ICRC				
		200,000 USD Secured JICA Beit Hanoun				
		160,000 USD Secured JICA Abassan	2,111,171 USD Secured World Bank			
		6,508,829 USD Secured World Bank	2,388,829 USD Unsecured	4,011,593 USD Unsecured		
Construction of new main warehouse; repair of GEDCO branches	1,764,706	0	1,764,706	0	0	1,764,706
			1,764,706 USD Unsecured			
Installation costs for replacement of electrical network assets	3,426,407	2,000,000	1,000,000	426,407	2,170,000	1,256,407
		100,000 USD Secured Islamic Bank				
		70,000 USD Secured ICRC	170,000 USD Secured World Bank			
		1,830,000 USD Secured World Bank	830,000 USD Unsecured	426,407 USD Unsecured		
Vehicles Damages	177,353	0	177,353	0	0	177,353
			177,353 USD Unsecured			
Total (USD)	**35,895,146**	**14,860,000**	**14,042,059**	**6,993,087**	**17,811,171**	**18,083,975**

Source: Data provided by GEDCO

3-3-2 Analysis of Challenges and Countermeasures

The objective of the energy sector is "to supply stable, reliable and sufficient electricity at a reasonable price". To realize this goal of energy sector, challenges which Gaza's energy sector encounters are itemized, causes are analyzed and countermeasures are proposed.

Table 3-9 Study of Challenges Facing the Power Sector in Gaza Strip and Countermeasures

Challenges	Causes	Countermeasures	Term
1. Rehabilitation of distribution network damaged by the assault in 2014 has not been completed yet and power supply in some areas is still suspended	1-1 Lack of materials for rehabilitation	Procure and supply conductors, electrical poles, distribution transformers, etc.	Medium−Long
	1-2 Lack of vehicles necessary for the work such as bucket truck, crane, etc.	Procure and supply bucket trucks and cranes	Medium−Long
2. Huge distribution losses	2-1 Electrical resistance increases with the increase of temporary connections [8] for repairing distribution lines	Reconductor the damaged line with temporary connections	Medium−Long
		Conduct a training on optimal distribution network design and operation and maintenance distribution of network	
	2-2 Increase in electricity loss from heavy current draw, which is due to the distribution network transmitting low voltage over long distances	Reduce power distribution loss by 70% by upgrading the distribution network from low to medium voltage	Medium−Long
	2-3 GEDCO is not adequately performing distribution network data collection, drawing management, power distribution planning, quality control, and construction management, which is resulting in significant electricity losses	Conduct OJT skill development to improve data collection, drawing management, power distribution planning, quality control, and construction management	Medium−Long
	2-4 A lot of transformers are over loaded or highly loaded	Conduct a training on operation and maintenance of distribution transformers	Medium−Long
		Replace overloaded transformers with a larger ones or reallocate the load with several transformers	
	2-5 A lot of non-technical losses, i.e. arrears and electricity theft	Introduce prepaid meters and tighten counter actions on arrears and electricity theft	Medium−Long
3. Significantly insufficient power supply compared to potential demand	3-1 Limited power supply from Israel and Egypt	Construct high voltage transmission lines (Israel-Gaza: 161kV, Egypt-Gaza:220kV) and grid substations (161/22kV and 220/22kV)	Medium−Long
	3-2 Limited generation at GPP	Convert the fuel of GPP from	Medium−Long

[8] Although electricity supply is possible by temporary repairs such as connecting disconnected wires by connector or twisting wires, it is necessary to replace the wires as permanent repairs because the reliability of distribution network is low. Currently, even if there are workmanship and tools, permanent repair is not impossible because there is not materials such as wires and wooden poles, etc.

Challenges	Causes	Countermeasures	Term
	due to high fuel cost	industrial diesel to cheaper natural gas	
	3-3 Limited generation at GPP due to scarce delivery to Gaza Strip	Expand the use of indigenous energy resources such as solar	Short−Medium
4. Restoration work on distribution networks cannot be performed properly, quickly, and safely	4-1 Lack of protective equipment, meters, tools, and lights	Provide protective equipment, meters, tools, and lights.	Short
5. Aerial platform vehicles are inoperable, causing issues for maintenance, new construction, and bill collection	5-1 Aerial platform vehicles are dilapidated and lacking in number	Introduce more aerial platform vehicles	Short
6. Low safety levels at night due to darkness from power outages	6-1 Insufficient power. Also, lack of funds to install street lighting	Introduce solar-powered street lights	Short

Source: JST

3-3-3 Constraint

"Defense Export Control Order of Israel" controls the transportation of goods and materials into the Gaza Strip. Missile equipment and munitions are prohibited and dual use items such as cement, aggregate, steel elements and construction materials, steel wires, vehicles other than those for personal use are also restricted. Dual use items to be used for a project approved by the Palestinian Authority and supervised by international organizations can be brought into the Gaza Strip based on GRM. However, the approval process for permission may take long time and the request may not be approved. Thus, the delivery of goods and materials is critical to the Gaza Strip in project implementation. For example, bucket trucks procured by PENRA were not allowed to enter into Gaza Strip because the height and rotating direction of an arm exceeded the Israeli limitation.

It seems to be difficult to increase the power supply from Israel to the Gaza Strip unless the political conflict between the two sides is solved. Under this situation, the construction of high voltage transmission lines from Egypt to the Gaza Strip is also difficult.

3-3-4 Medium-term Assistance Plan

The direction of medium-term assistance is examined considering the National Development Plan of Palestine, trend of donor assistance, needs for assistance from the Palestinian side, analysis of challenges and countermeasures and constraints, as shown in Table 3-10 from the viewpoints of urgency, effect and possibility. As a result, "Rehabilitation of distribution network", "Enhancement of power supply capacity in Gaza Strip", "Improvement of energy self-sufficiency" and "Technical assistance" are recommended for the areas of assistance in the medium-term. Even though "Enhancement of power supply capacity in Gaza Strip" in the second row of Table 3-10 is recognized to be highly necessary and effective, it seems not realizable unless the political conflict is solved.

Taking into account the difficulty of implementing a large-scale project due to political issues between Israel and Palestine as well as logistical constraints, and based on the above-mentioned directionality and pilot project results, the recommended Medium-term Assistance Plan, including compatibility with the National

Policy Agenda, is listed in columns1 to 7 in Table 3-11. Further, Table 3-12 shows an overview of the recommended medium-term Assistance Plan.

Table 3-10 Analysis to determine the direction of Medium-term assistance plan

Needs of assistance	Contents	Urgency	Term	Effect	Possibility
Rehabilitation of the distribution network	Permanent repair for temporarily connected lines	High	Short	High	High
Enhancement of power supply capacity in Gaza Strip	Construction of 220kV and 161kV transmission lines and grid substations	Med	Medium-long	High	Low
	Rehabilitation, expansion and fuel conversion of GPP	Med	Medium - long	high	Low
Improvement of energy self-sufficiency	Installation of solar power systems to priority public facilities listed in the Solar Action Plan	Med	Short-Medium	Med	High
Technical assistance	Training on operation and maintenance of overhead/ underground distribution lines and distribution transformers	Med	Short-Medium	Med	High

Table 3-11 Recommended Medium-term Assistance Plan and consistency with National Policy Agenda

No.	Recommended Medium-term Assistance Plan	National Policy Agenda	Compatibility of Medium-term Assistance Plan with the National Policy Agenda
1	GEDCO skill development a means to achieve restoration of distribution networks and reduce electricity loss	Building Palestine's Future Economy: ➢ Rebuild Palestine's productive sectors, focusing on manufacturing, agriculture, tourism and restoring Gaza's industrial base ➢ Plan and invest in strategic infrastructure (water, electricity, transportation and telecom networks, airports, seaport and industrial parks) Meeting the Basic Needs of Our Communities: ➢ Expand community access to reliable energy Ensuring a Sustainable Environment and Adapting to Climate Change: ➢ Increase energy efficiency and reliance on renewable energy	● Rebuilds productive sectors by restoring distribution networks in industrial areas ● Plans and invests in critical infrastructure (power) by reconstructing distribution networks and developing skills ● Expands community access to reliable energy by reconstructing distribution networks and developing skills ● Increases energy efficiency by developing skills and reducing loss in distribution networks
2	Supply of protective equipment, meters, tools, and lights (1 set)	Creating Job Opportunities: ➢ Ensure a safe work environment through application of health and occupational safety standards	● Ensures a safe work environment in construction through the use of protective equipment, etc.
3	Procurement of Aerial platform vehicles for maintenance, new construction work, and anti-theft measures	Creating Job Opportunities: ➢ Ensure a safe work environment through application of health and occupational safety standards	● Ensures a safe work environment in construction through the use of platform vehicles
4	Introduction of a solar power PV system (for public facilities such as hospitals)	Improving Primary and Secondary Education: ➢ Reform and modernize primary and secondary school curricula	● Modernizes education curricula by using solar-powered systems that enable computer use and e-learning

No.	Recommended Medium-term Assistance Plan	National Policy Agenda	Compatibility of Medium-term Assistance Plan with the National Policy Agenda
		➢ Develop of e-learning programs ➢ Upgrade educational facilities to ensure a safe, healthy learning environment Better Healthcare Services: ➢ Improve the quality of health care services (infrastructure, equipment, drugs, IT, training of health care workers, standards) Ensuring a Sustainable Environment and Adapting to Climate Change: ➢ Reduce and effectively control pollution and greenhouse gas emissions ➢ Manage, protect and promote sustainable use and conservation of natural resources (land, water and energy) ➢ Increase energy efficiency and reliance on renewable energy	without power outages ● Improves learning environments by using solar-powered systems to prevent dark, unhealthy learning environments caused by power outages ● Improves the quality of health care services by using solar-powered systems to allow use of medical equipment and IT without interruption during power outages ● The use of solar-powered systems is a measure against environmental pollution ● Promotes renewable energy use with solar power ● Increases reliance on the use of renewable energy with solar-powered systems
5	Introduction of Solar Street Lights	Ensuring a Sustainable Environment and Adapting to Climate Change: ➢ Reduce and effectively control pollution and greenhouse gas emissions ➢ Manage, protect and promote sustainable use and conservation of natural resources (land, water and energy) ➢ Increase energy efficiency and reliance on renewable energy	● The use of solar-powered systems is a measure against environmental pollution ● Promotes renewable energy use with solar power ● Increases reliance on the use of renewable energy with solar-powered systems
6	Introduction of a solar power PV system (for low-income group)	Ensuring a Sustainable Environment and Adapting to Climate Change: ➢ Reduce and effectively control pollution and greenhouse gas emissions ➢ Manage, protect and promote sustainable use and conservation of natural resources (land, water and energy) ➢ Increase energy efficiency and reliance on renewable energy	● The use of solar-powered systems is a measure against environmental pollution ● Promotes renewable energy use with solar power ● Increases reliance on the use of renewable energy with solar-powered systems
7	Technical Assistance	Building Palestine's Future Economy: ➢ Plan and invest in strategic infrastructure (water, electricity, transportation and telecom networks, airports, seaport and industrial parks) Meeting the Basic Needs of Our Communities: ➢ Expand community access to	● Realizes a high quality power plan by capacity building in the power sector through technical assistance ● Expands community access to reliable energy through skill development in the power sector through technical assistance

No.	Recommended Medium-term Assistance Plan	National Policy Agenda	Compatibility of Medium-term Assistance Plan with the National Policy Agenda
		reliable energy Ensuring a Sustainable Environment and Adapting to Climate Change: ➢ Increase energy efficiency and reliance on renewable energy	● Increases energy efficiency by reducing electricity loss through technical assistance

Source: State of Palestine (December, 2016) "National Policy Agenda 2017-2022 Putting Citizens First", JST

Table 3-12 Outline of Proposed Medium-term Reconstruction Assistance Plan

No.	Type	Location	Component	Description	Cost (USD)	Priority	Criteria	Term	Scheme
1	Material Supply	Alshejaia Refer to (a) in Figure 3-5	GEDCO skill development a means to achieve restoration of distribution networks and reduce electricity loss Power system analysis software (ETAP™) and training	Based on construction needs from GEDCO, to permanently repair distribution networks that have been temporarily repaired, and to build a long-term infrastructure for Gaza's power system by reducing electricity loss and restoring soundness to GEDCO's ability to manage the system.	Power distribution/skill development (1,610,000) Note: Power system analysis software (ETAP ™) and training are considered separately	1	Significant effect on electricity service improvement as well as economic reconstruction is expected since the scale of destruction is large, population density is high, and it is industry area	Medium-term Long-Term (2 years)	Implement in stages through follow-up (Example) 1st follow-up: Data collection/distribution plan (10 million yen) 2nd follow-up: Procurement/construction (20 million yen)
	Material Supply	Beit Hanoun Refer to (b) in Figure 3-5 Khoza'a and Alfukhari Refer to (c) in Figure 3-5	GEDCO skill development as a means to achieve restoration of distribution networks and reduce electricity loss Power system analysis software (ETAP™) and training	Based on construction needs from GEDCO, to permanently repair distribution networks that have been temporarily repaired, and to build a long-term infrastructure for Gaza's power system by reducing electricity loss and restoring soundness to GEDCO's ability to manage the system. Introduce aerial platform vehicles in to carry out construction properly, quickly, and safely.	Power distribution/skill development (780,000) Note: Power system analysis software (ETAP ™) and training are considered separately	1	The Beit Hanoun area is an extensively damaged new industrial area. Because of this, it is possible to greatly improve power service and also realize significant benefits for economic recovery. The Alfukhari area is an extensively damaged suburban area. Since the transmission network here is inadequate and substantial electricity loss occurs, it is possible to greatly improve power service as well as electricity loss here. GEDCO's aerial platform vehicles are dilapidated and need to be replaced		

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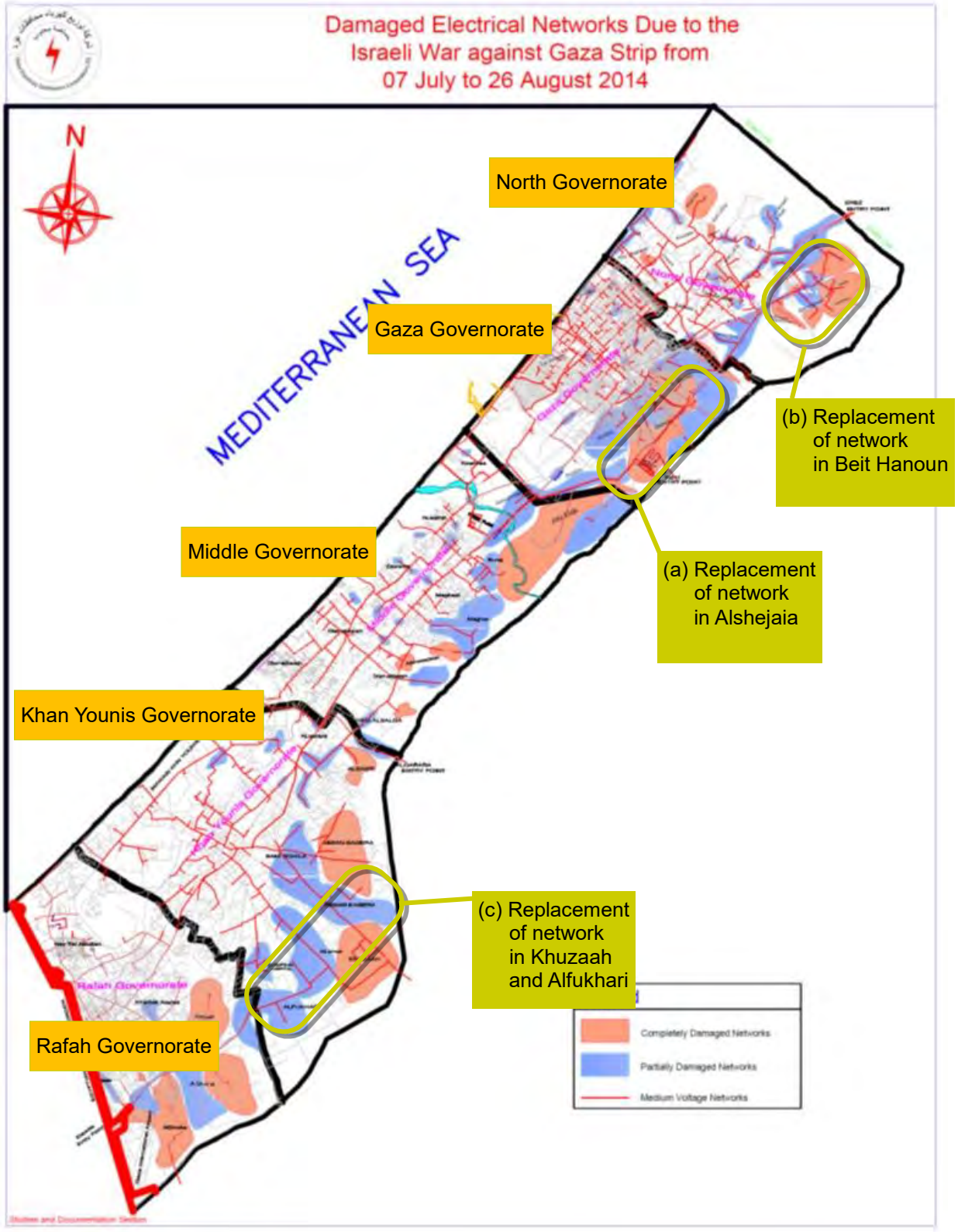
No.	Type	Location	Component	Description	Cost (USD)	Priority	Criteria	Term	Scheme
2	Material supply	5 GEDCO branches	Protective equipment, meters, tools, and light (1 set)	Introduce Protective equipment, meters, tools, and lights to enable restoration work on distribution networks to be performed properly, quickly, and safely.	Protective equipment, meter, tools, and light (1 set) (200,000)	1	Since these items are required for distribution network restoration work, and protective equipment is lacking at GEDCO	Short-term	Follow-up
3	Material supply	5 GEDCO branches	Aerial platform vehicles (6 vehicles)	Introduce aerial platform vehicles to perform maintenance, new construction work and anti-theft measures	600,000 (100,000 x 6)	1	Since this equipment is crucial for operations, and existing aerial platform vehicles are dilapidated as well as lacking in number	Short-term	Follow-up
4-1	Material Supply	1.ICU in Shuhada Al-Aqsa Hospital 2.ICU in Nassar Hospital 3.ICU in Elnajjar Hospital	Renewable Energy Photovoltaic System Projects	Install on-grid PV panels (30kWp) at three hospitals (ICUs) which are high-priority public services in order to ensure uninterrupted power during outages.	450,000 (150,000 x 3)	1	Select 3 hospitals (ICU) with high priority from “Action Plan” of PENRA	Short-term Medium-term (4years)	Implement in stages through follow-up
4-2	Material Supply	1.Premature Nurseries in Alshefa Hospital 2. Premature Nurseries in Mubarak Hospital	Ditto	Install on-grid PV panels (30kWp) at two premature infant care hospitals which are high-priority public services in order to ensure uninterrupted power during outages.	300,000 (150,000 × 2)	2	Select 2 premature nurseries with high priority from “Action Plan” of PENRA	Short-term Medium-term (4years)	Implement in stages through follow-up
4-3	Material Supply	1. Abo Obaida ben Aljarah boys secondary school 2. Khalil Alrahman Secondary Boys School 3. Alkuait secondary girls school 4. Alriyad secondary girls school 5. Khaled ben alwaleed boys	Ditto	Install on-grid PV panels (35kWp) at schools which are high-priority public services in order to ensure uninterrupted power during outages.	1,120,000 (140,000 x 8)	3	Select schools in North, Middle, and Rafah governorates which have few PV panels installed	Short-term Medium-term (4years)	Implement in stages through follow-up

3-19

No.	Type	Location	Component	Description	Cost (USD)	Priority	Criteria	Term	Scheme
		secondary school 6. Ahmed Alshokari boys secondary school 7. Tal Alzatar girls secondary school 8. Alaaishia secondary girls school							
5	Material supply	Parks	10 solar street lights	Safety levels at night are low due to darkness from power outages. This introduces on grid PV systems to compensate for insufficient power	92,000 (9200 × 10)	3	Use lights that are feasible, benefit the public, and use PV systems based on the National Development Plan	Short-term (1 year)	Follow-up
6	Material Supply	Low-income group area	Renewable Energy Photovoltaic System Projects	A solar-powered generating system with a capacity of around 500kWp will be gradually introduced into the area of low-income earners; ultimately expanding to reach a generation capacity of 2 to 3MWp. An on-grid photovoltaic power generating system will be used in conjunction with the distribution network.	1,300,000 (Generation capacity 500kWp)	3	Securing of electricity supply using PV systems based on the National Development Plan	Medium-term (4year)	To be discussed
7	Technical Assistance	Third countries (Egypt and Jordan)	Technical Training	Provide training on the operation and maintenance of overhead/underground distribution lines and distribution transformers to optimize distribution network planning and improve operation and maintenance capabilities		2	From among the technical assistance items requested from GEDCO, select training which will best lead to remedying technical loss and stabilizing the power supply	Short-term (1 year)	Technical cooperation in a third country

Source: JST

3-20



Source: JST edited based on "Damages Assessment Report Electricity Distribution Sector Israeli War against Gaza Strip (07 JULY-26 AUGUST 2014)"

Figure 3-5 Site location of distribution networks and reduce electricity loss

3-3-5 Medium Term Assistance Plan Practical Proposal

(1) [Assistance Plan 1] GEDCO skill development, a means to achieve restoration of distribution networks and reduce electricity loss

By permanently rehabilitating the current temporarily repaired electrical network, all consumers could access electricity, technical loss could be decreased, and electrical power supply could be much improved.

As shown in Table 1-11, Israeli attacks on the Gaza Strip in 2014 destroyed much of the medium voltage distribution network (46% of the entire network). It is believed that the consequent need to deliver power over a low voltage network for long distances worsened electricity losses. Although assistance from the World Bank to restore the distribution network includes goods and materials for the medium voltage distribution network, it is not enough to cover extension of the medium voltage network, meaning that there is not enough equipment and materials to complete the medium voltage distribution network. For this reason, we proposed the solution shown in Steps 1 to 4 below, which aims to reduce the distribution network transmission loss including distribution network restoration. Specifically, the solution will greatly reduce electricity loss by: upgrading the distribution network from low- to medium-voltage (e.g. 22kV) sending power at medium voltage until near the customers' location; stepping medium voltage down to low and then using a delivery method such as delivering power to customers via low voltage over short distance, or by increasing the number of low voltage wire conductors (thus reducing wire resistance). Achieving this requires a power distribution plan based on accurate data (positioning, current, voltage, power factor, etc.), drawing management, and demand forecasts.

GEDCO has measurement tools to collect accurate data (position, current, voltage power factor, etc.), GPS device and Geographic Information System (GIS). GEDCO also has a power system analysis software, ETAP™ [9], making it possible to optimize the distribution design by inputting the collected data into ETAP™. However, GEDCO only has a single-user licensed copy of ETAP™, which it uses to study and analyze medium-voltage networks for the entire Gaza Strip. GEDCO requested assistance to secure another five copies of ETAP™ for all the GEDCO Branch office for use in studying and analyzing the low voltage network for the entire the Gaza Strip, as well as assistance for training in ETAP™ within the Gaza Strip. Although all the electrical data of the network components and all technical measurements are available to GEDCO, no network improvements have been achieved based on the available technical measurements for the following reasons:

- The available energy in the Gaza Strip to supply is insufficient, and the energy deficit rate is around 80%;
- The energy sources are not fixed or stable
- The closures and siege imposed upon the Gaza Strip hinder ongoing efforts to secure the required materials, meaning GEDCO is forced to work solely with the materials at hand.

GEDCO proposed that the distribution network be studied professionally, despite the surrounding changeable and unstable political situation. Therefore, the use of ETAP™ is recommended in preparation of the power distribution design and the required material distribution network be supplied to GEDCO. Expanding a low electricity loss distribution network will help secure power in the Gaza Strip, which is experiencing a severe

[9] Using ETAP™, the electrical power system analysis software owned by GEDCO, makes it possible to find optimal configurations through trial and error by drafting a variety of study cases at the planning stage, and then analyzing them efficiently and systematically. Examples of use include power factor improvement by optimal placement of capacitors and capacity analysis; minimization of project costs, etc.

power shortage. Moreover, since a voltage upgrade will greatly increase distribution capacity, this would make it possible to support power supply increases in the future when lasting peace is achieved in the area, and it is believed that this will contribute to building the infrastructure for a long-term power system. Details of this assistance are provided below.

Purpose: Build a long-term infrastructure for Gaza's power system by restoring the distribution network, reducing electricity loss and restoring soundness of GEDCO's ability to manage the system

STEP 1: Site selection, distribution network data collection (electrical constants), and power demand forecast

* Electrical Constants: Israeli side Impedance, Palestinian side cable specifications, length, voltage transformer specifications and installed locations, load conditions, etc.

STEP 2: Optimization of the distribution network plan (upgrading the distribution network from low to medium voltage, increasing the number of conductors on low voltage lines, voltage regulation, power factor improvement, etc.)

* Including training on optimizing distribution network plans by videoconferencing in the Gaza Strip, which would be conducted by Japanese consultants who are experts in ETAP™

STEP 3: Procurement and installation of the low-loss power distribution network

STEP 4: Steps 1 to 3 are implemented at other sites to further expand electricity loss reductions

STEPS 1 through 4 are primarily carried out by GEDCO and the required material is supplied. STEP 2 targets fostering GEDCO's planning ability related to electricity distribution. STEP 3 aims at enhancing competencies in quality control and construction management. During STEP 2, Japanese technicians will provide training on overhead distribution network design using ETAP™. Should security issues hinder them from entering the Gaza Strip, remote training can be used as an alternative. The method of remote training would be Japanese technicians communicating remotely with GEDCO through a video conference system between Japan and Gaza Strip.

The scope of network restoration assistance funded by World Bank and IsDB is limited to provision of the equipment, while GEDCO handles electricity distribution planning and construction management. Therefore, skill development in design and construction management is considered sustainable, coupled with the support from other donors.

As a case study, GEDCO selected two sites in the pilot project in Khan Younis and studied the ETAP™ program in detail. Sites were visited and the basic project plan was compared with the situation on site. Real measurements were taken along the network and the number of subscribers on the transformer was counted. The following study outcomes were determined based on the ETAP™ program:

Case 1: Reconstruction of Eastern Feeder Transformer Abu Tabash Project

It was clear from the site visit that the basic plan matches the reality on site. By entering the load data according to the actual measurements, it was found that the rate of the power loss is 5.3%, which is within

permissible level. A one-line diagram of this study is shown below.

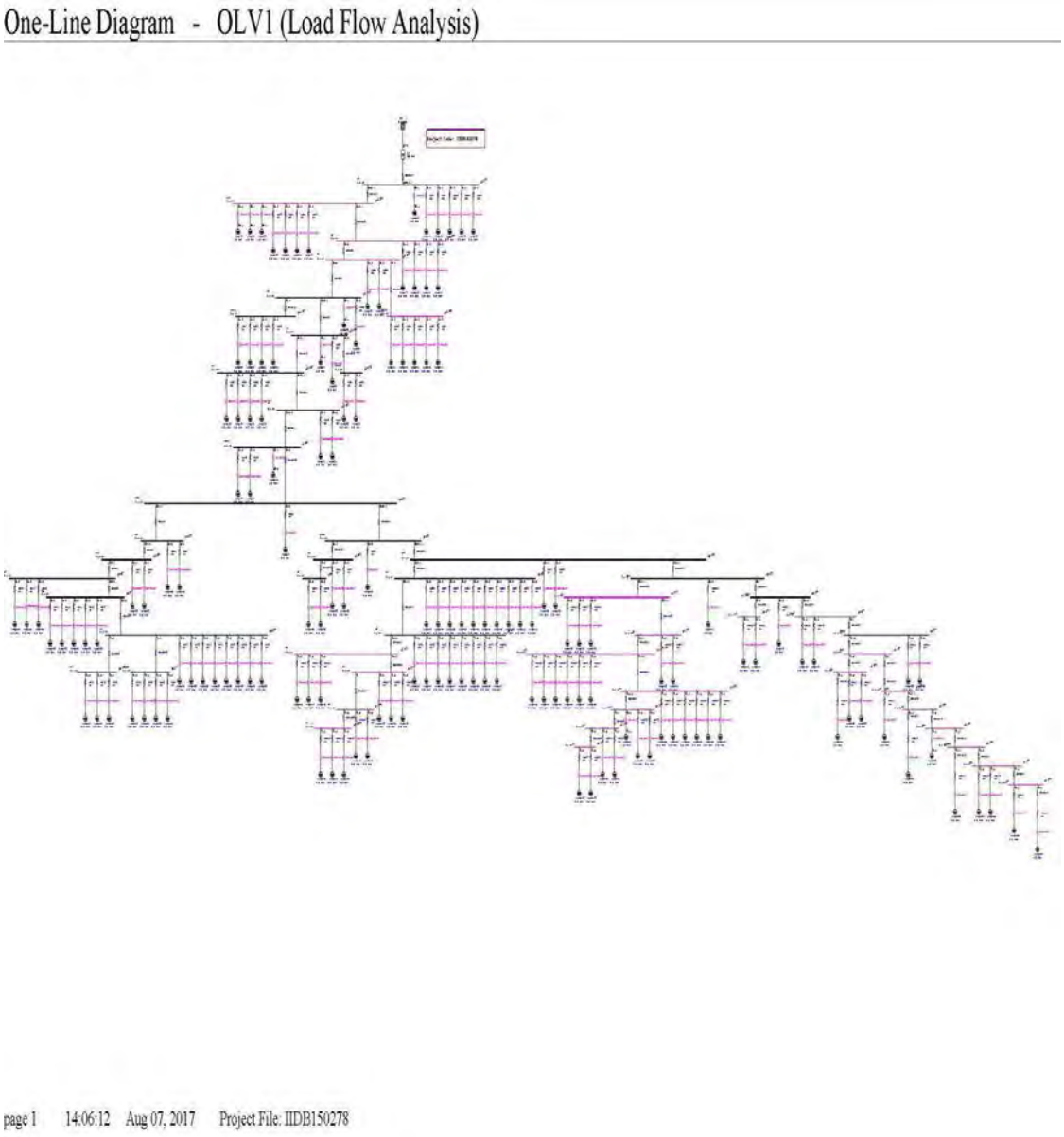


Figure 3-6 Analysis of low voltage distribution network by ETAP™ (Case 1)

Case 2: South Feeder Transformer Farrahin Reconstruction Project

Visiting the site clearly reveals significant changes in the basic plan and the way the network has been expanded with additional distance. During the ETAP™ study project, the result has shown power loss increase to 11.5%, which exceeds the permissible percentage, after extending the network by one kilometer. Accordingly, it is proposed that the project plan be modified by adding a new transformer to reduce existing loads, which will also reduce losses effectively and improve the voltage level. After preparing a study on the addition of a new transformer, it was found that the loss percentage would be reduced to 4.2%. A one-line diagram of this study is shown below.

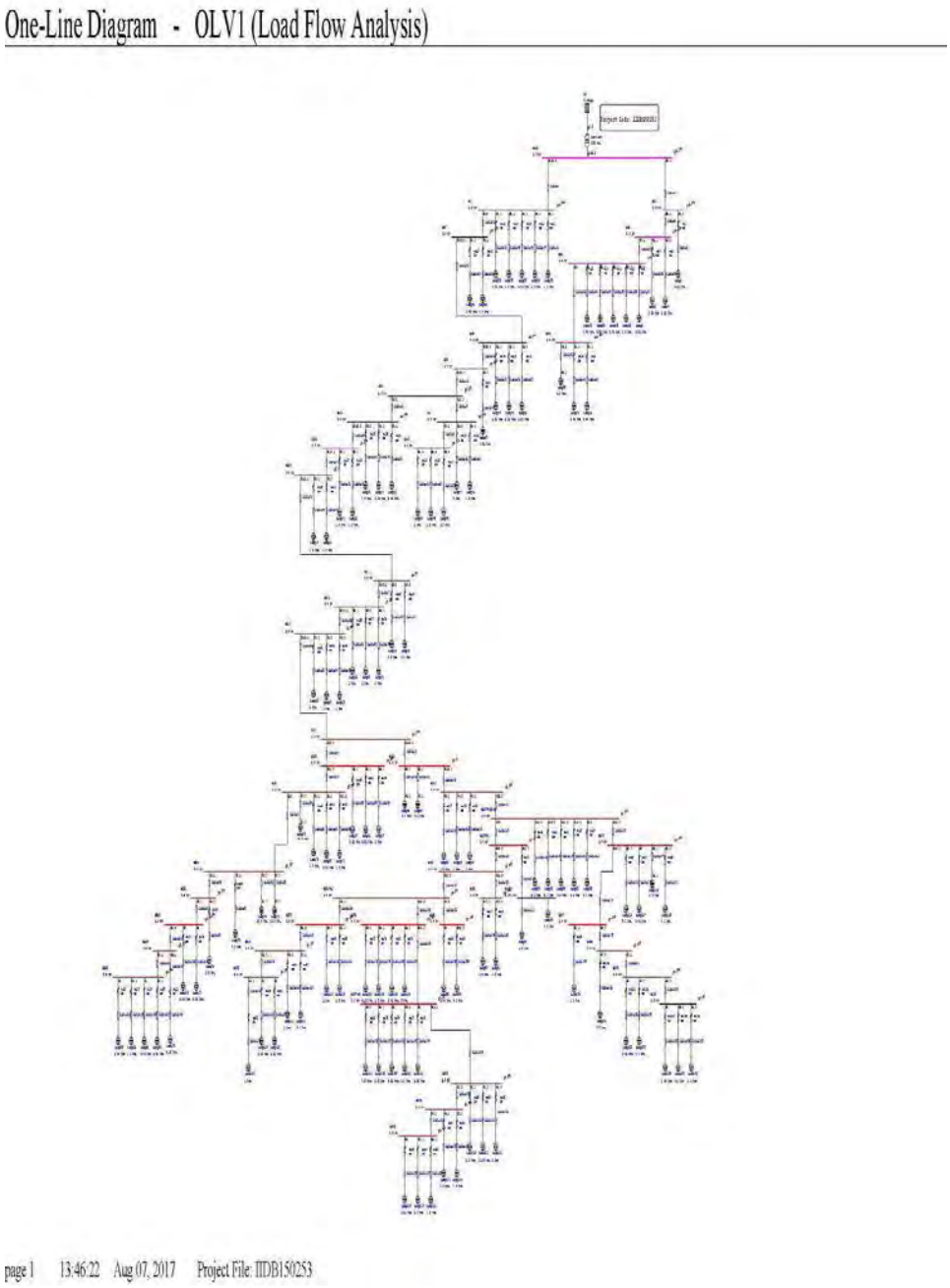


Figure 3-7 Analysis of low voltage distribution network by ETAP™ (Case 2)

In the Assistance Plan proposed in Table 3-12, the cost of restoring distribution networks in each area is the estimated based on "Damage Assessment Report Israeli War against Gaza Strip (07 JULY-26 AUGUST 2014" (DAR). Table 3-13 shows the cost estimation in each area.

Table 3-13 Cost estimation for distribution network rehabilitation

Unit: USD

Area		Total Damage Cost	Committed			Fund not secured	Priority
			World Bank	Turkey, OCHA, ISDB,ICRC	JICA		
Whole of Gaza		17,131,593	8,620,000	1,551,171	359,265	6,601,157	
North Governorate		3,291,633	1,865,379	298,039	200,000	928,215	
	Beit Hanoun	1,400,034	793,404	126,765	200,000	**279,865**	**1**
	Beit Lahia	1,065,003	603,541	96,430		365,032	3
	Jabalia	826,596	468,435	74,844		283,318	3
Gaza Govanernorate		6,198,007	3,181,759	561,195		2,455,053	
	Alshejaia	2,905,092	1,491,335	263,040		**1,150,717**	**1**
	Alzayton	1,250,470	641,931	113,223		495,316	2
	Defferent zones	2,042,444	1,048,493	184,932		809,019	3
Middle Governorate		2,558,816	1,077,565	231,687		1,249,564	
	Johr Aldik, Almoghraga and Alzahra	715,624	301,363	64,796		349,466	2
	Almaghazi	406,439	171,159	36,801		198,479	3
	Alburayij	332,691	140,102	30,123		162,465	3
	Alnusairat and Alzawayde	460,071	193,744	41,657		224,670	3
	Deir Albalah, Amosadar and Wadi Alsalga	643,992	271,197	58,310		314,485	3
Khan Younis Governorate		2,542,926	1,242,707	230,248	159,265	910,706	
	Khuzaah and Alfukhari	984,279	481,009	89,121	109,056	**305,093**	**1**
	Abassan	920,694	449,936	83,364	50,210	337,185	2
	Defferent zones	637,953	311,762	57,763		268,428	3
Rafah Governorate		2,540,652	1,252,591	230,042		1,058,019	
	Alshoka	1,106,181	545,369	100,159		460,654	2
	Alnasir and Kherbet Aladas	758,846	374,126	68,709		316,011	2
	Different Zones	675,625	333,096	61,174		281,355	3

To be considered by JICA's Mid-term assistance

Source: JST

Table 3-14, Table 3-15 and Table 3-16 show the number of components in each area[10]. Number of beneficiaries (Customers) are 7.831 for Alshejaia, 5.213 for Beit Hanoun, and 1,790 for huzaah and Alfukhari.

[10] The reason that the price of the same component may differ by area is considered to be due to the fact that the DAR component breakdown for each area is different.

Table 3-14 Components for Alshejaia

Damages Location	Damages Category	Assets name	Unit	Unit price (USD)	Qty	Subtotal
Alshejaia	Steel Materials and Wooden Poles	Steel Poles	No	1,013	105	106,108
		Wooden Poles	No	135	445	59,910
		Steel Bases	No	610	40	24,485
		Steel Arms	No	89	657	58,771
		Steel Accessories				6,856
	Transformers	Transformers	No	15,947	19	300,896
	Switches, Switchgears and Distribution Boards	M.V Switches	No	2,059	15	30,581
		L.V Switches	No	912	77	70,325
		Switchgears	No	13,603	2	21,844
		Distribution Boards	No			4,133
	Wires , Cables and M.V Cables Accessories	Wires	Km	2,063	36	74,458
		L.V Cables	Km	7,405	24	178,953
		M.V Cables	Km	23,033	4	88,768
		M.V Cables Accessories	No	183	29	5,292
	Fuse Holders, Insulators and Accessories	Surge Arrestors Fuse holders and Accessories	No	60	51	3,045
		Insulators and Accessories	No	46	430	19,892
		Overhead lines Accessories	No	9	961	8,257
		L.V Cables Accessories	No	7	6,288	44,950
		Another Accessories				14,108
Total Price (USD)						1,166,255

Source: Data provided by GEDCO, JST

Table 3-15 Components for Beit Hanoun

Damages Location	Damages Category	Assets name	Unit	Unit price (USD)	Qty	Subtotal
Beit Hanoun	Steel Materials and Wooden Poles	Steel Poles	No	960	30	28,807
		Wooden Poles	No	139	168	23,341
		Steel Bases	No	388	10	4,044
		Steel Arms	No	103	149	15,255
		Steel Accessories				2,404
	Transformers	Transformers	No	15,731	6	88,027
	Switches, Switchgears and Distribution Boards	M.V Switches	No	2,059	5	9,950
		L.V Switches	No	941	22	21,067
		Switchgears	No	14,706	1	7,481
		Distribution Boards	No			
	Wires , Cables and M.V Cables Accessories	Wires	Km	2,131	17	35,636
		L.V Cables	Km	7,360	10	73,015
		M.V Cables	Km	7,942	0	1,111
		M.V Cables Accessories	No	121	3	370
	Fuse Holders, Insulators and Accessories	Surge Arrestors Fuse holders and Accessories	No	57	25	1,410
		Insulators and Accessories	No	46	192	8,890
		Overhead lines Accessories	No	8	317	2,507
		L.V Cables Accessories	No	7	2,820	19,312
		Another Accessories				4,169
Total Price (USD)						356,105

Source: Data provided by GEDCO, JST

Table 3-16 Components for Khuzaah & Alfukhari

Damages Location	Damages Category	Assets name	Unit	Unit price (USD)	Qty	Subtotal
Khuzaah and Alfukhari	Steel Materials and Wooden Poles	Steel Poles	No	940	31	29,513
		Wooden Poles	No	138	181	24,917
		Steel Bases	No	364	9	3,115
		Steel Arms	No	97	150	14,613
		Steel Accessories				2,304
	Transformers	Transformers	No	16,320	2	31,070
	Switches, Switchgears and Distribution Boards	M.V Switches	No	2,059	3	5,879
		L.V Switches	No	941	8	7,167
		Switchgears	No	14,706	0	3,500
		Distribution Boards	No			0
	Wires , Cables and M.V Cables Accessories	Wires	Km	1,874	10	19,331
		L.V Cables	Km	7,299	8	57,324
		M.V Cables	Km			0
		M.V Cables Accessories	No			0
	Fuse Holders, Insulators and Accessories	Surge Arrestors Fuse holders and Accessories	No	57	23	1,319
		Insulators and Accessories	No	50	144	7,187
		Overhead lines Accessories	No	8	264	2,113
		L.V Cables Accessories	No	7	2,088	14,374
		Another Accessories				1,811
Total Price (USD)						234,236

Source: Data provided by GEDCO, JST

(2)【Assistance Plan No. 2】Supply of protective equipment, meters, tools, and lights required for the restoration of distribution network

In order to conduct high-quality electric power distribution network restoration work in a safe manner and in a short time frame, security supplies, measuring devices, tools and lights will be needed. World Bank support includes security devices, but the amount of support provided by the World Bank is insufficient, so this assistance plan will include an add-on of security supplies, measuring devices, tools and lights. Details are shown in the table below.

Table 3-17 Protective equipment, meters, tools, and lights

No	Description of Goods	Unit	Q'ty	Unit Price (USD)	Total Price (USD)
1	Clamp on Power 3 Phase Analyzer with Clamp on Sensors 1000A AC rated current	Set	5	5,500	27,500
2	C1amp on Power 3 Phase Analyzer With CT Flexible Clamp on Sensors 5000A AC rated current	Set	5	7,800	39,000
3	True RMS Digital Clamp-Meter, l000A AC	Set	40	180	7,200
4	Automated 5kV Insulation Tester	Set	2	3,800	7,600
5	Four Terminal Earth/Ground Resistance and Soil Resistivity Tester	Set	10	2,500	25,000
6	Up to 24 kV, 3 phase Actual current Recorder	Set	1	5,000	5,000
7	24kv Compact dual stick voltmeter	Set	1	2,000	2,000
8	Non-Contact AC Voltage and Current Detector	No.	100	50	5,000
9	Dieless Hydraulic Compression Tool	Set	10	2,000	20,000

No	Description of Goods	Unit	Q'ty	Unit Price (USD)	Total Price (USD)
10	36 kV insulating Rubber gloves	Pair	100	150	15,000
11	1000 V insulating Rubber gloves	Pair	200	105	21,000
12	Rechargeable LED's headlamp	No.	100	50	5,000
13	12VDC Vehicle Mounted Spotlight	Set	20	300	6,000
14	24VDC Vehicle Mounted Spotlight	Set	10	370	3,700
15	Rechargeable Handheld Spotlight	Set	50	100	5,000
16	12VDC Halogen Amber Light Bar	Set	20	300	6,000
				Total (USD)	200,000

Source: Data provided by GEDCO

(3)【Assistance Plan No. 3】 Procurement of Bucket trucks for maintenance & installation work and electricity-theft detection

Since its establishment, GEDCO has been financially unable to procure necessary aerial work vehicles. As shown in Figure 3-8, the truck crane used is a type with a basket at the boom end, which suffers poor operability and is considered dangerous. The bucket truck is deteriorating, having been used for as long as 18 years, and the costs and time loss caused by breakdowns and repairs are delaying construction schedules. The majority of the fourteen bucket trucks owned by GEDCO, as indicated in Table 3-18, are in a poor condition.

Figure 3-8 GEDCO's bucket truck (GEDCO North Branch)

Table 3-18 Distribution of GEDCO' bucket trucks

Vehicle	Model	Gaza		North	The middle	Khan Younis	Rafah
		Collection	Maintenance				
Basket Daff	Three 1998 Two 2003		1	1	1	1	1
Basket Nissan	1998	1					
Basket Mercedes	1998	1	1	1	1		
Volvo Basket	1998		1			1	1
Basket Mitsubishi	2010	1					
Total		6		2	2	2	2

Source: Data provided by GEDCO

Bucket trucks are used for maintenance work and installations. They are also used when cutting illegal wires connected to steal electricity. This compels power thieves to come to GEDCO and enables negotiation over their refund schedule, which in turn helps raise the electricity bill collection rate. During maintenance and new construction work, the trucks enable to carry out the construction works safely, properly and in a short time frame. GEDCO requested 6 areal work vehicles as detailed below.

Table 3-19 Number of bucket trucks requested by GEDCO

GEDCO Branch	Gaza	North	The middle	Khan Younis	Rafah
Vehicle with Aerial Platform (Basket)	2	1	1	1	1

Source: Data provided by GEDCO

Transporting bucket trucks from outside to inside the Gaza Strip requires a permit from COGAT. The truck specifications are also subject to restrictions as indicated below. Japanese bucket trucks are too heavy to meet the weight limit requirements, and therefore European-made trucks must be used, as the one shown in Figure 3-9, tailored to meet the specifications by limiting the height and rotation angle.

Specifications of a bucket truck required by COGAT

Total weight (Gross Vehicle Weight): not more than 4.5t

Height: not more than 16m

Rotation angle: within 180°

Source: Ruthmann Gmbh & Co. KG

Figure 3-9 A bucket truck made in Europe

(4)【Assistance Plan No. 4】Maintaining service at medical and educational institutions using solar power

One component in the Medium-term Assistance Plan aims at ensuring a reliable service delivery at key institutions (ICU hospitals, premature baby clinics, and schools) using solar power generation. As these systems can be installed by local contractors by themselves, a supervisor from manufacturer needs not to be present on site.

PENRA's Solar Action Plan (see **Appendix A**) intends to install a medium-scale solar power generation system (300kWp–350 kWp, 1,000 kWp in total) by 2017 that will cover public facilities such as hospitals, schools, and water supply and sewerage plants (30kWp–200kWp, 1,170kWp in total), and other utilities for low-income residences (1.5kWp, 600kWp in total), and road lamps (70kWp in total). Priority facilities are selected from the above. Most of the hospitals, which are rated top priority, have received some sort of equipment provision assistance from JICA and the provision of a solar power generation system in addition to this is believed to further increase the effectiveness of the assistance. Power outages are having unprecedented negative effects on local medical and educational facilities. Where healthcare services are being delivered, power outages and deteriorating power quality have damaged hundreds of medical devices used for the treatment of hundreds of patients. Furthermore, students are unable to study courses on science and information due to the power outages at schools. As a result these hospitals and schools are forced to operate or teach in darkness during power outages. A diesel generator is available as back-up during power outages, but generator fuel is expensive and very difficult to procure. It should also be noted that the diesel exhaust from these power generators adversely affects the natural environment and human health. Such effects are likely to be more serious in hospitals and other medical institutions, hence the need for solar power.

Candidate schools on a list included in the PENRA's Solar Action Plan are starting to move forward towards solar system installation through Qatar Charity. PENRA, therefore, has selected schools in North Governorate, Middle Governorate, and Rafah Governorate, where the number of installed PV is low, as proposed sites.

To address the issue of short battery service life in solar power systems (two to three years), the project proposes the use of Japanese Valve Regulated Lead Acid batteries with a long cycle life (the "VRLA batteries") (roughly 10 years with 4,500 cycles and 70% DOD). Long-life VRLA batteries last longer and require less maintenance than conventional open-type lead-acid batteries (no need to add water). Therefore, they are a more sustainable battery option. Though the initial cost is higher for long-life VRLA batteries, the long battery life means that when the cost of replacement is considered, overall costs are not high. However, in a high-temperature environment, water contained inside VRLA batteries evaporates, albeit a very small amount, and the service life declines as no water can be added to the sealed batteries. It is thus desirable to keep the batteries controlled at around 25℃ to avoid submitting them to a high-temperature environment. In comparison with VRLA batteries, open lead-acid equivalents batteries have a lower decline in the service life under high-temperatures, as water can be added as it evaporates (VRLA batteries have a longer service life when kept between 25℃ and 35℃). On the other hand, although alkaline batteries have the longest service life, they require maintenance by refilling electrolyte solution (solution of potassium hydroxide). Because the import restrictions imposed by Israel, electrolyte solution is unavailable in Gaza. Therefore, alkaline batteries are not a viable option. Given these circumstances, the VRLA batteries are considered suitable in the Gaza Strip on the condition that a high-temperature environment (35℃ or higher) is avoided.Table 3-20 shows a comparison of storage batteries.

Table 3-20 Battery Comparison

Battery Type	Lead-Acid Battery	Long-Life Valve Regulated Lead-Acid Battery	Alkaline Battery
Lifespan	Fair	Good	Good
Maintenance(Replenisher Procurement)	Fair	Good	Poor
Environmental Resistance (High Temperatures)	Good	Fair	Good
Cost(Including Replacement Cost)	Fair	Fair	Fair
Overall Recommendation	Fair	Good	Poor

Source: JST

(5)【Assistance Plan No. 5】Introduction of Solar-powered street lights

Lights in the streets on the Gaza Strip will increase safety in the city that is otherwise completely dark due to nighttime power outages. The project is highly feasible as local contractors are able to handle the installation. Given the flood risk in winter in the Gaza Strip, battery boxes will be elevated to 3m or more above the ground. The above-mentioned VRLA batteries are recommended. An on-grid solar power system will be applied, which normally supplies power to street lights from the distribution network. The batteries will serve as power supply only during power outages. This reduces the number of times they are used, thereby prolonging their service life. A high-temperature environment shortens battery life (30% by a 5℃ increase and halved by a 10℃ increase from 25℃). As intensive sunlight in the Gaza Strip will cause high temperatures in the battery chamber, anti-heat measures need to be taken, including fans and sunshades. During winter, on the other hand, shorter daylight hours limit the charging amount and longer hours after sunset discharge the batteries. This leads to a higher DOD, which eventually shortens the service life. In light of the above, battery capacity should be selected by mainly focusing on the solar radiation conditions during winter. In addition, given the cycle of power outages occurring in the Gaza Strip (a cycle of 8 hours of power supply, 12 hours of outage, and 8 hours of power supply), the battery capacity will be designed to endure during long time outage. Furthermore, as a measure against theft of batteries for solar-powered street lights, etc., batteries may be embedded in sturdy concrete block building or similar. An example of design specifications is shown below.

- **Solar panel**

Monocrystalline or Polycrystalline silicon wafer
Panel peak demand is minimum 10kWp
The module efficiency should not be less than 14 %

- **Battery**

Rechargeable and replaceable battery
Deep-cycle, VRLA (Valve Regulated Lead Acid), Gel Lead Acid
Battery capacity is minimum 100 kWh
Depth of discharge (DOD) is 70%
The battery must have more than 3000 charge cycles at 50% DOD
Operating temperature: - 20°C to + 60 °C
Battery room requires a fan to cool for long-life battery.

- **Lamp**

Type: LED
Power consumption per lamp: 40W
Number of lamp: 120

Minimum 4,000 lumen
Life is minimum 60,000 h
The color temperature of LED is 5,500 K to 6,500 K
Working height: 4 meters measured from the ground
Switching: Photo cell

- **Grid inverter**

On grid type
Max. DC power: 10,000W
Maximum Peak Power Tracking (MPPT)
Protection: Adjust current limit, Over voltage, Under voltage, Short circuit, Reverse polarity and Over temperature.
Grid inverter efficiency including self-consumption for charge: 90%
Operating temperature: - 20°C to +60 °C

- **Battery inverter**

Rated power: 6,000W
Grid inverter efficiency including self-consumption for charge: 90%
Battery inverter efficiency including self-consumption for discharge: 90%
Battery equalizing charge and temperature compensation by battery sensor

- **Working temperature**

- 20 to 60 deg. C.

- **Design for strength**

Wind speed of 45m/s

- **Pole, bracket and plate cover**

Hot dipped galvanizing (100 Microns minimum coating thickness)

- **Minimum ingress protection ratings**

Battery and controller is located minimum 3 meter from ground to avoid flood
Mast component: IP40, IK-07
PVs and electrical components: protected to IP66
Glass components: IK-08
Batteries: IP44
Battery housing above ground within pole-base: IP66, IK-07

(6)【Assistance Plan No. 6】Introduction of Solar-powered generating system for low-income group

A solar-powered generating system with a capacity of around 500kWp will be gradually introduced into the area of low-income earners, ultimately expanding to reach the generation capacity to 2 to 3MWp. PENRA will propose candidate sites when selecting the areas of low-income earners. Given that power supplied from photovoltaic generating systems alone is unstable, the system will be an on-grid photovoltaic power generating system that also draws power from the GEDCO distribution network. The batteries used in the battery system are costly and given the high cost of battery replacement after its service lifespan (around 5 years) has elapsed, batteries will not be used for this system. Therefore, at night time and at times of power failure, when no power is supplied from the photovoltaic power generating system, only grid power supply is provided. Figure 3-10 shows a single line diagram of Solar power PV system for low-income group for reference. The following points must be noted:

- The need to secure an installation site for the solar panels

  Since around 10,000 square meters of land will be required for installing solar panels to generate around 500kWp, the land usage requirement also needs to include public land.

- Installation and construction monitoring of the solar-powered generating system

  Due to the large scale of this solar power generation system, installation and construction monitoring will require expert technicians. However, the number of Japanese technicians who are able to enter to the Gaza Strip during long period is few. Therefore, construction monitoring by a local contractor or a third-country company must be considered.

- Permission from Israel to import materials and equipment

  The large scale of the photovoltaic power generating system means a high quantity of equipment and materials such as Photovoltaic panels, inverters, etc. is required. there is a need to consider that it takes a long time to get a clearance permission for the equipment and materials to the Gaza Strip.

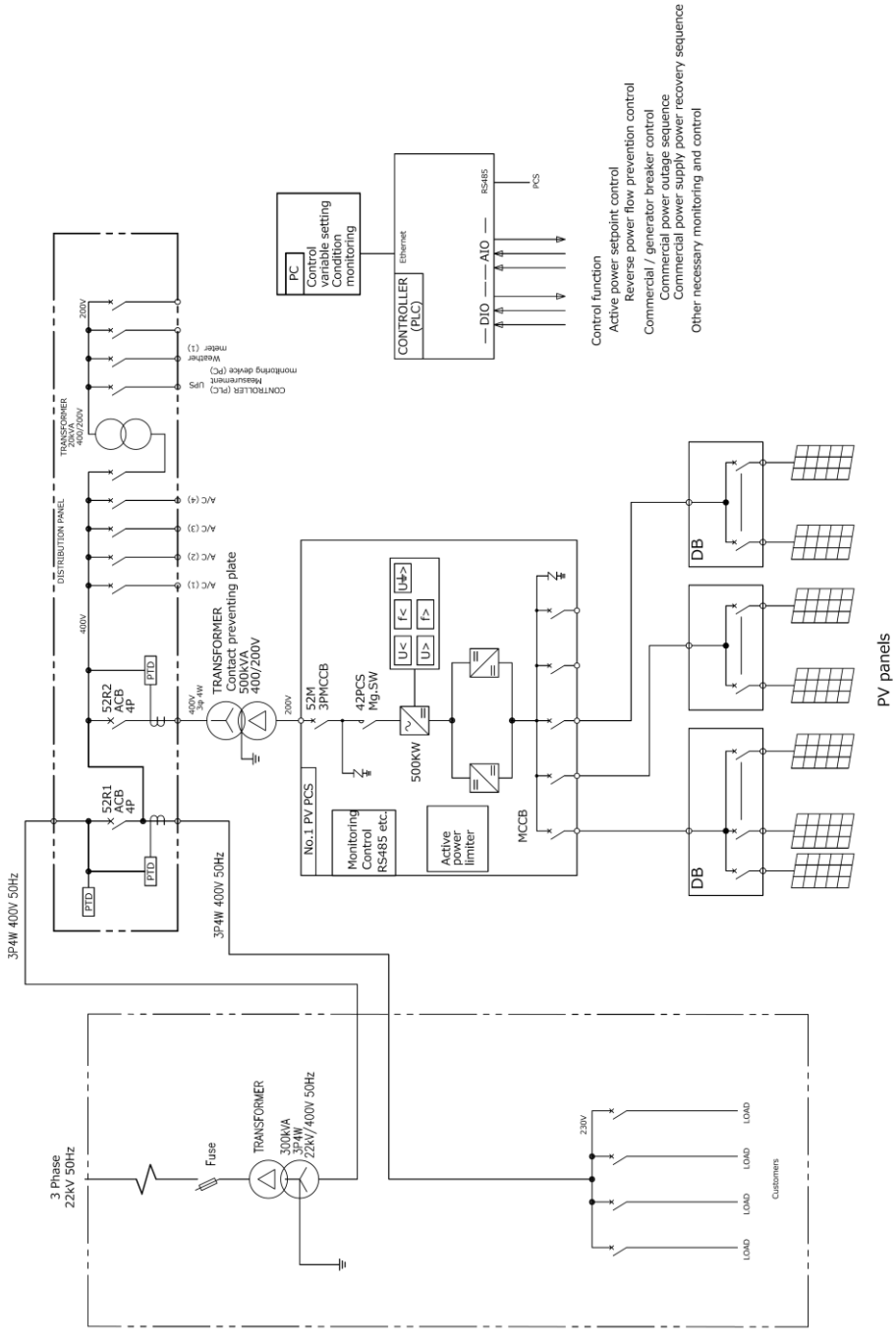


Figure 3-10 Single line diagram of Solar-powered PV system for low-income group

Source: JST

(7)【Assistance Plan No. 7】Capacity development

In 2017, GEDCO employees have been prevented from leaving the Gaza Strip due to trouble between the Israeli and Gaza governments. Therefore, this situation must be reviewed on when capacity building is conducted outside of the Gaza Strip. Technical training courses that are requested by GEDCO are listed in Table 3-21. In the Gaza Strip, there is only a distribution network, but no active transmission or substation. Thus, GEDCO needs the capacity development on distribution network. If a training in a third country such as Jordan and Egypt is possible, it is suitable for the training. Trained GEDCO staffs will participate in the distribution network rehabilitation project proposed in the 【Assistance Plan No.1】 for further capacity development through On-the-Job Training.

Table 3-22 provides further details and priority concerning the subjects listed in Table 3-21. Training related to distribution network restoration is prioritized to address urgent needs.

If third-country training such as training in Egypt or Jordan is unfeasible, for instance, because GECDO staff members are unable to obtain their entry permits, a training center for electric technicians owned by JDECO, one of electricity distribution company located in the West Bank in Palestine, will be considered as a suitable alternative. Table 3-23 shows JDECO's training courses (for 2009). While these courses mostly include training components required for GEDCO, it should be further checked if JDECO can train on subjects such as overhead distribution networks design, underground cable fault locating, fiber optics, and modern methods in the electricity projects management. Table 3-21 also indicates the availability of courses at JEDCO for the training requested by GEDCO.

Table 3-21 GEDCO-requested technical assistance in the area of electricity distribution (Including JDECO training courses under consideration of JST)

2015			
Classification of the training courses	No	Course Name	Availability in JDECO training course
Technical training courses	1	Advanced SCADA	Available
	2	Underground cables fault locating	Unknown
	3	Energy metering system	Available
	4	Qualifying safety and prevention guiders	Available
	5	Distribution earthling system	Available
	6	Inspection for house and industrial wiring	Available

2016			
Classification of the training courses	No.	Course Name	Availability in JDECO training course
Technical training courses	1	Overhead distribution networks design (MV and LV networks)	Unknown
	2	Modern methods in managing the electricity projects	Unknown
	3	Operation, inspection and maintenance of the electrical transformers	Available
	4	Distribution protection for engineers	Available
	5	Electrical networks maintenance (MV and LV networks)	Available
	6	Underground cable jointing	Available

2017			
Classification of the training courses	No.	Course Name	Availability in JDECO training course
Technical training courses	1	Underground cables fault locating	Unknown
	2	Overhead distribution networks design (MV and LV networks)	Unknown
	3	Electrical networks maintenance (MV and LV networks)	Available
	4	Qualifying safety and prevention guiders	Available
	5	Distribution earthling system	Available
	6	Underground cable jointing	Available
	7	Inspection for house and industrial wiring	Available
	8	Fiber optics	Unknown

Source: Data provided by GEDCO, JST

Table 3-22 Detailed technical assistance in the area of electricity distribution

Course name	Outline	Priority
Technical Training Courses		
Advanced SCADA	-Getting known of SCADA system -Know the components of SCADA system hardware and software for electrical distribution networks -General information about SCADA applications and the developments in SCADA -The importance of SCADA and Energy management system in promoting the electrical distribution network -Training in SCADA program to monitoring, controlling and gathering information of electrical distribution networks -Hardware configuration and commissioning -Writing and editing PLC Program -Human Machine Interface, general and applications -Graphic screens designer -Message archiving and display	3
Underground cables fault locating	-Identity and implement safety rules and personal safety to work on Power fault locator system -Identity the importance of cable fault locater device -Identity the different methods used in the test process	2
Energy metering system	-Getting known of energy metering systems -Types of the electrical meters -How to use the meter in calculating the consumed energy -Knowing the measurement unit -Ways of measuring and calculating the consumed energy -Getting experience about the ways of measuring and calculating the energy which will contribute in reducing the loss	1
Qualifying safety and prevention guiders	-Introduction to the risks of electricity works. -The general principles of the safety and prevention -Vocational health, and the risks in work environment -Knowing safety and precaution tools and equipment -The common risks in working in electricity environment and how to avoid and deal with them -Selecting and using of proper tools, equipment and Personal protective equipment, Safety -Rules related to work on O.H.T.L., underground cable and substations -Main and additional earthing	1

Course name	Outline	Priority
Technical Training Courses		
	-Safe switching operations -Poles and towers climbing and rescuing -Aid and rescue treatment of (Wounds, bleeding, Shock, Heart attack and Electrical injuries)	
Earthing for electrical networks	-Identify the importance of earthing system concepts -The installation of earthing -Testing the resistance of earthing -Earth resistivity and resistance measurements -Earthing fault current -Conductors of earthing system -Lethal current and human body. -Tolerable touch and step voltage -Earthing system design -Lightning protection system design -Duties and responsibility of designer	2
Inspection for house and industrial wiring	-Regulations & standards related to house & indoor wiring -Specification of house & indoor wiring components -Safety rules for house & indoor wiring -Using testing apparatus -Technical inspection reporting -Duties and responsibilities of house & indoor wiring technicians -Safety uses of tools, materials and testing apparatus -Visual inspection -The technical testing use testing apparatus -Practical applications on the visual and practical test	2
Overhead distribution networks design (MV and LV network)	-Understand the route manner of overhead distribution network -Execute calculations related to mechanical forces affect overhead distribution network elements -Execute voltage drop calculations -Select the appropriate size of overhead distribution networks conductors -Design overhead distribution network -Execute calculations of Sag and Tension to the overhead lines	1
Modern methods in the electricity projects management	-Comprehensive understanding of project management topics -Identifying the various methods for selecting the projects -Identifying the ways of establishing projects -The actual practice of the financial and time planning -Identifying the project works and formalizing work team -The practical practice of the project control -Managing the maintenance of the electrical networks and preventive maintenance -Deepened the safety concepts and qualifying and rehabilitating the trainee to perform the periodic maintenance and repairs work in the electrical networks -Preparing plans for preventive maintenance -Supervising the executions of the prepared plans -Enabling the participants of preparing the plans and programs for the electrical projects, executing, monitoring, evaluating and following the execution	2
Transformer operation, testing &maintenance	-Understand the principle of operation -Identify the transformer parts -Implement the faults allocation test -Maintain and test of the transformer -Understand the transformer components, insulation oil and transformer testing and maintenance	1

Course name	Outline	Priority
Technical Training Courses		
	-Testing operation and maintenance of MV switch gear -Setting testing and operation of LV circuit breakers -Testing and maintenance of transformer earthing -Protection of distribution system	
Overhead networks maintenance	-Understand the general safety -Replacing the overhead distribution network components -Getting the experience in maintaining the overhead electrical networks	2
Underground cable jointing	-Safety rules and personal safety in cables works -Types of cables and their sizes -Components of the cables and their functions -Laying of underground cables -Procedure of cable jointing -Measuring, cutting, stripping and shrinking of 22 kV power cables -Using equipment used for cable jointing -Straight and T-Joint 0.4 kV cables joint -Indoor and outdoor cable termination joints for 0.4 kV cables -Straight 11 kV cables joint.(normal and by-metallic joint) -Indoor and outdoor cable termination joints for 11 kV cables -Straight 22 kV cables joint.(normal and by-metallic joint) -Indoor and outdoor cable termination joints for 22 kV cables	1
Fiber optics	- Safety rules and personal safety equipment - Identify the tools used in constructing fiber optic cables. Procedure for pulling, hanging and sagging of All Dielectric Self-Supporting (ADSS) cables -Pulling, of fiber optic cables -Using the fiber optics splice machine -Testing of fiber optic cables using laser source, Power meter, and Optical time domain reflectometer -Providing the participants with the required skills in the fiber optics systems	3
Electrical distribution networks Protection for Engineers	-Kinds of faults -Importance of protection -Protection circuit components -Introduction and definitions -Elements of protection circuit -Instrument transformers -Protective relays function and classification -Design criteria for protection system -Fault and abnormal conditions of the distribution system -Relays operating principles for various types of protective relays (OCR,OVR,UVR) -Testing and setting of various types of protective devices -Line & feeder protection -Power transformer protection (over view & introduction) -Transformer physical protection -MV and LV fuses' protection -Surge arresters protection	1

Course name	Outline	Priority
Administrative courses		
Training of trainers (TOT) in the technical field	-Develop the awareness of dynamics of the training process -Use the training aids effectively -Assess and diagnose training needs -Specify training objectives -Develop a training program curriculum	1

Course name	Outline	Priority
Administrative courses		
	-Develop training modules -Evaluate training programs effectively - Manage the logistical aspects of training programs effectively -Acquire and develop practical skills and knowledge needed for delivery of effective training -Enabling the participants to manage the training process -Enabling the participants to supervise and cooperate the training -Trainers acquisition of the required skills and technologies -Acquisition of the required skills in dealing with trainees -Enabling the participants to identify the body language meanings	
Strategic leadership for setting the future visions , preparing the administrative plans and achieving them	-Identifying the strategic leadership and differentiating between it and the various patterns of leadership -Viewing the future challenges and ways to overcome -Providing the participants the concepts, objectives and skills of future forecasts -Identifying the strategic leadership regarding the foundations and the main skills of the senior administration to build the strategic thinking -Providing the basic practices of the strategic leadership through studying the outcomes of the practical experiences and the scientific background -Focusing on finding practical approach of the strategic leader to be applied in order to achieve the work objectives in the short and long term period	2
Strategies of the performance indicators and improving the productivity	-Identifying the strategies of the performance indicators -Improving the productivity through depending on the performance indicators -Identifying the performance indicators through productivity assessment -Obstacles of identifying the performance indicators for the organization -Ways of using the performance indicators	2

Course name	Outline	Priority
Financial Training Courses		
Tenders preparation and evaluations	-Providing the participants of the most recent concepts of the strategic planning of the procurement -Stages of the tender request (preparing the documents , announcement of the tender qualifying the contractors -tender offer) -Improving the skills of the local and international procurement -Improving the capabilities of choosing the appropriate purchase aspect -Ways of accomplishing the commercial correspondences and contract -Analyzing the tenders -evaluating the offers and suppliers	1
Financial strategic planning &budget analysis	-Enabling the participants to identify the definition , the importance and roles of the planning budget in both planning and monitoring sides -Providing the participants of the modem administrative , accounting and financial tools in preparing the capital and current budgets -Activating the participants contribution of following up and -Monitoring through the budgets and using reports to correct the strategic financial performance and improving it -The participants acquisition of the skills in dealing with actual problems through the practical practices	1
Setting the financial policies , financial analysis and liquidity and cash planning	-Identifying the financial policies -Ways of the financial analysis ,and financial performance -Planning for liquidity -Participants acquisition of the required experience in cash management -Providing the practical experience in cash management focusing on liquidity and solvency	2

Source: Data provided by GEDCO

Table 3-23 Training courses provided at JDECO Training Center (2009)

Training course	Outline
High and medium voltage cables	- High and medium voltage cables - Components and functions of electrical cables - Proper cable preparation procedure - Cables specifications and tests - Cables protection - Practical training for cable Joints & terminations
Transmission and distribution system	- Component of the transmission and distribution system - Preparing and installing electrical towers - Types of electrical networks (ACSR, AAC, AAAC) - (ABC) networks and accessories - Lightning arresters - Arial Isolators & auto-recloser - Live-Line electricity techniques & equipment
Protection and control systems	- Fundamental principles of relays - Current and voltage transformers& their protection system - Overload protection - Earth fault protection - High-temperature protection - Directional protection - Differential protection. - Unbalance load protection - Switchgear testing - Primary injection test - Secondary injection test - Protection of calibration devices - Protection device calibration
AutoCAD	- Introduction to the AutoCAD. - Patterns and drawing setup - Setting the borders of the drawing - Coordinates system. - Electrical schematics - Practical training in drawing electrical schematics
Power station and Transformers	- Main stations & sub-stations - Ear-thing stations - Testing methods for ground resistivity - Types of electrical transformers - Interpretation of the transformer nameplate data - Testing and maintaining procedure for medium voltage switchgear - Insulation test - Transformation ratio test - Group connection test - Transformer oil test - Practical training
Single phase electricity license	- Single phase electricity principle - Single phase test instructions for domestic services - Single phase electrical wiring principles - Electrical symbols & schemes - Public safety - Electrical testing equipment - First aid - Theoretical & practical training

Training course	Outline
Power station and Transformers	- Three phase electricity principle & rules - Three phase test instructions for domestic services - Three phase electrical wiring principles. - Protection & control devices - Electrical boards installation - Electrical symbols & schemes - Public safety - Electrical testing equipment - Theoretical & practical training - First aid
Electrical meters	- Fundamentals of kilowatt hour metering - Types and specification of meters (pre-payment, multi-rate, electronic, ...) - Meters calibration & reading - Assembly of Metering boards for high consumption customers - Practical training - Electrical meters installation according to JDECO standards
PLC	- Numbering systems, Binary, Octal, Decimal & Hexadecimal - Introduction to PLC's - I/O modules structure - Mathematical and Logical Instructions - Timers, Counters - Principles of writing LADDER program - Programming Stage and examples - Using Analogue I/O - Practical Examples (Traffic Light Control, Production) - Remote control and monitoring system
Testing and measurement equipment	- Current measurement devices - Voltage measurement devices - Insulation measurement devices - Wattmeter - kWh meter - How to install the electrical meter - Earth loop tester principle and installation - RCD tester device principle and installation
Supplying street lighting services with electricity	- Electrical manhole - Electrical Poles bases - Electrical poles & towers - Electrical cables and pipes - Electrical panels - Electrical lamps - Electrical boards - Earthing - Test and measurements - Maintenance and safety

Source: JDECO (Technical & Academic Training Center 2009)

3-3-6 Medium-term Reconstruction Assistance Plan when the political problem is solved

The following assistance will be provided once the Israeli and Gaza governments resolve their differences. (refer to **Appendix F**).

i. Increase the electricity supply from Israel by 25MW

Enhance the capacity of Karmia Substations in Israel by 30MW, and extend the transmission line

(22kV x 2 lines) to the North governorate and then supply 25MW to the desalination plant and the wastewater treatment facility.

ii. Construction of fuel tank in the GPP

Fuel capacity will be increased to 20 million liters (two fuel tanks' worth), to stabilize electricity supply by stabilizing fuel the supply.

iii. Restoration and expansion of the GPP (fuel conversion from diesel oil to natural gas)

Fuel will be switched from high-cost diesel oil to low-cost natural gas, increasing electricity supply by decreasing generation costs.

iv. Construction of 220kV transmission line to increase the electricity supply from Israel and Egypt (refer to **Appendix H**)

Electricity supply will be increased through import of electricity via high-voltage power lines from Israel and Egypt.

v. Construction and expansion of the substation in accord with 220kV transmission line (refer to **Appendix H**)

A substation will be constructed to reduce high-voltage power from Israeli and Egyptian high-voltage power lines to medium voltage, thereby increasing the electricity supply.

vi. Expansion of the GPP

More generators will be added to the Gaza power plant, thereby increasing the electricity supply.

vii. Introduction of renewable energy

Several MWp-class large-scale solar power generation systems will be introduced, thereby increasing the electricity supply.

viii. Survey on the Gaza marine gas field

The Gaza Marine Gas Field is located right off the coast of the Gaza Strip, and contains 28 billion m^3 of natural gas. If the Gaza Marine Gas Field is developed and a future gas pipeline is constructed, a stable supply of low-cost natural gas will become available, which will stabilize the Palestinian power supply and rescue the Palestinian economy.

Chapter 4

Conclusion

Chapter 4 Conclusion

Although the Gaza Strip receives electricity from three different power sources (up to 120MW from Israel, up to 60MW from the GPP and up to 28MW from Egypt) chronic power supply shortages have led to the ongoing power outages lasting 12 hours at a time. The electricity infrastructure was decimated by Israel-Gaza conflict in 2014, and although rebuilding of the power infrastructure progressed with support from donors, the energy deficit rate had reached 75 to 85% by July 2017. The reasons for the lack of improvement in power infrastructure include power supply shortages, instability of the power supply sources and the Israeli-imposed blockade on the Gaza Strip. With this in mind, the support required for this area must include enhancing the power supply capacity, enhancing the Israeli substation, bringing in high-voltage transmission lines to supply power from Israel and Egypt as well as renovating and expanding the Gaza Power Station. However, efforts to increase the power supply from Israel and Egypt have been further hindered by the current political problems between Israel and Palestine. Moreover, the fuel needed to generate electricity at the GPP is subject to high tax, making it economically infeasible to procure the required amount of fuel, which is why it generates less than half the rated output of electricity. Accordingly, renovation and expansion of the GPP is contingent on solving the political problems between Israel and Palestine, as well as that of fuel procurement.

Regarding the plan for medium-term support, when taking into consideration the political issues between Israel and Palestine, the logistical restrictions imposed by Israel on the Gaza Strip, the difficulty for Japanese engineers to enter the Gaza Strip for safety reasons and the need to outsource construction monitoring and installation to local contractors, providing this crucial support has become very challenging. Based on current feasibility, the proposed medium-term support plan includes improving the existing power infrastructure and securing the minimum power required for key infrastructure elements. Namely, the proposal is to improve the power infrastructure by developing GEDCO's capacity through repair of distribution networks and loss reduction, as well as the provision of maintenance tools and aerial work vehicles and the holding of capacity development seminars. In response to a request from PENRA, the proposal was also made to introduce a 500kWp photovoltaic power generating system to cater to the low-income group.

Despite various restrictions hindering efforts to provide support, both PENRA and GEDCO strongly requested to enhance the power supply capacity, improve the power supply infrastructure and introduce the solar-powered generating system. Due to this, more overlapping assistance will be provided. Donors, PENRA and GEDCO will be able to broaden assistance possibilities by building up assistance-related know-how. Therefore, it is of the utmost importance to keep on investigating continuing assistance possibilities and solutions to problems regarding the current pressing issues facing Gaza.

Appendices

Appendix A proposed Renewable Energy Photovoltaic System Projects

Source: PENRA '31 Aug 2015

Description	**Renewable energy project based on PENRA's Solar Action Plan achieve 3MW new production capacity of solar energy in Gaza Strip by 2017. It improves energy efficiency and energy conservation in Gaza Strip, it create a new green jobs and new industrial skills in Gaza Strip. The candidate sites are hospital, school, institution for handicapped people, water well, home of the poorest people and street lighting.**

First Section of action Plane for 2MW PV systems

Target sector	Target group	Term	Priority	Location	Project capacity (kWp)	Expected output	Start of projects	Estimated budget	Feasibility	
Health sector	ICU in all Gaza Strip hospitals	Short term (0 to 6 months)	1	ICU in Kamal Edwan hospital	30	Supplying sensitive health units of electricity. Reducing the continuous dependence on diesel generators which operate around the clock. Reducing the emission of toxic gases, which contribute directly to the pollution of the hospital medium. Ensuring that the health sector serves the citizens permanently, especially in primary care centers and emergency departments. Contributing to solving the problem of electric power deficit and the frequent power outages in the Gaza Strip. Capacity building for local staff.	01/2015	150,000	The candidate site is provided from PENRA and GEDCO. Donors and PENRA have already installed a lot of type of Photovoltaic Voltage system (PV system). The installation of PV system is comparatively easy, it is implemented by local constructor without supervisor of supplier.	High Feasibility
			1	ICU in Shuhada Alaqsa hospital	30		01/2015	150,000		
			1	ICU in Nasser hospital	30		01/2015	150,000		
			1	ICU in Gaza European hospital	30		01/2016	150,000		
			1	ICU in Elnajjar hospital	30		01/2016	150,000		
	premature babies nurseries		2	Nurseries in Alshefa hospital	30		01/2015	150,000		
			2	Nurseries in Mubarak hospital	30		01/2016	150,000		
			2	Nurseries in Gaza European hospital	30		01/2017	150,000		
	primary care centers		3	Sabha clinic	30		01/2015	150,000		
			3	Zawaedeh clinic	30		01/2015	120,000		
			3	Jabalia clinic	30		01/2017	120,000		
			3	Khan Younis clinic	30		01/2017	120,000		
			3	Umnasser clinic	30		01/2017	120,000		
Education sector	Schools		4	Abo Obaida ben Aljarah boys secondary school	35	Supply electricity to schools, ensuring the educational process functioning perfectly. Increase student achievement by providing a permanent lighting and the use of important educational means that dependent on the presence of electricity. Reducing the emission of toxic gases, which contribute directly to pollute the educational environment by the use of diesel generators. Capacity building for local staff.	01/2015	140,000		
			4	Khalil Alrahman secondary boys school	35		01/2015	140,000		
			4	Alkuait secondary girls school	35		01/2016	140,000		
			4	Alriyad secondary girls school	35		01/2016	140,000		
			4	Khaled ben alwaleed boys secondary school	35		01/2016	140,000		
			4	Ahmed Alshokari boys secondary school	35		01/2017	140,000		
			4	Tal Alzatar girls secondary school	35		01/2017	140,000		
			4	Alaaishia secondary girls school	35		01/2017	140,000		
People with special needs	Physically handicapped		5	National Association for Physically handicapped	50	Supply electricity to the urgent priority institutions thus ensure the provision of services continuously for these marginalized groups. Taking care of such groups, supports productivity increase and prove societal existence. Capacity building for local staff.	01/2015	175,000		
			5	Artificial limps	50		01/2015	175,000		
	Mentally handicapped		6	Palestine the future	50		01/2016	175,000		
			6	Pright to live society	50		01/2016	175,000		

Appendix A proposed Renewable Energy Photovoltaic System Projects

Source: PENRA '31 Aug 2015

Description	**Renewable energy project based on PENRA's Solar Action Plan achieve 3MW new production capacity of solar energy in Gaza Strip by 2017. It improves energy efficiency and energy conservation in Gaza Strip, it create a new green jobs and new industrial skills in Gaza Strip. The candidate sites are hospital, school, institution for handicapped people, water well, home of the poorest people and street lighting.**

First Section of action Plane for 2MW PV systems

Water Sector	Aquifers and wells	Short term (0 to 6 months)	7	Aquifers at the border line	50	Utilizing PV system for water pumping to provide tap water for the neighboring areas of the schools wells (there are some schools with wells within its boundary).	01/2016	175,000	The candidate site is provided from PENRA and GEDCO. Donors and PENRA have already installed a lot of type of Photovoltaic Voltage system (PV system) of Solar Energy. The installation of PV system is comparatively easy, it is implemented by local constructor without supervisor of supplier.	High Feasibility
			7	Umanasser Aquifer	50		01/2015	175,000		
			7	Municipality wells and school wells	200		01/2016	700,000		
Residential sector	the Poorest people		8	Provide 400 homes with electricity with a total capacity of 1.5 kW per house. The selection process through the social research taking into consideration the number of family members, educational level, especially, group of distinguished students in scientific collection.	600	Provide some poor homes with electricity who can't afford providing non-traditional alternatives, especially homes with superior students at school to raise their living standard.	01/2015	1,700,000		
			8				01/2016	50,000		
			8				01/2016	50,000		
Transportation sector	Street lighting		9	Erection of 200 poles at the main intersections of the Salah Eddin street	70	Lighting the main intersections of Salah al-Din Street Rduce traffic accidents on major intersections due to frequent power outages. Development of local capacities	01/2017	500,000		
Total capacity					**1840**	**Total budget**		**7,000,000**		

Second Section of action Plane for 1MW PV systems

Target sector	Target group	Term	Priority	Location	Project capacity (kWp)	Expected output	Start of projects	Estimated budget	Feasibility	
GEDCO	National grid network	Short term (0 to 6 months)	10	North Gaza	350	Supporting the national grid network in Gaza strip through the main feeders (Israel, Egypt, Gaza Power plant)	01/2016	1,000,000	Land acquisition is not yet, it needs negotiation with land owner and Public-owned land is used. The budget does not include land price, the land price may be free or lending. Medium scale PV system arround 300kW is first time in Gaza, therefore there may be some restriction of Islael in transportation.	Middle Feasibility
			10	Middle Gaza	350		01/2016	1,000,000		
			10	South Gaza	300		01/2017	1,000,000		
Total capacity					**1000**	**Total budget**		**3,000,000**		

Appendix B Committed Project List

Source: World Bank Report(No: 66412-GZ, PAD1143, ISR22266), IsDB, GEDCO, PENRA

31 Aug 2015

CATEGORY	PROJECT NAME	DONOR	COMPONENTS			TYPE OF SUPPLY	TERM	COST(US$)	BENEFICIARIES	FUND STATUS	PROJECT STATUS	LOCATION
POWER QUALITY	Improvement of power quality	Egypt	Voltage regulator	Installation of voltage regulator to boost up dropped voltage in Rafah area	The interconnection line from Egypt is very long distance (35km), therefore voltage drops from 22kV to 17kV. To improve the voltage drop, three voltage regulators are installed at three 22kV connection points near the border between Egypt and Rafah Governorate. The dropped voltage is boosted to be within the allowable range of voltage fluctuation. Supervisor of the supplier of the equipment is not necessary, and installation should be done by local contractors, and GEDCO will be in charge of the supervision.	Supply of materials	Undecided	0.36M	Whole of Rafah governorate	Fund not secured	Committed	-
		ICRC	Voltage regulator	Installation of voltage regulator to boost up dropped voltage in Rafah area	The line from IEC to Middle governorate has high voltage drops. To improve the voltage drop, one voltage regulators are installed on the line. The dropped voltage is boosted to be within the allowable range of voltage fluctuation. Supervisor of the supplier of the equipment is not necessary, and installation should be done by local contractors, and GEDCO will be in charge of the supervision.	Supply of materials	Undecided	0.16M	A part of Middle governorate	Fund not secured	Tender Launched	-

Appendix C Ongoing Project List

Source: World Bank Report(No: 66412-GZ, PAD1143, ISR22266), IsDB, GEDCO, PENRA

31 Aug 2015

CATEGORY	PROJECT NAME	DONOR	COMPONENTS			TERM AND STATUS	COST(US$)	BENEFICIARIES	LOCATION
NETWORK	Gaza Emergency Response for Electricity Network Rehabilitation (Additional fund 15MUS$) Project ID: P152411	World Bank	Electricity Network Reconstruction, Rehabilitation, and Expansion Material: US$12.42M Installation: US$2.0M Total: US$14.42M	North Gaza Governorate MV and LV Reconstruction	- Reconstruction of 25km of MV, and 54km of LV network in the North Gaza Governorate - Re-connection of 4000 residential consumers to supply approximately 36,000 people - Reconnection of 60 water supply pumping stations with 880kW capacity - Reconnection of 3 hospitals - Reconnection of 300 commercial consumers - Increase in supply to above consumers of 4,200MWh per month	19 Sep 2014 to 30 Jun 2017 (delivery of materials between Jan and Feb 2016)	2.03M (including VAT and installation cost)	(i) 190,000 people, 97 water pumping stations, nine hospitals/clinics and 950 commercial consumers that are currently not connected to electricity supply (ii) around 1.8 million people that are currently receiving only six hours of electricity per day in areas (iii) other basic humanitarian services providers that are reliant upon electricity supply including further hospitals, water supply and wastewater treatment plants (iv) GEDCO which has lost all goods and materials required to repair and maintain the electricity system	North Gaza Governorate
				Gaza Governorate MV and LV Reconstruction	- Reconstruction of 36km of MV, and 92km of LV network in the Gaza Governorate - Re-connection of 8,500 residential consumers to supply approximately 70,000 people - Reconnection of 15 water supply pumping stations with 250kW capacity - Reconnection of 2 hospitals - Reconnection of 417 commercial consumers - Increase in supply to above consumers of 6,800MWh per month		3.79M (including VAT and installation cost)		Gaza Governorate
				Middle Governorate MV and LV Reconstruction	- Reconstruction of 14km of MV, and 55km of LV network in the Middle Governorate - Re-connection of 2800 residential consumers to supply approximately 25,000 people - Reconnection of 7 water supply pumping stations with 120kW capacity - Reconnection of 1 hospital - Reconnection of 107 commercial consumers - Increase in supply to above consumers of 2,400MWh per month		1.42M (including VAT and installation cost)		Middle Governorate
				Khan Younis Governorate MV and LV Reconstruction	- Reconstruction of 22km of MW, and 51km of LV network in the Khan Younis Governorate - Re-connection of 4,500 residential consumers to supply approximately 30,000 people - Reconnection of 6 water supply pumping stations with 100kW capacity - Reconnection of 1 hospital - Reconnection of 88 commercial consumers - Increase in supply to above consumers of 3,350MWh per month		1.72M (including VAT and installation cost)		Khan Younis Governorate
				Rafah Governorate MV and LV Reconstruction	- Reconstruction of 24 km of MV and 49 km of LV network in Rafah Governorate - Re-connection of 3,250 residential consumers to supply approximately 28,000 people - Reconnection of 9 water supply pumping stations with 140kW capacity - Reconnection of 2 hospitals - Reconnection of 34 commercial consumers - Increase in supply to above consumers of 2,550MWh per month		1.66M (including VAT and installation cost)		Rafah Governorate
				Goods and Materials Supply	Replacement of destroyed equipment in Main warehouse - MV wires and cables/LV cables/MV steel poles/LV steel poles/LV wooden poles/Distribution transformers/MV Isolating Switch/LV Dis-connectors		3.8M (including VAT)		GEDCO Warehouse
	Gaza Emergency Response for Electricity Network Rehabilitation (Additional fund 15MUS$) Project ID: P152411	World Bank	GEDCO Capacity Building and Technical Assistance to PEA and PMU (US$0.58M)	Supply of Tools and Equipment	Electrical works tools for replacement of destroyed equipment in Main warehouse	2014 to May 2015 (Under tender)	0.28M (including		-
					PMU Gaza office vehicle	2014 to May 2015 (Fund secured)	40,000 (including		-
					PMU Gaza office furniture	2014 to May 2015 (Fund secured)	20,000 (including VAT)		-
					Computer Hardware (for goods and materials inventory management) for replacement of destroyed equipment in Main warehouse	2014 to May 2015 (Under tender)	60,000 (including		-
				Provision of Warehouse Space	Rental of temporary storage facility: Alternate warehousing areas to allow receipt of goods and materials procured under this Project.	Ongoing	0.1M		-
				Support for Operating Costs	- PMU Operating Costs (Office rental and running costs): US$40,000 - Consulting Services for Audit of Additional Financing Component: US$40,000	Nov 2012 to Jul 2014 (Completed)	80,000		-

Appendix C Ongoing Project List

Source: World Bank Report(No: 66412-GZ, PAD1143, ISR22266), IsDB, GEDCO, PENRA

31 Aug 2015

CATEGORY	PROJECT NAME	DONOR	COMPONENTS			TERM AND STATUS	COST(US$)	BENEFICIARIES	LOCATION
NETWORK	Gaza Electricity Network Rehabilitation Project (US$16M) Project ID: P116199	World Bank	**Network Rehabilitation and Expansion(US$4.5M)**	Rehabilitation of Medium and Low Voltage Networks	- Rehabilitation of Medium Voltage : This project will rehabilitate deteriorated medium voltage networks in the five governorates in Gaza. The project will include, among others, replacing and installing new poles and cables, transformers and switches. - Rehabilitation of the Low Voltage Networks: This project will rehabilitate deteriorated low voltage networks in the five governorates in Gaza suffering from unsafe installation, high losses and low voltages. The project will also include, among others, replacing and installing new poles and cables for about 139 km of low voltage networks.	2012 to Sep 2013 (Completed)	Material:1,655,989 Installation:623,843	Whole of Gaza	Whole of Gaza
				Network Supply Improvement.	New 22 kV underground feeders from the proposed 161 kV north Substation: The project will construct 22 kV underground feeders from the proposed 161 kV North Substation to Gaza and North Governorates. The new feeders will also be designed to increase the reliability of the 22 kV network in Gaza through ring network development.	2012 to Aug 2015 (Procurement:100% Installation: Ongoing)	Material:1,364,018 Installation:258,000	Whole of Gaza	North Substation
			Utility Capacity Building and Technical Assistance to PEA (US$3.5M)	Collection Improvement	Installation of Prepaid Meters: 12,000 single and three phase Prepaid Meters to Gaza. 13,000 prepaid meters were purchased under the ongoing EUMP/Phase V Program Project and financed by the Agency Francaise De Dé veloppement (AFD) and the Governments of Norway and Sweden.	2012 to 30 Jun 2017 (Under tender)	1M	Whole of Gaza	-
				Supply of Vehicles and IT System to GEDCO	Supply of Vehicles (US$ 940,000): This project will finance the supply of vehicles necessary for the operation, maintenance and repair works of the electricity networks in Gaza.	2012 to Dec 2014 (Final payment request process)	988,902		-
					Supply of Geographic Information System (GIS) to support network information management, planning and operation.	2012 to Sep 2013 (Completed)	261,377		-
					Supply of Load Flow hardware and software for network analysis and planning.	2012 to Jun 2014 (Completed)	208,800		-
					Supply of Control system hardware	2012 to Oct 2015 (Under tender)	0.5M		-
					Supply of Hardware equipment	2012 to Jul 2014 (Completed)	90,000		-
					Supply of GPS Devices	2012 to Apr 2015 (Re-Tender)	0.12M		-
				Technical Assistance to PEA	Consultancy: The Project will finance the hiring of a consulting firm to support PEA/GEDCO in preparing a Master Plan for the development of the electricity sector in Gaza.	2012 to 30 Jun 2017 (Under tender)	506,900		-
					Financial Audit: The Project will finance the hiring of a local consulting firm to carry out auditing services on the Project Cost.	2012 to Jul 2014 (Completed)	34,200		-
		Islamic Development Bank (Cooperation Council program for the reconstruction of Gaza)	**Network Rehabilitation and Expansion(US$8M)**	Network Supply Improvement.	War caused widespread destruction in Gaza Strip in 2008/2009 and massive electricity networks in many areas where caused damage in large parts of the electrical networks as well as a complete destruction of power grids and underground cable. There is a lot of the population untouched electricity intermittently as a result of lack of availability of the necessary energy by result of the war. Components: - New 22 kV underground feeders from the Gaza Power Plant: The project will construct three new 22 kV underground feeders from the Gaza Power Plant (GPP) to load centers in Gaza city. The feeders will be needed to support evacuation of additional electricity supply from GPP which will become available when the ongoing expansion of the GPP is completed. The total length of the feeders will about 36 km and will add a total of 36 MW of new network capacity. - Reconfiguration and Expansion of Medium and Low Voltage Networks: The project will finance an expansion of the existing distribution networks in Gaza's five governorates through the installation of medium and low voltage networks and transformers to reduce loading of existing networks, reduce losses and improve reliability of electricity supply. The project will install, among others, 34 km of new overhead networks, 5 km of new underground cables, and new distribution transformers.	8 Feb 2013 to 30 Jun 2017 Completion: 47% - Underground cable (Material: 100%, Istallation: 5% in tender) - LV/MV Network (Material: 10% in contract, Installation: 3% in tender)	2.8M (Underground cable) 3.5M (Material of LV/MV Network) 1.4M (Installation of LV/MV Network)		Gaza power plant and Gaza city (Underground cable) Whole of Gaza (LV/MV Network)
					Supply of reconstruction materials for LV and MV networks damaged by the 2014 Israeli war Clamps, Tap Connector, Compression Joint, Black Tape, Straight Joint for Cable, Heat Shrinkable, Outdoor Termination Kit for Cable, Terminal Lug for Conductor, Tension Compression Joint for Wire, Cables, Insulators, Wires, Wooden Pole	2014 (Material: 100% Installation: 100%)	Material: 0.2M Installation: 0.1M		Whole of Gaza

Appendix C Ongoing Project List

Source: World Bank Report(No: 66412-GZ, PAD1143, ISR22266), IsDB, GEDCO, PENRA

31 Aug 2015

CATEGORY	PROJECT NAME	DONOR	COMPONENTS			TERM AND STATUS	COST(US$)	BENEFICIARIES	LOCATION
SUBSTATION	**Increasing the electric power supplied from the Egyptian side**	**Islamic Development Bank (Kuwait Fund for Arab Economic Development through Cooperation Council program for the reconstruction of Gaza)**	**Increasing electric power supplied from the side-Egyptian**	Network Supply Improvement.	The project is to increase electrical power to the Gaza Strip 8 megawatts from Sheikh Azwaid substation. Total electrical power delivered from Egyptian side to the Gaza Strip will be 30 MW. Component: 1. The expanded installed capacity of transformer in Sheikh station Zuid will be 3 × 25 MVA + 1 × 10 MVA = 85 MVA, the transformer is 66/22kV with additional bay and civil work which will feed loads to Gaza, implemented through the Egyptian Electricity Transmission Company 2. The establishment of distribution feeders (22 kV voltage cables) from the substation to Gaza border, implemented through a canal company. aluminum double circuit distribution cable 2 x (3 × 1 × 400 mm2, 17.5 km) as an alternative to Amovean existing (Rafah - Palestine 1 & 2). The installation is according to the Egyptian Technical Specifications. Transformers have been installed to raise Sheikh Zuid station capacity. Preparing for the preparation of tender tanker lines. Obstacles: - Work is going very slowly as a result of security events in Egypt. - The project is turned off as a result of security events in Egypt.	16 Aug 2013 to 15 Aug 2014 (Completion: 15%, Turned off)	5M	Rafah governorate	Egyptian-Palestinian border, inside of the Egyptian border and Sheikh Azwaid substation
NETWORK	**Replacement of destroyed equipment in installed electrical network**	**OCHA-UNDP**	**Reconstruction of LV and MV networks damaged by the 2014 Israeli war**	All Materials was provided for Temporary Repairing of the Damages	- Wooden poles/Wires/L.V Cables/Termination Kits and Straight Joints/Compression Lugs - Insulators/Clamps/Fuse Holder , Fuses	2014 to 2015 (Material: 100% Installation: 70-80%)	Material: 0.23M Installation: 0.07M	Whole of Gaza	Whole of Gaza
	Replacement of destroyed equipment in installed electrical network	**ICRC**	**Reconstruction of LV and MV Networks due to Israeli war 2014**	All Materials was provided for water wells projects and repairing short term Damages	- Transformers/Wires/Cables/Termination Kits for Cable/Heat Shrinkable Joint for Cable/Switches - Switchgear and Short Circuit Current Ring Main Unit	2014 to 2015 (Material: 90% Installation: 60%)	1M	Whole of Gaza	Whole of Gaza
	Replacement of destroyed equipment in installed electrical network	**JICA**		Reconstruction of LV and MV Networks due to Israeli war 2014 in Bait Hanoun	- ACSR Wire Rabbit (According BS215 PART 2): 20km - ACSR 150/25 mm2 Conductor (According German Sizes DIN 48204): 20km - 0.6/1 kV ABC Cable with Stranded Aluminium Conductor 3x150+1x95+2x25 mm2: 8km - 0.6/1 kV ABC Cable with Stranded Aluminium Conductor 3x95+1x54.6+2x25 mm2: 5km - 0.6/1 kV ABC Cable with Stranded Aluminium Conductor 4x95+2x25 mm2: 5km	2014 to 2016 (Material: 100% Installation: 0%)	0.19M	Bait Hanoun	Bait Hanoun
	The Pilot Project for Reconstruction of Electricity Network in Khan Younis, Gaza Strip	**JICA**		Reconstruction of LV and MV Networks due to Israeli war 2014 in Bani Suhila and Khan Younis	- ABC150mm2(8km) - ABC95mm2(9km) - ABC50mm2(9.5km) - Wooden pole(Qty154)	May 2015 to Apr 2016 (Material: 20% Installation: 0%)	0.16M	3,700 Customers in Bani Suhila and Khan Younis	Khozaah, Bani Suhila

Appendix D Completed Project List

Source: IsDB, GEDCO, PENRA

31 Aug 2015

CATEGORY	PROJECT NAME	DONOR	COMPONENTS			TYPE OF SUPPLY	TERM	COST (US$)	BENEFIT EFFECT	LOCATION
NETWORK	**Replacement of destroyed equipment in installed electrical network**	PENRA	Supply of materials of LV and MV Networks due to Israeli war 2014	All Materials was provided from PENRA for Temporary Repairing of the Damages	- Wooden Poles/Wires/Cables/Insulators - Clamps/Compression Joints for Wire - Joints for Cable/Sealing Cap for Cables - Tap Connectors/Compression terminal lug - Bushing spare parts	Supply of materials	2014 to 2014	0.5M	Whole of Gaza	Whole of Gaza
	Replacement of destroyed equipment in installed electrical network	Turkish Grant	Reconstruction of LV and MV Networks due to Israeli war 2014	All Materials was provided for repairing short term Damages	- Wooden Poles/Switches/Wires/Cables - Termination Kits for Cable/Joints for Cable - Fuse Holders/Insulators/Clamps - Socket Eyes/Joint for Wire/Terminal Lug - Fuse/Knife Blade	Supply of materials	2014 to 2015	0.64M	Whole of Gaza	Whole of Gaza
	Finalize repairs to Israeli lines; urgent maintenance for other lines	Unknouwn	Unknouwn			Unknouwn	2014 to 2015	1.4M	Unknouwn	Unknouwn
	Qatari-donated fuel supplies	Qatar	Cost of Tax exemption of fuel of Gaza Power Plant			Donation	Dec 2014	10M	Whole of Gaza	Gaza Power Plant
	Rehabilitation of distribution and transmission of electricity networks in the Gaza Strip	Islamic Development Bank (Cooperation Council program for the reconstruction of Gaza)	- The rehabilitation of the power transformer in Gaza power plant due to the damage to her from the 2008-2009 war. - The supply and installation of iron materials and electrical materials and transformers for the rehabilitation of the electricity grid in Gaza City and North governorate.	Rapid rehabilitation of the electricity sector project that aims to increase Gaza power plant's capacity in the Gaza Strip by 40 megawatts, repair and improve network and distribution of electrical and damaged during the war and thus improve the service provided to citizens level by reducing the crash rates and reduce losses in electricity. And include the activities of the project. United Nations Development Programme UNDP / PAPP and GEDCO are supervisor. - Component 1. Supply and install lifting power transformers and reduce losses, and that the aim of the rehabilitation of transformer in Gaza power plant. 2. Rehabilitation of the line feeder in the affected areas and the installation work and civil works (foundations) and connect the network in Gaza city. 3. Supply and installation of transformers and electricity network in North governorate. - Obstacles 1. Delays in shipping materials and transformers for 70 days where it was ready for shipment by the end of December 2011 and were shipped in 10 Mar 2012 and arrived in Gaza 4 Sep 2012. 2. The arrival of Chinese installation teams was delayed for a whole month, equipment was arriving in 4 Sep 2012 while the West Bank team for the first installation arrived on 5 Sep 2012 and Chinese on 15 May 2012. 3. Delayed adoption of the control panel with the adoption of the manufacturer "ABB Shanghai-China."		Supply of materials, Installation and Civil Works	15 Apr 2009 to 15 Apr 2014	5M	Gaza city and North governorate	Gaza city and North governorate
	Rehabilitation of distribution and transmission of electricity	Islamic Development Bank (Al-Aqsa and Jerusalem Fund through the Islamic Development Bank)	- Supply and install 15,275m of medium voltage networks, terrestrial and air, as well as 5,100m of low voltage networks and 14 transformers to ease the load in different parts of North governorate. - Supply and install 14,650m of medium voltage network, as well as 6,100m of low voltage networks and 21 transformers to ease the load in different parts of the Gaza governorate. - Supply and installation of 9,440m of medium voltage networks, as well as 2,640m of low voltage networks and 11 transformers to ease the load in different parts of Middle governorate. - Supply and install 18,233m of medium voltage networks, as well as 13,860m of low voltage networks and 14 transformers to ease the load in different parts Khan Younis and Rafah. It is divided the work to material supply and installation within eight groups. United Nations Development Programme UNDP / PAPP and GEDCO are supervisor. Obstacles: - Closure of the crossings from mid-October until 16 December led to a stop and the delay in the termination of the projects in Gaza governorate and North governorate. - There are impediments by the municipalities regarding the identification path networks, as well as impediments by related citizens. - The recent war in the Gaza Strip from 8/7/2014 to 26/08/2014.			Supply of materials, Installation and Civil Works	12 Jan 2011 to 31 Dec 2014	5M	Gaza city and North governorate	Gaza city and North governorate
RENEWABLE ENERGY	**Street LED Lighting with Solar Panel**	NGO Society of Fisherman	In Public area in Gaza port, 17 set of 100W LED Street lighting with PV system Manufacturer is Chinese maker and battery is lead-acid type. PENRA estimates that battery life will be 1 year. 2,500USD per unit (Pole, lump, battery and PV system).			Supply of materials	2014-2015	42,500	Gaza port	Gaza port

Appendix E Renewable Energy Photovoltaic System Projects (Completed-Ongoing-Committed)

Source: PENRA 31 Aug 2015

Project name	Organization of Owner	Donor	Location	Year of installation	Status	Type of Solar PV	Installed Capacity KW_p	Cost/ Budget $
Street lighting	Ministry of Public Work and Housing	UNDP	Gaza Bridge	2005	Completed	Off Grid	1.5	20,000
Electrification of cardiology unit	Ministry of Health	Italy	Al shifa Hospital	2011	Completed	UPS	4	16,000
Electrification of community service center	Islamic University of Gaza	Islamic Relief	Islamic University of Gaza	2012	Completed	Grid Interactive (DC-coupling)	10	35,000
Electrification of alnaser hospital	Ministry of Health	Islamic Relief	Alnaser hospital	2013	Completed	Grid Interactive (DC-coupling)	20	100,000
Electrification of Alfokhary School	Ministry of Education	Islamic Relief	Rafah	2013	Completed	Grid Interactive (DC-coupling)	20	100,000
Electrification of ICU alshifa hospital	Ministry of Health	JICA	Alshifa hospital	2014	Completed	Grid Interactive (AC-coupling)	30	190,000
Electrification of supporting health & education sectors	Ministry of Health	UNDP	Al Harazin clinic	2014	Completed	On Grid With backup (AC-coupling)	12	450,000
	Private Sector		Right to live Society		Completed	On Grid With backup (AC-coupling)	10	
	Ministry of Education		Al Faloja school		Completed	On Grid With backup (AC-coupling)	12	
	Ministry of Education		Rabaa Adawia School		Completed	On Grid With backup (AC-coupling)	15	
	Ministry of Education		Basheer Alrais school		Completed	Grid Interactive (DC-coupling)	18	
	Ministry of Health		UAE clinic			Grid Interactive (DC-coupling)	9	
	Ministry of Education		Akka school		Completed	Grid Interactive (DC-coupling	12	
Electrification of Central Labs of Islamic university	Islamic University of Gaza	IsDB	Islamic University of Gaza	2014	Completed	Grid Interactive (DC-coupling)	130	600,000

Appendix E Renewable Energy Photovoltaic System Projects (Completed-Ongoing-Committed)

Source: PENRA 31 Aug 2015

Project name	Organization of Owner	Donor	Location	Year of installation	Status	Type of Solar PV	Installed Capacity KW_p	Cost/ Budget $
Electrification of alsahaba medical compound	Private sector	Islamic Relief	Alsahaba medical center	2014	Completed	Grid Interactive (DC-coupling)	12	50,000
Solar Photovoltaic Pilot Project	-	Funded by World Bank, implemented by MDLF	Dair Al Balah municipality	2015	Ongoing	Off-grid with option to use the grid as back feed to charge the system batteries when the solar input is off line	15	-
Solar Photovoltaic Pilot Project	-	Funded by World Bank, implemented by MDLF	Abasan Alkabira municipality	2015	Ongoing	Off-grid with option to use the grid as back feed to charge the system batteries when the solar input is off line	5	
Hospital	-	ICRC	European Gaza Hospital	-	Ongoing	PV system to secure the permanent operation of the ICU.	-	-
Primary health care center	-	CRCI	32 Primary health - care centers	-	Ongoing	PV system for vaccine fridges	-	-
Schools	Ministry of Education	Qatar Charity	14 schools	-	Ongoing	On Grid With backup	20-24	-
Schools	Ministry of Education	UNDP	23 schools	-	Committed	On Grid With backup	15	-
Schools	Ministry of Education	JICA	Shohada shatti School	-	Primary approved	On Grid With backup	20	-
Schools	Ministry of Education	JICA	Shohada Khan younis School	-	Primary approved	On Grid With backup	20	-
Electrification of 5 primary care centers and 3 schools' water supply facilities using solar energy	-	UNDP in partnership with JICA	5 primary care centers and 3 schools' water supply facilities	-	Proposed	-	30	-

Appendix F Proposed Project List

Source: GEDCO, PENRA, Palestinian Investment Fund Annual report 2014 and 2011

31 Aug 2015

CATEGORY	NEEDS	TERM	PRIORITY	COMPONENTS		TYPE OF SUPPLY	COST (US$)	BENEFIT EFFECT	FEASIBILITY		FUND STATUS	LOCATION
FACILITY	Rental of temporary storage facility	Medium-term (1 to 2 years)	Middle	Rental of temporary storage facility Instead of destroyed GEDCO Main Warehouse, temporary storage facility is required for materials storage		Rental costs	0.1M	Whole of Gaza 1.76 million Gazan	Temporary storage facility is not enough capacity for Structures, Cables, Poles, etc. therefore cable drums are put on other cable drums because of no space, it is not good for cable since it damages cable by weight, consequently, temporary storage facility is required until completion of main warehouse	High Feasibility	Fund not secured	Um Allymoun Street
	Construction of new main warehouse; repair of GEDCO branches	Medium-term (1 to 2 years)	Middle	- GEDCO Main Warehouse - GEDCO branches buildings		Supply of materials, Installation and Civil Works	1,764,706 (including VAT)		The location of new main ware house is under searching, existing main warehouse located in the Eastern side of Gaza City is dangerous due to near border of Israel. Currently, cables, poles, transformers, structures are exposed in the field of main warehouse without roof. Israel may block the distribution of construction materials.	Middle Feasibility (Israel may block the distribution of materials)	Fund not secured	Under searching
	Replacement of equipment destroyed in main warehouse	Medium-term (1 to 2 years)	Middle	GEDCO's main warehouse materials	- Transformers/Wires/Cables/Switches/Steel Poles - Fuse Holders and Surge Arrestors - Insulators/Overhead Lines Accessories - Cable Accessories /Terminal Lugs/Earthing/Accessories - Auto Recloser with control unit/Tools	Supply of materials	5,830,000 (including VAT)		GEDCO prefer to get main warehouse materials rather than to get materials of "Replacement of destroyed equipment in installed electrical network" because main warehouse materials has flexibility of allocation to each area and GEDCO is able to use materials whenever they want. However it is not suitable for JICA assistance since installation site is unclear.	Middle Feasibility (Israel may block the distribution of materials)	Fund not secured	
		Long-term (over 2 years)	Low			Supply of materials	2,555,087 (including VAT)					
NETWORK	Replacement of destroyed equipment in installed electrical network	Medium-term (1 to 2 years)	Middle	Replacement materials of Equipment in Installed Electrical Network	- Transformers/Indoor Transformers/Cables/Wires - Cables Accessories/Switches/Steel Poles - Fuse Holders and Surge Arrestors - Insulators/Overhead Lines Accessories - Terminal Lugs/Earthing/Accessories	Supply of materials	2,388,000 (including VAT)	Whole of Gaza 1.76 million Gazan	After 2014 war, PENRA, GEDCO and Donors have been already installed these materials. This equipment dose not need supervisor from supplier. Equipment made in Japan will be accepted by PENRA. But Japanese transformer may be bigger size and heavier weight than oversea products, therefore procurement from third country should be considered.	Middle Feasibility (Israel may block the distribution of materials)	Fund not secured	Whole of Gaza
		Long-term (over 2 years)	Low				4,011,593 (including VAT)				Fund not secured	
	Installation costs for replacement of electrical network assets	Medium-term (1 to 2 years)	Middle	Installation cost of "Replacement of destroyed equipment in installed electrical network		Installation and Civil Works	830,000	Whole of Gaza 1.76 million Gazan	This installation is implemented by local contractor in Palestine including West Bank.	High Feasibility	Fund not secured	Whole of Gaza
		Long-term (over 2 years)	Low				426,407					
	Construction of new transmission system for additional 150MW from Israel	Short-term (0 to 1 year)	High	220 kV Transmission line contributes reduction of technical loss and high demand in future		Supply of materials, Installation and Civil Works	10M		This is under coordination and negotiation between PETL and IEC, so PETL know the current situation. This 220kV line is under coordination and negotiation between PETL and IEC. Israel do not approve this project at this moment due to political issue.	Low Feasibility (Political issue)	Fund not secured	

Appendix F Proposed Project List

Source: GEDCO, PENRA, Palestinian Investment Fund Annual report 2014 and 2011

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CATEGORY	NEEDS	TERM	PRIORITY	COMPONENTS		TYPE OF SUPPLY	COST (US$)	BENEFIT EFFECT	FEASIBILITY		FUND STATUS	LOCATION
SUBSTATION	Repair and Upgrade Gaza North Substation including Construction of Distribution Networks	Short-term (0 to 1 year)	High	Gaza North Substation (GNS) has been designed for the purpose of regional interconnection with the Israeli Network at the 161 kV voltage level in order to supply the northern areas of Gaza strip and big parts of Gaza city with the necessary power demand. GNS is already built in the year of 2000 but has experienced sever damages during several wars in 2006, 2008, 2012 and 2014. Most of it's 220 kV outdoor equipment are completely damaged and need replacement. The low voltage switch gear and all control, protection facilities in the substation need to be replaced as well. In order to prepare the mentioned substation for the interconnection project with the Israeli 161 kV Networks and to be ready for power import, the following tasks have to be built and constructed as per the attached tables. GNS is designed to include two different voltage levels, namely the 161 kV (Israel network) and the Palestinian220 kV transmission system level. The proposed project is aiming to make the substation able to import power through the 161 kV level, therefore the 161 kV part of the substation is intended to be build and put into service while the 220 kV part can be implemented as a part of other projects.	- Remaining 161 kV Transmission line between Netivot substation and North substation - 161 kV Switchyard (outdoor) - Power Transformers (220/161/22 kV), Repair & modification for 120MW - 22 kV Switchgear, Auxiliary System, Erection, Rehabilitation of Control building & General Civil Works - Miscellaneous (Training, Capacity Building, & Consultancy) - 22 kV Outgoing Distribution Underground Cables	Supply of materials, Installation and Civil Works	26M	Whole of Gaza 1.76 million Gazan	This project used to be under Sweden. so this substation is existing. It requires experienced supervisor, PENRA knows the supervisor from Egypt. Israel do not approve this project at this moment due to political issue.	Low Feasibility (Political issue)	Fund not secured	East of Shejaiya Gaza Governorate
	Upgrading of KARMIA Substation in Israel Side, Procure and install Transmission and Distribution Networks in Israeli and Palestinian Sides (25MW additional)	Short-term (0 to 1 year)	High	- Upgrading KARMIA S/S from 45MW to 75MW - Transmission and Distribution Networks in Israeli and Palestinian Sides	Existing KARMIA S/S 45MW in Israel of 3.4 km north side from Gaza is upgraded into 75MW, it supplies 30 MW 22kV double circuit line to Waste water treatment facility 16MW and Desalination plant 10MW in Gaza north. Power source comes from Ashdod power station, the power station capacity is enough. but it is pending since Israel does not approve it. The project period is 5-6 months.	Supply of materials, Installation and Civil Works	10M	Waste water treatment facility and Desalination plant in north Gaza	Israel does not approve this project at this moment due to political issue.	Low Feasibility (Political issue)	Fund not secured	Israeli territory north side of Gaza
	Construction ANSAR Substation including Transmission Networks and Distribution Networks	Short-term (0 to 1 year)	Middle	The rapid increase in the load in Gaza city and the surrounding areas have made it necessary to build a new substation in the middle of Gaza (Ansar area) to meet the required demand and to enhance the electricity services in addition to decreasing the electrical losses. The new substation shall be connected to Gaza West Substation through a double cable connection on the 220 kV level and should be Gas Insulated Substation because of the location (heavy populated area) and the lack of land in the center of the city. Ansar Substation is a part of PENRA master plan prepared in the year of 2014 and shall be an important part of the overall transmission system in the Gaza Strip. The substation shall be connected to the 220 kV bus bar in Gaza West substation and supplied by the generated power of GPP.	- Construction of 2x100 MVA, 220/22 kV Gaza-Ansar Substation (Gas Insulated Substation) - Construction of around 10 km length, 220 kV double underground cable to connect Gaza Ansar to Gaza West Substation Implementing of 220 kV Double Circuit Underground Transmission Cable (XLPE, 1200 mm2, approximately 10 km length), with Fiber optic cable of buried type through conduits complete with all accessories such as splicing joint boxes, Fiber Optic patch panels …. etc.)., to connect Ansar substation to Gaza West Substation. The cables have to be laid in the farther western sidewalk of Al-Rasheed street as agreed upon with the municipality of Gaza.	Supply of materials, Installation and Civil Works	40M	Whole of Gaza 1.76 million Gazan	Israel does not approve this project at this moment due to political issue.	Low Feasibility (Political issue)	Fund not secured	Wahsh Gaza governorate
	Restoration of Gaza West Substation to 220kV design; connection to Gaza Middle Substation	Short-term (0 to 1 year)	Middle	Rebuilding of GWS to 220 kV System & Extension to include further Line bays & the connection to Middle Substation	- Supply of two Step-Up Power Transformers 11/220 kV (42/62.5/75 MVA ONAN/ONAF/ONAF with a Vector group YNd11) - Supply of two Step-Up Power Transformers 11/220 kV (23.3/31/36 MVA ONAN/ONAF/ONAF with a Vector group YNd11) - Supply of two Step-Down Power Transformers 220/22 kV (60/75 MVA ONAN/ONAF with a Vector group YNd11) - Replacement of the existing 66 kV Equipment (VTs & Surge Arrestors) - Building of 4x220 kV new line bays. - Substitution of the current operation software system (In touch) with a SCADA system and to modify the program back to the previous 220 kV system in cooperation with ABB/Sweden.	Supply of materials, Installation and Civil Works	40M	Whole of Gaza 1.76 million Gazan	Israel does not approve this project at this moment due to political issue.	Low Feasibility (Political issue)	Fund not secured	Al Barag Street Gaza Power Plant Middle Governorate

Appendix F Proposed Project List

Source: GEDCO, PENRA, Palestinian Investment Fund Annual report 2014 and 2011

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CATEGORY	NEEDS	TERM	PRIORITY	COMPONENTS		TYPE OF SUPPLY	COST (US$)	BENEFIT EFFECT	FEASIBILITY		FUND STATUS	LOCATION
	Upgrade of substation between Gaza and Egypt to support increase supply	Long-term (over 2 year)	Low	Regional Interconnection to the Egyptian Grid, Gaza South Substation, Gaza Middle Substation and 220 kV Transmission line between them are constructed.	- Inter-Connection of 220 kV Overhead Transmission Line (O.H.T.L.) 220 kV Double Circuit O.H.T.L (2x380 mm2 bundled ACSR, 1.6 km long), with two over head earth wires, and OPGW integrated to one of them, connecting the Gaza South Substation to similar 220 kV Double Circuit O.H.T.L., to be built at the Egyptian Side, coming from Al-Arish Steam Power Station up to a pre-defined point at the Egyptian / Palestinian Boarders to the Southern West of Rafah. - Gaza South Substation (GS-S/S); 220/22 kV Two Power Transformers (220/22 KV, 60/75 MVA, ONAN/ONAF), and control. - 220 kV Overhead Transmission Line (O.H.T.L.): 220 kV Double Circuit O.H.T.L (2x380 mm2 bundled ACSR, 16.0 km long), with two over head earth wires, and OPGW integrated to one of them, connecting GM-S/S to GS-S/S. . - Gaza Middle Substation (GM-S/S); 220/22 kV: Two Power Transformers (220/22 KV, 60/75 MVA, ONAN/ONAF), and control. Two Incoming 220 kV Line Bays (Outdoor) and Control, to connect to the GS-S/S.	Supply of materials, Installation and Civil Works	58M	Whole of Gaza 1.76 million Gazan	Israel does not approve additional 150MW at this moment due to political issue. Therefore this project which is part of additional 150MW is pending, in addition, the construction site of Egyptian side is very dangerous due to Egyptian military operation in Sinai Peninsula against terrorist. Therefore construction is not feasible.	Low Feasibility (Political issue and military operation in Sinai Peninsula)	Fund not secured	Gaza Middle Substation: Al Matahen Street Middle Governorate Gaza South Substation: Tal as Sultan Rafah Governorate
POWER PLANT	Repair Damage of Gaza Power Plant	Short-term (0 to 1 year)	High	Basically, Gaza power plant consists of two identical combined cycle power blocks. Each block consists of two gas turbines (2X23MW) and one steam turbine (1X24MW) with a total capacity of 70 MW of each block. There has been damaged for the following items. 1. The fuel treatment and storage facilities are completely destroyed. 2. One electrical generator of the first block was severely damaged and consequently one gas turbine and one steam turbine connected to it are out of operation. 3. Two boilers from the second power block were damaged and consequently the steam turbine connected to them cannot operate. All damages has been repaired locally and Gaza Power Plant is currently is capable of operation in its full capacity. Except that the fuel system has been replaced with a temporary fuel facility. Fuel Storage capacity has been diminished from 20,000 cubic meters (20 million litter) of fuel to 1200 cubic meters (1.2 million litter). Fuel treatment system was not replaced , therefore, a cleaner fuel has been used (transportation diesel instead of industrial diesel) which does not need treatment before consumption, only filtration from contaminations due to transportation.	- New two storage tanks are constructed(Two tank capacity is 20 million litter).	Supply of materials, Installation and Civil Works	5M	Whole of Gaza 1.76 million Gazan	Fuel Gasoil cost is expensive due to high fuel tax by Palestine Authority, therefore120MW full capacity generation dose not make profit due to high fuel price imposed by Palatine Authority and Israel does not approve the construction of it, therefore the repair of fuel storage tank is not proceeded until fuel tax issue and Israel issue are solved.	Low Feasibility (Fuel tax issue and Political issue)	Fund not secured	Al Barag Street Gaza Power Plant Middle Governorate
		Medium-term (1 to 2 years)	Middle				5M				Fund not secured	
	Switch GPP from industrial diesel fuel to natural gas	Medium-term (1 to 2 years)	Middle	Special urgency is the extension of natural gas to Gaza Power Plant in order to facilitate its operation in its current full capacity as the liquid fuel is very expensive compared to natural gas. Currently, the Palestinian Government is not capable of securing the amount of fuel required for operating Gaza Power Plant in its full capacity, considering also that the cost of energy produced from Gaza Power Plant is more than double the cost of sale of energy to consumers. On the other hand, Natural gas cost is one third of Gas oil. Moreover, operating Gaza Power Plant with natural gas will facilitate its expansion to cover the severe power shortage in Gaza Strip.	Operating Gaza Power Plant with natural gas in its current capacity (140 MW)will require an average daily quantity of gas about 25 million cubic feet. The closest source of NG is the Israeli Side. The following is needed:- 1. An inland pipeline of 20 km length from the north border of Gaza to Gaza Power Plant of cost about 10 million Dollars. 2. Pressure Reduction and Measuring system. 3. Conversion of Gaza Power Plant to NG operation (replacement of Burners and control system) of cost about 7 million dollars.	Supply of materials, Installation and Civil Works	40M	Whole of Gaza 1.76 million Gazan	Israel does not approve this project at this moment due to political issue.	Low Feasibility (Fuel tax issue and Political issue)	Fund not secured	Al Barag Street Gaza Power Plant Middle Governorate
RENEWABLE ENERGY	Identification of Land for Establishment of Renewable Energy Infrastructure	Long-term (over 2 years)	Low	Undesided		Supply of materials, Installation and Civil Works	1M	Undesided	This land means Mega Solar Power site, but the land acquisition may be difficult because it needs negotiation with land owner.	Middle Feasibility	Fund not secured	Undesided
ENERGY RESOURCES	Exploration and Study of Gaza marine Territory for Natural Gas Supplies	Long-term (over 2 years)	Low	These information is not available with PENRA, It could be obtained from Palestinian Investment Fund (PIF). Located off the coast of Gaza, the Gaza Marine Gas Field contains approximately 28 billion cubic meters of proven natural gas reserves. In addition to providing $2.4 billion in revenues to the government, the gas field will save the Palestinian economy $560 million annually by eliminating the need to import electricity from Israel. The substantial gas reserves can be used to fuel the Gaza power plant (when converted to gas, as planned) and the power plants being built in the West Bank. A consortium comprised of BG Group, the Consolidated Contractors Company, and PIF have the exclusive hydrocarbon exploration and marketing rights offshore the Gaza Strip.	Exploration and Study to develop Gaza marine Territory for Natural Gas Supplies	Exploration and Study	5M	Whole of Gaza 1.76 million Gazan	Israel does not approve this project at this moment due to political issue. Attempts to develop Gaza's gas fields have faced several major obstacles. significantly, Israel's de facto and illegal control of Palestinian territorial waters has impeded attempts to export Palestinian natural gas to international markets. For example, Israel has refused to implement measures required to extend a pipeline to al-Arish in Egypt, a prerequisite to liquefying the gas and exporting it to international markets. Israel has also refused to provide the necessary clearances required by developers. in addition, negotiations to export gas to Israel have been unsuccessful.	Low Feasibility	Fund not secured	Gaza Marine Gas Field

Appendix G Proposed Other Needs List

Source: GEDCO, PENRA

CATEGORY	NEEDS	TERM	PRIORITY	COMPONENTS		TYPE OF SUPPLY	COST (US$)	BENEFIT EFFECT	FEASIBILITY		FUND STATUS	LOC
ENERGY EFFICIENCY	**Prepaid Meter for Improvement of Bill collection rate**	**Long-term (over 2 years)**	**High**	Estimated number of destroyed buildings in the Gaza Strip (Complete and partial damaged) was about 70,000 building, which caused the destruction of very big part of the consumer's electrical meters and consumers cables during the war. The installation of prepaid meter assumed to increase bill collection from customers, but it had difficulties for Distributors which lack automatic integration system between their billing system and system of the various brands of meters, In addition, Distributors are not inspecting the meters, only recharging customer's meter cards in their office. It results in Electricity loss and nonpayment due to malfunction of prepaid meter, therefore Distributor is required to inspect and read the consumption readings of all prepaid meters as they do for post paid meters.	- Installation of Prepaid meter and consumers cable for 20,000 consumers electrical meters and consumers Cables except for Automatic salary deduction customer and Poor customer in order to improve collection rate. - Training for Administrators, Operators and Technicians in Prepaid meter and Billing system. after installation, Follow up for inspection of meters	Supply of materials and Training with follow up	2,124,000	Improvement of bill collection	Prepaid meter has a high effect of improvement of collection rate. 12,000 prepaid meter has been installed and additional 6,000 prepaid meter are under procurement. Local constructor is able to install the meter without supervisor.	High Feasibility	Fund not secured	Whol Gaza
	Street LED Lighting with Solar Panel	**Long-term (over 2 years)**	**Low**	Street LED lighting for Road, Public area		Supply of material	6,200 per unit	Safety during outage and Power saving	Israel may block importation into Gaza, he had blocked the solar type street lighting previously. Local constructor is able to install the lighting without supervisor. However the price is very high against the effect of power saving.	Middle Feasibility (Israel may block the distribution of materials)	Fund not secured	Whol Gaza
	LED lighting bulb	**Medium-term (1 to 2 years)**	**Low**	Replacement of Street lighting into 30,000 Power saving bulb (e.g. LED in order to save 5.2GWh/year	30,000 Power saving bulb for street lighting	Supply of material	2M	Power saving of 5.2GWh/year	Local constructor is able to install the lighting without supervisor.	High Feasibility	Fund not secured	Whol Gaza
	Voltage Regulator for Boosting of Voltage Drop	**Short-term (0 to 1 year)**	**High**	Interconnection line from Egypt is very long (35km), therefore voltage drops from 22kV to 17kV. Because Sinai is under military operation, it results in poor electricity service due to dangerous area. It result that the consumer's voltage in Rafah governorate drops from 220V to 170V. The Tap changing of Transformer is not unusable due to out of voltage range (±7.5%) and consumer's inverter is also useless because of high voltage boost inverter is expensive. Consequently, GEDCO proposed the Voltage Regulator for Boosting of the voltage drop. For instance, hospital is almost out of service due to voltage drop, therefore it is urgent matter and high priority in Gaza.	Booster: 3 Qty * Voltage regulator 880kVA 400/448A for Gaza1 line: 137,588USD * Voltage regulator 880kVA 400/448A for Gaza2 line: 137,588USD * Voltage regulator 330kVA 150/168A for Palestine line: 83,780USD	Supply of material	358,956	230,000 people of Rafah Governorate	The installation of Voltage regulator is implemented by local constructor without supervisor of supplier.	Middle Feasibility (Israel may block the distribution of materials)	Fund not secured	Interc n line near Egyp borde

Appendix G Proposed Other Needs List

Source: GEDCO, PENRA

CATEGORY	NEEDS	TERM	PRIORITY	COMPONENTS		TYPE OF SUPPLY	COST (US$)	BENEFIT EFFECT	FEASIBILITY		FUND STATUS	LOC
CAPACITY BUIDING	Technical training, Administrative training and Financial training	Long-term (3 years)	Medium	Capacity Building of Technical and Administrative for GEDCO	<Year of 2015> (Technical training courses) Number of Trainee: 6 - SCADA Advanced - Underground Cables Fault Locating - Energy Metering System - Qualifying Safety and Prevention guiders - Distribution Earthling System - Inspection for House and Industrial Wiring (Administrative Courses) Number of Trainee: 3 - Training of the trainers(TOT) in the technical field - Strategic leadership for setting the future visions and preparing the administrative plans and achieving them - Strategies for Performance Indicators and improving the productivity	Training	Undecided	Capacity Building of GEDCO	Some Japanese Electricity companies did not undertake the training in Japan, so it is difficult to implement the training in Japan. The third country such as Jordan and Egypt is suitable for the training. Training in Egypt because it is easy for young trainees to go out of Gaza in case of crossing Egypt. Crossing Israel is difficult since young people is not approved to go out of Gaza by Israel. GEDCO requires training of young people.	High Feasibility	Fund not secured	Egyp Jorda
			Medium	Capacity Building of Technical and Administrative for GEDCO	<Year of 2016> (Technical training courses) - Overhead Distribution Networks Design (Medium and Low Voltage Networks) - Modern Methods in Managing the Electricity Projects - Operation, Inspection and Maintenance of the electrical transformers - Distribution Protection for Engineers - Electrical Networks Maintenance (Medium and Low voltage) - Underground Cable Jointing (Financial Courses) - Tenders Preparation & Evaluations - Financial Strategic Planning & Budget Analysis - Setting the financial policies , Financial Analysis, &Liquidity planning and Cash	Training	Undecided	Capacity Building of GEDCO		High Feasibility	Fund not secured	Egyp Jorda
			Medium	Capacity Building of Technical and Administrative for GEDCO	<Year of 2017> (Technical training courses) - Underground Cables Fault Locating - Overhead Distribution Networks Design (Medium and Low Voltage Networks) - Electrical Networks Maintenance (Medium and Low voltage) - Qualifying Safety and Prevention guiders - Distribution Earthling System - Underground Cable Jointing - Inspection for House and Industrial Wiring - Fiber Optics (Administrative Courses) - Strategic leadership for setting the future visions and preparing the administrative plans and achieving them	Training	Undecided	Capacity Building of GEDCO		High Feasibility	Fund not secured	Egyp Jorda

Appendix H

PROPOSED TRANSMISSION SYSTEM