The Republic of Iraq
Ministry of Electricity (MoE)

Final Report
on
The Preparatory Survey
on
Electricity Sector Reconstruction Project (Ⅱ)
in
The Republic of Iraq

August 2013

Japan International Cooperation Agency

Tokyo Electric Power Services Co.，Ltd.

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Contents of Final Report

for JICA Preparatory Survey on Electricity Sector Reconstruction Project (II) in the Republic of Iraq

Abbreviations and Acronyms

Organization

CSO	Central Statistics Organization
GD	General Directorate
IEC	International Electrotechnical Commission
IOM	International Organization for Migration
JICA	Japan International Cooperation Agency
JOGMEC	Japan Oil, Gas and Metals National Corporation
MoE	Ministry of Electricity
MOEN	The Ministry of Environment
MOA	The Ministry of Agriculture
MOF	The Ministry of Finance
NGO	Non Governmental Organization
UN	United Nations
UNDP	United Nations Development Program
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
USAID	U. S. Agency for International Developement
WB	World Bank

Others

AC/DC	Active Current / Direct Current
ACSR	Aluminum cable steel reinforced
AMN	Al-Ameen S.S
AMR	Amar S.S
ANBG	Al-Anbar Gas P.S.
B.C.	Bus Coupler
B.S.	Bus Sectionalizer
BAB	Babil S.S
BAJP	Baiji Thermal P.S.
BGC	Bagdad Center (Al-Rasheed)
BGE	Bagdad East S.S
BGN	Bagdad North S.S
BGS	Bagdad South S.S
BGW	Bagdad West S.S
BIPE	Board of Protection & Improvement of Enviroment
BNW	Bagdad NorthWest S.S
BOT	build operate-transfer

BSR	Basra S.S
CB	Circuit Breaker
CSO	Central Statistics Organization
CVT	Capacitor Type Voltage Transformers
DAL	Diyala S.S
DBSG	Dibis Gas P.S.
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
FAC	Final Acceptance Certificate
FAT	Factory Acceptance Testing
FIRR	Financial Internal Rate of Return
G.R.	Growth Rate
GDP	Gross Domestic Product
GIS	Gas Insurated Switchgear
GPS	Global Positioning System
HDTH	Haditha Dam Hydro P.S.
HFO	Heavy Fuel Oil
HRTP	Hartha Thermal P.S.
HVAC	Heat, Ventilation & Air Conditioner
HYDG	Najaf Gas P.S.
ID	Iraq Dinar
IEE	Initial Environmental Examination
IOM	the International Organization for Migration
IPP	Independent Power Producer
JETRO	Japan External Trade Organization
JOGMEC	Japan Oil, Gas and Metals National Corporation
KAZG	Khor Zubayr Gas P.S.
KDS	Kadisiyah (Diwaniya)
KRK	Kirkuk S.S
KRTG	Khairat Gas P.S.
KUT	Kut S.S
LA	Line Arrester
LIWV	Lightning Impulse withstand voltage
LT	Line Trap
LTL	Long term loan
MMDH	Musul Dam Hydro P.S.
MNSR	Mansuriya S.S
MP	Master Plan for year 2012-2015 by Iraq Ministry of Electricity
MSE	Mosul East S.S.

MSL	Musul S.S
MUSP	Musayab Thermal P.S.
MXU	Multi Plexer Unit
NBJG	Baiji New Gas P.S.
NDC	National Dispatch Center
NJBG	Najibiya Gas P.S.
NSRG	Nasiriya Gas P.S.
NSRP	Nasiriya Thermal P.S.
NYNG	Nenava Gas P.S.
O/M	Operating & Maintenance
ODA	Official Development Assistance
OHL	Overhead Line
OPGW	Optical-fiber composite overhead Ground Wire
P/S, P.S,PS	Power Station
PLC	Power Line Carrier
PQ	Prequalification
PSE	Protection Signal Equipment
PSS/E, PSSE	Power System Simulator for Engineering
QIM	Qai'm S.S
QRN	Qurna S.S
RCC	Regional Control Center
RMLG	Rumaila Gas P.S.
ROA	Return On Asset
ROE	Return on Equity
RSF	Rusafa S.S
RTU	Remote Terminal Unit
RUS	Rated Ultimate Strength
S/S, S.S,SS	Sub Station
SCADA	Supervisory Control Anunciation & data Aguisition
SCS	Substation Control System
SDRG	Sadr City Gas P.S.
SHMP	Al-Shamal Thermal P.S.
SLDP	Salah Al Dean Thermal P.S.
SMWG	Samawa Gas P.S.
STEP	Special Terms for Economic Partnership
STL	short term loan
SVC	Static Var Compensator
T/S	Transmission / substation

TL	Transmission Line
TOAC	Taking Over Acceptance Certificate
UGC	Underground Cable
US$,USD	United States Dollars
W/C	Working capital
WACC	weighted average capital cost
YSFP	Yusfiya Thermal P.S.
ZBDP	Wasit Thermal -(1)

Currency Equivalents

Currency unit = Iraqi Dinar (ID)

Exchange rate: US$1.00 = 1,156.91ID (August 13, 2013)

Source; OANDA, Selling rate Average value

Chapter 1

Introduction

Chapter 1 Introduction

1.1 Background of the Study

Regarding the power supply issue in Iraq federal area, while the required power demand was about 13,000MW as of 2011, but the ability of supplying the power had just about 7,500MW. Therefore, it should be immediately needed not only to build some more new power stations, but also to construct transmission lines, substations, and distribution lines simultaneously to supply the power to consumers.
Especially, it is able to accommodate the power just only 5 hours a day in the summer, planned blackouts can't be avoided yet. This recent situation of unstable and insufficient power supply has become a one of causes of social unrest.
According to the above thing, establishing the stable power supply through the new power development and the new power network development of transmission lines, substations and distribution is a pressing issue in Iraq Federation.

Under the above circumstances, Japanese Government and JICA have targeted the reconstruction project of power facilities as one of the most important development issues from viewpoint of the activation of the private sector in Japan's priority areas for development assistance of Iqra. Then, Japanese Government has already provided any assistance concerned with the electric power development area such as the gratis fund aid in 2005-06 and the loan fund cooperation of five projects in 2007-09 as well. The electricity sector reconstruction project in Iraq, which was implemented as the 1st stage, was one of the loan fund cooperation.

Conection of substations was implemented in the first stage of this project. But substation facilities are still insufficient due to enhancement of the power plants with increasing power demand, and moreover, it is greatly necessary to construct the transmission lines connecting to substations as well. In addition, the trend of electricity demand of recent years in Iraq could show that the peak load in 2011 was 12,950MW while it was 3,644MW in 2005, which means the peak load had risen to about 3.5 times in 7 years.
For the above reasons, it still needs to have further more supports for the transmission and substation sector in MoE, which becomes incentive for this Study. Theoretically, high voltage electricity transmission system drascally reduces power transmisin losses, which has similar effect of building new power generation station. In fact, MoE has master plan for extension of 400kV network system and has been constructing 400kV transmission lines and substations as the power sector reconstruction projects. The construction of new 400 kV electricity system network will improve the tight electricity situation and power supply reliability, which results in regional social economic improvements and an enhanced quality of life.

1.2 Purpose and Activities

1.2.1 Purpose of the Study

.
As per the above background, it is obvious that the construction of 400kV substations and transmission lines is in line with electricity development plan of MoE.
The purpose of the Study is to investigate the information required for the Yen-Loan Project such as the cost estimate, schedule, implementation, organizational structure, management, and socio-environment.

1.2.2 Area in Which to Conduct the Study

Republic of Iraq

1.2.3 Scope of the Study Works

The following are the targeted study items.
(1) Review and Confirmation of the Network Planning
a) Review of the power development plan
b) Confirmation of the network development plans and power flow forecast
c) Confirmation of the regional demand and supply balance forecast
d) Review and confirmation of the necessity and appropriateness of the Project

(2) Review and confirmation of the components of the Project
a) To review the Feasibility Study undertaken in 2020 and update the Project scope and preliminary design
b) Proposal of consulting service and technical assistance under the Project
c) Estimation of the Project cost
d) Proposal of the Project implementation schedule
e) Proposal of the project's procurement package
(3) Confirmation of operation, maintenance and management
a) Confirmation of MoE's technical and financial capacity
b) Proposal of appropriate operations and the maintenance and management system to enhance project output

(4) Project evaluation
a) Proposal of the operation and evaluation indicators of the Project
b) Indication of project beneficiaries
c) Calculation of EIRR
d) Evaluation of the qualitative effect from the Project

(5) Environmental and social considerations
a) To confirm the legal and administrative framework for the environmental and social safeguards
b) To implement scoping
c) To monitor the progress of EIA implementation and to provide technical supports
d) To measure the environmental and social impact
e) To examine environmental management plan and environmental monitoring plan

1.3 Scope of the Project

The target facilities of the Project are shown in bellow

Subjects	Target Facilities	
Substation	Al-Madaain	400kV GIS Substation
	Al-Radwaniyah	400kV GIS Substation
	Al-Fayha'(Basra)	400kV GIS Substation
	Ninawa	400kV GIS Substation
	Thi Qar	400kV GIS Substation
	Al-Anbar	400kV GIS Substation
	New Diyara	400kV GIS Substation
	Missan	400kV GIS Substation

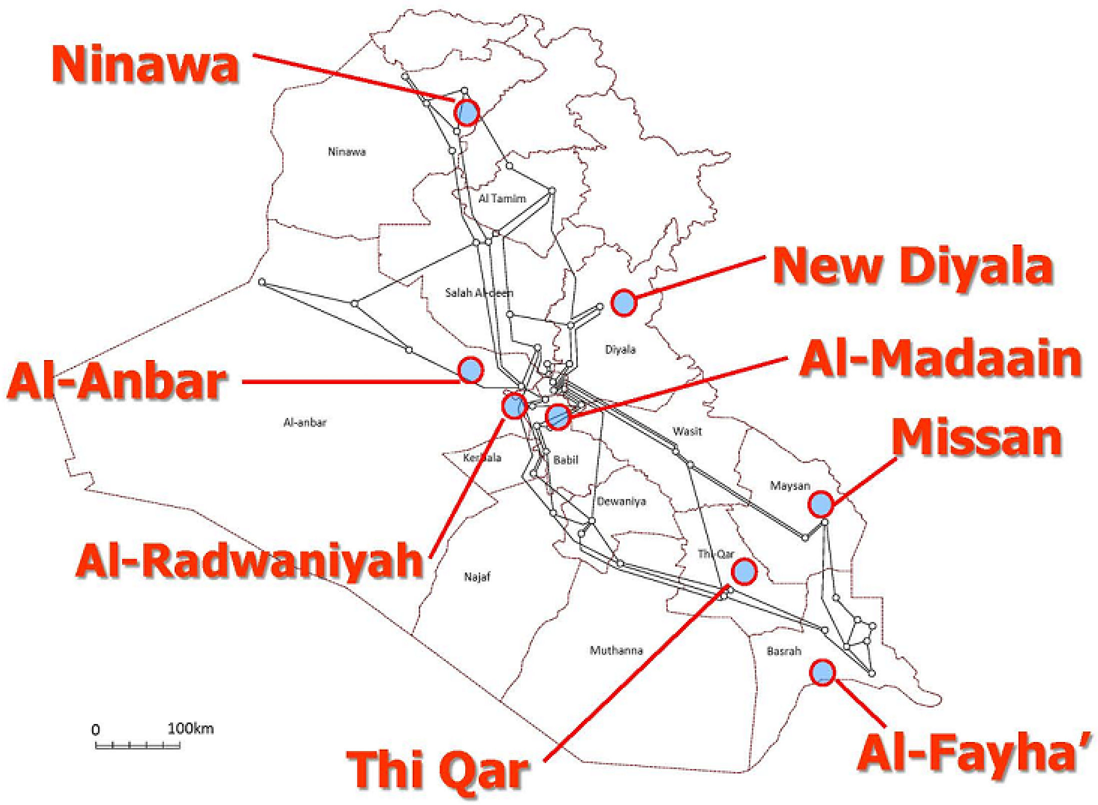


Figure 1.1.1 Scope of the Project

1.4 Organization and the Results

1.4.1 Conducting Organization of the Partner Country

MoE provided the following members for the Project.

Name	Assignment
Adel Hameed Mahdi	Minister Adviser, Head PMT Committee
Mohammed Jaffar Saleh	DG of Power Transmission office
Saud Salih Muhamammad	Transmission Office
Mahdi Daham Jasim	Planning and Studies Office

1.4.2 Member List of the Study Team

The Study Team of MoE is composed of the following experts.

Name	Assignment
Yoshio Kanda	Project Leader / General Planning
Masahiro Ogawa	Project Sub Leader / Facility Designing
Nobuyuki Kinoshita	Power System Planning
Hidekazu Takase	Power System Analysis
Hironobu Furuya	Substation Designing
Tomoyuki Inoue	Economic and Financial Analysis
Hiroshi Oomori	Environment and Social Consideration

1.5 Milestones and Events

1.5.1 Period of the Study;

From December 10, 2012 to July 31, 2013.

1.5.2 Study in MoE;

The following meeting and discussion have been carried out in Amman, and Baghdad; No.	Periods	Agenda
1st mission held in Amman	March 7, 2013 to March 9, 2013	Kick off meeting Coordination meeting-1 Questioners and discussions for the Project general such as target facilities, locations, financial and environmental issues, site survey etc
2nd mission held in Amman	May 8, 2013 to May 10, 2013	Coordination meeting-2 Confirmation and discussions for detailed Project issues such as finalization of the project scope, substation facilities, completion periods, budgets, financial and environmental issues etc
3rd mission held in Baghdad	July 4, 2013	Presentation of Draft Final Report of the Study

1.5.3 Reporting

The following reports have been submitted; No.	Descriptions	Dates
1	Inception Report	January 7, 2013
2	Interim Report	April 17, 2013
3	Draft Final Report	June 27, 2013
4	Final Report	August 19, 2013

Chapter 2

The Power Sector in the Republic of Iraq

Chapter2 The Power Sector in the Republic of Iraq

2.1 Economic Condition

2.1.1 General Outline

(1) Historical Overview

According to “Histrical Overview” in “National Development Plan for the years 2010 – 2014”, the past economic conditions (especially during 1990’s and 2000’s) are as the followings.

a) Over the past 40 years, the Iraqi economy has shown significant developments in general economic indicators such as GDP, national income, and fixed capital formation, though that are with ups and downs. This is natural when considering the circumstances in the years. Most typical evens in the past 40 years were nationalization of the oil industry in 1972, the first Gulf War in 1980-1988, the second Gulf War in 1991, international economic sanctions in 1991-2003, and the fall of Saddam Hussein in 2003.

b) Nationalization of the oil industry and correction of the price mechanism provided Iraq with sustainable financial strength, that makes Iraqi economy adopts an expansionary development policy, stimulated the production activities cycle, and raised consumption levels. The economy experienced high growth rates which were reflected in the Iraqi people’s standard of living and allowed them to enjoy economic and social prosperity. At the same time, the development policy in the 1970s made the consumer price index and import prices increase. Overall, the outcomes of the economy in 1970s appear to have been positive when evaluated using locally and internationally recognized economic and social development measures.

c) As the economic overview during 1980～2003, the economic development shrank in order that Iraqi economic policies adopted to support the war and resisted the sanctions. Especially Iraqi economy in 2003 was the most severe during the periods as shown in Table 2.1.1.

d) Oil revenues are the main source of financing for the developmental process in Iraq. The share of the oil revenue to GDP from 2009 to 2012 is over 60% described in the following Table 2.1.2. This has undermined the role and importance of other financing sources, particularly taxes. The financing policies are unable to generate an economic surplus that can effectively contribute to the financing process.

e) The Iraqi government revenue from 2009 to 2012 is over 70% to GDP shown as the following table 2.1.2. Therefore, it can say that Iraqi government has been used to manage the Iraqi economy for the past years. It means that the public sector has made the big roles to implement Iraqi economic developments. In fact, the private sector was marginalized to public sector. As the results, the private sector has no impact on developmental effectiveness, and the civilian social organizations in private sector cannot play with effectiveness.

f) The capital accumulation in Irag has been achieved by transferring from oil revenues to other economic sectors in the past years. There was no contribution to capital accumulation from technological advancement and higher productivity rates until recent years. It has been difficult that the GDP growth rate is achieved and the capital investment is accumulated as the government’s expectation.

Table 2.1.1 Iraqi economic indicators from 2000 to 2008

	GDP per capita	Investment share to GDP	Net savings rate of GDP	Consumer price Index	Productivity in Industrial sector
Unit	million ID	%	%	2000 yr=100	million dinars
2000	2.1	3.6	31.1	100.0	5.4
2001	1.7	7.4	23.9	116.4	6.5
2002	1.6	6.4	18.7	138.9	7.5
2003	1.1	Not clear	6.7	185.5	4.3
2004	2.0	7.5	3.7	235.6	6.1
2005	2.6	19.1	15.4	322.6	8.0
2006	3.3	21.0	23.8	494.3	10.0
2007	3.8	36.4	19.7	646.8	10.5
2008	5.1	10.7	32.1	664.0	13.9

Source : Priority Environment and Sustainable Development Indicaors in Iraq by Central Statistical Organization
Original sources : GDP per capita, Investment share ro GDP and Net savingsRate of GDP come from National Accounts Directorate.
Consumer Price Index comes from Index Number Directorate
Productivity price index comes from Industrial Statistics Directorate. The productivity includes only large establishments in industry sector.

Table 2.1.2 Iraqi economic indicators from 2009 to 2012

	Unit	2009	2010	2011	2012
Population	million	31.234	32.046	32.847	33.635
Exchange rate	ID /USD	1,193	1,170	1,170	1,170
Nominal GDP	Trillion ID	139.3	169.3	230.0	262.1
Nominal GDP	Billion USD	119.1	144.7	196.6	224.0
Real GDP growth rate(G.R.)	%	2.9	3.0	8.9	10.2
GDP per capita	USD / capita	3,879	4,565	6,012	6,686
Consumer Price Index	2005 =100	122.1	125.1	132.1	140.0
Government revenue	% to GDP	72	69	71	70.0
Oil Production	million bbl/d	2.38	2.35	2.75	3.15
Oil export price	US$ / bbl	55.6	74.2	76.5	78.0
Oil revenue	% to GDP	62	62	64	65

Note: There are several GDP data in Iraq, the above GDP are quoted from IMF dataset as of March 2013.
IMF revised Iraqi GDP Sep 2012, therefore the GDP before the date are difference the above GDP.
Source: IMF dataset http://www.imf.org/external/pubs/ft/weo/2012/02/weodata/weoselco.aspx?g=2406&sg=All+countries+%2f+Emerging+and+developing+economies+%2f+Middle+East+and+North+Africa

(2) Future economic development

According to the seminar report held by The Institutes of Energy Economics, Japan in December 2010, the followings are pointed out as the major economic development policies of Iraq.

a) The future weighted economic development policy is the job creation for the workers, especially, it is important for young generation. And it is required that Iraqi economy has to be diversified from current oil monopoly economy. Therefore, it is defined that the economic strength of Iraq are land, labor and energy resources.
b) Agriculture sector has to be promoted by implementing the countermeasures of keeping water resource and protecting from salt pollution (irrigation in South Iraq / rain water in North Iraq)
c) Shi'a holy land, hilly district in North Iraq and Mesopotamia monument have to be developed as tourism resource.
d) In “National Development Plan 2010 - 2014”, the average economic growth is targeted with 9.4 % and the total investments during 2009-2014 is expected with US$186 billion (Government US$100 billion, Private US$80 billion).

(3) General basic information

General basic information, governmental financial information, governmental financial comparison to GDP, Iraqi governorates and districts and Iraqi vegetation percentage in governorates are as the following tables and figures.

Table 2.1.3 Iraqi basic information

Items	Contents
Country area	437,400 (1.2 times to Japanese territory)
Ethnic group	Arabic (60%), Kurdish (20%), Assyrian, Turkmen, Others
Religion	Islam, Christian, Others
Proved oil reserves	143 billion bbl (No 5 in the world) as of June 2012

Source: Homepage of Ministry of Foreign affairs, Japan

Table 2.1.4 Iraqi governmental financial information

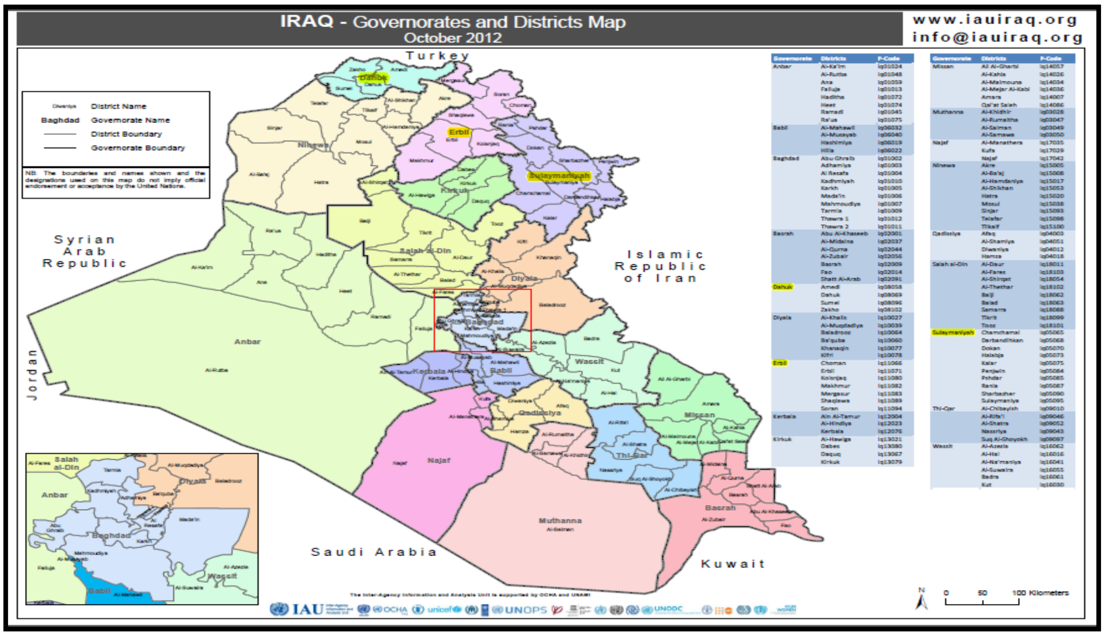
	Unit	2009	2010	2011	2012
Government revenue	Billion ID	60,330	71,647	104,417	112,858
Government expenditure	Billion ID	76,920	80,344	94,253	115,762
Government gross debt	Billion ID	109,693	114,806	118,575	118,292

Source: the same to the above

Table 2.1.5 Iraqi governmental financial comparison to GDP

	Unit	2009	2010	2011	2012
Government revenue	% to GDP	75	73	78	74
Government expenditure	% to GDP	95	82	71	76
Government gross deft	% to GDP	138	107	37	33

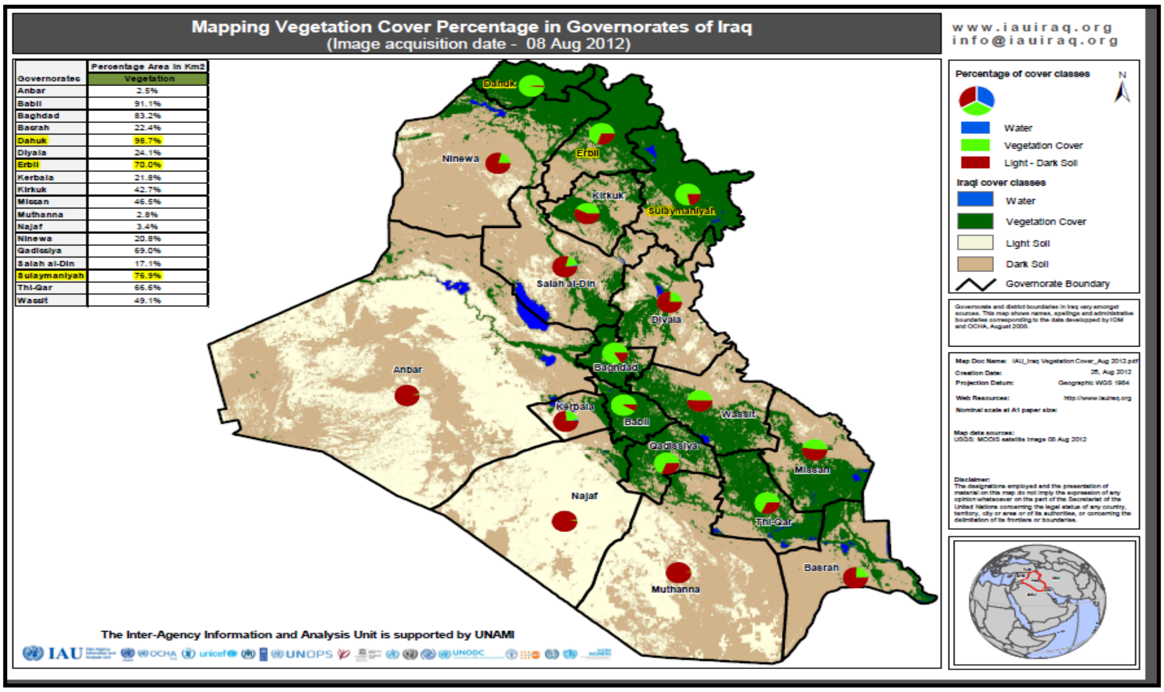
Source: the same to the above



Note: Yellow marks are the governorates in Kurdistan

Source: The Inter-Agency Information and Analysis Unit supported by United Nation Assistance Mission for Iraq

Figure 2.1.1 Iraq governorates and districts as of 2012



Source: The Inter-Agency Information and Analysis Unit supported by United Nation Assistance Mission for Iraq

Figure 2.1.2 Vegetation percentage in Iraqi governorates as of Aug 2012

2.1.2 Population and Employment

(1) Population

a) According to population survey and estimation by the Central Statistics Organization (CSO) in 2003, the Iraqi population increased from about 8 million people in 1965 to 12 million people in 1977, to 16 million people in 1987, to 22 million people in 1997, to 26 million people in 2003 and to 29.8 million people in 2008. The Iraqi population is expected to reach 35 million people by the year of 2014.

b) After 2003, Iraqi population demographics are changed, that is a decline in the overall fertility rate to 4 % in 2006 (it still remains higher than the international rate of 2.6 percent); a decline in birth rates to 31 per 1,000 people as the results of the survey conducted in 2006; a decline in the infant mortality rate to 35 per 1,000 live births during the period 2001-2005; and an increase in the number of displaced people within and outside Iraq.

c) The International Organization for Migration (IOM) estimates that one-fifth of Iraq's population has emigrated. Despite the decline in most indicators after 2003, Iraq's population growth rate has remained at 3 % over the mid- and long term because of increased birth rates and decreased death rates resulting from the expanded provision of preventive care and medical services. Accordingly, the current development plan will seek to contain these population phenomena and logical objectives that are founded on planning and organizational trends, so that population quantity and quality are used to guide development policy in Iraq with an eye toward sustainable development.

Table 2.1.6 Population trends in Iraq

	Unit	2003	2008	2010	2011	2014	2020	20/10
Population	Million	26.8	29.8	31.7	32.67	35.0	39.5	2.2%
Average G.R	%		2.8%	3.1%	3.1%	2.3%	2.0%	

Source: International Financial Statistics & "National Development Plan for the years 2010 - 2014"

Table 2.1.7 Estimation of population in Iraq

Year	Population (million)	Growth rate (%)
2011	**32.67**	
2012	33.45	2.3
2013	34.22	2.3
2014	35.00	2.3
2015	35.81	2.3
2016	36.52	2.0
2017	37.25	2.0
2018	38.00	2.0
2019	38.76	2.0
2020	39.53	2.0
2020/2011		2.1

Source; JICA SurveyTteam after referring the above table

(2) Working ages and Economic Active Population

a) The economic active population falls within the 15-64 years age group. The general population census in 1997 indicates that 23.5 % of the economic activity population to the total population. The figure increased reaches 29 % in 2008. However, the decline for a recent decade was an inevitable result of the economic recession; the lack of employment opportunities to working-age population groups; and the deterioration in the security situation after 2003.

b) Regarding the rate of economic activity population by the total population, there was a relative increase after 2003, when the rate reached 29 % in 2008. However, looking at the distribution of the economic activity population by gender males accounted for 46 % and females accounted for 11% in 2008. In contrast, the percentage of male participation in economic activity accounted for about 83 % as compared to females, whose participation was only 17 % per 2008 statistics.

Table 2.1.8 Economic activity population in Iraq

Years	Economic Activity Population (1,000 person)		
	Males	Females	Total
2002	5,724	1,201	6,925
2004	6,154	1,352	7,506
2008	7,129	1,717	8,847
08/02	3.7 %	6.1 %	4.2%

Source: "National Development Plan for the years 2010 - 2014"

Table 2.1.9 Economic activity rates in Iraq (Economic activity population/ total population)

Years	Economic Activity Rates (%)		
	Males	Females	Total
2002	44.7%	9.4%	27.1%
2004	45.2%	10.0%	27.7%
2008	46.3%	11.3%	28.9%

Source: "National Development Plan for the years 2010 - 2014"

(3) Employment

a) After 2003, unemployment rates skyrocketed, their trends varied and their reasons multiplied and were compounded by current conditions, resulting in an increase of the unemployment rate to 28 % according to the CSO employment and unemployment survey in 2003. The rate subsequently declined to 18 % in 2006 and 15 % in 2008 as a result of the employment policy adopted by the government after 2005 that aimed to increase employment by the state and the security apparatus.

b) The employment and unemployment survey data also showed that unemployment rates of males were higher in 2003, reaching 30.2 % and declined to 14.3 % in 2008. In contrast, unemployment rates of females increased in 2008 to 19.6 % after they had been 16 % in 2003.

c) The unemployment rate for youths between the ages of 15 and 24 years increased to 30 %, and the rate for males within that category was 30 %, as compared to 32 % for females. Individuals in the 60-64 years age group had the lowest unemployment rate at 4.6 % based on the results of the 2008 survey.

d) The differences are even clearer when comparing urban and rural areas. The unemployment rate in urban areas declined from 30 % in 2003 to about 16 % in 2008, while the rate declined in rural areas from 25 % in 2003 to 13 % in 2008. The lack of security, failure of reconstruction projects to create new job opportunities, decline in investment spending allocations as a percentage of total public spending, absence of foreign investment supporting the principle of national labor employment, and the inefficacy of external grants and loans in creating job opportunities are all considered factors in raising unemployment rates in Iraq.

Table 2.1.10 Unemployment rates in Iraq (2003 to 2011)

Year	Males	Females	Total
	%	%	%
2003	30.2	16.0	28.1
2004	29.4	15.0	26.8
2005	19.2	14.2	18.0
2006	16.2	22.7	17.5
2007	11.7	11.7	11.7
2008	14.3	19.7	15.3
2011			8.3

Source: Survey of Employment and Unemployment in Iraq for 2003 – 2008 by Central Organization for Statistics and Information Technology

Table 2.1.11 Unemployment rates by governorate in Iraq (2011)

Governorate	Rate (%)	Governorate	Rate (%)
Duhok	6	Kerbala	5
Ninawa	5	Kut	8
Sulaimani	7	Salah Al- Deen	11
Kirkuk	2	Al- Najaf	8
Erbil	4	Dewaniya	11
Diyala	14	Muthanna	13
Al- Anbar	16	Thi-Qar	16
Baghdad	7	Missan	13
Babil	6	Basra	7

Source: Iraq Knowledge net survey for 2011

(4) Human development and employment policies

According to “National Development Plan for the years 2010 - 2014”, human development and employment policies are described as follow;

a) The Iraqi economic efficiency has to improve by increasing the absorptive capacity of investment in order to increase the level of productivity and output and ensure coverage of the increases in aggregate effective demand for both the consumer and producer categories. This reduces the pressure on economic resources.

b) Advanced training and qualification programs can contribute to empowering the Iraqi labor force and increase its skill level in a manner consistent with and complementary to Iraqi job market needs, thereby increasing the rate of participation in economic activity.

c) Affirmation of women’s economic role by adopting a strategy to improve their economic and social conditions would empower them and expand their options and participation. This would reinforce the culture of parity and equality between genders in obtaining job opportunities.

d) Iraqi youths need to be empowered and their effective participation encouraged in areas that support the paths of sustainable development.

e) In order to ensure the effectiveness of employment policy, there must be balance for the labor force that achieves harmony between labor supply and demand. The development plan should evaluate the country’s actual needs from the available labor force and ensure the accuracy of its quantitative and qualitative sectoral trends.

f) To contain population movements resulting from urbanization, it is necessary to adopt advanced agricultural policies that make rural development a priority, attract and settle migrant labor, correct the sectoral problem of enlarged non-commodity sectors, and encourage the private sector to invest in rural areas and develop animal resources. For promoting the policy, the state would provide a comprehensive system of agricultural incentives that encourage investors and farmers to use modern technology and improved seeds to boost farmers’ output and income.

g) In order to address structural problems in the labor force distribution between commodity and non-commodity sectors, it is necessary to select and support the sectors that absorb large numbers of the labor force; that is, sectors that use a labor-intensive and less capital-intensive production approach, such as the construction and building sector and the service sector. This will effectively contribute to addressing high unemployment rates.

h) To achieve a complementary partnership between the public and private sectors there must be an economic/ institutional/legal framework that ensures promotion of this partnership and encourages the private sector to increase productive investment rates, embarks on fields that used to be monopolized by the public sector, and build a build operate-transfer (BOT) method that crowns the effectiveness of this partnership.

2.1.3 Macro Economy

(1) GDP and per capita

a) Iraqi GDP increased from ID 73 trillion in 2005 to ID 262 trillion in 2012 at current prices. The average growth rate is 20% per year during the years. This influenced GDP per capita which increased from US$ 1,823 per capita to US$ 6,686 per capita in 2012.

b) However, this increase slowed in the 1980s. The average rate of GDP growth fell to 13.6 % at current prices between 1980 and 1990 and 4.5 % at constant prices during the period. This deterioration was a result of the mobilization of economic, financial, and human resources to support military activities. This deterioration was further exacerbated by the stoppage of Iraqi crude oil exports from the Persian Gulf and stoppage of the pumping of oil through Syria in 1982. This was coupled with reduced production in most industrial establishments because of lack of human resources and insufficiency of foreign currency to import the intermediate commodities and raw materials needed for most economic activities, particularly conversion industries, but the transport and communications sectors as well.

c) During the 1990s, GDP increased to ID 6.7 trillion in 1995 and almost ID 50 trillion in 2000 at current prices.

d) When considering the GDP growth rate from 2005 to 2012, the growth rate of GDP at current price is 20 % per year and the GDP at constant price is 4.4 % per year. The difference is inflation with 15.6 % per year.

Table 2.1.12 Iraq GDP at current price and GDP per capita

Years	Population	Exchange	Iraq dinar		US dollar	
	million	ID / USD	GDP Billion ID	Per capita 1,000 ID	GDP Million USD	Per capita USD
2003	26.8	2133	29,586	1,104	13,871	518
2004	27.6	1,453	53,235	1,929	36,638	1,327
2005	27.4	1,472	73,533	2,684	49,954	1,823
2006	28.1	1,467	95,588	3,402	65,159	2,319
2007	29.0	1,255	111,456	3,843	88,810	3,062
2008	28.8	1,193	155,982	5,416	130,748	4,540
2009	30.7	1,170	139,330	4,538	119,085	3,879
2010	31.7	1,170	169,316	5,341	144,715	4,565
2011	32.7	1,170	230,030	7,035	196,607	6,012
2012	33.5	1,170	262,051	7,822	223,975	6,686
12/05	2.9%	-3.2%	19.9%	16.5%	23.9%	20.4%

Source: Exchange: International financial Statistics, and the other figures in 2012 are estimated by IMF.

Population: International financial Statistics & National Development Plan for the years 2010 - 2014"

GDP : International financial Statistics & National Development Plan for the years 2010 - 2014"

(2) Investment

a) The term of “Fixed capital formation” means the material outcome arising from investment such as machinery, equipment, buildings, facilities, and vehicles that are of a fixed nature and are used in the production process. The stages of fixed capital formation are considered strategic components not only in terms of long-term economic variables but also in terms of short-term fluctuations, and those are effective on the country’s overall economic activity.

b) After 2003, fixed capital formation experienced a tangible increase. As shown in the following table, between 2004 and 2008 fixed capital formation increased from ID 2.9 trillion in 2004 to ID 79 trillion in 2008 as measured at current prices. The average growth rate is 55 % per year during the period. When looking at the real capital fixed formation without inflation, the average growth rate adjusted by average inflation rate of 19 % during the term is 36 % per year.

Table 2.1.13 Investment capital funds from 2006 to 2011 in Iraq

Years	GDP Billion ID	Fixed capital Formation Billion ID	Shares %
2004	53,235	2,857	5.4
2005	73,533	10,182	13.8
2006	95,588	16,282	27.5
2007	111,456	33,832	30.4
2008	155,982	16,690	10.7
Total	489,794	79,843	16.3

Note: Capital formation in 2007 includes investment grants from donor countries, so the ratio was high.

Source: Board of Investment of Iraq

(3) Macro economy policies

According to “National Development Plan for the years 2010 – 2014”, the main policies on macro economy up to 2014 are as follows;

a) Work to increase the GDP at a rate of 9.3 % per year for the duration of the plan. And to diversify the economy and transform it into other sectors from oil industry, particularly agriculture, manufacturing industry and tourism sectors.

b) Work to improve and increase productivity and promote competition in all economic sectors, particularly as regards activities that have a comparative advantage, such as oil, gas, petrochemicals, cement, plastics, pharmaceuticals, and electricity across all of Iraq’s regions and governorates so as to guarantee and ensure a continuously robust economy for Iraq.

c) Work to increase the employment rate, particularly among youth and women, by activating the private sector’s role in employment. This should reduce the high unemployment rate of 15 %, consisting of both seasonal unemployment and underemployment.

d) Increase as well as quantitatively and qualitatively improve the water provided for human consumption over both the mid and long term, as well as double the coverage areas of sanitation projects and expand their spatial coverage to include all governorates.

e) Work seriously to alleviate the poverty that is currently widespread in Iraq by creating job opportunities and areas as well as sustainable income. Further, ensure basic social services to the poor by ensuring qualification and training in new job areas, particularly for high-risk groups like orphans, widows, and special need persons.

f) Work to achieve comprehensive growth that guarantees investments of human and natural resources in Iraqi governorates. This would be supported by the investment allocations and an attempt to decrease disparities, barriers, and dualities at the regional level. This would be achieved by establishment of economic activities, industrial complexes, and economic free zones. The plan aims to achieve distribution of infrastructure, social services, and suitable housing based on population size.

g) Address rural development issues, particularly the poor performance by the agricultural sector in terms of productivity and job creation, as well as unsuitable housing and weak infrastructure in the countryside. That is the reason why the plan seeks to reduce disparity and barriers between rural and urban areas in terms of the availability of infrastructure, social services, and areas of new job creation.

Table 2.1.14 Real GDP growth rate and future GDP trends in Iraq (at 2005 price)

	Population		Iraq Dinar				US dollar	
	Iraq Million	Growth %	Real GDP Billion ID at 2005 p	Growth %	Per capita 1,000 ID	Growth %	Real GDP Million USD	Per capita USD
2005	27.40		73,533		2,684		49,954	1,823
2006	28.10	2.6	78,087	6.2	2,779	3.5	53,048	1,888
2007	29.00	3.2	79,251	1.5	2,733	-1.7	53,839	1,857
2008	28.80	-0.7	86,788	9.5	3,013	10.3	58,959	2,047
2009	30.70	6.6	89,299	2.9	2,909	-3.5	60,665	1,976
2010	31.70	3.3	91,947	3.0	2,901	-0.3	62,464	1,970
2011	32.67	3.1	100,090	8.9	3,064	5.6	67,996	2,081
2012	33.45	2.4	110,269	10.2	3,297	7.6	74,911	2,239
2013	34.22	2.3	120,194	9.0	3,512	6.5	81,653	2,386
2014	35.00	2.3	131,011	9.0	3,743	6.6	89,002	2,543
2015	35.81	2.3	141,492	8.0	3,951	5.6	96,122	2,684
2016	36.52	2.0	152,811	8.0	4,184	5.9	103,812	2,843
2017	37.25	2.0	165,036	8.0	4,430	5.9	112,117	3,010
2018	38.00	2.0	178,239	8.0	4,690	5.9	121,086	3,186
2019	38.76	2.0	192,498	8.0	4,966	5.9	130,773	3,374
2020	39.53	2.0	207,898	8.0	5,259	5.9	141,235	3,573
15/12	2.3%		8.7%		6.2%		8.7%	6.2%
20/15	2.0%		8.0%		5.9%		8.0%	5.9%
20/12	2.1%		8.2%		6.0%		8.2%	6.0%

Note: Exchange rate is 1472 ID/ USD in 2005

Note: GDP growth rate of 9.8 % per year from 2010 to 2014 refers National Development Strategy for 2010 - 2014

Source: JICA Survey Team

2.2 Basic Policy and Background in the Power Sector

2.2.1 Policy of Power Sector

Electric power industry was started in Iraq in 1917 by a Belgium investment company (Tanweer Baghdad), and then developed into a Ministry of Electricity (MoE) founded in 2003 through the Electricity Authority in 1999.

MoE has been characterized by the electricity industry for manufacturing industries to balance the supply and demand of electric power before electricity section was formed in the Ministry of Industry and minerals.

Since the beginning of the nineties, Iraq Power Sector has been suffered by a very severe shortage in generation of electric power along with low performance of transmissiont and distribution,which caused to reach a very limited consumption of power per Iraqi citizens; the level 1100 kwh / person / year, while the levels in the neighboring countries exceed the rates 4000 kwh / person / year.

This shortage of power and limited rates of consumption forced changes in all Iraqi citizens activities (social, industrial, agricultural, commercial and scientific), as a result of MoE has a great mission to supply the power to all citizens by applying two major solutions:

(1) Rehabilitation of the existing power plants in order to bring it back to the nameplate capacity.

(2) Construction of new power plants (parallel with the first solution)

Therefore, the establishment as Master Plan is important in order to achieve the two major solutions actually, and then, the Master Plan is expected to cover the generation of Electricity,transmission Networks, Distribution, Control Centers, Financial issues and Human Recourses.

In order to establish the Master Plan, the following essential items should be available:

a) Financial allocations.
b) Fuel (natural gas, fuel oil (HFO), gas oil, crude oil).
c) Qualified Companies for implementation of the projects.
d) Experienced technical staff.

MoE is trying to ensure the implementation of the Master Plan by great efforts and by supporting from the government within the specified time periods.

The detail of Master Plan is shown in next clause.

2.2.2 National Development Plan

Iraq national development plan is based on the Master Plan. The first Master Plan was developed in 1973 to build and to update the electricity system in Iraq, and then Canadian company prepared and established specifications for the high voltage network (400 kV) in order to supply the demand loads during the seventies and later on. In addition, due to the Iraqi situation at that time, the Master Plan was not applied exactly.

Currnet national development plan is based on the Master Plan 2011-2015 (MP) by MoE.

MP has been established as the first phase in planning power network system for up to 2030, current power infrastructure is developing by MP. The outline of MP is as follows.

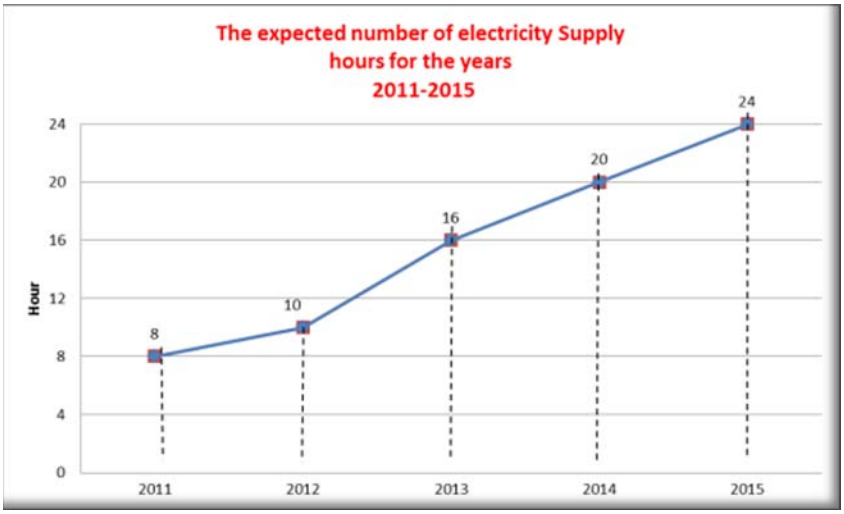
(1) The outline of MP (Master Plan 2011-2015)

Object of MP is to supply the electrical power to consumers with high-quality and high degree of reliability by improving the system electrically three basic functions (generation, transmission, distribution), and is to achieve the following goals:

a) Stop the collapse of the electrical system by rehabilitation of the total system (Generation, Transmission and Distribution).
b) Increase the available capacities in the system to meet the growing demand for electrical power, through the establishment of new Power plants (Gas, Steam and Diesel).
c) Development and extention of transmission and distribution networks throughout the country and to carry out the projects for the delivery of electricity to the new residential neighborhoods.
d) Improve the efficiency of the electricial system to maintain the continuity and stability of electricity supply and to increase the degree of readability
e) Provide better services to all consumers (domestic, commercial, industrial, agricultural and government).
f) Development building the human resources for the employees of the ministry.
g) Link the electricity networks with neighboring countries through the of the eight electrical connection network.
h) Promote the consumption of individual Iraqi electrical power from the current rate of up to 1700 kWh to get to 4000 kWh / person / year in 2015, which means uninterruptable supply power by 24 hours a day.
i) Involving the renewable energy sources /applications.

Based on the objectives described above, the concrete indicators on the implementation of MP has been shown as follows:

j) Expectation of a slight grouth by the end of the years 2011 and 2012 to reach a supplying rate of 9-10 hours per day.
k) In 2013 the expectation of additional system generation capacities around 7250 MW, which means that the supply houra will increase up to 16-17 hours a day.
l) During the year 2014 a new 7500 MW will be installed to the system so the supplying rate will be 20-22 hours per day.
m) In light of the plan is expected about 3000 MW to be added within the year 2015, then a 24 hours supply is expected.
n) As a result of the improvements in 2013 which is expected to be in range of 16-17 hours per day, and within 2014 which is expected to be in range of 20-22 hours, this expected to cause a reduction in the private generation by citizens , and more dependence on the house small generators during the shutdown hours.
o) The Ministry has prepared a program and issue guidance for the adoption of policies in the rationalization of consumption, which is to be applicable within the years 2013-2014 as a result of the improvement of the supplying rate
p) By the years 2013-2014 the Ministry will review/adopt the rates for the electricity tariff to coincide with the improvement of the power supply rate.
q) The Ministry is planning to introduce renewable energy technologies (solar, wind), to supplement the system during the coming years, specially for the isolated areas loads.
r) To implement the Master plan for the years 2011-2015 the following actions are required
    r1) Availability of financial allocations as stated in the plan up to 22 billion USD.
    r2) Availability of the the quantities and types of fuel as stated in the fuel plan and agreed with the Ministry of Oil
    r3) Construction and installation of the new power plants as per the plan timeline, which is related to the performance of the implementing companies and the following up by the Ministry.



Source from MP

Figure 2.2.1 Transition of electricity supply hours for years 2011-2015

Detail of the plan is shown in the following.

(2) The plan of power generation

The plan for the years 2011-2015 included construction of new power plants with different types gas, steam, diesel and as shown in the table 2.2.1, the plan did not include any projects for hydroelectric plants due to the decrease waters supply of Tigirs and Euphrates rivers.

Rehabilitation for steam and gas power plants is also included in the plan.

Table2.2.1 Future plan with total capacity

The Type of Power Station	Number	Capacity（MW）
Gas Power Station	24	12522
Steam Power Station	6	7330
Diesel Power Station	3	404
Easy Install (Mobile) Power Station	3	335
Hydroelectric Power Station	1	26
Total	37	20617

Source from MP

The rehabilitation plan is expected to add capacities to the system as shown in table 2.2.2 below:

Table 2.2.2 The total capacity expected to be added
after rehabilitates the units by 2011-2015

Year	**Total capacity expected to be added (MW)**
2011	410
2012	635
2013	185
2014	410
2015	320

Source from MP

(3) The plan of 400kV and 132kV Substation

According to the master plan, the construction of a 400kV substation has been declared to be required announcement as follows

Table2.2.3 400 kV substations (announced + announcement required)

Substation to be required announcement	**Substation has been announcement**
Northwest Baghdad Eastern Rusafa FAW Expansion Amara 5 diameter	East of Mosul Expansion the Mosul Dam

Source from MP

In addition, the 400kV substations currently under construction are shown as table2.2.4, and the future plans are shown as table2.2.5.

Table2.2.4 400 kV substations (currently under construction)

The expected date of completion	**The substation**	**Directorate**
2013	Basra 400	Basra
	Qurna 400	
2013	Najaf 400	Najaf

Source from MP

Table2.2.5 The number of 400 kV substations (future plan)

The expected date of completion	**The number of substation**
2012	2
2013	13
2014	1
2015	1
Total	17

Source from MP

132 kV substations currently under construction and the future plans of substations are as follows.

Table2.2.6 The number of 132 kV substations
(under construction + announced + announcement required)

Governorate	Substation under construction		Substation has been announcement	Substation to be required announcement	Total Substations for each governorate
	2011	2012			
Baghdad	2	3	-	10	15
Basra	3	-	1	5	9
`Mosul	1	2	3	3	9
Kirkuk	1	1	2	1	5
Diyala	1	1	1	-	3
Anbar	1	1	2	1	5
Najaf	1	2	-	2	5
Karbala	2	-	-	2	4
Babylon	1	-	-	3	4
Dhi Qar	-	1	2	3	6
Maysan	1	-	2	2	5
Wasit	-	-	3	2	5
Muthanna	-	-	-	3	3
Diwaniya	-	-	-	3	3
Salah al-Din	-	2	-	2	4
The total	14	13	16	42	85

Source from MP

(4) The plan of 400kV and 132kV transmission lines

According to the master plan, 400kV and 132 kV transmission lines of the schedule which is expected to add are as follows.

Table2.2.7 The schedule which is expected to add transmission lines

The expected date of completion	400kV lines (km)	132kV lines (km)	132kV cable lines (km)
2011	420	350	105
2012	460	325	45
2013	700	400	2
2014	60	550	30
2015	-	500	30
Total	1640	2125	212

Source from MP

2.3 Electricity Tariff System

2.3.1 Electricity Tariff System

(1) Current power tariffs

Tariff system of Iraq has the following transitional change from 2008 to as of June 2013. The tariffs are categorized by power consumption in business sector. As business sector, Domestic, Commercial, Industry, Agriculture and Government (Government, Party, Street light and Religious) are settled.

Table 2.3.1 Iraq power tariff system

Period	Customer	Category	I.D/ kWh	Cent/kWh
From October 2010	Domestic Commercial Industry Government Agriculture	1-1000	10	0.83
		1001-2000	20	1.66
		2001-4000	30	2.5
		Over 4001	50	4.16

Source: The data are submitted from MoE at the middle of April 2013

Since 2010, MoE would like to change the tariff system as the following table, however, the changes is not realized. When picking up the outstanding points of the MoE's new tariff system design, the category tariffs in Industry and Agriculture sectors have been applied by flat tariff from 2010.

Table 2.3.2 MoE's proposal tariff system from 2010 to 2013

Period	Customer	Category	I.D/ kWh	Cent/kWh
From 2010 To Sep 2012	Domestic Commercial Government	1-1000	20	1.66
		1001-2000	50	4.16
		2001-4000	80	6.66
		Over 4001	100	8.55
	Industry &Agriculture	Flat	120	10
Period	Customer	Category	I.D/ kWh	Cent/kWh
From October 2012	Domestic Commercial Government	1-1000	20	1.7
		1001-2000	50	4.3
		2001-3000	80	6.8
		Over 3001	100	8.5
	Industry, Agriculture	Flat	120	10.3

Source: The data dated March 2013 are submitted from MoE

(2) Future tariff system of MoE

MoE has a plan to introduce a new power tariff system, even though the implementation timing is not announced. The sectoral categories of the new power tariff system are as the followings table. In the new tariff plan, the big consumers own high tariffs and it is aimed that the power tariff plan makes MoE's financial conditions strengthen much more. However, the approval of the Government is not received as of June 2013.

Table 2.3.3 The MoE's design of new tariff system as of June 2013

Sector	Category(kWh)	I.D/ kWh	Cent/kWh
Domestic	1-,600	10	0.85
	601-,1,200	25	2.14
	1,201-,2,000	50	4.27
	2,001 - 2,500	60	5.13
	2,501 - 3,500	70	5.98
	3,501 - 4,500	80	6.84
	4,501 - 6,000	90	7.69
	Over 6001	100	8.55
Commercial	1- 300	10	0.85
	301- 600	25	2.14
	601- 900	50	4.27
	901 -,1,200	60	5.13
	1201- 3,000	70	5.98
	3001 – 6,000	80	6.84
	4501 – 6,000	90	7.69
	Over 6,001	100	8.55
Industry	0.4 kV	80	6.84
	11 kV	70	5.98
	33 kV	60	5.13
	132 kV	50	4.27
Government	1- 5,000	20	1.71
	5,001 - 10,000	40	3.42
	10,001- 20,000	60	5.13
	20,001 -40,000	80	6.84
	Over 40,001	100	8.55
Agriculture	Flat	50	4.27

Source: The data are submitted from MoE in the middle of 2013

(3) Average power tariffs

The following table shows the average power tariffs for the past three years in Iraq. The tariffs are the weighted average tariffs by power consumption from 2009 to 2011. The increase of the average power tariff is continued for the periods. As the result, Iraq average power tariff reaches 3.2 ¢ /kWh (38 ID/kWh) in 2011. The average power tariff in 2011 is around double to one in 2009.

Table 2.3.4 Average power tariffs in 2009 ～2011

Years	ID/ kWh	¢ /kWh
2009	19	1.6
2010	25	2.1
2011	38	3.2
2011/2009	41.4%	41.4%

Note: Exchange rate is 1,170 ID/ USD

Source : power tariffs shown by ID kWh are from MoE and ¢/kWh are calculated by JICA Survey Team

2.3.2 Power sales, costs and subsidy

(1) Power sales

According to MoE, the power sale volume of MoE are 26,300 GWh (3,000 MW distribution base) in 2009, 27,500 GWh (3,139 MW distribution base) in 2010 and 25,900 GWh (2,957 MW distribution base) in 2011. And the power sales incomes are US$427 million (ID 500 billion) in 2009, US$588 million (ID 688 billion) in 2010 and US$843 million (ID 986 billion) in 2011. The power sales volume (GWh) is not continuously increased due that the power sales volume is decreased in 2011 in comparing to 2010, but the power sales incomes are continuously increased year by year due that power tariffs are increased.

Table 2.3.5 Sales, Costs and Subsidy of MoE (ID base) during 2009～2011

Items	Unit	2009	2010	2011
Average power tariff	ID/kWh	19	25	38
Power sales	GWh	26,300	27,500	25,900
Power sales income	Billion ID	500	688	986
Fuel cost	Billion ID	1,573	1,349	1,383
Labor cost	Billion ID	987	1,065	1,085
Cash cost	Billion ID	2,560	2,414	2,468
Cash unit cost	ID/kWh	97.3	87.8	95.3
Subsidy (Cash cost - Sale)	Billion ID	2,060	1,726	1,482
Subsidy contribution	%	80.5	71.5	60.1

Source: The data are calculated by JICA Survey Team by using MoE data.

Table 2.3.6 Sales, Costs and Subsidy of MoE (USD base) in 2009 ～2011

	Unit	2009	2010	2011
Average power tariff	¢/kWh	1.6	2.1	3.2
Power sales	GWh	26,300	27,500	25,900
Power sales income	Million USD	427	588	843
Fuel cost	Million USD	1,344	1,153	1,182
Labor cost	Million USD	844	910	927
Cash cost	Million USD	2,188	2,063	2,109
Cash unit cost	¢/kWh	8.3	7.5	8.1
Subsidy (Cash cost - Sale)	Million USD	1,760	1,475	1,267
Subsidy contribution	%	80.5	71.5	60.1

Source: The data are calculated by JICA Survey Team by using MoE data.

(2) Average power costs and subsidy

According to calculation of JICA Survey Team, the average power cost in 2011 in Iraq is around located in 8.1 ¢/kWh (95.3 ID/kWh) based on MoE data. The cost almost consists of "direct cost", such as fuel cost and wages. It means that the depreciation of the investment and payable interest of the long term loan are not included in the cost. When calculating subsidy to the power tariff from the government, the subsidy ratios to the power costs reach 80 % in 2009, 72 % in 2010 and 60 % in 2011. It can say that the subsidies to power tariffs have been decreased for the past three years, as the results of calculating the subsidy ratios.

2.3.3 Restructuring of Tariff System

(1) Subsidy type and restructuring

60%～70 % of the power direct cost in Iraqi power system is covered by the Governmental subsidy. According to "Public Policy on Subsidies Iraq Ministry of Electricity" by USAID in 2005, the subsidy types for the power sector in Iraq are classified as the following table.

Table 2.3.7 Subsidy types for power tariff

Subsidy	Received by	Paid by
1) Capital expenditure subsidy	All customers (through MoE)	Ministry of Finance
2) Fuel price subsidy	All customers (through MoE)	Ministry of Oil
3) Inter-class subsidy among business sectors	Domestic, Government customers	Industrial, Commercial, Agricultural sectors
4)Intra-class subsidy among consumers in a sector	Domestic, Commercial, Government customers	Highest use domestic, Commercial, Government customers
5) Operating cost subsidy	All customers (through MoE)	Ministry of Finance

Note: "Subsidy" in the title line shows the kinds of subsidies, "Received by" shows beneficiary from the subsidy and "Paid by" shows payer of the subsidy

Source : "Public Policy on Subsidies Iraq Ministry of Electricity" by USAID

When looking at the tariff system of Iraq as of June 2013, "Inter-Class Subsidy", and "Intra-Class Subsidy" in the above table has been already solved. It seemed that "Capital expenditure subsidy", "Fuel price subsidy" and "Operating cost subsidy" are continued yet, even though as of June 2013. The recommendations of USAID are mentioned as the following sentences after disconnecting Iraqi poverty policy from the power business.

The Ministry of Electricity should not be in the welfare business. A subsidy for the poor should be paid by the central government though the social security program designed and administered by the government. Either a voucher scheme or direct payments are potentially attractive options.

Source : "Public Policy on Subsidies Iraq Ministry of Electricity" by USAID

Nowadays, the subsidy system for power sector from governmental budgets is introduced in world wide. And it is facts that some parts of power energy are used meaningless by the reason why lower power tariff is set by the subsidy system. The some subsidy system for the poor people is important policy for the governments in most of the countries. When considering current energy problems and global warming issues, efficient power utilization are even sought to people in the countries. For promoting the energy saving policy and consideration, it is sought that the power tariff system without any subsidy from the government should be introduced. In Iraq, it should be considered to introduce the said new power tariff system for promoting energy efficiency and conservation.

Chapter 3

The Necessity and Validity of the Project

Chapter 3 The Necessity and Validity of the Project

3.1 Power Demand in Iraq

3.1.1 Historical power demand and supply

The national electricity generation in Iraq reached approximately 2,958 megawatts in the period prior to the Second Gulf War in 1990. Production was sufficient to meet all energy demand until 1994, but increasingly began to suffer as a result of wars, economic sanctions, the halt of development plans, and the increase in consumer energy consumption. As a result, there was an increasing power shortage—the actual annual peak load was 3,409 megawatts as compared to a demand for 4,653 megawatts in 2003, a power shortage of 27 %. Deterioration of the electric energy situation continued. In 2004, peak load reached approximately 3,828 megawatts. This figure increased to 12,950 megawatts in 2011. In contrast, the demand was from 5,442 megawatts in 2004 to 13,000 megawatts in 2011. However, the country still suffered from a shortage of electric energy as of 2011. There were many reasons behind the decline in power supply including the destruction and damage of electric facilities and equipment, power theft to affect the majority of economic entities, deterioration of security and instability affecting workers in that vital activity and shortage and lack of delivery of fuel and oil products to power generation stations and projects. These factors were coupled with the difficulty in acquiring the tools necessary to maintain stations and energy-producing entities, the deterioration and decline in production efficiency, the aging of the generators. After 2006, the both of the power generation and peak load have been increased as the following table. According to MOE, the current situation as of June 2013 is in power shortage in Iraq due that power generation capacity is not enough. The statistical peak load in the following table is smaller than actual peak load.

Table 3.1.1 Actual peak load and required peak load

	Actual peak load (MW)	Required peak load (MW)	Shortage (%)
2003	3,409	4,653	-27%
2004	3,828	5,442	-33%
2005	3,644	6,355	-42%
2006	3,933	7,250	-46%
2007	4,093	7,839	-48%
2008	4,526	10,000	-55%
2009	10,967	11,000	Shortage
2010	11,939	12,500	Shortage
2011	12,950	13,000	Shortage
2011/2003	18.2%	11.0%	

Source : The data from 2003 – 2008 from "National development plan 2010 – 2014"
The data from 2009 – 2011 from "Master plan 2012 – 2015 by MOE"

3.1.2 Peak Load by Region

The following table shows the forecasts of peak loads from 2010-2015 in "MOE Master Plan 2013 – 2017". The average growth rate of peak load in the whole country is 7.9 % per year, and higher growth rates of governorates than the average growth rate are Al-Anbar（18.2% per years）, Babil（10.9% per year）, Kerbala(9.9% per year). The big contribution of the peak loads by governorates in 2011 are

Ninawa (10.6% per year), Baghdad (32.2 % per year）, Basra(11.0% per year).

Table 3.1.2 Peak load by Governorate (2010-2015)

Governorates	2010	2011	2012	2013	2014	2015	15/10
Ninawa	1,262	1,377	1,482	1,589	1,692	1,810	7.5
Al-Kirkuk	465	492	518	553	592	639	6.6
Diyala	359	380	401	426	453	487	6.3
Al-Anbar	516	629	800	984	1,107	1,192	18.2
Baghdad	3,874	4,168	4,450	4,753	5,072	5,434	7.0
Babil	548	609	691	783	854	919	10.9
Kerbala	403	451	502	552	601	647	9.9
Kut(Wasit)	392	440	471	502	531	563	7.5
Salah Al-Deen	560	599	640	681	725	779	6.8
Al-Najaf	507	539	578	622	668	721	7.3
Dewaniya	443	475	507	544	582	627	7.2
Muthanna	296	320	345	374	397	423	7.4
Thi-Qar	585	621	654	694	741	798	6.4
Missan	395	421	447	482	517	560	7.2
Basra	1,335	1,429	1,531	1,645	1,767	1,896	7.3
Total	11,940	12,950	14,017	15,184	16,299	17,495	7.9

Source : MOE "Master plan 2013- 2017"

Table 3.1.3 Contribution of peak load (2010 -2015)

Governorates	2010	2011	2012	2013	2014	2015	15/10
Ninawa	10.6	10.6	10.6	10.5	10.4	10.3	-0.4
Al-Kirkuk	3.9	3.8	3.7	3.6	3.6	3.7	-1.3
Diyala	3.0	2.9	2.9	2.8	2.8	2.8	-1.5
Al-Anbar	4.3	4.9	5.7	6.5	6.8	6.8	9.5
Baghdad	32.4	32.2	31.7	31.3	31.1	31.1	-0.9
Babil	4.6	4.7	4.9	5.2	5.2	5.3	2.7
Kerbala	3.4	3.5	3.6	3.6	3.7	3.7	1.8
Kut(Wasit)	3.3	3.4	3.4	3.3	3.3	3.2	-0.4
Salah Al-Deen	4.7	4.6	4.6	4.5	4.4	4.5	-1.0
Al-Najaf	4.2	4.2	4.1	4.1	4.1	4.1	-0.6
Dewaniya	3.7	3.7	3.6	3.6	3.6	3.6	-0.7
Muthanna	2.5	2.5	2.5	2.5	2.4	2.4	-0.5
Thi-Qar	4.9	4.8	4.7	4.6	4.5	4.6	-1.4
Missan	3.3	3.3	3.2	3.2	3.2	3.2	-0.7
Basra	11.2	11.0	10.9	10.8	10.8	10.8	-0.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	

Source : MOE "Master plan 2013- 2017"

The average growth rate of the peak load in the Master plan is 6.3 % per year from 2015 to 2020. The most growth rates of the governorates show near to the average growth rate. As outstanding point, the growth rate of Al-Anbar was 18.2 % from 2010 to 2015, however, it drastically declines to 3.7 % from 2015 to 2020. When looking at the contribution by governorate, the governorates with big contribution are Ninawa (10.3 % in 2020), Baghdad(31.4 % in 2020), Basra(11.0 % in 2020) as well as the contributions in 2011.

Table 3.1.4 Peak load by Governorate (2015-2020)

Governorates	2015	2016	2017	2018	2019	2020	20/15
Ninawa	1,810	1,922	2,041	2,165	2,297	2,438	6.1
Al-Kirkuk	639	687	737	790	845	903	7.2
Diyala	487	520	554	591	629	670	6.6
Al-Anbar	1,192	1,235	1,280	1,327	1,376	1,429	3.7
Baghdad	5,434	5,798	6,185	6,592	7,021	7,475	6.6
Babil	919	969	1,023	1,079	1,138	1,201	5.5
Kerbala	647	687	728	771	816	863	5.9
Kut(Wasit)	563	593	625	659	695	734	5.4
Salah Al-Deen	779	834	892	951	1,012	1,077	6.7
Al-Najaf	721	771	824	880	938	1,000	6.8
Dewaniya	627	671	717	764	814	866	6.7
Muthanna	423	451	481	513	545	578	6.4
Thi-Qar	798	858	923	991	1,061	1,135	7.3
Missan	560	603	647	692	739	788	7.1
Basra	1,896	2,028	2,167	2,310	2,459	2,618	6.7
Total	17,495	18,627	19,824	21,075	22,385	23,775	6.3

Source: MOE Master plan 2013- 2017

Table 3.1.5 Contribution of peak load (2015 -2020)

Governorates	2015	2016	2017	2018	2019	2020	20/15
Ninawa	10.3	10.3	10.3	10.3	10.3	10.3	-0.2
Al-Kirkuk	3.7	3.7	3.7	3.7	3.8	3.8	0.8
Diyala	2.8	2.8	2.8	2.8	2.8	2.8	0.2
Al-Anbar	6.8	6.6	6.5	6.3	6.1	6.0	-2.5
Baghdad	31.1	31.1	31.2	31.3	31.4	31.4	0.2
Babil	5.3	5.2	5.2	5.1	5.1	5.1	-0.8
Kerbala	3.7	3.7	3.7	3.7	3.6	3.6	-0.4
Kut(Wasit)	3.2	3.2	3.2	3.1	3.1	3.1	-0.8
Salah Al-Deen	4.5	4.5	4.5	4.5	4.5	4.5	0.3
Al-Najaf	4.1	4.1	4.2	4.2	4.2	4.2	0.4
Dewaniya	3.6	3.6	3.6	3.6	3.6	3.6	0.3
Muthanna	2.4	2.4	2.4	2.4	2.4	2.4	0.1
Thi-Qar	4.6	4.6	4.7	4.7	4.7	4.8	0.9
Missan	3.2	3.2	3.3	3.3	3.3	3.3	0.7
Basra	10.8	10.9	10.9	11.0	11.0	11.0	0.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	

Source : MOE Master plan 2013- 2017

3.1.3 Peak Load by JICA Survey Team

According to JOGMEC (Japan Oil, Gas and Metals National Corporation), the crude oil production in Iraq was 3 million bbl per day in 2012. And the total production will reach 12 million bbl per day in future. The following table shows bid wining companies contracted for exploring crude oil in Iraq as of Dec 2012.

Table 3.1.6 Bid winning companies for crude oil exploration as of Dec 2012

Oil field name	Bid winning companies	Production million bbl per day
Rumaila oil field	BP(England) CNPC(China)	2.85
Zubeil oil field	ENI(Italy), Occidental (USA), KoGas(Korea)	1.125
West Kurna oil field	ExxonMobil(USA), Shell (England)	2.325
Missan oil field	CNOOC (China), TPAO(Turkey)	0.45
Majunun oil field	Shall (England), PETRONAS(Malaysia)	1.80
Harfayah oil field	CNPC(China), PETRONAS Total (France)	0.535
Kaiyarah oil field	Sonangol (Angola)	0.12
West Kurna oil field	Lukoil(Russia), Statoil(Norway)	1.8
Garaf oil field	PETRONAS, JAPEX(Japan)	0.23
Badra oil field	Gazprom(Russia), PETRONAS, TPAO(Turkey)	0.17
Najima oil field	Sonangol(Angola)	0.11
Afdab oil field	CNPC(China)	0,11
Total		11.63

Source : Seminar hand out by JOGMEC (Japan Oil, Gas and Metals National Corporation), held in Dec 2012

While, according to Japanese newspaper (NIKKEI newspaper) dated 14th May 2013, Mr. Thamir Ghadban (Chairman of Prime Ministry Advisory Commission in Iraq) said that Iraq will increase crude oil production to 9 million bbl per day by 2017 ～2020. The prospected production is around triple to the current production in 2012.

It is said that Iraqi GDP growth rate is depended on the oil export growth rate. It is sure that Iraqi GDP growth rate with more than 9 % per year will be continued for 2010 – 2014 mentioned in “National Development Plan for the year 2010 -2014”. In the next five years, it is predicted with 8% per year due to the significant oil export.

Table 3.1.7 GDP growth rate for 2016 – 2020

	2013	2014	2015	2016	2017	2018	2019	2020
Growth rate	9.0%	9.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%

Note : GDP growth rate referred to “2.1.3 Macro economy”

The following table is peak load forecasts for 2013 - 2020 from “MOE Master Plan 2013-2017” and the Study team.

a) Peak loads in 2010 – 2012 are actual values or estimates.
b) Peak load forecasted by JICA Survey Team defined by GDP growth rate and elasticity.
c) The elasticity of JICA Survey Team are set after referring MOE peak load elasticity to GDP.
d) It seems that peak loads, elasticity, growth rates calculated by JICA Survey Team are reasonable and reliable.
e) Therefore, the peak load forecasts in “MOE Master Plan 2013 - 2017” are acceptable.
f) The peak load in 2012 is 14,000 MW and the peak load in 2020 becomes 24,000 MW～25,000 MW,

and the average growth rate from 2012 to 2020 is 7 %～8% per year.

Table 3.1.8 Peak loads of "MOE Master Plan 2013 -2017"and JICA Survey Team

Years		MOE			JICA		
	GDP(%)	Peak (MW)	GR (%)	Elasticity	Peak(MW)	GR (%)	Elasticity
2010	3.0	11,940			11,940		
2011	8.9	12,950	8.5	1.0	12,950	8.5	1.0
2012	10.2	14,017	8.2	0.8	14,017	8.2	0.8
2013	9.0	15,184	8.3	0.9	15,279	9.0	1.0
2014	9.0	16,299	7.3	0.8	16,654	9.0	1.0
2015	8.0	17,495	7.3	0.9	17,986	8.0	1.0
2016	8.0	18,627	6.5	0.8	19,281	7.2	0.9
2017	8.0	19,824	6.4	0.8	20,669	7.2	0.9
2018	8.0	21,075	6.3	0.8	22,157	7.2	0.9
2019	8.0	22,385	6.2	0.8	23,753	7.2	0.9
2020	8.0	23,775	6.2	0.8	25,463	7.2	0.9
15/12		7.7%			8.7%		
20/12		6.8%			7.7%		

Source: "MOE Master Plan 2013 – 2017" and calculation of JICA Survey Team

Table 3.1.9 Power consumption per capita

Years	Population	MOE			JICA		
	million	Peak load MW	Power demand GWh	Per capita kWh/person	Peak load MW	Power demand GWh	Per capita kWh/person
2011	32.67	12,950	79,409	2,431	12,950	79,409	2,431
2012	33.45	14,017	85,952	2,570	14,017	85,952	2,570
2013	34.22	15,184	93,108	2,721	15,279	93,691	2,738
2014	35.00	16,299	99,945	2,856	16,654	102,122	2,918
2015	35.81	17,495	107,279	2,996	17,986	110,290	3,080
2016	36.52	18,627	114,221	3,128	19,281	118,230	3,237
2017	37.25	19,824	121,561	3,263	20,669	126,743	3,402
2018	38.00	21,075	129,232	3,401	22,157	135,868	3,575
2019	38.76	22,385	137,265	3,541	23,753	145,651	3,758
2020	39.53	23,775	145,788	3,688	25,463	156,138	3,950
20 / 11	2.1%	7.0%	7.0%	4.7%	7.8%	7.8%	5.5%

*Note Power demand are calculated by "Load factor 0.7 * Peak Load *24*365"*

Source: "MOE Master Plan 2013 – 2017" and calculation of JICA Survey Team

Regarding the governorate peak load, it is said that the peak loads in "MOE Master Plan 2013- 2017" are reliable. Therefore, Table 3.1.2 and Table 3.1.4 can be referred for peak load by governorate.

3.2 Power Development Plan

3.2.1 Present Situation of Network System

(1) Areas and governorates in Iraq
Iraq is divided into 6 areas and 15 governorates as shown in Table 3.2.1.

Table 3.2.1 Areas and Governorate in Iraq

Area	Governorate	Area	Governorate
1. North	Ninawa (Mosul)	4. West	Al-Anbar
	Salah Al-Deen	5. South-west	Babil (Al-Hilla)
			Kerbala
2. East	Al-Kirkuk		Al-Najaf
			Dewaniya
3. Central	Baghdad	6. South	Muthanna
	Diyala		Thi-Qar
	Kut (Wasit)		Missan
			Basra

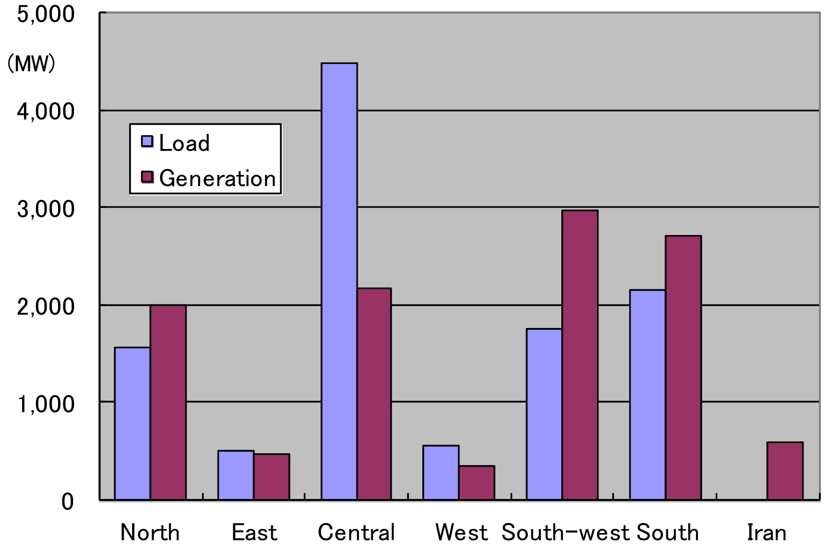
Source：MoE

(2) Areal demand and supply balance
The Study Team analyzed the network data of PSSE provided by MoE and figured out the areal demand and supply balance as shown in Table 3.2.2.
The total demand in 2013 is 11,011MW including transmission loss and station service power. Central area, which capital city is Baghdad with more than 5 million populations, accounts for 41% of the total demand, and Southern area, which has the second largest city Basra, accounts for 20%. Hence, Central and Southern areas account for about 60% of total demand.
Meanwhile, Central and Southern areas have 19% and 24% of the total power generation capacity over the country 11,264MW, respectively. Accordingly, the power is transmitted from Southern area power surplus area to Central area to meet the demand in Central area. Moreover, 5% of total generation is imported from Iran through international connection lines, as shown in Figure 3.2.1 and 3.2.2.

Table 3.2.2 Demand and Supply Balance by Area in 2013

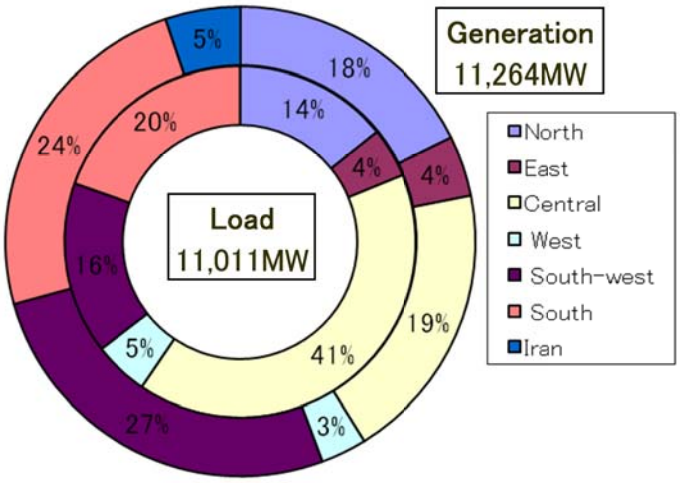
Area	Demand		Generation	
	MW	%	MW	%
1. North	1,564	14%	1,993	18%
2. East	504	4%	471	4%
3. Central	4,482	41%	2,174	19%
4. West	557	5%	355	3%
5. South-West	1,748	16%	2,972	27%
6. South	2,156	20%	2,715	24%
Iran	-	-	584	5%
Total	11,011	100%	11,264	100%

Source：PSS/E data of 2013 provided from MoE



Source : PSS/E data of 2013 provided from MoE

Figure 3.2.1 Demand and Supply Balance by Area in 2013



Source : PSS/E data of 2013 provided from MoE

Figure 3.2.2 Demand and Supply in 2013

(3) Network system

The 400kV network has performed as the bulk power transmission system among areas and 132kV network has played the role of local supply systems.

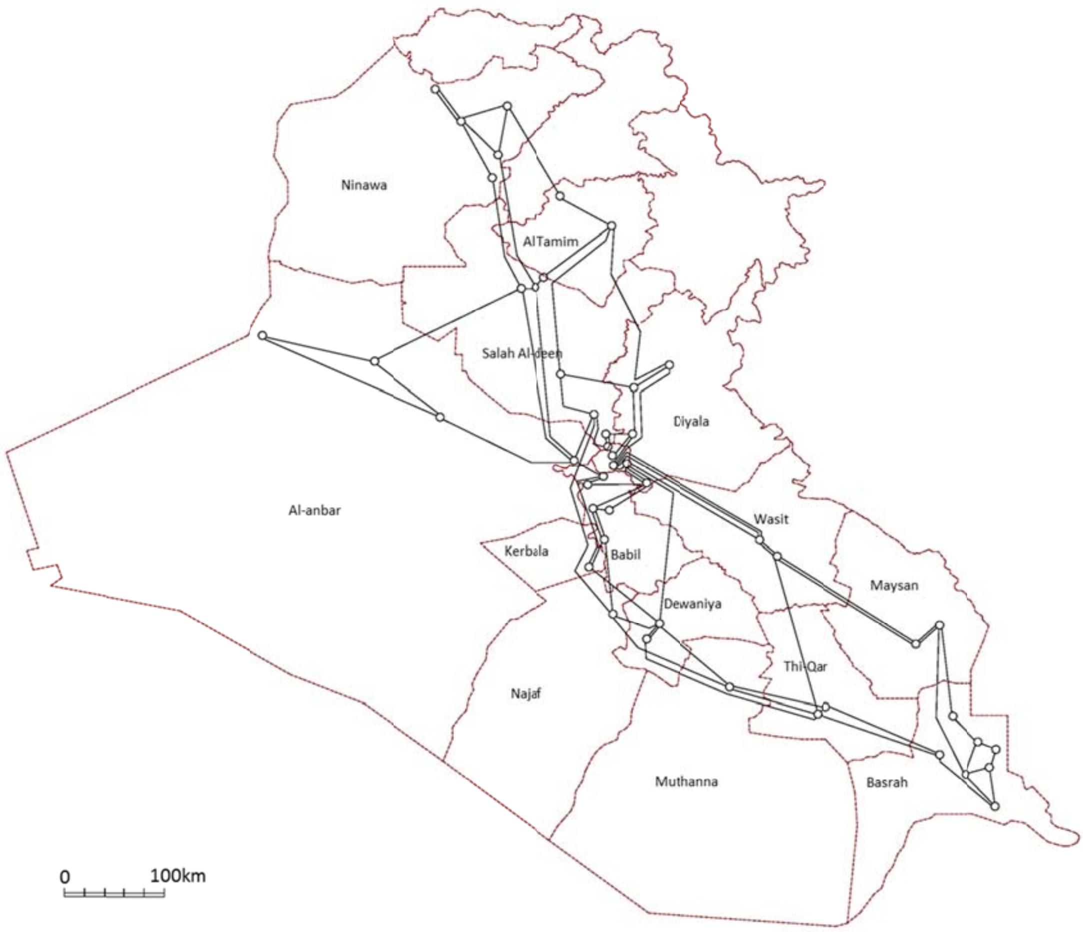
Figure 3.2.3 shows 400kV bulk power network as of 2012. Two 400kV single circuit transmission lines run between Basra and Baghdad with the length of about 500km transmitting power generated by the major power plants in southern Iraq.

Other two 400kV transmission lines run in northern Iraq with the length of about 400km between Mosil and Baghdad. The western line has two circuits and the eastern one is a single circuit. There are 3 circuits in total connecting North area system with Central area system.

Moreover, the Iraqi power system has been interconnected with Iranian power system by a 400kV single circuit transmission line at Diyala substation located in Central area.

(a) Transmission line

Table 3.2.3 shows the existing 400kV transmission lines. The total length of 400kV transmission lines reaches approximately 4,900km. The total transmission capacity of all 400kV lines is about 1,000MVA or 950MW power factor 0.95 assumed . This figure is considered relatively small.



Source : MoE

Figure 3.2.3 Power Network System in 2012

Table 3.2.3 Existing 400kV Transmission Line as of 2013

From	To	No. of circuit	Capacity per circuit (MVA)	Length (km)	From	To	No. of circuit	Capacity per circuit (MVA)	Length (km)
MSL	MMDH	1	1,000	63	BGE	AMN	2	1,000	41.8
MSL	MMDH	2	1,000	63	BGE	DAL	1	1,000	47
MSL	NYNG	1	1,000	104.88	BGN	QDSG	1	1,000	9.3
MSL	BAJP	1	1,000	183	BGN	QDSG	2	1,000	9.3
MSL	KRK	1	1,000	201	AMN	ZBDP	1	1,000	112
MMDH	MPSG	1	1,000	2.8	BGC	YSFP	1	1,000	30
MMDH	MPSG	2	1,000	2.8	DAL	IRAN-ZGRS0	1	1,000	324
NYNG	BAJP	1	1,000	79.12	KUT	ZBDP	1	1,000	80
BAJP	BAJG	1	1,000	1	KUT	NSRP	1	1,000	199.4
BAJP	BGW	1	1,000	223	KUT	AMR	1	1,000	229
BAJP	BGW	2	1,000	229	HDTH	QIM	1	1,000	128
BAJP	HDTH	1	1,000	159	QIM	TAYM	1	1,000	155.7
BAJG	KRK	1	1,000	92	MUSP	MUSG	1	1,000	5.5
KRK	BGE	1	1,000	222	MUSP	BAB	1	1,000	35.5
BGW	BGN	1	1,000	46	MUSP	BAB	2	1,000	35.5
BGW	BGC	1	1,000	39	BAB	KRTG	1	1,000	50
BGW	HDTH	1	1,000	223	BAB	KDS	1	1,000	101.4
BGS	AMN	1	1,000	51.3	KRTG	KDS	1	1,000	50
BGS	AMN	2	1,000	53.5	KDS	NSRP	1	1,000	176.9
BGS	YSFP	1	1,000	60	NSRP	RMLG	1	1,000	145
BGS	MUSP	1	1,000	53.5	KRKH	AMR	1	1,000	150
]BGS	MUSG	1	1,000	48	AMR	HRTP	1	1,000	134
BGS	KDS	1	1,000	140	HRTP	KAZG	1	1,000	54.5
BGE	BGN	1	1,000	13	KHORM-S	KAZG	1	1,000	110
BGE	QDSG	1	1,000	17.5	KAZG	RMLG	2	1,000	70
BGE	AMN	1	1,000	50	Total circuit length (km)				4,904

Source：PSS/E data of 2013 provided from MoE

(b) Substation

Table 3.2.4 shows the existing 400kV substations. The standard specification of the transformers is 400/132kV 250MVA. Each substation has 4 transformers as standard.

Table 3.2.4 Existing 400kV substation as of 2013

Substation name	Unit number	In Service ○ : In × : Out	Capacity (MVA)	Substation name	Unit number	In Service ○ : In × : Out	Capacity (MVA)
Mosul	1	○	250	Haditha	1	○	250
	2	○	250		2	○	250
	3	○	250	Qaim	1	○	250
	4	○	250		2	○	250
Rumaila	1	×	250	Musayab	1	○	250
	2	×	250		2	○	250
	3	×	250		3	×	250
	4	×	250		4	○	250
Baji	1	○	250	Babil	1	○	250
	2	○	250		2	○	250
Kirkuk	1	○	250		3	○	250
	2	○	250		4	○	250
	3	○	250	Kadisiya	1	○	250
	4	○	250		2	○	250
Baghdad West	1	○	250		3	○	250
	2	○	250		4	○	250
	3	○	250	Nasiriya	1	○	250
	4	○	250		2	○	250
Baghdad South	1	○	250		3	○	250
	2	×	250	Hartha	1	○	250
	3	○	250		2	○	250
	4	○	250	Nenava	1	○	250
Baghdad East	1	○	250		2	○	250
	2	○	250	Amara	1	○	250
	3	○	250		2	○	250
	4	○	250	Basra	1	×	250
Baghdad North	1	○	250		2	×	250
	2	○	250		3	×	250
	3	○	250		4	×	250
	4	×	250	Khor	1	○	250
Ameen	1	○	250		2	○	250
	2	×	250		3	○	250
	3	×	250		4	○	250
	4	○	250	Baghdad Center	1	○	250
Wasit	1	○	250		2	○	250
	2	○	250		3	○	250
Diyala	1	○	250		4	×	250
	2	○	250	Khairat	1	○	250
	3	○	250		2	○	250
	4	○	250				
Kut	1	○	250	Total (In-service)			16,750
	2	○	250	Total (Out-of-service)			3,500

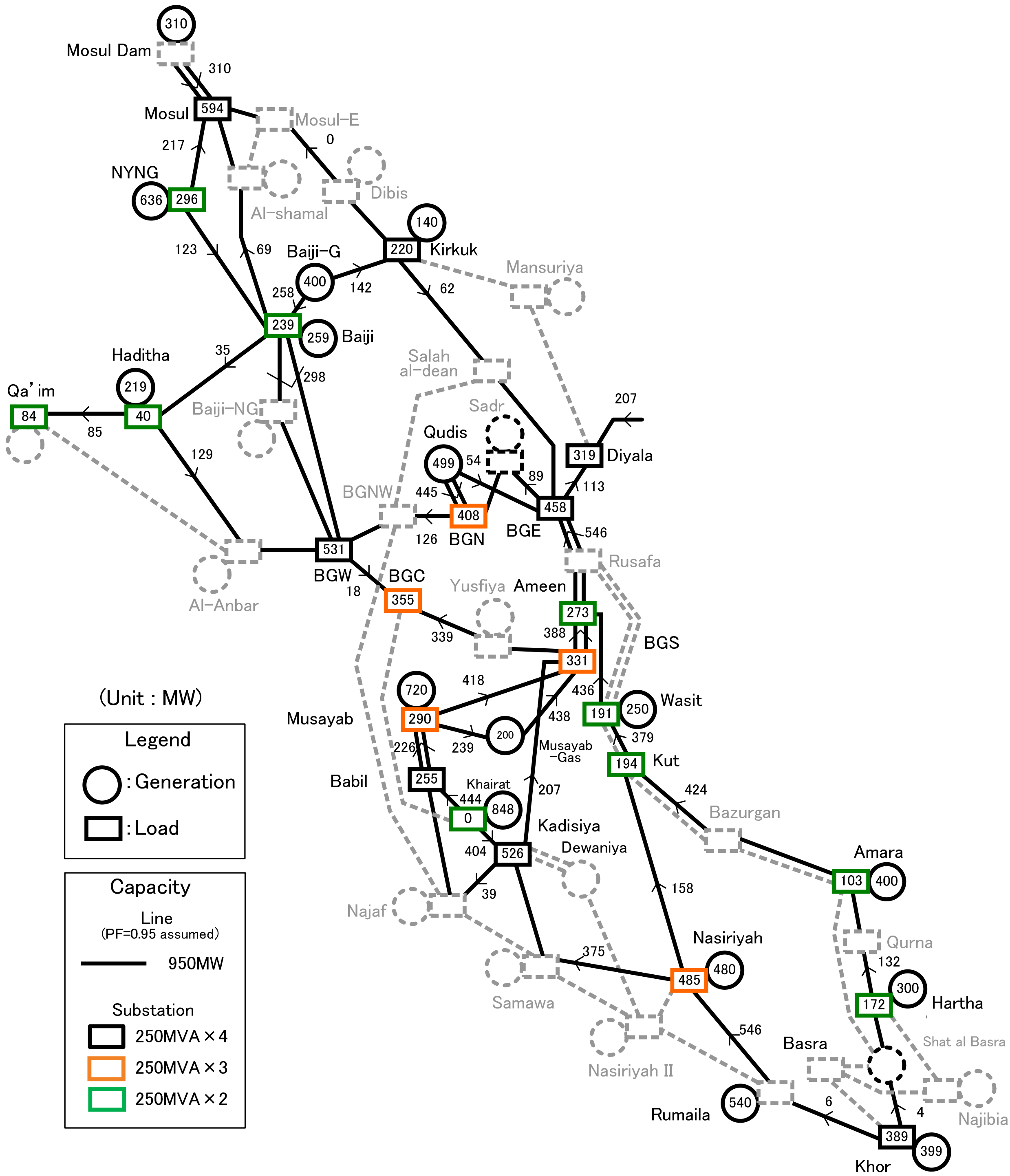
Source : PSS/E data of 2013 provided from MoE

(4) Power flow

Figure 3.2.4 shows power flow analysis results calculated based upon PSSE network data as of the year 2013 that was provided by MoE. Relatively large power flows are observed in Southern and South-western areas, where many power plants are located, to Central area, where a load center, Baghdad, is located. On the contrary, only small power flows are observed in Northern, Eastern and Western areas since demand and supply are almost balanced in each area power system. It’s noted that Iraq imports 207MW from Iran through the international transmission line.

The maximum power flow is 546MW in Rumaila-Nasiriyah line which figure is smaller than 950MW of the transmission line capacity.

In order to plan future networks, MoE applies N-1 criteria as described in its Grid Code as well as other countries. This is based on the concept that electricity should be supplied to customers, even if one unit in N units of facilities becomes outage due to fault occurrence. For transmission lines, in case that the circuit is suddenly opened after a fault occurs in one circuit, the problem like overload should be avoided in all other circuit, even if the power flow before the fault is bypassed to the other circuits.



Source : PSS/E data of 2013 provided from MoE

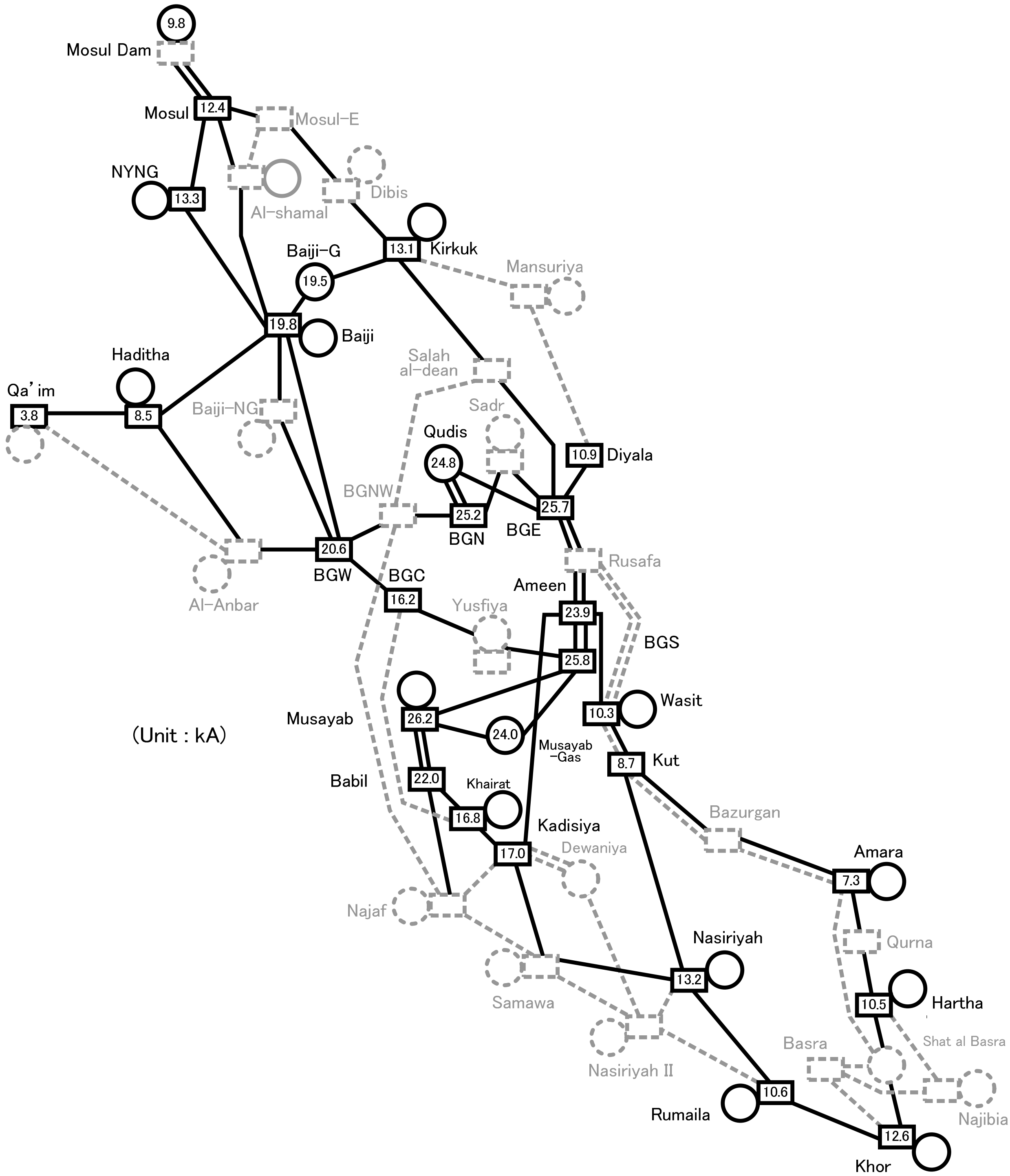
Figure 3.2.4 Power Flow of 400kV Network in 2013

(5) Fault current

Figure 3.2.5 shows the fault current analysis results. The maximum fault current in each area is as follows;

Baiji in Northern area: 19.8kA, Kirkuk in Eastern area: 13.1kA, Baghdad-South in Central area: 25.8kA, Haditha in Western area: 8.5kA, Musayab in South-west area: 26.2kA and Nasiryah in Southern area: 13.2kA.

Since there are many power plants and substations, relatively large fault currents are observed in Central area and South-west area. However, those are less than the rated breaking current of circuit breakers 40kA or 31.5kA. Therefore, it is judged there is no problem at present.



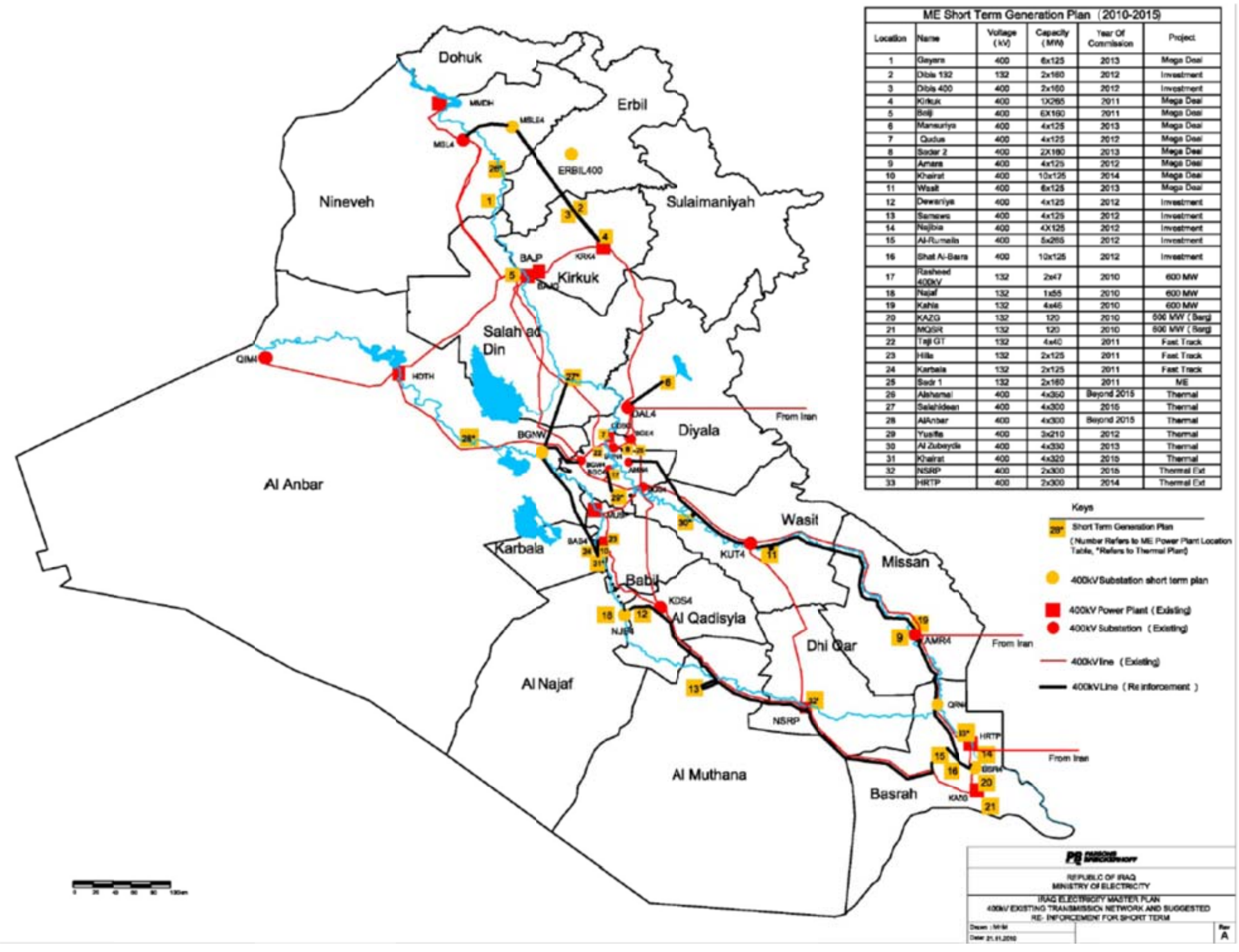
Source : PSS/E data of 2013 provided from MoE

Figure 3.2.5 Fault Current in 400kV Network in 2013

3.2.2 Power Development Master Plan

MoE prepared the Iraqi power development master plan (MP) in Dec. 2010. Figure 3.2.6 and Table 3.2.5 show both the power plant development plan and network expansion plan described in the MP. The total installed capacity to be developed from 2010 to 2015 is 20,293MW across the country. In particular, it is worth considering that Emara project (125MW x 4 units) in 2012, Nasiryah extension project (300MW x 2 units) in 2015, and Hartha extension project (300MW x 2 units) in 2014.

In the MP, 400kV transmission lines are planned to be upgraded in line with development of those power plants as shown in Table 3.2.5. Those upgrading projects will add 1,159km in length of the transmission line and 2,000MVA in transmitting capacity increasing the number of conductors from two to four as well as the number of circuits from one to two.



ME Short Term Generation Plan (2010-2015)

Location	Name	Voltage (kV)	Capacity (MW)	Year Of Commission	Project
1	Gayara	400	6x125	2013	Mega Deal
2	Dibis 132	132	2x160	2012	Investment
3	Dibis 400	400	2x160	2012	Investment
4	Kirkuk	400	1X265	2011	Mega Deal
5	Baiji	400	6X160	2011	Mega Deal
6	Mansuriya	400	4x125	2013	Mega Deal
7	Qudus	400	4x125	2012	Mega Deal
8	Sadar 2	400	2X160	2013	Mega Deal
9	Amara	400	4x125	2012	Mega Deal
10	Khairat	400	10x125	2014	Mega Deal
11	Wasit	400	6x125	2013	Mega Deal
12	Dewaniya	400	4x125	2012	Investment
13	Samawa	400	4x125	2012	Investment
14	Najibia	400	4X125	2012	Investment
15	Al-Rumaila	400	5x265	2012	Investment
16	Shat Al-Basra	400	10x125	2012	Investment
17	Rasheed 400kV	132	2x47	2010	600 MW
18	Najaf	132	1x55	2010	600 MW
19	Kahla	132	4x46	2010	600 MW
20	KAZG	132	120	2010	600 MW (Barg)
21	MQSR	132	120	2010	600 MW (Barg)
22	Taji GT	132	4x40	2011	Fast Track
23	Hilla	132	2x125	2011	Fast Track
24	Karbala	132	2x125	2011	Fast Track
25	Sadr 1	132	2x160	2011	ME
26	Alshamal	400	4x350	Beyond 2015	Thermal
27	Salahideen	400	4x300	2015	Thermal
28	AlAnbar	400	4x300	Beyond 2015	Thermal
29	Yusifia	400	3x210	2012	Thermal
30	Al Zubaydia	400	4x330	2013	Thermal
31	Khairat	400	4x320	2015	Thermal
32	NSRP	400	2x300	2015	Thermal Ext
33	HRTP	400	2x300	2014	Thermal Ext

Source : Iraq Electricity Master Plan Dec. 2010 by Parsons Brinckerhoff

Figure 3.2.6 Power Network Expansion Plan

Table 3.2.5 400kV Reinforcement Requirement

(km)

Line specification	Capacity per circuit (MVA)	2010	2011	2012	2013	2014	2015	Total
1 circuit, 4 conductors	>2000	0	0	220	0	0	0	220
2 circuits, 4 conductors	>2000	0	0	0	0	0	230	230
1 circuit, 2 conductors	1000	0	0	663	0	0	0	663
2 circuits, 2 conductors	1000	0	0	46	0	0	0	46
Total								1,159

Source ：Iraq Electricity Master Plan Dec. 2010 by Parsons Brinckerhoff

3.2.3 Latest Power Development Plan

MoE itself has modified its MP in 2012 reflecting changes of the circumstances and has formulated the power development plan of year 2020.

(1) Demand
Table 3.2.6 shows the forecasted demand, total demand of base case will increase steadily with growth rate of 10.0%, and reach 21,300MW in 2020.

Table 3.2.6 Demand Forecast

Year	2012	2013	2020	Growth rate (2012-2020)
Demand (MW)	9,930	11,011	21,300	10%

Source ：PSS/E data of 2013 provided from MoE

(2) Power Development
Table 3.2.7 and Table 3.2.8 show the power supply in 2013 and 2020 each. Since some power generation plants may not satisfy the rated output because of time-related deterioration or failures, this point is considered to show the maximum possible output.
The total of the power supply in 2020 is 30,636MW; i.e. 1.71 times of 17,956MW in 2013.
In addition, the ratio of it to the demand is 1.63 times (=17,956/11,011) in 2013 and 1.44 times (=30,636/21,300) in 2020.

Table 3.2.7 Power Plant in 2013

Area	Name	Max Output (MW)	Area	Name	Max Output (MW)
North	HMS	45	West	HHD	330
	GML	240		DSHD	161
	HMM	494		FLJH	30
	GNYN	810		Sub-total	521
	DSMR	204	South-west	SMB	1,200
	SBJ	420		GH1	355
	HSM	84		HIL-GE	270
	GBG	636		KRG	270
	BLDH	30		KHG	1,080
	Sub-total	2,963		KED	300
East	GDL	111		GNNJF	270
	GKR	65		GNF	126
	GMU	240		DEWD	400
	GNM	111		Sub-total	4,271
	GKR	259	South	GSM	35
	Sub-total	786		DSM	28
Central	DBGN	23		SNS	840
	GTA	120		GNS	40
	SDO	636		GBZ	40
	GDO	150		PRATAMR	188
	SSB	165		AMND	200
	GQD	939		GBZ	120
	GBGS	280		GKA	252
	GQD	135		GPT	40
	TAJ-GE	160		GSH	80
	GQD	540		SNJ	200
	GSDR	320		SHR	400
	IDORH	30		GKA	270
	FRBH	30		KARKAZ	246
	JDRH	30		MA'KIL	246
	BGNH	60		GEN	123
	KDMH	30		GRM	584
	HHM	25		HQRN	60
	ZPP	330		Sub-total	3,992
	Sub-total	4,003	Iran	IRAN	1,420
			Grand Total		17,956

Source ：PSS/E data of 2013 provided from MoE

Table 3.2.8 Power Plant in 2020

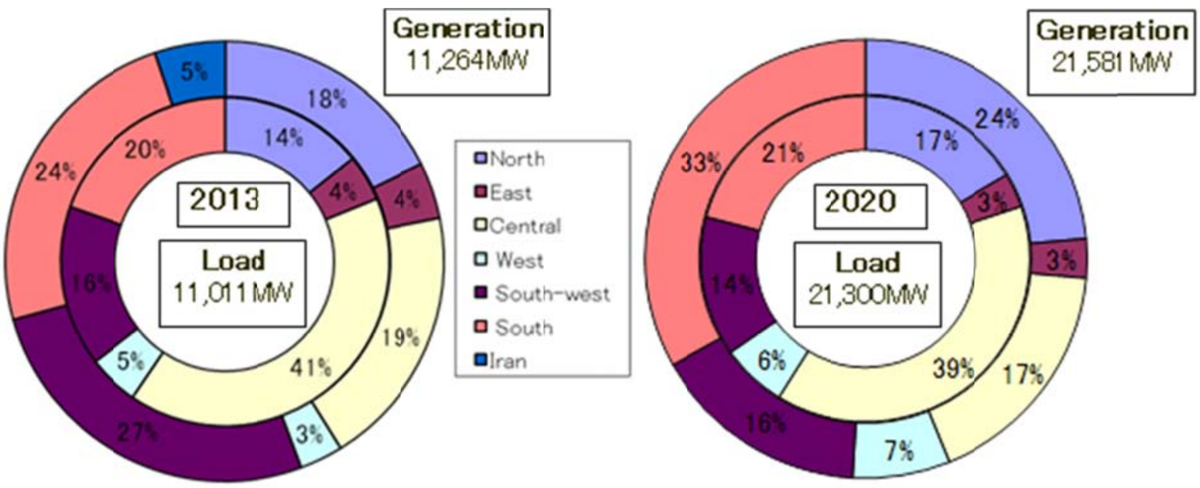
Area	Name	Max Output (MW)	Area	Name	Max Output (MW)
North	NYG	1,215	South-west	SMB	1,200
	SHP	1,400		GMB	500
	HMM	374		KHG	2,025
	SBJ	1,100		HDG	540
	GBG	636		DNG	750
	GNBJ	1,521		Sub-total	5,015
	SDP	1,200	South	SMG	750
	Sub-total	7,446		SNS	840
East	GKR	584		NSG	1,800
	GDBS	507		AMG	810
	Sub-total	1,091		HRTP	400
Central	GQD	1,522		SHTG	1,620
	SDG	507		SHR	400
	YFP	630		GKA	135
	MNG	720		SHTG	405
	ZBP	2,115		NJBG	810
	Sub-total	5,494		RLG	1,460
West	AZG	270		Sub-total	9,430
	ANG	1,890			
	Sub-total	2,160	Grand Total		30,636

Source : PSS/E data of 2020 provided from MoE

(3) Areal Demand and Suplly Balance

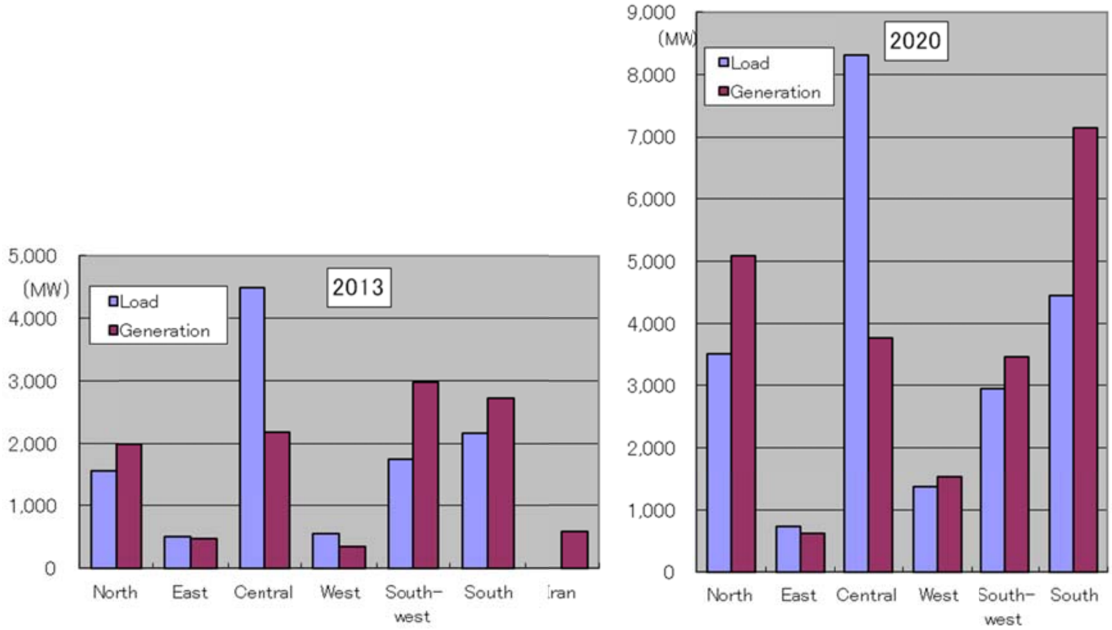
Figure 3.2.7 and Figure 3.2.8 show Areal Demand and Supply Balance in 2013 and 2020 each.

When attention is paid to the areal ratio of the demand, that of the Central area is 41% in 2013 and 39% in 2020 and that of the South area is 20% in 2013 and 21% in 2020; i.e. there is no great difference between years. On the other hand, the power supply of the Central area is 19% in 2013 and 17% in 2020; i.e. it decreases gradually and that of the South area is 24% in 2013 and 33% in 2020; i.e. it increases. Therefore, the role of the South area as the power supply area increases and the power flow toward the north from the South area to the Central area (demand center) is prominent.



Source : PSS/E data of 2013 and 2020 provided from MoE

Figure 3.2.7 Areal Demand and Suplly Balance



Source : PSS/E data of 2013 and 2020 provided from MoE

Figure 3.2.8 Areal Demand and Suplly Balance

3.3 Network Reinforcement Plan

3.3.1 Network Reinforcement Plan

To take measures for increased demand and power supply reinforcement, MoE plans to reinforce network facilities for mainly 400kV.
Table 3.3.1 shows the transmission lines in 2020. To transmit the power generated by the South area to the Central area (demand center), the existing transmission lines with single circuit from the South area to the Central area will be doubled. It allows the 400kV transmission line to increase from 4,904km in 2013 to 6,492km; i.e. about 1.3 times.
Table 3.3.2 shows the substation facilities in 2020. To take measures for increased demand, the 400/132kV substations as the supply center in each area are planned to be reinforced; i.e. from 23 substations in 2013 (excluding Basra and Rumaila substations under suspension) to 42 substations and the total of the transformer capacity is planned to be increased from 16,750MVA to 33,000MVA (almost doubled). In addition, 26 substations of 42 sites will be established in the power stations.
Table 3.3.3 shows the facility amount in 2013 and 2020, and Figure 3.3.1 shows the network reinforcement plan diagram.

Table 3.3.1 400kV Line in 2020

From	To	No. of circuit	Capacity per circuit (MVA)	Length (km)	From	To	No. of circuit	Capacity per circuit (MVA)	Length (km)
MSE	SHMP	1	1,000	70	BGC	YSFP	1	1,000	30
MSE	MSL	1	1,000	50	BGC	KRTG	1	1,000	80
MSE	DBSG	3	1,000	120	DAL	MNSR	1	1,000	60
SHMP	MSL	2	1,000	70	ZBDP	KUT	1	1,000	20
SHMP	BAJP	1	1,000	176	ZBDP	KUT	2	1,000	20
NYNG	MSL	1	1,000	104.88	KUT	NSRG	1	1,000	200
NYNG	NBJG	1	1,000	79.12	KUT	BZRG	1	1,000	190
MSL	MMDH	1	1,000	63	KUT	BZRG	2	1,000	190
MSL	MMDH	2	1,000	63	KDTH	QIM	1	1,000	128
BAJP	BAJG	1	1,000	1	HDTH	ANBG	1	1,000	100
BAJP	NBJG	1	1,000	15	QIM	ANBG	2	1,000	128
BAJP	BGW	1	1,000	223	MUSP	MUSG	1	1,000	5.5
BAJG	KRK	1	1,000	83	MUSP	BAB	1	1,000	35.5
NBJG	BGW	1	1,000	242	MUSP	BAB	2	1,000	35.5
NBJG	HDTH	1	1,000	151	BAB	KRTG	1	1,000	50
SLDP	KRK	1	1,000	230	BAB	KYDG	1	1,000	100
SLDP	BNW	2	1,000	80	KRTG	KDS	1	1,000	50
SLDP	DAL	1	1,000	90	HYDG	KDS	1	1,000	104.88
DBSG	KRK	1	1,000	55	HYDG	SMWG	1	1,000	140
KRK	MNSR	1	1,000	140	DWNG	KDS	1	1,000	12
RSF	BGE	1	2,774	20	DWNG	KDS	2	1,000	12
RSF	AMN	1	1,000	20	DWNG	NSRG	1	1,000	176
RSF	MNSR	1	1,000	120	KDS	SMWG	1	1,000	104.88
RSF	ZBDP	1	1,000	120	SMWG	NSRG	1	1,000	100
RSF	ZBDP	2	1,000	120	SMWG	NSRP	3	1,000	100
BGW	BNW	1	1,000	10	NSRG	NSRP	1	1,000	1
BGW	BGC	1	1,000	28.5	NSRG	RMLG	3	1,000	145
BGW	ANBG	1	1,000	100	NSRP	RMLG	1	1,000	145
BGS	AMN	1	1,000	38	AMR	BZRG	1	1,000	30
BGS	AMN	2	1,000	38	AMR	BZRG	2	1,000	30
BGS	YSFP	1	1,000	60	AMR	SHTG	1	1,000	150
BGS	MUSP	1	1,000	53.5	AMR	QRN	1	1,000	80.4
BGS	MUSG	1	1,000	48	RMLG	KAZG	2	1,000	70
BGE	QDSG	1	1,000	30	SHTG	BSR	2	1,000	54
BGE	SDRG	1	1,000	15	SHTG	HRTP	1	1,000	25
BGE	DAL	3	1,000	40	SHTG	KAZG	1	1,000	30
BNW	BGN	1	1,000	30	BSR	NJBG	1	1,000	10
BNW	HYDG	1	1,000	140	BSR	KAZG	1	1,000	15
BGN	QDSG	1	1,000	7	QRN	HRTP	1	1,000	53.6
BGN	QDSG	2	1,000	7	HRTP	NJBG	1	1,000	15
BGN	SDRG	1	1,000	15					
AMN	ZBDP	1	1,000	140					
AMN	KDS	1	1,000	160	Total circuit length (km)				6,492

Source ：PSS/E data of 2020 provided from MoE

Table 3.3.2 400kV Substation in 2020

Station Name		No. of Transfor-mers	Capacity (MVA)	Type*	Station Name		No. of Transfor-mers	Capacity (MVA)	Type*
MSL	Mosul	4	1,000	S	ZBDP	Wasit	2	500	P
MSE	Mosul East	4	1,000	S	KUT	Kut	2	500	S
SHMP	Al-Shamal	2	500	P	HDTH	Haditha Dam	3	750	P
NYNG	Nenava	2	500	P	QIM	Qai'm	3	750	P
MMDH	Mosul Dam	2	500	P	ANBG	Al-Anbar	2	500	P
BAJP	Baiji	4	1,000	P	MUSP	Musayab	4	1,000	P
NBJG	Baiji New	2	500	P	BAB	Babil	4	1,000	S
SLDP	Salah Al Dean	2	500	P	KRTG	Khairat	4	1,000	P
DBSG	Dibis	2	500	P	HYDG	Najaf	4	1,000	P
KRK	Kirkuk	4	1,000	P	KDS	Kadisiya	4	1,000	S
RSF	Rusafa	4	1,000	S	SMWG	Samawa	3	750	P
BGW	Bagdad West	4	1,000	S	NSRG	Nasiriya-gas	2	500	P
BGS	Bagdad South	4	1,000	S	NSRP	Nasiriya	4	1,000	P
BGE	Bagdad East	4	1,000	S	AMR	Amara	3	750	P
BNW	Bagdad North West	4	1,000	S	RMLG	Rumaila	4	1,000	P
BGN	Bagdad North	4	1,000	S	BSR	Basra	4	1,000	S
AMN	Al-Ameen	4	1,000	S	QRN	Qurna	4	1,000	S
SDRG	Sadr City	2	500	P	HRTP	Hartha	1	250	P
BGC	Bagdad Center	4	1,000	S	NJBG	Najibiya	2	500	P
YSFP	Yusfiya	2	500	P	KAZG	Khor Zubayr	3	750	P
DAL	Diyala	4	1,000	S					
MNSR	Mansuriya	2	500	P	Total			33,000	

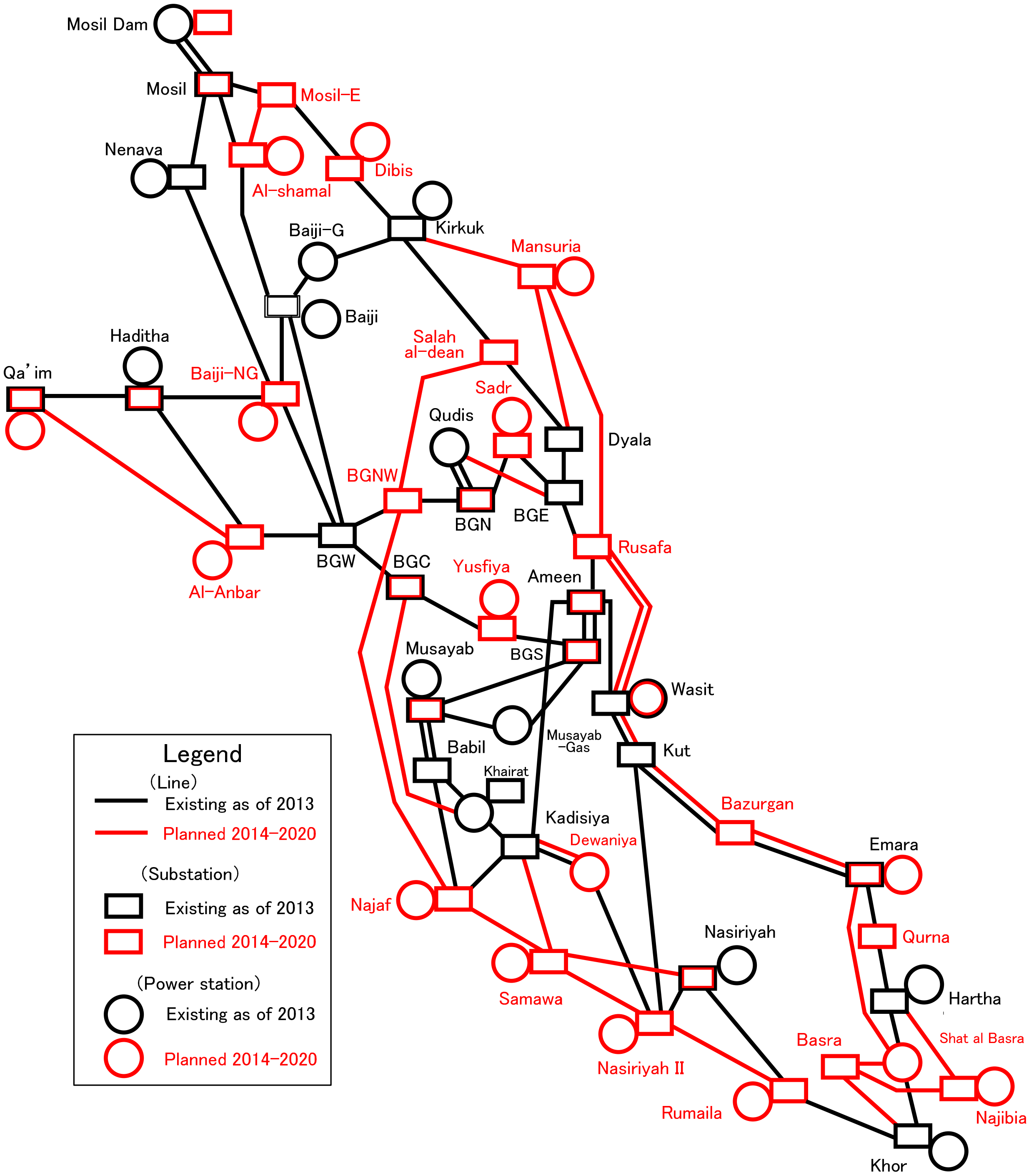
*: S: Substation P: Substation installed in the power station

Source : PSS/E data of 2020 provided from MoE

Table 3.3.3 400kV Facilities

	Year	2013	2020	2014 – 2020
Transmission line	Circuit length (km)	4,904	6,492	1,588
Substation	Number of stations	23	42	19
	Total capacity (MVA)	16,750	33,000	16,250

Source : PSS/E data of 2020 provided from MoE



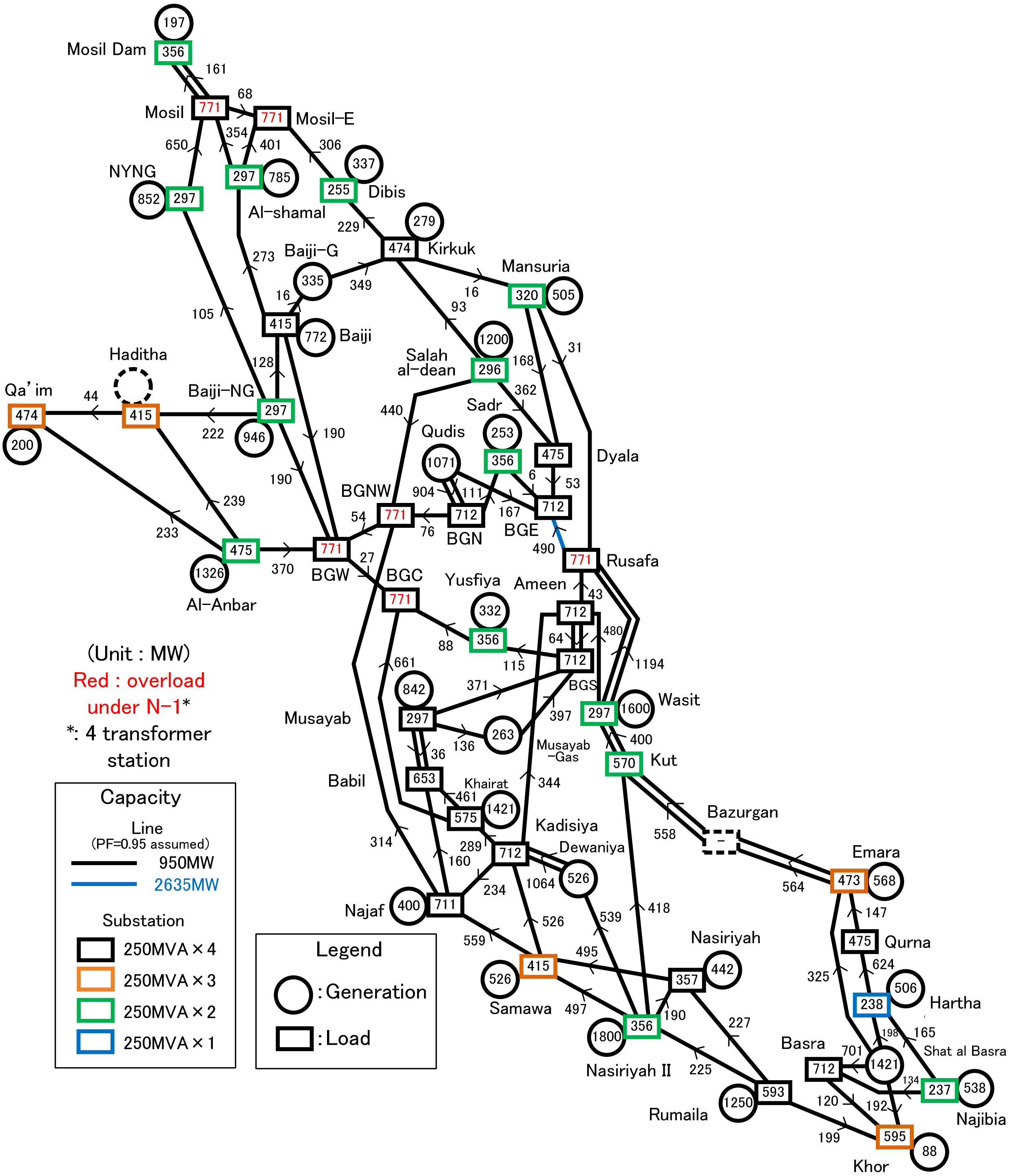
Source : PSS/E data of 2020 provided from MoE

Figure 3.3.1 Network Reinforcement Plan

3.3.2 Power Flow

Figure 3.3.2 shows the power flow in 2020 which reflects MoE's power development plan and network reinforcement plan. In this figure, the number of 400/132kV 250MVA transformers in the substation; i.e. 4, 3, 2, and 1 is indicated by the color of black, orange, green, and blue each. In addition, the red character indicates the power flow of the substation where the overloaded flow exceeds 712MW (the

power factor is assumed to be 0.95; = 250 × 3 × 0.95) when 4 transformers (final stage) in the substation decreases to 3 because of an accident or failure considering N-1 criteria.
Six (6) substations are overloaded by the condition N-1; Mosil and Mosil-E substations in the North area and Baghdad West (BGW), Baghdad North-West (BGNW), Baghdad Central (BGC), and Rusafa substations in the Central area. In addition, the heavy-loaded substation (not overloaded (712MW or less) by the condition N-1 but exceeding 700MW) is expected to be overloaded in the near future considering 10% of the annual growth rate of the demand, and therefore measures are required.
When attention is paid to the transmission line power flow, the demand and supply balance is properly kept in each area and transmission lines which connect the South area (power supply area) and the Central area (demand center) are reinforced (4 lines including East route and West route); therefore, the power flow of each transmission line is relatively small and any transmission line is not overloaded.

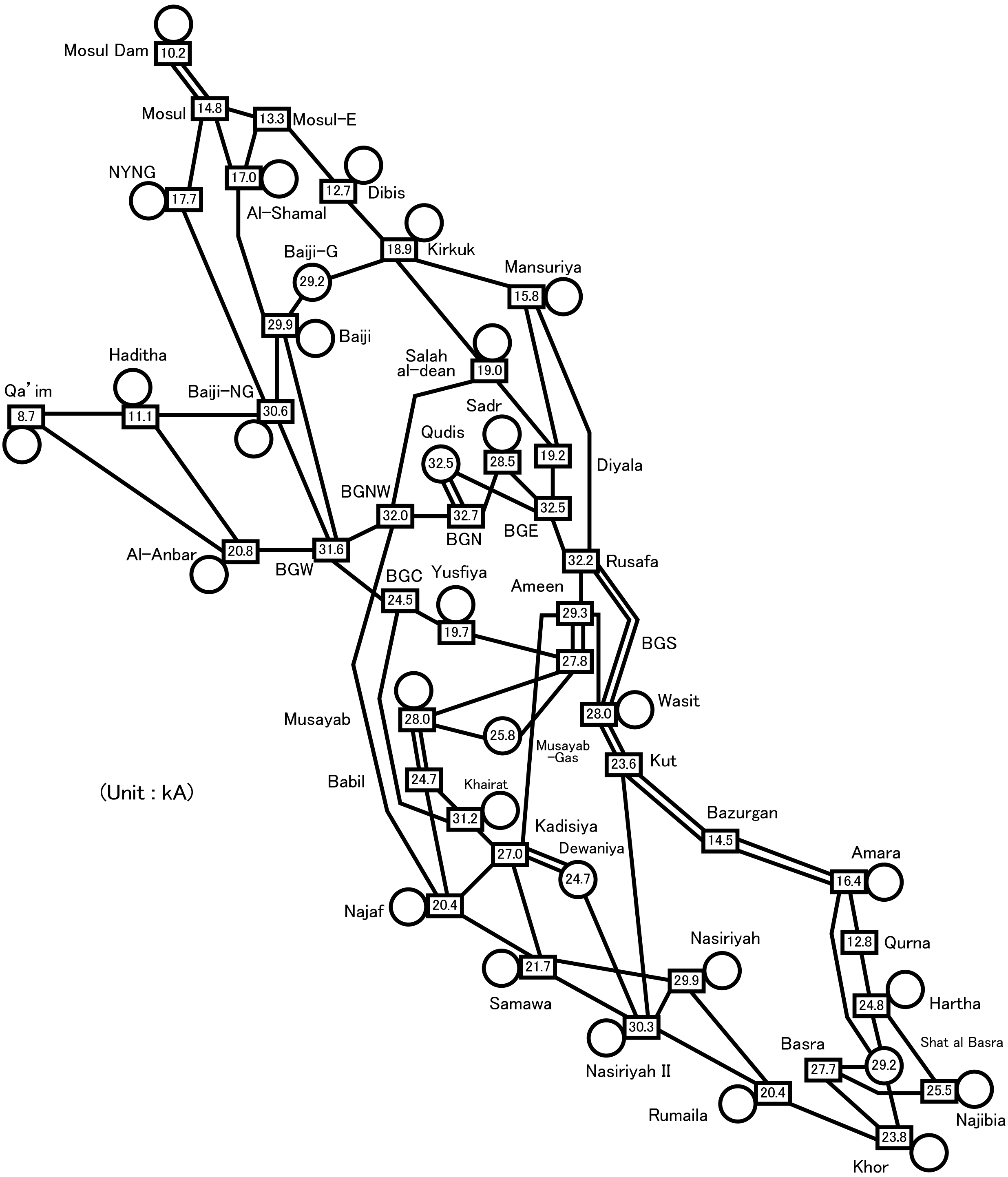


Source : PSS/E data of 2020 provided from MoE

Figure 3.3.2 Power Flow in 2020

3.3.3 Fault Current

Figure 3.3.3 shows the fault current in 2020. The maximum value is 32.7kA of Baghdad-North in the Central area, and the fault currents of almost all substations in the Central area are large nearly 30kA. Moreover, the values of substations in the South area on which power supply is concentrated are relatively large (30.3kA of Nasiriyah II). However, there is no problem in each area because the maximum permissible value of 40kA is not exceeded.



Source : PSS/E data of 2020 provided from MoE

Figure 3.3.3 Fault Current in 2020

3.4 Evaluation of Candidate Substations

Evaluation is performed by 8 candiadte substations based on new establishments which are desired by MoE in the power supply aspect and technical aspect.

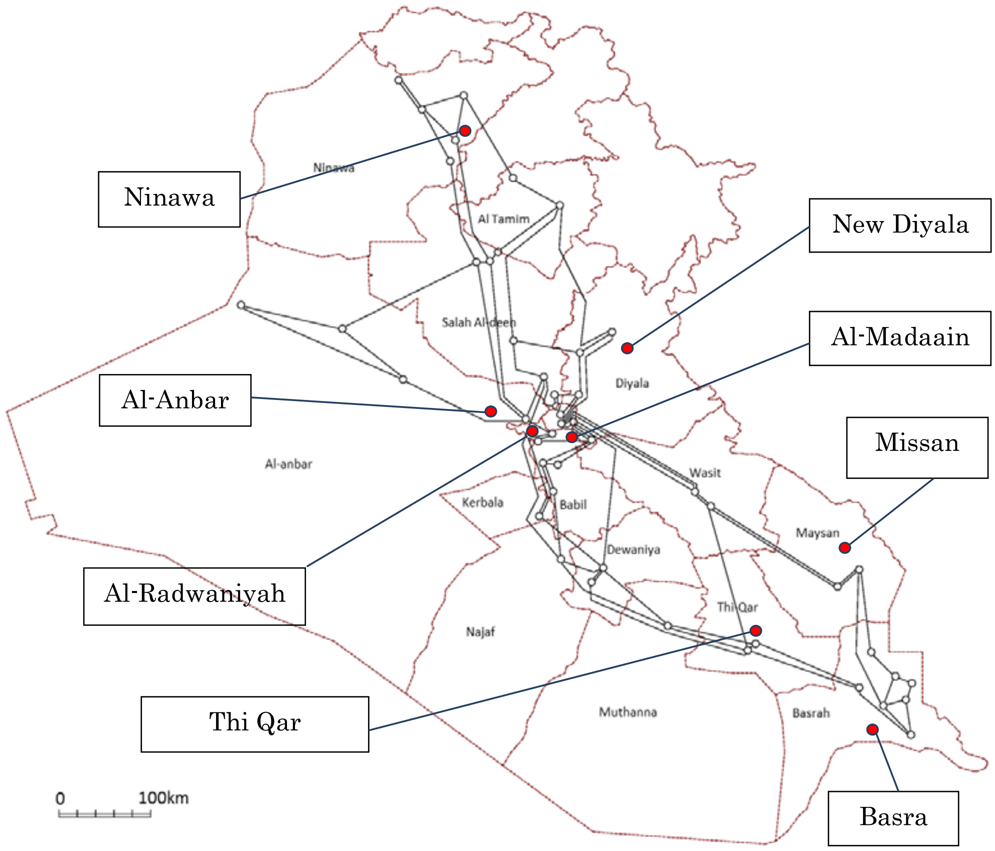
3.4.1 Candidate Substations

Table 3.4.1 and Figure 3.4.1 show the candidates for newly-established substations presented by MoE.

Table 3.4.1 Candidate Substations

Substation Name	Governorate Name	Candidate Substations	
		Latitude	Longitude
Ninawa	Ninawa	36° 08' 15.32"N	43° 23' 47.24"E
AI-Radwaniyah	Baghdad	33° 15' 00.77"N	44° 06' 56.12"E
Al-Madaain	Baghdad	33° 10' 51.99"N	44° 30' 52.82"E
Anbar	Anbar	33° 21' 49.80"N	43° 36' 22.81"E
New Diyala	Diyala	33° 57' 39.09"N	44° 55' 51.29"E
Thi Qar	Thi Qar	31° 08' 00.98"N	46° 25' 44.94"E
Missan	Missan	31° 53' 30.04"N	47° 06' 44.12"E
AI-Fayha'	Basra	30° 05' 05.67"N	47° 48' 04.49"E

Source : MoE



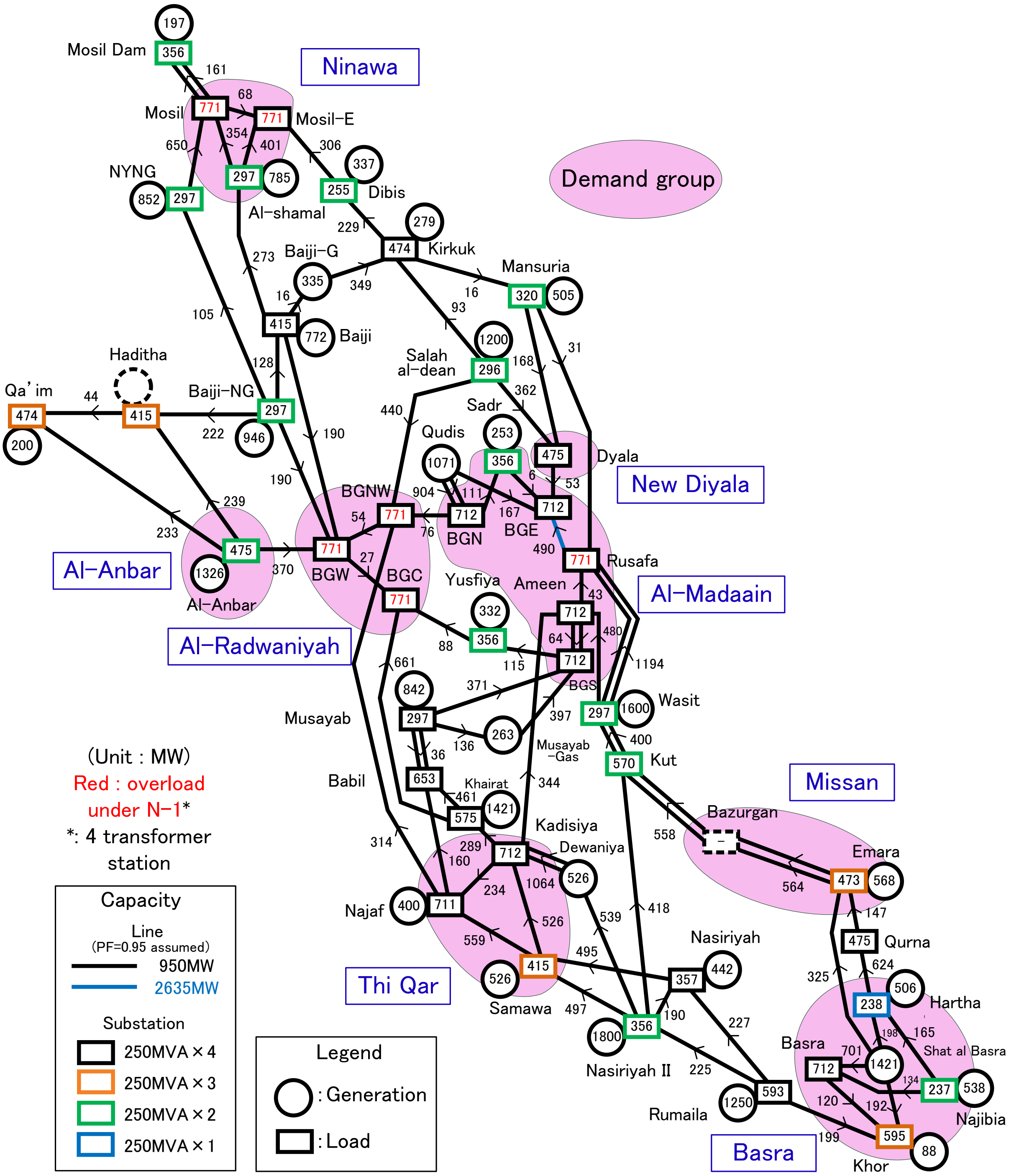
Source : MoE

Figure 3.4.1 Candidate Substations

3.4.2 Power distribution area covered by the Candidate Substations

The main purpose of substations which are desired by MoE as 8 candidates is to improve the heavy-loaded or the overloaded status of the existing substations. Therefore, substations about 100km away from the candidate substation are considered as one demand group.

Figure 3.4.2 shows the demand groups drawn on the 2020 power flow diagram. It shows that demand groups (excluding parts of them) include heavy-loaded or overloaded substations.



Source : by the Survey Team based on PSS/E data of 2020 provided from MoE

Figure 3.4.2 Demand Group for Candidate Substations

3.4.3 Expected Load of Planned Substation

The final scale of the existing substations is 1,000MVA; i.e. four 250MVA transformers. On the other hand, to take measures for increased demand and expanded system scale, 500MVA of the transformer standard capacity in future is adequate. In addition, the transformer should be added when the load is increased from the economical viewpoint and the number of transformers when starting operation should be 2 assuming that one transformer stops because of a failure (N-1 condition). Therefore, the scale of all the existing and newly-established substations is 1,000MVA and the load when the candidate substation starts the operation is expected to be obtained by dividing the total load in the group by the number of substations in the group.
Table 3.4.2 shows the expected load of the candidate substation in each demand group obtained by this idea.
The maximum total load of the demand group is 3,975MW for Al-Madaain which includes existing 6 substations (BGN, Sadr, BGE, Rusafa, Ameen, and BGS) in Baghdad city (demand center) and the expected load of candidate substation is 568MW.

Table 3.4.2 Expected Load of Candidate Substation in 2020

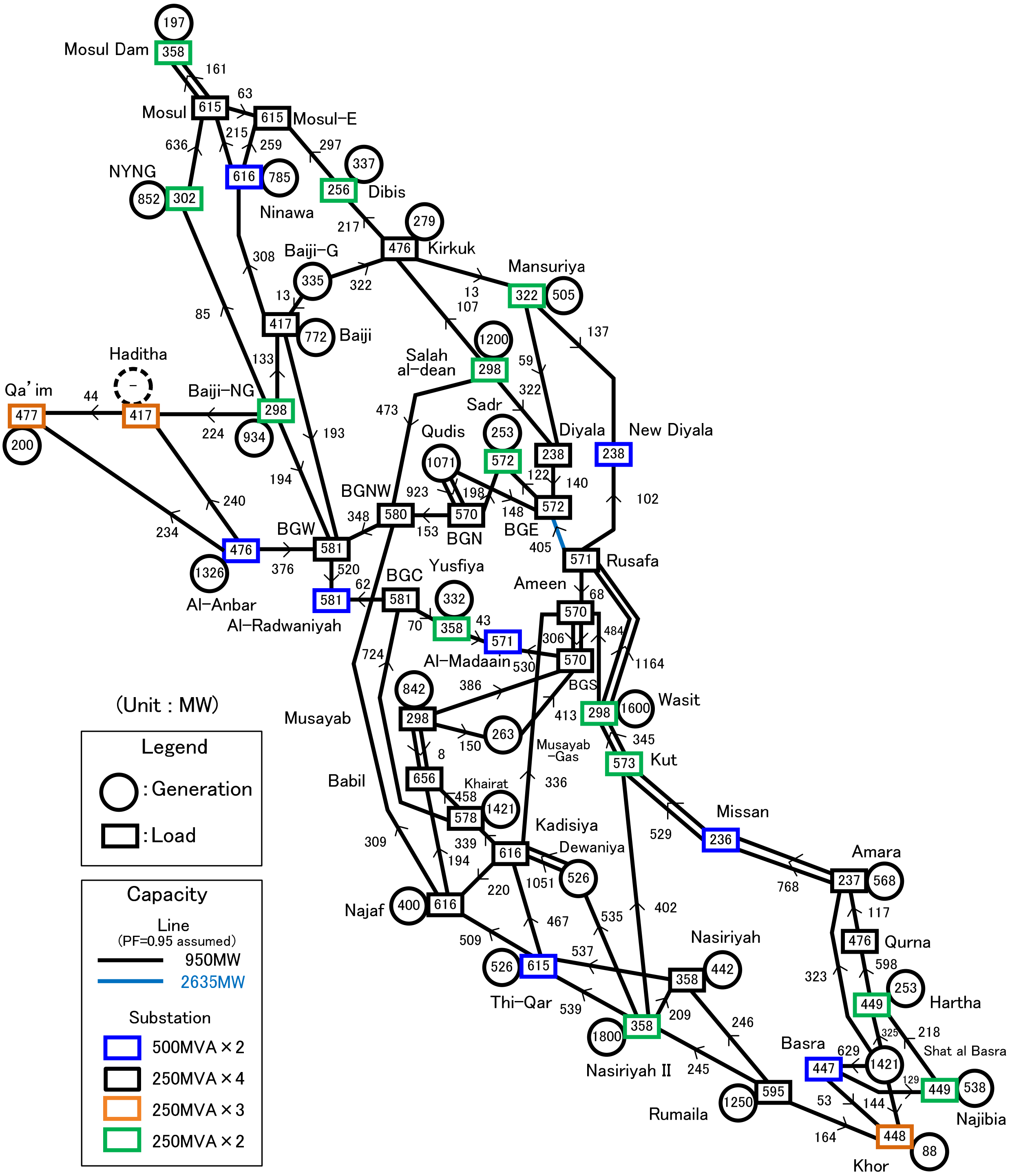
Planned Substations for supplying area	Substation in the group area	Total load (MW)	Expected load of candidate substation* (MW)	Registered substation in PSSE
Ninawa	Mosil, Mosil-E Al-Shamal	1,839	613	Al-Shamal (Ninawa)
Al-Anbar	Al-Anbar	475	475	Al-Anbar
Al-Radwaniyah	BGW, BGNW BGC	2,313	578	-
Al-Madaain	BGN, Sadr BGE, Rusafa, Ameen, BGS	3,975	568	-
New Diyala	Diyala	474	237	-
Thi-Qar	Samawa Najaf, Kadisiya	1,838	613	Samawa (Thi-Qar)
Missan	Emara	473	237	-
Basra	Basra, Hartha Najibia, Khor	1,782	446	Basra

*: (Total load)／(Number of substations)

Source：by the Survey Team based on PSS/E data of 2020 provided from MoE

3.4.4 Power Flow after Candidate Substation Developed

Figure 3.4.2 shows the result of the power flow analysis using the value obtained in the previous chapter as the load of the substations in the group (including the candidate).
Since the substations are newly established for heavy-load and overload measures, there is no overloaded substation; i.e. it can be confirmed that the measures are effective. In addition, since only load distribution among the substations in the group is changed, the power flows in transmission lines do not change greatly.



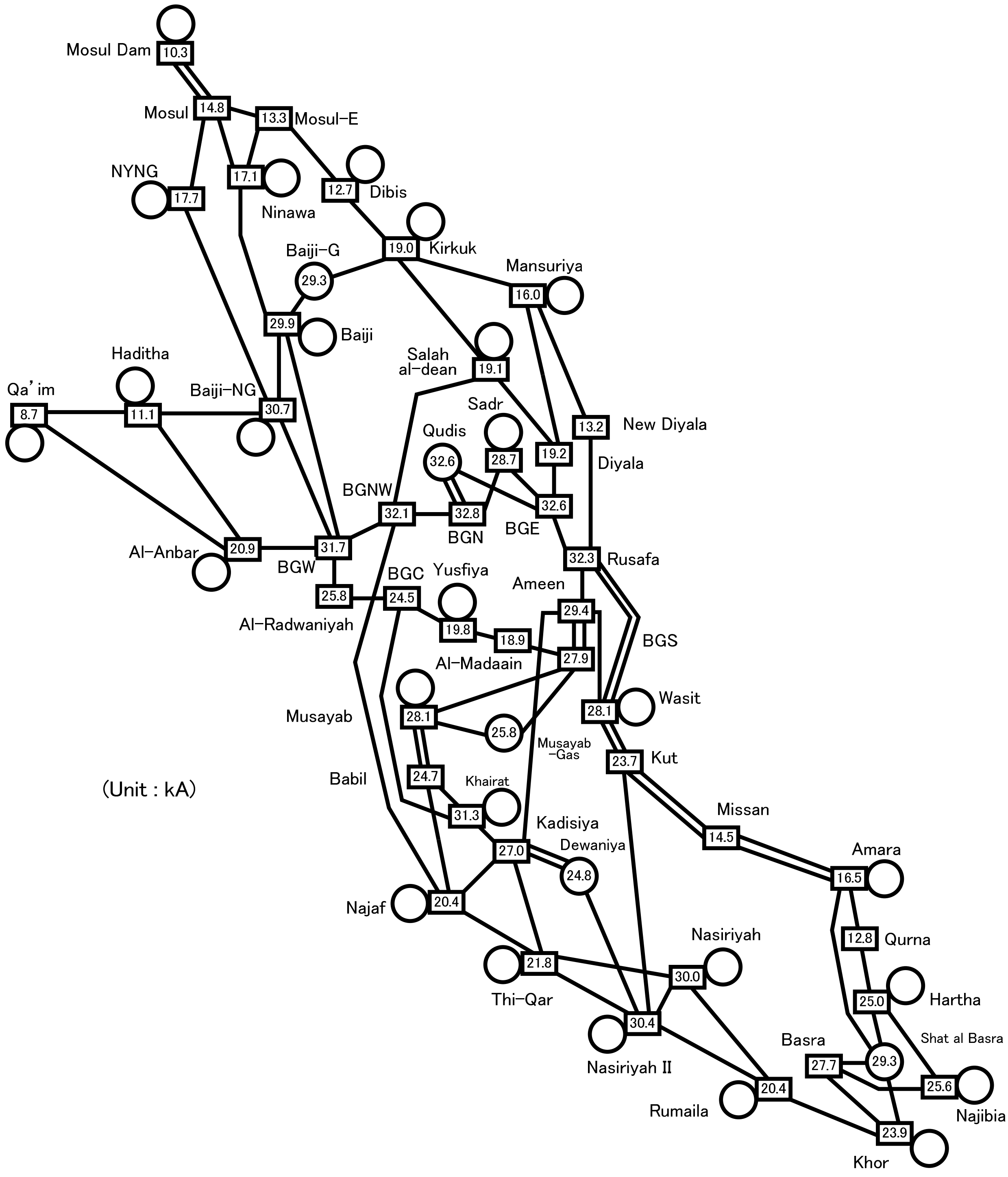
Source : by the Survey Team based on PSS/E data of 2020 provided from MoE

Figure 3.4.3 Power Flow after Candidate Substation Developed

3.4.5 Fault Current after Candidate Substation Developed

Figure 3.4.4 shows the fault current after Candidate substation developed in 2020. The maximum value is 32.8kA of BGN in the Central area, and the fault currents of almost all substations in the Central area are nearly 30kA.
Table 3.4.3 shows the fault current of candidate substations in 2020.
The largest value 27.7kA and the second large 25.8kA among candidate substations are recorded in Basra

and Al-Radwaniyah respectively.



Source : by the Survey Team based on PSS/E data of 2020 provided from MoE

Figure 3.4.4 Fault Current after Candidate Substation Developed

Table 3.4.3 Fault Current of Candidate Substation in 2020

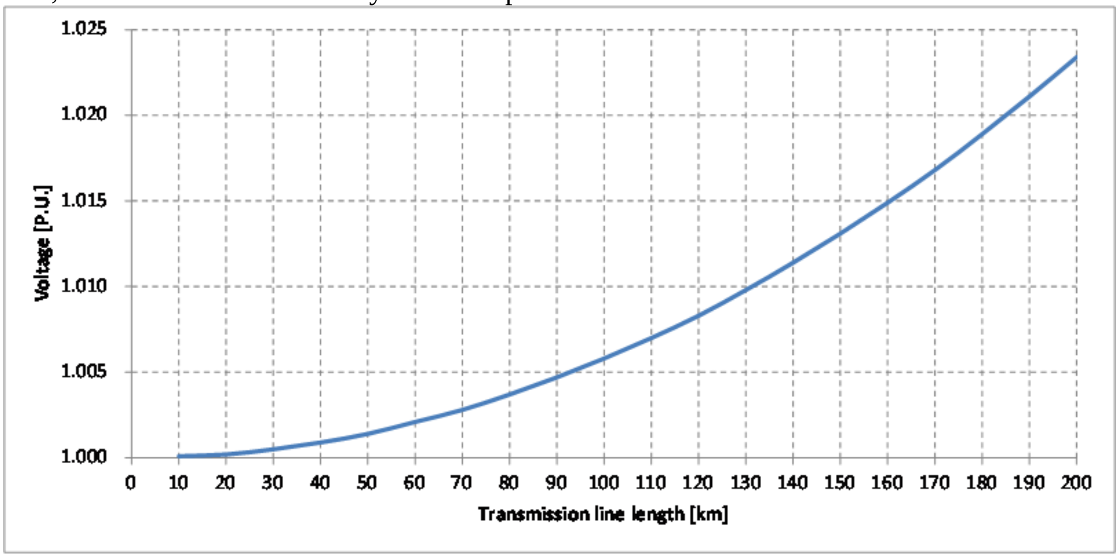
Candidate substation	Fault current (kA)
Al-Madaain	18.9
Al-Radwaniyah	25.8
Basra	27.7
New Diyala	13.2
Missan	14.5
Ninawa	17.1
Al-Anbar	20.9
Thi-Qar	21.8

Source : by the Survey Team based on PSS/E data of 2020 provided from MoE

3.4.6 Necessity of Shunt Reactor in Candidate Substation

When a long transmission line is charged without load, there is possibility that the voltage at the open end may exceed the maximum design voltage, because the large admittance of the line causes voltage rise.
Moreover, in the case of low load of transmission line, the reactive power loss in the line caused by reactance component of line is smaller than the reactive power charge caused by admittance component of line. As a result, the network voltage rises and generators are forced to operate in the condition of lead phase not lag phase, and the network stability gets worse.
For this reason, paying attention to the voltage rise of line without load and reactive power balance in the line, a necessity of 400kV reactor is studied.

(1) Open end voltage in the case of charging 400kV line without load
Figure 3.4.5 shows the open end voltage in the case of charging line at the sending end by 1.0pu (400kV) without load.
The open end voltages of line with length of 100km and 200km are 1.006 pu (100.6%) and 1.023 pu (102.3%) respectively, and the values of voltage rise are relatively small 0.6% and 2.3% .
The lengths of the longest transmission lines connected to the candidate substations are shown in Table 3.4.4, and the longest one is 190km of Kut-Missan line, and in this case, the voltage rise is 2.2%.
Since the maximum design voltage of MoE’s 400kV transmission line is 420kV (105%), there is enough allowance to charge the line without load, if the voltage at sending end is kept 400kV.
Therefore, the reactor is not necessary from this point of view.



Source : by the Survey Team based on PSS/E data of 2020 provided from MoE

Figure 3.4.5 Open End Voltage in the case of Charging 400kV Line without Load

Table 3.4.4 Longest Transmission Line Connected to Candidate Substation

Candidate substation	Longest line	Length (km)
Al-Madaain	Yusfiya-Al-Madaain	30
Al-Radwaniyah	BGW-adwaniyah	14
Basra	Shat Al Basra-Basra	54
New Diyala	Mansuria- New Diyala	60
Missan	Kut- Missan	190
Ninawa	Baiji-Ninawa	176
Al-Anbar	Qa'm- Al-Anbar	128
Thi-Qar	Najaf-Thi-Qar	140

Source ：PSS/E data of 2020 provided from MoE

(2) Voltage reactive-power balance in the network

The reactive power is lost in the line because of existence of reactance of the line, on the other hand, the reactive power is evolved from admittance element of the line. The power flow which the reactive power loss equals to the evolution is referred to as Surge Impedance Loading (SIL). In the condition of SIL, the voltage at sending end becomes equal to one at receiving end, and the active power loss is minimized. Therefore, SIL is ideal power flow in the transmission line.

If the power flow is larger than SIL, the network facilities such as generators and power capacitors have to supply the reactive power to the network to maintain proper voltage, the other way, the power flow is smaller than SIL, the excess reactive power has to be consumed by the shunt reactors.

SIL is expressed by the below equation.

$$SIL = \sqrt{Y/X}$$ Y: Admittance of line, X: Reactance of line

Substituting the real value of 400kV line Y=0.0059 pu/km、X=0.00019pu/km into this equation, SIL=5.57pu (557MW) is obtained.

Table 3.4.5 shows the power flow in the longest lines connected to the candidate substation.

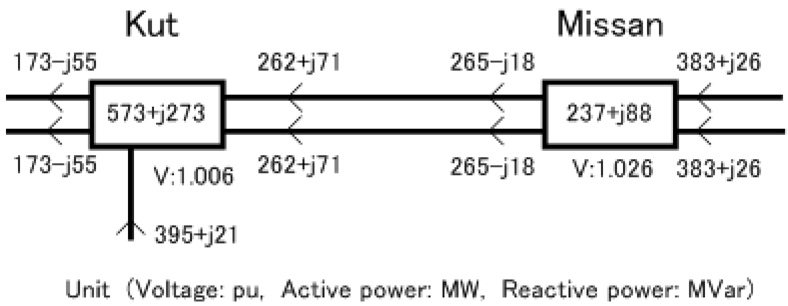
Since the small power flow in the long transmission line causes large reactive power excess, Kut-Missan line is paid attention in this point of view.

Figure 3.4.6 shows precise power flow around Missan. The power flow in the Kut-Missan line is 265MW at about half of 557MW of SIL, as a result, 89MVar (=71+18)（total 178MVar of 2 circuits）of reactive power surplus occurs. However, 88MVar and 273MVar are consumed at Missan and Kut substations respectively. Then, the proper voltages of 102.6% at Missan and 100.6% at Kut are kept.

Table 3.4.5 Power Flow in the Longest Line Connected to Candidate Substation

Candidate substation	Longest line	Length (km)	Power flow (MW)
Al-Madaain	Yusfiya-Al-Madaain	30	43
Al-Radwaniyah	BGW-adwaniyah	14	520
Basra	Shat Al Basra-Basra	54	629
New Diyala	Mansuria- New Diyala	60	137
Missan	Kut- Missan	190	529/2 (2 circuits)
Ninawa	Baiji-Ninawa	176	308
Thi-Qar	Najaf-Thi-Qar	140	509
Al-Anbar	Qa'm- Al-Anbar	128	234

Source ：by the Survey Team based on PSS/E data of 2020 provided from MoE



Source : by the Survey Team based on PSS/E data of 2020 provided from MoE

Figure 3.4.6 Precise Power Flow around Missan

(3) Judgement of necessity of shunt reactor

From the study results of open end voltage without load and voltage reactive-power balance in the network, installing the shunt reactor seems to be not necessary in the candidate substations.

It is recommended that further study on the necessity of shunt reactor at the tender stage, including the analysis for voltage/reactive power balance in off-peak time

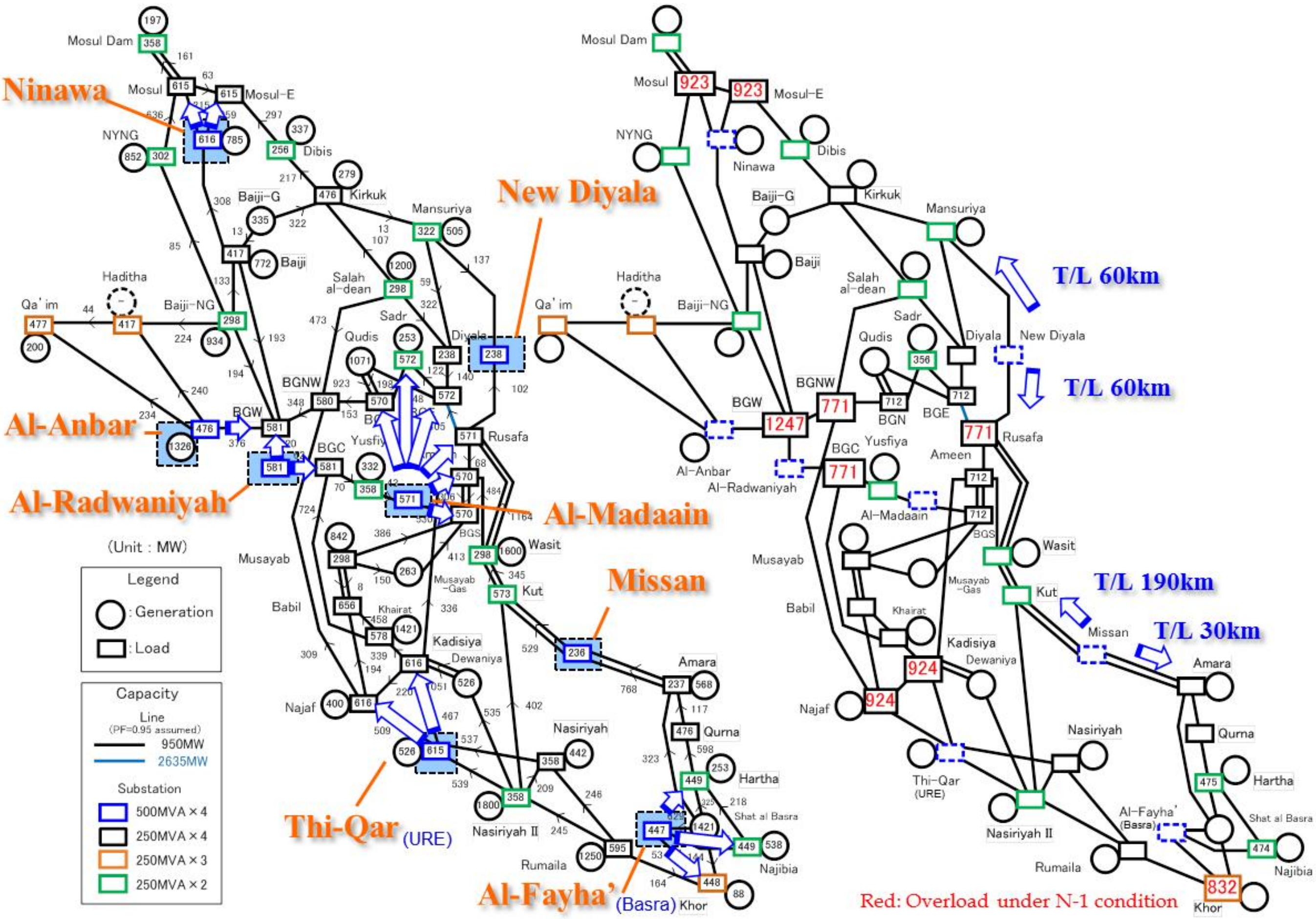
3.4.7 Conclusion of the power flow analysis

From power flow calculation results of 2020, when candidate substations are constructed, power system will not have the following problems, which will contribute to a stable power system operation.

a) Overload of transmission lines and transformers at normal condition
b) Voltage profile of the substation bus
c) Overload under N-1 condition
d) Leading power factor operation of generator

However, if the candidate substations are not constructed, as shown in Figure 3.4.7, the nine substations are overloaded of taransfoemers under N-1 condition, and the neighboring zones of New Diyala and Missan which are connected via long transmission line are at a risk of wide area power outage because there are no substations in the intermediate distance.

Based on a result of the power flow analysis, eight candidate substationa as mentioned in Table 3.4.6 are necessary for stable power supply system in the planned 2020 power system.



Source : by the Survey Team based on PSS/E data of 2020 provided from MoE

Figure 3.4.6 Result of Power Flow Analysis in case of no 8 Candidate Substations

Table 3.4.6 Result of Power Sysytem Analysis

Governorate	Substation Name	Total load of demand group	Expecte load	If not
Ninawa	Ninawa	1,839MW	613MW	Overload
Baghdad	Al-Radwaniyah	2,313MW	578MW	Overload
	Al-Madaain	3,975MW	568MW	Overload
Al-Anbar	Al-Anbar	475MW	475MW	Overload
Diyala	New Diyala	474MW	237MW	Wide area outage
Thi Qar	Thi Qar	1,838MW	613MW	Overload
Missan	Missan	473MW	237MW	Wide area outage
Basra	Al-Fayha' (Basra)	1,782MW	446MW	Overload

Source : by the Survey Team based on PSS/E data of 2020 provided from MoE

Note:

MoE informed the following comments about Missan and New Diyala substation.

MoO has plans to develop and construct plants in Missan and New Diyala governorates in the near future. MoE forecasts that there will be growing demand in along with construction of 400kV network across both governorates as MoE develops the plants. However, the detail plan of MoO is currently under review by higher authority in the country and has not yet been approved. Therefore, this information is not allowed to be disclosed.

Moreover, MoE imports power to supply Diyala governorate with 400kV and 132kV from Iran, and MoE plans to supply power from the network of MoE within three years. Consequently, MoE needs to construct new network including associated substations to supply power to the governorate. This will be another justification to have the substation in the governorate.

Chapter 4

Selection of the Substation Locations

Chapter 4 Selection of the Substation Locations

4.1 Required conditions of site location and Route

4.1.1 Substation

The substation is designed and constructed based on the Design Condition of Substation, such as Topographical conditions, Electrical criteria, Standards and Technical Specification etc., which are descried in Chapter 6.
The sizing of the substation is basic factor to select the construction site and the typical layout drawing of the Substation is shown in Figure 6.3 (Chapter 6). The layout drawing includes the temporally working area and storage area etc. considering site construction works. The substation sites shall be selected to suite the accommodation of the whole substation facilities.

400kV and 132kV transmission lines routes, regardless existing or planned, also shall be considered to select the site of the substation which shall be connected/diverted the new Substation.

Access road from existing main road to the new substation shall be constructed during the project implementation and then, the location of the main road shall also be taking into consideration.

Environmental and social issues for the substation sites are described in Chapter 5.

4.2 Site Survey

4.2.1 Site Survey of the Candidate Substation

According to the the hearing with MoE and the PSS/E analysis, the study team extract the 400 kV Substations which are required in order to improve the overload as shown following table and figure.

Table 4.2.1-1 The list of the Candidate Substation

No.	Governorate	Substation Name
1	Ninawa	Ninawa
2	Baghdad	Al-Radwaniyah
3	Baghdad	Al-Madaain
4	Anbar	Anbar
5	Diyala	New Diyala
6	Thi Qar	Thi Qar
7	Missan	Missan
8	Basra	Al-Fayha’

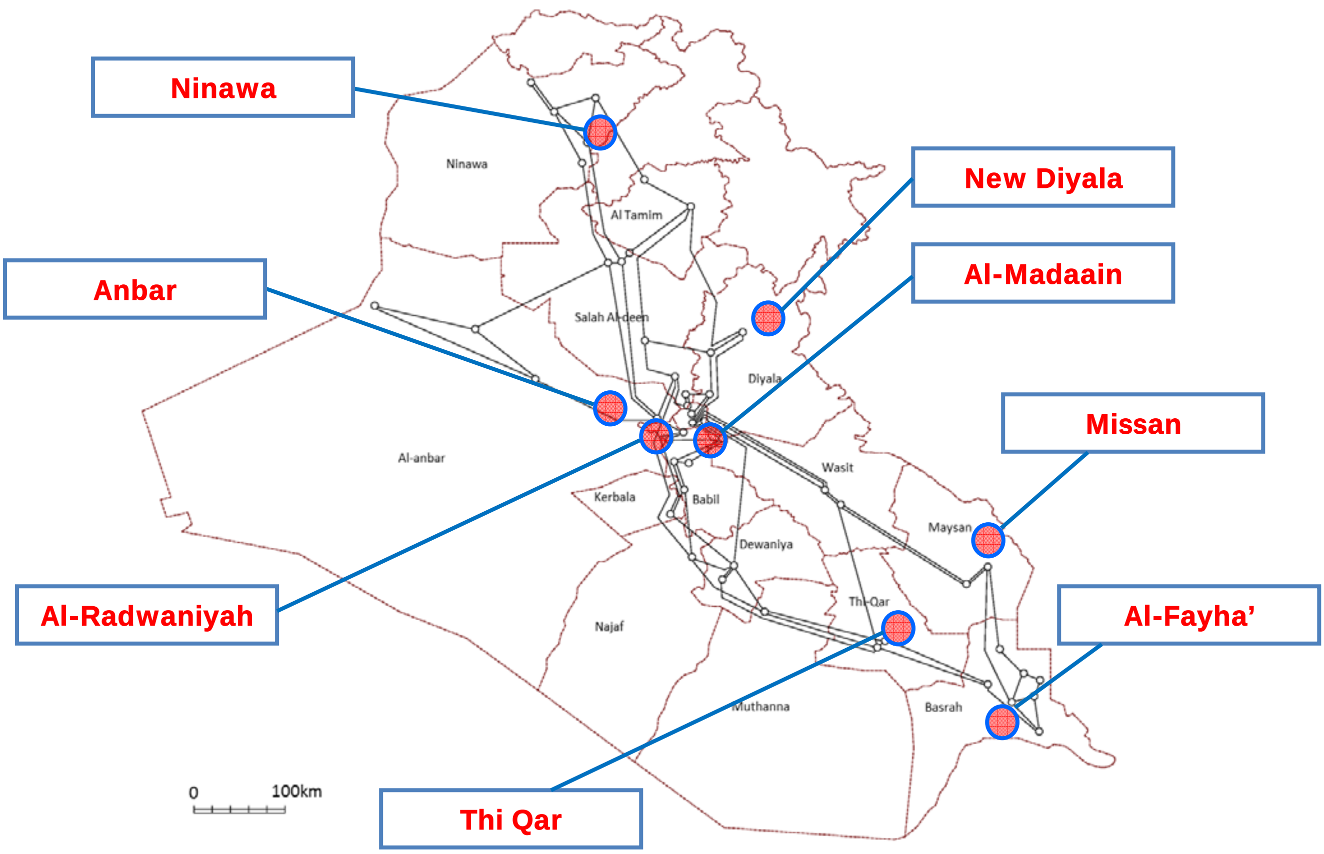


Figure 4.2.1-1 The location of the Whole Candidate Substation

(1) Ninawa

a) Location of the candidate site

The site is in Mosul, Khether,, where is outside rural area of Mosul city, in southern east.

Figure 4.2.1-2 Location of the Candidate Site

b) Summary of the Site Survey

The situation of the candidate site based on the site survey is as shown in the summary below. Details of the Site Survey refer to the Appendix 1.

Table 4.2.1-2 Summary of the Site Survey

Items	Description
Governorate, City	Mosul, Khether
Land Category	Agricultural area
Ownership	Ministry of Agriculture
Any obstructions	No apparent
Water Appearance	None
Topographical Condition	Flat
Distance to 400kV T.L.	25 km
Access road	Paved road is required (Approx. 100m)
Coordination	36°7‘ 42.36“ N, 43°24‘ 19.19“ E
Remarks	

c) Recommended Site Layout

The recommended site layout for 400kV Substation is as shown below.

Land required for 400kV Substation construction is an area of Approx.300m×300m including the storage, temporary facilities and future expansion spaces.

Access road from the gate of the substation to the existing main road will be created along the existing public dirt road as shown below.

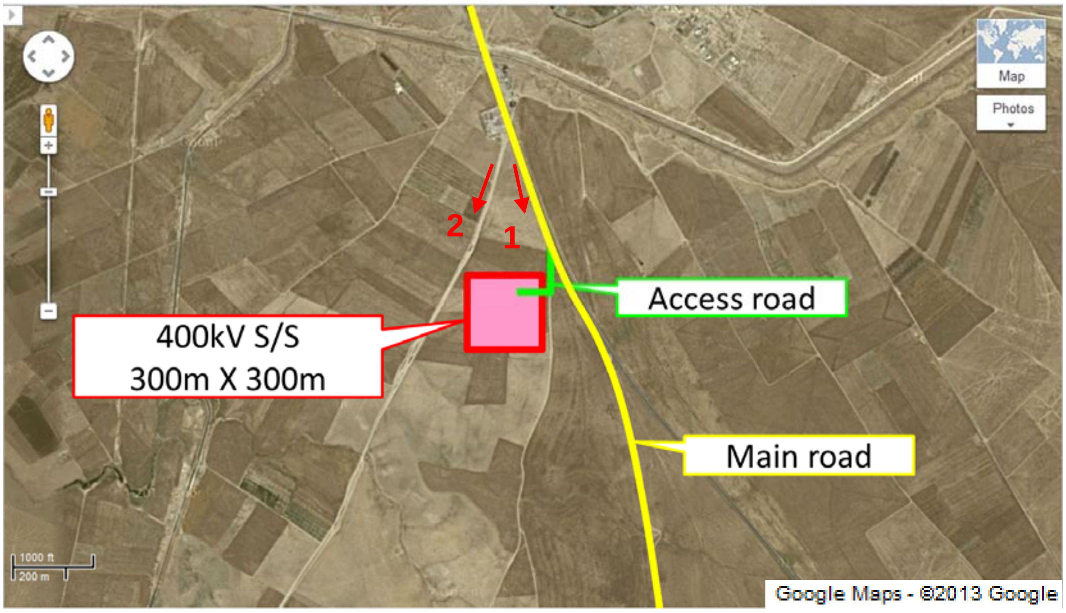


Figure 4.2.1-3 The Recommended Site Layout (Reference)

d) Photograph near the Site

The following Photographs show the site views;

Photo 1 (Direction 1 of Figure 4.2.1-3)	Photo 2 (Direction 2 of Figure 4.2.1-3)
	

(2) Al-Radwaniyah

a) Location of the candidate site

The site is in Baghdad, Radwaniyah, where is outside rural area of Baghdad city, in west.

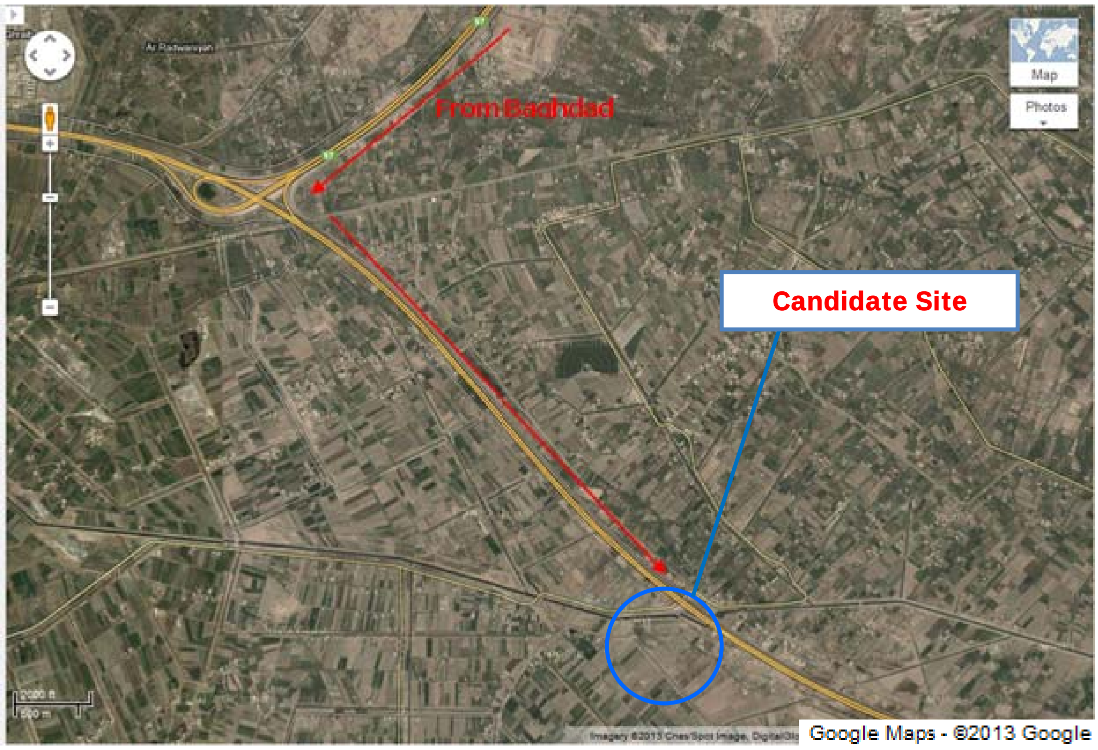


Figure 4.2.1-4 Location of the Candidate Site

b) Summary of the Site Survey

The situation of the candidate site based on the site survey is as shown in the summary below. Details of the Site Survey refer to the Appendix 1.

Table 4.2.1-3 Summary of the Site Survey

Items	Description
Governorate, City	Baghdad- Radwaniyah
Land Category	Agricultural area
Ownership	Ministry of Agriculture
Any obstructions	No apparent
Water Appearance	None
Topographical Condition	Flat
Distance to 400kV T.L.	2 km
Access road	Paved road is required (Approx. 400m)
Coordination	33°14‘ 43.58“ N, 44°7‘’ 30.66“ E
Remarks	・15m-wide irrigation canal is near ・Some houses exist around the site

c) Recommended Site Layout

The recommended site layout for 400kV Substation is as shown below.

Land required for 400kV Substation construction is an area of Approx.300m×300m including the storage, temporary facilities and future expansion spaces.

Access road from the gate of the substation to the existing main road will be created along the existing public dirt road as shown below.

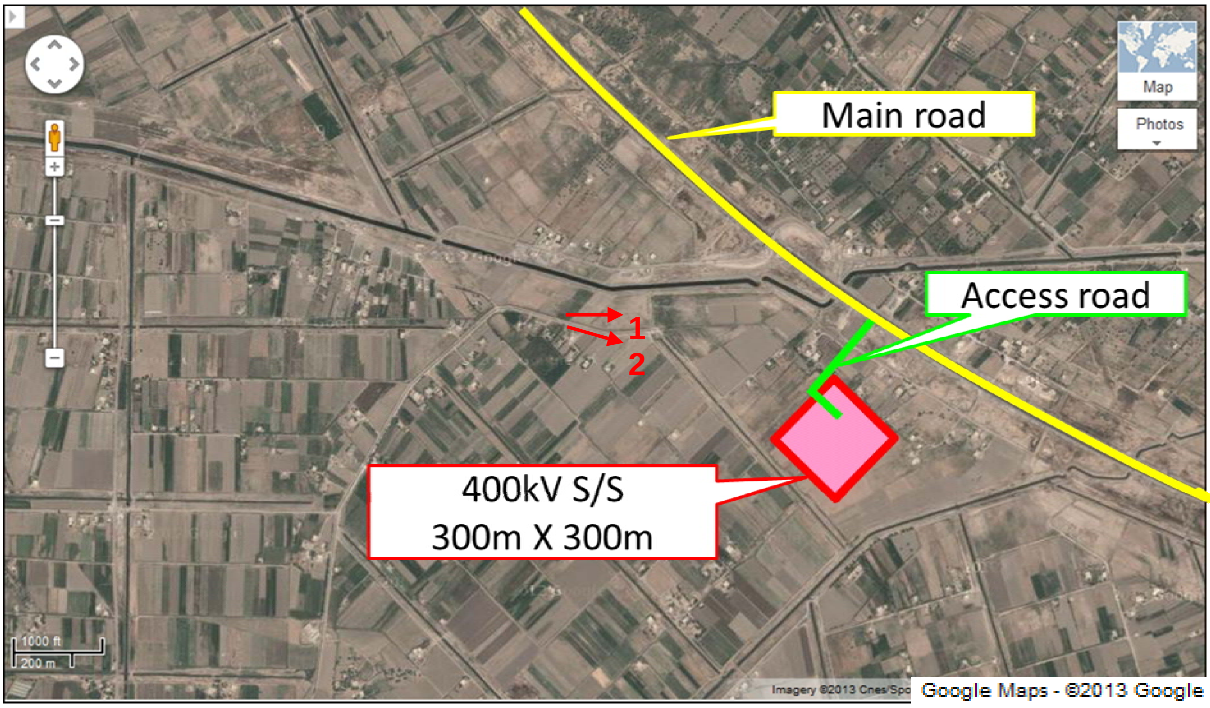


Figure 4.2.1-5 The Recommended Site Layout (Reference)

d) Photograph near the Site

The following Photographs show the site views;

Photo 1 (Direction 1 of Figure 4.2.1-5)	Photo 2 (Direction 2 of Figure 4.2.1-5)
	

(3) Al-Madaain

a) Location of the candidate site

The site is in Baghdad, Madaain, where is outside rural area of Baghdad city, in southern east.

Figure 4.2.1-6 Location of the Candidate Site

b) Summary of the Site Survey

The situation of the candidate site based on the site survey is as shown in the summary below. Details of the Site Survey refer to the Appendix****.

Table 4.2.1-4 Summary of the Site Survey

Items	Description
Governorate, City	Baghdad-Madaain
Land Category	Agricultural area
Ownership	Ministry of Agriculture
Any obstructions	No apparent
Water Appearance	None
Topographical Condition	Flat
Distance to 400kV T.L.	15km
Access road	Paved road is required (Approx. 600m)
Coordination	33°11‘ 6.70“ N, 44°30‘ 19.65“ E
Remarks	・Surface water on eastern side the site ・Nuclear Power plant (Non Operation) is near ・Access road ; Agreement by Ministry of Science and Technology is required

c) Recommended Site Layout

The recommended site layout for 400kV Substation is as shown below.

Land required for 400kV Substation construction is an area of Approx.300m×300m including the storage, temporary facilities and future expansion spaces.

Access road from the gate of the substation to the existing main road will be created along the existing public dirt road as shown below.

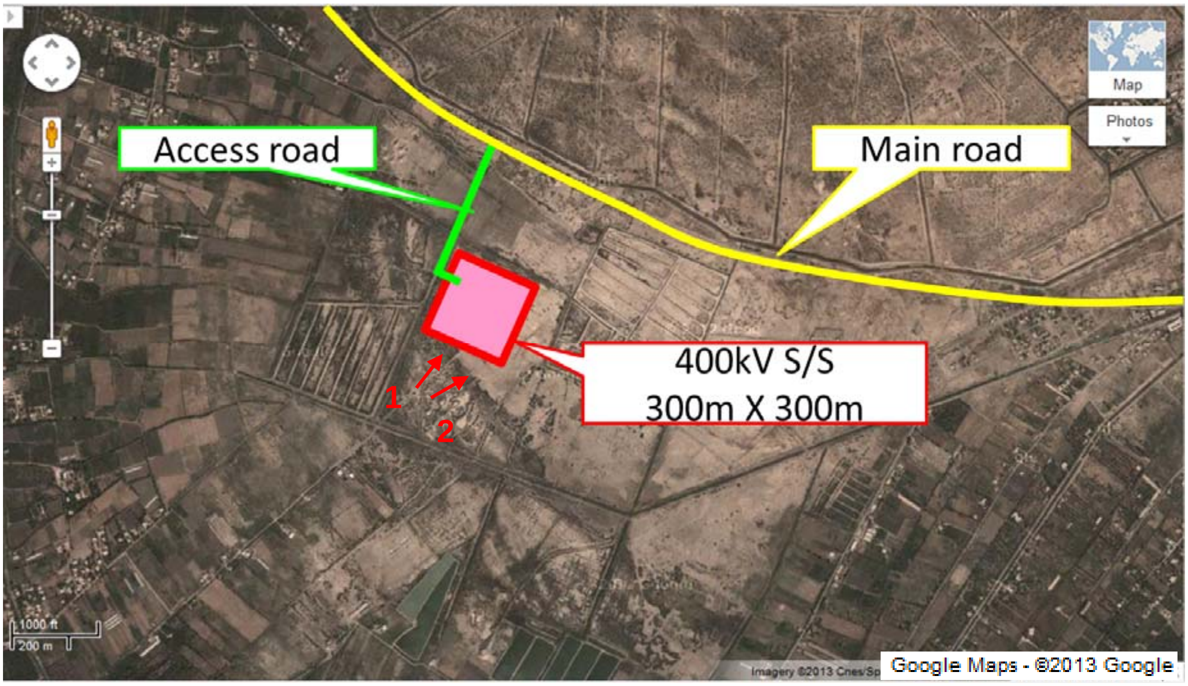


Figure 4.2.1-7 The Recommended Site Layout (Reference)

d) Photograph near the Site

The following Photographs show the site views;

Photo 1 (Direction 1 of Figure 4.2.1-7)	Photo 2 (Direction 2 of Figure 4.2.1-7)
	

(4) Al-Anbar

a) Location of the candidate site

The site is in Anbar, Ramadi, where is outside unexploited area of Ramadi city, in northern east.

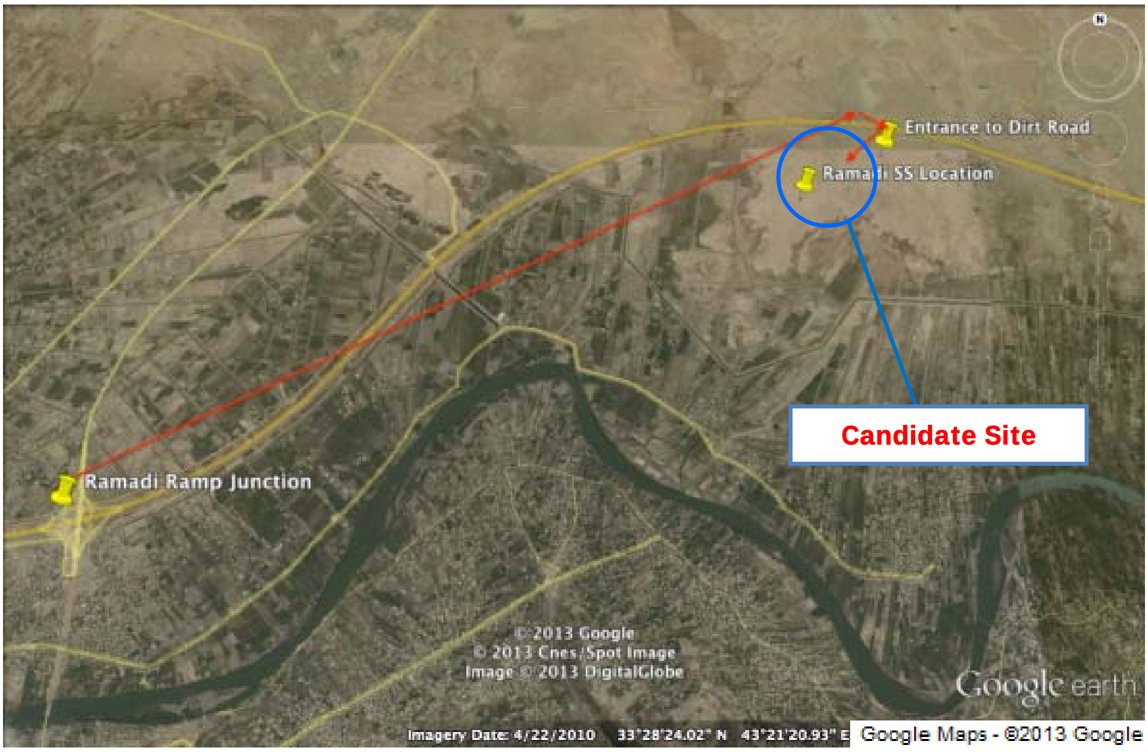


Figure 4.2.1-8 Location of the Candidate Site

b) Summary of the Site Survey

The situation of the candidate site based on the site survey is as shown in the summary below. Details of the Site Survey refer to the Appendix 1.

Table 4.2.1-5 Summary of the Site Survey

Items	Description
Governorate, City	Anbar, Ramadi
Land Category	Unexploited area
Ownership	Ministry of Finance
Any obstructions	No apparent
Water Appearance	None
Topographical Condition	Flat
Distance to 400kV T.L.	2km
Access road	Paved road is required (Approx. 400m)
Coordination	33°29‘ 57.84“ N, 43°23‘ 7.35“ E
Remarks	

c) Recommended Site Layout

The recommended site layout for 400kV Substation is as shown below.

Land required for 400kV Substation construction is an area of Approx.300m×300m including the storage, temporary facilities and future expansion spaces.

Access road from the gate of the substation to the existing main road will be created along the existing public dirt road as shown below.

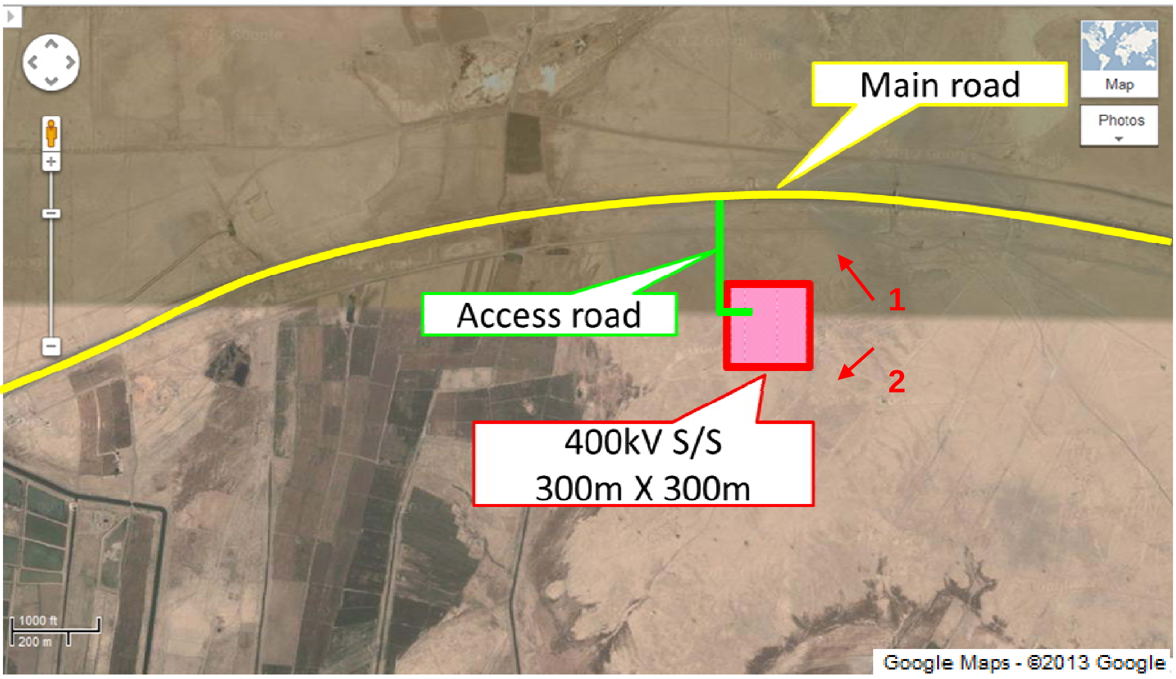


Figure 4.2.1-9 The Recommended Site Layout (Reference)

d) Photograph near the Site

The following Photographs show the site views;

Photo 1 (Direction 1 of Figure 4.2.1-9)	Photo 2 (Direction 2 of Figure 4.2.1-9)
	

(5) New Diyala

a) Location of the candidate site

The site is in Diyala, Failaq, where is desert area of Diyara governorate.

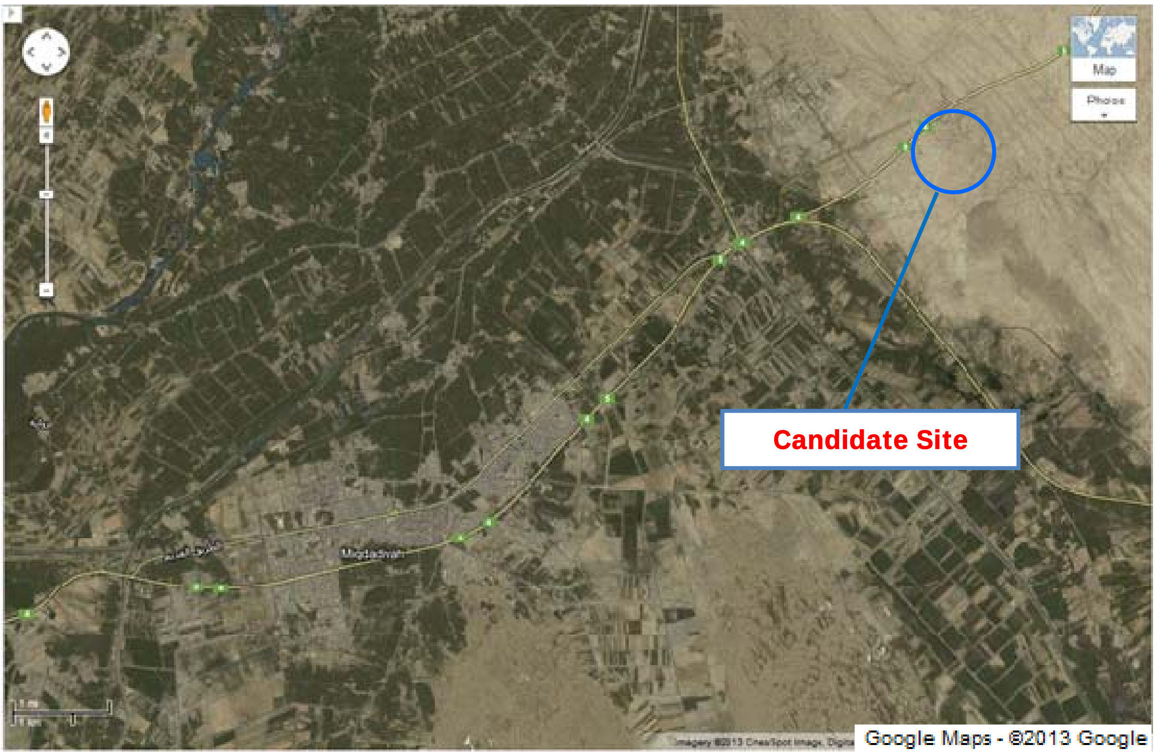


Figure 4.2.1-10 Location of the Candidate Site

b) Summary of the Site Survey

The situation of the candidate site based on the site survey is as shown in the summary below. Details of the Site Survey refer to the Appendix 1.

Table 4.2.1-6 Summary of the Site Survey

Items	Description
Governorate, City	Diyala, Failaq
Land Category	Desert area
Ownership	Ministry of Finance
Any obstructions	No apparent
Water Appearance	None
Topographical Condition	Flat
Distance to 400kV T.L.	2-3 km
Access road	Paved road is required (Approx. 100m)
Coordination	34°1‘ 53.00“ N, 45°1‘ 23.04“ E
Remarks	

c) Recommended Site Layout

The recommended site layout for 400kV Substation is as shown below.

Land required for 400kV Substation construction is an area of Approx.300m×300m including the storage, temporary facilities and future expansion spaces.

Access road from the gate of the substation to the existing main road will be created along the existing public dirt road as shown below.

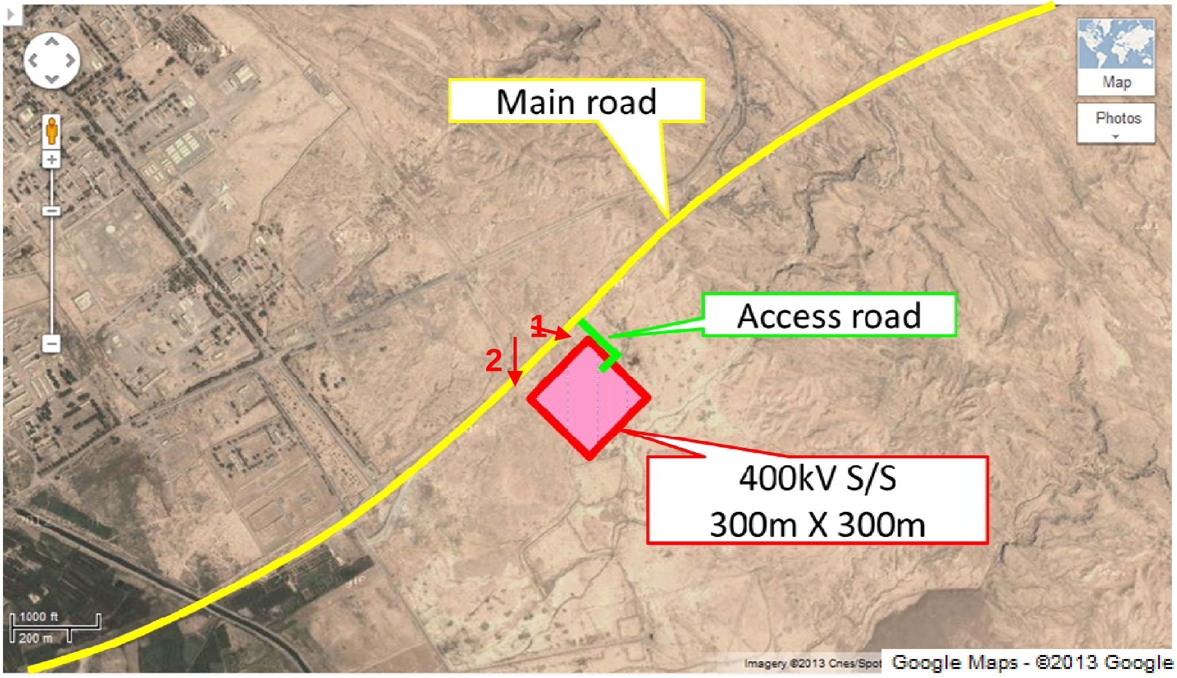


Figure 4.2.1-11 The Recommended Site Layout (Reference)

d) Photograph near the Site

The following Photographs show the site views;

Photo 1 (Direction 1 of Figure 4.2.1-11)	Photo 2 (Direction 2 of Figure 4.2.1-11)
	

(6) Thi Qar

a) Location of the candidate site

The site is in Thi Qar, Nasiriya, where is agricultural area of Thi Qar governorate.

Figure 4.2.1-12 Location of the Candidate Site

b) Summary of the Site Survey

The situation of the candidate site based on the site survey is as shown in the summary below. Details of the Site Survey refer to the Appendix 1.

Table 4.2.1-7 Summary of the Site Survey

Items	Description
Governorate, City	Thi Qar, Nasiriya
Land Category	Agricultural area
Ownership	Ministry of Finance
Any obstructions	No apparent
Water Appearance	None
Topographical Condition	Flat
Distance to 400kV T.L.	1.5 km
Access road	Paved road is required (Approx. 100m)
Coordination	31°25‘ 57.16“ N, 46°9‘ 17.85“ E
Remarks	・Some parts of the site are covered by water ・Two irrigation canals exist near site ・New apartment complex plan (1,200 Units)

c) Recommended Site Layout

The recommended site layout for 400kV Substation is as shown below.

Land required for 400kV Substation construction is an area of Approx.300m×300m including the storage, temporary facilities and future expansion spaces.

Access road from the gate of the substation to the existing main road will be created along the existing public dirt road as shown below.

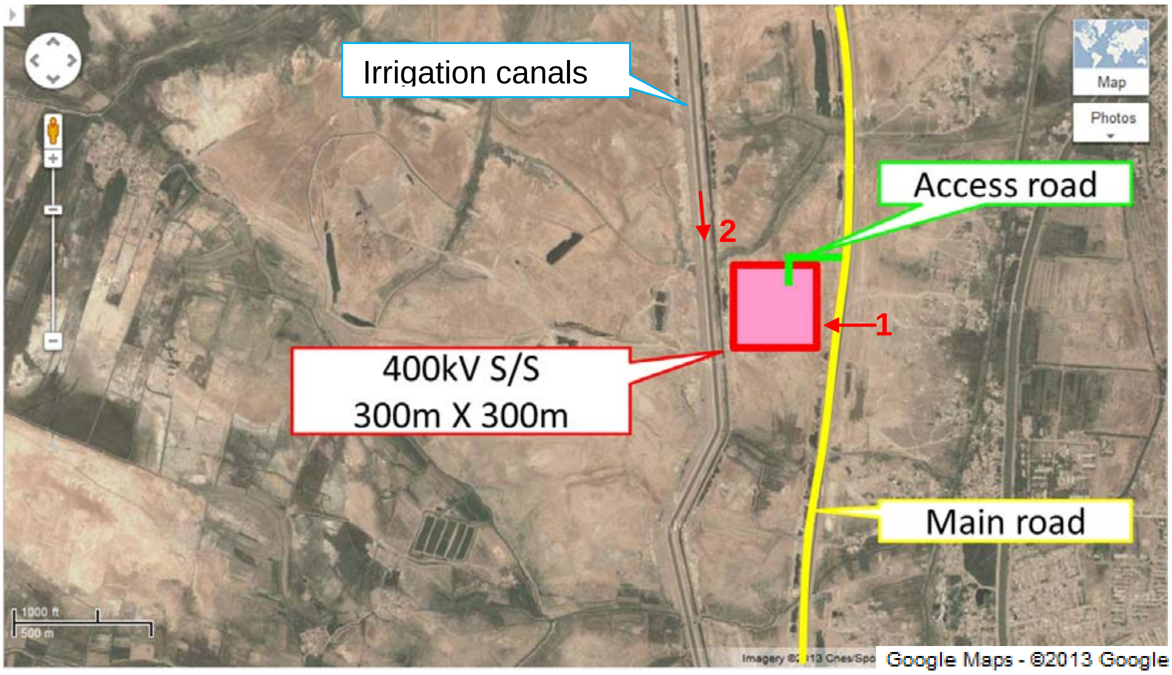


Figure 4.2.1-13 The Recommended Site Layout (Reference)

d) Photograph near the Site

The following Photographs show the site views;

Photo 1 (Direction 1 of Figure 4.2.1-13)	Photo 2 (Direction 2 of Figure 4.2.1-13)
	

(7) Missan

a) Location of the candidate site

The site is in Missan, Amarah, where is agricultural area of Missan governorate.

Figure 4.2.1-14 Location of the Candidate Site

b) Summary of the Site Survey

The situation of the candidate site based on the site survey is as shown in the summary below. Details of the Site Survey refer to the Appendix 1.

Table 4.2.1-8 Summary of the Site Survey

Items	Description
Governorate, City	Missan, Amarah
Land Category	Agricultural area
Ownership	Ministry of Finance
Any obstructions	No apparent
Water Appearance	None
Topographical Condition	Flat
Distance to 400kV T.L.	Close to the Site
Access road	Paved road is required (Approx. 100m)
Coordination	31°54‘ 31.35“ N, 46°57‘ 52.08“ E
Remarks	・Korea (STX) new 200MW project is near

c) Recommended Site Layout

The recommended site layout for 400kV Substation is as shown below.

Land required for 400kV Substation construction is an area of Approx.300m×300m including the storage, temporary facilities and future expansion spaces.

Access road from the gate of the substation to the existing main road will be created along the existing public dirt road as shown below.

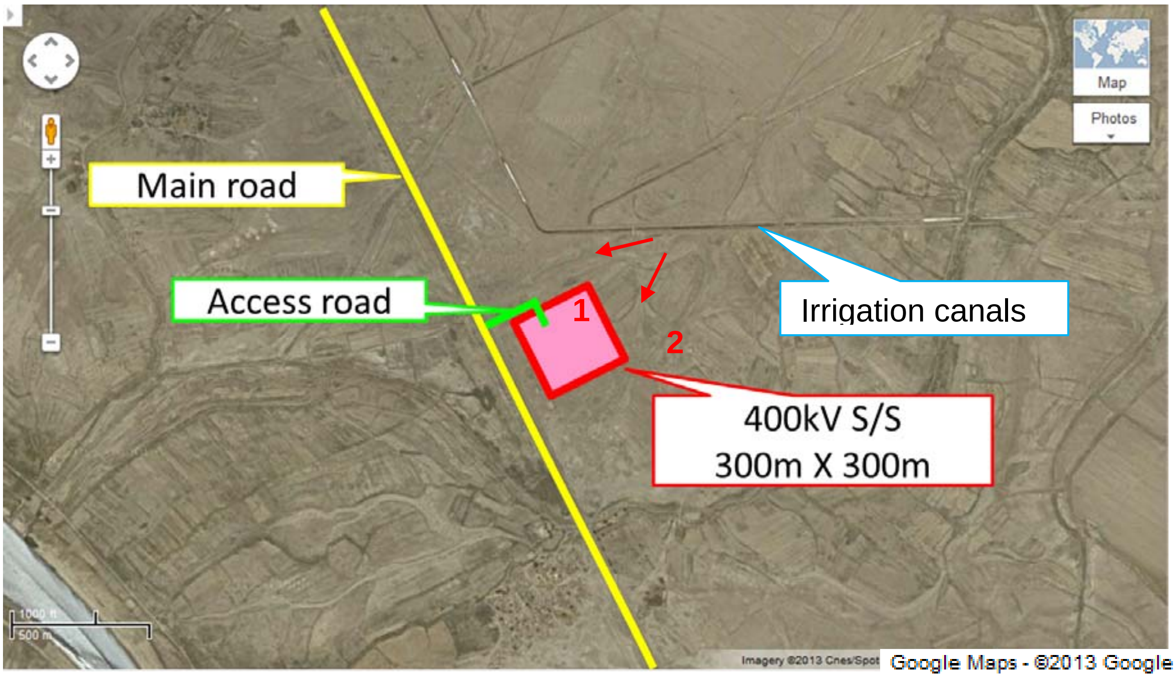


Figure 4.2.1-15 The Recommended Site Layout (Reference)

d) Photograph near the Site

The following Photographs show the site views;

Photo 1 (Direction 1 of Figure 4.2.1-15)	Photo 2 (Direction 2 of Figure 4.2.1-15)
	

(8) Al-Fayha'

a) Location of the candidate site

The site is in Basra,Basra, where is deserted salty area of Basra governorate.

Figure 4.2.1-16 Location of the Candidate Site

b) Summary of the Site Survey

The situation of the candidate site based on the site survey is as shown in the summary below. Details of the Site Survey refer to the Appendix 1.

Table 4.2.1-9 Summary of the Site Survey

Items	Description
Governorate, City	Basra ,Basra
Land Category	Deserted Salty area
Ownership	Government
Any obstructions	No apparent
Water Appearance	None
Topographical Condition	Flat
Distance to 400kV T.L.	2 km
Access road	Paved road is required (Approx. 100m)
Coordination	30°25‘ 22.47“ N, 48°1‘ 24.46“ E
Remarks	・Existing SS around the site is overloaded ・High power demand area

c) Recommended Site Layout

The recommended site layout for 400kV Substation is as shown below.

Land required for 400kV Substation construction is an area of Approx.300m×300m including the storage, temporary facilities and future expansion spaces.

Access road from the gate of the substation to the existing main road will be created along the existing public dirt road as shown below.

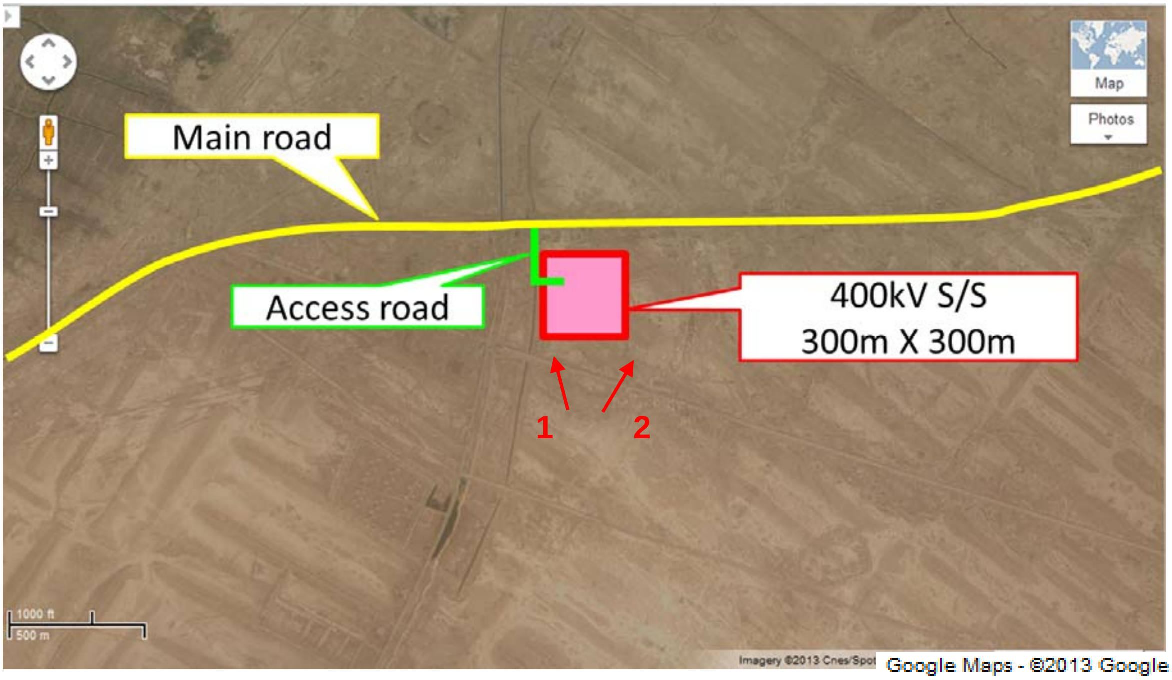


Figure 4.2.1-17 The Recommended Site Layout (Reference)

d) Photograph near the Site

The following Photographs show the site views;

Photo 1 (Direction 1 of Figure 4.2.1-17)	Photo 2 (Direction 2 of Figure 4.2.1-17)
	

Chapter 5

Environmental and Social Considerations for the Project

Chapter 5 Environmental and Social Considerations for the Project

5.1 Legal and Administrative Framework of Iraq on Environmental Issues

5.1.1 Law and Regulation

(1) Law No 27 of 2009 for Protection and Improvement of Environment
In 2009, "Law No 27 of 2009 for Protection and Improvement of Environment" was issued. It aims at preserving public health, natural resources, biodiversity as well as natural and cultural heritage. Accordingly, this transfer station and transfer line project must comply perfectly with this law.
Board for Protecting and Improving Environment was founded attached to the Ministry of Environment. This Board consists of:

a) Minister of Environment- president
b) Technical undersecretary of the Environmental Minister- Vice-president
c) A director general from the Environment Ministry- Member and rapporteur
d) Representatives of each Ministry including Ministry of Electricity

Article 10 of Law No 27 of 2009 stipulates the responsibility of projecSub-Districters including the preparation of the report regarding the estimation of environmental impact.
This report must include followings:

e) The estimation of negative and positive impact of the project on the environment and impact of surrounding environment on it.
f) The proposed means to avoid and to treat the causes of the pollution to be abode by Environmental regulations and directives.
g) Emergency pollution cases and probability and the precautions should be taken to prevent its occurrence.
h) The possible alternatives to use technology less harmful for the environment and rationalizing the resources usage.
i) Reduction the waste and recycle or reuse it as much as possible.
j) Evaluation of environmental feasibility for the project and evaluation the cost of pollution compare with production.

(2) Environmental Regulation for Industrial, Agricultural and Service Projects
Environmental Regulation for Industrial, Agricultural and Service Project (No. 14 of 1990) stipulate concrete regulations, which was formulated to pursue the Law of Protecting and Improving the Environment (No. 76 of 1986).

5.1.2 Ministry of Environment and Regional Directorates of MOEN

(1) Ministry of Environment
The Ministry of Environment (MOEN) was established in November 2003. MOEN is responsible for protecting and conserving the environment in a view of harmonizing other sectors' development and for implementing its functions by developing policies, running environmental programs and promulgating and enforcing standards.
(2) Organization Structure
Overview of the institutional structure of the MOEN is presented below. There are approximately 150 ministry staffs under the Technical Directorate in Wazirea/Baghdad but there are additional district offices and staff of the MOEN throughout the country. Ministry staff reaches to 1,500 employments distributed to many branches (north, center, middle and south directorate) as well as (Radiation center, central laboratory, legal department, technical deputy, administrable deputy, minister office, Administrable directorate etc.)

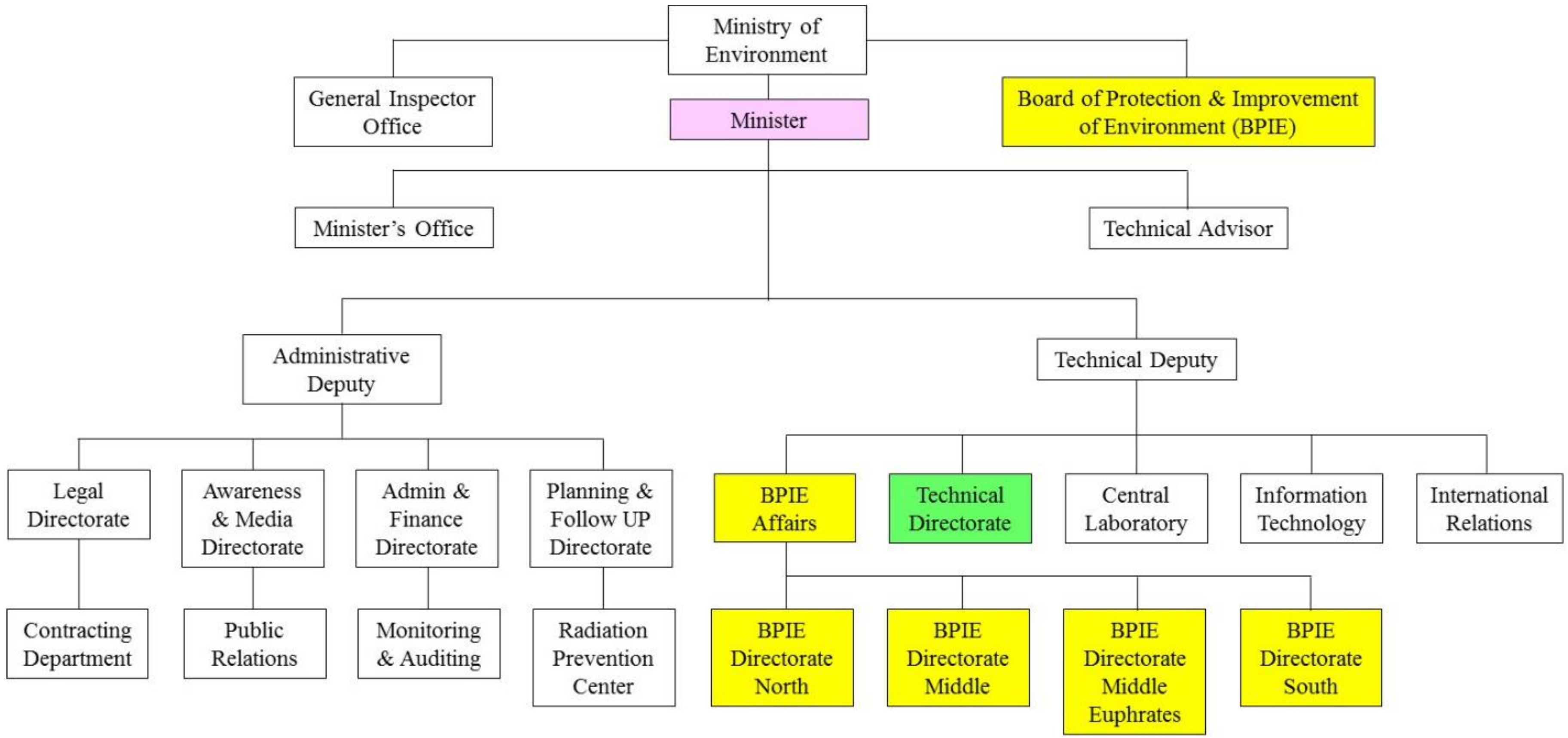


Figure 5.1 1 Organization Structure of MOEN[1]

[1] *A joint project of the Ministry of Environment and Nature Iraq with funding support from the Italian Ministry of Environment, Land and Sea "Working on biodiversity in a post - war country: Key Biodiversity Areas monitoring 2004 - 2010"*

(3) Regional Directorates/Local Units of MOEN
(Shown yellow color in Figure 5.1.1.)
Each regional directorate under BPIE has following units:

a) Air Quality
b) Water (Natural Sources and Drinking) Monitoring Unit
c) Solid Waste and Chemical Hazardous Management Unit
d) Biodiversity Unit
e) Marshlands Unit
f) EIA Unit
g) Desertification and Land Use Unit
h) Industrial Activities Monitoring Unit

The related organizations of this transfer station and transfer line project are not only MOEN, but also each regional directorate where designated substations and transforming lines are located.

5.1.3 Environment Polluting Activities Category

Environment Polluting Activities Categories are stipulated in Environmental Regulation for Industrial, Agricultural and Service Projects. There are three categories as shown in Table 5.1.1.

And concrete list of environment polluting activities category "A" and "B" are shown in Table 5.1.2. This transfer station project is categorized as "Environment polluting activity category B". On the other hands, thermal power station, gas power station and distributing station are categorized as "A", "B" and "C" respectively.

Table 5.1. 1 Environment Polluting Activities Category[2]

Categories	Contents
A	They are the intensive environment polluting activities, including huge agricultural or industrial projects that have several impacts on environment quality on large areas, so they have to be far away from the principal designs and their expansion of cities, districts, sub-districts and villages nominated for development according to the plan of rural housing with the condition of providing all treatment providing enough environmental protection.
B	They are the activities polluting with less degrees than category (A), including industrial or agricultural and other resources producing site pollution that can be controlled, so they can be established inside the boundaries of principal designs and within the block allocated for them, provided that treatment units are to be available according to instructions and regulations; and in case it is not possible to control all pollutions aspects (bad smells and the like), the site will be set outside the boundaries of principal designs according to the site restrictions of such type of activities that are mentioned in details within the regulations.
C	They are other human activities causing minor pollution that can be treated, such as industrial factories that are not causing significant pollution, small agricultural projects, residence compounds, hotels and hospitals that produce pollutions of mainly organic content and can be easily treated via treatment units, so they can be established within the boundaries of the principal designs with no restrictions as well as outside them, according to the central regulations, that farm owners are allowed to establish un-polluting industries inside their farms.

[2] *Environmental Regulation for Industrial, Agricultural and Service Project*

Table 5.1.2 List of Environment Polluting Activities Category "A" and "B"[3]

A	B
- Chemical, petrochemical and petroleum industries - Synthetic fiber industry - Protein plants - Pharmaceutical industries - Tannery plants - Cement plants - Gypsum plants - Bricks plants - Asbestos products plants - Mines - Glass and ceramic industries - **Thermal power station** - Hazardous waste dumping sites - Asphalt plants - Iron , steel and aluminum industries - Waste water treatment plants - Rocks grinding plants	- Food industries - Slaughtering houses - **Gas power stations** - Solid waste landfills - Fish breeding lakes - Textile industries - Chemical industries ,low production capacity - Construction products industries - Metal Melting plants - Electronic and electrical industries. - Fertilizer storage building - Pesticides storage building - Soap industries - Ice production plant - Sand and rocks serving sites - Tobacco industries - Reuse waste oil plants - **Electro power transfer station**

5.2 JICA Guidelines for Environmental and Social Considerations

5.2.1 Project Categorization by JICA Guidelines

According to guideline for environmental and social consideration by JICA (2010), there are four project categorizations shown in Table 5.2.1.

Table 5.2.1 Project Categorization by JICA[4]

Categories	Contents
A	Proposed projects are classified as Category A if they are likely to have significant adverse impacts on the environment and society. Projects with complicated or unprecedented impacts that are difficult to assess, or projects with a wide range of impacts or irreversible impacts, are also classified as Category A. These impacts may affect an area broader than the sites or facilities subject to physical construction. Category A, in principle, includes projects in sensitive sectors, projects that have characteristics that are liable to cause adverse environmental impacts, and projects located in or near sensitive areas.
B	Proposed projects are classified as Category B if their potential adverse impacts on the environment and society are less adverse than those of Category A projects. Generally, they are site-specific; few if any are irreversible; and in most cases, normal mitigation measures can be designed more readily.
C	Proposed projects are classified as Category C if they are likely to have minimal or little adverse impact on the environment and society.
F1	Proposed projects are classified as Category FI if they satisfy all of the following requirements: JICA's funding of projects is provided to a financial intermediary or executing agency; the selection and appraisal of the sub-projects is substantially undertaken by such an institution only after JICA's approval of the funding, so that the sub-projects cannot be specified prior to JICA's approval of funding (or project appraisal); and those sub-projects are expected to have a potential impact on the environment.

[3] *EIA in Iraq "Inception Reports" Eng. Lateef B. Hussein AL-Sudany and Eng. Shurooq S. Qasem AL-Dabas (Environmental Impact Assessment and land Use Dep. of Ministry of Environment)*
[4] *Guideline for Environmental and Social Consideration by JICA (2010)*

JICA conducts environmental and social surveys at the Environmental Impact Assessment (EIA) level for Category A projects and at the Initial Environmental Examination (IEE) level for Category B projects. This transfer station and transfer line project is classified as B category.

5.2.2 Environmental Impact Assessment (EIA) and Initial Environmental Examination (IEE) by JICA Guidelines

Table 5.2. 2 Environmental Impact Assessment (EIA) and Initial Environmental Examination (IEE) by JICA Guidelines

Environmental Impact Assessment	Initial Environmental Examination
Category A	Category B
Study that includes the analysis of alternative plans, the prediction and assessment of environmental impacts and the preparation of mitigation measures and monitoring plans based on detailed field surveys.	Study that includes an analysis of alternative plans, a prediction and assessment of environmental impacts and a preparation of mitigation measures and monitoring plans based on easily available information including existing data and simple field surveys.

This transfer station and transfer line project requires Initial Environmental Examination as shown in Table 5.2.2 based on JICA guidelines.

5.2.3 Required Study Items by Land Acquisition and/or Residents Relocation on Environmental and Social Consideration

Land acquisition and residents relocation by the project implementation are the serious impact from the points of environmental and social consideration. JICA specified following requirements aroused by land acquisition and resident relocation.

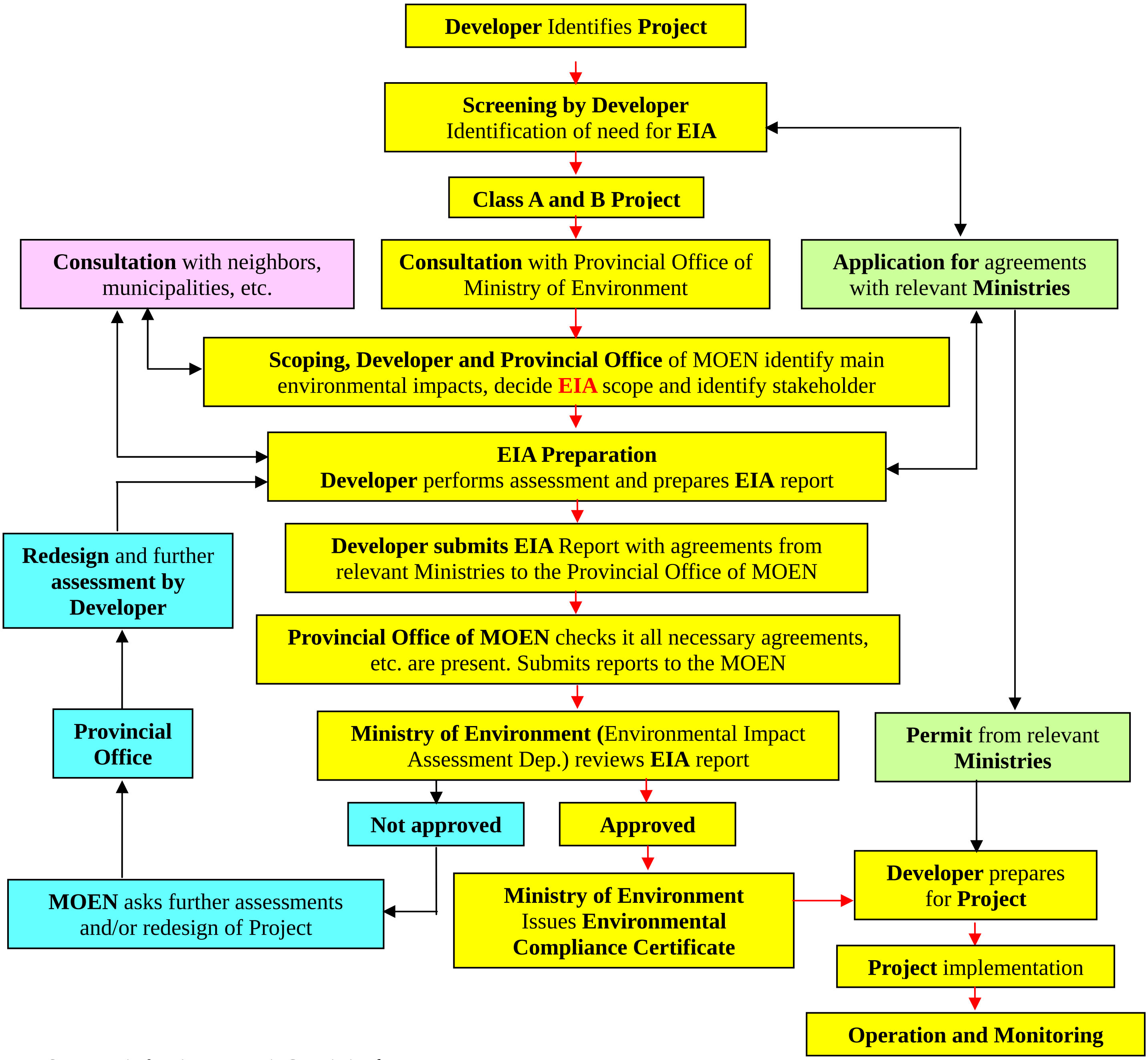
a) Population census survey of all occupants of the project area
b) Property and land survey
c) Household and lifestyle survey (At least 20% of the occupants of the project area)
d) Compensation of loss assets including beneficiaries' requirements of life reconstruction measures
e) Compensation procedures of loss assets based on the replacement survey or re-acquisition costs
f) Life reconstruction measures, which could improve household and living standards of beneficiaries or recover at least
g) Responsible organization for complaint handling including complaint handling procedures
h) Responsible organizations for residents relocation and their responsibility
i) Relocation schedule of residents after compensation payment
j) Financial resources and cost
k) Monitoring system by implementing agency
l) Resident's agreement to Initial design and livelihood reconstruction measures

If this project cause land acquisition and residents relocation, above study items must be included in the report.

5.3 Procedure of Environmental and Social Consideration for the Project

5.3.1 EIA (IEE) process in Iraq Class A and B

Figure 5.3.1 shows typical process of EIA in Iraq for Class A and B. As described above, this transfer station and transfer line project identified as Class B category. And instead of EIA, IEE report is required. Based on this figure, the actual methodology of environmental and social consideration on this project is described in the following sections.



Source: United Nations Economic Commission for Europe

Figure 5.3. 1 EIA process in Iraq Class A and B[5] (Original)

5.3.2 IEE Process of This Project

As this project is specified as Class B in Iraq law and JICA guideline, the study procedure of environmental and social consideration of this project is shown in Figure 5.3.2, reflecting MOE's strategy and survey result. MOE and JICA study team agreed that selected eight substations in eight regions need not to be narrow down to several substations, because all eight substations should be realized in certain time span. Accordingly the target substations by JICA loan could not be identified in this study.

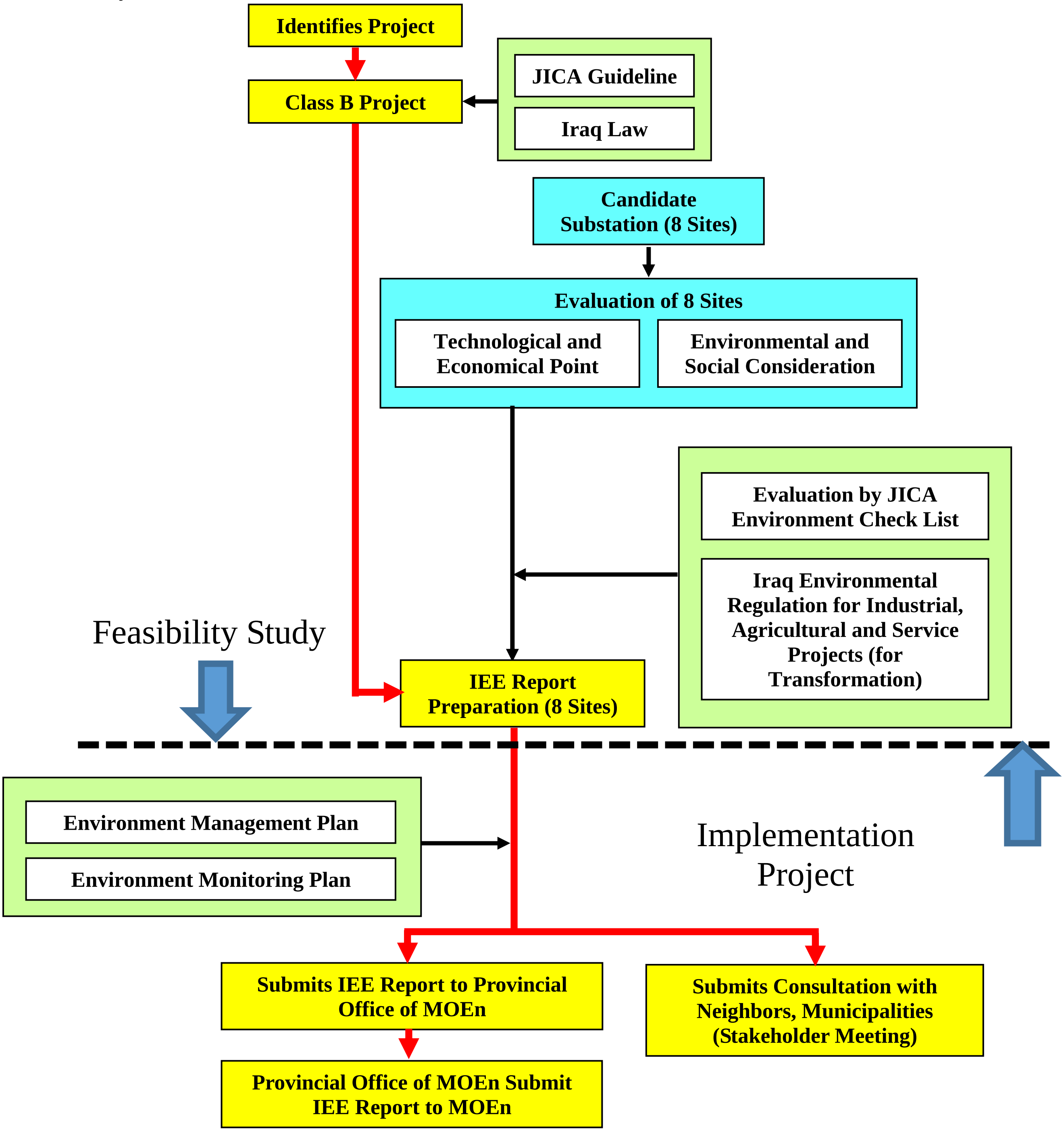


Figure 5.3. 2 Study Procedure of Environmental and Social Consideration (Reviewed)

5.4 Environmental and Social Consideration of Designated Substations

Selected eight candidate sites of substation are shown in Figure 5.5.1. These are dispersed from south to north regions. Accordingly environmental and social consideration of each site should be studied independently.

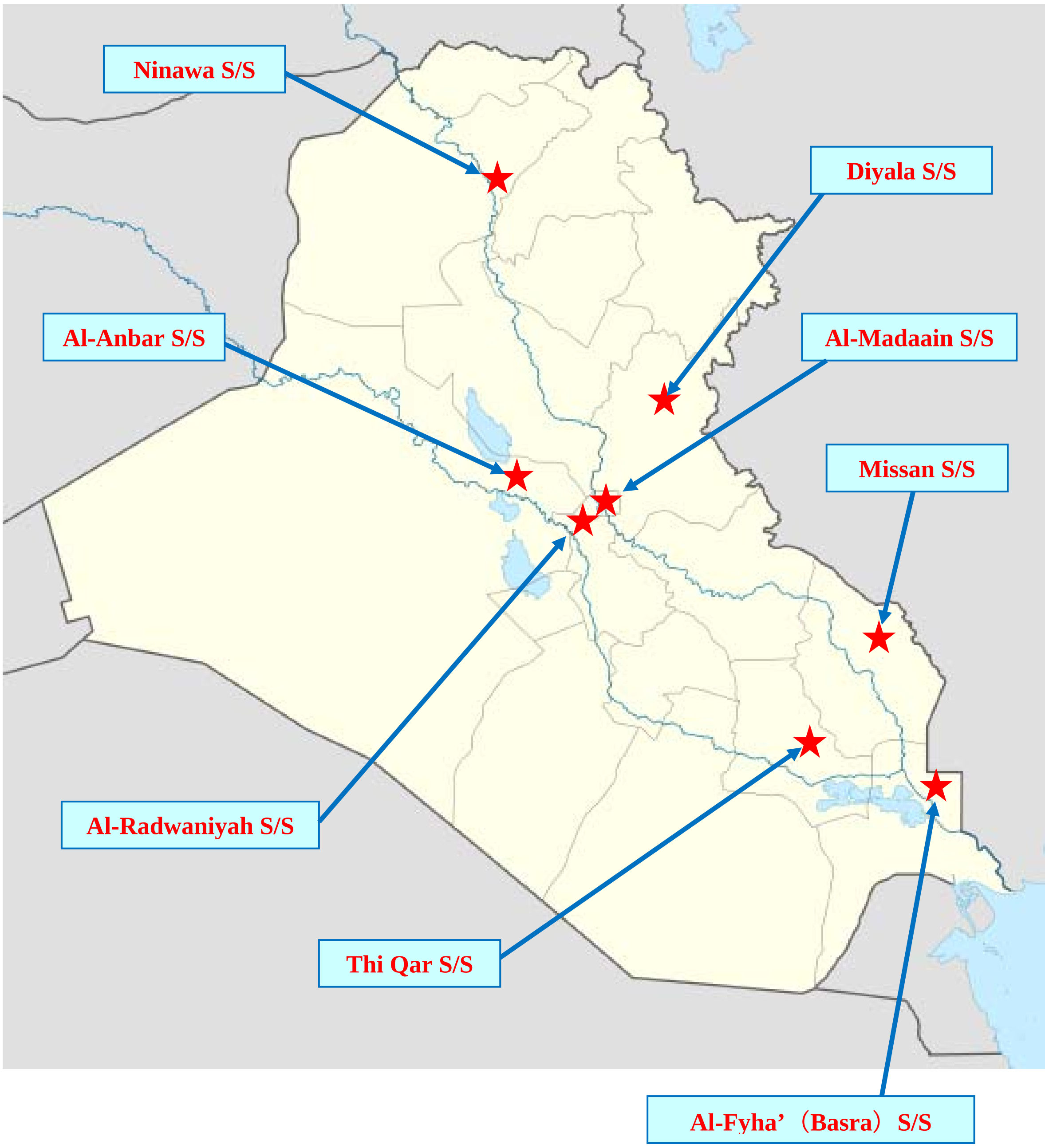


Figure 5.5. 1 Selected Eight Candidate Sites of Substation

5.4.1 Environmental and Social Consideration Summary of Designated Substation

Table 5.4 1 Environmental and Social Consideration Summary of Designated Substation

	Ninawa	Al-Anbar	Diyala	Thi Qar	Missan	Basra	Al-Radwaniyah	Al-Madaain
Transformer								
Site Category	Agriculture	Un-Exploited	Un-Exploited	Un-Exploited	Un-Exploited	Un-Exploited	Agriculture	Agriculture
Ownership	MOA	MOF (?)	MOF (?)	MOF	MOF	MOA	MOA	NOA
Residential Area	Al Khidhir SD. 1.3 km	Small Village 4 km	Muqdadiyah C. 11 km	Shatrah SD. 0.9 km	Maysan C. 16 km	Abu Flus SD. 2 km	Abu Grail 6 km	Small Sub-District 2.3 km
Near Main Road	Route 80 Nil	Route 23 1 km	Route 5 Nil	Route 7 0.2 km	Route 6 0.3 km	Route 6 0.2 km	Route 8 0.4 km	Sub-District Road 3.4 km
River	Tigris 9 km	Euphrates 3.5 km	Diyala River 4 km	Gharraf Canal 0.8 km	Tigris 2 km	Tigris 4 km	Tigris 25 km	Tigris 2 km
Heritage, Natural Recourse & Others	Monastery of Mar Behnam 0.9 km		Lake Dukan 9 km				Baghdad International Airport: 7 km	Osirak Reactor (Ex-nuclear Plant):1.3 km
Existing 400 kV Line	West 26 km	Nil	West 43 km	Nil	Nil	West 25 km	South 1.8-1.9 km	South 11.9 km
Existing 132 kV Line	North 17 km	Nil	Nil	Nil	Nil	Nil	North 7 km	Nil
Non-Government Stakeholders	Farmers Al Khidhir SD.	Ramadi C.	Muqdadiyah C.	Shatrah SD.	Maysan C.	Abu Flus SD.	Farmers Rasheed District	Farmers Karadah District
Transmission Line								
New 400 kV Transmission Line	Agriculture Un-exploited	Nil	Out of JICA Scope	Nil	Nil	Un-exploited	Agriculture	Agriculture
	West 29km					West 27 km	South 1.8-1.9 km	South 11.9 km
Non-Government Stakeholders	Farmers Buwayr V.					Hadman SD.	Farmers Rasheed D.	Farmers Karadah D.

Note: C. = City, SD = Sub-District, V= Village, D= District

5.4.2 Owenership of Agricultural Land and Leasing

(1) Land ownership in modern Iraq[6]

As with many Middle-Eastern nations, Iraq has continued with the civil law system. In 1958, following a socialist revolution, the Iraqi government seized all large land holdings and distributed them to individuals and cooperative societies in smaller parcels. This land was registered as miri.

A holder of miri does, however, forfeit the right to the land if the holder leaves it unused for three years without cause. Upon the land holder's death, the right is assigned to the holder's heirs. If they choose not to accept the land, it is auctioned to the highest bidder.

Iraqi law, however, is clear in its guarantee against expropriation without compensation. It requires the central government to compensate for takings of private property. Holders of land property are entitled to such compensation when the government takes possession of their land. In the words of the Ministry of Justice, Real Estate Registration Department, 'any party, whether the state, a natural person or incorporeal person, should pay a recompense amount if this party exploited or used the lands, the right of which revert to any natural person or incorporeal person during the period of exploitation or if he benefited from it.

The Iraqi Constitution also reflects this balance between the needs of the state and incentives for individuals. Article 16 states that:

a) Ownership is a social function, to be exercised within the objectives of the society and the plans of the state, according to stipulations of the law.
b) Private ownership and economic individual liberty are guaranteed according to the law, and on the basis of not exercising them in a manner incompatible with the economic and general planning.
c) Private property is not expropriated except for considerations of public interest and for just compensation in accordance with the law.

Accordingly, the candidate lands of Nisawa, Al-Radwaniyah and Al-Madaain could be utilized for substation contributing public interest with appropriate compensation.

5.4.3 Stakeholder Meeting

Stakeholder meeting should be arranged on each finally selected sites. The procedure of meeting is as follows;

a) Identification of stakeholders on each finally selected sites: Provincial Office of Ministry of Environment, neighbors, municipalities, NGO and so on.
b) IEE report will be prepared by JICA study team.

[6] "The unique forms and rights of Iraqi real property law" http://www.ibanet.org/Article/Detail.aspx?ArticleUid=e2f9fb38-c584-4854-972c-95378836f941

Chapter 6

Substation Facilities

Chapter 6 Substation Facilities

6.1 Design of Substation Facilities

6.1.1 Design Concept

All electrical equipment and materials for substation shall be designed in accordance with following conditions.

(1) Topographical and Meteorological Site Conditions
Topographical and Meteorological Site Conditions are shown in following Table 6.1.1

Table 6.1.1 Topographical and Meteorological Site Conditions

No	Item	Description	Condition data
1	Ambient temperature	Maximum outdoor peakshade(for about 6 hours per day), which shall be considered as the maximum design ambient temperature	+ 55 °C
		Maximum daily average	+ 45 °C
		Maximum yearly average	+ 35 °C
		Lowest Minimum	- 10 °C
		Maximum temperature of allmetal part exposed in direct sunshine	+ 80 °C
		Maximum ground temp. at depth of 1 meter	+ 35 °C
		Highest one day variation	25 °C
2	Humidity	Maximum relative humidity	92%
		Minimum relative humidity	12%
		Yearly average	38/44 %
3	Wind	Max. wind velocity for design purpose	145 km/hr or 40.2 m/sec.
4	Altitude above sea level	Maximum	1,000 m
		Minimum	0 m
5	Barometric pressure	Yearly average	0.101 MPa
6	Rain fall (Annual Total Rainfall)	Maximum	500 mm
		Minimum	50 mm
		Maximum in one day	72 mm
		Yearly average	150.8 mm
7	Sand and Thunder Storms	Average number of dust storms (days/year)	25
		Average number of thunder storms(days/year)	15
8	Pollution Level	HEAVY airborne contamination	
9	Ice loading, radial thickness mm	NIL	NIL
10	Seismic Loading	Uniform Building Code	Zone 3

Source: MoE Specification

(2) Electrical Design Criteria;
The scope of this project is the construction of new 400kV substation,which is based on design criteria of MoE. The Electrical Design Criteria for 400kV Transmission System is shown in following Table 6.1.2.

According to the design criteria, tertiary voltage is applied 11kV, tertiary voltage of this project shall be designed as 33kV in order to correspond to appropriate current capacity of tertiary winding.Because the capacity of transformer will be upgraded to 500MVA from 150MVA standard, tertiary capacity shall be designed as 150MVA based on discussion with MoE.

Table 6.1.2 Design criteria for Main Electrical System

No	Item	400kV system	132kV system	33kV system
1	Rated voltage	420 kV	145 kV	36 kV
2	Nominal voltage	400 kV	132 kV	33 kV
3	Number of phases	3	3	3
4	Frequency	50Hz	50Hz	50Hz
5(1)	Lightning Impulse withstand voltage (LIWV)	1425 kV	650 kV	170 kV
6	Power frequency withstand voltage (for 1 min.)	650 kV	275 kV	70 kV
7	Estimated X/R ratio	Less than 100	-	-
8	Rated breaking current	50 kA(2)	40 kA	31.5 kA
9	Short time current	50kA/1 sec	40kA/1 sec	31.5kA/3 sec
10	System Short Circuit Level	34700 (MVA)	9200 (MVA)	1800 (MVA)
11	Busbar rated current	4000 A	3150 A	3000A
12	Neutral point Earthing system	Solidly grounded	Solidly grounded	Reactor/ Earthing TR
13	Sound level (IEC60551, NEMA TR1)	88dB	88dB	

Source: MoE Specification

Note: (1) ; All other detailed design data such as withstand voltage between across isolatting distance of switchgears, withstand voltage of transformer winding/neutral etc will be discussed with MoE during Tender stage.

Note :(2) ;Rated breaking current of 50kA; According to the network analysis, although 40kA is sufficient level, 50kA is applied in consideration of the future through the discussion with MoE.

Note: Control/protection scheme such as auto reclose, breaker failure protection etc will be discussed with MoE during Tender stage.

(3) Main Equipment Requirement;
a) Basic Standard of Electrical Equipment ; IEC
b) Applicable Specification; MNISTRY OF ELECTRICITY IRAQ SUPERGRID PROJECTS
400/132kV GIS SUBSTATIONS (ISSUED – JANUARY 2007)
VOLUME 1 : TECHNICAL SPECIFICATION
VOLUME 2 : CIVIL AND BUILDING WORKS, AND BUILDING SERVICES
VOLUME 3 : TECHNICAL SCHEDULE
The detailed descriptions/technical data in the Specification will be reviewed & discussed during Tender Stage.

c) Switchgear

This project shall be designed based on GIS (Gas insulated switchgear) Subsation. Because GIS is new technilogy comparing with AIS conventional switchgear and MoE prefered the application of GIS.

c1) Type of switchgear

400kV ; GIS
132kV ; GIS
33kV ; GIS

c2) Type of Busbar

400kV ; One and a half circuit breaker system
132kV ; Double Busbar
33kV ; Single Busbar

d) Power Transformer

d1) Winding arrangement (Separate or Auto) ; Auto Transformer

d2) Single phase or three phase type ; Single phase type

d3) Capacity of each windings

Primary winding ;500 MVA
Secondary winding ;500 MVA
Tertiary winding : 150 MVA

Note : Transformer capacity will be upgraded to 500MVA from 250MVA standard based on discussion with MoE.

d4) Voltage of each windings

Primary winding ;500 MVA
Secondary winding ;500 MVA
Tertiary winding : 150 MVA

Note:Tertiary capacity shall be designed with 30% of the primary capacity.

e) Control system; Substation Control System (SCS)

f) Type of Protection relays; Numerical type

Note: Main relay will be Distance Relay, High impedance differential or Low impedance differencial relay etc, which detailes shall be discussed with MoE during Tender stage.

6.1.2 Detailed Design for Main Facilities of Each Substation

(1) Single Diagram of main facilities

a) 400 kV GIS

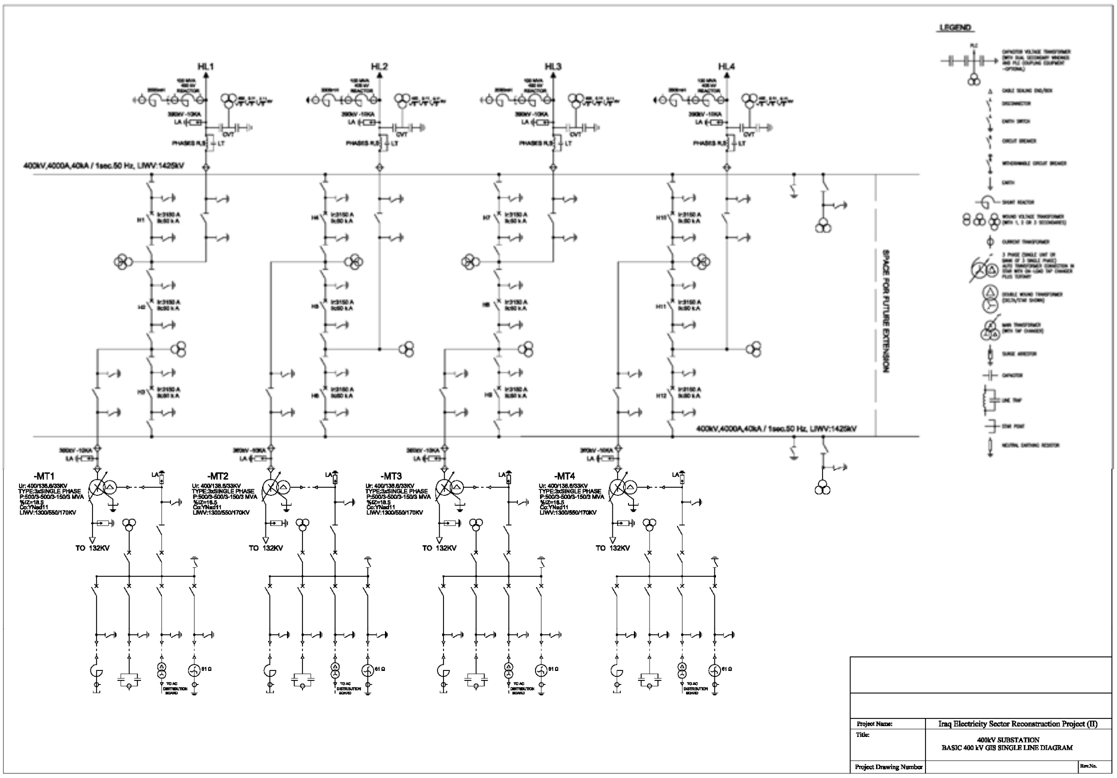
400kV GIS shall be consisted of four (4) diameters for 400kV Line Feeder and Main Transformer, and one (1) future diameter (space only).

Twelve single phase 500/3MVA Transformers (four (4) units of complete transformer) shall be installed.in the substation.

On the condition of long transmission lines with no-load voltage, the receiving end voltage may be exceeded the sending end voltage, because the large admittance of the line causes voltage rise, ie Feranchi effect. According to the network analysis, by PSS/E data of 2020 MoE plan, the voltage rise is less than 1.025pu. Although 400kV Shunt Reactor will be considered to install in each substation from the point of view for the budgetary cost, the study team recommend to review the necessity of the 400kV Shunt Reactor based on the actual network condition at the tender stage.
Main specifications are shown below:

a) Bus Type：1-1/2 bus system
b) Rated Voltage : 420kV
c) Rated frequency : 50Hz
d) Bus Rated current：4000A
e) Bus Rated breaking current：50kA
f) Line（Tr）Rated current：3150A (Based on the capacity of 400kV transmission; ie 2000MVA)
g) Line（Tr）Rated breaking current：50kA

The typical Single line diagram of 400kV system is shown in fllowing Figure 6.1.1.



Source: JICA Survey Team(MoE Specification & Discussion)

Figure 6.1.1 Single line Diagram of 400kV System

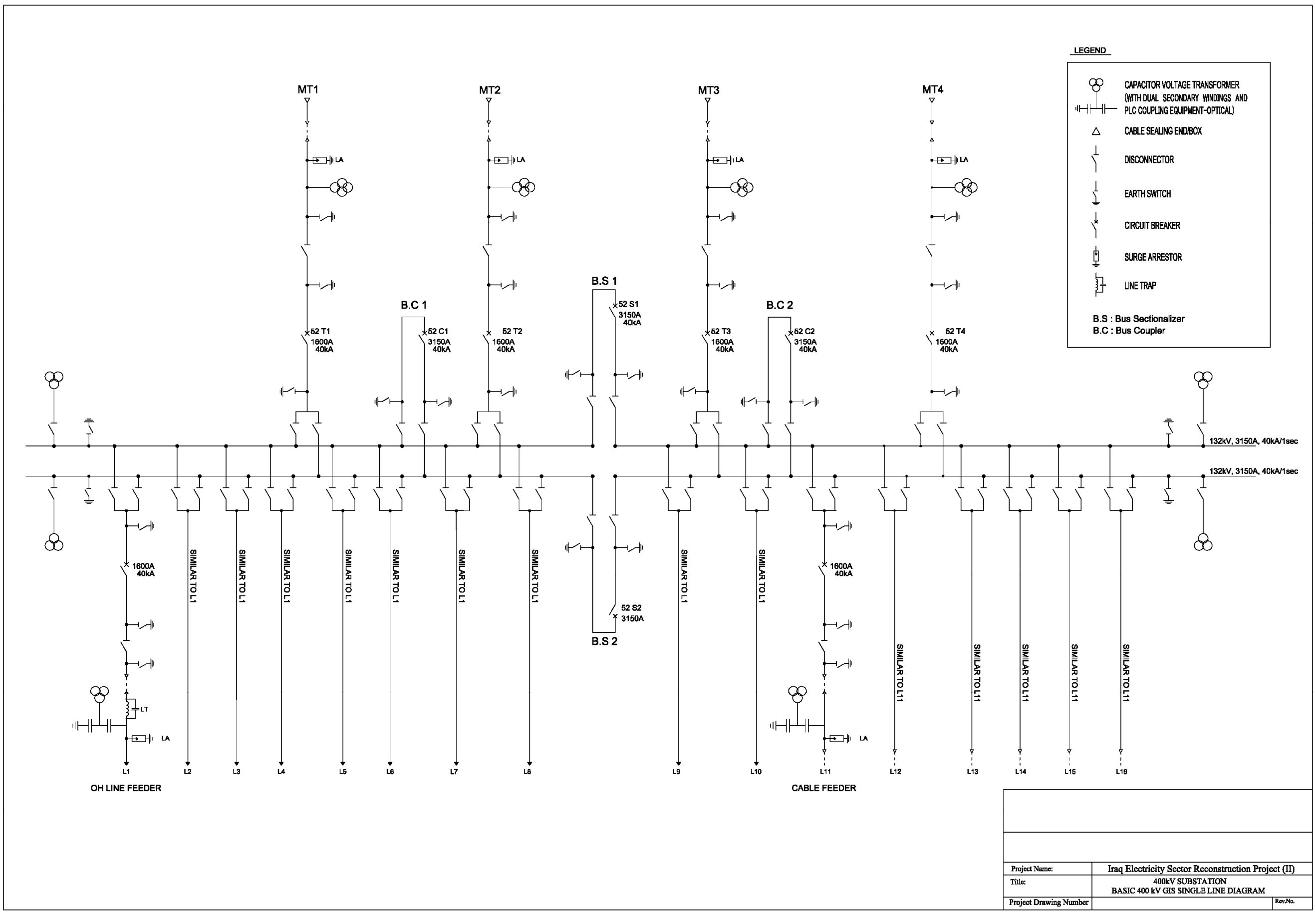
h) 32 kV GIS

The 132kV GIS shall be consisted of four (4) transformer feeders, sixteen (16) outgoing feeders for 132kV Lines, two (2) bus sections and two (2) bus coupler circuits.

Main specifications are shown below:

h1) Bus Type : double bus system
h2) Rated Voltage : 145kV
h3) Rated frequency : 50Hz
h4) Bus Rated current：3150A （40kA）
h5) Bus Rated breaking current：40kA
h6) Incoming（Tr Feeder）Rated current：3150A （40kA）
(Based on the 120% over load condition of 400kV transformer)
h7) Incoming（Tr Feeder）Rated breaking current：40kA
h8) Outgoing (line Feeder) Rated current：1600A （40kA）
(Based on the capacity of 132kV transmission; ie 337MVA)
h9) Outgoing (line Feeder) Rated breaking current：40kA

The typical Single line diagram of 132kV system is shown in fllowing Figure 6.1.2



Source: JICA Survey Team(MoE Specification & Discussion)

Figure 6.1.2 Single Line Diagram of 132kV System

(2) Substation layout

Equipment layout is considered based on the single diagram and following items

a) Both 400kV and 132kV GIS shall be indoor type, and be installed in the each purpose building.

b) The overall area dimensions of the substation will be considered as 320m x 270m including temporally storage area, site offices etc.

c) The 400kV GIS outgoing feeders are connected to 400kV Over Head Transmission Lines.

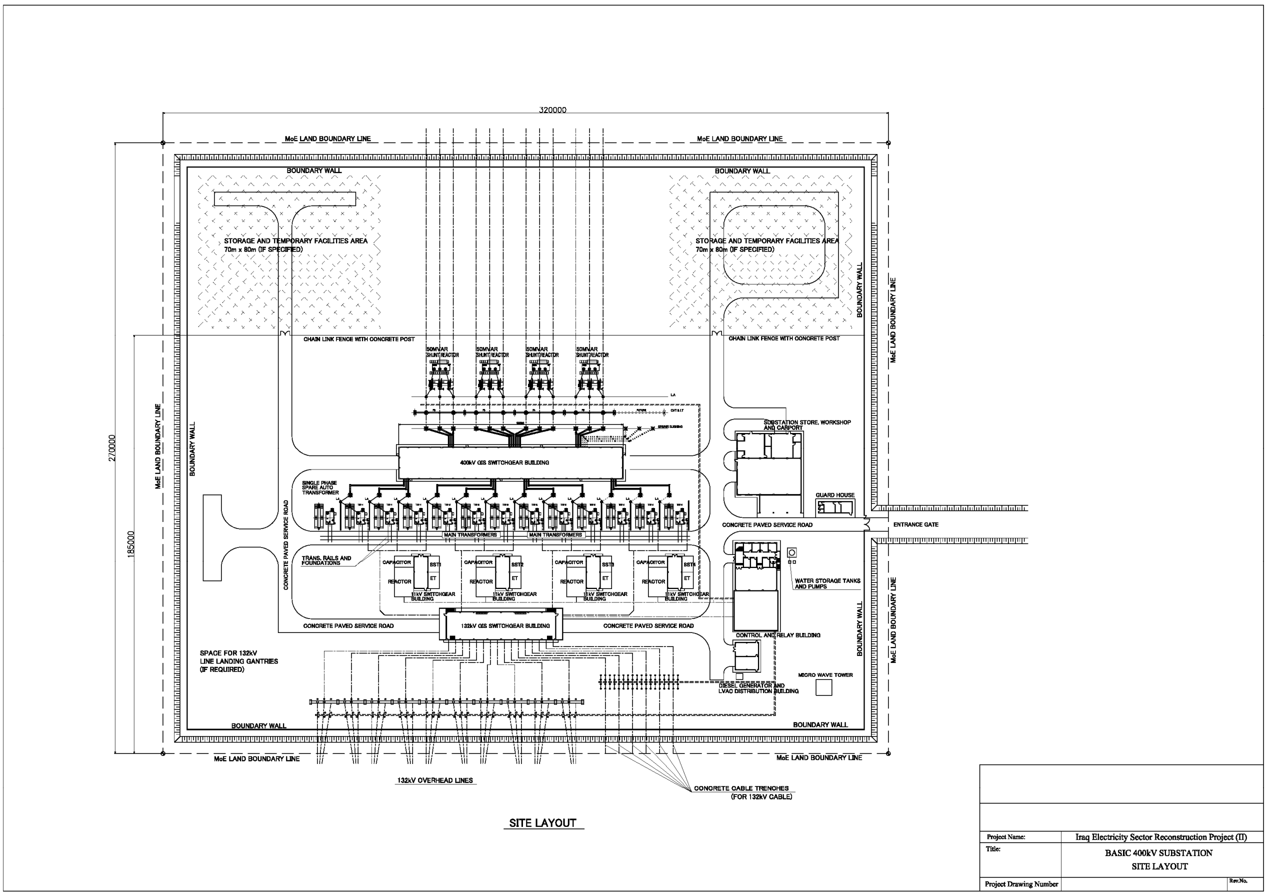
d) 400kV GIS and 500MVA/3 transformers are connected by overhead conductors.

e) Secondary transformer; ie 132kV side is connected to 132kV GIS by 132kV power cable.

f) 132kV GIS outgoing feeders are arranged as ten (10) Over Head Transmission Lines with the Gantry tower and six (6) Underground Transmission Cables.

400kV shunt reactors are recommended to review the necessity of installation based on the network conditions in the actual bidding stage.

The typical substation layout is shown in fllowing Figure 6.1.3.



Source: JICA Survey Team(MoE Specification & Discussion)

Figure 6.1.4 Typical substation layout (Shunt Reacor installation)

6.2 Quantities of Substation Facilities

The scope of works for the project includes design, manufacturing, factory testing, delivery, civil works, installation and testing & commissioning of the following substation equipment / facilities:
Typical quantities of facilities/equipment for 400kV Substation facilities are shown in the following table 6.2.1 for each substation;

Table 6.2.1 Typical quantities of Facilities of each Substation

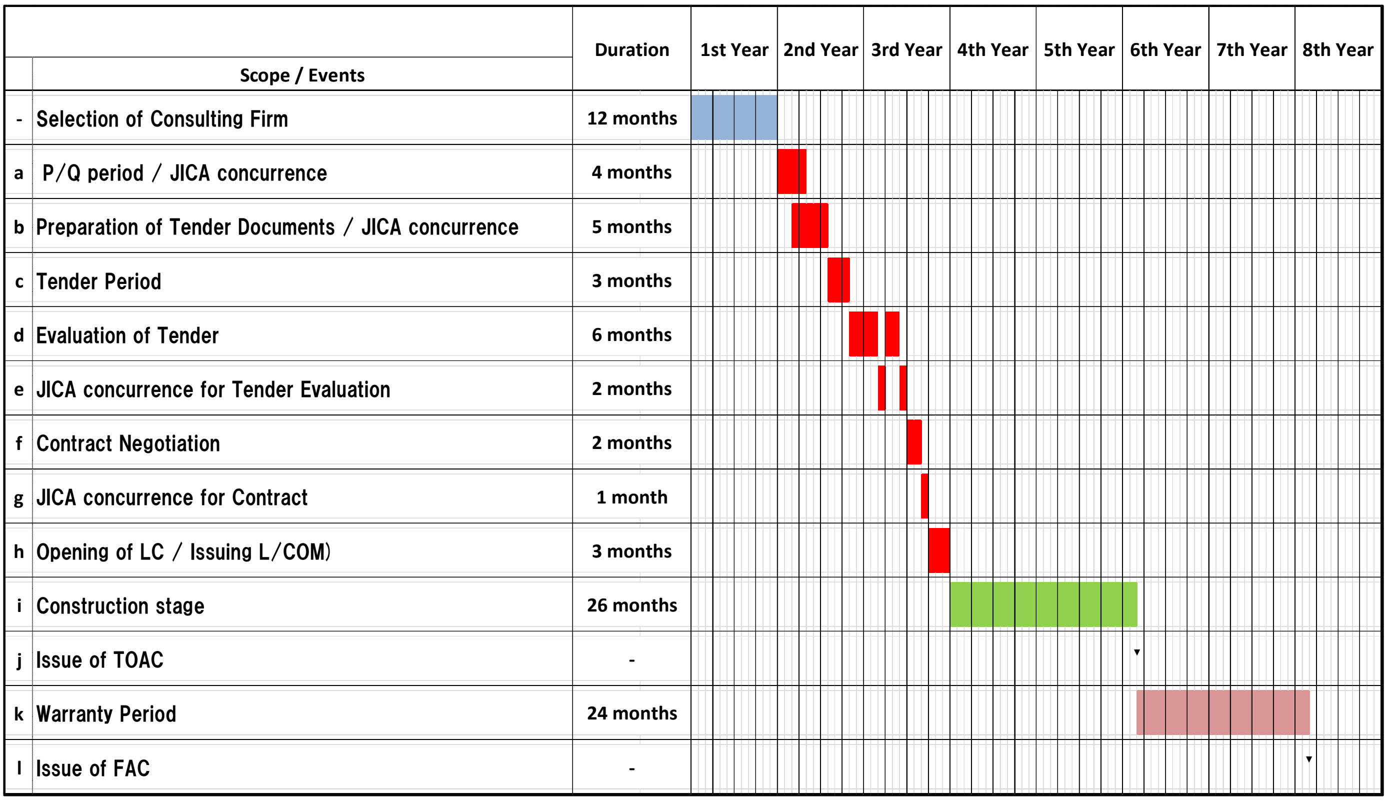
No.	Descriptions	Qty
1	Indoor type 400kV GIS -50kA	12CB
2	Indoor type 132kV GIS -40kA	24CB
3	Single phase 500/3MVA Auto transformer, 400/√3／138.6/√3／33kV	12units
4	400kV 50MVA Shunt Reactor	4Units *
5	Indoor type 33kV GIS For auxiliary circuits	4sets
6	400kV Outdoor Equipment (For transmission line)	4ccts
7	132kV Outdoor Equipment (Fir transmission line)	16ccts
8	SCS (Substation Control System)	Lot
9	Protection system	Lot
10	AC/DC System	Lot
11	Tele-communication system	Lot
12	Cables for 132kV, 33kV, LV & control	Lot
13	33kV E-Tr, NGR, 33kV capacitor bank, 33kV Shunt reactor	Lot
14	Buildings and building services equipment	Lot

Note; (*)
400kV shunt reactors are recommended to review the necessity of installation based on the network conditions in the actual bidding stage.

6.3 Construction Schedule

6.3.1 The Whole Construction Schedule for the Project

The whole Project Construction schedule for each case is shown in the following Figure 6.5.1.
As shown, the period of the Consultant selection will be 12 months. And, engineering service stage-1, i.e., Prequalification, Tender periods up to the Contract with the Contractor will be 24months. Guarantee period is 24 months from Taking Over the sites.
The construction period of the substation is 26months.

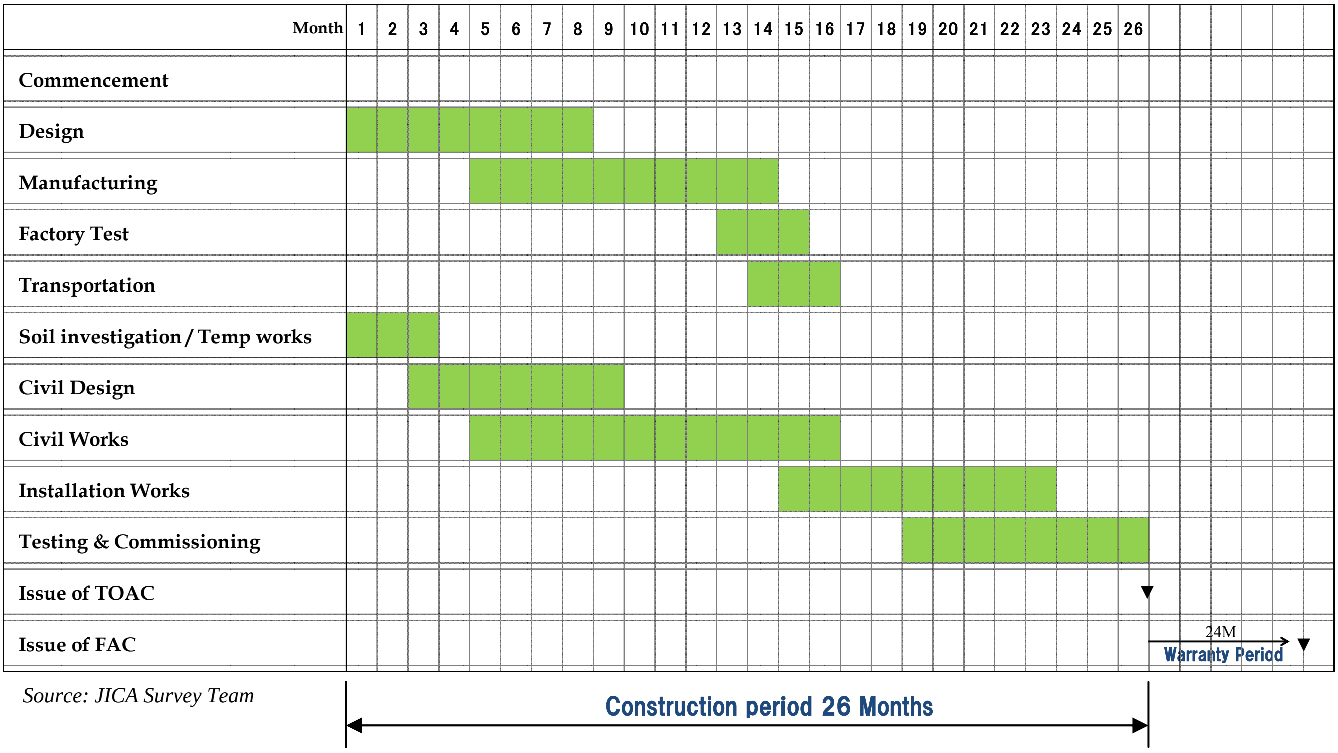


Source: JICA Survey Team

Figure 6.3.1 Whole Construction Schedule

6.3.2 Construction Schedule of the Substations

The construction periods will be 26 months from the commencement date and the warranty period by the Contractor would be 24 months from the taking over (TOAC) as shown in Figure



Source: JICA Survey Team

Figure 6.3.1 Construction Schedule of Al-Madaain Substation

6.4 Project Cost Estimation

6.4.1 Construction Cost of 400 kV Substation

The budgetary construction cost of the proposed 400kV substation (one substation) is 150 million dollars (including escalation and contingency).which is converted to this project scope from Tender Price submitted on September 2012 in JICA Electricity Reconstruction Project (MoE).

Table 6.6.1 shows the budgetary construction cost of the proposed 400kV substationm, the breakdown for construction cost of each substation facility is shown in the following Table 6.6.2.

Table 6.4.1 Construction Cost of S/S Facilities

Items / Descriptions			Price USD	Price JPY (USD 1=JPY 100)
Supply & Service	Supply of Equipment			
	a	Electrical & Communication Equipment	$ 82.318 M	¥ 8,232 M
	b	Insurances and Security for Inland Transportation	$ 8.232 M	¥ 823 M
	Site Work			
	c	Electrical Site Work & Civil/Building Work	$ 18.110 M	¥ 1,811 M
	d	Insurance	$ 1.876 M	¥ 188 M
	Specified Spare Parts & Maintenance Equipment		$ 3.526 M	¥ 353 M
	Recommended Spare Parts		$ 0.221 M	¥ 22 M
Common	Engineering, Electrical Design, Civil Design, Factory Inspection and Management etc including Training.		$ 7.317 M	¥ 732 M
Net Contract Price			$ 121.6 M	¥ 12,160 M
Contingency (10% of Net Contract Price)			$ 12.2 M	¥ 1,220 M
Cost Escalation (10% of Net Contract Price)			$ 12.2 M	¥ 1,220 M
Total FTK Construction Price			**$ 146.0 M**	**¥ 14,600 M**

Source: JICA Survey Team (MoE discussion)

Note ; MoE and Study Team confirmed about tax exemption as following;
In accordance with the note of exchange which will be signed by the Japanese government and the Iraqi government, personal income tax and corporate tax will be exempted in case of Japanese contractor though the details will be discussed and agreed between the two governments. In case of Iraqi investment project, which will mostly include this project, personal income tax and corporate tax will be exempted as long as they are listed as investment project by the Iraqi government.
Note : Foreign currency is generally applied for international contract in Iraq.

Table 6.4.2 The breakdown cost for Electrical & Communication Equipment

Items / Descriptions		Q'ty	Rrice (USD)
Electrical & Communication Equipment (Japanese Firms & Product)		-	$ 82,318 M
Cost Break Down)			
1	400kV GIS	12CB (4 Diameters)	$ 21,070 M
2	500MVA Auto Transformer	4 Units	$ 24,641 M
3	400kV Shunt Reactor	4 Units	$ 5,801 M
4	132kV GIS	24CB (16 Bays)	$ 6,305 M
5	Control / Protection	1Lot	$ 3,530 M
6	Others	1 Lot	$ 20,971 M

Source: JICA Survey Team (MoE discussion)

6.4.2 Consulting Service Cost

Table 6.4.3 shows the TOR Draft for the Consulting Services for the Project.

Table 6.4.3 Terms of Reference (Draft) for the Consulting Services

1. Common	1.1	The Consultants shall draft letter from the Owner to JICA, Contractors and anyone instructed by the Owner.
	1.2	The Consultants shall answer and explain questions and clarifications from the Owner for technical and commercial issues anytime requested.
	1.3	The Consultants shall advise the Owner the guidelines of JCIA anytime requested.
2. PQ Management	2.1	The Consultants shall draft the PQ documents which consists of invitation to applicant, instruction to applicant and templates which applicants shall fill in.
	2.2	The Consultants shall make announcement of the PQ (one English newspaper in Jordan, one Arabic newspaper in Jordan, three Arabic newspapers in Iraq) on behalf of the Owner.
	2.3	The Consultants shall receive PQ applications at the presence of delegates from the Owner.
	2.4	The Consultants shall evaluate PQ applications and submit the report to the Owner.
	2.5	The Consultants shall prepare and explain evaluation criteria and submit evaluation sheet to the Owner.
	2.6	The Consultants shall submit draft of the PQ evaluation report for Owner's review.
	2.7	The Consultants shall submit list of clarifications for applicants to answer if need be.
	2.8	The Consultants shall draft answers to JICA's clarification.
3. Tender Management	3.1	The Consultants shall perform site survey for each of the project sites.
	3.2	The Consultants shall submit draft of the tender documents: invitation to tenderer, instruction to tenderer, special conditions, and technical specifications.
	3.3	The Consultants shall draft answers to JICA's clarifications to the tender documents.
	3.4	The Consultants shall reproduce the tender documents for tenderers.
	3.5	The Consultants shall distribute the tender documents for tenderers on behalf of the Owner.
	3.6	The Consultants shall receive the tenders at the presence of the Owner on behalf of the Owner.
	3.7	The Consultants shall perform tender opening of Envelop A (technical) in accordance with checklist at the presence of the Owner and JICA on behalf of the Owner.
	3.8	The Consultants shall submit draft of the technical evaluation report to the Owner.
	3.9	The Consultants shall explain evaluation criteria and provide technical evaluation sheet.

	3.10	The Consultants shall submit draft of the technical evaluation report for Owner's review.
	3.11	The Consultants shall submit list of clarifications for applicants to answer if need be.
	3.12	The Consultants shall perform tender opening of Envelop B (financial) in accordance with checklist at the presence of the Owner and JICA on behalf of the Owner.
	3.13	The Consultants shall submit draft of the financial evaluation report to the Owner.
	3.14	The Consultants shall explain evaluation criteria and provide evaluation sheet.
	3.15	The Consultants shall submit draft of the financial evaluation report for Owner's review.
	3.16	The Consultants shall submit list of clarifications for applicants to answer if need be.
	3.17	The Consultants shall assist and support the Owner in negotiating with the first ranked tenderer.
	3.18	The Consultants shall draft the contract documents (commercial and technical).
4. Implementation	4.1	The Consultants shall assist and support the Owner in opening LC in favor of the contractor.
	4.2	The Consultants shall attend the kick off meeting.
	4.3	The Consultants shall attend the progress/coordination meetings.
	4.4	The Consultant shall supervise the progress of the Project Schedule (design, manufacturing, factory tastings, delivery, site installation, site testing and commissioning tests) and comment, if any.
	4.5	The Consultant shall review the Contractor's proposed Project Schedule, Organization Chart, Drawing list etc and comment, if any.
	4.6	The Consultant shall assist the Owner and draft the documents if the Amendment of the Contract became necessary with the Contractor.
	4.7	The Consultants shall review the Contractor's "For approval drawings" and make comments on them.
	4.8	The Consultant shall review the Factory Test Reports and comments, if any.
	4.9	The Consultants shall draft (1) Documentation Manual and (2) Site Management Manual for smooth/safety project execution.
	4.10	The Consultants shall assist and support the Owner for the site works, such as Civil works, installation works etc.
	4.11	The Consultants shall assist and support the site testing and commissioning test.
	4.12	The Consultant shall assist and support the Owner to collect O & M Manuals, Site tests reports, Red-marked drawings and As built Drawings".
	4.13	The Consultants shall assist and support the Owner in taking over the site (TOAC).
	4.14	The Consultant shall assist and support the Owner in cooperating with JICA, if any.

5. Warrantee Period	5.1 5.2 5.3	The Consultants shall assist and support the Owner technically and commercially. The Consultant shall assist and support the Owner to complete the outstanding in Snag list of TOAC. The Consultant shall assist and support the Owner in Final Acceptance Certificate.
6. Office	6.1	The Consultant should have an office in Baghdad/Iraq

Source: JICA Survey Team

The study team calculated the Consulting Service Cost as following 2 cases.

Table6.4.4 Calculation case for the Consulting Service

Item	Description
1	Consulting Service Cost（Fixed Porion）
2	Consulting Service Cost（Variable Porion）

Source: JICA Survey Team

The following Figure 6.4.1 shows Draft Consultant MM Plan, Table 6.4.5 and 6.4.6 show Consulting Services cost for Fixed Prtion and Variable Portion.

	No.	Scope / Events	Descriptions	Duration	2014												2015												2016												2017												2018												2019											
Implementation Schedule					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	49	50	51	52	53	54	55	56	57	58	59	60
	LOT1	400kV GIS Substation Construction		26 months	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
MM for Consultants	Consulting Services			XX months																																																																										
	1. Foreign Consultant (JP)			MM																																																																											
	F-1	Project Manager	Multiple LOT ; If Any	54.0													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1			1			2
	F-2	Senior Electrical Engineer	Multiple LOT ; If Any	54.0													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1			1			2
		Senior Civil Engineer	Multiple LOT ; If Any	54.0													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1			1			2
		Senior Control & Protection Engineer	Multiple LOT ; If Any	54.0													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1			1			2
		Senior Telecom.,Engineer	Multiple LOT ; If Any	54.0													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1			1			2
		Senior Commercial Expert	Multiple LOT ; If Any	54.0													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1			1			2
			S-Engnr Sub Total	270.0																																																																											
	Total for Foreign Consultants			270.0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	0	0	0	6	0	0	6	0	0	12
	2. Local Site Consultant (in Baghdad office)			MM																																																																										
	L-1	Senior Engineer / Leader	Multiple LOT ; If Any	53.0													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1			1			1
	L-2	Senior Electrical Engineer /Leader of the LOT	SS 1 LOT	53.0													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1			1			1
		Senior Civil Engineer	SS 1 LOT	53.0													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1			1			1
		Senior Control & Protection Engineer	SS 1 LOT	53.0													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1			1			1
		Senior Telecom.,Engineer	SS 1 LOT	53.0													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1			1			1
			S-Engnr Sub Total	212.0																																																																											
	L-3	Electrical Engineer	SS 1 LOT	53.0													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1			1			1
			S-Engnr Sub Total	53.0																																																																										
	3. Local Site Consultant (in each site)																																																																													
	Q-1	Site Mamager	SS 1 LOT	26.0																																					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1										
			SM Sub Total	26.0																																																																												
	Q-2	Senior Electrical Engineer	SS 1 LOT	26.0																																					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1										
		Senior Civil Engineer	SS 1 LOT	26.0																																					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1										
			S-Engnr Sub Total	52.0																																																																												
	Total for Local Consultants (Item2+3)			78.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	0.0	0.0	0.0	6.0	0.0	0.0	6.0	0.0	0.0	6.0

Note: Calendar months stipulated in the above is just reference only.

: Selection of Consultant Firm
: Tender Stage, Consulting Service
: Construction Stage
: Warranty Period

Source: JICA Survey Team

Figure 6.4.1 Draft Consultant MM Plan

Table 6.4.5 Consulting Services cost of the Project (Fixed Portion)

1. Engineer Fee

No.	Descriptions	MM, other	Rate(Yen)	Unit	Price (Yen)
1.1	Engineer Fee				
	Foreign Consultant (Japanese)				
	1.1 Project Manger	54	2,500,000	MM	135,000,000
	1.2 Senior Engineer	270	2,500,000	MM	675,000,000
	MM Sub Smm	324			
1.2	Local Site Consultant (Baghdad)				
	(1) Senior Engineer / Leader	53	1,560,000	MM	82,680,000
					0
	(2) Senior Engineer	0	1,020,000	MM	0
					0
	(3) Engineer	0	1,020,000	MM	0
1.3	Local Site Consultant (Site)				
	(1) Site Manager	0	1,560,000	MM	0
	(2) Senior Engineer	0	1,020,000	MM	0
	MM Sub Smm (1.1 + 1.2)				
		53			
	(A) Sub Summ (1.1 : 1.3)				892,680,000

2. Direct Cost

Descriptions	MM, other	Rate(Yen)	Unit	Price (Yen)
2.1 Direct Cost (Office rent, Air fee, Accomodation, etc ; (A)*35%)				312,438,000
2.1 Air Fee				
2.1.1 Iraq-Japan for Japanese	72	900,000	trip	64,800,000
6persons * 3trips / year.for 4years				
2.2 Accommodation				
2.2.1 In Iraq for Japanese	28	12,000,000	Person-years	336,000,000
Breakdown)				
PM 54 MM/12 = 5				
SE 270 MM/12 = 23				
Total : 28				
2.3 Transpotation				
2.3.1 In Iraq				
(1) Initial cost	0	3,000,000	cars	0
0 car / Site office				
(2) Running cost	0	500,000	car-months	0
0 cars * 26 months				
2.4 Office				
2.4.1 Office Rent for Project Management in Iraq Baghdad	56	2,000,000	months	112,000,000
Office furniture, IT equipment, the other				
2.4.2 Office Rent for Project Management in Iraq Baghdad	56	80,000	months	4,480,000
Project coordinator, Secretary, Receptionist, the other				
2.4.3 Office Rent for the project Site in Iraq				
(1) Initial cost	0	1,000,000	months	0
(2) Running cost	0	80,000	months	0
2.4.4 Office Staff for the Site office in Iraq	0	80,000	months	0
Admin, Secretary, Office boy, the other				
2.5 Communication and Document Delivery Cost				
Telephone bill, fax, mobile, internet access, other	56	336,000	months	18,816,000
2.6 Security cost in Iraq	4	240,000,000	years	960,000,000
(B) Sub Summ (2.1 : 2.6)				1,496,096,000

Total Cost				2,388,776,000
				Say 2,400,000,000

Source: JICA Survey Team

Table 6.4.6 Consulting Services cost of the Project (Variable Portion)

1. Engineer Fee

No.	Descriptions	MM, other	Rate(Yen)	Unit	Price (Yen)
1.1	Engineer Fee				
	Foreign Consultant (Japanese)				
	1.1 Project Manger	0	3,000,000	MM	0
	1.2 Senior Engineer	0	3,000,000	MM	0
	MM Sub Smm	0			
1.2	Local Site Consultant (Baghdad)				
	(1) Senior Engineer / Leader	0	1,560,000	MM	0
					0
	(2) Senior Engineer	212	1,020,000	MM	216,240,000
					0
	(3) Engineer	53	1,020,000	MM	54,060,000
1.3	Local Site Consultant (Site)				
	(1) Site Manager	26	1,560,000	MM	40,560,000
	(2) Senior Engineer	52	1,020,000	MM	53,040,000
	MM Sub Smm (1.1 + 1.2)				
		343			
	(A) Sub Summ (1.1 : 1.3)				363,900,000

2. Direct Cost

2.1 Direct Cost (Office rent, Air fee, Accomodation, etc ; (A)*35%)					127,365,000
2.1 Air Fee					
2.1.1 Iraq-Japan for Japanese		0	900,000	trip	0
4persons * 3trips / year,for 5years					
2.2 Accommodation					
2.2.1 In Iraq for Japanese		0	12,000,000	Person-years	0
Breakdown)					
PM 0 MM/12 = 0					
SE 0 MM/12 = 0					
Total : 0					
2.3 Transpotation					
2.3.1 In Iraq					
(1) Initial cost		1	3,000,000	cars	3,000,000
1 car / Site office					
(2) Running cost		26	500,000	car-months	13,000,000
1 cars * 26 months					
2.4 Office					
2.4.1 Office Rent for Project Management in Iraq Baghdad		0	2,000,000	months	0
Office furniture, IT equipment, the other					
2.4.2 Office Rent for Project Management in Iraq Baghdad		0	80,000	months	0
Project coordinator, Secretary, Receptionist, the other					
2.4.3 Office Rent for the project Site in Iraq					
(1) Initial cost		1	1,000,000	months	1,000,000
(2) Running cost		26	80,000	months	2,080,000
2.4.4 Office Staff for the Site office in Iraq		26	80,000	months	2,080,000
Admin, Secretary, Office boy, the other					
2.5 Communication and Document Delivery Cost					
Telephone bill, fax, mobile, internet access, other		26	336,000	months	8,736,000
2.6 Security cost in Iraq		0	240,000,000	years	0
	(B) Sub Summ (2.1 : 2.6)				29,896,000

Total Cost					393,796,000
					Say 400,000,000

Source: JICA Survey Team

6.4.3 Total Project Costs

Table 6.5.1 shows the summary of the total costs for the Project.

Table 6.5.1 Total Project Costs

Items	Unit（US$）	Q'ty	Total（US$）
Substations Construction Cost	146 M	8	1,168 M
Consulting Service Cost (Fixed Portion)	24 M	1	24 M
Consulting Service Cost (Variable Portion)	4 M	8	32 M
Ground Total			1,224 M

Source: JICA Survey Team

Note: 100Yen/USD
Cost of the fixed portion includes the security cost in Iraq.
Contingency cost is included in the construction cost.

Chapter 7

Proposal of Appropriate Operation, Management and Maintenance System for MOE

Chapter 7 Proposal of Appropriate Operation, Management and Maintenance System for MOE

7.1 Financial Analysis of MOE

7.1.1 Financial Structure of MOE

As the above mentioned regarding MOE financial conditions in 2011, the revenue was only 40 % to operating and management cost (O/M cost). The remains with 60 % to the total cost are covered by subsidy from the Government. The details of the subsidy are mainly O/M cost and fuel cost expenses, and capital funds for investment are also supplied by the Government. As MOE is not independent company and it is one of the ministries in Iraq, MOE does not make their financial statements regarding power business.
When looking at the MOE data on power business, the average power tariff in 2011 was 3.2 ¢ /kWh（37.4 ID/kWh） and the subsidy was 4.9 ¢ /kWh（57.4 ID/kWh）. Therefore, the cost was 8.1 ¢ /kWh（94.8 ID/kWh）. The above data are calculated by revenue and cost data of MOE in 2011, other management cost accounts data such as payable interests, repayment of long term loan (cash flow management base) and profit are not available to collect.

Table 7.1.1 Revenue, subsidy and cost of MOE（Actual data for 2009～2011）

ID base	Unit	2009	2010	2011
Average power tariff	ID/kWh	19.0	25.0	38.0
Cash unit cost	ID/kWh	97.3	87.8	95.3
Subsidy (Cash cost - Sale)	ID/kWh	78.3	62.8	57.3
Subsidy contribution	%	80.5	71.5	60.1
USD base	Unit	2009	2010	2011
Average power tariff	¢ /kWh	1.6	2.1	3.2
Cash unit cost	¢ /kWh	8.3	7.5	8.1
Subsidy (Cash cost - Sale)	¢ /kWh	6.7	5.4	4.9
Subsidy contribution	%	80.5	71.5	60.1

Source: Original data are from MOE

7.1.2 Calculation for Power Tariffs as Power Business of MOE

Under the current data collected, the average power tariffs are simulated when MOE becoming an independent company.

(1) Power sales and generation
The following table shows power sales and generation. The sales are the forecasting values of JICA Study team, power sales are calculated with “MW × 8,760 hours” and the generation is “Sales + own use with 5% to power sales volume”. And the power sales include social loss and technical loss.

Table 7.1.2 Prediction for Power sale and Generation of MOE

		2012	2013	2014	2015	2016	2017	2018	2019	2020
Peak load	MW	14,017	15,279	16,654	17,986	19,281	20,669	22,157	23,753	25,463
Average Load	MW	9,812	10,695	11,658	12,590	13,497	14,468	15,510	16,627	17,824
Own use	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Generation	TWh	90.5	98.6	107.5	116.1	124.5	133.4	143.0	153.3	164.4

Source: JICA Study team

(2) Investment and Long term loan repayment plan

The following table shows MOE investments for generation, transmission and distribution facilities. The investment trends are as the following table. The investments from 2004 to 2012 are actual values, and the investments forecasted after 2013 are referred to generation, transmission and distribution investments in " Overview and Introduction to the Iraq Electricity M/P by PB". The following table includes investments, loan repayment and loan balance from 2012 to 2020.

Table 7.1.3 Investment and long term loan plan

	Investment	Accumlative	Balance									
	ID Billion	ID Billion	ID Billion	2012	2013	2014	2015	2016	2017	2018	2019	2020
2004	160	160	152	8	8	8	8	8	8	8	8	8
2005	469	629	598	23	23	23	23	23	23	23	23	23
2006	1,375	2,004	1,904	69	69	69	69	69	69	69	69	69
2007	1,223	3,227	3,066	61	61	61	61	61	61	61	61	61
2008	1,211	4,438	4,216	61	61	61	61	61	61	61	61	61
2009	2,284	6,722	6,386	114	114	114	114	114	114	114	114	114
2010	1,547	8,268	7,855	77	77	77	77	77	77	77	77	77
2011	4,414	12,683	12,049	221	221	221	221	221	221	221	221	221
2012	7,018	19,700	18,715	351	351	351	351	351	351	351	351	351
2013	4,867	24,568	23,339		243	243	243	243	243	243	243	243
2014	4,639	29,207	27,746			232	232	232	232	232	232	232
2015	4,026	33,233	31,571				201	201	201	201	201	201
2016	3,116	36,348	34,531					156	156	156	156	156
2017	3,398	39,746	37,759						170	170	170	170
2018	4,210	43,956	41,758							210	210	210
2019	4,523	48,479	46,055								226	226
2020	4,597	53,076	50,422									230
			Repayment	985	1,228	1,460	1,662	1,817	1,987	2,198	2,424	2,654

Source: "Generation + Transmission + Distribution" in Overview and Introduction to the Iraq Electricity M/P by PB

In the analysis, it is assumed that the investment capital funds are applied by long term loan, and the repayment term is 15 year. Therefore, the annual repayment of the long term loan is one fifteenth of the loan. The "Repayment" column in the table shows repayment of the long term loan every year, and the repayment plan in the table starts from 2004. Although long term loan before 2003 exists in MOE, the loans are omitted in the analysis. As the results, the payable interests can be calculated.

(3) Factors of power tariff calculation

As the factors required at time of calculating power tariffs, GDP growth rates, investments, long term loan balance, payable interest of loan term loan, required return on asset and power generation efficiency and so on are required. The details are as follow;

a) GDP growth rates are 8 %～9 % per year and it is used for calculating the required investment.
b) The required investments are used for building generation, transmission, distribution and substation facilities.
c) The payable interests are used for repayment of long term loan balance.
d) Return on asset (ROA) is set with 10 % to the total assets. The asset values are applied by the same to long term loan balance.
e) The improvement of power efficiency shows fuel consumption efficiency in company with introducing gas combined cycles. And the average power efficiencies in MOE are improved with 1 % per year.
f) Fuel and wage costs are increased by the growth rate of " Power generation growth * Power efficiency index". Power efficiency index is accumulation of the power efficiency rate (2012=100).

Table 7.1.4 Factors for calculating power tariff

Items	Unit	2012	2013	2014	2015	2016	2017	2018	2019	2020
GDP growth rate	%	6.7	9.0	9.0	8.0	8.0	8.0	8.0	8.0	8.0
Investment	Billion ID	7,018	4,867	4,639	4,026	3,116	3,398	4,210	4,523	4,597
LTL Balance	Billion ID	18,715	23,339	27,746	31,571	34,531	37,759	41,758	46,055	50,422
Interest rate	%	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
ROA	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Power efficiency	2012=100	100	99	98	97	96	95	94	93	92

Note: LTL = long term loan, LTL balance = Investment + LTL balance in previous year – LTL repayment in MOE

Power efficiency means power generation efficiency and energy conservation index

Source: JICA Study team

(4) Cash flow and power tariff

As contents of "Cash in" in the table, it is revenue of power sales, the factors as "Cash out" are fuel cost, wages payable interest, repayment of long term loan and profit before tax. As the purpose of the analysis is to calculate power tariffs for MOE to keep suitable profits as independent company, the factor arrangement of the cash flow is defined as the above. The discount rate is given by 10% and it is applied for cash in and cash out.

Under the above definition, if the power tariffs are calculated with taking account of balancing cash in and cash out, (it is not "Income statements") the results are as the followings.

a) The power tariff in 2012 is 15.6 ¢ /kWh（182 ID/kWh）, and it increases gradually to 16.4 ¢ /kWh（191 ID/kWh） in 2020.
b) The average power tariff during the calculation period is 16.2 ¢ /kWh (190 ID/kWh） . The average fuel and wage costs in the same period is 9.9 ¢ /kWh （116 ID/kWh） .

Table 7.1.5 Cash flow and power tariff

			2012	2013	2014	2015	2016	2017	2018	2019	2020
Cash out	Fuel	ID Billion	10,383	11,205	12,090	12,923	13,711	14,545	15,428	16,363	17,353
	Labor	ID Billion	1,107	1,129	1,151	1,174	1,198	1,222	1,246	1,271	1,297
	Interest	ID Billion	1,310	1,634	1,942	2,210	2,417	2,643	2,923	3,224	3,530
	Repayment	ID Billion	985	1,228	1,460	1,662	1,817	1,987	2,198	2,424	2,654
	Profit	ID Billion	1,872	2,334	2,775	3,157	3,453	3,776	4,176	4,606	5,042
	Total	ID Billion	15,656	17,530	19,418	21,126	22,597	24,173	25,971	27,888	29,875
Chash in	Tariff	ID /kWh	182	187	190	192	191	191	191	191	191
	Tariff	c /kWh	15.6	16.0	16.3	16.4	16.3	16.3	16.3	16.4	16.4
	Revenue	ID Billion	15,656	17,530	19,418	21,126	22,597	24,173	25,971	27,888	29,875
Present	DCF	10%	100	91	83	75	68	62	56	51	47
Value	Power sales	GWh	85,952	85,173	84,399	82,863	80,753	78,697	76,693	74,743	72,840
	Revenue	ID Billion	15,656	15,936	16,048	15,873	15,434	15,010	14,660	14,311	13,937
	Tariff	ID /kWh	190								
		c/ kWh	16.2								
	Fuel cost	ID Billion	10383	10186	9991	9709	9365	9031	8709	8397	8095
	Cost	ID /kWh	116								
		c/ kWh	9.9								

Source: JICA Study team

(5) Financial condition analysis for MOE

The return on sales is 12.0 % in 2012 under the condition of return on assets with 10 %, after that, it gradually increases to 16.9 % in 2020. As an additional assumption, the profit used for return on sales is "Profit before tax", not "Profit after tax". When using profit after tax for return on sales, it is 10.3 % in 2012 and 14.7 % in 2020.

Table 7.1.6 Profit analysis of MOE

Items	Unit	2012	2013	2014	2015	2016	2017	2018	2019	2020
Profit on sales	%	12.0	13.3	14.3	14.9	15.3	15.6	16.1	16.5	16.9
Variable profit ratio	%	33.7	36.1	37.7	38.8	39.3	39.8	40.6	41.3	41.9
Investment per VA	%	133.1	77.0	63.3	49.1	35.1	35.3	39.9	39.2	36.7
Profit per kWh	ID / kWh	21.8	24.9	27.2	28.6	29.2	29.8	30.7	31.6	32.3
Profit per kWh	c / kWh	1.9	2.1	2.3	2.4	2.5	2.5	2.6	2.7	2.8

Note: VA: Value added

Source: JICA Study team

The marginal profit ratio defined by "(Sales – Variable cost) / Sales" in 2012 is 33.7 % and it is 41.9 % in 2020. At the same time, the investment per value added ratio (Investment / Value added (= "Sales – Variable costs") is 133 % in 2012, after that, it becomes 36.7 % in 2020. Therefore, as the results it can say that the current MOE is over investment, however, after 2016, MOE gets well balance on investment ratio (Investment / valued added). Generally, it is said that the maximum investment ratio (Investment / Value added) is 40 %.

The profit before tax per kWh is 1.9 ¢ /kWh（21.8 ID/kWh）in 2012, and it is 2.8 ¢ /kWh（32.3 ID/kWh） in 2020. The profits before tax per kWh almost do not change during the calculation period.

As the above mentioned, the power tariffs have to be set as the following table for MOE to implement business activities as independent company.

When looking at the power tariff system as resulting the analysis, it is required that the average power tariff is 16.3 ¢ /kWh（190 ID/kWh）. For keeping the average tariff , the power tariff in 2012 has to be improved to 15.6 ¢ /kWh（182 ID/kWh） and it is gradually increased to 16.4 ¢ /kWh（191 ID/kWh）in 2020. However, as the current average power tariff is around 3.2 ¢ /kWh（38 ID/kWh）, the average power tariff in the analysis is around five times to the current average power tariff.

Table 7.1.7 Future power tariffs of MOE as independent company

	2012	2013	2014	2015	2016	2017	2018	2019	2020
ID /kWh	182	187	190	192	191	191	191	191	191
c /kWh	15.6	16.0	16.3	16.4	16.3	16.3	16.3	16.4	16.4

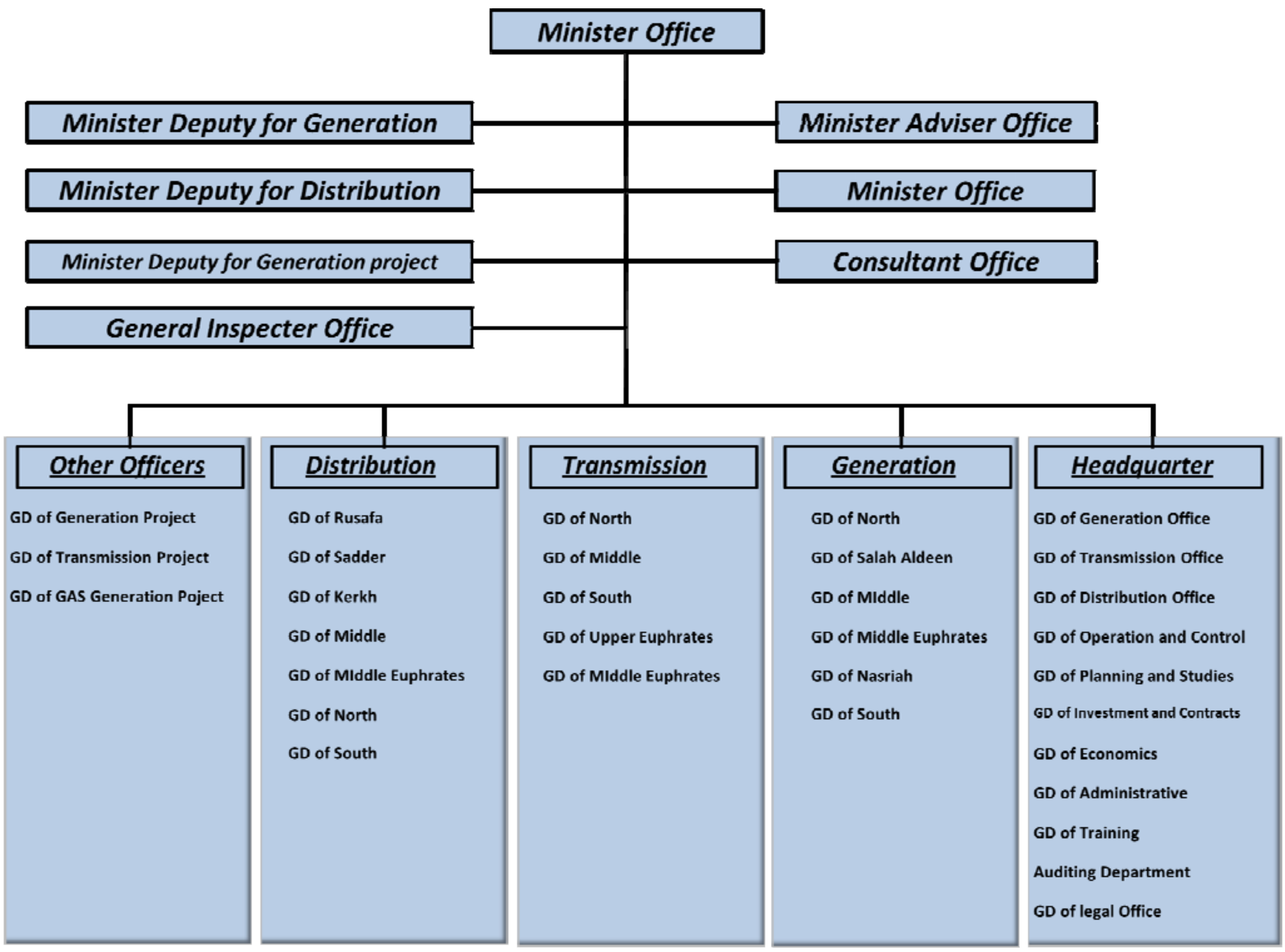
Source: JICA Study team

7.2 Operation and Maintenance Management System

7.2.1 Organization of MOE

Electricity Sector of Iraq is governed by Electricity Law. MoE is engaged in operation of whole of electrical power system from generation, transmission, distribution and collection of electricity bill from the consumers based on the law. The Electricity Law had previously prohibited private companies from participating in the electricity business. However, the law has already been amended and Independent Power Producer (IPP) has been allowed to be involved in power generation.

The organization chart of MoE, which was provided by the MoE through the study, is as shown in Figure 7.2.1 below.



Source: MoE

Figure7.2.1 Organizational Chart of MoE

7.2.2 Directorate to be involved in the Project

In order to implement the project smoothly, mutual understanding based on the close communication between MoE and the contractor (also the consultant) is very important.

And it is necessary to be cooperated with MoE that the project will be sufficiently planned and implemented and that the Substation will be successfully completed and being operated with its full capacity.

The department of MoE to be assigned for each stage of the project will be as follows:

a) Planning Stage

General Directorate (GD) of Transmission Projects and **GD of Planning and Studies** will be assigned for planning of the project.

b) Implementation Stage

GD of Transmission Projects and **GD of regional Transmission department** will be assigned for the implementation of the project.

c) Operation Stage

After completion of construction works, the facilities will be transferred from **GD of Transmission Projects** to **GD of regional Transmission department**.
And the facilities will be operated by **GD of regional Transmission department .**
Furthermore, if necessary, the training of the staff will be performed by **GD of Training**.

Chapter 8

Project Evaluation

Chapter 8 Project Evaluation

8.1 Financial Analysis

8.1.1 Principles of Financial Appraisal

(1) Project appraisal

a) Project criteria are generally conducted as financial analysis based on “Direct accounting principles”. In particular, when project feasibility is expressed in a manner that is dependent on fund procurement, rather than estimating the inherent profitability of the project, sometimes the project feasibility is determined by the quality of fund procurement. However, project feasibility is essentially independent of fund procurement, and which should be used to determine the profitability of a project. As achieving the purposes, the internal rate of return method (FIRR) that is based on the present value has been prepared and is used widely today.

b) However, when concerning projects for infrastructure construction or energy development to have an extremely strong publicity, the financial internal rate of return is often low, and such projects cannot be realized without support from governments and international development agencies. The phenomenon is particularly true in newly emerging nations, middle and developing countries.

c) For a long time, the FIRR criterion was set at more than 15 % throughout the world. In this case, assuming an interest rate of 7 % on a loan with 70 % of total investment. Such an investment return was previously standard practice for private sector enterprises, however, the situation has undergone major change after the Lehman shock, global recession, fiscal worsening of the EU, worldwide deflation and low interest policies, etc. In other words, the profitability can still be secured even when the FIRR is low due to the low interest rates applied to fund procurement now.

d) Considering the current conditions of investors and financing institutions in Middle and Developing countries, the interest rate of ODA projects is in the range of 1~3 %, the FIRR in state-owned or public project operators is deemed to be in the range of 2~6 %.

Table 8.1.1 Expected FIRR (Interest rate =7%) at private sector

Minimum FIRR	＝ 1.0＊Interest ＋ (Interest* 1/2)	10.5%
Standard FIRR	＝ 1.5* Interest + (Interest *1/2)	14.0%
Maximum FIRR	＝ 2.0 *Interest + (Interest *1/2)	17.5%

(2) Effective interest rate

a) Borrowing rates in middle developed and developing countries are generally higher than in developed countries. For example, when inflation percentage of a country is 5 % and interest rate is 12 %, the interest rate is determined in a manner that includes the inflation rate. This is referred to as the nominal interest rate, however, inflation factors are generally excluded in financial analysis, the effective interest rate (7 % = 12% - 5%) that doesn’t include inflation should be used.

b) Until now the effective interest rate in middle developed and developing countries has usually been around 7 %, while in developed countries with smaller demand for funds, it has been around 5 %. However, the present effective interest rate in middle developed and developing countries is between 7~10 %.

8.1.2 Preconditions of Financial Analysis

(1) Discount rate

Discount rate is one of measures to convert the future values to present values. The discount rate becomes higher in proportion with project risk and interest rate in the targeted country. When deciding the discount rate, usually loan and deposit interest rates are referred in the targeted country. Iraqi effective interest rate has been 11.5 % from 2007 to 2012. However, the effective interest rates from 2010 to 2012 are around 10 %. In middle income countries, Iraqi effective lending rate with 10 % is almost equivalent to other middle income countries. Therefore, Iraqi discount rate is set with **10 %** though including project risk. The following table shows loan and deposit interest rates in Iraq.

Table 8.1.2 Deposit and Lending rates in Iraq

	2007	2008	2009	2010	2011	2012	Average
Discount rate	20.00	16.75	8.83	6.25	6.00	6.00	10.7
Deposit rate	10.43	10.54	7.82	6.06	5.91	6.88	7.6
Lending rate	18.78	19.22	16.16	14.35	14.13	13.59	15.8
Inflation rate	14.7	27.1	-15.4	2.1	6.2	5.8	4.3
Effective deposit rate	6.1	6.2	3.5	1.8	1.6	2.6	0.1
Effective lending rate	14.5	14.9	10.1	10.1	9.8	9.3	11.5

Note: Effective deposit Effective lending rate is defined by "Nominal rate – inflation rate"

Source: International Financial Statistics

Table 8.1.3 Discount rates of International development institutes

Institutes	Values
International Development Bank rate＋Risk(Interest/2)	10.5 % (7.0%+3.5%）
Commercial bank interest rate ＋Risk(Interest /2)	12.7 % (8.45%+4.22%)
Overseas Development Administration announces	10.0 %

Note: half of interest rates are set for hedging risk for each indicator.

(2) Depreciation conditions

Depreciation conditions for the project such as calculation period, depreciation period, residual value rate and depreciation method are as the following table.

Table 8.1.4 Calculation and Depreciation conditions

Items	Equipment	Values
Calculation period	Transmission line Substation	30 years after operation 30 years after operation
Depreciation period	Transmission line Substation	25 years after operation 20 years after operation
Residual value rate	Substation and Transmission line	5% of investment
Depreciation method	Substation and Transmission line	Straight line method

Source: JICA Study team

(3) Long term loan

When financed by JICA, the following loan term loan conditions are applied.

Table 8.1.5 Conditions of long term loan (JICA loan)

Items	Values
Classification of income	Middle income country class (1,916USD～3,975USD)
Loan condition	Standard interest rate
Interest rate	1.4 %
Repayment period	25 years
Grace period	7 years
Procurement condition	Un-tight

Source: JICA HP

(4)Short term loan (STL)

There is time delay between power generating time and collecting power sale money. The implementation organization like MOE has to borrow short term loan for filling the capital shortage due to the time difference. It is called “Working capital” in accounting aspect and the implementation organization has to pay the interest of the short term loan, if borrow the short term loan from local banks. Regarding transmission and substation projects, the interest cost of the short term loan has to be owned as well as power generation sector and power distribution sector.

Table 8.1.6 Short term loan for working capital

Items	Calculation methods	Values
Required W/C	Calculate receivable additional SS& TL costs	One month sight
Sort term loan (STL)	Make STL for W/C and business deficits	
Interest rate of STL	Effective lending rate of private banks	10.0%

Note W/C: Working capital STL: Short term loan

8.1.3 Tax system of Iraq

Japan External Trade Organization(JETRO) who is Japanese governmental organizations and Deloitte who is a certified public accountant firm have surveyed Iraq tax system in recent year. The main contents are as follows;

(1) JETRO survey
According to ”Iraq Accounting Finance & Tax Overview” surveyed by JETRO in March 2011, the tax system is as follows;

a) The system requires that a payer of payable interest to foreign companies should make withholding tax with 15%.
b) It is required that public and private companies make withholding tax with maximum 10% to employee’s salaries. (Final tax rates are fixed by their incomes)
c) Import tax is levied to all kinds of imported goods as Iraq recovery tax. (Permanent import tax is defined at the time of lifting recovery tax.)
d) In the agreement between Japan and Iraq governments, Japanese companies for Iraq power sector can obtain preferential tax system.
e) The tax system of Iraq is compliant with Iraqi tax system.

(2) Deloitte survey
According to ” Middle East Tax Handbook 2011” published by Deloitte certificated public accountants in April 2011, Iraqi tax system is as follows;

a) Corporate tax is 15%（Capital gains is proceeded in net profit of a corporate.）
b) Losses can be carried over next 5 years. However, the losses can be applied up to the maximum half of the incomes in the years that corporate tax is levied.
c) Receiver of dividend is not levied.
d) No Surtax
e) Regarding payable interest abroad, a payer has to make withholding tax with 15% to the interest.
f)
g) No tax to intelligence property.
h) As withholding tax of social security, employees expense 5 % from their salaries, and the corporates expense 12% to the employees’ salaries.
i) Exist fixed asset tax
j) Stamp tax for the contract is 1% to the contract amounts.
k) Land transfer tax paid by transmitter is 0-6% to the transfer amounts.
l) No added value tax

(3) Tax methods and tax rate
After referring the above surveys, the tax calculation methods and tax rates are as the following table.

Table 8.1.7 Tax methods and tax rate of Iraq

Items	Tax Rates	Target values
Payable interest abroad	15%	Payable interest
Import tax	5%	Import value
Corporate tax	15%	Profit before tax
Fixed asset tax	Small	Booked value of Fixed assets
Stamp tax to private	1 %	Contract price
Stamp tax to Government	0.2 %	Contract price
Land transfer tax	0- 6 %	Transfer price
Added value tax	None	
Local tax	1 – 2 %	Imported goods
Interest rate of STL	10 %	Effective lending rate
JICA loan rate	1.4 %	JICA loan

Source: JICA Study team after referring Deloitte & JETRO surveys

In case of MOE, the all taxes to new investments from foreign companies are exempted by the current Iraqi investment laws. For applied the laws, the investment activity has to be registered to the Iraqi authorities in advance. However, the import tax is levied to the imported parts and materials in the purpose of maintenance.

8.1.4 Methodologies for Financial Analysis

(1) Substation (SS) tariff and cost calculation
The methodology for calculating SS tariff and cost is as the following table. By comparing SS tariff and cost when power consumers use SS system, FIRR for the project is calculated.

Table 8.1.8 Substation tariff and cost calculation

Items	Values
• SS tariff is calculated by the estimated power tariff	SS tariff = Power tariff *15% /2
• SS yearly cost are calculated with Wages, depreciation, O/M cost, interest and administration cost • SS unit cost are calculated from the SS yearly cost divided by the transmitted power	
• FIRR are calculated under the SS tariff and costs.	Calculation period: 30 years after operation

Note: SS tariff s are defined in “8.2.2 Results of Financial Analysis (2) Partial tariffs”

(2) Income statements
The cost calculation and income statements are described as the account items in following table.

a) Sales amount is defined by “Transmission volume * Usage charge”
b) The total costs include direct costs for transmissions and substations (maintenance and labor costs)、management cost (Depreciation, Interest, Fixed asset tax and Administration costs).

Table 8.1.9 Income statements

Items	Accounts	Expressions	Values
Sales	a) Usage charge	Power tariff * SS share %	Power tariff*15%/2
	b) SS loads	From 30% to 70%	
	c) Sale amounts	SS access * Usage charge	
SS&TL costs	d) Maintenance costs	Estimate by the team	
	e) Labor costs	Estimate by the team	
	f) Depreciation	Straight line depreciation after the start	
	g) Administration costs	(e)* α %	α %=20%
	h) Interest of LTL	Calculated by loan conditions	
	i) Interest of STL	Sale /12 * interest rate	Interest rate = 10%
	j) Cost total	d+e+f+g+h+i	
Profit	k) Profit before tax	Sales (c) - Cost total (j)	
	l) Corporate tax	Profit before tax(k) * Corporate tax rate	Corporate tax= 0%
	m) Profit after tax	Profit before tax (k)– Corporate tax(l)	

Note: LTL=Long term loan, STL=Short term loan

(3) FIRR sheet

The FIRR table for calculating Benefits, Capex(total of capital investment), Opex costs (total of maintenance cost), Net benefits and FIRR is as follows;

Table 8.1.10 FIRR calculation table

Items	Contents
Benefits	Sales
Capex	Investment
Opex	Wages + O/M expenses + Import tax + Administration cost
Net Benefits	Benefits- Capex - Opex
FIRR	f(Net Benefits)

Note: Capex is the total of capital investment, Opex is the total of maintenance cost

(4) EIRR

The EIRR table for calculating Benefits, Capex, Opex costs, Net benefits and EIRR is as follows;

Table 8.1.11 EIRR calculation table

Items	Contents
Benefits	Reduction of small diesel power generation
	GDP increase due to national labor productivity up
Capex	Investment – Tax and duties
Opex	Wage total – Unskilled labor wages O/M expenses + Administration cost
Net Benefits	Benefits – Capex – Opex
EIRR	f(Net Benefits)

8.2 Results of Economic & Financial Analysis

8.2.1 Project contents and evaluation

The substations including connection lines to the nearest main transmission lines in the project are in the following table. In the financial analysis, only substation costs are targeted for the analysis.

Table 8.2.1 Candidate Substations

Site	Substation names	Governorates	Connection line (km)
1	Ninawa	Ninawa	25
2	Al-Radwaniyah	Baghdad	2
3	Al-Madaan	Baghdad	15
4	Al-Anbar	Al-Anbar	2
5	New Diyala	Diyala	3
6	Thi-Qar	Thi-Qar	1.5
7	Missan	Missan	Close
8	Al-Fayha’	Basra	2

*Note: Each substation is 400kV GIS Substation with capacity of 500MW*2.*

Note: Length of connection lines are distances to the nearest main transmission lines.

8.2.2 Results of Financial Analysis

(1) Investments

The investments per substation are the same values in the eight substations, the main investment items for the substations are equipment, cost escalation (include pre-operation interest) , consultant service cost and tax and duties (Japanese companies are exempted). Construction period of the substation is 18 months, first year includes 9 months and second year also 9 months. The equipment cost of substation includes Insurance for transport, Site work cost, Insurance for site work, Spare parts and Engineering service. Cost escalation is 10 % to equipment of substation. Tax & Duties are exempted for Japanese companies by exchange note (EN), and ones of other foreign companies are also exempted by the Iraqi investment laws.

Table 8.2.2 Investments per substation

Items	Unit	Costs
a. Substation costs	Million USD	146.0
b. Consultant service cost	Million USD	28.0
c. Investment total	Million USD	174.0

(2) Partial tariff

The power tariff mainly consists of generation cost, transmission cost, distribution cost and profit. Furthermore, transmission cost is separated to substations and transmission lines. In the analysis, substation tariff and transmission tariff are required for calculating sales income and cost. The substation tariffs and transmission tariffs are estimated by the shares of the investments in power sector. The tariffs are called “Partial tariff”. The partial tariffs for the substation and transmission line are calculated with based on the average power tariff (15.6 cent / kWh, include subsidy) of MOE in 2012.

According to “Greater Mekong Sub-region Northern Power Transmission Project by ADB” and “System Grid Master Plan of Lao by JICA”, when dividing power tariff to generation cost, transmission cost and distribution cost, the power tariff of Iraq mainly supplied by fired power generators are separated as the following table, even though the contributions of the power tariff are a little bit difference in countries.

Table 8.2.3 Partial tariffs of Generation, Transmission and Distribution

	Contribution	ID / kWh (Actual in 2012)	¢ / kWh (Actual in 2012)
Power tariff	100%	182	15.6
Generation	70%	128	10.90
Transmission	15%	27	2.34
Distribution	15%	27	2.34

Furthermore the transmission cost is divided to substation cost and transmission line cost. The contribution is given by the ratio between the investments of the two. In the calculation, the contribution of Substation and Transmission line is 1 : 1 is assumed. Under the conditions, the partial tariff for eight substations is 1.17 cent/kWh (15.6 cent/kWh * 15% /2) . This is calculated based on the average power tariff (15.6 cent / kWh) in 2012 of MOE.

(3) Income and cost accounts
The economic and financial accounts for substation are as the followings. The sales income is calculated by the partial tariff.

Table 8.2.4 Expressions for calculating sales income and costs

Accounts	Expressions
Sales	Power transmitted * Substation partial tariff Power transmitted is 30 % to capacity in the beginning year and the maximum becomes 70% by increasing 8%~10% per year. Partial tariff : 1.17 cent/kWh
Cost	Wages, Repair cost, Depreciation, Long and Short term loan for substation 20% to Wages as Administration cost of Head quarter
Tax	5% levied to the imported repair parts Asset tax and corporate tax are not levied

(4) Escalation factor
The discount rate, exchange rate and escalation factors of wage, oil products price, power tariff and O/M costs are as the following table. The growth rate of wage is half of GDP growth rate, the growth rate of oil products price is the same as crude oil price. The growth rate of power tariff is defined by oil price growth rate * elasticity (0.7). The growth rate of O/M is defined by (Wages + Oil price)/2.

Table 8.2.5 Escalation Factors

Items	Unit	Values	Expression
Wage escalation	%	3.0%	
Oil price escalation	%	2.0%	
Tariff escalation	%	1.4%	Oil price *Elasticity (0.7)
O/M cost escalation	%	2.5%	(Wage + Oil price)/ 2
Discount rate	%	10.0%	
Exchange rate ID	ID /USD	1,170ID/USD	

(5) Results of Financial analysis
As the FIRRs of one substation (Site 1～Site 8) are the same values, the FIRR is shown by the following table. The scenario of the following FIRR named by "Likelihood scenario" is calculated by partial tariffs based on the actual power tariff (15.6 ¢/kWh) in 2012.
The second scenario of the FIRR named by "10 % less scenario" is calculated by 90% to the partial tariffs (it means 10% less than the actual power tariff with 15.6 ¢/kWh).
The third FIRR scenario of the FIRR named by "20% less scenario" is calculated by 80% to the partial tariffs (it means 20% less than the actual power tariff with 15.6 ¢/kWh). The concepts of the items are

in the tables are as the followings.

a) FIRR with escalation 1.4% per year: The likelihood tariffs, 10 % less tariff and 20 % less tariff are increased with 1.4 % per year from 2019 to 2048.
b) FIRR at constant tariff: the partial tariffs in likelihood scenario (15.6 ¢/kWh), 10 % less scenario (14.0 ¢/kWh) and 20 % less scenario (12.5 ¢/kWh) are constant from 2019 to 2048.
c) Partial tariff: It is the 10 year weighted average partial tariff for substation from 2019 to 2028.
d) Unit cost: It is the 10 year weighted average unit cost for substation from 2019 to 2028.

Table 8.2.6 FIRR, Partial tariff and Costs

Scenario	FIRR with escalation	FIRR at constant tariff	Partial tariff	Cost
	%	%	¢/kWh	¢/kWh
likelihood tariff (15.6 ¢/kWh)	19.0%	16.8%	1.28	0.69
10 % less tariff (14.0 ¢/kWh)	20.0%	17.8%	1.14	0.69
20 % less tariff (12.5 ¢/kWh)	20.8%	18.6%	1.02	0.69

Note: The calculation period of FIRR is from 2017 to 2048 and the operation period is for 30 years from 2019 to 2048.

Note: The Partial tariff and unit cost is the 10 year average from 2019 to 2028.

The combination of two substations is set as “Two substations” and the combination of eight substations is set as “Eight substations” in the following table. The consultant fee of “Two substations” is 32 million USD (24 million USD + 4 million USD * 2 set). And “Eight substations” is 56 million USD (24 million USD + 4 million USD * 8 set). The total investments of the combinations are as the following table.

Table 8.2.7 Investments for the combinations

Number of SS	Substation names	Unit	SS Investment
Two substations	Substation	Million USD	292.0
	Consultant fee	Million USD	32.0
	Total	Million USD	324.0
Eight substations	Substation	Million USD	1168.0
	Consultant fee	Million USD	56.0
	Total	Million USD	1224.0

The FIRRs of the combinations in case of “Two substations” and “Eight substations” are as the following tables.

Table 8.2.8 FIRR, Partial tariff and Costs of "Two substations"

Scenario	FIRR with escalation	FIRR at constant tariff	Partial tariff	Cost
	%	%	¢ /kWh	¢ /kWh
likelihood tariff (15.6 ¢ /kWh)	20.0%	17.8%	1.28	0.65
10 % less tariff (14.0 ¢ /kWh)	18.0%	15.7%	1.14	0.65
20 % less tariff (12.5 ¢ /kWh)	15.8%	13.4%	1.02	0.65

Note: The calculation period of FIRR is from 2017 to 2048 and the operation period is for 30 years from 2019 to 2048.
Note: The Partial tariff and unit cost is the 10 year average from 2019 to 2028.

Table 8.2.9 FIRR, Partial tariff and Costs of "Eight substations"

Scenario	FIRR with escalation	FIRR at constant tariff	Partial tariff	Cost
	%	%	¢ /kWh	¢ /kWh
likelihood tariff (15.6 ¢ /kWh)	20.8%	18.6%	1.28	0.63
10 % less tariff (14.0 ¢ /kWh)	18.7%	16.5%	1.14	0.63
20 % less tariff (12.5 ¢ /kWh)	16.5%	14.1%	1.02	0.63

Note: The calculation period of FIRR is from 2017 to 2048 and the operation period is for 30 years from 2019 to 2048.
Note: The Partial tariff and unit cost is the 10 year average from 2019 to 2028.

(6) Evaluation of FIRR

The minimum FIRRs of a substation are 18 % in likelihood tariff scenario (15.6 ¢ /kWh in 2012), 16 % in 10 % less tariff scenario (14.0 ¢ /kWh in 2012) and 14 % in 20 % less tariff scenario(12.5 ¢ /kWh in 2012). As the interest rate for the project loan even though including local fund procurement is less than 2 % per year. When the FIRR might be 4 %, it is feasible as infrastructure project under such low interest rate. According to the above financial analysis, all kinds of FIRRs exceed the mentioned target (should be over 10 %) in the previous session. Therefore, the profitability of the financial analysis is acceptable. It can be considered that future Iraqi power tariff (including subsidy) is decided by the increase of fuel prices and power efficiencies. It can be expected that power efficiencies are increased by introduction of Independent Power Producers (IPP) and Gas Combined Cycle (GCC). Therefore, it can consider that the increase with 2 % per year of fuel cost is absorbed by the improvement of the productivity in the power sector. When the power tariffs in 2012 are set constantly in all calculation periods, the FIRRs are decreased by around 2 % from FIRRs of the power tariff cases with escalation factor 1.4% per year. Even though, as the FIRRs can be kept over 10% in all scenarios, the profitability of the project as infrastructure financial analysis is kept.

8.2.3 Results of economic analysis

As benefits of economic analysis, it can be considered that the project substitutes private small diesel generators to be inefficiency due to high diesel oil cost. Until now, some power consumers have had small diesel generators for measuring power shortage in Iraq. The main reason of power shortage is the shortage of power generator capacity and transmission network in Iraq. Therefore, introduction of new power generators and new power transmission networks make power shortage decrease, after that, it can make private small diesel generators reduce. The reduction of private small diesel generators makes the imported diesel oil decrease into Iraq, which becomes national benefit for Iraq. Other hand, resolution of power shortage makes labor productivity increase, which makes GDP growth rate increase as the results. This is big economic benefits for Iraq. In the economic analysis, the above two impacts are applied as economic benefit.

(1) Cost calculation of diesel generator

The following table is expressions for estimating diesel generator cost in 2012. The costs are separated to fuel cost and fixed cost.

Table 8.2.10 Estimation of Diesel generation cost

Diesel oil price	75 cent /liter
Power efficiency	35%
Fuel cost	75cent/liter/(9,000kcal/liter＊35%/860kcal/kWh) =20.5 cent/kWh
Fixed cost	$1,000/kW ＊ （Depreciation*10%＋Interest*10%＋Other cost*10％）＝ 3.5cent/kWh
Generation cost	20.5 cent/kWh＋3.5 cent/kWh＝24.0 cent/kWh
Minimum cost	24.0 cent/kWh＊70%＝17.0 cent/kWh

Source: Diesel oil price and Fixed costs are estimated by JICA Study team

(2) GDP increase by power shortage reduction

The following table shows calculation procedures of the benefit as GDP increase from the project. At first, labor productivity are calculated by GDP per capita and number of consumers from the project. As the next stage, the labor productivity makes GDP increases.

Table 8.2.11 GDP increase by reduction of power shortage

Number of beneficiary	(1,000MW ＊ 50%)*(8,760hour*70%)/4,000kWh/person ＝ 767,000person
Minimum beneficiary	767,000person * 70%＝537,000person
GDP per capita	$6,600 per capita in 2012
Power shortage reduction rate	5% in year average （10 labor hours/day*5%＝0.5 hour / day）
Labor productivity increase	GDP per capita* Minimum beneficiary*
GDP increase from SS	Labor productivity *Power shortage reduction rate *(15% of the tariff/2)

Source: GDP per capita is shown in "Chapter 2.1 GDP at current price and GDP per capita"

(3) The results of economic analysis

Benefits of economic analysis are diesel oil reduction and GDP increase, and the Cost are Investment (none tax), Wages (manager + skilled), O/M expenses (none import Tax) and Administration cost. The following table shows the present value benefits including diesel reduction (summation in 2019～2048) and GDP increase (summation in 2019～2048) and EIRR. The year of the present value is in 2017 and the discount rate is 10% per year.

Table 8.2.12 EIRR, Benefits and Costs by number of substation

Number of Substation	EIRR	Total Benefits million USD	Diesel reduction Benefit million USD	GDP increase Benefit million USD	Total Cost million USD
One substation	22.6%	609	525	84	131
Two substations	23.8%	1,219	1,051	168	263
Eight substations	24.9%	4,880	4,209	671	1,055

Note: The benefits and costs are summations of present values from 2019 to 2048.

(4) Evaluation of EIRR

EIRR reaches 22 % and it is higher than the maximum FIRR with 20 %. The present value benefit of diesel oil reduction is around 525 million USD per substation and the present value benefit of GDP increase is around 84 million USD per substation in operating 30 years. The average net present value benefit per year of a substation is around 15 million USD ((Benefit:609 – Cost :131)÷30) per years.

Other hand, the investment per substation is around 174 million USD. Therefore, the average Pay Back Period (PBP) based on cash flow (it is not present value) per substation is around 5 years. It means that the total net present value benefit from 2019 to 2023 almost equal to the total investment.

The project does not target the whole power business, it is only substation. Therefore, the partial tariffs for substation are introduced and used in economic financial analysis, which complicates the procedures of the analysis. As the mind position of the analysis, the benefits should be evaluated by rather lower worth, and the cost items in financial analysis are remained as cost item in the economic analysis as much as possible. As the results of the above procedures, EIRR reaches 22 %. It can be said that the profitability of the project is comparatively kept at higher level than other infrastructure projects.

8.3 Achievement indicators for the project

As achievement indicators for the project after implementation, the following indicators should be selected. Power distribution targets in Iraqi governorates are the forecasted peak load in 2020. As power shortage, even though the Master plan of MOE has already had the targets of power shortage reduction by 2017, herein, what it is resolved by 2020 is set as the project target.

Table 8.3.1 Project achievement indicators

Items	Indicators & Targets
Indicator for measuring the project effect	Indicator 1 :Implementation of power supply plan Indicator 2 :Reduction of power shortage
Targets of peak load as power supply plan	The targeted peak loads by governorate are as the following table.
Targets of Power shortage reduction	The targeted governorates that substations are settled have to be almost zero up to 2020.

Table 8.3.2 Targeted Peak loads by Governorate

governorates	2012 (Actual peak load) MW	2020 (MoE forecasting) MW	2020/2015 %
Ninawa	1,482	2,438	6.4
Diyala	401	670	6.6
Al-Anbar	800	1,429	7.5
Baghdad	4,450	7,475	6.7
Thi-Qar	654	1,135	7.1
Missan	447	788	7.3
Basra	1,531	2,618	6.9

Note: Targeted peak loads are forecasted in MOE master plan up to 2017.

“Indicator 1” means the power supply plan by MOE up to 2020. By the plan, MOE considers that the current power shortage will be resolved in 2020 at the latest. Therefore, the MOE and JICA Study team select MOE’s power supply plan in 2020 as “Indicator 1”. The targeted power supply plans by governorate are shown in Table 8.3.2.

“Indicator 2” means that the power shortage will be resolved by the implementation of MOE’s plan. In the past years, there was power shortage even though implementing MOE’s power supply plan. “Indicator 2” puts emphasis that the power shortage is resolved if the current MOE’s power supply plan will be implemented through the project and so on.

Chapter 9

Pilot Project for 132 kV Transmission Line

Chapter 9 Pilot Project for 132 kV Transmission Line

MOE requested JICA to apply Inver Conductor for two kinds of existing 132 kV transmission lines. Therefore, the survey team proposes these technical scope and cost estimation on this chapter.

9.1 Inver Conductor

(1) Nessecity of Inver Conductor

Neccesity of existing conductor's replacement to Inver Conductor is increasing currentry, because of the following reasons.

- Increasing transmission capacity of conductor by rapid growth in power demand
- Objection from inhabitants to construct new transmission lines

(2) Experences of applications of Inver Conductor

a) Japan (1981 – 2012)

a1) Total Length: Around 6,000 km

a2) Total Number of Transmission Lines: Around 350 lines

b) Foreign (1990 – 2012)

b1) Total Length: Around 4,500 km

b2) Country: More than 10 (Hong Kong, Greece, Korea, France, Malaysia, U.A.E, Sri Lanka, China, Italy, Thailand, U.S.A., etc.)

- Total Number of Transmission Lines: Around 40 lines

(3) Advantages and Disadvantages for Replacement of Inver Conductor

a) Advantage

a1) Achieving 1.6～2 times current capacity with the same size conductor

a2) No modifications or reinforcements on existing towers

a3) Same Installation method of conventional conductor can be applied

b) Disadvantage

b1) Price is higher than conventional ACSR conductor (Around 4 times)

Therefore, application of Inver Conductor becomes effective, when the following subjects occur.

b2) Land limitation

b3) Environmental and Social restriction for new overhead line construction

b4) Requirement of high capacity in short period

b5) Not enough initial funds

(4) Inver Conductor

"Invar" means an abbreviation of the adjective "invariable".

a) Structure

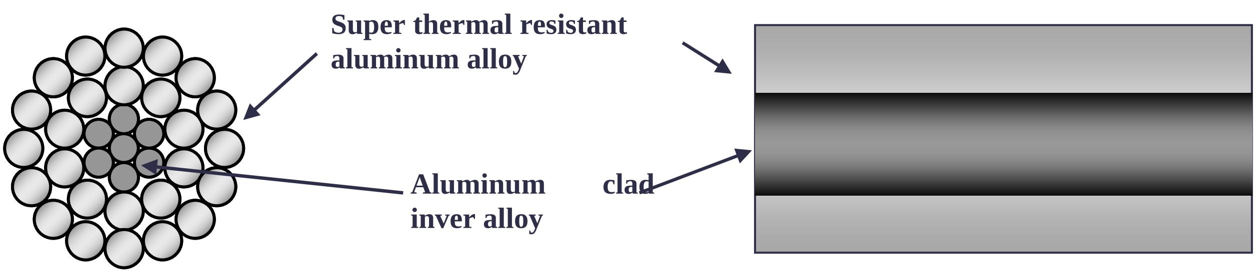
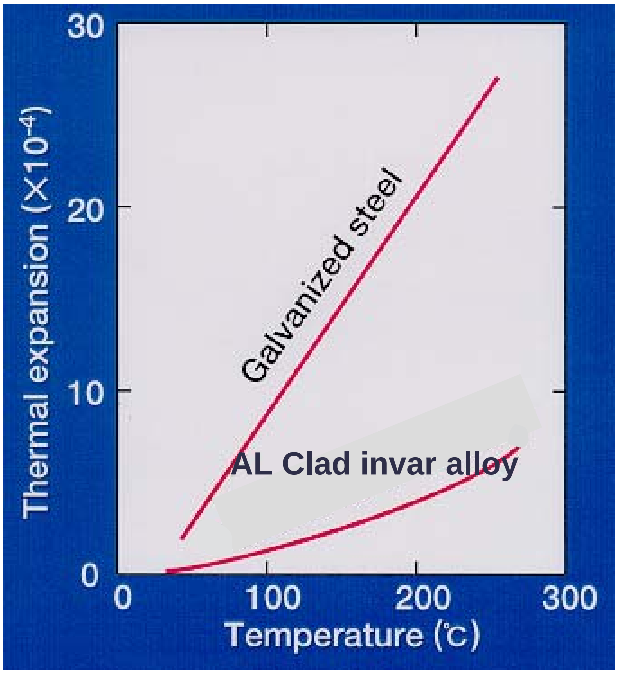


Figure 9.1 Basic Structure of Invar Conductor

b) Performance

Fe-36%Ni alloy (Ni% can vary slightly) is applied as inver alloy and coefficient of thermal expansion is very small compared to general steel.



Coefficients of thermal linear expansion:

Al-Clad Invar alloy: 3.7 x 10^{-6} (1/℃)

Steel : 11.5 x 10^{-6} (1/℃)

Figure 9-2. Basic Thermal Evpansion – Tempreture Characteristics

c) Design Concept

Invar conductor has very small thermal expansion at temperatures above KPT (Knee Point Temperature) and KPT is a temperature at which Al layers do not bear any tension due to its thermal expansion in ACSR conductor. Therefore, sag of invar conductor does not increase even though high conductor tempreture.

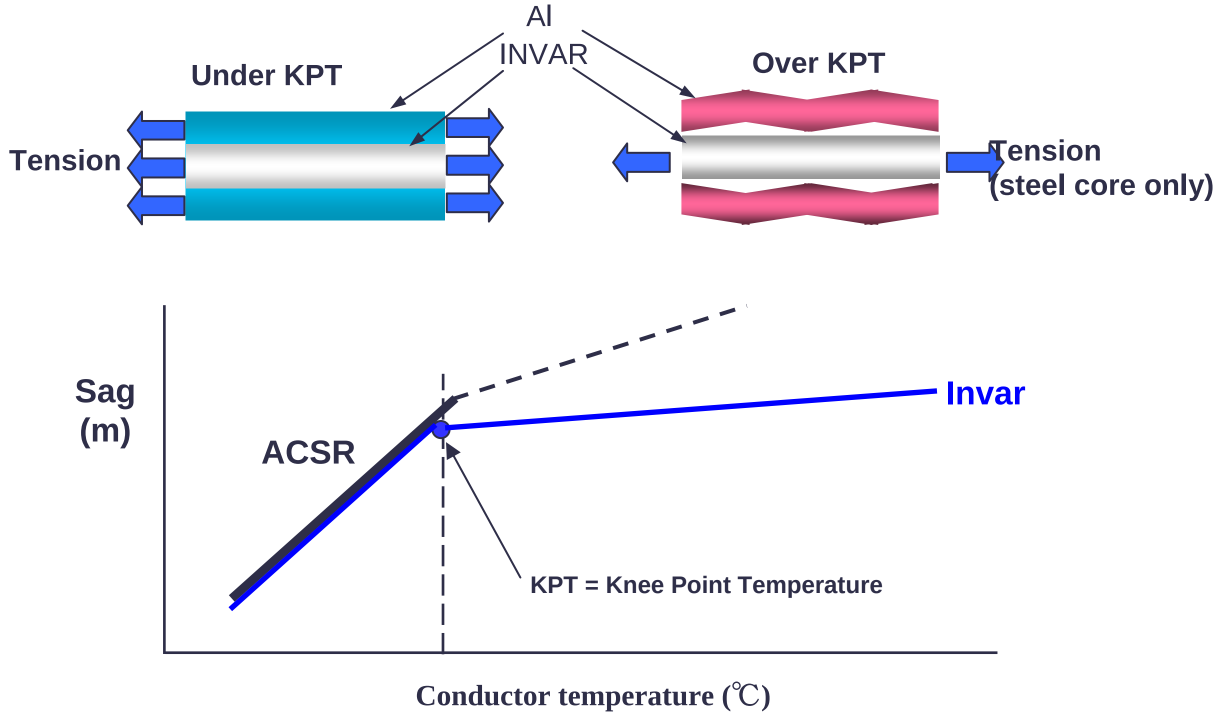


Figure. 9-3 Basic Sag-Tempreture Characteristics

9.2 Applicable Transmission Lines

The following two kinds of transmission lines are objective facilities.

- Section A

132 kV Baghdad North – Taji, Length: 4.2 km, Double circuits with Teal conductor

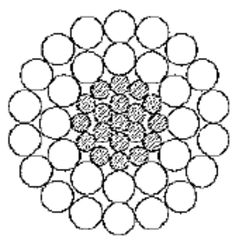
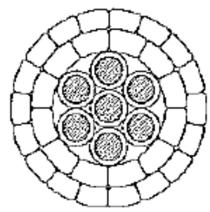
- Section B

132 kV Al Rasheed - Yusfies, Length: 12.0 km, Double circuits with Teal conductor

9.3 Applicable Conductors (for reference)

The applicable conductors for the aforementioned replacement would be described below that has equal weight and more than 1.8 times the capacity compared to the “Teal” used for the existing transmission lines(Table 9.1 and Fig 9.4). The sag is almost same depth at 1.8 times the capacity of Teal Conductor. (Fig 9.5)

Table 9. 1 Comparison with ACSR Teal and ZTACIR/AS

Type of Conductor			ACSR	ZTACIR/AS
Nominal area			Teal	244 mm^2
Stranding		No./mm	30/ 3.607- AL	18/TW*[2](3.05)*[3]-ZTAL*[1]
				12/ TW*[2](3.44)*[3]- ZTAL*[1]
			19/ 2.164- ST	7/ 4.27-IR/AS*[5]
Min. breaking load		kN	133.4	133.5
Diameter	Conductor	mm	25.25	22.31
	Core		10.82	12.81
Cross sectional area	Al	mm^2	306.6	243.7
	St		69.88	100.2
	Total		376.48	343.9
Weight		kg/km	1398	1390
D.C. resistance at 20°C		ohm/km	0.09443	0.110
Modulus of elasticity	Conductor	GPa	88.5	88.1
	Core		205.9	152.0
Co-efficient of linear expansion	Conductor	$\times10^{-6}$/°C	18.0	13.3
	Core		11.5	3.7
Cross sectional view				

Note *1 (Z)TAL：(Super) Thermal resistant aluminum alloy wire

*2 TW：Trapezoid shaped wire

*3 Value in parenthesis：Equivalent diameter (mm)

*4 EST：Extra high strength galvanized steel

*5 IR/AS：Aluminum-clad Invar alloy

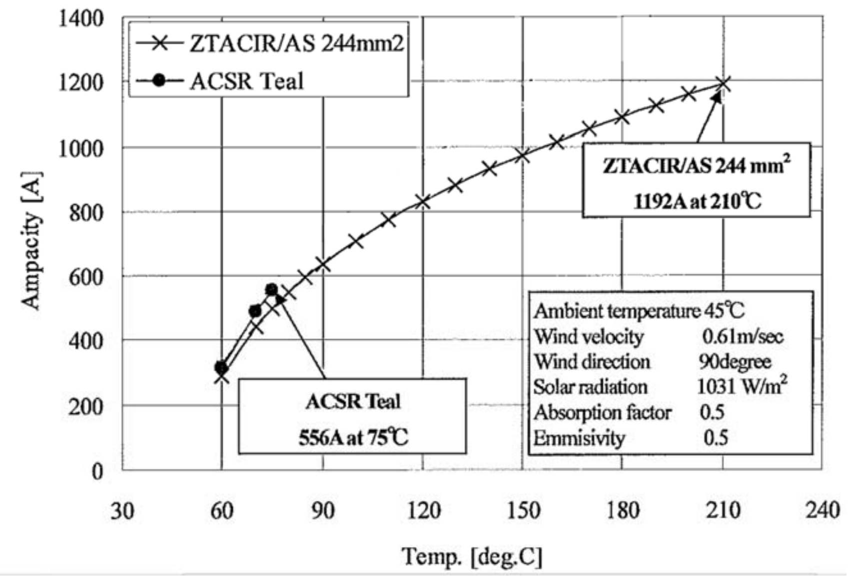


Figure 9.4 Ampacity – Tempreture Characteristics of Invar Conductor

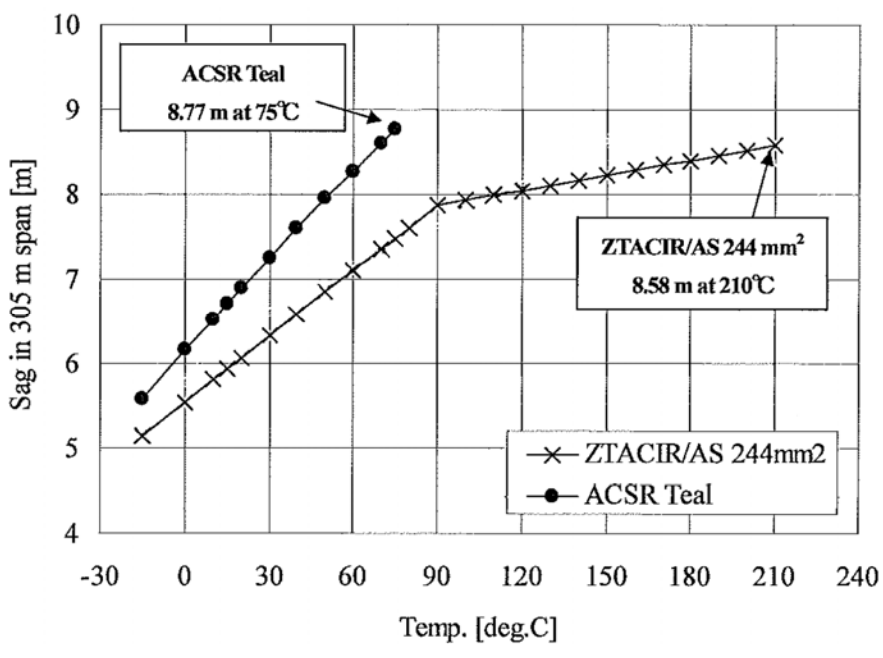


Figure 9.5 Sag – Tempreture Characteristics of Invar Conductor

9.4 Cost for Conductor Replacement

The cost estimation for the conductor replacement of the existing transmission lines for the above conductor is shown in the tables below (Not including consultant fee).

The total replacement costs for the conductor replacement are estimated at around 0.8 million US dollars and 2 .0 million US dollars, respectively.

Table 9. 2 Cost for Conductor Replacement (ZTACIR/AS 244 mm^2)

	Items	Unit	132 kV Baghdad North – Taji, 4.2km (Section A)			132 kV Al Rasheed - Yusfies, 12.0 km (Section B)		
			Quantity	Unit Rate (US$)	Amount (US$)	Quantity	Unit Rate (US$)	Amount (US$)
Cost, Insurance and Freight	Conductor ZTACIR/AS 244 mm^2	km	25.2	20,000	504,000	72	20,000	1,440,000
	Accesories	lot	1	10%	50,400	1	10%	144,000
	subtotal				554,400			1,584,000
Cost of Labour, Inland Transportation and Expenses	Drafting of Tower Structual Drawings	Nos	4	5,000	20,000	4	5,000	20,000
	Calculation of Tower Strength	set	4	10,000	40,000	4	10,000	40,000
	Stringing	km	4.2	3,500	14,700	12	3,500	42,000
	Inland Transportation			CIF*18%	99,800		CIF*18%	285,100
	Miscellaneous	lot	1	5%	8,700	1	5%	19,300
	General Expenses	lot	1	10%	17,400	1	10%	38,600
	subtotal				200,600			447,000
Total					**755,000**			**2,031000**

9.5 Schedule for Conductor Replacement

It is important to check the strength of the existing towers to avoid tower collapse, when the conductor replacement is conducted, but there is a high possibility that the structural drawings and structural calculation sheets would be unavailable, therefore, the drafting of the structural drawings and the strength check of representive towers will be necessary work. These examinations will take 6 months and should be carried out by foreign consultant including technical transference of these procedures to MoE**.**
To avoid outage for both circuits for conductor replacement, these works should be carried out one circuit by one circuit in outage.Outage plan for these transmission lines and safety countermeasures for workers are important and they should be examined carefully.
The survey team proposes that these conductor replacement works will be as shown in Figure 9. 6.

Figure 9. 6 Implementation Schedule for the Project including Conductor Replacement (Month)