Japan International Cooperation Agency

No.

Baseline Survey
for
Supporting Electric Power Sector
in Republic of Iraq

Summary Report

July 2004

NIPPON KOEI CO.,LTD.

in cooperation with

United Nations Development Programme

ED
JR
04-034

BASELINE SURVEY
FOR
SUPPORTING ELECTRIC POWER SECTOR
IN REPUBLIC OF IRAQ

SUMMARY REPORT

TABLE OF CONTENTS

SUMMARY

1. General

The electricity sector in Iraq has long experienced shortage of supply capacity to the demand due to lack of maintenance and repair of the facilities and delay in addition of new facilities. This situation was triggered by the Gulf War which occurred in 1990 and has continued to date, being further influenced by the recent conflict in 2003. Load shedding is usually made throughout the country and people are supplied with electricity only for less than a half of 24 hours in a day. Various efforts for the rehabilitation works are being made for the electric facilities by MoE and CPA and power is imported from Turkey and Syria. The actual load of the national grid in May 2004 was only 4,200 MW, although the potential power demand of the country is estimated at more than 6,000 MW.

It is quite apparent that restoration of the electricity sector be given a high priority among the various efforts for rebuilding of Iraq since it is essential to meet the humanitarian needs and enhance development of various industries.

2. Generating Equipment

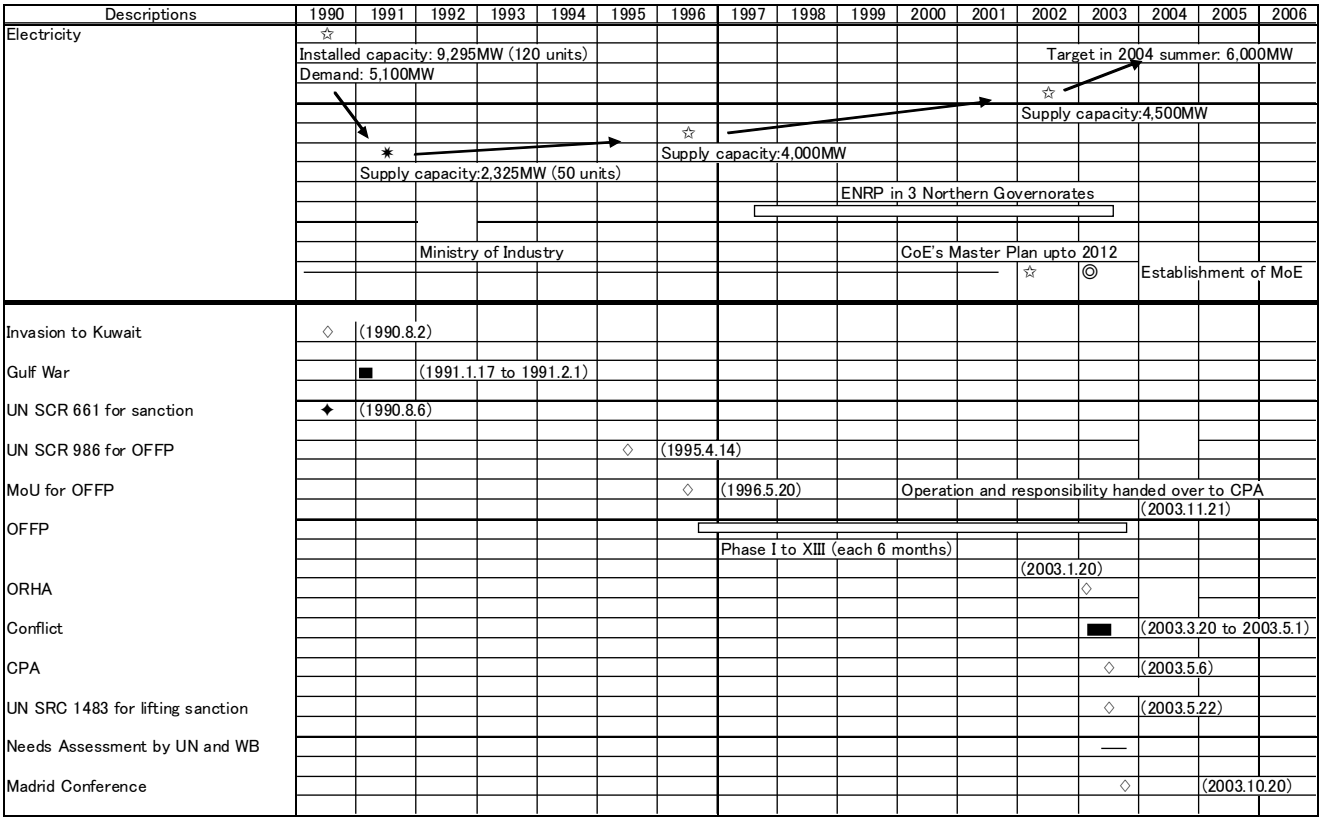
Electric energy in Iraq has been supplied by steam plant, gas turbine, hydropower and diesel plant. Some of these plants are obsolete and the generating capacities are much lower than the rated capacity due to lack of regular maintenance and repair and non-availability of spare parts. This situation was caused by the economic sanction by UN in 1990. Hydropower suffers from shortage of water in the drought year. Gas turbines decreases output due to de-rating by rise of ambient temperature. Water facilities for cooling as well as main generating equipment need rehabilitation and repair.

Existing Generating Facilities in Iraq

Type	Number of Stations (Nos.)	Total Installed Capacity (MW)	Actual Capacity (MW) *
Steam	8	5,415	1,600
Gas turbine	14	2,181	800
Hydro	7	2,518	650
Diesel	3	87	87
Total	32	10,206	3,137

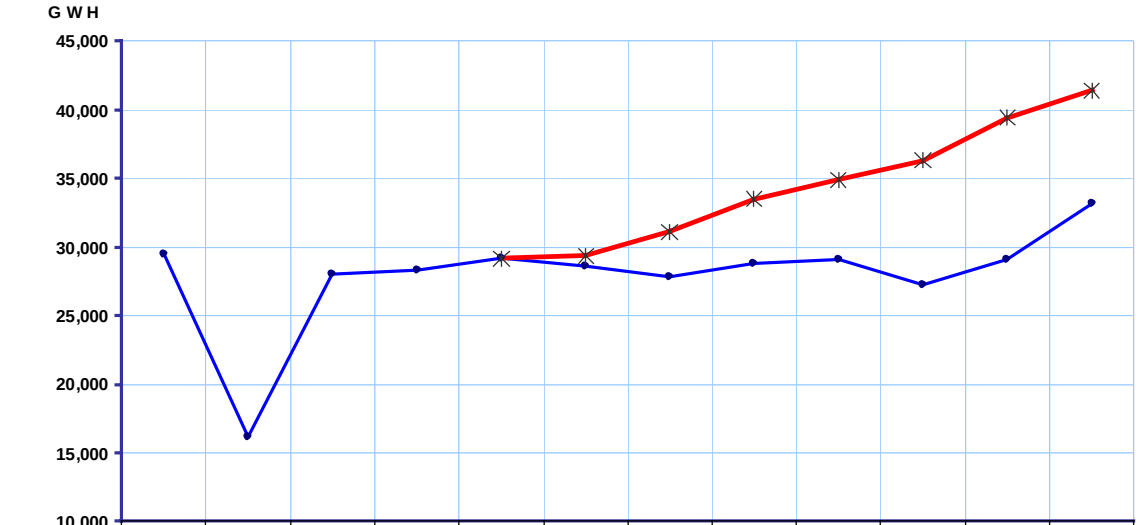
Note: * reported in NA in 2003, but subject to change by the on-going rehabilitation works.

The present generating capacity in May 2004 is lower than the level in 1990 (5,100MW) prior to the Gulf War and the level in 2003 (4,500MW) prior to the recent war. Necessary spare parts and materials for the electric facilities were procured under the Oil-for-Flood Program (OFFP) to maintain the plant capacities. For the implementation of this program, UN undertook it directly for the northern 3 governorates, while the Iraqi government undertook with the UN's observation. After 2003, rehabilitation and repair works were continued with the initiative by CPA. However it appears difficult to attain a target of 6,000MW by the summer of 2004.



Recent Events of Iraq

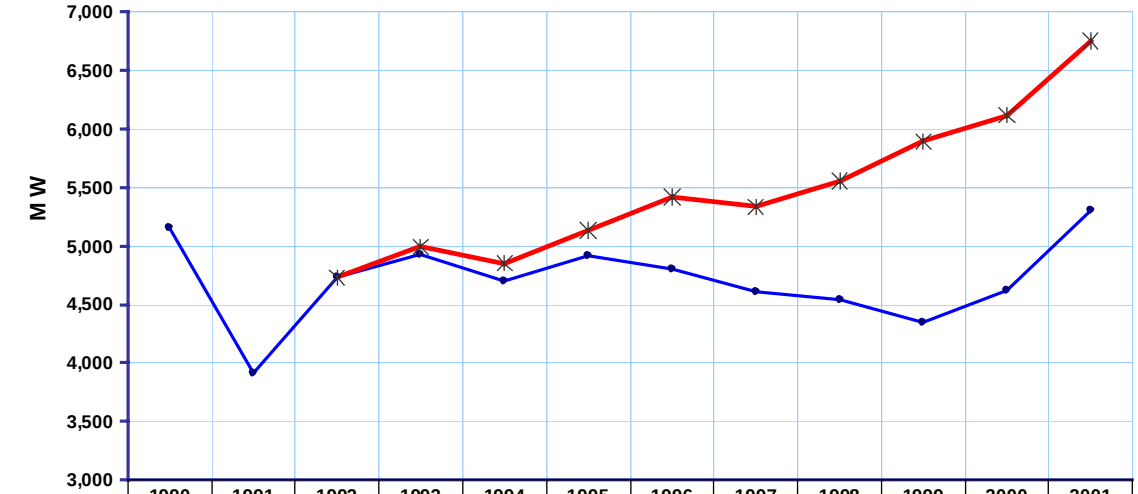
The energy production and peak load in Iraq from 1990 to 2002 are given in the figure below. The energy production in 2002 was shared by steam plant (63%), gas turbine (24%), and hydropower (13%).



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Load	29,469	16,202	28,051	28,355	29,160	28,600	27,838	28,783	29,139	27,201	29,126	33,213
Demand					29,160	29,369	31,096	33,518	34,916	36,344	39,442	41,413

Source: Needs Assessment of the Electricity Sector, Annex F: Energy Statistics

Energy Production (1990-2001)



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Load	5,162	3,920	4,733	4,926	4,701	4,913	4,804	4,615	4,541	4,350	4,616	5,301
Demand			4,733	4,994	4,852	5,134	5,419	5,336	5,556	5,892	6,120	6,753

Source: Needs Assessment of the Electricity Sector, Annex F: Energy Statistics

Annual Peak Load (1990-2001)

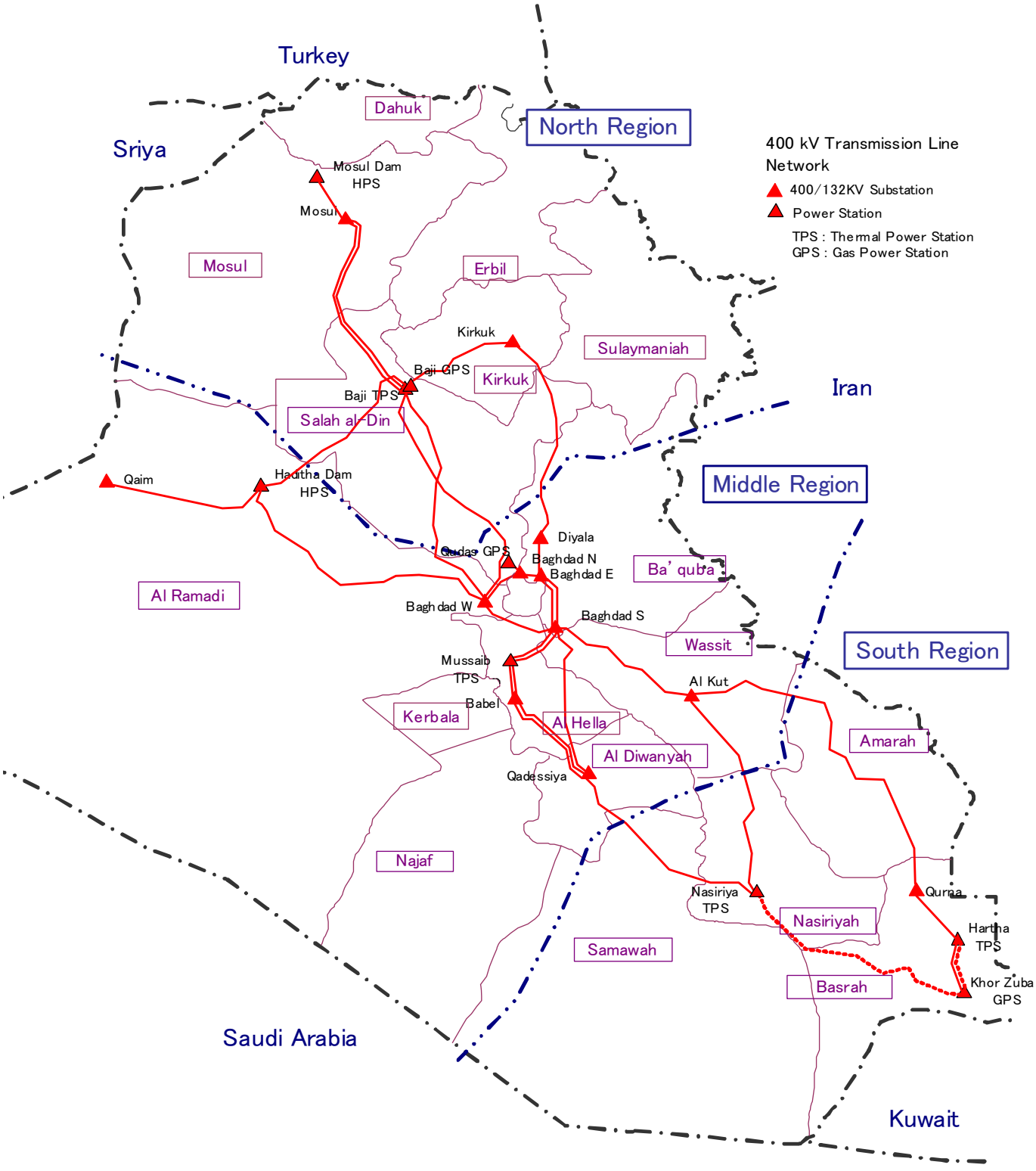
3. Transmission Lines

The transmission network covers over the country, which voltage is 400kV and 132 kV. The voltage of distribution network is 33 kV or 11 kV. The two northern governorates, Erbil and Sulaymaniah, have been isolated from the national power grid after the Gulf War. Most of the transmission lines were built in the later part of 1990's and are deteriorated. Proper spare parts are not available for these long-aged facilities.

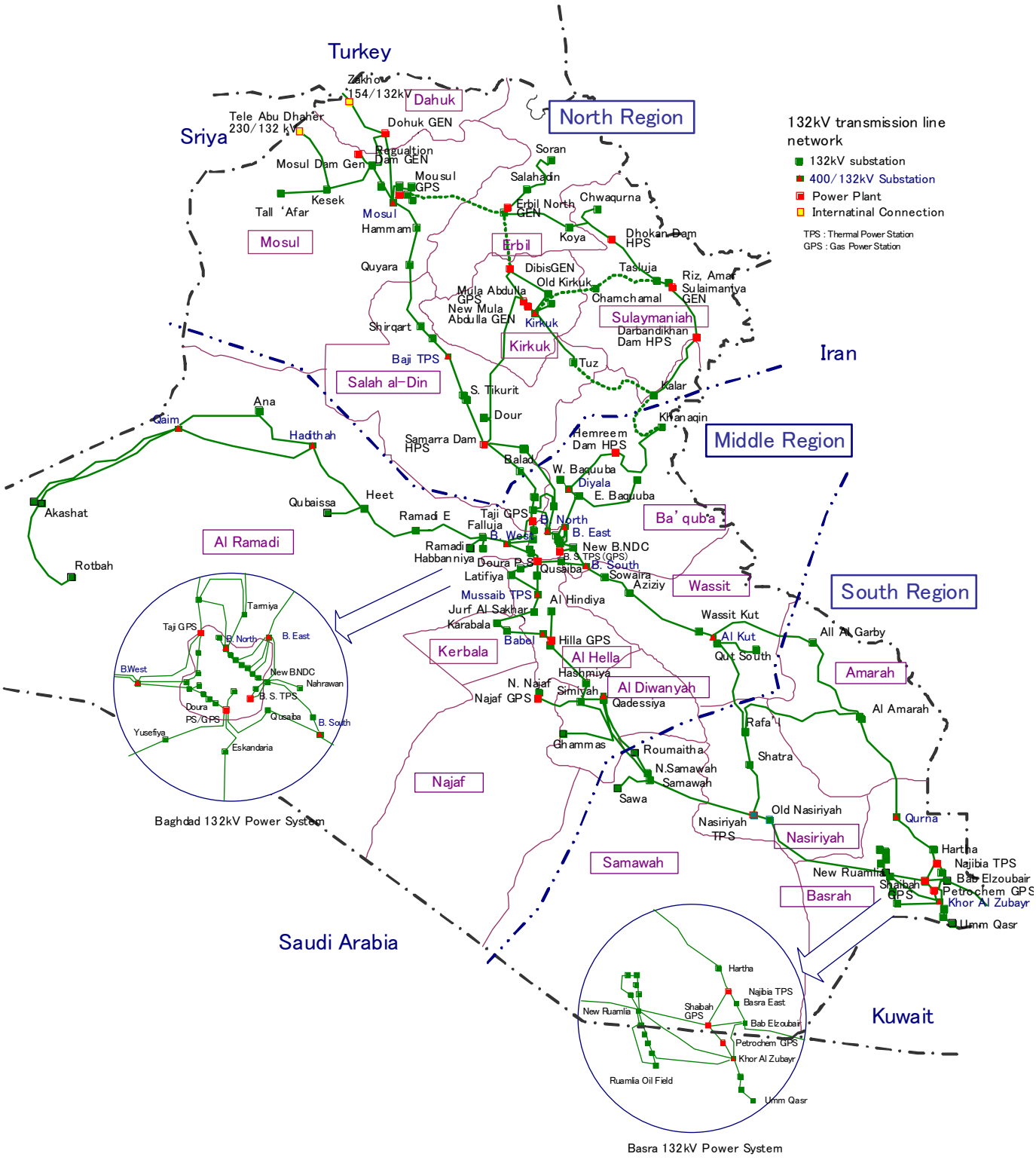
Number and Length of Transmission Lines

Region	400 kV Line		132 kV Line	
	No.	km	No.	km
North	7	695	98	4,344
Middle	17	1,859	205	6,353
South	6	987	94	2,882
Total	30	3,541	397	13,579

Source: UNDP/WB Needs Assessment of the Electricity Sector of Iraq



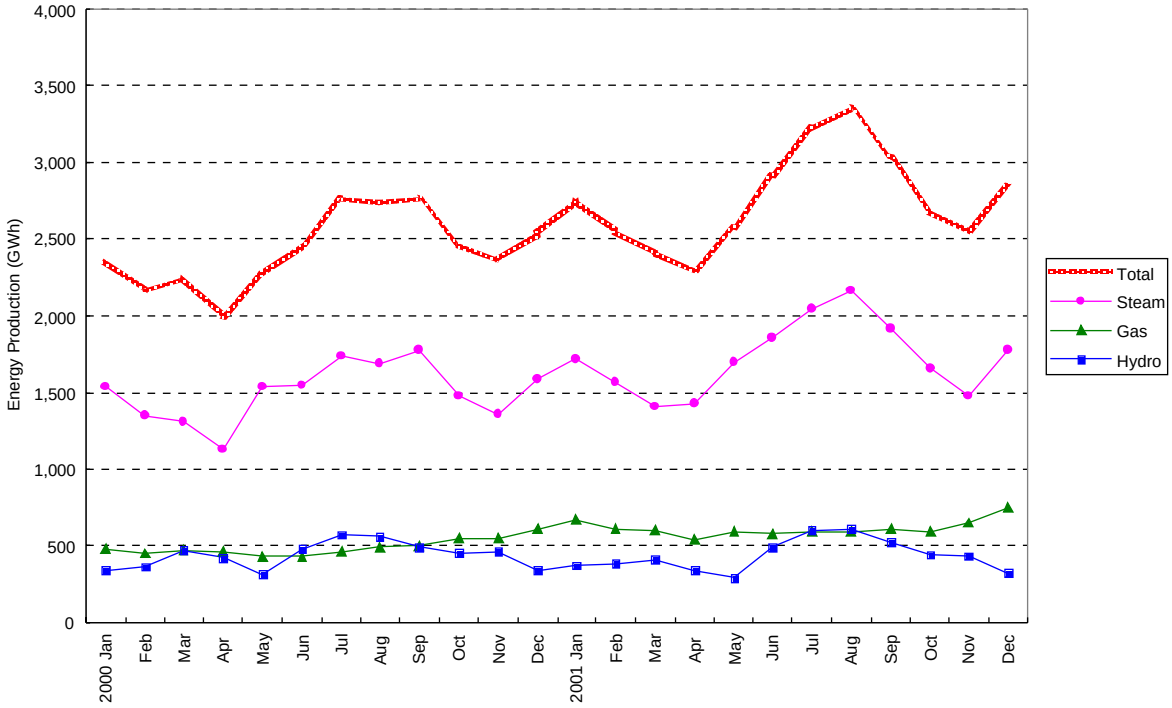
400 kV Power Transmission Line Network



132 kV Power Transmission Line Network

4. Past Trend of Power Demand and Supply

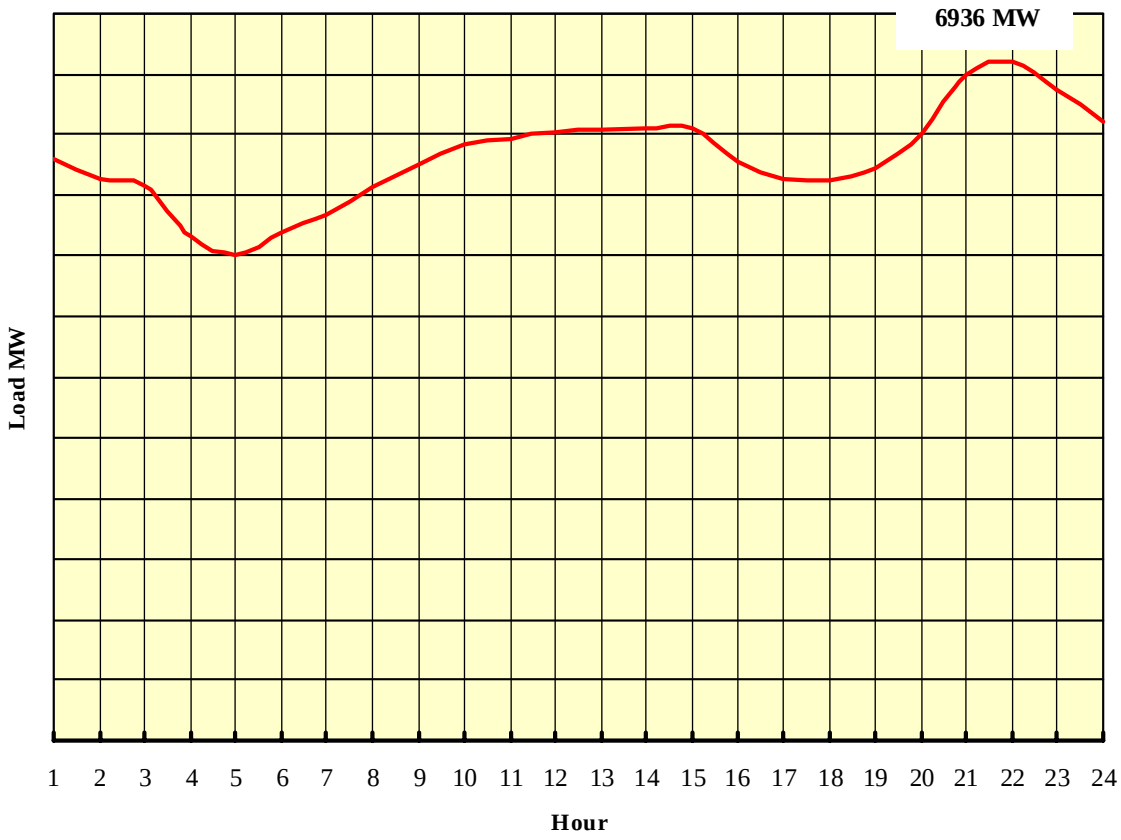
Load shedding is being made over the country. Power stations are obliged to operate with higher plant factors. Peak load usually occurs in the summer months from July to August, and drops in November and March to April. In terms of monthly energy, the summer load is 50 % higher than the off-season load. The annual load factor is approximately 70%. On the other hand, in the northern region the winter load exceeds slightly the summer load.



Source: Generation & Energy Balance Report for 2001, 2002; MoE

Monthly Energy Production in 2001 and 2002

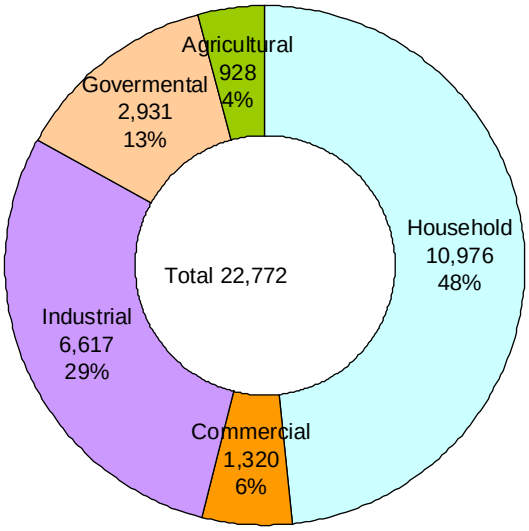
It is supposed that the daily peak load occurs at 21 to 22 o'clock in the night and the off-peak occurs at 5 o'clock or 17 to 18 o'clock. Daily load factor of the national grid would be 85% if the load shedding is not made.



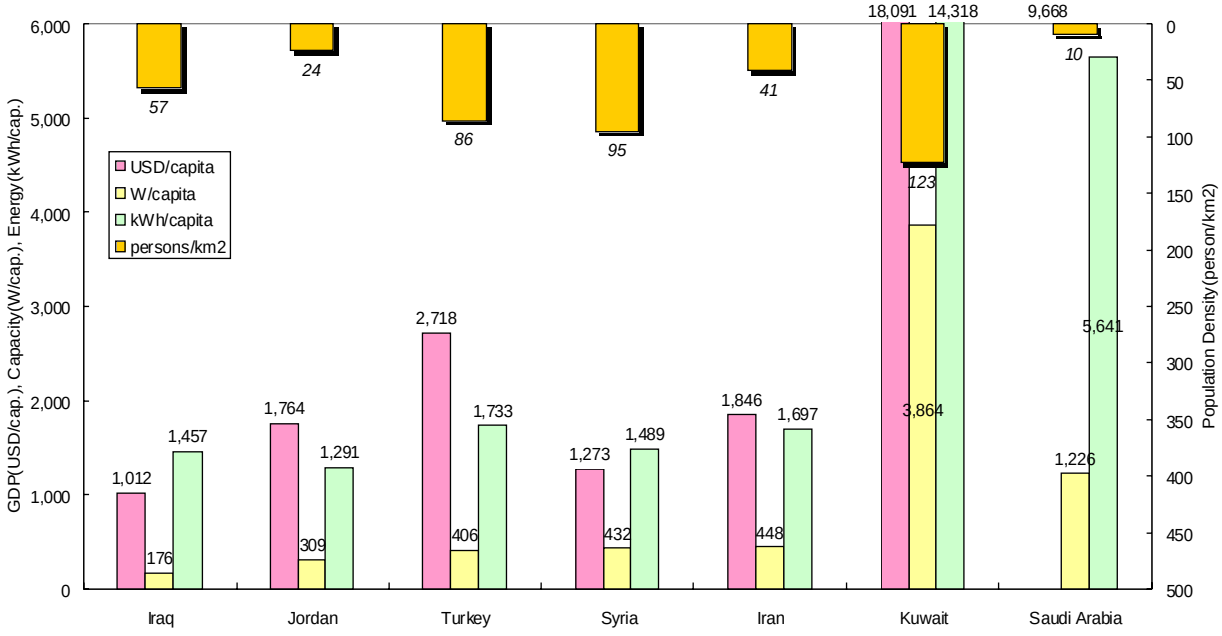
Daily Load Pattern

Electric energy is used for domestic use(48%), industrial use (29%), government use (13%) , commercial use (4%). Electrification rate is reportedly 87%, but subject to further investigation. Per capita consumption of energy is rather fair but per capita kW is very low, when compared to those in the neighboring countries. This may indicate that the load is suppressed. It can be said that the power demand and supply in Iraq grew normally until the Gulf War occurred.

Category	Baghdad		Middle		North		South		Total	
	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%
Household	5,981	61.8	1,837	42.8	1,762	37.0	1,395	34.4	10,976	48.2
Commercial	1,004	10.4	105	2.4	108	2.3	104	2.6	1,320	5.8
Industrial	1,146	11.8	1,430	33.4	1,939	40.8	2,102	51.9	6,617	29.1
Govermental	1,414	14.6	494	11.5	683	14.4	341	8.4	2,931	12.9
Agricultural	130	1.3	422	9.9	264	5.6	111	2.7	928	4.1
Total	9,675	100.0	4,288	100.0	4,756	100.0	4,053	100.0	22,772	100.0
	42.5%		18.8%		20.9%		17.8%		100.0%	



Power Demand by Sector



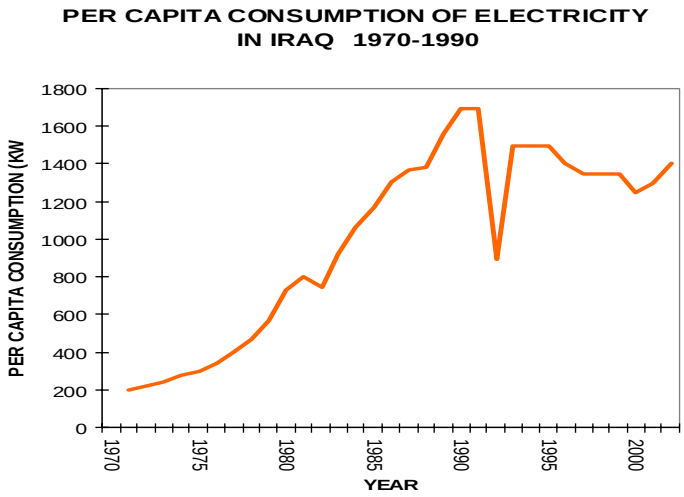
Data source: Country Analysis Briefs; EIA

GDP/ Electricity Consumption per Capita and Population Density in Neighboring Countries

Increasing Rate in Energy Production in Neighboring Countries before the Gulf war

Country	Annual energy production in 1980 (GWh)	Annual energy production in 1989 (GWh)	Increasing ratio (1989/1980)
Iraq	10,736	27,196	2.53
Iran	21,256	45,789	2.15
Turkey	23,322	45,879	1.96
Syria	3,729	9,945	2.66
Jordan	1,002	3,229	3.22
Saudi Arabia	20,452	61,568	3.01
Kuwait	8,818	20,204	2.29
(Japan)	(549,107)	(766,152)	(1.39)

Source: Energy Information Administration, International Energy Database, February 2003



At present, Iraq imports power from Turkey by 80MW and from Syria by 60MW. For further import, construction of a 132 kV transmission line is underway between Iraq and Kuwait.

5. Demand Forecast

In this study, a demand forecast was made, placing a time horizon in 2020. Some basic conditions used in the forecast are as follows.

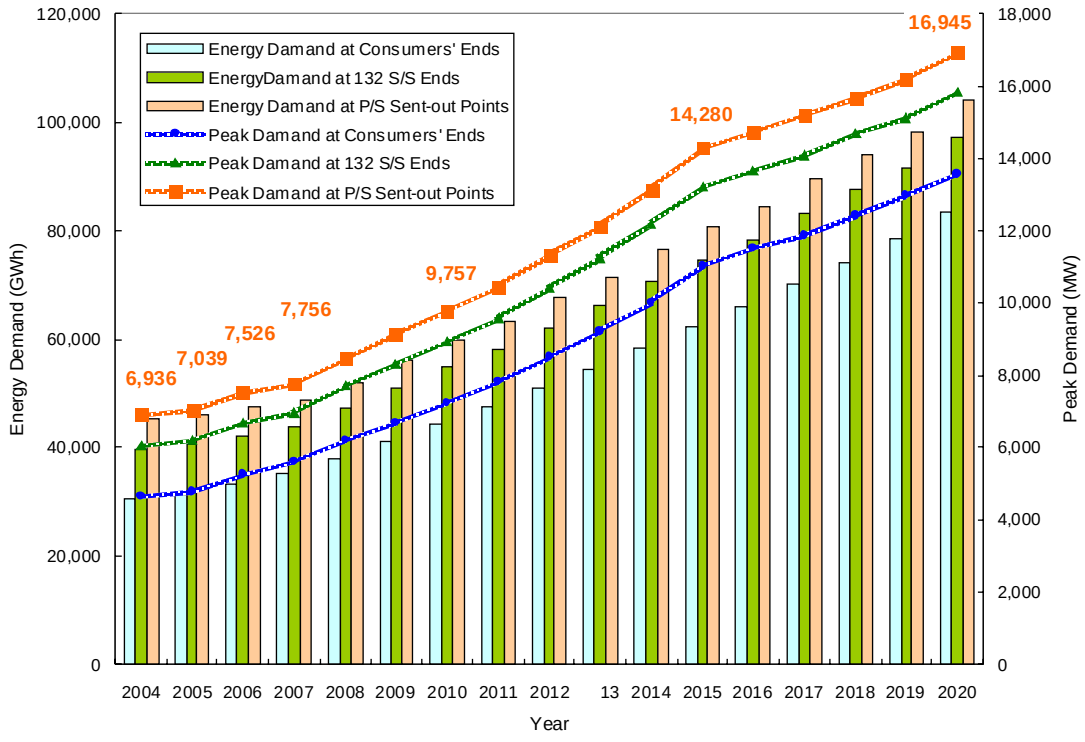
- Target year: 2020
- Demand in 2004 is same as demand in 1990.

- Annual growth rate: 3,6,8,7,6 %
- System loss: 33, 32, 30, 28, 26, 23, 20 %
- Annual load factor:75,72, 70, 65, 70%

The result of forecast is given below.

Year	Energy (GWh)	Peak Load (MW)	Population (thousand)
(1990)	*(29,469)*	*(5,162)*	*(17,890)*
2004	45,393	6,936	26,665
2005	46,065	7,039	-------
2006	47,431	7,526	-------
2007	48,880	7,756	-------
2010	59,913	9,757	31,932
2015	80,765	14,280	37,137
2020	104,046	16,945	43,220

Note：Consumption at sending point



Annual Energy and Peak Demand (2004-2020)

However, the above forecast should be reviewed based on more reliable and sufficient data. The demand for industry should be separately analyzed in line with the national industrial development plan. Review should be extended to demand for government, commerce and agriculture. There is a considerable number of captive power, being separately operated from the national grid. This captive power is reportedly approximately 1,000 MW in total. People also use small generators to cope with frequent load shedding. There is an idea to isolate these captive powers to suppress the load in the national grid for the time being.

6. Continuation of Rehabilitation Works and Technology for Rehabilitation

The on-going and under-planned rehabilitation works of the generating facilities should be continued in order to maintain or upgrade the present supply capacities as long as possible. In parallel with the rehabilitation works of generating plant, the rehabilitation works for transmission lines, substations, distribution lines and load dispatching centers should be carried out to realize a more stable supply system of electricity. It is highly recommended to prepare a comprehensive and updated data sheet for transmission lines, distribution lines and substations for discussion on priority for fund allocation and implementation schedule.

Under the economic sanction and various difficult situations, maintenance and repair works for the power facilities have been done with limitation. It is essentially required to use spare parts same as used in the original design. Technologies used for rehabilitation works are probably different from the ones used for original installation and might be more sophisticated in some cases. Even in the rehabilitation works, qualified experts should be assigned prior to establishment of the rehabilitation plan and commencement of the works.

7. Rehabilitation of Distribution Lines

During the study period, no detail information on the distribution line is available. Even if a master plan study of the electricity sector is conducted in due time, the first focus will be given to generation and transmission lines for convenience. However, it is recommended to conduct a master plan study for the distribution lines separately at the same time or soon. This study for the distribution lines can be called “Bottom–Up Approach”, while the former can be called “Top-Down Approach”. The study on the distribution lines will be made in region-wise and step-wise since it takes a considerable time for completion. For this study, experiences gained in the ENRP (Electricity Network Rehabilitation Program) undertaken in the northern governorates by UNDP would be helpful. Energy loss in the transmission and distribution

network counts for about 30% while that in the generation is about 6%. Therefore, rehabilitation and improvement of the distribution lines are essentially required.

8. Committed Plants

MoE considers commissioning several power generating plants of steam power or gas turbine, which are presented in the CoE's 10 Year Plan prepared in 2002. It is keenly required to complete installation of these power plants as early as possible to cope with the serious shortage of power supply capacity for the increasing power demand. These plants are nominated in the generation expansion plan in the study, though any detail for preparedness or information of the work progress of each project is not known. It is recommended to review the fund requirements and implementation schedule. For the new installation of thermal plants, the basic items such as land clearance and acquisition, availability of water, availability of fuel, route of transmission line, etc. should be reviewed and confirmed.

9. Fuel Price and Electricity Tariff System

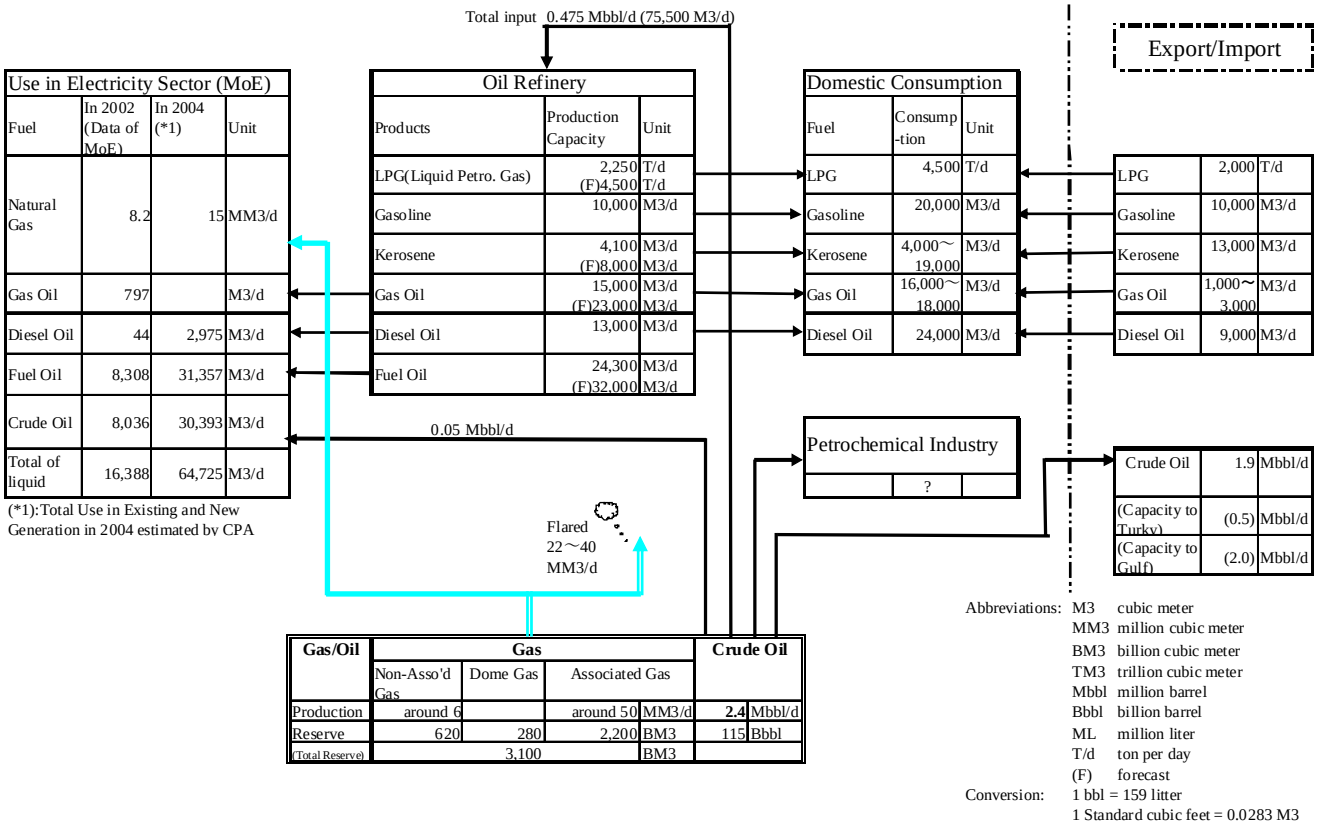
Fuel price for power generation has been set very low and accordingly the tariff was also set low in comparison with the international price level. Under the situation no incentive may occur for more effective use of fuel and for saving energy.

It is necessary to review the tariff structure which was applied in the past. On the other hand, billing and collecting of the electricity tariff has been suspended after the recent conflict in 2003. Resumption of collection of the tariff is essentially needed, if new projects are implemented with international assistance for fund and a privatization policy is introduced in the electricity sector.

10. Fuel Balance

For fuel for thermal generating plants, crude oil, fuel oil, gas oil, diesel oil and natural gas are used. The present power generation may use fuel oil effectively, which can not be used for other purposes. A considerable amount of natural gas, which is mainly associated gas, is not used effectively and the flared gas would be 40 to 80 % of the total production. Use of more natural gas for power generation would contribute to the environmental protection and may be one of the energy policies of the country, but is subject to discussion among the parties

concerned, including cost sharing for the gas related structures such as pipelines.



Iraq Fuel Production and Consumption Balance

11. National Policy and Strategy on Energy Production and Use

Electricity generation in Iraq depends much on thermal plants for which fuel supply is prerequisite and is properly arranged. Fuel supply to the power plants should be carefully planned in line with the national policy and strategy on energy production and use. Needless to say, export of oil and use of oil and gas for the domestic use including use for the power plants should be well harmonized. On this point, close and continued communication and coordination with Ministry of Oil and Ministry of Industry are indispensable. The subjects to be considered are use of natural gas, effective use of flared associated gas, effective use of residual oil in the refineries, route of pipelines and location of relevant facilities and various measures for environmental protection. Share of cost for the infrastructures such as pipelines and relevant facilities would be subject to discussion.

12. Conventional Thermal Plants and Combined Cycle Plant

Steam power plants have contributed much to electricity production in Iraq and this role would remain unchanged for the time being. For the steam plants, fuel oil, crude oil or natural gas are used. However, combustion of the liquid fuels, if used without proper treatment in the course of refinery or power generation, might be a major source of air pollution. On the other hand, use of natural gas would be freer from air pollution since it contains less sulfur content.

In the mid and long perspective, however, use of more natural gas would be a promising option from the viewpoint of environment protection and saving of crude oil. In this regard, introduction of combined cycle plants would be recommended, which energy efficiency is much higher than other types of plant. If this option is accepted by MoE, preparatory works should be started for the introduction, including capacity building for new and advanced technologies.

13. Hydropower and Renewable Energies

Iraq is blessed with hydropower and renewable energies such as solar power and wind power, while they have not been tapped fully. It is recommended to investigate potentials of hydropower and renewable energies and identify the feasible projects for implementation. Especially these projects should be implemented from the environmental viewpoints and in case they would contribute electricity supply to remote areas.

14. Communication System

The power system needs a proper communication system in order to operate and maintain the system in a stable and reliable manner. For upgrading the present communication system, introduction of OPGW (Composite Fiber Optic Overhead Ground Wire) is recommendable.

15. Diagnostic Technology

The diagnostic technology has gained ground, which is a current advanced technology to make assessment of any plant and equipment in a more systematic manner aiming at elongation of their useful life time. It is recommended to introduce this technology to assess the residual life of any plant and to take necessary actions.

16. Environmental Protection

In Iraq, several environmental protection laws were established. However, various environmental issues remain unsolved, such as air pollution caused by oil-fired plants, deterioration of water quality in the rivers and contamination of subsoil by waste. A more appropriate monitoring system for the environment issues should be established at the earliest time in order to grasp the real situation.