UNITED NATIONS

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ESCWA EEA EEAA

Distr.
LIMITED
E/ESCWA/ENR/1999/WG.3/12
24 June 1999
ORIGINAL: ENGLISH

Economic and Social Commission for Western Asia

Expert Group Meeting on the Harmonization of Environmental Standards in the Energy Sector of the ESCWA Member States
29 June - 1 July 1999
Cairo, Egypt

TOWARDS HARMONIZATION OF ENVIRONMENTAL STANDARDS IN THE ENERGY SECTOR OF ESCWA MEMBER STATES

99-0691

PART ONE

THE ESCWA ENERGY SECTOR, RELEVANCE TO ENVIRONMENT

CONTENTS

PART ONE

ESCWA ENERGY SECTOR, THE RELEVANCE TO ENVIRONMENT

INTRODUCTION

The energy services are essential for the social and economic development for both developing and developed countries, however all energy cycles has been a source of serious environmental impacts that threaten human health and welfare. Fossil energy fuel cycles are the major source of air pollution in general involving sulphur and nitrogen oxides, partially combusted hydrocarbons, particulate and carbon monoxide. Such pollution arises along many stages of the fossil fuel cycle starting from the extraction to the end-uses in different economic sectors. However, the main sources of air pollution would be the large industrial energy systems such as petroleum industries and power plants rather than distributed end-use applications. Non fossil energy system would also have their specific but limited environmental impacts.

In spite of the major role of the energy sector in the economy of the ESCWA region, the region is characterized by unsustainable energy use patterns, with both high energy intensities(*) and CO_2 emissions rates. The exploration, production and distribution processes on the ESCWA energy sector has their serious adverse environmental impacts on natural resources "mainly air, water and soil", urban environment, as well as the eco-systems, marine life and demographical setup. Therefore, the need for developing mitigation measures for environmental impacts of the energy sector is crucial for sustainable development in the ESCWA region.

In 1992, Rio Declaration on Environment and Development, Agenda 21, as well as the commitments stated in the Framework Convention on Climate Change (FCCC) have emphasized the need for "Precautionary Measures" to mitigate the impact of energy sector emissions. The World Energy Council (WEC) has supported the principle and recommended that precautionary actions for sustainable energy systems should focus on: (1) raising energy efficiency; (2) pricing energy to cover the full costs of its provision; and (3) accelerated development of cleaner fuels and non-fossil energy sources, including renewable resources, where feasible.[1]

In view of the above, appropriate energy schemes and plans that can support the sustainable development (SD) would: (i) increase productivity; (ii) conserve natural resources; (iii) improve the quality of life of poor rural inhabitants; (iv) develop income and job generation activities; and (v) reduce degradation of natural resources.

To achieve the above described objectives, the ESCWA energy sector should develop policies and plans that are directed to reduce the adverse environmental impacts of the sector including: (i) upgrade the energy use efficiency; (ii) promote the use of cleaner fuels and technologies; (iii) promote a cost-effective mix of fossil and renewable energy (RE) sources; and (iv) develop appropriate environmental regulations and standards that can mitigate to the maximum possible the environmental impacts of the energy sector.

Environmental standards and regulations have been used worldwide, among a wide variety of policy instruments for environmental management. There are several approaches for developing environmental management, however the available environmental regulations

(*) Energy Intensity: The rate of energy consumption per GDP.

and standards in the ESCWA region are mostly following the command and control approach including: ambient standards, performance standards, practice standards and to a less extent technology standards. Environmental performance standards, aim at prescribing to industry an objective bench mark against which to measure acceptable performance, or to provide common reference points for quality control. One of the areas for improving environmental policy making and standards is the need for regional and global harmonization of environmental standards in order to address the issues of trade competition and transboundary nature of pollution problems.

It is obvious that environmental standards vary considerably among different countries, though there is a strong tendency towards increasing stringency especially within the developed countries. International activities relating to environmental problems have multiplied recently and are increasingly affecting the formulation of local and national environmental goals and standards. These efforts have developed along two major lines: harmonization on the one hand and coordination on the other. The major drive towards the harmonization of environmental standards is the issue of trade and competition. International action in this field has been particularly intense in the European Union (EU) and the United States/EPA of America (USA). Regional or international coordination efforts have been essentially motivated by environmental degradation that transcends local or national boundaries. Acid deposition, maritime pollution, ozone depletion, global warming and radioactive releases are on growing list of environmental problems for which action can no longer be considered merely on a local scale. Obviously, the principles of regional and/or international coordination and harmonization are related, and their application to international energy and environmental policy follows similar processes involving the exchange of information, the negotiation of agreements and the subsequent implementation at a national level of commitments made to meet targets or requirements. International efforts to harmonize environmental control efforts have focused on avoiding large differences in environmental control standards and in some instances in environmental control costs as well.

In view of the above, and the fact that energy relevant environmental standards in the ESCWA region are either not existing, fragmented, non-integrated or incomplete, the Energy Issues Section (EIS) of the Energy, Natural Resources and Environment Division (ENRED) at ESCWA has included in its 1998-1999 work programme a study to investigate the availability and compatibility of environmental regulation and standards in the energy sector of ESCWA member States. The core objective is to identify the requirements and possibilities for the harmonization of environmental standards in the energy sector of ESCWA region and recommend an approach for its realization. The specific objectives of the study are:

1. To overview the main features of the ESCWA energy sector focusing on issues that lead to better understanding of the energy situation and its relevant environmental impacts of the major energy subsectors, mainly, oil and gas, electric power sector and end-use transport sector.

2. To review and assess the available and most commonly used energy relevant environmental standards issued or enacted by leading developed countries, international organizations and compare it to those of the ESCWA member States to evaluate its confirmity and compatibility.

3. To identify and discuss the problems and prospects facing the possible coordination and/or harmonization of environmental standards in the ESCWA region.

4. To identify the main issues that need further investigation for facilitating the harmonization of environmental standards among the member States of ESCWA;

5. To develop a framework for an action plan for harmonization of environmental standards in the energy sector of the ESCWA member States.

This background paper presents the study findings in three parts:

Part One on:	ESCWA Energy sector, the relevance to environment (item 1 of the study objectives)
Part Two on:	The environmental regulations and standards of the energy sector (item 2 of the study objectives)
Part Three on:	An approach for harmonization of environmental standards in the energy sector of ESCWA member States (items 3-5 of the study objectives).

I. ESCWA ENERGY SECTOR, THE RELEVANCE TO ENVIRONMENT

The energy sector of the ESCWA member States (MS) had and will continue to play an important role in the region's economy, particularly through the oil and gas export revenues and its major role in satisfying the energy needs for economic and social development in the region. In spite of the decline in the oil prices during the last few years, the contribution of the sector to the region's GDP in 1997, excluding Iraq and Lebanon, reached over 88.0 billions of US dollars (B.US$), counting for 24.1 percent of the total regions GDP. It was distributed as 85.155 B.US$ from oil and gas subsector and 2.984 B.US$ from the electricity sector[2].

On the other hand, the energy sector could be a major source of air pollution, water pollution, effects on eco-systems, demographical changes, and disturbances of marine life and adverse impacts on urban environment. All or some of these environmental impacts are likely to occur during oil and gas exploration, production, transportation, refining, distribution, electricity generation, transmission and distribution as well as all energy end-use sectors.

The following is an overview of the main features of the energy sector in the ESCWA region focusing on issues that lead to a better understanding of the energy situation and its relevant environmental implications. It overviews: (1) the main energy resources, production and consumption patterns, (2) the economic and environmental indicators of the energy consumption patterns; and (3) the structural features, activities and the environmental impacts of three energy subsectors that are the major contributors to the environmental impacts of the sector namely: the two energy producing subsectors, the oil and gas sector and the electric power sector, and the transport sector as the most polluting energy end-use sector. The objective of the subsectors overview is to assess the main features and classification of each subsector that would help to evaluate its main environmental impacts and the required relevant regulations and standards. The emphasis on the energy end-use transport subsector does not ignore the importance of other end-use sectors, since in many member States it's the highest energy consuming and polluting sector. However, this would help to identify the priority areas of concern for the development and enforcement of energy relevant environmental policies, regulations and standards.

A. Energy Resources and Production

The ESCWA member States enjoy tremendous energy resources both fossil "Oil and Gas" and non-depletable renewables. However, the primary energy production in the region has been dominated by oil and gas during the last 25 years with limited contributions of renewable (hydro and others) and coal resources. Table (1) shows the 1996 total primary energy production together with the Oil and Gas reserves and production in the region[3]. The main energy resources and production trends are as follows.

TABLE (1). 1996 TOTAL ENERGY PRODUCTION, CRUDE OIL AND NATURAL GAS PROVEN RESERVES AND PRODUCTION IN ESCWA REGION*

Member States	Crude Oil[a]		Natural Gas (NG)[b]		Total energy tb.o.e/day
	Reserves (Bbl)	Production (tbl/day) 1996	Reserves (Bcm)	Production Bcm/year 1996[c]	
Bahrain	0.21	143	147.0	9.6	319
Egypt	3.7	923	645	17.7	1399
Iraq	112.0	726	3360.0	3.4	881
Jordan	0.3	--	28	0.3	005
Kuwait	96.5	2006	1483.8	0.9	2377
Lebanon	--	--	--	--	0006
Oman	5.1	887	849.0	7.3	1039
Palestinian Authority	--	N.A.	--	--	--
Qatar	4.5	473	8985	18.8	862
Saudi Arabia	261.5	8030	5341.0	79.9	10316
Syrian Arab Republic	2.5	612	500.0	6.6	761
United Arab Emirates	97.8	2209	5831.0	45.9	3287
Yemen	4.0	337	481	13.4	571
ESCWA Total[c]	588.11	16346	27650.8	213.8	21823
Total Arab Countries	643.4	18645	32839	380.0	27662
% ESCWA	91.4	87.74	84.2	56.26	79%

(*) *Source*: Annual Statistical Report 1997, Organization of Arab Petroleum Exporting Countries (OAPEC)

a/ Bbl : Billions of barrels
Tbl/day : trillion barrels/day

b/ Bcm : Billions of cubic meters

c/ The total values excluding Lebanon and Palestinian Authority.

1. Energy Resources

Nine ESCWA member States (MS) are among the largest oil exporting countries, while three countries in the region have limited resources and depend on imported fuels, namely Jordan, Lebanon and the West Bank and the Gaza Strip. Meanwhile, the region enjoys huge renewable energy resources.

(a) **The proven oil reserves** in the region have reached 588 Bbl(*) by the end of 1996 with the GCC countries totaling 466 Bbl which accounts for 79.2 percent of the regions oil reserves, such reserves are almost double those of 1975 (305 Bbl).

(b) **The natural gas reserves** have reached 23 443 BCM in 1996 counting for 5.85 times that of 1975 (4725 bcm)(**). Such gas reserves are mainly in Qatar, United Arab Emirates, Saudi Arabia and Egypt.

(*) Bbl: Billions of barrels.
(**) BCM: Billion cubic meters

In 1997, the oil and gas reserves in the region counted for 56.8 percent and 18.4 percent of the total world reserves and more than 91.7 percent and 59 percent of the total Arab States reserves respectively.

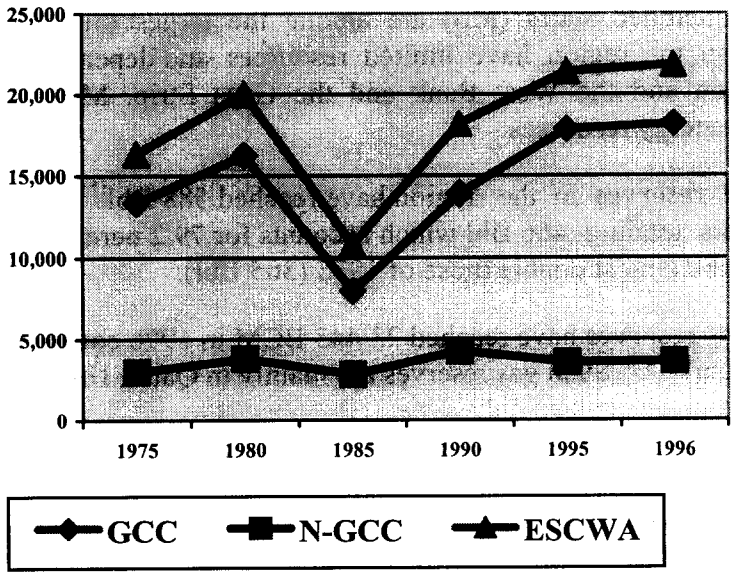
(b) **The renewable energy resources**. The region also enjoys a very high availability of indigenous, clean and non-depletable RE resources, specifically Hydro, Solar, Wind, and Biomass. Such RE resources can be technically and economically utilized for several energy services in the region based on currently mature or maturing RE technologies, and the accumulated experience for its development in the region. As well, exploration has shown promising potentials for oil shale, particularly in Jordan and Syria, it is not yet commercially recovered. In addition, geothermal resources are limited and yet geological resources not recovered.

2. The Primary Energy Production

The primary energy production in the region has been dominated by oil and gas during the last 25 years with limited contributions of hydro and coal resources. As shown in Figure (1), the main energy production trends were as follows:

(a) **The total energy production** in the region has increased between 1975-1996 from 16.330 to 21.823 mb.o.e/day with an average growth rate of 1.39 percent annually. The Gulf Cooperation Council (GCC) countries share in such production was maintained at about 81-83 percent, except for the period 1985 to 1990 where it was reduced to around 75 percent only due to the impact of the export crisis of the early 1980's when the oil production collapsed to almost 50 percent of its level in 1980. Although the recovery of oil output was rather swift after the 1985, though the 1980 level was not fully attained ten years later in 1995[4].

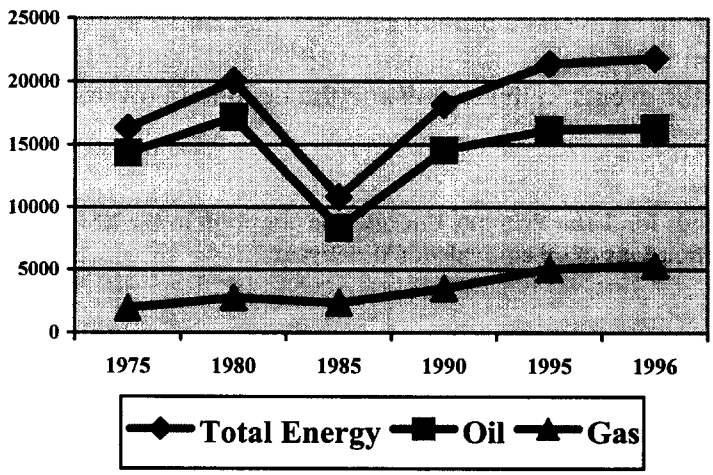
Figure (1-a). Total Energy Production Region (1975-1996)
in the ESCWA region (1000 bl.o.e/day)



(b) **The oil production** in the ESCWA region reached 16.346 mb.o.e/day(***) in 1996, counting for 56.3 percent of the total Arab countries production and 25.4 percent of the world production. The GCC countries produced 12.86 mb.o.e/day of oil, counting for 78.6 percent of the total region's production, and 20 percent of the world production. The actual production of oil in the region reached 87.4 percent of its production capacity in 1996.

(c) **The natural gas production** in the region, although still lower than oil production, has increased during the last 25 years more rapidly than that of oil. The production of 213.8 MCM in 1996 was 2.539 times that of 1975 (84.2 MCM) with a growth rate of 4.53 percent annually compared to only 0.6 percent growth in oil production. It is also to be noted that, although the GCC countries are the main contributors to gas production in the region (87 percent in 1975 and 81 percent in 1996), gas production has been increasing at a rate of 6.6 percent annually in the non-GCC countries more rapidly compared to 4.14 percent growth rate in the GCC countries.

Figure (1-b) Trends in Energy Production in the ESCWA Region (1975-1996) (1000 bl.o.e/day)



During the last decade, development in exploration and enhanced recovery has led to tangible results in increasing the production and identifying additional oil and gas resources, in addition to enhancing the productivity of existing fields. In addition, OAPEC studies estimate that the oil production capacities in the region will reach 27.0 mbl/day in 2010 and 28.1 mbl/day in 2020.

(***) mb.o.e/day: Million barrels oil equivalent.

(d) **The renewable energy production**, Few countries in the region, particularly Egypt, Iraq and Syria have effectively utilized their hydro resources for electricity generation (about 6450 Mw installed), however limited unrecovered small hydro resources are still available in the region.

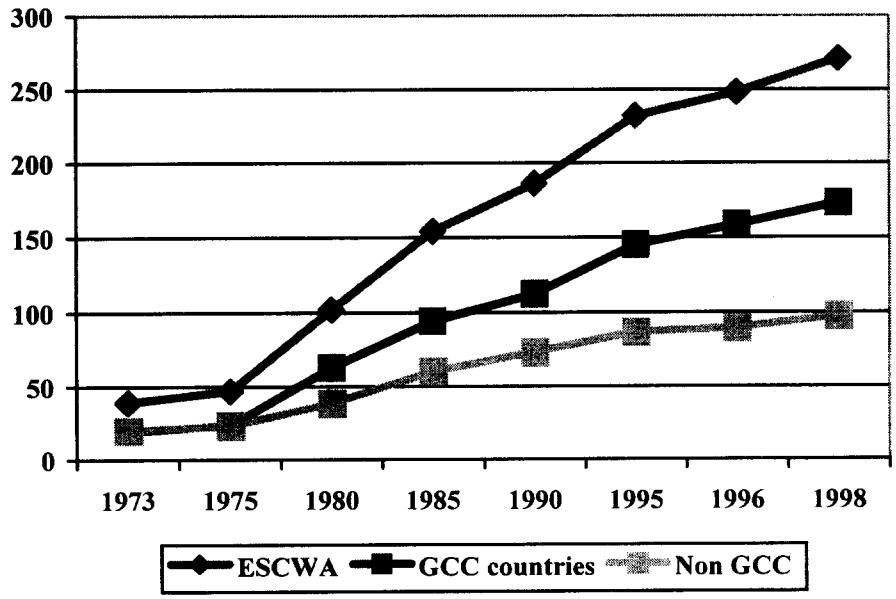
The production of electricity from hydro resources in the region accounted for an equivalent of 53.2 tb.o.e./day in 1975, raised to 135.7 tb.o.e/day in 1996 with an average growth rate of 4.3 percent annually. Other renewable resources particularly solar, wind and biomass were in a development stage during the last 25 years, however they started to have a slight contribution to the energy supplies particularly in Egypt, Jordan and Syria. Such limited contribution has reached about 250 tt.o. in 1997 (about 5 tb.o.e/day) and is expected to start growing more rapidly.

B. Energy Consumption Trends

1. The Total Primary Energy Consumption

Figure (2) shows the evolution of the primary energy consumption in the region during the period 1973-1998, it has increased from 39.4 mt.o.e in 1973 to 271.0 mt.o.e in 1998, 6.8 times with an average growth rate of 8 percent. The growth rate was not regular, it reached more than 12 percent in the period 1973-1985 and dropped to 4.4 percent between 1986-1996 due to the events in the region and the decline in oil prices.

Figure (2). The trends for Total Primary Energy Consumption in the ESCWA Region (1973-1998)
Million tons of oil equivalent (Mtoe)/year



During the last 25 years, energy consumption increased about (9) times in GCC countries and only (5) times in mixed economy countries in the region with average growth rates of 10.9 percent and 6.65 percent respectively. Meanwhile, as a result of the development in the petroleum and gas industries and the change of living standards in GCC countries, the growth rates reached 31 percent in the UAE, 18 percent in Saudi Arabia and 15 percent in Bahrain. The share of the ESCWA region in the world primary energy consumption has increased from less than 0.8 percent in 1973 to about 3 percent in 1997.

2. Primary Energy Consumption Patterns

The trends for the energy consumption patterns in the ESCWA region during the period 1973-1998 were characterized by the following[5].

(a) **The per capita energy consumption**, the use of energy per capita in the region was estimated at 545 kgoe in 1973 and rose to 1740 kgoe in 1998. In 1998, the average per capita energy consumption in the region was very close to the world average, however, there has been a diverse situation in the region where the per capita consumption varied between member countries from about 20 percent of the world average in Yemen (200 kgoe) to more than 8 times in Qatar (12740 kgoe). When compared to the real GDP in the region, the rate of per capita energy consumption in the region does not show equivalent economic productivity, but prove to be rather wasteful as will be shown hereinafter.

(b) **The fuel consumption structure**, the member States of ESCWA have adopted since the mid 1970's a policy for displacing oil by domestically produced gas, since gas is a cleaner fuel and the net back from gas exports is usually much lower than that of oil. Table (2) shows the changes in the distribution of total energy consumption by fuel type between 1973 and 1998, including:

- The share of oil in total energy consumption has declined from almost 75 percent in 1973 to 56 percent in 1998, while the natural gas contribution to the energy mix increased from 20 percent to 41.1 percent during the same period with a growth rate of about 11.2 percent;

- The natural gas contributions in 1998 reached 88 percent in Bahrain, 87 percent in Qatar, 60 percent in Kuwait, 54 percent in Oman and about 40 percent in Saudi Arabia as well as 23 percent, 30 percent in Syria and Egypt respectively;

- The contribution of hydro resources was only about 2.5 percent in 1998, while the current contribution of other renewable sources is limited to about 250 tt.o.e/year;

- The balance of 100% consumption in the following table is coal only in Egypt for some industrial uses.

TABLE (2). CHANGES OF ENERGY CONSUMPTION BY TYPE OF FUEL IN THE ESCWA REGION (1973-1998)[6]

Groups of countries	Year 1973				Year 1998			
	Total M.t.o.e	Oil	Gas	Hydro	Total M.t.o.e	Oil	Gas	Hydro
GCC	19.3	12.4	6.9	0	173.31	83.6	89.5	--
	100%	64.3%	35.7%	-	100%	48.2%	51.8%	-
Mixed economy	20.12	17.04	1.0	1.8	97.7	68.4	21.9	6.6
	100%	84.7%	5%	8.9%	100%	70%	22.5%	6.7%
ESCWA Region	39.4	29.4	7.8	1.8	271.0	152.0	111.41	6.6
	100%	74.7%	20%	4.6%	100%	56%	41.1%	2.4%

Source: Al-Lababidi, M., "Arabian Gulf Countries: Oil and Gas Resources and Trade with Asian Countries". The Sixth Arab Energy Conference, Damascus, Syria. May, 1998.

(c) **Local consumption share in total supplies**, the gradual rapid increase in energy consumption has reduced the percentage supplies available for export. In the 1970's, only 5 percent of the production was used locally, while it reached 20 percent in 1996. Countries that are consuming a high percent of their production are: Iraq, Egypt, Bahrain and Syria currently consuming 66 percent, 46 percent and 33 percent of their production respectively, while Oman and Yemen consume as low as 8 percent and 17 percent of its production respectively. Such ratio is expected to become higher by year 2010 to reach 67 percent in Iraq, 75 percent in Egypt, 48 percent in Syria and 93 percent in Bahrain, while it will reach only 12 percent at both Oman and Kuwait.

(d) **The energy consumption by sector**, ESCWA studies have shown that in 1995 the residential, industrial and transport sectors were the highest end-use energy consumers in the ESCWA region. However, the residential sector comes first in GCC countries, while industry is the main consumer in mixed economy countries. Both sectors consumed about 28 percent each of the petroleum products and 52.4 and 24.7 percent of the generated electricity, for residential and industrial sectors respectively. The study also showed that the transport sector is the highest consuming sector of petroleum products sharing 38.4 percent of its total consumption in the region. This emphasizes its possible impacts on the environment, especially gases emissions leading to air pollution and health problems.

3. Economic and Environmental Indicators of Energy Consumption

Many countries in the ESCWA region are characterized by high per capita energy consumption together with high energy intensities, showing that energy consumption in the region is not appropriately servicing the economic development but rather wasteful. Moreover, it can lead to more pollution, both locally and globally through GHG emissions, particularly CO_2 emissions.

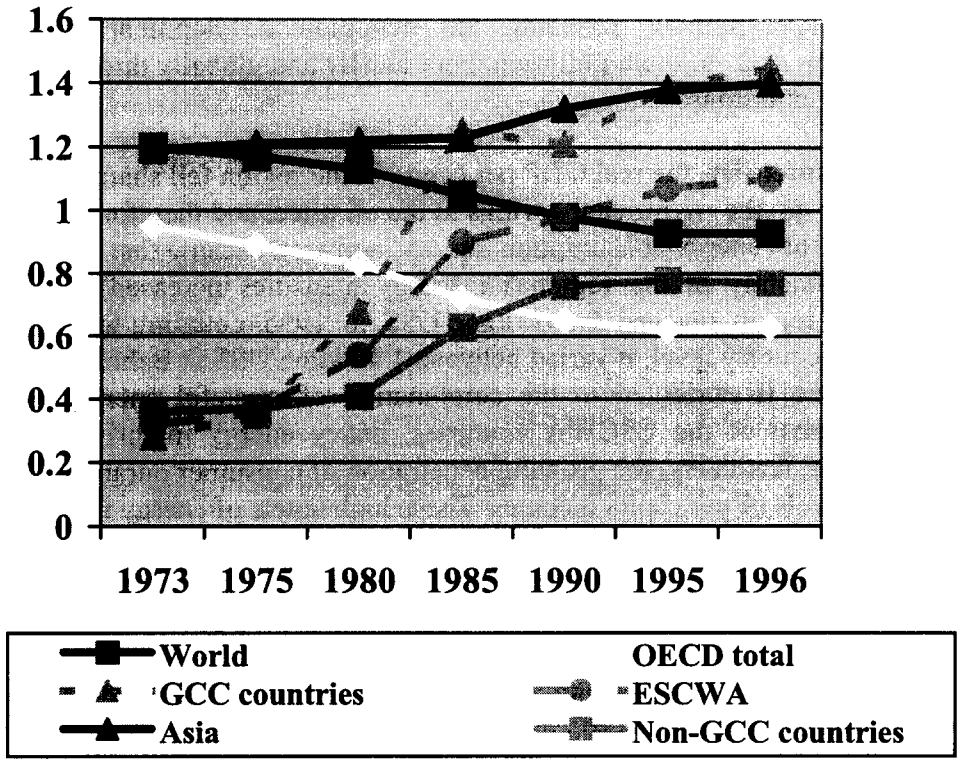
(a) **Energy intensity**, the real GDP per capita in the region fell sharply during the period 1980-1998. Due to the significant swings in the oil price, and therefore oil revenues, and at the same time, the energy consumption rapidly increased causing that the energy content of GDP rose significantly in the region (i.e. energy intensities increased). The average energy intensity in the region reached 0.549 kgoe/US$ in 1996 counting for 1.7 times the world means. On the country level, it varied between 1.42 kgoe/US$ in Bahrain to 0.284 in Oman. This characteristic is attributed to the combination of wasteful energy, under-pricing of electricity in most of the ESCWA countries, heavy energy intensive industries (petro-chemicals, metals, fertilizers) the growing penetration of consumer durables and vehicles, and the increased levels of per capita incomes. These high levels of energy intensity in the region together with the analysis of CO_2/GDP trends given below indicate clearly the urgent need to the development and realization of policies, regulations and standards that targets more productive, environmentally friendly energy consumption patterns.

(b) **CO_2 emission trends of the energy sector**, historical GHG emissions which have contributed to the concentration of GHG in the atmosphere have come overwhelmingly from industrialized countries. Meanwhile, its growth has occurred mostly in the OECD countries, but increasingly over the past two decades in regions outside OECD including the ESCWA region. Table (3) shows the changes in total energy consumption and CO_2 emissions and indicators in the region between 1973 and 1996. The GDP values used are based on the purchase power parity values.

(i) Total CO_2 emissions, the total CO_2 emissions from fuel combustion in the ESCWA region has increased from 102.4 mt CO_2 in 1973 to 661.3 mt in 1996 (6.46 times) at an average growth rate of 8 percent. The GCC countries contribution to such CO_2 emission has increased from 46 percent in 1973 to 63.5 percent in 1996 reflecting the rapid increase in the level of per capita energy consumption;

(ii) CO_2/GDP trends, as shown in Figure (3-a), the CO_2/GDP at the ESCWA region was almost one fourth of the world average and about one-third of OECD average in 1973. In the period 1975 to 1985, while CO_2/GDP at other world group started to decline, the CO_2/GDP at the ESCWA region increased drastically during the same period to exceed that of OECD and world average. This emphasizes the fact that energy consumption in the region is wasteful rather than productive and is not reflected appropriately in the economy of the region. Such a fact is further emphasized by the fact that the contribution of the natural gas as a cleaner fuel has increased during the same period.

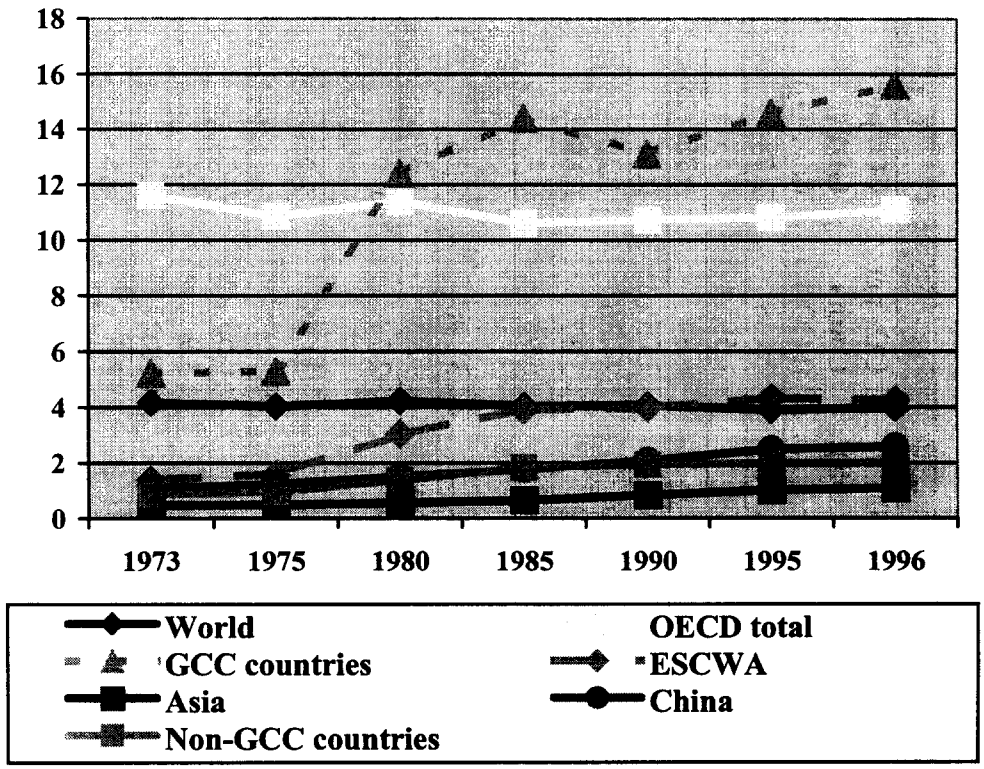
Figure (3-a) CO_2 Emissions/GDP by region
(Kg CO_2/US$)



(iii) CO_2/Capita trends, the CO_2/capita is an environmental indicator that reflects the level of energy consumption per capita and the fuel mix in a specific country. In 1973, CO_2/capita in the ESCWA region was below the world average and about 12 percent of that of the OECD, however, it grew very rapidly between 1975 and 1985 to reach the world average of about 4.0 tCO_2/capita. In the period 1985-1996 the CO_2/capita in the ESCWA region had a slight increase, thanks to the increased natural gas shares in the energy consumption in the non-GCC countries.

Two points should be pointed out: (1) the situation of the sanction at Iraq had resulted in an unplanned reductions in the emissions at the non-GCC countries; and (2) the CO_2/capita at the GCC countries has increased at a very high rate to reach almost 4.0 times the regions average and continued exceeding it. Currently, the GCC countries CO_2/capita is about 40 percent above that of OECD.

Figure (3-b) CO_2 Emissions per capita
(tonnes of CO_2 per capita)



In view of the above, the region should be alerted to: (1) the adverse effect of the current energy consumption trends on the opportunities for economic and social development in the region as well as the local, regional and possibly global environment. Two issues should be seriously realized: (1) the environmental impacts of the energy sector affects the local environment and health conditions as it contributes to global warming and transboundary ozone problems; (2) although there is no quantified emissions commitments on non-annex 1 parties, under the FCCC, however they have reporting requirements including periodic dissemination of emission inventories and they will be requested to be committed not too far in the future.

Table (3). Total Energy Consumption and CO_2 Emission Trends in the ESCWA region 1973-1996[7]

Country	1973				1996			
	TPSE (MTOE)	**CO_2 per Capita** ($t\ CO_2$)	**CO_2 per GDP** ($kg\ CO_2$)	**Mt CO_2** From Fuel comb	**TPSE (MTOE)/ year**	**CO_2 per Capita** ($t\ CO_2$)	**CO_2 per GDP** ($kg\ CO_2$)	**Mt CO_2** From Fuel comb
Bahrain	2.25	22.03	2.11	5.24	6.56	26.36	2.73	15.79
Egypt	8.08	0.61	0.46	21.19	37.79	1.59	0.53	94.21
Iraq	5.3	1.41	0.22	14.55	25.03	3.34	3.78	71.4
Jordan	0.66	1.13	0.36	1.90	4.49	3.03	0.61	13.06
Kuwait	5.74	14.89	0.42	13.31	13.86	24.36	1.22	38.74
Lebanon	2.57	2.61	0.42	7.34	4.75	3.37	0.69	13.74
Oman	0.1	0.38	0.05	0.3	4.85	5.98	0.4	12.99
GCC countries	19.27	-	-	-	-	-	-	-
Qatar	1.46	23.85	0.78	3.51	8.73	31.96	2.36	21.03
Saudi Arabia	8.23	3.17	0.19	20.89	92.24	12.81	1.37	248.68
Syrian Arab Republic	2.5	1.09	0.64	7.6	14.54	2.79	0.9	40.42
United Arab Emirates	1.49	10.73	0.4	3.79	32.34	32.75	2.9	82.91
Yemen	1.01	0.41	0.44	2.74	2.94	0.53	0.31	8.29
Total ESCWA	**39.39**	**1.5**	**0.34**	**102.4**	**248.12**	**3.9**	**1.1**	**661.26**
GCC Countries	**19.27**	**5.0**	**0.31**	**47.1**	**158.58**	**15.2**	**1.41**	**420.14**
Non-GCC Countries	**20.12**	**1.2**	**0.35**	**55.3**	**89.54**	**2.0**	**0.8**	**241.12**

Source: International Energy Agency (IEA), CO_2 Emissions from fuel combustion (1971-1996), 1998.

C. ESCWA Oil and Gas Sector, the Relevance to Environment

The ESCWA Oil and Gas subsector represents today the largest economic sector in the region, particularly for the GCC countries. On the other hand, the sector could be a major source of environmental negative impact which is likely to occur during exploration, production, transportation, refining, distribution and use.

1. Overview of the Oil and Gas Sector

The 1997 statistical yearbook of OAPEC has presented a statistical assessment of the Oil and Gas subsector activities in the Arab countries. Table (4) shows the extracted information for the ESCWA region compared to the total Arab countries and the following is a brief on the development and activities of the sector and its environmental impacts.

The countries in the region have directed efforts towards enhancement of the national contribution to oil and gas exploration and production through joint ventures, concession agreements and service contracts. The current development status of these activities is summarized below:

(a) **Oil and gas exploration** is usually in undeveloped areas where huge operations take place on site and in the areas around either on-shore or offshore. It includes access roads, seismic exploration activities, traffic, drilling operations, air transport, construction, operation, and exploratory wells.

In 1996, 308 seismic exploration crew were activated each month counting for 59.7 of the total seismic activities in the Arab world. In addition, a total of 183 rigs were active compared to 220 rigs in all Arab countries. Also more than 2500 km of exploratory drilling were achieved. Egypt, Oman and Saudi Arabia had the most intensive exploration activities in the region.

(b) **Oil and gas production** requires extensive on-site industrial activities for the life of the field. Construction of well sites, access roads, air fields and transport pipelines, and ancillary support facilities are common components of a production field. In addition, facilities will be required for the living of the operation and maintenance staff.

In 1996, the number of productive wells in 1996 reached 1092 wells with the highest number in Oman (355), Egypt (164), Saudi Arabia (160) and the United Arab Emirates (149), while 47 new discoveries were realized including 28 oil fields and 19 gas fields. The majority of the new discoveries were in Egypt (29) only, and 12 at Bahrain, the rest are in Yemen (3), Saudi Arabia (2) and Bahrain (1).

(c) **Oil and gas industries.** Several oil and gas industries particularly refineries, petrochemicals and liquifying Natural Gas were developed in support to the policy to diversify sources of national income adopted by several governments in the region. Late 1996, eleven countries in the region had a total installed refinery capacity reached 4.88 mbl/day. The largest are (1676 tbl/day) in Saudi Arabia and 850 tbl/day in Kuwait.

The first gas liquifying factory was established in 1977 at Abu Dhabi (UAE) and its capacity was extended in 1998 to reach 8 mt/year (240 tbl/day) exported to Japan. The second in Qatar in 1996 (8 mt/year), 2.9 of it will be exported to Korea. GCC production of

liquefied gas will reach 26 mt/year in the year 2000 and 31 mt/year in the year 2010 to Asia markets.

A remarkable success has been achieved in building national and intra-regional capacities in the field of oil and gas industries, the main development features are: (1) liquified gas capacities reached 20.0 times that of 1975; (2) the natural gas marketing has increased seven times; and (3) the refinery capacities have increased to 2.5 times their 1975 level.

(d) **Oil and Gas exports and transport facilities.** The development of the region's industrial capacity and the availability of petroleum products have encouraged the intra-industry trade among countries in the region, associated with a parallel development of the petroleum infrastructure including: (1) national transport and distribution facilities; and (2) the development of intra-regional network of pipelines for oil and gas.

The crude oil exports in 1996 have exceeded 11.5 mbl/day together with 2.9 mbl/day of petroleum products counting for 1.47 times that of 1990 with a growth rate of 2.8 percent annually, almost 60 percent of such exports were to Asian countries. The countries in the region have 77 tanker fleets for oil transportation with 6.52 million/tons capacity, as well as 9 liquid gas carriers with a total capacity of 602 thousand m^3. In addition, more than half of the world's petroleum has been estimated to pass through the waters of the Arabian Gulf to its adjacent Gulf of Aden. Such huge volume of exports, transport facilities and networks required reflect the tangible impact that they can pose on the environment.

2. Environmental Impacts of the Oil and Gas Sector

The oil and gas sector has considerable environmental impacts, which is affecting water and marine resources, leading to air pollution and disturbing land resources. The risks of major environmental accidents and oil spills are also additional impacts of the sector.[8]

(a) **Impacts of exploration and production**, the oil and gas major development phases include the initial geophysical surveys of broad regions to identify exploration targets, drilling wells to test likely targets, and construction of the transportation and processing infrastructure. Production units may include various types of platforms with multiple production and re-injection wells, storage tanks, separators, and ancillary support facilities. Oil and gas transport is usually by pipeline, occasionally by barge or tanker to shore-based refineries and/or gas processing facilities. The environmental impacts of exploration and production include:

(i) Air pollution. Resulting from flaring of unwanted gases, sour gas discharge (hydrogen sulfide), and burning of oil waste pits, in addition to emissions from transport traffic, drilling and the operations of the production equipment;

(ii) Water pollution. Contamination of local surface waters, leakage from pipelines, pits and storage tanks, rain water runoff from roads, pads and other paved or packed surfaces, improper handling of domestic sewage and wastes from equipment maintenance and erosion of disturbed soils. In addition, water needed for drilling and domestic purposes may diminish local sources;

TABLE (4). 1996 OIL AND GAS, EXPLORATION, PRODUCTION, INDUSTRIES AND TRANSPORT ACTIVITIES IN THE ESCWA MEMBER STATES (1996) [3]

Countries	Exploration		Production		Industries		No. of Transport Facilities			Oil Export [b/] tb/d
	Seismic crew/month	Exploratory & Development Drilling (KM)	Active No. of Rigs	No. of Wells	Installed Refining Capacities tb/d	LNG Production tb/d	Length of Pipelines Miles[a/]	Tanker Fleet Oil	Liquid Gas Carriers	
Bahrain	--	20	1	20	280	10	--	1	--	272
Egypt	64	511	40	164	585	60	1,530	7	--	508
Iraq	36	54	10	20	550	25	4,593	17	--	83
Jordan	--	--	--	--	103	--	--	--	--	--
Kuwait	12	149	9	50	850	101	623	18	7	1,980
Oman	75	505	21	355	80	10	--	--	--	822
Qatar	15	141	11	64	63	55	492	2	--	366
Saudi Arabia	60	355	20	160	1,676	701	5,526	15	--	7,613
Syria	13	191	19	63	233	99	3,105	--	1	412
UAE	25	488	27	149	240	160	1,046	15	1	2,194
Yemen	8	93	5	47	200	--	--	2	--	247
Total ESCWA	**308**	**2,507**	**183**	**1,092**	**4,860**	**1,221**	**16,275**	**77**	**9**	**14,496**
Total Arab Countries	**516**	**3,232**	**220**	**1,358**	**5,988**	**1,317**	**30,976**	**95**	**22**	**16,446**
% ESCWA	**59.7**	**77.67**	**83.2**	**80.4**	**81.2**	**92.7**	**42.85**	**81.0**	**41**	**88.1**

Source: Annual Statistical Report, 1997. Organization of Arab Petroleum Exporting Countries (OAPEC).

a/ include the total length of pipelines for crude oil, natural gas and petroleum products.
b/ include both crude oil and petroleum products exports, natural gas exports are not included.

(iii) Accidental oil spillage. Offshore oil and gas development carries with it the risk of oil spills at the platform and in transporting the oil from the platform to shore. Pipelines may suffer chronic leaks or even rupture. The environmental impact of an offshore spill depends on a number of factors, including the type of oil; the size of the spill; and weather conditions. Even under good conditions, the percentage of oil recovered from a spill is between 10-15%. Generally the larger a spill the worse the potential environmental consequences. However, in inshore areas even regular, small-scale spills and leaks may cause considerable environmental damage, particularly if it is a highly toxic oil or a heavy crude. The marine environment in the ESCWA region, particularly at GCC countries, is subjected to considerable stress through the deliberate or accidental oil spills;

(iv) Produced water. In addition to oil and natural gas, oil reservoirs may contain considerable quantities of water, (fossil or formation). During production, formation water may also come to the surface and will be separated from the oil and/or gas. This water, which contains hydrocarbons and chemicals from the reservoir and chemicals injected during production is called 'production water' and is generally discharged into the sea after simple treatment. API estimates that six to eight barrets of water are produced for each barrel of oil. In old fields, production may consist of 94 per cent water and 5 percent oil or gas. Produced waters are principally salt solutions and most are more concentrated than sea water. Based on available analysis, different metals may be present in substantially higher concentrations than in sea water;

Produced water may also contain radionuclides, primarily in the form of radium (Ra); and contains high concentrations of oil which is allowed to separate in a gravity separator, and then be treated to remove dispersed oil before being discharged into the sea;

(v) Limitation of land use and surface disturbance. Where the construction and operation of oil and gas facilities can affect the eco-system in areas that can have alternate uses, particularly coastal tourism areas. Surface disturbance is caused by the geologic tests, exploratory wells, access roads and construction works;

(vi) Drill cuttings and muds. During exploration and the initial phases of production, extensive drilling operations are undertaken producing particles of crushed sedimentary rock, drill cuttings and drilling muds. Such discharges have a variety of effects, including smothering of resident flora and fauna and affecting organisms exposed to contaminated drill cuttings. In addition, it can affect the fish growth and caused elevated levels of hydrocarbons in fish tissue and it is considered possible that this may be linked to the reported higher incidences of liver diseases. It raise local levels of heavy metals (in particular, Cu, Hg, Pb and Zn) in sediments, clays and weighting agents;

(vii) Production Chemicals. Chemicals used in the offshore production process include biocides, corrosion inhibitors, scale inhibitors and gas treatments. The complex nature of some of the chemical cocktails involved. Elevated Cd and Hg levels for waters in active oil production areas and disrupt endocrine function in freshwater fish;

(viii) Disturbing fishing distribution, catch and marine mammals, particularly those who use sound for communication with the same frequency used by seismic surveys for exploration;

(ix) Noises caused by seismic exploration, explosive charges, equipment operations, trucks or air transport;

(x) Damage of cultural resources and eco-system, due to seismic operations and exploratory wells.

(b) **Impacts of oil and gas industries**, the environmental impacts of oil and gas industries are mainly related to petroleum refineries. It results primarily from gaseous emissions, wastewater discharges, solid wastes, noise, odor, and visual or aesthetic effects:

(i) Air Pollution. Atmospheric emissions are the most significant causes of adverse environmental impacts from refineries. Most important are particulate, hydrocarbons, carbon monoxide, sulfur oxides, and nitrogen oxides. Pump seals and valves can be fugitive emission sources. The combination of emissions can produce obnoxious odors affecting large areas in the neighbourhood of the refinery;

(ii) Water pollution and waste water. Large quantities of water are used in petroleum refining for washing unwanted material from the process stream, for cooling and steam production, and in the reaction processes. The major pollutants present in petroleum refinery wastewater discharges are oil and grease, ammonia, phenolic compounds, sulfides, organic acids, and chromium and other metals. These pollutants may be expressed in terms of biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), and total organic carbon (TOC). In addition, there is potential for serious surface water, soil, and groundwater contamination and degradation from leaks or spills of raw materials or products;

(iii) Solid wastes. Refineries generate large volumes of solid wastes; chief among them are catalytic fines from cracking units, coke fines, iron sulfides, filtering media, and various sludges;

(iv) Noise. Petroleum refining can be a noisy operation. The main sources of noise include high-speed compressors, turbines and motors, flares, air-cooled heat exchangers, cooling towers and vents;

(v) Toxics. Some of the processes used by industry in producing oil and natural gas, such as glycal dehydrators equipment that separates water from natural gas to make it safe for transportation by pipeline emit into the air toxics like benzene.

(c) **Major environmental accidents' impacts**, the risks of major environmental accidents are currently receiving an increased public concern due to the fact that developments in industrial structures have resulted in an increased scale of production units and trade flows of hazardous substances. Urbanization and demographic concentration have made the major accidents worse, in terms of human lives lost, as well as injured people. Finally, though major industrial accidents do not always result in large-scale environmental damage, awareness of the risk affecting eco-systems rather than human health has become more acute.

Some of the most important oil and gas related areas of risk are: on-shore and off-shore blow-outs, explosions and fires due to the production, treatment, transport and use of oil and gas, such as, fires at refineries, oil rigs, gas storage tanks, explosions of pipelines, ... etc.

Accidents, such as rupture of pipeline or storage tank, may result from improper installation or poor maintenance, aging facilities, third-party actions (sabotage, collisions, etc.) and seismic occurrences. Infrequently, unexpected drilling conditions can result in a well blowout, causing an uncontrolled release of large volumes of oil and/or gas and formation waters into the surface waters.

(d) Impacts of oil and gas transportation, offshore, near-shore, and upland, oil and gas pipelines have different environmental impacts. The magnitude of their impacts depends on the type and size of pipeline installed; the significance depends on the degree to which natural and social resources are affected. Installation of pipelines in offshore areas may result in the loss of bottom-feeding organisms, and can result in the temporary resuspension of bottom sediments which may alter aquatic habitat characteristics and lead to changes in species composition. The pipeline can also result in a resuspension of these toxic sediments and temporarily lower water quality immediately. In addition, pipelines can result in loss or damage to fishing equipment as well as the accidental ruptures to pipelines, and can also result in oil spills.

D. ESCWA ELECTRIC POWER SECTOR, THE RELEVANCE TO ENVIRONMENT

1. *Overview of the Electric Power Sector*

The electricity sector in the ESCWA region has developed tremendously during the last two decades in response to the development needs in the region, particularly in Saudi Arabia, Egypt, Iraq, Kuwait and UAE. Table (5) shows the main features of the sector and its development status as described hereinafter:

(a) **Installed capacity**. The total installed capacity of power plants in the region grew at 9.3 percent from 1975 to 1997 to reach 71613 MW out of which 65164 MW are thermal generation plants, counting for 91 percent of the total installed capacity, while hydro power stations counted for only 640 MW representing less than 9 percent of the total installed capacity. he thermal generation capacity included: 33 550 MW and 25 709 MW of steam and gas power plants respectively. The combined cycle and diesel generation counted for 4053 MW and 1852 MW. The reserve margin of the installed capacities in the region varies widely, from 3 percent for some countries, such as Bahrain, to about 40 percent for other countries, such as the United Arab Emirates. Studies show that the total installed capacities in the region will grow at a rate of 4.5 percent up to year 2010 to reach 127 121 MW.

(b) **Electric distribution grids**. Some of ESCWA member States are covered with unified electric grids, while others have several isolated grids. Transmission voltages at the extra high-voltage level differ from one ESCWA member to another and include 500 kV, 400 kV and 380 kV; for the high-voltage level, they include 220 kV, 275 kV, 150 kV, 132 kV, 115 kV, 66 kV and 33 kV. The total length of the transmission lines in the region reached 167313 km in 1997 out of which 10152 are at extra high voltage (300-500 kV).

(c) **The total electric energy consumption**. In 1997, the electricity consumption in the region reached 266 077 GWh equal to 16.15 that of 1975 with an average growth rate of 13.8 percent. Saudi Arabia and Egypt are the largest electric energy consumers in the region consuming 34.6 percent and 20.9 percent of the total 1997 electric consumption, however, the average per capita consumption varies widely from about 110 kWh/year in Yemen to 13 700 kWh/year in some of the GCC countries. The peak load in 1997 has varied from as low as 387 MW in Yemen to as high as 17 995 MW in Saudi Arabia and 9235 MW in Egypt.

(d) **Electric grids interconnection**. There is a growing trend in the region for electric grid interconnection motivated by the availability of primary energy resources, their geographical locations and the diversified daily and seasonal changes in the demand for electricity. The first interconnection in the ESCWA region started in 1973 between the Syria and Lebanon through two electric links (66, 230 kV) each of 80 MVA. The second exists between Syria and Jordan with two links (66, 230 kV) started in 1977 and 1981 consequently with a total transfer capacity of 110 MVA. Recently, the interconnection between Egypt and Jordan was inaugurated in March 1999 through 500 kV crossing Suez Canal and Sinai Peninsula to reach the Gulf of Aqaba, and a 400 kV overhead transmission line in Jordanian side. The project will be completed to cover the interconnection between six countries, Egypt, Iraq, Jordan, Syria, Lebanon and Turkey. In addition, the GCC agreed, in 1997, on the implementation of the Arabian Gulf States Electrical Power System Interconnection. The implementation, operation and promotion of interconnection projects will generate need for development of relevant power and grid quality environmental relevant standards.[9]

2. Environmental Impacts of the Electric Power Sector

In a typical electric power system, electricity is generated in power stations, transmitted at high voltage by overhead lines, distributed at various intermediate voltages to large consumers and finally supplied at a low voltage to individual small consumers. The following is a brief description of the environmental impacts of the electric power sector classified by type of generation and transmission and the category of impacts of each.

(a) **Potential environmental impacts of thermoelectric projects**, negative environmental impacts can occur both during construction and operation of thermoelectric plants. Construction impacts are caused primarily by the site preparation and building activities: impounding bodies and establishing lay-down areas, ... etc. The large number of workers employed in constructing power plants can have significant socio-cultural impacts on local communities.

(i) Air pollution, thermoelectric plants are considered major air emission sources which can affect local and regional air quality: (VOCs), (SO_2), (NO_x), (CO), (CO_2), (CH_4), and particulates matters (PM1O). The combustion of fuels by thermoelectric projects emitted. The amounts of each pollutant depend on the type and size of facility, the type and quality of fuel, and the manner in which fuel is burned. The dispersion and ground level concentrations of these emissions are determined by the physical characteristics of the plant stack, physical chemical characteristics of the emissions, meteorological conditions at or near the site, topography of the plant site and surroundings, and the nature of recieptors (e.g., people, crops, and native vegetation).

Electric utility power plants currently account for only a small percentage of particulate emissions due to the use of control devices such as baghouse filters and electrostatic precipitators. Similarly, it contributes only small percentages of total emissions of VOCs, CO, and CH_4.

TABLE (5) THE 1996 INSTALLED CAPACITY OF ELECTRIC POWER PLANTS AND LENGTHS OF TRANSMISSION LINES IN ESCWA MEMBER STATES[10]

Country	Total capacity MW	Capacities of Thermal Power Stations by station type				Length of Transmission lines (km)	
		Diesel	Gas	Steam	Combined Cycle	Extra high voltage 300-500 Kv	High voltage 150-33 Kv
Bahrain	1286	0	1186	100	0	0	485
Egypt	13303	0	715	7178	2605	1736	23324
Iraq[1]	9414	-	1496	5455	-	3634	62697
Jordan	1250	85	462	696	0	650	2158
Kuwait	6898	0	244	6654	0	775	6015
Lebanon	1752	-	160	1016	300	-	-
Oman	1961	387	1168	406		0	2057
Palestinian Authority	18	18	-	-	-	-	-
Qatar	1951	10	1881	60	0	0	1284
Saudi Arabia	19351[2]	722	12800	5573	256	3027	42057
Syrian Arab Republic	6058	24	1540	2996	600	330	3884
United Arab Emirates	7634	304	4057	2981	292	0	3376
Yemen	737	302	0	435	0	0	600
Total ESCWA	**71613**	**1852**	**25709**	**33550**	**4053**	**10152**	**157161**
Total Arab Countries	**76381**	**1910**	**29291**	**34608**	**4777**	**10152**	**290280**
% ESCWA	**93.76%**	**96.96%**	**87.77%**	**96.94%**	**84.84%**	**100%**	**54%**

2. Data collected from Iraqi Ministry of Planning (April 1999).
3. Excluding generation capacity from desalination.

Source: Badawi, M. "Arab cooperation in the field of electricity". Sixth Arab Energy Conference, Damascus, Syria. May 1998, and the Statistical Book of the Year 1997, OAPEC.

The composition of emissions from electric power plants is, in part, a function of the completeness of the combustion process and fuels type and contents. It contains CO_2 and water vapour byproducts in case of complete fuel combustion. In case of incomplete combustion it yields smoke particles (primarily carbon), CO and nitrogen oxides NO_x's. The level of SO_2 emitted is a function of the type of fuel burned and the control equipment used rather than the combustion process.

Electric power plant emissions are factors in three major environmental issues: acid rain, urban ozone, and global climate change. These issues are discussed below:

Acid rain. Acid rain refers to rain, fog, mist, or snow that is more acidic than normal. The acidity of precipitation is stated in terms of its pH level. Acid rain is defined as any precipitation with a pH of 5.5 or less. The acidity of the precipitation depends upon the amount of acid in the atmosphere and the amount of water in which it is dissolved.

Urban ozone. In many cases, electric power plants contribute heavily to NO_x emissions, which are precursor chemicals that (along with VOCs) react in the atmosphere in the presence of sunlight to form ozone. Strong concentrations of ozone often occur in and downwind of large urban areas. Human exposure to ozone has been shown to result in serious health problems. Tighter controls on NO_x may be required for health reasons.

Global climate change. GHG are necessary for life on Earth because they keep ambient temperatures well above what they would otherwise be. Many scientists believe that anthropogenic additions (some from electric power plants) to the Earth's natural complement of GHG are augmenting this greenhouse effect and thus raising global temperatures.

(ii) Effects on water resources, the large wastewater streams from thermoelectric plants are typically rather clean cooling water, particularly the wastewater can be either recycled or discharged to a surface water body with minimal effects on chemical quality. The impacts of waste heat on ambient water temperature need to be considered, if once-through cooling is being considered, since it can radically alter aquatic plant and animal communities. Other effluents from thermoelectric projects can significantly affect water quality. Oil spills have a negative impact on water quality at oil-fired facilities. In addition, changes in surface water and ground water quality can be caused. A number of the impacts can be avoided or mitigated by prudent site selection.

(iii) Other negative impacts, thermal power plants contribute also to several other adverse impacts on the environment, including: Increased noise and vibration; toxic effects of chemical discharges and spills; and modification of historically or archaeologically significant structures or lands. In addition, it creates Changes in demographic patterns and disruption of social and cultural values and patterns, and worker exposure to excessive noise and toxic gases leaking from boilers.

(b) **Potential environmental impacts of hydroelectric projects**, the principal source of impacts in a hydroelectric project is the construction and operation of a dam and reservoir. Large dam projects cause irreversible environmental changes over a wide geographic area and thus have the potential for significant both negative and positive impacts. However, the hydropower generation provides a clean alternative to the burning of fossil fuels.

(i) Effect on water and soil resources. While there are direct environmental impacts associated with the construction of the dam (e.g., dust, erosion, borrow and disposal problems), the greatest impacts result from the impoundment of water, flooding of land to form the reservoir, and alteration of water flow downstream. These effects have direct impacts on soils, vegetation, wildlife and wildlands, fisheries and climate. The dam's indirect effects include those associated with the building, maintenance and functioning of the dam, (access roads, construction camps, deterioration of water quality in reservoir, formation of sediment deposits at reservoir entrance creating backwater effect and flooding and waterlogging upstream, salinization of floodplain lands, salt water intrusion in estuary and upstream, and increasing water loss through transpiration.

(ii) Demographic and social impacts. Hydroelecteric projects are labour-intensive, as well as providing employment opportunities. Roads and other infrastructure may create positive development of agricultural, industrial or municipal activities made possible by the dam and provide local inhabitants with better access to markets for their crops, educational facilities for their children, health care, and other social services. In addition, dams create a reservoir fishery and the possibilities for agricultural production on the reservoir drawdown area, which in some cases can more than compensate for losses in these sectors due to dam construction. On the other hand, it contributes to: dislocation of people living in inundation zone, and social disruption and decrease in standard of living of resettled people.

(c) **Potential environmental impacts of electric power transmission systems**, electric power transmission lines are linear facilities that have negative environmental impacts caused by their construction, operation and maintenance. The effects on natural, social, and cultural resources depends on the design and geometry of the transmission line conductors, the towers carrying the conductors and the voltage of the conductors. Due to the avian hazards from stacks and towers, at any of the voltage levels, there is a right of way surrounding the transmission lines and/or transformers where it is prohibited to build or plan any structures/activities within this area. The audible noise, produced by corona discharges on the transmission lines, increases with transmission voltages. Operation and maintenance of the transmission line involves chemical or mechanical control problems. On the positive side, power line ROWs, when properly managed, can increase habitat diversity resulting at the contact between the ROW and the existing vegetation "edge effect".

E. The ESCWA Transport Sector, Relevance to Environment

Transport is essential to economic development and social welfare. Meanwhile, the transport sector has significant effects on the environment. In particular, it is the main source of urban air pollution, mostly due to road transport. All forms of motorized transport contribute to probable global warming through CO_2 emissions and precursors of tropospheric ozone. Transport is essential to economic development and social welfare.

1. Overview of the Transport Sector

The transport demand in the ESCWA region is increasing rapidly because of movements of population from rural areas to urban areas and of increasing movements of goods within and between countries, and the fact that ownership of motor vehicles is growing at a faster pace than the availability of road in urban areas.

(a) **The sector's structure**, the structure of the transport sector in the ESCWA region vary from one country to the other, particularly regarding the volume and the relative penetration of each transport mode and the quality of infrastructure serving the sector.

In the GCC countries, the light duty vehicles (LDV) are dominant and maritime transport is quite sizeable specially oil tankers, while railways are limited to Saudi Arabia (Dammam to Riyadh), with ambious plans to include three other lines by 2005 totaling about 1400 km. In other ESCWA countries of mixed economy, the road freight is dominant both for LDV and trucks. Railways are existing in remarkable capacities in Egypt (4000 km), and Iraq, and have limited capacities in Syria and Jordan.

(b) **The sector's energy demand**, the transport sector in ESCWA region is one of the major energy consuming sectors. In 1996, the transport sector consumed about 973,000 bl.o.e/day (48.5 mt.o.e/year) of petroleum products which is 4.85 times the sector's energy consumption in 1975 and counts for over 42 percent of the total petroleum products consumption in the region. Such percentage varied widely among member States in 1995 it counted for as high as 85 percent in Bahrain to about only 27.8 percent in Egypt.

The World Energy Council study (WEC '98)[11] has indicated that the global total transportation energy use will increase by over 55 percent between 1995 and 2020, or 1.8% per year, and that the same rate of growth applies to the Middle East and North Africa (MENA) countries including ESCWA member States. Such a rate of growth in transport energy use has serious implications for the quality of the environment. Table (6) shows the 1995 energy use in ESCWA member States by the different transport modes, and its projection to year 2020. It is calculated as 50 percent that of MENA countries which coincide with the previous ESCWA estimates.

The structure of transport energy demand is very different in the ESCWA region than in the rest of the world. While light duty vehicles (LDV) use accounted for almost 49 percent of world transport energy demand in 1995 and is expected to decline to nearly 44 percent by 2020, it represented only 11.6 percent in the ESCWA region in 1995, and is expected to increase to 20 percent in 2020. Road freight in the ESCWA region represented about 80 percent of total transport energy use in 1995 and is expected to decline to nearly 67.0 percent by 2020. Energy consumption for light duty vehicles is expected to increase at higher rate than other transport modes (3.8 percent). In addition, the air transport in the ESCWA region is expected to increase its share of total transport energy consumption from 7.3 percent in 1995 to almost 11.2 percent in 2020.

2. Environmental Impacts of the Transport Sector

Transport is a major source of nuisance for the environment, in particular, urban air pollution as it is estimated that traffic would contribute to 70 percent of the estimated increase in CO_2 emissions between 1990-2000. Its impacts differ significantly by mode of transport however, some of it are common for all modes of transport. Several of the pollutants emitted by the transport sector especially by motor vehicles have damaging effects on health. The following is a brief on the environmental impacts if different transport modes on air, water and land resources.

TABLE (6). TOTAL TRANSPORTATION ENERGY DEMAND (MTO.E) IN ESCWA REGION (1995 – 2020) [a/]

	Transportation Energy Demand Mto.e/year ESCWA Region					Transport Energy Demand Mto.e/year
	LDV	Aviation	Road Freight	Railway	Total	Total World
1995 Total	4.0	2.5	27.5	0.5	34.5	1,918
1995 % mode	11.6	7.25	79.71	1.45	100	100
2020 Total	11.0	6.5	36.5	0.5	54.5	2,997
2020 % mode	20.18	11.22	67	0.92	100	100
% Growth Rate	3.8	3.6	1.2	0.0	1.8	1.8

Source: The World Energy Council (WEC) study on "Global Transport and Energy Development, the Scope for Chane", 1998.

[a] / Calculated as (50%) of the total Middle East and North Africa, according to the population ratio and similarity among countries in (MEA) and ESCWA.

(a) Impacts on natural resources:

(i) Air pollution by transport. All modes of transport generate engine and evaporative emissions of CO, HC, NO_x, PM, lead. It also produces emissions of CO_2 from fossil fuel combustion and CFCs released during vehicle manufacture and disposal.

With the consistent increase of the motorization, rate and the concentration of vehicles in urban areas, air quality in cities might be seriously affected in the future. However, it is expected that the wide streets, faily fast traffic flow, well-developed and automated traffic plans, and the recent introduction of unleaded gasoline in most countries of the region commonly reduce the impact of the vehicle-generated pollution.

(ii) Impacts on water resources:

Road transport cause surface and groundwater pollution from runoff (lubricants, coolants, vehicle deposits, road sale), in addition to the modification of water systems from road building. The effect of Railroad is limited to release oil and grease, and creosote from track beds;

Aviation: result on modification of water tables, river courses, and field drainage in airport construction and deicing chemicals and degreasers on runways;

Maritime: Discharge of ballast wash, modification of water systems during port construction and canal cutting and dredging, and sanitation device discharge. In addition, maritime pollution by oil spills is considered as the most common pollutant of concern in the region, since more than half of the world's petroleum has been estimated to pass through the waters of the Arabian Gulf to its adjacent Gulf of Aden.

(iii) Impact on land resources:

Road transport, impacts include land taken for infrastructure, extraction of road building materials, abandoned rubble from road works, road vehicles withdrawn from services, waste oil, tires, and batteries;

Railroad result on land taken for rights-of-way and terminals, dereliction of obsolete facilities, abandoned lines, equipment and stock;

Aviation, effects include: land taken for infrastructure, dereliction of obsolete facilities, aircraft withdrawn from service, buffer zones for noise abatement, dereliction of obsolete port facilities and canals, vessels and craft withdrawn from services, and land disposal of dredged material.

(b) **Global Warming, Noise and Troposphic Ozone,** in addition to its effects on natural resources, the transport sector also contributes to the following:

- Global warming through CO_2 emissions generated by all forms of motorized transport. Several countries in the ESCWA region have developed greenhouse gases inventories which proved that the transport sector is a main contributor to the GHG emissions in the region, particularly CO_2;
- Local noise, accidents, congestion and precursors of tropospheric ozone;
- Tropospheric ozone pollution. The increased motor vehicle traffic is a main reason for increasing the ground level ozone.

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