بسم الله الرحمن الرحيم

The Hashemite Kingdom of Jordan

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1. National Circumstances

The Hashemite Kingdom of Jordan stretches over an area of over 90,000 km^2 in the hot and dry region of West Asia. It is an almost land-locked country, bordered by Israel and the West Bank to the west, Syria to the north, Iraq to the east and Saudi Arabia to the southeast. The port of Aqaba in the far south gives Jordan a narrow outlet to the Red Sea. Its eastern part is largely desert; elevations therein range from 300 to 1,500 metres and annual precipitation is less than 50 millimeters. The central region of the country contains the Jordanian highlands (average altitude 900 metres), with rainfalls of up to 600 millimeters in the north. Jordan's outstanding topographical feature is the great north-south rift, stretching from Lake Tiberias through the Jordan River Valley to the Dead Sea (the lowest point on earth, more than 400 meters below sea level). Jordan has three major rivers: Jordan River and its two principal tributaries, the Yarmouk and the Zarqa rivers. Because of its salinity and other quality problems, surface water is used mainly for irrigation. Drinking water is taken from underground aquifers and King Abdullah Canal.

Jordan, according to mid-1994 statistics, has a population of 4.14 million and a population density of about 42.4 inhabitants per km^2. Over 40 per cent of Jordan's population resides in the Amman area, with the capital, Amman, having over 1.48 million people. In the longer term, Jordan is likely to face severe water shortages, a problem that can be overcome only through increased regional co-operation. Jordan's most pressing environmental problems are the need to manage more effectively the scarce water resources and cultivable land in order to meet the growing needs of a population which grew at a rate of 3.4% per annum in the decade between 1980 and 1990.

More than 80% of the country is made up of unpopulated desert. Water resources in Jordan depend chiefly on precipitations within the country; exceptions are the Yarmouk River, which is fed mainly by the rain that falls on Syrian territory, and the Azraq aquifer, whose replenishment also depends on precipitations in Syria. The annual average rainfall ranges between 600mm in the northern uplands and less than 50mm in the southern and eastern desert areas. It usually rains between October and May, with heavier precipitations between December and March, when 80% of the annual rain falls.

Table (1)
NATIONAL CIRCUMSTANCES

Criteria	***1994***
Population (in million)	4.14
Area (square kilometres)	90,000
GDP (1994 million $)	5900
GDP per capita (1994 $)	1450
Estimated share of the informal sector in the economy in GDP (percentage)	5
Share of industry in GDP (percentage)	14.5 (Manufact. + Mining)
Share of services in GDP (percentage)	57.5
Share of agriculture in GDP (percentage)	4.5
Other Sectors	18.5
Land area used for agricultural purposes (square kilometres)	500
Urban population as percentage of total population	70
Livestock population	Cattle 58000 / Goats 852000 / Sheep 182000
Forest area (square kilometres)	1500
Population in absolute poverty	10 %
Life expectancy at birth (years)	M = 67 F = 69
Literacy rate	85%

2. *Macro-Economic Performance*

Jordan's population is made up mainly of lower middle-income class, with, in 1995, an annual per capita income estimated at $1,536. Its economic structure is dominated by trade- and service-related activities, which account for about 57.5% of the GDP, and manufacturing, agriculture, mining and construction activities, which account for the rest.

Construction has been the driving force during periods of strong economic growth. Workers' remittances from the neighboring oil-exporting countries and processed mining-based exports are the primary sources of Jordan's foreign exchange earnings.

At the end of 1988, the Jordanian economy witnessed a sharp decline as a result of huge capital flight from Jordan. This led to the initiation of an economic adjustment programme for the period 1989-1993, disrupted by the Gulf crisis of 1990. The crisis created several problems, including the forced return of around 300,000 expatriates from Kuwait and the Gulf region, the discontinuation of Arab financial assistance and the decrease of exports to neighbouring countries.

In order to overcome the ensuing difficulties and the economic imbalances, the government initiated the New Economic Adjustment Programme for the period 1992-1998 and the Five-Year Economic and Social Development Plan for the period 1993-1997.

The programme was designed to achieve the following:

1. Reduce chronic imbalances in the balance of payments and in the government budget.
2. Achieve fiscal and monetary stability.
3. Build a strong foundation for sustained economic growth with stable prices.

The programme relies heavily on:

1. The private sector to expand its role and relative importance in the economic development of the country.

2. The government to rationalise its resources to achieve sustained economic growth and a stable investment environment.

3. Restructuring of the tax system so as to make it more flexible and comprehensive.

Fully consistent with the adjustment programme, the five-year plan aims to achieve the following:

- Promote financial and monetary stability.
- Remove price and production distortions.
- Increase domestic savings.

- Promote domestic private investments.
- Reduce government budget and balance of payments deficits.
- Promote domestic production.
- Reduce income disparities among individuals and regions.
- Train and retrain workers to promote entrepreneurship.
- Create conditions conducive to private investment.
- Promote participation in the decision-making process and enhance accountability.
- Expand employment opportunities and reduce rate of unemployment.
- Increase exports of goods and services.
- Promote responsible development through safeguarding the environment.

When achieving these goals, the plan will have attained sustained economic development through economic restructuring and adaptation of fiscal and monetary policies.

Fiscal policies aim at reducing the budget deficit through reduced expenditures and increased revenues. Thus, the plan aims at restructuring the tax system in order to increase direct taxes, introduce a sales tax to replace the consumption tax, remove subsidies on basic goods, and price government services commensurate to their cost.

Monetary policies aim at maintaining financial and price stability through increasing foreign reserves to cover at least three months of imports, controlling the growth rate of money supply, in line with the GDP growth rate, deregulating interest rates, establishing depository insurance companies, minimizing the central bank's supervision of all financial institutions, and floating exchange rates.

Social policies aim at increasing family income and reducing poverty through directing support to lower income groups, at an equitable distribution of developmental projects in all regions, at reducing the dependency rate through family planning, and at working with the family as the basic building block of the society.

3. Expenditures on GDP in 1994

The Jordanian economy fulfilled largely its 1994 objectives, as set out in the Economic Adjustment Programme (1992-1998) and the Economic and Social Development Plan (1993-1997), despite the atmosphere of uncertainty surrounding the signing of the peace process in the region. Available estimates indicate a growth in real GDP almost identical to that of the previous year, 1993, a continued containment of the inflation rate within acceptable limits, and a sustained drop in the unemployment rate. The real GDP growth rate registered during 1994 is largely attributable to the outstanding performance of the transport, communications and manufacturing sectors.

Several factors were responsible for the positive developments in the spheres of economic output, prices and employment during 1994. The most prominent was the continued implementation of procedures and measures designed to eliminate structural imbalances in all sectors of economy with a view to improving their efficiency and enhancing confidence in the investment climate in Jordan.

Moreover, there was continued implementation of management policies aimed at maintaining fiscal and monetary stability in the country, concomitant with the impact of the private investment boom witnessed by Jordan in 1992 and 1993.

The GDP at current market prices registered a growth rate of 9.9% in 1994, while the GNP at current market prices rose by 10.7% in the same year.

According to the results of a population census carried out in late 1994, per capita GDP at current prices rose to $1,450, against $1,418 in 1993. It is worth noting that during 1994, the export sector had a positive contribution to the economic growth, while the impact of fixed capital formation was slightly negative. The improvement in 1994 is attributable to a 6.3% growth in Jordan's exports of goods and services and a drop in its import of goods and services by 2.6%, as compared to 1993.

Aggregate consumption expenditures in 1994 grew by 6.2% over the 11.6% in 1993, and its relative importance in the GDP fell to 95.5% against 98.8% in 1993. Aggregate investments registered a 4.7% decline in 1994, against a growth of 2.2% in 1993, thus displaying a drop in its relative importance in the GDP, of 4.2% in 1993, to reach 28.6% in 1994.

4. Sectoral Performance in 1994

Sectoral developments in the GDP, against the constant cost factor in 1994, indicate an increase in value in all sectors, except for the household domestic services. The increase varied from 1% in the agriculture and mining and quarrying sectors to 11% in the transport and communications sectors.

The commodity producing sectors grew collectively in 1994 at a rate of 4.9% against 7.5% and 19.2% in 1993 and 1992 respectively. Consequently, their contribution to the GDP, at constant cost factor, declined by 0.2% below its 1993 level, to reach 37.6% in 1994.

The decline in the contribution of the commodity producing sectors arose from a marked slowdown in the growth rate of the construction and agriculture sectors in 1994, compared to 1993. These two sectors grew at the rate of 4.1% and 1%, against 12% and 10% in 1993 respectively. Had it not been for this slowdown, the contribution of the commodity producing sectors to the GDP would have clearly improved in view of the accelerated growth in the mining and quarrying, manufacturing, electricity and water sectors. The value of the manufacturing sector rose by 9.3% in 1994, to take a leading role among the commodity producing sectors and helping add to the growth rate of the GDP. Likewise, the mining and quarrying sector managed to achieve a positive growth, following the period of decline experienced since 1990. It registered a real growth rate of 1% against a decline of 2.6% in 1993. The electricity and water sectors achieved the considerable growth rate of 6.4% in 1994, against the 4.1% growth posted in 1993.

As a result of these developments, the share of the industry sector in the GDP, at constant cost factor, rose by 0.4% in 1994, to reach 15.2%, retaining thereby the highest position among other sectors. By contrast, the relative importance of the agriculture and construction sectors remained constant, while electricity and water sectors maintained their relative importance of 1993.

5. Balance of Payments:

One of the major objectives of the five-year plan is to eliminate the deficit in the current account of balance of payments by the end of 1997. This is projected to be achieved through the reduction of the balance of trade deficit and an increase of the surplus in the balance of services. Hence, an increase in the exports of trade and services is the key to addressing imbalances and attaining the targeted GDP growth rate.

The export activities reflected outstanding developments in the years 1994 and 1995, in comparison with the previous years. Since 1992, there has been a downwards trend in the current account external deficit percentage relative to the GDP. The improvement achieved with respect to the trade balance was due to an increase in total exports and an unusual decrease in imports. Regarding the current account deficit, it should be mentioned that the ratio of the current account to the GDP in the years 1994 and 1995 was heading towards the targets designated by the five-year plan. The declining trend of this rate will make it possible to achieve positive external savings.

In this regard, the monetary policy was geared towards creating incentives for savings to be effected in Jordanian dinars and enhancing services. Thus, the interest rate on dinar savings was increased.

The growth rate registered in the export sector helped redress the chronic deficit in the balance of trade. That was made possible by the government's intervention through providing the necessary financing for exports and supporting export projects. The government is also considering further trade liberalization by (a) reducing import restrictions and instating import tariffs; (b) further narrowing the tariff range; (c) phasing out the trade protocols that give privileges to specific countries; (d) streamlining customs administration; and (e) reducing other regulatory constraints and submitting an application to join WTO (World Trade Organization), which requires lowering tariffs.

Exports of raw materials and intermediate goods took the lead, with 54.9% and 54.7%, in the years 1995 and 1994 respectively. Second in order were exports of consumer goods, which accounted for 38.8% and 41.0% of the exports in 1994 and 1995 respectively. On the other hand, in 1995, imports were kept at almost the same level as in 1994, with minor differences. The rate of import of raw materials and intermediate goods rose from 53.7% in 1994 to 55.1% in 1995, but remained almost constant where consumer goods, parts and accessories were concerned.

Following are some of the key policy actions that were adopted in 1995:

- Several amendments to the general sales tax, with a view to improving the tax system efficiency. The main amendments increased the standard rate to 10%, replaced the positive list of services subject to taxation with a negative list of limited exemptions, allowed for voluntary registration of taxpayers and made room for the introduction of a supplementary duty on selected luxury or socially undesirable products in order to protect revenue in the context of the next stage, that of tariff reform.

- Improvement of the direct taxation system, which included: eliminating tax holidays, limiting tax deductibility to net interest payments, reducing the number of tax rates and the maximum tax rates for both personal and corporate income taxes; rationalizing corporate income tax rates with a view to treating all corporate sectors on an equal footing -- which was done by establishing three flat corporate tax rates of 15% for companies in "encouraged" sectors (mining, industry, hotels and hospitals), 35% for banks and financial institutions and 25% for all other companies -- encouraging capital accumulations by imposing a withholding tax of 10% on distributed profits; and broadening the tax base by reducing and simplifying exemptions and applying uniform, standard deductions to all wage earners.

- Exemption from customs duties of some raw materials used in medical, electrical, paper and textile industries, in addition to final goods pertaining to public safety equipment, vehicles, on which customs duties were reduced to a maximum of 20%, instead of 50%, intermediate goods used in manufacturing transformers for lighting equipment, containers, metal furniture, cellular phones, footwear, marble, pay and cable telephone sets.

It should be noted that a complex customs law is being enacted, through constitutional channels, aimed at simplifying administrative procedures related to the customs department and at expediting customs formalities, particularly those pertaining to customs clearance, goods in transit, free zones and temporary entry.

6. Greenhouse Gas Emissions, 1994

Greenhouse Gas Emissions (GHGs)/Energy Sector for the year 1994 were calculated using two approaches, viz the Reference Approach and Bottom-up Approach. The results obtained by using the two approaches are nearly the same. The assumptions made and the results are summarized below, details are discussed in the main report.
Greenhouse Gas Emissions (Reference approach) as carbon dioxide were about 11,967 Gg. Net GHGs emissions during 1994, calculated by using the IPCC Bottom-up methodology (ENPEP and IMPACT modules were used), are summarized in Table 2:

Table (2)
Greenhouse Gas Emissions, 1994

GHGs	*Kilo Tonnes*
CO_2	13,390
CH_4	403.8
N_2O	0.40

Table (3)
Initial National Greenhouse Gas Inventory of Anthropogenic Emissions by Sources and Removals by Sinks of all Greenhouse Gases not Controlled by Montreal Protocol

Greenhouse Gas Source & Sink Categories	CO_2	CH_4	N_2O
Total (Net) National Emission (Gigagram per year)	**11935**	**403.9**	**0.40**
All Energy	**13390**	**403.9**	**0.40**
1. Fuel Combustion	**11689**	**1.6**	**0.39**
Energy & Transformation Industries	**5306**	**0.1**	**0.14**
Industry	**1616**	**0.1**	**0**
Transport	**2798**	**1.2**	**0.08**
Commercial-Institutional	**738**	**0.1**	**0.15**
Residential	**1231**	**0.1**	**0.02**
2. Industrial Processes 1- Cement	**1701**	**0**	**0**
3. Agriculture	**0**	**26.6**	**0.01**
Enteric Fermentation	**0**	**23.6**	**0**
Savanna Burning	**0**	**0**	**0**
Others	**0**	**1.4**	**0**
Burning of Agricultural Residue	**0**	**0.3**	**0.01**
Manure Management	**0**	**1.3**	**0**
4. Land Use Change & Forestry	**1455**	**0.1**	**0**
Changes in Forest & other woody biomass stock	**249**	**0**	**0**
Forest & Grassland Conversion	**374**	**0**	**0**
On-Site Burning of Forest	**0**	**0.1**	**0**
Abandonment of Managed Land	**832**	**0**	**0**
5. Other Sources	**0**	**375.6**	**0**
Domestic Solid Wastes	**0**	**370.9**	**0**
Industrial Refuse	**0**	**0.1**	**0**
Domestic Sewage	**0**	**4.6**	**0**

7. Energy Sector

Jordan's consumption of primary energy amounted to 4.15 million TOE in 1994. The transport sector consumed the largest portion of the total, 38.8%, followed by industry, with 22.2%, and household, with 19.0%. In 1995, the demand increased to 4.4 million TOE. Primary energy demand projections are expected to reach 4.8 million TOE in the year 2000 and 6.2 million TOE in 2005, corresponding to an average annual growth rate of 4.6% during the period 1995-2000 and 5.1% during the period 2000-2005.

Total electricity consumption was 4676 Gwh in 1994, with industry's consumption ranking first, at 35.1%, followed by the residential sector, 30.4%, water pumping, 17.7%, and others, 16.8%. In 1995, electricity consumption increased to 5201 Gwh.

Jordan depends heavily on imported oil as its main source of energy. In 1995, crude oil imports amounted to 3.16 million tonnes. Other oil products imported were fuel oil

(670,000 tonnes), LPG (75,000 tonnes) and diesel (173,000 tonnes). Total imports were valued at JD 331 million.

New, major developments are either under way or being proposed in the energy sector, which will have considerable impact on its future outlook. These are considered below.

7.1 Natural Gas:

In 1987, natural gas was discovered at Risha. To date, 29 wells have been drilled in the area; of these, six have produced gas. Current production is estimated at 30 million cubic feet per day. Expansion is currently under way to reach an output of 35 million cubic feet per day by the end of 1996. Over 48 billion cubic feet of natural gas have been harvested so far. The current annual production is about 10 billion cubic feet; it is anticipated that the annual production will reach about 15 bcf in the near future.

7.2 Oil:

In 1981, crude oil reserves were discovered in small quantities near Azraq. In 1984, modest reserves were found in Hamzeh field. Today, a small amount of oil is extracted at the Hamzeh oil field and in the Azraq basin, yielding up to 25 barrels per day.

The government is currently negotiating new concession agreements with foreign companies to explore oil reserves in different parts of the kingdom (northeast area, the Dead Sea region and the eastern part).

The Jordan Petroleum Refinery Company (JPRC) is the owner of the only refinery in Jordan. It is located in Zarqa, 35 km north of Amman. Its maximum output is 100,000 barrels per day. Historically, Zarqa refinery used to receive all its crude oil needs from Saudi Arabia through the T.A.P. pipeline. In 1984, Jordan started diversifying its sources by importing about 10% of its crude oil needs from Iraq; this quantity reached around 87% in 1990. Since the Gulf war, in 1991, the Saudi supply was stopped and Iraq became the sole source of crude oil and other oil-product imports.

7.3 Coal:

There is no coal production, nor is coal used as an energy source in Jordan.

7.4 Electric Power:

The total installed capacity is 1121 MW, of which 655 MW are generated by heavy fuel oil fired units, 342 MW by diesel units, 120 MW by natural gas units and 4.3 MW by hydro and wind generators.

In 1995, total electricity generated was 5201 Gwh. Over the past decade, demand for electricity increased at an average annual growth rate of 9.5%. MEMR projections indicate an expected generation of 7625 Gwh in the year 2000 and 10635 Gwh in the year 2005, corresponding to an average annual growth rate of 6.9% between the years 1995 and 2000 and 6.9% for the period 2000 to 2005. The associated peak demand is expected to be 1200 MW in the year 2000 and 1520 MW in the year 2005.

Two new steam fuel oil fired units at Aqaba power plant, each with a capacity of 130 MW, are expected to come on line by the end of 1997. Another unit is scheduled to be commissioned in 1999. Additional units will be either gas turbine or combined cycle units, depending on the availability of natural gas.

8. Renewable & Indigenous Energy Sources:

Despite significant interest in the development of alternative energy sources, their actual contribution to the energy consumption of the country is rather limited. In 1993, the share provided by solar water heaters (by far the main form of utilization of renewable energy) was between 1.7% and 1.8%; the photovoltaic systems' share was 0.0016%; hydro power provided only 0.06% of the system; and wind power contributed 0.007%. The development of oil shale, by far the largest indigenous energy resource, is still at the planning stage.

Jordan enjoys very high average solar radiation; consequently, the potential for utilizing solar water heaters, the simplest and therefore the first use of solar energy, is great.

In 1993, about 26% of the dences were equipped with solar water heaters. An increased utilization of solar water heaters is a realistic and valuable objective, but it needs more support, by providing both a regulatory framework and financial incentives.

8.1 Oil Shale:

Extensive studies performed by the Natural Resources Authority (NRA) of Jordan and several foreign associates have identified large reserves of oil shale with relatively thin overburden. Geological reserves are estimated at about 40 billion tonnes. There are 17 known surface and near surface occurrences of oil shale distributed over an area of about 70 km^2 in the E-W direction and about 100 km in the N-S direction. The westernmost deposits are EI Lajun, located 10-15 km east of Karak, and Jurf-El-Darawish, located about 60 km south of EL Lajun. Research work, shale characterization and combustion tests have indicated that utilization of oil shale either for direct combustion or for oil extraction by retorting would be feasible.

8.2 Hydroelectric and Geothermal:

The potential for hydroelectric power in Jordan is very limited. At present, the only hydroelectric station that generates electricity is the King Talal Dam. In 1993, the total electricity generated at King Talal Dam was 22 Gwh.

As far as geothermal energy is concerned, a limited number of thermal springs are known; hot water has been found in several boreholes, but the quantity of fluid is usually small and the water temperature is at the lower end of the enthalpy range.

8.3 Wind Power & Biomass:

The wind atlas of Jordan indicates that large areas in the country have average annual wind speeds in excess of 6 to 6.5 m/s; some, limited, areas have average wind speeds above 7 m/s.

The total potential of wind energy in Jordan has been estimated to be about 100 MW, of which 50 MW could be connected to the grid without changes of any kind. In 1988, a 320-kW pilot wind farm was commissioned at Al-Ebrahemiyeh. The wind farm, owned and operated by NEPCO, consists of four 80 kW wind turbines. The annual electricity generation of the farm is about 645 Mwh. Smaller wind demonstration projects exist in other parts of the country, such as the rural electrification and water pumping project in the village of Jurf-El-Darawish. A project is under way for the construction of a 1.35 MW wind farm in the northern part of the country. The project, the result of cooperation between MEMR and NEPCO, received the support of the German government and uses German wind turbines.

Little information is available about the current use of biomass. Preliminary studies performed by MEMR indicate that a significant potential exists for biogas production from animal and municipal waste. In 1992, NEPCO started a demonstration project on anaerobic digestion of cow manure at the University of Jordan’s farm in the Jordan Valley. The digester’s size was $16m^3$ and was designed to power a 1 kW engine. The demonstration project ended in 1993.

9. Existing and Future Energy Supply Options

Despite exploration efforts undertaken by the government, Jordan will still rely heavily on imported energy in the foreseen future.

The present situation (importing crude oil and oil products by land trucks from Iraq) is unacceptable by all accounts: economically, environmentally or strategically.

9.1 Existing Supply Options

9.1.1 T .A .P. Line

Starting with 1960, the year when Zarqa refinery started operations, the T.A.P. line had served as the only source of supply of crude oil from Saudi Arabia to Jordan.
In 1984, Jordan started diversifying its import sources by importing about 10% of its crude oil needs from Iraq.
This percentage grew during the following six years, to reach 87% in 1990.
Since the Gulf war, in 1991, supply from Saudi Arabia stopped and Iraq became the only source of energy import.

Maintenance of the line and associated equipment continued during the pipeline closure period; thus, the pipeline is now deemed operational and capable of supplying Jordan with its crude oil needs of 100 thousand barrels per day, (equal to the current maximum capacity of the Zarqa refinery).

9.1.2 Aqaba Port

The Jordan Petroleum Refinery Company initiated a major storage capacity building both at the refinery site, in Zarqa, and in Aqaba; the latter will serve the dual purpose of increasing storage capacity in Jordan and facilitating import of crude oil and oil products by sea.

The project was expected to be completed by mid-1997 and together with the existing oil terminal in the Aqaba Port will constitute a reliable and flexible source of imports.

9.2 Future Supply Options

9.2.1 Iraq-Jordan Crude Oil Pipeline

Extensive discussions have been held with Iraq regarding the construction of a pipeline from Iraq to Jordan, to either supply the Zarqa refinery or, at later stages, to supply a new refinery in the Aqaba region. Preliminary studies were done and the project seems to be favored by both sides; nevertheless, political (embargo) and financial constraints are delaying the execution of the project.

9.2.2 Natural Gas Imports

Taking into consideration Jordan's geographical location, the extent to which domestic demand for energy is growing and the environmental problems associated with heavy reliance on petroleum products, especially heavy fuel oil, the introduction of natural gas into Jordan's energy system seems imperative.

Recently, the newly formed National Oil Company (previously the Petroleum Department at the Natural Resources Authority), in its capacity as Risha Gas Field developer, entered into negotiation with international oil companies in order to further develop the Risha field and increase gas production, currently estimated at 30 million cubic feet per day. If successful, Risha field would replace an important quota of heavy fuel oil used for electricity generation with cheap and clean fuel.

Other possible alternative for introducing natural gas in the Jordanian energy system is importing natural gas from (1) Egypt by pipeline and (2) LNG from Qatar (the Enron Qatar LNG terminal project at Aqaba). Discussion is under way with both parties (Egypt, Enron Qatar) to reach an agreement on supplying Jordan with its gas requirements.

Introducing natural gas (especially as a substitute for heavy fuel oil) would significantly reduce emissions both at the local level (SO_x, Particulate) and globally (CO_2).

10. Energy & Electricity Demand Forecast

Energy and electricity demand forecast analysis was carried out by using DEMAND Module, the second part of the ENPEP package. Below is a summary of the analysis; details are given in the main report:

* In the base year 1994, the total final energy demand was 3.73 million TOE. By the year 2023, it is forecasted to increase to around 16 million TOE. The average annual growth rate of energy demand during this period (1994-2023) is 4.9%.

* The average annual growth rate of electricity demand during the same period is 6.1%.

* The average annual growth rate of kerosene is 5.6%.

* The average annual growth rate of gasoil is 3.2%.

* The average annual growth rate of fuel oil is 5.4%, while the average annual growth rates of gasoline and jet fuel are 4.8% and 2.8% respectively.

11. Steps to Implement UNFCCC

Developing countries face both challenges and opportunities in reducing their emissions of greenhouse gases (GHGs). Challenges consist in overcoming lack of information about available ways and means to do that, in the fact that national development trends must be maintained and expanded and that training to cope with the new technology must be implemented. Opportunities include the advantage of modernizing production processes, in line with demands for environmental protection, making new business contacts, as a result of investment and participation in international technology transfers, and strengthening domestic business networks, as the infrastructure is developed. Financial assistance can help reduce GHG emissions rapidly in some developing countries that can benefit from the policies of multinational corporations which offer assistance in technology transfer.

Consequently, it is technically feasible to limit GHG emissions. It may be logistically and financially difficult, but it could be achieved with appropriate government and industry attention and financial support. There are special concerns regarding technology transfer to developing countries, including environmental and water safety. The incremental costs of the new technology hinges on the ease of access to technical information, the cost of water and energy, and on whether there are trade restrictions that limit the choice of the new technology.

Jordan’s energy consumption today relies almost solely on combustion of fossil fuels. Furthermore, the country depends heavily on imports of oil for energy from neighboring countries, due to its lack of fossil resources. In 1994, Jordan’s consumption of primary energy amounted to 4.15 million tonnes of oil equivalents (TOE), the transportation sector accounting for the largest share, of 39%, followed by industry, at 22%, and households, at 19%. Electricity generation also accounted for a major share of gaseous emissions. Of a total installed capacity of 1121 MW, only 163 MW run on fuels other than fossil fuel. It is estimated that renewable energy production accounts for about 2% of the total energy consumption in Jordan. Government studies show a growing demand and the average annual growth rate is estimated to reach 4.6% a year between 1995 and 2000. Jordan, therefore, faces major challenges before meeting the goals of the UN Framework Convention on Climate Change (UNFCCC).

Jordan’s contribution to world emissions causing greenhouse effect was minimal, about 0.09 (index per ten million people, UNDP HDR, 1996) in 1989. However, the impact of the greenhouse effect in Jordan is expected to be proportionately much higher. Water is a scarce resource in Jordan, and demands for water are growing both in the agricultural sector, which depends heavily on rainfall as its main source of water, and for domestic use, due to the population growth that reaches rates of approximately 3.5% per annum. Since a rise in global temperatures, due to climate changes, is predicted, the resulting decrease in rainfalls will have a disastrous impact on Jordan.

Steps are already being taken by the national authorities to curb emissions of greenhouse gases. Among them, Jordan’s energy strategy includes plans to increase the utilization of renewable energy to cover 5% of the national energy balance in the year 2000. However, in order to meet the threats and challenges brought by climate changes, Jordan needs international, experienced, assistance to build up its potential and skills properly.

In 1996, the government of Jordan prepared the National Environment Action Plan (NEAP), based on the National Environment Strategy of Jordan (NES), which outlined the measures to be taken in order to safeguard and preserve Jordan's environment for future generations. Five strategic directions for action were recommended in the NES:

1. Creating a legal framework for environmental management, including the enactment of a comprehensive environment law, and creating a national environment impact assessment mechanism.

2. Strengthening institutions concerned with environment protection and conservation, including a national environment agency, line ministries and NGOs.

3. Expanding Jordan's protected areas.

4. Raising public awareness, through environmental education programmes, environmental health awareness and the creation of urban natural parks and green spaces.

5. Identifying main areas to be urgently addressed in order to safeguard the environment, e.g., water resources management.

Subsequently, some of the key legal and institutional recommendations of the NES were followed up and, in 1995, a new Environment Protection Law became effective and the General Corporation for Environment Protection (GCEP) was established. The government formulated the National Environment Action Plan in order to rehabilitate past damage, control degradation and prevent future deterioration of the already limited resources base. The plan identified national priorities and provided the impetus for concrete environmental actions. Action was also taken to raise public awareness of the environmental challenges facing Jordan in the near future and in the next century. Some of the priority actions, their goals and objectives, and their preliminary cost estimates are presented below:

1. Estimating Impact of Climate Changes on the Water Resources of Jordan

Knowing that climate changes affect water resources, major objectives are:

a. Identifying areas potentially vulnerable.
b. Designating potential impact.
c. Identifying future adaptive responses and analysing their feasibility as adaptation strategies.

Action includes investigating the changes of the three major hydrologic regimes of Jordanian catchments under alternative climate scenarios and evaluating the climate change. The overall cost of this action is estimated at about $0.1 million.

2. Measuring GHGs Emission Factors for all Identified Source-Sectors in Jordan

Here, Jordan's and the region's contribution to GHG emissions would be measured for an overall estimated cost of $0.6 million.

3. Building Environmental Management Capacity

The main objective of this action is to strengthen the capacity of GCEP, to facilitate the implementation of NEAP, and to carry out its related environmental management and coordination responsibilities by providing technical and managerial expertise, training and equipment to GCEP. The total cost of this action is estimated at about $1.5 million.

4. Building Capacity to Operate and Maintain Waste Water Treatment Plants

The main goal of this action is to alleviate Jordan's water pollution by ensuring optimum waste water treatment and improving effluent quality. The total cost of this action is estimated at around $0.65 million.

5. Building Capacity to Operate and Maintain the Domestic Water Network

The objective of this action is to alleviate Jordan's water shortage by ensuring optimum water conveyance and delivery to urban and industrial users, through rehabilitation of domestic water network, and minimizing water leakage and, hence, reducing pumping energy requirements (energy saving). The total cost of this action is estimated at about $17 million.

6. Building Capacity to Operate and Maintain the Irrigation Network

The main aim of this action is to alleviate Jordan's water shortage by ensuring optimum water conveyance to irrigation perimeters and farmers and thus reduce the energy needed and minimize water leakage. The overall cost of this action is estimated at around $8 million.

7. Rehabilitation of Waste Water Treatment Plants and Implementation of Waste Water Reuse Programmes

The specific objectives of this action are to rehabilitate the existing waste water plants and implement on-site and/or off-site waste water reuse programmes. The overall cost of this action is estimated at $34 million.

8. Upgrading Industrial Technologies to Minimize Energy and Water Uses

The specific aim of this action is to provide up-to-date, clean technology to major industries, in line with the recommendations of the industrial audit sponsored by USAID and the COWI consult study. Technologies would ensure pollution control and prevention. The total cost of this action is estimated at about $50 million.

9. Development of a National Land Use Planning and Zoning System

The main objectives of this action are:

a. Develop a national land use plan.
b. Achieve government's enactment of a land use and zoning law.
c. Strengthen the capacity of the government department designated to monitor and follow-up the planning/zoning process.

The overall cost of the action is about $1.0 million.

10. Fighting Forest Fires

The main objectives of this action are:

a. Develop a forest fighting emergency unit at the Civil Defence Department.
b. Develop a volunteer fire fighters programme to support the Civil Defence Department efforts.

The overall cost of this action is estimated to be about $5.0 million.

11. Preservation of Forest Lands

The main aim of this action is to prohibit the use of Jordan's remaining forest lands for any other use and to declare forests, like the nature reserves, protected areas.

The cost of this action is estimated at around $1.5 million.

12. Assessment of the Environmental Impact of All Infrastructure Projects

The aim of this action is to ensure that all infrastructure projects that have a negative impact on the environment are identified and modified at the design stage. The overall cost of this action is estimated at $0.5 million, mainly for capacity building and training.

13. Promotion of Public Awareness and NGOs

The objective of this action is to create public pressure groups and empower appropriate NGOs to monitor the environmental effects of industry, agriculture, mining and urban development. The overall cost of this action is around $0.6 million.

14. Range Land Development

The aim of this action is to involve target groups in range land development planning, project design and action implementation. The overall cost of this activity is estimated at about $0.5 million.

15. Development of Regulations to Control Urban Industrial Pollution

The specific objective of this action is to set up regulations and standards for industrial and municipal waste treatment, and industrial and vehicular emissions. The overall cost of this activity is estimated at around $1 million.

16. Establishment of an Environment Monitoring System

This action aims at:

a. Providing line ministries with monitoring facilities.

b. Regulating industry to provide data on air, wastewater, gaseous and dust emissions.

c. Developing a national data bank for environmental monitoring.

The overall cost of this action is estimated at about $4.0 million.

17. Reduction of Methane Emissions and Utilization of Municipal Waste for Energy in Amman

The aim is to reduce the amount of GHG in Jordan by utilizing methane gas produced from anaerobic conversion of municipal waste in Amman for electricity generation and the production of organic fertilizers.

The project will be funded by UNDP's Global Environment Facility at a total cost of $2.5 million, with possible cost sharing, of $1.5 million, by the Danish government.

18. Replacement of Old Vehicles

A law to replace old passenger vehicles with modern cars was passed in 1995. The law exempts the owners of old cars who are willing to replace them with new ones from all taxes, as an incentive. The estimated total number of passenger cars (taxis and point to point service) in the Kingdom is about 18,196; to date, around 3,700 vehicles were replaced; by the year 2000, the number of cars that will have been replaced is estimated at around 8,000. CO_2 reduction is estimated at around $ 413 tonnes/year. The overall cost of this action is estimated at about $ 68.0 million.

12. Financial and Technological Needs and Constraints

12.1 Technology Inventory

In Jordan, as everywhere in the world, almost all economic activities affect emissions. However, some sectors, like energy, industry, transportation, forestry, agriculture and waste management, are generally more climate-relevant than others and deserve special attention with regard to the transfer of environmentally sound technology. On this basis, it is necessary to collect information from different sources in the country and to prepare an inventory and assessment of the technologies already available prior to considering the transfer/retrofit of the existing technology.

In some sectors, limiting GHG emissions is technically feasible; it is certainly logistically and financially difficult, due to the legal and institutional measures affecting the transfer and operation (adaptation) of the new technologies and the added new investment cost. In order for Jordan to fulfill its obligations under the UNFCCC, financial and technological support (on grant basis) is necessary to ensure technology transfer; for example, building institutional capacity, stablishing/strengthening research centers and funding demonstration projects that mitigate climate changes.

12.2 Improving the Quality of Future Communication Reports

Determining the full implications of the greenhouse gas emissions of an energy system using the IPCC Bottom-up methodology requires examination of every phase of the whole energy chain, from the supply side of the energy system (i.e., resources extraction, refineries, electric power plants) to the demand side (i.e., industrial plants, residential and commercial units). ENPEP and IMPACT modules were used to calculate GHG emissions from the energy sector. During the preparation of the 1994 GHGs inventory, two sources of emission factors were utilized, viz, IPCC guidelines and the generic facility database of IMPACT Module wherever IPCC emission factors did not apply or were not available.

In order to improve the quality of future communication reports, it is necessary to determine local/regional emission factors. Efforts are under way to prepare a project proposal in this respect, to be financed by GEF. The project is divided into three parts: the first covers emissions from energy production and consumption, the second focuses on process and area source emissions, the third is concerned with emissions from agriculture and land use changes. The overall cost of this project is estimated at around $.55 million.

Another project proposal, expected to upgrade future communication reports, is being prepared as well. It is titled “Impact of Climate Changes on Water Resources of Jordan” and the results obtained would identify the areas of potential vulnerability and determine future adaptive responses and adaptation strategies. It would also help evaluate the close relationship between the water resources and the climate changes. The overall cost of this research project is estimated at around $ 0.1 million.

12.3 Technological Constraints

The constraints listed below need to be addressed in order to facilitate adequate adaptation of clean technology to meet UNFCCC obligations:

12.3.1 Environmental technology assessment

Analysis of the implications of any technology on human health, natural resources and ecosystems is important in order to make informed choices of processes that are compatible with the sustainable development concept. The environment implications of various processes must be known before selecting the new technology: environmental hazards associated with the processes have to be identified, possible social consequences have to be revealed and cleaner production characteristics have to be evaluated.

12.3.2 Lack of information

Small and medium enterprises in Jordan account for a large percentage of economic activities; it is difficult to influence their behavior due to their small size, their isolated nature and, due to their limited infrastructure, their usually limited access to information regarding environmental issues. Therefore, it is vital to create a national information network to raise their awareness and give them the required support to meet the specific new needs.

12.3.3 Commercial transborder for transfer of environmentally sound technology

Access to and transfer of patent-protected environmentally sound technologies and economically feasible technologies and know-how could pose problems.

12.3.4 Establishment of incentives for private sector activities that advance the transfer of technologies to address climate change and its adverse impact

13. Adaptation Measures and Response Strategies

External financial resources are available to assist Jordan in implementing the following, but not limited to, measures to reduce the GHGs emissions in the economic sectors mentioned below:

13.1 Energy:

13.1.1 Fuel Switching

Jordan's energy strategy recommends an increase utilization of renewable energy, to cover 5% of the national energy balance by the year 2000. One biogas demonstration plant at Rusaifeh landfill is being constructed to utilize methane generated in the landfill (7800 m3/day) to produce electricity (1 MW) at an overall cost of $ 2.5 million. According to the "Electricity Generation Expansion Requirements" study, the first oil shale fired power plant may be introduced in the power generation system in the year 2005, with a net capacity of 90 MW. Also, natural gas would be used but only on newly added combined cycle units and not to replace fuel oil in the existing power units. Combined cycle units are expected to enter the system in 2006. The share of fuel oil fired power plants is expected to drop from 65% in 1994 to around 21% in 2023. The government is in the process of negotiating natural gas supplies to the Aqaba area with both Egypt and Qatar. Natural gas from Egypt is expected to be supplied by pipeline, while LNG would be imported from Qatar**.**

13.1.2 Energy Efficiency

Major industrial establishments (oil refinery, cement producers, phosphate company) initiated measures to increase energy efficiency, reduce energy losses and, hence, reduce greenhouse gas emissions. International technical assistance is very much needed to expedite their efforts in this respect.

13.1.3 Renewable and Indigenous Energy Sources

The Renewable Energy Research Center of the Royal Scientific Society installed various solar and wind energy technology systems at Tal Hassan station, 13 km north of Azraq. The objective of this project is to test system components, system optimizing and system monitoring under field conditions. The Royal Scientific Society intends to upgrade this station to a regional training center in the field of renewable energy technologies. International technical assistance is needed to realize a significant increase in the share of renewable energy in the energy supply system.

13.1.4 Restructuring the Domestic Water Network

Restructuring the distribution system would resolve the existing problems of the water supply system. This would rectify the hydraulic problems, would effect a 33% reduction in leakage levels, and provide the means for achieving further reductions.

Restructuring would also provide an efficient energy distribution system and secure a sound basis for future extension to the system.

The immediate benefits of the restructured system, compared to the intermittent supply system, are difficult to estimate. However, a tentative comparison, displayed in Table 4, shows that the restructured system reduces leakage.

Table (4)
Difference in Volume and Cost of Distribution Losses

	1	2	3 [= 1-2]
	Existing Distribution Areas	Restructured Distribution Zones	Reduction
Distribution losses : m3/y x 1,000 %	68,637 49%	22,794 23%	45,843 26%
Cost [JD/y]	27,010,983	8,956,419	18,054,564

A simulated comparison of both systems yields a 46 million cubic meters/year leakage reduction, valued at 18 million JD/year.

Table 2 shows the difference between electricity consumption and the costs of the existing and restructured distribution systems, if they are equated to a production equivalent to 130 /I/c/d at the 1995 population of 1,556,375. The comparison is based upon applying to the 130 I/c/d production the factors for the kW/cubic meter from the existing and the restructured systems. This gives the respective power requirement for each system and the power difference between the respective systems is priced and shown in the last column of Table 5.

Table (5)

Simulated Comparison Between Electricity Consumption of Existing and Restructured Distribution System

A	B	C	D	E=[D/C]	F	G=[F*E]	H=[H3-	I
System	**Operating Condition**	**Volume (m3/y)**	**Power (k/w)**	**Factor for power utilized [kW/m3]**	***Volume at 130 I/c/d [cm/y]**	**Simulated power quirement at 130 I/c/d [kW]**	**Power Difference [kW .hr]**	**Energy Cost ** (JD/y)**
Existing	Simulated Continuous year 1995	177,538,920	12478	7.03E-05	73,849,994	5190	45468013	
Re-structured	Year 2000	166,416,103	3927	2.36E-05	73,849,994	1743	15265820	
Saving								1,087,279

Notes: * Using 1995 population of 1,556,375
** Cost per kW/hr taken as $ 0,0507

The energy costs related to pumping are expected to be reduced by 30,202,194 kW hr/year, valued at $1,531,379/year.

On the basis of these projected benefits, the pay back period for the investment is unlikely to exceed 10 years.

If all potential benefits are to be fully exploited, it is necessary to see the restructuring in the wider context of a rehabilitation strategy. Essentially, restructuring will secure immediate savings in leakage and energy consumption. This will implicitly secure a CO_2 reduction cost estimated at $706 per tonne.

13.1.5 Public Awareness

The government, in cooperation with the National Electric Power Company and in response to UNFCCC obligations, prepared a public awareness programme focusing on the role to be played by the general public, the consumer, in increasing energy efficiency, reducing energy losses and greenhouse gas emissions, and including energy production, industrial, transport, household, water pumping and agricultural sectors.

The awareness campaign consists of the following:

1. Distribution of energy conservation brochures.

2. TV spots on ways to conserve energy in all economic sectors.

3. Electric sector activities on demand side management (DSM) and energy conservation practices in all sectors.

4. Interviews with top ranking officials at NEPCO, to introduce the awareness campaign to the general public.

13.2 <u>Transport:</u>

13.2.1 Improving Vehicle Fuel Efficiency

In 1995, the government passed a law which encourages taxi owners to replace their cars with modern cars by exempting the purchase of a new taxi from all taxis and duties. To date, a total of 3,700 old taxis were replaced. By the year 2000 the total number of taxis to be replaced is expected to reach around 8,000.

13.2.2 Traffic Congestion Reduction

The Greater Amman Municipality has completed several projects (construction of bridges and tunnels) and has computerized traffic lights at certain locations with high traffic during rush hours. This has considerably reduced congestion on the roads, minimized time spent in traffic and, consequently, reduced energy use per passenger-seat-kilometer.

13.2.3 Public Transport

The government recognizes the need for a major upgrading of the road transport system and for additional links to serve the evolving regional market. Several important projects are planned, but in view of their high overall cost, the government plans to seek a mix of private donors to supplement its own contribution.

While repairs and construction of most new links in the road system is a public sector responsibility, the government plans to shift funding for the maintenance of the road system to road users, through road tolls that will be subsequently channeled through a fund dedicated to road maintenance.

The rapid construction of the Shidiya rail line is absolutely important for the future of the railway sector. The government is considering private financing as part of a concession agreement for private operation and maintenance of rail services on this line.

Other priority investment projects in the transportation sector include a restructuring of the public transport and the development of a light-rail system. The planned expansion and development of Aqaba Port, vital to Jordan's export-led development strategy, includes the construction of new jetties for passengers, industrial usage and special cargo handling. Likewise, planned expansion and upgrading of the Queen Alia International Airport should play an important role in facilitating the arrival of tourists. The government envisions that a substantial part of this planned development will be financed by the domestic and foreign private sector. Developing Aqaba International Airport is also under consideration, with private sector participation.

The light rail system project includes construction of a 42-km light rail system (LRS) in the greater Amman and Zarqa areas, supply of the required rolling stoke, and the operation management of the system. The project was divided into three stages: L1, L2, and L3.

The construction cost of the project will be about $65 million. Betweeen 20 and 53 rail cars will have to be purchased; the cost of each estimated at about $1.8 million.

A feasibility study was prepared by Austria Rail Engineering in 1996 based on a public transport survey and on public transport figures provided by the Ministry of Public Work and Housing. Accurate and up-to-date data was provided for simulating future passenger traffic within the project area.

The total population of Jordan, according to the Population and Housing Census of 1994, is 4.1 million; about 38% of the total population lives in the Amman governorate (1.57 million). Adding the figure of the adjoining Zarqa Governorate (0.65 million), it will result that 53% of the Jordanian population will be affected by the new public transport system.

Improving efficiency is also one of the important goals in the development plans of Jordan. The government is considering introduction of double-deck buses in the Greater Amman area and other municipalities to reduce fuel consumption and GHG emissions while securing a more efficient public transport system. The government is also restructuring public institutions that deal with transportation with a view to improving their efficiency and gradually eliminating subsidies, recovering costs and adopting commercial performance criteria.

Improvement-oriented investment will continue to be crucial to the process of upgrading efficiency and quality of service. Since transportation and cost distribution account for a substantial share of the cost of delivered goods, the transport sector itself has to be competitive, to economize on the use of scarce resources, and to increase market-oriented activities with a view to encouraging regional and rural development and enhancing competition. In short, investment in upgrading the transport sector is necessary withing the overall effort to develop the economy and to maintain Jordan's key position as a transit country.

13.3 Industry

One) Jordan's energy-related pollution problem stems from the refinery. It is the location where crude oil can be processed and purified to improve its performance and reduce emissions during its subsequent use in all downstream sub-sectors. Furthermore, with appropriate investment in modern processes, the refinery's own contribution to local emissions could be very substantially reduced. Detailed studies undertaken by government, in cooperation with the refinery, showed that immediate investment is required for the following reasons:

- Expansion to meet increasing demand for its products.
- Improved product quality.
- Reduced refinery emissions.

Table 6 indicates the size of investment required for the different refinery processes.

Table (6)
Investment Levels

Required Investment	US$ Million
Distillation capacity *	80 - 140
Sulfur recovery plant	5-10.0
Merox upgrade	1.0
Continuous catalytic reformer - i.e. platformer	85.0
Hydro desulphurisation for diesel	50-60
Modern fluid catalytic cracker	200
Isomerisation unit	30.0
Alkylation unit	30.0
Hydrocracking	100.0
Gasification**	225.0

Note* atm. and atm. + vacuum distn
Note** approx. for 350 MW equivalent capacity

Two) Increasing energy efficiency and reducing energy losses and greenhouse gas emissions in large industrial establishment in Jordan depends on the availability of external financial and technical aid as an incentive for minimizing GHG emissions in a cost-effective manner.

Three) Small and medium industrial establishments account for a large percentage of the industry sector. Therefore, it is vital to seek international technical assistance to determine ways to reduce GHG emissions in a cost-effective manner.

13.4 <u>Agriculture</u>

One) There are ongoing research and development programmes aimed at attaining sustainable agriculture.

Two) Forest management practices, including afforestation and reafforestation policies, that expand carbon storage in the forest ecosystem, including soils, were adopted.

Three) Afforestation and desertification control is an ongoing activity.

Four) Green spaces in urban areas continue to be developed.

13.5 Waste Management

Steps were taken to reduce emissions of methane through recovery and use.

بسم الله الرحمن الرحيم

The Hashemite Kingdom of Jordan

The General Corporation for the Environment Protection (GCEP)

Initial Communication Report Under the UN Framework Convention on the Climate Change

Volume 2
Main Report

January 1997

(Updated November 1997)

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1. NATIONAL CIRCUMSTANCES

The Hashemite Kingdom of Jordan, a 90,000-km^2 area in the hot and dry region of West Asia, is an almost land-locked state bordered by Israel and the West Bank to the west, Syria to the north, Iraq to the east and Saudi Arabia to the southeast. The port of Aqaba in the far south gives Jordan a narrow outlet to the Red Sea. The country is made up, in the east, of mostly desert, with elevations ranging from 300 to 1,500 metres and annual precipitation of less than 50 millimeters. The central region contains the Jordanian highlands (average altitude 900 metres) which witness an annual rainfall of up to 600 millimeters in the north. Jordan's outstanding topographical feature is the great north-south rift, starting at Lake Tiberias, passing through the Jordan River Valley and reaching the Dead Sea (the lowest point on earth, 400 meters below sea level). Jordan has three major rivers: Jordan River and its two principal tributaries, Yarmouk and Zarqa. Given its salinity and other quality problems, surface water is mainly used for irrigation. Drinking water is taken from underground aquifers and the King Abdullah Canal.

In mid-1994, Jordan had a population of 4.14 million, with a 42.4-people-per-km^2 density. More than 40 per cent of Jordan's population resides in the Amman Governorate; the capital, Amman, has over 1.48 million inhabitants. In the longer term, Jordan is liable to face severe water shortage, a problem that could be overcome only through increased regional co-operation. Jordan's biggest environmental challenge is managing the scarce common resources of water and cultivable land more effectively to meet the increasing needs of a population which grew at a rate of 3.4% per annum in the decade 1980- 1990.

More than 80% of the country is made up by unpopulated desert. Water resources in Jordan depend mainly on precipitations within the country, except for the Yarmouk River, whose water is replenished by rainfall on Syrian territory, and the Azraq aquifer, which is recharged by precipitation in Syria as well. Rainfall ranges from 600mm per year in the northern lands to less than 50mm per year in the southern and eastern desert areas. It rains mainly between October and May, with the highest level of annual precipitations, 80%, witnessed between December and March.

The national circumstances are summarized in table 1.1, while initial national greenhouse gas inventory is summarized in table 1.2.

Table (1.1)
NATIONAL CIRCUMSTANCES

Criteria	***1994***
Population (in million)	4.14
Area (square kilometres)	90,000
GDP (1994 million $)	5900
GDP per capita (1994 $)	1450
Estimated share of the informal sector in the economy in GDP (percentage)	5
Share of industry in GDP (percentage)	14.5 (Manufact. + Mining)
Share of services in GDP (percentage)	57.5
Share of agriculture in GDP (percentage)	4.5
Other Sectors	18.5
Land area used for agricultural purposes (square kilometres)	500
Urban population as percentage of total population	70
Livestock population	Cattle 58000 Goats 852000 Sheep 182000
Forest area (square kilometres)	1500
Population in absolute poverty	10 %
Life expectancy at birth (years)	M = 67 F = 69
Literacy rate	85%

Table (1.2)
Initial National Greenhouse Gas Inventory of Anthropogenic Emissions by Sources and Removals by Sinks of All Greenhouse Gases not Controlled by the Montreal Protocol

Greenhouse Gas Source & Sink Categories	*CO_2*	*CH_4*	*N_2O*
Total (Net) National Emission (Gigagram per year)	**9094**	**403.9**	**0.40**
All Energy	**13390**	**403.9**	**0.40**
1. Fuel Combustion	**11689**	**1.6**	**0.39**
Energy & Transformation Industries	**5306**	**0.1**	**0.14**
Industry	**1616**	**0.1**	**0**
Transport	**2798**	**1.2**	**0.08**
Commercial-Institutional	**738**	**0.1**	**0.15**
Residential	**1231**	**0.1**	**0.02**
2. Industrial Processes 1- Cement	**1701**	**0**	**0**
3. Agriculture	**0**	**26.6**	**0.01**
Enteric Fermentation	**0**	**23.6**	**0**
Savanna Burning	**0**	**0**	**0**
Others	**0**	**1.4**	**0**
Burning of Agricultural Residue	**0**	**0.3**	**0.01**
Manure Management	**0**	**1.3**	**0**
4. Land Use Change & Forestry	**4296**	**0.1**	**0**
Changes in Forest & other woody biomass stock	**249**	**0**	**0**
Forest & Grassland Conversion	**374**	**0**	**0**
On-Site Burning of Forest	**0**	**0.1**	**0**
Abandonment of Managed Land	**832**	**0**	**0**
Agriculturally Impacted Soils	**2841**	**0**	**0**
5. Other Sources	**0**	**375.6**	**0**
Domestic Solid Wastes	**0**	**370.9**	**0**
Industrial Refuse	**0**	**0.1**	**0**
Domestic Sewage	**0**	**4.6**	**0**

2. MACRO-ECONOMIC PERFORMANCE, 1994

2.1 Jordan Development Challenges

Jordan is a lower middle-income country of about 4.2 million inhabitants whose annual per capita income, in 1995, was estimated at $1,536. Its economic structure is dominated by trade and service-related activities which account for about 57.5% of GDP; manufacturing, agriculture, mining and construction account for the rest.

Construction has been the driving force during periods of strong economic growth. Worker's remittances from the neighboring oil-exporting countries and processed mining-based exports are primary sources of Jordan's foreign exchange earnings.

In late 1988 the Jordanian economy witnessed a sharp decline, result of a huge capital flight from Jordan. This led to the initiation of an economic adjustment programme for the period 1989-1993, disrupted by the Gulf crisis of 1990. The Gulf crisis was also responsible for several problems, including the forced return of around 300.000 expatriates from Kuwait and the Gulf region, the discontinuation of the Arab financial assistance, and the shrinking of exports to neighbouring countries.

In order to overcome the ensuing economic imbalances, the government tackled them through initiating the New Economic Adjustment Programme for the period 1992-1998 and the Five-Year Economic and Social Development Plan for the period 1993-1997.

The programme was designed to achieve the following:

1. Reduce chronic imbalances in the balance of payments and government budget.
2. Achieve fiscal and monetary stability.
3. Build strong foundations for sustained economic growth with stable prices.

The programme relies heavily on:

1. The private sector to expand its role in the economic development of the country.

2. The government to rationalize its resources to achieve a sustained economic growth and a stable investment environment.

3. Restructuring the tax system in order to increase its flexibility and make it comprehensive.

Consistent with the adjustment programme, the five-year plan aims to achieve the following:

- Promote financial and monetary stability.
- Address price and production distortions.
- Increase domestic savings.
- Promote private domestic investments.
- Reduce government budget and balance of payment deficits.
- Promote domestic production.
- Reduce income disparities among individuals and regions.
- Train and retrain workers to promote entrepreneurship.
- Create conditions conducive to private investment.
- Promote participation in the decision-making process and improve accountability.
- Expand employment opportunities and reduce rate of unemployment.
- Increase exports of goods and services.
- Promote responsible development that safeguards the environment.

The plan aims to achieve a sustained economic development by restructuring the economy and adapting fiscal and monetary policies.
Fiscal policies aim at reducing the budget deficit through curtailing expenditure and increasing revenues. In order to achieve this, the plan aims at restructuring the tax system towards increasing direct taxes, introducing a sales tax that would replace the consumption tax, removing subsidies on basic goods and pricing government services commensurate with their quality.

Monetary policies aim at maintaining financial and price stability through increasing foreign reserves, to cover at least three months of imports, controlling the growth rate of money supply, in line with the growth rate of the GDP, deregulating interest rates, establishing depository insurance companies, minimizing central bank's supervision of all financial institutions and floating the exchange rates.

Social policies aim at increasing income and reducing poverty through supporting lower-income groups, through an equitable distribution of developmental projects to all regions, through the reduction of dependency rate through family planning, and through working with the family as the basic building block of the society.

2.2 <u>Expenditure on GDP in 1994</u>

The Jordanian economy fulfilled largely its 1994 objectives, as set out in the Economic Adjustment Programme (1992-1998) and the Economic and Social Development Plan (1993-1997). This was achieved despite the uncertainty surrounding the signing of the peace process in the region. Available estimates for 1994 indicate a real GDP growth almost identical to that of the previous year, a containment, within acceptable limits, of the inflation rate and a sustained drop in unemployment rates. The real GDP growth rate registered during 1994 is attributable largely to the outstanding performance of the transport, communication and manufacturing sectors.

A number of factors were responsible for the positive developments in the spheres of output, prices and employment during 1994, the most prominent being the continued implementation of procedures and measures designed to eliminate structural imbalances in all sectors of the economy, with a view to improving their efficiency and to enhancing confidence in the investment climate in the country.

Moreover, there was constant implementation of management policies aimed at maintaining fiscal and monetary stability, concomitant with the impact of the private investment boom witnessed by Jordan in 1992 and 1993.

The following table shows that in 1994 the GDP, at current market prices, registered a growth rate of 9.9%. With the narrowing of the deficit in the net income from abroad by 11.5% of its level in 1993, GNP, at current market prices, rose by 10.7%, compared to its 1993 level.

Table (2.1)
Economic Growth Rates
1985 = 100

Year	Current Prices		Constant Prices	
	GDP (Factor cost)	**GDP (Market Prices)**	**GDP (Factor cost)**	**GDP (Market Prices)**
1990	10.2	12.5	-1.1	1.0
1991	7.8	7.0	2.6	1.8
1992	18.2	22.3	12.1	16.1
1993	8.6	9.1	5.3	5.9
1994	9.8	9.9	5.7	5.9
1995	8.9	10.3	5.0	6.4

Source : CBI, 32nd annual report, 1995 and 31st annual report, 1994, table No. (2) p.16.

Due to the drop in the inflation rate, measured by changes in GDP deflator, the GDP at constant cost factor registered a growth rate of 5.7% in 1994, marking a growth rate of 5.7% against 5.9% in the previous year. The real growth rate of the GDP at market prices was higher than that at cost factor as a result of a tangible rise, of 6.8%, in indirect tax proceeds at constant prices. This was largely due to the application of the general sales tax, accompanied by a set of customs reforms.

According to population census results carried out in late 1994, per capita GDP at current prices rose to $1,450 against $1,418 in the previous year, marking a growth rate of 6%. Real per capita income continued the ascending line that began in 1992, registering a growth of 1.9% in 1994, against 1.9% and 11.8% in 1993 and 1992 respectively.

During 1994, there were several noticeable changes in pattern and growth rates of expenditure items for final goods and services. Contrary to the previous year, the export sector made a positive contribution in activating the economic growth movement, while the impact of fixed capital formation was slightly negative.

Aggregate consumption expenditure continued to serve as the principal driving force behind the economic growth achieved in 1994, although it marked a decline compared to 1993.

Table 2.2 shows that the net export sector improved tangibly in 1994. Its deficit gap narrowed by 17.2% of its 1993 level. Its contribution to the GDP growth thus amounted to 5.3 points out of a growth of 9.9%, against a negative share of 1% in 1993. The improvement in 1994 is attributable to a 6.3% increase in exports of goods and services and to a 2.6% drop in imports of the same, compared to 1993. This also led to a drop in the balance of goods and services deficit in the to GDP at current market prices, to reach 23.1% in 1994 against 30.6% in 1993.

Table (2.2)
Major Indicators of GDP Expenditure Components at Current Market Prices in the Year 1994

	Relative Importance	**Growth Rate**	**Contribution to Growth in GDP**
Govt. final consumption expenditure	21.2	6.1	1.3
Private final consumption expenditure	74.3	6.2	4.8
Change in stocks	-1.0	-	-1.1
Gross fixed capital formation	28.6	-1.2	-0.4
Net external transactions	-23.1	-17.2	5.3
Gross Domestic Product	100.0	9.9	9.9

Source : CBJ, Annual Report, Vol. 31, table 5 p21.

Aggregate consumption expenditure in 1994 grew by 6.2%, against 11.6% in 1993, and, accordingly, their relative importance in GDP at current market prices fell to 95.5%, against 98.8% in 1993. As a result, the contribution of consumption expenditure to the GDP growth dropped from 11.4% to 6.1% in 1994. This downward trend led to an increase in the rate of domestic savings, from 1.2% in 1993 to 4.5% in 1994. Besides a slowdown in consumption, this increase of the saving rates is attributable to a rise in interest rates in the domestic market, particularly on deposits in Jordanian dinars.

Aggregate investments in 1994 registered a decline of 4.7%, against a growth of 2.2% in 1993, thus displaying a 4.2% drop in its relative importance in GDP at current prices, from its 1993 level, to reach 28.6%. Accordingly, its contribution to the GDP growth in 1994 was a negative - 1.5%, against a positive 0.8% in 1993. This decline is attributable basically to the state of uncertainty that prevailed among investors awaiting the outcome of the regional peace process.

2.3 Expenditure on GDP in 1995

In 1995, the Jordanian economy vigorously continued the upwards trend of real growth and price stability, within the framework of an ongoing economic adjustment programme that was meant to enable the economy to adapt to domestic, regional and international developments. The performance of the national economy in 1995 surpassed the targets envisaged in the economic adjustment programme. A slight drop in the unemployment rate was also registered. The growth during 1995 was strongly marked in the mining and quarrying and in the trade, restaurants and hotels sectors, as a result of a noticeable improvement in exports of goods obtained through mining and quarrying and of a growing activity in the tourism sector.

A number of factors were responsible for the positive achievements in the spheres of output, prices and employment; most important was the continued implementation of adjustment policies aimed at restructuring various economic sectors and redressing distortions through activating market forces that would reinforce the supply side of economy. The adjustment also aimed at strengthening confidence in the investment environment in order to attract both domestic and foreign investments. Within this framework, the income tax law and the General Tax Law were amended and a new law for the promotion of investment was promulgated. Furthermore, demand and management policies continued to be implemented to maintain monetary and fiscal stability and increase domestic savings, and to bolster confidence in the investment surge witnessed by the Jordanian economy starting with 1992.

Table 2.1 shows that GDP, at current market prices, registered a growth rate of 10.3% in 1995, against 9.9% in 1994, due to a 22.6% reduction, compared to 1994, in remitted income. Thus, GNP realized a 11.5% growth in 1995, against 10.3% in 1994.

Due to the drop in inflation rate, GDP registered a growth rate of 5% in 1995, against 5.7% in 1994. As a result of the increase in net indirect taxes, which reached 14%, GDP, at constant market prices, registered a 6.4% growth in 1995 against, 5.9% in 1994.

As a result of these developments, per capita GDP at current market prices rose by 6.4% in 1995, reaching $1,536. Real per capita income in 1995 achieved a 2.6% growth over 1994. Despite the fact that per capita income at current prices had registered continued growth, it was still below the record level registered in 1987, as expressed in dollars.
In 1995, domestic demand, particularly aggregate consumption expenditure, took the lead in pushing up the growth witnessed by the Jordanian economy in 1995, contrary to 1994 when the export sector was the main driving force behind the economic growth.

Data in Table 2.3 shows that aggregate consumption expenditure registered in 1995 a growth rate of 6.4%, against 3.1% in 1994. This noticeable increase came as a result of a rise in both government and private consumption expenditure in 1995, of 1.6% and 3.7% respectively, over their levels in 1994. Consequently, the contribution of government and private consumption expenditure to the GDP growth rate rose from 2.4 and 0.5% respectively, in 1994, to 2.8 and 2.9% respectively, in 1995. This was accompanied by a marked decline in the rate of aggregate consumption in the GDP at current market prices, which reached 85% in 1995, against 88% in 1994. This represents a rise in the rate of domestic savings, both public and private, to the GDP, from 12% in 1994 to 15% in 1995.

Table (2.3)

Major Indicators of GDP Expenditure Components at Current Market Prices for the Year 1995

(%)

	Relative Importance to GDP	Growth Rate	Contribution to Growth in GDP
Govt. final consumption expenditure	23.1	12.4	2.8
Private final consumption expenditure	61.9	4.4	2.9
Change in stocks	3.0	9.2	0.3
Gross fixed capital formation	32.8	9.2	3.0
Net external transactions	-20.8	-5.3	1.3
Gross Domestic	100.0	10.3	10.3

Source : Central Bank of Jordan, vol. No. 32, Annual Report, table 5 p.21

Aggregate investment registered a 9.2% growth in 1995, against 6.6% in 1994, which led to a rise in its contribution to the GDP growth in 1995; this was accompanied by a drop in the relative importance of aggregate investment to the GDP at current market prices by 0.4% of its level in 1994, reaching 35.8% in 1995.

The expansion in the volume of investment in 1995 is attributable to the growth in domestic savings and enhanced confidence in the country's investment climate. Available data reveals a 0.9% rise in the total capital of new companies registered at the Ministry of Industry and Trade. The expansion in the volume of investments is considered significant in view of the fact that it was realized after the record level this indicator reached during 1994, when it grew by 68.4% of its 1993 level.

The export sector's deficit narrowed by 5.3% in 1995, against a noticeable drop of 14.7% in 1994. Consequently, the contribution of this sector to the GDP growth, at current market prices, amounted to about 1.3% of the overall growth of 10.3% in 1995. The reduction of the export sector deficit came as a result of a 17.9% increase in exports of goods and services in 1995 and of a 10.3% increase, in 1995, in the amount of imports of goods and services, as compared to their decline by 1.4% in 1994. These developments led to a drop, from 24.2% in 1994 to 20.8% in 1995, in the deficit of the goods and non-factor services balance in the GDP at current market prices.

2.4 <u>Sectoral Performance in 1994</u>

Sectoral developments in 1994 display an increase in value added in all sectors except for that of domestic services of households. The increase varied from 1% in the agriculture and mining and quarrying sectors to 11% in the transport and communications sectors.

Table 2.4 shows that the commodity producing sectors collectively grew in 1994 at a rate of 4.9%, against 7.5% and 19.2% in 1993 and 1992, respectively. Consequently, their contribution to the GDP at constant cost factor declined by 0.2% below their 1993 level, to reach 37.6% in 1994.

The decline in the contribution of the commodity producing sectors arose from a marked slowdown in the growth rate of the construction and agriculture sectors in 1994, as compared to 1993. These two sectors grew at the rate of 4.1% and 1%, against 12% and 10% in 1993, respectively. Had it not been for this slowdown, the contribution of the commodity producing sectors to the GDP would have clearly improved in view of the accelerated growth in the mining and quarrying, manufacturing, electricity and water sectors. The value added of the manufacturing sector rose by 9.3% in 1994, assuming a leading role among commodity producing sectors and pushing upwards the growth rate in the GDP. Likewise, the mining and quarrying sector managed to achieve a positive growth, following the decline they had experienced since 1990. It registered a real growth rate of 1% against a decline of 2.6% in 1993. Electricity and water sectors achieved a considerable 6.4% growth rate in 1994, against 4.1% in 1993.

Table (2.4)
Growth Rates of Economic Sectors
at Constant Factor Cost

(%)

	1990	*1991*	*1992*	*1993*	*1994*	*1995*
Agriculture	31.1	9.6	17.3	10.0	1.0	4.0
Mining & quarrying	-17.8	-14.9	-1.1	-2.6	1.0	18.0
Manufacturing	9.6	-1.5	15.0	6.0	9.3	3.0
Electricity & water	-23.2	5.4	4.4	4.1	6.4	5.0
Construction	-6.3	10.5	55.4	12.0	4.1	5.0
Total Commodity Producing Sectors	4.1	2.4	19.2	7.5	4.9	4.9
Trade	-25.2	2.3	10.8	7.0	8.0	9.0
Transport & Communication	-3.5	-5.6	9.2	5.0	11.0	4.0
Finance, real estate & business services	-7.8	10.2	4.5	5.0	4.0	4.5
Social services	3.7	29.8	23.7	4.0	2.9	6.0
Imputed bank service changes	-35.4	28.1	-26.0	4.8	1.1	4.6
Producers of government services	-0.5	1.7	5.8	6.0	4.0	5.5
Non-profit institutions	9.5	5.0	9.5	5.5	3.7	4.1
Domestic services of households	-10.0	-13.9	35.5	2.4	0.0	4.5
Total services sectors	-3.7	2.7	8.3	5.4	5.8	5.1
Gross Domestic Product	-1.1	2.6	12.1	6.2	5.5	5.0

Source : Central Bank of Jordan , Annual report, vol. No. 32 for the years from 1991-1995 & vol. No. 32 for the year 1990, table (2.3)

As a result of these developments, the share of industry to the GDP at constant factor cost rose by 0.4% in 1994, to reach 15.2%, thereby retaining the highest position among commodity producing sectors. By contrast, the relative importance of the agriculture and construction sectors remained constant, while electricity and water sectors maintained their relative importance of 1993, as shown in the following Table 2.5:

Table (2.5)
The Relative Importance of Economic Sectors' Contribution to GDP at Constant Factor Cost

(%)

	1991	*1992*	*1993*	*1994*	*1995*
Agriculture	10.5	11.0	7.7	7.3	7.3
Industry	16.1	16.1	15.4	15.7	15.7
Electricity & water	3.3	3.1	3.3	3.4	3.4
Construction	5.2	7.2	8.6	8.5	8.5
Total commodity producing sectors	35.1	37.4	35.0	34.9	34.9
Trade	3.5	3.4	4.1	4.2	4.3
Transport & communication	15.0	14.6	14.4	15.1	15.0
Finance, real estate & business services	21.7	20.2	21.9	21.5	21.4
Produces of govt. services	23.0	21.7	22.4	22.1	22.2
Other services	1.7	2.7	2.2	2.2	2.2
Total services sectors	64.9	62.6	65.0	65.1	65.1
Gross Domestic Product	100.0	100.0	100.0	100.0	100.0

Source : Central Bank of Jordan, Annual report, vol. No.32 table No. 4

2.5 Sectoral Performance in 1995

The sectoral performance in the GDP at constant factor cost in 1995 reveals an increase in value added for all sectors. Growth rates varied from 3%, in the manufacturing sector, to 18%, in the mining and quarrying sector.

Table 2.4 shows that, for the second consecutive year, the commodity producing sectors joined the services sectors in pushing forward real economic growth. The commodity producing sectors collectively registered a 4.9% growth in 1995. Since the commodity producing sectors grew at a rate close to that of the GDP at constant factor cost, of 5%, these collectively retained their relative importance to the GDP, registered in 1994 at 34.9%.

Considering the developments witnessed by the commodity producing sectors in 1995, the manufacturing sector lost its leading position, in pushing up the real growth in the GDP in 1995, to the mining and quarrying sector. This came as a result of a noticeable lag in the growth rate of the manufacturing sector in the same year, a growth that did not exceed 3%. By contrast, the mining and quarrying sector registered a 18% growth.

The agriculture and construction sectors also witnessed real growth, reaching 4% and 5% respectively in 1994. The electricity and water sector fell by 1.4%, reaching 5% in 1995. These developments kept the industrial sector, with both its manufacturing and mining and quarrying divisions, in the leading position among the commodity producing sectors. Table 5 shows its relative importance to the GDP.

Regarding the services sectors, the value added generated collectively rose by 5.1% in 1995 as a result of the similarity between the growth rate of the services sectors and that registered by the GDP, registered at 65.1% in 1994.

It should be noted that the real value added to all the services sectors in 1995 registered rates varying between a minimum of 4%, in the transport and communication sector which in 1994 constituted the major driving force behind economic growth. Government services, finance, real estate and business services sectors rose by 5.5% and 4.4%, respectively. This resulted in a relative stability in the structure of services with regards to their relative importance to the GDP at constant factor cost. The government services sector maintained its rank regarding its share in the GDP.

2.6 Balance of Payments:

One of the major objectives of the five-year plan is to eliminate the deficit in the current account of the balance of payments by the end of 1997. This is to be achieved through reducing the deficit in the trade balance and increasing the surplus in the balance of services. Hence, the increase in exports of trade and services will be the key to correcting imbalances in the export sector and attaining the targeted GDP growth rate.

As shown in Table 6, the export activities reflected prominent developments in 1994 and 1995 compared to previous years. Since 1992, there has been a downwards trend in the percentage of deficit of the external current account to the GDP. The improvement achieved with respect to the trade balance was due to the increase in total exports and the unusual decrease in imports. As per the five-year plan target regarding the current account deficit, it is worth mentioning that the ratio of the current account to the GDP in 1994 and 1995 was heading towards the designed targets. The declining of this ratio increases the potential to achieve external savings.

Table (2.6)
Main Items of the Balance of Payments as a Percentage of GDP

(%)

	1990	*1991*	*1992*	*1993*	*1994*	*1995*
Current account	-10.2	-10.1	-16.3	-11.4	-6.7	-3.7
Trade balance	-37.8	-34.8	-41.9	-41.6	-32.5	-29.2
Exports	22.9	21.0	18.1	18.1	18.9	21.7
Imports	-64.2	-61.8	-65.6	-64.3	-56.3	-56.0
Re-exports	3.5	6.0	5.6	4.5	4.8	5.1
Service balance	12.2	12.9	17.6	23.1	20.4	21.6
Unrequited transfers	15.3	11.8	8.0	7.1	5.4	3.9
Capital account	-1.7	13.9	4.5	-3.2	0.3	2.8

Source : Central Bank of Jordan, 32nd Annual Reports, 1995, and 31st Annual Report, 1994, table No. 26, P.88.

In this regard, the monetary policy was geared towards continuing to provide incentives for financial assets denominated in Jordan dinars and creating customer friendly official. As a result, deposits and assets denominated in Jordanian dinars witnessed an increase.

The growth in exports helped address the chronic trade balance deficit. The outstanding performance of the Jordanian exports was mainly the outcome of the government's efforts to provide the necessary financing support. The government is also considering further liberalization of the trade regime by: (a) reducing import restrictions and replacing them with import tariffs, (b) further narrowing the tariff range; (c) phasing out the protocol trade that gives privileges to specific countries; (d) streamlining customs administration, and (e) reducing other regulatory constraints and applying to join the World Trade Organization (WTO), which requires lowering the tariffs.

Exports registered a 26.5% growth, against 14.8% and 9.1% realized in 1994 and 1993, respectively. They constituted 21.7% of the GDP in 1995, against 18.9% in 1994 and 18.1% in 1993. On the other hand, imports registered a growth rate of 9.6% in 1995 and 3.7% in 1994. Regarding the composition and structure of exports and imports, Table 7 shows the relative importance of each of the items of foreign trade:

Table (2.7)
External Trade by Economic Function

(%)

	1994	***1995***
EXPORTS	100.0	100.0
- Consumer goods	38.8	41.0
- Raw materials and intermediate goods	54.7	54.9
- Parts and accessories	0.8	0.8
- Capital goods	5.7	3.3
IMPORTS	100.0	100.0
- Consumer goods	23.4	23.2
- Raw materials and intermediate goods	53.7	55.1
- Parts and accessories	6.4	6.0
- Capital goods	16.0	15.2
- Miscellaneous	0.5	0.5

Source : Central Bank of Jordan, 32 Annual Report, table 36 P.156

It is noted in Table 2.7 that exports of raw materials and intermediate goods take the lead, making up 54.9% and 54.7% in 1995 and 1994, respectively. Second in order were exports of consumer goods, which make up 38.8% and 41.0% in 1994 and 1995 respectively. On the other hand, imports in 1995 maintained almost the same trend as in 1994, with minor changes. The relative importance of raw materials and intermediate goods rose from 53.7% in 1994 to 55.1% 1995, while it remained almost constant for consumer goods and parts and accessories.

2.8 Public Finance

As the government budget deficit is strongly related to the internal structural imbalances, addressing it is considered one of the major goals of the adjustment programme as well as of the five-year development plan. Reducing the government budget deficit hinges mainly on reducing the percentage of total consumption to the

GDP, which will eventually lead to an eradication of domestic dissavings and make more room for positive savings to finance investments.

In this regard, positive signs have been noticed, that reinforced the foundation of the economic adjustment course adopted by the government in the way towards high and sustainable real growth rates. In this sense, Jordan's remarkable fiscal adjustment is the single most important macro-economic policy instrument that favorably influenced its investment and growth performance.

The fiscal policy seems to have worked through two channels: the crowding out effect on investment and thus growth; and the effect of signaling whether or not the government is in control of the economy. Overall, empirical analysis highlights the importance of sustained fiscal and external adjustments in creating a stable macro-economic environment and in fostering growth and investment, and the importance of large transfers of workers' savings in easing the adjustment process.

It can be noticed in Table 8 that total domestic revenues, in proportion to the GDP, increased form 29% in 1991 to 31.2% in the years 1994 and 1995, while for public expenditure this percentage declined from 38.5% in 1994 to 34.9% in 1995. It is worth mentioning in this respect that the percentage of current expenditure of the GDP declined from 31.7% in 1991 to 26.5% in 1995, while the capital expenditure percentage of the GDP increased form 6.9% in 1991 to 8.4% in 1995.

Table (2.8)
Development of Public Revenues and Public Expenditure of the GDP
(%)

	1991	*1992*	*1993*	*1994*	*1995*
Public revenues	38.9	38.9	36.9	36.7	36.2
Domestic revenues	29.0	33.5	31.3	31.2	31.2
Foreign grants	7.9	3.9	4.3	4.2	3.8
Loans repaid	2.0	1.5	1.3	1.3	1.3
Tax revenues	14.1	18.3	16.9	16.6	17.0
Non-tax revenues	15.0	15.2	14.4	14.6	14.1
Public expenditure	38.5	33.7	35.1	34.2	34.9
Current expenditure	31.7	26.6	27.4	26.6	26.5
Capital expenditure	6.9	7.1	7.7	7.6	8.4

Source : Central Bank of Jordan, 32nd Annual Report 1995, tables No. 21, 22, 23, PP 71, 73, 74 .

The current level of total domestic revenue in relation to the GDP is broadly satisfactory and comparatively high among developing countries. There is need, however, for further efforts to enhance revenue elasticity and the efficiency of the tax system and to reduce dependence on non-tax revenues.

The issuing of the Sales Tax Law in 1994 helped improve the performance of public finance, pursuing the implementation of the structural reforms programme. Furthermore, and within the context of controlling budget deficit, developing domestic revenues and increasing their coverage of current expenditure, the government implemented actions aimed at rationalizing current expenditure as percentage of the GDP and granting further customs duty exemptions and reductions on imports of goods and services in the year 1995.

Following are some of the key policy actions that were adopted in 1995:

- Several amendments to the general sales tax were adopted, with a view to improving the efficiency of the tax system. The main amendments increase the standard rate to 10%, replace the positive list of services subject to taxation with a negative list, with limited exemptions, allow for voluntary registration of taxpayers, and provide for introducing supplementary duty on selected luxury or socially undesirable products in order to protect revenue in the context of the next stage of external tariff reform.

- The direct taxation system was improved to eliminate tax holidays, limit tax deductibility to net interest payments, reduce the number of tax rates and set a maximum of tax rates for both personal and corporate income taxes; rationalize corporate income tax rates with a view to treating all corporate sectors on an equal footing by establishing three flat corporate tax rates [of 15% for companies in "encouraged" sectors (mining, industry, hotels and hospitals), 35% for banks and financial institutions and 25% for all other companies]; encourage capital accumulations by imposing a withholding tax of 10% on distributed profits; and broaden the tax base by reducing and simplifying exemptions and applying uniform standard deductions for all wage earners.

- Exemption from customs duties covered some raw materials used in medical, electrical, paper and textile industries, in addition to final goods pertaining to public safety equipment for vehicles; customs duties were also reduced to a maximum of 20%, instead of 50%, on intermediate goods used in manufacturing of lighting and discharge equipment, containers, metal furniture, cellular telephony, footwear, marble, paying and cable telephone sets.

It is worth noting that a complex customs law is being enacted through the constitutional channels, aimed at simplifying administrative procedures related to the customs department and expediting completion of customs formalities, particularly those pertaining to customs clearance, goods in transit, free zones and temporary entry.

2.9 Consistency Forecasts for Major Economic Indicators

A- Scenario Key Variables

1- GDP Yearly Growth Rates

1995 - 2000	6.5%
2000 - 2010	7%
2010 - 2020	5%

2- ***Consumption Propensities***

Year 2000

Govt. consumption	21.2%
Private consumption	57.6%
Total consumption	78.8%

Year 2010

Govt. consumption	18.2%
Private consumption	53.1%
Total consumption	71.3%

Year 2020

Govt. consumption	18.2%
Private consumption	53.1%
Total consumption	71.3%

3- ***Foreign Trade Propensities***

Year 2000

Exports of goods	30.1%
Exports of services	39.3%
Total exports	69.4%
Imports of goods	59.8%
Imports of services	21.6%
Total imports	81.4%

Year 2010

Exports of goods	35.3%
Exports of services	39.9%
Total exports	75.2%
Imports of goods	66.1%
Imports of services	18.7%
Total imports	84.8%

Year 2020

Exports of goods	35.3%
Exports of services	39.9%
Total exports	75.2%
Imports of goods	66.1%
Imports of services	18.7%
Total imports	84.8%

B. Forecasts in Absolute Figures

The forecasts shown in Table 2.9 are based upon the above-mentioned scenario. It is worth noting that GDP growth rates up to the year 2000 are taken from the Economic Adjustment Programme.

Table (2.9)
Forecasts for Major Economic Indicators up to 2020
Values in Mil. JDs & at 1994 Prices

	1994	*2000*	*2010*	*2020*
Govt. consumption	994	1312	2212	3604
Private consumption	2613	3563	6456	10516
Total consumption	3607	4875	8668	14120
Investments	1609	2054	4669	7605
Exports of goods & services	2093	4291	9155	14912
Exports of goods	995	1862	4298	7001
Exports of services	1098	2429	4857	7911
Imports of goods & services	3108	5034	10322	16814
Imports of goods	2363	3698	8050	13113
Imports of services	745	1336	2272	3701
GDP	4201	6186	12169	19823

3. INVENTORY OF ANTHROPOGENIC EMISSIONS BY SOURCES & REMOVAL BY SINKS OF ALL GREENHOUSE GASES NOT CONTROLLED BY MONTREAL PROTOCOL, 1994

3.1 IPCC Bottom-up Approach

Determining the full implications of the greenhouse gas emissions of an energy system, using the IPCC Bottom-up methodology, requires examination of every phase of the entire energy chain, from the supply side of the system (i.e., resources extraction, refineries, electric power plants) to the demand side (i.e., industrial plants, residential and commercial units). Therefore, the approach used ENPEP and IMPACT modules, described in Annex III, to calculate the energy sector's GHGs emissions. The methodology used to calculate the emissions may be summarized as follows:

3.1.1 Step I

One) Determining the energy system configuration inputs for the year 1994; type A 78 facilities were determined as a list of IMPACT facilities that are to be included in the analysis.

Two) Collecting data to establish the energy system configuration or energy network. The data sources were:

- Annual Energy Balance, and Annual Report / Ministry of Energy and Mineral Resources, 1994.
- Jordan Petroleum Refinery Annual Report, 1994.
- Operation and Production Division / National Electric Power Company, Annual Report, 1994.
- Site visits to all major industries.
- Household, commercial, agriculture energy surveys / Ministry of Energy and Mineral Resources.
- Jordan Electricity Authority Annual Report, 1994.
- Natural Resources Authority Annual Report, 1994.

3.1.2 Step II

Determining Impact Coefficients

As mentioned in Annex III, IMPACT Module provides the user with two extensive databases that can be used directly or can be modified with local data. Based on this, locally available data concerning domestic fuel properties was used.

Table (3.1)
Fuel Properties

Fuel	Net Calorific Value GJ/Ton	Carbon wt %
Crude oil	42.88	84.5
Diesel	43.65	87.2
Gasoline	44.60	85.7
Jet kerosene	44.23	86.1
LPG	47.64	37.5
Fuel oil	41.43	85.6
Natural gas	45.00	70.6

With regard to emission factors, two sources were adopted:

- IPCC Guidelines
- The Generic Facility Database available in IMPACT Module.

IPCC Guideline emission factors were used, IMPACT database was used whenever IPCC emission factors did not apply or were not available.

3.1.3 Total GHGs Emissions:

GHGs emitted in all sectors in 1994 are presented in the following table:

Table (3.2)
GHGs Estimatted in 1994

GHGs	K Tonnes
CO_2	13,390
CH_4	403.8
N_2O	0.40

Details of GHG emissions in relevant sectors are in the following sheets (1-11).

Energy : IA Fuel Combustion Activities (Sheet 1) - Detailed Technology Based Calculation

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSIONS ESTIMATES						AGGREGATE EMISSION FACTORS					
	A	B						C					
Sector Specific Data by fuel	Consumption (PJ)	Quantities Emitted (Gg of Full Mass of Pollutant						Emission Factor (t Pollutant/TJ)					
								C=B/A					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
IA Fuel Combustion Activities													
1. Energy & Transformation Industries	195.537048	5,305.8760	0.11867	0.1348	14.57201	2.49901	0.35807	27.13489	0.000607	0.000689	0.074523	0.01278	0.001831
2. INDUSTRY .	21.6150	1,615.9849	0.06673	0	33.08431	0.36633	0.86685	74.7622	0.003087	0	1.530618	0.016948	0.040104
3. Transport.	38.99117	2797.9816	1.22571	0.0843	18.9952	277.0426	26.42506	71.75937	0.031436	0.002162	0.487167	7.105266	0.677719
4. Small Combustion	28.067891	1,968.5904	0.12673	0.03191	7.90013	1.65306	0.84586	70.13674	0.004515	0.001137	0.281465	0.058895	0.030136
a- Resedential	17.864839	1,230.9366	0.06044	0.01667	0.98381	0.23349	0.03802	68.90275	0.003383	0.000933	0.05507	0.01307	0.002128
b- Comertial - Institional	10.203051	737.6500	0.06629	0.1524	6.91632	1.41957	0.80784	72.297	0.006497	0.014937	0.677868	0.139132	0.079176

Energy : IA Fuel Combustion Activities (Sheet 2) - Detailed Technology Based Calculation

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSIONS ESTIMATES						AGGREGATE EMISSION FACTORS					
	A	B						C					
Sector Specific Data by fuel	Consumption (PJ)	Quantities Emitted (Gg of Full Mass of Pollutant						Emission Factor (t Pollutant/TJ)					
								C=B/A					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
IAI Energy & Transformation Industries													
a. Electricity and heat production.	68.783748	4,949.4456	0.10067	0.13118	13.57953	2.40775	0.353	71.95661	0.001464	0.001907	0.197424	0.035005	0.005132
b. Petroleum Refining.	126.7533	356.43025	0.018	0	0.99248	0.09126	0.00507	2.812	0.000142	0	0.00783	0.018996	4E-05

Energy : IA Fuel Combustion Activities (Sheet3) - Detailed Technology Based Calculation

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSIONS ESTIMATES						AGGREGATE EMISSION FACTORS					
	A	B						C					
Sector Specific Data by fuel	Consumption (PJ)	Quantities Emitted (Gg of Full Mass of Pollutant						Emission Factor (t Pollutant/TJ)					
								C=B/A					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
IAI Elctricity & Heat production													
IAI-ai													
1. N.GAS RISH.G. 4*30 MW	8.836439	437.40372	0.00088	0	1.63474	0.17673	0	49.5	9.96E-05	0	0.185	2.000E-02	0
2. FUEL HTPS 3*33 MW	7.256251	549.2982	0.00583	0	1.48753	0.10406	0.01582	75.7	0.000803	0	0.205	0.014341	0.00218
3. FUEL HTPS 4*66 MW	21.363560	1,617.221	0.01716	0	4.37953	0.30636	0.04657	75.69998	0.000803	0	0.205	0.01434	0.00218
4. FUEL ATPS 2*130 MW	11.30530	855.81106	0.00908	0	2.31759	0.16212	0.02464	75.69999	0.000803	0	0.205	1.434E-02	0.00218
5. DIES HTPS.G. 1*14 MW	0.143934	10.543170	0.00039	0.00669	0.02245	0.00461	0.00012	73.25003	0.00271	0.04648	0.155974	3.203E-02	0.000834
6. DIES MARK.G. 4*18 MW	1.45335	106.45833	0.00392	0.06758	0.22672	0.04651	0.00117	73.2503	0.002697	0.046499	0.155998	3.200E-02	0.000805
7. DIES MARK.G. 1*130 MW	0.821823	60.198560	0.00222	0.03821	0.1282	0.0263	0.00066	73.25003	0.002701	0.046494	0.155995	3.200E-02	0.000803
8. DIES KARA.G. 1*18 MW	0.363338	26.614510	0.00098	0.0169	0.05668	0.01163	0.00029	73.25	0.002697	0.046513	0.155998	3.201E-02	0.000798
9. DIES RAHP.G. 1*30 MW	0.038765	2.84149	0.0001	0.0018	0.00605	0.00124	0.00003	73.3004	0.00258	0.046434	0.156069	3.199E-02	0.000774
10. DIES AQA.G. EN 2*3.5 MW	0.122944	9.01182	0.00038	0	0.19092	0.00209	0.00496	73.3002	0.003091	0	1.552902	1.700E-02	0.040344
11. DIES MARK.EN 8*3 MW	0.526904	38.62206	0.00164	0	0.81822	0.00896	0.02127	73.29999	0.003113	0	1.552882	1.700E-02	0.040368
12. DIESAQA.C.EN 2*5 MW	0.175634	12.87402	0.00055	0	0.27274	0.00299	0.00709	73.30027	0.003132	0	1.552888	1.702E-02	0.040368
13. DIES KARAK .EN 3*1.5 MW	0.079009	5.79139	0.00025	0	0.12269	0.00134	0.00319	73.30038	0.003164	0	1.552861	1.696E-02	0.040375
14. IDCO EN 6 MW	0.103575	7.83631	0.00032	0	0.16084	0.00176	0.00418	75.65832	0.00309	0	1.552884	1.699E-02	0.040357
15. POTASH8 MW ENELE	0.04472	3.38344	0.00014	0	0.06944	0.00076	0.00181	75.65832	0.003131	0	1.552773	1.699E-02	0.040474

Energy : IA Fuel Combustion Activities (Sheet4) - Detailed Technology Based Calculation

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSIONS ESTIMATES						AGGREGATE EMISSION FACTORS					
	A	B						C					
Sector Specific Data by fuel	Consumption (PJ)	Quantities Emitted (Gg of Full Mass of Pollutant						Emission Factor (t Pollutant/TJ)					
								C=B/A					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
IAI Elctricity & Heat production													
IAI-aii													
16. H. STEEL CO. ELE	0.09288	7.11461	0.00008	0	0.00533	0.00133	0.00027	76.60002	0.000861	0	0.057386	0.01432	0.002907
17. JO. STEEL CO. ELE	0.10191	11.67323	0.00013	0	0.00875	0.00218	0.00044	114.5445	0.001276	0	0.08586	0.021391	0.004318
18. PHOS RUSYFA D. ELE	0.002905	0.21323	0	0	0.00017	0.00004	0.00001	73.40103	0	0	0.05852	0.013769	0.003442
19. CEMENT FUHYS D. ELE	0.424228	31.13834	0.00034	0	0.02433	0.00608	0.00122	73.40001	0.000801	0	0.057351	0.014332	0.002876
20. OTHERS IND. D. ELE	9.936876	729.36675	0.00798	0	0.57	0.1425	0.0285	73.40001	0.000803	0	0.057362	0.014341	0.002868
IAI-aiii													
1. FELTILIZER CO. CO GEN	0.941289	71.25558	0.00076	0	0.19296	0.0135	0.00205	75.7	0.000807	0	0.204995	0.014342	0.002178
2. REFINERY CO. GEN	1.411934	106.8834	0.00113	0	0.28945	0.02025	0.00308	75.7	0.0008	0	0.205003	0.014342	0.002181
3. POTASH 15 MW CO. GEN	3.23618	247.89138	0.04641	0	0.59403	1.36441	0.18563	76.6	0.014341	0	0.183559	0.421611	0.057361

Energy : IA Fuel Combustion Activities (Sheet 5) - Detailed Technology Based Calculation

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSIONS ESTIMATES						AGGREGATE EMISSION FACTORS					
	A	B						C					
Sector Specific Data by fuel	Consumption (PJ)	Quantities Emitted (Gg of Full Mass of Pollutant						Emission Factor (t Pollutant/TJ)					
								C=B/A					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
IAI-b PETROLEUM REFINING *													
IAI-b													
1. JO.P. REFINERY CO	126.75330	356.43025	0.018	0	0.99248	0.09126	0.00507	2.812	0.000142	0	0.00783	0.00072	4.000E-05

Energy : IA Fuel Combustion Activities (Sheet 6) - Detailed Technology Based Calculation

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSIONS ESTIMATES						AGGREGATE EMISSION FACTORS					
	A	B						C					
Sector Specific Data by fuel	Consumption (PJ)	Quantities Emitted (Gg of Full Mass of Pollutant						Emission Factor (t Pollutant/TJ)					
								C=B/A					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
IA2 Industry (ISIC)													
IA2 a													
1.N STEEL CO. IND PROC	0.215903	16.33485	0.00067	0	0.33527	0.00367	0.00872	75.65828	0.003103	0	1.552873	0.016998	0.040389
2.H STEEL CO. IND PROC	0.129	9.75992	0.0004	0	0.20032	0.00219	0.00521	75.65829	0.003101	0	1.552868	0.016977	0.040388
3. JO STEEL CO. IND PROC	0.152392	7.80631	0.00009	0	0.00585	0.00146	0.00029	51.2252	0.000591	0	0.038388	0.009581	0.001903
IA2-b													
1. POTASH IND PROCESS	0.800875	60.59284	0.00249	0	1.24366	0.01361	0.03234	75.6583	0.003109	0	1.552877	0.016994	0.040381
2. POSHATE HASA F PROC	0.9321	70.521	0.00289	0	1.44744	0.01585	0.03763	75.6583	0.003101	0	1.552881	0.017005	0.040371
3. POSPHATE RUSYFA . PROC	0.05103	3.86084	0.00016	0	0.07924	0.00087	0.00206	75.65824	0.003135	0	1.552812	0.017049	0.040368
4. POSPHATE W.V.M. FUEL PROC	0.511388	38.69075	0.00159	0	0.79412	0.00869	0.02065	75.65831	0.003109	0	1.552872	0.016993	0.04038
5. PHOS RUSYFA D. PROC	0.00601	0.44053	0.00002	0	0.00933	0.0001	0.00024	73.2995	0.003328	0	1.552413	0.016639	0.039933
6. CEMENT RASH FUEL PROC	6.149	465.22291	0.01909	0	9.54866	0.10453	0.24827	75.6583	0.003105	0	1.55288	0.017	0.040376
7. CEMENT RASH D. PROC	0.0774	5.67342	0.00024	0	0.12019	0.00132	0.00313	73.3	0.003101	0	1.552842	0.017054	0.040439
8. CEMENT FUHYS F PROC	5.05446	382.41184	0.01569	0	7.84897	0.08593	0.20407	75.6583	0.003104	0	1.55288	0.017001	0.040374
IA2 c 1. FERTILIZER F. IND PROC	0.87462	66.17227	0.00272	0	1.35818	0.01487	0.03531	75.65831	0.00311	0	1.55288	0.017002	0.040372
2. FERTILIZER D. IND PROC	0.1806	13.23076	0.00056	0	0.0298	0.00307	0.00729	73.26002	0.003101	0	0.165006	0.016999	0.040365
IA2 f 1. OTHERS IND D. PROC	6.3729	467.13359	0.01979	0	9.89635	0.10834	0.25731	73.3	0.003105	0	1.55288	0.017	0.040376
2. OTHERS IND F. PROC	0.1075	8.13327	0.00033	0	0.16693	0.00183	0.00434	75.65833	0.00307	0	1.552837	0.017023	0.040372

Energy : IA Fuel Combustion Activities (Sheet 7) - Detailed Technology Based Calculation

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSIONS ESTIMATES						AGGREGATE EMISSION FACTORS					
	A	B						C					
Sector Specific Data by fuel	Consumption (PJ)	Quantities Emitted (Gg of Full Mass of Pollutant						Emission Factor (t Pollutant/TJ)					
								C=B/A					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
IA3 b Road Transportation *													
IA3 bi 1. SMALL SALOON P+ TOUR	12.278	865.599	0.42642	0.01228	6.99846	160.9646	10.66051	70.5	0.03473	0.001	0.57	13.11	0.868261
2. SMALL SALOON TAXI	6.278000	442.59897	0.21804	0.00628	3.57846	82.30458	5.45094	70.5	0.034731	0.001	0.57	13.11	0.868261
3. MIDDLE SALOON	1.032000	72.65280	0.06857	0.00103	0.58824	13.52952	1.71436	70.4	0.066444	0.000998	0.57	13.11	1.661202
IA3 bii 1. PICK UP LESS THAN 2 TON	0.903000	63.57120	0.06	0.0009	0.51471	11.83833	1.50006	70.4	0.066445	0.000997	0.57	13.11	1.661196
2. SMALL VAN & PICK UP	10.95615	803.08581	0.02346	0.04382	3.28684	4.49202	1.45435	73.3	0.002141	0.004	0.3	0.41	0.132743
IA3 biii 1. BUSSES	0.650567	47.75162	0.00266	0.0026	0.18866	0.26673	0.1647	73.4	0.004089	0.003997	0.289993	0.409996	0.253164
2. AGR. CALTIVTER & OTHERS	0.62035	45.53369	0.00253	0.00248	0.1799	0.2534	0.15705	73.4	0.004078	0.003998	0.289998	0.408479	0.253164
3. TRUCKS & TANKS	0.656481	48.12006	0.12473	0.00197	0.65648	0.55144	0.02895	73.3	0.189998	0.003001	0.999998	0.839994	0.044099
4. AGR. TRACTORS	0.620353	45.47188	0.00133	0.00248	0.18611	0.25434	0.08235	73.30001	0.002144	0.003998	0.300007	0.409992	0.132747
5. TRAILER TRACTORS	0.646591	47.20114	0.00187	0.00194	0.10022	0.00989	0.00052	73	0.002892	0.003	0.154998	0.015296	0.000804
6. SEME TRAILER	1.74064	127.69335	0.10966	0.00522	1.74064	1.46214	1.74934	73.36	0.063	0.002999	1	0.840001	1.004998
IA3 c 1. RALL TRAINS	0.501975	36.82489	0.03162	0.00151	0.50198	0.42166	0.50448	73.36001	0.062991	0.003008	1.00001	0.840002	1.00499
IA3 di 1. SHIPS FUEL OIL	0.1075	8.00875	0.00892	0.00032	0.1075	0.0903	0.1081	74.5	0.082977	0.002977	1	0.84	1.005581
2. BUNKERS	0.16572	12.34614	0.01375	0.0005	0.16572	0.1392	0.16664	74.5	0.082971	0.003017	1	0.839971	1.005552
3. SHIPS DIESEL	0.50195	36.82489	0.03162	0.00151	0.50198	0.42166	0.50448	73.36366	0.062994	0.003008	1.00006	0.840044	1.00504

Energy : IA Fuel Combustion Activities (Sheet 8) - Detailed Technology Based Calculation

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSIONS ESTIMATES						AGGREGATE EMISSION FACTORS					
	A	B						C					
Sector Specific Data by fuel	Consumption (PJ)	Quantities Emitted (Gg of Full Mass of Pollutant						Emission Factor (t Pollutant/TJ)					
								C=B/A					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
IA3 aii													
1. TRANS INTER AVIATION	0.4443	31.58973	0.03353	0	0.08353	0.01422	0.76268	71.1	0.075467	0	0.188004	0.032005	1.716588
2. TRANS D AVIATION	0.8876	63.10836	0.06699	0	0.16687	0.0284	1.52365	71.1	0.075473	0	0.188001	0.031996	1.716595

Energy : IA Fuel Combustion Activities (Sheet 9) - Detailed Technology Based Calculation

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSIONS ESTIMATES						AGGREGATE EMISSION FACTORS					
	A	B						C					
Sector Specific Data by fuel	Consumption (PJ)	Quantities Emitted (Gg of Full Mass of Pollutant						Emission Factor (t Pollutant/TJ)					
								C=B/A					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
IA4 a Commercial / Institutional													
1. COM LPG STOVE	0.05049	3.19097	0.00006	0	0.00242	0.00048	0.00011	63.20004	0.001188	0	0.04793	0.009507	0.002179
2. COM LPG W. HEATER	0.050490	3.19097	0.00006	0	0.00242	0.00048	0.00011	63.20004	0.001188	0	0.04793	0.009507	0.002179
3. COM DIESEL BOILER	4.411800	322.06138	0.01275	0.01324	0.68383	0.0675	0.00354	73	0.00289	0.003001	0.155	0.0153	0.000802
4. COM KEROSENE STOVE	0.534399	39.06457	0.00295	0	0.03201	0.00803	0.00118	73.10001	0.00552	0	0.059899	0.015026	0.002208
5. COM LPG. FURNCES	0.403924	25.4876	0.00046	0	0.01932	0.00386	0.0009	63.09999	0.001139	0	0.047831	0.009556	0.002228

Energy : IA Fuel Combustion Activities (Sheet 10) - Detailed Technology Based Calculation

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSIONS ESTIMATES						AGGREGATE EMISSION FACTORS					
	A	B						C					
Sector Specific Data by fuel	Consumption (PJ)	Quantities Emitted (Gg of Full Mass of Pollutant						Emission Factor (t Pollutant/TJ)					
								C=B/A					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
IA4 - b Residential													
1. HH LPG STOVE	2.0547550	129.86053	0.00234	0	0.09828	0.01964	0.00459	63.20001	0.001139	0	0.047831	0.009558	0.002234
2. HH DIESEL BOILERS	1.0621	77.74572	0.0006	0.01667	0.0681	0.01756	0.00066	73.2	0.000565	0.015695	0.064118	0.016533	0.000621
3. HH DIESEL W.HEATER	0.04085	2.99022	0.00023	0	0.00257	0.00063	0.00009	73.2	0.00563	0	0.062913	0.015422	0.002203
4. HH LPG FURMCES	4.998324	315.39425	0.0057	0	0.23908	0.04777	0.01117	63.1	0.00114	0	0.047832	0.009557	0.002235
5. HH LPG W. HEATER	0.481621	30.43845	0.00055	0	0.02304	0.0046	0.00108	63.20001	0.001142	0	0.047838	0.009551	0.002242
6. HH DIESELSTOVE	0.31046	22.69462	0.00172	0	0.0186	0.00482	0.00069	73.09998	0.00554	0	0.059911	0.015525	0.002223
7. HH KERSOSENE STOVE	8.830519	645.511	0.04882	0	0.52898	0.13713	0.01955	73.10001	0.005529	0	0.059904	0.015529	0.002214
8. HH KEROSINE COOK & LI	0.08621	6.30195	0.00048	0	0.00516	0.00134	0.00019	73.09999	0.005568	0	0.059854	0.015543	0.002204

Energy : IA Fuel Combustion Activities (Sheet 11) - Detailed Technology Based Calculation

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSIONS ESTIMATES						AGGREGATE EMISSION FACTORS					
	A	B						C					
Sector Specific Data by fuel	Consumption (PJ)	Quantities Emitted (Gg of Full Mass of Pollutant						Emission Factor (t Pollutant/TJ)					
								C=B/A					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
IA4 c AGRICULTURE/ FORESTRY / FISHING													
1. AGR D. ENG WATER PUMP	4.2076	308.22828	0.04902	0	6.1283	1.33287	0.44108	73.256	0.01165	0	1.456501	0.316781	0.104831
2. AGR LPG WATER HEATER	0.04085	2.57763	0.00005	0	0.00171	0.00035	0.00009	63.09988	0.001224	0	0.04186	0.008568	0.002203
3. AGR LPG STOVE L-S	0.296162	18.71744	0.00034	0	0.01417	0.00283	0.00066	63.20001	0.001148	0	0.047845	0.009556	0.002229
4. AGR D. BOILER	0.207337	15.13500	0.0006	0.002	0.03214	0.00317	0.00017	72.9971	0.002894	0.009646	0.155013	0.015289	0.00082

Energy : IA Fuel Combustion Activities (Sheet 1) - Detailed Technology Based Calculation

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSIONS ESTIMATES						AGGREGATE EMISSION FACTORS					
	A	B						C					
Sector Specific Data by fuel	Consumption (PJ)	Quantities Emitted (Gg of Full Mass of Pollutant						Emission Factor (t Pollutant/TJ)					
								C=B/A					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
IA Fuel Combustion Activities													
	792.0273	30,651.3293	3.32107	0.79919	172.1264	567.2739	57.94372						

4. CO_2 EMISSION FROM ENERGY SECTOR ACCORDING TO IPCC REFERENCE APPROACH 1994

Table (4.1)
Energy Sector

			A	B	C	D	E	F
			Production	Imports	Exports	International Bunkers	Stock Change	Apparent Consumption
Fuel Types			10^3 Tonne	10^3 Tonne	10^3 Tonne	10^3 Tonne	10^3 Tonne	f=(A+B-C-D-E)
Liquid Fossil	Primary Fuels	Crude Oil	1.2	2977			-19.9	2998.1
		Natural Gas Liquids						
	Secondary Fuels	Gasoline						
		Jet Kerosene				189.2	-12.0	-177.2
		Other Kerosene					-14.8	14.8
		Gas / Diesel Oil		102		2	-23.7	123.7
		Residual Fuel Oil		767.3		2	13.4	751.9
		LPG		52.4			-7.9	60.3
		Ethane						
		Naphtha						
		Bitumen					2.8	-2.8
		Lubricants		30.3				30.3
		Petroleum Coke						
		Refinery Feedstocks						
		Other Oil						
Liquid Fossil Totals			1.2	3929		193.2	-62.1	3799.1
Solid Fossil	Primary Fuels	Anthracite						
		Coking Coal						
		Other Bit. Coal						
		Sub-bit. Coal						
		Lignite						
		Peat						
	Secondary Fuels	BKB & Patent Fuel						
		Coke						
Solid Fossil Total								
Gaseous Fossil		Natural Gas (DRY)	240.3					240.3
Total			241.5	3929		193.2	-62.1	4039.4
Biomass Total								
		Solid biomass						
		Liquid biomass						
		Gas biomass						

Table (4.1) continued

			G Conversion Factor (GJ/T)	H Apparent Consumption (TJ)	I Carbon Emission Factor (t C/TJ)	J Carbon Content (t C)	K Carbon Content (Gg C)
Fuel Types				H=(F×G)		J = (H×I)	K=(J×[10-3
Liquid Fossil	Primary Fuels	Crude Oil	42.88	128558.53	20	2571170.6	2571.17
		Natural Gas Liquids					
	Secondary Fuels	Gasoline	44.6		18.9		
		Jet Kerosene	44.38	-7864	19.5	-153350	-153.35
		Other Kerosene	44.23	654.60	19.6	12830.16	12.83
		Gas / Diesel Oil	43.65	5399.50	20.2	109069.9	109.07
		Residual Fuel Oil	41.43	31151.21	21.1	657290.53	657.29
		LPG	47.64	2872.69	17.2	49410.27	49.41
		Ethane					
		Naphtha					
		Bitumen	40.67	-113.87	22.0	-2505.14	-2.50
		Lubricants	41.43	1255.3	20.0	25106	25.10
		Petroleum Coke					
		Refinery Feedstocks					
		Other Oil					
Liquid Fossil Totals				161913.9	20.2	3269022.3	3269.02
Solid Fossil	Primary Fuels	Anthracite					
		Coking Coal					
		Other Bit. Coal					
		Sub-bit. Coal					
		Lignite					
		Peat					
	Secondary Fuels	BKB & Patent Fuel					
		Coke					
Solid Fossil Total							
Gaseous Fossil		Natural Gas (DRY)	45.00	10813.5	15.3	165446.55	165.44
Total				172727.4	19.8	3434460	3434.46
Biomass Total							
		Solid biomass					
		Liquid biomass					
		Gas biomass					

Table (4.1) continued

			L	M	N	O	P
			Carbon Stored (Gg C)	Net Carbon Emissions (Gg C)	Fraction of Carbon Oxidized	Actual Carbon Emissions (Gg C)	Actual CO_2 Emissions (Gg CO_2)
Fuel Types				M = (K-L)		O = (M×N)	P=(o×[44/12])
Liquid Fossil	Primary Fuels	Crude Oil		2571.170	0.99	2545.46	9333.35
		Natural Gas Liquids					
	Secondary Fuels	Gasoline					
		Jet Kerosene		-153.35	0.99	-152	-556.6
		Other Kerosene		12.38	0.99	12.20	46.56
		Gas / Diesel Oil		109.87	0.99	107.98	395.92
		Residual Fuel Oil		657.99	0.99	650.72	2385.96
		LPG		49.41	0.99	46.91	179.33
		Ethane					
		Naphtha					
		Bitumen	125.03	-127.53		-127.53	-467.61
		Lubricants	12.55	12.55		12.55	46.01
		Petroleum Coke					
		Refinery Feedstocks					
		Other Oil					
Liquid Fossil Totals				3132.55	0.988	3096.29	11363.01
Solid Fossil	Primary Fuels	Anthracite					
		Cooking Coal					
		Other Bit. Coal					
		Sub-bit. Coal					
		Lignite					
		Peat					
	Secondary Fuels	BKB & Patent Fuel					
		Coke					
Solid Fossil Total							
Gaseous Fossil		Natural Gas (DRY)		165.44	0.995	164.61	603.57
Total				3298	0.998	3260.9	11966.58
Biomass Total							
		Solid biomass					
		Liquid biomass					
		Gas biomass					

Table (4.2)
Carbon Stored

	A	B	C	D	E	F	G	H
	Estimated Fuel Quantities	Conversion Factor (Gj/T)	Estimated Fuel Quantities (TJ)	Carbon Emission Factor (t C/T)	Carbon Content (t C)	Carbon Content (Gg C)	Fraction Carbon Stored	Carbon Stored (Gg C)
			C=(A×B)		E=(C×D)			F=((E×10^{-3})
FUEL TYPES								
Naphtha							08.80	
Lubricants	30.3	41.43	1255.3	20.0	25106	25.10	0.50	12.55
Bitumen	139.740	40.67	5683.22	22.0	125031	125.03	1.0	125.03
Coal Oils & Tars (from Cooking Coal)							0.75	
Natural Gas							0.33	
Gas/Diesel Oil							0.50	
LPG							0.80	
Other Fuels								

Table (4.3)
International Bunkers

		A	B	C	D	E	F
		Quantities Delivered	Conversion Factor (TJ/unit)	Quantities Delivered (TJ)	Carbon Emission Factor (t C/TJ)	Carbon Content (t C)	Carbon Content (Gg C)
Fuel Types		10^3 Tonne		C=(A×B)		E=(C×D)	F=((E×10-³)
Solid Fossil	Other Bituminous Coal						
	Sub-Bituminous Coal						
Liquid Fossil	Gasoline						
	Jet Kerosene	189.2	44.38	8396.7	19.6	164575.2	164.57
	Gas/Diesel Oil	2	43.65	87.3	20.2	1763	1.763
	Residual Fuel Oil	2	41.43	82.86	21.1	1748	1.748
	Lubricants						
			Total	8566.86			

Table (4.4)
Emissions from International Bunkers

		G	H	I	J	K	L
		Fraction of Carbon Stored	Carbon Stored (Cg C)	Net Carbon Emissions (Cg C)	Fraction of Carbon Oxidized	Actual Carbon Emissions (Cg C)	Actual CO_2 Emissions (Gg CO_2)
Fuel Types			H=(FxG)	I=(F-H)		K=(IxJ)	L=(Kx44/12)
Solid Fossil	Other Bituminous Coal	0	0				
	Sub-Bituminous Coal	0	0				
Liquid Fossil	Gasoline	0	0				
	Jet Kerosene	0	0	164.57	0.99	162.92	597.37
	Gas/Diesel Oil	0	0	1.763	0.99	1.7454	6.4
	Residual Fuel Oil	0	0	1.748	0.99	1.731	6.347
	Lubricants	0.5					
						Total (a)	610.117

5. GHGs EMISSIONS / AGRICULTURAL SECTOR, 1994

Table (5.1)
Methane Emissions from Domestic Livestock

MODULE		**AGRICULTURE**				
SUBMODULE		**METHANE EMISSIONS FROM DOMESTIC LIVESTOCK ENTERIC FERMENTATION AND MANURE MANAGEMENT**				
WORKSHEET		**4-1**				
SHEET		**L OF 1**				
Livestock Type	A Number of Animals (1000s)	B Emissions Factor for Enteric Fermentation (kg/head/year)	C Emissions from Enteric Fermentation (t/year)	D Emissions Factor for Manure Management (kg/head/year)	E Emissions from Manure Management (t/year)	F Total Annual Emissions from Domestic Livestock (Gg)
			C=(AxB)		E=(AxD)	F=(C+E)/1000
Dairy Cattle	29.3	36	1054.8	2	58.6	1.1134
Non-Dairy Cattle	29.0	32	928	1	29	0.957
Buffalo	0.1	55	5.5	5	0.5	0.006
Sheep	2670	5	13350	0.16	427.2	13.7772
Sheep (imported)*	50	5	250	0.16	8	0.258
Sheep (cross border from neighboring countries)**	100	5	500	0.16	16	0.516
Goats	1079	5	5395	0.17	183.43	5.57843
Camels	32	46	1472	1.92	61.44	1.53344
Horses	10	18	180	1.64	16.40	0.1964
Mules & Asses	48	10	480	0.90	43.2	0.5232
Swine	-	-		-		
Poultry	25000	-	-	0.018	450	0.450
		Totals	23615.3		1293.77	24.90907

* The average number of sheep present per month in free zone.
** The average number of sheep present per month in border area cross from Saudi Arabia, Iraq & Syria.

Table (5.2)
Prescribed Burning of Savannas

MODULE		**AGRICULTURE**					
SUBMODULE		**PRESCRIBED BURNING OF SAVANNAS**					
WORKSHEET		**4-3**					
SHEET		**1 OF 3**					
		STEP 1			Step 2		
A Area Burned by Category (specify (k ha)	B Biomass Density of Savanna (t dm/ha)	C Total Biomass Exposed to Burning (Gg dm)	D Fraction Actually Burned	E Quantity Actually Burned (gg dm)	F Fraction of Living Biomass Burned	G Quantity of Living Biomass Burned (Gg dm)	H Quantity of Dead Biomass Burned (Gg dm)
		C=(AxB)		E=(CxD)		G=ExF)	H=E-G)
2	0.5	1.0	0.8	0.8	0.2	0.16	0.64

Table (5.2) Continued

MODULE	AGRICULTURE		
SUBMODULE	PRESCRIBED BURNING OF SAVANNAS		
WORKSHEET	4 – 3		
SHEET	2 OF 3		
Step 3			
1 Oxidized Fraction of Living and Dad Biomass	J Total Biomass Oxidized (Gg dm)	K Carbon Fraction of Living & Dead Biomass	L Total Carbon Released (Gg C)
0.8 1.0	Living: J= (GxI) Dead: J= (HxI)	0.5 0.40	L = (JxK)
Living	0.128		0.064
Dead	0.64		0.256
Living			
Dead			
Living			
Dead			
Living			
Dead			
	0.768	**Total**	0.32

Table (5.2) Continued

MODULE			AGRICULTURE			
SUBMODULE			PRESCRIBED BURNING OF SAVANNAS			
WORKSHEET			4 - 3			
SHEET			3 OF 3			
		STEP 4				STEP 5
L Total Carbon Released (Gg C)	M Nitrogen-Carbon Ratio	N Total Nitrogen Content (Gg N)	O Emissions Ratio	P Emissions (Gg C or Gg N)	Q Conversion Ratio	R Emissions from Savanna Burning (Gg)
0.32	0.006	N=(LxM)		P=(LxO)		R=(PxQ)
		0.00192	0.004	0.00128	16/12	CH_4 = 0.0017066
			0.06	0.0192	28/12	CO = 0.0448
				P=(NxO)		R=(PxQ)
			0.007	0.0000134	44/28	N_2O = 0.0000491
			0.121	0.0002323	46/14	No_x = 0.0007632

Table (5.3)
Field Burning of Agricultural Residues

MODULE			**AGRICULTURE**					
SUBMODULE			**FIELD BURNING OF AGRICULTURAL RESIDUES**					
WORKSHEET			**4-4**					
SHEET			**1 OF 3**					
		STEP 1			Step 2		Step 3	
Crops (specify locally important crops)	A Annual Production (Gg crop)	B Residue to Crop Ratio	C Quantity of Residue (Gg biomass)	D Dry Matter Fraction	E Quantity of Dry Residue (Gg dm)	F Fraction Burned in Fields	G Fraction Oxidized	H Total Biomass Burned (Gg dm)
			C=(AxB)		E=(CxD)			H=ExFxG
Wheat	122.5	1.3	159.25	0.8	127.4	0.2	0.90	22.932
Barley	103.2	1.2	123.84	0.8	99.072	0.2	0.90	17.83296
Lentils	5.3	1.4	7.42	0.3	2.226	0.1	0.90	0.20034
Bean	3.2	2.1	6.72	0.3	2.016	0.2	0.90	0.36288
Chickpea	5.1	1.5	7.65	0.4	3.06	0.2	0.90	0.5508
Maize	1.5	1.0	1.5	0.4	0.6	0.3	0.90	0.162
							Total:	42.04098

Source: Ministry of Agriculture

Table (5.3) Continued

MODULE		**AGRICULTURE**		
SUBMODULE		**FIELD BURNING OF AGRICULTURAL RESIDUES**		
WORKSHEET		**4-4**		
SHEET		**2 OF 3**		
	Step 4		Step 5	
	I Carbon Fraction of Residue	J Total Carbon Released (Gg C)	K Nitrogen-Carbon Ratio	L Total Nitrogen Released (Gg N)
		J=(HxI)		L=(JxK)
Wheat	0.4853	11.128899	0.012	0.13335466
Barley	0.4567	8.14431228	0.012	0.0977317
Lentils	0.4709	0.0943401	0.02	0.0018868
Bean	0.4567	0.01657272	0.02	0.00331454
Chickpea	0.4567	0.2515503	0.02	0.005031
Maize	0.4709	0.0762858	0.02	0.00152571
Total:		19.711958		0.2398612

Table (5.3) Continued

MODULE	AGRICULTURE			
SUBMODULE	FIELD BURNING OF AGRICULTURAL RESIDUES			
WORKSHEET	4-4			
SHEET	3 OF 3			
Step 6				
	M Emission Ratio	N Emissions (Gg C or Gg N)	O Conversion Ratio	P Emissions from Field Burning of Agricultural Residues (Gg)
	19.711958	N=(JxM)		P=(NxO)
CH_4	0.005	0.0985597	16/12	0.1314129
CO	0.06	1.1827174	28/12	2.7596739
	0.2398612x	N=(LxM)		P=(NxO)
N_2O	0.007	0.001679	44/28	0.0026384
No_x	0.121	0.0290232	46/14	0.0953619

Table (5.4)
Changes in Forest and Other Woody Biomass Stock

MODULE			**LAND USE CHANGE AND FORESTRY**				
SUBMODULE			**CHANGES IN FOREST AND OTHER WOODY BIOMASS STOCKS**				
WORKSHEET			**5-1**				
SHEET			**1 OF 3**				
			STEP 1				
			A Area of Forest/ Biomass Stocks (kha)	B Annual Growth Rate (t dm/ha)	C Annual Biomass Increment	D Carbon Faction of Dry Matter	E Total Carbon Uptake Increment (kt C)
					C=(AxB)		E=(CxD)
Tropical	Plantations	Acacia sp.					
		Eucalyptus sp.					
	Other (specify)*						
Natural	Evergreen Oak & Wild Olive		25.626	1	25.626	0.5	12.813
	Deciduous Oak		4.194	1.2	5.0328	0.5	2.5164
	Coniferous (Pine & Juniper)		7.782	2	15.564	0.5	7.782
	Mixed (Oak & Pine)		2.957	1.5	4.4355	0.5	2.21775
Plantations	Pine & Acacia		35.361	2.5	88.4025	0.5	44.20125
Temperate	Plantations	Douglas fir					
		Loblolly pine					
	Commercial	Evergreen					
		Deciduous					
	Other						
Total							69.53
Non-Forest Trees (specify type)			A Number of Trees (1000s of trees)	B Annual Growth Rate (kt dm/1000 trees)			
		Olive	5307	0.001	5.307	0.5	2.6535
		Grape	5048	0.002	10.096	0.5	5.048
		Citrus	2140	0.0015	3.21	0.5	1.605
		Banana	1220	0.003	3.66	0.5	1.83
		Pome (Apple, Pear...)	1120	0.002	2.24	0.5	1.12
		Stone Fruit (Almond, Apricot...)	1540	0.002	3.08	0.5	1.54
		Others(Fig, Pomegranate..)	820	0.002	1.64	0.5	0.82
						Total	84.1464

* Local classification and figures.

Table (5.4) Continued

MODULE	LAND USE CHANGE AND FORESTRY							
SUBMODULE	CHANGES IN FOREST AND OTHER WOODY BIOMASS STOCKS							
WORKSHEET	5-1							
SHEET	2 OF 3							
				STEP 2				
Harvest Categories (specify)	F Commercial Harvest (if applicable) (1000 m^3 roundwood	G Biomass Conversion/ Expansion Ratio (if applicable) (t dm/m^3)	H Total Biomass Removed in Commercial Harvest (kt dm)	I Total Traditional Fuelwood Consumed (kt dm)	J Total Other Wood Use (kt dm)	K Total Biomass Con-sumption (kt dm)	L Wood Removed From Forest Clearing (kt dm)	M Total Biomass Consum p- tion From Stocks (kt dm)
			H=(FxG)	(From column H, Worksheet 1-2)		K=(H+I+J)	(From column M, Worksheet 5-2, sheet 3)	M=K-L
All The Country * (From Forests)	1.2	o.95	1.152	10		11.152		11.1 52
All The Country * (From Orchards)				3		3		3
All The Country * (From Steppe & Desert Areas)				3		3		3
Total	1.2		1.152	16		17.152		17.1 52

* Ministry of Agriculture

Table (5.4) Continued

MODULE		**LAND USE AND FORESTRY**	
SUBMODULE		**CHANGES IN FOREST AND OTHER WOODY BIOMASS STOCKS**	
WORKSHEET		**5-1**	
SHEET		**3 OF 3**	
STEP 3			
N Carbon Fraction	O Annual Carbon Release (kt C)	P Net Annual Carbon Uptake (+) or Release (-) (kt C)	Q Convert to CO_2 Annual Emission (-) or Removal (+) Gg CO_2)
0.5	O=(MxN)	P=(E-O)	Q=(Px[44/12])
	17.152x0.5=8.576	84.146- 8.576= 75.57	75.57 x 44/12= 277.09

Table (5.5)
Forest and GrassLand Conversion

MODULE				LAND USE CHANGE AND FORESTRY				
SUBMODULE				FOREST AND GRASSLAND CONVERSION				
WORKSHEET				5-2				
SHEET				1 OF 6				
				STEP 1				
				A	B	C	D	E
Land types				Area Converted Annually (kha)	Biomass Before Conversion (t dm/ha)	Biomass After Conversion (t dm/ha)	Net Change in Biomass Density (t dm/ha)	Annual Loss of Biomass (kt dm)
							D=(B-C)	E=(AxD)
Tropical	Moist	Primary						
	Forests	Secondary						
Temperate	Evergreen:	Primary						
		Secondary						
Boreal	Primary							
	Secondary							
Grassland				2	0.5	0.1	0.4	0.8
Other								
	Natural	Evergreen Oak & Wild olive		0.1	20	18	2	0.2
		Deciduous Oak		0.2	20	18	2	0.4
		Coniferous (Pine & Juniper)		0.1	21	17	4	0.4
		Mixed (Oak & Pine)		0.1	19	16	3	0.3
Plantations		Pine & Acacia		0.3	22	16	6	1.8
Total				2.8				3.9

Table (5.5) Continued

MODULE			LAND USE CHANGE AND FORESTRY					
SUBMODULE			FOREST AND GRASSLAND CONVERSION					
WORKSHEET			5-2					
SHEET			2 OF 6					
			STEP 2					
Land types			F Fraction of Biomass Burned On Site	G Quantity of Biomass Burned on Site (kt dm)	H Fraction of Biomass Oxidised On Site	I Quantity of Biomass Oxidised On Site (kt dm)	J Carbon Fraction of Above-ground Biomass (burned on site)	K Quantity of Carbon Released (from biomass burned) (kt C)
				G=(ExF)		I=(GxH		K=(IxJ)
Tropical	Moist	Primary						
Temperate	Evergreen	Primary						
		Secondary						
	Deciduous	Primary						
		Secondary						
Grassland			0.45	0.8x0.45=0.360	0.9	0.324	0.45	0.1458
Other								
Natural		Evergreen Oak & Wild olive	0.45	0.2x0.45=0.09	0.9	0.081	0.45	0.03645
		Deciduous Oak	0.45	0.4x0.45=0.18	0.9	0.162	0.45	0.0729
		Coniferous (Pine & Juniper)	0.45	0.4x0.45=0.18	0.9	0.162	0.45	0.0729
		Mixed (Oak & Pine)	0.45	0.3x0.45=0.135	0.9	0.1215	0.45	0.054675
Plantations		Pine & Acacia	0.45	1.8x0.45=0.810	0.9	0.729	0.45	0.32805
		Subtotal	0.45	3.9x0.45=1.755	0.9	1.5795	0.45	0.710775

Table (5.5) Continued

Module			**Land Use Change and Forestry**							
Submodule			**Forest and Grassland Conversion**							
Worksheet			**5-2**							
Sheet			**3 of 6**							
						Step 3				Step 4
Land types			L Fraction of Biomass Burned Off Site	M Quantity of Biomass Burned Off Site	N Fraction of Biomass Oxidised Off Site	O Quantity of Biomass Oxidised Off Site	P Carbon Fraction of Above-ground Biomass (burned off site)	Q Quantity of Carbon Released (from biomass burned off site (kt C)	R Total Carbon Released (from on & off site burning)	S Total CO_2 released (from on & off site burning (kt CO_2)
				M=(ExL)		O=(MxN)		Q=(OxP)	R=(K+Q)	S= Rx[44/12]
Tropical	Moist Forests	Primary								
		Secondary								
	Seasonal Forests	Primary								
		Secondary								
Temperate	Evergreen	Primary								
		Secondary								
Boreal	Primary									
	Secondary									
Grassland*			0.55	0.8x0.55= 0.44	1	0.44	0.45	0.198	0.1458+ 0.198= 0.3438	**1.2606**
Other*										
Natural		Evergreen Oak & Wild olive	0.55	0.2x0.55= 0.11	1	0.11	0.45	0.0495	0.03645+ 0.0495= 0.08595	0.31515
		Deciduous Oak	0.55	0.4x0.55= 0.22	1	0.22	0.45	0.099	0.0729+ 0.099= 0.1719	0.6303
		Coniferous (Pine & Juniper)	0.55	0.4x0.55= 0.22	1	0.22	0.45	0.099	0.0729+ 0.099= 0.1719	0.6303
		Mixed (Oak & Pine)	0.55	0.3x0.55= 0.165	1	0.165	0.45	0.07425	0.054675 + 0.07425= 0.128925	0.47273
Plantations		Pine & Acacia	0.55	1.8x0.55= 0.99	1	0.99	0.45	0.4455	0.32805 + 0.4455= 0.77355	2.83716
		Subtotal	0.55	3.9x0.55= 2.145	1	2.145	0.45	0.96525	0.710775 + 0.96525= 1.676025	6.14543

* Local classification and figures.

Table (5.5) Continued

MODULE	**LAND USE CHANGE AND FORESTRY**
SUBMODULE	**FOREST AND GRASSLAND CONVERSION**
WORKSHEET	**5-2**
SHEET	**4 OF 6**

				STEP 5								
Land types				A Average Area Convert-ed (10 Year Average) (kha)	B Biomass Before Conve-rsion (t dm/ha	C Biomass After Conver-sion (t dm/ha)	D Net Change in Biomass Density (t dm/ha)	E Average Annual Loss of Biomass ((kt dm)	F Fraction Left to Decay	G Quantity of Biomass Left to Decay (kt dm)	H Carbon Fraction in Above-Ground Biomass	I Carbon Released from Decay of Above-ground Biomass (kt C)
							D=(B-C)	E=(AxD)		G=ExF)		I=(GxH)
Tropical	Moist Forests	Primary										
		Secondary										
	Seasonal Forests	Primary										
		Secondary										
Temperate	Evergreen	Primary										
		Secondary										
	Deciduous	Primary										
		Secondary										
Boreal	Primary											
	Secondary											
Grassland*				2	0.5	0.1	0.4	0.8	0.2	0.16	0.45	0.072
Other*												
Natural		Evergreen Oak & Wild olive		0.1	20	18	2	0.2	0.2	0.04	0.45	0.018
		Deciduous Oak		0.2	20	18	2	0.4	0.2	0.08	0.45	0.036
		Coniferous (Pine & Juniper)		0.1	21	17	4	0.4	0.2	0.08	0.45	0.036
		Mixed (Oak & Pine)		0.1	19	16	3	0.3	0.2	0.06	0.45	0.027
Plantations		Pine & Acacia		0.3	22	16	6	1.8	0.2	0.36	0.45	0.162
				2.8				3.9	0.2	0.78	Subtotal	0.351

* Local classification and figures.

Table (5.5) Continued

MODULE				**LAND USE CHANGE AND FORESTRY**				
SUBMODULE				**FOREST AND GRASSLAND CONVERSION**				
WORKSHEET				**5-2**				
SHEET				**5 OF 6**				
						STEP 6		
Land Type				A Average Annual Forest/ Grassland Converted (25 year average) (kha)	B Carbon Content of Soil Before Conversion (t/ha)	C Total Annual Potential Soil Carbon Losses (Kt C)	D Fraction of Carbon Released over 25 years	E Carbon Release from Soil (kt C)
Tropical	Moist Forests	Primary				C=AxB		E=(Cxd)
		Secondary						
	Seasonal Forests	Primary						
		Secondary						
	Dry Forests or Woody Savannas	Primary						
		Degraded						
Temperate	Evergreen	Primary						
		Secondary						
	Deciduous	Primary						
		Secondary						
Boreal	Primary							
	Secondary							
Grassland				2	60	120	0.5	60
Other								
Natural		Evergreen Oak & Wild olive		0.1	100	10	0.5	5
		Deciduous Oak		0.2	100	20	0.5	10
		Coniferous (Pine & Juniper)		0.1	100	10	0.5	5
		Mixed (Oak & Pine)		0.1	100	10	0.5	5
Plantations		Pine & Acacia		0.3	100	30	0.5	15
				2.8		200	**Subtotal**	100

Table (5.5) Continued

MODULE	LAND USE CHANGE AND FORESTRY			
SUBMODULE	FOREST AND GRASSLAND CONVERSION			
WORKSHEET	5-2			
SHEET	6 OF 6			
STEP 7				
A Immediate Release From Burning (kt C)	B Delayed Emissions from Decay (kt C) (10-year average)	C Long Term Emissions From Soil (kt C) (25-year average)	D Total Annual Carbon Release (Kt C)	E Total Annual CO_2 Release (Gg CO_2)
			D=(A+B+C)	E=(Dx[44/12])
1.676025	0.351	100	102.02702	374.09906

Table (5.6) On - Site Burning of Forests

MODULE			LAND USE CHANGE AND FORESTRY				
SUBMODULE			ON-SITE BURNING OF FORESTS				
WORKSHEET			5-3				
SHEET			1 OF 1				
STEP 1			STEP 2				
A	B	C		D	E	F	G
Quantity of Carbon Released (kt C)	Nitrogen-Carbon Ratio	Total Nitrogen Released (kt N)		Trace Gas Emissions Ratios	Trace Gas Emissions	Conversion Ratio	Trace Gas Emissions from Burning of Cleared Forests (Gg CH_4 CO)
(From column K, sheet 2, of Worksheet 5-2)		C=(AxB)			E=(AxD)		G=(ExF)
0.710775	0.01	0.00710775	CH_4	0.012	0.085293	16/12	0.113724
			CO	0.06	0.0426465	28/12	0.0995085
					kt N		Gg N_2O, No_x
					E=(CxD)		G=(ExF)
			N_2O	0.007	0.0000497	44/28	0.0000781
			NO x	0.121	0.00086	46/14	0.0028257

Table (5.7) Abandonment of Managed Lands

Module		**Land-use Change and Forestry**				
Submodule		**Abandonment of Managed Lands**				
Worksheet		**5-4**				
Sheet		**1 of 3 Carbon Uptake By Aboveground Regrowth - First 20 years**				
Vegetable types		A 20-Year Total Area Abandoned & Regrowing (kha)	B Annual Rate of Aboveground Biomass Growth (t dm/ha)	C Annual Rate of Aboveground Biomass Growth (kt dm)	D Carbon Fraction of Aboveground Biomass	E Annual Carbon Uptake in Aboveground Biomass (kt C)
				C=(A×B)		E=(C x D)
Tropical	Wet/very Moist					
	Moist, short dry season					
	Moist, long dry season					
	Dry					
	Montane Moist					
	Montane Dry					
Tropical	Savanna/Grasslands					
Temperate	Coniferous					
	Broadleaf					
Grasslands		860	0.3	258	0.5	129
Boreal	Mixed Broadleaf/Coniferous					
	Coniferous					
	Forest tundra					
Grasslands/Tundra						
Other		100	2	200	0.5	100
					Subtotal	229

Table (5.7) Continued

Module		Land-use Change and Forestry				
Submodule		Abandonment of Managed Lands				
Worksheet		5-4				
Sheet		2 of 3				
Regrowth Land Type		G Total Area Abandoned More than Twenty Years (kha)	H Annual Rate of Above-ground Biomass Growth (t dm/ha)	I Annual Abovegrou nd Biomass Growth (kt dm)	J Carbon Fraction of Abovegrou nd Biomass	K Annual Carbon Uptake in Aboveground Biomass (kt C)
				I= (G x H)		K = (I x J)
Tropical Forests	Moist					
	Seasonal					
	Dry					
Temperate Forests	Evergreen					
	Deciduous					
Boreal Forests						
Grasslands	Range Reserves					
	Abandoned (desert wadis)	800	0.2	160	0.25	40
Others						
Forest Plantations	Pine & Acacia					
Fruit Trees	Orchards					
					Subtotal	40

Table (5.7) Continued

Module	**Land-use Change and Forestry**
Submodule	**Abandonment of Managed Lands**
Worksheet	**5-4**
Sheet	**3 of 3 Total CO_2 Removals from Abandoned Lands**
L Total Carbon Uptake from Abandoned Lands (kt C)	M Total Carbon Dioxide Uptake (Gg CO_2)
L = (E + k)	M = L x (44/12))
227	832.3

Table (5.8) Change in Soil Carbon for Mineral Soils

Module			Land-use Change and Forestry				
Submodule			Change in Soil Carbon for Mineral Soils				
Worksheet			5.5				
Sheet			l of 4				
A Land-Use/ Management Systems	B Soil type	C Soil Carbon (t) (Mg C/ha)	D Land Area (t-20) (Mha)	E Land Area (t) (Mha)	F Soil Carbon (t-20) (Tg)	G Soil Carbon (t) (Tg)	H Net change in Soil Carbon in Mineral Soils (Tg per 20 yr)
					F = (C x D)	G = (C x E)	H = (G-F)
Grasslands							
	Low Activity Soils	40	0.1	0.76	4	30.4	26.4
	Sandy	10	0.76	0.1	7.6	1.0	-6.6
Totals			0.86	0.86			19.8

Table (5.9) Carbon Emissions from Intensively - Managed Organic Soils

Module			**Land-use Change and Forestry**
Submodule			**Carbon Emissions from Intensively - Managed Organic Soils**
Worksheet			**5-5**
Sheet			**2 of 4**
Agricultural Use of Organic Soils	A Land Area (ha)	B Annual Loss Rate (MgC/ha/yr) (Default)	C Net Carbon Loss from Organic Soils (Mg/yr)
			C=(A x B)
Coo temperate			
Upland crops			
Pasture/Forest	860,000	0.25	215,000
Warm temperate			
Upland crops			
Pasture/Forest			
Tropical			
Upland crops			
Pasture/Forest			
		Total	215,000

Table (5.10) Carbon Emissions from Liming of Agricultural Soils

Module			**Land-use Change and Forestry**
Submodule			**Carbon Emissions from Liming of Agricultural Soils**
Worksheet			**5-5**
Sheet			**3 of 4**
Type of lime	A Total Annual Amount of Lime (Mg)	B Carbon Conversion Factor	C Carbon Emissions from Liming (Mg/C)
			C=(A x B)
Limestone $Ca(CO_3)$	0	0.120	0
Dolomite $CaMg(CO_3)_2$	0	0.122	0
		Total	0

Table (5.11) Calculation of Total CO2-C Emissions from Agriculturally- Impacted Soils

Module	**Land-use Change and Forestry**			
Submodule	**Calculation of Total CO2-C Emissions from Agriculturally- Impacted Soils**			
Worksheet	**5-5**			
Sheet	**4 of 4**			
Source	A Worksheet values	B Unit Conversion Factor	C Total Annual Carbon Emissions (Gg)	D Convert to Total Annual CO_2 Emission (Gg/yr)
			C=(AxB)	D=(Cx(44/12)
Total Net Change in Soil Carbon in Mineral Soils	19.8	-50	-990	-3630
Total Net Carbon Loss from Organic Soils	215,000	0.001	215	788
Carbon Emissions from Liming	0	0.001	0	0
			Total	-2841

Table (5.12) Soil Carbon for Agriculturally Impacted Lands

Module			Land-use Change and Forestry			
Submodule			Soil Carbon for Agriculturally Impacted Lands			
Worksheet			5-5 A (supplemental)			
Sheet			l of l			
A Land-Use/ Management Systems	B Soil type	C Soil Carbon under Native Vegetation (Mg C/ha)	D Base Factor	E Tillage Factor	F Input Factors	G Soil Carbon in Agriculturally Impacted Lands (Mg C/ha)
						E=(C x D x E x F)
Grasslands						
	Low Activity Soils	40	1.1	1.1	1	48.4
	Sandy	10	1.1	1.1	1	12.1

6. GHGs EMISSIONS / DOMESTIC SOLID WASTE, 1994

6.1 Methane Emission from Municipal Waste in Jordan

The government of Jordan has prepared and endorsed a national strategy on the environment in which the energy sector figures prominently. The expected annual growth rate of energy demand is 4.9%, and the government is seeking to meet part of the demand through the renewable energy sector. A separate department at the Ministry of Energy and Mineral Resources (Renewable Energy Department) was created to promote the use of alternative energy resources. The private sector is encouraged to participate in the development and implementation of alternative technologies.

The Greater Amman Municipality (GAM) is responsible for municipal affairs in Amman and its suburbs. Amman has a population of over one million, which, together with the inhabitants of the nearby suburbs reaches around 1.6 million, representing more than one third of the total population of 4.14 million, the figure of 1996. The city's population is growing rapidly, at the rate of almost 5% annually, due to a high birth rate, of 3.0% - 3.5%, and migration to the city.

Zarqa, including its suburbs to the northeast of Amman, has a population of half a million and is the second largest city in the country. It is also growing rapidly due to urbanization and high population growth. The municipalities of Amman and Zarqa share the same dumping landfill for municipal solid waste (MSW). It is an old phosphate mine in the Ruseifeh area, situated between the two cities. The Public Cleansing Department in the Greater Amman Municipality, responsible for collecting waste from the city of Amman and dumping it into this landfill, collects annually 0.6 million tonnes of MSW (Amman & Zarqa). By the year 2000, waste collection in the two urban areas will exceed 2,300 tonnes daily, rendering it a sizable MSW collecting system by world standards.

The total domestic solid waste generated and treated in other municipalities in the country is estimated to be around 410,000 tonnes/year.

The following table shows the quantity of domestic solid waste collected and treated in the main population centers in the Kingdom.

6.2 Quantity of Municipal Solid Waste

The amount of methane presently emitted from the MSW at the Ruseifeh landfill is about 190,000 tonnes per year, as only half the waste is digested anaerobically in the landfill. In 1994, this was equivalent to the greenhouse effect equal to almost 4.7 million tonnes of CO_2 per year, and it will continue to increase by 4%-5% annually.

The Ruseifah landfill is presently a major emitter of greenhouse gases. More than 190,000 tonnes of methane is generated annually at the landfill site and released into the atmosphere, due to anaerobic digestion of the organic waste fraction, which makes up approximately 65% of the waste received. Methane is a highly concentrated greenhouse gas with a global warming effect 24.5 times higher than that of CO_2. Therefore, the present emissions equivalent to CO_2 amount to over 4.6 million tonnes.

The overall emission of methane resulting from the treatment of MSW in the country is estimated at around 371,000 tonnes, as shown in table 6.1.

The overall reduction in greenhouse gas emission to be realized by exploiting CH_4 emitted from 876,000 tonnes of SW, of the municipal waste generated annually in Jordan, and deposited in landfills is equal to 281,224 tonnes of CH_4 annually, suming that 77% of the waste is degraded anaerobically if deposited in a landfill.

Module	WASTE
Submodule	METHANE EMISSIONS FROM LANDFILLS
Worksheet	6-1
Sheet	1 OF 1

	Step 1	**Step 2**				**Step 3**					
	A Annual MSW Landfilled (Gg)	B Fraction DOC	C Annual DOC Landfilled (Gg)	D Fraction which actually degrades	E Annual Carbon Released as Biogass (Gg)	F Fraction $C\text{-}CH_4$ to C-Biogass	G Annual Carbon Released as CH_4 (Gg C)	H Conversion Ratio (16/12)	I CH_4 Released (Gg CH_4)	J CH_4 Recovered (Gg CH_4)	K Net CH_4 Emissions (Gg CH_4)
			C=AXB		E=CXD		G=EXF		I=GXH		K=I-J
Rusaifeh	584	0.65	380	0.77	293	0.5	147	16/12	196	0	196
Akaider	274	0.65	178.1	0.77	137	0.5	69	16/12	92	0	92
Dhulail	9.13	0.65	6	0.77	5	0.5	2.5	16/12	3.33	0	3.33
Um-Qutain*	4.4	0.65	2.9	0.77	2.2	0.25	0.55	16/12	0.73	0	0.73
Khorah*	12.8	0.65	8.3	0.77	6.4	0.25	1.6	16/12	2.13	0	2.13
Shubek*	7.3	0.65	4.75	0.77	3.7	0.25	0.9	16/12	1.2	0	1.2
M.Ghor*	18.3	0.65	11.9	0.77	9.2	0.25	2.3	16/12	3.1	0	3.1
Ail District*	11	0.65	7.2	0.77	5.5	0.25	1.4	16/12	1.87	0	1.87
Harta*	4.75	0.65	3.1	0.77	2.4	0.25	0.6	16/12	0.8	0	0.8
Thaiban*	14.6	0.65	9.5	0.77	7.3	0.25	1.8	16/12	2.4	0	2.4
Taibeh*	4.75	0.65	3.1	0.77	2.4	0.25	0.6	16/12	0.8	0	0.8
Seru*	9.13	0.65	6	0.77	5	0.25	1.25	16/12	1.7	0	1.7
Mafraq*	30	0.65	19.5	0.77	15	0.25	3.8	16/12	5.1	0	5.1
Salt	45.7	0.65	29.7	0.77	22.9	0.5	11.5	16/12	15.33	0	15.3
Tafila	11.43	0.65	7.43	0.77	5.7	0.5	2.9	16/12	3.9	0	3.9
Ma'an	12.5	0.65	8.13	0.77	6.3	0.5	3.2	16/12	4.3	0	4.3
Karak	35.2	0.65	22.9	0.77	17.6	0.5	8.8	16/12	11.7	0	11.7
Aqaba	22.71	0.65	14.8	0.77	11.4	0.5	5.7	16/12	7.6	0	7.6
Ajlun	13.7	0.65	8.9	0.77	6.9	0.5	3.5	16/12	4.7	0	4.7
Madaba	22.84	0.65	14.9	0.77	11.5	0.5	5.8	16/12	7.73	0	7.73
N.Ghor	13.3	0.65	8.65	0.77	6.7	0.5	3.4	16/12	4.53	0	4.53
										TOTAL	**370.92**

* : OPEN DUMPS (total of 19.83 Gg)

<u>Domestic and Commercial Wastewater Treatment</u>:

The 14 operating WW treatment plants in the country were surveyed for these calculations (see attached table). The type of treatment technology in each plant was noticed in order to be able to reasonably estimate the fraction of WW that is anaerobically treated. Efficiency records of each plant were reviewed for this factor and found to be highly relevant to the question.

How an aerobic system becomes anaerobic ?

For example, the aerobic ponds of Al-Samra plant usually go anaerobic or facultative due to operation and maintenance problems as well as elevated summer temperatures.

The 14 plants were categorized according to type of technology into five groups:

	WSP	**BF & MP**	**BF & AS**	**RBC & AS**	**AS**
	SAMRA	AQABA	IRBID	ABU-NUSIER	JERASH
	MAFRAQ	TAFILA			SALT
	RAMTHA	KARAK			
	MADABA	KUFRANJEH			
	MA'AN	BAQ'A			
Fraction WW Anaerobically Treated	0.6	0.25	0.15	0.15	0.2

WSP: Waste Stabilization Ponds
BF : Bio-filters (trickling filters)
MP : Maturation Ponds
RBC: Rotating Biological Contactors
AS : Activated Sludge

The fraction of WW that is anaerobically treated was estimated based on the two factors mentioned above, namely the type of treatment technology used and the observed efficiency of each treatment plant. The fraction estimates are shown on the table above for each treatment category.

Table (7.2)
Liquid Waste Treatment Plants

Treatment plant	Amount of the treated water m^3/Day	Quality of influent water inlet) BOD (mg/I)	Quality of effluent water outlet BOD (mg/L)	Area Dunum
Khirbet Samra	147328	500	130	10,000
Irbid	7900	1440	40	290
Al-Mafraq	3000	600	275	770
Al-Ramtha	1450	1450	100	185
Abu-Nseir	1430	630	20	50
Al-Baqa'a	6780	1700	400	60
Jerash	1365	900	30	200
Kufranja	1300	920	45	95
Madaba	3000	685	385	460
Salt	4550	840	25	385
Karak	1375	510	60	160
Al-Tafileh	855	1085	50	45
Ma'an	1910	1190	200	220
Aqaba	7400	360	15	500

Module	WASTE
Submodule	METHANE EMISSIONS FROM DOMESTIC AND COMMERCIAL WASTEWATER TREATMENT
Worksheet	6-2
Sheet	1 OF 1

		STEP 1			STEP 2				STEP 3	
		A	B	C* Annual BOD ($Gg\ BOD_5$)	D Fraction WW Anaerobically Treated	E Quantity of BOD from Anaerobically Treated WW ($Gg\ BOD_5$)	F Methane Emissions Factor ($Gg\ CH_4$ / $Gg\ BOD_5$)	G Total CH_4 Released ($Gg\ CH_4$)	H Methane Recovered ($Gg\ CH_4$)	I Net CH_4 Emissions ($Gg\ CH_4$)
WW Plant	Treatment Type					E=CXD		G=EXF		I=G-H
As-Samra	WSP			26.9	0.6	16.14	0.22	3.6	0	3.6
Irbid	BF+AS			4.15	0.15	0.623	0.22	0.14	0	0.14
Mafraq	WSP			0.66	0.6	0.4	0.22	0.1	0	0.1
Ramtha	WSP			0.77	0.6	0.462	0.22	0.102	0	0.102
Abu-Nusier	RBC+AS			0.33	0.15	0.05	0.22	0.011	0	0.011
Baq'a	BF+MP			4.21	0.25	1.053	0.22	0.232	0	0.232
Jerash	AS			0.45	0.2	0.09	0.22	0.02	0	0.02
Kufranjeh	BF+MP			0.44	0.25	0.11	0.22	0.024	0	0.024
Madaba	WSP			0.75	0.6	0.45	0.22	0.1	0	0.1
Salt	AS			1.4	0.2	0.28	0.22	0.062	0	0.062
Karak	BF+MP			0.26	0.25	0.065	0.22	0.014	0	0.014
Tafila	BF+MP			0.34	0.25	0.085	0.22	0.02	0	0.02
Ma'an	WSP			0.83	0.6	0.5	0.22	0.11	0	0.11
Aqaba	BF+MP			0.973	0.25	0.243	0.22	0.0535	0	0.0535
									TOTAL	**4.5885**

* : The values in this coloumn were calculated using actual "BOD" and "WW flow rate" data for each treatment plant, skipping the need for col. A and B.

Module	WASTE
Submodule	METHANE EMISSIONS FROM INDUSTRIAL WASTEWATER TREATMENT
Worksheet	6-3
Sheet	1 & 2

	STEP 1			**STEP 2**			**STEP 3**		
	A Annual Wsatewater Outflow (M liters)	B BOD Concen. (kg/liter)	C Total BOD Generated (Gg BOD)	D Fraction WW Anaero bically Treated	E Quantity of BOD from Anaerobically Treated WW (Gg BOD5)	F Methane Emissions Factor (Gg CH_4 / Gg BOD5)	G Total CH_4 Released (Gg CH_4)	H Methane Recovered (Gg CH_4)	I* Net CH_4 Emissions (Gg CH_4)
INDUSTRY			C=AXB		E=CXD		G=EXF		I=G-H
IRON AND STEEL	109.5	8x10-6	8.8x10-4	0.15	1.3x10-4	0.2	0.29x10-4	0	
NON-FERROUS METALS	36.5	1.1x10-5	4x10-4	0.15	0.6x10-4	0.22	0.13x10-4	0	
PULP & PAPER:									
Jordan Hygenic Paper Co.	36.5	6x10-4	0.022	0.15	3.3x10-3	0.22	0.73x10-3	0	
Pulb & Mill Manufacturing	730	0.2x10-3	0.1117	0.15	0.0168	0.22	3.7x10-3	0	
TEXTILES:									
Imperial Underwear	18.25	0.2x10-3	3.1x-3	0.15	0.46x10-3	0.22	0.101x10-3	0	
Textile Co. (TPAKHI)	7.3	0.3x10-3	2x10-3	0.15	0.3x10-3	0.22	0.065x10-3	0	
Tent & Blanket Factory	29.2	8.4x10-4	0.0245	0.15	3.7x10-3	0.22	0.814x10-3	0	
PETROLEUM REFINING/ PETROCHEMICALS:									
Jordan Petroleum Refinery	584	0.1x10-3	0.027	0.15	4.1x10-3	0.22	0.891x10-3	0	
Intermediate Petrochemicals	0.73	0.2x10-3	1.5x10-4	0.15	0.2x10-4	0.22	0.049x10-4	0	
HUSSEIN IRON & STEEL	18.25	0.1x10-3	1.4x10-3	0.15	0.22x10-3	0.22	0.047x10-3	0	
OTHERS:						0.22		0	
Jordan Yeast Co.	128	0.02	1.946	0.15	0.292	0.22	0.0642	0	
Arab Detergent Manufacturing	14.6	0.7x10-3	0.0102	0.15	1.53x10-3	0.22	0.337x10-3	0	
ICA Co.	43.8	1.5x10-3	0.065	0.15	9.75x10-3	0.22	2.15x10-3	0	
Overall Co.	45.7	1.8x10-4	8.5x10-3	0.15	1.28x10-3	0.22	0.282x10-3	0	
Chemical Polymers	1.46	9.8x10-3	0.0142	0.15	2.13x10-3	0.22	0.47x10-3	0	
Jordan Tiles Co.	20.1	5.5x10-6	1.1x10-4	0.15	0.17x10-4	0.22	0.037x10-4	0	
Jordan Ceramics Co.	31.1	0.04x10-3	1.2x10-3	0.15	0.18x10-4	0.22	0.04x10-4	0	
Chemical Ind. Co.	0.365	0.5x10-3	1.8x10-4	0.15	0.28x10-4	0.22	0.062x10-4	0	
Jordan Matches Mfg	1.46	1.6x10-3	2.3x10-3	0.15	0.35x10-3	0.22	0.077x10-3	0	
Jordan Sulphochemical Co.	10.95	0.5x10-3	5.2x10-3	0.15	0.78x10-3	0.22	0.172x10-3	0	
Warehouse Mfg Co.	3.65	3x10-5	1.1x10-4	0.15	0.165x10-4	0.22	0.036x10-4	0	
Hussein Thermal Station	621	0.02x10-3	0.0124	0.15	1.86x10-3	0.22	0.41x10-3	0	
							TOTAL		**0.075**

*: The entries of col. I are the same of col. G since no Methane recovery is practiced in all plants.

8. CO_2 EMISSION FROM CEMENT PRODUCTION

Cement is manufactured in two locations, viz,

1. Fuheis Cement Factory, 17 Km north of Amman.

2. Rashadia Cement Factory, 240 Km south of Amman.

The Jordan Cement Manufacturing Company produces different types of cement.

During cement manufacturing, CO_2 is emitted from two sources.

1. From the process

Total clinker production during the period 1991-1995 is summarized in the following table:-

Table (8.1)
Clinker Production

Year	Rashadia Factory *	Fuheis Factory *	Total *
1991	1400133	1351360	2751493
1992	1511469	1234635	2746104
1993	1700921	1373010	3073931
1994	1603065	1472940	3076005
1995	1630342	1521525	3151867

* quantities in tonnes

CO_2 emission during the process for the year 1994 is

$$CO_2 \text{ emission} = 0.553 \frac{\text{kg } CO_2}{\text{kg clinker}} \times \text{production kg clinker}$$

$$= 0.553 \times 3076005$$

$$= 1701 \text{ k tonnes.}$$

9. ENERGY SECTOR OVERVIEW

9.1 General:

Jordan's consumption of primary energy in 1994 amounted to 4.15 million TOE. The transportation sector had the largest share of the total consumption, amounting to 38.8%, followed by industry, with 22.2%, and household with 19.0%. In 1995, the demand increased to 4.4 million TOE. Primary energy demand projections are expected to reach 4.8 million TOE in the year 2000 and 6.2 million TOE in 2005, corresponding to an average annual growth rate of 4.% during the period 1995-2000 and 5.1% during the period 2000-2005.

In 1994, total electricity consumption was 4,676 Gwh, industry ranking first with 35.1%, followed by the residential sector with 30.4%, water pumping with 17.7% and others with 16.8 %. In 1995, electricity consumption increased to 5,201 Gwh.

Jordan depends heavily on oil imports as the main source of energy. In 1995, crude oil imports amounted to 3.16 million tonnes. Other oil products imports included fuel oil, 670,000 tonnes, LPG, 75,000 tonnes, and diesel, 173,000 tonnes. Total imports were valued at JD 331 million. Table 9.1 shows oil imports during the period 1990-1995.

Table (9.1)
Oil imports (million tonnes)

Year	1990	1991	1992	1993	1994	1995
Crude oil	2.689	2.344	2.975	2.900	2.977	3.160
Fuel oil	0.591	0.691	0.737	0.715	0.767	0.670
LPG	0.019	0.030	0.032	0.042	0.052	0.075
Diesel	0.172	0.047	0.150	0.143	0.102	0.173

Source: MEMR

Several major developments in the energy domain, that will have considerable impact on the future structure of the energy sector are considered below:

9.2 Natural Gas:

In 1987, gas was discovered in Risha. To date, 29 wells have been drilled, six of which have produced gas. Current production is estimated at 30 million cubic feet per day. Expansion is currently under way, aiming at reaching an output of 35 million cubic feet per day by the end of 1996. Over 48 billion cubic feet of natural gas have been produced so far. The current annual production is about 10 billion cubic feet. It is anticipated that annual production will reach about 15 bcf in the near future.

Table 9.2 presents natural gas production during the period 1990-1995.

Table (9.2)
Natural Gas Production

Year	Natural Gas (Billion Cubic Feet)
1990	5.5
1991	5.5
1992	6.0
1993	6.9
1994	10.0
1995	9.9

Source: MEMR

9.3 Oil:

In 1981, crude oil reserves were discovered in small quantities near Azraq. In 1984, modest reserves were found in the Hamzeh field. Today, a small amount of oil is produced in the Hamzeh oil field and the Azraq basin, yielding up to 25 barrels a day.

Table 9.3 shows crude oil production figures during the period 1990-1995.

Table (9.3)
Crude Oil Production

Year	Production (Tons)
1990	17000
1991	7000
1992	3000
1993	1500
1994	1200
1995	1400

Source: MEMR

The government is currently negotiating new concession agreements with foreign companies to explore oil reserves in different parts of the Kingdom (northeast area, the Dead Sea region and the eastern part).

Jordan Petroleum Refinery Company (JPRC) is the owner of the only refinery in Jordan. It is located in Zarqa, 35 km north of Amman. Its maximum output is 100,000 barrels per day. Historically, the Zarqa refinery used to receive all its crude oil needs from Saudi Arabia through the T.A.P. pipeline. In 1984, Jordan started diversifying its import sources by importing about 10% of its crude oil needs from Iraq; in 1990, the import from Iraq had reached around 87% of the total import. Since the Gulf war in 1991, the supply from Saudi Arabia was stopped and Iraq became the sole source of crude oil and other oil products imports.

Table 9.4 shows petroleum products production over the past six years.

Table (9.4)
Petroleum Products Production (1000) Tonnes

Year	1990	1991	1992	1993	1994	1995
LPG	102	99	121	125	126	131
Gasoline	400	427	432	405	456	482
Avtag	15	9	10	8	15	29
Avtur	235	96	200	220	198	213
Kerosene	205	228	298	238	222	266
Diesel	745	717	753	769	859	877
Fuel oil	772	590	901	862	900	1.014
Asphalt	120	134	124	156	140	136
Total	2,594	2,300	2,839	2,783	2,916	3,151

Sources: MEMR

9.4 Coal:

There is no coal production, or coal use as an energy source in Jordan.

9.5 Electric Power:

The total installed capacity is 1,121 MW, of which 655 MW are generated by heavy fuel oil fired units, 342 MW by diesel units, 120 MW by natural gas units and 4.3 MW by hydro and wind generators. Table 9.5 presents the National Electric Power Company (NEPCO) power stations. In addition, the Arab Potash Company has an installed capacity of 23 MW (8 MW run on diesel and 15 MW run on fuel oil).

Table (9.5)
National Electric Power Company's Power Stations

Power Station	Type	Number of Units	Nominal Capacity (MW)
King Hussein Thermal	Steam	3	33
	Steam	4	66
	Gas turbine	1	14
	Gas turbine	1	18
Aqaba thermal	Steam	2	130
Aqaba central	Diesel engine	2	3.5
	Diesel engine	3	5
Marka	Gas turbine	4	18
	Diesel engine	8	3.5
Amman south	Gas turbine	2	30
Karak	Gas turbine	1	18
	Diesel engine	3	1.5
Risha	Gas turbine	4	30
			100
Rehab	Gas turbine	2	30
	Gas turbine	1	100
Other	Hydro & wind		4.3

Source: NEPCO

Total electricity generated In 1995 was 5,201 Gwh. Over the past decade demand for electricity has increased at an average annual growth rate of 9.5%. Table 9.6 shows the monthly breakdown of generation and peak demand for 1995.

Table (9.6)
Monthly Electricity Generation and Peak Demand, 1995

Month	Generation (Gwh)	Peak Demand (MW)
January	400.7	732
February	364.7	710
March	400.6	748
April	398.8	744
May	434.1	801
June	449.8	800
July	478.1	826
August	489.3	861
September	464.2	862
October	460.4	851
November	421.1	797
December	439.5	797
TOTAL	5,201.3	

Source: NEPCO

The peak is reached usually in the summer (July or August); the winter peak is only slightly less (92%) than the summer peak.

MEMR projections indicate an expected generation of 7,625 Gwh in 2000 and 10,635 Gwh in 2005, corresponding to an average annual growth rate of 6.9% between the years 1995 and 2000, and 6.9% for the period 2000 and 2005. The associated peak demand is expected to be 1,200 MW in the year 2000 and 1520 MW in the year 2005.

Two new steam fuel oil fired units at Aqaba power plant, each with a capacity of 130 MW, are expected to come on line by the end of 1997. Another unit is scheduled to be commissioned in 1999. Additional units will be either gas turbine or combined cycle units, depending on the availability of natural gas. NEPCO's expansion plan is shown in Table 9.7.

Table (9.7)
Power System Expansion Plan

Year	Capacity (MW)	Type & Location
1996	2 x 130	Fuel oil / Aqaba
1999	1 x 130	Fuel oil or C. Cycle / Aqaba
2002	1 x 30	Gas Turbine / Amman
2003	1 x 160	C. Cycle / Aqaba
2004	1 x 160	C. Cycle / Aqaba
2005	1 x 30	Gas Turbine / Amman
2006	1 x 160	C. Cycle / Zarqa
2007	1 x 100	C. Cycle / Zarqa
2009	1 x 100	C. Cycle / Amman
2010	1 x 30	Gas Turbine / Amman

Source: NEPCO

9.7 Renewable & Indigenous Energy Sources:

9.7.1 Overview

Despite significant interest in the development of alternative energy sources, their actual contribution to the energy consumption of the country is rather limited. In 1993, the share provided by solar water heaters (by far the main form of renewable energy) was between 1.7% and 1.8%; photovoltaic system's share was 0.0016%; hydro power provided only 0.060% of the system; and wind power contributed only 0.007%. The development of oil shale, the largest indigenous energy resource, is still at the planning stage.

9.7.2 Solar energy

Jordan enjoys very high average solar radiation; consequently, the potential for utilizing solar water heaters, the simplest and therefore providing the first use of solar energy, is high. In 1993, about 26% of the residencies of Jordan were equipped with solar water heaters. An increased utilization of solar water heaters is a realistic and valuable objective, but it needs more support through providing a regulatory framework and financial incentives.

9.7.3 Oil Shale

Extensive studies performed by the Natural Resources Authority (NRA) of Jordan and several foreign associates have identified large reserves of oil shales with relatively thin overburden. Geological reserves are estimated at about 40 billion tones. There are 17 known surface and near surface occurrences of oil shales distributed over an area of about 70 km^2 in the E-W direction and about 100 km^2 in the N-S direction. The westernmost deposits are EI Lajun, located 10-15 km east of Karak, and Jurf-El-Darawish, located about 60 km south of EL Lajun. Research work, shale characterization and combustion tests have indicated that utilization of oil shale either for direct combustion or for oil extraction by retorting would be feasible.

9.7.4 Hydroelectric and geothermal

The potential for hydroelectric power in Jordan is very limited. At present, the only hydroelectric station is located by the King Talal Dam. In 1993, the total electricity generated by King Talal Dam was 22 Gwh.

As far as geothermal energy is concerned, a limited number of thermal springs are known. Hot water has been found in several boreholes, but the quantities of water is usually small and its temperature is in the low range.

9.7.5 Wind power & biomass

The wind atlas of Jordan indicates that large areas in the country have average annual wind speeds in excess of 6 to 6.5 m/s; some, more limited, areas have average wind speeds above 7 m/s. Conventional wisdom based on international prices of equipment indicates that in the latter areas, wind energy would be economically competitive with current wind turbines, while in the previous ones small improvements in wind turbine efficiency would be required to reach competitiveness.

The potential of wind energy in Jordan has been estimated to reach a total of about 100 MW, of which 50 MW could be connected to the grid without changes of any kind. In 1988, a 320 kW pilot wind farm was commissioned at Al-Ebrahemiyh. The wind farm, owned and operated by NEPCO, consists of four 80 kW wind turbines. The annual electricity generation at the farm is about 645 Mwh. Smaller wind demonstration projects exist in other parts of the country; they include the rural electrification and water pumping project at Jurf-El-Darawish. A project is under way for the construction of a 1.35 MW wind farm in the northern part of the country. The project, cooperation between MEMR and NEPCO, received the support of the German government and uses German wind turbines.

Little information is available about the current use of biomass. Preliminary studies performed by MEMR indicate that a significant potential exists for biogas production from animal and municipal waste. In 1992, NEPCO started a demonstration project on anaerobic digestion of cow manure at the University of Jordan’s farm in the Jordan Valley. The digester’s size was $16m^3$ and was designed to power a 1 kW engine. The demonstration project ended in 1993.

9.7.6 Institutional Framework & Regulatory Aspects

The energy sector in Jordan is the responsibility of the Ministry of Energy and Mineral Resources (MEMR), which was established in 1984; the role of MEMR is to define policy, fix tariffs and regulate all activities with impact on energy. MEMR works in close collaboration with the Ministry of Planning (MOP) which reviews the energy sector plans and incorporates them within the national planning process. MOP also co-ordinates the foreign borrowing requirements for development projects.

Under MEMR, the Natural Resources Authority (NRA) is responsible for all activities related to the exploration and development of minerals and hydrocarbons. NRA’s efforts have established the potential for oil and gas by making small oil discoveries in the Azraq and Sirhan basins and discovering gas at Risha.

In the oil sector, the Jordan Petroleum Refinery Company (JPRC) is responsible for all downstream phases of petroleum activities, such as oil refining, storage, transportation and distribution. It was established in 1957 as a private company with the exclusive right to invest in and operate petroleum refining and derivative industries, including the right to market, store and distribute all such products. JPRC's operations are regulated by MEMR in accordance with a concession agreement. JPRC operates the only refinery in the country, located in Zarqa, 35 km^2 north of Amman.

Regarding electricity production and distribution, important actors are: the National Electric Power Company (NEPCO), the Jordan Electricity Power Company (JEPCO) and the Irbid District Electricity Company (IDECO).

Jordan Electricity Authority (JEA) was established in 1967, as the national producer of electricity, by merging the electricity generating assets of JEPCO and IDECO. It is also responsible for electricity distribution in large parts of the country which are sparsely populated and, as such, is not economically attractive to private companies.

Recently, and according to the New Electricity Law, JEA was transformed into a public shareholding company (NEPCO) totally owned by the government, as a first step towards full privatization.

JEPCO was established in 1947. It is a private company responsible for electricity distribution in Amman and central Jordan. At present, about 80% of the JEPCO stock is in the private sector.

IDECO was established in 1961, also as a private company. It is responsible for distributing electricity in the northern part of the country. At present, slightly over 50% of its stock is owned by NEPCO, about 30% belongs to the municipalities in its concession area and the rest is in the private sector.

9.7.7 Existing and Future Energy Supply Options

Despite exploration efforts undertaken by the government, Jordan will heavily rely on imported energy in the foreseen future.

The present situation whereby Jordan imports crude oil and oil products by land trucks from Iraq is unacceptable economically, environmentally or strategically.

The increasing dependence on fuel oil imports (see Table 1) and the latter's adverse environmental effects should also be given proper consideration when future options are considered.

9.7.8 Existing Supply Options

- **The T .A .P. Line**

Since 1960, the year when Zarqa refinery started operation, the T.A.P. line served as the only source of supply of crude oil from Saudi Arabia to Jordan.

In 1984, Jordan started diversifying its sources, importing about 10% of its crude oil needs from Iraq, a percentage that grew to 87% in 1990.

Since the Gulf war, in 1991, supply from Saudi Arabia was stopped and Iraq became the only source of energy imports.

Since maintenance of the pipeline and associated equipment continued during the closure period, it is considered operational and capable of supplying Jordan with its crude oil needs of 100,000 barrels per day (equal to the current maximum capacity of the Zarqa refinery).

- **Aqaba port**

Jordan Petroleum Refinery Company initiated a major storage capacity building both at the refinery site in Zarqa and in Aqaba. The latter will serve the dual purpose of increasing storage capacity in Jordan and facilitating import of crude oil and oil products by sea.

The project is expected to be completed in mid-1997 and, together with the existing oil terminal at the Aqaba port, will constitute a reliable and flexible source of imports.

Future Supply Options

- **Iraq-Jordan crude oil pipeline**

There have been extensive discussions with Iraq regarding the construction of a pipeline to Jordan that would either supply the Zarqa refinery or, at later stages, supply a new refinery in the Aqaba region. Preliminary studies were done and the project seems to be favoured by both sides, but political (embargo) and financial constraints are delaying the execution of the project.

- **Natural Gas Imports**

Taking into consideration Jordan's geographical location, the growing domestic demand for energy and the environmental problems associated with heavy reliance on petroleum products, especially heavy fuel oil, introduction of natural gas into the Jordanian energy system seems imperative.

Recently, the newly formed National Oil Company (previously the Petroleum Department of the Natural Resources Authority), in its capacity as Risha gas field developer, entered into negotiation with international oil companies in order to further develop the Risha field and increase gas production, currently estimated at 30 million cubic feet per day. If successful, the Risha field would replace an important part of heavy fuel oil used for electricity generation with cheap and clean fuel.

Other possibilities for introducing natural gas in the Jordanian energy system could include importing natural gas from: (1) Egypt by pipeline and (2) LNG from Qatar (the Enron Qatar LNG terminal project at Aqaba). Discussion is under way with both parties (Egypt and Enron Qatar) to reach an agreement to supply Jordan with its gas requirements.

Introducing natural gas, especially as a substitute for heavy fuel oil, would significantly reduce emissions, both at the local level (SOx, particulate) or globally (CO_2).

10. ENERGY AND ELECTRICITY DEMAND FORECAST IN JORDAN

10.1 Introduction

Carrying out the GHGs emissions study in Jordan involved many highly interrelated substudies. The first was determining Jordan's energy and electricity requirements until the year 2023 taking into account the social and economic development objectives.

Therefore, the analysis of energy and electricity demand was conducted by means of the DEMAND module, the second part of ENPEP package, a computer module developed by the LAEA and Argonne National Laboratory, USA.

The DEMAND module, described in Annex I, enables to compute projections of future energy demand in one of two forms: useful energy demand or fuel and electricity demand.

In order to analyze the energy demand, it was first necessary to determine the most important socio-economic factors affecting energy demand, i.e., population, GDP, as well as major government policies and assumptions for future national development, such as the Economic Reform Programme, all important factors in determining the level of activity in all economic and energy sectors. The most likely major policies and assumptions were applied to constitute the so called "Medium scenario within the framework of economic reform programme".

The MACRO module, which allows formulating economic and demography growth rates for subsequent ENPEP modules, was used in this regard. The MACRO module is described in Annex II.

It should be pointed out that the economy is sub-divided into the following major sectors:

- Industry
- Household
- Transport
- Agriculture
- Commercial

Where the future energy demand is computed in the form of fuel and electricity demand, the elasticity of fuel demand in each sector is calculated using the regression module, depending on historical time series.

10.2 Total Final Energy Demand Forecast:

The final energy demand forecasts resulting from the analysis carried out with the DEMAND module for the medium scenario (baseline scenario) is shown in Table 10.1

while the forecasts for sectoral final energy demand are presented in tables 10.2, 10.3, 10.4, 10.5, 10.6, 10.7, 10.8, 10.9, and 10.10.

It can be seen from the tables that:

* In the base year 1994, the total final energy demand was 3.73 million TOE. By the year 2023, it is forecast to increase to around 16 million TOE. The average annual growth rate of energy demand during this period (1994- 2023) will be 4.9%.

* The average annual growth rate of electricity demand during the same period is 6.1%.

* The average annual growth rate of kerosene is 5.6%.

* The average annual growth rate of gasoil is 3.2%.

* The average annual growth rate of fuel oil is 5.4%, while the average annual growth rates of gasoline and jet fuel are 4.8% and 2.8%, respectively.

Table No. (17)

Petroleum Products * Demand Forecast (1000 TOE)

Year	LPG	Kerosene	Diesel	Fuel Oil	Gasoline	Jet Fuel	Asphalt	Total
1994	206.1	237.9	979.4	1471.6	473.2	233.5	132.8	3734.5
1995	221.6	250.4	994.0	1517.8	492.6	230.8	145.5	3852.7
1996	237.3	260.0	1008.9	1596.8	520.2	236.4	160.9	4020.5
1997	254.1	270.0	1027.8	1680.6	549.5	242.2	178.0	4202.0
1998	272.0	280.3	1050.2	1769.4	580.4	248.1	196.9	4397.3
1999	291.3	291.2	1076.0	1863.6	613.0	254.1	217.8	4606.9
2000	311.9	302.3	1104.9	1963.4	647.4	260.3	241.0	4831.3
2001	333.5	313.7	1136.6	2070.9	683.4	267.1	266.7	5071.9
2002	356.5	325.6	1171.2	2185.1	721.5	274.1	295.1	5329.1
2003	381.2	337.8	1208.8	2306.2	761.6	281.2	326.7	5603.6
2004	407.5	350.5	1249.3	2434.9	804.0	288.5	361.7	5896.5
2005	435.7	363.7	1292.8	2569.5	848.8	296.1	400.7	6207.3
2006	464.4	377.1	1339.0	2718.7	895.2	304.7	443.7	6542.7
2007	494.9	391.0	1388.2	2877.6	944.0	313.7	491.5	6900.9
2008	527.4	405.3	1440.8	3046.6	995.6	322.9	544.5	7283.0
2009	562.0	420.3	1496.8	3226.5	1050.0	332.4	603.3	7691.2
2010	599.0	435.7	1556.3	3418.0	1107.4	342.1	668.6	8127.1
2011	628.7	449.1	1613.4	3616.1	1159.7	354.7	734.3	8556.1
2012	659.9	462.6	1672.7	3817.8	1213.9	367.3	804.9	8999.2
2013	688.0	475.1	1733.0	4035.5	1266.6	381.6	880.4	9460.1
2014	717.1	487.5	1795.0	4256.5	1320.1	395.5	961.1	9932.9
2015	747.5	499.8	1858.8	4486.5	1375.0	409.1	1047.4	10424.0
2016	779.1	512.1	1924.6	4725.6	1430.9	422.3	1130.3	10924.9
2017	812.1	524.4	1991.9	4973.9	1487.3	434.6	1237.0	11461.1
2018	846.3	536.7	2061.1	5231.3	1545.0	446.7	1340.5	12007.7
2019	875.9	548.1	2131.3	5517.0	1600.6	461.2	1449.5	12583.6
2020	906.5	559.8	2203.2	5814.2	1656.8	475.4	1564.4	13180.2
2021	938.1	571.5	2276.7	6123.5	1713.6	489.1	1685.3	13797.8
2022	970.8	583.3	2352.0	6444.6	1771.5	502.5	1812.1	14436.9
2023	1004.7	595.2	2428.9	6777.7	1829.8	515.3	1944.8	15096.4
Avg.								

* Excluding the Refinery's Consumption of Pertroleum Products

Table No. (18)

Electricity Demand Forecast (GWh)

Year	Industry	Agriculture	Household	Commercial	Total	Growth Rate (%)
1994	1518.9	767.6	1317.7	725.7	4329.8	-
1995	1616.2	825.1	1404.4	779.5	4625.2	6.8
1996	1728.2	884.8	1485.5	845.6	4944.1	6.9
1997	1848.0	948.8	1571.4	917.4	5285.7	6.9
1998	1976.2	1017.4	1662.1	995.5	5651.2	6.9
1999	2113.2	1090.9	1758.3	1080.5	6042.9	6.9
2000	2259.7	1169.8	1859.8	1172.9	6462.2	6.9
2001	2415.2	1252.2	1964.1	1273.9	6905.4	6.9
2002	2581.3	1340.3	2074.6	1384.0	7380.2	6.9
2003	2758.9	1434.6	2191.0	1503.7	7888.3	6.9
2004	2948.7	1535.6	2313.7	1634.2	8432.3	6.9
2005	3149.0	1643.7	2443.7	1776.8	9013.2	6.9
2006	3361.6	1753.2	2573.5	1933.3	9621.6	6.7
2007	3588.3	1869.7	2710.1	2104.0	10272.1	6.8
2008	3830.4	1994.2	2853.9	2290.2	10968.7	6.8
2009	4088.9	2126.9	3005.6	2493.5	11714.8	6.8
2010	4364.8	2268.4	3165.1	2715.2	12513.6	6.8
2011	4624.7	2381.2	3291.2	2943.2	13240.4	5.8
2012	4896.4	2500.3	3421.8	3184.3	14002.8	5.8
2013	5169.2	2606.5	3537.0	3444.5	14757.3	5.4
2014	5452.8	2717.4	3655.4	3719.0	15544.6	5.3
2015	5747.2	2833.2	3776.9	4007.9	16365.2	5.3
2016	6052.7	2954.4	3902.3	4311.0	17220.3	5.2
2017	6369.1	3081.1	4031.7	4628.2	18110.1	5.2
2018	6696.7	3213.3	4165.2	4959.4	19034.5	5.1
2019	7020.3	3326.6	4277.8	5313.7	19938.3	4.7
2020	7353.3	3444.0	4393.8	5682.6	20873.7	4.7
2021	7702.4	3565.8	4512.8	6065.7	21846.6	4.7
2022	8061.2	3692.2	4635.1	6462.3	22850.8	4.6
2023	8429.6	3824.8	4760.8	6871.8	23887.1	4.5
Avg.						6.1

Table No. (19)

LPG Demand Forecast (1000 TOE)

Year	Industry	Agriculture	Household	Commercial	TOTAL	Growth Rate (%)
1994	2.1	7.2	183.4	13.4	206.1	-
1995	2.2	7.5	198.0	14.0	221.6	7.5
1996	2.3	7.9	212.5	14.7	237.3	7.1
1997	2.4	8.2	228.0	15.5	254.1	7.1
1998	2.5	8.6	244.7	16.3	272.0	7.1
1999	2.6	9.0	262.6	17.1	291.3	7.1
2000	2.7	9.4	281.8	18.0	311.9	7.1
2001	2.8	9.9	301.8	18.9	333.5	6.9
2002	2.9	10.4	323.3	20.0	356.5	6.9
2003	3.0	10.9	346.3	21.0	381.2	6.9
2004	3.2	11.4	370.8	22.1	407.5	6.9
2005	3.3	11.9	397.2	23.3	435.7	6.9
2006	3.4	12.5	423.8	24.6	464.4	6.6
2007	3.6	13.1	452.2	26.0	494.9	6.6
2008	3.7	13.8	482.4	27.4	527.4	6.6
2009	3.9	14.4	514.8	28.9	562.0	6.6
2010	4.1	15.2	549.2	30.5	599.0	6.6
2011	4.2	15.9	576.4	32.2	628.7	5.0
2012	4.4	16.6	604.9	33.9	659.9	5.0
2013	4.6	17.4	630.1	35.8	688.0	4.2
2014	4.8	18.2	656.4	37.7	717.1	4.2
2015	5.0	19.0	683.8	39.6	747.5	4.2
2016	5.3	19.8	712.4	41.6	779.1	4.2
2017	5.6	20.7	742.2	43.7	812.1	4.2
2018	5.7	21.5	773.4	45.7	846.3	4.2
2019	5.9	22.4	799.6	47.9	875.9	3.5
2020	6.1	23.4	826.8	50.1	906.5	3.5
2021	6.4	24.3	855.0	52.4	938.1	3.5
2022	6.6	25.3	884.2	54.7	970.8	3.5
2023	6.9	26.3	914.5	57.0	1004.7	3.5
Avg.						5.6

Table No. (20)

Kerosene Demand Forecast (1000 TOE)

Year	Industry	Agriculture	Household	Commercial	Total	Growth Rate (%)
1994	1.2	4.6	223.6	8.5	237.9	-
1995	1.2	4.6	236.1	8.5	250.4	5.3
1996	1.3	4.6	245.3	8.7	260.0	3.8
1997	1.3	4.7	255.0	8.9	270.0	3.9
1998	1.4	4.8	265.0	9.2	280.3	3.8
1999	1.4	4.8	275.5	9.4	291.2	3.9
2000	1.5	4.9	286.3	9.7	302.3	3.8
2001	1.5	4.9	297.3	9.9	313.7	3.8
2002	1.6	5.0	308.8	10.3	325.6	3.8
2003	1.6	5.0	320.6	10.6	337.8	3.8
2004	1.7	5.1	332.8	10.9	350.5	3.7
2005	1.8	5.2	345.5	11.3	363.7	3.8
2006	1.9	5.2	358.3	11.7	377.1	3.7
2007	1.9	5.3	371.5	12.2	391.0	3.7
2008	2.0	5.4	385.2	12.7	405.3	3.7
2009	2.1	5.5	399.5	13.3	420.3	3.7
2010	2.2	5.5	414.2	13.8	435.7	3.7
2011	2.3	5.6	426.5	14.7	449.1	3.1
2012	2.4	5.8	438.8	15.6	462.6	3.0
2013	2.5	5.9	449.9	16.8	475.1	2.7
2014	2.6	6.0	460.9	18.0	487.5	2.6
2015	2.8	6.1	471.7	19.2	499.8	2.5
2016	2.9	6.2	482.6	20.4	512.1	2.5
2017	3.0	6.3	493.4	21.6	524.4	2.4
2018	3.1	6.5	504.4	22.7	536.7	2.3
2019	3.3	6.6	513.9	24.3	548.1	2.1
2020	3.4	6.7	523.7	25.9	559.8	2.1
2021	3.6	6.9	533.6	27.5	571.5	2.1
2022	3.8	7.0	543.5	29.1	583.3	2.1
2023	3.9	7.1	553.5	30.6	595.2	2.0
Avg.						3.2

Table No. (21)

Diesel Demand Forecast (1000 TOE)

Year	Industry	Agriculture	Household	Transportation	Electricity	Commercial	Total
1994	113.7	191.1	34.6	450.5	94.0	95.5	979.4
1995	118.1	193.9	37.3	455.6	86.2	102.9	994.0
1996	122.8	197.2	39.6	466.1	71.5	111.7	1008.9
1997	127.6	200.6	42.1	476.9	59.3	121.3	1027.8
1998	132.6	204.0	44.7	488.0	49.1	131.7	1050.2
1999	137.9	207.5	47.5	499.3	40.7	143.1	1076.0
2000	143.3	211.1	50.5	510.8	33.8	155.4	1104.9
2001	148.8	214.8	53.5	522.7	27.9	168.9	1136.6
2002	154.6	218.5	56.8	534.9	23.0	183.5	1171.2
2003	160.5	222.3	60.2	547.4	19.0	199.4	1208.8
2004	166.7	226.2	63.9	560.1	15.6	216.8	1249.3
2005	173.1	230.1	67.8	573.2	12.9	235.7	1292.8
2006	179.5	234.2	71.7	586.7	10.6	256.3	1339.0
2007	186.2	238.3	75.8	600.5	8.6	278.7	1388.2
2008	193.1	242.5	80.2	614.7	7.0	303.2	1440.8
2009	200.2	246.9	84.9	629.2	5.8	329.9	1496.8
2010	207.6	251.2	89.8	644.1	4.7	358.9	1556.3
2011	213.8	255.6	93.8	658.6	3.8	387.9	1613.4
2012	220.1	260.0	97.9	673.2	3.1	418.5	1672.7
2013	225.8	264.3	101.5	687.8	2.5	450.9	1733.0
2014	231.8	268.7	105.3	702.2	2.1	485.0	1795.0
2015	237.8	272.9	109.1	716.4	1.7	520.9	1858.8
2016	243.9	277.3	113.0	730.5	1.4	558.5	1924.6
2017	250.2	281.5	117.1	744.0	1.2	597.9	1991.9
2018	256.6	285.7	121.3	757.5	1.0	639.1	2061.1
2019	262.3	290.0	124.8	771.2	0.8	682.1	2131.3
2020	268.1	294.4	128.5	784.7	0.7	726.8	2203.2
2021	274.1	298.7	132.3	797.9	0.5	773.2	2276.7
2022	280.1	303.1	136.2	811.0	0.5	821.2	2352.0
2023	286.2	307.6	140.2	823.8	0.4	870.9	2428.9
Avg.							

Table No. (22)

Fuel Oil Demand Forecast (1000 TOE)

Year	Industry	Electricity	Total	Growth Rate (%)
1994	398.6	1073.0	1471.6	-
1995	404.2	1113.6	1517.8	3.1
1996	411.7	1185.1	1596.8	5.2
1997	419.4	1261.2	1680.6	5.2
1998	427.2	1342.2	1769.4	5.3
1999	435.1	1428.4	1863.6	5.3
2000	443.2	1520.2	1963.4	5.4
2001	451.7	1619.3	2070.9	5.5
2002	460.3	1724.8	2185.1	5.5
2003	469.0	1837.2	2306.2	5.5
2004	477.9	1957.0	2434.9	5.6
2005	486.7	2082.8	2569.5	5.5
2006	496.3	2222.3	2718.7	5.8
2007	506.1	2371.5	2877.6	5.8
2008	516.0	2530.6	3046.6	5.9
2009	526.2	2700.3	3226.5	5.9
2010	536.5	2881.4	3418.0	5.9
2011	547.8	3068.3	3616.1	5.8
2012	559.0	3258.9	3817.8	5.6
2013	570.9	3464.6	4035.5	5.7
2014	582.7	3673.8	4256.5	5.5
2015	594.4	3892.1	4486.5	5.4
2016	606.0	4119.7	4725.6	5.3
2017	617.4	4356.5	4973.9	5.3
2018	628.6	4602.7	5231.3	5.2
2019	640.7	4876.3	5517.0	5.5
2020	652.6	5161.6	5814.2	5.4
2021	664.7	5458.8	6123.5	5.3
2022	676.6	5768.0	6444.6	5.2
2023	688.4	6089.3	6777.7	5.2
Avg.				5.4

Table No. (23)

Gasoline & Jet Fuel Demand Forecast in Transport Sector

(1000 TOE)

Year	Gasoline	Growth Rate (%)	Jet Fuel	Growth Rate (%)
1994	473.2	-	233.5	-
1995	492.6	4.1	230.8	-1.2
1996	520.2	5.6	236.4	2.4
1997	549.5	5.6	242.2	2.4
1998	580.4	5.6	248.1	2.4
1999	613.0	5.6	254.1	2.4
2000	647.4	5.6	260.3	2.4
2001	683.4	5.6	267.1	2.6
2002	721.5	5.6	274.1	2.6
2003	761.6	5.6	281.2	2.6
2004	804.0	5.6	288.5	2.6
2005	848.8	5.6	296.1	2.6
2006	895.2	5.5	304.7	2.9
2007	944.0	5.5	313.7	2.9
2008	995.6	5.5	322.9	2.9
2009	1050.0	5.5	332.4	2.9
2010	1107.4	5.5	342.1	2.9
2011	1159.7	4.7	354.7	3.7
2012	1213.9	4.7	367.3	3.6
2013	1266.6	4.3	381.6	3.9
2014	1320.1	4.2	395.5	3.6
2015	1375.0	4.2	409.1	3.4
2016	1430.9	4.1	422.3	3.2
2017	1487.3	3.9	434.6	2.9
2018	1545.0	3.9	446.7	2.8
2019	1600.6	3.6	461.2	3.3
2020	1656.8	3.5	475.4	3.1
2021	1713.6	3.4	489.1	2.9
2022	1771.5	3.4	502.5	2.7
2023	1829.8	3.3	515.3	2.5
Avg.		4.8		2.8

Table No. (24)

Natural Gas Demand Forecast (1000 TOE)

Year	Nat. Gas	Growth Rate (%)
1994	210.0	-
1995	235.7	12.2
1996	265.2	12.5
1997	298.4	12.5
1998	335.7	12.5
1999	377.8	12.5
2000	425.1	12.5
2001	477.1	12.2
2002	535.5	12.2
2003	601.0	12.2
2004	674.5	12.2
2005	756.9	12.2
2006	845.3	11.7
2007	943.9	11.7
2008	1054.0	11.7
2009	1177.1	11.7
2010	1314.4	11.7
2011	1432.3	9.0
2012	1560.2	8.9
2013	1681.7	7.8
2014	1811.8	7.7
2015	1952.0	7.7
2016	2103.0	7.7
2017	2265.8	7.7
2018	2441.1	7.7
2019	2602.5	6.6
2020	2774.4	6.6
2021	2957.3	6.6
2022	3152.0	6.6
2023	3359.1	6.6
Avg.		10.1

Table No. (25)

Asphalt Demand Forecast (1000 TOE)

Year	Asphalt	Growth Rate (%)
1994	132.8	-
1995	145.5	9.6
1996	160.9	10.6
1997	178.0	10.6
1998	196.9	10.6
1999	217.8	10.6
2000	241.0	10.7
2001	266.7	10.7
2002	295.1	10.7
2003	326.7	10.7
2004	361.7	10.7
2005	400.7	10.8
2006	443.7	10.7
2007	491.5	10.8
2008	544.5	10.8
2009	603.3	10.8
2010	668.6	10.8
2011	734.3	9.8
2012	804.9	9.6
2013	880.4	9.4
2014	961.1	9.2
2015	1047.4	9.0
2016	1130.3	7.9
2017	1237.0	9.4
2018	1340.5	8.4
2019	1449.5	8.1
2020	1564.4	7.9
2021	1685.3	7.7
2022	1812.1	7.5
2023	1944.8	7.3
Avg.		9.7

Table No. (26)

Electricity Demand Forecast (1000 TOE)

Year	Industry	Agriculture	Household	Commercial	Total	Growth Rate (%)
1994	130.6	66.0	113.3	62.4	372.3	-
1995	139.0	70.9	120.8	67.0	397.7	6.8
1996	148.6	76.1	127.7	72.7	425.1	6.9
1997	158.9	81.6	135.1	78.9	454.5	6.9
1998	169.9	87.5	142.9	85.6	485.9	6.9
1999	181.7	93.8	151.2	92.9	519.6	6.9
2000	194.3	100.6	159.9	100.9	555.7	6.9
2001	207.7	107.7	168.9	109.5	593.8	6.9
2002	222.0	115.2	178.4	119.0	634.6	6.9
2003	237.2	123.4	188.4	129.3	678.3	6.9
2004	253.5	132.0	198.9	140.5	725.0	6.9
2005	270.8	141.3	210.1	152.8	775.0	6.9
2006	289.0	150.8	221.3	166.2	827.3	6.7
2007	308.5	160.8	233.0	180.9	883.3	6.8
2008	329.4	171.5	245.4	196.9	943.1	6.8
2009	351.6	182.9	258.4	214.4	1007.3	6.8
2010	375.3	195.1	272.2	233.5	1076.0	6.8
2011	397.7	204.8	283.0	253.1	1138.5	5.8
2012	421.0	215.0	294.2	273.8	1204.0	5.8
2013	444.5	224.1	304.1	296.2	1268.9	5.4
2014	468.9	233.7	314.3	319.8	1336.6	5.3
2015	494.2	243.6	324.8	344.6	1407.2	5.3
2016	520.4	254.0	335.5	370.7	1480.7	5.2
2017	547.7	264.9	346.7	398.0	1557.2	5.2
2018	575.8	276.3	358.1	426.4	1636.7	5.1
2019	603.6	286.0	367.8	456.9	1714.4	4.7
2020	632.3	296.1	377.8	488.6	1794.8	4.7
2021	662.3	306.6	388.0	521.6	1878.5	4.7
2022	693.1	317.5	398.6	555.7	1964.8	4.6
2023	724.8	328.9	409.4	590.9	2053.9	4.5
Avg.						6.1

11. STEPS TO IMPLEMENT UNFCCC

11.1 Introduction

Developing countries face both challenges and opportunities in the process of reducing their emissions of greenhouse gases (GHGs). The challenges lie in the fact that they must overcome their lack of information about available ways and means to do that while maintaining and expanding national development trends and that training in the new technology must be implemented. The opportunities include the advantages of modernizing production processes in a way that secures environmental protection, making new business contacts, as a result of investment and participation in international technology transfers, and strengthening domestic business networks as the infrastructure is developed. Financial assistance can help reduce GHG emissions rapidly in some developing countries which can benefit from the policies of multinational corporations which offer assistance in technology transfer.

Therefore, it is technically feasible to limit GHG emissions. It may be logistically and financially difficult, but it could be achieved if government and industry give it priority and appropriate financial support. There are special concerns regarding technology transfer to developing countries with respect to environmental and water safety. The incremental cost of the new technology will depend on the ease of access to technical information, the cost of water and energy, and on whether there are trade restrictions that limit the choice of the new technology.

Jordan's energy consumption today relies almost solely on combustion of fossil fuels. Furthermore, Jordan depends heavily on import of oil for energy from neighboring countries due to lack of fossil resources within the country. In 1994, Jordan's consumption of primary energy amounted to 4.15 million tonnes of oil equivalents (TOE). Electricity generation also accounted for a major share of gaseous emissions. Of a total installed capacity of 1,121 MW, only 163 MW run on fuels other than fossil fuel. It is estimated that renewable energy production accounts for about 2% of the total energy consumption in Jordan. Government studies show a growing demand and the average annual growth rate is estimated to reach 4.6% a year between 1995 and the year 2000. Thus, Jordan face major challenges on its way to meet the goals of the UN convention on climate change (UNFCCC).

Jordan's contribution to world emissions causing greenhouse effect in 1989 was minimal, amounting to about 0.09 (index per ten million people, UNDP HDR, 1996). However, the impact of the greenhouse effect in Jordan is expected to be proportionately much larger. Water is a scarce resource in Jordan and demands are growing both in agriculture, which depends heavily on rainfall as its main source of water, and by a population whose growth rates are approximately 3.5% per annum. Consequently, the rise in global temperature that is predicted due to climate changes will result in less rainfalls, with a disastrous impact on Jordan.

Steps have already been taken by the national authorities to curb emissions of greenhouse gases. Among others, Jordan's energy strategy contains plans to increase the utilization of renewable energy, to cover 5% of the national energy balance in 2000. However, in order to meet the threats and challenges facing the country due to climate changes, and in order to properly build its capacity and skills, Jordan needs internationally experienced assistance.

In 1996, the government of Jordan prepared the National Environment Action Plan (NEAP), based on the National Environment Strategy of Jordan (NES), which set up the measures to be taken in order to safeguard and preserve Jordan's environment for future generations. Five strategic directions for action were recommended in the NES:

1. Construction of a legal framework for environmental management, including the enactment of a comprehensive environment law and the creation of a national environment impact assessment process.

2. Strengthening institutions concerned with the protection and conservation of the environment, including a national environment agency, line ministries, and NGOs.

3. Expanding Jordan's protected areas.

4. Raising public awareness, through environmental education programmes, environmental health awareness and creating urban natural parks and green spaces.

5. Identifying main areas to be urgently addressed in order to safeguard the environment, e.g., water resources management.

Subsequently, some of the key legal and institutional recommendations of the NES were followed up and in 1995, a new Environment Protection Law became effective and the General Corporation for Environment Protection (GCEP) was established. The government formulated the National Environment Action Plan in order to rehabilitate past damage, control degradation and prevent future deterioration of the already limited resources base. The plan identified national priorities and provided the impetus for concrete environmental actions. Public awareness of the environmental challenges facing Jordan in the near future and in the next century was also addressed. Some of the priority actions, their goals and objectives, and their preliminary cost estimates are presented below:

11.1 Priority Actions

1. Impacts of Climate Change on Water Resources of Jordan

The major objectives here are:

a. Identify areas of potential vulnerabilities.
b. Characterize potential impacts.
c. Identify future adaptive responses and carrying out analysis on the feasibility of their implementation as adaptation strategies.

Also investigated would be the hydrology of the three major hydrologic regimes of Jordanian catchments and their changes under alternative climate scenarios, as well as an evaluation of the climate change. The overall cost of this action is estimated at around $0.1 million.

2. Measurements of GHGs Emission Factors for all Identified Source-Sectors in Jordan

Here, Jordan's and the region's different sources' contribution to GHG emissions would be measured. The overall cost of this action is estimated at around $0.6 million.

3. Building Environmental Management Capacity

The main objective of this action is to strengthen the capacity of GCEP to facilitate the implementation of NEAP and to carry out its related environmental management and coordination responsibilities by providing it technical and managerial expertise, training and equipment. The total cost of this action is estimated at around $1.5 million.

4. Building Capacity for Operation and Maintenance of Waste Water Treatment Plants

The main goal of this action is to alleviate Jordan's water pollution by ensuring optimum waste water treatment and improving effluent quality. The total cost of this action is estimated at around $0.65 million.

5. Building Capacity to Operate and Maintain the Domestic Water Network

The objective of this action is to alleviate Jordan's water shortage by ensuring optimum water conveyance and delivery to urban and industrial users through rehabilitation of the domestic water network and through minimizing water leakage and, hence, reducing pumping energy requirement (energy saving). The total cost of this action is estimated to be around $17 million.

6. Building Capacity to Operate and Maintain the Irrigation Network

The main aim of this action is to alleviate Jordan's water shortage by ensuring optimum water conveyance to irrigation perimeters and farmers and thus reduce the energy needed and minimize water leakage. The overall cost of this action is estimated to be around $8 million.

7. Rehabilitation of Waste Water Treatment Plants and Implementation of Waste Water Reuse Programmes

The specific objectives of this action are to rehabilitate the existing waste water plants and to implement on-site and/or off-site waste water reuse programmes. The overall cost of this action is estimated at $34 million.

8. Upgrading of Industrial Technologies to Minimize Energy and Water Uses

The specific aim of this action is to provide up-to-date clean technology to major industries, in line with the recommendations of the industrial audit sponsored by USAID and the COWI consult study. Technologies would ensure pollution control and pollution prevention. The total cost of this action is estimated at around $50 million.

9. Development of a National Land Use Planning and Zoning System

The main objectives of this action are:

a. Develop a national land use plan.
b. Achieve government enactment of a land use and zoning law.
c. Strengthen the capacity of the government department designated to monitor and follow-up the planning/zoning process.

The overall cost of the action is around $1.0 million.

10. Fighting Forest Fires

The main objectives of this action are:

a. Develop a forest fighting emergency unit at the Civil Defense Department.
b. Develop a volunteer fire fighters programme to support the Civil Defense Department efforts.

The overall cost of this action is estimated to be in the order of $5.0 million.

11. Preservation of Forest Lands

The main aim of this action is to prohibit the use of Jordan’s remaining forest lands for any other use and to declare forests protected areas, like the nature reserves.

The cost of this action is estimated at around $1.5 million.

12. Environmental Impact Assessment of All Infrastructure Projects

The aim of this action is to ensure that all negative environmental impacts of infrastructure projects are identified and mitigated at the design stage. The overall cost of this actions is estimated at around $0.5 million, mainly for capacity building and training.

13. Promotion of Public Awareness and NGOs

The objective of this action is to create public pressure groups and strengthen appropriate NGOs to monitor the environmental effects of industry, agriculture, mining and urban development. The overall cost of this action is around $0.6 million.

14. Range Land Development

The aim of this action is to involve target groups in range land development planning, project design and implementation. The overall cost of this activity is estimated to be around $0.5 million.

15. Development of Regulations to Control Urban Industrial Pollution

The specific objective of this action is to set regulations and standards for industrial and municipal waste treatment and for industrial and vehicular emissions. The overall cost of this activity is estimated at around $1 million.

16. Establishment of an Environmental Monitoring System

The goals of this action are:

a. To provide line ministries with monitoring facilities.

b. To regulate industry to provide data on air, wastewater, gaseous and dust emissions.

c. To develop a national data bank for environmental monitoring.

The overall cost of this action is estimated to be around $4.0 million.

17. Reduction of Methane Emissions and Utilization of Municipal Waste for Energy in Amman

The aim of this action is to reduce the amount of GHG in Jordan by utilizing methane gas, produced from anaerobic digestion of municipal waste in Amman, for electricity generation and the production of organic fertilizers.

The project will be funded by UNDP's Global Environment Facility, at a total of $2.5 million, with the Danish government possibly sharing $1.5 million of the cost.

18. Replacement of Old Vehicles

A law to replace old passenger vehicles with modern cars was passed in 1995. The law exempts the owners of old cars from all taxes as an incentive to encourage them to replace them with new ones. The total number of passenger cars (taxis and point to point service) in the Kingdom is around 18,196 vehicles. To date, around 3,700 vehicles were replaced. By the year 2000, the total number of cars to be replaced is estimated to be around 8,000. CO_2 reduced is estimated to be around $ 413 tonnes/year. The overall cost of this action is estimated at around $68.0 million.

11.2 Financial and Technological Needs and Constraints

11.2.1 Technology Inventory

In Jordan, as everywhere else, almost all economic activities affect emissions and some affect the removals of greenhouse gases. However, some sectors, like energy, industry, transportation, forestry, agriculture and waste management, are generally more climate relevant than others and deserve special attention with regard to the transfer of environmentally sound technology. On this basis, it is necessary to collect information from different sources in the country and to prepare an inventory and an assessment of the already available technologies before considering the transfer/retrofit of the existing technology.

In some sectors, limiting GHG emissions is technically feasible; it is certainly logistically and financially difficult due to the legal and institutional measures affecting the transfer and operation (adaptation) of the new technologies, and the added new investment cost. In order for Jordan to fulfill its obligations under the UNFCCC, financial and technological support (on grant basis) is necessary to ensure technology transfer, for example, for building institutional capacity, establishing/strengthening research centers and funding demonstration projects that mitigate climate change.

11.2.2 Improvement of the Quality of Future Communications Reports

Determining the full implications of the greenhouse gas emissions of an energy system using IPCC Bottom-up methodology requires examination of every phase of the whole energy chain, from the supply side of the energy system (i.e., resources extraction, refineries, electric power plants), to the demand side (i.e., industrial plants, residential and commercial units). ENPEP and IMPACT modules were used to calculate GHG emissions from the energy sector. During the preparation of the 1994 GHGs inventory, two sources of emission factors were utilized viz, IPCC guidelines and the generic facility database of IMPACT module, wherever IPCC emission factors did not apply or were not available.

In order to improve the quality of future communications reports, it is necessary to determine local/regional emission factors. Efforts are under way to prepare a project proposal in this respect, to be financed by the GEF. The project is divided into three parts; the first part covers emissions from energy production and consumption, the second focuses on process and area source emissions, the third is concerned with emissions from agriculture and land use changes. The overall cost of this project is estimated at around $0.55 million.

Another project proposal being prepared, when completed, is expected to upgrade future communications reports. The project is entitled “Impacts of Climate Change on Water Resources of Jordan”. The results obtained would identify the areas of potential vulnerabilities and determine future adaptive responses and adaptation strategies. It would also help evaluate the sensitivity of the water resources system to climate changes. The overall cost of this research project is estimated to be around $0.1 million.

11.2.3 Technological Constraints

The constrains listed below would be addressed to facilitate adequate adaptation of clean technology to meet the obligation of UNFCCC:

1. Environmental Technology Assessment

The analysis of a technology's implications on human health, natural resources and ecosystems would help make informed choices on processes that are compatible with the sustainable development concept. Environmental implications of various processes must be known before selecting new technology; that would help identify environmental hazards associated with the processes, reveal possible social consequences and evaluate cleaner production characteristics.

2. Lack of Information

Small and medium enterprises in Jordan account for a large percentage of economic activities. It is difficult to influence their behavior due to their small size, their isolated nature and, usually, to their limited access to necessary information pertinent to environmental issues. Therefore, it is vital to build up a national information system that would help raise their awareness and support them in their endeavour to meet specific needs.

3. Commercial Transborder for Transfer of Environmentally Sound Technology

Access to, and transfer of, patent protected environmentally sound technologies and economically feasible technology and know-how is not readily accessible.

4. Incentives should be established for private sector activities that advance transfer of technologies that address climates change and their adverse impacts.

11.3 Adaptation Measures and Response Strategies

These are taken provided that external financial resources are made available to assist Jordan to implement the following, but not limited to, measures to reduce the GHGs emissions in the following economic sectors:

11.3.1 Energy:

One) Fuel Switching

1. Jordan's energy strategy recommends to increase the utilization of renewable energy to cover 5% of the national energy balance by the year 2000. One biogas demonstration plant at Rusaifeh landfill is being constructed to utilize methane gas generated in the landfill (7,800 m^3/day) and produce electricity (1 MW) at an overall cost of $5.2 million.

According to the "Electricity Generation Expansion Requirements" study, the first oil shale fired power plant may be introduced in the power generation system in the year 2005, with a net capacity of 90 MW. Natural gas will be used only on newly added combined cycle units and not to replace fuel oil in the existing power units. Combined cycle units are expected to enter the system in the year 2006. The share of fuel oil fired power plants is expected to drop from 65% in 1994 to around 21% in 2023. The government is in the process of negotiating natural gas supplies to the Aqaba area with both Egypt and Qatar. Natural gas from Egypt is expected to be supplied by pipeline, while LNG would be imported from Qatar**.**

Two) Energy Efficiency

Major industrial establishments (oil refinery, cement producers, and phosphates company) initiated work to increase energy efficiency, reduce energy losses and hence reduce greenhouse gases emissions. International technical assistance is very much needed to expedite their efforts in this respect.

Three) Renewable and Indigenous Energy Sources

The Renewable Energy Research Center at the Royal Scientific Society installed various solar and wind energy technology systems at Tal Hassan station, 13 km north of Azraq. The objective of this project was to test system components, system optimizing and system monitoring under field conditions. The Royal Scientific Society intends to upgrade this station to become a regional training center in the field of renewable energy technologies. International technical assistance is needed to realize a significant increase in the share of renewable energy in the energy supply system.

Four) Restructuring the Domestic Water Network

Restructuring the distribution system would solve the problems existing in the water supply system; it would imply rectifying the snags in the hydraulic system and is expected to produce an immediate reduction of at least 33% in leakage levels, while also providing means to achieve further reductions.

Restructuring will also provide an energy efficient distribution system and a sound basis for future extension of the system.

The immediate benefits of the system operating with intermittent supply are difficult to be estimated since it is not possible to directly compare the existing system with the restructured one; however, some comparison figures of the two systems, shown in Table 11.1, demonstrate that the restructured system reduces leakage.

Table (11.1)
Difference in Volume and Cost of Distribution Losses

	1	2	3 [= 1-2]
	Existing Distribution Areas	Restructured Distribution Zones	Reduction
Distribution losses: m3/y x 1,000 %	68,637 49%	22,794 23%	45,843 26%
Cost [JD/y]	27,010,983	8,956,419	18,054,564

A simulated comparison of the two systems yields a leakage reduction of around 46 million cubic meters/year, valued at 18 million dinars/year.
Table 2 shows the cost and electricity consumption difference between the existing and the restructured distribution systems calculated for a production equivalent to 130 /I/c/d at the 1995 population of 1,556,375. The comparison is done by applying to the 130 I/c/d production the factors for the kW/cubic meter from the existing system and the restructured system. The respective power requirement for each system and power difference between the respective systems are priced and shown in the last column of Table 11.2.

Table 11.2 Simulated Comparison between Electricity Consumption of Existing and Restructured Distribution Systems

	A	B	C	I	E=[D/	I	G=[F*	H=[H3-H	I
	System	Operati Conditi	Volun (m3/y)	Po (k/w)	Factor power utilize [kW/m3]	*Vo at 130 I/ [cm/y]	Simulat power requireme 130 I/c/d [kW	Power Differ [kW .hr]	Energy Co (JD/y)
	Existing	Simulated Continuous year 19	177,538,9	1247	7.03E-05	73,8 4	5190	45468013	
	Re-struc	Year 2000	166,416,1	3927	2.36E-05	73,8 4	1743	15265820	
	Saving								1,087,279

Notes: * Using 1995 population of 1,556,375
** Cost per kW/hr taken as $0,0507

The energy costs related to pumping are expected to be reduced by 30,202,194 kW hr/year, valued at $1,531379/year. On the basis of the projected benefits, the payback period for the investment is unlikely to exceed 10 years.

If all the potential benefits of the process are to be fully exploited, it is necessary to see restructuring in the wider context of a rehabilitation strategy. Essentially, the restructuring will guarantee immediate savings in water, through reducing leakage, and energy consumption. Consequently, the CO_2 reduction cost is estimated at $706 per tonnes.

Five) Public Awareness

The government, in cooperation with the National Electric Power Company, and in response to UNFCCC obligations, prepared a public awareness programme focusing on the role to be played by the general public, the consumer, in increasing energy efficiency and reducing energy losses and greenhouse gas emissions. The programme also targeted the energy production, industrial, transport, household, water pumping and agricultural sectors.

The awareness campaign made use of:

1. Distribution of energy conservation brochures.

2. TV spots on ways and means recommended to conserve energy in all economic sectors.

3. Tackling the electric sector's activities, on demand side management (DSM), and the energy conservation practices in all sectors.

4. Interviews with top ranking NEPCO officials, to introduce the awareness campaign to the general public.

11.3.2 Transport:

One) Improving Vehicle Fuel Efficiency

In 1995, the government passed a law which encouraged taxi owners to replace their old cars with modern cars by exempting the purchase of a new taxi from all taxis and duties. To date, a total of 3,700 old taxis have been replaced. By the year 2,000, the total number of taxis to be replaced is expected to reach around 8,000.

Two) Traffic Congestion Reduction

In order to ease traffic congestion, the Greater Amman Municipality has completed several projects (construction of bridges and tunnels) and has computerized the traffic lights at certain locations with a high density of vehicles during rush hours. This reduced considerably road congestion, minimized time spent in the traffic and, hence, reduced energy use per passenger-seat-kilometer.

Three) Public Transport

The government recognizes the need for a major upgrading of the road transport system and for additional links to serve the evolving regional market. A number of vitally important projects are planned but in view of their high overall cost, the government is seeking a mix of private donors whose financing would supplement its own contribution.

While repairs and construction of most new links in the road system is the public sector's responsibility, the government plans to shift funding for the maintenance of the road system to road users. This would be done through road-user toll charges that will be channeled to and through a Road Maintenance Fund. The money thus obtained could be then managed on a more commercial basis with the involvement of the private sector and the road users.

The rapid construction of the Shidiya rail line is critical to the future of the railway sector. The government is considering private financing as part of a concession agreement for private operation and maintenance of rail services on this line.

Other priority investment projects in the transportation sector include restructuring the public transport and development of a light-rail system. The planned expansion and development of the Aqaba Port, vital to Jordan's export-led development strategy, includes the construction of new jetties for passengers, industrial usage and special-cargo handling. Similarly, planned expansion and upgrading of the Queen Alia International Airport should play an important role in facilitating the arrival of tourists. The government envisions that a substantial part of this planned development will be financed by domestic and foreign private sectors. The Aqaba International Airport is also under consideration for development with private sector participation.

The light rail system project includes: the construction of a 42-Kms light rail system (LRS) in the greater Amman area and Zarqa; supplying the required rolling stoke; and managing operation of the system. The project was divided in three stages: L1, L2, L3. The construction cost of the project is about $65 million. Between 20 and 53 rail cars have to be purchased; the cost of each was estimated to be about $1.8 million.

A feasibility study, based on a public transport survey carried out by the Ministry of Public Works and Housing, was prepared by Austria Rail Engineering in 1996. Accurate and up-to-date data was provided for simulating future passenger traffic within the project area.

The total population of Jordan, according to the Population and Housing Census conducted in 1994, is 4.1 million, of which about 38% live in the Amman Governorate (1.57 million). Adding the population figures of the adjoining Zarqa Governorate (0.65 million), it is clear that 53% of the Jordanian population will be affected by the new public transport system.

Improving efficiency is one of the important goals of all development plans in Jordan. Thus, in the transport sector, the government is considering the introduction of double-deck buses in Greater Amman and other municipalities to reduce fuel consumption, achieve greater efficiency and reduce GHG emissions. The government is also restructuring public institutions that deal with transportation with a view to improving their efficiency and gradually eliminating subsidies, recovering costs and adopting commercial performance criteria.

Improvement-oriented investment will continue to be crucial to the process of upgrading efficiency and quality of service. Since transport and cost distribution account for a substantial share of the cost of delivered goods, the transport sector itself has to be competitive to economize on the use of scarce resources, increase market-oriented activities, with a view to encouraging regional and rural development, and enhance competition. In short, investment in upgrading the transport sector is necessary to enhance the supporting role provided by the transport sector in the development of the economy and to maintain Jordan's key position as a transit country.

11.3.3 Industry

One) Improving the Performance of the Refinery

Jordan's energy-related pollution problem stems from the refinery. It is the place where crude oil is processed and purified in order to improve its performance and reduce emissions during its subsequent use in all downstream sub-sectors. With appropriate investment in modern processes, the refinery's contribution to local emissions could be substantially reduced. Detailed studies undertaken by the government, in cooperation with the refinery personnel, advocated immediate investment required for the following:

- Expansion to meet increasing demand for products.
- Improvement of product quality.
- Reduced refinery emissions.

The following table indicates the size of the investment required for the different refinery processes.

Table (11.3)
Investment Levels

Required Investment	$ Million
Distillation capacity *	80 - 140
Sulphur recovery plant	5-10.0
Merox upgrade	1.0
Continuous catalytic reformer - i.e., platformer	85.0
Hydro desulphurisation for diesel	50-60
Modern fluid catalytic cracker	200
Isomerisation unit	30.0
Alkylation unit	30.0
Hydrocracking	100.0
Gasification**	225.0

Note* atm. and atm. + vacuum distn
Note** approx. for 350 MW equivalent capacity

Two) Energy Efficiency

Increasing energy efficiency, reducing energy losses and greenhouse gas emissions in large industrial establishment in Jordan depends on the availability of external financial and technical aid; these act as an incentive for minimizing GHG emissions in a cost-effective manner.

Three) Industrial Establishments

Small and medium industrial establishments account for a large percentage of the industry sector. Therefore, it is extremely important to seek international technical assistance to determine the means to reduce GHG emissions in a cost-effective manner.

11.4 Agriculture

One) Research and development programmes are continuing; their aim is to attain sustainable agriculture.

Two) Forest management practices, including afforestation and reafforestation policies that expand carbon storage in the forest ecosystem, including soils, were adopted.

Three) Afforestation and desertification control is an ongoing activity.

Four) Development of green spaces in urban areas is also pursued constantly.

11.5 Waste Management

Steps were taken to reduce emissions of methane through recovery and use.

12. PROJECTS

The following projects, in Table 12.1, have been identified at this stage; more projects are to be identified and formulated in the near future.

Table (12.1)
List of Projects

COST (MILLION $)	PROJECT
2.5	Crude distillation unit preheater for the charge heater 301H1
2.74	Co-boiler for the fluid catalytic cracking unit
26	Heat Recovery from Sulfur Acid Plant / Jordan Phosphate Mining Company
2.17	Power supply by photovoltaic system to remote villages
1.6	Exploration for geothermal energy in Jordan
0.894	Salt-gradient solar pond pilot plant
2.4	Reverse osmosis water desalination
0.7	Regional training centre in the field of renewable energy
0.1	Impact of climate change on water resources of Jordan
0.6	Measurements of GHG emission factors for identified source-sectors in Jordan
80-140	Expansion of distillation capacity
5-10	Sulphur recovery plant
1	Merox upgrade
85	Continuous catalytic informer
50-60	Hydro desulphurisation for diesel
200	Modern fluid catalytic cracker
30	Isomerisation unit
30	Alkylation unit
100	Hydrocracking
225	Gasification

12.1 Crude Distillation Unit Preheater for the Charge Heater 301 H1

12.1.1 <u>Objective:</u>

To recover heat from the heater's effluent gases by means of an air preheater, thus conserving energy and, consequently, reducing flue gas emission.

12.1.2 <u>Background:</u>

The charge heater 301 H1 is the largest fired heater at the refinery and serves Topping-3, is a crude distillation unit of 10,000 T/D throughput. The absorbed heat duty of this furnace is 40.7 million KCal/hr and it has a 77% efficiency. Cooling of the stack gases to 200úC in an air preheater for the air of combustion will increase the furnace efficiency to 88%, thus contributing to energy conservation and reduction in flue gases emission.

The main design parameters for the air preheating installation are based on data collected with the Crude Distillation Unit operating at full capacity.

12.1.3 <u>Environmental Impact:</u>

Present fuel consumption	130 T/D
Expected fuel consumption	113.8 T/D
Fuel oil saving in tonnes	16.3 T/D
	5380 T/Y
Reduction in CO_2 emission	16730 T/Y

12.1.4 <u>Economic Aspects:</u>

Fuel oil saving in dollars	538000 $/Y
Increase in power consumption	96000 $/Y
Increase in maintenance cost	100,000 $/Y
Net savings	342,000 $/Y
Estimated required investment	2,500,000 $
I.R.R	5%

12.1.5 <u>Conclusions:</u>

- Installing the air preheater will reduce carbon dioxide emission by 16,730 tonnes/year.

- If the project is subsidized by $1 million, the IRR will increase to 19%.

12.2 CO- Boiler for the Fluid Catalytic Cracking Unit

12.2.1 <u>Background</u>

The Fluid Catalytic Cracking Unit incorporates a generator where coke is combusted and heat generated. However, there is significant loss of heat, through the regenerator stack, by the flue gases which are discharged in the atmosphere at a temperature of 670úC and contain substantial amounts of carbon monoxide. In this project, and in order to maintain the CO combustion, the regenerator gases must be heated to 800úC by firing supplementary fuel gas before heat is recovered in the CO-boiler. At the unit's designed feed rate of 640 T/D, the quantity of fuel gas required is 140 kg/h and the estimated rate of steam generation is 14 T/h.

12.2.2 <u>Environmental Impact:</u>

Based on the assumption that one tonne of fuel oil produces about 15 T of steam.

Reduction in fuel oil consumption	7391 T/Y
Reduction in CO_2 emission	22989 T/Y
CO_2 generated by combusting 140 kg/h fuel gas	1108 Tonnes
CO_2 generated by combusting CO	185000 Tonne
Overall reduction in CO_2 emission	3380 Tonne/Year

12.2.3 <u>Economic Aspects:</u>

Value of steam generated	638872 $/Y
Cost of supplementary fuel	126000 $/Y
Maintenance cost	110000 $/Y
Net annual saving	402872 $/Y
Required investment	2,740,000 $
IRR	7%

12.2.4 <u>Conclusions:</u>

- The project will reduce the CO_2 emissions by 3,380 Tonnes/Year.

- IRR 7%.

12.3 Heat Recovery from Sulfuric Acid Plant/Jordan Phosphate Mining Company

The main aim of this project is to utilize the waste heat from the sulphuric acid unit at the fertilizer compound in Aqaba to desalinate sea water. Desalinated water would be used as a process water and for domestic purposes. It is expected that the proposed desalination unit would produce 5 MCM/year at a cost of $26 million.

12.4 Power Supply by Photovoltaic Systems to Remote Villages

12.4.1 Project Description

The proposed project (henceforth referred to as the Project) is intended to supply electricity produced by photovoltaic (PV) systems to public facilities and residents in selected villages in remote regions, where no electricity is currently available. PV systems are designed to generate electricity by converting light energy directly to electric energy by using PV devices.

Basically, small-scale PV systems will be installed on the premises of each customer, with ownership retained by the utility. The electricity is provided on a fee-for-service basis. (Grid-connected applications are also possible, although, in this case, construction of a local distribution grid will be required).

12.4.2 Background

1. Current situation in the power sector

Under the supervision of the Ministry of Energy and Mineral Resources (MEMR), Jordan Electricity Power Company and Irbid District Electricity Company (IDECO) are responsible for public power service in the country.

NEPCO is in charge of the generation and transmission of power to the nationwide interconnected system. It also distributes power to most of the country, including the rural regions. NEPCO is a private distribution company in charge of the country's most affluent regions, including the capital, Amman. IDECO distributes power in the northern district of Irbid.

The country had a total generation capacity of 1,265 MW, in nominal terms in 1996, of which about 1,100 MW belong to NEPCO. IDECO has an installed capacity of 6 MW. Industries and municipalities own the remaining 159 MW. The largest power station is the Hussein Thermal P.S., with an installed capacity of 395 MW, the second largest is the Aqaba Thermal P.S., with a capacity of 263 MW. (See Exhibit 1 for Electrical System in Jordan, page 133).

The country's total electric energy production in 1996 was 6,085 GWH, 7.7% up from the previous year. Approximately 92% of the production was attributable to NEPCO. With regard to the electric energy source (type of generation employed), about three-quarters of the electric energy was produced by steam generation units (heavy oil) and less than one-fifth by gas turbines (natural gas). Diesel oil gas turbines and diesel engines accounted for most of the remaining share. The peak load of the interconnected system was 941 MW in 1996, as compared to 794 MW in the previous year.

The total electric energy consumption was 5,122 GWH in 1996, as compared to 2.910 GWH in 1989. This represents an annual increase of 8.3% during the intervening five years. About half the consumption was attributed to the region where NEPCO serves; IDECO sold 517 GWH and 377 GWH in the two above-mentioned years, respectively. Industrial use accounted for 35% of the total consumption, domestic use for 30%, and water pumping for 18%. The average per capita consumption was 1,152 kWh. The electric energy demand is projected to increase to 7,600 GWH in 2000 and to 10,800 GWH in 2010.

2. Problems to be solved in the sector

Important problems awaiting solution in the county's power sector include:

1. Air pollution from thermal power plants
2. Unstable supply of fuel oil
3. Difficulty in electrifying small, remote villages

The first problem arises from the use of fuel with high content of sulfur and the fact that no desulphurization system is installed at the existing power stations. As steam generation units are being replaced gradually by gas turbines, that use natural gas, and other types of generation, the problem will eventually be solved.

The second problem is considered to be more serious. Since the Gulf war, in 1991, the only pipeline bringing crude oil from Saudi Arabia to Jordan has been shut down. Jordan is currently dependent on oil imported from Iraq by road tankers.

The third problem concerns mainly supplying power to bedouins and people in remote villages, where no electricity is served. There are many such villages, particularly along the borders with Iraq, Syria and Saudi Arabia. It is too costly to provide electricity to those villages by expanding the existing national grid. About 170 villages of the total 992 in the country have not been electrified yet.

3. Necessity and importance of improvement in the sector, which led to the formulation of the project

The government regards electricity as one of the basic needs for the welfare of the citizens, one without which no decent standard of living can be ensured. Therefore, it considers it its major responsibility to provide electricity to every citizen of the country. The project, though, being a quasi-pilot project, is concerned with only few of the villages that are not yet electrified. The project is expected to pave the way for the fulfillment of this responsibility.

The government hopes that similar projects, which also utilize solar energy, but on a much larger scale, will follow after the project.

When the project is implemented, power will reach the inhabitants of the villages concerned, as well as public facilities which provide basic social needs for the inhabitants and the bedouins who live in the surrounding area.

Availability of power will make it possible to establish additional public facilities, including clinics and telecommunication centers, which are essential for a decent community life. With the help of the Project, both efficiency and effectiveness of the provision of social services will be improved.

Efforts have been made towards rural electrification for many years. As a result, approximately 97% of the population is now reached by electricity. The government launched a new campaign in 1992 to facilitate electrification of more remote areas. It was envisioned that all villages with 20 houses or more will be electrified by the end of 1995. However, the objective was not easy to attain because of the remoteness of those villages, away from the existing national grid. Even if small, independent power systems are built with diesel generation units, the cost for the transportation of fuel and for operation and maintenance (O&M) will be prohibitive, compared to financial benefits.

The Project which applies PV systems for rural electrification will be a breakthrough. The use of solar energy has several advantages over conventional systems. First, no fuel is required. Fuel costs saved can be spent on other urgently required projects in the sector. The O&M is much easier than for diesel jets. Similarly, the O&M costs are much lower than those of conventional power systems.

The Project is also responsive to the government's stated policy regarding environmental protection and sustainable development. The Project will not affect the environment neither globally nor locally. Considering the fact that the existing power plants continue to pollute the air, the country needs an environment friendly power source like the one found in the Project.

Power demand in rural villages is characterized by a high demand for a short period of time, because of the limited types of electrical appliances used. PV systems, which can store electricity in batteries, are ideal in this situation, whereas diesel power systems are not. It is expected that the Project will be an example which exhibits a significant improvement in rural power services.

4. **Relations between the sector and the Project**

The Project is important for the development of the power sector. Expectations for the Project are high, since it is anticipated to demonstrate the viability of the application of PV systems for the rural electrification in Jordan. The Project will also be significant for the sector as an instance of renewable energy application, which the government strongly advocates.

12.4.3 **Objectives of The Project**

The Project has short-, medium- and long-term objectives; they are briefly described below.

i- Short-term objectives

Short-term objectives of the Project include the following:

One) To provide electricity, as one of the basic needs for a decent life, to inhabitants of the villages concerned.

Bedouins who may settle down in or around the villages can also benefit from the electricity installed.

Two) To provide electricity to public facilities that serve various domains, like education, medical care, communication, to the benefit of the village inhabitants and of the bedouin population living around the villages.

ii- Medium and long-term objectives

Medium- and long-term objectives of the Project include the following:

One) To facilitate the general welfare of bedouins by helping them meet their basic social needs.

Two) To promote economic development in and around the villages.

Three) To reduce disparities in the social and economic development of urban and rural regions.

Four) To promote environment friendly power systems.

Five) To save foreign currencies for other vital needs, by reducing imported fuel bills.

Six) To attain sustainable development.

Provision of power is the most important part of infrastructure for economic development. The Project will contribute indirectly to the increase in the production of livestock farming, while bedouins, with an improved living standard, will participate in the market economy, which will result in further economic development.

iii- Relations between the Project and objectives

The Project is the optimum option that will help achieve the objectives stated above. It is also in line with all related government policy goals and it will contribute towards those goals in an effective fashion.

12.4.4 Project Sites

Thirty eight priority sites (villages) for the implementation of the Project have already been selected. Basic data on the priority sites is presented in Exhibit 2 (see also location map). The sites are located in remote areas and the cost of transporting diesel to these villages would be considerably high. In most of the villages there are presently one elementary school and a small clinic.

12.4.5 Project components

PV systems will consist of:
1. PV panels
2. Storage batteries
3. Charge controllers
4. Inverters
5. Wiring, fuses and switches

As part of the Project, local personnel will be formally trained to act as local maintenance technicians and supervisors of the installation of works. In addition, two mobile workshops will be required, one operating in the eastern part of the country, the other in the south.

The total power and energy demands are estimated respectively at 300 W and 1,520 Wh/day for each household (see Exhibit 4).

12.4.6 Implementation schedule

The Project includes the following steps:

1. Final selection of the candidate villages.

2. Specifying and designing the PV power systems and their components, according to the energy needs and the potential solar radiation.

3. Bidding for tenders and evaluation of offers.

4. Supply of PV systems and transportation to the selected villages. Installation of the equipment, including civil and electrical work, functional test, final inspection and instructions to users.

5. Documentation and final report.

The expected duration of the above steps is two years (see Exhibit 4).

12.4.7 Estimated costs

The total project cost is estimated at $3.5 million (in 1996 prices).

1.	PV system equipment and transportation costs	$1.600.000
2.	Installation/electrical work	$1.200.000
3.	Indirect costs and training	$700.000
	Total	$3.500.000

12.4.8 Benefits, Effects and Publicity of The Project

1. Population to benefit from the Project

The population directly benefiting from the Project includes residents of the villages concerned and bedouins who live around these villages. Better and more social services will become available to all.

The availability of power will make it possible to establish new public facilities for basic social services. Basically, those who are living in and around the villages will benefit from these additional services.

2. Population to benefit indirectly from the Project

3. When any economic development is induced, its benefit will be shared by many people, including the residents of the villages and those around them.

4. Economic and social effects of the Project

The Project will raise the standard of living of the affected population and secure its better access to social services. It will facilitate socio-economic development in the affected areas with no adverse effects on environment expected.

5. Publicity

Renewable energy technologies and the application of PV systems became important issues in the energy sector in recent years. The Project will receive wide attention from those who are involved in the relevant areas. Besides local press, journals in the relevant academic fields, including power and environment, are expected to tackle and follow the Project.

EXHIBIT (2)
Priority sites (village)

SN	Village Name	District	No. of Houses	L.V. PDES	Distance from Grid (km)
1	El - Eina	Karak	60	120	2
2	R. Al Shargia	Mafrak	18	120	29
3	G. Al- Gharbia	Mafrak	24	200	32
4	Rawdet Al- Bendan	Mafrak	12	50	21
5	Salhyet Al- Naim	Mafrak	33	50	21
6	Qatar	Aqaba	36	60	2
7	Ez- Heiqa	Tafileh	10	45	3.5
8	Ras Al- Naqab	Ma'an	4	15	10
9	Al Mafrak / Shehabia	Karak	12	80	2
10	Al Mwaqar	Amman	20	100	3
11	Hammam Al Shamot	Amman	10	70	4
12	Ghadeir Al - Naqa	Ajloun	8	35	3.5
13	Samra Marba Wahsh	Zarqa	12	72	3
14	Al Tafeh Al Janouby	Zarqa	8	48	4
15	Al- Tayar (3)	Zarqa	6	40	3
16	Fagou Ajhay Shamai	Karak	8	60	5
17	Hujaira	Karak	25	150	6
18	Afra Village	Tafileh	16	80	8
19	Al Burbatia	Tafileh	16	60	6
20	Al La Aban	Tafileh	8	100	9
21	Al Hareer	Tafileh	5	100	3
22	Zebaideh	Tafileh	6	30	3
23	Attwaneh	Tafileh	4	30	3
24	Emlaih	Madaba	4	50	4
25	Maghayer Enhanna	Amman	19	130	4.5
26	Arainbeh Gharbeyeh	Amman	14	100	4
27	Al Eqnatera	Amman	6	50	2.5
28	Al Ktaifeh	Amman	16	60	7
29	Al Ktaifeh/ Al Khbab	Amman	12	60	22
30	Ezmailat / Garagier	Amman	10	70	5
31	Al Emshagar	Amman	15	65	4
32	Al Mashta	Amman	13	35	3
33	Maysara (7)	Balqaa	4	40	3
34	Hamrethusen	Balqaa	8	60	5
35	Alkanesa	Ajloun	6	60	2.5
36	Shtttoura	Ajloun	10	45	5
37	Al Shra A/GAA	Mafrak	9	60	2
38	Ga Akhanna	Zarqa	11	70	6

EXHIBIT 3
Power and Energy Demand

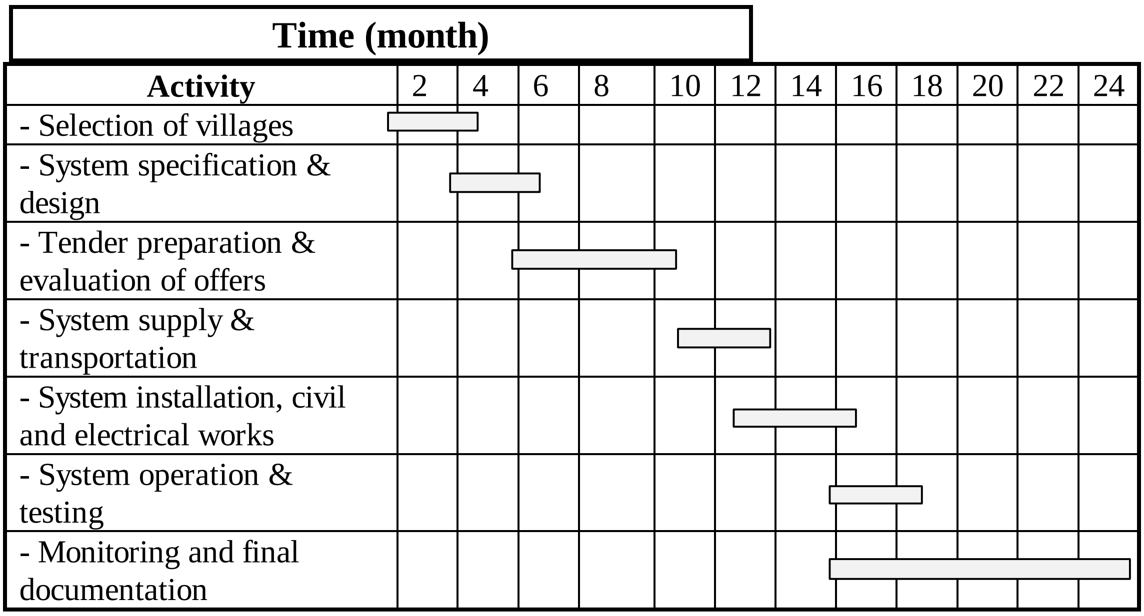
1. Households

Appliance	Unit	Power (W)	Hour of use (h)	Energy (Wh)
a. Lights	2	80	6	480
b. Fan	1	60	10	600
c. TV	1	80	4	320
d. Radio/cassette player	1	10	5	50
e. Other		70	1	70
Total		**300 W**		**1520 Wh**

2. Public facilities (e.g., elementary school and a clinic)

Appliance	Unit	Power (W)	Hour of use (h)	Energy (Wh)
a. Lights	3	20	6	360
b. Fan	2	50	6	600
c. Refrigerator	1	60	10	600
d. Radio/cassette player	1	10	5	50
e. TV	1	80	2	160
f. Other (e.g., tele-communications system)	1	500	0.2	100
Total		**720 W**		**1,870 Wh**

Project Time schedule



12.5 Exploration Regarding Geothermal Energy in Jordan

12.5.1 <u>Introduction</u>:

Several investigations regarding geothermal energy in Jordan have taken place over the last twenty years. The studies have generally concentrated on the Zarqa, Ma'in and Zara regions. Geothermal activity in Jordan is expressed entirely in the form of thermal springs; other geothermal phenomena, such as fumarolic activity and boiling mud pools, are not found in Jordan.

The location of nearly all of the thermal springs and anomalously hot boreholes is due to their proximity to the Dead Sea Rift. The thermal springs and boreholes are distributed along a distance of some 200 km on the eastern side of the rift. The temperatures of the springs range from slightly above ambient to 63úC in the major spring of Zarqa Ma'in.

The Zara and Ma'in hot springs, together with the Zarqa springs, form the main geothermal manifestation in Jordan (both in terms of temperature and flow). The area is located about 45km to the northwest of Amman.

From available evidence it is concluded that the thermal springs of Jordan are the results of groundwater in deep aquifers moving under regional potentiometric gradient towards the Dead Sea Rift and ascending via faults.

There is no evidence, to date, of the existence of thermal waters substantially heated by volcanic material. However, in regional geothermal terms, Jordan is fortunate in two respects:

First, there are two regions in the country where the geothermal gradient is substantially higher than normal (up to 50 C/km has been calculated for one area) and, therefore, high temperature can be encountered at drillable depths.

Second, most of Jordan is covered by a thick layer of sedimentary rocks, including material with good aquifer properties.

If the aquifers maintain their water-bearing quantities at depths where useful temperatures are encountered, then the available geothermal resources will be significant. Information suggests significant quantities of water at temperatures in excess of 100 ú C are likely to present.

Geothermometers indicate that the waters feeding the Zarqa, Ma'in and Zara thermal springs originate at 100-110ú C and it seems reasonable to expect that aquifers at around 150ú C may exist. Higher temperatures can and have been obtained (e.g., 170ú CNE Jordan), but whether aquifers exist at the depth where these temperatures are encountered is entirely speculative. However, it is possible to use medium enthalpy water for electrical production (depending on temperature and flow).

12.5.2 Project Description

Objectives of the project

Most of the electrical power now being produced in Jordan is generated by imported fuel oil. If sources of geothermal energy could be identified and brought into production, the resulting benefits would contribute substantially to the following objectives:

a- Reduced electric energy cost.
b- Establishment of an indigenous source of base load energy.
c- Diversification of energy resources.
d- Reduced impact on the environment.

However, the immediate objective of the project is to identify geothermal drilling targets by advising the Natural Resources Authority (NRA) on the execution of appropriate geological, geophysical and geochemical studies in areas to be selected after evaluation of all previous activities and documents.

The project would also assist the NRA in interpreting the data resulted from the above-mentioned studies by providing the necessary equipment.
A follow-up stage will be required to assist the NRA in drilling exploration holes and in evaluating the results of drilling.

12.5.3 Work Plan

Proposed area of the project

a- The area located east of the Dead Sea.
b- Northeast part of Jordan.

Phase I

Review and evaluation of available geological, geophysical, geochemical and hydrogeological data. Based on the results of the evaluation, an exploration programme has to be prepared for the proposed areas or any promising additional areas.

Expected duration of this phase: 2-3 months.

Phase II

Execution of the prepared exploration programme which, most probably, will include geological, geophysical, geochemical and hydrogeological studies.

The results of the studies will be integrated to define the target areas for deep drilling.

Expected duration of this phase is one year.

Phase III

Drilling of projected deep wells to a depth not less than 2,000m.

Carrying out different geophysical logging, including temperature measurements.

Carrying out the necessary tests in case of positive results.

Submitting a final report with all the results of the above-mentioned studies and recommendations for further phases.

Duration of this phase is at least one year, depending on the proposed drilling programme.

Jordanian Input:

personnel:

Two geologists.
Two geophysicists.
One hydrogeologist.
One geochemist.
One chemical engineer.
Geophysical crew (upon request).

Equipment:

All ground geophysical equipment is available.
Office and field facilities.
Transportation in the field.

Foreign Input:

Personnel:

One geologist.
One geophysicist.
One hydrogeologist.
One geochemist.
Drilling expert.

At least 24 persons/months are needed.

Equipment:

Heat conductivity meter for rock samples and any additional equipment needed.

- Drilling of at least two deep boreholes.

12.5.4 Project Cost Estimation:

Jordanian Contribution	US $
Personnel	100,000
Equipment	30,000
Office & field facilities	20,000
Transportation	50,000
TOTAL	**200,000**

Foreign Contribution	US $
Experts	150,000
Air tickets	025,000
Equipment	025,000
Drilling	1,200,000
Total	**1,400,000**

12.5.5 Environmental Aspects

Geothermal fluid is a cause of possible pollution of the environment. Drilling wells, testing the productive ones and constructing energy distribution and conversion systems can pollute the environment. These activities disturb vegetation and the environment, scatter dust, cause noise, etc. All this, however, is limited to the time when the activity takes place. Since there is similarity with other industrial activities, the entire matter can easily be kept under control.

On the basis of the above considerations, the analysis of the various environmental problems connected with the utilization of geothermal sources will be limited to the operational period of the plants, during which the fluid evolves in the various components and systems.

12.5.6 Conclusion

The project proposal offers some interesting economic possibilities. It will make it possible to produce geothermal heating power for different purposes.

The proposed programme of drilling and testing will produce data enabling water resources to be exploited rationally and reliably over the long term.

With this in mind, the initial project could form the beginning of a long collaboration, with the goal of managing water resources, be they destined for geothermal heating or for human consumption.

12.6 SALT-Gradient Solar Pond Pilot Plant

12.6.1 Introduction

Research on solar ponds started as early as 1960. The sharp escalation of energy costs during the 1970s brought more interest in solar ponds which can provide an alternative source of energy for generating electricity, heating green houses, etc.

There are several types of solar ponds, namely, salinity solar ponds, stratified solar ponds, shallow solar ponds, fresh water collecting solar ponds and advanced solar ponds. The type and size of the solar ponds are determined by the required heating load and the use of such load.

Solar gradient solar ponds are attractive, low-cost solar collectors for Jordan, when designed in connection with the Dead Sea. Potential applications include: electricity generation, heating green houses to prevent freezing during winter and industrial production of some chemicals from the Dead Sea.

12.6.2 Objectives

The long-term objective of the proposed project is to develop a national capability to design and build solar ponds for various energy purposes, while the immediate objectives are:

1. To learn as much and as quickly as possible about the technical, practical and economical aspects of the solar ponds by actually constructing demonstration pilot solar ponds.

2. To monitor the operation of the pond over a period of one year to determin the operating characteristics, including water and salt make-up requirements.

3. To improve, develop and modify components in order to obtain an optimal system.

4. To prepare designs and plans for larger pilot plant.

5. To train personnel on the design and operation of solar ponds.

12.6.3 Implementation Plan

The proposed project could be implemented through the execution of the project phases and work packages outlined below; the time schedule is explained in the next section. However, at designated intervals (worked out upon the approval of the project), as well as at the conclusion of each technical phase, a project review board will meet to discuss the progress and affect any modifications that are deemed necessary.

PHASE I

Preparation:

This phase should result in the assessment, testing and evaluation of the Dead Sea brine and of the soil at the proposed site, in dissemination specific information on the site, training study team members and designing pilot ponds.

This phase consists of the following work package (WP):

WP100 :

Study of the thermal and physical properties of the Dead Sea brine.

Most of the existing solar ponds utilize sodium chloride in creating storage and gradient zones where the properties are well known. However, in the proposed project, the Dead Sea brine is projected to be utilized as a medium to create such zones where little data and information are available. Thus, a major study will be carried out to establish the following data:

One) **Density and static stability as a function of temperature**

This will include various brine concentrations, from zero up to 30%, at temperatures between 20 ú C to 110ú C.

Two) **Viscosity**

This parameter analysis if fairly easy to be determined; it is necessary for the dynamic stability.

Three) **Diffusion (thermal and brine)**

These parameters are also needed for dynamic stability; determining them involves multi-component diffusion.

Four) **Solubility and proximity to precipitation as a function of temperature**

Five) **Brine Composition**

WP 101:

Light transparency in the Dead Sea brine and clarification techniques and materials. It is important to improve the light transparency to permit maximum solar rays to penetrate the gradient zone and reach the storage zone.

WP 102:

Soil physical and chemical properties. Several types of tests will be performed on selected soil samples to determine the standard structural properties. There is the potential for interacting with Dead Sea brines to generate unwanted gaseous products and soil permeability upon exposure to heated brines. Gas evolution testing will consist of soil samples immersed in heated brine for periods of up to two months, with continuous monitoring for possible gaseous output.

WP 103:

Training members of a study team. The need for training stems from the fact that in Jordan, the technology of salt gradient solar ponds is not developed yet and many questions still exist. However, Jordanian researchers can benefit from their foreign counterparts' experience in this field. Training programmes will be outlined during the detailed work packages planning.

WP 104:

Design of solar ponds. It will include design of the base for lined and unlined ponds, plumbing, heat dissipation draining system, test programme, instrumentation, support facilities and utilities, filling techniques, selection of equipment, etc. The preliminary designs and blue prints can be performed in Jordan, but it would be helpful if experts assist in review, modification and approval.

An exact list of the necessary equipment and instruments should be also worked out during this phase.

WP105:

Site selection and preparation. It will include selection of site, excavation, leveling, roads, water pipes, electric lines, etc.

PHASE II

Construction & Operating Phase

WP 200:

Field construction of solar ponds and support facilities. It will include the physical construction of pond facilities, placing the instruments and equipment in position, plumbing, lining the line ponds, compacting the unlined ones, constructing brine and fresh water tanks, pumps, and having the ponds ready for filling.

WP 201:

Initial operation. The ponds will be filled according to the preplanning filling techniques, observing brine and salinity quality. In addition, a shake down test, establishing gradient zones and maintaining them, is part of this work package.

WP 202:

Test of components. Data-collection equipment, weather data, salinity and other components have to be fully tested prior to regular monitoring and data collection.

WP 203:

Material compatibility. The Dead Sea brine is very corrosive. A survey of APC brine compatibility data will be made and material will be selected. The selected material will be subjected to bent and straight coupon exposure tests. The test will be conducted using Dead Sea brine and diluted brine at various temperatures (20-110 úC)

WP 204:

Data collection and analysis. This is devoted to research and development. It consists of data collection, monitoring of variable measuring parameters and observing the gradient zone depth for potential leakage.

WP 205:

Maintenance. This is to adjust the ponds according to the local environment conditions, optimize the pond operation and achieve a better efficiency.

PHASE III

Large Pond Design, Construction and Potential Application Study

WP 300:

Design of a large unlined pond. The execution of this work package depends mainly on the second phase and on the successful operation of the unlined ponds.

WP 301:

Construction of a large, unlined pond. The construction will be similar to that of the small, unlined pond and the site will be in the vicinity of the prototype pond.

WP 302:

Initial operation; it will include the filling operation of the pond under static condition.

WP 303:

Heat extraction. Will include several types of heat exchangers for studying the energy extracted corrosion, fouling, etc.

WP 304:

Potential application study. Will identify possible areas of application of such technology and type of application.

WP 305:

Manufacturing cost. The cost of energy delivered by such technology will be studied and compared to systems using conventional energy.

WP 306:

Plant manual. A manual has to be written to include all parameters, operation material selection, maintenance, recommendations, etc.

12.6.4 Budget

The total cost associated with this project, according to the work plan and duration, is estimated at $ 633,000 (JD=0.7$) distributed as follows:

First year

1-	Construction	200,000
2-	Materials	100,000
3-	Salaries	036,000
	Subtotal	$ 336,000

Second year

1-	Instruments	150,000
2-	Salaries	036,000
3-	Computer	060,000
	Subtotal	$ 246,000

Third year

1-	Salaries	036,000
2-	Publication cost	015,000
	Subtotal	$ 051,.000

TOTAL	$ 633,000

Table (12.1)
Project Time Schedule
Time (Month)

Description of activities	4	8	12	16	20	24	28	32	36
Thermal and physical properties of brine									
Light transparency									
Soil characteristics									
Meteorological									
Design of solar ponds and support facilities									
Site preparation									
Construction of ponds and facilities									
Initial operation									
Test of components									
Material Compatibility									
Data collection & analysis & maintenance									
Design of a large unlined pond									
Construction of a large pond									
Initial operation of a large pond									
Heat extraction									
Market study & manufacturing cost									
Plant manual									

12.7 Reverse Osmosis Water Desalination (ROWD) with Renewable Energy Hybrid Systems in Remote Areas

12.7.1 Introduction:

The shortage of drinking water in the Middle Eastern countries, especially in Jordan, is considered a very serious problem. The issue of drinking water in the Middle East plays a major role in the bilateral and multilateral peace process. One of the proposed solutions for this problem is water desalination and treatment, due to the fact that Jordan has a high proportion of brackish and salty water.

The government of Jordan is giving great consideration to the utilization of brackish and salty water. It is proposed to utilize small- and medium-scale reverse osmosis (RO) technology systems for water treatment and desalination. It is deemed that the utilization of renewable energy (RE) hybrid systems, solar and wind, to supply the RO system is feasible.

Jordan has a long experience in RE application, but it does not have the experience in utilizing the small- and medium- scale RO systems which are powered by RE systems. Here, it can be said that treatment and desalination of brackish and salty water using RO systems, powered by RE hybrid systems, can contribute considerably to covering part of the drinking water requirements in Jordan and in the countries of the region, since:

- The source of salty water is available in Jordan and the region.
- The government of Jordan is very interested in utilizing brackish and salty water.
- The inhabitants of remote areas, that have salt water, are in need of drinking water.

12.7.2 Objectives:

- Providing the technical reliability and economic feasibility of small-scale ROWD systems powered by renewable energy (solar + wind) systems.
- Transferring technical know-how on ROWD.
- Contributing to solving the brackish water problems for the inhabitants of remote areas.
- Securing environmental protection and sustainable management of natural resources.

12.7.3 **Work Content**

The scientific focus of the project is the use of RE (solar + wind) to power small- and medium-scale RO systems for desalination and treatment of brackish water to produce up to $100m^3$ /day drinking water.

The process of RO is used to separate two homogeneous fluids with the help of a membrane. The propelling force of hydrostatic pressure is applied to enable different components to permeate the membrane, while others are retained. When the pressure required to reverse the flow of fluid with osmosis can no longer be ignored, compared with the working pressure, it is known as Reverse Osmosis (RO). This is usually the case when removing or concentrating low-molecular components such as salts, lyes, etc., which can already develop significant osmotic pressure levels at low concentration. See figure (1).

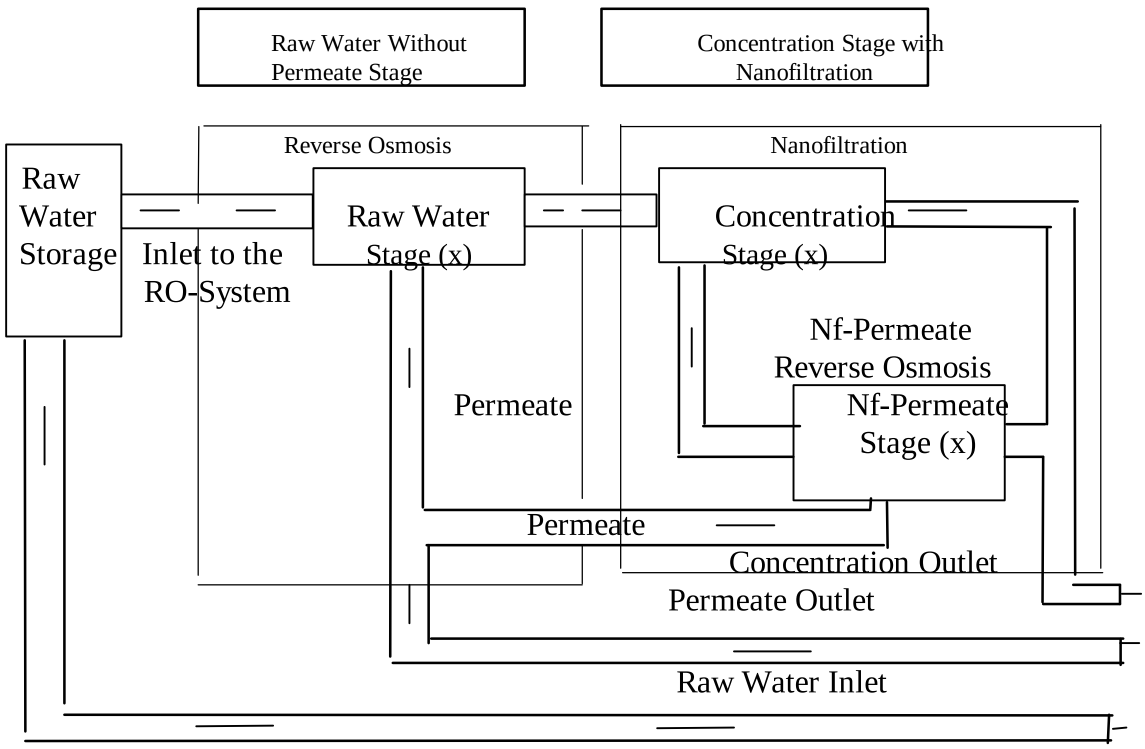


Fig (1) : Principle of water desalination using the RO system

The whole system will be powered by RE system. The RE power can be a hybrid solar and wind system or a single solar wind system, depending on the potential of wind energy and solar radiation in the selected site of the project.

The project is divided into the following steps:

1. Selection of the location and determination of solar radiation and wind energy potential and water quality (analysis and evaluation of water samples).

2. Specifying and planning the RO system, calculating the needed energy for such system.
3. Specifying and designing the power supply system based on the needed energy and the potential of the solar radiation and wind energy in the selected site.
4. Coordinating and designing the whole plant.
5. Site preparation.
6. Purchasing the system components.
7. Building the plant and installing the measuring system components for control and testing.
8. Functional testing of the installed plant.
9. Collecting data and evaluating energy supply and water quality.
10. Optimizing the system's components and the system as a whole, relying on the results of the evaluation.
11. Noticing the improvements resulting from optimization.
12. Documentation and final reports.
13. Meeting for coordination, at least once a year.

The whole project is divided into three phases. The implementation period for each is one year. The first stage contains steps 1 to 6 and will be implemented in the first year, the second stage contains steps 7 to 8 and will be implemented in the second year, and the third phase contains steps 9 to 13 and will be implemented in the third year.

The time schedule for implementing the project is shown in Table 12.2.

12.7.4 Cost Estimation:

The steps listed in Table 12.2 should be carried out in order to implement the proposed project. The cost of the project components is estimated at $2,400,000. The cost break down is shown in the Table 12.3.

Table (12.2) Project Time Table

Phase No.	Steps No.	Description of the activities	Time: Year 1				Year 2				Year 3			
			1	4	8	12	1	4	8	12	1	4	8	12
1.	1.	Selection of the location, determination of solar radiation & wind energy potential, and the water resource & quality												
	2.	Specifying & planning of the RO systems, calculation of needed energy												
	3.	Specifying & designing the power supply system based on the needed energy												
	4.	Coordination & design of the whole plant												
	5.	Site preparation												
	6.	Purchasing the system components												
2.	7.	Building up the plant & installation of the measuring systems for control & testing												
	8.	Function test of the installed plant												
3.	9.	Data collection & evaluation concerning energy supply & water quality												
	10.	Optimization of the systems depending on the results of the evaluation												
	11.	Realization of the improvements concerning the optimization												
	12.	Documentation & final report												
	13.	Meeting for coordination												

Table 1: Time schedule for implementation of the proposed project

Table (12.3)
Cost Break - Down

NO.	Item of cost	Estimated cost ($)		
		Y1	Y2	Y3
1.	Meteorological data collection and evaluation, determination of the potential of water resources and quality. Site selection, infrastructure and site preparation. Specifying, planning and designing the systems of the whole project.	**600,000**		
2.	Systems (RO system, power supply system, control and measuring systems purchase and installation) and training activities.		**1,.300,000**	
3.	Executing field tests, data collection and evaluation, systems optimization, realization of the improvements, documentation, final report, official meetings.			**500,000**
4.	**Total**	**2,.400,000**		

Table 12.3: Estimated cost for implementation of the project

12.7.5 <u>Benefits</u>

By treating and desalinating brackish and salty water using RO systems, to produce drinking water, a double profit is gained: on the one hand, the problem of brackish and salty water is solved, on the other, clean water can be supplied.

This has far-reaching positive effects. With the help of the desalinated water, remote areas which are not inhabited because of the shortage of drinking water, can be helped. Besides improving the supply of fresh water, the social and economic situation of the inhabitants in remote regions can also be improved. Another benefit of the project is that it utilizes renewable energy, which means minimal cost and no pollution.

The use of renewable energy for the purpose of water desalination is a novel project that presents interest to all sunny regions. Although the single components are not new, the combination of components (solar cells, wind energy converters, power conditioning units, batteries, pumps, etc.) sets high requirements on the know-how of electrical engineers.

The transfer of water desalination technology and the experience gained during the installation and operation of the plant can be used by other countries of the region with similar problems.

The concept of the project is not only to start a know-how transfer, but also to evaluate the project technical and economic feasibility.

12.7.6 Environmental Impact and Ethical Considerations:

Social Impact

If the project is carried out efficiently, the living conditions of the inhabitants of remote areas will be improved, drinking water will be made available, the time saved by the fact that drinking water was made available can be utilize for other activities, such as improving education and the income.

Environmental Impact

It has already been mentioned that water desalination has several positive environmental effects: use of renewable energies, sustainable management of natural resources and preservation of soil. Sustainable management will be approximated both in the energy sector and regarding the material benefits.

12.8 Regional Training Center in the Field of Renewable Energy

12.8.1 Introduction

Within the framework of the R&D project in the field of renewable energy technology, which was designed and implemented by the Renewable Energy Research Center (RERC) of the Royal Scientific Society (RSS), various solar and wind energy technology systems were installed in Tal Hassan station, 13 km north of Azraq. The scientific objective of the project was to test system components, system optimizing and system monitoring under fields conditions. After completion of the R&D activities, RSS intends to upgrade the station to a regional training center in the field of renewable energy technologies as the project integrates different solar and wind energy systems in a remote area which has ideal climate conditions for measuring, testing and evaluating solar energy systems. Such a centre is needed in view of the widespread use of the solar energy systems, particularly their multiple applications in Jordan and other countries of the region. This means that there is great need for various training activities for decision makers, engineers, technicians and students who work in this field.

The United Nations Educational Scientific and Cultural Organization (UNESCO) approved the transformation of the center into as a regional training center on renewable energy in a cooperation agreement signed with the RSS.

12.8.2 Objectives

- Building Arab capability in the field of renewable energy technology.
- Studying the technical and economic feasibility of the systems in utilizing renewable energy sources.
- Evaluating and developing these systems to generalize their use in the region.
- Exchanging the experience and studies in the field of renewable energy between RSS and other institutions through the participants and lecturers in the training programmes.
- Intensifying scientific and technological cooperation in this field between RSS and similar institutions.

12.8.3 Training Needs

Estimates on quantified needs for Jordan, for the countries of the region and worldwide came to the conclusion that about 200 decision makers, engineers and technicians per year might request training. In addition, 50 to 100 students and a similar number of end users can be considered.

12.8.4 <u>Present Tal Hassan Station</u>

The RSS station at Tal Hassan has a 50,000m^2 area which has been cultivated and planted with different kinds of trees (fruit and forest trees) suited to the climate of the remote areas of Jordan. The station consists of the following systems:

- Solar passive building designed to utilize developed materials' passive features and insulation materials.
- Solar thermal system for hot water heating system with 60m^2 of locally made solar collectors.
- Cooling system with 3 desert coolers.
- Mechanical wind pumping system with a locally made windmill and two (55 m^3) water storage tanks to deliver an annual average of 40m3/day of water for drinking and irrigation purposes.
- Stand-alone wind farm for water pumping and heating purposes. This system consists of two electrical wind energy converters, the rated power of each is 20kW.
- Photovoltaic pumping system to deliver an annual average of 40m^3/day of water.
- Photovoltaic power supply system to provide the necessary power of resistive and inductive loads (220/380 Vac) with a daily load of 43,78 kWh/day for electrification and power supply of different electrical equipment.
- Electrical wind energy converter systems with a medium-scale down wind machine for generating electricity and water pumping with rated power of 10 kW.

The station is also well equipped with measuring and monitoring devices and recorders.

12.8.5 <u>Project Requirements</u>

The following additional equipment is requested to upgrade the Tal Hassan station to a regional training center in the field of renewable energy:

- Small demonstration systems for training purposes, such as small solar home systems, small solar water pumping systems, small solar flat plate collectors systems, etc.
- Additional measuring and calibration equipment.

- 10 personal computers and software for simulation of system design, load, etc.

- Electronic and mechanical workshop for small repairs.

- A lecture hall furnished with the necessary facilities.

12.8.6 Teachers' Curriculum

In principle, the teachers (lecturers, instructors) can be provided by the RSS, mainly by its RERC. For special lectures, teachers or experts might be invited from the countries of the region or even from Europe. The curriculum development will be worked out according to the target group requirements.

12.8.7 Method of Implementation & Expected Duration

The implementation programme of this project consists of the following phases:

Phase 1: Determine the systems and their specifications, design the systems, tender documents, tender invitation, collect and evaluate the quotations and purchasing the systems.

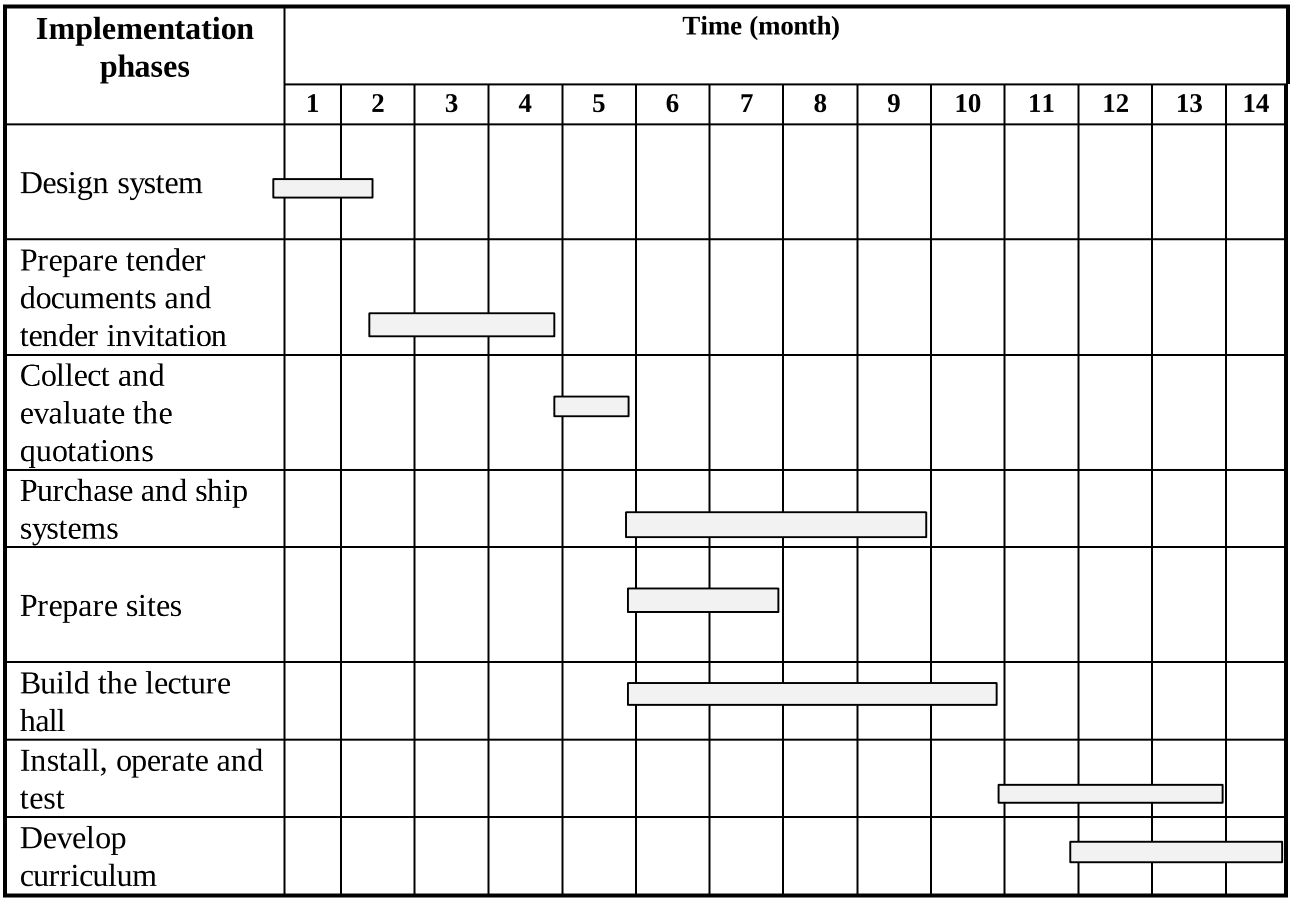
Phase 2: Prepare the sites for the systems and build the lecture hall.

Phase 3: Ship and install the systems and execute the operational and functional test.

Phase 4: Prepare and develop the curriculum for the training courses.

The expected duration for the implementation of the entire project is 14 months, as shown in the following table:

Table (12.4)
Project Time Table



12.8.8 <u>Estimated Costs</u>

The estimated total cost for additional equipment needed by the project is $700,.000, as shown in the following table:

Table (12.5)
Project Cost Estimated

Requirements	**Cost ($)**
Small demonstration systems	150,000
Measuring and calibration equipment	50,.000
Personal computers and software for simulation of systems design, load, etc.	100,000
Electronic and mechanical workshop for testing and repair	50,000
Building of lecture hall (15-20 persons)	80,000
Manpower	120,000
Pilot phase of training for one year	130,000
Development of curriculum	20,000
Total	***700,000***

Annex (I)

Energy and Power Evaluation Programme (ENPEP)

Abstract: Demand Module (Energy Demand Analysis)

<u>Objective</u>

This module allows definition of energy-demand sectors and their base-year energy consumption by fuel type. All base-year fuel-consumption data must be calculated exogenously; the DEMAND Module allows formulation of previously computed values for use by the Balance Module. Fuel-consumption data is specified in physical units (such as barrels); conversion factors are required to change these physical units to either the metric system [tonnes of oil equivalent (TOE)] or barrels of oil equivalent (BOE). All subsequent computations use either thousands of TOE or thousands of BOE.

<u>Approach</u>

With this module, energy from 38 fuels can be distributed among 48 consumption subsectors that are grouped in 9 major consumption sectors. The names of any of the fuels can be changed using the appropriate data entry form. The names of the default sectors are Industry, Commercial and Institutional, Agriculture, Mining and Quarrying, Transportation, Households, Rural Communities and Energy Export, plus one of one's own definition.

Once the base-year fuel requirements for each major consumption sector have been specified, there is the option of dividing these sectors into 72 useful energy demand (UED) categories, such as motive power, steam production and street lighting. Then, efficiencies of fuel-to-UED conversion processes can be specified and the fractions (splits) of fuel that are to be allocated to specific UED categories can be established. The DEMAND Module has two major alternatives that allow projection of either useful energy demand or fuel consumption. If fuels are allocated to UED categories, the efficiencies and splits are used to generate a table of the aggregated base-year useful energy demand for each of the nine major consumption sectors. This aggregation is done by summing each UED over all fuels that are allocated to that UED category. If one chooses not to split fuel consumption into the useful energy categories, but instead choose to project fuel consumption, a table of base-year fuel consumption for each of the nine major sectors is generated. The end result in either case is a table of base-year energy (fuel or useful energy) requirements by sector.

Once this table has been created, an equation for each entry in the table can be specified. These equations are used to apply the growth rates to each base-year energy (fuel or useful energy) requirements in order to calculate energy requirement projections in each of the major sectors. Growth rates from the MACRO Module, which are stored in the ENPEP Data Dictionary and labeled in a MACRO report, are available when these equations are specified. The energy growth rate in any year is computed by using a linear combination of growth rates from up to two MACRO variable growth rates (Mrate l and Mrate 2) in the same year:

Energy growth rate = (1+Mrate 1) x (1+Mrate 2) x (1+Mrate 3) -1

The three elasticity values a, b, and c are entered in a corresponding form; they are used to calculate projected energy growth rates (in percentages) and projected energy requirements (in TOE or BOE).

A report generated after this step of the Demand Module is completed contains a table of projected energy requirements and growth rates for each of the major energy sectors. These growth rates are labeled, placed in the Data Dictionary, and made available to the BALANCE Module. A table of these growth rates can be viewed or printed and any of these values can be graphed on screen or a plotter.

<u>Functions</u>

The specific functions of this model are:

* By means of data entry forms, specifying the following information:

  1-Energy units, fuel names and characteristics (such as heat content).

  2-Energy demand sector and subsectors.

  3-Base-year fuel consumption by energy sector.

  4-Fuel to useful energy demand efficiencies and fractions.

* Previously defined macroeconomics growth rates (obtained from the MACRO Module) are applied to base-year useful energy (or fuel consumption and unique growth rates are labeled for later use by BALANCE.

* Resulting energy consumption values can be tabulated or graphed.

* Any modifications made to a specific case study can be saved and the new data can be saved in a planning-study subdirectory.

Annex (II)

Energy and Power Evaluation Programme (ENPEP)

Abstract: Macro Module

(Macroeconomics Analysis)

Objective

The objective of the MACRO Module is to formulate macroeconomics growth projections to assist in developing energy demand estimates. MACRO is not an economic planning model or a forecasting model, but simply an analytical methodology for making use of macroeconomics growth data derived from such models or from other estimates.

MACRO is based on the assumption that energy growth is driven by macroeconomics variables, such as population, gross domestic product (GDP), or sectoral GDP. After the macroeconomics growth data is formulated by MACRO, it is passed to the DEMAND Module from where it can be retrieved to project energy demand growth.

Approach

Specifying the planning period, the local currency and the local-to-U.S. currency conversion rates enables one to formulate three types of macroeconomics variables: GDP, population and special growth rates in the GDP; population and special categories can be specified in one of two ways: Either by entering exogenously calculated absolute values (such as $ millions) for each year of the study period (in which case MACRO computes the growth rates), or by specifying a base-year absolute value and a series of growth rates to be applied to that value (in which case MACRO computes the absolute values).

Once these macroeconomics growth rates are computed, MACRO prints, labels and stores each of them. The labels can be used later in the Demand Module, where they generate energy demand growth rates.

Functions

The specific functions performed by the MACRO Module are:

- It enables specification of the years in the planning period and the local-to-U.S. currency conversion rates.

- After specifying the GDP by sectors and subsectors, the GDP growth rates can be specified in one of two ways: either by entering a series of exogenously calculated GDP values or by entering a base-year value for each of the subsectors and their associated growth rates (again, exogenously calculated).

- As with GDP growth rates, exogenously calculated population growth rates, that are divided into several categories (such as urban and rural), can be entered.

- As with GDP and population growth rates, up to 10 additional sets of special growth rates that may not logically fall into the GDP or population type of data categories can be specified.

- Once these macroeconomics growth rates are computed, MACRO prints, labels and stores them; the labels can be used later in the DEMAND and IMPACTS modules, where they generate -energy demand growth rates.

- Any modifications made to a specific case study can be saved and data can be saved back to the planning study subdirectory.

Annex (III)

Energy and Power Evaluation Programme (ENPEP)

Abstract: Impact Module

Once an energy system configuration has been designed, the environmental impacts and resource requirements of that configuration must be evaluated. Frequently, an energy system that is designed solely from the energy supply perspective cannot be implemented because of environmental constants or resource limitations. The IMPACTS Module is designed to assess these effects. Facilities of both energy supply systems and energy consuming systems can be included in the IMPACTS analysis. For example, coal mines, power plants, refineries and natural gas lines may be included as supply systems. Industrial boilers, residential space heaters and automobiles may be included as demand facilities. IMPACTS will determine the impacts of all these types of facilities. It carries out five major functions:

Develops facility build schedule. As with other modules in ENPEP, the IMPACTS Module may be run in conjunction with other modules or in a stand-alone fashion. IMPACTS and their energy use for up to 75 years of the analysis period. These facilities and energy use may be drawn from a BALANCE case, an ELECTRIC case, or input directly by the user. With the energy input and output, IMPACTS determines the build schedule for each facility. For example, it may have been determined from a BALANCE analysis that refineries will need to process a given amount of crude oil over the planning period. Using the typical size of these facilities, IMPACTS will determine the refinery build schedule.

The build schedule is used to compute impacts on a plant-by-plant basis, to allow for a geographical distribution of impacts, and to selectively apply regulatory control programms.

Assigns facilities to geographical regions. Each of the IMPACTS facilities can be located geographically to give an analysis of the spatial distribution of impacts. The regions and subregions are defined by the user. The location of facilities or individual plants that make up the build schedule can be assigned to each region.

Selects impact coefficients from databases. One of the biggest problems encountered while doing an impact analysis, particularly in developing counties, is the unavailability of a consistent set of data. IMPACTS addresses this issue by providing the user with two extensive databases that can be used directly or can be modified with local data. The databases are the Generic Energy Database (GED) and the Generic Facility Database (GFD).

The GED gives information on different forms of energy that can be used in the impact analysis. For each generic energy form, the GED gives a set of data that is needed to make the impact calculations. This data includes physical, cost and chemical content parameters. The parameters specified vary with the energy form.

The GFD gives data on typical energy facilities. This data includes information on the following impacts:

- Air pollutants
- Water supply and pollutants
- Land use
- Solid waste
- Resource requirements (labour and materials)
- Occupational health and safety

For each impact, information is given on uncontrolled conditions (e.g., air pollutant emissions, water pollutant emissions) and on available control techniques. Up to 10 control techniques are specified for each type of impact. The techniques may be in the form of add-on equipment (e.g., electrostratic precipitators, biological water treatment plants) or they may be operational procedures (e.g., the use of low excess air for nitrogen oxide air pollutant control). The process of selecting the technique will be discussed later.

The data in the GFD is specified in a form adapted to the size of the plant. For example, air pollutant emission factors are given in kg per GJ of energy input. This allows the information to be used when analyzing real facilities that are not exactly the same size as the generic facility. To allow for the limitations in scaling (e.g., scaling emissions from an 800 MW coal-fired power plant down to a 100 MW unit may not be appropriate), the GFD contains information on a range of facility sizes.

In using the GED and the GFD, the user simply identifies which generic energy and which generic facility are the closest to the actual facility under study. The model then copies all the necessary coefficients and scales them appropriately to the actual facility size.

Applies regulatory controls. For each of the impacts considered, regulations can be applied to reduce the environmental discharges or other effects. The type of regulation varies with the impact being evaluated. The regulations can be imposed singly or in combination. It is possible to designate regulations that will apply only to certain facilities or types of facilities, in designated geographical areas after a specified starting date, or to new, existing, or all facilities. This gives the user flexibility to apply different regulatory control programmes.

Computes impacts. Once the coefficients from the GED and GFD have been selected and the regulatory control structure has been established, IMPACTS proceeds to compute each of the impacts both with and without controls. This calculation is repeated for all pollutants, for all years of the analysis. It is also repeated for all facilities included in the study. The uncontrolled emission calculation is one of the basic output of IMPACTS. The next step is to apply the regulatory controls that have been specified.

IMPACTS first considers which of the regulations applies to the facility under study. The regulation's facility application, regional application, start year and applicability to new or existing sources is checked. If the regulation does apply to the facility, then an appropriate control device, from the list of those available for use on this facility, is selected. There are a series of decision rules that determine how devices are selected for both new and existing facilities. The basic principle is that the lowest cost device that meets the regulation is selected, where cost is calculated considering both capital and operating costs. The decision rules allow for situations where different equipment must be used to control different pollutants (e.g., electrostatic precipitators for particulate control and scrubbers for sulfur oxide control) and for situations where the user has specified a regulatory programme that cannot be met with any of the available devices. Once the control device is selected, IMPACTS recomputes the impacts, this time accounting for the effectiveness of the control equipment. Again, calculation is carried out for all pollutants, for all years, for the facilities. Calculations for all the other impact parameters are done in an analogous fashion.

In dealing with the impacts in this fashion, IMPACTS is said to address the "residuals" of the energy system. IMPACTS does not delve into the next steps of a complete environmental assessments by doing calculations of pollutant transport, population exposure or risk assessment. These are better left to other models for the time being.