

CHAPTER 8

NATURAL RESOURCES

8 . NATURAL RESOURCES

This chapter reviews the progress made in the development of the Kingdom's natural resources during the Third Plan period and outlines the strategy for their further development during the Fourth Plan period. Included in this review is a presentation of the main objectives, policies and public expenditure programs to be undertaken in the following sectors:

- Water
- Energy
- Mineral Resources

8.1 WATER

8.1.1 BACKGROUND

The availability of a reliable water supply of sufficient quantity and acceptable quality is a necessary condition for social and economic development in any country. The development of water resources is determined by a complex pattern of demand and supply relationships. On the one hand, population growth, living standards and economic development determine the quantity and quality of water demand; on the other hand, the availability, quality and cost of water influence both where this growth will occur and the nature of economic development. In a country with scarce and finite water resources, such as Saudi Arabia, the availability of water is a key element in determining the scale and location of longer-term development. Water planning is, therefore, an integral part of a comprehensive development planning process.

Four principal government agencies are involved in the planning, management, development, production and distribution of water supplies:

- the Ministry of Agriculture and Water (MOAW), the Saline Water Conversion Corporation (SWCC), the Ministry of Municipal and Rural Affairs (MOMRA) and Al-Hassa Irrigation and Drainage Authority (HIDA).

8.1.2 PRESENT CONDITIONS AND REVIEW OF THIRD PLAN PROGRESS

Rapid progress during the past decade led to an upsurge in demand for water, which has been successfully matched by an increase in water supply and the development of large-scale sewerage networks. This has been achieved through extensive public investment in the water infrastructure, so that by the end of the Third Plan period a reliable, high-quality piped water supply is available to most of the population throughout the Kingdom.

While the need for water conservation was recognized in the Third Plan, priorities for the water sector were oriented more towards resource development and were governed largely by the need to eliminate critical supply shortages in some areas. Furthermore, agriculture had been identified as a priority sector for investment and it was anticipated that this would lead to an increase in the demand for irrigation water. This demand, however, has been underestimated.

8.1.2.1 Development of Water Resources during the Third Plan

Water resources in the Kingdom can be divided into four categories: surface water, groundwater, desalinated seawater and reclaimed wastewater.

Surface Water

Surface water occurs mainly in the west and southwest of the Kingdom, where periodic rainfall is sufficient to produce runoff. Although current usage is much lower it is estimated that a potential surface water supply of up to 900 million cubic meters can be utilized annually through the efficient use of dams. Dam construction is important not only for the development and efficient use of surface water, but also for the purpose of protecting population settlements, roads and agriculture from the damaging effects of floodwater. During the Third Plan, 124 new dams were constructed. In addition, numerous water resources studies of wadi basins were completed.

Groundwater

There are two types of aquifer in the Kingdom: renewable and non-renewable. Most **renewable** groundwater is already in use for traditional agriculture and domestic purposes. It occurs generally in isolated aquifers, comprising alluvial deposits which follow the alignment of the wadi courses. The Kingdom's **non-renewable** groundwater is stored in principal and secondary aquifers, both of which receive no recharge. These aquifers currently supply over 70 percent of the Kingdom's water needs.

The Third Plan period was one of intense activity in the development of non-renewable groundwater supplies. These activities included:

- the completion by MOAW of detailed hydrogeological studies of the Um Er Radhuma aquifer and the Saq formation;
- the drilling of 715 wells for the purpose of water supply, aquifer testing and observation of water levels;
- the drilling of 162 wells by MOMRA for water supply to Riyadh and 57 wells in the Eastern Region;
- the development of a large number of agricultural wells by the private sector;

- the completion of large water supply projects by MOAW and MOMRA in cities and regions throughout the Kingdom.

While renewable groundwater supplies are estimated to continue at levels of around 950 million cubic meters per year, the intensive development of non-renewable groundwater during the Third Plan has resulted in a rapidly rising rate of depletion of this valuable resource. Proven reserves from the seven principal aquifers amount to 337,500 million cubic meters, as shown in Table 8-1.

Table 8-1

NON-RENEWABLE WATER RESOURCES

Principal Aquifer	Proven Reserves (million cubic meters)
Wasia/Biyadh	89,000
Wajid	69,000
Um Er Radhuma	65,600
Minjur/Dhurma	53,400
Saq	49,900
Tabuk	5,600
Dammam	5,000
Total	337,500

Together with secondary aquifers, total proven non-renewable groundwater reserves amount to approximately 500,000 million cubic meters.

Desalinated Seawater

Desalinated seawater has reached an advanced stage of development in the Kingdom, which now has the largest desalination plants in the world. By the end of the Third Plan almost 90 percent of SWCC's total planned desalinated water capacity had been installed and this source provided a significant addition to freshwater supplies. SWCC was operating 20 water desalination plants by 1405 — 15 on the West Coast and 5 on the East Coast. The large-scale plants implemented also have the capacity to produce electricity. Total 'exportable' (or useable) water capacity increased almost tenfold during the Third Plan period, to reach a level of around 400 million cubic meters per year by 1405. In addition to

those plants operated by SWCC, other government desalination plants include those operated by the Royal Commission for Jubail and Yanbu, MOAW, the Saudi Ports Authority, SAUDIA and ARAMCO. During the Third Plan, SWCC also completed the 460-kilometer dual water pipeline from Jubail to Riyadh, with a maximum design capacity of 830,000 cubic meters per day.

Desalinated water is blended with brackish groundwater to produce drinking water for domestic use in major cities. By 1405/06, this source will supply around 50 percent of the water demand of domestic users. However, because of the high costs associated with current desalination production technology and the long distances for conveyance, desalinated seawater cannot presently be regarded as a viable long-term substitute for groundwater in meeting domestic users' needs completely.

Reclaimed Wastewater

The reclamation of wastewater is in its early stages of development in the Kingdom, and requires extensive treatment and control in accordance with strict water quality standards. Advances in treatment technology and the improvement of sewerage networks during the Third Plan period have resulted in the ability to utilize this resource for irrigated landscaping and industrial uses, though not for human consumption. It is estimated that around 100 million cubic meters per year of reclaimed wastewater had been made available for use by the end of the Third Plan. These supplies are expected to double during the Fourth Plan and will be available near large cities.

8.1.2.2 Water Supply and Sewage Networks

The Water and Sewage Departments of MOMRA and the project execution departments of MOAW and HIDA completed extensive investment projects during the Third Plan, including water supply networks, and sewage and rainwater drainage systems in cities and regions throughout the Kingdom. In addition, many new reservoirs, sewage pumping stations and water purification stations were constructed.

8.1.2.3 Key Issues for Water Development

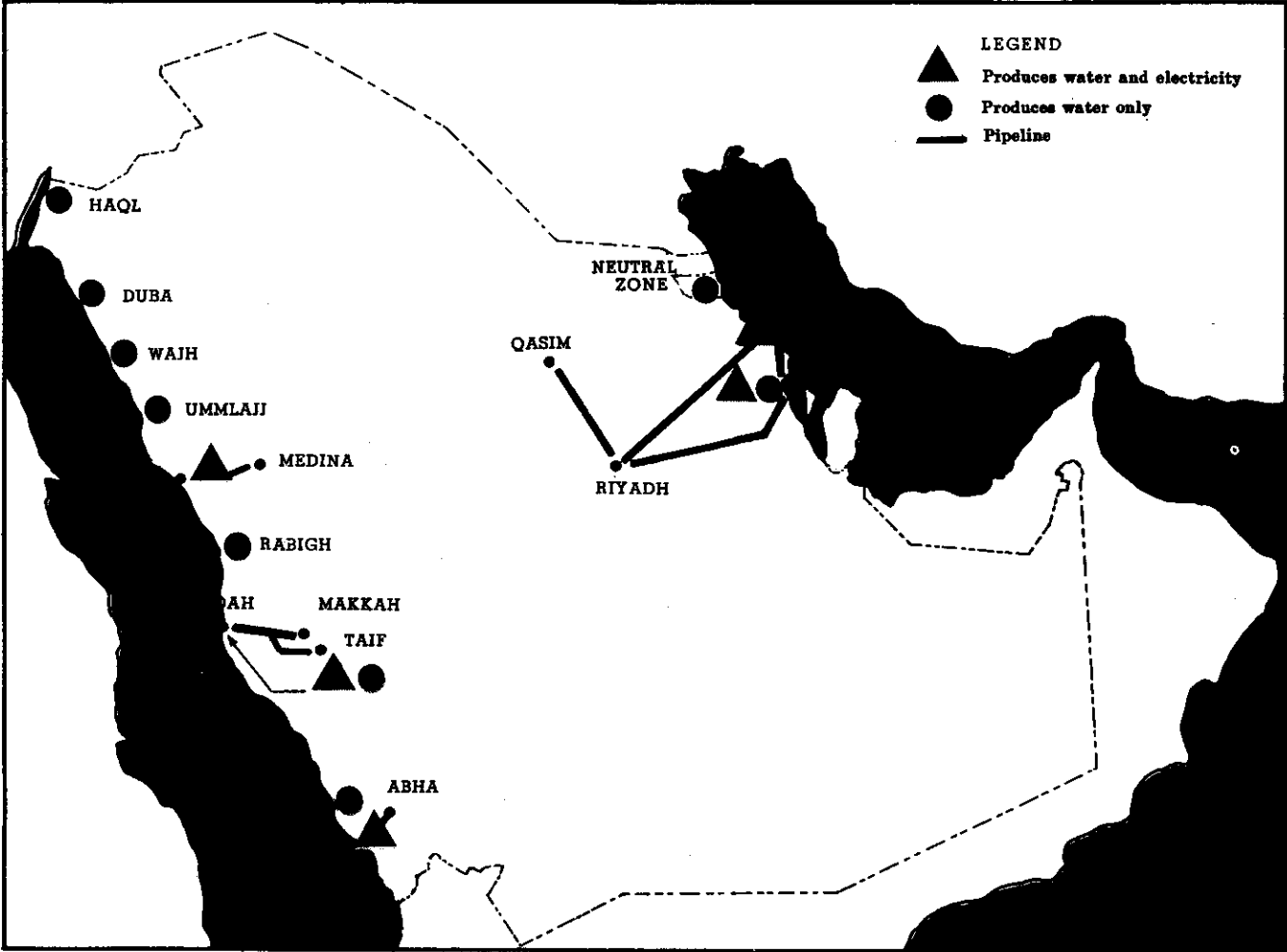
While the achievements described above confirm the substantial progress made in satisfying the water needs of the Kingdom's population, the rapid increase in water consumption raises some key policy issues for the further development of the water sector during the Fourth Plan period and beyond.

Water Resources - Demand Balance

In the water sector, a single policy issue dominates all others. This is the significant shift which has taken place in the Kingdom's water balance during the Third Plan period. Of the three end-user categories — domestic, agricultural and industrial — agricultural water demand rose fastest during

Figure 8 - 1

WATER CONVERSION PROJECTS: OPERATING AND UNDER CONSTRUCTION



the Third Plan. From less than 2,000 million cubic meters per year estimated in 1400, water consumption in agriculture rose to an estimated 7,430 million cubic meters per year in 1405, or 84 percent of total consumption. This rate of water consumption in agriculture is almost four times greater than anticipated in the Third Plan. As indicated in Table 8-2, over 70 percent of this water comes from the Kingdom's non-renewable groundwater reserves, currently estimated to be 500,000 million cubic meters.

Table 8-2

NATIONAL WATER RESOURCES - DEMAND BALANCE

	Million cubic meters per year		Percentage Share
	1400	1405	1405
Demand			
Agriculture	1,860	7,430	84
Domestic, Industrial, Other	502	1,400	16
Total	2,362	8,830	100
Resources			
Surface Water	485	900	10
Groundwater			
— renewable	660	950	11
— non-renewable	1,154	6,480	73
Desalinated seawater	63	400	5
Reclaimed wastewater	—	100	1
Total	2,362	8,830	100

During the first four years of the Third Plan, around 435,000 hectares of cultivable land were distributed to the private sector by the Ministry of Agriculture and Water. Over 90 percent of all land distributed has been in the Central, Northern and Eastern Regions, all of which rely mainly on non-renewable groundwater for their water needs. The spectacular growth in agricultural production, associated with the expansion in land reclamation, has led to extensive depletion of non-renewable water resources in some areas. As the aquifer depletion rates in several areas are approaching critical levels, immediate measures may be required for individual locations, such as controlling and rationalizing water consumption.

Table 8-3 shows the estimated water consumption by agriculture in 1404.

Table 8-3

AVERAGE WATER CONSUMPTION BY CROP (IN 1404)

Crop Category	Area (hectares)	WATER DEMAND		
		m³/ha/year	m³/million per year	Percent
Wheat	320,000	8,700	2,784	37.5
Coarse grains	144,600	9,000	1,301	17.5
Vegetables	74,600	15,000	1,120	15.1
Fodder	45,000	25,000	1,125	15.1
Dates and fruit	85,000	5,000	425	5.7
Other perennial crops and plants	67,500	10,000	675	9.1
Total Agriculture	736,700		7,430	100.0

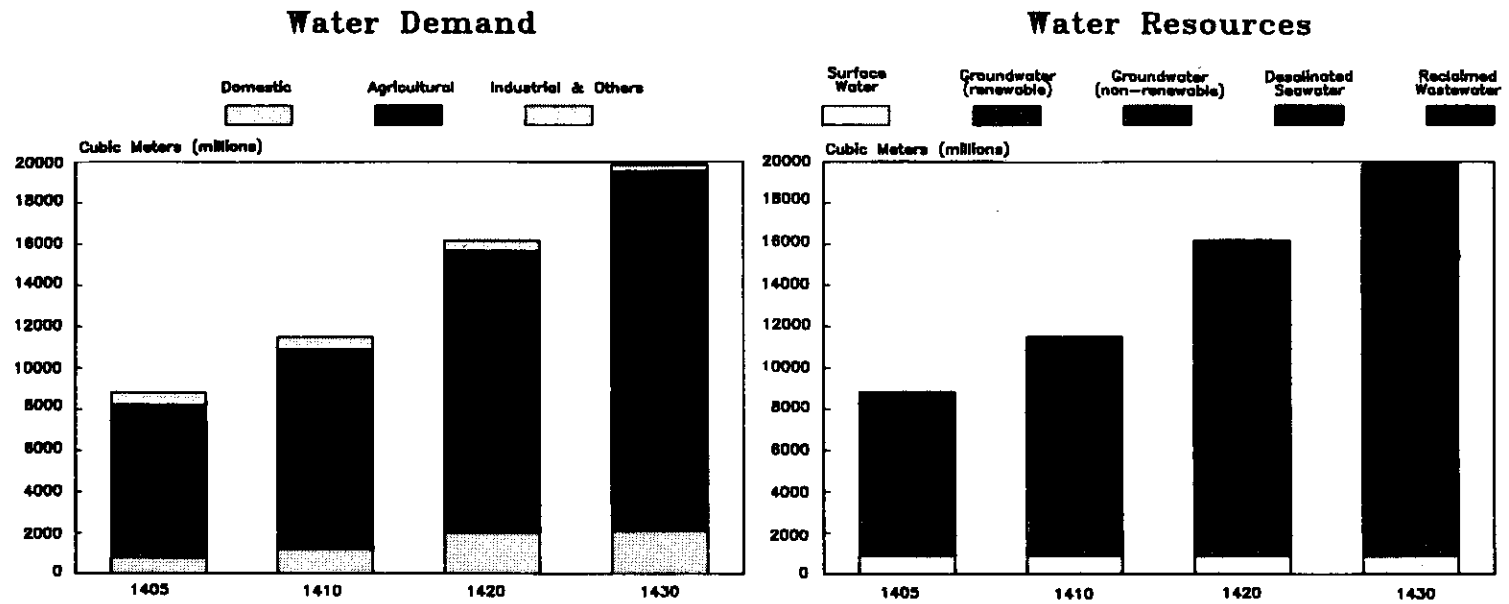
Coordination of Water Use

There are now some critical areas in the Kingdom in terms of a rapidly growing imbalance between water use and available water resources. With much of the water supply infrastructure already established, there is now a need to organize and coordinate all activities in the field of water, in particular to establish control of, to regulate and to rationalize water use. This is the task of the National Water Plan to be published by the MOAW, which will begin to create the necessary institutional and legal arrangements for its enforcement.

A further justification for the early publication of the National Water Plan is the need to coordinate the water supply activities of government agencies. Appropriate phasing of project implementation is a highly effective method of reducing costs. The early enforcement of the National Water Plan will partly ensure that the provision of services and expansion of capacity is not excessive to current and foreseeable requirements, as recommended by the first basic strategic principle of the Fourth Development Plan Strategy.

Figure 8 - 2

National Water Demand and Supply



Water Tariff

Throughout the Third Plan period water has been supplied free of charge to industrial and agricultural users. Charges to domestic consumers have been heavily subsidized. In addition, SWCC has been supplying desalinated water at no cost to the municipalities. While this policy has benefited all citizens of the Kingdom, it is conducive to waste. Furthermore, some sectors and consumers necessarily receive a disproportionate share of the benefits, which rise in direct relation to the volume of water consumed.

Water is a critical finite resource and its conservation must be encouraged. The most effective market-based scheme of incentives and disincentives is a progressive system of tariffs. Such a policy measure is in accordance with the third basic strategic principle of the Fourth Development Plan Strategy, which aims to reduce subsidy rates in ways that will rationalize consumption. Low-income consumers can be protected by applying only a small tariff for basic minimum needs. A progressive tariff rate was introduced towards the end of the Third Plan.

Water Administration

The first basic strategic principle of the Fourth Plan Strategy states that economic performance may be improved by developing appropriate administrative organizations to serve the new needs of the community. In this connection, a need has arisen to reassess the institutional framework of water administration in the Kingdom.

When the Ministry of Agriculture and Water was established over thirty years ago, it was impossible to foresee the increase in water demand, particularly in the agricultural sector, and the resulting pressure on the Kingdom's water resources. It was intended that MOAW's water supply functions would be limited when MOMRA was given the responsibility for developing water services in the defined growth centers. However, MOAW has retained most of its functions in the water supply and water network sectors, and continues to expand these functions, thus gradually acquiring a dominant position in the Kingdom's entire water infrastructure management. The function of drinking water distribution through networks to settlements belongs more appropriately within the jurisdiction of MOMRA. On the establishment of MOMRA's own administrative units, these functions will be handed over by MOAW.

Regional Development

While great progress was made during the Third Plan period in providing adequate and reliable water supplies to most of the population, many people living in small towns, isolated villages and rural areas are still facing water shortages. With the emphasis on regional development in the Fourth Development Plan, the government aims to redress this imbalance in meeting the basic water needs of the population. In this regard, almost 70 percent of planned expenditure by the Deputy Ministry of Water Affairs (MOAW) in the Fourth Plan will be towards the construction of drinking water supply networks, with special emphasis on small towns and villages in rural areas.

8.1.3 WATER DEVELOPMENT STRATEGY IN THE FOURTH PLAN

The Fourth Development Plan Strategy lays special emphasis on the rational utilization of scarce water resources. As future water supply will come largely from finite non-renewable reserves, the main focus of policy during the Fourth Plan period will be on the introduction of conservation measures, strict regional water management, the establishment of priorities in water use, the introduction of tariff systems and closer coordination of agricultural and water development plans. Such policy measures will be in accordance with the National Water Plan.

8.1.3.1 Objectives and Policies

Objectives

The development of the water sector during the Fourth Plan will be guided by the following major objectives:

- to meet the present and future water needs of society;
- to limit the development of all water resources to prudent levels and to effect their conservation in accordance with the long-term needs of the Kingdom;
- to enhance the utilization of existing water resources through the construction of dams for recharging aquifers, and through improved methods of collection, treatment and utilization of sewage water.

Policies

To achieve these objectives the following policies will be adopted:

- coordination of the development and utilization of all water resources under the guidance of the National Water Plan;
- maintenance of a reliable data base on water resources and demand — including aquifer characteristics, groundwater storage, water quality, change in water levels, rainfall, infiltration and evaporation — based on hydrological and hydrogeological studies;
- the continued implementation of projects which supply water from local resources, or from alternative resources, such as desalinated seawater, where the local groundwater supply is insufficient in quantity or quality, while giving highest priority to the water requirements of the population;
- the establishment of administrative units for the enforcement of laws, by-laws, regulations and water rights in accordance with established priorities for water use;
- monitoring the consumption of all water users and the quality of water used, through the installation of water meters and the preparation of a progressive tariff system in all sectors of water use;

- restriction of pumping rates in areas experiencing serious depletion of groundwater resources and deterioration in water quality, to levels which will sustain future water supplies, and the definition of short-, medium- and long-term pumping rates for all aquifers or parts of aquifers;
- the introduction of water-saving techniques through the establishment of national specifications and standards (in cooperation with SASO) for water quality, treatment and usage of sewage water, irrigation equipment, water supply and distribution works, plumbing in houses, factories and other buildings.

8.1.3.2 Programs

In accordance with the Fourth Plan strategy for the water sector, the above policies will be implemented through the following programs:

Water Management

This program includes the preparation and enforcement of regional master plans based on the National Water Plan. Its primary aim will be the rationalization of water use. Major elements of the program include:

- implementation of the National Water Plan, including the national water code (laws, by-laws and regulations);
- preparation of regional master plans for the water sector;
- regular assessment of water and agricultural policies;
- monitoring consumption in all sectors of water use;
- defining maximum pumping rates for aquifers and/or parts of aquifers;
- establishment and implementation of a water tariff system for all water users;
- definition and introduction of technical standards for water works and water quality.

Water Resources Development

This program comprises projects for the development of surface water resources by MOAW, both for direct use and to augment recharge to existing aquifers, reclaiming wastewater, and the establishment of a comprehensive water data bank. It also includes a program of HIDA for the collection and re-use of drainage water, and the treatment and use of reclaimed sewage water. Surface water development projects of MOAW will include wadi basin studies, in addition to the construction of dams for irrigation supply, flood protection and augmentation of recharge to shallow aquifers.

The application of technology for the reclamation of wastewater is relatively recent in the Kingdom, so the implementation of any major reclamation project will be preceded by economic and technical feasibility studies, which will also assess prospective impacts on the environment.

In this program, the important factor for the evaluation and development of water resources is the need for continuous control and monitoring of resources, to provide the data necessary for their optimal management.

Drinking Water Supply

This program of MOAW includes the design, construction and supervision of drinking water supply networks, including the drilling of wells. In accordance with a Royal Decree No. M/22 dated 23/6/1391 the task of supplying drinking water will be passed over to MOMRA, when it has established its own organizational structure for this purpose.

The program emphasizes the design, construction and supervision of supply networks in small towns and villages in rural areas. An additional element of this program is the preparation of a time schedule for handing over water supply project activities to MOMRA.

Operation and Maintenance

The water sector comprises an extensive and diverse infrastructure, which includes water supply and sewerage networks, wells, dams, pipelines, water treatment plants and desalination plants. An improvement in operation and maintenance performance is a necessary condition for the reduction of costs in line with the Fourth Plan Strategy. Special attention will be paid by all water sector agencies — MOAW, MOMRA, SWCC and HIDA — to *preventive* maintenance of the facilities, networks and installations within their authority. An important element of all maintenance activities will be on-the-job training of Saudi manpower.

8.1.3.3 Program Expenditures: Water Sector

The planned government expenditures for each water sector program during the Fourth Plan are shown below in Table 8-4.

Table 8-4

WATER SECTOR PROGRAM EXPENDITURES*

	Fourth Plan Total
	SR million
Ministry of Agriculture and Water (Water Affairs)**	
Water Management	90.0
Water Resources Development	2,260.2
Drinking Water Supply	6,814.6
Operation and Maintenance	652.2
Sub-total	9,817.0
Saline Water Conversion Corporation	
Development and Construction	14,156.2
Operation and Maintenance	5,563.8
Administration	1,216.2
Sub-total	20,936.2
Expected Revenues	320.5
Al-Hassa Irrigation and Drainage Authority	
Management, Operation and Maintenance	946.0
Research, Studies and Development of Water Resources	43.0
Construction	37.5
Manpower Development	10.0
Sub-total	1,036.5
Total	31,789.7

* MOMRA expenditures on water, sewage, rainwater drainage and flood control are shown in Table 13-10.

** Administration expenditures included in Agriculture sector.

8.1.3.4 Private Sector Considerations

The private sector participates in numerous activities related to the water sector. In the field of water resources development, all well drilling is carried out by private sector contractors. Dam construction and cleaning of dams, resources studies and design work are conducted by private sector companies. On the drinking water supply side, all projects are executed by the private sector, which also conducts many operation and maintenance activities. Future opportunities for the private sector will include activities related to water conservation, such as the introduction of applied technology in techniques of water-saving and water re-use.

8.2 ENERGY

8.2.1 BACKGROUND

The Kingdom is generously endowed with significant energy resources, most notably its deposits of crude oil and natural gas. Coal deposits have also been found in a number of locations in the Kingdom, although their commercial viability is yet to be determined.

The development of oil and gas resources is in many ways a partnership between the public and private sectors. ARAMCO, the government-owned oil company, the Arabian Oil Company and the Getty Oil Company are responsible for crude oil production, whereas refining, blending and exporting is under the control of a wider range of institutions: Petromin, multinational oil companies and the domestic private sector. Within the domestic market, Petromin is the sole marketing agency for refined petroleum, but in lubrication oils it faces private sector competition.

The high rates of insolation over a wide area of the Kingdom make solar energy a potential alternative energy source. Research and development programs have been undertaken for many years in solar electricity generation, solar water desalination, solar-assisted agriculture and solar hydrogen generation. In the long term, the finite nature of hydrocarbon resources will necessitate the development of viable alternatives, such as nuclear energy, which have not yet been used in the Kingdom.

8.2.2 PRESENT CONDITIONS AND REVIEW OF THIRD PLAN PROGRESS

8.2.2.1 Crude Oil

The level of Saudi Arabian oil production is heavily influenced by the state of the world oil market and OPEC policies. Since 1400, when Saudi Arabia's oil production peaked, its share of world production has fallen from 16.6 percent to 7.4 percent in 1404, and OPEC's share of world production has fallen from 45 percent to 31 percent over the same period. Table 8-5 summarizes the relative shares of world production.

Table 8-5

WORLD OIL PRODUCTION

	1975		1980		1984	
	mbd	%	mbd	%	mbd	%
Saudi Arabia	7.1	13.3	9.9	16.6	4.3	7.5
OPEC (Excluding Saudi Arabia)	20.1	37.6	17.0	28.4	13.5	23.4
Non-OPEC	26.2	49.1	32.8	55.0	40.0	69.2
Total World	53.4	100.0	59.7	100.0	57.8	100.0

Several factors have contributed to this decline. These include the increasing capacity of non-OPEC producers, particularly the North Sea countries, Mexico, Canada and Egypt; and also the softening of world demand for oil resulting from world economic recession, the development of alternative energy sources and substantial conservation measures. A strengthening dollar has also contributed to reducing demand by effectively increasing prices to most countries. Between 1980 and 1984, Saudi Arabia experienced a parallel fall in oil exports, which dropped from 9.2 mbd to 3.7 mbd of crude and from approximately 0.5 mbd to 0.4 mbd of refined products.

The revenue effects of lower oil exports have been compounded since 1983 by falling world oil prices. This is exemplified by a decrease in official prices from U.S. \$34 per barrel in 1982 to U.S. \$29 in 1983.

Main developments in exploration and production during the Third Plan

- Progress was made in achieving exploration targets. Between 1400 and 1403, exploratory drillings increased to an average of 9 per year, resulting in the discovery of 10 new fields. Crude reservoirs were discovered and additional resources established in 7 fields: Tinat, Amad, Al Aasbeh, Abu Jiffan, Al Gurdahy, Abu Sa'fa and Saffaniyah. Recoverable oil reserves rose by 12.0 billion barrels.
- To avoid reservoir damage, studies were undertaken on reservoir conditions, capacity changes and production optimization for major producing oil fields.

- In line with the Third Plan objective of increasing the proportion of heavy and medium crudes in exports, the proportion of light oil in production has declined from 72 percent in 1980 to 60 percent in 1984.
- An important development in the Third Plan was the completion in 1402 of the East-West crude oil pipeline between Shadgum and Yanbu. The pipeline has a capacity of 1.85 mbd. Tapline flows to Sidon in Lebanon have ceased since 1402.
- In 1403, the Kingdom became the sole owner of ARAMCO, which is responsible for 96 percent of the country's oil production.
- The Third Plan placed substantial emphasis on manpower development. As a result, staff training was expanded and there was greater involvement by the Saudi workforce in planning, supervision and direction of oil operations.
- ARAMCO has implemented a project for the treatment and injection of 660 thousand cubic meters per day (tcmd) of sea water into the oil fields to support pressure in the oil reservoirs. With the average total daily water injection rate (including seawater and groundwater from aquifers) required in oil production estimated at 1.5 million cmd, the resultant saving in groundwater is equivalent to 840 tcmd.

8.2.2.2 Oil Refining

Production of refined products has been steadily increasing since 1370, when 3 million barrels were produced, to over 310 million barrels in 1403. Production is from six operating refineries with a combined capacity of 0.9 mbd. Generally, refineries are dedicated either to exports or domestic production according to their production slates. There is some flexibility, however, as Ras Tanura is a refinery that can be used for both markets as required.

Domestic refineries

As shown in Table 8-6, the capacity of domestic refineries increased from 105 thousand barrels per calender day (tbcd) in 1399, to 374 tbcd in 1404. This is 250 tbcd short of the Third Plan target for 1404 due to the cancellation of the expansion of the new Yanbu (Phase II) refinery.

Export refineries

Export refinery capacity is also shown in Table 8-6. This stood at 530 tbcd in 1399, of which 450 tbcd belonged to the Ras Tanura refinery. Because of delays in the completion of Petromin joint-venture refineries presently under construction in Jubail, Yanbu and Rabigh, capacity has not changed as targeted in the Third Plan. The 250 tbcd refineries in Jubail and Yanbu will be on-stream in 1405, while completion of the 303 tbcd refinery at Rabigh has been postponed till 1408. Total capacity of the export-oriented refineries will be 1,030 tbcd by the end of 1405.

Table 8-6

OIL REFINERY CAPACITY*
(Thousand barrels per calendar day)

	Actual Capacity		Third Plan	Under con-
	1399	1404	Target	struction
Domestic Refineries				
Jeddah	85	85	85	—
Riyadh	20	135	135	—
Yanbu (Phase I)	—	154	154	—
Yanbu (Phase II)	—	—	250	—
Domestic Capacity	105	374	624	—
Export Refineries				
Jubail	—	—	250	250
Yanbu	—	—	250	250
Rabigh	—	—	303	303
Ras Tanura**	450	450	450	—
Arabian Oil	30	30	30	—
Getty Oil	50	50	50	—
Export Capacity	530	530	1,333	803
Total Capacity	635	904	1,957	803

* Design capacity.

** ARAMCO's Ras Tanura refinery serves both export and domestic markets.

Base oil refining

The only base oils plant in the Kingdom is Luberef, a Petromin/Mobil joint venture located in Jeddah. The Luberef plant capacity was around one million barrels per year in 1399 and was later increased to 1.5 million barrels. Production has grown from 1,090,000 barrels in 1399 to 1,479,000 barrels in 1403, while base oil exports have fallen from a high of 75.2 percent of production in 1399 to a low of 23.4 percent in 1403. This decrease was due to the growth in domestic blending of lubricants.

Lubrication blending

Domestic blending capacity for lubricants increased from 500,000 barrels per year in 1399 to 1,500,000 barrels per year in 1404, compared to a Third Plan target capacity of 2 million barrels per year (see Table 8-7). All existing capacity is owned by a Petromin/Mobil joint venture (Petrolube) and located in two plants in Jeddah and Riyadh.

Table 8-7

DOMESTIC LUBRICANT BLENDING CAPACITY 1399-1404
(thousand barrels per year)

Plant	Actual capacity		Target for 1404
	1399	1404	
Petrolube - Jeddah	500	1,000	1,000
Petrolube - Riyadh	—	500	500
Jubail	—	—	500
Total	500	1,500	2,000

8.2.2.3. Natural Gas

The natural gas produced in Saudi Arabia has been predominantly associated gas whose production rate is a function of the crude oil production level. The Kingdom's remaining recoverable gas reserves at the end of 1403 were estimated to be approximately 3,500 billion cubic meters. This is an estimated 3.8 percent of world natural gas reserves.

Gas gathering

Prior to 1397, most of the gas produced was flared, except for small quantities of untreated gas which were utilized in re-injection for reservoir pressure maintenance and as fuel and feedstock in utilities and local industries. In 1395, construction and management of the Master Gas System was undertaken by ARAMCO on behalf of the Government. The program was designed to collect and treat about 34 billion cubic meters of associated gas per year.

Four main gas gathering/treatment centers, namely Shedgum, Uthmaniyah, Ju'aymah and Yanbu, became operational during the Third Plan. Dates of completion and products produced are listed in Table 8-8 (see also Figure 8-3).

Figure 8 - 3

THE GAS GATHERING PROGRAM, STAGES AND LINKAGES

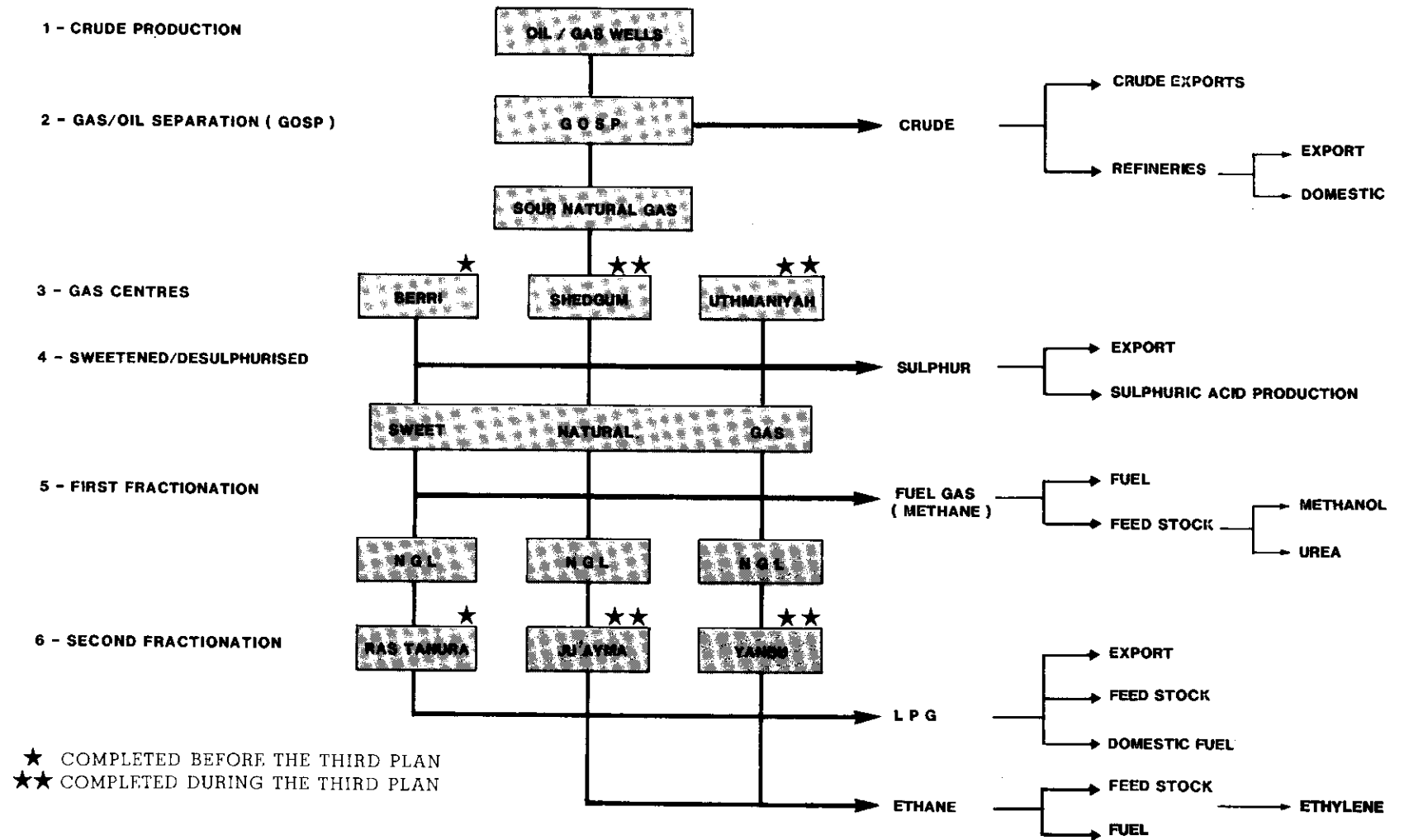


Table 8-8

THE GAS GATHERING AND TREATMENT SCHEME

Center	Product	Year of Completion
Berri	Sulphur & Fuel gas (Methane)	1977
Shedgum	Sulphur & Fuel gas (Methane)	1980
Uthmaniya	Sulphur & Fuel gas (Methane)	1982
Ras Tanura	LPG	1961
Ju'aymah	LPG and Ethane	1980
Yanbu	Ethane and LPG	1982

The total capacities of the fractionation plants are: 4,100 tons sulphur/day; 2 billion cubic feet methane/day; 360 million cubic feet ethane/day; and 374 thousand barrels/day of LPG (Propane, butane and natural benzine).

The 1,168 km. East-West pipeline from Shedgum to Yanbu was completed in 1401 with a capacity of 270,000 barrels per day of natural gas liquids.

Production

The absolute quantities of gas utilized were raised from 12.7 billion cubic meters in 1399 to 28.2 billion cubic meters in 1402, growing at an average annual rate of 30 percent. More significantly, the proportion that is utilized increased from 23.6 percent to 82.0 percent over the same period.

Exploration

One of the significant developments during the Third Plan was the discovery of substantial additional quantities of non-associated gas. Deeper pool tests resulted in the discovery of gas below the Ghawar and Abu Sa'fa oil fields.

8.2.2.4 Solar and Nuclear Energy

A long-standing national objective of the Kingdom has been to develop alternative energy sources, in order to diversify its energy base and prepare for eventual depletion of fossil fuel reserves.

The high levels of insolation throughout the year over wide areas of the Kingdom, make **solar energy** a potentially major renewable resource. Organized research and development work in the solar energy field is performed by SANCST. This identifies four broad areas for research and development:

rural/agricultural applications, urban applications, industrial applications and resource development activities. These activities are being conducted jointly in Saudi Arabia and international specialized centers, under technical cooperation agreements with the United States Department of Energy and with the Ministry of Research and Technology of the Federal Republic of Germany.

A pilot 350 KW photo-voltaic solar electric power plant, located outside Riyadh city, was completed in 1402. It supplies three villages with a portion of their power needs. The plant has been under evaluation and assessment since its completion. A solar greenhouse pilot project is underway, which aims at developing solar-assisted controlled environment agriculture. The solar cooling program is a multi-faceted program being conducted at four Saudi Arabian Universities. The objective of this program, which is presently in its second phase of development, is to develop three-ton capacity cooling units based on the Lithium Bromide absorption cycle and a solar-assisted Rankine cycle. Site studies have been conducted and design is presently underway for a pilot project to be located in Yanbu, which will investigate the use of solar energy for seawater desalination.

Nuclear power also offers an important alternative energy source. The responsibility for initiating and developing a nuclear energy program in the Kingdom was given to SANCST in 1401.

8.2.2.5 Domestic Energy Consumption

The pattern of energy consumption in the Kingdom has changed in recent years, as shown in Table 8-9. The transportation and industrial sectors increased their share of total energy consumption between 1399 and 1402.

Table 8-9

DOMESTIC ENERGY CONSUMPTION (1402)

	Level	Structure	
	1402	1399	1402
	(million barrels) *	(percent)	(percent)
Transportation	150.9	32.0	44.5
Utilities	81.3	29.0	24.0
Industry	50.8	4.0	15.0
Other	55.9	35.0	16.5
Total	338.9	100.0	100.0

* Crude oil equivalent

The annual domestic demand for petroleum and heavy oil products is expected to grow by 5.5 percent per year and 9 percent per year respectively over the Fourth Plan period. Forecasted domestic energy demand is summarized in Table 8-10.

Table 8-10

**DOMESTIC DEMAND FOR ENERGY PRODUCTS
DURING THE FOURTH PLAN
(million barrels per year)**

	Actual 1403	Estimated 1405	Forecast 1410
Petroleum Products			
LPG	5.3	6.1	7.9
Motor Gasoline	49.0	56.0	77.3
Diesel	93.0	81.3	86.9
Other Light Products	16.3	18.8	23.7
Heavy Fuel Oil	78.2	91.4	140.4
Lubes & Greases	1.9	2.0	2.5
Other Heavy Products	15.0	12.0	23.9
Crude Oil for Direct Burning	30.3	44.9	45.1
Sub-total	289.1	312.5	407.7
Natural Gas and Ethane	96.0	140.7	198.2
Total Oil (incl. LPG)	385.1	453.2	605.9

8.2.2.6 Issues and Constraints

Marketing of Refined Products

Because of worldwide over-capacity in refining, estimated at twenty million barrels per day in 1402, refining profit margins during the period have been depressed. These conditions are not likely to improve greatly in the medium term. Indeed, it is anticipated that they may worsen as new refining capacity comes on-stream. It will therefore be necessary for the Kingdom to pursue an active marketing policy for its refined products and, at the same time, to integrate the production processes of its domestic and export-oriented refineries to attain greater overall flexibility.

Storage and Distribution System

Owing to the anticipated increase in the use of heavy fuel oil by the electric utilities and by SWCC in the Western and South Western Regions, a coordinated storage and distribution system for this product is desirable.

Coordination

The need for improved coordination in the implementation and utilization of bulk plants, product pipelines and refineries will be addressed during the Fourth Plan period.

Flexibility for utilization

Given the present dependence of natural gas production on crude oil production, the growing domestic demand for gas as a feedstock and fuel for industry and the utilities imposes a minimum level of crude oil production. Greater flexibility in crude oil production requires the development of non-associated gas in addition to the completion of the second phase of the Gas Gathering Program.

Water injection

Because of the high rate of depletion of existing non-renewable groundwater it is essential to take positive measures to conserve water resources. More seawater treatment and injection into the Kingdom's oil fields is seen as an important contribution towards conservation efforts.

Energy prices

The controlled low domestic prices of conventional energy are an obstacle to the penetration of feasible and economic solar energy uses. Government support will be necessary so that the potential economic returns of promising ongoing research and development can be realized.

8.2.3 DEVELOPMENT STRATEGY

The development strategy for the Kingdom's energy sector during the Fourth Plan will be guided by the following objectives and policies.

8.2.3.1 Objectives and Policies

Objectives

- to conserve and manage hydrocarbon resources for the maximum long-term benefit of the Kingdom;
- to ensure that international trade relations are compatible with the national objectives for oil and gas development;

- to increase the share of Saudi Arabian citizens in the oil and gas sector's work force and strengthen their technical and managerial capabilities in the hydrocarbon sector;
- to provide sufficient petroleum products to meet the forecast regional demand during the period of the Fourth Development Plan;
- to maximize value added in the oil sector;
- to encourage private sector investment in suitable Petromin ventures and other specialized activities;
- to develop solar energy as one of the alternative energy sources in the Kingdom and to make the research results widely available;
- to establish the necessary conditions for the efficient utilization of nuclear energy for peaceful purposes.

Policies

- pursue a production policy which, in the long term, reflects the structure of hydrocarbon resources contained in the national reserves;
- ensure that the best methods, technologies and facilities are used or introduced in hydrocarbon exploration, production, distribution and refining;
- continue to direct search and exploration towards discovery of new oil reserves;
- strengthen the Organization of Arab Petroleum Exporting Countries (OAPEC); enhance the cooperation with GCC member countries in studies, planning and implementation of joint petroleum programs and projects; and continue the Kingdom's major role in OPEC;
- expand the participation of Saudi universities in theoretical and applied research in hydrocarbon-related fields;
- strengthen training programs to increase productivity in hydrocarbon-related activities;
- design future refineries with sufficient flexibility to allow reasonable changes in both crude oil and product slates;
- take proper account of strategic, safety, security and environmental factors when deciding the location and process configurations of new facilities;
- ensure that interdependent projects in storage and distribution are well coordinated in capacity and implementation schedules;
- continue research and development work in solar and nuclear energy under SANCST supervision;
- encourage greater use of solar water and space heating systems in the construction specifications for public and privately financed buildings;
- promote practical solar processes in agricultural applications.

8.2.3.2 Programs

With respect to the development of oil and gas resources, the Government's programs focus on maximum long-term benefit through their emphasis on conservation and increased value added.

Oil

The exploration program will consist of seismic surveys, geological studies and exploratory drilling.

The management and operation program aims at increasing efficiency in administering and supervising the oil industry and promoting domestic and overseas oil marketing.

The oil reservoir program will carry out production and optimization studies, which will seek to establish the optimum technical and economic production methods for application in the Kingdom's oil fields.

Maintenance programs will consist of maintenance and/or replacement of existing plant and equipment within an explicit program geared to long-term cost-effectiveness.

Within the ***marine pollution program*** studies will be carried out for those areas where risks of pollution exist.

Natural Gas

Under the ***gas gathering program*** an extensive network of NGL and gas pipelines, linking gas and oil separation plants to the gathering centers, is to be completed early in the Fourth Plan. Furthermore, links have been built to major gas consumers in Jubail, to SWCC desalination plants and to SCECO's electricity generating plants.

The basic elements of the ***natural gas conservation*** program include a comprehensive study of natural gas reserves, introducing conservation measures, developing ways and means to ensure continuous gas supply to prospective gas-based industries and other end-users.

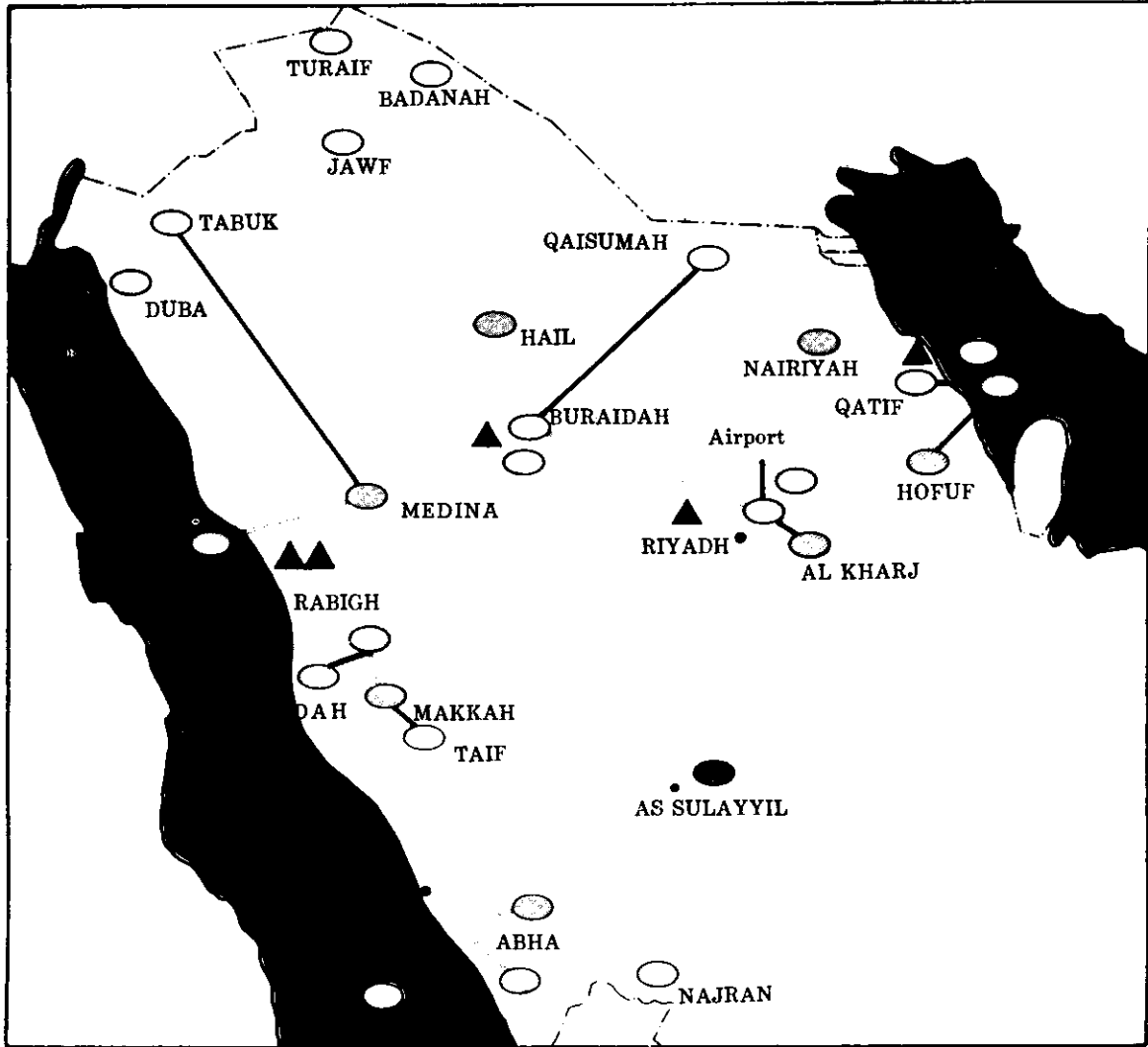
The ***pipeline program*** will maintain existing lines, complete the gas gathering program and construct a new pipeline to supply the proposed Qasim refinery.

Oil Refining Program

Within the ***domestic refineries program*** a new refinery with a capacity of 160 tbcd will be constructed at Qasim to come on-stream in 1409. This will increase overall domestic refinery capacity to 534 tbcd.

Figure 8 - 4

PLANNED DISTRIBUTION SYSTEM FOR CLEAN PRODUCTS FOR 1410



- | | |
|-------------------------------------|----------------------------------|
| ○ Existing bulk plant | — New product pipelines |
| ○ New bulk plant | — New priority product pipelines |
| ● Reconstructed bulk plant | — Existing product pipelines |
| ○ Reconstructed priority bulk plant | |
| ○ New priority bulk plant | |
| ▲ Refineries | |

The *export refineries program* will complete the 303 tbcd Rabigh refinery which is also scheduled to come on-stream in 1409. As a result, export capacity will be increased to 1,333 tbcd.

Two major projects are planned under the *base oils and lubricants* program:

- a new 1.6 million barrels per year (mby) oil refinery will be built in Yanbu (Luberef II) by 1407, increasing the country's annual total capacity to 3.1 mby;
- a 1 mby lube blending plant will be built by Petromin in Yanbu by 1409. In addition, a total capacity of 700 thousand barrels per year is expected to be added by the private sector, thus increasing annual capacity to 3.2 mby.

As part of the *storage and distribution program* new bulk storage plants and pipelines will be constructed. Also a plan will be developed for the optimization of supply of heavy fuel oil to the utilities in the Western and South Western regions.

Solar and Nuclear Energy

The implementation of the following programs will be continued:

- Solar green house
- Solar water desalination
- Solar turbine electric power plant
- Solar village

Solar hydrogen: A new program will be initiated for the solar production of hydrogen.

Nuclear energy safety program: Rules and regulations for safe handling and storage of radioactive materials and equipment will be prepared, and contingency plans made to cope with possible nuclear accidents. The scientific and technical capability to provide consultation in the nuclear energy field will be established at SANCST.

Nuclear Training Program: Specific training programs will be developed according to the needs of various institutions dealing with nuclear energy, and suitable training institutions both in the Kingdom and abroad will be identified.

8.2.3.3 Program Expenditures: Energy Sector

The planned government expenditures for each program in the energy sector during the Fourth Plan are shown below in Table 8-11.

Table 8-11

ENERGY SECTOR PROGRAM EXPENDITURES*

<u>Ministry of Petroleum</u>	<u>Fourth Plan Total</u> (SR million)
Seismic Survey	550.0
Management and Operation	418.0
Exploratory Drilling	330.0
Evaluation and Improvement of Oil and Gas Facilities	122.0
Oil Reservoirs Study	108.0
Petroleum Researches/Services Development	91.0
Geological Studies	73.0
Computer Application	42.0
Construction	36.0
Gas Conservation	33.0
Sub-total	1,803.0
 <u>Petromin**</u>	
Domestic Refineries	5,138.0
Distribution	3,777.0
Export Refineries	2,377.0
Lubricants Processing	1,085.0
Rabigh Infrastructure	2,839.0
Support Facilities	890.0
Ancillary	58.0
General Administration	854.0
Sub-total	17,018.0
Total	18,821.0
 Expected Profits	 895.0

* SANCST's Expenditures are shown in Table 11-20.

** Petromin's expenditure on minerals development is shown in Table 8-13. Of Petromin's *total* expenditure of SR 17,854 million, SR 17,000 million is financed through loans from the Public Investment Fund (See Table 10-5).

8.2.3.4 Private Sector Considerations

Most activities in the energy sector are administered by government-owned agencies. Nevertheless, there is considerable scope for the expansion of private enterprise in domestic gasoline and lubricant oil retailing, and in solar energy projects. The greatest scope, however, lies in the continuing opportunities for private enterprise to supply the services, components, construction and equipment which are required by the energy sector. In the past, ARAMCO has been one of the major sources of business opportunities in the Kingdom, and the expanded scope of ARAMCO and Petromin operations will extend this established trend.

8.2.3.5 GCC Consideration

Energy policy is coordinated with the Kingdom's partners in OPEC and OAPEC rather than through the GCC. Nevertheless, some particular projects are specific to the GCC.

8.3 MINERAL RESOURCES AND MINING

8.3.1 BACKGROUND

The Deputy Ministry for Mineral Resources (DMMR) fulfills the role of a national geologic survey and mineral exploration agency. It is concerned with the management, administration and operation of the main government programs and is responsible for the administration of the Kingdom's Mining Code and Mining Regulations.

The commercial exploitation of discovered mineral deposits is carried out by private enterprise and Petromin. During the Third Plan period there has been a significant increase in private sector activity in mining and quarrying. In addition, the Saudi-Sudanese Joint Red Sea Commission is actively exploring the sea-bed mineral resources of the Red Sea.

8.3.2 PRESENT CONDITIONS AND REVIEW OF THIRD PLAN PROGRESS

Many mineral discoveries have been made including gold, silver, copper, zinc, lead, aluminum, rare metals (such as tin, tungsten and niobium), industrial minerals (including phosphates), magnesite and coal, as well as raw materials for the construction industry. Some of these discoveries are of major long-term importance to the nation.

8.3.2.1 Mineral Exploration

Metallic Minerals

Exploration for metallic minerals has concentrated on the Arabian Shield which is considered the most promising host environment for mineralization.

The widespread presence of *gold* occurrences and the revival of the Mahad al Dhahab gold mine have given a strong impetus to gold exploration. Approximately 600 gold occurrences have been identified and a total of 29 prospects have been drilled.

The majority of base metal deposits in Saudi Arabia are associated with volcanic and sedimentary rocks which carry *copper, lead, and zinc*. A total of 75 prospects have been drilled. *Silver* minerals occur in Saudi Arabia, apart from the high-grade sulfide deposit at Nuqrah and at the Samrah deposit, as components in lead, zinc and gold ores. Exploration of the Phanerozoic Cover Rocks has resulted in the discovery of the large Az Zabirah *bauxite* deposit. Lead, zinc and *iron* prospects have also been discovered in the cover rocks. An overall assessment of the economic potential of felsic plutonic rocks has led to the investigation of several radioactive granites containing *rare elements*. One deposit, Al Ghurayyah, is being targeted for an exploration license. In 1400 two major *tin* occurrences were discovered, followed in 1403 by a spectacular occurrence of tin in a ring complex.

Figure 8-5 shows the major deposits of metallic minerals as well as significant prospects.

Non-Metallic Minerals

Exploration for non-metallic minerals in the Kingdom has been very successful. *Phosphates, magnesite* and a wide range of mineral deposits of *potash, diatomite, bentonite, kyanite, fluorite*, and high-purity *silica sand* have been discovered.

Deposits of *ornamental stone, clays, high-purity limestone, gypsum and aggregates* have also been discovered. These are of special importance to the construction industry. A study by the Deputy Ministry for Mineral Resources has identified *coal/lignite* resources of considerable potential. The Sirhan-Turayf region has several areas with near-surface *phosphate* rock suitable for open-pit mining. A high-grade *magnesite* deposit at Zargat has been explored in detail and could become an important source of magnesite if infrastructure problems can be solved.

Figure 8-6 shows the location of deposits of industrial minerals as well as the coal occurrences.

8.3.2.2 Mining Investment

Investment in the Arabian Shield

At *Mahad al Dhahab* Petromin is developing a high-grade underground gold mine with a capacity of 400 tons of ore per day. The production of gold, silver and copper will commence in 1407. Two private mining companies, both of which have Saudi Arabian majority shareholders, have been granted a mining lease for the *Al Masane* base metal deposit, to establish a 1,500-ton per day underground mine which will produce zinc, copper, gold and, silver. At *Wadi Qatan*, a massive nickeliferous sulfide deposit is licensed. Positive results have been obtained from metallurgical studies and

Figure 8 - 5

METALLIC MINERALS

Major Deposits and Significant Prospects

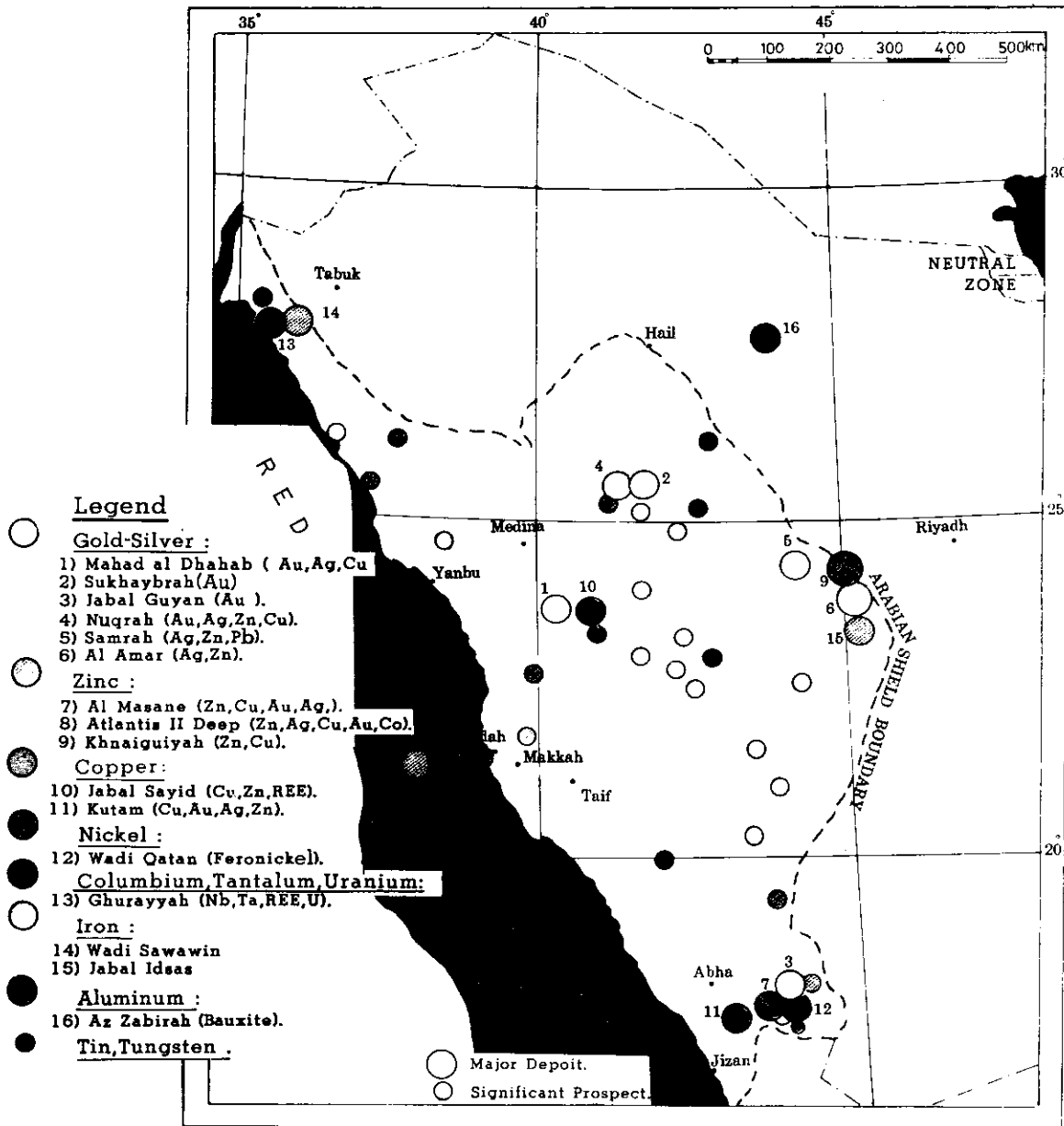
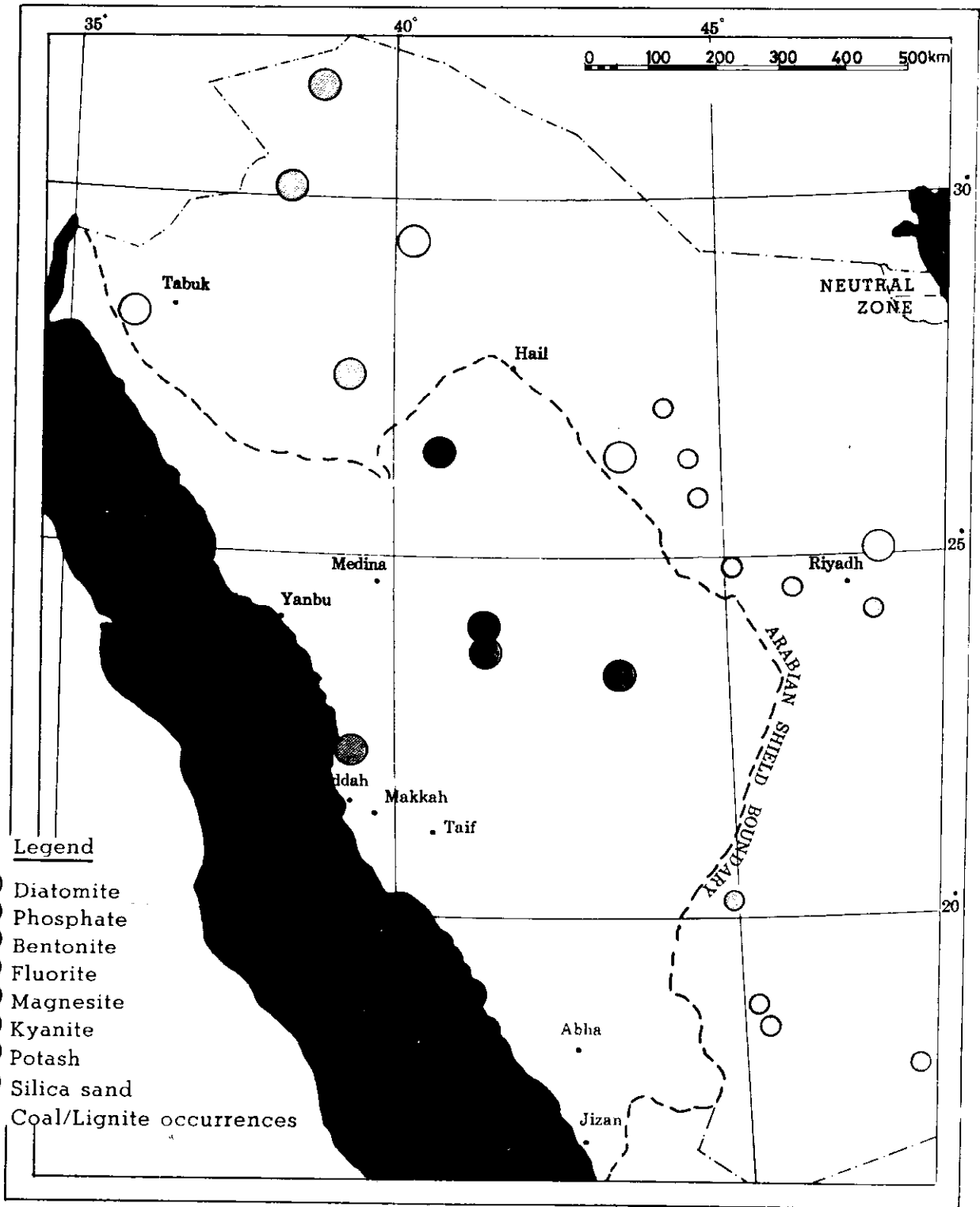


Figure 8 - 6

INDUSTRIAL MINERALS AND COAL



marketing possibilities of nickel-iron pellets or ferronickel are being investigated. At the *Wadi Sawawin* iron ore deposit a large pilot plant is being erected in the final stage of proving the feasibility of supplying iron ore pellets to the Jubail steel plant. The further development of the big copper mine in *Jabal Sayid* is being delayed due to the depressed world copper price and the costs of the required infrastructure. In *Sukhaybrah* on the Nuqrah as Safrah license area detailed exploration work by a foreign company in partnership with Petromin may result in an open-pit gold mine.

Red Sea Mining Investment

In the central and northern parts of the Red Sea, several research ships have carried out seabed exploration and discovered many locations of metalliferous sediments. The most significant discovery to date is Atlantis II Deep, the proven reserves of which amount to 1,890,000 tons of zinc; 425,000 tons of copper; 3,890 tons of silver; about 50 tons of gold, and more than 5,000 tons of cobalt. The pre-pilot mining test showed that mining these seabed deposits is technically feasible.

Quarrying

In the sub-sector of mining where construction materials and some industrial minerals are exploited by quarrying, a substantial increase in private sector activities has been witnessed during the Third Plan, as illustrated by Table 8-12.

Table 8-12

QUARRY LEASE PERMITS ISSUED TO THE PRIVATE SECTOR

Mineral	Industrial Product	Plants in Operation	
		1400	1404
Aggregate	Construction material	55	113
Clay	Redbrick	10	14
	Ceramics	—	1
	Clay pipes	1	1
Limestone, Clay	Cement	4	10
Granite, Marble	Ornamental stone	—	41
Sand	Lime-sand bricks	1	2
	Glass bottles	—	1
	Plaster panels	—	2
Gypsum	SABIC Petrochemicals	—	1
Salt			
	Total	71	186

8.3.2.3 Geologic Survey

Geologic survey data forms an essential basis for mineral exploration and development. By the end of the Third Plan, mapping at 1:100,000 and 1:250,000 scale had been completed over the whole Arabian Shield, comprising an area of 650,000 square kilometers. Responding to the need for geological maps to assist mineral exploration in the Phanerozoic Cover Rocks, a 1:250,000 scale mapping program was started by the Deputy Ministry for Mineral Resources. At the end of the Third Plan seven maps have been published and another four were being prepared.

8.3.2.4 Key Issues

Inputs of Capital, Technology and Know-how

To share the costs and risks and to secure the necessary mining experience, the private sector will need to form joint-venture companies. The role of Petromin, besides representing the public interest, is to contribute funds to mining projects in the framework of joint-venture arrangements. In addition, government loans are available for mining projects.

Finance alone, however, will not be sufficient. Given the wide range of discovered minerals in the Kingdom and the competitiveness of international mineral markets, access to specialized know-how and managerial skills will also be required. The most efficient vehicle for transferring these to the mining sector will continue to be equity investment by experienced international mining companies.

Mining Code

The objective of the Kingdom's mining code is to attract investors, through the provision of investment incentives designed to improve the commercial viability of mineral projects. It is essential that incentives and regulations keep pace with economic developments. The last major revision of the code was made more than ten years ago. Since then, major changes have occurred in the economy and it is becoming increasingly clear that the existing code needs revision.

Infrastructure

A critical issue for most mining projects in remote areas is the extent to which the costs of the required infrastructure facilities are shared or allocated to the mining project alone. This affects the profitability of the mining projects considerably. Provision does exist for the Government to contribute to the costs of mining infrastructure. It is the Government's intention that this should have a major positive effect on the development of mining projects.

8.3.3 DEVELOPMENT STRATEGY

8.3.3.1 Objectives and Policies

One of the major objectives of the Fourth Plan is to encourage the discovery, development and utilization of mineral resources. This is transformed into a set of detailed *policies* for the mineral resources and mining sector as follows:

- surveying and recording the geology of Saudi Arabia as a basis for mineral exploration and other applications in agriculture, industry and construction;
- prospecting for all types of mineral resources;
- exploring mineral occurrences for exploitable ore, applying modern technological and theoretical concepts;
- investigating and assessing infrastructure and economic cost conditions which affect mining development;
- encouraging the development of mining support services and downstream processing industries;
- evaluating mineral deposits and conducting pre-feasibility studies;
- providing information services to the private sector;
- promoting the formation of joint-venture companies to invest in mineral projects;
- advising the community on the practical significance of geohazards and application of construction materials;
- training Saudi nationals in the practical application of geosciences and mining engineering.

8.3.3.2 Public Sector Programs

In the Fourth Plan the shift from basic geologic research towards mineral exploration and mining development will increase. Emphasis will be on direct support to the national industry and economy rather than scientific work. For the implementation of the policies described above the required activities are organized in the following programs:

The *Mineral Exploration Program* is the core of DMMR's activities. The range of target commodities includes both those with export potential and those which could promote national industrial and agricultural development. The prime targets are gold, silver, copper and zinc. Tin-tungsten deposits are also given priority. Increasing effort is being directed towards the Cover Rocks areas, where important commodities have already been discovered.

The **Mining Development Program** is concerned with the promotion of mining, including the review of the Kingdom's Mining Code and the present government policies regarding the mining sector. Detailed evaluation of individual deposits will also be carried out in this program, including further evaluation of the Az Zabirah bauxite deposit. In the Sirhan-Turayf region, areas with near-surface high-grade phosphorite will be identified to assess those which have superior mining development potential. Pilot-plant testing of the Wadi Sawawin iron ore deposit will be completed and, in the Khnaiguiyah zinc district, the technical and economic appraisal of the mineral deposits will be carried out. In addition, feasibility studies will be prepared on small deposits of high-value commodities to promote mining by the private sector.

The **Geologic Survey Program** will provide the information base for mineral exploration. It is concerned with geologic mapping of selected areas of the Arabian Shield as well as the mapping of the Phanerozoic Cover Rocks at a scale of 1:250,000. Basic geological research will include geochronological studies and geomorphological studies, as well as studies on the stratigraphy and the resource potential of rock formation.

Within the framework of a new program for **Geological Services to the Community**, information will be provided on geological and mineralogical conditions of importance to construction projects, as well as information and advice concerning geohazards such as earthquakes, subsidences and landslides.

A program for **Exploration Geochemistry, Geophysics and Drilling** provides the specialized facilities that are required in mineral exploration.

Support programs will be concerned with the provision of services such as laboratories, specialist equipment, publications, storage and transportation facilities.

DMMR's **Management and Administration Program** is concerned with the overall planning and management of DMMR's activities and of the other operating units (such as foreign missions). This program also deals with administration of the Mining Code. An intensified training scheme for Saudi geoscientists, technicians and administrative staff at all levels is included in this program.

Petromin

At **Mahad Al Dhahab** the construction of the mine and concentration plant with a capacity of 400 tons per day will be completed. The production of gold, silver and copper will start in 1407. The rich ore yields an average grade of 26 grams of gold per ton. Together with a joint-venture partner, Petromin will carry out detailed exploration on the **Nuqrah As Safra** license area, concentrating on the Sukhaybrah gold deposit and the Nuqrah silver deposit. If economic viability of the **Wadi Sawawin iron ore deposit** is proven, Petromin may be involved during the Fourth Plan in the initial stages of mine preparation. Petromin will also participate in new mineral ventures with the private sector.

Saudi-Sudanese Red Sea Joint Commission

The Saudi-Sudanese Red Sea Joint Commission will carry out pilot operations for mining and processing the Atlantis II Deep deposit in the Red Sea; the metal-rich sediments on the seabed will be pumped to a mining vessel. Onboard, a flotation process will produce an ore concentrate containing zinc, silver, copper, gold and cobalt. The concentrate will be shipped to a processing and smelting plant in Yanbu.

8.3.3.3 Program Expenditures: Mineral Resources and Mining

The planned government expenditures for each program in the mineral resources sector are shown below in Table 8-13.

Table 8-13

MINERAL RESOURCES AND MINING PROGRAM EXPENDITURES

	Fourth Plan Total
	(SR million)
Deputy Ministry for Mineral Resources	
Management, Administration and Training	432.2
Geological Survey	189.5
Mineral Exploration	847.7
Mining Development	565.6
Geological Service to the Community	70.6
Exploration Geochemistry, Geophysics and Drilling	523.6
Technical Support	550.3
Logistic Support	224.2
Saudi-Sudanese Red Sea Joint Commission	187.1
Sub-total	3,590.8
Petromin	
Mineral Programs	836.0
Total	4,426.8

8.3.3.4 Private Sector Considerations

As part of the Government's overall diversification policies, major emphasis is to be given to developing the mineral sector during the Fourth Plan period and beyond. In line with the Plan strategy, the main impetus for development is expected from the private sector, in joint ventures with either foreign companies or Petromin. With the revision of the mining code, the Government intends to create an environment conducive to investment and it anticipates a positive response from the private sector.

In considering mineral investment, the private sector should recognize the many different forms of mineral retrieval. Underground mining is not required to exploit many of the Kingdom's deposits; lower technologies, including quarrying and surface mining, are more appropriate. Generally, these require substantially less investment.

Some of the mineral industries considered as high priority for private sector involvement are as follows: the Kingdom's basalt deposits offer very good potential to manufacture rockwool insulation material; the zinc deposits could provide the basic input for a hot-dip galvanizing plant which would enjoy a very substantial local market; lead offers potential, not only as a petroleum additive but also for electric cable coatings and solder plants; there is a growing demand for electric cables and brass products, both key markets for refined copper; steel and aluminum plants will require silicon, ferro-silicon and magnesite as inputs for alloy production.