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Enabiling Activities for Preparation of Syria's Initial National Communication to UNFCCC

Mitigation of greenhouse gas emissions within the Oil & Gas Production Sector in Syria

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Mitigation of greenhouse gas emissions within the Oil & Gas Production Sector in Syria

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This report has been approved unanimously by the technical committee, during the Technical Workshop which took place on 28.2.2010, in Samiramis Hotel, Damascus.

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Syria is regarded as the only important producer of oil and gas in the eastern Mediterranean According to BP statistics in 2008 Syria has reserves of 2.5 billion barrel of oil at end of 2007. Production of oil continues to drop due to technical difficulties and exhaustion of wells. After reaching a peak of 604000 b/day in 1996, the production fell continuously to reach 460000 b/day in 2004 and 393900 b/day in 2006 after old fields discovered in 1968 especially huge Gbesa fields reached maturation. Production is expected to decrease while consumption continues to increase so export decreases and Syria becomes an importer of oil after 10 years as it was in the middle 80's as shown in Figure (E1) [3].

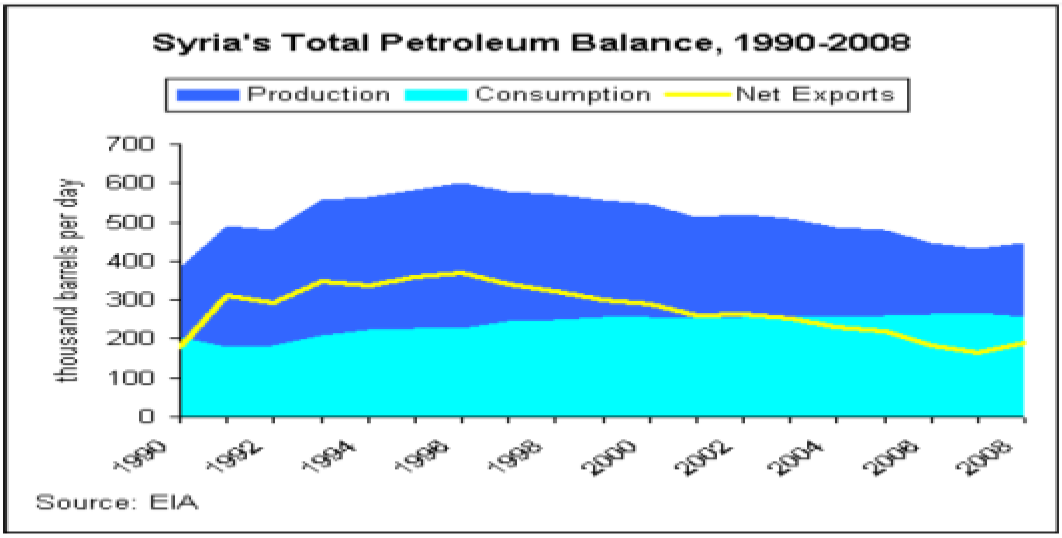


Fig.(E1) Production and Consumption of Oil in Syria from 1990-2008

Figure (E2) shows production of all kinds of energy in Syria. It shows that oil production decreased steadily since 1996 while hydroelectric power remained constant and liquids from gases increased slightly due to the increase in production of natural and associated gas.[4] In contrast Figure (E3) shows consumption of Syria from energy and from oil and gas for the same period. [4] It shows that consumption of Syria from oil and energy in general has increased steadily from 1995 to 2007. This is due to the growth in demand for oil derivatives to generate electricity and especially for transport. These two sectors witnessed a steady increase due to the continuous high increase in population, rise in the standard of living and migration from the countryside to the big cities.

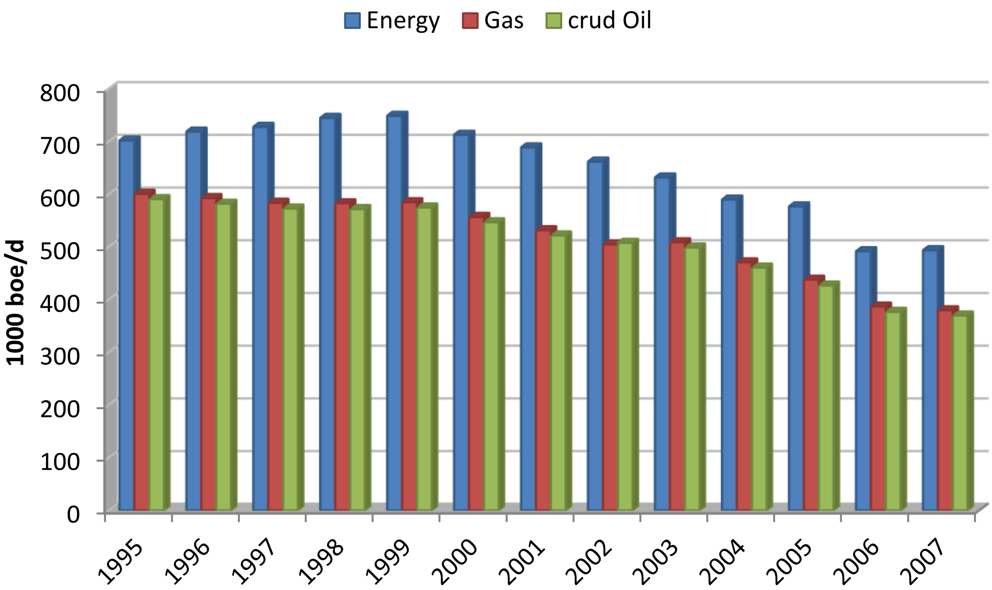


Fig (E2). Production of energy, crude oil , gas liquids for the period 1995-2007 (4).

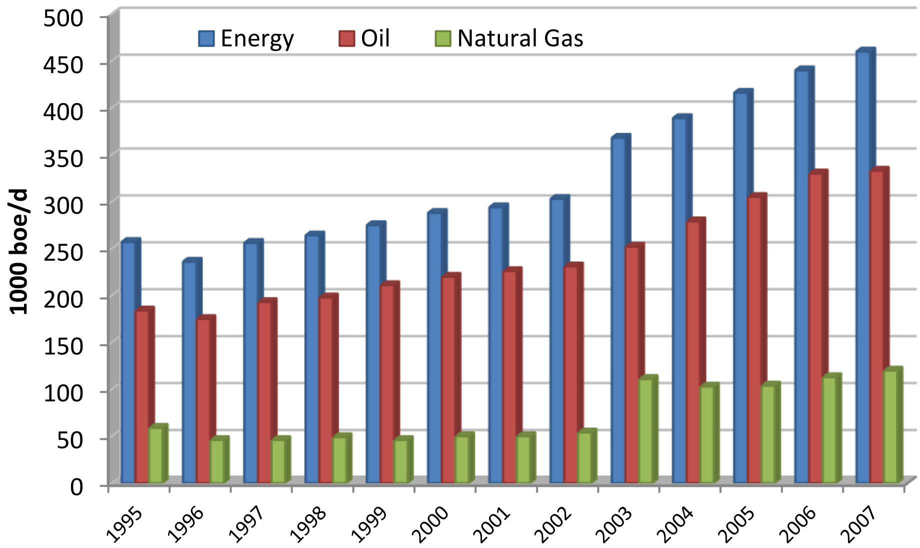
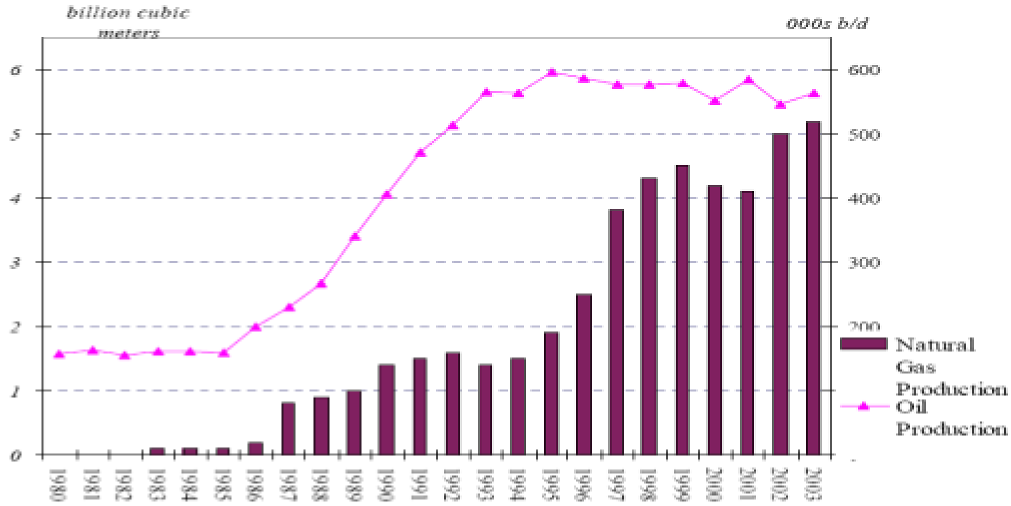


Fig. (E3). Consumption of Energy, Crude Oil, Gas Liquids for the period 1995-2007 [4]

Geological reserve of gas in all its forms in Syria is estimated at around 705 Billion m^3 while the reserve which can be produced is estimated at around 405 Billion m3. Figure (E4) shows that consumption of Syria from natural gas and associate gas increased steadily over the years. Production of gas was very small in the 80's and it started to increase in the 90's and jumped to a higher level at the end of 90's. The rise in gas production was accompanied with the stability of oil production in the 90's and its gradual decline after that[7]

As for petroleum refining there are two refineries in Syria. The first is Homs refinery with a capacity of 5.7 million tons/year from heavy and light oil. The refinery was operated in 1959 and expanded 6 times to raise its capacity and to add additional units to optimize its capacity from middle distillates and gasoline. The second is Banias refinery which was operated in 1980 with a capacity of 6 million tons/year. It operates on a mixture of light and heavy oil. Figure (E5) shows the production of Syria from oil derivatives from 1995-2007. It is shown that production remained more or less constant during this period since no new refineries were built or no expansion of existing ones.



Source: BP, *Statistical Review of World Energy 2005*

Fig (E4) Development of Oil & Gas Production in Syria 1980-2003 [7]

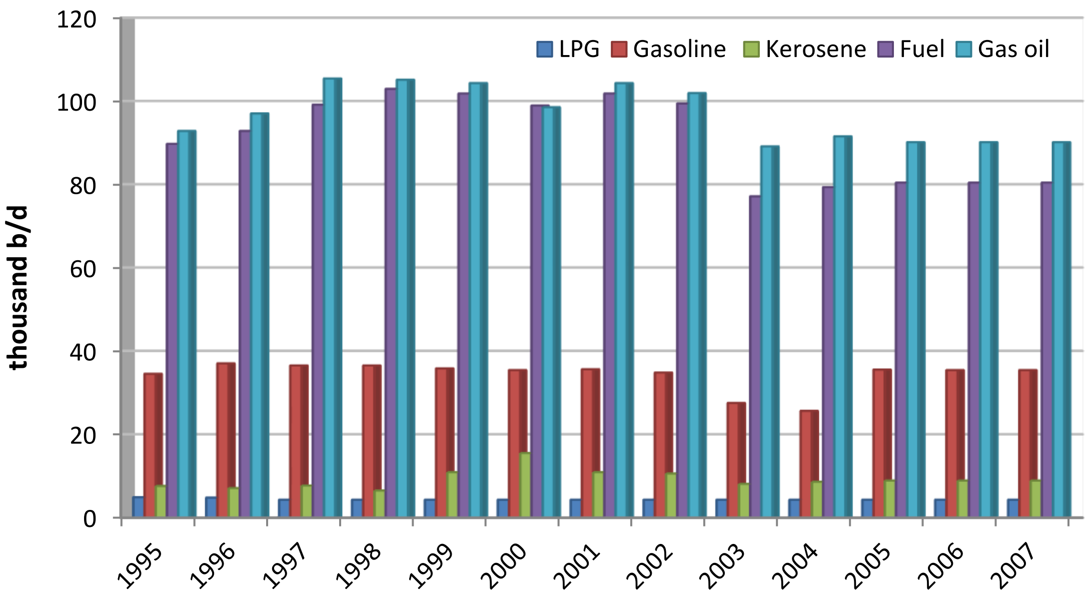


Fig.(E5) Refining Capacity of Syrian Refineries for 1995-2007[4]

As for transport of oil the Syrian Company for Oil Transport SCOT manage 9 pipelines with total length of 1019 miles and 16-32 inches. The Syrian Company for Storage and Distribution of Oil Derivatives " Mahrookate " 7 pipelines with a length of 611 miles and a diameter of 6-24 inch .As for natural gas the Syrian Gas Company the increase in production and consumption of gas led to rapid development of gas pipelines. In 1981 the length did not exceed 323 miles and it is 1328 miles now.

2. Mitigation of GHG Emissions:

Mitigation by conservation of energy consumption:

Oil and gas companies in Syria took many steps to conserve energy .Turbines were installed to generate electricity locally from gas used to be burnt in flares and which is not economic to recover . At the same time old turbines were replaced by new ones . The same was done to old electrical equipment .There are still many areas to conserve energy in the oil and gas sector such as controlling the burning process , reduce scaling on walls of boilers , ovens and heat exchangers tubes ,the use of the waste heat from the products or the flue gases and the good insulation of equipment .

Mitigation by converting to lighter fuels (Decarbonization) :

Syria carried out great efforts during the 90's of the last century to switch from fuel oil to natural gas for generating electricity. Many power stations were erected using natural gas only like Gender while old stations such as Banias and Mahrada were converted to operate on fuel oil as well as natural gas. In industry production of ammonia in the Homs Fertilizer Company was switched from naphtha to natural gas . This switch was facilitated by the Ministry of Petroleum erecting factories to recover associated gas and treat it instead of burning it in flares. It was also possible because of the discovery of new natural gas fields in ,any places and its exploitation.

Mitigation by recovery of flared gases :

Amount of gas burnt in flares decreased by 72% from 3420 000 m^3 /d in 2003 to 952 000 m^3/d in 2005. Kharta field was connected to exploit 200 000 m^3/d. Gas burnt in flares decreased to 452 000 m^3/d and the total reduction percentage became 78%. Quantities of gas still burnt in flares are estimated at 215 000 m^3/d from 6 stations. All of these are not connected to the gas treating plant because the distance is larger than 70 km.

Mitigation by maintenance of pipelines and prevention of leaks [13]

Number of leaks in the Syrian Petroleum Company SPC in 2004 averaged 464 oil leaks and 16 gas leaks. The total quantity of oil leaked was 3755 b (512 tons) which is equal to 17.5 leaked unit in every million produced unit. In 2005 a clear improvement took place to the number of oil leaks and the quantity of oil leaked. Number of leaks dropped to 416 leaks and the total leaked quantity was 2 925 b (345 tons) and the ratio was 16.79 units leaked to 1 million unit produced. The measures taken to limit leaks were to increase the regular maintenance at site and the use of modern super somic equipment to detect leaks and the injection of anti corrosion chemicals in the pipelines.

Mitigation by sequestering CO_2 in oil fields and enhanced recovery :

The other method called Enhanced or Tertiary Oil Recovery EOR is performed by injecting CO_2 in semi depleted oil fields so oil is pushed by mixed or unmixed displacement which leads to its flow to the surface. It is possible by this method to produce not less than 10-15% of the oil in the field. The operation requires injecting a quantity of

140-280 m^3 of CO_2 to produce 1 barrel of crude oil. IPCC estimated that it is possible to reduce CO_2 in the world by 15-55% by 2100 (15) using CCS. In order that this method is economic the source of CO_2 emission should be large and the flue gas rich in CO_2. The possibility is not present in Syria to benefit from this mitigation technique since the emission sources are far away from the exhausted oil fields.

1. Description of oil & gas sector in Syria :

1.1 History

Exploration for oil & gas in Syria started in 1933. In 1956 the first flow of commercial oil from Karatchok formation in the north east of Syria. The exploration was confined to foreign companies till law 167 in 1958 was issued by which the General Commission of Petroleum was formed. The legislator gave the commission the authority of exploration and production in addition to its other tasks of refining, transport and trading with oil derivatives and they are all connected to the Ministry of Oil and Mineral resources , The Syrian Petroleum Company SPC engage in all activities related to extraction of oil and gas from prospecting and drilling to finally pumping oil and gas in pipelines to local refineries or to export ports through all operations of prospecting, drilling, study of reservoir, production, collection ,development and pumping inside pipelines(1).

Production of oil in Syria started in May 1968 after installation of the first station in Tel-Ades in the north eastern part of Syria when the oil was pumped to Tartous port passing Homs Refinery and the oil production reached 1.13 Million m3 in the year. Production of oil increased after that to reach 11 Million m3/ year in 1976. Service companies started operating afterwards and light oil was discovered in Der Al –Zoor in 1984. Before that most discoveries were from heavy oil. Service companies achieved other commercial discoveries so that oil production reached 30 Million m3 / year in 2002(2).

In the gas sector SCP started exploiting associated gas to generate electricity since 1975, and the exploration activity of the company increased to extend to the middle and eastern areas of Syria after it was limited to the northern and eastern north areas. Gas became one of the main sources of energy. In the year 2002 gas production reached 6 Billion m3/ year.

1.2 Future of oil and gas industry in Syria

Syria is regarded as the only important producer of oil and gas in the eastern Mediterranean. Production of oil continues to drop due to technical difficulties and exhaustion of wells. After reaching a peak of 604000 b/day in 1996, the production fell continuously to reach 460000 b/day in 2004 to 393900 b/day in 2006 after old fields discovered in 1968 especially huge Gbesa fields reached maturation. This equals 0.5% of world production and it has changed by – 6.4% compared with 2006. Production is expected to decrease while consumption continues to increase so export decreases and Syria becomes an importer of oil after 10 years as it was in the middle 80's as shown in Figure (1) (3).

According to BP statistics in 2008 Syria has reserves of 2.5 billion barrel of oil at end of 2007 and its reserve of natural gas reached 0.28 Trillion m3 at end of 2007. This equals 0.16% of world reserve. Production of natural gas in 2007 reached 5.26 billion m3. To reverse this trend exploration and production activities increases with switch in generating electricity from oil to gas. Syria opened new areas to foreign companies exploration. In January 2003 five new exploration areas were awarded. Shell obtained exploration rights in Palmyra-Damascus area and ONGC Videsh obtained an additional area. Static Energy and Independents Ocean Energy obtained new additional areas. Syria announced 3 exploration agreements in 2003 with exploration companies Canada Tanganyika , Petro Canada, CNPC of China and Devon Energy Gulfsands Petroleum from USA. In January 2004 new additional areas were awarded to IPR Transoil , ONGC of India and INA of Croatia INA announced a discovery of oil in Jihar field in September 2004 and expects production of 5000 b/d . Figure (2) shows prospecting areas for oil in Syria as in 2007(3).

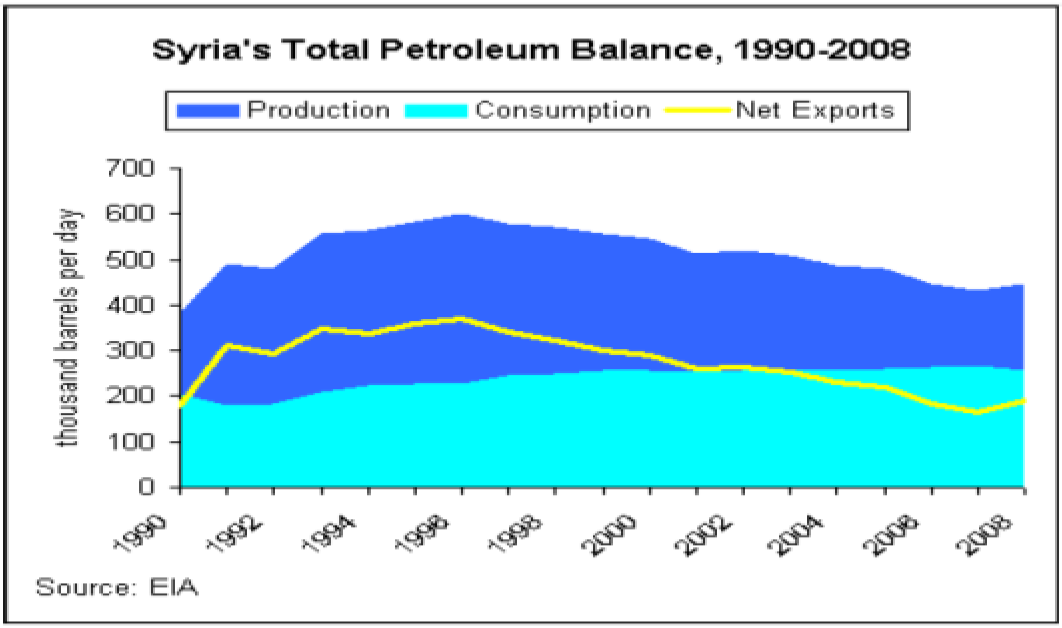
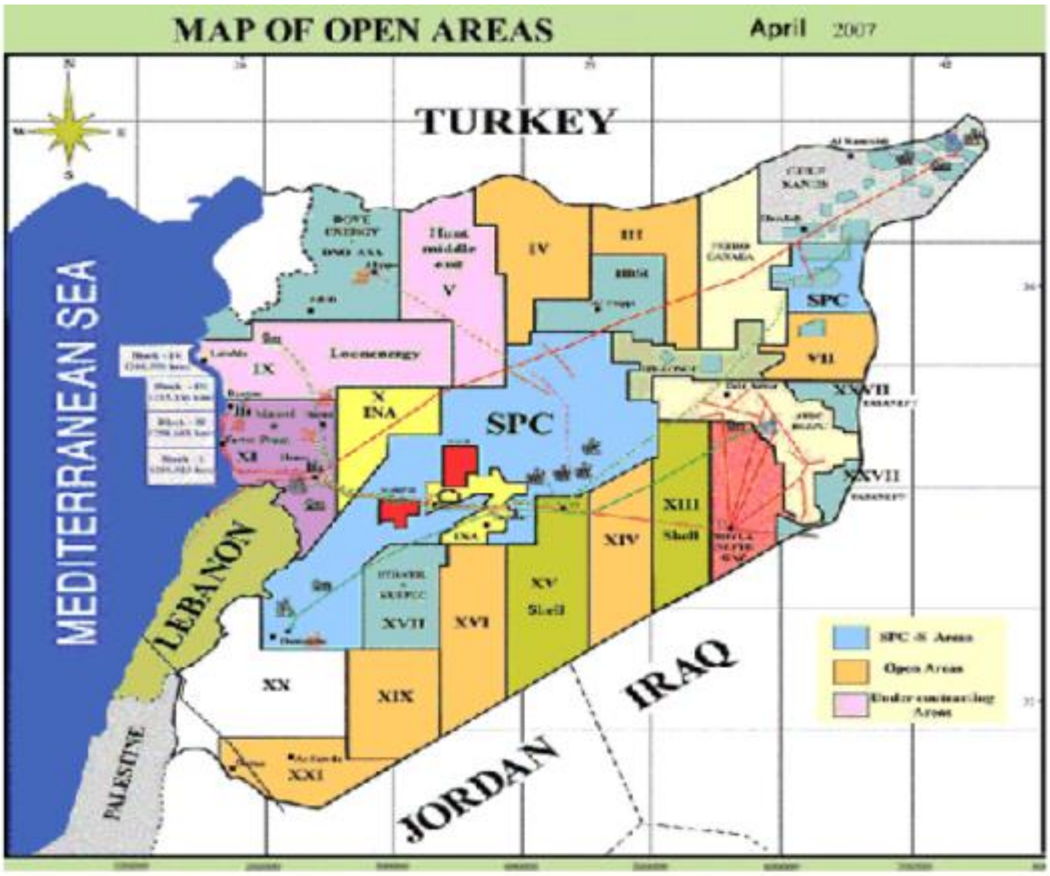


Fig.1 Production and Consumption of Oil in Syria from 1990-2008

1.3 Production and consumption of energy and oil in Syria

Table (1) shows production of energy in Syria in thousands boe/d. It also shows production of crude oil between 1997 – 2007 in thousands b/d and also the production of crude oil plus gas liquids in thousands b/d. Production in 1996 reached 604000 b/d and then it started decreasing gradually until it reached 432 000 b/d in 2005.

Figure (3) shows production of all kinds of energy in Syria, from crude oil to crude oil and gas liquids. It shows that production decreased steadily since 1996. This is due in the first place to decrease in crude oil production due to ageing of oil wells which were in operation since the 70's and the lack of new discoveries. The hydroelectric power remained constant while liquids from gases increased slightly due to the increase in production of natural and associated gas.[4]



Source: Syrian Petroleum Company

Fig.2 Areas of prospecting for oil in Syria in year 2007 (3)

Table 1. Production of Oil, Energy and Liquids from Gases (thousand b/d)

Year	Energy	Oil & gas liquids	Crude Oil
1995	702	601	591
1996	719	593	582
1997	728	584	573
1998	745	583	572
1999	749	585	575
2000	713	557	547
2001	689	532	522
2002	662	505	508
2003	632	509	499
2004	590	471	461
2005	577	438	427
2006	492	387	377
2007	494	380	370

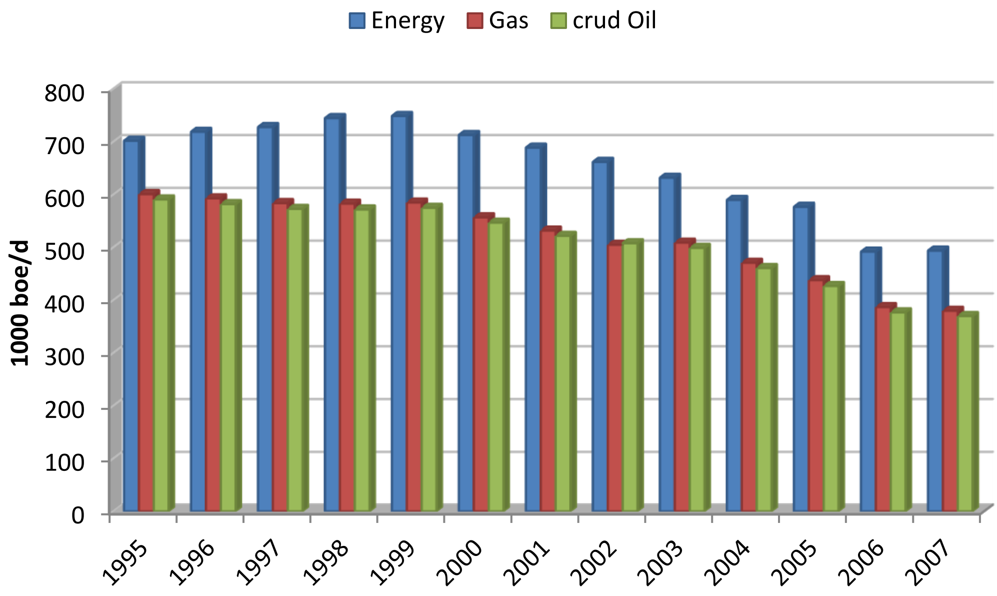


Fig (3) Production of Energy, Crude Oil, Gas Liquids for the period 1995-2007 [(4)]

In contrast Figure (4) shows consumption of Syria from energy and from oil and gas for the same period [(4)]. From the figure it can be shown that consumption of Syria from oil and from energy in general has increased steadily from 1995 to 2007. This is traced to the growth in demand for oil derivatives to generate electricity and especially for transport. These two sectors witnessed a steady increase due to the continuous high increase in population, rise in the standard of living and migration from the countryside to the big cities.

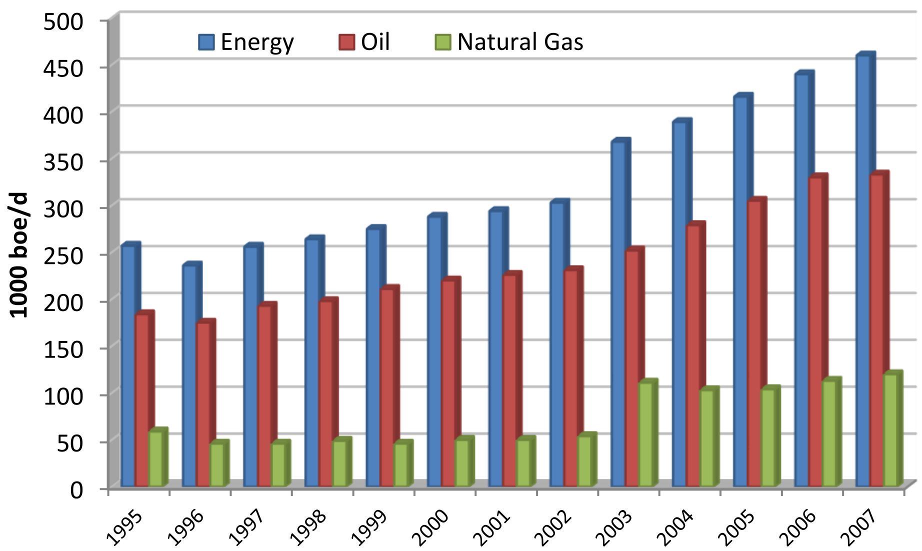


Fig.4 Consumption of Energy, Crude Oil, Gas Liquids for the period 1995-2007 [(4)]

The demand for oil nearly doubled from 180 000 b/d in 1997 to reach 330000 b/d in 2007. If this is compared with the drop in production of crude oil from 520000 b/d in 2003 to 370000 b/d in 2007 it is seen that Syria has switched from a net exporter of oil to a self-sufficient country in a period of 4 years only due to the increase in consumption and the drop in production. Consumption of natural gas increased during the same period due to switch to natural gas for generating electricity and the discovery of new gas fields while production of hydroelectric power remained nearly constant due to the constancy of dams generation which depends chiefly on water coming from Turkey and on climate conditions as shown in Figure (5)[3]

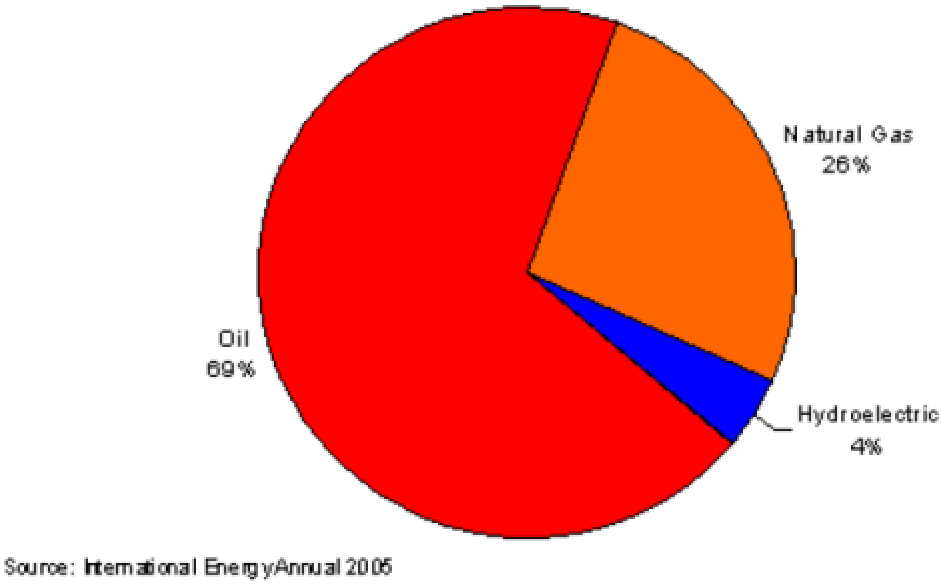


Fig.5 Share of Different Energies in Syria for Year 2007 (3)

Fossil fuels dominate consumption of energy with the absence of renewable energies and the drop in efficiency of energy conversion. Total amount of consumed energy in 2005 reached about 15.25 million tons of equivalent oil. This is distributed on 27% for transport, 23% for domestic consumption, 19% for industry and 11% for agriculture. The share of building industry, extraction industry and service sector reached 7%, 7% and 6% successively as shown in Figure (6) [5].

Table (2) shows distribution of primary energy according to type of oil (prior to electricity generation) for the period 2003-2005. It is shown that demand for primary energy has grown during this period by 5.3%. This growth was covered by oil derivatives (mainly gas oil) and natural gas and with a modest contribution from renewable energies represented by hydroelectric energy. [5]

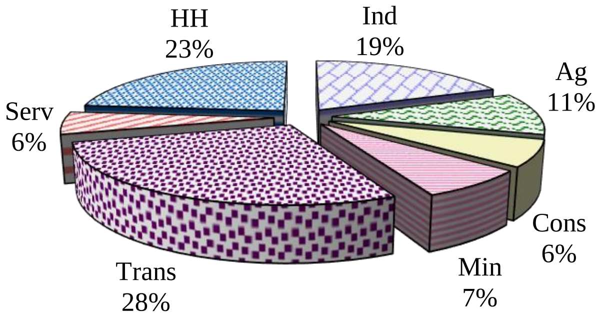


Fig 6 Distribution of consumption of energy on different sectors (5)

Table 2. Distribution of Primary Energy According to Type of Fuel for 2003-2005 period [5]

Oil Derivative	2003	2004	2005
Diesel	32.3%	32.2%	33.0%
Gasoline	6.9%	6.8%	6.9%
Fuel Oil	23.2%	25.3%	24.7%
LPNG	4.4%	4.4%	4.5%
NG	23.1%	22.1%	21.6%
Asphalt	3.7%	3.6%	3.6%
Heavy products	2.3%	2.2%	2.2%
Hydro power	3.1%	2.5%	2.4%
Traditional	1.0%	1.0%	1.0%
Total Annual (Mtoe)	**18.13**	**19.00**	**19.41**

Table (3) shows indicators of consumption of energy in Syria compared with Arab countries and other countries in the world.

Table 3. Some Indicators of Energy Sector in Syria Compared with World Values for 2005[5]

	Primary Energy (toe/capita)	Final Electricity Consumption (kWh/capita)	CO_2-Emission (tCO_2/toe)	CO_2-Emission (tCO_2/capita)
Syria	0.99	1367	2.59	2.57
Arab World	1.4	2881	2.47	6.51
Asia	0.63	617	1.94	1.22
Africa	0.67	547	1.39	0.93
World	**1.77**	**2516**	**2.37**	**2.57**

1.4 Production and consumption of natural gas in Syria:

Proven estimates of natural gas are estimated at 8.5 T ft^3. Most of these reserves 73% owned by Syrian Gas Company SGC including 3.6 ft^3 in Palmyra area (including Arak , Haal, Dubiat, Nakeeb and Sukhna) and 1.6 ft^3 in oil fields of Al-Furat Oil Company and Der Al-Zoor Company including Omar field and 1.3 ft^3 in Sweidya and 0.8 Tft^3 in Gbessa and 0.7 Tft^3 near Der Al-zoor and the rest in Hoal , Algoona and Al-Murkeda (3) . In 1998 Syria produced about 208 billion ft^3 of natural gas which was an increase by 5 times what it produced a decade before. Quantity of natural gas produced in Syria in 2009 reached about 24 million m^3/day. 16 million m^3/day of free natural gas and 8 million m^3/day of associated gas. So associated gas constitute about 50% of free natural gas. Syria intends to increase its production from natural free and associated gas in the future and to use it in electricity generation instead of fuel oil and thus free larger quantities of oil for export to the outside and in the same time to reduce pollution of air and reduction of CO_2 emissions. (6)

Syrian Gas Company SGC works to increase gas production through many projects. Palmyra area is considered as the major area for most of these activities including Arak gas field which started production at the end of 1995 . In October 1997 Syria declared the discovery of a new gas field in Abu Riah area in Palmyra. One of the difficulties for the gas sector is that its location in the north eastern part of Syria while major population centers are situated in the south west. Considering the small size of gas fields in Syria major oil companies did not show a great interest in it . The exception was the American company Conoco. Also there is the French company Elf which signed a contract with the Syrian Oil Company SPC in 1998 to use the associated gas in Der Al-Zoor fields. The Der Al-Zoor gas project includes the building of a network for collecting gas and a unit to treat it and a pipeline with a 155 mile length to transport the gas to the gas network in Palmyra which serves the western part of Syria. When it is finished the production will include 22 fields and the quantity will be around 289 million ft^3/day.

The Geological reserve of gas in all its forms in Syria is estimated at around 795 Billion m^3 while the reserve which can be produced is estimated at around 405 Billion m^3 . Table (4) shows the consumption of Syria from natural gas and the liquefied petroleum gas LPG in thousands of barrels / day for the period 1997 to 2007 . (4) Fig (7) shows that consumption of Syria from natural gas increased slightly from 45000 b oe /d in 1997 to 55 000 boe /d in 2002. But the consumption jumped in 2003 to 110000 boe/d in 2003 and slightly dropped in 2004, but it increased steadily from 2005 to reach 120000 boe/d in 2007 . Also production of liquefied petroleum gas LPG in Syria increased from 18000 boe/d in 1997 to 30000 boe/d in 2007 . This reflects the increase in demand for gas in industry and for electricity generation instead of oil derivatives and the discovery of significant gas fields. (6) Fig (8) shows the development of oil and gas production in Syria for the period 1980-2005 . This shows the increasing dependence of Syria on natural and associated gas. Production of gas was very small in the 80's and it started to increase in the 90's and jumped to a higher level at the end of 90's . The rise in gas production was accompanied with the stability of oil production in the 90's and its gradual decline after that. (7)

Table (4) Consumption of Natural Gas and Liquefied Petroleum Gas LPG ,1000 boe/d[4]

Year	Natural Gas	LPG
1995	59	14.2
1996	46	15.5
1997	46	16.1
1998	49	16.7
1999	46	17.5
2000	50	18.2
2001	50	19.3
2002	54	20.4
2003	111	22.0
2004	103	23.0
2005	104	25.0
2006	113	26.0
2007	120	28.0

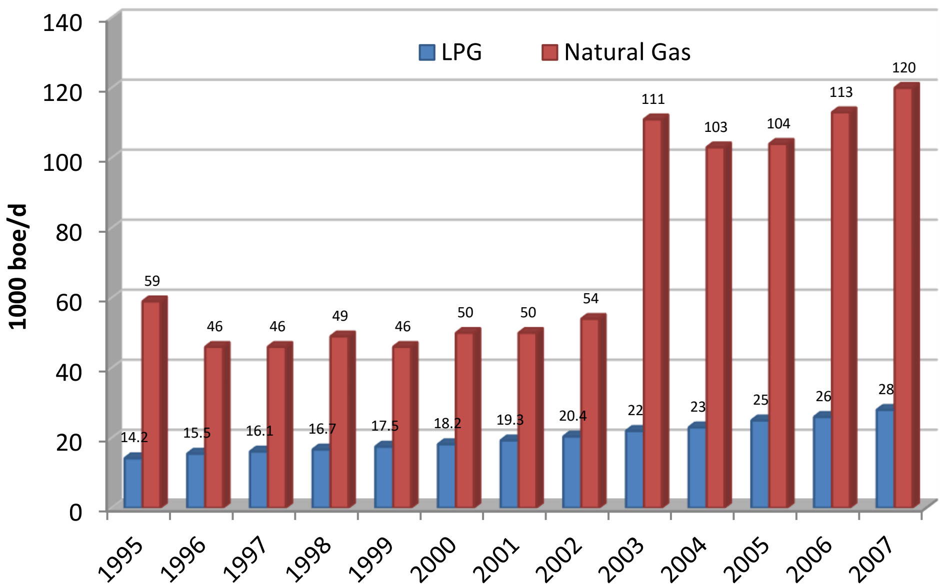
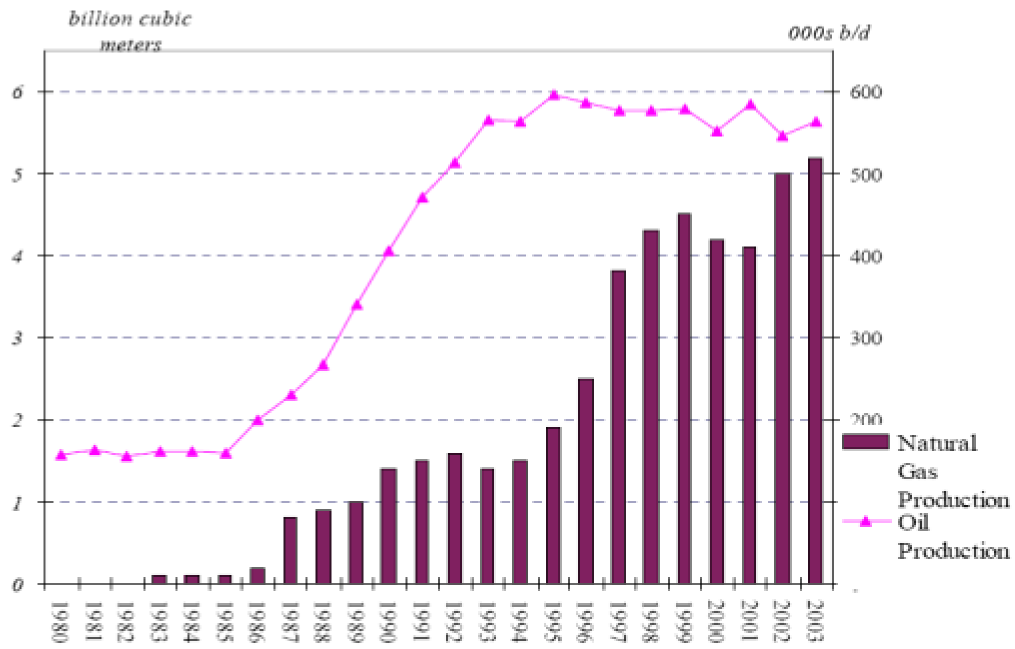


Fig (7) Consumption of Natural gas & LPG in Syria 1995-2007



Source: BP, *Statistical Review of World Energy 2005*

Fig. 8. Development of oil & gas production in Syria 1980-2003 (7)

1.5 The industry of oil refining

In Syria there are two refineries

1.5.1 Homs Oil Refinery:(8)

Homs Oil refinery was established in 1959 as the first oil refinery in Syria with a refining capacity of 1 million tons /y of light Iraqi crude in order to satisfy the need of the local Syrian market from oil derivatives and to export the excess outside . Homs refinery witnessed a number of extensions over the last 50 years. With the extraction of oil in Syria in 1968 and its exploitation and the increase of the demand for oil derivatives the first expansion of the refinery was carried out in 1969 and the capacity was expanded to 2 million tons/year from Syrian heavy oil. After that many expansions were carried out so that its refining capacity increased to 5.7 million tons / year from light and heavy oils .The refinery was built in Homs because of its strategic position in the middle of Syria and the existence of Al- Assi River which supplies it with water. The refinery lies 7 km to the west of the city on the road which leads to Lebanon. The refinery occupies at present an area of 7 km^2 and around 4500 persons work in it.

In 1959 the refinery started operation with a distillation unit U-100 with a capacity of 1 million tons/year of Iraqi light crude and a reforming unit, asphalt unit and some other service units such as a nitrogen unit and a power unit. In 1969 the former distillation unit was revamped to 1.7 million tons/year and to operate on heavy Syrian crude. A new distillation unit U-10 was built so the total capacity of the refinery was expanded to 2.7 million tons/year. A coking unit, gas separation unit, hydrotreatment units for naphtha, kerosene , light and heavy gas oils , recovery of acid gases unit , a hydrogen production unit , a power unit and a sulfur recovery unit were added . In 1974 a third distillation unit

U-22 with a capacity of 1 million tons/year and a unit for oil lubricants were built. The capacity was thus expanded to 3.7 million tons/year. In 1976 a fourth distillation unit U-21 with a capacity of 1.7 million tons /year and so the capacity of the refinery increased to 5.4 million tons/year. In 1979 a unit for asphalt production and a unit for industrial effluent water treatment were built. The capacity of the first distillation unit was expanded to 2 million tons/year and so the total capacity of the refinery reached 5.7 million tons/year. In 1989 other units were established to improve the quality of products and to hydrotreat naphtha, kerosene , gas oil and a unit for reforming of gasoline , an isomerisation unit , a new sulfur unit and a power and steam generating unit .

The refinery produces liquefied petroleum gas LPG , solvents , super and ordinary gasoline , domestic and jet kerosene , heavy and light gas oils , fuel oil , asphalt , petroleum coke , sulfur and lubricants . All these products are according to standard Syrian specifications .

Fig (9) shows a simple schematic diagram of Homs refinery .

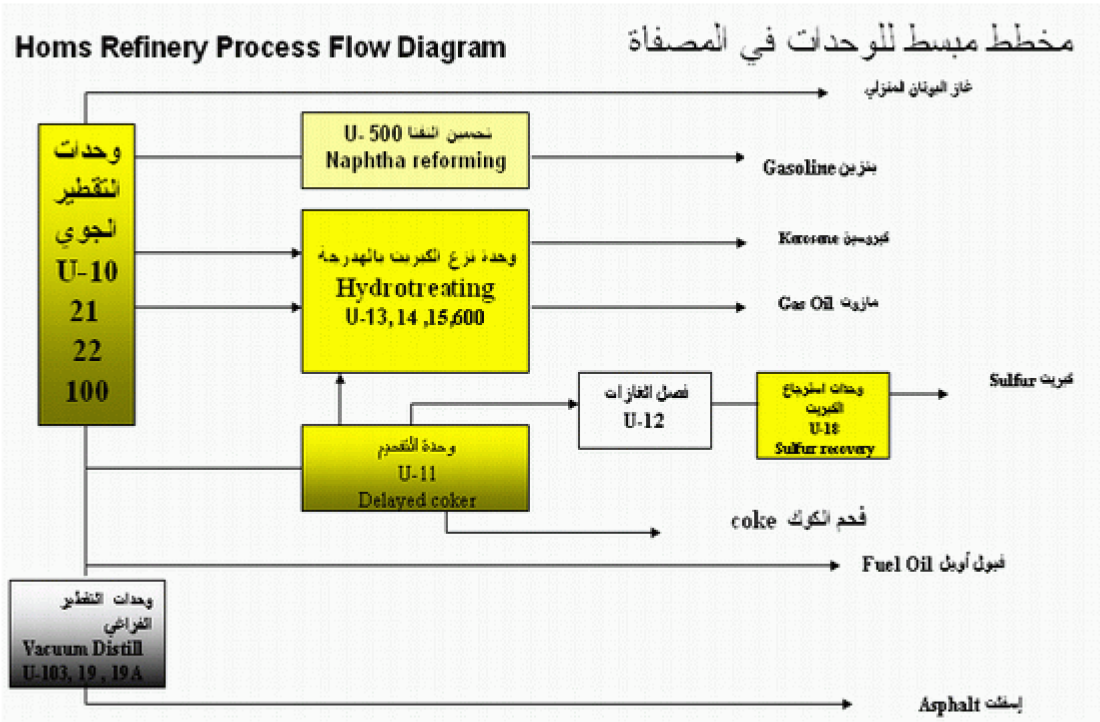


Fig 9. A simplified schematic diagram of Homs refinery

1.5.2 Banias Oil Refinery(9)

Banias oil refinery was established according to contract number 20 in 1974 which was signed with Industrial Export of Romania. The purpose of the contract was to build a refinery to refine crude oil and to produce oil derivatives with an annual capacity of 6 million metric tons / year in the northern part of Banias on the sea in Tartous Municipality. The contract had two annexes: The first numbered 15 in 1974 aimed at securing the feed of the refinery with water from Sin River. The second numbered 2 for the year 1976 aimed at changing the mixture of the crude to be refined according to contract 20 to enable refining a mixture of 50% heavy Syrian crude and 50% Syrian light crude. In 1981 the refinery was operated as a whole for the guarantee tests. In 1982 the commissioning of the refinery was completed. Banias refinery was designed at an annual capacity of 6 million tons/year of a mixture of light and heavy Syrian crude oil with percentages of 80% light and 20% heavy to 50% light and 50% heavy. The annual refining quantities since 1988 until now surpassed the design capacity and reached 102-117% of the designed including fuel oil and naphtha delivered from Homs refinery and the commercial activity of the rest of derivatives. This disorder in the supply of imported light crude remained an obstacle in the orderly operation of production and its increase until light crude became available from Syrian fields from 1987. Fig (10) shows the annual production of Banias refinery from the crude derivatives.

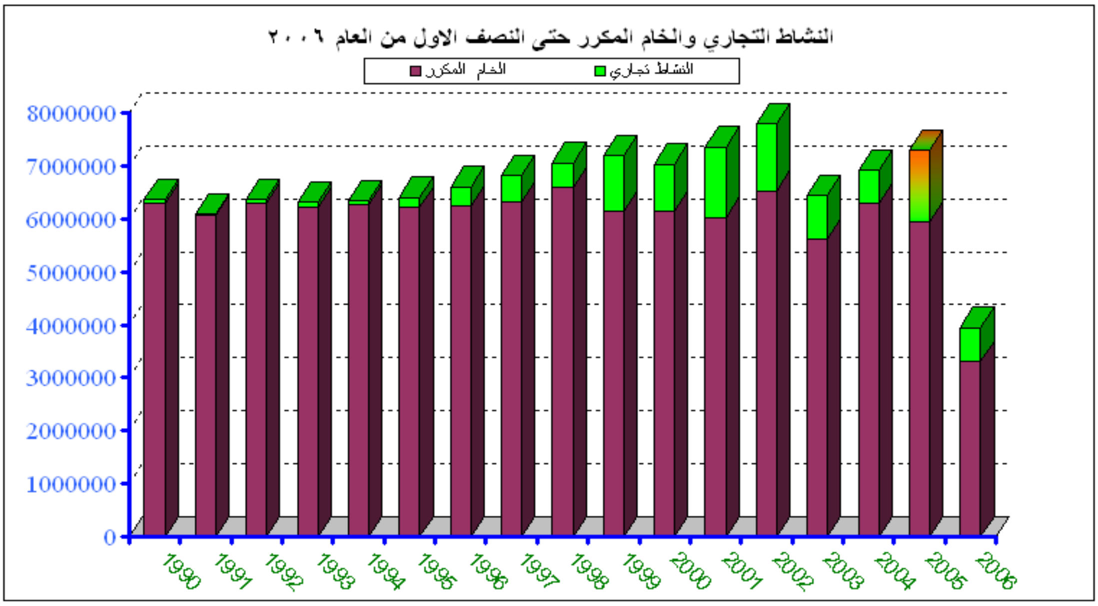


Fig 10. Annual production of crude derivatives from Banias refinery, (million tons /year)

Table (5) shows the annual capacity of oil refining in Syria for the years 1997 till 2007 [4]

Table (5) Refining capacity of Syria from 1997-2007 .1000 b/d [4]

Year	LPG	gasoline	kerosene	Gas-oil	Fuel oil	Others
1995	4.9	34.5	7.6	89.7	92.8	16.3
1996	4.8	37.0	7.1	92.8	97.0	12.9
1997	4.3	36.5	7.7	99.1	105.4	15.6
1998	4.3	36.5	6.5	102.9	105.1	17.8
1999	4.3	35.8	10.9	101.8	104.3	17.6
2000	4.3	35.4	15.5	98.9	98.5	16.5
2001	4.3	35.6	10.9	101.8	104.3	17.6
2002	4.3	34.8	10.6	99.4	101.9	17.2
2003	4.3	27.5	8.1	77.1	89.1	14.7
2004	4.3	25.6	8.6	79.3	91.5	15.8
2005	4.3	35.5	8.9	80.4	90.1	25.8
2006	4.3	35.4	8.9	80.4	90.1	19.4
2007	4.3	35.4	8.9	80.4	90.1	19.4

Fig (11) shows the crude derivatives produced from Homs and Banias refinery for the years 1995 – 2007 . It is clear that gasoline increased from 25.6 to 35.5 thousand b/d between 2004 and 2005 and then remained nearly constant . This is due to the increase in the demand for gasoline since reduction of custom duties on importing transport vehicles . The rest of the derivatives remained more or less the same over the years especially gas oil, fuel, kerosene and LPG . This is attributed to the fact that the refining capacity of the two refineries remained constant over the years since there was no building of new refineries and no expansion of existing ones.

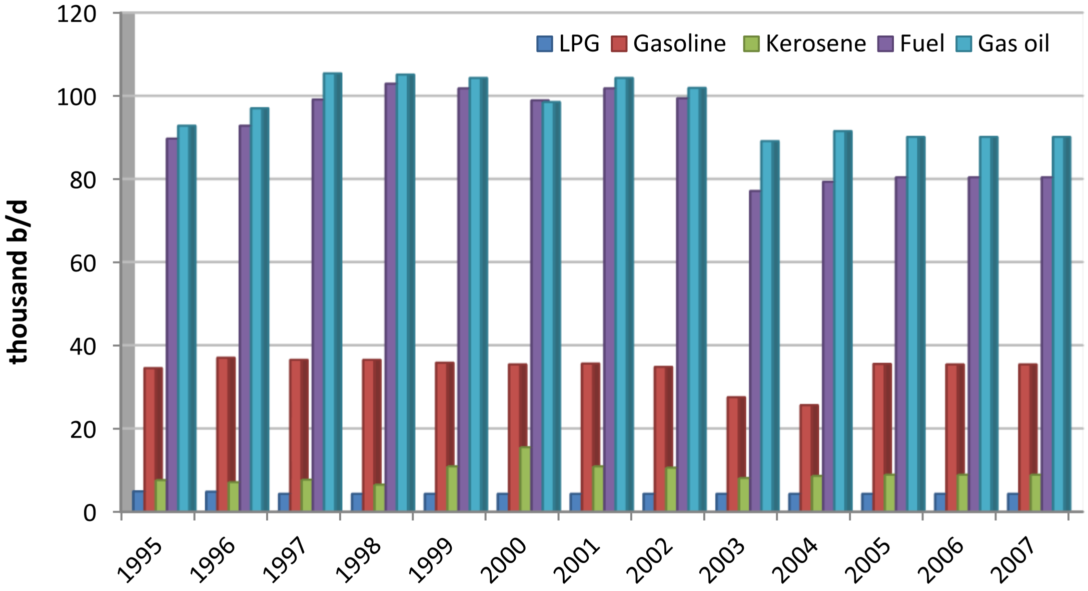


Fig 11. Refining capacity of Syrian refineries for 1995-2007[4]

1.6 Transport of oil and gas: [10]

Methane gas leaks from oil and gas pipelines and this is termed **Fugitives**. This is regarded as one of the most important sources of methane anthropic emissions to the atmosphere. Syrian Company for Oil Transport SCOT is in charge of managing these pipelines. The company is a merger of two previous companies:

1- The Syrian Company for the Transport of Oil (Iraq Petroleum Company IPC previously) which was established in the 30's to transport Iraqi crude oil to Tripoli and Banias . The length of operating pipe lines is around 808 miles.

2- Syrian Oil Transport Company SOTC: This was established in 1968 for transporting Syrian crude oil from (Karatchuk , Sweidiya and Rumilan) through pumping stations to Tartous with a length of 202 miles .

OAPEC statistics for the year 2008 shows that number of oil pipelines in Syria are 9 lines with a total length of 1019 miles and with a diameter of 16-32 inches as shown in Table (6)[10].

Table (6) Crude oil pipelines in Syria

Line	Diameter (inch)	Length (mile)
Tel Ades – Homs	22	358
Homs - Tartous	18	56 * 2
Al-Ward – Second station	16	40
Al-Tayem – Second station	20	57
Omar – Second Station	24	56
Al-Jafra- Second Station	16	67
Tartous – Banias	24	25
Jambor – Banias	32−26	304
Karkook - Banias	30/24	NA

There is also the Syrian Company for Storage and Distribution of Oil Derivatives (Mahrookat) which store and distribute the products mentioned. The company posses a network of pipelines to transport the various derivatives with 7 pipes and with a length of 611 miles and a diameter of 6-24 inches as shown in Table (7).

Table (7) Pipelines for transport of oil derivatives. [10]

Line	Diameter (inch)	Length (Mile)
Homs/Damascus	6	103
Homs/Damascus	12	103
Homs/Aleppo	6	114
Homs/Aleppo	20	115
Homs/Banias	6	77
Banias/Homs	24	72
Banias / Latakia	6	27

As for natural gas the increase in production and consumption led to a rapid development of gas pipelines in Syria . In 1981 the length of the network did not exceed 323 miles and in the year of 1991 it became 724 miles and 926 miles in 1996 and became 1225 miles in 2002 and it is now 1328 miles as shown in Table (8) .

Table (8) Gas pipelines in Syria at end of 2008 [10]

Line	Diameter (inch)	Length (Mile)
Gbese /Homs/Zara	16	323
Omar/Damascus/Homs/Muharada	18	423
Arak/Homs/Zara/Zezon/Aleppo	24	347
Gas Factory/Der-Al-Zoor	18	153
Homs/Banias / Lebanon	24	112
Der Al-Zor /Tichreen	18	273
Palmyra/Idlb	24	202
Palmyra/Muharada	18	127
Palmyra/Aleppo	24	147

Fig (12) shows a map of gas pipelines network in Syria . [10]

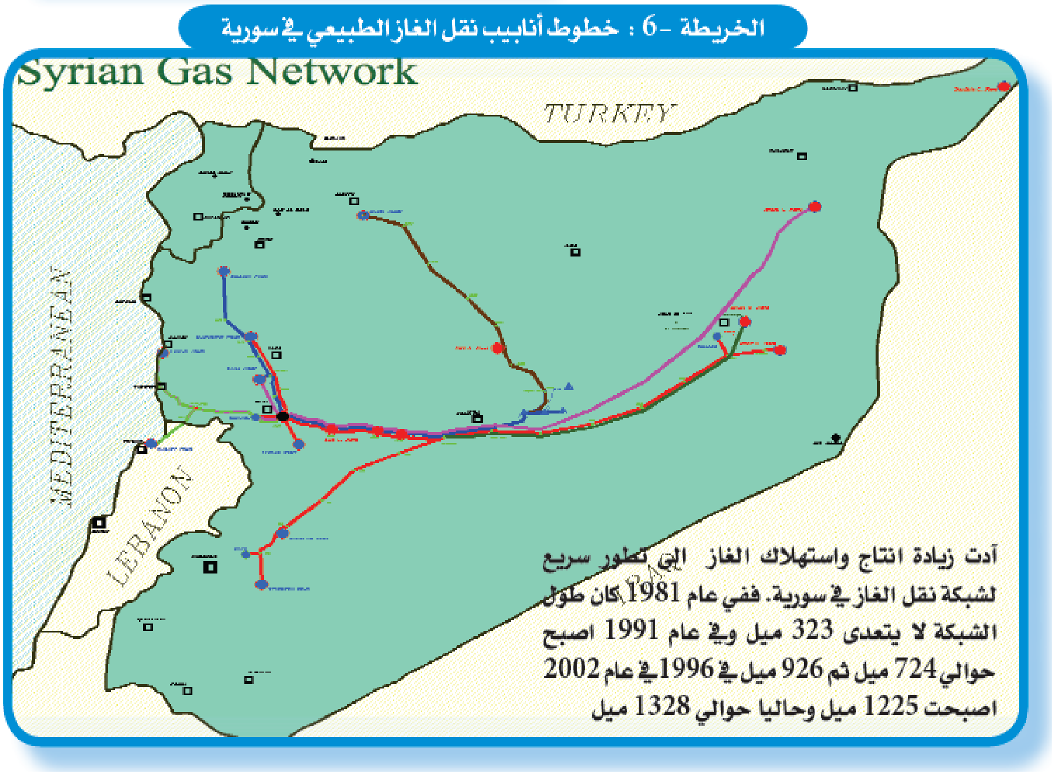


Fig (12) A map of gas pipelines network in Syria . [10]

1.7 Companies operating in the oil and gas fields:

Al-Furat Oil Company AFPC is regarded as the largest oil producer in Syria. It is a joint company established in 1985 between the Syrian Petroleum Company SPC and Shell Bectin and PetroCanada . The area of its operation lies mainly in the north eastern part of Syria and in Der Al-Zoor area where important quantities of oil were discovered in the late eighties. The company produces around 400000 b/d of high quality oil. The main field of the company is Thayem field although production is falling since 1991. The other important field is Omar / Omar North which produces around 15000 b/d by natural pressure and 30000 b/d by injection of water. Other fields for the company include Azba , Maleh , Sijan and Tank .

The Syrian Petroleum Company SPC is regarded the second most important oil producer in Syria. The fields exploited by SPC reached a peak in production at end of 70's with more than 165000 b/d. The fields of SPC include:

1- Karatchuk field which is the first oil discovered field in Syria and lies near the Iraqi – Turkish borders.

2- Sweydiya field which is a huge oil field south of Karatchuk in the Haska area and extends to the northern part of Iraq.

3- Gbeisa field which is an important oil and gas field.

4- Rumelan field which is a small field near Sweidiya and produces heavy crude oil .

5- Tishreen , Alyan , Gbeibi fields which are small fields producing heavy oil with a diminished production .

The Chinese CNPC company signed a contract with SPC in March 2003 for enhanced recovery of Gbeibi field to increase the production from 4500 b/d now to 10000 b/d .

Other fields include Maleh , kahar , Sijan , Azrek , Tanak and Gefr which was discovered in 1991 near Der Al-Zoor are operated from Der Al-Zoor Oil Company which is a joint venture between the French Total Fina Elf . Company and the Syrian Petroleum Company SPC. Its present production is 60000 b/d .

In February 2005 the Canadian Tangayika Oil Company announced a new drilling program in Tishreen and Sheikh Mansoor fields in the productive area of oil in Gbeisa at 120 km south west of Oada field which belongs to the same company. The average production from Oada field reached 2032 b/d in 2004. [11]

Hayan Company operates in the fields discovered by INA company (50% Croatia and 50% SPC) in the fields of Jihar , palmyra , Mahr, Gazal , Mustadira , Mazroor) which lies in Der Al-Zoor area at 45 km from Palmyra and 120 km from Homs . Production started in November 2009 at an average of 6000 b/d . There is also a gas factory to recover the associated gas .Fig (2) shows the areas allocated to oil companies .Table (9) shows the most important companies producing oil in Syria[12]

Table (9) The important crude oil producing companies in Syria[12]

The Company	Type of Company	Production 1000 b/d
Syrian Petroleum Co SPC	Syrian Government	200000
Al-Furat Petroleum Co AFPC	Joint SPC + Shell + CNPC	120000
Der Al Zoor Petroleum Co DAZPC	Joint SPC + Total Elf	30000
Dublin Co	Joint SPC + Dublin	20000
Kawkeb Syrian Chinese Co	Joint SPC + CNODC	10000
Hayan Petroleum Co	Joint SPC + INA Croatia	6000

Syrian Gas Company SGC was established by the presidential degree 50 for the year 2003 as an independent company financially and administratively. Its task was defined to exploit and develop gas resources discovered in Syria and the optimum operation of the existing facilities. The company is the operator of gas collection and treatment systems and its transport from various production sites to collection and treatment sites .It also collect crude gas produced (free and associated) from production sites belonging to other companies through a huge net of collection systems and pumping stations to the central treatment unit where the gas is treated from contaminants and then sweetened and dried and cooled to separate liquids and produce LPG and condensates and the remaining gas which consists from methane mostly is pumped through pipelines network to consumers .

The company at present operates the followings:

- Three gas factories in Der Al-Zoor , Hasaka and Gbesa .
- Wide network of clean gas pipelines which extends over 2500 km with various diameters.

- Huge network of gas collecting systems and a big group of collecting stations and stations to raise pressure.
- Center of gas coordination for managing and operating the gas network in the optimum way.

In addition to what mentioned before the company executes projects to develop gas discoveries in the south and north of middle region of Syria. Two factories for treating natural gas and the required collection systems are erected. It also supervises the erection of two additional treatment factories belonging to service contract companies such as Petro-Canada and Hayan companies. It is planned to put these four plants in operation successively starting in the middle of 2009 till 2011. It is expected to enforce the supply of gas in Syria with its production which is expected to reach 15 million m^3 /day so that the production of total clean gas exported to consumer will reach 26 million m^3/day. [(6)]

The company continues the cooperation with neighboring countries through the Arab Gas Pipeline. The execution of first part from the third stage from the Jordanian border to Homs with a length of 320 km is finished and the flow of Egyptian gas to the country started from July 2009. The Syrian network is being connected right now to the Turkish network from Aleppo to Kylys on the Turkish border with a length of 62 km . The operation is expected to end in 2010. This will allow the possibility of exporting and importing gas to the country. By cooperating in the regional gas projects like the Arab Gas Pipeline Syria hopes to benefit from its strategic position and to make it a cross point toward Turkey and Europe . [(6)]

2. Emissions of GHG in the oil and gas sector [5]

Inventory of emission of GHG in the energy sector for the period 1994 – 2005 was carried out according to procedures of IPCC . These include estimating emissions from burning fuels (in stationary and mobile sources) distributed over the sectors which consume energy. These include 4 main sectors. The industry of energy sector, industry sector, construction sector ,and the sector of other activities (domestic , service and agriculture) . Fig (13) and Fig (14) show the development of GHG emissions between 1994 – 2005 distributed over sectors [5] . Emissions of GHG for 1994 reached 38.24 million tons CO_2 equivalent with CO_2 constituting around 89% , This has nearly doubled over 11 years to reach about 58.35 million tons CO_2 equivalent with CO_2 constituting around 95% in 2005 . This is equivalent to an average increase of 3.9% a year . It is obvious that this percentage is less than the growth in demand for primary energy which increased from 11.7 to 19.39 million tons of equivalent oil for the same period . Emission average decreased from 3.30 to 2.98 ton CO_2 equivalent / ton of crude equivalent during the same period . This is justified by the increase in the efficiency of energy conversion and the change from fuel oil to natural gas in power generation. It is noted that power generation took the largest share of emissions and its share increased from 28% to 39% during that period . Transport came next with share between 17% - 22%. The share of the building sector regressed from 17% to 12%. The share of industry and construction and extractive industry and refining retreated from 13% to 8% during the same period.

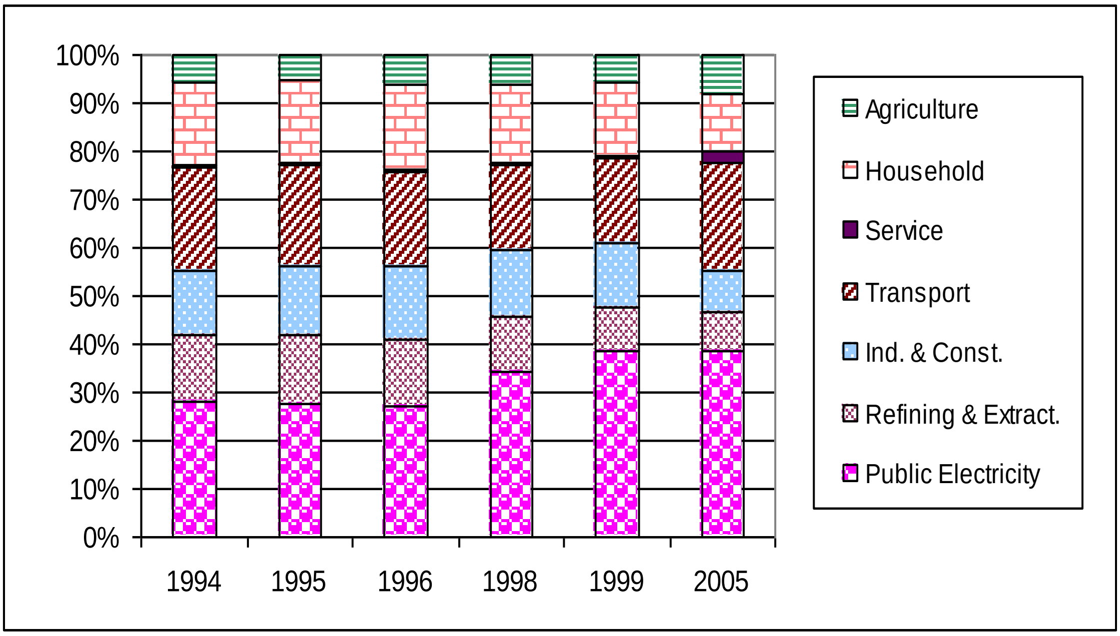


Fig 13. Development of relative distribution of GHG emissions according to sector [5]

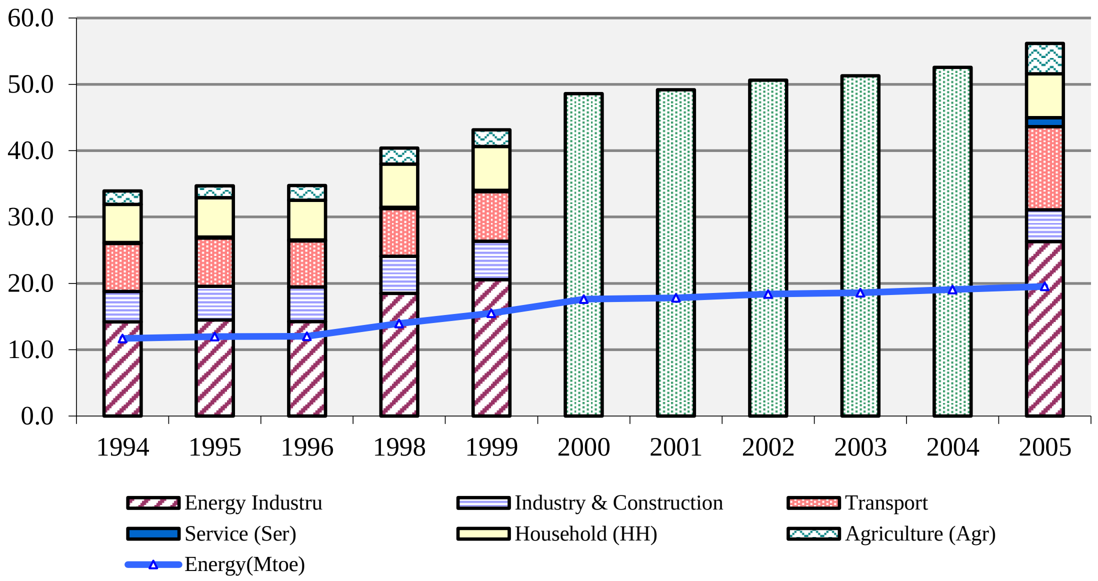


Fig 14. Development of relative distribution of GHG emissions according to sector [5]

The quantity of leaked methane or what is termed **Fugitive** Emissions was calculated separately according to the methodology of IPCC [5]. This leaked quantity constituted 88% of the total emissions of methane (about 2.2 million ton CO_2 equivalent) while the rest 12% came from burning fuels in different sectors . This type of emissions accompanies extraction of fossil fuel (oil , natural gas …etc) , its transport , refining and storing in addition to the burning the gas in flares . This does not include burning fuel and its consumption which were mentioned. The methodology of IPCC allows calculation of methane emissions which is the main gas associated with these operations.

The results shown in Fig (11) indicate a sharp drop in the quantity of methane emissions from this sector in 2005 compared with 1994. Methane emissions in 1994 constituted over 98% of methane emission in the energy sector and reached a value of 4.3 million tons CO_2 eq while emissions in 2005 were 2.2 million tons CO_2 eq or 86% of the total . The reason for this drop is the decrease in the quantity of produced oil and the drop in the quantity of flared gas due to its use in injection in oil wells to improve extraction factor or to benefit from it. Fig (15) shows the development of methane emissions between 1994 and 2005.

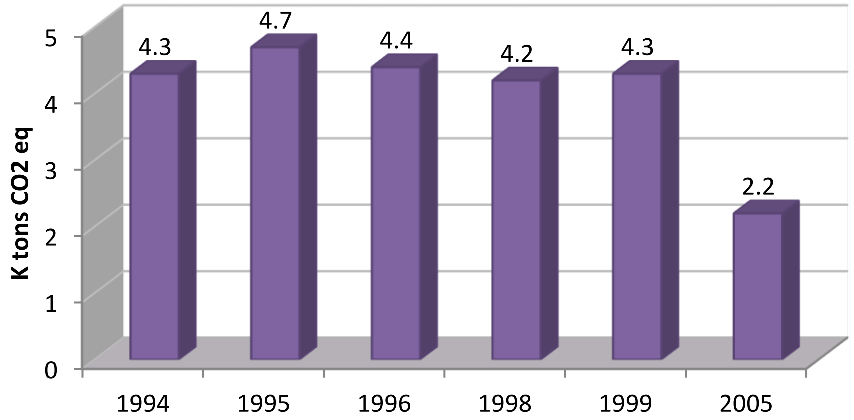


Fig 15. Development of CH_4 emissions from 1994 to 2005

Mitigation of GHG emissions :

3.1 Mitigation by conservation of energy consumption:

Conservation of energy is one of the most important methods to mitigate GHG emissions. Despite the increase in population and the improvement of the standard of living for the majority of them there are still important areas for conservation of energy. Consumption of energy is related to the price of fuel for the consumer. The pricing should depend on the principle of conservation of energy, the prevention of waste and the punishment of waster. This means supplying the minimum amount of energy to large section of the population for easy and dignified life and to increase its price with the rise in consumption. This requires informing people by conservation of energy for economic and environmental reasons by various public media, education and training. There is a need for changing the style of life which lasted for decades, which is based on the culture of consumption any price without considering the environmental consequences.

The Escwa –UN report [13] gives the measures taken to conserve electrical and heat energy by oil and gas sector in Syria such as:

- Place condensers on electricity network to raise power factor to minimize loss in the network and installing electric condensers tableau of 20 kv in 20 kv transformers in the main stations to improve power factor to 93% and to limit back power.
- Replace the old gas turbines installed 25-30 years ago in SPC (Hasaka field directorate) which have a low efficiency by new ones .
- Replace the old electric equipment in bad technical condition by modern ones to minimize loss in production due to electric failure and the purchase of 7 new drilling machines to replace the old ones in bad conditions requiring constant maintenance.
- Regular programmed maintenance and regular checking for consumption of energy in equipment. Installation of firing and extinguishing equipments to lightning and use of gradual start-up of large electric motors.

In the **refining field** many measures could be taken to diminish consumption of energy and reduction of GHG emissions such as:

- Watch burning in furnaces and boilers to maintain the required amount of air and limit emission of methane and other unburnt hydrocarbon gases.
- Limit the scaling on the walls of furnaces, boilers and heat exchangers tubes which enhance transfer of heat and limit amount of fuel burnt.
- Ensure that steam traps operate well and choose traps with the suitable capacity.
- Recover most of the water condensate to benefit from its thermal content and lack of salts .
- The optimum operation of refinery units and observation of quantity re pumped or recycled in the different units .

- Send the middle product from the unit producing it to the receiving unit without storing it as possible.
- Erect systems to recover energy from hot products and to use it to heat others
- Recover heat from flue gases to superheat steam and heat water entering the boilers to increase its efficiency.
- Use flue gases in producing steam which can be used in generating electricity by steam turbine in the refinery.
- Insulate tanks of products very well if not insulated.
- Use of heat from flue gases from furnace of distillation unit.
- Use of heat from the flue gases which leaves the reforming unit.

3.2 Mitigation by converting to lighter fuels (Decarbonization) :

Conversion of fuel from coal to oil and to natural gas minimizes emissions of GHG. This is an important tool for mitigating global warming. The process of change from solid fuel to liquid and then to gas is called Decarbonization . This process was adopted by many European countries especially UK and Norway where huge oil and gas fields were discovered and exploited from the North Sea . Many other European countries consume the gas which comes from Russia by pipeline or from Algeria by ships. This process influences the quality of air favorably by reducing emissions of gases such as sulfur oxides SOx , nitric oxides NOx and soot which pollute the environment both locally and regionally . They also influence the global environment by releasing GHG gases such as CO_2 , NOx , CH_4 and others . But natural gas is a fossil exhaustible fuel in the end. So this solution is temporary and not strategic. There is a possibility to convert the coal to a gas in a process called gasification. Coal reacts with steam or air at high temperature and with presence of a catalyst. This process was used in UK from the middle of the nineteenth century to obtain the gas which was called "Town Gas" from coal . Much research was done on this process to improve its efficiency and make it commercial. But this method is not going to solve the problem of climate change in the long run.

Syria carried out great efforts during the 90's of the last century to switch from fuel oil to natural gas for generating electricity. Many power generation stations were erected using natural gas only like Gender while the old stations were converted to operate on fuel oil as well as natural gas such as Banias and Mahrada . Table (10) shows the important power stations in Syria, their capacities and the fuel they use. [(3)] In industry production of ammonia in the Homs Fertilizer Company was switched from naphtha to natural gas. This switch was facilitated by the Ministry of Petroleum erecting factories to recover associated gas and treat it instead of burning it in flares. It was also possible because of the discovery of new natural gas fields and its exploitation. Fig (4) shows that the consumption of Syria from natural gas increased tremendously from 45 000 boe/d in 1997 to 120 000 boe/d in 2007. Consumption of Syria from LPG increased as well from 18 000 boe/d in 1997 to 30 000 boe/d in 2007.

Table (10) Important power stations in Syria [3]

Power stations	**Capacities – Mg w**	Fuel
Aleppo-Palmyra	1000	Gas
Banias	680	Gas
Jander	600	Gas
Mharada	630	gas
Al-Naserya	600	gas
Tishreen	380	fuel/gas
Al-Zara	650	fuel/gas
Zezon	380	fuel/gas

3.3 Mitigation by recovery of flared gases:

There are many reasons for burning gases in the flares such as:

1- No possibility to treat the associate gas.

2- Lack of suitable ways to transport the gas.

3- Lack of abilities to export gas to outside.

4- Presence of production fields in areas away from consumption.

5- Quantities of gas produced uneconomic.

Escwa Study [13] evaluated the quantity of gas burnt in flares in 2004 by 150 B m^3/y which is equal to 30% of the consumption of the European Union countries from gas · Burning natural gas efficiently emits CO_2 and water and burning with less efficiency CH_4 which is 25 times more potent as a GHG gas from CO_2 . Emissions due to burning in flares in the world regressed continuously since the 70's from 2% to 0.5%. The Escwa report discussed the decrease in gas burnt in flares in Syria. The amount of gas burnt in flares decreased by 72% This is due to the measures taken by companies such as:

- Connection of a number of fields producing associate gas with gas treatment units. And preparation of a pipeline to connect Kharta field to exploit 200 000 m^3/d .. The remaining quantities of gases burnt in flares are widely distributed from separated fields. These are under economic and technical feasibility studies to recover it and connect it to the network.

- Gases burnt in flare are reduced by installing a unit to recover petroleum vapors at reduced pressures < 0.5 bar in Omar and Tank fields. 4 compressors were hired in two main stations.

Table (11) shows the production of natural and associate gas in Syria in December 2009 [6] . From the table it can be shown that:

1- No natural gas is burnt in flares.

2- Associate gas produced = 8.699 M m^3 / d . 1.401 M m^3 /day is burnt in flares .

So:

1- Percentage of gas burnt in flare to total = (1.401 / 8.699)* 100 = 16.10 %

2- Percentage of gas used to generate electricity locally by gas turbines = (0.449 / 8.699) * 100 = 5.16%

3- Percentage of gas used in other purposes (increase pressure of well)= (0.544/8.699) * 100 = 6.21 %

4- Percentage of gas recovered = (6.309 / 8.699) * 100 = 72.52 %

This quantity of gas depends on the production of oil which has decreased during the last decade.

3.4 Mitigation by maintenance of pipelines and prevention of leaks [13]

The number of leaks in the Syrian Petroleum Company SPC in 2004 averaged 464 oil leaks and 16 gas leaks. The total quantity of oil leaked was 3755 b (512 tons) which is equal to 17.5 leaked unit in every million produced unit . In 2005 a clear improvement took place to the number of oil leaks and the quantity of oil leaked. Number of leaks dropped to 416 leaks and the total leaked quantity was 2 925 b (345 tons) and the ratio was 16.79 units leaked to 1 million unit produced. The measures taken to limit leaks were:

- Working groups perform daily inspections to maintain the surface equipment in all wells and collecting substations and prevent leak of oil in these places according to the capabilities using equipments which operate by ultrasound equipment for inspecting production lines and detecting places of corrosions before leaks and injecting anti-corrosion chemicals inside production lines and head of wells. The oil is also withdrawn from leaking sites.

- Urea fertilizer is sprayed over oil polluted earth. Ploughing is done by a tractor in one direction only in the first time of good mixing. The operation is repeated by ploughing in the opposite direction (once every week for 4 weeks) until soil becomes in soft and in good condition. Results showed that plants grew in 40% of soil in the first year although the area is desert.

-

Table (11) Natural & Associate gas produced in Syria [6]

December 2009

Gas produced	Associate Gas					Natural Gas					Total Gas				
	Tota	burn	Turb	Fac	other	كلي	حرق	عنفة	معمل	اخرى	كلي	حرق	عنفة	معمل	اخرى
Hasaka	1.52	0.271	0.40	0.78	0.065	1.10	0	1.083	0	0.020	2.623	0.271	1.484	0.783	0.085
Gbessa	2.289	0.588	0.048	1.478	0.175	1.432	0	0	1.432	0	3.721	0.588	0.048	2.910	0.175
Al-phorat	2.828	0.201	0	2.415	0.212	NA						0.201	0	2.415	0.212
Middle Area	NA					1.209		0	1,209	0	1.209	0	0	1.209	0
Der Zor + Tabiya	1.407	0.297	0	1.025	0.085	6.030	0	0	6.030	0	7.437	0.297	0	7.055	0.085
Hatan Co	0.655	0.044	0	0.608	0.003	0.682	0		0.682	0	1.337	0.044	0	1.290	0.003
South Midland	NA					6.414	0	0	6.414	0	6.414	0		6.414	0
Total	**8.699**	**1.401**	**0.449**	**6.309**	**0.540**	**16.87**	**0**	**1.083**	**15.767**	**0.020**	**25.569**	**1.401**	**1.532**	**22.076**	**0.560**

3.5 Mitigation by sequestering CO_2 in oil fields and Enhanced Recovery:

The technique of capturing CO_2 and storing it is known as Carbon Capture and Sequestering CCS. The first step is to capture CO_2 and collect it. The biggest source is from large industrial complexes such as cement factories, large refineries and power stations. These account for third of all anthropic emissions of CO_2 in the world. The CO_2 is captured from the flue gas by absorption with amine solvents. After that the gas is transported from place of capture to place of storage or injection. CO_2 is an inert gas nearly and can be transported readily. Because of the large quantity the best method of transport is by pipelines. It is also possible to transport it by ships for more distant places and for storage in the sea. The gas is then injected from a tanker or platform into a geological formation and the mouth of the well is sealed so it will not leak again. In order that this method is useful the source of emission must be large and continuous and the flue gas rich in CO_2. It is also possible to store CO_2 by injecting it underground inside caves, deserted mines or into suitable geological cracks or saline underground water reservoirs. There are also other possibilities to capture CO_2 and to use it in industry to manufacture urea. The CCS is still being studied to use it especially if the carbon tax in the Koyoto Protocol is enforced. Drain of CO_2 takes place through absorption by plants and conversion by solar energy into living cells by the chlorophyll process. This is one important reason for conservation of forests. Research is ongoing to develop algae and other water plants which can do this job effectively. Capture of CO_2 after burning is by removing it from flue gases. Capture before burning means producing reaction gas which is a mixture of CO and H_2 by reacting hydrocarbons with steam or by partial oxidation with air. CO reacts once again with steam to produce CO_2 and H_2 by the shift reaction. It is possible to remove CO_2 by one of the usual methods and use H_2 for burning or to feed fuel cells. [14] Fig (16) shows the process of capturing CO_2 , collecting , transport and storing it .

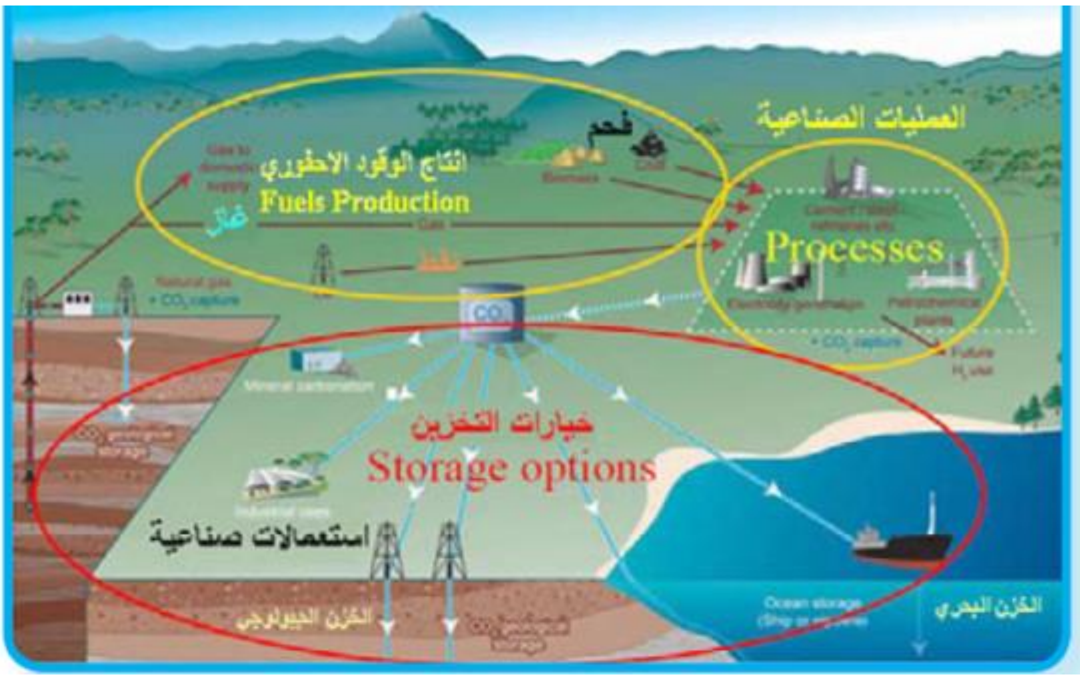


Fig 16. The process of carbon collection and sequestering CCS

The other method called Enhanced or Tertiary Oil Recovery EOR is performed by injecting CO_2 in semi depleted oil fields so oil is pushed by mixed or unmixed displacement which leads to its flow to the surface. It is possible to inject CO_2 alone or with water. It is possible by this method to produce not less than 10-15% of the oil in the field. The operation requires injecting a quantity of 140-280 m^3 of CO_2 to produce 1 barrel of crude oil. Although more than 71% of CO_2 remains in the field, a sizable quantity of gas goes out with the crude oil. It is possible to separate this quantity of CO_2 from the crude oil after production and inject it again in the well. IPCC estimated that it is possible to reduce CO_2 in the world by 15-55% by 2100 [15] using CCS. Fig (17) shows a method for tertiary or enhanced oil recovery EOR.

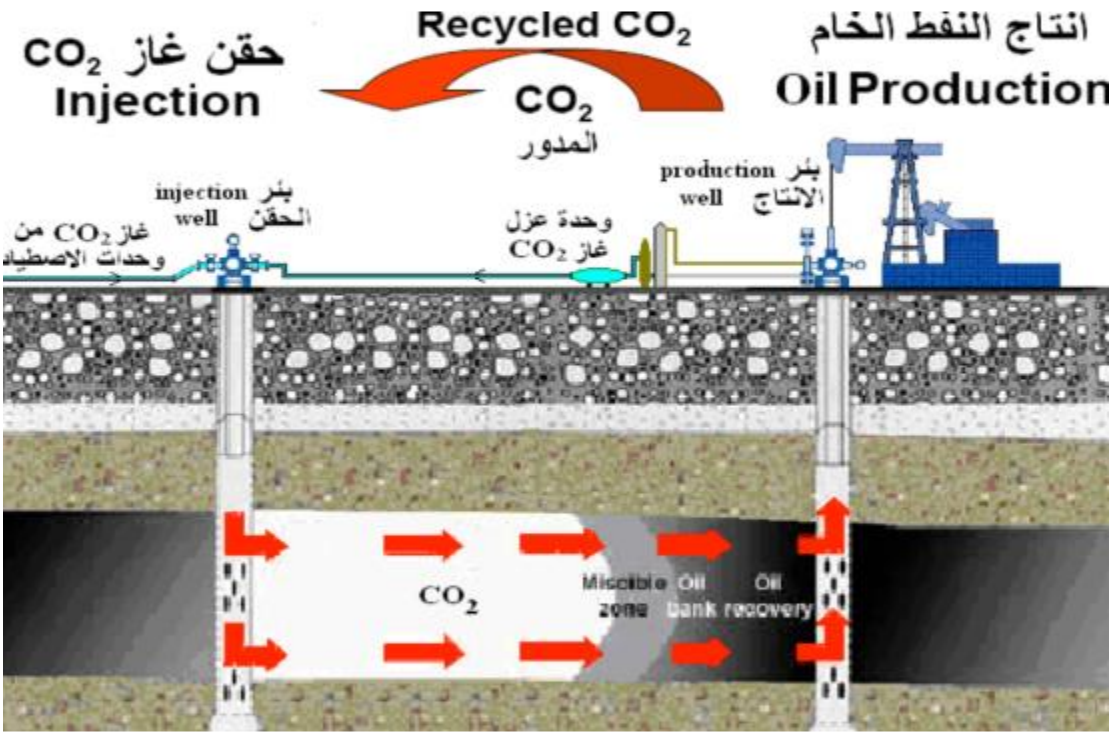


Fig 17. A schematic diagram for enhanced oil recovery by CO_2 [14]

Most CO_2 stored until now comes from natural sources. Dakota Company for gasification produces CO_2 and transports it by a 204 mile pipeline to Wyburn oil field in Canada. This adds another 25 years to exploit the oil fields and produces 130 million additional barrels of oil. Hall Gorny field in Texas / USA applies the EOR-CO_2 in 10 fields: 4 new, 3 renewed and 3 old. 89 million additional barrels of oil were extracted. The Norwegian Oil Company injects 1 million tons of CO_2 /year since 1996. CO_2 is a secondary product of the natural gas produced by statoil in Sleinpner gas field in the North Sea which contains a high percentage of CO_2 so it is injected in the geological formations under the sea bed. In Syria secondary recovery is tried by injection of steam or water in the wells. Some natural gas is also injected to raise the pressure of the well. Injection CO_2 is not feasible since the oil wells lie far away from the large urban centers in the country where large power stations or industrial complexes emitting CO_2 are present.

Fig (18) shows the various methods of mitigation in the world by different scenarios . It is clear that conservation of energy comes first followed by conversion to lower carbon or biological fuel then comes renewable energies then nuclear energy and finally carbon sequestering CCR. [15]

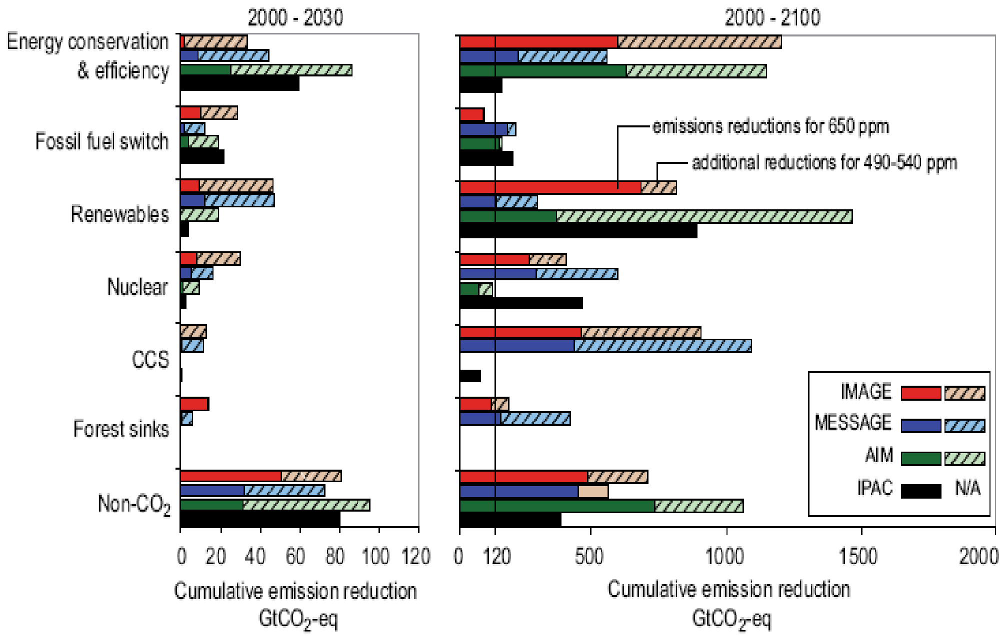


Fig 18. Method of mitigation in the world according to different scenarios [15]

6. Clean Development Mechanism CDM : (16)

Protocol Koyoto established the Clean Development Mechanism CDM by which industrial countries finance projects of mitigation in developing countries so that reduction in emissions from these projects is counted as part of the industrial countries obligations according to the protocol.

Paragraph 12 of the protocol states:

- To help Non – Annex 1 parties to achieve sustainable development and participate in the final object of the agreement.
- To help parties in Annex 1 to comply with their obligations to limit emissions and to reduce their quantities.

The clean development mechanism CDM can achieve many purposes:

1- To benefit Non-Annex 1 parties from projects to mitigate emissions.

2- Establish an executive bureau to supervise this activity.

3- To endorse operating entities appointed by COP about mitigating emissions on the basis of :

4- Voluntary participation by each side.

5- Achieve real benefits which can be measured and with a long term to mitigate global climate change.

6- Public and private sectors can participate in the clean development mechanism

7- It is possible to use mitigated emissions which can be realized from 2000 to first obligatory period of 2008-2012 to help achieve adherence to the protocol during this period.

CDM participates in creating investments in the developing countries especially in the private sector. It also enhances the adoption of environmentally clean technologies in this direction.

In the field of gas and oil sector it is possible to benefit from CDM in the following ways:

1- Limit the burning of gas in flares.

2- Limit emissions and leaks of pollutants from oil and gas industries.

3- Use of cleaner technologies.

4- Production of clean fuel.

5- Conservation of energy in oil refining , gas liquefaction , petrochemicals and others

6- Storage of carbon or use it in enhanced recovery ER.

7. Calculating emissions of GHG in oil & gas sector in Syria :

7.1 Mitigation of GHG by conservation of Energy in oil & gas :

- Daily production of oil in 2009 = 380000 b /d

- Suppose oil used for energy in the oil & gas sector = 10% = 38000 b/d [17]

- Suppose it is possible by good measures to save 10% of the energy consumed = 3800 b/d

- Mitigation by energy conservation = 3800 b /d * (364 d /y)/ 7.33 t/b = 188704 t / y

- Heat conserved = 188704 * (40 / 1000) = 7548 TJ / y

- Quantity of CO_2 conserved = 7548 * 20 * (44/12) / 1000

= **553 K ton** CO_2 / y

7.2 Calculation of Mitigation of GHG from recovery of burnt gas in flares:

- Assume the possibility of recovery of 1 M m^3/d which is burnt in flares. This is equivalent to 71 % of all associate gas burnt in flares now.

- From reference (4) 1000 m^3 gas = 0.9 ton crude oil

- 1 M m^3/d / 714 = 900 t oil /d

- NCV =900 * 40 / 1000 = 36 TJ/d

- CO_2 emitted = 36 * 20 * (44/12) = 2640 t CO_2 / d

- CO2 emitted in a year = 2640 * 364/ 1000 = **961 K ton CO_2 / y**

7.3 Calculating Mitigation from fugitives from pipelines :

- from the inventory report – energy section – Fugitives = 105 K ton CH_4 / y

- This is equal 105 * 25 = 2625 K ton CO_2 / y

- Suppose good maintenance will save 25% of gases leaked

- So mitigation from maintenance of pipelines = **656 K ton CO_2 / y**

7.4 Mitigation of GHG bu using gas instead of fuel :

- Syria production of oil in 2009 = 380000 b/d

-Suppose 10% of it is used for energy in the same sector

- Quantity of oil consumed in oil & gas sector = 38000 b/d

- Suppose 50% is replaced by gas (according to reference 17)

- Quantity of oil replaced by gas =19000 b/d

- Quantity of oil replace by gas = (19000 /7.33) * 364 = 946112 t / y

- Heat from oil replaced = 946112 * 40 / 1000 = 37844 TJ/y

- CO_2 saved by replacing oil with gas = 37844 * (20 – 15) * 44/12

- = 694 K ton CO_2 / y

7.5 Total GHG mitigation in oil & gas sector :

Total of mitigation from 10% conservation + 71% recovery from flares + good maintenance of pipelines 25% + replace 50% of oil by gas =

= 553 + 961 + 656 + 694 = **2863 K ton CO_2 / y**

According to inventory report:

Total emissions of GHG gases from energy sector for the year 2005 = 60 M ton CO_2/y .

So Mitigation from oil & gas sector = 2.863/60 * 100= **4.78 %** of GHG in energy sector .

8. Summery

The oil and gas sector in Syria has witnessed a high and steady increase in the demand for energy especially power generation and transport. While hydroelectric power generation remained constant, the increase in demand was satisfied from oil derivatives and natural gas. Syria followed a policy of increasing its production of natural gas and use it especially in power generation. While production of crude oil decreases it becomes roughly equal to consumption and Syria will change in the coming years into an importer of crude oil and its derivatives. Syria made many steps to collect the associated gas which was previously burnt in flares, treat it and then use the gas and condensates in energy applications. This has contributed greatly to minimize atmospheric pollution and mitigation of GHG. There are still some opportunities available to collect the associate gas, treat it and use it which can be done by the CDM mechanism. Also the drop in the productivities of oil wells especially the old ones can be treated by considering enhanced recovery ER-CO_2. Some companies are now using injection of water or steam or even natural gas to increase the pressure of the field and thus increasing its production. The CCR technique could be investigated especially in the context of CDM if conditions allow it. Finally conservation of energy is the first and best available mean to mitigate emissions in this sector and in other sectors of the economy in Syria.

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