مـركـز الإحـصـاء ـ أبـوظـبـي
STATISTICS CENTRE - ABU DHABI

Annual Bulletin of
Climate and Air Statistics 2009

Issued in December 2010

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Contents

Introduction

Air pollution is a local as well as cross-border issue at the same time. Pollutants emitted from a given country move through the air and harm humans and the environment in other places. In other words, local problems may lead to world-scale consequences, such as the phenomenon of global warming.

Sources of air pollution are varied. The main pollutants result from various human activities, such as the burning of fossil fuel for electricity generation, transportatin and industry. Another source of pollution lies in the use of solvents in different industrial processes, such as chemical and metal industries, in addition to waste and its treatment methods.

Air pollution has environmental and health consequences that affect ecosystems and their inhabitants of humans, plants and animals, such as climate change and acid deposits. Among the most important pollutants that are known for their serious that affect human health are particulate matter in air and ground-level ozone. Long exposure to these pollutants can lead to a several effects on health, ranging from mild and serious disorders of the respiratory system and premature death .

This brochure about climate and air statistics consists of three chapters, covering the historical climate data of in Abu Dhabi, in addition to statistics on air quality, which presents information pertaining to the key air pollutants, such as sulphur dioxide, nitrogen oxides and particulate matter. The bulletin also gives statistics related to emissions of air pollutants from the energy sector, including the subsectors of oil and natural gas and water and electricity.

1. Climate Statistics

Climate change is a global phenomenon but its impacts are felt at the local level in varying ways from one place to another. One of the aspects of this phenomenon is the gradual rise in the temperature of the lower layer of the atmosphere. This is caused by an increase in emissions of greenhouse gases, such as carbon dioxide, ozone and chlorofluorocarbons. These gases are necessary to maintain the earth temperature. However, human activities associated with industrial and technological progress and dependence on fossil fuels as the main source of energy have lead to an increase in the emissions of greenhouse gases, exceeding the concentrations necessary to maintain the earth temperature and leading to the phenomenon of global warming, i.e. the rise observed in the earth's temperature above normal levels, due to the absorption of infrared rays by these gases, which in turn causes a global change in temperature.

Official international reports have confirmed this change in climate, especially the rise in temperature, which has already affected several physical and biological systems, leading to floods, cycles of drought and a rise in sea level. Adapting to these is a global imperative in order to mitigate the severity of the impacts of climate change on low-lying lands, urban areas, etc.

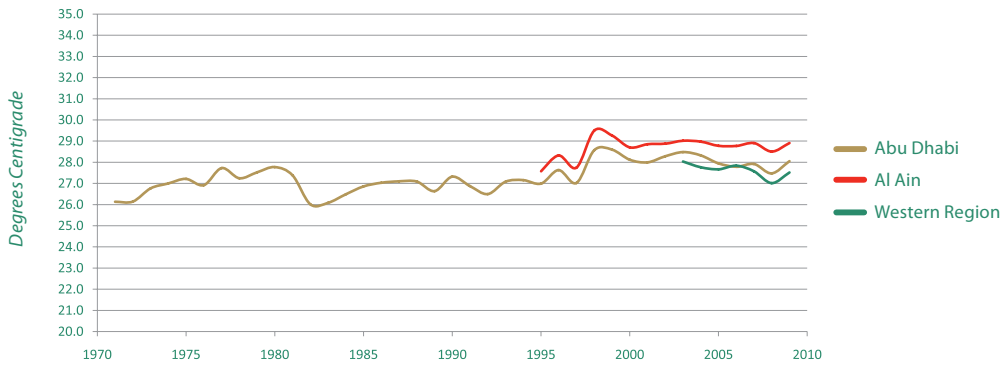
1.1 The Climate of Abu Dhabi Emirate

This chapter addresses historical weather data in Abu Dhabi, tracking changes across time , back to the seventies of past century, namely 1971. It was collected from administrative records of the National Centre for Meteorology and Seismology through four main stations: Al-Bateen Airport Station (1971-1982), Abu Dhabi Airport Station (1982-2009), Al-Ain Airport Station(1995-2009) and Zayed City Station in the Western region (2003-2009).

1.1.1 Temperature

Average temperature in Abu Dhabi started to rise from the mid-seventies of the past century until the early eighties. This was followed by a drop in temperature in the early 1980's, before it rose back to its normal average through the end of nineties of the past century. Since then, temperatures in the emirate have been on the rise again. On average, temperature in the Emirate of Abu Dhabi increased by 1.5 - 2 degrees centigrade from 1971 to 2009.

Figure (1.1) Average Temperatures by Region in Abu Dhabi (1971 - 2009)*

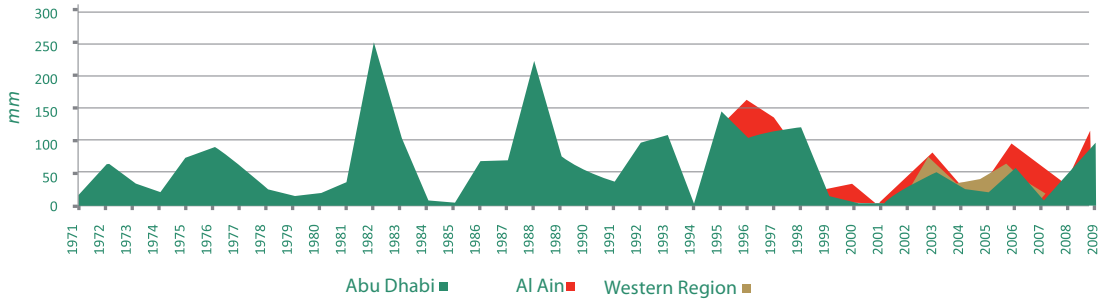


* As per the data available about each region
Source: National Centre for Meteorology and Seismology

1.1.2 Rainfall

Yraly variation in the amount and seasonal distribution of rainfall is one of the manifestatons of climate change. Some periods, e.g. the decade between 1999 and 2009 were generally characterized by a sharp drop in annual rainfal, unlike the early 1980's and the end of the 1990's of the past century, during, which rainfall was relatively high and occured mostly in Winter. Al-Ain region and mountain tops, however, received some showers in Summer, especially in August and July, carried by the seasonal indian winds, whcih drives clouds across the Arabian Sea.

Figure (1.2) Average Annual Rainfall over Abu Dhabi Emirateby Region (1971 -2009)*



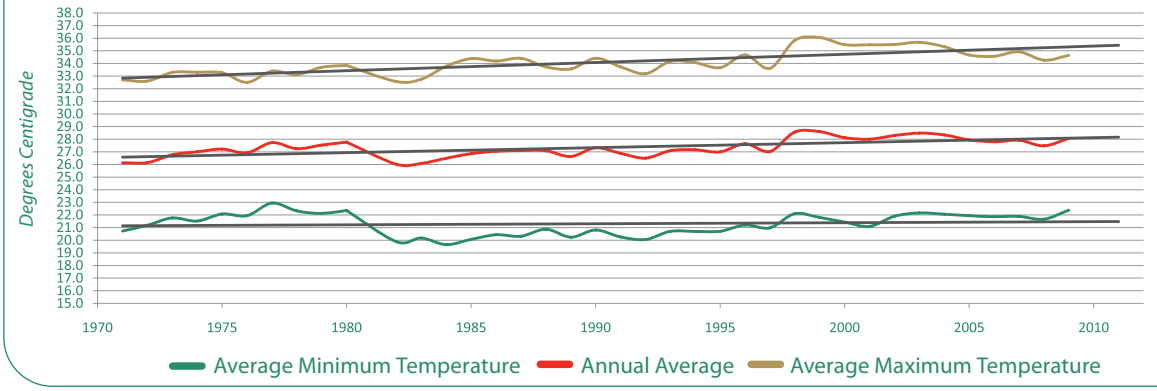
* As per the data available about each region
Source: National Centre for Meteorology and Seismology

1.2 The Climate of Abu Dhabi City

1.2.1 Temperature

Average of maximum temperature in Abu Dhabi City increased 1.9 degrees centigrade over the period (1971-2009) from 32.7 to 34.6 degrees centigrade. The end of 1990's were characterized by a marked rise in average maximum temperatures, a ternd that continued through the first four years of this century, reaching a peak value of 36 degrees centigrade, while average annual temperature rose by 2 degrees centigrade from 26.1 to 28.1 degrees centigrade, with the peak value (28.6 degrees centigrade) recorded in 1999.

Figure (1.3) Average Temperature in Abu Dhabi 1971-2009



Source: National Centre for Meteorology and Seismology

1.2.2 Rainfall

Rainfall in the city of Abu Dhabi is generally scanty. In the course of the decade from 1971 to 1981, total annual rainfall decreased to an average of 14.7 mm per annum, in spite of the relative increase in number of rainy days. In contrast, the period 1982-1998 witnessed relatively high rainfall that occured in a short period of of time, with the total comparable to the reading for the rainiest day of the year. In 1982 total rainfall in the City of Abu Dhabi was aproximately 250 mm, of which about 120 mm fell in one day. Between 1999 and 2009, rain fall showed a downward trend, reaching a minimum of 2 mm in 2001, but increased to 98 mm in 2009.

Figure (1.4) Number of Rainy Days in Abu Dhabi City, 1971 - 2009

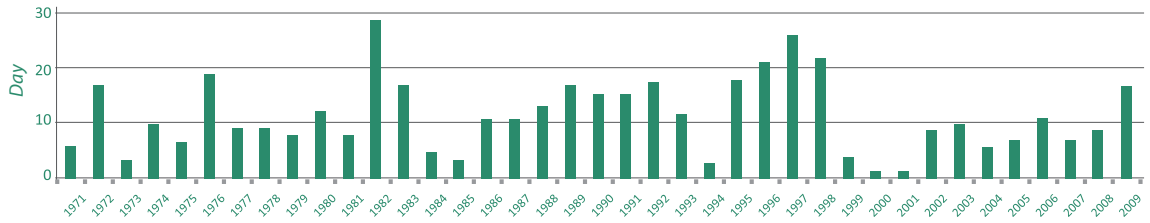


Figure (1.5) Gross Annual Rainfall in Abu Dhabi City, 1971 - 2009

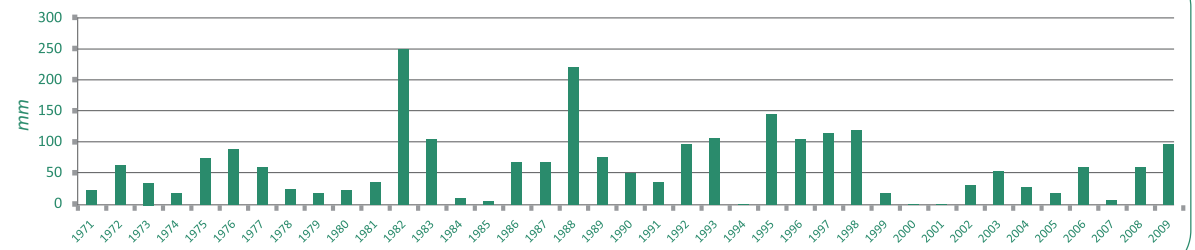
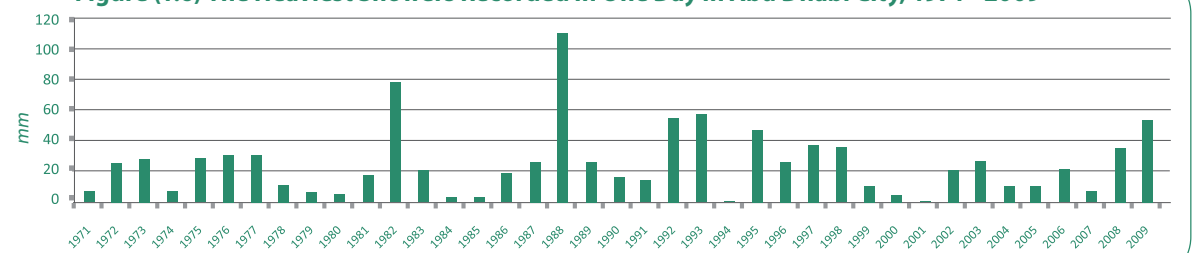


Figure (1.6) The Heaviest Showers Recorded in One Day in Abu Dhabi City, 1971 - 2009



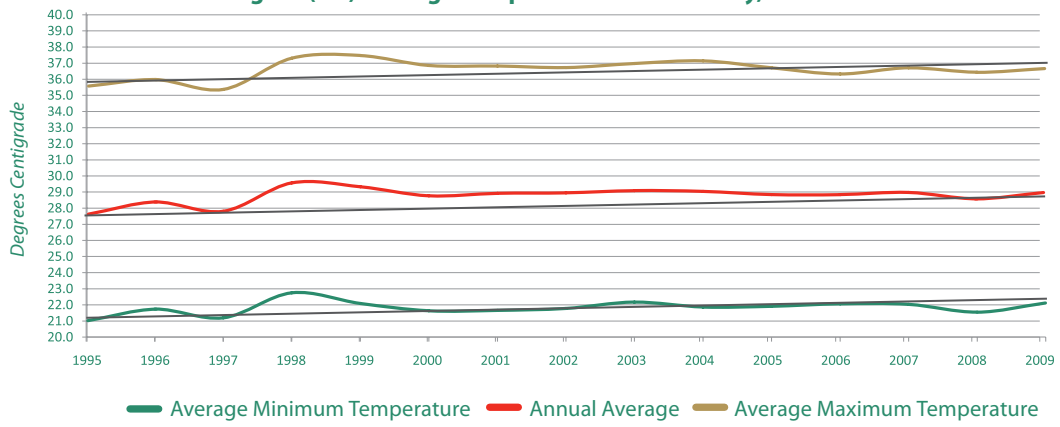
Source: National Centre for Meteorology and Seismology

1.3 The Climate of Al Ain City

1.3.1 Temperature

Annual average temperature in Al-Ain City increased 1.3 degrees centigrade from 27.6 to 28.9 degrees centigrade. The year 1998 witnessed an increase in temperature average to 29.5 degrees centigrade, while average maximum temperature reached about 37.2 degrees centigrade.

Figure (1.7) Average Temperature in Al Ain City, 1995 - 2009



Source: National Centre for Meteorology and Seismology

2.3.1 Rainfall

Rainfall in Al-Ain City decreased during the period 1999-2001, but the opposite trend was observed over te period 1995-1998, during whcih the highest annual rainfall of 162 mm (approx.) was recorded in 1996. The lowest annual rainfall (1 mm only) was recorded in 2001, the year in which the Emirate of Abu Dhabi in general suffered a sharp drop in rainfall, whch has shown a steady rise since then, reaching 115 mm in 2009.

Figure (1.8) Number of Rainy Days for Al Ain City 1971 - 2009

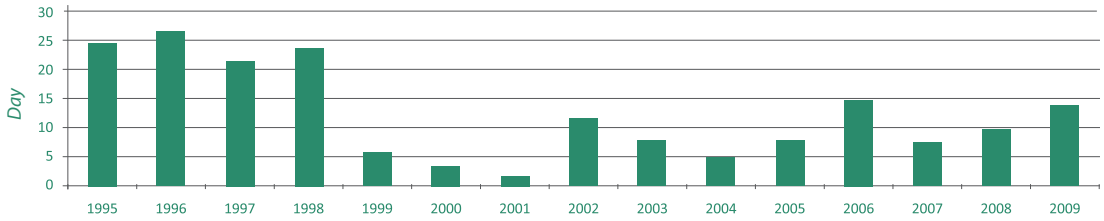


Figure (1.9) Gross Annual Rainfall in Al Ain, 1995 - 2009

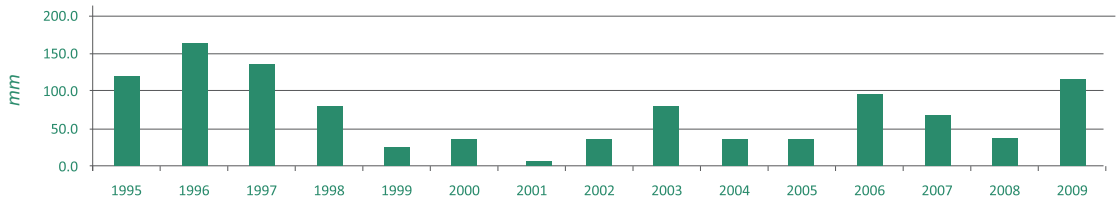
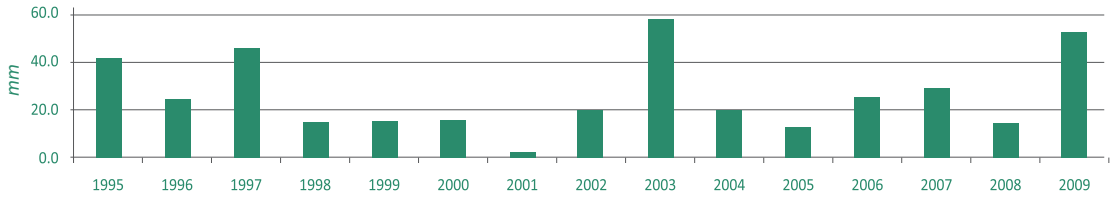


Figure (1.10) The Heaviest Showers Recorded in One Day in Al Ain, 1995 - 2009



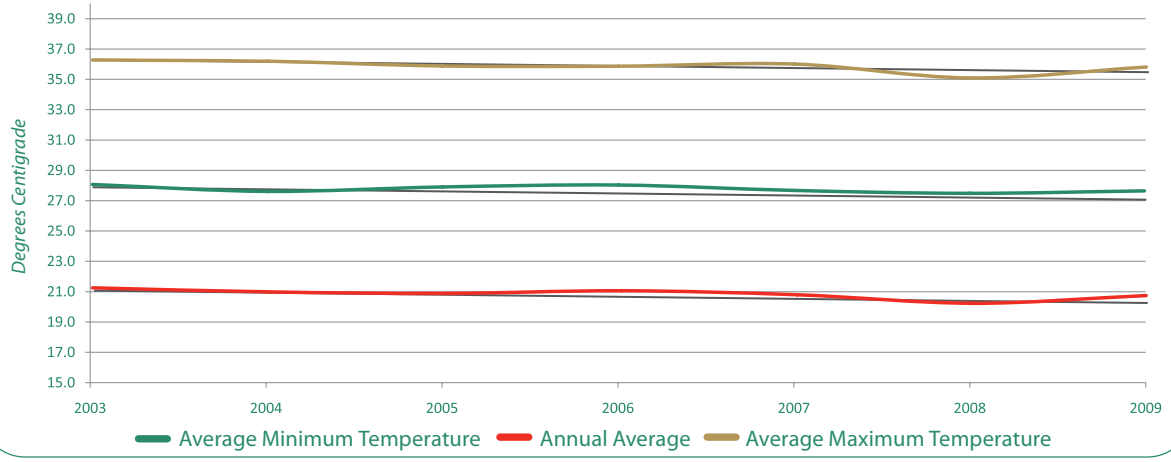
Source: National Centre for Meteorology and Seismology

1.4 The Climate of the Western Region

1.4.1 Temperature

In general, average annual temperature in the Emirate of Abu Dhabi decreased over the period 2003-2009, especially in the Western region, giving inland areas of the emirate a relatively moderate weather all the year round. In 2003, average annual of temperature in the Western region reached 28 degrees centigrade, but decreased to 27.5 degrees centigrade in 2009. Average maximum temperature was 36 degrees centigrade in 2003, but retreated seadily in the following years, reaching 35.6 degrees centigrade in 2009.

Figure (1.11) Average Temperature in the Western Region, 2003-2009



Source: National Centre for Meteorology and Seismology

1.4.2 Rainfall in the Western Region

The lowest annual rainfall in the Western region was recorded during the period 2003 - 2009, with the minimum (8 mm) recorded in 2008. This trend began to reverse in 2009, not only in the Western, but all over the emirate as well. Total rainfall in Western region during that year was 50.8 mm.

Figure (1.12) No. of Rainy days in the Western Region, 2003-2009

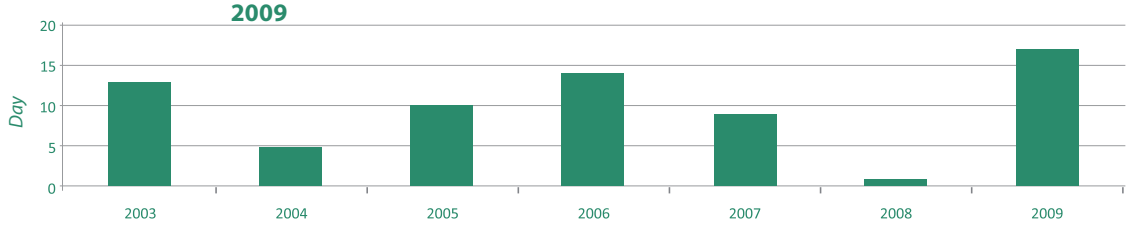


Figure (1.13) Gross Annual Rainfall in the Western Region, 2003-2009

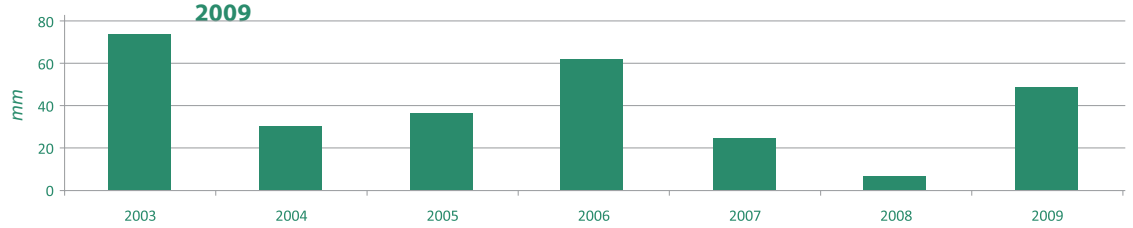
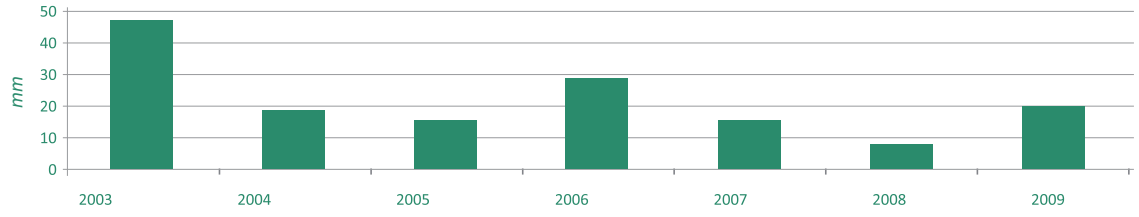


Figure (1.14) The Heaviest Showers Recorded in One Day in the Western Region, 2003- 2009



Source: National Centre for Meteorology and Seismology

2.Air Quality

Availability of data about air quality is important in monitoring the concentrations of air pollutants determining their likely impacts on human health. Some parts of the Emirate of Abu Dhabi suffer from poor air quality, especially in particulate matter, which exceeds the permissible limits. This section looks into the concentration of air pollutatns in the emirate of Abu Dhabi by region for the period 2007-2009. Pollutants include sulphur dioxide, nitrogen dioxide, methane, ground-level ozone, air particles, hydrogen sulphide, carbon monoxide and carbon dioxide. These pollutants are a source of concern for their contribution to the phenomenon of global warming. The section also presents data on noise levels, measured at selected locations across the Emirate of Abu Dhabi.

2.1 Sulphur Dioxide (SO_2)

Sulphur dioxide is generated by the burning of fossil fuels. Its most important sources are oil installations, power plants and industrial facilities that use a fuel containing a high proportion of sulphur. This gas contributes to the formation of acid rain, which causes damage to the ecosystem. In the years from 2007 to 2009, sulphur dioxide concentrations did not exceed their allowable limits in ambient. The maximum concentrations are recorded in areas of traffic congestion and residential areas.The maximum reading in the Emirate of Abu Dhabi in 2009 was 330 mcg/m^3, recorded in Abu Dhabi City.

2.1 Sulphur Dioxide Concentration in Ambient Air in the Emirate of Abu Dhabi by Region, 2007-2009

Micrograms / cubic meter

Location	Allowable Limit (World Health Organization)	Allowable Limit (Environment Agency - Abu Dhabi)	2007			2008			2009		
			Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.
Abu Dhabi	500 mcg/m^3 in ten minutes	350 mcg/m^3 in an hour									
Down Town - Khadija School			10	100	0.03	10	173	~	9	86	0.3
Residetial Area - Khalifa School			5	84	0.03	8	149	~	6	31	0.2
Road Side - Hamdan Street			14	109	0.03	7	138	~	7	112	0.2
Urban/Residential Area - School Beni Yas			22	149	0.05	24	156	0.03	7	37	0.03
Indutrial - Musffah Indutrial Zone			3	90	0.03	3	72	0.03	19	330	0.3
Al-Ain											
Urban/Residential Area - Al-Ain School			5	86	0.03	4	123	0.03	3	19	0.2
Road Side - Al-Ain Street			9	64	6.2	23	91	0.03	4	31	0.1
Western Region											
Urban/Residential Area - Bida Zayed			9	162	1.03	5	105	0.05	3	38	0.1
Down Town Ghayathi School			5	118	0.03	5	125	0.05	7	179	0.1
Remote Area - Liwa Oasis			8	81	0.16	5	124	0.05	3	66	0.1

(~) Below the minimum detectable value
Source: Environment Agency - Abu Dhabi

2.2 Nitrogen Dioxide (NO_2)

Nitrogen dioxide gas is produced from most burning processes, especially motor vehicles exhausts, then power plants and industrial plants. This gas is associated with diseases of the respiratory system, even in low concentrations. The year 2009 saw the concentration of nitrogen dioxide in ambient air rise to its peak value compared to the years 2007 and 2008. The maximum reading increased from 278 mcg/m^3 in 2007 to 321 mcg/m^3 in 2009. Both readings were taken in Musffah Industrial area.

2.2 Nitrogen Dioxide Concentration in Ambient Air in the Emirate of Abu Dhabi by Region, 2007-2009

(Micrograms / cubic meter)

Location	Allowable Limit)World Health Organization)	Allowable Limit (Environment Agency - Abu Dhabi)	2007			2008			2009		
			Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.
Abu Dhabi	200 mcg/m^3 in an hour	400 mcg/m^3 in an hour									
Down Town - Khadija School			14	22.19	0.19	22	168	~	36	159	0.4
Residetial Area - Khalifa School			77	274	0.10	39	175	0.04	41	240	0.2
Road Side - Hamdan Street			65	222	12.43	21	179	~	49	270	0.9
Urban/Residential Area - Bani Yas School			27	223	0.10	20	181	~	27	132	0.2
Indutrial - Musffah Industrial Zone			88	278	6.22	46	187	~	53	321	1.5
Al-Ain											
Urban/Residential Area - Al-Ain School			41	120	0.27	34	114	0.08	-	-	-
Road Side - Al-Ain Street			94	271	2.30	16	147	~	45	234	1.6
Western Region											
Urban/Residential Area - Bida Zayed			2	3	0.96	4	22	0.08	16	289	0.2
Down Town - Ghayathi School			13	192	0.13	8	73	0.094	17	282	0.01
Remote Area - Liwa Oasis			5	6	0.13	3	32	~	3	33	0.01

(~) Below the minimum detectable value
(-) Data are unavailable
Source: Environment Agency - Abu Dhabi

2.3 Volatile Organic Compounds (Methane)

Different types of volatile organic compounds (VOC's) contribute to the formation of ozone and have a wide range of effects on health. Methane (CH_4), one of the volatile organic compounds, is one of the most potent greenhousegases that contribute to global warming. Methane concentration is high in urban residential areas of the emirate. In 2007 and 2008, the highest readings in Abu Dhabi City were 53.03 and 41.12 mcg/m^3 respectively, while in 2009 the concentration of methane in the emirate remained generally unchanged.

2.3 Methane Concentration in Ambient Air in the Emirate of Abu Dhabi by Region, 2007-2009

(Micrograms / cubic meter)

Location	2007			2008			2009		
	Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.
Abu Dhabi									
Down Town - Khadija School	2.19	29.94	0.04	1.91	5.29	0.01	0.73	3.5	0.01
Residetial Area - Khalifa School	2.08	53.03	0.00	4.90	29.28	0.00	-	-	-
Road Side - Hamdan Street	1.95	3.67	0.61	0.86	1.49	0.49	1.14	2.71	0.28
Urban/Residential Area - Bani Yas School	1.88	24.21	0.13	1.51	41.12	0.13	-	-	-
Indutrial - Musffah Indutrial Zone	1.21	1.90	0.31	1.79	3.28	0.29	-	-	-
Al-Ain									
Urban/Residential Area - Al-Ain School	1.22	4.57	0.01	1.58	4.13	0.67	-	-	-
Road Side - Al-Ain Street	2.87	5.20	0.01	3.17	7.70	0.97	0.67	1.58	0.011
Western Region									
Urban/Residential Area - Bida Zayed	1.66	2.97	0.19	1.90	21.51	0.07	-	-	-
Down Town - Ghayathi School	1.82	23.12	0.03	1.81	6.81	0.01	0.63	1.3	0.14
Remote Area - Liwa Oasis	1.31	6.83	0.66	1.35	16.53	0.48	-	-	-

Data are unavailable (-)

Source: Environment Agency - Abu Dhabi

2.4 Ozone (O_3)

Ground-level Ozone is formed because of reaction between pollutants such as nitrogen oxides (NOx) emitted from motor vehicles eaxhausts, industrial facilities, etc in the presence of sunlight. It is also produced by photochemical reactions involving volatile organic compounds (VOC's) and catalyzed by sunlight. Ozone concentrations are generally high in the Emirate of Abu Dhabi. The maximum reading was 184 mcg/m3, recorded in Abu Dhabi City in 2009. Ozone concentration in the Western region dropped remarkabl from 167 mcg/m3 in 2008 to 120 mcg/m3 in 2009.

2.4 Ground-level Ozone Concentration in Ambient Air in the Emirate of Abu Dhabi by Region, 2007-2009

(Micrograms / cubic meter)

Location	Allowable Limit (World Health Organization)	Allowable Limit (Environment Agency - Abu Dhabi)	2007			2008			2009		
			Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.
Abu Dhabi	100 mcg/m^3 in an hour	200 mcg/m^3 in an hour									
Down Town - Khadija School			51	159	0.02	35	133	0.02	45	184	0.3
Residetial Area - Khalifa School			38	139	0.00	37	153	1.53	34	129	0.8
Urban/Residential Area - Bani Yas School			54	155	1.14	33	135	0.49	33	149	0.7
Al-Ain											
Urban/Residential Area - Al-Ain School			37	139	0.32	30	137	0.37	27	140	0.2
Western Region											
Urban/Residential Area - Bida Zayed			15	94	0.04	47	167	0.00	47	120	0.6
Down Town - Ghayathi School			73	160	0.00	54	163	1.65	54	156	2.3
Remote Area - Liwa Oasis			86	153	0.00	76	154	2.62	44	107	22.3

Source: Environment Agency - Abu Dhabi

2.5 Particlulate Matter (PM_{10})

Particulate matter refers to the ultra fine particles suspended in air and arising from different sources such as dust and smoke. They linger in the air and move with air current for a long time. Their threat they pose to human health increases with with the amount inhaled. They can also be dangerous when combined with other secondary more dangerous pollutants. Therefore, they increase the risk of cancer and respiratory diseases, in addition to corrosion of buildings and facilities. Emirate of Abu Dhabi suffers from extremely high concentrations of pollution by particles in air. In 2009, the highest reading excessed 12 times the allowable concentration particulate matter in air, exceeding the allowable level by 12 folds and reaching a maximum concentration of 1902 mcg/m^3 in 2009, which is almost double the maximum concentration for 2008 (1033 mcg/$m^{3)}$. On the other hand, mean concentration of particulate matter remains within the locally allowable limit in most areas of Abu Dhabi Emirate.

2.5 The Concentration of Particulate Matter in Ambient Air in the Emirate of Abu Dhabi by Region, 2007-2009

(Micrograms / cubic meter)

Location	Allowable Limit (World Health Organiza-tion)	Allowable Limit (Environment Agency - Abu Dhabi)	2007			2008			2009		
			Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.
Abu Dhabi	50 mcg/m^3 in an hour	150 mcg/m^3 in an hour									
Down Town - Khadija School			126	1020	11.60	139	1021	10.1	152	1862	6.5
Residetial Area - Khalifa School			119	764	10.10	98	1020	10.1	98	666	10.2
Road Side - Hemdan Street			126	756	18.14	134	1026	10.2	148	1902	6.0
Urban/Residential Area - Bani Yas School			140	1024	42.70	97	1024	11.6	71	580	9.4
Indutrial - Masfah Indutrial Zone			214	1024	17.40	287	1025	13.8	209	1060	7.4
Al-Ain											
Urban/Residential Area - Al-Ain School			95	512	2.68	117	1027	10.1	115	825	8.2
Road Side - Al-Ain Street			142	1032	1.28	200	1033	6.1	147	1039	18.6
Western Region											
Urban/Residential Area - Bida Zayed			80	139	12.20	143	1025	10.1	149	1359	11.2
Down Town - Ghayathi School			148	1020	10.10	209	1022	10.1	143	1624	11.9
Remote Area - Liwa Oasis			145	1025	10.10	195	1026	10.1	147	828	10.5

Source: Environment Agency - Abu Dhabi

2.6 Hydrogen Sulphide (H_2S)

Hydrogen sulfide is naturally formed by the degredation of organic matter or through reactions of acidic water in reservoirs with sulphur containing materials. It can also be formed by bacteria that feeds on iron and manganese. Therefore, the gas spreads in areas near oil fields, waste collection, drainage networks and ground water. It is a colourless gas, with offensive smell. The levels of pollution with hydrogen sulphide in the emirate are generally low and within the normal limits, but increase in residential areas. In 2009 hydrogen sulphide concentration reached a record value of 49 mcg/m3.

2.6 Hydrogen Sulfide Concentration in Air in the Emirate of Abu Dhabi by Region, 2008 - 2009

(Micrograms / cubic meter)

Location	2008			2009		
	Average	Max.	Min.	Average	Max.	Min.
Abu Dhabi						
Down Town - Khadija School	2.63	14.94	0.01	0.87	7.67	0.1
Residetial Area - Khalifa School	2.73	71.02	0.00	5.24	49.35	0.04
Urban/Residential Area - Bani Yas School	2.01	110.67	0.01	0.73	2.3	0.01
Indutrial - Masfah Indutrial Zone	2.66	24.72	0.07	-	-	-
Al-Ain						
Urban/Residential Area - Al-Ain School	1.69	51.61	0.01	1.75	13.36	0.07
Western Region						
Urban/Residential Area - Bida Zayed	2.49	20.48	0.01	1.83	9.35	0.08
Remote Area - Liwa Oasis	1.26	44.51	0.01	1.75	13.36	0.07

(-)Data unavailable

Source: Environment Agency - Abu Dhabi

2.7 Carbon Monoxide (CO)

The gas of carbon monoxide is a highly toxic, colourless gas, produced by incomplete burning processes. It is emitted from cars exhaust and the burning of firewood, coal or gas operated machines. The most serious threat to health posed by carbon monoxide is in its ability to combine with blood hemoglobin to form carboxy hemoglobin, which in turn prevents oxygen from combining with hemoglobin. The levels of pollution with this gas decreased in the streets of Abu Dhabi City and Al-Ain in 2009. The average concentration of carbon monoxide in ambient air reached 1.1 and 1.4 mg/m^3 in Hamdan and Al-Ain streets respectively, down from 1.94 and 2.41 mg/m^3 in 2008.

2.7 Carbon Monoxide Concentration in Ambient Air in the Emirate of Abu Dhabi by Region, 2008 - 2009

(Milligrams / cubic meter)

Location	Allowable Limit (Environment Agency - Abu Dhabi)	2008			2009		
		Average	Max.	Min.	Average	Max.	Min.
Abu Dhabi	30 mg/m^3 in an hour						
Road Side - Hemdan Street		1.94	10.54	0.36	1.10	5.40	0.07
Al-Ain							
Road Side - Al-Ain Street		2.41	13.27	0.82	1.40	7.90	0.11

Source: Environment Agency - Abu Dhabi

2.8 Noise

Noise is universally regarded as a form of pollution, especially in industrial and residential areas. Among the most important external sources of noise are the different means of transportation and machinery used in building and construction works, such as drillers. The Emirate of Abu Dhabi has set limits for allowable noise levels as per the area and its activity. Noise levels in 2008 and 2009 reached values higher than the allowable limits. The maximum average was recorded in Hamdan street in Abu Dhabi, where noise reached 66 decibel in 2009.

2.8 Extent of Allowable Noise in the Emirate of Abu Dhabi

(Decibel)

Number	Area	Allowable limits	
		Day (7 a.m. – 8 p.m.)	Night (8 p.m. – 7 a.m.)
1	Residential areas with low traffic	40-50	30-40
2	Residential down town areas	45-55	35-45
3	Residential areas with commercial and trades facilities or on highways	50-60	40-50
4	Commercial areas and periods of closure of industrial facilities	55-65	45-55
5	Industrial Zones	60-70	50-60

2.9 Noise Levels by Region in the Emirate of Abu Dhabi, 2007-2009

(Decibel)

Location	2007			2008			2009		
	Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.
Abu Dhabi									
Down Town - Khadija School	58	67	53	58	65	52	58	65	52
Residetial Area - Khalifa School	53	66	46	51	66	46	52	66	46
Road Side - Hamdan Street	69	79	63	69	75	62	66	69	59
Urban/Residential Area - Bani Yas School	51	77	42	49	74	41	51	79	40
Indutrial - Musffah Indutrial Zone	57	65	-	55	66	43	50	79	40
Al-Ain									
Urban/Residential Area - Al-Ain School	50	57	46	50	58	45	50	67	43
Road Side - Al-Ain Street	67	75	63	62	71	51	62	80	52
Western Region									
Urban/Residential Area - Bida Zayed	53	68	50	53	70	48	54	70	50
Down Town - Ghayathi School	49	67	41	51	63	45	51	67	43
Remote Area - Liwa Oasis	55	69	46	54	68	42	54	68	42

Source: Environment Agency - Abu Dhabi

3. Air Emissions

Air emissions are mainly produced by burning of fossil fuel, which is produced from oil refineries, power plants, transportation activities and others. These activities produce different air pollutants such as sulphure oxides, nitrogen oxide, carbon monoxide and volatile organ compounds. The major environmental impact of the sectors of oil and natural gas and electricity consists in the emission of greenhouse gases, which contribute to such environmental phenomena as global warming and acid rain, in addition to damage to the ozone layer. It is important to mention that emission rates depend on the type and amount of fuel used, in addition to the efficiency of the combustion process. Energy statistics in the next chapter inlcude statistics of emissions from resulting from oil and gas production and water and electricity production.

3.1 Sulphur Oxides (SO_x)

The total amount of sulphur dioxide emissions produced by the oil sector in the Emirate of Abu Dhabi in 2009 was 185870 tons. It is worth noting that the emissions increased by about 18.6% compared to 2008. Mining and production companies in the oil sector contributed to the increase in these emissions by 68%. Power plants in the emirate also witnessed an increase in their emissions of sulphur oxides in 2009. Total emissions reached nearly 5383 tons, an increase of 336.4% compared to 2008.

3.1 Sulphur Oxides Emissions Produced by Oil Sector by Activities - Emirate of Abu Dhabi, 2002-2009

(Ton)

Year	Mining and Production	Gas Processing	Marketing and Refining	Production of Chemicals	Total
2002	115,174	125,053	9,536	184	**249,947**
2003	152,636	145,979	10,159	210	**308,984**
2004	150,422	210,019	10,693	194	**371,328**
2005	103,516	148,743	10,040	240	**262,539**
2006	103,415	153,900	10,185	239	**267,739**
2007	88,390	114,045	10,075	212	**212,722**
2008	45,619	99,349	11,506	200	**156,674**
2009	76,641	97,780	11,271	178	**185,870**

Source: Abu Dhabi National Oil Company (ADNOC)

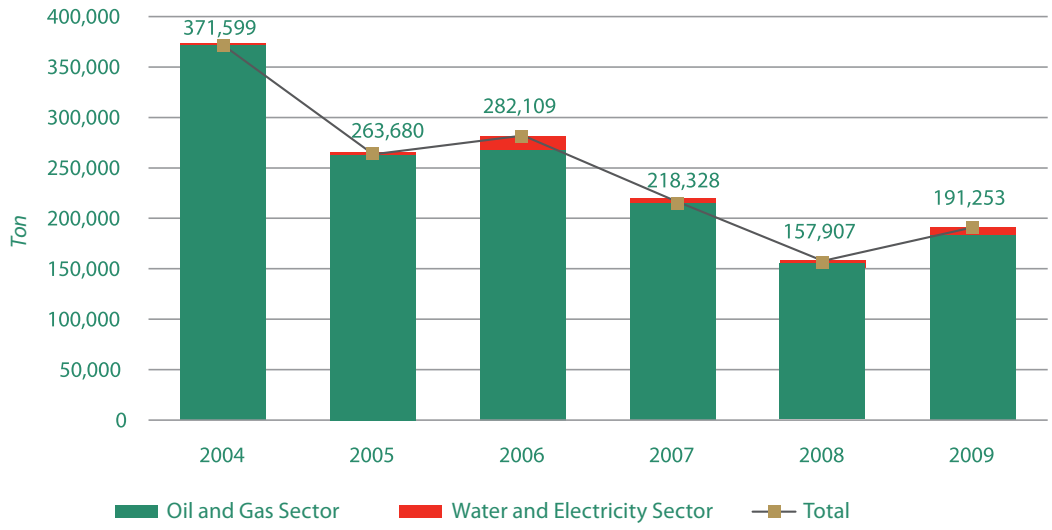
3.2 Emissions of Sulphur Oxides from Power Plants in the Emirate of Abu Dhabi, 2004 - 2009

(Ton)

Year	Arabian Power Company	Shuweihat CMS International Power	Emirates CMS Power Company	Gulf Total Tractebel Power Company	Taweelah Asia Power Company	Al Marfa Power and Desalination Plant	Zayed City Power Plant	Total
2004	-	-	249.00	17.74	-	3.13	1.02	**270.89**
2005	841.00	108.00	173.84	15.63	-	2.26	0.34	**1,141.07**
2006	10,590.00	1,028.00	439.48	14.27	2,295.00	2.64	0.33	**14,369.72**
2007	3,208.00	326.00	230.29	19.42	1,819.00	3.42	0.13	**5,606.26**
2008	706.00	146.00	150.00	19.54	207.00	4.90	0.03	**1,233.47**
2009	4,104.00	245.00	219.84	19.49	789.00	5.69	0.02	**5,383.04**

Source: Abu Dhabi Water and Electricity Authority

Figure (3.1) Emissions of Sulphur Oxides from the Power Sector in Abu Dhabi, 2004-2009



3.2 Nitrogen Oxides (NO_x)

The total emissions of nitrogen oxides from the oil sector in the Emirate of Abu Dhabi increased to 54782 tons in 2009, which is 3.8% above 2008 emissions, which were in turn lower by 5.6% than 2007. The year 2009 also registered an increase of 128% in the emissions of nitrogen oxides from power plants in the Emirate of Abu Dhabi by, whcih leapt to nearly 14480.

3.3 Nitrogen Oxides Emissions Produced by the Oil Sector by Type of Activity - Emirate of Abu Dhabi, 2002-2009

(Ton)

Year	Exploration and Production	Gas Processing	Marketing and Refining	Production of Chemicals	Total
2002	15,517	23,186	17,430	1,272	**57,405**
2003	18,935	18,406	18,433	1,247	**57,021**
2004	16,956	14,465	19,173	1,282	**55,176**
2005	16,655	20,263	17,795	1,512	**56,225**
2006	17,359	19,956	18,523	1,494	**57,332**
2007	16,287	18,473	19,596	1,525	**55,881**
2008	15,045	16,004	20,253	1,453	**52,755**
2009	17,670	15,696	20,031	1,385	**54,782**

Source: Abu Dhabi National Oil Company - ADNOC

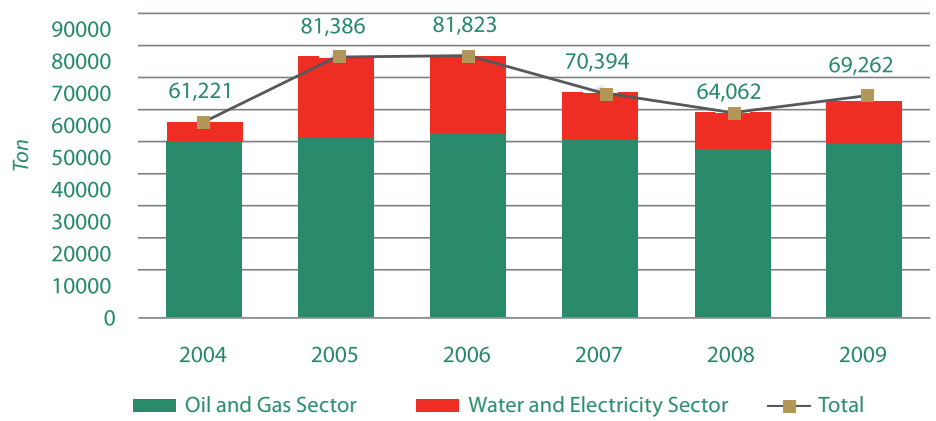
3.4 Nitrogen Oxides Emissions from Power Plants by Energy Companies - Emirate of Abu Dhabi, 2004-2009

(Ton)

Year	Arabian Power Company	Shuweihat CMS International Power	Emirates CMS Power Company	Gulf Total Tractebel Power Company	Taweelah Asia Power Company	Al Mirfa Power and Desalination Plant	Zayed City Power Plant	Total
2004	-	-	756.00	2,108.47	2,213.00	729.51	238.25	**6,045.23**
2005	18,510.00	889.00	831.18	1,958.04	2,368.00	526.25	78.80	**25,161.27**
2006	15,610.00	2,228.00	1,035.33	2,206.52	2,717.00	616.04	77.61	**24,490.50**
2007	6,761.00	2,128.00	784.22	2,301.51	1,710.00	796.95	31.09	**14,512.77**
2008	3,324.00	2,349.00	637.64	2,094.48	1,752.00	1,142.29	7.84	**11,307.25**
2009	5,710.00	2,542.00	568.90	2,490.84	1,836.00	1,326.86	5.03	**14,479.63**

Source: Abu Dhabi Water and Electricity Authority

Figure (3.2) Emissions of Nitrogen Oxides from Power Plants by Activities of the Energy Sector - Emirate of Abu Dhabi, 2004-2009



3.3 Volatile Organic Compounds (VOC's)

The oil sector in the Emirate of Abu Dhabi has cut down its emissions of volatile organic compounds significantly in 2009 reducing them by 11.42% compared with emissions of VOC's in 2008. Conversely, emissions of VOC's from power plants in the Emirate have been on the rise since 2007. In 2009 emissions of VOC's from this activity grew 3% to 231 tons, up from approximately 224 tons in 2008. This rise is due to the growing demand for electricity and the consequent increase in fuel consumption meet it.

3.5 Emissions of Air Polluting Volatile Organic Compounds Generate by the Oil Sector - Emirate of Abu Dhabi, 2002 - 2009

(Ton)

Year	Exploration and Production	Gas Processing	Marketing and Refining	Production of Chemicals	Total
2002	39,821	9,022	8,185	201	**57,229**
2003	46,133	8,335	8,218	659	**63,345**
2004	47,720	9,076	8,205	717	**65,718**
2005	47,490	8,503	8,222	700	**64,915**
2006	51,476	8,754	8,401	708	**69,339**
2007	50,532	7,027	8,430	709	**66,698**
2008	50,404	5,978	8,310	783	**65,475**
2009	42,835	6,206	8,343	615	**57,999**

Source: Abu Dhabi National Oil Company - ADNOC

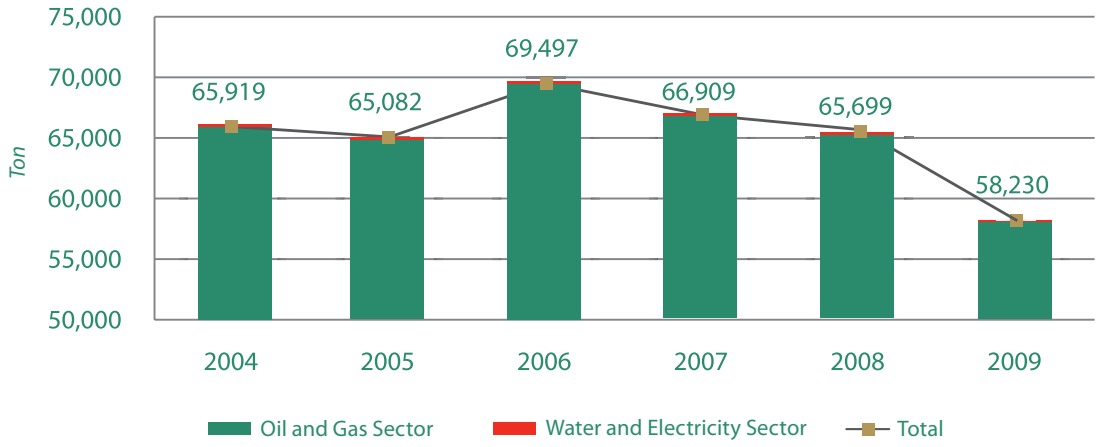
3.6 Emissions of Volatile Organic Compounds from Power Plants by Company - Emirate of Abu Dhabi, 2004 - 2009

(Ton)

Year	Gulf Total Tractebel Power Company	Al Marfa Power and Desalination Plant	Zayed City Power Plant	Total
2004	162.64	28.66	9.36	**200.66**
2005	143.29	20.67	3.10	**167.06**
2006	130.77	24.20	3.05	**158.02**
2007	178.06	31.31	1.22	**210.59**
2008	179.10	44.88	0.31	**224.29**
2009	178.70	52.13	0.20	**231.03**

Source: Abu Dhabi Water and Electricity Authority

Figure (3.3) Emissions of Air Polluting Volatile Organic Compounds Generated by the Energy Sector- Emirate of Abu Dhabi 2004-2009



3.4 Total Emissions from the Energy Sector

Total Emissions include emissions of sulphur oxides, volatile organic compounds and nitrogen oxides generated by the energy sector. The percentage of total emissions from oil and natural gas sector in the Emirate of Abu Dhabi increased by 8.46% in 2009. Total emissions from the power sector in the emirate also increased by a significant 57% in the same year.

3.7 Total air Polluting Emissions Generated by the Oil Sector the Emirate of Abu Dhabi, 2002-2009

(Ton)

Year	Sulphur oxides	Volatile Organic Compounds	Nitrogen Oxides	Total of Gross Emissions
2002	249,946	57,229	57,405	**364,581**
2003	308,984	63,345	57,021	**429,350**
2004	371,328	65,718	55,176	**492,222**
2005	262,539	64,915	56,225	**383,679**
2006	267,739	69,339	57,332	**394,410**
2007	212,722	66,698	55,881	**335,301**
2008	156,674	65,475	52,755	**274,904**
2009	185,870	57,999	54,782	**298,651**

Source: Abu Dhabi National Oil Company - ADNOC

3.8 Total Air Polluting Emissions Produced from Power Plants of Abu Dhabi Water and Electricity Authority - Emirate of Abu Dhabi, 2004 - 2009

(Ton)

Year	Sulphur oxides	Volatile Organic Compounds	Nitrogen Oxides	Total of Gross Emissions
2004	270.89	200.66	6,045.23	**6,516.78**
2005	1,141.07	167.06	25,161.27	**26,469.40**
2006	14,369.72	158.02	24,490.50	**39,018.24**
2007	5,606.26	210.59	14,512.77	**20,329.62**
2008	1,233.47	224.29	11,307.25	**12,765.01**
2009	5,383.04	231.03	14,479.63	**20,093.70**

Source: Abu Dhabi Water and Electricity Authority

3.5 Emissions of Carbon Dioxide

There was no reduction in emissions of carbon dioxide from the oil and gas sector over the period 2002 -2009. CO2 is the main cause of global warming. Emissions due to the oil and gas activity increased by nearly 79% in 2009. Accordingly, per capita annual share of carbon dioxide emissions from oil sector increased in the same year to 24.35 tons, which is 71% above the level recorded in 2008. Likewise, emissions of carbon dioxide from power plants in the Emirate of Abu Dhabi have been continuously increasing since 2004. In 2009, these emissions increased by about 11% compared with 2008, reaching 26.88 million tons.

3.9 Carbon Dioxide Emissions Generated by the Oil Sector in Emirate of Abu Dhabi by Activity, 2002 – 2009

(Million Tons)

Year	Exploration and Production	Gas Processing	Marketing and Refining	Production of Chemicals	Total
2002	6.11	12.47	4.13	1.52	**24.23**
2003	6.10	10.6	4.45	1.55	**22.7**
2004	6.22	10.7	4.51	1.87	**23.29**
2005	5.73	11.71	4.24	1.35	**23.03**
2006	6.05	11.40	4.84	1.50	**23.79**
2007	5.95	10.73	5.07	1.68	**23.43**
2008	5.66	10.67	4.47	1.59	**22.39**
2009	11.2	15.77	10.66	2.38	**40.01**

Source: Abu Dhabi National Oil Company - ADNOC

3.10 Carbon Dioxide Emissions from Power Plants by Company - Emirate of Abu Dhabi, 2004 - 2009

(Million Tons)

Year	Arabian Power Company	Shuweihat CMS International Power Company	Emirates CMS Power Company	Gulf Total Tractebel Power Company	Taweelah Asia Power Company	Al Marfa Power and Desalination Plant	Zayed City Power Plant	Total
2004	-	-	2.46	2.81	3.76	6.25	0.20	**15.48**
2005	7.25	2.31	2.66	3.05	3.97	0.45	0.07	**19.76**
2006	8.15	4.36	2.75	2.86	3.55	0.53	0.07	**22.27**
2007	7.66	4.50	2.63	3.90	4.22	0.68	0.03	**23.62**
2008	6.49	4.58	2.57	3.87	5.65	0.98	0.01	**24.15**
2009	7.23	5.25	2.39	3.87	7.00	1.14	0.00	**26.88**

Source: Abu Dhabi Water and Electricity Authority

Figure (3.4) Carbon Dioxide Emissions Generated by the Energy Sector in the Emirate of Abu Dhabi by Type of Activity, 2004-2009

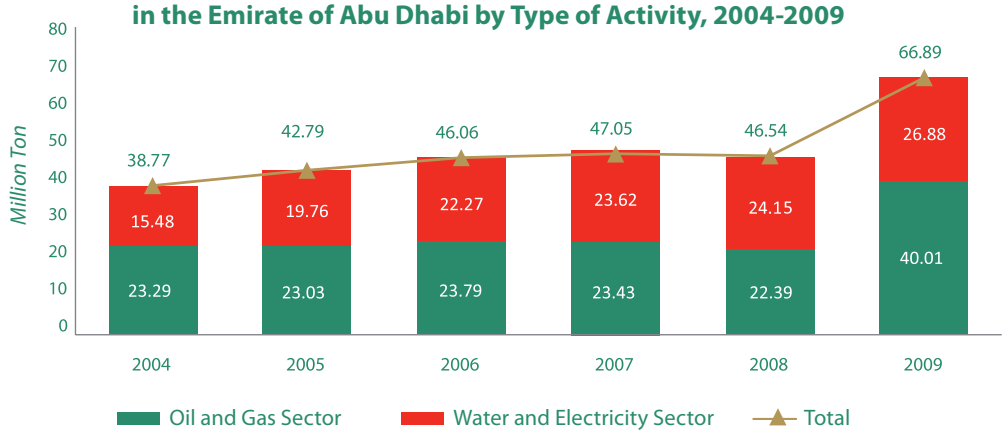
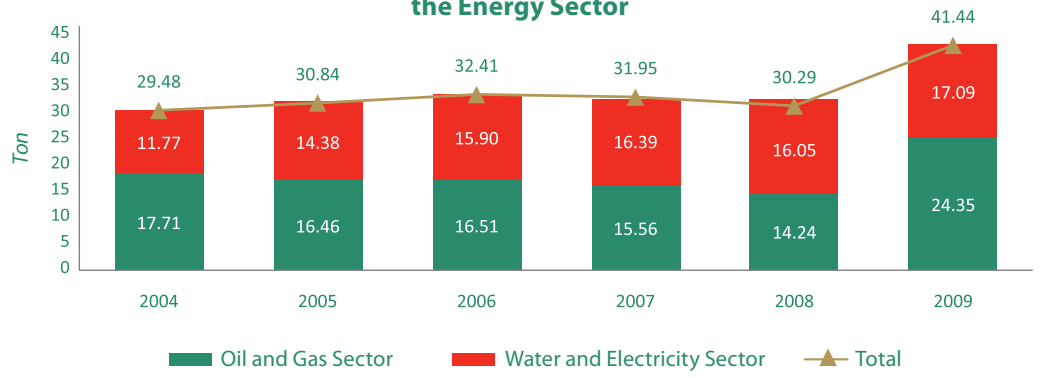


Figure (3.5) Annual Per capita Shares of Carbon dioxide Emissions from the Energy Sector



3.6 Other Emissions from Electric Power Plants

There are other emissions from power plants in the Emirate of Abu Dhabi, including carbon monoxide, a poisonous gas that is harmful to health. They also include methane, which is a greenhouse gas that contributes to the phenomenon of global warming. Power plants also release emissions of lead, which is dangerous to human health if its rates in human body exceeded allowable limits. It affects nervous, circulatory and blood systems, in addition to other effects. Increase in lead rates in cities air in general is because of emissions from burning of fuel containing lead.

3.11 Emissions from Power Plants - Emirate of Abu Dhabi, 2004 -2009

(Ton)

Pollutants	2004	2005	2006	2007	2008	2009
Caron Monoxide	2,799.26	3,505.66	4,811.58	6,476.93	4,896.82	5,360.69
Lead	0.02	0.02	0.01	0.02	0.02	0.02
Methane	83.99	69.94	66.16	88.16	93.89	96.61

Source: Abu Dhabi Water and Electricity Authority

Note:

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