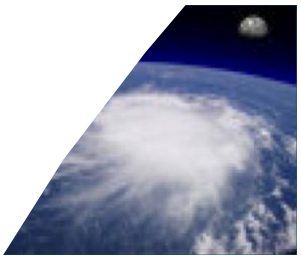
United Arab Emirates

Ministry of Energy



3rd National Communication under the United Nations Framework Convention on Climate Change

December 2012

This page intentionally left blank

Foreword

On behalf of the government of the United Arab Emirates, it is my pleasure to present our "Third National Communication" to the Conference of the Parties through the UNFCCC Secretariat in fulfillment of obligations under the United Nations Framework Convention on Climate Change.

Responding to the challenge of climate change is a strategic development priority for the UAE, a country well aware of the adverse impacts from rising seas, reduced rainfall, and more frequent extreme weather events. We believe that urgent and decisive action is needed, and as this Communication describes, innovative and coordinated actions are underway in the UAE to prepare for the future. We consider this a moral obligation to our children and their children.

The National Communication has been prepared by a team of scientists and experts specializing in different disciplines and has been coordinated by the Ministry of Energy. It has been prepared in accordance with the methodologies provided by the Intergovernmental Panel on Climate Change (IPCC) and the guidelines by the Conference of Parties. The information contained in this submission reflects the best available at the time of writing this report.

I would like to seize this opportunity to thank H.H Sheikh Hamdan Bin Zayed Al Nahyan, Ruler`s Representative in the Western Region and chairman of the Abu Dhabi Environmental Agency for his support. I would also like to extend my heartfelt gratitude to all the parties and individuals who participated in the preparation of this report.

HE Dr. Mattar Hamed Al Neyadi
Under-Secretary
Ministry of Energy,
Vice-Chairman of the National Communication Committee
Abu Dhabi
United Arab Emirates.

Contributors

National Communications High Committee Permanent Members

HE Mohammed Bin Dha'en Al Hameli, Minister of Energy (Chairman)

HE Dr. Mattar Hamed Al Neyadi, Under-Secretary, Petroleum & Mineral Resources Sector, Ministry of Energy, (Vice-Chairman)

HE Nasser Mohammed AlSharhan, Previous Under-Secretary, Petroleum & Mineral Resources Sector (Ministry of Energy)

HE Razan Khalifa Al Mubarak, General Secretary of Environmental Agency Abu Dhabi

HE Abdulla Ahmed AlMandos, Chief Executive Officer of National Center of Meteorology and Seismology

HE Salem Ali Al Zaabi, Assistant Undersecretary of Land and Maritime Affairs, National Transport Authority

HE Ali Obaid Al Yabhouni, Chief Executive Officer, Abu Dhabi National Tanker Company and National Gas Shipping Company

Dr. Mohammed Ahmed Alzarooni, Dean of the University General Requirement Unit, UAE University (Al Ain)

Dr. Thani Ahmed AlZayoudi, Energy and Climate Change Department Manager, Ministry of Foreign Affairs

National Communications Executive Committee Members

Eng. Ahmed Majid, Director of Petroleum Department, Ministry of Energy, (Chairman of the Executive Committee)

Eng. Abdulla Mohammed Sharif, Deputy Director of Petroleum Department, Ministry of Energy (Head of Energy Sector)

Dr. Saad Al Numairy, Environment Advisor, Ministry of Environment & Water

Eng. Daham Kandah, Ministry of Energy, Senior Chief Petroleum and Environment Engineer (Coordinator of National Communication development process)

Eng. Hamdan Khalifa Alshaer, Environmental Department Manager, Dubai Municipality (Head of Waste Sector)

Mr. Naser Khamis AlSuwaidi, Director of Industrial Development (Head of Industrial Sector)

Dr. Abdulla H. AlBloushi, Executive Director of Municipal Affairs Support, Department of Municipal Affairs, Municipality of Abu Dhabi City, (Head of Land Use and Forestry Sector)

Eng. Shaikha Saleh AlHosani, Climate Change and Air Pollution Department Manager, Environment Agency, Abu Dhabi

Ms. Marwa Ahmed Akbari Alawadhi, Climate Change Coordinator, Environmental Sector, Ministry of Environment & Water (Head of Agriculture Sector)

Energy Sector

Eng. Yousri K. Al-Tamimi, Planning Advisor, Corporate Planning Division, Abu Dhabi National Oil Company

Land use & Forestry Sector

Dr. Abdul-Sattar Salih Al-Mashhadani, Landscape Expert, Parks & Recreational Facilities Division, Municipality of Abu Dhabi City, Abu Dhabi, UAE

Agriculture Sector

Eng. Hamlan Abu Alkebash, Organic Fertilizers Expert, Ministry of Environment and Water

Mr. Humaid Rashid AlZaabi, Fisheries Coordinator, Ministry of Environment and Water

Waste Sector

Eng. Narciso Zacarias, Principal Engineer, Air Pollution Control Department, Dubai Municipality

Industrial sector

Dr. Inaam Qurashi Mubarak, Ministry of Economy, Economic Researcher, Abu Dhabi, UAE.

Mr. Farid Mohammed Al Najjar, Ministry of Economy, Senior Economic Researcher, Abu Dhabi, UAE.

Others

Dr. William W. Dougherty (Climate Change Research Group, Boston, USA)

Table of Contents

List of Tables

List of Figures

List of Boxes

List of Acronyms

°C	degrees Centigrade
ADICO	Abu Dhabi Chamber of Commerce
ADNOC	Abu Dhabi National Oil Company
ADUPC	Abu Dhabi Urban Planning Council
AGEDI	Abu Dhabi Global Environmental Data Initiative
BCM	billion cubic meters
CCS	carbon capture and storage
CDM	Clean Development Mechanism
CERT	Centre of Excellence for Applied Research and Training
CFL	Compact florescent light bulbs
CH_4	methane
CHP	Combined heat and power
CNG	Compressed natural gas
CO	carbon monoxide
CO_2	carbon dioxide
CO_2-equiv	carbon dioxide equivalent
COP	Conference of the Parties
CSP	Concentrated solar power
DBEM	Dynamic Bioclimate Envelope Model
DEWA	Dubai Electricity and Water Authority
DoT	Department of Transport (Abu Dhabi)
EAD	Environment Agency Abu Dhabi
EmiratesGBC	Emirates Green Building Council
ENEC	Emirates Nuclear Energy Corporation
EOR	enhanced oil recovery
EPFL	École Polytechnique Fédérale de Lausanne (Switzerland)
ESCO	Energy Service Company
EWS	Emirates Wildlife Society
GCAA	General Civil Aviation Authority
GCC	Gulf Cooperation Council
GCM	Global Circulation Model
GDP	gross domestic product
Gg	Gigagrams (i.e., one billion grams)
GHG	Greenhouse gas
GWh	gigawatt-hour (billion watt-hours)
IATA	International Air Transport Association
ICBA	International Centre for Agriculture
IMF	International Monetary Fund
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
Km	kilometers
Kt	kilotonnes (thousand metric tonnes)
kWh	thousand watt-hours
LED	Light-emitting diode
MED	Multiple Effect Distillation (desalination)
MEW	Ministry of Environment and Water
MIT	Massachusetts Institute of Technology (USA)
MODFLOW	MODular finite difference groundwater FLOW model

MOFA	Ministry of Foreign Affairs (UAE)
MSF	Multi-Stage Flash (desalination)
MW	Megawatt (million watts)
N_2O	nitrous oxide
NCAR	National Center for Atmospheric Research (USA)
NCEP	National Centers for Environmental Prediction (USA)
NGCC	natural gas combined cycle power station
NGO	Nongovernmental organization
NMVOC	non-methane volatile organic compounds
NOAA	National Oceanic and Atmospheric Administration (USA)
NO_x	nitrogen oxides
PV	photovoltaic (solar)
QFCA	Qatar Financial Centre Authority
ROMS	Regional Ocean modeling Systems
RTA	Roads and Transport Authority (emirate of Dubai)
SDM	Species Distribution Models
SLR	Sea level rise
SNC	Second National Communication
SO_2	sulfur dioxide
TSE	Treated sewage effluent
UAE	United Arab Emirates
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UV-B	ultraviolet radiation of relatively short wavelengths
WEAP	Water Evaluation And Planning model
WRF	Weather Research and Forecasting

Executive Summary

National Circumstances

The UAE is located on the Arabian Peninsula between latitudes 22.0° and 26.5° North and between 51.0° and 56.5° East. It is situated between Oman to the southeast and Saudi Arabia to the south and west. It has about 1,318 km of coastline that extends along the southeastern part of the Arabian Gulf to the western shores of Gulf of Oman. The UAE's location along the southern approaches to the Straits of Hormuz makes it strategic to maritime trade in the region.

The UAE's climate is hot and arid. There are two main seasons, winter and summer. Winter, between November and March, averages a temperature of about 26˚C during the daytime and 15˚C during the nighttime, with temperatures seldom dropping below 6˚C. Summers are very hot, stretching from April through the month of September, and temperatures can rise to about 48˚C in coastal cities – with humidity levels reaching as high as 90%. In the southern desert regions temperatures can climb to 50°C with very low humidity.

Population continues to increase rapidly. In 2010, total population was approximately 8.3 million people, a doubling over 2005 population levels. Most of the increase in population occurred between 2005 and 2008, with a plateauing since the global financial crisis in 2008. On average, the urban population accounts for about 83% of the total population.

The UAE's government is a constitutionally-based federal system under the leadership of Sheikh Khalifa bin Zayed bin Sultan Al Nahyan. The political system comprises several intricately connected governing bodies that include the Supreme Council, the Council of Ministers, the Federal National Council and the Federal Judiciary. Legislative power is shared with the Federal National Council, which debates, reviews and makes recommendations to federal draft laws, constitutional amendments, annual budgets, and international treaties. Consisting of 40 members from all seven emirates half of whom are directly elected by the citizenry.

The UAE's economy is well diversified and has experienced robust growth since the global financial crisis of 2008. Overall GDP has been growing at an average real annual rate of 4.3% over the period 2000-2010. Despite being a major oil-exporter, oil and gas activities accounted for only about 30% of national GDP in 2010.

Environmental awareness is high on the policy agenda and public service reminders are ubiquitous of the obligation to the natural world. Environmental legislation has been promulgated, involving several laws affecting water resource management, air pollution, and biodiversity conservation. Some apply at a federal level, others only at the emirate level.

The UAE has proven oil reserves of 97.8 billion barrels as of 2011, accounting for about 7% of global oil reserves. The majority of UAE oil is exported to Asian markets, particularly Japan. In addition, the country has proven natural gas reserves of 6.1 trillion cubic meters as of 2011, which represent about 3.2% of global natural gas reserves. Advancing clean energy, primarily solar power, is also a key component in the UAE's efforts to diversify energy production while promoting sustainable development.

The UAE has a comprehensive, government-funded health service and a developing private health sector. This has helped to achieve health statistics on par with those in the most developed nations. Life expectancy is now 78.5 years and child mortality rates have dropped steadily from 16.3 per 1000 in 1995 to 7.1 per 1000 in 2010. Endemic diseases have been

eradicated leaving cardiovascular disease as the principal cause of death.

Since forming the federation in 1971, the UAE has maintained education as a top priority. This focus is particularly important given that the UAE's age distribution is skewed to school-aged individuals. According to the latest census, 51% of nationals are under the age of 19 and 26% are under the age of 9. High school enrollment rates have led to a drop in illiteracy, which hit an all time low of 7% in 2009. There is also an extensive private education sector at the primary, secondary and tertiary levels.

The UAE continues to work towards expanding its transportation infrastructure, consisting of road networks, ports, airports and shipping lanes. Dubai is a major transportation hub in the Middle East, due to its airport and ports, which experience high traffic throughout the year.

Greenhouse Gas Emission Inventory

The UAE compiled an update to its inventory of greenhouse gas emissions for the year 2005 (see Table ES-1). Total GHG emissions were 174,357 Gg CO_2-equivalent, which includes 153,833 Gg from energy; 9,426 Gg from industrial processes; 3,976 Gg from agriculture, and 7,122 Gg from waste. CO_2 sequestration by the forestry and land use sector in 2005 amounted to 13,223 Gg. Net GHG emissions in the UAE are estimated at 161,134 Gg CO_2-equivalent.

The UAE's GHG emissions profile is illustrated in Figure ES-1. Most GHG emissions, about 88%, are associated with energy production and consumption activities, while CO_2 dominates total emissions, accounting for about 79% on a CO_2-equivalent basis. Emissions from hydrofluorocarbons (HFCs) are negligible, as the products containing these gases are not produced in the country. Emissions of sulfur hexafluoride (SF_6) have not been estimated due to data constraints. On a net CO_2-equivalent basis, emissions in the UAE increased by about 34% over the period 2000 to 2005, or by about 6% per year.

Vulnerability and Adaptation

There are many levels at which the UAE is concerned about climate change. Already subject to extreme climatic conditions that will likely become only more extreme, there is growing awareness in the seven emirates of the potential consequences of climate change. Even small long-term variations in temperature and precipitation are expected to have adverse effects on productive activities due to the fragile nature of the country's precious natural resources and interconnectivity with regional and global economic activity.

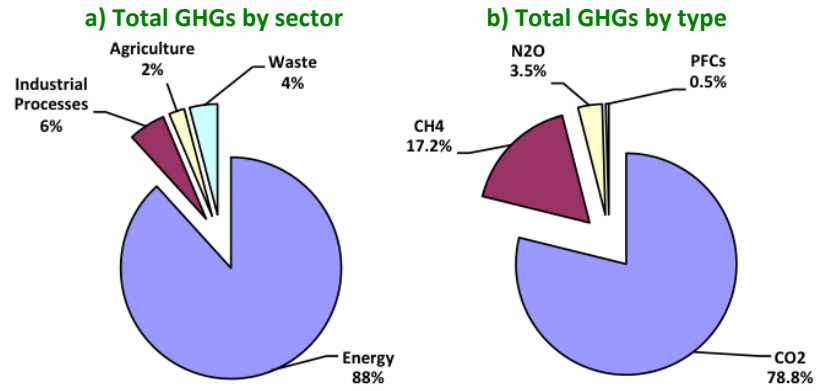
Since the submission of its Second National Communication, the UAE has undertaken detailed planning for a comprehensive climate change impacts study at the local, national, and regional levels. Specifically, there have been five (5) priority areas that have emerged in which there exists a growing consensus about their vulnerability to climate change. These priority areas are regional climatic change, environmental

Table ES-1: Total and net GHG emissions in the UAE, 2005 (Gg)

	CO_2-equiv		Direct GHGs			Indirect GHGs			
GHG Sources & Sinks	**Gg**	**(%)**	**CO_2**	**CH_4**	**N_2O**	**NO_x**	**CO**	**NMVOC**	**SO_2**
1 Energy	153,833	88%	128,824	1,011	12	330	491	27	10,346
2 Industrial Processes	9,426	6%	8,629	0	0	2	207	37	9
3 Solvent & Other Product Use	0	0%	0	0	0	0	0	0	0
4 Agriculture	3,976	2%	0	75	8	0	0	0	0
5 Land-Use Change & Forestry	-13,223	NA	-13,223	0	0	0	0	0	0
6 Waste	7,122	4%	0	339	0	0	0	0	0
Total National Emissions	174,357	100%	137,453	1,425	20	332	698	64	10,355
Net National Emissions	**161,134**	**NA**	**124,230**	**1,425**	**20**	**332**	**698**	**64**	**10,355**

Note: the percentages of CO_2-equiv are computed relative to total emissions of CO_2e-equiv.

Figure ES-1: Shares of total GHG emissions in the UAE, 2005



systems, water resources, coastal zones, and socioeconomic sectors. A total of twelve (12) studies are planned for the 2013-2014 time frame, as briefly described below.

Regional Climate change: Regional climatic modeling is in initial planning stages in the UAE. Two projects are planned. For the atmosphere, regional climate modeling efforts will use the Weather Research and Forecasting (WRF) model to represent climate change on a smaller scale by accounting for local topography, land use, coastlines, and vegetation characteristics. For oceans, the Regional Ocean Modeling Systems (ROMS) model will be used to enhance the understanding of how Arabian Gulf waters will be affected by increasing GHG concentrations. The model will account for local oceanographic conditions such as bathymetry, tidal responses, wind speed/direction, sea surface temperatures, and evaporation rates. The use of such atmospheric and oceanographic regional models will benefit not only the UAE but other Arabian Gulf countries.

Environment: The potential loss of terrestrial and marine biodiversity under climate change is a major concern in the UAE. Two projects are planned. For the terrestrial environment, a Species Distribution Model (SDM) framework, together with a range of climate change scenarios, will be used to explore the vulnerability of priority species, ecosystems, and patterns of terrestrial biodiversity on the Arabian Peninsula. For the marine environment, a Dynamic Bioclimate Envelope Model (DBEM) will be used to explore the vulnerability of marine ecosystems and fisheries to long-term physical, chemical and biological changes is for the Arabian Gulf.

Water: Adequate future supplies of water in the context of rapid socioeconomic growth is a strategic priority. Three projects are planned. First, using the Water Evaluation And Planning (WEAP) model, a national-level assessment will be undertaken to assess the vulnerability of the UAE's range of water resources to long-term regional climate change and socioeconomic growth. Second, the NOAH land surface model will be used to explore the vulnerability of renewable groundwater supply in Al Ain along the Hajar Mountains. Third, a coupled WEAP and MODular finite difference groundwater FLOW (MODFLOW) model will be used to assess vulnerability of the Arabian Peninsula's shared, transboundary groundwater resources due to sea level rise associated with long-term climate change and socioeconomic growth.

Coastal Zones: Coastal zone impacts are also particularly important due to the concentration of industry, population, and infrastructure in these areas throughout the UAE. Two studies are planned. At the regional level, GIS modeling techniques will be applied to assess the inundation extent associated with plausible sea level rise scenarios. At the national level, a coastal vulnerability index will be developed for all segments of the UAE coastline in order to provide actionable information relevant to near-term planning in a high-growth development context.

Socioeconomic Systems: Several other sectors and systems are considered to be potentially highly vulnerable to climate change. Studies are planned for desalinated water supply, food security, and public health. Regarding desalinated water supply, a quantitative

assessment will be undertaken to better understand the impact of business-as-usual practices in seawater desalination and electricity supply relative to the vulnerability of the Arabian Gulf to climate change. Regarding food security, a quantitative assessment will be undertaken to better understand the impact of climate change on long-term food price shocks, which can then impact vulnerable segments of the UAE population. Finally, for public health, a quantitative assessment will be undertaken to better understand the beneficial impact on public health from efforts to reduce greenhouse gas emissions in the Abu Dhabi emirate.

Greenhouse Gas Mitigation

In 2012, His Highness Sheikh Mohammed bin Rashin Al Maktoum, Prime Minister and Vice-President of the UAE and Ruler of Dubai, announced the UAE's Green Growth strategy, the first of its kind in the Middle East, which puts greenhouse gas mitigation at its core through a reaffirmation of existing green growth programmes and proposed measures that focus on energy decarbonization.

Indeed, the UAE is playing a major role in GHG mitigation at every level. New domestic policies and investment decisions are driving the rollout of clean energy technologies throughout the country and affect key GHG-emitting sectors such as power generation, electricity consumption, and transportation. New intellectual property is being developed within the country in clean energy options such as carbon capture and storage (CCS). Moreover, UAE institutions are investing in clean energy abroad through aid programmes to developing countries for renewable energy and efficiency activities.

At the forefront of these developments innovation is the Masdar initiative. Powered entirely by solar and other renewable energy sources, Masdar City will be one of the world's most sustainable cities when complete. Built by the Abu Dhabi Future Energy Company (a subsidiary of state-owned Mubadala Development Company), Masdar City will aim to attract clean tech companies and provide them with the infrastructure necessary to research, develop, test, implement and showcase emerging clean technologies that can sharply reduce future GHG emissions.

Implementing the Convention

The UAE has taken major steps to implement the Convention. These include a nurturing of an expansive environmental vision, actions to improve understanding of vulnerability to climate change, launching the Eye on Earth international information access initiative, and taking proactive steps to promote alternative sustainable investments to reduce GHG emissions. Going forward, a threefold strategy is being planned, as outlined below.

- *Develop systematic national GHG inventory:* The UAE plans to establish a process to develop a full national GHG inventory as part of the Vision 2021 agenda, which sets a comprehensive range of indicators for the development of the UAE.
- *Integrate climate risks in planning:* The UAE plans to develop a strategy to account for climatic risks in policies, institutions and attitudes such that enabling conditions are established to respond appropriately.
- *Strengthen capacity:* The UAE plans to enhance the individual, institutional and public/private capacity to address the challenges of climate change. This will enhance public awareness, develop institutions undertaking needed analyses, and contribute to better decision-making.

Chapter 1: National Circumstances

1.1. Introduction

This chapter provides a description of the United Arab Emirates' national and regional development priorities, objectives and circumstances, on the basis of which, it will address climate change and its adverse impacts. This chapter also includes information on features of UAE geography, demography, climate and economy to provide a sense of the overall national context in which climate change mitigation and adaptation challenges are being addressed.

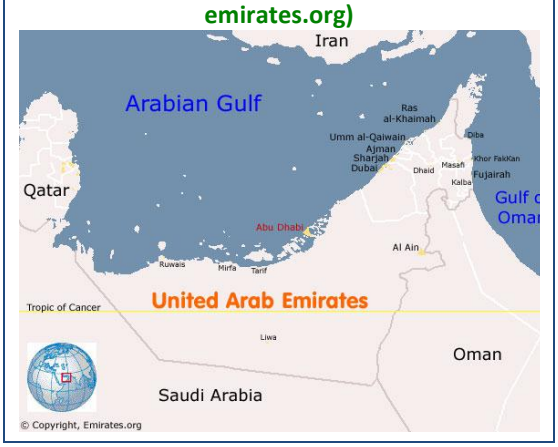
1.2. Geography

The UAE is located on the Arabian Peninsula between latitudes 22.0° and 26.5° North and between 51.0° and 56.5° East. It is situated between Oman to the southeast and Saudi Arabia to the south and west (see Figure 1-1). It has about 1,318 km of coastline that extends along the southeastern part of the Arabian Gulf to the western shores of Gulf of Oman. The UAE's location along the southern approaches to the Straits of Hormuz makes it strategic to maritime trade in the region.

Total land area is about 83,600 square kilometers. There are seven emirates that make up the United Arab Emirates – the emirates of Abu Dhabi, Dubai, Sharjah, Umm al-Quwain, Ajman, Ras Al Khaimah and Fujairah. Ongoing land reclamation projects in the Gulf are extending the coastline and increasing the total land area of the UAE. As the largest emirate, Abu Dhabi takes up approximately 80% of the UAE's total area, about 67,340 square kilometers, followed by Dubai and Sharjah. The smallest emirate, Ajman, encompasses just 260 square kilometers.

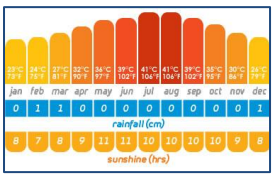
The UAE's topography consists of three main types of terrain: flat or rolling desert of the Rub al-Khali desert, low-lying coastal plains that extend along the southern shore of the Arabian Gulf, and mountains along the border with Oman. The UAE's highest point is Jabal Yibir, which rises 1,527 meters high and belongs to the Al Hajar al Gharbi mountain chain, which separates the UAE from Oman.

Figure 1-1: Map of the UAE (source emirates.org)



Arable land accounts for about 6.5% of the UAE's total land surface (UAE, 2002). This is land that is under permanent crops or under permanent pastures. Most of the arable land lies within four key areas: a strip of land along the east coast, Al Ain at the foot of the Hajar mountains in the Abu Dhabi emirate, the oasis of Dhaid in the Sharjah emirate, and the gravel plains in Ras Al Khaimah (MOE, 2010).

1.3. Climate



The United Arab Emirates has an arid climate with only two main seasons, winter and summer. Winter, between November and March, averages a temperature of about 26˚C during the daytime and 15˚C during the nighttime. Summer, which occurs from April through September, tends to be very hot. Temperatures can rise to about 50˚C in the southern inland areas, with low humidity while certain coastal cities experience temperatures exceeding 40°C along with humidity levels reaching as high as 90%. In contrast, the Al Hajar al Gharbi Mountains tend to be much cooler due to higher elevation. Average minimum temperatures in the winter months of January and February in this region are between 10°C and 14°C.

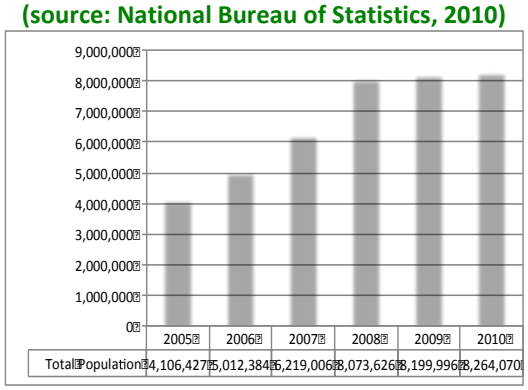
Rainfall is sparse and inconsistent in the UAE. The country averages between 140-200 mm of rainfall per year, with some mountainous areas experiencing up to 350 mm/year. A combination of atmospheric depressions and northwesterly winds from the Mediterranean Sea produce most of the rainfall in winter months, primarily February and March.

Summer rainfall tends to be lower, particularly in the coastal areas away from the mountains. In some years, however, there is no rain at all, and in others, rain occurs on only a few days in the year and can total more than three times the long term annual average (MOE, 2010). The UAE is also prone to occasional, violent dust storms, locally known as shamal winds, which can severely reduce visibility and cause air and road traffic problems.

1.4. Demography

In 2010, the UAE had a total population of approximately 8.3 million people, based on the results of a census (Ministry of Economy, 2011). This represents a doubling of 2005 population levels, or roughly 19%/year on average. Trends in population over the period 2005-2010 are summarized in Figure 1-2.

Figure 1-2: Population trends in the UAE (source: National Bureau of Statistics, 2010)



As Figure 1-2 shows, the country experienced rapid population growth between 2005 and 2008. Since the global financial crisis in 2008, the total population has plateaued at just over 8 million. Although the 2010 census did not investigate the urban-rural demographics, in 2006 the estimated urban population of the UAE was about 83% of the total population. This urban population level varied considerably at the emirate level, ranging from about 50% in Fujairah to 99% in Dubai.

1.5. Governance

The government of the UAE is a constitutionally-based federal system. As is common to federal governance structures, each of the individual emirates retains certain powers. The federal agencies

oversee foreign affairs, security, immigration, education, public health, banking, labor relations, communications, territorial waters and extradition of criminals. All other issues are under the control of individual emirates.

At the federal level, the governance structure comprises several interconnected governing bodies that include the Supreme Council, the Council of Ministers (Cabinet), the Federal National Council (parliamentary body) and the Federal Supreme Court, an independent judiciary.

The Supreme Council, comprising the rulers of each constituent emirate, holds both legislative and executive powers, directs policy and elects a president from amongst the Supreme Council to serve for a five-year term. In 2009, the Supreme Council re-elected President Sheikh Khalifa for another five-year term.

The Council of Ministers or Cabinet is the executive authority for the federation and is headed by the Prime Minister (also the Vice President) following approval by the Supreme Council and President. The Prime Minister/Vice President then proposes the Cabinet, which requires the president's ratification.

Legislative power is shared with the Federal National Council, which debates, reviews and makes recommendations to federal draft laws, constitutional amendments, annual budgets, and international treaties. Consisting of 40 members from all seven emirates half of whom are directly elected by the citizenry and the other half appointed, the Federal National Council wields considerable influence over the drafting of new legislation as the majority of their recommendations and amendments have been implemented.

The Federal Judiciary, whose independence is guaranteed by the Constitution, includes the Supreme Court and the Courts of First Instance. The Federal Supreme Court consists of five judges who are appointed by the Supreme Council and who arbitrate on the constitutionality of laws, inter-emirate disagreements, and the disputes between individual emirates and the federal government.

As a federal system, each emirate has an established local government, which varies according to size, population, and development. Each emirate is administered through a similar collection of municipalities, departments and agencies.

Over the past several years, major steps have been taken to reform the structure of government to be more responsive to the fact that the UAE's population is increasingly dominated by a young and educated demographic (Roudi, 2011). President Khalifa supports modernizing the political process in three stages: first, conduct elections via electoral college for half the members of Federal National Council, second, increase the scope, size and power of the Federal National Council and third, an open election for half the Council.

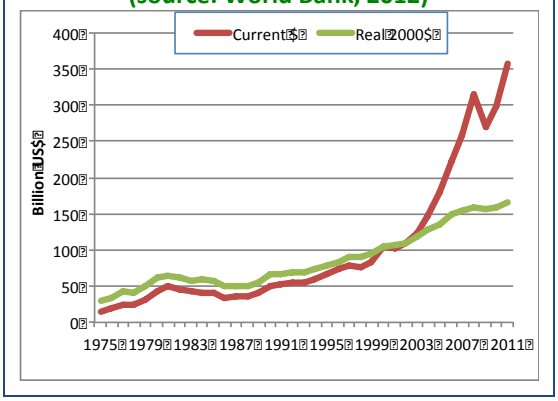
1.6. Economy

The UAE's economy has proven largely resistant to the global financial crisis. Although the 2008 slump in oil prices caused GDP to contract from a high of nearly US$315 billion to US$270 billion 2009, the government swiftly acted to ensure sufficient liquidity in the banking systems (World Bank, 2012). This allowed the economy to quickly recover, surpassing its 2008 GDP high to reach US$360 billion in 2011 (see Figure 1-3).

Key economic performance indicators demonstrate the UAE's continued resilience to the tumultuous global economy. Between 2000 and 2010, GDP grew at an average real annual rate of nearly 4.3%, inflation levels were maintained at below 1% in 2011 and the Central Bank has made concerted efforts to keep interest rates low. The UAE's trade balance increased from US$64 billion in 2010 to US$86 billion in 2011 (AMF, 2011).

To a large extent, the UAE's diversified economy is responsible for its continuing

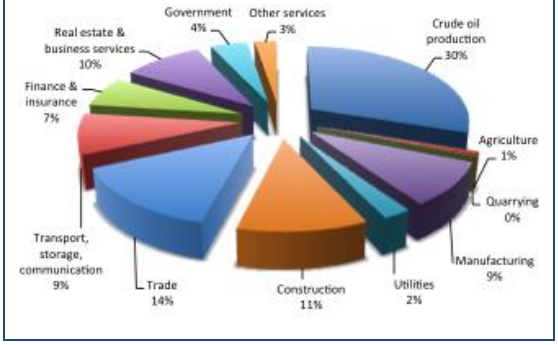
Figure 1-3: GDP trends in the UAE (source: World Bank, 2012)



resilience to global financial crises. Although the UAE's is reliant on oil revenues, non-hydrocarbon sectors make significant contributions as well, roughly 70% of GDP in 2010 (see Figure 1-4). In 2011, the collective non-hydrocarbon sector grew 3.3%, with construction (+8.6%), whole retail, trade and maintenance (+4.8%) and transport (+4.3%) performing particularly well (IMF, 2012). In contrast, the oil sector contracted by 5.6%.

Diversified economic planning helps explain the strong performance of the UAE economy. For example, the Abu Dhabi Council for Economic Development recently developed its strategic plan for 2008–2012, which calls for more liberal economic policies, boosting industrial infrastructure, and supporting small/medium scale businesses through leveraging the emirate's strong hydrocarbon sector. In contrast, Dubai's economic plan downplays the importance of oil revenues and aims to sustain real economic growth at a rate of 11% per year by promoting tourism, transport, trade, construction and financial services.

Figure 1-4: UAE's economic profile, 2010 (source: IMF, 2012)



1.7. Water

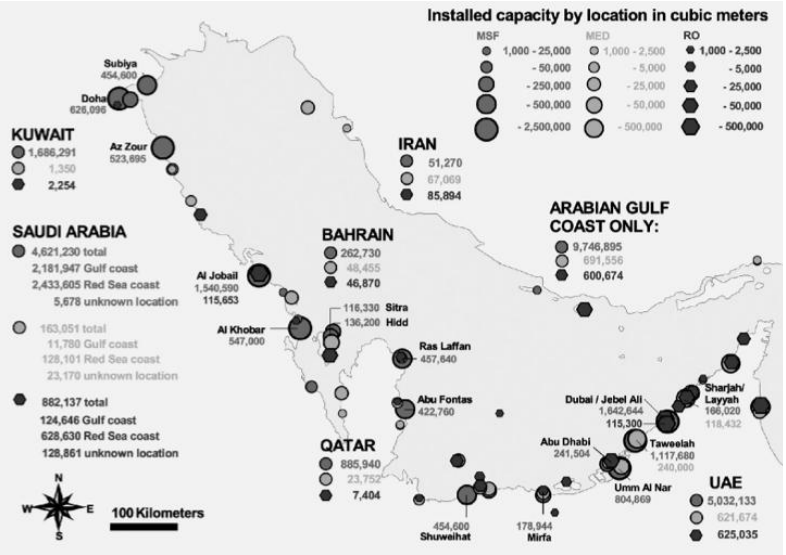
As a country with a hyper arid climate, water is critical issue. Conventional water resources include seasonal floods, springs, falajes and groundwater. The country has less than 100 mm/yr of rainfall outside of mountainous areas, very high evaporation rates (2-3 meters/yr), very low groundwater recharge rates (<4% of total annual water used) and no reliable, perennial surface water resources, such as rivers or lakes. Some of the small rivers (wadis) that are present near mountainous areas are prone to flash flooding during extreme rainfall events and can often damage agricultural areas. Furthermore, the country is a downstream water user and shares trans-boundary water resources with Saudi Arabia and the Sultanate of Oman.

Historically, the UAE population relied on wells, rainfall harvesting methods and the traditional falajes system to access groundwater aquifer systems. However, economic development, combined with explosive population growth and a subsidized expansion of the agriculture sector has led to both rising water demands and falling groundwater tables. Many wells have dried up and most recent estimates indicate that groundwater in the UAE is being extracted at over 13 times the annual recharge rate (Murad *et al*, 2007).

With one of the highest per capita consumption rates in the world, water use is about 25 times larger than total annual renewable water resources. The UAE has compensated for this pronounced shortage by growing increasingly dependent on desalination through co-generation with power stations. As of 2012, the UAE has 191 operational desalination plants that use seawater to produce potable water (GWI, 2012). An additional 243 seawater desalination plants are in operation throughout the region (see Figure 1-5).

The Arabian Gulf functions as a sink for the discharge of highly saline byproducts and

Figure 1-5: Desalination plants in the UAE and Arabian Gulf countries (source: Lattemann and Höpner, 2008)



treatment chemicals associated with the desalination process. However, the Arabian Gulf is a shallow, marginal sea that is already one of the most stressed marine environments on earth. In the future, it will be important to assess new measures and technologies to mitigate desalination impacts on Gulf water, given the dependence of the UAE and the other countries in the region on this water supply source.

Other non-conventional water resources include reuse of treated wastewater as well as developing alternative measures such as recharge dams, storage damns, recharge wells, and water transfers from other Emirates.

Typically, groundwater supplies about 51% of available water, which is used mostly for irrigation. Desalinated water contributes 40% and is used for mainly for domestic consumption. The remaining 9% is supplied by treated wastewater used for industrial purposes (MWE, 2009). These are average trends as water use varies by emirate, with differences stemming from variations in economic development, emirate size, population growth, and land use strategies. For example, in the Abu Dhabi emirate, groundwater contributes about 72% to total water consumption, followed by desalinated water at about 24%, and treated wastewater at roughly 4%.

If current consumption trends persist, the UAE's total annual water demand is expected to double from 4.4 billion cubic meters (BCM) in 2008 to nearly 9 BCM in 2030 (Al Mulla, 2011). While water demand for agriculture and forestry is expected to decline, urban demand in household, industrial, commercial and public facilities is expected to grow. As a result of these projections, water policy is now shifting from a traditionally supply side focus to a more balanced approach that integrates supply and demand side management measures. For example, the government launched a National Water Conservation Strategy in 2010 focusing on water demand measures in all sectors. In addition, the government funded an Aquifer Storage and Recovery project to develop a domestic water supply that could serve Abu Dhabi city for up to 90 days at a daily rate of 40 MGD in the case of an emergency.

1.8. Environment

Environmental awareness is high on the policy agenda and public service reminders are ubiquitous of the obligation to the natural world. Environmental legislation has been promulgated, involving several laws. Some apply at a federal level, others only at the emirate level. Overall, there is a clear move toward consistency across the country in an effort to ensure resources are used both sustainably and equitably, while at the same time protecting the UAE's precious environmental heritage.

A variety of habitats occur in the marine and terrestrial environment of the UAE (see Figure 1-6). The marine environment

Figure 1-6: UAE marine (top) and terrestrial environment (bottom) (source: EAD, 2008a, EAD, 2008b)
Top pictures, from left: *beach, mangroves, dugong, seagrass bed*
Bottom pictures, from left: *mountains, wadi, sand gazelles on sand dune, migratory birds*

includes sand dunes, beaches, islands, coral reefs, seagrass beds, mangrove stands, and tidal inlets. The terrestrial environment includes thousands of species of flora and fauna existing throughout sand dunes, mountains and wadis, and freshwater oases.

The protection of the coastal environment is a high priority in the UAE. The MEW planted a thousand trees of mangroves on the eastern coast of the country during 2012, and will raise the total number to 45 thousand trees scattered on the coastline of the state by the end of 2013.

Since ratifying the UNFCCC in 1996, the UAE has been persistent in its efforts to tackle climate change at the local, regional and international level. The federal Ministry of Environment and Water, as well as local agencies such as the Environment Agency – Abu Dhabi (EAD) are responsible for conducting scientific research and for implementing environmental regulations and guidelines.

In 2010, the EAD finalized the Abu Dhabi Environment Strategy 2010-2014, which focused on water resources, air quality, climate change, hazardous materials, waste, biodiversity, awareness, and environmental health and safety. That same year, the EAD finalized its Environment Vision 2030, which aims to renew environmental policies and develop mechanisms and strategies to ensure environmental protection in the long term. EAD policy leadership, combined with legal obligations under the UNFCCC and clean technology programs form the basis of the UAE's environmental strategy. Notable programmes and policies are described in the bullets below:

- *Biodiversity*. Recent years have seen an expansion in protected areas as well as regulating the effect that industrial and other development activities have on the natural environment and wildlife. For example, the Fujairah Municipality recently declared the country's first mountain reserve. In Abu Dhabi, the EAD enlarged the Yasat Marine Protected Area, home to roughly 20% of the UAE's endangered dugong population, to include several more islands so that it now spans nearly 3,000 square km. The Sharjah emirate's four protected areas, Seer Bu Neer Island, Khor Kalpaas, Wadi Al Helow, and Wasit, are reserves for a range of birds, reptiles, and saline plants. Moreover, the Ras Al Khor Wildlife Sanctuary in Dubai and Wadi Wurayah in Fujairah are areas of international importance, having been designated as Ramsar sites under the Ramsar Convention on Wetlands.
- *Water*. The government is also engaging in efforts to conserve its limited reserves of fresh water. To encourage water conservation, the government of Abu Dhabi created a Permanent Committee for Agriculture and Water Resources in

late 2009. The Committee is tasked with preparing an inventory of all water resources in Abu Dhabi, assessing future needs, and developing measures to control water demand. In 2009, the EAD also developed: (1) the first Uniform Plumbing Code of Abu Dhabi to guide the design of water supply an sanitation networks, (2) a Policy for Sustainable and Integrate Water Resources Management, and (3) the Abu Dhabi Water Resources Master Plan which has since been adopted by the Executive Council of Abu Dhabi Emirate.

- *Air Quality*. In 2009, the EAD, in collaboration with the Norwegian Institute for Air Quality, began work to improve and expand their air quality monitoring efforts. This included installing three new monitoring units, developing a quality assurance/quality control documentation system and creating an air quality website that allows officials to directly access relevant information. External air quality studies have been conducted in Al Gharbia and in Mohammed bin Zayed City and the government is working to expand access to alternative fuels. Other emirates are also active in assessing air quality such as the Ambient Air Quality Monitoring (AAQM) system in Dubai and an online GPRS-Sensors Array for air pollution monitoring in Sharjah.

1.9. Energy

The UAE is a leading global producer of oil and natural gas., ranking 7th in proven reserves for oil and 6th in the world regarding natural gas (EIA, 2012).

The UAE has proven oil reserves of 97.8 billion barrels as of 2011, accounting for about 7% of global oil reserves. Although recent explorations have not yielded new oil reserves, the UAE has been able to maintain its proven reserves through enhanced oil recovery (EOR) technologies that increases extraction rates of mature oil projects. The majority of UAE oil is exported to Asian markets, particularly Japan. In 2011, the UAE produced about 3.1 million barrels per day, roughly 9% of OPEC production.

The vast majority of oil production takes place in the Abu Dhabi emirate, which produced about 92 billion barrels, followed by Dubai with 4 billion barrels, and Sharjah with 1.5 billion barrels. Because the majority of oil is concentrated in Abu Dhabi, the oil sector is administered by the Supreme Petroleum Council (SPC) through the Abu Dhabi National Oil Company (ADNOC). ADNOC operates 14 subsidiaries in the oil and natural gas sectors and contracts are structured on a long-term, production sharing basis where the state is mandated to own a majority of the equity stake in all major projects.

The most important domestic players in the oil industry are Zakum Development Company, the Abu Dhabi Company for Onshore Operations, and the Abu Dhabi Marine Operating Company while key international players include BP, Shell, Total, ExxonMobil, Petrofac and Partex. Notably, in 2010, the ruler of Sharjah created the Sharjah National Oil Corporation to handle oil projects in the Sharjah emirate.

The UAE has developed a system of domestic pipelines to link production fields with processing plants and ports. The largest of these is the 370 km long Abu Dhabi Crude Oil Pipeline (ADCOP) which transports 1.5 million barrel per day (bbl/d) from ADCO's Habshan facility to Fujarah. The ADCOP was completed in March 2011 and was created in order to increase security of supply while also reducing oil transportation through the heavily trafficked Strait of Hormuz.

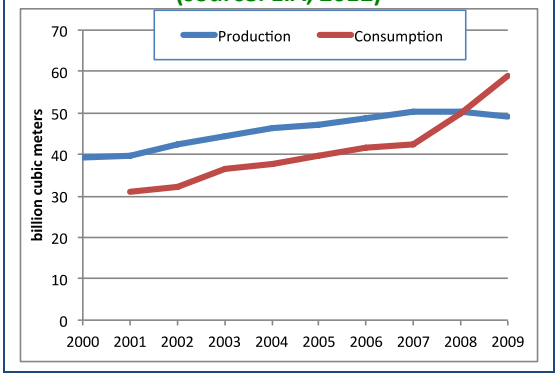
The country has proven natural gas reserves of 6.1 trillion cubic meters as of 2011, which represent about 3.2% of global natural gas reserves. The majority of reserves are located in Abu Dhabi, though Sharjah,

Dubai and Ras al-Khaiman also have marginal amounts.

Natural gas exports are managed by an ADNOC subsidiary, Abu Dhabi Gas Liquefaction Co. (ADGAS). The National Gas Shipping Company (NGSCO) handles shipments from the LNG plant, and operates the LNG carriers.

In contrast with oil, the UAE is a net importer of natural gas. With electricity and desalinated water generation dependent on natural gas, a rapidly increasing population has placed added pressure on the UAE's natural gas reserves such that in 2008, domestic consumption of natural gas exceeded production for the first time (see Figure 1-7). In 2009, approximately 10.2 billion cubic meters (BCM) was imported from Qatar's North Field to Abu Dhabi and then Dubai via a subsea pipeline, the first transboundary natural gas line in the Gulf Arab region.

Figure 1-7: UAE's economic profile, 2010 (source: EIA, 2012)



Advancing clean energy is a key component in the UAE's efforts to diversify energy production while promoting sustainable development. One component is the emphasis on the development of a corporate culture for energy efficiency improvements. For example, the use of high-efficiency natural gas-fired combined cycle technology as well as ongoing efficiency investments at Dubai Aluminum ("DUBAL") has resulted in average combustion efficiency exceeding 43% in 2011.

Another important recent development was the 2009 Abu Dhabi government's announcement that 7% of electricity would be generated by renewable energy by 2020, the majority of which will be met by solar power plants.

Almost all renewable energy projects in the UAE are lead by the MASDAR Initiative - a multi-billion dollar commitment to invest in alternative and renewable energy sources; sustainable development; education; manufacturing and carbon management with the aim that alternative energy becomes a cornerstone of the country's future economic stability. While solar is the country's most widely used renewable energy source, MASDAR is also investing in other technologies, such as wind and geothermal.

1.10. Public health

The UAE enjoys a comprehensive, government-funded health service and a developing private health sector. This has allowed the country to achieve health statistics on par with those in the most developed nations. Life expectancy is now 78.5 years and child mortality rates have dropped steadily from 16.3 per 1000 in 1995 to 7.1 per 1000 in 2010 (World Bank, 2012). Endemic diseases have been eradicated leaving cardiovascular disease as the principal cause of death.

In 2009, the Ministry of Health, in partnership with the Ibn Sina Pharmacy group, conducted a comprehensive health survey of 28,000 UAE residents. The results showed that 18% were diabetic, 12% were borderline diabetic, 68% were overweight or obese and 47% had normal cholesterol levels. These results demonstrate how critical preventative medicine will be to future health policy in the UAE.

While health expenditures as a portion of government expenditure has remained fairly constant since 1995, health expenditures per capita in real terms has increased 70%, from US$920 in 1995 to US$1,544 in 2010 (see Table 1-1). As a result, substantial health care infrastructure exists throughout the country, though Dubai and Abu Dhabi typically have the most modern facilities.

The UAE has approximately 40 public hospitals and both public and private institutions are investing in either expanding or improving existing facilities. For example, SEHA, the health services company that operates government hospitals and clinics in Abu Dhabi, has plans to replace both the Al Mafraq Hospital and Al Ain Hospital by 2013. The Ajman Health Zone is also investing US$140 million to create a set of primary health centers, a diabetes and obesity center and a medical fitness center. Umm al-Qaiwain Hospital is also undergoing a revamp costing about US$110 million and the new 400-bed Jebel Ali Trauma and Emergency Centre in Dubai is now open. The 200-bed Al Jalila Children's Specialty Hospital in Dubai was also recently completed.

The government is also working to expand health insurance. In 2008, the Abu Dhabi emirate made medical insurance mandatory, an add-on to previous mandate that all expatriates and their dependent have health insurance. As of 2009, the number of insured people in Abu Dhabi was 1.9 million, up from around 150,000 in 2006. Moving forward, the UAE government plans to expand health care coverage to every Emirati and expatriate.

In order to develop an integrated healthcare policy throughout all Emirates, the UAE established a Health Council in July 2008. This national council coordinates federal and local healthcare efforts in both the public and private healthcare sectors. Regional and local bodies also exist, such as the Health Authority-Abu Dhabi and the Dubai Health Authority.

Since 2009, the Ministry of Health has concentrated on bringing health care in northern emirates up to levels offered in Abu Dhabi and Dubai. The Government finances 81% of the cost of health care, but several initiatives towards privatization have been launched recently (Alrawi and Hussain, 2011).

1.11. Education

Since forming the federation in 1971, the UAE has maintained education as a top priority. This focus is particularly important given that the UAE's age distribution is skewed to school-aged individuals. According to the 2005 census, 51% of nationals are under the age of 19 and 26% are under the age of 9. Providing an adequate P-12 school system is critical to the viability of the UAE's future workforce.

In 2009, the government earmarked 23% of the federal budget for education, which is free to male and female students from kindergarten to university. In 2005, 100% of eligible children were enrolled in primary school; 98% of female and 97% of male students persisted to grade 5; and 90% of students enrolled in secondary school. High enrollment rates have led to a drop in illiteracy, which hit an all time low of 7% in 2009. There is also an extensive private education sector at the primary, secondary and tertiary levels. The majority of expatriate children and children of many urban Emirati parents attend private institutions.

In 2008, the Ministry of Education released its strategic plan for educational policy reform at the federal level, of which a key component is replacing the old curriculum. In 2009, the Abu Dhabi Educational

Table 1-1: UAE's health expenditure indicators, 1995-2010 (source: World Bank, 2012)

Indicator	1995	2000	2005	2010
Health expenditure, public (% of government expenditure)	8.1%	7.6%	8.6%	8.8%
Health expenditure per capita (current US$)	$ 713	$ 699	$ 896	$ 1,450
Health expenditure per capita, (2005 international US$)	$ 920	$ 805	$ 811	$ 1,544

Council (ADEC) released its strategic plan for the P-12 grades, which will education reform in Abu Dhabi through 2018. The plan involves shifting the curriculum so that it is more skills focused, improving English instruction, and providing professional development for teachers without degrees or certificates in education. The goal is to produce graduates that are competitive in both regional and global labor markets.

Secondary school graduates who meet the necessary requirements can attend federal universities free of charge and scholarship funds exist to enable citizens to attend universities outside of the UAE. In the 2009–2010 academic year, 13,102 secondary school graduates were given a place at a federal university or awarded a scholarship to study abroad. The largest University is the UAE University located in Al Ain, which admitted 3,146 students in 2009, followed by the Higher Colleges of Technology, which admitted 7,423, and Zayed University, which admitted 1,813. Females make up over 62% of admitted university students.

1.12. Agriculture

Agriculture in the UAE, including fishing, is a minor part of the economy, contributing less than 1% of GDP in 2010. Lack of arable land, intense heat, and limited water supplies are the main obstacles to agriculture and the major reasons for a heavy reliance on food imports. In 2007, nearly 90% of food supply was imported (see Figure 1-8).

Notably, imports of items such as cereals and sugar accounted for 100% of all consumption of these foods. In addition, the import of other food items such as milk, meat, and vegetables accounted for substantial shares of the total supply for these food items, about 94%, 81%, and 62%, respectively.

The UAE is also a hub for re-exports of food commodities, with roughly one third of annual supply being re-exported to world markets. In 2007, the re-export of cereals, for example, amounted to 3.3 million tonnes, or about 60% of total cereal imports. Despite the small share of local agricultural production in overall food supply, agriculture currently accounts for about 80% of freshwater use (MOE, 2010), an imbalance largely due to the legacy of past agricultural policies that tended to equate food security with self-sufficiency in agricultural production.

New approaches to agriculture are being considered to cope with the food security challenges of the UAE. Before the global food crisis of 2008, traditional policies such as food subsidies, price controls, or wage bonuses were the preferred options to mitigate food price spikes. Increasingly, the UAE has purchased or leased agricultural land abroad as way to pursue long-term sustainable growth (QFCA, 2010). The objective is to secure deals, particularly in other Islamic countries, by which capital and oil contracts are exchanged for guarantees that private corporations from the Gulf will have access to farmland and be able to export the produce back to the region (GRAIN, 2008). This policy is well underway with a total of 2.9 million hectares already under agreement, and another 300,000 hectares in process (see Table 1-2), with North Africa and Asia accounting for 97% of the total land area between them (82% and 15%, respectively).

Figure 1-8: UAE food balance, 2007 (FAOSTAT, 2012)

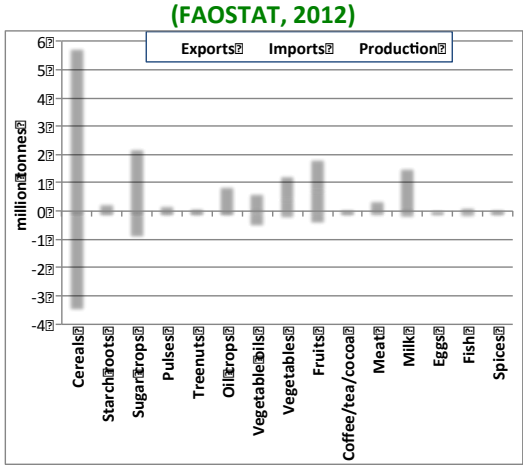


Table 1-2: UAE food outsourcing to other countries (GRAIN, 2012)

Region	Country	Size (hectares)	Production	Status
North Africa	Algeria	31,000	Milk, olive oil, potatoes	Complete
	Egypt	68,500	Dill, maize, potatoes, wheat, fodder	Complete
	Morocco	700,000	Citrus and olives	Complete
	Sudan	1,799,100	Barley, cotton, hay, maize, sugar cane, sunflowers, wheat, peanuts, sorghum, alfalfa	1,643,100 ha done; 156,000 ha in process
Sub-Saharan Africa	Ghana	10,000	Maize	Complete
	Namibia	200	Date Palm	Complete
	Tanzania	50,000	Rice	In process
Asia	Pakistan	369,100	Rice, crops, dairy, alfalfa, livestock	334,100 ha done; 35,000 in process
	Indonesia	100,000	Fruit, palm oil, rice, sugar cane	In process
Europe	Romania	50,000	Cereals	In process
	Spain	5,050	alfalfa	Complete

Within the UAE, the federal Ministry of Environment and Water has developed a National Strategic Plan for the Development of Livestock Production and Plantation in collaboration with the International Centre for Agriculture (ICBA). The aim of the National Strategic Plan is to develop a general framework for policies, regulations and legislation on plant and animal production. The implementation of the strategy was begun in April 2012 to be finalized in September 2013. The initial achievement of the strategic plan is a database for plant and animal production in the UAE containing information on a range of factors that affect agricultural production. A summary of other strategic phases are summarized below:

- *Baseline characterization:* This involves defining the current status of plant and animal production in the country, including regulatory framework for production, marketing, and quarantine.
- *Environmental impacts:* This involves an evaluation of the environmental impacts associated with plant and animal production including the use of plastics, fertilizers and pesticides.
- *Information infrastructure:* This involves augmenting information on agricultural factors of production, the number/ distribution of livestock, and requirements for greater use of GIS capabilities.
- *Future food security:* This involves undertaking a study of future demand for agricultural products and the possibility of achieving some aspects of food security in 2022.

The Ministry of Environment and Water (MEW) is also actively encouraging farmers to use organic inputs (i.e., fertilizers, pesticides) through an incentive in which half of the cost of inputs are subsidized. Moreover, in March 2012, the MEW launched a public campaign to build awareness among consumers that organic-certified produce from the UAE uses production process in compliance with the highest global standards and requirements of organic food production.

1.13. Transportation

The UAE continues to work towards expanding its transportation infrastructure, consisting of road networks, ports, airports and shipping lanes. Dubai is a major transportation hub in the Middle East, due to its airport and ports, which experience high traffic throughout the year.

Dubai's main ports of Jebel Ali, Port Rashid, Hamriya Port and Dubai Creek serve more than 13,000 vessels each year and handle a significant share of the world's shipping cargo. Abu Dhabi and Sharjah also have major ports, which are used to export

of crude oil, refined oil products and petrochemicals.

The UAE is attempting to reduce dependence on cars by building comprehensive public transit systems. For example, the Abu Dhabi Department of Transport recently released its Surface Transport Master Plan, which aims to increase public transport use to 35% to 40% of all daily trips by 2030 (Abu Dhabi DoT, 2009). To facilitate this goal, Abu Dhabi is in the process of building a public transit system, valued at more than US$ 82 billion, to be completed over the next 20 years. The system will include buses, trams, metro and regional rail and battery-powered podcars. A 140-km motorway from Al Ain to the new Khalifa Port is also planned.

1.14. Institutional arrangements for national communications

In the UAE, climate change activities are coordinated by the climate change Executive Committee. This committee is chaired by the Federal Ministry of Energy and has representation of all relevant institutions (i.e., energy, agriculture, forestry, waste, industry).

Since the Initial National Communication, the Executive Committee has been focused on three key activities. These in include promoting broad public awareness on climate change issues, coordinating data acquisition/data quality enhancement activities for the development of updated GHG inventories, and the implementation of a range of technical capacity building initiatives. These activities are undertaken in coordination with other national and emirate-level institutions.

1.15. List of References

Abu Dhabi Department of Transport (DoT), 2009. "Surface Transport Master Plan – A Vision for Connecting Abu Dhabi", available at http://dot.abudhabi.ae/wcms/forms/surface_transport_master_plan_en.pdf

Al Mulla, M., 2011. "UAE State of the Water Report", Ministry of Environment and Water, UAE, summary presentation available at http://www.arabwatercouncil.org/AWF/Downloads/Sessions/Topic1/P2-3-Mohamed-AlMulla-UAE-State-of-Water-Report.pdf

Alrawi, K and Hussain, A., 2011. "The promise of the services sector: A United Arab Emirates perspective- case study", *American Journal of Social and Management Sciences*, 2(1): 116-125

Arab Monetary Fund (AMF), 2012. *Financial statistical database*, as reported on the UAEinteract website (available at http://www.uaeinteract.com/docs/UAE_trade_surplus_put_at_US$86.2bn_in_2011/49178.htm)

EAD, 2008a. Marine and costal environment of Abu Dhabi emirate, AGEDI Sector Paper.

EAD, 2008b. Terrestrial environment of Abu Dhabi emirate, AGEDI Sector Paper.

Energy Information Administration (EIA), 2012. *UAE Country analysis brief,* available at http://www.eia.gov/countries/country-data.cfm?fips=tc

FAOSTAT, 2012. "Food Balance Database", available at: http://faostat.fao.org/site/291/default.aspx (accessed on 3 June 2012).

Global Water Intelligence (GWI), 2012. DesalData.com database (available at http://desaldata.com/), accessed on 25 May 2012.

GRAIN, 2008. "SEIZED! The 2008 land grab for food and financial security", October.

GRAIN, 2012. "Database documenting 416 recent, large-scale land grabs by foreign investors for the production of food crops", February.

International Monetary Fund (IMF), 2012. *United Arab Emirates: Selected Issues and Statistical Appendix,* IMF Country Report

No. 12/136, June (available at http://www.imf.org/external/pubs/ft/scr/2012/cr12136.pdf)

Lattemann, S. and Höpner, T., 2008. "Environmental Impact and Impact Assessment of Seawater desalination, *Desalination*, 200, pp 1-15.

Ministry of Economy, 2011. Annual Economic Report, UAE, available at http://www.economy.ae/English/Documents/EconomicAnnualReport-en.pdf

Ministry of Energy (MOE), 2006. First National Communication under the UNFCCC, UAE.

Ministry of Energy (MOE), 2010. Second National Communication under the UNFCCC, UAE.

Murad A., Nuaimiu, H., and Hammadi, M., 2007. "Comprehensive Assessment of Water Resources in the United Arab Emirates (UAE)", *Water Resources Management*, 21:1449-1463.

National Bureau of Statistics, 2010. "Methodology for Estimating the Population in UAE", available at http://www.uaestatistics.gov.ae/ReportPDF/Population%20Estimates%202006%20-%202010.pdf

Qatar Financial Centre Authority (QFCA), 2010. "The GCC in 2020: Resources for the future", A report from the Economist Intelligence Unit.

Roudi, F., 2011. "Youth Population and Employment in the Middle East and North Africa: Opportunity or Challenge?", "UN Department of Economic and Social Affairs (UNDESA), available at http://www.un.org/esa/population/meetings/egm-adolescents/p06_roudi.pdf

UAE, 2002. Second National Communication under the UNCCD, available at http://www.unccd.int/RegionalReports/united_arab_emirates-summary-eng2002.pdf

World Bank, 2012. *World Development Indicators – UAE*, available at http://data.worldbank.org/.

Chapter 2: Greenhouse Gas Inventory

2.1. Introduction

This chapter presents estimates for the United Arab Emirates of national anthropogenic greenhouse gas emissions and sinks for the year 2005. The inventory includes five categories: energy; industrial processes; agriculture; land use, land use change and forestry (LULUCF) and waste.

2.2. Methodology

The methodology used to develop the inventory is based on the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* and the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (Good Practice Guidance) prepared by the Intergovernmental Panel on Climate Change (IPCC) and the *Good Practice Guidance for Land Use, Land-Use Change, and Forestry*, which further expanded upon the methodologies in the Revised 1996 IPCC Guidelines.

As recommended by the IPCC Guidelines, country specific methods have been used as appropriate for certain GHG emitting sectors. In the subsections that follow, GHG emissions are reported both in absolute units of carbon dioxide, methane and nitrous oxide emissions, as well as in units of CO2-equivalent by applying 100-year GWPs of 1 for CO2, 21 for CH4, 310 for nitrous oxide, 6,500 for CF_4 and 9,200 for C_2F_6.

2.3. Total GHG Emissions

Table 2-1 presents total GHG emissions and sinks for the year 2005. Total GHG emissions in 2005 were 174,357 Gg CO2-equivalent, which includes 153,833 Gg from energy; 9,426 Gg from industrial processes; 3,976 Gg from agriculture, and 7,122 Gg from waste. CO_2 sequestration by the forestry and land use sector in 2000 amounted to 13,223 Gg. Net GHG emissions are estimated at 161,134 Gg CO2-equivalent. These national emissions are quite low relative to global emission levels.

Emissions from hydrofluorocarbons (HFCs) are considered negligible, as the products containing these gases are not

Table 2-1: Total GHG emissions in the UAE, 2005 (Gg)

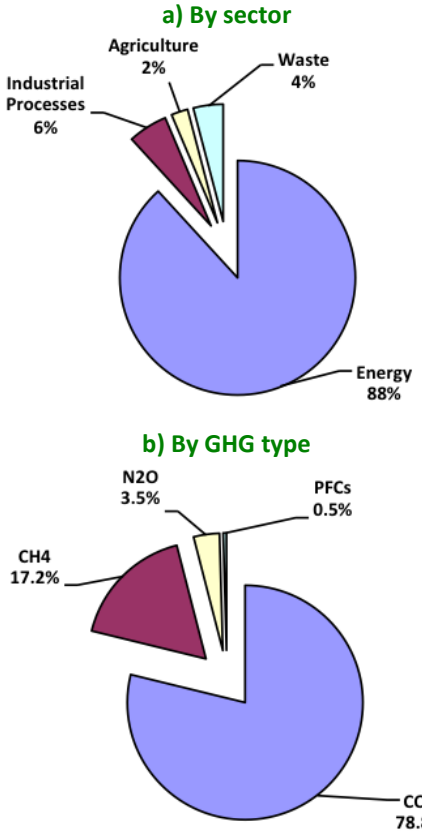
GHG Sources & Sinks	CO_2-equiv	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
1 Energy	153,833	128,824	1,011	12	330	491	27	10,346
2 Industrial Processes	9,426	8,629	0	0	2	207	37	9
3 Solvent & Other Product Use	0	0	0	0	0	0	0	0
4 Agriculture	3,976	0	75	8	0	0	0	0
5 Land-Use Change & Forestry	-13,223	-13,223	0	0	0	0	0	0
6 Waste	7,122	0	339	0	0	0	0	0
Total National Emissions	174,357	137,453	1,425	20	332	698	64	10,355
Net National Emissions	**161,134**	**124,230**	**1,425**	**20**	**332**	**698**	**64**	**10,355**

produced in the country. Emissions from sulfur hexafluoride (SF_6) in the UAE could not be estimated due to a lack of data.

Figure 2-1a illustrates the shares of total GHG emissions by sector for the year 2005. Energy-related activities accounted for the dominant portion of GHG emissions in the UAE. Approximately 88% of all GHG emissions are associated with the combustion of fossil fuels for electricity/desalinated water production and the release of fugitive emissions from oil and gas operations. Industrial processes accounted for 6% of all GHG emissions, followed by waste with 4% and the agriculture sector with 2% of total emissions. Approximately 8% of total GHG emissions in 2005 were sequestered by the extensive system of hardwood tree plantations throughout the country.

Figure 2-1b illustrates the shares of total GHG emissions by GHG type for the year 2005. Carbon dioxide dominates total emissions, accounting for about 79% on a CO_2-equivalent basis. Methane accounts for less than 18% and nitrous oxide less than 4% on a CO_2-equivalent basis. PFC emissions associated with aluminum production account for the remaining 0.5% of total GHG emissions.

Figure 2-1: Shares of total GHG emissions in the UAE, 2005

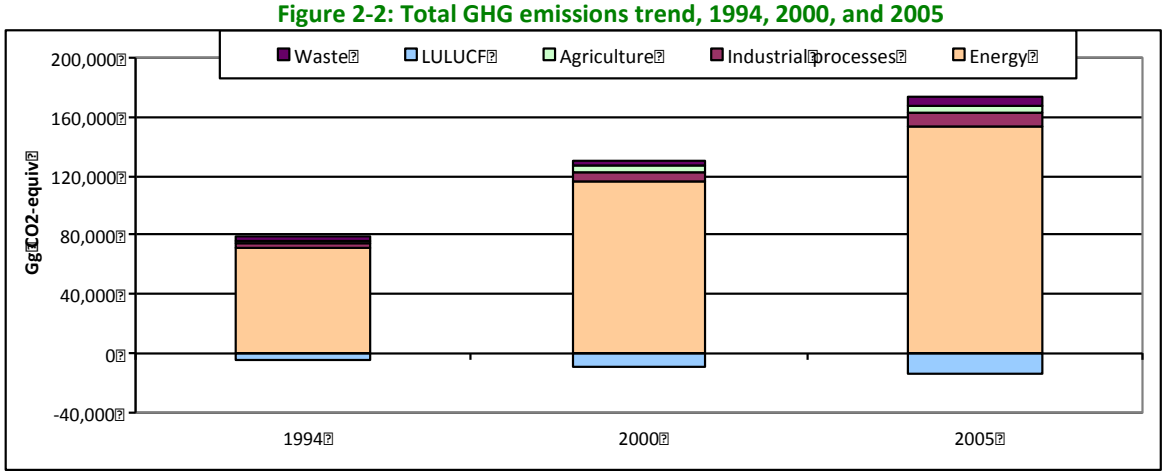


2.4. GHG emission trends

Figure 2-2 presents the trend in total GHG emissions for 1994 and 2000, the years of GHG inventories submitted as part of previous National Communications (UAE, 2006; UAE, 2010), and the current inventory year of 2005. On a net CO_2-equivalent basis, emissions in the UAE increased by about 117% over this period, or about 7.3% per year.

On the emissions side, GHG emissions have increased by about 121%; from 78,653 Gg CO_2-equivalent in 1994 to 174,357 Gg CO_2-equivalent in 2005. Emissions from energy and industrial processes increased by roughly 117% and 174%, respectively. Agricultural and waste-related emissions also increased substantially, by 124% and

Figure 2-2: Total GHG emissions trend, 1994, 2000, and 2005



179%, respectively. Regarding GHG sinks, the small but important contribution of managed green parks increased by about 213% and is consistent with local and national policies to expand and maintain green areas throughout the country.

Figure 2-3 compares GHG emissions for all sectors for the years 1994, 2000, and 2005. Over the entire period, CO_2-equivalent emissions from energy use have been growing about 7.3% per year. This is due primarily to a continued and consistent growth in energy use for power generation and process heat in manufacturing industries, plus even steep growth in road transport. Also over this period, CO_2-equivalent emissions from industrial processes have been growing by about 9.6% per year. This trend is dominated by cement and iron/steel production, both of which nearly tripled between the tears 1994 and 2005. LULUCF activities have also shown a sharp increase with a near tripling of sequestered GHG emissions between 1994 and 2005.

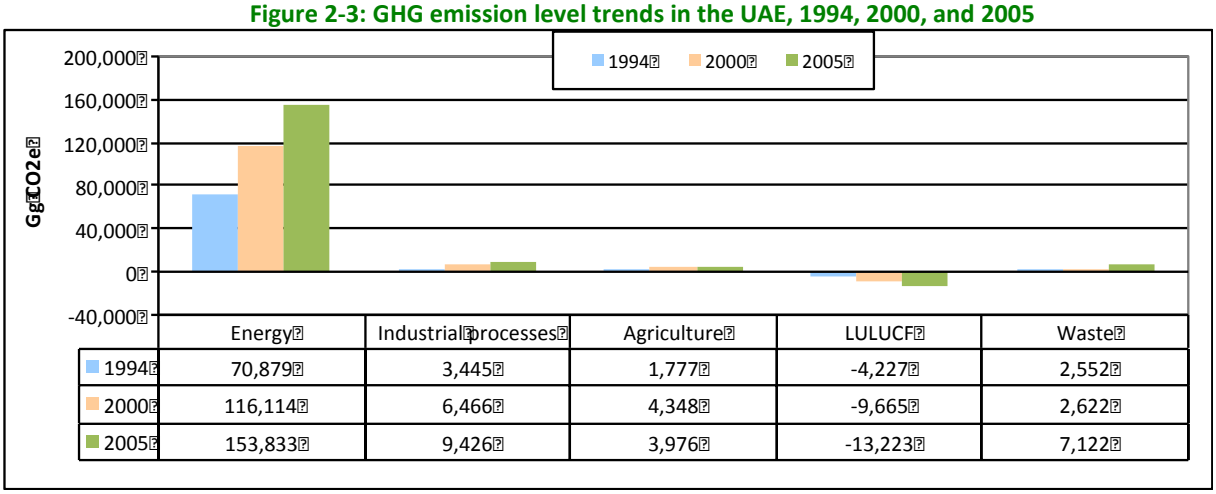
These trends in GHG sources and sinks are largely explained by the overall strong demographic and economic growth that took place in the UAE over the 1994-2005 period, as well as the sustained commitment during this period to maintaining and expanding green park areas, particularly in the Abu Dhabi emirate. Demographic growth, for example, grew at the rate of about nearly 5% per year for the indigenous and expatriate population (see section 1.4 in the previous chapter for additional details).

Economic growth, as most clearly evident in energy use patterns in the residential, commercial, industrial, and transportation sectors grew at similar levels.

The rate of growth in energy use has been decreasing in recent years in certain sectors. For example, the quantity of fuels used to produce electricity and desalinated water in the UAE grew about 13%/year between 1994 and 2000, but by a considerably lower rate, about 5%/year, between the years 2000 and 2005. Over the entire 1994-2005 period, the average annual growth rate for energy use for power and desalinated water production was 9%/year. In the land use sector, the total number of trees in plantations and green parks grew by about 15%/year between 1994 and 2000, while growing at a rate of 6%/year between 2000 and 2005. Over the 1994-2005 period, the average annual growth rate for tree plantings was 11%/year.

An opposite trend is evident for the transport sector where the number of light duty vehicle registrations (i.e., cars and light duty trucks such as sport utility vehicles) have been growing at steadily increasing rates. Between 1994 and 2000, registrations grew about 9%/year. On the other hand, between the years 2000 and 2005, car registrations grew by about 15%/year. Averaged over the 1994-2005 period, the annual growth rate for light duty vehicle registrations was about 12%/year, which is over twice the than the population growth rate over the same period.

Figure 2-3: GHG emission level trends in the UAE, 1994, 2000, and 2005



	Energy	Industrial processes	Agriculture	LULUCF	Waste
1994	70,879	3,445	1,777	-4,227	2,552
2000	116,114	6,466	4,348	-9,665	2,622
2005	153,833	9,426	3,976	-13,223	7,122

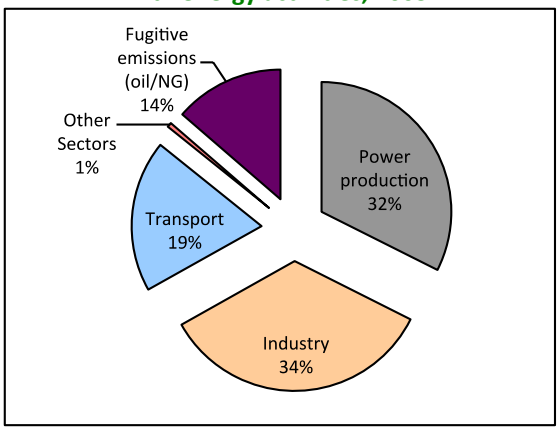
2.5. Energy

Table 2-2 summarizes GHG emissions associated with energy activity in 2005. Relative to overall anthropogenic GHG emissions, the 153,833 Gg CO_2-equivalent represented about 88% of total national emissions. This is essentially the same share as in previous inventories. Activity data for energy use was based on UAE energy and trade Statistics (Al Tamimi, and Sharif, 2011).

GHG emissions from energy activities are due to fossil fuel combustion and fugitive emissions from oil and gas exploration activities. Fuel combustion emissions are associated with the use of a variety of petroleum products and natural gas. Natural gas and residual fuel oil are used exclusively for power production and process heat in manufacturing processes. Most diesel and gasoline fuels are consumed in road transport and industry, with relatively small quantities used for power production. LPG is used in the residential and commercial/institutional sectors for cooking.

Figure 2-4 illustrates the breakdown in energy-related GHG emissions in 2005 by consuming activity. Industrial energy-consuming activities in the form of manufacturing (mostly cement, iron and steel, and aluminum production) and construction activities accounted for about 34% of all energy-related emissions. Power production is based overwhelmingly on the use of natural gas, with small amounts of crude oil, residual oil, and diesel, and accounted for about 32% of total emissions from all energy production/consumption activities in the UAE.

Figure 2-4: Breakdown of GHG emissions associated with energy activities, 2005



These levels are roughly 33% higher than the year 2000 levels. This is equivalent to a growth rate of about 6%/year, or roughly consistent with the economic growth rate in the UAE over that 5-year period.

Notably, fugitive emissions of methane, a gas that has a high global warming potential, accounted for about 14% of all GHG emissions in the energy industries sector on

Table 2-2: GHG emissions from energy activities, 2005 (Gg)

GHG Source Categories	CO_2-equiv	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
All energy emissions	**153,833**	**128,824**	**1,011**	**12**	**330**	**491**	**27**	**10,346**
A Fuel Combustion Activities	132,849	128,824	12	12	330	490	27	10,346
1 Energy Industries	49,870	46,421	11	10	110	58	1	2,296
2 Manufacturing Industries & Construction	52,970	52,694	1	1	133	165	8	3,382
3 Transport	29,128	28,913	0	1	60	252	18	4,350
4 Other Sectors	881	797	0	0	27	15	0	317
B Fugitive Emissions from Fuels	20,984	0	999	0	0	1	0	0
1 Solid Fuels	0	0	0	0	0	0	0	0
2 Oil and Natural Gas	20,984	0	999	0	0	1	0	0
Memo Items	18,198	18,198	0	0	0	0	0	5
International Bunkers	18,198	18,198	0	0	0	0	0	5
CO2 Emissions from Biomass	0	0	0	0	0	0	0	0

a carbon dioxide equivalent basis, as the UAE continues to be a major supplier of the world's energy needs. Transport emissions for road transport (where diesel accounts for 33% and gasoline accounts for 67% of total road transport energy), and domestic civil aviation (jet kerosene) accounted for about 2% of total transport-related emissions in 2005.

2.6. Industrial Processes and Other Product Use

Table 2-3 summarizes GHG emissions associated with industrial processes and product use in 2005. Including an additional 0.12 Gg of PFCs from aluminum production (i.e., 0.11 Gg of CF_4 and 0.01 Gg of C_2F_6), industrial processes are the second largest emitter of anthropogenic GHG emissions in the UAE, accounting for 9,426 Gg of CO_2–equivalent, or about 5% of national CO_2–equivalent emissions in 2005.

These levels are roughly 45% higher than the year 2000 levels. This is equivalent to a growth rate of about 8%/year. However, the previous estimate of industrial process GHG emissions did not include PFC emissions so the actual growth is lower.

Activity data for the industrial sector was based on Trade Statistics, the national industrial license database; and surveys of key industries collected by the Ministry of Energy (MOE, 2012).

Mineral products (i.e., cement production and limestone/dolomite use) accounted for the largest share of industrial process GHG emissions, about 68%; followed by metal production (i.e., iron/steel and aluminum) at about 25% and emissions from the chemical industry (i.e., ammonia production) at roughly 7% of emissions from industrial processes. These shares have remained similar to the shares found in the year 2000 inventory.

2.7. Agriculture

Table 2-4 summarizes GHG emissions associated with agricultural activity in 2005. Relative to overall anthropogenic GHG emissions, the 3,976 Gg CO_2-equivalent represented about 2% of total national emissions.

Table 2-3: GHG emissions from industrial activities, 2005 (Gg)

GHG Source Categories	CO_2-equiv	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	PFCs
All industry emissions	**9,426**	**8,629**	**0**	**0**	**2**	**207**	**37**	**9**	**0.1**
Industrial Processes	8,629	8,629	0	0	2	207	37	9	0.1
A Mineral Products	6,406	6,406	0	0	0	0	24	3	0
B Chemical Industry	656	656	0	0	0	3	2	0	0
C Metal Production	2,364	1,567	0	0	2	204	0	6	0.1
D Other Production	0	0	0	0	0	0	11	0	0
E Production of Halocarbons and Sulphur Hexafluoride	0	0	0	0	0	0	0	0	0
F Consumption of Halocarbons and Sulphur Hexafluoride	0	0	0	0	0	0	0	0	0
Total Solvent and Other Product Use	0	0	0	0	0	0	0	0	0
A Paint Application	0	0	0	0	0	0	0	0	0
B Degreasing and Dry Cleaning	0	0	0	0	0	0	0	0	0
C Chemical Products, Manufacture and Processing	0	0	0	0	0	0	0	0	0
D Other	0	0	0	0	0	0	0	0	0

Table 2-4: GHG emissions from agricultural activities, 2005 (Gg)

GHG Source Categories	CO_2-equiv	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
All agriculture emissions	**3,976**	**0**	**75**	**7.8**	**0**	**0**	**0**
A Enteric Fermentation	1,528	NA	73	0.0	0	0	0
B Manure Management	438	NA	2	1.3	0	0	0
C Rice Cultivation	0	NA	0	0.0	0	0	0
D Agricultural Soils	2,011	NA	0	6.5	0	0	0
E Prescribed Burning of Savannas	0	NA	0	0.0	0	0	0
F Field Burning of Agricultural Residues	0	NA	0	0.0	0	0	0

These levels are roughly 9% lower than the year 2000 levels. This is equivalent to about -2%/year. Most of the reduction in GHG emission levels can be explained by a dramatic reduction in the area of cultivated soils; from 256,000 in 2000 to only 45,000 hectares in 2005, a reduction which also led to decreased application of synthetic fertilizers. As a result, direct and indirect N_2O emissions decreased substantially in the UAE over the 5-year period.

Activity data was based on national livestock statistics and census information and expert judgment by specialists in the Industrial Development Authority and the General Directorates of respective emirates. All such data was compiled and synthesized by the Ministry of Energy (MOE, 2012).

On a CO_2–equivalent basis, the majority of emissions from agriculture are associated with nitrous oxide emissions from agricultural soils (51%), followed by methane emitted during the livestock enteric fermentation process (about 38%). Emissions from manure management of poultry, camels, sheep, goats, cattle, and other livestock account for 11% of agricultural GHG emissions.

2.8. Land Use, Land Use Change and Forestry

Table 2-5 summarizes GHG emissions associated with land use, land use change and forestry in 2005. The 13,233 Gg CO_2-equivalent sequestered through managed plantations was roughly 8% of the UAE's overall anthropogenic GHG emissions.

Sequestered carbon dioxide levels are roughly 37% higher than the year 2000 levels. This is equivalent to a growth rate of about 6%/year. Most of the increase in these GHG sink levels can be explained by the continued expansion in the managed tree plantations in green parks and green areas.

Annual activity data was compiled from a mixture of sources including annual land use management assessments available from the General Directorates of respective emirates. All such data was compiled and synthesized by the Ministry of Energy (MOE, 2012).

The prominence of carbon sequestration in the national GHG inventory reflects a long-

Table 2-5: GHG emissions from LULUCF activities, 2005 (Gg)

GHG Source Categories	CO_2-equiv	CO_2	CH_4	N_2O	NO_x	CO
All LULUCF emissions	**-13,223**	**-13,223**	**0**	**0**	**0**	**0**
A Changes in Forest & Other Woody Biomass Stocks	-13,223	-13,223	0	0	0	0
B Forest and Grassland Conversion	0	0	0	0	0	0
C Abandonment of Managed Lands	0	0	0	0	0	0
D CO2 Emissions and Removals from Soil	0	0	0	0	0	0
E Other	0	0	0	0	0	0

standing national vision to continually expand and maintain the green parks and planted forest areas. This is particularly noteworthy in the Abu Dhabi emirate where efforts are continually made to turn arid desert into green areas, reflecting the vision of the late Sheikh Zayed bin Sultan Al Nahyan. Total government-managed green areas accounted for about 577,000 hectares in the UAE in 2005, of which nearly 400,000 hectares have been planted within the Abu Dhabi emirate.

2.9. Waste

Table 2-6 summarizes GHG emissions associated with waste management activity in 2005. Relative to overall anthropogenic GHG emissions, the 7,122 Gg CO_2-equivalent represented about 4% of total national emissions.

These levels are significantly higher than the year 2000 levels, by nearly three times. Most of the increase in GHG emission levels can be explained by a dramatic increase in the reported amounts of municipal solid waste (MSW) sent to solid waste disposal sites. This is particularly true for the Dubai and Abu Dhabi emirates, which reported a combined 1.4 million tonnes in 2000 sent to solid waste sites and about 4.6 million tones in 2005.

Sources for waste management data included expert judgment regarding municipal solid waste management in the UAE, published literature on population from the Ministry of Planning, and available data from waste treatment plants (El Shaer, 2011).

There are two main sources of greenhouse gases within the UAE's waste sector. Solid waste disposal on land accounted for 89% of total waste-related emissions. Eight cities (i.e., Dubai, Sharjah, Abu Dhabi, Al Ain, Fujairah, Ras El Khaimah, Um Al-Qwain, and Ajman) are included in the inventory. Domestic and commercial wastewater handling accounted for the remaining 11% of total waste-related emissions. These emissions are associated with the only three cities in the UAE that have centralized domestic and commercial sewage treatment facilities; Abu Dhabi, Dubai, Sharjah. There was no sewage treatment in other cities in 2005, with the wastewater directly dumped into anaerobic lagoons in the desert.

2.1. Emissions summary by type

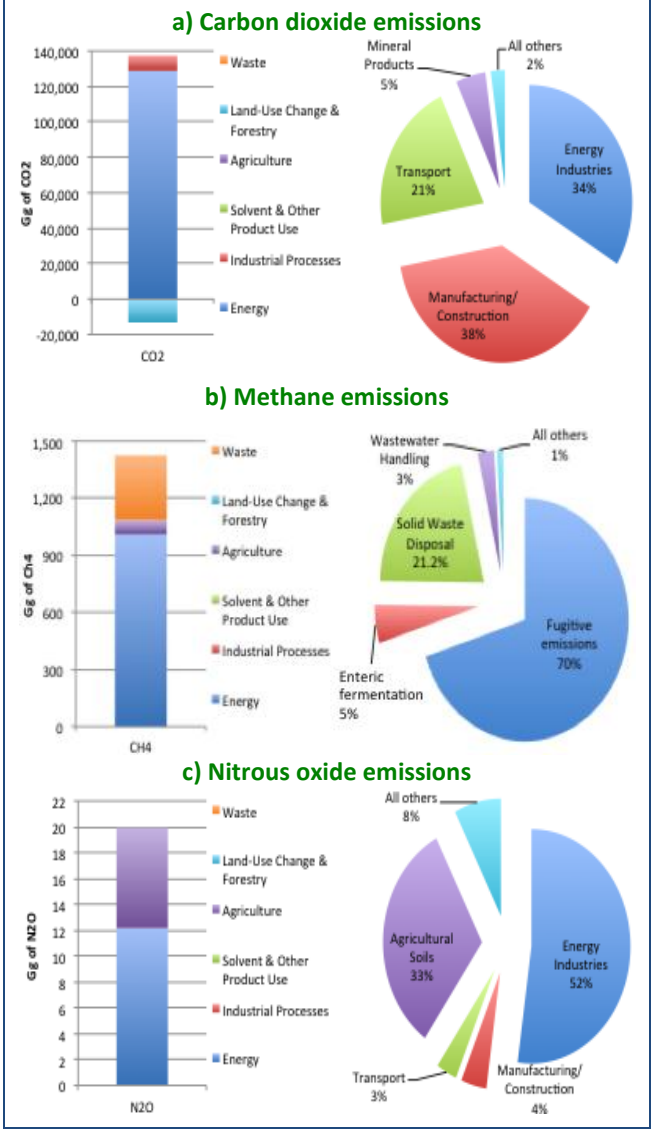
The following bullets provide an overview of GHG emission totals by all GHG types for the year 2005.

- *CO_2:* Net CO_2 emissions were estimated to be 124,230 Gg, or 77.1% of the UAE's total greenhouse emissions in the year 2005. Figure 2-5a summarizes the contribution associated with CO_2 emissions at both the sector and activity levels.
- *CH_4:* Methane had the second largest share of greenhouse gas emissions. Total and net CH_4 emissions were estimated to be about 1,425 Gg, or about 18.6% of the UAE's total greenhouse emissions on a CO_2e basis. Figure 2-5b summarizes the contribution associated with CH_4 emissions at both the sector and activity levels.
- *N_2O.* Nitrous oxide emissions were very small compared to other GHGs. Total and net N_2O emissions were estimated to

Table 2-6: GHG emissions from waste management activities, 2005 (Gg)

GHG Source Categories	CO_2-equiv	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
All waste emissions	**7,122**	**0**	**339**	**0.0**	**0.0**	**0.0**	**0.0**
A Solid Waste Disposal on Land	6,356	0	303	0.0	0.0	0.0	0.0
B Wastewater Handling	766	0	36	0.0	0.0	0.0	0.0
C Waste Incineration	0	0	0	0.0	0.0	0.0	0.0
D Other (please specify)	0	0	0	0.0	0.0	0.0	0.0

Figure 2-5: Breakdown in GHG emissions, 2005 (Gg)



be only about 19.9 Gg, or about 3.8% of the UAE's total greenhouse emissions on a CO_2e basis. Figure 2-5c summarizes the contribution associated with N_2O emissions at both the sector and activity levels.

2.10. Emissions of HFCs, and SF_6

According to the Revised IPCC Guidelines, the major emission sources of HFCs, and SF_6 these gases are the following activities: replacement of ozone-depleting substances; HCFC-22 production; electric power transmission; production of semiconductors; and production and processing of magnesium. As when the Second National Communication (SNC) was prepared, only the third activity occurred in the UAE at the time of the inventory development for the TNC (power transmission). HFCs were still not produced or imported/consumed as substitutes for ozone depleting substances in refrigeration and fire extinguishers because ozone-depleting substances were not banned in the UAE in 2005. The estimation of SF_6 emissions associated with electric power transmission proved to be a significant challenge due to data constraints and was assumed to be negligible.

2.11. Uncertainty Assessment

An uncertainty assessment was considered to be an essential element of the GHG emission inventory update to help prioritize efforts to improve the accuracy of future inventories. For the TNC, the same methodology was used to prepare the inventory as was used in the SNC. Therefore, to a large extent, the same uncertainties that were discovered then are still currently relevant.

In the UAE, uncertainties continue to be associated with data access/constraints, potential unsuitability of generic emission factors, and an incomplete understanding of the processes associated with emissions. Some of the current estimates, such as those for CO_2 emissions from energy-related activities and cement processing are considered to have minimal uncertainty associated with them. For some other categories of emissions such as animal production and commercial forest harvest, however, a lack of information increases the uncertainty surrounding the estimates presented. Nevertheless, since energy activities accounted for about 89% of the overall GHG emissions in 2005, uncertainty of the overall GHG inventory is considered to be low.

Table 2-7 summarizes the uncertainty assessment for the UAE GHG inventory. Based on expert judgment of specialists participating in the development of the inventory, the confidence in the results for each source/sink category was evaluated relative to the uncertainty associated with data quality and emission factor suitability.

Table 2-7: Uncertainty assessment associated with the UAE GHG inventory, 2005

Sector	Activity	Uncertainty		Confidence in Inventory
		emission factor	data quality	
Energy	Public Electricity and Heat Production	low uncertainty	good quality	High
	Domestic Aviation	low uncertainty	medium quality	medium
	Road transport	low uncertainty	medium quality	medium
	Commercial/Institutional	low uncertainty	medium quality	medium
	Residential	low uncertainty	medium quality	medium
	Agriculture/Forestry/Fishing	low uncertainty	medium quality	medium
	International aviation (bunkers)	low uncertainty	medium quality	medium
Industrial processes	Cement production	low uncertainty	good quality	High
	Lime production	medium uncertainty	good quality	medium
	Limestone and Dolomite Use	medium uncertainty	good quality	medium
	Iron/steel production	medium uncertainty	good quality	medium
	Ammonia Production	medium uncertainty	good quality	medium
	Aluminum production	medium uncertainty	good quality	medium
Agriculture	Enteric fermentation	medium uncertainty	good quality	Medium
	Manure management	medium uncertainty	medium quality	Medium
	Agricultural Soils	medium uncertainty	poor quality	Low
LULUCF	Changes in Forest and Other Woody Biomass Stocks	medium uncertainty	medium quality	medium
Waste	CH4 emissions from SWD sites	medium uncertainty	poor quality	low
	CH4 emission from Domestic and Commercial Waste water	medium uncertainty	medium quality	Medium
	N2O emissions from human waste	medium uncertainty	good quality	Medium

Less than 10% uncertainty was considered to be low; uncertainty between 10% and 50% was considered medium; and uncertainty greater than 50% was considered high.

Attention to two areas could help reduce uncertainty in the UAE GHG inventory. First, enhancing the availability of detailed and high quality activity data will increase confidence in the inventory results. Although adequate methodologies have been developed to estimate emissions for some sources, problems persist in obtaining activity data at a level of detail in which aggregate emission factors can be applied. Addressing these areas through additional capacity strengthening and development of dedicated observation networks will enhance the quality and accuracy of future emission inventories. Steps are being undertaken with the GHG Emissions Inventory Project launched by the EAD in 2011 to compile, in coordination with all local institutions, a systematic database on greenhouse gas emissions for the Emirate of Abu Dhabi that can be relied upon for future inventory updates.

Second, improving the accuracy of emission factors to calculate emissions from a variety of sources is vital. Most emission factors noted in the above table are classified as having medium uncertainty. For example, the accuracy of current emission factors for enteric fermentation by animals at low altitude and subject to high temperatures throughout the year remains uncertain in the absence of local sampling and testing activities.

Finally, improving the methodology by which managed biomass plantations are accounted for in the inventory is essential. Currently, the quantification template does not readily allow for the incorporation of shrubs into the inventory, hence leading to underestimates of the likely amount of carbon sequestered by the UAE's many urban parks.

2.12. List of References

Al Shaer, H., 2011. *Estimates for Year 2005 & 2010 - Module 6: Waste Sector*

Al Tamimi, Y. K. and Sharif, A. O., 2011. *Greenhouse Gases Inventories – Energy Sector,* 3rd National Communication Report for the year 2005, Draft Report, December.

Ministry of Energy (MOE), 2012. *Internal statistical reports and compilations for the GHG inventory for the Third National Communication,* UAE.

UAE, 2006. Initial National Communications, MOE (available at http://unfccc.int/resource/docs/natc/arenc1.pdf).

UAE, 2010. Second National Communications, MOE (available at http://unfccc.int/resource/docs/natc/arenc2.pdf).

Chapter 3: Vulnerability & Adaptation

3.1. Introduction

There are many levels at which the UAE is concerned about climate change. Already subject to extreme climatic conditions that will likely become only more extreme, there is growing awareness in the seven emirates of the potential consequences of climate change. Even small long-term variations in temperature and precipitation could have adverse effects on productive activities due to the fragile nature of the country's precious natural resources and interconnectivity with regional and global economic activity (EAD, 2009).

What has emerged from past and current work is a framework by which to understand climate change vulnerability and adaptation challenges. Specifically, there have been five (5) priority areas that have emerged in which there exists a growing consensus about their vulnerability to climate change. These priority areas are regional climatic change, environmental systems, water resources, coastal zones, and socioeconomic sectors.

Future work will focus on achieving a better understanding of the magnitude of the future climatic changes and their potentially adverse impacts, together with the new frameworks needed to ensure that effective adaptation is central in policy/planning decisions in the UAE. Such efforts are already underway with results projected to be available within the next several years. The subsections below provide a broad overview of the vulnerability and adaptation research programme underway.

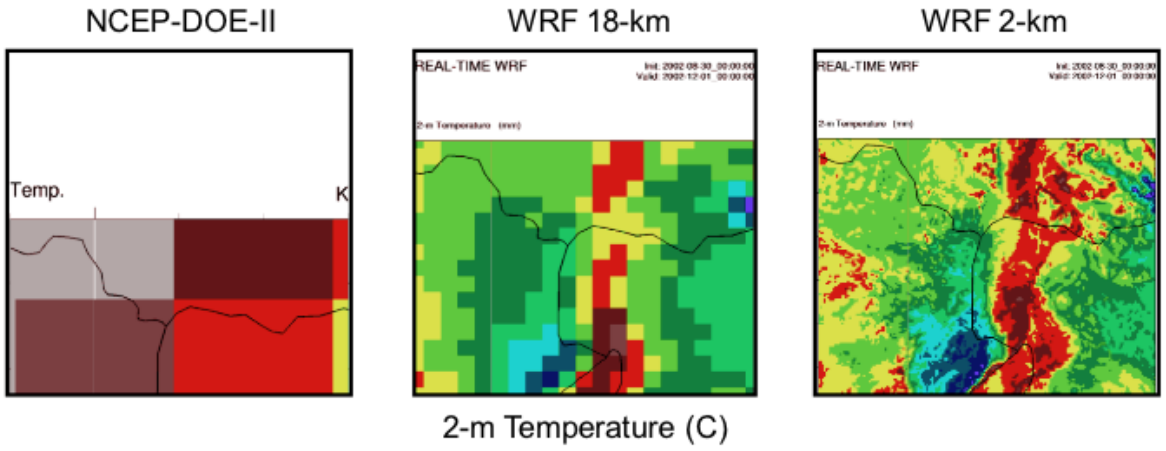
3.2. Regional Climate Change

In the UAE, the current understanding of climate change for the Arabian Gulf region is based on the outputs of coarse-resolution atmosphere-ocean general circulation models that do not provide a representative description of *regional* climate change. Regional climatic modeling of atmospheric and oceanographic conditions is in initial planning stages in the UAE. Such modeling efforts will strengthen understanding of how climate change will unfold in the Arabian Peninsula. Once completed, these studies will provide a fundamental starting point for the range of vulnerability assessments of potentially sensitive systems and sectors.

For the atmosphere, regional climate modeling efforts will be able to represent climate change on a smaller scale by accounting for local topography, land use, coastlines, and vegetation characteristics. Using the Weather Research and Forecasting (WRF) model, it will be possible to provide a more accurate regional picture of future changes in temperature, precipitation, humidity, and wind patterns for the Arabian Peninsula region.

Figure 3-1 shows an example of the increasing clarity in temperature that can be achieved over NOAA's NCEP-DOE

Figure 3-1: Simulated near-surface air temperature for three different model datasets over the mountainous border region of Uganda, Congo, and South Sudan (source: Yates and Monaghan, 2012)



Reanalysis-2 by using the WRF model at 18-km and 2-km resolution. Given the greater availability and quality of regional meteorological data, the modeling framework and data necessary to perform first-pass regional climate modeling in the Arabian Peninsula are now in place.

For oceans, regional climatic modeling will enhance the understanding of how Arabian Gulf waters will be affected by increasing GHG concentrations. The current understanding of climate change for the Arabian Gulf is also based on the outputs of coarse-resolution atmosphere-ocean general circulation models that do not provide an adequate description of biophysical changes within Gulf waters themselves.

Using the Regional Ocean Modeling Systems (ROMS) model, it will be possible to better represent local oceanographic conditions on a smaller scale by accounting for local bathymetry, tidal responses, wind speed/direction, sea surface temperatures, and evaporation rates. The use of such models will benefit both the UAE and the other Arabian Gulf countries.

While research and data are available on current/past Arabian Gulf conditions, there has not yet been any research regarding the future conditions of the Gulf due to climate change. Once completed, will provide a fundamental starting point for national vulnerability assessments focusing on the marine environment.

3.3. Environment

The potential loss of terrestrial and marine biodiversity under climate change is a major concern in the UAE and across the region. The Arabian Peninsula/Gulf is a meeting point between the Indo-Asian and the Afro-European regions and enjoys a rich biodiversity in a hyper arid environment.

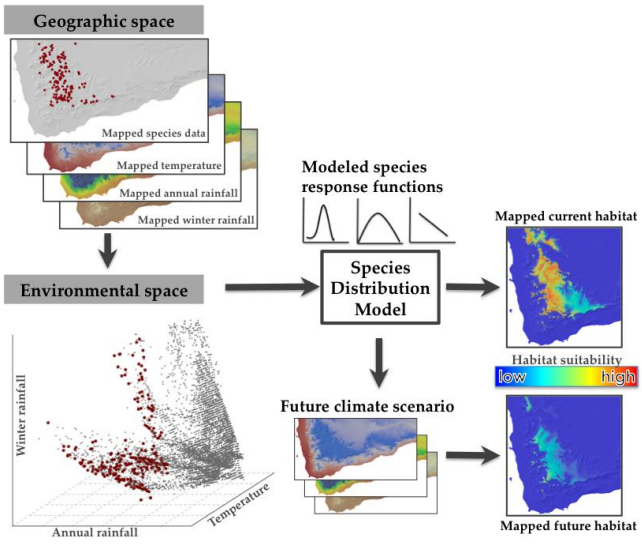
For the terrestrial environment, the Arabian Peninsula has dozens of mammal species, hundreds of bird species, and scores of amphibian and reptile species. For the marine environment, the Arabian Gulf's relative shallowness supports a number of highly productive coastal habitats, including intertidal mudflats, seagrasses, algal beds, mangroves, and coral reefs, together with a wide variety of fish species, some of which are endangered. With climate change, some species such as migratory birds and dugongs may be adversely affected. To date, the region has not undertaken an assessment of the potential for loss of biodiversity due to climate change.

For the terrestrial environment, a quantitative assessment is in the planning stages to explore the vulnerability of key terrestrial species and ecosystems to long-term changes in temperature and

precipitation for the Arabian Peninsula region. This assessment will improve the understanding of what climate change means for the region's unique biodiversity. Over the last decade, methods for modeling the potential responses of species to climate change have advanced considerably while at the same time, the availability of geo-referenced species occurrence data and datasets describing current and future environmental conditions have increased dramatically. Using a Species Distribution Model (SDM) framework and a range of climate change scenarios, the assessment will explore the vulnerability of priority species, ecosystems, and patterns of terrestrial biodiversity. An overview of the modeling process to be used is illustrated in Figure 3-2. Once completed, the study will be able to inform adaptation strategies such as cooperative frameworks to protection key migration pathways.

For the marine environment, a quantitative assessment in the planning stages to examine the vulnerability of marine ecosystems and fisheries to long-term physical, chemical and biological changes is for the Arabian Gulf. Previously published results of global-scale modeling analyses show that climate change may result in a high rate of local extinction and a large reduction in maximum fisheries catch potential in the Gulf region. Climate change is expected to alter ocean conditions in the Arabian Gulf region including changes in sea surface temperature, salinity, oxygen levels, acidity and primary productivity. Using the Dynamic Bioclimate Envelope Model (DBEM), to explore the impact of these changes on changes in fish species' distribution and maximum fisheries catch potential.

Figure 3-2: Overview of the terrestrial species distribution modeling process (source: Fitzpatrick, 2012)



3.4. Water

The UAE will likely be adversely affected by changes in future rainfall patterns, surface runoff quantities, and groundwater recharge patterns. Ensuring adequate future supplies of desalinated water in the context of rapid socioeconomic growth is a high priority national policy concern. Also, while climate change is unlikely to affect fossil groundwater resources, there are local areas that rely on groundwater recharge for a significant portion of their water supply; at a regional scale, this includes several countries north of the UAE that rely on transboundary groundwater under threat from seawater intrusion from rising sea levels.

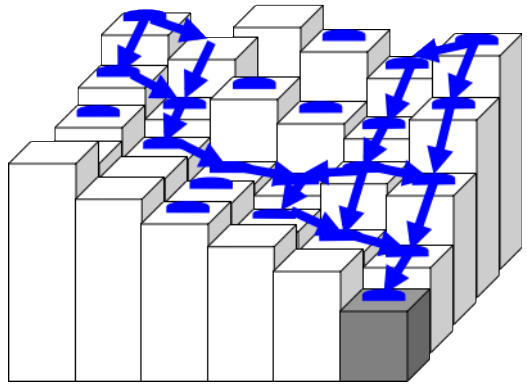
Water is very much a cross-cutting planning issue, with implications for agriculture, human health, coastal zones, energy, and infrastructure, as well as its essential role in ecosystems and sustaining life. To better inform national water supply and demand management under climate change, a quantitative national-level assessment is in the planning stages to assess the vulnerability of the UAE's range of water resources to long-term regional climate change and socioeconomic growth. Using the Water Evaluation And Planning (WEAP) model, the effects of multiple combinations and water supply/demand and climate change scenarios will be explored. Once completed, the study will be able to identify specific management strategies that can increase the

resilience of the UAE's water resources to long-term climate change and socioeconomic development.

For local rechargeable groundwater resources, a quantitative assessment is in the planning stages to better understand the vulnerability to long-term climate change of one of the UAE's only regions with a renewable water supply, the area around Al Ain along the Hajar Mountains. With climate change, rainfall patterns in the Hajar Mountains, which annually recharge groundwater levels in the Al Ain region, could be adversely affected, leading to a gradual decline in aquifer productivity and raising long-term sustainability concerns for the region.

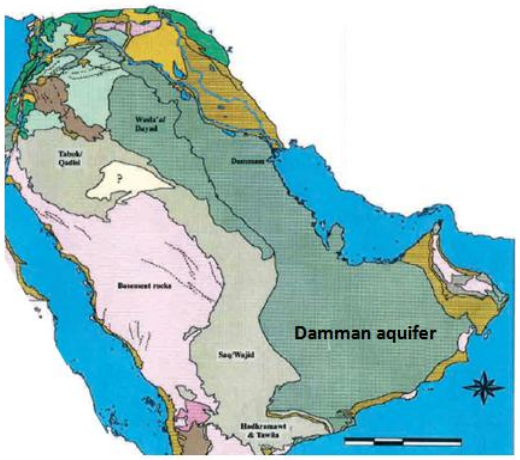
Using outputs from the regional climate modeling component, the study will use the NOAA land surface model which is capable of modeling overland surface water flow (see Figure 3-3) to explore sustainable water resource management strategies in Al Ain relative to a set of regional climate change and socioeconomic development scenarios. Once completed, there should be specific management strategies identified that can enhance long-term sustainability and resilience to climate change in the area.

Figure 3-4: Illustrative modeling of overland surface water flow with the NOAH-distributed modeling system (Gochis and Chen, 2003)



For regional transboundary groundwater resources, a quantitative assessment is in the planning stage to better understand the vulnerability of the Arabian Peninsula's shared, transboundary groundwater resources due to sea level rise associated with long-term climate change and socioeconomic growth. At present, the Dammam aquifer (see Figure 3-4), the main groundwater resource that is shared by all countries bordering the Arabian Gulf, is already characterized by unsustainable groundwater use, which over the past decades has contributed to increasing salt-water intrusion and water quality challenges.

Figure 3-3: Spatial domain for climate change impact study on Damman aquifer (UNESCO, 2009)

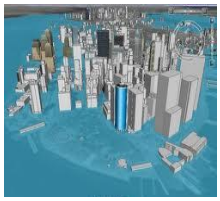


With climate change, sea levels are projected to rise in the Arabian Gulf further exacerbating the potential for saltwater intrusion into the aquifer. In addition, declining rainfall in the mountains of central Saudi Arabia may lead to reduced groundwater recharge levels into the aquifer when compared to historical patterns.

Using a coupled WEAP and MODular finite difference groundwater FLOW (MODFLOW) model, the study will produce a better understanding of how the regional Dammam aquifer will respond to this combination of stresses. This will involve the development of a systematic database that will be useful within the UAE, as well as in the other countries in the region that rely on the Damman aquifer as a crucial water supply source. Once completed, the effort should inform potential adaptation strategies that could be implemented, both within the UAE, as well as potentially within a regional

transboundary groundwater cooperation framework.

3.5. Coastal Zones



Coastal zone impacts are also particularly important due to the concentration of industry, population, and infrastructure in these areas throughout the UAE. Sea-level rise (SLR) could lead to inundation, erosion, and flooding. At present, integrated coastal zone management, though recognized as an important adaptation strategy, is practiced unevenly within Arabian Gulf countries and lacks an effective regulatory framework in most of the countries. It will be important that future shoreline management activities be coordinated as the installation of hard coastal protection in one country may lead to increased erosion in neighboring countries.

At the regional level, a quantitative assessment is in the planning stage to better understand the vulnerability of Arabian Gulf countries due to a long-term rise in sea level from climate change. Like the UAE, much of the region's population, infrastructure and economic activity are located in coastal zones and are vulnerable to climate change–induced sea level rise and potential storm surges that would accompany more frequent extreme weather events. Climate change (and other anthropogenic factors) could be a primary cause for the increasing degradation of such coastal areas leading to an increase in coastal erosion and the inundation of productive lands and infrastructure.

Using GIS modeling techniques, a vulnerability assessment of the inundation extent associated with plausible sea level rise scenarios should produce a better understanding of the specific coastal zones in the region which may be most at risk. Once completed, the effort will inform potential adaptation strategies that could be implemented within a regional cooperation framework.

At the national level, a quantitative assessment is in the planning stage to better understand the near-term vulnerability of coastal zones in the UAE due to sea level rise and other risks. Past studies of climate change impacts along coastal zones in the UAE have been undertaken from a long-term planning perspective.

However, planners today in the UAE are in need of actionable information relevant to their near-term planning horizons with a high-growth development context. Using a "coastal vulnerability index", the effort will aim to provide insights on issues of near-term concern to planners such as the relative risk to existing infrastructure, recommendations for coastal protection priorities, strategic land development offset zones, and potential set-aside areas for future protection. Such studies have yielded actionable results in other settings (see Figure 3-5).

Figure 3-5: Coastal vulnerability index applied to the coast of Andalusia, Spain (Iglesias-Campos *et al.*, 2010)

Once completed, the proposed research will inform potential coastal adaptation strategies that could be implemented within either an existing or enhanced coastal planning framework.

3.6. Socioeconomic Systems

Several other sectors and systems are considered to be potentially highly vulnerable to climate change. These include desalinated water supply, food security, and public health. Climate change could adversely impact salinity levels in the Gulf, and hence the long-term sustainability of desalination activities in the region. Given the already high salinity levels, desalination technologies are already operating near their upper limit of 50 parts per thousand. Regarding food security, the UAE depends on imports for most of its food supply. With rainfall projected to diminish crop yields in many supplier countries, there may be significant food price impacts from constrained food supplies. Finally, adverse health impacts of climate change include thermal stress and air pollution-related diseases, and diseases related to higher ultraviolet radiation of relatively short wavelengths (UV-B) exposure.

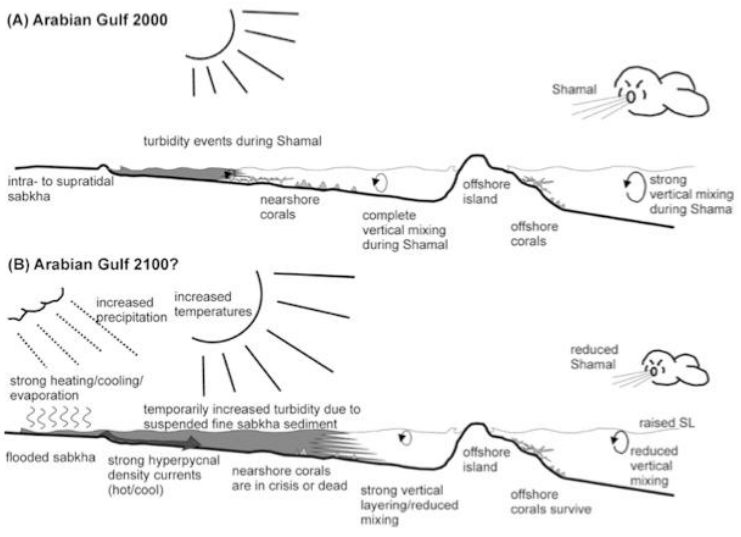
Regarding desalinated water supply, a quantitative assessment is in early planning stages to better understand the impact of business-as-usual practices in seawater desalination and electricity supply relative to the vulnerability of the Arabian Gulf to climate change. The Arabian Gulf is a region of intense desalination activity. Of the 100 largest desalination plants in operation, in construction, or planned as of 2005, 47 plants, accounting for 13.7 million cubic meters per day in production capacity, or 64%, are located in the UAE and other countries bordering the Arabian Gulf (Pacific Institute, 2011).

Most desalination takes place at dual-purpose power stations that are able to co-produce electricity and desalinated water. However, there are significant environmental impacts associated with current business-as-usual practices. Desalination is responsible for discharges of highly saline brine and treatment chemicals directly into the Gulf, causing harm to marine biodiversity. In a fast-growing region with virtually no renewable water resources and rapidly depleting fossil groundwater, desalination is currently considered the only option to meet future water supply requirements.

However, with climate change, the Gulf may become even more saline due to increased evaporation from higher temperatures, reduced vertical circulation due to reduced shamal winds, and increased near-shore salinity due to permanently flooded salt-crusted sabkha areas from sea level rise (see Figure 3-6). These potential impacts combined with the implementation of business-as-usual desalination plans in the small, shallow and slow-circulating Gulf, could lead to an environmental tipping point in which the chemical properties of Gulf waters exceed the coping thresholds of corals, fish species, and other marine life. An integrated assessment of climate change, desalinated water production, and electricity generation can be used to develop alternative plans that can reduced desalination impacts to Gulf waters.

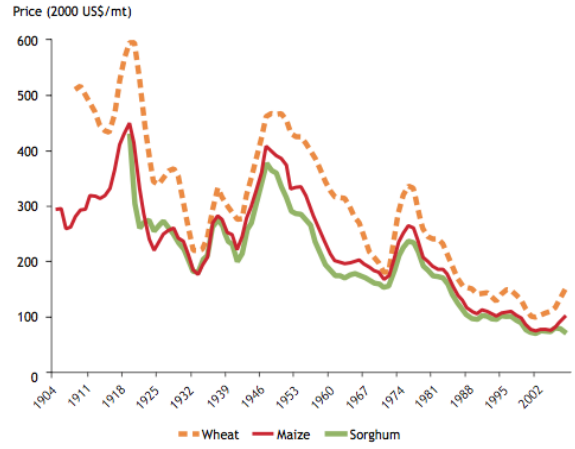
Regarding food security, a quantitative assessment is in early planning stages

Figure 3-6: Anticipated effects of climate change on Arabian Gulf corals (Riegl, 2003)



proposed to better understand the impact of climate change on long-term food price shocks to the UAE. Historically, food prices have spiked from time to time (see Figure 3-7), leading to social hardship. The recent global food crisis of 2008, with its price spikes and subsequent unrest in several countries, represents an important challenge to the development of food security plans capable of contributing to human well-being and social harmony.

Figure 3-7: Prices of selected US farm commodities, 1904-2006 (5-year moving average, constant $2000 per metric tonne (Nelson *et al.*, 2010)



Even without the additional threat posed by climate change, the global food crisis exposed interlinked vulnerabilities associated with agricultural productivity, international trade markets, and food commodity prices. With climate change, current challenges of soil destruction, inadequate water supply, and stagnant mono-cultured crop yields will likely be seriously exacerbated, leading to reduced crop productivity in food-exporting countries, steady increases in food prices, and increased food insecurity around the world.

The UAE, a country that is heavily dependent on food imports, is particularly vulnerable. An integrated adaptation assessment that accounts for climate change impacts on agriculture, international food trade, and economic livelihoods can help to identify potential options to increase long-term food security under climate change.

Regarding public health, a quantitative assessment is in early planning stages to better understand the beneficial impact on public health from efforts to reduce greenhouse gas emissions in the Abu Dhabi emirate. Several notable initiatives have been underway to reduce the carbon footprint of energy consuming activities in Abu Dhabi (see Chapter 4). While many of these initiatives have attempted to quantify the reduction in greenhouse gas emissions, to date there has not been a comprehensive assessment of the positive impacts that such measures can have on public health. An improvement in public health is considered a "co-benefit" of GHG mitigation, which is not typically accounted for in the cost of saved carbon.

With continued progress in the UAE to expand and intensify GHG-reducing activities, particularly in the energy and transport sectors where the majority of potential GHG reductions exist, these public health co-benefits will likewise increase. An improved understanding the public health benefits of current measures can help to leverage policymaker support for continued investments, while also promoting public awareness of the benefits of sustainable development practices. An integrated assessment that accounts for the public health co-benefits associated with initiatives in the power supply and transportation sectors offers a basis for more comprehensive accounting of the broader scope of benefits associated with GHG mitigation initiatives.

3.7. List of References

EAD, 2009. "Climate Change Impacts, Vulnerability and Adaptation, Abu Dhabi environment Agency.

Fitzpatrick, M., 2012. "Assessment of Climate Change Impacts on Key Terrestrial Ecosystems and Species in the Arabian Gulf Countries", Technical Concept Note prepared for the Phase II Work Programme on Climate Change Vulnerability and Adaptation, EAD.

Gochis, D.J. and F. Chen, 2003. "Hydrological enhancements to the community Noah land surface model", NCAR Technical Note, NCAR/TN-454+STR, 68 pgs.

Iglesias-Campos, A., Simon-Colina, A., Fraile-Jurado, P. and Hodgson, N., 2010. "Methods for assessing current and future coastal vulnerability to climate change", ETC/ACC Technical Paper 2010/8, available at http://acm.eionet.europa.eu/docs/ETC_ACC_TP_2010_8_Coastal_vuln_methods.pdf

Nelson, G., Rosegrant, M., Palazzo, A., Gray, I., Ingersoll, C., Robertson, R., Tokgoz, S., Zhu, T.,. Sulser, T., Ringler, C., Msangi, S. and You, L., 2010. "Food Security, Farming, and Climate Change to 2050: Scenarios, Results, Policy Options", International Food Policy Research Institute.

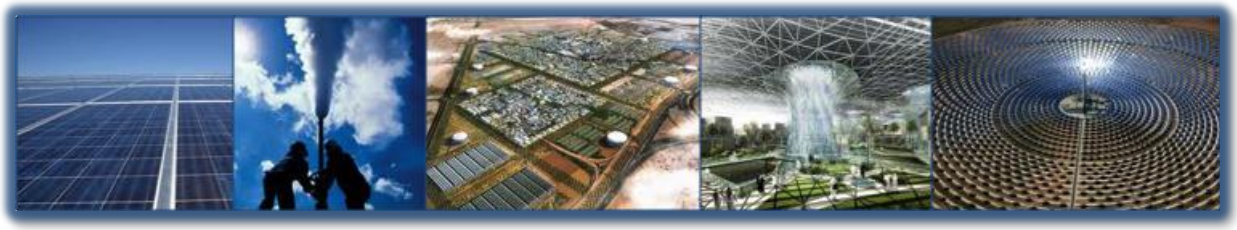
Pacific Institute, 2011. The World's Water, Volume 7 (available at http://www.worldwater.org/)

Riegl, B., 2003. "Climate Change and coral reefs: different Effects in Two High-Latitude areas (Arabian Gulf, South Africa)", Coral Reefs, 22:433-446.

UNESCO, 2009. "Atlas of Transboundary Aquifers: Global Maps, Regional Cooperation and Local Inventories, ISARM Programme.

Yates, D. and Monaghan, A., 2012. "Regional Climate Modeling for the Arabian Gulf region- Future Scenarios and Capacity Building", Technical Concept Note prepared for the Phase II Work Programme on Climate Change Vulnerability and Adaptation, EAD.

Chapter 4: Greenhouse Gas Mitigation



4.1. Introduction

The UAE is now playing a major role in GHG mitigation at every level. Voluntary domestic policies and investment decisions are driving the rollout of clean energy technologies throughout the country. New intellectual property is being developed within the country in clean energy options such as carbon capture and storage (CCS). Moreover, UAE institutions are investing in clean energy abroad through aid programmes to developing countries for renewable energy and efficiency activities.

4.2. Mitigation policy initiatives

In 2012, His Highness Sheikh Mohammed bin Rashin Al Maktoum, Prime Minister and Vice-President of the UAE and Ruler of Dubai, announced the UAE's Green Growth strategy, the first of its kind in the Middle East, which puts greenhouse gas mitigation at its core through a reaffirmation of existing green growth programmes and proposed measures that focus on energy decarbonization. Box 4-1 provides an overview of the UAE's Green Growth Strategy.

It is important to stress that UAE initiatives to reduce GHG emissions are proceeding on a violuntary basis. The UAE wishes to reserve the option to pursue its rights as an oil-exporting country within the relevant articles of the UNFCCC regarding financial assistance relative to response measures undertaken by Annex I countries.

Box 4-1: UAE's Green Growth development strategy

Green Energy

- Promote renewable energy and related technologies
- Promote clean fuels for energy production
- Promote energy efficiency standards for public/private sectors

Green investment

- Develop policies to encourage green investments
- Facilitate the production, import and export and re-export of products and green technologies
- Build capacity building and create employment opportunities in all fields related to green economy

Green cities

- Develop urban planning policies aimed at environmental preservation
- Improve building efficiency from an environmental perspective
- Encourage sustainable transport
- Improve urban indoor air quality

Climate Change

- Develop policies/programs to reduce carbon emissions from industry and commerce
- Promote organic farming with federal/local incentives
- Conserve biologic diversity and protect the terrestrial and marine ecological balance

Green Living

- Save water, electricity and natural resources
- Implement waste recycling projects
- Enhance public awareness to raise participation in green economy initiatives

Green technologies

- Develop and implement carbon capture and storage technologies
- Introduce waste-to-energy facilities
- Disseminate energy-efficient technologies

4.2.1. Energy supply

Energy issues are mainly the prerogative of individual emirates, and most targets and policies that affect GHG emissions are set at the emirate rather than the federal level. Three major types of options have been progressing within the UAE, as briefly summarized below.

Renewable Energy

The emirate of Abu Dhabi has set a target for renewable energy to account for 7% of electricity generation capacity by 2020. In support of this policy, several major actions are underway in the emirate, as briefly described in the bullets below:

- *Concentrating solar power:* The first industrial scale solar power plant in the region, the 100 MW Shams 1 plant is due to open at the end of 2012. Shams 1 is a concentrating solar plant using parabolic trough technology.
- *Solar Photovoltaics:* The next major plant, Noor 1, will be a PV array of approximately 100 MW. This is the first phase of a 300MW solar park located close to Al Ain.
- *Wind:* A 28 MW Wind Power project on Sir Bani Yas Island is nearing approval. The UAE has comparatively limited wind resources but is assessing additional possibilities for commercially viable projects.
- *Waste-to-energy:* A technical feasibility studies for a 100 MW waste-to-energy plant by 2016 are currently underway.

As part of its Integrated Energy Strategy 2030, the emirate of Dubai has set a target of producing 1% of its electricity from renewable energy by 2020, a level rising to 5% by 2030. Dubai has also mandated that new buildings have solar hot water systems installed that are capable of meeting 75% of hot water needs.

A major component of Dubai's plan to diversify its energy sources is the planned 1,000 MW Mohamed Bin Rashed Al Maktoum Solar Park (see Figure 4-1). Work has started on an initial 10 MW PV field of the solar park. A technical study on the effectiveness of a feed-in tariff for promoting distributed generation is nearing completion.

Finally, the emirate of Sharjah is undertaking a technical feasibility study for a waste-to-energy facility, while power generation in some of the northern emirates are making use of highly efficient combined cycle technology.

At the federal level, the UAE is active in characterizing the solar and wind energy resource base in the country. Funding is provided by the Ministry of Foreign Affairs (MOFA), the Dubai Supreme Council of Energy, the Environment Agency of Abu Dhabi (EAD), and the French energy company Total. The Masdar Institute is one of the ley local organizations involved in the effort.

For solar energy, a solar resource atlas is currently being developed to identify the highest-quality, lowest-cost sites for future solar energy projects in the country. For wind energy, the first edition of a wind atlas is scheduled for completion by late 2012. Once completed, both the solar and wind atlas will be publicly available through access to the International Renewable Energy Agency's website.

Nuclear Power

Figure 4-1: Model plan of the future 1,000 MW Mohamed Bin Rashed Al Maktoum Solar Park in Dubai

Construction began in 2012 of the first of four nuclear reactors to be built in the Emirate of Abu Dhabi. Operation is currently planned for 2020.

Under a US$ 20 billion contract with Korea Electric Power Corporation, the station will have a capacity of 5.6 GW and account for roughly 20% of power supply in the UAE, reducing the power sector's carbon footprint by 20% as well.

The UAE government and the Emirates Nuclear Energy Corporation (ENEC) continue to partner with the International Atomic Energy Agency and leading nuclear experts to ensure the highest safety and environmental standards. ENEC also regularly engages with the local community in Abu Dhabi to address their questions and solicit their input on development plans.

Oil and Gas

As described in section 1.9, the UAE is one of the world's major hydrocarbon producers. The UAE has had a "zero flaring" policy for many years. Gas flaring is not permitted unless capture is technically infeasible. As a result, gas flaring today represents less than 1% of the UAE's gross gas production.

4.2.2. Energy demand

The emirate of Dubai has set a goal of reducing total energy consumption by 30% by 2030, with a corresponding fall in its carbon footprint. To this end, a new tariff policy for water and electricity was introduced in Dubai in 2011 that reduced subsidies in order to encourage energy-efficient consumer behavior, with consumption declines already evident.

The Al Basama Al Beeiya (i.e., "ecological footprint" in Arabic) Initiative was launched in October 2007. The aim of this national effort is to better understand the country's ecological footprint, including its GHG emissions. The initiative involves multiple stakeholders across the UAE and consists of data collection, quantitative and qualitative analysis, assessment of UAE data used nationally/internationally, and research into the methodology of measuring the ecological footprint.

Buildings

In 2010, the emirate of Abu Dhabi implemented mandatory minimum efficiency standards for all new residential and commercial buildings through the Estidama Pearl Rating System. The minimum standard (Pearl 1) improves building efficiency by 30-35% efficiency vs. the existing baseline. Higher mandatory standards (Pearl 2) were set for public buildings. The system also sets what are effectively mandatory energy efficiency standards for public spaces and systems in planned developments, including mixed-use zoning, shading, and public transport links.

Saadiyat Island, Abu Dhabi's flagship development expected to be completed in 2020, which will host the Louvre and Guggenheim museums, and hundreds of thousands of residents, will conform to the highest standards in the Estidama System. (see Figure 4-2) .

The Estidama rating system also includes a monitoring and verification component. All approved buildings and communities are subject to evaluation by government-accredited inspectors throughout their lifetime to ensure that they are being

Figure 4-2: Saadiyat Island, a development project in Abu Dhabi adhering to the highest energy efficiency standards (source: http://www.saadiyat.ae)

operated according to approved specifications. Voluntary standards for existing buildings are currently under study.

The Emirates Green Building Council (EmiratesGBC) was formed in 2006, with the goal of advancing green building principles for protecting the environment and ensuring sustainability in the United Arab Emirates. In the emirate of Dubai, Green Building Regulations for new construction were introduced in 2010. These regulations will become mandatory in 2014.

Appliances

In the UAE's hot climate, cooling applications account for as much as two thirds of electricity consumption. In 2012, the UAE became the first country in the region to apply mandatory efficiency standards for air conditioning.

These new standards, implemented by the Emirates Standards and Metrology Authority (ESMA), remove roughly the lowest-performing 20% of air conditioning models from the UAE market. For other models, a 5-level labeling system has been introduced, with a financial incentives applied to higher standards to encourage rapid stock turnover. Planning is underway to eventually bring additional appliances under minimum efficiency standards.

Smart Grids

To date, 506,000 digital water and electricity meters have been installed in the Abu Dhabi Distribution Company's (ADDC) area of operations that cover Abu Dhabi Island and the Western Region. An additional 180,000 meters have been installed in Al Ain and Eastern region served by AADC. Together, this represents about 90% of the total meters in the emirate. The remaining 10% of analogue meters are located in older buildings that are expected to be replaced soon, or in buildings that pose difficult conditions for replacement.

By the end of October 2012, roughly 400,000 meters, or 52% of the total meter stock throughout the emirate, will be linked to the Meter Data Management System and provide daily electricity and water consumption data. This provides the Abu Dhabi Water and Electricity Authority (ADWEA), the largest utility in the UAE, the capability to capture and analyze consumption data at time intervals as low as every 15 minutes and to use such data for evaluating the effectiveness of new demand-side-management initiatives.

In November 2010, the Dubai Electricity and Water Authority (DEWA) launched a 10,000 smart meter pilot program to assess the challenges and parameters associated with widespread diffusion of advanced metering infrastructure in the emirate.

Transport

Energy demand in the transport sector is being reduced by a number of initiatives for aviation, road travel, light rail and freight.

For aviation, UAE airlines are committed to supporting the International Air Transport Association's (IATA) target of reducing the aviation industry's net CO_2 emissions by 50% by 2050 compared to 2005 levels. This has involved significant investments in fuel-efficient fleets, flight route optimization for efficiency, and rigorous maintenance schedules to ensure efficient and safe operations. Together, these steps make UAE airlines, Etihad and Emirates, among the most efficient fleets in the industry.

Moreover, in 2012 the UAE's General Civil Aviation Authority (GCAA) approved a detailed Action Plan for promoting sustainable aviation in the UAE. The Action Plan includes actions on aircraft efficiency, avionics, improved flight path and air traffic management and the evaluation of alternative fuels.

Finally, Etihad Airways, in partnership with Masdar Institute, Honeywell, and Boeing, is also sponsoring a biofuels pilot project, using saline water plants. In early 2012, Etihad completed its first flight from Seattle to Abu Dhabi using a blend of traditional jet fuel and biofuels.

Figure 4-3: Overview of Dubai light rail system

For on-road transport, Dubai's Roads and Transport Authority (RTA) has devised a long-range comprehensive transportation strategy that addresses current and future transportation issues and provides a wide range of solutions to promote a sustainable transport system. Abu Dhabi's Department of Transportation is actively pursuing integration of sustainable transport options and strategies within the framework of the Plan Abu Dhabi 2030 and governmental priorities for creating one of the most sustainable cities in the Arab region.

Recent investments in public transport networks in Dubai and Abu Dhabi reflect these commitments to sustainable transportation. These investments have resulted in high levels of public ridership, as briefly outlined below.

- In Dubai, 332 million public transport rides were recorded in 2010. With a daily ridership of around 314,000 passengers, the bus system is the core of the transport system. In 2009, a multi-billion dollar light-rail/metro system opened, the first such system in the region (see Figure 4-3), and continues to construct new lines. Ridership already exceeds 145,000 passengers per day. Water taxis also serve some 42,000 passengers daily.
- In Abu Dhabi, the city bus network has expanded its scope and ridership rapidly. In 2010, 761 public buses on 75 routes registered 58 million rides, up from 115 buses on 9 routes with 10 million rides in 2008, when the network was launched. The city is also planning to introduce a metro system.

For freight transport, a rail network, connecting all seven emirates and integrated into the GCC network, is planned for a 2017 launch. Investment is expected to total roughly US$ 11 billion.

Public lighting

Abu Dhabi has issued the first specifications for public lighting in the Middle East, with estimated energy savings of 67% and carbon savings toward 80% compared to current practices and technologies. All street lighting is now undertaken using light-emitting diode (LED) technology. Dubai is studying lighting standards as well.

4.2.3. Alternative fuels

In 2011, the Abu Dhabi National Oil Company (ADNOC) began building a pilot network of natural gas fueling and engine conversion stations. Notably, the government is targeting conversion of 25% of Abu Dhabi's taxi fleet to natural gas by 2013, and compressed natural gas (CNG) buses are being piloted.

The emirate of Dubai is also exploring CNG as a transportation fuel, focused on public transport opportunities.

4.3. Water efficiency

Due to extremely low rainfall (less than 120 mm per year), groundwater over-withdrawal for farm irrigation, and the increasing scarcity and salinity of groundwater resources, almost all water supplied into the distribution system is produced through natural gas-fired cogeneration power & desalination plants, with repercussions for water security, cost, and carbon emissions.

Figure 4-4: High efficiency in-line drip irrigation system in greenhouse in Abu Dhabi's western region (source: http://www.uaeinteract.com)

The UAE government has consequently set water efficiency as a leading priority.

As of 2011, the Abu Dhabi government has issued a new agriculture and food safety policy calling for a more sustainable use of water, aiming to reduce water use in agriculture by 40% until the end of 2013. As part of the policy, it has phased out subsidies for certain livestock feed crops, Rhodes fodder grass for example, that consume 60% of water used for agriculture and up to 33% of total water consumption. Pilot programs have been running for several years to confirm climatically appropriate alternatives, and a training and subsidy program for crop transition is in place. The emirate of Sharjah has banned Rhodes fodder grass, a particularly thirsty crop.

Abu Dhabi is also subsidizing the roll-out of new, highly efficient irrigation systems in the farming sector, as well their mandatory implementation in all public landscaped spaces. Greenhouse agriculture, with a potential 15-fold improvement in the quantity of crops produced per cubic meter of water, is additionally being piloted (see Figure 4-4).

Moreover, water efficiency standards are embedded in the new mandatory building codes, including Estidama. Water distribution system leakage (currently around 20%) is also being tackled. Additionally, softscapes in building projects will be limited to 30% of surface area, and all plants must meet salinity and drought-resistance standards issued in 2011.

Recycled water will also be increasingly utilized. Currently, 67% of treated wastewater in Abu Dhabi is reused, but a new pipe network, to be completed by 2013, will enable 100% utilization.

The Dubai Integrated Energy Strategy 2030 has similarly set targets for use of efficient water dispensers in households, irrigation, and commercial buildings to reduce water demand. Re-use of certain wastewater (grey water) is being assessed to reduce reliance on desalinated water.

New desalination plants being built in the UAE use the latest high efficiency electricity and water generation technology in order to maximize energy utilization. Modern cogeneration plants built mainly over the last decade provide the base load capacity for power and water production. In these plants, "waste" heat from gas turbines used for electricity generation is used to produce potable water as part of the multistage flash (MSF) or multiple effect (MED) distillation processes, enabling fuel utilization efficiencies of over 80%. Cogeneration plants are supplemented by highly efficient Combined Cycle Gas Turbine plants, such as the recently approved 1,500 MW Phase 3 project at Schuweihat and others, such as the hybrid plants at Qidfa in Fujairah, which use a combination of MSF/MED and reverse osmosis technologies to optimize annual thermal efficiencies.

As of 2009, the UAE is also piloting the use of solar-powered reverse osmosis desalination, with 18 test sites (and 12 more to follow by the end of 2012) currently producing data on implications for larger scale application.

4.4. Technology and innovation

In addition to applying technology and policy solutions today, the UAE is investing in innovation for the climate and energy solutions of the future.

Figure 4-5: Master plan view of Masdar City (source: http://www.masdar.ae)

4.4.1. Masdar

At the forefront of this innovation is the Masdar initiative. Powered entirely by solar and other renewable sources, Masdar City will be one of the world's most sustainable cities when complete. Built by the Abu Dhabi Future Energy Company (a subsidiary of state-owned Mubadala Development Company), Masdar City will aim to attract clean tech companies and provide them with the infrastructure necessary to research, develop, test, implement and showcase emerging clean technologies (see Figure 4-5).

The city is in the process of being constructed and is already home to the Masdar Institute of Science and Technology, a research-oriented university that provides graduate level instruction in the science and engineering of alternative energy, sustainability, and the environment. Masdar City is intended as a test bed for a range of new technologies that will be essential to its operation as well as to new urban sustainability strategies around the world.

4.4.2. Education and research

The UAE has begun a process of reforming school and university curriculums to improve science training, including around climate change. The UAE has also launched two graduate-level universities dedicated to "clean energy" in partnership with globally leading technical universities. In Abu Dhabi, the Masdar Institute, developed with the Massachusetts Institute of Technology (MIT), graduated its first class in 2011. The École Polytechnique Fédérale de Lausanne (EPFL) is building a campus in Ras Al-Khaimah, in partnership with the emirate's sovereign wealth fund.

Targeted at the populace generally, Abu Dhabi's environment agency, in partnership with the World Wildlife Fund, has led the "Heroes of the UAE" for several years, encouraging energy and water conservation in homes and offices.

The Dubai Electricity & Water Authority has launched energy conservation initiatives with Dubai schools, which have already generated significant savings in energy.

4.4.3. Carbon capture and storage

The UAE continues to develop, through Masdar, a CCS network linking CO_2 emitters to users, namely for enhanced oil recovery (EOR). In early 2012, the UAE released a tender for a CCS-EOR project of 850,000 tonnes of carbon annually, connecting an Emirates Steel factory to an ADNOC oil field. In addition, the emirate of Abu Dhabi is evaluating policy frameworks for a domestic CCS industry, with a road map for technology deployment and rollout of commercial scale projects.

The Dubai Integrated Energy Strategy 2030 and Ras Al Khaimah government have also called for consideration of clean-coal power plants equipped with CCS in the next ten years.

4.5. International engagement

The UAE is not only building a cleaner energy future at home. It is also engaged actively in international efforts, as briefly outlined in the subsections below.

4.5.1. Clean energy investment

The UAE is a major investor in renewable energy abroad, notably through the state investment vehicle Masdar. Masdar has a 20% stake in the 1,000 MW London Array offshore wind project, currently under construction, as well as 40% stake in the joint venture Torresol with the Spanish company Sener. In May 2011, Torresol commissioned the 20 MW Gemosolar CSP electric generation station that includes molten salt energy storage capability that allows round-the-clock power generation for much of the year (see Figure 4-6). Two additional solar projects of 50 MW each are under construction.

Figure 4-6: Gemasolar CSP electric generation plant located near Seville, Spain

4.5.2. Renewable energy aid

On behalf of the UAE, Masdar has also completed a 6 MW wind project in the Seychelles and is funding a 500 kW PV plant in Tonga, as well as installation of PV in remote Afghan villages. A solar project in Mauritania will also shortly be announced. All projects are on a grant basis.

The UAE has also made US$ 350 million in soft loans available for renewable energy projects in developing countries. These projects are being implemented in cooperation with IRENA.

4.5.3. International Cooperation

The UAE is host to the International Renewable Energy Agency (IRENA), the 158-member organization that is headquartered in Abu Dhabi, as well as its largest financial supporter. IRENA is the first major international agency located in the Middle East. The UAE is actively engaged in supporting IRENA's work in promoting renewable energy around the world. IRENA will soon be based in the cutting-edge headquarters bring built for it in Masdar City.

The UAE also hosts a number of high-profile international gatherings focusing on sustainable development issues such as the annual World Future Energy Summit (see Figure 4-7 for gatherings scheduled for 2013). Moreover, the UAE participates in international cooperation on clean energy through the Clean Energy Ministerial process, the G20's clean energy working group, and others.

The UAE has a total of 33 CDM projects that are either already registered or under validation with Masdar Carbon, the Dubai Carbon Center of Excellence, and others in the UAE. These efforts are serving to actively develop new carbon emission reduction projects both in the UAE and abroad (see Table 4-1). As of the time of this writing, total estimated CO2e reductions exceed 65 million tonnes.

Figure 4-7: Events during Abu Dhabi Sustainability Week; 13-17 January 2013

Table 4-1: Carbon reduction projects undertaken by project participants in the UAE

No.	Project	Project Participant	Status	Total estimated reductions (tCO2e)
1	Biogas Technology Group Ras Al khaimah landfill Gas to Energy Project	PWSD	Registered (2496)	309,142
2	DEWA Chiller Station L	Dubai Carbon Center of Excellence	Registered (7260)	281,360
3	DESAL Energy Optimisation	Dubai Carbon Center of Excellence	Under Validation	91,127
4	Dubai CFL Project	Dubai Carbon Center of Excellence	Registered (6316)	160,941
5	10MW PhotoVoltaic Plant in Dubai, UAE	Dubai Carbon Center of Excellence	Registered (6964)	56,809
6	UCC RAK Waste Heat Recovery	Dubai Carbon Center of Excellence	Registered (7384)	668,250
7	Regenerative Burners for Melting Furnaces	Dubai Carbon Center of Excellence	Registered (7270)	119,060
8	Low Pressure steam generation by recovering waste heat using Heat Re-claimers	MASDAR	Registered (2686)	115,000
9	Recovery and utilization of flare waste gases at GASCO, Habshan Refinery	GASCO	Under Validation	101,620
10	Implementing Energy efficient measures to reduce fuel Gas consumption at GASCO	GASCO	Registered (4508)	13,995
11	LFG flaring project at Dubai	Green Energy Solutions & Sustainability LLC	Registered (8269)	2,291,872
12	Energy efficient natural gas fired thermal fluid heating system at JBF RAK FZLLC Ras al Khailmah	JBF RAK FZLLC	Under Validation	410,000
13	Natural gas based packaged Cogeneration System	JPF RAK LLC	Under Validation	582,000
14	Single to Combined cycle Conversion at Al Ghail & Al Hamra power plants, Ras al Khaimah	MASDAR	Under Validation	1,517,830
15	Sir Bani Yas Wind Farm	MASDAR	Registered (7198)	423,470
16	Nour 1 PV Project	MASDAR	Under Validation	1,000,931
17	Gas Flare Recovery at Suez Oil Processing Company, Egypt	MASDAR	Under Validation	1,284,470
18	Flare Gas Reduction through spiking compressor at Shah	MASDAR	Under Validation	1,100,550
19	Reducing gas leaks in low pressure and medium pressure gas distribution networks in Ferghana Valley	MASDAR	Registered (2534)	14,000,000
20	Leak Reduction in above ground gas distribution system in the gas distribution networks in khorezm region and the Republic of karakalpakstan	MASDAR	Under Validation	10,396,500
21	Abu Dhabi solar thermal power project	MASDAR	Registered (4085)	1,175,797
22	Reducing gas leaks in low pressure and medium pressure gas distribution networks in Ferghana Valley	MASDAR	Under Validation	14,000,000
23	Leak Reduction in above ground gas distribution system in the gas distribution networks in khorezm	MASDAR	Under Validation	10,396,500
24	Flare gas recovery at Ruwais refinery (Takreer)	MASDAR &TAKREER	Under Validation	189,338
25	Associated Gas Recovery and Utilization at Block 9	Oman Trading International Ltd	Under Validation	694,964
26	Switch from fossil fuel to alternate fuel at Star Cement	Star Cement Co LLC	Under Validation	305,110
27	Waste Management Project at Dubai, United Arab Emirates	Tadweer Waste Treatment LLC	Under Validation	1,306,273
28	Flare Reduction and Utilization of Low Pressure Gas at New Khuff Production Platform TOTAL ABK	MASDAR	Under Validation	1,460,490
29	Biogas Fuel for Steam Generation	Union Paper Mills	Under Validation	99,670
30	ADFEC 10 MW Solar Power Plant	MASDAR	Registered (2444)	104,749
31	Fuel Switching from Mazout to Natural Gas in Misr Fine Spinning & Weaving and Misr Beida Dyers at Kafr El Dawar	MASDAR	Under Validation	450,510
32	Recovery and utilization of flare waste gases	ADGAS	Under Validation	101,620
33	Recovery of flash gases from the acid gas removal processes in train 1 and 2 at DAS Island for productive use as fuel gas in SRU Incinerators	ADGAS	Under Validation	173,900
Total				**65,383,848**

Chapter 5: Implementing the Convention

5.1. Introduction

The discussion in the previous chapters makes clear that through its environmental vision, fulfillment of its international commitments, actions to improve understanding of vulnerability to climate change, and proactive steps in promoting alternative energy investments, the UAE has already taken important steps in the implementation of the Framework Convention on Climate Change. Going forward, the UAE will seek to improve data collection, deepen mitigation efforts, assess adaptation strategies, and strengthen institutional capacity. Each is briefly described in the subsections below.

5.2. Measuring and managing emissions

No effort to reduce the nation's carbon footprint can succeed without the accurate measuring and tracking of GHG emissions.

The UAE has announced in 2012 the establishment of a process to develop a full national GHG inventory. This process will be part of the Vision 2021 agenda, which sets a comprehensive range of indicators for the development of the UAE.

The national system will build on existing efforts to develop inventories in both Abu Dhabi and Dubai. These are being led respectively by the Environment Agency of Abu Dhabi and the Dubai Carbon Center of Excellence.

5.3. Adaptation strategies

The overarching need for adaptation is the development of a strategy to account for climatic risks in policies, institutions and attitudes such that enabling conditions are established to respond appropriately. In pursuing this aim, the UAE is working towards the development of a strategy for adaptation to climate change that has four main aims, as follows:

- Build adaptive capacity in key vulnerable sectors
- Increase ecosystem resilience and reducing the risk of climate-related disasters
- Mobilize and manage knowledge for adaptation policy and planning
- Take advantage of synergies and overlaps between adaptation and mitigation activities

Developing a climate change adaptation policy around such aims will effectively integrate climate change risks into programme planning within a cross-cutting framework. At the broadest level, implementing the Convention for adaptation should promote the following objectives:

- Increase understanding of vulnerability and adaptation options on potentially vulnerable sectors such as public health, human settlements, energy infrastructure, and agriculture/food security.
- Deepen understanding of vulnerability and adaptation options for the marine/terrestrial environment as better data becomes available or circumstances change;
- Integrate/coordinate climate change adaptation concerns into planning frameworks as existing codes/practices were developed with little consideration of future climate change and the

corresponding extreme weather events and adverse impacts.

5.4. Information access

Through the Eye on Earth initiative, the UAE is working to enable global leaders, innovators and decision-makers to focus on an issue critical to wise decision-making: how to ensure effective access to the world's expanding pool of environmental and societal data by all of those who need it. Climate change, one of several key policy focal areas of the initiative, is framed as an issue that requires data-driven solutions that extend beyond political boundaries.

Under the Patronage of His Highness Sheikh Khalifa Bin Zayed Al Nahyan, President of the UAE, facilitated by the EAD's Abu Dhabi Global Environmental Data Initiative (AGEDI), and in partnership with the United Nations Environment Programme (UNEP), the Eye on Earth initaitive seeks to inspire collaborative solutions to the challenge of data access and availability.

The initiative was launched at an inaugural international Summit held in December 2011 in Abu Dhabi. Under the theme, "Dynamic systems to keep the world environmental situation under review", global leaders attended the Summit from government, business, science, civil society and academia.

One of the outcomes of the Summit was a declaration on "Blue Carbon", a strategic approach to capitalize on potentially large carbon sequestration potential of coastal ecosystems namely, mangroves, saltmarshes and sea grasses. The declaration also sought to encourage a more effective and sustainable management of these ecosystems and their services. The next Eye on Earth summit is planned for 2014.

5.5. Capacity strengthening

This refers to enhancing the individual, institutional and public/private capacity to address the challenges of climate change. Implementing the Convention for this category will help to produce a better informed general public about the challenge of climate change, as well as strengthened capacity in key institutions to undertake the needed analyses and studies that contribute to better decision-making.

At the broadest level, several public awareness initiatives are in place to sensitize the general public to the link between consumption patterns and climate change; and increase technical capacity to analyze and integrate climate change strategies into planning activities. One of the ongoing initiatives is to build awareness among youth through targeted awareness-raising events and updates to school curriculum