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TOURISM AND CARBON FOOT PRINTS IN UNITED ARAB EMIRATES – CHALLENGES AND SOLUTIONS

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Abstract:

The article brings into picture the tourism progression and its environmental consequences in a recently emerged international tourist destination, United Arab Emirates (UAE). The country attracted around 8 million tourists in the year 2008 and at the same time made to the news-lines for generating highest carbon footprints per capita in the world! The article intends to generate a comprehensive analysis on background of United Arab Emirates (UAE), its resources, infrastructure and relevance of developing tourism which is strongly emphasized on energy intensive “man made tourism resources”.

The article is divided into three sections to assess the challenges and solutions related to tourism and environment in the country. In the first section, an analysis is drawn on the background of United Arab Emirates (UAE), its resources, infrastructure and progression made in the tourism sector. At the same time a discussion is made on the prevailing environment problems in the country and its status in terms of environment performance with regard to other countries. The second section of the paper throws light over the attempts made by the UAE government and major tourism stakeholders to deal with the current situation. A summary of these attempts and environmental laws is also taken into consideration under this section. In the last section, three carbon mitigation methodologies have been identified which best suit the prevailing condition and requirements in the UAE. A special investigation is also carried out to evaluate the business potential of these methodologies attracting the investors' interest.

Keywords: UAE, GHG emissions, climate change, carbon footprints, tourism

1. Introduction

The tourism industry and the environment are closely related. (Gössling, S., and Hall, C. M. 2006), (Scott, D. 2006), (Becken, S., and Hay, J. 2007). Climate and nature coupled with manmade activities define the length and experience of the tourist at a destination. Though the attractions can be divided into two major categories – natural and artificial, yet the natural resources are exploited even for the development of later. Eventually, the environment has to pay cost for these artificial attractions such as building shopping malls, resorts, sports, infrastructure, wild -life safaris and so on. At the same time a lot of energy is consumed in order to create and maintain these sectors especially transportation, accommodation and tourist activities.

According to a study by United Nations Environment Program (UNEP), international and domestic tourism emissions from three main sub-sectors are estimated to represent between 3.9% and 6.0% of global emissions in 2005, with a best estimate of 4.9%. Table 1 presents the data of tourism related sectors' contribution to the CO₂ emissions. In 2005, tourism's contribution to global warming was estimated to contribute between 5% and 14% to the overall warming caused by human emissions of greenhouse gasses. Of the 5% of the global total of CO₂ emissions contributed by tourism, transport generates around 75%. Looking at the increasing number of international tourists and domestic tourists particularly in the developing economies such as India and China, the

carbon emissions in future would increase drastically. According to a “business-as-usual” emission forecast scenario for the year 2035, assuming that no extensive mitigation strategies will be implemented in future; CO₂ emissions in tourism are projected to rise by 152 % (UNWTO 2007, p. 18).

Table 1. Estimated emission from global tourism (including same day visitors)

	CO ₂ (Mt)
Air transport	515
Car	420
Other transport	45
Accommodation	274
Activities	48
Total	1,302
Total world	26,400
Share (%)	4.9

Source: UNWTO-UNEP-WMO 2008

2. Objectives

The present study aims at analyzing the intricacies involved in the process of recent tourism growth and environment degradation in United Arab Emirates (UAE). An attempt has been made to find out how far tourism progress can be blamed for increased carbon footprints of the country. In particular, the research revolves around the following objectives:

- generating a comprehensive analysis of tourism developments in UAE in the background of country's infrastructure and resources.
- exploring the efforts being carried out by the tourism sector and the government to address the emerging environment issues.
- presenting solutions in terms of carbon mitigation techniques.
- analyzing the business potential of these carbon mitigation technologies from investors' point of view.

3. Research Methodology

The paper is divided broadly into three sections. In the first section, an analysis is drawn on the background of United Arab Emirates (UAE), its resources, infrastructure and progression made in the tourism sector. At the same time a discussion is made on the prevailing environment problems in the country and its status in terms of environment performance with regard to other countries.

The second section of the paper throws light over the attempts made by the UAE government and major tourism stakeholders to deal with the current situation. A summary of these attempts and environmental laws is also taken into consideration under this section.

In the last section, three carbon mitigation methodologies have been identified which best suit the prevailing condition and requirements in the UAE. Further, an attempt is made to analyze these optimum methodologies with a standard template consisting of ten factors including Porter's five forces. The idea is to present a strong base to the potential investors looking for business ventures which are economically, politically and environmentally viable. Each of these ten factors were deeply analyzed for every abatement technology and scaled on a range from “High”, “Moderate” to “Low”. For instance if “threat of substitutes” for CCS is “Moderate”, it means that there are a few other alternatives that can easily take its place. Efforts are made to justify the scaling with facts and figures, nevertheless, in some cases the analyses could be perceived as subjective and be seen in relative terms.

All investigations are made on the basis of secondary information collected from credible websites sponsored by the governments, NGOs, Newspapers, research organizations and so on. Proper references are included for further investigation and details.

4. Literature review

Although climate change and carbon footprints have been a serious concern for the last almost two decades, it was only during 2003 when the tourism sector officially recognized its role as a contributor to climate change, next to its role as a victim (UNWTO 2003). An interesting shift from the researches carried on “impact of climate change on Tourism” to “tourism impacts on climate change”, was revealed during the last decade (Peeters 2006). There were a number of studies conducted on the topic, however, most of these studies concentrated on evaluating the extent of impacts than finding ways to mitigate these impacts (Wall, G. 1992) Elsasser, (H. & Bürki, R. 2002), (Scott, McBoyle, and Minogue 2007). It was further found that there was still a missing balance between the analysis of destinations in developed and developing economies, and a lack of detailed studies which could support governments and other tourism stakeholders in taking the “right” decisions (Fischer 2007). Subsequently, emphasis was placed on measuring and mitigating the impacts on environment by adopting certain practices by the airlines, accommodation sector and tour operators (Gössling 2011).

In fact the entire phenomenon is a vicious circle. Tourism if grown out of proportion will lead to environment deterioration which in turn dilutes the natural beauty of the destination thus coming across as an unattractive choice for the potential tourist. The climate affects a wide range of the environmental resources that are critical attractions for tourism, such as snow conditions, wildlife productivity and biodiversity, water levels and quality (Copenhagen Diagnosis 2009). According to a report published by UNEP the climatic impacts of tourism can be broadly divided into two categories: direct climatic impacts and indirect environmental change impacts. In the direct impacts the climate is a principal resource for tourism, as it establishes the main activities at the tourist spot and has an important influence on operating costs, such as heating-cooling, snow-making, irrigation, food and water supply, and insurance costs. Climatic changes at these destinations will affect the tourism industry through increased infrastructure damage, additional emergency preparedness requirements, higher operating expenses (e.g., insurance, backup water and power systems, and evacuations), and business interruptions. Indirect environmental change impacts such as changes in water availability, biodiversity loss, reduced landscape aesthetic, altered agricultural production (e.g., wine tourism), increased natural hazards, coastal erosion and inundation, damage to infrastructure and the increasing incidence of vector-borne diseases will all impact tourism to varying degrees. In contrast to the varied impacts of a changed climate on tourism, the indirect effects of climate induced environmental change are likely to be largely negative. Mountain, island, and coastal destinations are considered particularly sensitive to climate-induced environmental change, as are nature-based tourism market segments (IPCC 2007a, 2007b), (UNWTO 2003), (Gössling, and Hall 2006), (Scott 2006), (Becken, and Hay 2007). Under these circumstances, tourism's contribution to global warming including all greenhouse gasses will be even larger, with an expected increase in radiative forcing of up to 188%, most of this caused by aviation.

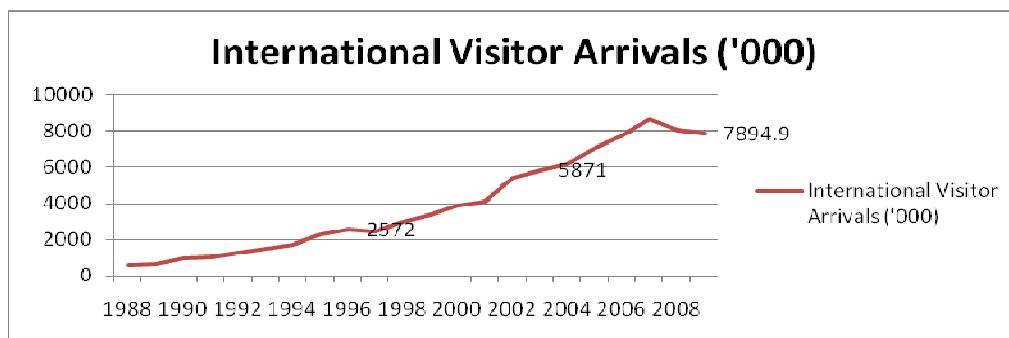
5. United Arab Emirates Tourism and Environment

United Arab Emirates (UAE), a federation of 7 emirates with the second largest economy in the Arab Middle East after Saudi Arabia (EIA 2005) suddenly became cynosure for its highest carbon footprints per capita in 2008. The country has the seventh largest proven oil reserves in the world at 97.8 billion barrels and possess sixth largest proven natural gas reserves in the world at 214 trillion cubic feet (EIA 2005). The emirate of Abu Dhabi is the focal point of the UAE's oil and gas industry, followed by Dubai, Sharjah, and Ras al Khaimah in that order while other emirates Fujairah, Ajman and Umm al-Qaiwain are on the way of developing infrastructure

likewise. These emirates vary considerably in size and population, but all have undergone modernization and urbanization (Clements 1998) since the 1960s when the area was described as one of 'barren coastlands largely populated by nomadic tribes' where 'the only occupations are fishing and pearl'ing' (Goodwin 2003). In the early nineties, the UAE government began to spend on infrastructure (Balasubramanian 1992, and 1993), with activity being greatest in Abu Dhabi and Dubai. Propelled by a wider federation policy, Dubai started to invest substantially in tourism (Trade and Industry, 1990; Middle East Economic Digest, 1995), which was soon to be a pillar of the economy (Crookston 1998). Tourism was positioned at the centre of the diversification programme alongside construction, telecommunications, media, real estate and financial trading. There was thus a strong shift towards services, but manufacturing still remains a sector of significance (EIU 2005).

Subsequently, the country has been ranked sixth in the world for the quality of its infrastructure according to the World Economic Forum (WEF). UAE has advanced infrastructure in public premises, roads, ports, aviation and electricity. This development is expected to attract investment and generate employment opportunities in the near term. The extremely rapid pace of economic growth until 2008 was due to the steady demand for oil, supplemented by a shift in focus to a number of non-oil sectors. As a result of Government's planned approach, the country has not only successfully diversified from oil industry to development of tourism sector but also poses an example of excelling in tourism in the absence of conducive environment and natural attractions. The country has been promoting shopping malls and shopping festivals which remain one of the major attractions for the tourists. Burj Khalifa, a skyscraper in Dubai, was opened in January 2010, is considered to be the tallest man-made structures at 828 meters and is a part of the flagship development called Downtown Dubai. According to WTTC statistics UAE attracted more than 8 million tourists in the year 2007 but the figure was brought down by the economic recession in 2009 and 2010. The country has diversified itself from oil and gas sector to tourism and other industries quite successfully. Interestingly, United Arab Emirates' Travel and Tourism Direct Industry is expected to contribute 4.6% to Gross Domestic Product (GDP) in 2010 (US\$11,766.3mn), rising in nominal terms to US\$27,722.6mn (4.3% of total) by 2020. At the same time the country's 119,000 T&T Direct Industry jobs account for 3.8% of total employment in 2010 and are forecast to total 149,000 jobs or 3.6% of the total by 2020. The contribution of the Travel & Tourism Economy to employment is expected to rise from 13.8% of total employment, 429,000 jobs or 1 in every 7.2 jobs in 2010, to 18% of total employment, 745,000 jobs, or 1 in every 5.5 jobs by 2020. (WTTC 2011)

Figure 1. International tourist traffic to UAE



Source: Computed from World Bank Data (2011)

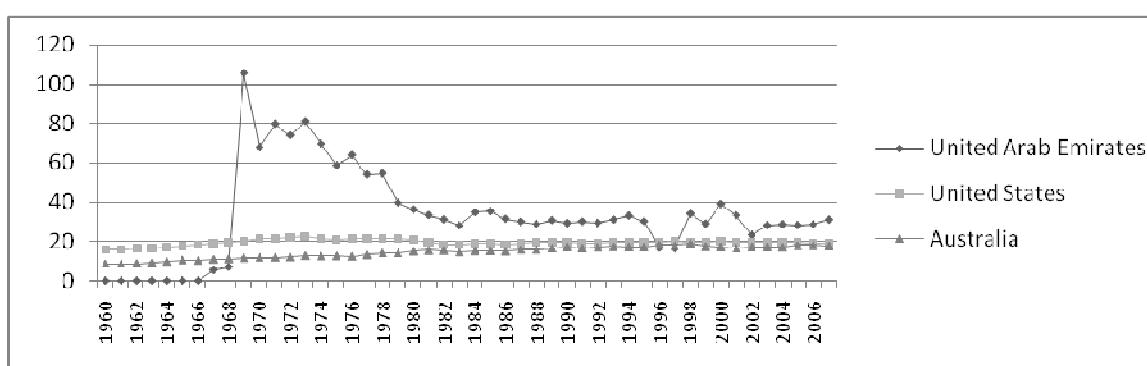
Impact on the environment

Parallel to the overall economic and tourism developments, UAE also excelled in carbon emissions per capita which became highest in the world in 2008 (WWF/Ecological Footprint report *Our Living Planet*). According to the findings of the report the people in the UAE are placing the most stress per capita on the planet.

Compared to the world average Total Ecological Footprint (TEF) of 1.8 global ha/person, the TEF for the UAE was 11.9 global ha/person (hectares/person). Though the report indicates an unsustainable pattern of resources usage, yet some facts were conveniently ignored. For instance how far is it justified to compare the natural resources consumption between tropical countries and arid climate which face adverse climatic conditions? At the same time the country has been investing extensively in the environment related projects not only domestically but also in other countries including Pakistan, Morocco, and Lebanon (Mohamed, Raouf 2008).

Nevertheless, the environmentalists blame large scale developments such as artificial islands, skyscrapers, shopping malls, artificial ski resorts and others the cause of present status. According to them tourism based on such artificially created and maintained attractions is not sustainable as it consumes exponentially high energy for its functionality (Caine 2010). Although statistics are not available, tourism industry might be paying a big opportunity cost in terms of its impacts on the environment (Butler 2005). Some of the main environmental issues in the UAE are declining natural vegetation, increasing overgrazing on rangelands and desertification. Moreover, the extensive groundwater pumping has lead to a rise in soil salinity levels and effluents from the oil industry have contributed to increased air pollution. CO₂ emissions in the UAE increased at 3.9% to reach 169.4 million metric tons during 2009 (EIA 2009). The study also suggests that CO₂ emissions will increase to reach 187.1 million metric tons by 2013. The effects of climate change on tourist resorts in this part of the world will mainly be in the summer months, as they are faced with loss of comfort resulting from rising temperatures and with water shortages. The range of tourist products in the UAE is narrower and if the temperature keeps on rising same rate, by 2030 rising temperatures could increase seasonal differences: as a result, seaside tourists would increasingly avoid the summer months. In the UAE, tourism is geographically concentrated very strongly on Dubai. Looking at the major contributors to the pollution, the figures are alarming! Only Dubai's Executive Flight Service handled 6,060 flights and 19,797 customers in 2009, according to figures from Dubai International Airport. In ground transportation, Dubai Taxis made 70 million journeys in 2009, in which they transported more than 140 million passengers, the emirate's transport authority said. That compares with 120 million people who took public buses in 2009. Since its inauguration in September 2009, the number of passengers using the Dubai Metro has risen from about 40,000 a day to more than 120,000 a day. In total, it has transported more than 19 million people so far and expects 35 million passengers in 2010. Speaking about the newly launched cruise tourism, Dubai Department of Tourism and Commerce Marketing (DTCM) has reported that the emirate will receive as many as 135 cruise ships bringing in a total of around 375,000 passengers during the new marine tourism season in Dubai, expected to last until June 2011. Over the coming years, DTCM expects these figures to increase to 195 ships with 575,000 passengers in 2015, which in whole going to increase the carbon foot prints of UAE. (AMEinfo.com 2010)

Figure 2. UAE Carbon emission trend in comparison to other countries



Source: Computed from World Bank Data

Incidentally, the country has only 0.2 km³ of renewable water resources, with 67% used for farming activity, 10% for industrial purposes, and the rest for drinking and other purposes. The combined average of solid waste produced per year by the cities of the UAE amounted to around 0.5 million tons during 2000–06. The per capita household waste reached an average annual 730kg in Abu Dhabi and 725kg in Dubai during the same period. In comparison, the US had an average of 710kg, Australia 690kg and the UK 300kg. In the UAE region, the greatest sources of pollution are the oil and gas industry, followed by the power and transportation sectors. Furthermore, the country also ranks poorly on the Environmental Performance Index (EPI), with a score of 40.7 compared to a 54.1 score for the Middle East and North Africa region. In 2010, the country was ranked 152nd among 163 countries (EPI, 2010).

Environment initiatives by tourism companies

Although UAE has successfully diversified itself from oil sector to booming tourism industry, there is a long way to go to make this progress environmentally sustainable. The country has started a number of environment projects and fortunately the absence of multi layered government structure expedites the implementation of such initiatives. Looking at the tourism sector alone however, few hoteliers have adopted humble practices such as using solar panels for energy, composting for organic farming, and so on (The National Aug 9, 2011). However, there are miles to go for the hoteliers to put themselves in the "Eco-friendly" category in the absence of concrete guidelines to adopt renewable energy. In one recent conference held in Abu Dhabi, the capital of UAE, the Government announced its ambitious target to cut hotels' energy use by 10 per cent, their water use by 20 per cent and reduce the amount of hotel waste going to landfills by 20 per cent as a first step in its environmental programme (ADTA 2011).

The average Dubai hotel produces 6,500 tonnes of carbon dioxide emissions a year, while the average European hotel produces 3,000 tonnes, according to a report by the energy consultancy Farnek Avireal at the conference. A typical five-star hotel in Dubai has a total energy bill of up to Dh7 million (US\$1.9m) a year. The guidelines for existing hotels were developed with Estidama, the sustainability initiative of Abu Dhabi's Urban Planning Council, and in consultation with engineers from more than 30 hotels. The rules for new hotels will supplement Estidama's recently announced "Pearl Rating Scheme" for all new buildings in Abu Dhabi (Gulf News 2011).

In contrast, the prominent airlines of UAE have gone a long way to reduce their carbon footprints by deploying environment friendly operations and material wherever possible. In particular, Emirates airlines reported detailed information about its operation's environmental impacts and ways dealt with it in its annual report 2010-2011. The airline claimed that its fuel efficiency for 2010-2011 was 4.12 liters per 100 passenger kilometers which is better than IATA's forecast 2010 industry average of 5.4 liters per 100 passenger kilometers (IATA 2009). Similarly, Air Arabia, the first and largest low-cost carrier (LCC) in the Middle East and North Africa, was recognized by Airbus, one of the world's leading aircraft manufacturers, for achieving the highest operational utilization in the world. Etihad airways, relatively new carrier from the capital Abu Dhabi embarks upon its initiatives to collaborate with business units of Masdar (Abu Dhabi Future Energy Company), in helping to drive the development of sustainable bio-fuels and incorporate environmental issues into its procurement mechanisms. All the airlines, however, have reservations against proposed European Union Emissions Trading Scheme (EU ETS) which according to them results in paying for emissions more than once in the EU (Emirates annual report 2020-2011).

These concerns are in line with the critics who blame that whatever actions might be taken by the airlines, eventually the end consumer will be adversely affected. Earlier studies have also raised concern over increasing transport costs fostering environmental attitudes that lead tourists to change their travel patterns (e.g., shift transport mode or destination choices). Long-haul destinations can be particularly affected and officials in Southeast Asia, Australia-New Zealand, and the Caribbean have expressed concern that carbon mitigation

policies implemented in Europe and USA could adversely impact their national tourism economy (Bartlett 2007; Boyd 2007; Caribbean Hotel Association and Caribbean Tourism Organization 2007).

6. Potential Carbon Abatement Techniques

Though UAE tourism sector should consider better and more efficient practices which are not only cost effective but also lead to reduce the carbon contents yet they have the responsibility to keep the tourists interest abreast in the destination. How far a tourist could be educated and motivated towards keeping his/her activities environment friendly has been a debatable topic? Particularly in the field of aviation, stringent practices and rules can result in de-motivation due to high elasticities of air travelers to increasing costs of air travel. For instance, the bloggers in the UK reported their unhappiness on the issue of curbing emissions from transport through taxes or fee. Most of them perceived these taxes as a threat to their freedom (Riehl World View 2010). It was also found that emission trading system could result in favoring medium-distance flights than the short trips (Mayor, and Tol 2008).

Furthermore, bringing a change in the masses' behavior towards climate change is also considered as quite challenging as the material comfort needs and high energy dependence justified the impossibility of behavioral change (Steg, and Vlek 2009). Thus in addition to implementing small scale mitigation strategies in the tourism sector, there is a need to adopt a mix of proven methodologies with promising results. McKinsey consultancy in 2007 recommended at least thirty five measures including energy efficiency of buildings and vehicles, carbon capture and storage (CCS) especially for fuel burning hubs such as refineries, and potential in forestry and agriculture (Mc Kinsey 2007). A few researches have also been performed to bring the issue to a level that could attract investors' interest in these methodologies with a business orientation (Vij 2009). However, these methodologies were general in nature without emphasizing on a specific region or country.

Considering the geographical location and the nature of economy of UAE, three carbon mitigation methodologies have been identified which best suit the prevailing condition and requirements. An attempt is made to analyze these optimum methodologies with a standard template consisting of ten factors including Porter's five forces. The idea is to present a strong base to the potential investors looking for business ventures which are economically, politically and environmentally viable.

Solar power – Photovoltaic technology

Although no concrete information is available on the emissions from hotels in UAE, accommodation sector, globally, is responsible for almost 21% of emissions from tourism. The sector has been identified as having great potential to reduce emissions (IPCC 2007b), and substantial efficiency gains have been made in hotels in the recent years (Bohdanowicz, and Mrtinac 2007), (Butler 2008), (Bohdanowicz 2009). Being located within the Northern desert belt, the UAE climate is an arid subtropical climate. The weather is generally hot and humid with a high daily average of sun hours. This makes country a perfect spot to utilize the solar energy by deploying state of art technology. Photovoltaic (PV) is a solar power technology that uses solar photovoltaic cells to convert sunlight into electricity. Photovoltaic production has been growing twice every two years, with an average growth rate of 48 % each year since 2002 (IEA 2010). At the end of 2007, cumulative global production of solar PV systems was 12,400 megawatts. Though the technology is proven in terms of its efficiency yet it is still an expensive one. Reducing the capital costs (installation and system value of components like cells, modules, batteries etc.) of a solar power installation is the biggest barriers for the widespread usage of this technology. Bakos, and Soursos (2002) have shown the photovoltaic cell (PV) installations for small scale tourist operations in Greece are economically viable. The government incentives and subsidies play a large role in reducing these capital costs and besides that the technological development is vital too.

Table 2. Business Factors for Solar PV Technology

FACTORS	Solar PV Technology
Geographical prominence	Europe dominates the global PV market, with Germany being largest European PV market. Japan is second largest PV market. Future prediction is that India and China will dominate this industry. (RNCOS 2008)
Industry Rivalry: Competitors	High - The technology is intensely competitive and rapidly evolving. Key players are BP Elecnor, Solar, Kyocera, Q-Cells AG, Shell Solar, SunPower Corporation, Sharp Corporation, Powerlight and Sanyo Corporation. (Solar Power (2007). Competitors are trying to optimize solar technology with IT and "smart grid" is one such example that refers to highly integrated generation, transmission, and distribution strategies using IT. There is growing competition to bring down costs through technical innovation like crystalline silicon ribbon and sheet technologies. (Platt's 2007)
Barriers to entry	Moderate - Solar PV is currently expensive and has high initial costs. But government support has made it easier for entrants to invest in the industry. Establishing vendor relationships is also considered a barrier. Geographical location is an important factor and is also a deciding factor about the technology employed.
Threat of Substitutes	Low - Threat from substitute sources, both conventional sources as well as other emerging technologies like wind, geothermal etc.
Bargaining Power of Buyers	High (in short term) - There are projected supply spikes due to relax in polysilicon supply which would lead to more supply than demand by 2009, leading to falling prices. (WIKINVEST 2010)
Bargaining Power of Suppliers	Moderate - Although there is abundance of raw material (silicon) but there is lack of refined polysilicon used in manufacturing of solar panels due to demand surge and limits of mining and processing capital; this in turn has raised the costs for manufacturers. (Cliburn K. Jill et. al. 2007).
Govt. Regulations	The UAE government has initiated a number of projects to generate electricity from solar power. However, most of these projects are in experimental stage and yet to be deployed at mega level. The most expansive project is Shams 1 which will produce 100 megawatts and cover one square mile of the desert in Madinat Zayed, about 75 miles southwest of Abu Dhabi (Boyle 2010). Impressive though no concrete guidelines or subsidies are in place enabling other organizations to avail this technology at a cheaper price.
Stage in life cycle	Besides the technical innovation, it is still in nascent stage and is highly driven by government initiatives due to high initial costs.
Opportunities	Costs can be driven less due to negligible O&M costs when compared to traditional coal or gas power plants and also due to manufacturing in low cost economies like India and China.
Abatement potential	Current cost of producing power is 496 EUR/MWh. Projected cost in 2030 110 EUR/MWh. Abatement potential by 2030: 125 Mt CO ₂ /EUR

Carbon Capture & Sequestration (CCS)

Although not connected directly with tourism, CCS is one method which cannot be ignored in the larger picture of the country's environment. The method is related to burning of fossil fuel which exists in abundance in UAE. Fossil fuel comprises coal, oil, petroleum, and natural gas products. The UAE has an open economy with a high per capita income and a sizable annual trade surplus. Successful efforts at economic diversification have reduced the portion of GDP based on oil and gas output to 25%. (www.tradingeconomies.com 2011). CCS describes efforts to "capture" the CO₂ emissions from the burning of fossil fuels (primarily coal) and "sequestering" them from release into the atmosphere thus mitigating coal's role as an agent of climate change. Precisely, it means capturing the emissions from burning coal at power generation plants and preventing their

release into the atmosphere. There are several methods of storing the CO₂, Enhanced Oil Recovery (EOR) is the process by which oil reserves that cannot be recovered by conventional extraction techniques, may still be brought to market economically when CO₂ is stored in mature old fields. Capturing CO₂ from the source is the most expensive part of the CCS process. Transporting the CO₂ through a pipeline is the least expensive part of CCS and injecting it deep into the earth is more expensive than transporting it. (Philip, and Patricia 2008)

Table3. Business Factors for CCS

FORCES	Carbon Capture & Sequestration (CCS)
Geographical prominence	Canada
Industry Rivalry: Competitors	Low - Although, currently, there are no full scale CCS operations in place but three companies are currently sequestering coal although only one uses the EOR process which is a Canadian company, HTC-Purenergy, based in Regina. The European Union, Australia, and China are all moving ahead with CCS demonstration projects. (R.M. Sussman 2008)
Barriers to entry	High - Deploying the technologies at a reasonable cost (and who will pay for it?), and on a scale that can make an impact on emissions and how to reach the scattered oil fields, is a matter of concern.
Threat of Substitutes	Moderate -Currently several sequestration strategies are being considered other than EOR, they are: saline formations, coal seams, terrestrial absorption, commercial value, oceanic storage and basalt formation.
Bargaining Power of Buyers	High - As far as CCS initiatives in UAE are concerned, the Government is primarily responsible to implement the method. Abu Dhabi Future Energy Company (ADFEC) has already taken up the task to conduct feasibility study. ADFEC has invited bid from the selected companies which include Foster Wheeler, Technip, Parsons, SNC-Lavalin and Jacobs Engineering. The study targets initially the Emirate of Abu Dhabi and is expected to later expand to cover the rest of the UAE. Existence of handful yet powerful fuel companies and Government as buyers for CCS holds strong bargaining power.
Bargaining Power of Suppliers	Information not available.
Govt. Regulations	Governments are just beginning to consider implications from CO ₂ emissions from large industrial emitters. UAE has initiated the CCS technology by collaborating with RTI International, an independent non-profit research institute, on a high potential carbon capture technology research project at Masdar, Abu Dhabi. (www.uaeinteract.com 2007)
Opportunities	When EOR is involved, economic returns can be made from CO ₂ , at a cost per ton that makes CO ₂ capture and EOR a profit centre. To improve the return on investment of clean coal technology, the bridging solution is all about EOR. Injecting one ton of CO ₂ can increase production by four to seven barrels of incremental additional oil. Pessimistic look: costs \$60/ton and incrementing 4 barrels @120= \$480 of oil.
Abatement potential (CO ₂ saved, costs)	If implemented successfully, the CCS method can reduce the UAE's CO ₂ emissions by almost 40%, while increasing oil production by up to 10% and liberating large quantities of natural gas. (www.uaeinteract.com 2007)

Waste—Anaerobic Digestion

In the year 2011, Centre of Waste Management, Abu Dhabi announced that the UAE economy is losing Dh1.5 billion every year due to inadequate recycling of waste (Gulf News 2011). The Government has already started taking actions in the areas of waste water treatment, advanced water recycling, sewage treatment waste recycling and so on ([www.uaeinteract.com](#) 2011, c). Interestingly, over 90% of GHG produced by waste is

methane (McKinsey et al. 2007). Anaerobic digestion technology produces renewable energy by capturing methane emitted from household waste and wastewater. Though the technology is well adopted in Europe, it is very rare in the North America and Asia. As the waste management facilities are generally owned by municipal governments, selling technology and knowledge is a business opportunity for corporations. Regional difference is significant in market competition, of which European market is mature; thus the competition in Europe is fierce. However, UAE has already initiated its efforts towards implementing the technology by signing Memorandum of Understanding (MOU) with private sector (Mahabir Ron 2007). The method becomes relevant especially for the accommodation sector as the waste produced by a hotel falls into two categories – for disposal and for reuse or recycling. Most waste for disposal is organic waste, grease, hazardous chemicals, wood, construction related waste and glass. Waste that is reused or recycled is cardboard, paper, plastic, aluminum (cans), glass, used oil and electronic waste (batteries, cartridges). There is a wide scope of implementing anaerobic digestion method to generate energy out of the waste, provided it is implemented successfully.

Table 4. Business Factors for Anaerobic Digestion

FORCES	Waste—Anaerobic Digestion
Geographical prominence	The technology is better adopted in Europe than the North America. The major global technology suppliers are located in Europe and have partnership in the North America.
Industry Rivalry: Competitors	Low - There are 15 technologies providers in Europe. However for the middle east, the completion is not that high. The UAE government operates focused facilities for waste management which keep on inviting tenders for the upcoming projects (Beeah 2011).
Barriers to entry	High – High fixed costs. Need good experience and knowledge.
Threat of Substitutes	Moderate - Composting and incineration are also major solutions for municipal waste management (MWS).
Bargaining Power of Buyers	High - Waste collection was usually managed by municipal government. Governments' buying power tends to be high. However, the buyers are not scattered as each emirate has its dedicated waste management department to be accessed.
Bargaining Power of Suppliers	High - Facilities need to receive continuous maintenance services by the supplier. Switching cost would high or even impossible.
Govt. Regulations	Issuing the landfill directive stating to minimize landfill waste, the EU countries has adopted alternative solution such as AD and composting. UAE is still in infancy stage to implement such advanced methods.
Opportunities	There is an increasing interest in the UAE and feasibility studies are being undertaken. At least three emirates in the UAE have come up with separate organizations to implement such waste management methods towards the environment.
Abatement potential (CO ₂ saved, costs)	It is estimated that food waste has an energy-producing capability, through biogas, of 12-15 times that of conventional animal wastes. Anaerobic Digestion is sustainable in the fact that it extracts energy from the organic waste and returns the used digestate to the land. Considering the increasing number of tourists visiting UAE, the food waste is bound to increase in the coming years. However, the facility operation costs \$190/MTon of waste.

Conclusion

It is quite clear that UAE has identified tourism as one of the alternatives to reduce its reliance on the oil and petrol which remain the backbone of country's economy. From the present scenario, it can safely be concluded that the country has excelled in attracting the world's attention by both – its tourism potential and

environmental impacts. However, blaming tourism alone for these increased levels of pollution is not justified as relevance of climate change to tourism is not inconceivable. Fortunately, the concept of climate change and carbon footprints is already influencing decision making within the tourism sector particularly in airlines and hotels. UAE has been striving hard to reduce its carbon foot prints by investing hugely in the environment related projects, MASDAR remains a prime example.

The present paper suggests that the usage of Photovoltaic technology and Anaerobic Digestion has a wide scope in the hospitality industry whereas the application of CCS remains a viable alternative in the larger picture of the country. Any one solution will not develop into a technology that will reduce the carbon footprints in the UAE; renewable energy, nuclear and CCS technologies need to coexist as part of a cost-effective portfolio of options for reducing CO₂ emissions from energy production. The investors are advised to critically assess these potential technologies before making an effort to commercialize them. Also irrespective of the levels of maturity of these technologies, which may differ in various countries, profitability from any of such businesses cannot be expected without government support and assistance.

Last but not the least, the business environment for these mitigation technologies is highly dynamic in nature hence, it is imperative that the investors keep a track of new developments in the market.

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