BEDP ENVIRONMENT DESIGN GUIDE

LOW-ENERGY DESIGN IN THE UNITED ARAB EMIRATES – DRIVERS AND URBAN DESIGN PRINCIPLES

Peter St.Clair

Climate responsive design and traditional design elements of the Persian Gulf may provide a basis for low-energy design. Current building models employed in the United Arab Emirates are often unsuited to the region's climate, causing massive cooling loads as a result of inappropriate site planning, orientation and building envelopes with high levels of glazing. The application of an inter-disciplinary design approach that considers urban design, landscape design, architecture and meteorology may provide a more appropriate low-energy design for such hot and arid climates.

This paper forms the first part of two parts, and is to be read with the companion paper: DES 30 Low-Energy Design in the United Arab Emirates – Building Design Principles

Keywords:
arid climate, climate responsive design, environmental design strategies, low-energy design, UAE, United Arab Emirates

1.0 INTRODUCTION

1.1 Summary

The United Arab Emirates (UAE) provides a unique opportunity and challenge for architects and other design professionals to develop a new low-energy urbanism and architecture. The UAE is currently the world's largest user of energy on a per capita basis, with 70 per cent of primary domestic energy usage being committed to buildings, primarily in the form of mechanical ventilation (air-conditioning and heating) and artificial lighting (Kazim, AM, 2007).

Countries of the Middle East such as the UAE possess a rich architectural legacy based upon climate responsive design. Diminishing oil supplies in some Emirates within the UAE have lead to a diversification of the economy expressed in dramatic levels of building and infrastructure development. This ongoing strategy of economic diversification coupled with a desire by government and developers for market differentiation, the UAE's commitment to the Kyoto Protocol and a changing regulatory framework, are providing the opportunity for the UAE to become a centre of research, experimentation and development of low-energy solutions for building and urban design. This can already be seen in projects such as Masdar, a proposed zero energy city and research hub currently being designed by Sir Norman Foster in Abu Dhabi, based upon traditional planning principles of the "walled city" (Foster + Partners, 2008, Masdar Initiative, 2008) and the development of sustainability codes and voluntary rating systems in both Dubai and more extensively in Abu Dhabi.

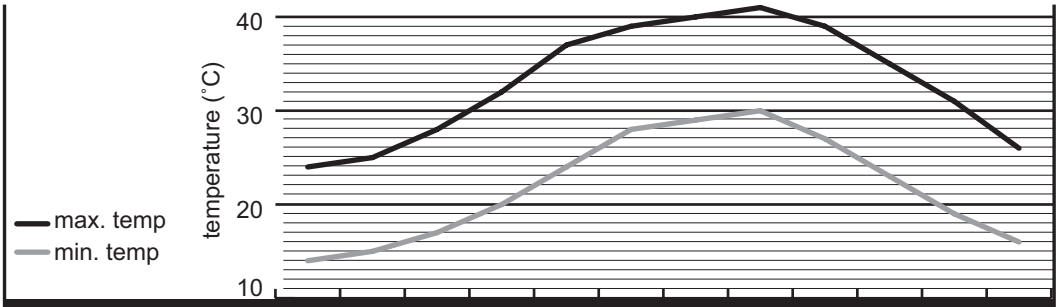
Traditional architecture in the Gulf region is based upon a sophisticated response to climate that employs passive techniques for the cooling and heating of urban spaces and buildings. Australia shares a similar hot and arid climate across much of the country and employs many low-energy strategies that originated in the Gulf region, such as the courtyard, or 'courthouse' building model (as they are known in the Middle East and North Africa), can be seen in Australia, which respond to the problems of solar radiation and hot winds.

Contemporary buildings in the UAE are often based upon imported building models unsuited to the climate and culture. These solutions can only function through extensive intervention by mechanical air-conditioning leading to disproportionate usage of oil and natural gas reserves and consequently high levels of carbon emissions.

This paper identifies passive design strategies and relevant literature that may contribute to a low energy urban design and architecture in the UAE. The severe climate and market expectations within the UAE require the use of HVAC systems in most cases. Building design that responds to the climate can complement active systems through reducing building energy usage and associated carbon emissions, while contributing to an appropriate vernacular architecture and forming a legitimate starting point for architectural expression relating to place and lifestyle. The goal of these guidelines is that they can contribute to the education and awareness of architects and clients and be incorporated into organisation practice management systems.

1.2 Guideline Scope

Climate responsive design can be equally applied to all building types and scales and so this guideline is intended to be generic, applying to high-rise and low-rise construction. The design strategies that are considered are those primarily relevant to passive considerations such as floor planning, façade design



Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum temperature (daily mean)	24	25	28	32	37	39	40	41	39	35	31	26
Minimum temperature (daily mean)	14	15	17	20	24	28	29	30	27	23	19	16
Cooling degree days above 18°	57	82	183	310	456	501	571	574	482	365	222	115
Heating degree days below 18°	7	3	0	0	0	0	0	0	0	0	0	1
Precipitation (mm/month)	14	31	18	9	1	0	1	0	0	0	2	16
Sunshine hours (avg. per day)	8.2	8.3	8.5	10	11.3	11.5	10.5	10.5	10.4	10	9.5	8
Relative humidity (%)	65	65	63	55	53	58	56	57	60	60	61	64
Relative humidity (%) (10m above ground)	51	48	43	37	32	34	33	33	34	39	46	50
Insolation (monthly average on a horizontal surface) (kw/m²/day)	4.09	4.8	5.23	6.32	7.18	7.23	6.45	6.32	6.05	5.39	4.53	3.78
Prevailing wind direction	NW	W	WNW	WNW	WNW	WNW	NW	NW	NW	NW	WNW	WNW
Wind speed (km/h)	11	13	13	13	14	14	13	13	12	11	10	11
Daylighting levels (lux)			75,000						107,500			
Dust storms				yes	yes							

Table 1 – Climatic data for Dubai
(Adapted from Aboulnaga, 2006, Club Air Travel, 2008, NASA, 2008, Weather Network Statistics, 2008, Wind Finder, 2008)

and orientation and not those driven by engineering solutions such as co-generation. Strategies are focused on the reduction of cooling loads in buildings, as this represents both the bulk of energy usage and the fastest growing energy demand in the UAE, where the cooling season is much longer than the heating season.

The research and case studies for low-energy design in the UAE are still developing and so this report draws from a wide range of sources including recent academic papers and media articles in addition to established literature by authors such as Baruch Givoni, (architect and climatologist), Hassan Fathy (noted Egyptian architect) and Richard Hyde (coordinator of architectural and design science discipline at Sydney University) that analyse building in other similar hot and arid climates of the world.

2.0 BACKGROUND

2.1 The Climate of the UAE

The Arabian Peninsula is situated in one of the most hostile climatic zones on earth, featuring extremely high summer temperatures, limited fresh water and high evaporation rates. The UAE lies in the arid tropical zone extending across Asia and North Africa

and contains at least four climatic zones, with that of principal interest for this guideline being the coastal zone containing Dubai and Abu Dhabi. The climate of this coastal zone is classified as semi-arid to hyper-arid (Boer, 1997).

The data demonstrates the climate of the UAE to be primarily hot and dry, while exhibiting some qualities of hot and humid climate with a higher rate of relative humidity than in typical arid climates. The sunshine hours per day are among the highest in the world varying from 8.0 hours in December to 11.5 hours in June. Clear sky conditions result in a high diurnal temperature range of 10-13°C providing the opportunity for night cooling between November and April (NASA, 2008). Insolation, which is a measure of solar radiation levels, is higher at this latitude than at the equator or equivalent south latitude (Givoni, 1976). The combination of sunshine hours, clear skies, high solar radiation and highly reflective terrain (sand and gravel) lead to extreme temperature and daylight and consequently high evaporation levels.

The prevailing winds or **Shamal** are from the north-west bringing cooler and wetter conditions in the winter time and hot dusty conditions from the deserts of Saudi Arabia, Kuwait and Iran in summer time (Arabianbusiness, 2008). Summer winds also extend from the south east, bringing hot and dry conditions and occasional sand storms.

The period between the months of May and November is typified by extreme day time heat and night time temperatures above comfort conditions. The building design focus during this period should be upon reducing cooling loads which can be achieved through increased energy efficiency measures. The period between the months of November and April are, however, typified by night time temperatures below 21°C, higher humidity, and lower insolation and sunlight hours, providing the opportunity for cooling load reductions through passive cooling strategies such as nocturnal ventilative cooling. Humidity levels in summer, although lower than in winter time, are coupled with the extremely high temperatures and produce very uncomfortable conditions. Energy efficiency measures can provide further benefits to both cooling and heating loads in this period.

Refer to Table 1 for analysis and summary of Dubai's climatic data.

2.2 Changing to Low-energy Design

Movement toward low-energy building design in the UAE may result from the influence of a variety of inter-connected factors including the political context, ethical considerations, design and technological advancements, economic costs and opportunities, risk management and marketability. Architects and design professionals who understand these drivers may be better prepared to provide more strategic and relevant design advice and outcomes for their clients.

Drivers include the risk of buildings losing competiveness and asset value in the property market as a result of not matching global drives for sustainability and the decreasing costs of solar energy. The emirates of Abu Dhabi and Dubai are showing strong commitment to sustainability principles (Austrade, 2008, Ecospecifier, 2008) leading to changes in planning and building codes such as Dubai's announcement of a new green building code. The appendix to this paper lists further drivers and opportunities for the private and government developers and their consultants categorised under the following headings:

- Political and Economic
- Regulatory and Voluntary Standards
- Environmental, Ethical and Corporate Governance
- Design, Climate and Technology
- Business and Research Opportunities
- Design, Climate and Technology

3.0 DESIGN STRATEGIES FOR HOT AND ARID CLIMATES

3.1 Classification of Strategies

Givoni, who is considered a leading authority on building climatology, classifies passive energy design strategies according to two categories. The first category is the design of buildings to minimise its energy needs through strategies such as building layout, orientation and façade design. The second category is strategies that utilise natural energy sources in the form of passive cooling and heating systems, including ventilative cooling, radiant cooling and evaporative cooling systems (Givoni, 1998).

Givoni further classifies passive energy design strategies against scale. The first classification being the urban environment and the second being individual buildings (Givoni, 1998).This classification has been adopted for the following description of strategies.

3.2 Design Strategy Summary

The following design strategies can provide low-energy outcomes for low and high rise building types in the UAE. Graham Farmer of the University of Newcastle upon Tyne, describes the most effective way to reduce building energy consumption is "to exploit natural means and depend less on mechanical means" (Boake, 2008). Traditional and contemporary climate responsive strategies can be adapted to contemporary building programmes and construction techniques and so form the main generator of building design. The strategies below have been drawn from generic writings by authors such as Givoni, Fathy and Baker, complemented by current and regional literature.

3.3 Urban Design Strategies

3.3.1 Overview

Urban climate varies from the climatic conditions in surrounding rural areas. Givoni states that these differences are a consequence of both climatic factors such as wind speed and cloud cover, as well as the city structure in the form of street layouts and building densities (Givoni, 1998). The major impact affecting human comfort and cooling loads of buildings are air temperatures and wind speeds near street levels, caused by convective heat exchange between the ground and buildings and the air flowing above, and the heat generation within the city. This leads to the Heat Island phenomenon where the average diurnal temperature in a densely built urban area is higher than in the surrounding rural areas. This results in significant temperature elevation at night times. In arid desert regions such as the UAE, this effect may be reversed, whereby the introduction of building shade and vegetation can lower temperatures in comparison to surrounding desert areas. Wind speeds generally increase with additional height, as a consequence of a reduced number of barriers and reduced friction. Urban climate conditions and resultant cooling loads can be modified through urban design strategies.

3.3.2 Street Orientation

The objective in a hot, dry climate is to maximise shading for pedestrians and minimise the solar exposure of building facades along streets whilst maintaining optimum urban and building ventilation. An east west orientation of streets promotes north and south solar exposure to buildings that can be more readily controlled as a result of the greater solar altitude. Narrower streets promote greater shading thus reducing radiant heat gains on ground surfaces and building facades. (Givoni, 1992).

Street orientations should allow cooling by ventilation with the prevailing afternoon winds, when the urban temperature reaches its maximum. This is demonstrated by the street design for Masdar in Abu Dhabi, where streets are oriented NW/SE, benefiting from the prevailing NW daytime winds and SE night time winds (Maxmakers, 2009). Building ventilation can be further enhanced by exposing buildings along the streets to differing air pressures on their front and rear facades. This may be achieved in the UAE by orientating streets east west, thereby at an oblique angle of approximately 45°C to the prevailing NW and SE winds (Wind Finder, 2008). Studies completed in the UAE have compared the energy usage of a variety of low rise buildings as a result of building orientation and concluded that street and block orientation and lot dimensions can impact the energy required for cooling. Building clusters orientated within 30°C of north perform considerably better when combined with the correct orientation of short and long elevations and window to wall ratio (Aboulnaga, et al, 2000, Givoni, B, 1989).

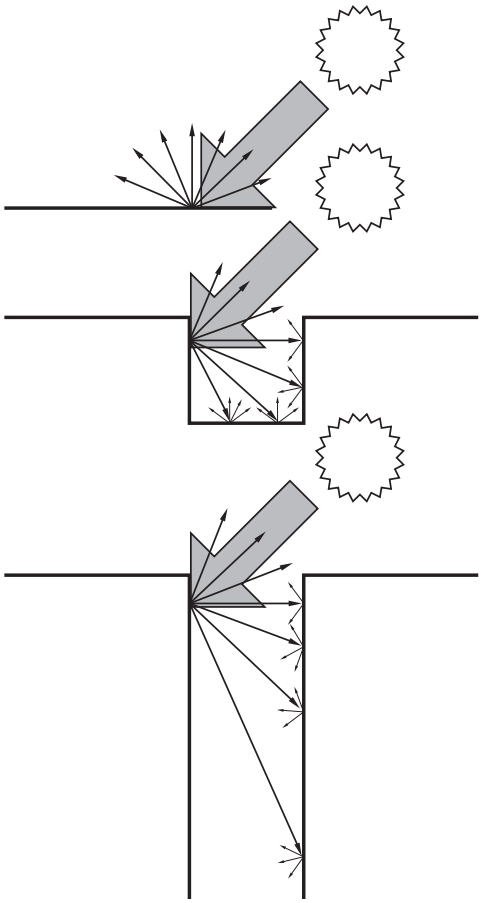


Figure 1: Narrow, deep streets reduce radiant heat gains

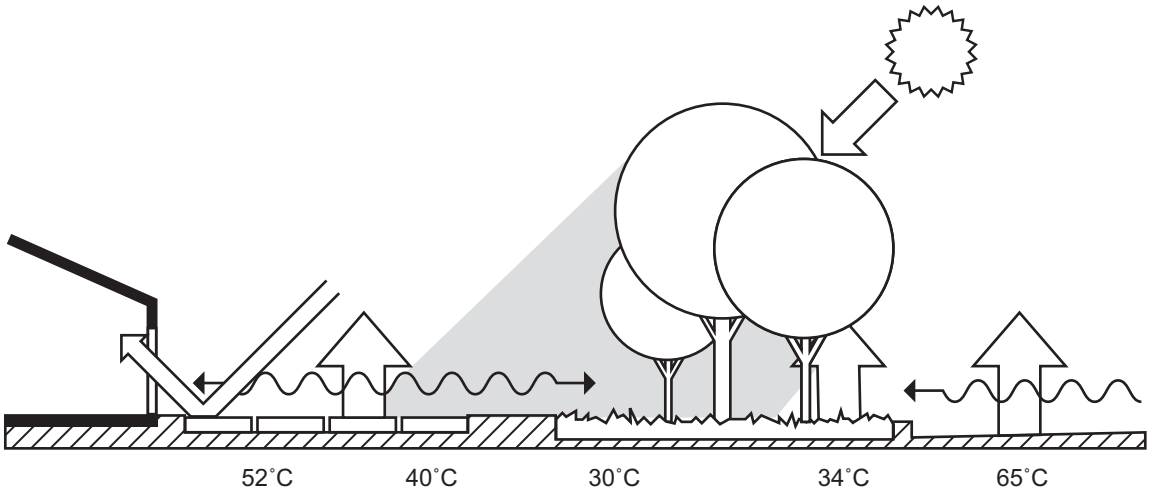
(Adapted from Givoni, 1998)

3.3.3 Urban vegetation

Urban planting in the form of parks and planting around buildings can significantly reduce the heating loads of buildings by lowering air temperature next to the building facades and thus reducing radiant heat gains reflected from the ground (Givoni, 1991, 1989). The percentage of total solar radiation that reaches the area below a tree is typically only 10-30 per cent in summer. This leads to cooler surface temperatures below the trees, which in turn reduces the heat transmitted into buildings or re-emitted into the atmosphere.

Green roofs and green walls (or 'living walls') can further reduce cooling loads by shading and insulating the building envelope and removing heat from the air through evapo-transpiration. The temperature of a conventional rooftop can exceed the surrounding air temperature by up to 50°CC, whereas a vegetated rooftop can be cooler than the surrounding air.

While planting and green roofs should not be used as a substitute for conventional insulation, and should be considered carefully in the UAE where water is scarce, they can contribute to building insulation, improve the site micro-climate and reduce the heat island effect on the surroundings (US Environmental Protection Agency, 2009).



Typical urban temperature conditions in hot and arid climates

Temperatures shown were measured on a 40°CC day

(Adapted from Koch-Nielsen, 2002)

3.3.4 Building density and type

Urban density and building heights are a major determinant of urban ventilation and thus building cooling loads. Tall, long buildings of similar height will limit air movement and should be avoided, whilst buildings of varying heights with long facades, oblique to the wind, enhance urban ventilation.

Streets and urban spaces such as street courtyards which have a higher height to width ratio can provide reduced external air temperatures when associated with tree shading. This is achieved by reducing solar radiation exposure and thus absorption in the same way traditional narrow streets limit solar access to ground and wall planes (Shashua-Bar, Hoffman, 2004, Givoni, 1989, 1994).

An understanding of traditional city planning aimed at developing favourable micro-climates, coupled with the application of sustainable precinct design tools such as United States Green Building Council (USGBC) LEED rating tool for Neighbourhoods, the new Abu Dhabi Estidama Pearl Design System for New Communities, Urban Centres and Neighbourhoods may support the design of energy efficient precincts and cities in the UAE.

4.0 CONCLUSION

The traditional building design practices of the Gulf region, based upon an understanding of climate, provide a foundation for low-energy buildings in the UAE today that is appropriate to the environment and results in reduced carbon emission. This may also lead to an appropriate vernacular architecture replacing imported building models that have contributed to a dramatic rise in energy usage and a proliferation of culturally non-specific building forms (Bouman, Khoubrou, Koolhaas, R (eds), 2007).

Significant generic literature exists to support education in the design of low-energy buildings in hot and arid climates, complemented by regional journals and research papers that have measured the benefits of traditional design strategies and the poor performance of imported models, in particular those incorporating curtain glass facades. The dramatically different climatic conditions of the Gulf region mean these imported solutions can only function through extensive intervention by mechanical air conditioning.

Strategies for low-energy design extend beyond buildings to include urban design strategies such as correct street and building orientation to promote urban ventilation and shading and the use of urban parks to promote a 'cool island' effect. Buildings can be designed to operate in mixed mode (that is the ability to use air-conditioning or outside air, when it is appropriate), thereby satisfying contemporary market expectations for air-conditioning, while benefiting from passive strategies during the winter and transition seasons.

The rate of development in the UAE has demonstrated the economic and lifestyle opportunities that exist within the region, despite the harsh climate. Architects such as Rem Koolhaus see the UAE as a unique opportunity for urban designers and architects stating in Al Manakh

"The Gulf's entrepreneurs are reaching places that modernity has not reached before…Perhaps the most compelling reason to take the Gulf seriously is that its emerging model of the city is being multiplied in a vast zone of reduced architectural visibility that ranges from Morocco in the West, then via Turkey and Azerbaijan to China in the East. In each of the countries of this Silk Belt, the Gulf's developers operate on a scale that has completely escaped "our" attention. The burgeoning campaign to export a new kind of urbanism – to places immune to or ignored by previous missions of modernism – may be the final opportunity to formulate a new blueprint for urbanism"

(Bouman, Khoubrou, Koolhaas, 2007)

REFERENCES

'Polystyrene products Industry', viewed March 2009, http://www.ei.ae/contents/June07e.swf

Aboulnaga, M, Al-Sallal, KA and Diasty, RE, 2000, *'Impact of city Urban patterns on building energy use: Al-Ain city as a case study for hot-arid climates'*. Architectural Science Review, 43 (3), pp. 147-158.

Aboulnaga, MM and Elsheshtawy, YH, 2001, 'Environmental sustainability assessment of buildings in hot climates: The case of the UAE', *Renewable Energy*, 24 (3-4), pp. 553-563.

AMEinfo, 2008, *'Hyder Consulting Middle East launches regional sustainable design group'*, 4 October 2007, viewed September 2008: http://www.ameinfo.com/133944.html

Arabian Business, 2008, '*Sustainability key to gulf real estate success*', 1 November 2007, viewed September 2008: http://www.arabianbusiness.com/504236-sustainability-key-to-gulf-real-estate-success?ln=en

Austrade, 2008, *'Green building to the United Arab Emirates'*, 10 June 2008, Viewed September 2008: http://www.austrade.gov.au/Default.aspx?PrintFriendly=TrueandArticleID=8658

Boake, TM [et al.], 2008, '*The Tectonics of the Double Skin*'. School of Architecture, University of Waterloo, USA, viewed October 2008: http://www.fes.uwaterloo.ca/architecture/faculty_projects/terri/ds/tectonic.pdf

Boer, B, 1997, 'An introduction to the climate of the United Arab Emirates', *Journal of Arid Environments*, 35 (1), pp. 3-16

Bouman, O, Khoubrou, M and Koolhaas, R, (ed's), 2007, *'Al Manakh'*, Volume, Vol.12

Cheng, V, Ng, E and Givoni, B, 2005, 'Effect of envelope colour and thermal mass on indoor temperatures in hot humid climate', *Solar Energy*, 78 (4 SPEC. ISS.), pp. 528-534

Ecospecifier, 2008, '*All construction in Dubai is going 'green' in 2008'*, 30 November 2007, viewed September 2008: http://www.infolink.com.au/c/Ecospecifier/All-construction-in-Dubai-is-going-green-in-2008-n743743

Foster + Partners, 2008, *'Masdar Development'*, Foster + Partners, viewed September 2008: http://www.fosterandpartners.com/Projects.1515/Default.aspx

Givoni, B, 1976, *'Man, climate and architecture'*. 2nd ed., Applied Science Publishers, London, UK

Givoni, B, 1989, *'Urban design in different climates'*. World Meteorological Organization, Geneva, Switzerland

Givoni, B, 1991, *'Impact of planted areas on urban environmental quality: A review'*. Atmospheric Environment - Part B Urban Atmosphere, 25 (3), pp. 289-299

Givoni, B, 1992, *'Climatic aspects of urban design in tropical regions'*. Atmospheric Environment - Part B Urban Atmosphere, 26 (3), pp. 397-406

Givoni, B, 1994, *'Passive and low-energy cooling of buildings'*. Van Nostrand Reinhold, New York, USA.

Givoni, B, 1994, *'Urban design for hot humid regions'*. Renewable Energy, 5 (5-8), pp. 1047-1053

Givoni, B, 1998, *'Climate considerations in building and urban design'*. Van Nostrand Reinhold, New York, USA

Hails, C (ed), 2006, *'2006 Living planet report'*, WWF International, viewed October 2008: http://www.panda.org/news_facts/publications/living_planet_report/lp_2006/index.cfm

Jaacoub, W, 2007, '*Solar solution*', 5 August 2007, viewed on 9 September 2008: http://www.arabianbusiness.com/497306-solar-solution

Kazim, AM, 2007, *'Assessments of primary energy consumption and its environmental consequences in the United Arab Emirates'*. Renewable and Sustainable Energy Reviews, 11, pp. 426-446

Khaleej Times, 2008, *'Green building code in Dubai from next year'*, 12 August 2008. viewed September 2008: http://www.uaeinteract.com/docs/Green_building_code_in_Dubai_from_next_year/31516.htm

Luke, A, 2008, *'Building benchmarks, 4 June 2007'*, viewed September 2008: http://www.arabianbusiness.com/13870-building-benchmarks

Masdar Initiative, 2008, '*Introduction, Masdar Initiative*', viewed September 2008: http://www.masdaruae.com/text/introduction.aspx

Maxmakers, 2009, *'Masdar City Abu Dhabi'*, viewed March, 2009: http://www.nachhaltigkeitschweiz.ch/fileadmin/pdf/Projekte/DUE/AGS_Side_Event/2_hahn.pdf

NASA, 2008, *'Surface Meteorology and Solar Energy'*, viewed October 2008: http://eosweb.larc.nasa.gov/cgi-bin/sse/grid.cgi?.Accesed 15/10/08

Pears, A, 2005, 'DES 37: Energy systems, appliances and equipmen', *BEDP Environment Design Guide*, Australian Institution of Architects, Melbourne, 2005, pp. 1-7

Prasad, D, Chandra, S and Fisher, M, 2003, *'Revisiting energy efficiency in commercial buildings'*, Royal Australian Institute of Architects, Melbourne 2003, viewed August 2008: http:content.environmentdesignguide.net.au/i-cms?page1.21.60.245.247.452

RAIA (Royal Australian Institute of Architects), 2005, UAE Free Trade Agreement: submission to the Department of Foreign Affairs and Trade, Canberra

Samarai, MA and Qudah, LM, 2007, *'Planning sustainable mega projects in UAE'*. World Housing Congress 2007: affordable quality housing, Malaysia, 1-5 July,2007

Shashua-Bar, L and Hoffman, ME, 2004, 'Quantitative evaluation of passive cooling of the UCL microclimate in hot regions in summer, case study: Urban streets and courtyards with trees', *Building and Environment*, 39 (9), pp. 1087-1099

Southwall Technologies, *'Heat Mirror Insulating Glass'*, viewed March 2009, http://www.southwall.com/southwall/Home/products/Residential/HeatMirrorInsulatingGlass.html

US Environmental Protection Agency, 20XX *'Reducing Urban Heat Islands : Compendium of Strategies – Green Roofs'*, viewed on March, 2009: http://www.epa.gov/heatisland/resources/pdf/GeenRoofsCompendium.pdf

Wind statistics, 2008, viewed October 2008: http://www.windfinder.com/windstats/windstatistic_dubai.htm

Wood, A, 2007, 'Sustainability: A new high rise vernacular?', *The Structural Design of Tall and Special Buildings*, 16 (4), pp. 401 - 410

BIOGRAPHY

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APPENDIX – DRIVERS AND OPPORTUNITIES FOR LOW ENERGY DESIGN

Political and Economic

- Kyoto Protocol: to which the UAE has signed, and is therefore required to reduce greenhouse gas emissions (Austrade,2008).
- Projected growth: expectations in the Middle East, predict US$500 billion of development to 2015. The region's infrastructure is unable to match this projection unless energy, waste and water issues are addressed (Austrade, 2008). Attending to this economic "risk" will have to include energy conservation measures and the incorporation of renewable energy sources (Arabian Business, 2008).
- Desire for energy conservation: The development of energy conservation and renewable energy technologies is consistent with the UAE's economic growth strategy of diversification. The UAE holds almost 10 per cent of the world's proven crude oil reserves, however single emirates such as Dubai generate hold limited reserves whereby only 6 per cent of their GDP stems from oil production (Kazim, 2007).
- Risk profiles: Professionals operating in the UAE believe that the global drive for sustainability is directly changing opportunity and risk profiles for developers and investors in the Middle East, requiring improvements in building design practices in order to ensure competiveness and ongoing asset value (AMEinfo, 2008).
- Cost savings:Long term building operation cost savings.
- Increased occupant productivity: by up to 30 per cent (Samarai, Qudah, 2007).
- Poor construction standards result in high levels of energy loss through infiltration and shorter building life cycles (Samarai, Qudah, 2007, Wood, 2007).

Regulatory and Voluntary Standards

- Government Commitment: Sheikh Mohammed bin Rashid Al Maktoum, Vice President and ruler of Dubai has committed to all new buildings being "green" from January 1 2008. Abu Dhabi is also showing a strong commitment to sustainability principles (Austrade, 2008, Ecospecifier, 2008).
- Green planning codes: The new Abu Dhabi Urban Planning Council Planning Application requirements combine mandatory integrated design processes with energy and water modelling as of February 2009 for all applications. Major new Town Planning Schemes in Abu Dhabi also mandate specific aspects of passive building design, energy and water efficiency such as for the Capital City District.
- Green building codes: The Dubai Municipality (DM) has announced that a green building code will be introduced from 2009 (Khaleej Times, 2008). Minimum environmental requirements are stipulated by the municipal governments in each Emirate. Free Trade Zone who set their own standards, and which may exceed building regulations (Austrade, 2008).
- Green rating tools: The Emirates Green Building Council (EGBC) introduced a Draft LEED Emirates scheme in late 2007 and issued this to the USGBC, where it is still under review (Austrade, 2008, Luke, 2008), and the Estidama (Arabic for sustainability) Pearls Design Rating System has commenced, which covers New Communities and New Buildings
- Shortfalls in market driven improvements in energy efficiency, may lead to further government intervention and regulation (Pears, 2005).

Environmental, Ethical and Corporate Governance

- High emissions: Primary energy consumption of oil and natural gas in the UAE has quadrupled since the mid 1980's. Per capita energy consumption is the highest in the world with carbon emissions of 10.5 tons carbon equivalent compared with the world average of 1.1 (Kazim, 2007). The ecological footprint of the UAE as measured by the WWF Living Planet Report 2006 is almost 12 hectares per person. This is the highest in the world and compares with Australia at 6.5 hectares (No. 6 in the world) (Hails (ed), 2006).
- Policy: Corporate and environmental policies of architectural practices themselves as well as those of related professional organisations.

Design, Climate and Technology

- Harsh climate: Specific climate conditions and traditional climate responsive architecture
- New buildings using more energy: A survey of sustainable building practices in the UAE was completed in 2001, comparing the energy usage of contemporary buildings in the UAE with international baselines and with traditional buildings in the UAE. This demonstrated that traditional buildings in the UAE use on average 55 kWh/m^2 per annum and contemporary buildings 268 kWh/m^2 (Aboulnaga, 2001)
- Rising fuel costs: Rising fuel costs are making renewable energy more competitive. The World Bank predicts that advances in solar technology will reduce the costs of solar power to below US 6 cents per kWh (Jaacoub, 2007).

Business & research opportunities

- New leading precedents: The government owned Future Energy Company, is developing Masdar in Abu Dhabi, the world's first carbon zero city covering an area of 6 square kilometres. Designed by Sir Norman Foster this city will be a commercial and residential hub for research, development and investment in green technologies aimed at providing energy security and economic diversification for the UAE (Masdar Initiative, 2008). As well, the Burk Ahab development by Nakheel in Dubai will provide valuable case studies and market precedents.
- Opportunity of foreign consultants: Austrade believes the combination of large development scale and the similarity of climatic conditions and openness to Australian technologies, provides substantial opportunities for Australian professionals providing sustainable building design services (Austrade, 2008).The UAE provides an opportunity for global marketing of company skills in ESD and low-energy, zero energy buildings and master planning solutions.

Design, Climate and Technology

- International skilled professionals: The large number of international skilled professionals residing in the UAE and the economic and market driven innovation in design and technology may support innovation in low energy design practices (RAIA, 2005).
- Zero energy building: Research and design may provide a means for building owners to isolate themselves from future energy price increases and shortfalls.
- Early involvement gives highest impact: Architects can influence energy efficient briefs and design through their early involvement in the project definition and subsequent design process (Prasad, Chandra and Fisher, 2003).