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Sustainability in Traditional Houses in the UAE

Potentials and improvement of buildings abilities

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Abstract

Traditional houses in a particular community are considered the most suitable way of life for its own people. It has been made and developed out of local, available and sustainable materials and matching its context whether climatic, social and even economic contexts. In their path to modernity, most of developing countries have dropped their history and traditional products to import those which created and developed from the west, inserting them in a totally un-matching environment. That insertion creates separation between individuals and their built environment especially their own houses; the most intimate spaces; in addition to the high cost of related services and systems needed to overcome the differences between inserted buildings an and their natural context.

UAE in general and Dubai in Particular, has its own heritage and traditional buildings which were created originally from available material and matching their own context. Rather, it has never been developed to match the progressive needs of the community.
These houses while producing a sustainable environments and social context can be developed in a manner to provide sustainable response to progressive needs of modernity and to minimum energy consumption as well.

Studying week points of old structures, such as short time deterioration and lack of services and technology, will be the start to propose adaptation and addition of modern technology to model an adapted version of old structures that satisfies current needs and overcome mistakes been experienced while implementing western style communities in a hot arid climate with no impact of social, culture aspects.

1. Introduction to Sustainability

"Perhaps the most important thing to say about the origins of sustainable residential designs is that they lie in ageless vernacular architecture, the kind of construction that was practiced for most of human history and continues to be practiced in what we in the West call the Third World. This approach relies on simple, renewable, and naturally insulating materials and passive strategies like sitting, thick walls, and natural ventilation to keep houses cool in summer and retain heat in winter"[1] (Stang, A. & Hawthorne, C., 2005)

Built Environment in a particular city is considered as the sum of the buildings' construction of that community through centuries. Part of that built environment is being demolished and reconstructed several times every few decades, which is the majority. The rest is being conserved and renewed through centuries and remains the most valuable part which is historical part of the city. Such part of the built environment gains its value by being flexible to be upgraded, modified and has the ability to suite the changing needs of different ages, and functions.

Historical Hotel, Al-Bastakia, Dubai, 2004

This historical part of the built environment is clear evidence that sustainable architecture exists in our community and can be achieved through particular age. But development and upgrading process need to be planned in accordance with modern requirement of each time.

1.1. Why Sustainability?

The UAE has been rated of having the worst ecological footprint in the world. This means that UAE requires much more land that is already available. The global average is 2-3 globes, while the UAE's one is 9 (WWF World Wildlife Fund). The first two questions to be raised in such subject are "Why one should pay a lot of efforts to work on the improvement of building efficiency in one of biggest oil producers and exporters?" and "Shall we stop using the advanced technology and go back to the tents and primitive mud's architecture?".
In order to answer both questions we need to understand the current situation of the international markets and policies leads to reducing the dependence on normal and vanished energy resources like oil specially in the field of building construction there some indications appeared clearly during latest years that

shows the danger in such reliance on non-stable and vanishing resources. For example, the shortage of natural gas supplies to east and middle Europe in winter 2006 during the temporary cut of gas supplies from Russia through Ukraine. That shortage closed many factories in Eastern Europe for few days; all energy resources and reserves have been oriented to supply houses during a very cold winter. All industries were about to stop totally.
If we added the increment of construction materials especially the imported ones, we can realize the feasibility of the study that can reduce 50% energy that oriented to buildings construction and related activities[2].

1.2. Sustainability in Principle:

"Sustainability and sustainable development stands for meeting the needs of present generations without jeopardizing the needs of future generations- a better quality of life for every one, now and for generations to come."[3]

As implementation in building design a lot of factors need to be considered, most of it are physical factors that are related to building materials and systems as well as surrounding natural resources and environment. Therefore, we would like to rescale these factors to include those factors that are related to social and cultural issues, which we think they are essential to the success of this process especially in the gulf in general and the UAE in particular. These factors are:

1. ***Urban Design***: (Integration with surrounding environment)
2. ***Landscape***: (Utilization of regional and micro climate)
3. ***Building Interior***: (Flexibility of design and space utilization)
4. ***Tectonics: Materials, Systems****:*
   (Natural resources, available materials, and considering the building as independent station of systems)
5. ***Social Patterns:*** (recognition of social traditions and cultural emphasis)
6. ***Economics:*** (Long term feasibility and running cost considering variables)
7. ***Energy Performance & Efficiency****.*

These factors are essential in recognizing for the ability of particular building to sustain for long time with the proper functioning and the flexibility to accept different variables to life style and new patterns of life.

"From the above factors and requirements, we can identify three sides of Sustainability in Architecture: 1. the physical model, 2. the internal ecological system, 3. the social integration. Each of these factors needs to be implemented in relation to the other two factors to accomplish the ideal form of sustainability in buildings"

In the age of globalization some economic patterns has changed, which affects all aspects of architectural and urban design; even it affects city planning. So, tower and business centers with all it requirements of massive resources of energy can not be easily challenged. However, the resulted negative effects of

these buildings on the overall natural resources can be reduced if we directed our housing and real estate policies towards sustainable architecture in housing design to begin with; the limited scale construction which has strong ties with people in their very intimate and relaxing spaces.*

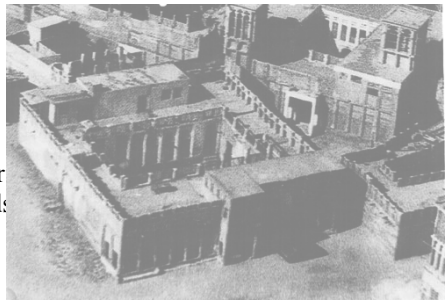
Hence we can conclude that the feasibility of Sustainability is very high when compared with the high risks expected in the near future due to the shortage of oil production or political conflicts.

1.3. Sustainability and social factors:

As stated by the secretary General of the UN; Mr. Kofi Anan, in the Environment day 2002, the three main pillars of **Sustainable Development** as: economic growth, social progress, and protection of our environment and natural resources.[4] This statement shows the great importance of social factor in the success of sustainability in general. However, all work for sustainable architecture ignored that factor and its required priority. Consideration of social patterns of particular community is the only guarantee that the process will continue and will develop by people themselves. All previous studies shows that people are the fuel for sustainability process, without which the process won't go on.

From the social point of view, sustainability in building design should work on the changing needs of people. Then it should understand nature of people; how they interact together; what are their patterns of life which can be used as a reference, as these facts doesn't change but it develops. Understanding people is vital to recognize how they utilize their spaces and what are their basic needs and tradition that doesn't change, and others that can change. This helps in developing design patters providing flexibility in design.

1.4. Sustainable House Strategies:



Due to the uniqueness of the United Arab Emirates of its climate, geography and social structure; her need for expansion and creating new communities should be based on sustainable development principles in order to maintain a long term development with the very limited natural resources and tough conditions. We need to ask the main question, as *Awotona* asked, is "*what kind of strategy must be devised for sustainable development so that environmental issues can be linked with*

* In recognition of size and scale of housing projects we can refer work for one company's in an office space of (100 sq.m.) needs (100sq.m.) which means houses to offices 10:1.

national social, cultural and economic objectives?"[5]*. " what might the implications of such strategy, which seeks to reduce overall demand for resources…. On economic growth, social and health issues, agriculture development, urban form,…etc.?*" he continued.

"*Home is the node of the community*" Traditional and historical example, Old Dubai. [6]

Awoton suggested based on Brundtland Report's "Our Common Future", (1987) some principles to guide the desert regions for sustainable developments; we are concerned mainly in the scope of this paper with the first principle:

1. A sustainable World Begins at home.

The home is the node for sustainability, once the family is sustainable, the community, region and nation then the world will follow. The following chart explains the how the design of homes can be more energy and environmentally efficient.

2. A systematic determination of future needs.

As one of the main sustainability principles is to conserve the natural resources for future generations, then it is a must to provide a room for future generation to determine their needs and having the resources to reply these needs. Then it is essential to develop a systematic approach of living that doesn't depend on vanishing sources or producing a pollution that affect natural life or the surrounding environment.

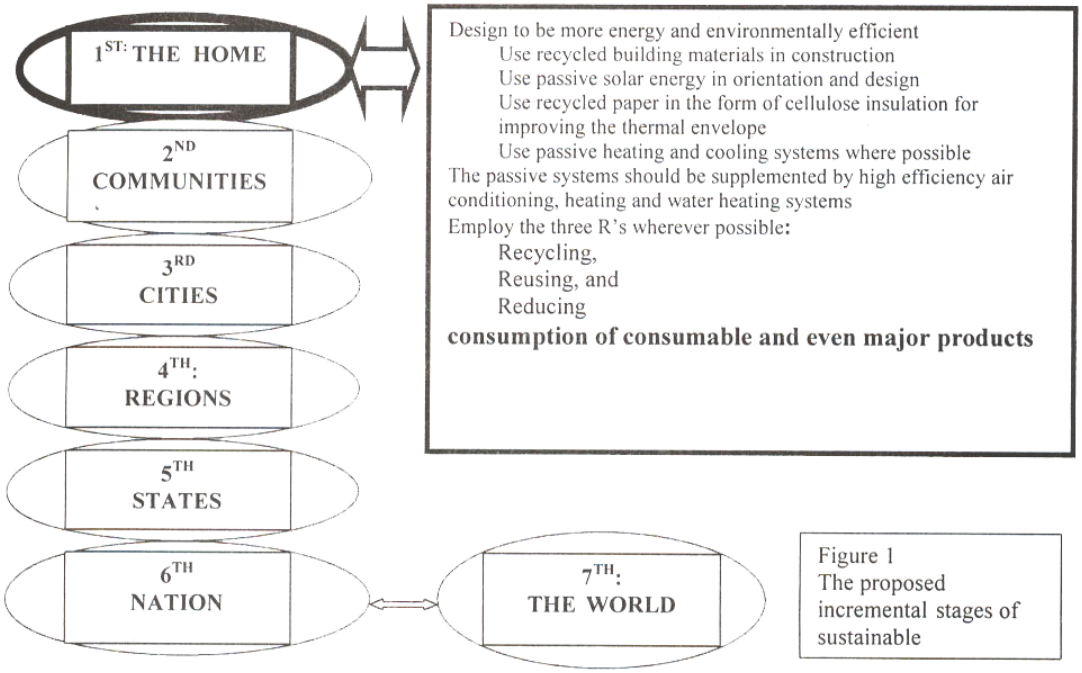


Figure 1
The proposed incremental stages of sustainable

"Home as a nade and Sustainable Starting Point", Awoton, A., 1999.

3. Poverty alleviation as a means of protecting the environment.
While *Awoton* refers under this principle to the needs of the poor from the moral obligation of sustainability point of view, we would like to build the importance of this point to the first point which is to provide the sustainability for particular community you should start with homes. These homes should cover all sides and sectors of the community. You can never provide well being community following the suggested strategies while a big sector is not covered or included in this strategy.

Building on the suggested strategy, we can start to work on homes, developing which to a sustainable units integrated together with social life will complete the image of sustainable communities.

2. The UAE and the Need to Sustainable Development:

2.1. Economic growth

There is no doubt that UAE is one of the fastest growing economies in the world. As one of the largest oil producers and due to the stable increment in oil prices, it was exposed to increment in the national income which had to be imposed in growth plans and policies.
Economic growth is the leading force in a small country with limited number of Population (less than 5,000,000 person, as per 2006 governmental records[7]). Out of this population; 75% are not locals or national citizen but, rather, they are imported manpower and human recourses to push the wheel of economy with similar pattern to the model of Canada, with some exceptions. * This growth needs supported services and facilities of housing projects, services centers, schools, etc…

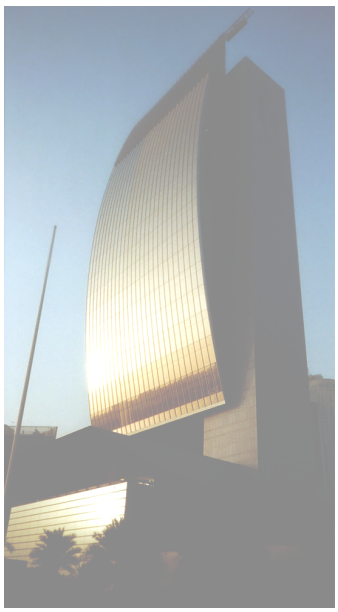
* It is important to identify that real estate sector assemble AED 29,540 Millions in 2004, and construction assemble AED 28,468 Millions in addition to AED 6,720 Millions for Electricity, water & Gas sectors. These figures clarify to what extend the housing, real estate and construction sectors use of the national income during 2004 (last published figures). Since then these sectors have a rapid growing factors whoever we can't refer to exact percentage unless it is published, but it is clear that it grows with not less than 10% annually.[1]

Currently, massive housing projects are going on for he potential future of economic growth and predicted expansion of business in the UAE. Such massive scale projects need to be planned for as a part from long term sustainable development plan, rather than short term solutions.

Massive Housing Projects in Dubai, 2006.

2.2. Environmental Situation of the UAE

These coastal areas suffer from the highest level of humidity that reaches to approx. 100% during some periods in summer. The temperature reaches to an average of 40 C among seaside cities and reaches to 49 C as a maximum for desert cities like Al Ain. [8] . In winter the temperature average 20 C & 35 C which is very comfortable climate for living in the Middle East.[9]



Therefore, the produced model has to provide internal ecological system that reduces external temperature about 13~20 C in summer, and has to absorb the high level of humidity to reach the comfortable level around 10~30%. On contrary of that, the current situation of housing design and construction technologies is working in the opposite direction. It depends mainly on European style architecture with its long span curtain walls facades and very thin skin which allow for the maximum heat gain. These design lead to the total dependence on heavy air conditioning systems, which in case it is off, all the building should be evacuated in few minutes, before, medical hazards appear.

Limited applications of solar energy started to appear in other sectors of services like traffic lights, but until now, as far as we know, there is now large scale implementation of energy alternatives in the field of housing design and construction.

2.5. Current Housing Projects in the UAE

Despite the fact that local governments are paying efforts to improve the quality of produced buildings in terms of sustainability and environmentally friendly behavior, most of produced housing projects lack of such understanding. Residential housing has two categories in the UAE; Residential towers and complexes; and housing compounds and

neighborhoods, which mainly used by either local citizens of UAE or by high paid employees and businessmen.

We can determine to what extend the current models are designed with regard to western models and facilities ignoring the special nature and environment of the gulf and its desert nature as these compounds mainly are located on the borders of the existing built environment and in direct touch with desert climate and nature.

We would like to propose criteria of analysis based on the following points of evaluation:

1. **Urban integration**, Site Selection and landscape design. (3 Points)
   Measures: Building forms, locations, and external organization
2. **Building materials**, Systems, and Detailing (5 Points)
   Measures: recycled, pollution produced, and thermal performance.
3. **Ecological treatments** and level of human comfort. (5 Points)
   Measures: System of Air conditioning, natural ventilation, and health environment.
4. **Natural Resources**: its efficiency, usage and deployment. (5 Points)
   Measures: Energy resources, water resources, usage, and waste.
5. I**nternal spaces organization** and its reply to the social needs. (2 Points)
   Measures: Flexibility of design, Ability to modify, spaces interaction.
   Total scale: 20 Points

We wanted to use criteria of points' scale, which is similar to LEED* Certificate in the USA[10], in order to judge on a particular building or design, and build my result on to what extend these measures have been applied.

Dubai has many developed regions that include housing compounds. Some of which have been assigned to local citizens and others to real estate investment. Therefore, we will select green community and the springs as an example of the current designs as it shares most of the features with other modern developed projects and have been occupied already.

First Measure: Urban Integration, Site Selection & Landscape design

* Leadership in Energy and Environmental Design (LEED), is a standard rating system applied by U.S. Green building council to certify applied buildings to be sustainable and environmental efficient product.

Site is located at the south border of Dubai city built zones. Away from the city center, adjacent to huge desert which is natural site for that kind of occupation. However, on urban scale there are no major treatments to the site or units to resist expected sand winds or storms or at least to reduce it. e.g., there are no wide buffering zones of high level palms and low level trees which can filter winds to the required standards. Level of vegetations is rather low around the units, while there good distribution of water features, fountains and the swimming pools.

Units' distribution and spaces in between beside the lack of vegetation don't help in providing shadows of the external skin of the building. Units are designed mainly of compact forms without internal open spaces
Points 2 out of 5

Second Measure: Building Materials, Systems and Detailing
Main structure have been made of reinforced concrete, which is a non recycled material and need high level of energy for its construction, and has low thermal insulation properties. External skin is made of Hollow concrete blocks that shares concrete the properties. Internal finishing is of typical systems in UAE is cement plaster and acrylic paint for walls and ceiling, Ceramic tiles and marble slabs for flooring. Ceramic tiles are used for wet areas. Out of these materials; marble can be re-used and recycled, has a high thermal resistance and environmentally efficient. Small windows is located on the external walls made on double glazing panels that have high performance of thermal insulation, however it is the not the optimum units to be used for such hazard conditions.
Points 2 out of 5

Third Measure: Ecological treatments and level of human comfort

Due to the nature of compact forms that depends only on the perimeter walls for openings, the units depend mainly on central Air-Conditioning system to reach the thermal comfort level for during 6~8 months a year. Almost there are no internal air circulations that planned to treat hazard climatic conditions. The total dependence on central AC systems causes medical problems and sickness especially for young people and children.
Points 1 out of 5

Fourth Measure: Natural Resources: efficiency, usage and deployment.

Units get their need of power through the central power plants which are basically based on oil based generators and transformers that transfer medium and low voltage power through underground cable networks. This power source creates high level of pollution creating greenhouse gases like CO2. no utilization of clean and renewable energy resources like wind power or solar energy that can be fulfill all the units needs of power.
Points 1 out of 5

Fifth Measure: Internal spaces organization and its reply to the social needs.

The compact design forms that depend on the efficiency of space circulation regardless of social effect and traditional habits of the occupants lead to separation between people and space. These models lake the flexibility of design that can be modified based on change of occupants or change of usage. There four compact designs with minimum areas for spaces that have been adjacent to each other with hollow concrete blocks partitions.
Points 1 out of 2

Then we can conclude that in our proposed scale a typical housing compound in Dubai achieved result **7 out of 20 points** which means total failure in replying sustainability measures.

Therefore, we are going to analyze traditional housing units of Al-Bastakya zone in Dubai which have been created and developed through decades by original citizens out of natural materials and natural resources.

3. Traditional housing of Al-Bastakya.

3.1. Historic

The Bastakia district is a settlement of initially Iranian merchants from *Bastak* and *Lingah* built around 1902. The location ensures close proximity to the ruling sheikh house of the Al Maktoums as well as proximity to the *Souk* and the merchandise off loading area of the creek. The houses generally compromised apart from the living sector also the storage of merchandise.

Urban planning wise the district is arrange in two directions parallel to the creek as well as a perpendicular alignment. The *sikkas* (alleyways) have an average width of 2-3m. An array of open air public spaces is distributed across the district allowing space for socializing. The outdoor areas are often additional shaded by native trees and shrubs which make it into a visual pleasant environment. The geographical position of the creek also enables the use of the breeze to and from the water to be creating a cool breeze that goes through the *sikkas* (narrow streets).

Unfortunately …'staggering urban growth was implemented while sacrificing many heritage districts to allow space for new "modern" developments. As a matter of fact a large number of these heritage relics vanished in a very short period. In terms of figures, out of a total of 3,000 existing heritage buildings only 371 have survived.'… [11]

3.2. Climatic and structural analysis of traditional houses of Al-Bastakia .

Regarding the question which one (the western or eastern model) is more sustainable, one needs to distinguish between the old and adapted eastern

house, the passive traditional version would not full fill today's requirements for thermal comfort, the retrofitted units do no doubt – but it would be beneficial if the systems could better integrated within the design for better efficiency and also less obvious visual intrusion.



3.3. Building Materials

As the tradition of the gulf cities' constructions by the beginning of 20th century, the construction is mainly made of primitive mud soil available at the deserts. However, the settlers utilized the use of coral stones distributed a long the beaches in Dubai and coastal regions to replace the usage of unbaked bricks as main structure component for load bearing walls. That structural system withstands loads until 3 stories high. Roofs and slabs are built out of available timber and trees branches that work as beams covered with layer of palm leaves. Basic spaces are located in ground floor, minor and additional spaces located in first floor.

With the very simple analysis to these building materials we can conclude that these materials are:

a. Derived from surrounding and available environment.
b. Natural materials don't cause any harm to the environment.
c. Cause no pollution and no need for energy while construction other than sun rays.
d. Can be easily recycled, reused, and even reproduced for new purposes.

3.4. Environmental treatment and field of comfort.

As these building materials are derived from nature, they are the best to deal with the

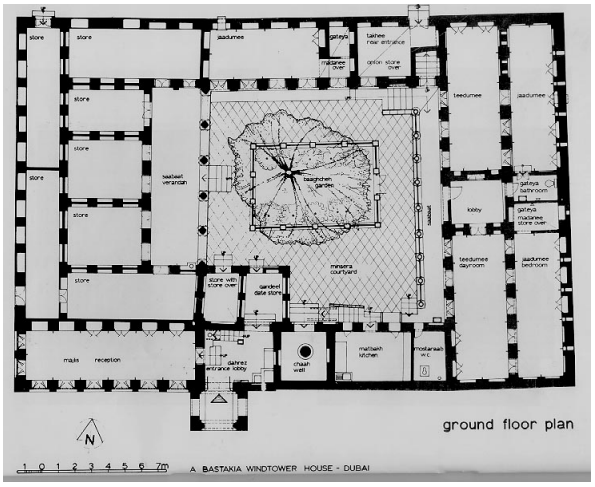
climatic conditions. For example; Primitive mud or salt stones with mud mortar walls construction need in wide cross section that was used provided the best thermal insulation due to the huge content of natural fibers and air gaps included in both components. In parallel with reducing sizes of doors and windows, the majority of walls are negative thermal transformers. Small size windows and doors oriented mainly towards the middle courtyard are closed with wooden leaves.

These openings allow ventilation though the desired access from either the courtyards or from the *Brajeel* (Wind tower), where which incoming air is cooled naturally through wet tissues (the *Brajeel*) or through the passive air movement through the court*.

3.4. Social integration and cultural emphasis.

As produced by the occupants themselves these houses are the best formula to reply their need at the time. Therefore, these constructions are considered social models for family relations in Dubai Community. It, moreover, reflects the basic traditions and relation among the community members and units. By the analysis of these relation we will reach the conclusion of *Awoton* (to which we referred earlier) first principle for desert regions which is **"***A sustainable World Begins at home* **".**

The orientation of spaces divisions towards the inside and the closure of external skins are a policy or privacy as well as a climatic treatment. The social pattern of local families in the UAE totally separates family movement, circulation, interaction spaces from those of public and visitors' spaces. In this regards, it matches with all Arab and Islamic concept of housing, which last until today among local citizens.



4. Developing future housing units based on the traditional models

* The common concept of cooled air ventilation in desert regions , mainly the Arabian peninsula.

The old traditional houses, as found in Al-Bastakia have no doubt their own charm providing strong link with their own context, physically and culturally. These houses concepts and designs' contrast with the western models and estates developments in Dubai, is clearly recognized not only on urban scale but also on the functional plan, materials and systems scales as well. No doubt the new estates are generic and will serve therefore for the global citizens of Dubai, however they are a bit life and soulless and do not respond to the climatic conditions given.

The adapted old houses would provide a broader diversity in the Dubai residential market, as well as it predicted success in managing long term energy consumption and cost saving policies.

Traditional housing of Dubai has replied successfully the social, natural, environmental needs of its occupants of its time. Definitely, we are not going to challenge technology to impose the historical models today, rather we can abstract the concept of sustainability and environmental integration to develop our housing models today in the same city.

Therefore, we would like to define the objectives and features of that concept of adaptation in the following categories

4.1. Development of traditional building materials

There are moves one could explore the adaptation of traditional building materials and methods to match modern standards or the search in finding material and methods that would mimic the traditional ones, since coral stones out of sustainability and availability reasons would not be an option for new constructions.

Combined with ease of construction, financial consideration it will lead us to the translation of the physical characteristics into modern materials. System wise the basics of sustainability will lead to a hybrid solution passive design combined with an active system solution mainly for the summer months.

Materials and systems of constructions derived from traditional concepts can be divided into three main items:

1. Natural material deployed for the use of interior organization of a building.
2. Developed system with high performance of thermal insulation for the external skin.
3. Utilization of recycled materials with no harm to the environment.

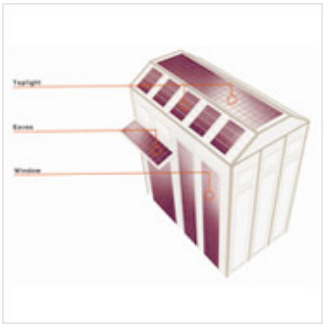
Developed bricks out of the available sandy soil with chemical additives can be used in lieu of hollow concrete blocks. In association with steel frames (Natural & Recycled materials) sand bricks will allow for the construction stability with the utilization o timber beams for internal slabs and openings. Cavity walls and external insulation cladding systems can provide similar insulation systems to those of traditional ones.

The use of newly developed double glazing panels, which can work as solar cells and high thermal insulation performance, can influence the use of traditional concepts in new constructions. However, it gives the occupant the best feel of conatc with nature rather than the concrete structures that can not be work without the existence of Heavy Air conditioning systems.

4.2. Implementation of sustainable energy sources *(Unit as independent station)*

Integration of sustainable devices such as solar systems can be easily integrated within the roof and shading structures within any house or even estate wise –shaded walkways etc could provide additional surfaces to generate electricity. The aim of such development is to provide an independent station building its energy source on Sun rays which is available form 10~14 Hours daily. The proposed system is built on the following:

1. Solar cells that generates electricity and power from Sun Rays.
2. Main plant room that control power distribution.
3. Central cooling unit(s) and Central Boiler
4. Cool water pipes that go through walls and roofs to provide radiated cooling energy
5. Cooled water pipes surrounding building openings to use natural ventilation to cool interior spaces.



PV_TV Panels, 10% Transparency, and its layout Arrangement.

<u>On the urban scale:</u>

1. Utilization of Solar floor tiles that generate power and turn it to light source at night.*
2. Connect all houses and units to one network to utilize the extra power produced to provide electricity to the entire district services and can sell it to the government.
3. Utilizing similar cooling systems to the some of the semi open spaces through cooled water pipes networks.

Photo courtesy of the New Jersey Board of Public Utilities.

* Newly developed solar lit products that absorb solar energy at during day time and use it to generate light at the evenings.

4.3. Concept of Development

Following the housing units strategies for sustainable design of Awoton mentioned previously in (1.3.) we need to apply his three ***Rs***: ***Recycle, Reuse & Reduce***[12].

4.3.1. Recycle/ Reuse

Building materials should have the possibility to be recycled into other products, then not to harm the environment. Therefore, concrete structure and most of concrete or cementatious materials need to be avoided or at least reduced as it can't be recycled again. Other natural material can be widely used in the region. Primitive mud bricks can be developed and Timber is also natural material that can be used for internal elements and it is not preferable to be used as main structural elements due to the excessive heat load that affecting its stability.

These materials can be recycled into other products after the building is demolished like MDF panels and papers for wood remains; sand or crashed aggregates for bricks and stones.

Light partitions and insulation systems have been developed to increase the level of flexibility and reduce pollution.

These materials should conserve natural resources, doesn't need pollutant materials like oil while construction, and have minimum effect on the surrounding environment.

It is however important to note that the construction or better said the destruction of buildings has some commendable mechanism- such as the fact that the windows, doors and sanitary ware are often removed and re-used.

4.3.2. Reduce

Reduce consumption of energy and water resources are one of essential and vital parts of sustainability of housing units. As we learned from historical units that it was independent, we can reduce the required energy by three ways:

- Insulation
- Cross ventilation
- Reduction in electric wiring and utilization of automatic consumption controls for lighting.
- Reduction of water consumption and utilization of water recycling.

4.3.3. Amorph /hybrid solar

It has been often criticized that the UAE is not investing into solar power modules- this was partially due to the inefficiency, high cost and durability problems attached to traditional PV panels. However with the new generation of amorph and hybrid solar panels since the beginning of 2005, which are not only

more durable, inexpensive, but also versatile in its application use into old and new buildings alike. The new generation material enables to integrate solar panels not only within roof and shading structures but also into façade as well as walling solutions.[13]

5. Conclusion

1. Current housing design in the UAE is unsatisfactory in terms of sustainability, energy consumption and social integration.

2. There are vital need to adapt current housing stock, improving building physics and systems.

3. It is essential to develop a criteria and guidelines of sustainable residential development for hot arid climate of the UAE, and translate these guidelines into practice.

4. Further research is required to develop building materials and systems building on the traditional concept of environmental conscious design.

5. Mechanical and Air Conditioning companies are urgently required to develop Air- Conditioning systems that utilize the local climatic conditions in improving the used systems.

6. New technologies need to be integrated and implemented in the special climatic conditions of the UAE.

7. New rules need to be issued to control the construction of buildings to reduce their energy consumption, and the harm to the environment.

8. Social Patterns are one of the main factors to be respected while designing a sustainable model for housing projects in the UAE, without which the model won't have high potential for success.

8. Developing a long term strategy to develop a modern housing that built on the special character and personality of the UAE.

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