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SUPREME COUNCIL OF ENERGY

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Abstract
Green building is the result of a well-designed, energy-efficient, environmentally friendly building that reduces the negative impact of a building on the environment and its occupants. Since Saudi Arabia is in its development phase, the role of the architect is to benefit from its potential as one of the leading countries in energy conservation and the practice of renewable resources. Thus, this work presents the proposal of developing a Supreme Energy Council (SEC) in Saudi Arabia. In this work, four case studies were analysed for the designing of SEC. For this work, the estimated buildable area for SEC was 14,985 m2. The SEC will comprise of several zone , which are SCE office spaces, knowledge center space, auditoriums and hall. For this work, 3 sites were compared, and Site 1 was selected as the build site as it exhibited highest evaluation value of 8.84. The proposed SCE was designed based on the deconstruction of the desert rose. With the development of SCE, it will allow Saudi to be a pioneer in energy conservation.

Keywords--green building, renewable energy, architecture, environment friendly, Saudi Arabia

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INTRODUCTION

Saudi Arabia is the largest oil producer and exporter in the world and has one of the largest natural gas reserves in the world, leaving it one of the richest countries in the world in terms of energy resources [1]. Simultaneously it has the largest resource consumers in the Middle East. The energy consumption of Saudi Arabia is four times higher than the average worlds due to its large population [2]. As the number of inhabitants increases, the awareness of efficient energy usage is slowly growing in comparison. However, the Saudi society is still unaware of economic growth and its impact on the environment, and this issue is still not well addressed within the Saudi community [3].
Saudi Arabia has potential to develop a leading sustainable renewable energy sector. The vast empty stretches of desert are suitable for the development of solar energy, using 3,000 hours of sunshine a year [4]. The ability to promote energy efficiency measures is not lacking in Saudi Arabia. Developing a sustainable renewable energy sector requires: a clear, specific and transparent legislative framework and encouraging private sectors to invest and/or financially support renewables [5]. Tlili [6] has reported that Saudi Arabia was among the primary nations to contribute to sustainable energy source exploration through real joint universal collaboration programs, despite the fact that it has a very propelled rank in terms of oil producing nation.

In 2009, Dubai Supreme Council of Energy (DSCE) was founded to secure energy for sustainable development in the region [7]. The council ensures energy supply, plans for an efficient use of energy and organizes the rights and duties of energy services. It also ensures environmental sustainability by rationalizing energy use and enhancing the quality of energy supply services provided [8]. In Saudi, different energy organizations are trying to develop a plan to ensure energy supply for the future, but there is no clear framework to follow. Thus, in this work, a proposal for the development of the Supreme Energy Council (SEC) is presented. SEC development will enable collaboration to be fostered between the various ministries, organizations and companies involved or interested in participating in the designated work center.

CASE STUDIES

Four case studies are presented for this work. The case studies studied were:

a. Masdar City
b. Masdar Institute
c. U.S Green Building Council
d. Editt Tower

Masdar City

Masdar City aims to build a hub for knowledge, business, research and development (Figure 1). It is located at Abu Dhabi. It was designed by architect Foster and partners. The type of project was urban development. Masdar city comprised of a total area of 700 hectares, with 3.7 million sqm of gross floor area which comprised of 52% residential area, 38% commercial area, 2 % of retail area and 8% of community. Masdar's vision is to of be Abu Dhabi's leading source of knowledge about renewable energy, development, implementation and a global mark for sustainable development. Their mission is to advance renewable energies and sustainable technologies. The goal is to become a global leader in sustainability and energy efficiency, and to make Abu Dhabi a diverse knowledgeable economy to reduce its carbon footprint. The project consists of dense neighborhoods, low-rise accommodation and a friendly pedestrian environment with multiple eco-friendly transport approaches. Masdar will be the world's first carbon-neutral city, home to renewable energy resources and sustainability research and many other projects, businesses and residential projects that are planned to be sustainable, energy-efficient, environmentally friendly and with zero carbon footprint. Trends from old traditional Arab city planning have been used in the design, such as the street layout, and the landscape and greenery are designed to protect and create the microclimate of their city with the water features. Solar energy is used in every part of the city's design, whether in the generation of electricity in buildings or in site furniture such as the umbrellas that use solar power and respond to its intensity. Waste from around the city will be fed to the central processing unit through ducted, vacuum-based systems to form layers of rich soil to supply the entire city. Productive landscapes will provide habitat, so both will benefit from each other, and the landscape will increase wind speed and movement. Furthermore, it incorporates water features that feed on rain or ground water further supporting the creation of pleasant atmosphere.

Figure 1. Masdar city perspective

Masdar Institute

Masdar Institute is located in Masdar city, Abu Dhabi, UAE. It was designed by architect Foster and partners. It is a academic/residential type of area (Figure 2). Masdar institute comprised of with 4000m^{2}sqm of area. It consists of 3 different functions: research laboratories, high-density, low-rise student residence (one, two or three-bedroom apartments) and social spaces that include gymnasium, canteen, café, knowledge center, and landscape areas. As part of the entire Masdar city, the institute offers a program to further educate and research the entire Masdar city concept. It sets an example to try out different technologies that other buildings within the city can use, from passive design and technologies to renewable resources that a building can fully rely on and use green materials. Furthermore, Masdar institute is within the green sustainable zero-carbon city of Masdar, and close to the main railway that connects Masdar to downtown Abu Dhabi. It comprised of 40% residence area, 13 % of social center are and 47% of labs. In addition, building orientation and massing is designed to provide maximum shades for landscape areas, pedestrian walkways and adjacent buildings. All façades are treated to protect against direct sunshine and to provide indoor privacy. Rooftop covered with about 5,000 m^{2}photovoltaic installation, supplying the building with electricity and protecting it from direct sun gain. City is designed to take care of health, as it encourages walking by improving the microclimate, making it care-free and using underground electric transportation through its own channels. Furthermore, it has demonstrated the use of low carbon concrete with replacement of cement (all materials are certified). Waste is segregated and recycled. The design also allows an adequate natural sunlight penetration through different types of openings, atrium and skylights.

Figure 2. Masdar Institute

U.S Green Building Council

US Green Building Council is located at Washington DC (Figure 3). It was designed by architect Perkins and Will. It is an exhibition and office building type of structure. It is comprised of 2044 m^2 area. The building is divided into public and private spaces. There are office and work spaces, educational and exhibition spaces. The U.S. Green Building Council wants to deliver the message by educating and setting its building as an example, making the building itself environmentally friendly from top to bottom, from the smallest to the greatest detail. Since its establishment, it has been a pioneer in sustainable design. It is located in the nation's capital, in the middle of a business district, easily accessible, and good existing infrastructure. The building consists of two office floors designed using green materials that transform the ordinary workspace into a motivational space. The place is completely treated with green features, from the reception and throughout the workspace. Workspace is laid along parameter, therefore it provides it all with natural lighting, and they can overlook outer greenery. Central atrium is used as huge return air duct and light shaft. Building is dependent on natural lighting. Building envelope is predominantly a high-performance glazing curtain wall system with operable windows. The outer envelope is mostly double — façade ventilated, more than 32 percent of it, allowing for sunlight without extreme gain during the summer and trapping it during the winter. Steam from a nearby power plant is used for central heating and cooling. Using water-efficient techniques such as waterless urinals, double-flush toilets, automatic faucets and low-flow fixtures, water use in buildings is reduced by 32 percent of similar office buildings. Furthermore, storm water is collected to irrigate the landscape of the roof. In construction, recycled content or local manufacturing, low-emission materials are used. The building is entirely environment friendly.

Figure 3. U.S Green Building Council

Editt Tower

Editt Tower is located at Singapore (Figure 4). It was designed by architect T.R Hamzah and Yeang. It is a commercial type tower. The site area is 838 m^2, with gross area of 6033 m^2. The net area is 3567 m^2 and the plantation area is 3841 m^2. It is situated on a street known for its multicultural population in the entertainment district of the city near the national library; there are also many art organizations in the street, some commercial buildings and residential buildings in the same area. The high-rise building will feature alternative plants for energy, natural ventilation, and biogas generation, all enclosed within a living wall (vegetative blanket) covering half of the façades. The skyscraper has green features that support users in the future; it is designed to enrich the biodiversity and local ecosystems of the area. The design trend are stated as follow. Plant façades and vegetated terraces, the building integrates green spaces in a ratio of 1:2 to the human-use area. Building is supplied with an integrated waste management system, where waste is collected and separated from each floor and recycled. The building comprised of low-embodied energy materials. In addition, the build consists of a storm water collection system that uses water purification technology, where the water within the tower is self-sufficient by 55 percent through rainwater collection and gray water reuse. Furthermore, photovoltaic technologies and panels are installed on the outer envelope, resulting in 40% energy self-sufficiency.

Figure 4. Editt Tower

PROGRAM ASSUMPTION AND SPACE DETAILS

Based on the case studies, the following program assumption was done for the proposed Supreme Energy Council. For the buildable area, it contains SCE office, open learning facilities, auditoriums and halls and other services and recreational facilities. Expected area in total is 14,985 $m^2$31% of entire projects area. Table 1 shows the overall details of the buildable area.

Table 1. Buildable areas

Facility	Number of users	Total current area
SCE office spaces	161	4135m^2
Knowledge center space	780	4,307 m^2
Auditoriums and hall	2100	6,270 m^2
Services	15	273 m^2
Total buildable area		14,985 m^2

For the unbuildable area, it contains both parking spaces and outdoor recreational areas, with a total space of 32,573 m^2, which is 69% of the entire project area. Table 2 shows the overall details of the unbuildable area. Parking numbers are reduced to encourage people to use alternative transport methods to reduce car use and use more environmentally friendly ways. Recreational outdoor spaces are used as safe grounds for activities, enhance microclimate within the project, integrate project with the environment and provide a buffer zone between different spaces while keeping them united.

Table 2. Unbuildable areas

Facility	Quantity	Total current area
Parking for SCE offices	170	4250 m^2
Parking for knowledge center	290	7250 m^2
Parking for social center	900	22500 m^2
Total number of parking	700	17500 m^2
Outdoor recreational area		7893 m^2
Total unbuildable area		25393 m^2

SITE SELECTION

Proposal site: Site 1

The first site is located on the north-west side of Riyadh, on both Olaya Street and King Fahd Road (Figure 5). The advantages of this site is, in the direction of the new expansion of the city, in front of the financial district (under construction), multipurpose zone where important governmental, commercial and business bodies are located, and accessed by the new metro line.

Figure 5. Site 1

Proposal site: Site 2

The second site is located at the north of Riyadh close to the airport, surrounded by Thumamah Road, Airport Road and Anas bin Malik Road. (Figure 6). The advantages of this site is it is in the direction of the new expansion of the city, near King Abdullah Petroleum Studies and Research Center, next to educational facilities, area with headquarters and offices, and can be accessed by the new metro line.

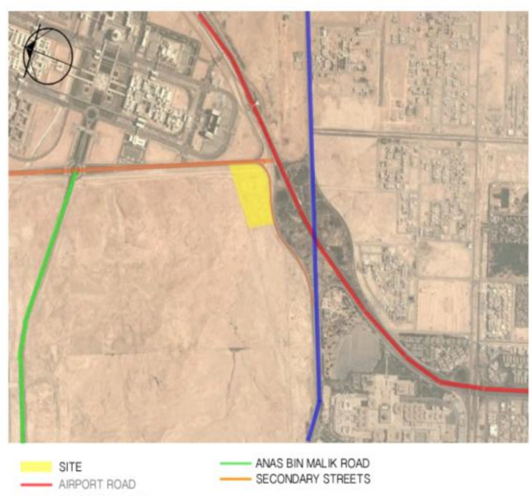

Figure 6. Site 2

Proposal site: Site 3

The third site is located closer to the city center on King Abdullah Road (Figure 7). The advantages of this site is it next to the Riyadh Convention Center, near to a dense commercial area, a short distance from major organizations, and can be accessed by the new metro line.

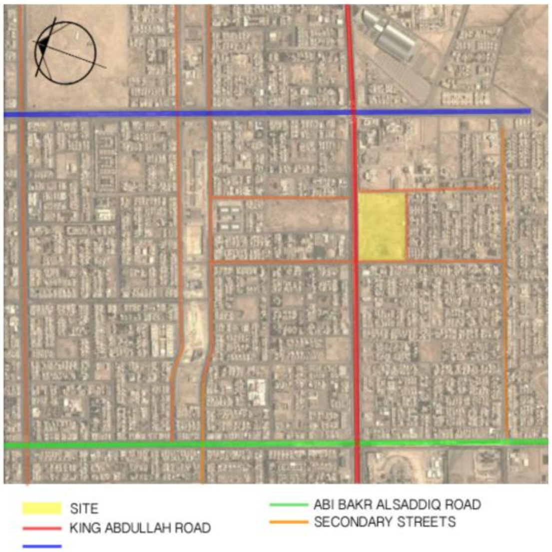

Figure 7. Site 3

SITE EVALUATION

The site evaluation was conducted based on a few factors that included accessibility, views, visibility, land use and surroundings, physiographic elements, climate, urban development, and expansion capability.

All three sites were compared and the outcome is shown in Table 3. Based on Table 3, Site 1 achieved the highest evaluation score of 8.84. This site is therefore chosen for SCE development.

Table 3. Sites evaluation

Criteria	Site 1	Site 2	Site 3
Accessibility (20%)	0.20 x 8= 1.6	0.20 x 8= 1.6	0.20 x 10= 2
Views (8%)	0.08 x 10 =0.8	0.08 x 10 =4.8	0.08 x 6=0.48
Climatic aspect (10%)	0.10 x 8= 0.8	0.10 x 8= 0.8	0.10 x 6= 0.6
Visibility (20%)	0.20 x 10=2	0.20 x 8=1.6	0.20 x 8=1.6
Land use and surroundings (11%)	0.11 x 8=0.88	0.11 x 8=0.88	0.11 x 4=0.44
Physiographic elements (7%)	0.07 x 8=0.56	0.07 x 6=0.42	0.07 x 8=0.56
Urban development (14%)	0.14 x 10 =1.4	0.14 x 10 =1.4	0.14 x 6 =0.84
Capability of expansion (10%)	0.10 x 8 =0.8	0.10 x 10 =1	0.10 x 6=0.6
Total (100%)	8.84	8.18	7.12

SITE AND DESIGN ANALYSIS

Figure 8 shows the site size and area of the selected Site 1. Based on Figure 8, the site area is approximately 71,600 m^2. The land will be used for residential, commercial and educational development. The landmarks of the site is King Abdullah financial center and Arrubat roundabout.

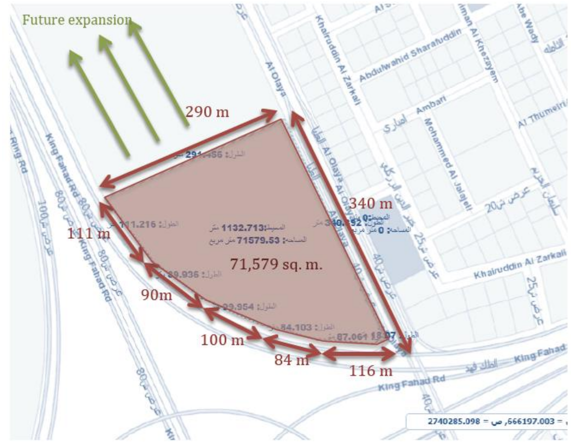

Figure 8. Site dimensions and area

In terms of accessibilities, the site can be accessed through two main streets, the King Fahd Road and the Olaya Street, the Thumama Street and the North Ring Road are two essential streets, giving access to the main streets and the site. A small street is suggested as another approach to the site, as it is part of a larger one. The advantages of the site is surrounded on three sides by main streets, the King Abdullah financial center opposite the site, the orientation of the site itself avoids natural constraints. The constrained faced by the site is northeastern sandy wind, and sandstorms and direct southern sun. The zoning of the SCE site is shown in Figure 9. Based on Figure 9, the placement of social center, open spaces and office building, direction of wind and position of sun is observed.

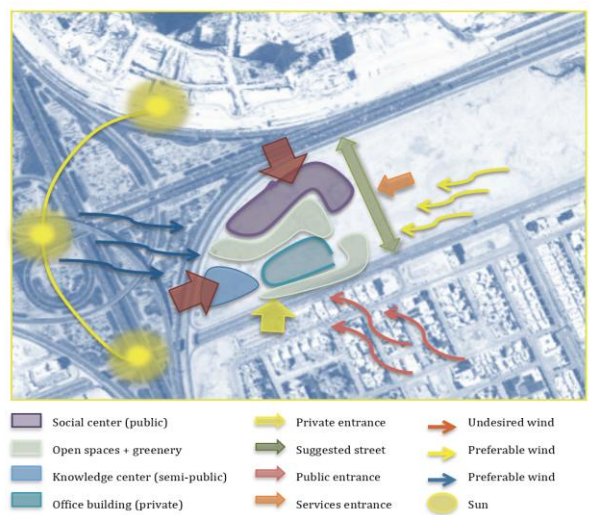

Figure 9. Main zoning

For the SCE building development, the main inspiration was the deconstruction of the desert rose and the composition of a new form combined with the offsets of the site boundaries. The design included surface texture and color (recycled stucco) to give the camouflage influence similar to the desert rose, lots of open spaces and short walking distances to the entrances to encourage walk ability, middle oasis that is accessible and connecting all major areas together and providing an inner view. In addition, the design included solar-responsive shading devices, solar panels on the roof to protect against direct sun gain, lower front part of the project to give a panoramic view of the project and the oasis, and different levels for a better experience felt by the desert in addition to protecting the project within the site. The concept design of SCE structure is shown in Figure 10. Figure 11 shows detailed sustainability concept of the building structure.

Figure 10. Concept generated from the desert rose and site boundaries

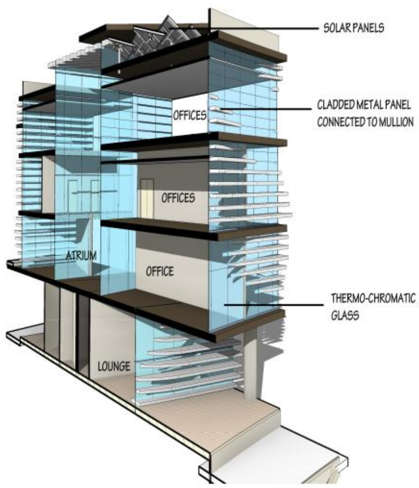

Figure 11. Sustainability concept of the structure

CONCLUSION

This work has proposed a design plan for Supreme Energy Council (SEC), to be built at Saudi Arabia. For this development, the proposed site is located at north-west side of Riyadh, Saudi Arabia. This site attained the highest evaluation score and it is multipurpose zone where important governmental, commercial and business bodies are located, and accessed by the new metro line. Thus, by developing this SEC, it will promote collaboration between the different ministries, organizations and companies involved or interested in participating. This will consolidate the efforts and resources of the groups involved and create a centralized focus on energy conservation and its efficient use. Furthermore, it will also set an example for the Saudi architect community for energy-efficient building and green architecture and demonstrate the viability and value of green architecture. By establishing a green design with zero carbon footprint, the negative impact on the environment can be significantly reduced.

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