Sustainable Design Strategy of Expo 2020 DuBai

Lin Mo[1a*], Chen Lin[1b], Hao Hu[2c]

[1]*Department of Architectural and Engineering, Kunming University of Science and Technology Oxbridge College, Kunming 650106, China*
[2]*Hong Kong Metropolitan University, Guangzhou 510623, China*
[a*]*linmo91@163.com,* [b]*linchen872@163.com,* [c]*huhao@126.com*

ABSTRACT
Sustainable development is the common goal of mankind. The World Expo brings together the world's most cutting-edge science and technology and ideas. This article aims to introduce the ongoing sustainable development design strategy of the Dubai Expo site and pavilions for the current architectural design ideas in the context of climate change and energy depletion.

Keywords- *expo*，*energy*，*sustainability.*

1. INTRODUCTION

The Ongoing World Expo 2020 Dubai is a great stage for gathering the wisdom of the world. Exhibitors from around the world are contributing their 'Green wisdom'. From the construction of self-built pavilions in foreign countries to the themes and contents displayed in the pavilions, all of them reflect the latest environmental protection concepts and cutting-edge scientific and technological achievements of participating countries and international organizations.

Sustainability and Opportunity is the core of Expo 2020 Dubai, encompassing social sustainability and equality of opportunity as enshrined in the United Nations SDGS (Sustainable Development Goals)[1], which were unveiled in 2015 as a blueprint for a better future for all. The global COVID-19 pandemic, Global warming and Energy depletion further highlight the urgency of this global agenda. Taking as an opportunity, let's take a look at the latest sustainable design achievements of Expo Dubai.

2. SUSTAINABLE DESIGN STRATEGY OF MASTER PLANNING

The total project area of Expo 2020 Dubai is 3000000 square meters, including 200,000 square meters of GFA of commercial and residential space. The population of full capacity is 145000 people per hour. The whole project is LEED certified. The infrastructure is 5G connection, autonomous public transit, dedicated Metro station, and access to four arterial roads.

In addition, The Expo site includes a 220000 square meters nursery behind the cultivation of more than 12000 trees, including palms, more than 256000 shrubs and thousands of flowering plants and herbs. The Expo 2020 Dubai Master plan has three theme pavilion districts: opportunity pavilion district, mobility pavilion district and sustainability pavilion district. The plan like a maple leaf is in the form of a radial parallel connection. This kind of spatial streamline organization has strong advantages in gathering and evacuating people for super-large-scale expositions. From this point of view, from the initial design of intensive land use and traffic evacuation, Dubai Expo grasps the most fundamental aspect of sustainable design.

| Project Details	
Project type	Mixed-use development
Total project area	3,000,000 sq m
Population	145,000 (full capacity)
Built assets	200,000 sq m of GFA
Land	residential,commercial, hospitality, mixed-use
Infrastructure	5G connectivity, autonomous public transit, Metro station, four arterial roads
WELL certified	certified by the International WELL Building Institute (IWBI)

Fig.1 Project Details of Dubai Expo

**Fig.2** Expo 2020 Dubai master plan

Fig.3 three theme pavilion districts [2]

Dubai hopes to deploy the convening power of World Expos and the UAE to stimulate collective and meaningful actions. During the opening days, the most popular area is the sustainability pavilion district. Sustainability runs through the whole planning and design, which reflected in the following aspects: Minimising energy consumption from the perspective of planning and landscape ecosystems; Optimising the usage of potable water, Low water planting strategy in the desert; Encouraging the use of local and recycled materials such as minimising the impact of single-use plastics; Achieving high rate of waste segregation; Implement of a carbon emissions management; Considering in a hot, dry climate and to creating a comfortable and enjoyable public realm; maximum utilizing ventilation and passive cooling in the design to the best, considering open space shading on all of the public squares and roads.
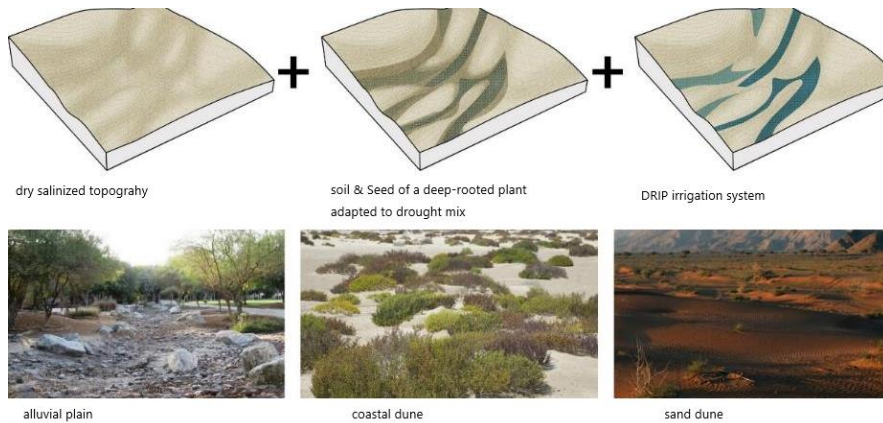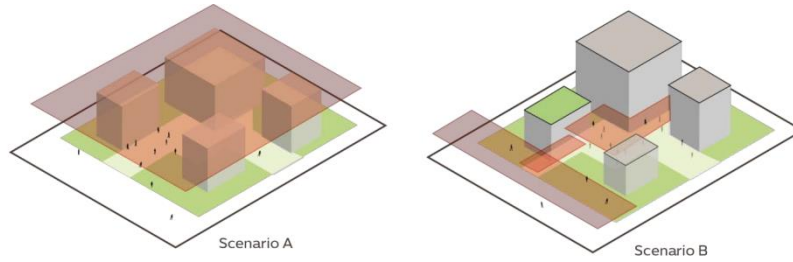

Fig.4 Low water planting strategy
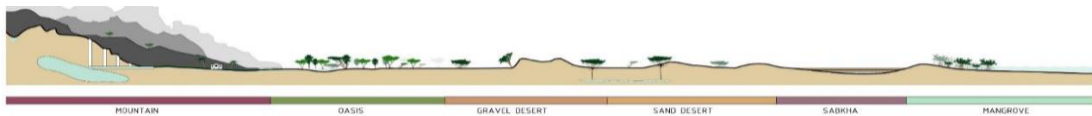
Fig.5 Dubai's landscape ecosystems
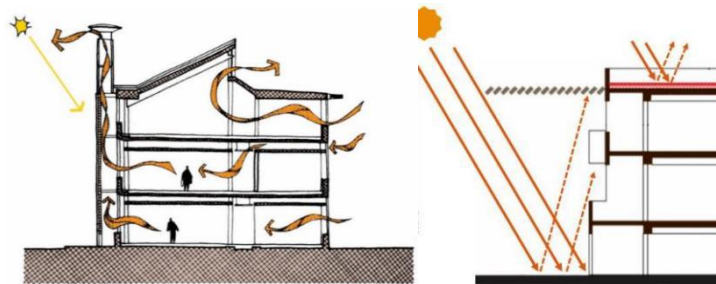
Fig.6 Natural ventilation and passive cooling

Fig.7 Open space shading and queueing area shading [3]

3. SUSTAINABLE DESIGN STRATEGY OF THE MAIN PAVILION

Sustainability pavilion (the main pavilion) covers 6300 square meters of the expo site and is entirely generated by solar energy and recycled water. A 130-metre-wide canopy acts as a roof for the building and is covered with 1055 photovoltaic panels that supplies energy to the pavilion.

**Fig.8** Sustainability pavilion [4]

Enable the building to generate its own energy and water in harsh weather conditions. Through a series of closed loop systems to achieve water filtration, replenishment and recycling, creating water-saving landscape, the pavilion is planted everywhere from the surrounding desert plants, with which being combined with water recycling and reuse technologies, it has led to a new understanding of the region's uniqueness and its biodiversity.

The energy tree is designed as an expansible stand-alone shading structure that captures the sun's energy. The structure of the energy tree, made of steel

Massive 'energy trees' in the shape of sunflowers are spread throughout the area and also distribute power, which rotate throughout the day to track and store sunlight. In total, the building's technology will produce four Gwh per year of electricity enough for a Nissan Leaf to drive halfway to Mars.
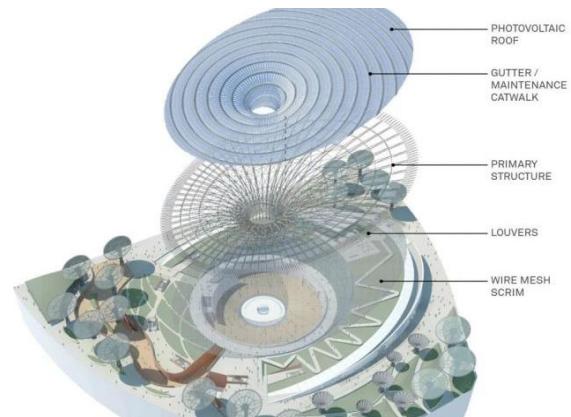
Fig.9 the canopy is a giant collector of sunlight and water

and some complex composite materials, supports a photovoltaic array spanning 18 meters. The array can follow the sun's movements like a sunflower, maximizing energy production and solar cell efficiency. The carbon fiber structure used to support the array is based on the design of the steering wheel of the yacht, which maximizes the strength of the shape and reduces the load of the structure by surrounding the compression ring around the radial branch. The reason for choosing carbon fibre is that it is light enough to extend the canopy profile up to 9M in all directions without support.

Fig.10 the energy trees [5]

Fig.11 plants are self-sufficient in water

4. SUSTAINABILITY THEME OF NATIONAL PAVILIONS

Azerbaijan pavilion theme is seeds for the future. The nature-inspired pavilion, which has a leaf- shaped roof, will cause visitors to consider the impact of their individual choices and invest in the future to restore balance to our natural world.

Singapore pavilion theme is nature, nurture, future. Showcasing Singapore's urban innovations, the net-zero energy pavilion exploring our journey towards livability and resilience, showing the possibility of the integration of nature and the urban environment. More than 170 species of plants from different habitats in Singapore are planted at different levels of greening, forming a multi-dimensional green space with hanging gardens, vertical green walls, etc, leading visitors through tropical rain forests, mangrove areas and forest streams. The Green Drip Irrigation in the exhibition hall uses potable water produced by seawater desalination to reduce water consumption as much as possible. The pavilion also uses a model of a robot that crawls across a Green Wall to monitor the health of plants and collect environmental data. The robot, offers a possible solution for maintaining the vertical green walls and hanging gardens that are common in modern architecture in Singapore.

Fig.12 Singapore Pavilion and its climbing robot

Brazil pavilion theme is together for diversity. Recreating the amazon basin, the pavilion will have a water feature that visitors can walk through as they take in the sights, sounds and scents of Brazil's riverside areas.

Philippines pavilion theme is 'Bangkota'- Philippine coral reef. The natural, organic shape of the coral reef, or Bangkota, will draw visitors to the Philippines Pavilion into defined, free-flowing, open spaces, reflecting how Filipino culture embraces openness and meaningful encounters.

The Dutch pavilion features a conical vertical farm that can rain itself and grow mushrooms that can be used as building materials, uniting water, energy and food, which is a climate circulation system creating a temporary biosphere. And it is the largest vertical farm in the world. The farm's fresh produce was on display at the expo, showcasing the future of sustainable agriculture.

Fig.13 Dutch pavilion's vertical farm which produce rain and food

Spain Pavilion Theme is People and Places. Exploring everything from historical innovation and adventure to biodiversity and organ transplants, the Spain Pavilion offers a diverse experience with a town square atmosphere. As people stroll through the various designs, the Spanish pavilion will offer tired visitors a place to rest and shade. This design is meant to be welcoming and friendly to visitors. The exhibition hall is designed as an open space cooled by a passive system, and the pavilion will be suitable for any site after the expo, and the materials used for its construction can be easily recycled or reused.


Fig.14 Spain Pavilion and its passive cooling design [6]

Germany pavilion theme is campus Germany. Visitors can wear cutting-edge connected devices as they venture through themed areas featuring a wonderful array of creative environmental ideas with real-life results. And the Germany show their new Solar-Powered Concrete in it.

The 3D-printed Concrete Pavilion creates a concrete structure 3D-printed by robots, saving material waste by reducing the amount of formwork used during the pouring process, as well as providing a cleaner construction site, while allowing for higher design complexity. It is also an autonomous energy generator that absorbs abundant solar energy to power itself. These elements generate energy during the day, and at night they flicker programmatically to form patterns.
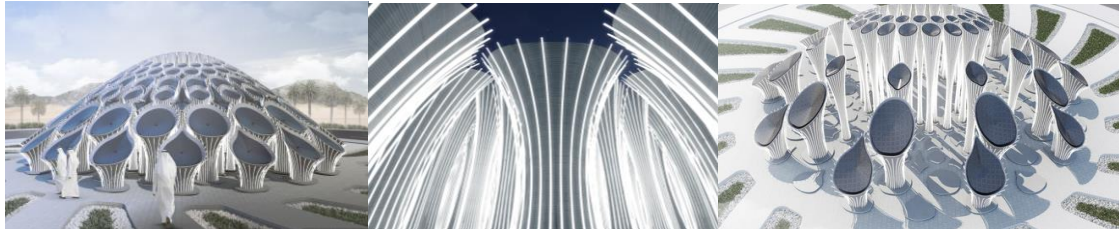
Fig.15 3D-printed Concrete Pavilion

5. CONCLUSION

As a Response to Expo's sustainability standards, Countries across the Expo site have wonderfully demonstrate sustainable models for climate protection and biodiversity conservation through their pavilion content, featuring sustainable designs, programming and operations.

Almost a month of operation till now, a number of achievements have been made: Overall reduction in water use of 25% against DEWA baseline; 90% of materials used in permanent construction retained for legacy; Renewable energy will provide 50% of the site's power, 50% of this will be generated on-site. Expo 2020 Dubai could be a critical catalyst for restoring balance with our planet.

Sustainability Achievements	
Save electricity	50%
Save water	25%
save land	17% less than Shanghai Expo
plant trees	12000+ trees
plant shrubs	256000+ shrubs
Waste Recycle	85%
Carbon reduction	35%

Fig.16 Sustainability Achievements of Dubai Expo

REFERENCES

[1] Expo 2020 Targets +971 4 555 2020 connect@district2020. ae

[2] EXPO 2020 DUBAI'S PROGRAMME FOR PEOPLE AND PLANET+971 4 555 2020 connect@district2020. ae

[3] D2020-brochure_jan2021_final+971 4 555 2020 connect@district2020. ae

[4] Terra-Sustainable pavilion at Dubai World Expo/GRIMSHAW https://xw.qq.com/cmsid/20211019A0E6NZ00?f=newdc

[5] Sustainability Pavilion (Terra) https://propsearch.ae/dubai/sustainability-pavilion

[6] Cooling Space, Spain pavilion at Expo 2020 Dubai https://www.archdaily.cn/cn/970487/2020di-bai-shi-bo-hui-xi-ban-ya-guan-amann-canovas-maruri?ad_source=search&ad_medium=projects_tab