**WAVES**

Description

The WAVES is an open park that adds an inviting space for visitors to enjoy in the Masdar city campus. It combines green as well as water surfaces to the existing site, increasing its attractiveness and livability to visitors. The WAVES consists of a gathering area and 550 meters running trail and bike path covered with transparent and flexible silicon PV that provide shading as well as the view to the night sky. The smart waves have integrated photochromic layers, which are activated by solar radiation and changed the opacity. The WAVES improves the micro-climate on site and provides spaces for people to enjoy a park in the Masdar city campus. The park is an opportunity for people working in the surrounding buildings to enjoy short walks as a break from work, to get lunch, or to work in a different environment. The WAVES is orientated to block the heat east & west and filter the breeze. The open concept provides multiple entries to the park enhancing accessibility. The site is designed to not only stimulate the interest of visitors but serve as a space to be utilized by the people in the surrounding area.

The smart waves cover over about 13,500 of 20,000 square meters of the park. The freeform structure made out of cold-formed steel supports the network of curved midribs to create the WAVES design that resembles the Gulf waves. The floor (substructure) is made out of concrete for the main walking areas, and there would be a large portion of green, meadows, and ponds to improve microclimates. The hard surfaces are in bright colors with a high thermal mass capacity to reduce the heat gain of the park.

The shads have an intertwined design with multiple layers and have constant transitions of heights to diversify the spatial experience and resemble the gulf waves. The smart shades forms correspond to the transformation of landscapes. The shades are composed of transparent and flexible silicon PV and photochromic layer installed underneath.

These freeform waves act as the shading device for the trails, gardens, ponds and gathering spaces. The smart shades harvest solar power and are used to operate WAVES park equipment such as lighting and irrigations systems. The major part of the electricity is stored or connect to the power grid. An additional layer of photochromic glass provides 80% shading during day time while it would be 10% transparent during the night time. So residents can enjoy the night sky and be protected from the sun.

Technology used in design

The PV technology utilized in this project is the transparent Crystalline Silicon PV glass commercialized by the ONYXSOLAR. The multifunctional properties of PV glass surpass those of conventional glass as it can be customized to optimize its performance under different climatic conditions. The solar factor, also known as “g-value” or SHGC, is key to achieve thermal comfort in any use. It also offers a wide range of U-Values, according to the architectural spec.

Storage batteries will be available and connected to the PV panels. The batteries are sized to be capable of supplying electric demands during any outage of the grid; therefore the operation of the park and its surrounding areas will not be only feasible during the routine operation of the grid. The batteries also provide technical advantages to the grid during normal operating conditions of the network. It will be utilized to help operators support the voltage and frequency of the grid, enhancing the resiliency and stability of the national grid.

One of the distinguishing features of the PV system designed for WAVES is its integration of a new technology that reduces the energy losses occurring during partial shading (caused by clouds). This approach improves the total energy production in comparison to other PV systems installed currently in any other place in the world. The technology utilizes optical cameras that monitor the PV cells and employs this information to optimize the electrical operating points ensuring the minimization of the power losses occurring during partial shading conditions.

The cameras used in this technology also serve as eyes for the PV cells and provide an exciting concept to visitors to check the operations of cameras on their phones. WAVES will be the first project to utilize this technology, which may provide some economic advantages to the Masdar Campus.

Peak Capacity

The total area of PV surface is 13,500 m2. Due to the power density of this transparent PV cells reaches to 160 W/m2, the total rated peak power will be 2,160 KWp.

Annual kWh (kilowatt-hours)

As the average peak sun hours used in calculations in the UAE is 5.84, the annual energy provided by WAVES will be 4,604,256 KWh (4.6 GWh). Note that the expected annual energy should be higher than this number (almost 10%) as predicted by using the new Camera technology.

The primary materials used in design and conceptual cost estimate

The dimensions of the site are roughly 277 meters in length and 73 meters in width totaling just over 20,000 square meters in area. The canopy foundation is made of concrete, and the canopy frame is made of cold formed steel. The construction is estimated to cost about USD 15 million including the solar cells and camera technology. The price for the PV electricity is equal to 7$ per Watt (way less than the 20$ limit), which is in a reasonable range.

Environmental impact summary

The WAVES project is an open park located in the Masdar City campus. The purpose of the project is to create a landmark in the city, which is both attractive to visitors as well as improve the microclimate on the site. The construction consists of building a 20,000 square meters park, which is covered with 70% shades. The original sandy area is transformed into multiple trails, biking paths, turfs area, vegetated spaces, and ponds. The impact of construction can be summarized as follows. The air quality improves by increasing green, turfs, and trees. The installation produces electricity with zero emissions, therefore, improve the air quality as this power can replace power that was produced with carbon emissions. Planting part of the area helps to reduce the rate of desertification and land degradation. Given the covered area, the groundwater supplement from rain may be affected. There are no effects on marine water, seismicity, and the soil underneath the structure. One of the project goals is to engage the people working in the surrounding area to visit the site and make social and business interaction. We anticipate this has a positive socio-economic effect as a whole.