**LAGI 2019 Entry : Mirage**

**Thought Premises**

While LAGI 2019 competition is returning to the source, for its association with Masdar and a reference to the sun, our thoughts were provoked to go over and beyond these references while adhering to the broad design guidelines. Returning to the source, or rather going back to origin in the social and anthropological landscape of Abu Dhabi and the UAE flashes visuals of the Bedouin tents, the pearl diving, the herding and the desert landscape that thrived around the oasis. This installation with its pneumatic tented structure tries to give a subtle reference to all these glory and grace of the past. A metaphysical reference.

If the desert living of the past had been around the oasis, there had also been instances of mirage, a faux hope experience. Just like a mirage, that entices with hope of something only to reveal a different reality at the end, this installation also tries to deliver a mirage experience in a choreographed trail in the sequences of curiosity, realization and discovery. The point of curiosity being the entry point, which welcomes the visitors to a gentle ramp to the elevated space shaded by the installation. The visitor takes the experience through the shaded space amidst and against visual cues of mirage delivered with frosted glass and mirrors, and a reference to a glistening patch of water at the end of the horizon. The visuals that he gets to see changes while he moves forward in the trail and the journey culminates at the point of discovery at end of the structure overlooking the Masdar where he discovers that it was just a mirage. An overhang with reflective finishes at the floor reflects the surroundings to a view of the Masdar and its context.

The core of the installation is this mirage experience which is delivered physically through a shaded pavilion created by PV cells embedded in ETFE cushion structure, reflective finishes, mirrors & frosted glass.

The visitor experience starts where his mind transitions from the point of ‘false hope’ or ‘mirage’ wherein he spots the glistening patch of water at the end of the horizon. He is lured by a myriad of hazy images of green amid the dry landscape of rocks as expressed at the floor he walks on. Through the path he slowly understands that the greens he saw a minute ago are merely mirror reflections of the greener landscape far behind & the translucent colored ceiling. This draws parallels to our past which was greener & is slowly being lost to us. At the final point of realization, he sees that there is no water. The glisten he saw was a foil created by an undulating mirror surface reflecting the sky. The water & the vegetation he saw 10 minutes ago were a lie & are lost to him in the blink of the eye.

But all is not lost. As he sees ahead, he sees Masdar city..the way forward. Thence is created a fitting gateway to the city.

**Technology used in the Design**

Photovoltaic power generation using flexible thin a-Si solar cells.

Thin film a-Si solar cells placed within ETFE films cushions. The technology is already commercially available (eg: Fuji Electric FWAVE module) with different organisation working on improving the efficiency of the cell & optimising the modules. The whole module is housed within the ETFE cushions which is connected to an air pump to maintain the pressure. Thin film amorphous silicon laminated within ETFE film forms the upper layer of the cushion. The module has a lower layer of an ETFE film and this combination of two layers of ETFE with air in-between will deliver superior thermal insulation, shade and eventually thermal comfort to the people under. ETFE cushion structure was selected to carry the solar module because of the following reasons:

1. Lightweight characteristics (2 layer ETFE cushion only weights ~1kg/m2). Lightweight characteristics will help to reduce the overall carbon footprint of the structure from the point of material savings. It will also help to explore engineered wood or timber options for the realization of such renewable energy structures.
2. Possibility to realize different shapes and hence explore structures and compositions earlier not possible with photovoltaics
3. Because of the low surface energy of these structures, only minimal dust will settle on the structure and hence easier maintenance and less effects of performance drop due to soiling of the surface.

**Nameplate capacity of the installation**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl.No** | **Name plate capacity** | | **unit** |
| 1 | Area covered by ETFE cushions | 16200 | sqm |
| 2 | Assuming 90% of area be covered by Photovoltaic cell | 14580 | sqm |
| 3 | Power output for a Flexible ETFE thin film a-Si cell (data from manufacturers data FWAVE solar modules) | 92 | W/m2 |
| 4 | Therefore, total power from the ETFE cushions Photovoltaic modules | 1016181.818 | W |
| 5 | Nameplate capacity | 1.016181818 | MW |

**Annual Power Generation**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl.No:** | **Annual power generation** |  | **unit** |
| 1 | Area covered by Photovoltaic cells | 14580 | sqm |
| 2 | Power conversion efficiency (PCE) of thin film a-Si cells | 10% |  |
| 3 | Average Annual solar radiation in Abu Dhabi | 2285 | kWh/m2 |
| 4 | Performance Ratio | 0.75 |  |
| 5 | Annual Power generation | 2498647.5 | kWh |
|  |  | 2498.6475 | MWh |

**Dimensions of the structure**

Area of coverage: 60m X 270m

**Conceptual Cost Estimate**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Rated power of the Installation | | 1016181.818 W | | | |
| Approved cost/watt | | 20 USD | | | |
| Maximum Budget for the structure | | $20,323,636.36 USD | | | |
|  | | | | | |
| **Sl. No:** | **Item** | **Qty** | **unit** | **Costs (USD/m2)** | **Total** |
| 1 | Reinforced Concrete | 13000 | m3 | $63.00 | $819,000.00 |
| 2 | Solar cell cost | 14580 | m2 | $3.00 | $43,740.00 |
| 3 | 3 layer ETFE Film + Engineered wood support structure | 16200 | m2 | $800.00 | $12,960,000.00 |
| 4 | Mirrors, Glass | 3000 | m2 | $150.00 | $450,000.00 |
| 5 | Special reflective finishes | 2700 | m2 | $150.00 | $405,000.00 |
| 6 | Balance of system |  |  |  |  |
|  |  |  |  |  | $13,822,740.00 |

**Environmental Impact summary**

Renewable energy is an attractive alternate to reduce the carbon emissions emitted into the atmosphere. However while utilising renewable energy and environmentally friendly sources of energy, emphasis must be placed on conserving the energy and reducing the consumption. While return of investments(ROI) is an important criterion that guides renewable energy applications, the new metric of Energy Payback time(EPBT) proves more important from the environmental perspective. Various studies have revealed that embodied energy of photovoltaic systems, rather than the efficiency of the cells will be an important deciding factor in the future in the selection of photovoltaic technologies. The selection of the technology for this project was done with this mindset.

The most efficient photovoltaic cells of today consume a lot of materials to produce solar cells and carries a higher share of energy embodied in it. When these solar cells are made into modules, the use of additional materials like glass, which also has a higher embodied energy adds to the total embodied energy of the structure. Finally, since these solar modules weigh heavily, steel and other metals structures are introduced to provide the adequate support that will still add to the embodied energy of the material. All in, the traditional photovoltaic system has a higher share of embodied energy. As opposed to this, the Organic photovoltaics and thin film cells have even lesser embodied energy and carbon footprint. Between the OPVs and the a-Si cells where both are flexible and lightweight, a-Si are more efficient and gives a higher yield and a longer life.

Thin film a-Si cells were chosen because of these impacting benefits. ETFE film is introduced as a replacement to the glass because of its low carbon footprint and a lighter structure that enables to explore lighter support systems such as the engineered wood. High performance film has a very low surface energy that will prevent the soiling of the modules from the dust cover, which can make the maintenance of the system easier and less events of performance drop due to dust or soiling.

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