**Dhow**

**Masdar symbolizes the future,**

**but people here look back to the past…**

Masdar means ‘**source**’ in Arabic, and people in this city place their deep understanding of ‘**resource**’ -- ***Return to the source***, which may be the right attitude of human beings towards resources.

In Masdar, a zero-carbon city, ancient Arabian techniques are used to capture wind and solar energy and to update the expression of **Dhow**, a traditional sailing vessel, through the Land Art. We hope to lead people to think about the meaning behind ‘resources’ in a way that evokes ancient memories.

**What is Masdar / what is Source?**

Arab civilization has always been associated with vast deserts, but it has always been associated with the sea. Dhow was born in the Persian gulf more than 2,000 years ago (The exact origin of Dhow remains in dispute. *The History & construction of ‘The dhow’*. Nabataea.). Dhow features a jib attached to a mast. This unique, more flexible sail structure makes Dhow more flexible and adaptable than other types of sailboats. As a result, Dhow has a unique advantage in taking advantage of the wind to keep the ship moving efficiently even against the wind.

With this advantage, Dhow dominated the early commercial traffic in Persian gulf, Indian Ocean and even Red Sea and the Mediterranean. Centuries-old pearl trade has propelled Abu dhabi to the pinnacle of prosperity since the park's first century. Although the discovery of vast oil reserves after the second world war changed Abu dhabi's fortunes once again. However, Dhow and the ocean are undoubtedly important "sources" for Abu dhabi, and should not be forgotten.

**Dhow in Masdar**

**About ‘Desert Fingers’**

Dhow in Masdar city is not as serious as history. These two ‘fleets’ (generator clusters) are the most attractive and dynamic leisure places among Masdar city's scientific research and education group. Layout of the public space continues overall pattern of the wedged finger shaped green space in Abu dhabi's urban strategic planning. Located at the gateway of the urban green space system in the prevailing northwest wind environment, Dhow fleet enjoys the unique high-quality wind energy resources.Winds from the Persian gulf wash through the Dhow almost year-round at speeds of tens of kilometers per hour, converting it into electricity with the subtle help of a capture device. During the day, the photovoltaic modules embedded in the sails also work, providing an efficient solution for Masdar's energy supply.

**Form Generation I - Space and Security**

In order to adapt to the desert environment far away from the ocean and complete the extremely challenging task of generating electricity, Dhow realized its transformation in Masdar.From the original traffic function to the static power production service for the city, Dhow no longer needs to use oversize sails for activities. Therefore, in order to increase people's activity space on the ground, we decided to reduce the size of the sail and make it rise along the mast to ensure a safe distance of at least 4 meters from the ground.

**Form Generation II- Solar Expansion**

Sailing away from the ground increases the activity space and security, but significantly reduces the interactive experience and weakens people's perception of the image of Dhow. This clearly goes against the original intention of ‘Return to the Source’. It is considered to be an effective way to explore the functionality of sailing. By embedding the photovoltaic material with great deformation potential into the sail and taking advantage of the unique sunshine of Masdar, it brings higher power generation efficiency to the whole power generation device. The use of solar energy means the sail will be changed from vertical to horizontal. We also cleverly considered the arrangement of photovoltaic materials to enhance Dhow's interaction with people through the traditional Mashrabyia pattern in the Middle East:

During the day, sunlight passes through the translucent sail, shading the photovoltaic modules to create the tindal effect, a miniature mirage that attracts passersby to stop. At the same time, the wind shield protects pedestrians from strong sunlight and ultraviolet rays, which is the key to creating a sustainable attraction.

At night, the LED diodes embedded in the photovoltaic modules emit a beautiful shimmer of light, and the luminous electricity is part of the daytime savings. Apart from Dhow, there is no more lighting in the area, which is enough to keep the walking party focused on the overhead. As people immerse themselves in the city sky lit up by the shimmering starry night sky, the waving sails will remind them that nature is the best source of energy.

**Back to the Dhow…**

At Masdar, wind is an eternal subject. Unlike the urban fabric of ABU dhabi and dubai, Masdar better reflects the context of traditional Arab settlements -- an ancient urban settlement whose enhancement of wind is highlighted. The narrow and crisscross urban roadway makes the prevailing northwest wind from the Persian gulf present a complex and diverse local microclimate in Masdar city. Dhow is born for the complex wind direction conditions, and its principle of action has the potential to realize the efficient utilization of urban wind.

Therefore, it is necessary to design a device capable of self-regulation and rotation. Dhow in Masdar city is equipped with vertical rotation axis and horizontal rotation axis, which respectively realize the horizontal and vertical rotation of the core components of the device. On the one hand, the biaxial rotation system enhances the adaptability of the device to high frequency wind direction. On the other hand, the dynamic earth art installation is more interesting to watch.

At the heart of the Dhow is a jib with one side attached to a single mast and the remaining corner secured by a rope. This structure is particularly suitable for upwind sailing, where horizontal sails, due to the Bernoulli effect, accelerate the flow of air. Wind energy collection system (windbelt) is always located in the downwind of the sail, to ensure the maximum of wind energy collection and utilization. After a short period of high speed local wind power generation, once again flow to the street space of Masdar city, bringing continuous cooling to the hot desert.

Overall evaluation, the positive significance of Dhow for Masdar city is reflected in the following aspects:

* **Clean Energy Contribution**

Wind and solar power mark their source, and Masdar receives gifts from the ocean and the sun through Dhow.

* **Space Attraction Remodeling**

Dhow makes the space a charming gathering point for crowds day and night, and can attract more foreign tourists to Masdar and promote local development.

* **Cultural Education and Social thinking**

With profound historical and cultural connotations, Dhow subtly influences people's views on energy through the form of artistic interaction, so as to better understand the original intention and goal of Masdar city.

* **Urban Microenvironment Reconstruction**

By blocking the sunlight and guiding the airflow to form a convergence, the temperature of the open space in the city can be reduced, and local land water evaporation can be reduced, which is conducive to the concentration of plant diversity.

* **Integration of Urban Environment**

Coordinate with the urban green space, and continue the finger-like green space structure system through wind direction flow and guidance; Starting from the cultural spirit of Mashrabyia, it emphasizes the inheritance of urban context in the innovation of space.

**Technical specifications**

**Windbelt**

Windbelt invented by Humdinger was placed at the end of each Dhow device's sail. According to the Bernoulli effect. Tiny arc of a sail under the force of the wind will accelerate the speed of the wind passing above it. The upper and lower double-layer fixed plates of the Windbelt were also curved, and the local space before entering the Windbelt was accelerated for the second time by the wind of the sail. The wind after the second enhancement causes the elastic belt in the windbelt to generate high-frequency vibration, which drives the magnet to generate current.

**Thin Film Organic Photovoltaic Cell (OPV) - Thin Film Organic Photovoltaic Cell (OPV)**

Thin-Film Organic Photovoltaic Cells are often made into flexible shapes that can be attached to other objects.Organic solar cells have the ability to utilize larger areas than its inorganic counterparts, Containing flexible solar modules, Organic cells can be fabricated using roll - to - roll production. The generation efficiency of OPV is about 10%~12%.

**Approximate Energy Calculation**

**Windbelt** - 60 MWh/year

**OPV** - 448 MWh/year

**Total Energy** - 508 MWh

**Total Power** - 57,991 W

**Total Cost** - 167,209 USD

**Total Cost/Total Power** = 2.88 USD/W

**Device size & material specification**

The height of Dhow goes from 4m to 10m, sail the average area of about 36㎡.

The hole unit consists of 75 individual units.

* Surface - **Fiber - reinforced plastic (FRP)**
* Core Support structure - **Painted steel**
* Sail Support structure - **carbon fiber resin**
* Sail - **Recycled fibre**
* Base plate - **E-crete (using by-products and waste materials)**

**Environmental impact statement**

Dhow in Masdar City electricity which reduces the reliance on regional fossil fuel burning. It forms a collection by blocking sunlight and guiding airflow, reduces the temperature of open urban space, reduces partial land water evaporation, and is conducive to the concentration of plant diversity. Reasonable density and translucent shading do not affect plant photosynthesis.

Except for the hard pavement crossing the site, the other sites are all natural soil (including local soil and introduced soil), which has a low impact on the underground soil quality. The foundation of the Dhow power generation device is buried in the ground for about 1m, and the main contact components are the recycled concrete without pollutants and the protective pipeline outside the transmission line. The power storage and energy storage equipment is set on the top of the device, which has little impact on the ecological environment.

Through the creation of the land art landscape space with Dhow power generation device as the main body, local residents, researchers, students and foreign tourists in Masdar can have the opportunity to get close to the desert oasis, and perceive the significance of energy, ecology and environment in the pleasant and pleasant space, so as to further promote the thinking of "returning to the origin".