**ENERGY FIELD**

“Form Follows Energy”

**Introduction:**

**ENERGY FIELD** is the symbolic metamorphosis of the 8-element energy system onto a built environment. The Energy system founded by Dr. Park Jae Woo portrays 8 energies governing every element in the universe. The philosophical adaptation of the oriental energy system is to demonstrate the dynamic operation of the energy constitutions and how they inseparably co-exist in equilibrium. The project seeks to depict the sequential outworking of the 6 energy constitutions endlessly charged by the solar plexus and sustained by the absence & presence of light, thereby forming the 8-element energy system. The six energies are articulated in the English language as – Wind vs Humidity, Heat vs Dryness and Hotness vs Coldness. The six energy constitutions undisputedly rely on the sun as their primary source of energy. As for the depiction of the energy constitutions, a spatial layout is modelled that exhibits large scale energy-harnessing methods.

**Design Concept:**

The design approach is found on an architectural agenda; “Form Follows Energy”. Wherein, every design punctuation has a direct or a symbolic correspondence to the energy-source paths. Based on the climate data, solar power was identified as the primary source, wind as the secondary source and Fog as a tertiary source of energy. Additionally, micro-level harnessing of energy through piezoelectric surface materials was adapted based on the concept of “crowd farm” which have been tested at train stations in Japan. The study of sound frequencies showed the arcing dynamics of spin & rotation in molecules which was further adapted in the overall design form. The wave patterns generated in the site correspond to the sun and wind paths.

A research lab on cymatics and sonoluminescence was installed as new age studies indicate the successful utilization of electrical charges from sound waves. Symmetric patterns generated by a cymascope enlighten us, on building matrix of matter, whatever the medium, consists of vibrating molecules. Freezing the frames of the waves in motion reveal that harmony exist at all levels in nature; Euclidian geometry becomes perceptible with the unveiling of orbital paths intersecting, vertices becoming legible and straight lines connecting the points become clearly evident. Patterns linking the energy constitutions were perused to form the basis to design a series of linear plazas along the site.

The spatial layout was derived from the line-up of the energy constitutions adopted from the ancient Egyptian chakra system and the Korean acupuncture system. Theoretically, sequence of energy manifestation through time are of two types, spin type and progressive type. The spin type was adapted for the functional outworking and to show how energies are interconnected and exist in unison. The progressive type shows how energies are organized as a structured layout so the spin type can assist in the spiral progressive journey of each energy.

To accentuate the architectural style of the land, the fabric derivation for the built structure had to be contextual. The Islamic 12-point geometric patterns where perused methodically, giving light to the existence of tessellations that substantiates the frequency patterns of the energy constitutions. Furthermore, the design methodology convened the need to fuse natural functions of the energy constitutions with traditional architecture.

Each of the module for the six-energy constitutions was constructed as a means to harness energy either in the form of electricity or clean water. A detailed explanation of how each energy is mechanized to give an output is shown below.

**Design Development:**

**Building Geometry -** the over-lapping shell structures lined in a wave pattern cause a diverting effect to the wind flow and the wave-shells intersect at nodes creating a wake interference flow. The Wave patterns of the assembled shells increase the wind velocity by 2 m/s. The flow is further diverted using wind-catchers to rotate underground fans that generate electricity.

**Structural design** of the framework for the PV panels is laid on a self-supporting inter-locking cellulose membranes that rests on arcing steel structures. The inner shell is laid with layers of fog-rigging materials and interconnecting pipes to an underground reservoir. The plazas depicting each energy are laid out with tiles with a combination of permeable surface and potassium sodium niobate (KNN) based lead-free piezoceramic.

**Dimensions & Technology used:**

**Coldness & Hotness Energy** is depicted by installing solar hydro-panels that generate both electricity and water. The outer surface is covered with triangular shaped PV panels that cover a total area 9343 sq.m. Each panel takes upto 1.63 sq.m. The total practical applicable panels on the given area is 4000. Each panel produces 30 KWh.

The inner layer is masked with layered materials of MOF-801, condensers and OTTI Aerogels that are connected with pipes to a reservoir. The condensation rigs collect 20lts of water/day from an area of 2 sq.m.. The total amount of water collected from the site using this technology is 40000 lts/day.

**Hotness**, the energy of joy, is symbolically depicted by installing a solar kitchen. The Concentrating Solar Power (CSP) technology generates 75 KWh enough to produce energy to cook 100 whole meals every hour. This opens the eastern end of the site to an increased footfall as it is directly linked to institutional and residential neighborhoods.

**Dryness & Heat Energy** is depicted by harnessing electricity from evaporation engines installed below sand-pits. 30% of the water obtained from the condensation rigs is used to generate steam that power the evaporation engines. These with an efficiency of 85% produces 3 watts/sq.m. Thereby producing 22 KWh in an area of 7500 sq.m. The cost of assembly is $45/KWh.

Heat is the energy of progress. A cymatics and sonoluminiscence research lab measuring 220 sq.m. on the eastern site is installed to celebrate scientific progress. The lab is aerodynamically designed in the form of large speakers that have 25000 small aluminum flaps that rotate when steam is generated from surface heat receptors. The metals flap create a roaring noise that is further modulated into various frequencies. An exhibition area displays the effect of sound on sand-particles that respond to the frequencies creating complex geometric patterns.

**Humidity & Wind Energy** is depicted by harnessing steam from water and hot sand to generate electricity. Landscaped community gardens being sustained by 20% of the collected water from the fog-condensation-rigs to show how humidity and wind energy are essential to sustain earth’s green cover.

The wave-shells and a series of wind-catchers increase the velocity by 3 m/s. which in turn mobilize 3 large turbines that produce a total output of 131 MW/year. The cost of the wind generation system amounts to $220/KWh. Another display of wind and heat energy is in the science of cymatics that will exhibited at the “Heat-plaza”. The cost of which is $65/KWh

The pathways are laid out with potassium sodium niobate (KNN) based lead-free piezoceramic made up of polycrystalline quartz that produce 11 KWh with an ideal footfall of 500,000 people/year. The cost of the KNN piezo-ceramic paving for the entire site is $260/KWh

**ENVIRONMENTAL IMPACT:** *(300 words)*

**Solar PV Panels**

Embodied Energy Solar cell Production - 120 kWh/ m2

Module Assembly - 190 kWh/m2

Support Structure - 300 kWh/m2

Total Energy per m2 = 610 kWh/m2

Total Energy = Total No of Panels x Panel Size x Energy required for 1 Square Meter 4000 x 1.63 x 610 = 3904000 kWh ( 3904 mWh )

Therefore = 3904/120 = 32.5 Months to recover.

**Wind Turbines**

Embodied energy for wind turbine fan production – 180 kWh/m2

Module Assembly – 165 kWh/m2

Support Structure – 220 kWh/m2

Total Energy per m2 = 1125 kWh/m2

Total Energy = Total no. of turbines x turbine size x Energy required for 1 sq. m. 3 x 310 x 1125 = 33750 kWh

Therefore, 1300/95 = 13.6 Months to recover.

**Fog Condensers**

Embodied energy for OTTI aerogel and mof-801 – 480 kWh/m2

Module Assembly – 240 kWh/m2

Support Structure – 210 kWh/m2

Total Energy per m2 = 2250 kWh/m2

Total no. of layers x panel size x energy required for 1 sq. m = 4000 x 2 x 2250 = 1800000 kWh.

Therefore, 96000/225 = 426 months to recover.

**Piezo-ceramic tiles**

Embodied energy for piezo-ceramic poly-crystalline production – 350 kWh/m2

Module Assembly – 95 kWh/m2

Support Structure – 65 kWh/m2

Total energy per m2 = 11 kWh

Total Energy = Total no. of tiles x piezo-ceramic size x Energy required for 1sq. m 7000 x 1 x 11 = 77000 kWh

Therefore, 77000/120 = 641 months to recover.