**AIRnergy is a synergetic pedagogy that fosters a dialogue between wind energy generation and the community of Copenhagen and the greater world.**

DESIGN CONCEPT

AIRnergy emulates the movement of wind through the meticulously structured form that not only captures wind but also generates new spectacles and vantage points along the infamous Københavns Havn and its neighbouring structures. Refshaleøen is a rich complex of creative entrepreneurships, warehouses, and cultural and recreational venues. The design site is grounded within a dilapidated reclaimed land. AIRnergy celebrates the weakness of the site with the potential of harvesting renewable energy through the flow of wind. Alongside the community people of Copenhagen, AIRnergy will propel towards a new era of Carbon Neutral social nomenclature.

It is inherent that this Land Art Generator is a system that rises from the glory of Copenhagen. The form is an abstraction of the combined elements of wind, climate, views and the nature of its surroundings. The design captures these influencing factors by projecting tension points across the site and thus generating a network of structural energy lines which gave AIRnergy its form. The detail of the structure is reminiscent of the industrial identity of the landscape and its origins. AIRnergy is a micro-sensitive emergent system that transcends from the urgent need for a sustainable energy generation.

DESIGN EXPERIENCE

A journey through AIRnergy will break the social stigma against the grim aesthetics and lack of efficiency of renewable energy generators. The division of spatial programs encompasses the intricacy of energy generation, the human context of joyous kinfolk, building activities, education and a display of technology. Through the articulation of different spatial qualities, three main functions will be executed; View, Play, Learn.

**VIEW**
The monstrous aesthetic provides a stark contrast to the fluid overall form. The structure creates a labyrinth of intricately populated wind-sensitive piezoelectric panels. This display is influenced by the motion of wind as it passes through the site. This intensifies the intricate details of energy generation and results in safe, carbon neutral and eco-friendly energy generation. Through the structure, technology and sub-components, the fluid display of motion and natural flow illustrates a tangible and logical harvesting of wind energy.

**PLAY**
The form of AIRnergy exhibits a playful organisation of spaces. It provides a cheerful experience and juxtaposition between revealed and concealed spaces, creating a subtle interlocking relationship between the interior and exterior environment. With the dynamics of the piezoelectric flaps, a cheeky hide-and-seek playground setting is shaped, which hence structures a platform for creative interaction between fellow visitors and the landscape. The visual qualities are a reflection that AIRnergy is an extension of a landscape that captures wind energy and funnels it through the geometry of the design. It is not only an energy generator but also a public space, creating a future landmark and escapade for the people of Copenhagen.

**LEARN**
The educational structures comprise of a pavilion, workshop and exhibition space. In the exhibition space, the power-generating machine of the system is framed like a jewel, symbolising the appreciation of the beauty of renewable energy. This space can be used as an exhibition space for further revolutionary or conventional pieces of renewable energy systems and to host other renewable energy or community based programs. The workshop space is an opportunity to learn and a public workshop where visitors are able to fabricate their own piezoelectric panels. A CNC machine and other industry standard facilities will be retrofitted into the space to allow guests to gain first-hand experience on manufacturing their own panel design onsite. AIRnergy is a breakaway from the austere perception towards renewable energy systems that is a divine option which genuinely has a fresh breath away from the otherwise chaos, machine-like dystopia.

TECHNOLOGY

A windy day causes leaves to flutter and road signs to shake. It is these vibrations that resulted in the proposal of a piezoelectric wind energy generating system (inspired by Vibro-Wind Systems). The four structures strategically positioned across the site comprises of a triangulated panel series, each of which houses a kinetic flap/membrane that bends and flutters in response to the prevailing wind. The collection of small vibrating plates are designed to capture wind and generate energy but also to bring an aesthetic element to the site through the wave-like effects created by the moving flaps. These fluctuations not only reveal the shifts in wind movement but also provide a visual map of the panels’ collection of wind energy.

The basic science behind each of these movable flaps involves wind-induced vibration due to the non-linear fluid flow and vortices around a flexible structure. The energy harvest device comprises, in one embodiment (each the triangular panel), an oscillating flap, a piezoelectric bender (transducer) and an energy convertor that converts the vibration of the oscillating element into direct current.

The piezoelectric sheet benders are attached to the panel and are connected via a hinge that allows for rotation along the vertical axis. In wind conditions, the rotation of the flap about the bearing joint creates a modal flutter response and hence a vibration that is picked up by the piezoelectric benders connected to an energy convertor (full rectifier bridge) concealed within the joints between each triangular panel. The energy collected from the panels throughout the day is stored in a generator and capacitor, during the night, the energy stored will be able to power the organic LED light panels attached to the joints between the triangle panels. The lights emitted from the panels provide a visual reminder even to viewers at a distance of the real-time energy production on site.

ENVIRONMENTAL IMPACT STATEMENT

Unlike the commonly used rotary wind turbines which requires a start-up velocity of 9-10m/s, these piezoelectric panel systems can be effective in wind-velocity environments as low as 2-3m/s. This technology is virtually silent, significantly cheaper to build and has lower impact on the surrounding landscape. The relatively low lying composition of the structure does not impose any danger for birds flying in the area.

The maximum energy can be attained when the flap and piezoelectric bender are deflecting with 90 degrees phase difference. A 6X6 panel array is estimated to be able to produce an output of up to 50W/m2. If all the panels on each of the four structures are fully operational at a given time, an average of 300,000 kWh/yr will be produced. On a spring day, the energy collected would be enough to power up to a few hundred households. Organic LED lights are installed at the joints between each panel which causes the structure to glow at night. The energy consumption of these LED lights is minimal and the surplus of energy is directed to the electrical grid.

Integrating the ideas of promoting green energy generation, the proposal incorporates existing technologies that maximizes the generation of energy and at the same time minimizes the structure’s environmental footprint. The triangular grid framework are made of recycled steel tubes that provide a lightweight structure that holds up the panels and allows for the wires from the piezoelectric system to run through the structure and then to the generator. The various parts of the system can be easily assembled offsite and then brought onto site. The flaps are made of flexible PVDF sheets which are recycled, lightweight, translucent and waterproof to allow for maximum capture of wind under all weather conditions.

All the materials used for the installation are recyclable and offer great Energy Pay-Back Time (EPBT). The estimated embodied energy inclusive of the processing, manufacture, transport and assembly of AIRnergy is around 200,000 gigajoules. The embodied energy will be covered in around 5 years depending on the wind conditions.