**WEAVES**

***Hard to soft public landscapes***

Landscapes are multi-layered overlays of natural processes and human action, embodying the cultural values of its inhabitants. The landscape of St. Kilda has been transformed from its original fluid and permeable landscapes of seashore and swamplands to constructed hard surfaces developed over time. The St. Kilda Triangle, in its current state of a car park, represents the many challenges associated with the hard surfaces common to urban development. Urban hard surfaces block water, sun, and wind, disconnecting human experience from the environment, decreasing the landscape’s natural ability to function, and often times increasing the demand for energy consumption.

***Energy harvesting textiles: a new kind of power lines***

*Weaves* offers ideas for integrating energy harvesting textiles as part of the design of a sculptural public landscape for the St. Kilda Triangle. Keeping the idea that a productive landscape is a result of the natural environment and its people at the core of the proposal, *Weaves* investigates ways in which textiles can harness energy from the environment and from people’s interaction while creating an airy, inviting public space. As such, *Weaves* proposes the use of solar fibers (organic photovoltaic fibers) to harvest energy from the sun, and triboelectric textiles to harness energy from wind and from movement generated by the park’s users.

The design takes its inspiration from the nearby ocean. The wave forms speak of fluidity, power, excitement, buoyancy, and provide the experience of rising, descending, and being held or suspended inside a wave. The wave is both the park and a sculpture: it rises from the ground, transforming from a plaza and gardens along the Jacka Boulevard, slowly rises and descends into areas for trampolines and public hammocks, and continues to rise onto viewing platforms nestled within the crest of the wave. The wave provides the public with several uses and experiences: multiple vantage points from which to view and experience the site and the nearby shore, shelter from the sun and wind, places to gather and promenade, and the ability to bounce on a trampoline or rest in a hammock.

The waves are made from structural steel ribs that rise from the ground surface to become giant looms housing solar fibers, triboelectric fabrics, and batteries for energy storage. On the ground level, triboelectric textiles are woven into permeable, sponge-like, soft walking surfaces that capture energy from footsteps, while allowing rainwater to permeate and be filtered as part of the roof garden system above the underground parking. Inside the wave, triboelectric textiles comprise the trampolines and hammocks, harnessing electric charges generated upon human contact. On the northern portion of the wave structures, solar fibers are woven in a double layer creating a visually permeable surface that harnesses sunlight while allowing views from The Esplanade. Wind energy is additionally harnessed in the “sail-like” fins on the upper part of the wave structure by triboelectric textiles that gently flutter with the breeze.

*Weaves* presents a model for renewable energy production through the harnessing of environmental and human interaction to create a pleasurable public space that increases the connection to the local landscape. Through the use of energy harvesting textiles, *Weaves* invites the public to rethink urban hard surfaces and consider how ephemeral, lightweight, billowy, soft materials can provide new experiences in public space. By scaling up energy harvesting technology associated with wearable electronics, energy harvesting textiles may become the new power lines to be woven into our cities’ public spaces.

**TECHNOLOGY & ENERGY OUTPUT**

*Weaves* proposes the use of two main energy harvesting textile technologies: organic photovoltaic fibers and textile-based triboelectric generators.

**Organic photovoltaic fibers**

Solar fibers are constructed using a green, vapor deposition process that coats readily-available natural threads, such as cotton, silk or bast fibers, with nanoscale layers of conducting and light-absorbing organic polymers. Unlike other thin film photovoltaic technologies, including plastic-backed silicon or cadmium telluride, organic photovoltaic fibers make use of diffuse incident light, thus performing similarly under various incident light angles and low light intensities. While these solar fibers can be woven into textiles, *Weaves* proposes its use as fibers in order to create a more visually permeable structure that creates moiré patterns and can also allow for the inclusion of other linear elements such as electroluminescent lighting for nighttime illumination. The vapor coating process used to create these solar fibers is compatible with any thread, therefore allowing natural, unprocessed fibers and yarns from local mills to be readily used.

**Solar textiles length**: 18,000 meters

**Efficiency factor** (based on the number of daylight hours): 0.2

**Output**: 10 watts per 1 meter. 18,000 (10)= 180,000 watts

**Total solar output:** 180,000 watts x 8,760 hours x (0.2) = **315.36 MWh/year**

**Triboelectric textiles**

Triboelectric textiles work in any environmental condition, including under darkness and upon being subjected to sea salt spray, and are activated when the constituent threads of the textile come into dynamic contact with one another due to small mechanical deformations, as when a fabric billows in the wind. Triboelectric textiles are created by weaving together two different silk or cotton threads that have each been vapor coated with a nanoscale layer of a polymer insulator that carries positive surface charge or a complementary insulator that carries a negative surface charge. These textiles are commonly used for scavenging energy from small body motions. *Weaves* proposes their use as ground surfaces, as textiles incorporated in trampolines and hammocks, and as textiles activated by the wind on sail-like structures on the top of each wave.

**Triboelectric textile output:** 0.5Watt/ m2

**Sail triboelectric area** (constantly productive): 300 m2

**Sail triboelectric output:**

300 m2 x 0.5 W/m2 x 8,760 hours= **1.314 MWh/year**

**Ground triboelectric textile area:** 3167 m2

Foot surface area (average): 100cm2 (0.1m2)

Crowd estimation: well attended park 1 person per 1m2

*Area of foot contact*: 3,167 m2 x 1 person/m2 x (0.1 m2)= 316.7 m2

Average daily use: 4 hours (16%)

**Ground triboelectric output:**

0.5Watt/ m2 x 316.7 m2 x 0.16 x 8760 hours = **0.22 MWh/year**

**Hammock & Trampoline area:** 634 m2

Body surface area of contact (average): (0.7 m2)

Crowd estimation: (0.5) person per 1m2

Area of contact: 634 m2 x 0.7 m2 x 0.5/ m2 = 221.0 m2

Average daily use: 4 hours (16%)

**Hammock & Trampoline triboelectric output:**

0.5Watt/ m2 x 221.0 m2 x 0.16 x 8,760 hours = **0.154 MWh/year**

**TOTAL PARK OUTPUT: 317.04 MWh/year**

**MATERIALS AND DIMENSIONS**

**Steel structure:**

The structure of the waves for the project will be predominantly made of recycled stainless steel coated with recycled fiberglass coating.

Approximate area: 2078 m2

**Solar fibers:**

Solar fibers will make the majority of the vertical cladding in between the shells.

Length: 18,000 meters

**Triboelectric Textiles:**

Triboelectric textiles made from natural fibers will be incorporated in the ground surfaces, trampoline, hammocks and sails of the structures.

Total triboelectric fabric area: 4101 m2

**ENVIRONMENTAL IMPACT STATEMENT**

The construction of *Weaves* will improve the current environmental conditions and performance of the St. Kilda Triangle. Existing soil contaminants will be properly removed or contained within to allow for the construction of the underground garage. In areas where underground construction is not required, such as the northeast and southeast corners of the site, parks with native plantings will provide ecological benefit, while providing permeable surfaces to contain and filter storm and flood waters. Additionally, the main (ground) level of the project will act as a green roof through intensive plantings of native sedges, grasses and small trees in its linear stormwater planters, and by providing additional permeable surfaces through its triboelectric ground surfaces. Every drop of rainwater will be collected, treated through planters for cleansing and stored in an underground cistern. By removing the current asphalt and replacing with vegetation and permeable surfaces, the St. Kilda triangle will have improved ecological performance, provide habitat, reduce the heat island effect, and better adapt to flooding from rising tides and storms.

Through the incorporation of natural fibers as the main substrate for the solar fibers and triboelectric textiles, *Weaves* reduces the embodied energy required to build the project and presents a new precedent for their incorporation at the urban scale. Other materials, like the steel of the armatures, will come from recycled sources to minimize their embodied energy. By harnessing solar, wind, and human-activated mechanical energy, *Weaves* provides a new public landscape that interlaces clean energy, resiliency, beauty and life into the St.Kilda Triangle.