DESIGN SUBMISSION: THE CANOPY

ST KILDA TRIANGLE MASTERPLAN

LAGI COMP- 2018

The Canopy is a modulated, urban, renewable energy park that employs the concepts of biomimicry within art, architecture and landscaping to capture all potential renewable energies within a given site in much the same way as a natural tree canopy would. Similar to natural trees, the canopy follows the topography of the site and responds to each localities’ contextual needs to provide empathetic structures. These structures consider and are attuned to both the natural and community needs of the St. Kilda triangle foreshore masterplan. The Canopy’s structures don’t aim to overpower the St. Kilda foreshores proposed masterplan but be considerate of it. Our aim was to provide narrow architectural incisions through the site that help provide extra linkages, interactions, amenities and sheltered community spaces. These site incisions aim to draw the user away from a standard interaction with the ground plane using a layered/levelled approach to draw inhabitants up into the treetops and out towards the ocean.

At the micro level, the tree like structures of the canopy are designed to respond to the environmental conditions of the site in similar ways to how natural trees would. The larger canopy tree structures support solar dishes, and wind turbines that absorb solar and wind energies in much the same way as a trees leaves would through natural mechanisms such as photosynthesis and wind resistance. The trunks of the structure hold batteries that store the power produced from renewable energy sources and water tanks that collect rainwater. The structures upper eaves and overhangs act to shade the inhabitants and support growth in the planter beds below.

The lower canopies provide open air shading and spaces that can shelter and accommodate different community needs such as digital libraries, food stalls, markets, etc. The lower canopies also act to structurally support a pedestrian platform, cycleway, gardens, seating, community decks and kinetic nets. The kinetic nets within the platforms allow inhabitants to interact with the energy production process by using their own movements to contribute to it. Simple pleasures such as reading a book, relaxing or catching up with friends on the experimental kinetic nets allow users to interact with the energy production process and contribute to it in a small but meaningful way.

At the macro level, the canopy employs the concept of a dynamic and adaptable, modulated hexagonal structural grid. This grid consists of a limited number of environmentally sustainable pre-fabricated components that allow the structure to effortlessly adapt and respond to the changing landscapes within the site. The hexagonal nature of the structural grid allows the structures incisions on site to turn (60 degree turns) and snake its way along the topography. Employing this hexagonal structural grid allowed us to design platforms that fit seamlessly into the contextually diverse site.

The whimsical almost futuristic nature of the canopy is not purely incidental but as a direct and complementary response to the whimsicality of the St. Kilda triangle’s surrounding context. From the free, fun loving nostalgia of the Luna Park theme park bounded by rollercoasters, to the Art Deco grandeur of the Palais theatre, and the Mediterranean-inspired landscaping of Carlo Catani’s original early 20th Century Masterplan; the sites contexts lends itself to a design that’s playful, forward thinking and futuristic. We employed this whimsical design intent on site in order to capture the users’ imagination and bring about a contemplation of the future potentials of renewable energy infrastructure within architecture. The designs primary goal is to help instigate societies conversation on the integration of renewable energy technologies within our urban landscapes and the transition from the 20th century view of power generation from one of a purely utilitarian view-point to a 21st century mindset of power production as a thing of beauty, integration, sustainability and nature. The design helps to brand St. Kilda council and the City of Melbourne as pioneers at the forefront of this new sustainable, energy integrated world.

While exploring the master planning on site we looked at 3 concepts we believed the site needed. These concepts were:

1. Incisions- the designers of the St. Kilda purple masterplan had already done a fantastic job of creating pathways, parklands, site amenities and open green space. It wasn’t our intention to change a scheme that had been formulated over hundreds of hours of hard work and analysis. We wanted to design a scheme that placed slender incisions above the ground plane that complemented the purple masterplan and provided even more connectivity, activated new spaces, experiences, amenities, sheltered open air spaces and new uses on site. We wanted to give the site the ability to reach its full potential of use within the community- an integrated, power generating heart of the community.
2. Ecosystems- the site has been designed with four ecosystems placed contextually to capture each localities positive features. The ocean ecosystem provides the structural framework to support all of the site and communities aquatic needs. The Wellness, reflection and entertainment ecosystems as seen in the masterplan analysis are also placed in specific areas as designed to encapsulate all potential community needs such as performance, exercise spaces, research spaces, etc on site.
3. Connecting the site- with Jacka Boulevart splitting the sites green spaces in two we decided to use a raised platform to connect the site.

In summary, ‘The Canopy’ uses a layered approach with tidal turbines, wind turbines, and photovoltaic cells/parabolic trough superconductors and biomimicry of natural tree processes such as photosynthesis and wind resistance to create a community park that sits empathetically within the landscape while generating 2,200 Mwh of carbon neutral power annually (enough to power 315 standard family homes per year). We wanted a renewable energy art installation that was not just aesthetic or alternatively utilitarian, but designed to connect the site and draw the inhabitants within the architecture- above the trees and out towards the ocean. The Canopy shapes natural and man-made habitats and forms a design that complements the St. Kilda purple masterplan and the unique whimsicality of a site that’s adjoined to the eccentric Luna Park bounded by roller coasters, the art deco grandeur of the Palais theatre and sits within Carlo Catani’s early 20th Century Mediterranean inspired promenade. The design intent was to create a whimsical almost futuristic universe inspiring visitors and providing the catalyst for a greater conversation on the place of renewable energy infrastructure and its integration within the urban built environment in the 21st Century.

TECHNOLOGY USED IN THE DESIGN AND TOTAL ENERGY OUTPUT

**TECHNOLOGY 1:**

**\*Type:** Onshore and Offshore Horizontal Axis Wind Turbines (HAWT)
**\*Changes to the standard Technology:** Horizontal Axis profile to be in the shape of a double helix (Similar to the shapes of ornamental wooden wind spirals) rather than blades in order to pick up wind from all directions.
**\*Notes on Technology:** Most Canopy structures on site have been placed on the North/South Axis so as to pick up the highest rate of wind on site. However, due to the double helix design of the blades wind will be picked up originating from any direction.
**\*Average wind speed on site** (St Kilda Harbour Station Wind data analysis 2011-2017) = 20.5 km/hr
**\*Average Wind Direction on site** (Ibid) = 182 degrees (Southerlies).
**\*P= Air Density** = At sea level air density is around 1.2 kg/m³

**\*A=Swept Area of the rotor** = 5m² (small canopy structures), 8m² (large canopy structures) = 6.5m² Average rotor blade surface area.

**\*V=Average Velocity of the wind =** 20.5 km/hr
\***Power (Watts)** = 800W nameplate capacity per Turbine

**\*Energy Produced (Kwh/yr)** = Power x time / 1000 = 800W x 8760 / 1000 = 7008 KW hr/yr per turbine

\*Energy Produced x Conversion Efficiency = 7008 Kwh/yr x 0.4 (HAWT 40% Capacity Factor) = 2800 Kw hr/Yr per Horizontal Axis Wind Turbine
\*Number of HAWT’s on site = 36
**\*Total Energy Produced by HAWT’s on site per year** = 2800 Kw hr/yr x 36 = **100,900 Kw hr/yr = 101 Mw hr/yr**

**TECHNOLOGY 2:**
**\*Type:** Kinetic Energy Harvesting
**\*Changes to the standard Technology:** Our design uses the concept of tensile nets that create gravitational strain to pull upon Piezolelectric Generators that produce electrical energy. These kinetic nets will be situated within the lower canopy platform level of each module and be meeting/working/social spaces where people can gather and relax on the nets. These nets will use human movement and weight to charge the Piezolectric Generators- the design intent behind this being that visitors to the site will be able to interactively and personally contribute to the energy production process. Of course while Kinetic energy harvesting doesn’t produce enough energy to put back into the grid, this form of production will facilitate workplace charging stations within the Educational Ecosystem. This will allow users to plug their laptops, tablets, phones and electronics into the charging stations and charge their items with their own gravitational weight and movements while they work/relax and play.

**TECHNOLOGY 3:**
**\*Type:** Concentrated Photovoltaic and Thermal Parabolic Trough/Dish Integrated System
**\*Changes to the standard Technology:** Our design aims to maximise the efficiency of your standard photovoltaic panel system by utilizing a combined PV panel/thermal parabolic dish system. The problem with standard photovoltaic panels is that they only absorb approximately +- 30% of the suns energy with the remaining 70% bouncing off. The parabolic design of our dish within the upper canopies of our structures captures the suns rays at whatever location it is within the daytime and bounces any reflected/wasted rays not absorbed from the PV panels towards a raised set of superconductor coils in the centre of the dish that store collected rainwater from the canopy structures tank below. This rainwater is heated and converted to steam that travels within the system to a steam turbine sitting just above the rainwater tank within the structure and that capturing a lot more of the potential solar/thermal energy on site.
**\*Standard Solar Panel Size:** 1600mm x 800mm = 1.28m²

**\*A=** Average surface area of each canopy structures Parabolic dish= 60m² (small canopy structures), 95m² (large canopy structures) = 77.5m² Average Parabolic dish surface area.

**\*Power (standard solar panel nameplate capacity wattage) =** 300W x number of panels on one average parabolic dish
**\*Power =** 300W x (77.5m²/1.28m² panel size) = 300W per panel x 60.5 panels per average dish size = 18,150 W
**\*Capacity Factor** (Melbourne industry standard capacity factor to account for efficiency output) = 15%
\*However, as our capacity factor needs to include our combined Concentrated PV and Thermal Parabolic Trough systems our conversion efficiency/capacity factor is effectively doubled thus giving the design a capacity factor = 35%.
**\*Energy Produced (Kwh/yr)** = Power x time/1000 = 18,150W x 8760/ 1000 = 158,994 Kw hr/yr x 0.35% capacity factor = 55,650 Kw hr/yr per dish.
**\*Total Energy Produced (Mwh/yr) =** 55.65 MWh/yr x 36 = 2,003 Mw hr/yr

**TECHNOLOGY 4:**
**\*Type:** Ocean Tidal (Hydrokinetic) Ebb Generation pumping barge
**\*Changes to the standard Technology:** Not only will these rotors be influenced by tidal flow but they will be connected to rowing exercise machines on the platform above that allow the sites users to exercise while powering the water turbines below. Furthermore, these tidal rotors will act to filter and move the usually placid waters of Port Phillip bay thus stimulating water cleaning within our man made aquatic ecosystem and also providing moving waters to help support the filtration needs of the new man made shellfish regeneration habitats.
**\*Notes:** This would be experimental technology that combines tidal flows with Kinetic human power.
**\*Number of tidal turbines** powered by tides and rowing machines: 3
**\*Total estimated Energy Produced** by experimental Technology (Mwh/yr) = 100 Mwh/yr (estimation)

**300 WORD ENVIRONMENTAL IMPACT STATEMENT**

In terms of sustainability, the design aims to create a reduced environmental footprint, employing a range of materials and techniques to ensure that its presence within the environment is as minimal as possible.

We’ve generated new habitats using footings that support the structure out along the water that can be mounded to create man made shellfish habitats to support the Port Phillip bay shellfish populations that have been almost wiped out to 5% of their coverage since the 1850’s. We’ve used pre-fab construction techniques to have as little impact on the surrounding environment as possible. Recycled materials and green materials such as glulam beams have been used predominantly on site while lightweight structures ensure the design touches the ground lightly. The modulated nature of the design also ensures easy replacement and low maintenance of the structure once completed. Carbon offsetting gardens, natural materials, habitat regeneration programs and techniques such as housing the wind turbines within the structures so as not to harm native wildlife such as birds have all been employed on site to ensure minimal environmental impact through the design.

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| **MATERIAL CALCULATIONS (PER MODULE- 10 MODULES ON SITE- 1 MODULE = 4 TREE STRUCTURES + PODIUM)** | **SQM OR QUANTITY** |  **RATES**  |  **TOTAL**  |
| TIMBER PEDESTRIAN PATH | 263 |  $ 220.00  |  $ 57,860.00  |
| CONCRETE PATH |  |  $ 100.00  |  |
| TIMBER FLOOR BOARD - MIDDLE AREA | 30 |  $ 220.00  |  $ 6,600.00  |
| PLANTERS (QUANTITY) | 2 | $15,000 |  $ 30,000.00  |
| CONCRETE PLANTER (VOLUME) | 11 |  $ 120.00  |  $ 1,320.00  |
| NATURAL LAWN | 123 |  $ 32.00  |  $ 3,936.00  |
| PLANTERBOX TREE | 43 |  $ 120.00  |  $ 5,160.00  |
| TIMBER BENCHES | 4 | $5,000 |  $ 20,000.00  |
| CONCRETE FRAME FOR KINETIC MESH (VOLUME) | 2 |  $ 120.00  |  $ 240.00  |
|  |  |  |  $ 67,256.00  |
| TIMBER COLUMN |  |  |  |
| MARINE GRADE GLULAM | 2 |  |  $ 320,600.00  |
| SCOTS PINE CLT QUANTITY | 782 |  $ 135.00  |  $ 121,405.50  |
|  |  |  |  |
| TIMBER STRUCTURAL FRAMES |  |  |  |
| MARINE GRADE GLULAM (FRAMING) | 4.5 |  |  $ 192,915.00  |
|  |  |  |  |
| PREFINISHED CFC (MEDIUM SIZE - BLUE) | 264 |  $ 300.00  |  $ 79,200.00  |
| PREFINISHED CFC (LARGE SIZE - PINK) | 259 |  $ 300.00  |  $ 77,700.00  |
| PREFINISHED CFC (HIGH LIGHT COLOURS) | 71 |  $ 300.00  |  $ 21,300.00  |
|  |  |  |  |
| RAILING | 78 |  $ 200.00  |  $ 15,600.00  |
|  |  |  |  |
| FLOORING SUBSTRATE | 446 |  N/A  |  |
| WINDMILL | 4 |  N/A  |  |
| LIGHT UNDERNEATH SOLAR PANEL | 275 |  N/A  |  |
| SOLAR PANEL | 275 |  $ 588.00  |  $ 161,700.00  |
| LINEAL LIGHT (UNDERNEATH STRUCTURE) |  |  N/A  |  |
| WATER TANK LARGE (QUANTITY 2) | 50 |  N/A  |  |
| WATER TANK MEDIUM | 15 |  N/A  |  |
| FILTRATION UNIT | 3 |  N/A  |  |
| KINETIC MESH | 25 |  N/A  |  |
| **SUB-TOTAL PER MODULE** |  |  |  **$ 1,182,792**  |
| **SUB-TOTAL PER SITE (10 MODULES TOTAL ON SITE)** |  |  | **APPROX $12,000,000** |

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