**LUMINA PLEX**

**CONCEPT:**

As a seaside attraction, St. Kilda represents an important subculture within Melbourne that deserves to be celebrated. Although its locale is ideal for bringing in locals and tourists alike, one of the largest concerns pertaining to the site is exposure to harsh sunlight. This project attempts to ameliorate this drawback by utilizing solar energy collection methods with an aesthetic layer.

Each building of the cultural facility has a “hanging pavilion” with a photovoltaic façade that functions similarly to a building-integrated array. Acting as a solar collector, each structure will celebrate a different aspect of the community, including food, art, and music. Visitors can rent these venues in advance to host a variety of events, from lectures to live demonstrations and solar education. In addition to its bright color scheme influenced by the local Bohemian lifestyle, every panel is operable and can maximize energy production at nearly any angle. This is due to the usage of dye-sensitized solar cell (DSSC) technology, the color of each panel is determined by how much light is absorbed in any given day. The harvesting process is designed to mimic the biological phenomenon of photosynthesis, with colored dye in place of chlorophyll. Each façade will collect enough light to power the pavilions—and by extension the cultural facility.

Once the day shifts to dusk, another solar collecting system activates. A network of wide paths creates an internal hub that makes up Lumina Plex. Connections on the Esplanade and Jacka Boulevard also draw pedestrians in from the city and beach, especially at night. Translucent concrete is infused with a photochemical called luminophore, which absorbs sunlight and releases it in the form of photons. This allows the sidewalks to transform into LED displays of varying imagery. There are several opportunities for local and international artists to express their creative visions through a unique platform. Paths are expected to produce enough electricity for these exhibits to last until sunrise, providing 24-hour access to the triangle.

**TECHNOLOGY:**

A majority of solar renewable energy on-site is produced by dye-sensitized solar cell (DSSC) arrays developed by EPFL in Switzerland. Each cultural pavilion consists of a module ranging from 32-64 panels covering a trapezoidal surface area of about 245 m2. Panel installations have a minimum height of 2.5 m and maximum height of 3.7 m. Once light is absorbed and “sensitized,” the dye catches photons to excite electrons that are later stored inside titanium dioxide and platinum layers. Nanocrystalline photoelectrodes convert particles into electricity that is ready available all day. Electrolytes close this circuit and return electrons back to the dye, creating a recyclable energy system. This form of artificial photosynthesis thereby produces a clean fuel source without releasing harmful byproducts into the environment in the process.

What sets these colored panels apart from the more common silicon-based PV systems is their optimization and exceptionally long durability. The metals and organic dyes used are tunable for both natural and artificial lighting; this means that the efficiency of each panel does not change whether they are inside or outside the structure.[[1]](#footnote-1) Due to their high thermal performance, DSSCs also do not lose efficiency with drastic changes in temperature or weather, making them ideal given the direct sunlight conditions present in the St. Kilda Triangle. Even during a cloudy day, DSSC arrays are guaranteed to absorb the same amount of light from the atmosphere.

Another type of white solar module developed by CSEM will be installed specifically for the hanging pavilions located in the maker studio spaces of Lumina Plex’s art gallery. The making and viewing of sculptural forms usually involves a natural or white light to view and appreciate them properly. However, these modules can also be fabricated with nanotechnology and colored pigments to emit a visible colored light during times when artists are not at work.[[2]](#footnote-2)

Circulatory luminophore paths are also relatively harmless in their utilization of photochemicals. Functioning in a similar fashion to the dye-sensitized solar cells, luminophores transform the 15-meter wide translucent paths into luminescent solar concentrators that glow in the dark when the sun sets. After charging over an 8-hour collection period, the luminophores release photons that are later converted into power for LED art displays. There are several opportunities available for local Bohemians and Aboriginals in St. Kilda, as well as artists from across the globe, to present their visions through a platform not found anywhere else. Inspired by bike paths designed by Daan Roosegaarde in the Netherlands, these translucent concrete paths provide an intriguing method of safe night travel throughout the site.

**ENVIRONMENTAL IMPACT:**

Lumina Plex utilizes two different forms of solar technology, which coupled together generate an expected annual energy production of approximately 10,000 MWh (or 10,000,000 kWh).[[3]](#footnote-3) This is also the amount of energy consumed per year by 2,000 households in St. Kilda (Victoria alone consumes an average of 5,000 kWh of energy per household per year)[[4]](#footnote-4). In addition to the cultural hub, the electricity stored by dye-sensitized photovoltaics will also supply power to nearby homes, public institutions, and other important heritage sites, including the Palais Theatre. The low manufacturing and installation costs of DSSCs also presents a higher return of investment compared to local residential and commercial solar PV systems already existing in the community. More importantly, both path and pavilion create natural energy systems that are not only inexpensive and feasible, but also elegant and entertaining to a wide demographic.

1. ## Yi-Hua Fan, Ching-Yuan Ho, Yaw-Jen Chang. “Enhancement of Dye-Sensitized Solar Cells Efficiency Using Mixed-Phase TiO2 Nanoparticles as Photoanode.” *Scanning*, vol. 2017, August 2017.

   [↑](#footnote-ref-1)
2. J. Escarre, G. Cattaneo, L. Sansonnens, J. Bailat, L.-E. Perret-Aebi, S. Nicolay, C. Ballif. “White Solar Modules: From Prototypes to Industrial Products.” *CSEM Scientific and Technical Report*, December 2015. <https://www.csem.ch/Doc.aspx?id=39404&name=CSEM-STR-2015-p%2069.pdf> [↑](#footnote-ref-2)
3. Calculations for dye-sensitized solar panels use a projected 20% efficiency model provided by EPFL. <http://gcell.com/dye-sensitized-solar-cells/advantages-of-dscc/efficiency> [↑](#footnote-ref-3)
4. 2016 Australian Energy Market Commission. <https://www.mountalexander.vic.gov.au/files/Environment/What_is_a_Typical_Energy_Consumption_Presentation.pdf> [↑](#footnote-ref-4)