Radiant Link

# The Design

The curving steel arches of the Radiant Link reflect the duality at play within the site. On one hand there is the need to reunite St Kilda Triangle that is divided by Jacka Boulevard. On the other, the desire to stimulate public contemplation through a sculptural form. These two ‘requirements’ provide the opportunity for a link that reclaims the overlooked airspace above the road.

The Link is composed of three fundamental parts - the ‘rock’ ramp/plinth housing the energy storage, the pedestrian bridge and the solar arrays integrated into the arches supporting the pedestrian bridge.

Utilising the overlooked airspace identifies and optimises land development in an area that has otherwise been overlooked. Primarily, the placement of the link above the road maximises the exposure of the sculptural leaf form and its solar array to the public in passing car and pedestrian traffic. Placing the solar array with the link also releases the ground plane of the Triangle from the responsibility of housing the array, and free to respond to other public needs for green relief space. Facilitating circulation through the Triangle to the beach and environs functionally fits into the surrounding landscape needs and development goals of the council, outlined in the St Kilda Master Plan.

The abundant sunlight available makes using photovoltaic panels ideal. Expressing solar panels as part of the sculptural design is intended to celebrate PV cell technology in a public way and demonstrate that PV cells are not limited to ‘panels’. By cladding the steel arches in flexible plastic (ETFE) PV film, the solar array can be manipulated into the sculpted form of the link, promoting this developing technology.

The abstracted leaf form is derived from a desire to inform technology from nature. Much like a leaf, the arches of the link address the sun, maximising northern solar exposure onto the PV array. Structurally, the link is further inspired by the voronoi structure of a leaf. A pattern generated from plotting the optimal path across a surface, voronoi patterns are an example of the duality that can exist between architecture/manmade structures and nature. This duality is further built upon with the energy collecting photosynthesis of leaves to the tree and the ‘electric leaf’ function of the solar-link to the St Kilda Triangle sharing common purpose. The aesthetic, functional and structural inspirations of the link support the overall goals of generating public discussion for appreciating and conserving nature through sustainable design.

The ‘rock’ plinth/ramp element of the link intervention into the site acts as an intermediary between the land and constructed form. Sitting below the leaf, this ‘rock’ acts as the anchor of the link design, much like a tree would sit on the land. The electricity storage system is housed within this ‘rock’ that ramps up towards the link from the beach – transparent windows along the ramp allowing the viewing of technology within. The storage system secures the energy requirements of the site when energy isn’t immediately required. This ‘securing’ relationship reflects that of the rock securing the leaf.

# Technology Used

The overall design of The Radiant LInk’ has been developed with direct consideration to the site and context regarding how it would be best located to capture energy. To achieve this, the design proposes the use of Perovskite solar cells or printable solar panels. Typical solar panel systems were not considered because of their rigid construction. Printed solar cells offer flexibility in application which enables he fluid form. This means that within our proposal we were able to cover a large surface area to maximize solar generation. Printable solar cells also offer higher generation efficiencies, lower production cost, faster manufacturing speeds and greater construction flexibility than standard photovoltaic systems. By using this system, the project can minimize impact to the site, while maximizing energy generation.

The link deck is 10 m wide and 150 m long. Emphasis will be placed on sourcing recycled steel and concrete. The each voronoi arch structure is 7 m wide and is constructed from recycled steel. On top of this supporting structure is a thin layer of transparent Ethylene tetrafluoroethylene (ETFE) film made from recycled plastic. This technique requires little maintenance and is very durable. The solar panels fixed to the ETFE layer are also constructed using two layers of thin recycled plastic with a semi-conductive layer of ink between them. Typical printing methods are used, involving a flatbed and rotary screen printer. This ensures a consistent thickness of the semi-conductive ink (Demirci Sankir and Sankir 2017). These printable solar panel strips cover each of the 7 m wide arches. This system will be able to supply energy required for lighting on site, stored in the on-site energy storage facility. Surplus energy will feed into the wider Council energy system. Collectively, these panels collect approximately 1,146 kWh/d with a total annual output of 418,290 kWh or ≈ 418 mWh per year.

Energy storage is accommodated in a 350m² space under the ‘rock’ ramp/plinth. There are two available options for storage. Hydrogen is perhaps the more ‘pie in the sky’ solution due to the complexity involved with the technology. However, the opportunity to transport hydrogen and use it in other ways, such as for public transport(e.g, buses in Adelaide), is an exciting prospect. On the other hand, Sodium-Ion batteries are the most realistic medium for energy storage. As a battery solution, their integration for wider council usage is better understood as purely a storage medium. For either process, the intent is for pedestrians using the ramp to be able to see into the Energy storage space and have a visual connection to this part of the project’s energy solution.

The transportability of hydrogen and the ability to harvest it via water electrolysis makes hydrogen a sustainable zero-emission fuel alternative when combined with sustainable electricity production. A possible application is its use in a fuel cell. Energy storage capacity is dependant on supply power and available surface area - similar sized systems (e.g Sir Samuel Griffith Centre in Queensland) have a capacity of 1.3kg of gas producing 80 kwh (Power, 2018). As a zero emission energy storage solution, electricity and water are the primary byproducts of using hydrogen fuel cells.

The Lithium-Ion Power Facility installed in South Australia has demonstrated the viability of large-scale battery systems. Due to their energy density, lithium-ion is currently the leading battery chemistry used. However, the material scarcity involved in making Lithium-Ion batteries, amongst other potential procurement difficulties in the future, makes them a poor long-term solution for storage requirements. Sodium-ion batteries (SiBs) are a good alternative for static energy storage requirements due in part to the similar manufacturing processes involved to Lithium-Ion batteries. SiB’s are currently being researched by the University of Wollongong and implemented by Sydney Water. While they are up to 30% larger than Lithium-Ion batteries, static use largely neutralises this problem (Knott, 2018).

# Environmental Impact

The link localises clean energy production for St Kilda and promotes a sustainable design for its community, reducing distance between the energy source and point of use. Constructed primarily from steel and concrete, the link aims to spread the embodied energy cost over a long period of time as a civic structure to offset the carbon cost. Furthermore, utilising a voronoi pattern for the structural logic minimises material use due to the optimised paths ways across the surface being pursued. The embodied energy of the materials and construction of the link are further offset by ongoing clean energy production.

The printable solar cells promote research conducted by the Victorian State Government and the Federal Australian Renewable Energy Agency. Through it’s lightweight construction and low-impact manufacturing process, it eliminates the use of toxic materials such as silicon tetrachloride, lead and cadmium (Moss, 2014). The semi-transparent and light weight solar cells consist of printable solar inks on flexible plastic films, which requires low impact manufacturing. This further reduces the environmental cost of the proposal (CSIRO, 2018).

The link sets a precedent for future council and commercial developments to identify and promote solar panel installations in locations traditionally ignored within the city. Typically, large scale solar harvesting is pushed out to rural regions, consequently extending the distance between the energy source and it’s distribution point. The placement of the printable solar cells on the link utilises a residual space above the road, greatly reducing the land usage requirements traditionally needed. The link reduces issues of line loss and utilises unused space in a dense urban environment, all whilst adhering to the proposed masterplan.

To align with the community’s current requirements, the link makes minimal impact on the masterplan by integrating into the proposed development of the Triangle. It aims to have a small footprint by primarily occupying air space above Jacka Boulevard, an otherwise un-utilised space. The current master plan outlines increasing the ground level of the triangle (primary boundary). The link ‘links’ this higher level of the primary boundary with the lower secondary boundary, neutralizing the separation caused by the height difference and the intersecting Boulevard. As there is already a proposal to ‘disturb’ the current site in the masterplan, the link aims to integrate with this and minimise impact to the surrounding community during construction.

References

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