***NIGHT AND DAY***

***St Kilda Hydro-Solar Generator***

St Kilda’s seaside location on Port Phillip Bay has always been a special place. The indigenous Boonwurrung people saw the bay as both resource and source, fishing its waters and respecting its life-giving potential. When the railway line reached St Kilda in 1857, thousands of visitors arrived annually to sunbathe on the beach, soak in the sea baths and later, ride roller coasters at Luna Park. Today, arts and cultural resources like the Palais Theatre and annual St Kilda Festival continue to be a major draw for both residents and visitors from around the world.

Water, sunshine and the arts have always been St Kilda’s defining assets, resources key to its character as a seaside cultural hub. Now, as Melbourne moves towards a post-carbon economy, these same resources hold new potential.

The Hydro-Solar Generator is a power generator that works night and day, combining solar energy with a hydro battery to leverage the full potential of St Kilda’s most abundant natural resources: water and sunshine. The structure is a machine that generates and stores power, but it can also be inhabited. The machine takes the form of a pedestrian bridge linking the Esplanade to the Waterfront, knitting together public spaces at St Kilda that have become fragmented over time. It connects the city to the bay, offering dynamic new spaces for gathering and observation.

Suspended above the walkway are a solar sail and a water vessel, exhibiting the generator’s transformation of sun and water to power. During the day, harvested solar energy is used to pump bay water into the hydro battery storage vessel, high above St Kilda Triangle. As the sun sets and solar energy disappears, the water is released through a turbine, transforming the kinetic movement of water into electricity. The release of water is a lively community event, expressing the power of the battery’s embodied potential energy. Visitors can experience the machine through its full diurnal cycle, watching renewable energy in action and deepening their understanding of St Kilda’s, and our natural world’s, full potential.

***The design: a synthesis between complementary functions***

The generator’s form serves multiple functions. It integrates with and hovers over the site, preserving views and important master plan functions through a visually porous structure, while moving seawater and people to and from the bay’s edge.

The solar sail’s curvature is optimized for annual solar energy harvest. Winter and summer solar angles are averaged to form the arc of the 5,400 m2 array, allowing it to produce averages of 2,700 kWh daily, and 1,000 MWh annually. Crystalline silicon photovoltaic (PV) glass panels allow light to penetrate the structure during the day, illuminating the hydro battery’s volume and the park below. 82% of this power is pushed to the grid; 18% is utilized for pumping water into the hydro battery.

As the sun rises and solar collection begins, PV energy pumps 10,400 m3 of bay water into the hydro battery. The storage vessel is composed of translucent cast recycled acrylic with integral reinforcing, displaying the rising level of pumped seawater. At sundown, when the hydro battery is fully “charged,” water falls by gravity for ten hours to two Pelton turbines at a rate of 17.3 m3/minute, charging a generator and providing clean energy to the grid. Exposing the turbines educates visitors on the workings of potential energy, which is defined as mass + height + gravity. [[1]](#footnote-1)

Per volume of water released, the hydro battery provides 350 kWh, which moves Melbourne closer to achieving Victoria’s Renewable Energy Action Plan targets.[[2]](#footnote-2) After its work is done, the water is conveyed for gradual release back into the bay. A long basin extends the water’s release to daylight hours, when it can become an interactive park feature, telling the story of water’s potential for energy generation and storage.

***Potential for broader impact***

The Hydro-Solar Generator addresses a renewable energy conundrum: storage.Conventional battery technologies are resource-intensive, often using toxic and heavy metals that pose a hazardous end-of-life problem.[[3]](#footnote-3) We solve this by using potential energy (mass + height + gravity) and borrowed seawater – an abundant local resource. According to the Australian Bureau of Statistics, approximately 85% of Australia’s population lives within 50 km of the coast. [[4]](#footnote-4) A battery solution that incorporates ocean water could be extended across the country, and positively impact the global landscape of renewable energy deployment.

***Environmental Impact Statement***

The generatordoes not produce emissions – greenhouse or otherwise – nor any physical or airborne waste products. The structure is composed of recycled and renewable materials and, whenever possible, local materials with low transit impact. The steel structure is composed of recycled steel bar stock welded into custom shapes, and is designed for clean deconstruction. The pathway is made from salvaged wood and timber. Acrylic scrap, part of the industrial waste stream, will be recycled and cast through pyrolysis.[[5]](#footnote-5) Steel cable is locally available and easy to transport. Monocrystalline silicon PV glass panels are distributed locally.

The installation is designed for minimal impact on St Kilda’s coastal ecosystem. Because Port Phillip Bay is a shallow, sandy beach, conditions shift frequently – it is not an environmentally sensitive habitat area.[[6]](#footnote-6) Far from the Yarra River outlet, foraging species should not be affected by construction or shifts to hydrodynamics on site. Water cycling through the hydro battery system will not be exposed to anthropogenic pollutants or chemicals, thereby minimizing impact on water quality and marine habitats.

A two-part filter system at the pump intake reduces risk of entraining marine organisms. Water is pumped at approximately 14.4 m3/minute for 12 hours. The discharge basin stages the release of water to reduce the impact to the marine ecosystem. Water discharges at a flow rate of 8.6 m3/minute at the surface of the water - ostensibly similar to the hydrodynamic impact of industrial and recreational watercraft.

***Primary Materials List***

* (23) Primary structural ribs, each containing:
* (2) I-beam steel masts – combined length of 45 m @ 1 m deep (average size)
* (1) Stainless steel tension cable – 6 m length @ 50mm diameter
* Solar Sail:
* Onyx Solar Crystalline Silicon PV Glass panels & attachment components– 5,600m2
* Stainless steel cables – 1,750 Lm
* Hydro Battery:
* Cast acrylic enclosed water vessel – 4,800 m2
* Integral carbon fiber reinforcement – 2,350 Lm
* Intake & output reinforced acrylic pipes – 200 m @ 50cm diameter
* Drainage Basin:
* Cast acrylic vessel – 3,600 m2
* Integral carbon fiber reinforcement – 720 Lm
* Perimeter stainless steel cables – 665 Lm
* Reclaimed wood boardwalk – 330 m @ average 3 m width
* Energy Generation
* (2) Impulse-type Pelton Turbines – 4.5 m diameter
* Generator powered & axel driven by turbines

1. Fujihara, Tetsuo, Haruo Imano and Katsushiro Oshima. “Development of Pump Turbine for Seawater Pumped-Storage Power Plant.” *Hitachi Review*, January 1998. [↑](#footnote-ref-1)
2. The State of Victoria, *Renewable Energy Action Plan*, 2017. [↑](#footnote-ref-2)
3. Akinyele, Daniel, Juri Belikov and Yoash Levron. “Battery Storage Technologies for Electrical Applications: Impact in Stand-Alone Photovoltaic Systems.” *Energies*, 2 November 2017. [↑](#footnote-ref-3)
4. Australian Bureau of Statistics. “Year Book Australia 2004.” 27 February 2004. <http://www.abs.gov.au/Ausstats/abs@.nsf/Previousproducts/1301.0Feature%20Article32004> [↑](#footnote-ref-4)
5. Singh, Yashpal. “Acrylic Scrap Recycle.” *Wealthy Waste,* 15 March 2017. <http://www.wealthywaste.com/acrylic-scrap-recycle> [↑](#footnote-ref-5)
6. The State of Victoria, Commissioner for Environmental Sustainability. “State of the Bays 2016.” 2016. <http://www.ces.vic.gov.au/sites/default/files/reports/State%20of%20the%20Bays%20Report%202016.pdf> [↑](#footnote-ref-6)