**Alg-E**

St Kilda is known as Melbourne’s seaside playground. From the iconic Luna Park, beach front and esplanade it has long been a desired destinations for tourists and residents alike. Bustling St Kilda is the perfect example of the bohemian lifestyle combining a vibrant night-life and laidback day-time beach scene.

This artistic green power installation titled ‘Alg-E’ seamlessly ties in the historic narrative of this suburb and introduces a sustainable and educational quality.

Visually the installation will allow for stunning views during both days and nights that complement the picturesque skylines whilst showcasing and referencing St Kilda’s historic landmarks.

 **Description**

A light and a dark cycle form the basis of the Alg-E installation. The light cycle produces the fuel and the dark cycle converts it into electrical energy.

**Light Cycle**

The above ground light cycle consists of an interactive field of microorganism filled tubes of varying heights. The bright green colour of the Cyanobacteria microbes will be on full display within a series of enclosed transparent vertical and interconnected tubes. The microbe mixture will be slowly circulated to create a visually interesting and interactive installation.

The microbes use photosynthesis to convert sunlight and CO2 into sugars which is to be used as fuel for the dark cycle. The microbes release the produced sugar directly into the water and therefore no extraction process needs to be applied.

At night 20% of the tubes will be artificially lit using high efficient LED strips to emulate bioluminescent dinoflagellate which is naturally occurring along the St Kilda foreshores.

**Dark Cycle**

The underground dark cycle is effectively a microbial fuel cell that produces renewable electricity through the oxidation of sugars. The sugar saturated water will be directed into an 85 kL tank filled with an active biocatalyst and anaerobic organism known as Shewanella Oneidensis. The biocatalyst will consume the sugars and releases an electron and a proton. The electron will attach to the anode (positive terminal) and the proton will travel through a proton exchange membrane to the cathode (negative terminal). This process generates a voltage between the two terminals and thus produces electricity.

A secondary algae species being Shewanella Hanedi will be used for its bioluminescent characteristic. As the tank will be transparent, information centre visitors will be able to experience the ethereal beauty of bioluminescence directly from the car park entry, offering a microcosmic entry point for a day at the beach.

All media used are natural, there is no need for filtration or further treatment prior to release. There are two options available: release the microbes naturally back into the bay or harvest the materials and use in a third stage process being – Biofuel.

**Seawater Extraction**

Given that the primary site will be excavated to locate an underground car parking facility, the design utilises this opportunity by integrating the dark cycle and visitor centre. Sea water will be readily accessible as the site is located within close proximity of the foreshore. This ground water will offer an inexhaustible supply. The sea water is also the perfect environment for the distinct microbes to inhabit.

**Operational Power**

The extraction of ground water and circulation of the bacteria will require the installation of pumps to facilitate these processes. Further to this an aeration pump will be installed to pump air into the negative terminal side of the water tank. The 41MWh energy demand for the pumps and artificial lighting will be generated using a wave energy installation. The total operational energy demand will be met by installation of an 8kW wave energy installation.

20 floating ocean-current turbines with a 2m diameter rotor and equipped with a 1kW electric generator will be installed in the bay at the southern secondary site boundary. These turbines are designed with a float at top and a counterweight at bottom to maintain their location in the water (‘Experimental verification of a floating ocean-current turbine with a single rotor for use in Kuroshio currents’ Shirasawa et.al 2016).

**Produced Electricity**

According to ‘The potential of Synechococcus elongatus UTEX 2973 for sugar feedstock production.’ (Song et al., 2016) the light cycle produces 35 mg of sugar per litre per hour. Based on the total volume of the tubes (500 kL), 5 grams of sugar per second can be produced.

The sugar will be transferred to the fuel cell in which an algal biocatalyst will facilitate an oxidation process. According to ‘A novel microbial fuel cell stack for continuous production of clean energy’ (Rahimnejad et al., 2012) a small scale experimental system will generate 2W/m2 of electrode area in a 2.45 litre tank. Assuming increased efficiency through upscaling a continuous output of 17kW can be achieved with an 85 kL tank. On a yearly basis this will equate to 138MWh.

Alg-E has the ability to function as a battery as the energy source (sugar and microbes) can be stored and used when necessary. The production can be customised to the demand pattern and function in harmony with other renewable sources i.e. solar and wind.

**Resources & Materials**

Alg-E has been designed to minimise embodied energy by way of material selection and carefully integrates locally available resource. The use of seawater, plastic (ocean) waste, wave energy, sunlight and CO2 will not only allow the installation to blend in with the environment but also improve its overall quality.

**Education / Interaction**

The above ground installation will be 24/7 accessible for people to interact, learn and enjoy. A visitor centre and signage will be incorporated to tell the story of Alg-E and educate people on the renewable energy production process using microbes and algae.

**Staging of Project**

Stage 1: Harvesting (ocean) waste plastic

Floating trash collectors will capture plastics in and around stormwater discharge points in the bay. A series of plastic recycling drop points will also be established within the project boundaries to gather the required 8,000kg of raw plastic. This plastic will be recycled locally and will form the transparent PVC piping and the 85kL polyethylene tank.

Stage 2: Excavation and system installation

The excavation for the car parking facility will be followed by the installation of the tank and plumbing infrastructure. The above ground tubes will be erected to form the interactive microbe installation.

Stage 3: Biological development

Microbe and algae development will commence on-site. It is anticipated that following 2-3 months the facility will become fully functional as an art, education and renewable electricity installation.

**Environmental Impact Summary**

Alg-E is an interactive, visual experience that enhances the St Kilda beach front environment. The installation will be net zero greenhouse gas emissions and will generate 168MWh of electricity per year that will be fed to Luna Park via the mains grid. Production can be ramped up or down based on demand requirements. This project offers the public a glowing reminder of the climate change challenge and the role that local and accessible renewable energy technologies will need to play.

Alg-E is a low embodied energy process consuming readily available resources i.e. microbes, seawater, plastic (ocean) waste, wave power, sunlight and CO2.Using waste products such as plastics and CO2 will also result in a cleaner and improved quality of the local environment.

Throughout the staging of the project both the community and skilled workers will be involved to successfully build and operate the installation. The local community will partly supply the soft plastics. The end product will be beautiful, thought provoking, and will stimulate social interaction thereby delivering a sustainable urban design response to compliment the St Kilda foreshore precinct.