**The Borrowed Net**

Situated along Øresund, one of the world’s busiest shipping channels, lies Copenhagen—a city whose history, economy, and culture are built on this direct connection to water and shipping. Indeed, the ties to the sea extend back centuries, including legends of Rán, whose magical net captured sailors and their offerings of gold as they left home.

Today, Denmark is still intrinsically linked to the sea. In 2012, ports within Copenhagen handled nearly 1,125,000 passengers. Additionally, Copenhagen received 375 cruise calls, 175 ship turnarounds, and 840,000 cruise guests. These cruise ships are practically cities of their own, with dining, shopping, recreation, and all the wastes that cities produce. Inspired by the legend of Ran, The Borrowed Net is simultaneously a park, a monument, a sculpture, and a factory that harnesses the waste water produced by ships to create energy and clean water, while fostering the economic and cultural growth of Refshaleøen.

Wasted Waste?

The average cruise ship produces as much waste water as a small town. Over the course of a week, a ship will produce 3,800,000 liters of graywater, 800,000 liters of blackwater, and 95,000 liters of bilge water (water that collects in the ship from rain, rough seas, or small leaks). With much of this water, international maritime laws allow for a simple method of disposal—into the ocean. This practice differs based on the type of water being dispersed. While blackwater must be released a minimum of five kilometers from shore, graywater can be emptied anywhere; filling Rán’s nets with a golden opportunity. How can we motivate a cruise line to process its waste in a more environmentally conscious manner that benefits all parties? Water, in any condition, is a valuable resource, and the established system of disposal is due for an overhaul. Waste water contains embodied energy that can be harnessed to produce electricity, and The Borrowed Net is the means of capturing this energy.

We Love MFCs

Microbial fuel cells (MFC) are the star child of waste water energy conversion. Using common bacteria, MFCs convert chemical energy from waste streams into electrical energy through catalytic reactions in an anaerobic environment. The system works in three simple steps. Firstly, a bacteria-coated anode is submerged into a carbon source (waste water) that is placed under anaerobic conditions. The bacteria consume the carbon in the waste water, generating hydrogen, carbon dioxide, and an electrical current. This electrical current is captured as it passes along a conductive material to a cathode, and the hydrogen combines with oxygen to form water. The process produces three products—electricity, carbon dioxide, and water.

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The Borrowed Net takes the process a step further. By combining the energy-generating potential of MFCs with the carbon sequestration and biofiltration provided by living plant matter, we are able to create a system that produces three products—electricity, water, and a fresh landscape. The Borrowed Net is made up of three distinct landscapes, each with its own aesthetic, programmatic function, and cultural significance. These three landscapes are the Beach, the Greenhouse, and the Promenade.

The Beach

Swimming is fundamental to Danish culture. Copenhagen alone boasts four harbour baths and a number of public beaches. The Beach at The Borrowed Net draws on this swimming culture, as well as Øresund’s pristine water quality, to create a new, recreational, aquatic landscape. Additionally, portions of the Beach are planted with aquatic and riparian plant species that filter harbour water and progress the water quality efforts of the city. With its clean water and open views, the Beach is a space to stroll, swim, lounge, kite board, and fish in Refshaleøen.

The Greenhouse

Acting as the engines of this landscape machine, the Greenhouse is a vital space of exchange for the three byproducts of MFCs—electricity, carbon dioxide, and water. The Greenhouse is positioned over five large holding tanks where the microbial process is taking place. Two of these tanks are the accepting points for black, gray, and bilge water from cruise ships docked at the northern edge of Refshaleøen. These tanks contain spherical anode arrays coated in the bacteria *Aermonas hydrophilia.* The spherical shape of the anode allows for maximized surface area between the bacteria and wastewater, resulting in overall increased energy generation. Electrons created by the *Aermonas hydrophilia* travel along a membrane towards the cathode array, which is integrated into the tessellated domes of the Greenhouse.

Besides housing the cathode arrays, the Greenhouse contains a vast diversity of flora that serve three important functions—converting CO2 (created as a byproduct of MCFs) to O2, filtering graywater during the final stages of the MFC, and acting as a conservatory for endangered ecosystems in Denmark. Additionally, the exterior of the Greenhouse serves as a massive greenroof structure for native ecosystems, including sedge meadows and heather dunescapes. These ecologies are dispersed via a matrix across the tessellated landforms, creating a parkscape that is wild, yet controlled, ancient, yet cutting edge.

The final products of this parkscape are clean energy (nearly 51,750,000 kWh annually) and clean water. This water can be used in two ways: repurposed on the cruise ships for various tasks, and piped into Refshaleøen to be used in homes, businesses, and industries.

The Promenade

Connecting the Beach and the Greenhouse is the Promenade, a linear boardwalk that acts as a spine of invitation and entertainment to locals and tourists. Situated along the northern edge of the site, the Promenade provides access for large cruise ships, smaller boats, and frequent harbour buses. The Promenade’s geographical advantage allows for a strategic connection between the land and sea, providing pristine backdrops for festivals, concerts, and events including the annual Kulturhavn.