

JORMUNGANDR

Looming across the harbor from Den Lille Havfrue (The Little Mermaid) is a shimmering and luminescent skin erected on an armature of scaffolds, ramps, catwalks, overlooks, and platforms. About a 30 minute westward walk from the historic center of Copenhagen, it is also a public space and a new destination in a transitioning part of the city designed to provide activities, respites, and new views back towards the city and out towards the sea. If at first, the landscape-scale sculpture seems out-of-place, somewhat ominous, and even threatening, providing a stark contrast to the fairy tale favorite that is the Little Mermaid, it is because Jormungandr is a destructive sea serpent from Norse mythology. It has been told that the serpent grew large enough to wrap itself around the earth and grasp its own tail, but when the serpent releases its clutching bite from its own tail, the world will come to an end.

The Jorgunmandr myth is our trope or reflection of our society's over-reliance on fossil fuels and difficulties transitioning into the production of industrial scale clean energy. It is an acknowledgment of the struggle between what is convenient and what is sustainable, what is cost-effective and expensive, and ultimately, what is traditional and unprecedented. It suggests that there is such a thing as a tipping point, for better or worse, in our energy and natural resource management practices, and that there may be a point of no return if sustainable practices are not realized at a scale necessary to support all aspects of human habitation. Denmark needs no introduction to the more popular alternative energy sources: wind, solar and even tidal. Looking toward the Øresund, the Middelgrunden Wind Farm is visible from Copenhagen. Roughly 1/3 of the Danish energy usage is supplied by wind energy and in 2012 the country produced 200 megawatts of solar power, already exceeding its goal set for 2020.

Our proposal for LAGI at Refshaleøen, an empty pier at an abandoned shipyard and now an area for cultural and economic renewal in the city, is a living sea monster. It is not apparent from a distance that the skin of Jormungandr is, in fact biologic. The individual scales of the skin are pods of algae, which when aggregated over the intervention site, serves as an algae farm capable of producing utility scale clean energy for Refshaleøen and the city of Copenhagen. It is also designed as a lens to quantitatively compare means of alternative energy production. Like the serpent and the earth, we see it as an opportunity to highlight synergy between site and surrounding. Jormungandr will be an opportunity to create a working laboratory dedicated to the study of various alternatives to fossil fuels, while simultaneously creating a recreational, educational, and destination landscape for the citizens of Copenhagen.

In addition to the other significant renewal energy initiatives and production undertaken by Copenhagen, algae biofuel can become another very promising source of alternate energy. Refshaleøen pier is an ideal location to support Jormungandr, as various industrial infrastructures are already in place from its previous economic and land uses. Somewhat removed from the city center, the pier is served by water taxi and municipal buses. Nearby are the Lynetten wastewater treatment plant and wind farm.

Algae may be 10 times or more efficient as an agricultural source for biofuel than traditional biofuel crops such as corn. Unlike corn, sugar cane, switch grass or oil palm, algae does not require arable land for production. Algae also grows at much faster rates than land based crops and the per unit yield is somewhere between 50,000 to 135,000 l/ha/year.

Genetically modified algae can convert waste byproducts directly into ethanol. Unlike traditional fossil fuels, the carbon that is emitted through burning biodiesel or ethanol is carbon that is currently present in the atmosphere resulting in carbon neutral energy production. Projected average yields for algae suggest that Jormungandr algae farm could produce annually 935,000 liters of ethanol or 561,000 liters of bio-diesel which is enough fuel to satisfy the annual petrol consumption of approximately 2,000 Danish families.

In addition, there are a number of algae species that may be used for the production of biofuels that thrive in salt and brackish water, and some can be grown in gray or processed wastewater. The variety of species also offers a palette of colors. Environmental conditions will also affect the color of algae. Through careful modulations of the salinity or chemical composition of the water medium, the colors of the growth pods can be changed to create a dynamic and ever-changing environmental artwork. The skin also becomes canopy of colored pods that is at the primary focus of Jormungandr. The displaced topography of color can be seen as an object on the waterfront, as well as creating dazzling arrays of colored light on the ramps and the space below the canopy.

Overlaid on Jormungandr will be inclined bicycle paths to reward the Danes who ride to the site. Starting at the grade just off Refshalevej Street, a path will traverse and climb the site affording unprecedented sight lines and vistas along the way. Included in the structure are viewing platforms along the way. After climbing to the top of Jormungandr he might feel like a modern-day Czar Peter the Great who in 1716 rode his horse followed by his Czarina in a carriage to the top of the Rudentårn Observatory to survey the monuments of the City. Now he would see not just the Northern Renaissance structures of his time but more significantly the monuments of new technology: Middelgrunden Wind Farm just offshore and the Jormungandr at his feet.

