

Thesis Project Portfolio

ASNE PEP2024 Unmanned Design Competition

(Technical Report)

How New International Pollution Regulations on Cargo Ships are Influencing the Debate on Solar Geoengineering

(STS Research Paper)

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Contents of Portfolio

Executive Summary

ASNE PEP2024 Unmanned Design Competition

(Technical Report)

How New International Pollution Regulations on Cargo Ships are Influencing the Debate on Solar Geoengineering

(STS Research Paper)

Prospectus

Executive Summary

Transitioning to cleaner energy sources for maritime applications is an important step in addressing climate change. The marine shipping industry represents 3% of global carbon emissions and has also traditionally used lower quality fuel that releases more harmful pollutants than energy sources used by other industries. These pollutants are not only accelerating global warming and climate change, but they are also wreaking havoc on ecosystems through processes such as ocean acidification which is making oceans inhospitable for many species of coral, fish, shellfish, and other marine wildlife. There are many possible options for decreasing the pollution from maritime vehicles, ranging from using cleaner fuel that releases less pollutants, using electric propulsion systems similar to current trends in the automobile industry, using wet scrubbers to remove pollution from exhaust sources, or even transitioning to nuclear power as much of the US Navy has done, though this thesis portfolio focuses primarily on the former two options.

The Promoting Electric Propulsion (PEP) competition, hosted by the American Society of Naval Engineers (ASNE), is a race intended to promote the electric powered watercraft and get engineering students interested in the research and development of maritime vehicles. For this competition, an 84” unmanned maritime vehicle was developed with semi-autonomous capabilities. The 48-volt electrical propulsion system has a theoretical peak power rating of 40 horsepower, creating one of the highest power-to-weight ratios in the competition. The 160 amp-hour battery bank along with the powerful drivetrain system makes the design highly competitive for placing highly in the five-mile race. A passive cooling system takes advantage of the boat’s high speed and cools the electronics using externally collected water. The system also proved capable of using GPS data to autonomously navigate to predefined waypoints. Although more

work needs to be done to improve reliability and maneuverability, the design shows promise for high performance fully electric maritime vehicles.

In 2020, the United Nations International Maritime Organization (IMO) established new regulations on the fuel used by international marine shipping vessels, dropping the allowable sulfur content of fuel from 3.50% to 0.50%. Although this change has overall positive implications for the environment, this change in pollution has unintentionally decreased the cloud cover over the Atlantic Ocean which has led to a dramatic increase in ocean surface temperatures and accelerated global warming. To some, this data represents strong evidence that marine cloud seeding, a form of geoengineering, could have significant impacts on the climate and become an invaluable tool in our fight against climate change. Others argue that geoengineering is still a dangerous idea, and the potential effects are not well understood and could be disastrous. Geoengineering is a controversial topic among climate scientists, and when analyzing this new evidence suggesting that it can be effectively implemented, we must not only consider the efficacy of geoengineering strategies but also other potential environmental and social consequences that may cause negative side effects. With current projections showing that climate change will reach disastrous levels of 1.5°C and possibly even 2°C warmer compared to pre-industrial conditions, it is becoming increasingly clear that we will need more investment in climate change solutions including funding more research on geoengineering in addition to measures to aggressively decrease greenhouse gas emissions. Geoengineering is a complex topic that extends beyond its potential impacts to the climate, and it is paramount that geoengineering is implemented thoughtfully and responsibly if it is to be implemented at all.

Significant progress has been made this year regarding the technical and STS research projects. Although the electric maritime vehicle suffered from reliability issues and was unable to

complete the five-mile course as it was designed to do, the system was still impressively designed and has high potential if minor steps were made to improve its safety and consistency. Compared to other competitors at the PEP competition, the design had one of the highest strength-to-weight ratios and great build quality. The topic of geoengineering is still relatively young and not well studied, but it is transitioning from a fringe and highly controversial idea to a proposal that is beginning to be taken seriously by many climate scientists. Although there are many legitimate criticisms of geoengineering, most can be resolved by more research, responsible marketing of geoengineering as a potential solution alongside emission reductions, and multilateral political treaties by governments around the world on how it should be implemented responsibly. It is expected that geoengineering will become an increasingly important topic as the climate continues to warm, and the need to study geoengineering more seriously is growing by the day.