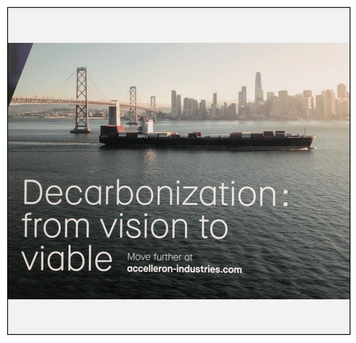
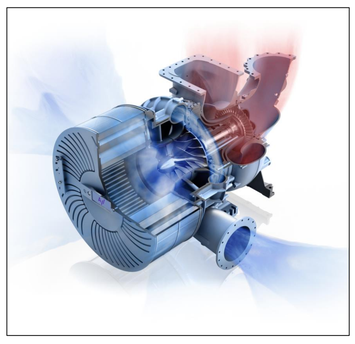
HSLU Hochschule Luzern

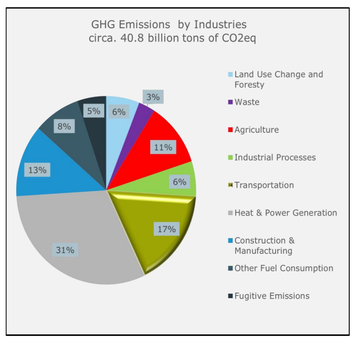
Technik & Architektur

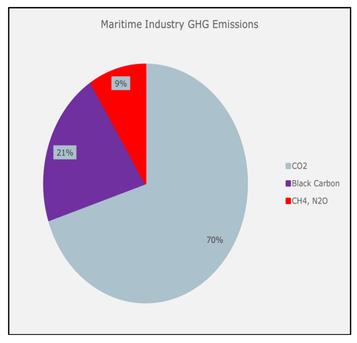
Master-Thesis, MSE Energy and Environment

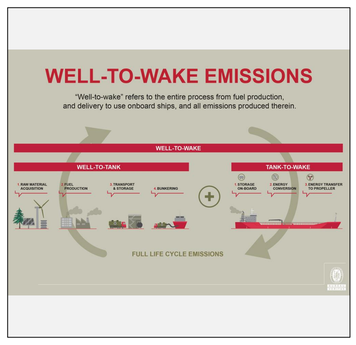
Techno-Economic Analysis of Algal-based Fuels for the Maritime Industry

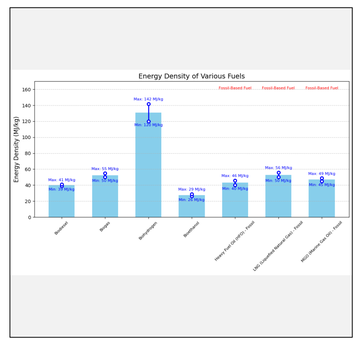


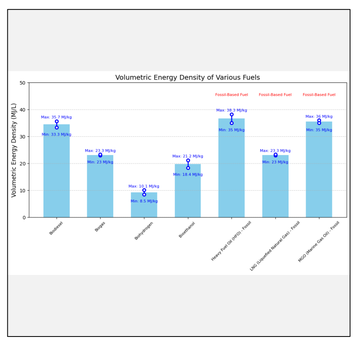


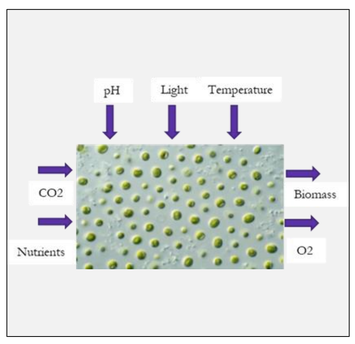


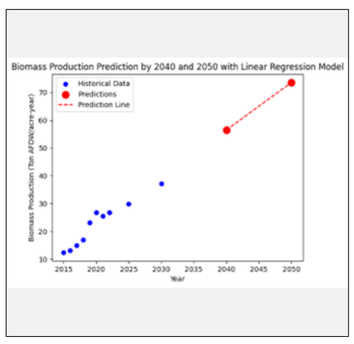


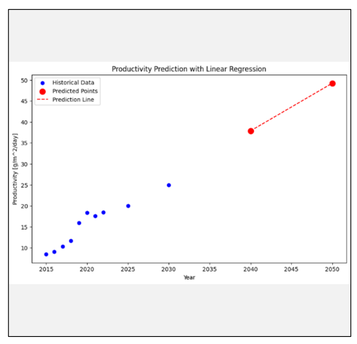


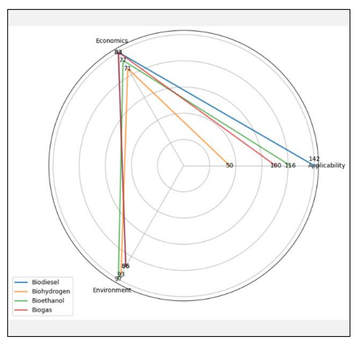


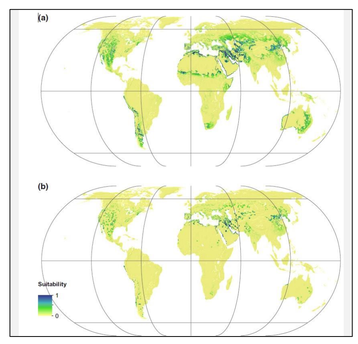


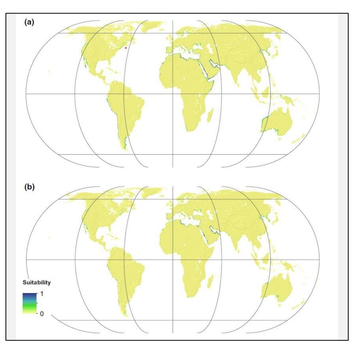


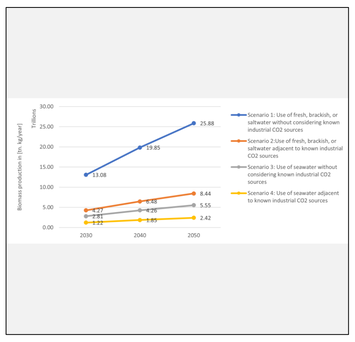


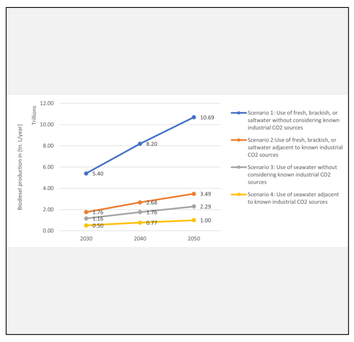


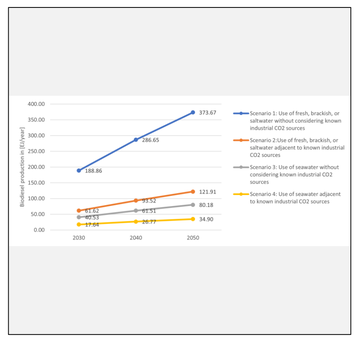


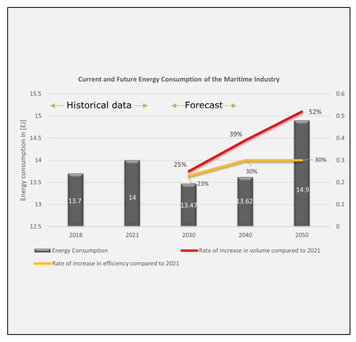


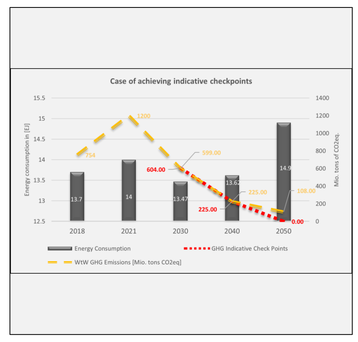


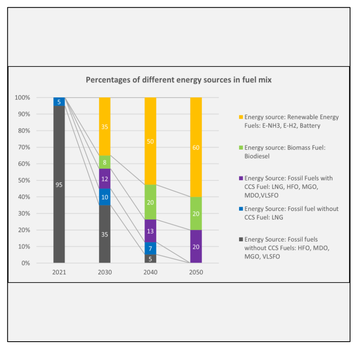


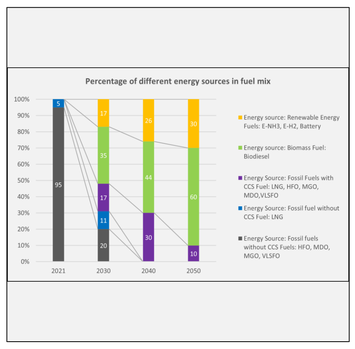


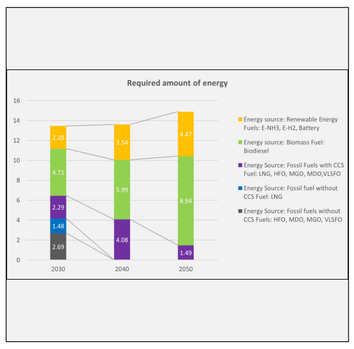


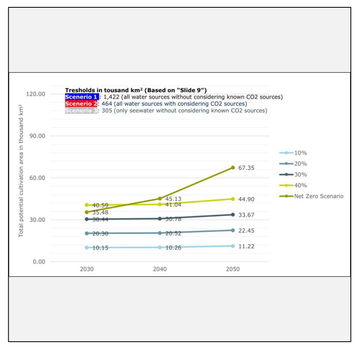












Problem Statement

The emissions of greenhouse gases (GHGs) resulting from the burning of fossil fuels accelerates the global warming phenomenon. This rapid elevation in temperature poses an unprecedented threat to the equilibrium of the biosphere, encompassing all facets of the world, including the sustainability of human life. In 2015 Paris Agreement established the goal of keeping the increase in the global average temperature to no more than 2 Celsius and to try not to surpass 1.5 Celsius. More than 80% of world trade in goods is carried out by ships. Currently, the primary energy source of maritime industry is fossil-based fuels (~99%). Maritime transportation causes about 3% of the total GHGs even more than aviation industry. The International Maritime Organization (IMO) has set a target of achieving net-zero emissions by 2050.

Solution Concept

Biofuels produced from biomass are considered as a promising alternative fuel for the energy transition from fossil-based to renewable fuels. Microalgae can be used as a feedstock to produces various biofuels such as biodiesel, biogas, bioethanol, and biohydrogen.

Results

Microalgae seems a better option as a biofuel feedstock compared to other feedstocks especially having the potential to mitigate food versus fuel dilemma. Biomass cultivation is the key contributor (60% to 70%) to biofuel production cost. The minimum biomass selling prices of biomass and biofuel by 2050 are estimated 330 dollar per tons ash free dry weight [$/tons AFDW] and 1.7 dollar per gallon gasoline equivalent [$/GGE], respectively. The estimated biomass productivity 49 gram per square meter per day [g/m^2/day] by 2050. The estimated future energy demand of maritime industry 13.47 EJ, 13.62 EJ and 14.9 EJ by 2030, 2040, and 2050, respectively.

Biodiesel could be a simpler way to meet the IMO short-term GHG Emission targets due to its drop-in fuel feature. It is not possible to reach Net-Zero Emissions (NZE) by 2050 without CO2 compensation sourcing out of the industry due to a certain level of Well-to-Wake (WtW) emissions of all type of alternative fuels.

Orhun Cakmakci

Advisor
Prof.Dr. Ulf Christian Müller

Expert
Dr. Gianfranco Guidati

Advisor Industry Partner
Raphael Ryser

Accelleron

MSE | MASTER OF SCIENCE IN ENGINEERING

FH Zentralschweiz