DYNAMIC SIMULATION OF MARINE SOFC POWER PLANT

RESEARCH MOTIVE

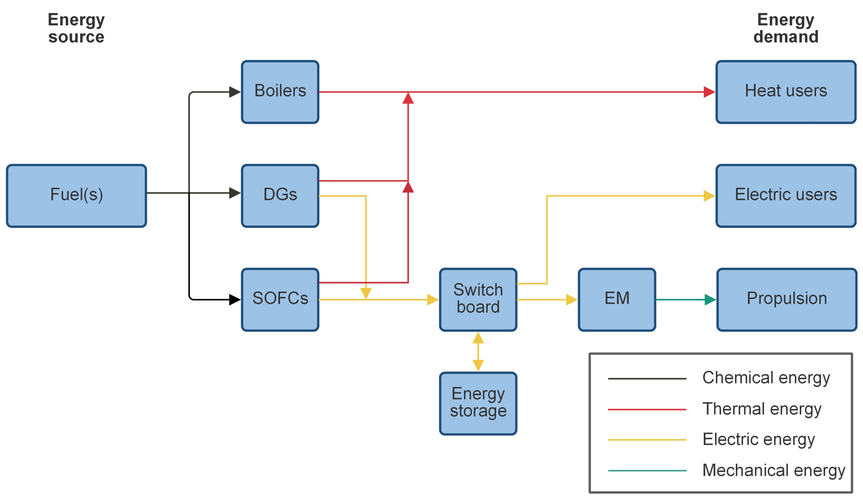
SOFC systems are a potent technology to reduce greenhouse gas and pollutant emissions from ships. But it is unknown how such a power plant should be sized, controlled, and how it would perform.

Gaps in power plant simulation

- Electric and thermal integration
- Part-load behaviour
- Degradation effects of components
- Load transients and battery coupling

OBJECTIVE

Evaluate the performance of a marine SOFC power plant for different hybrid scenarios.



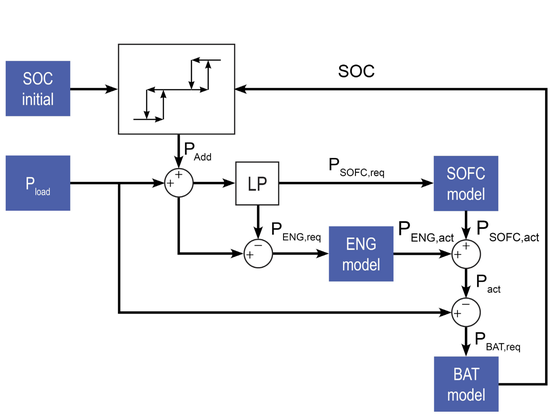
METHODS

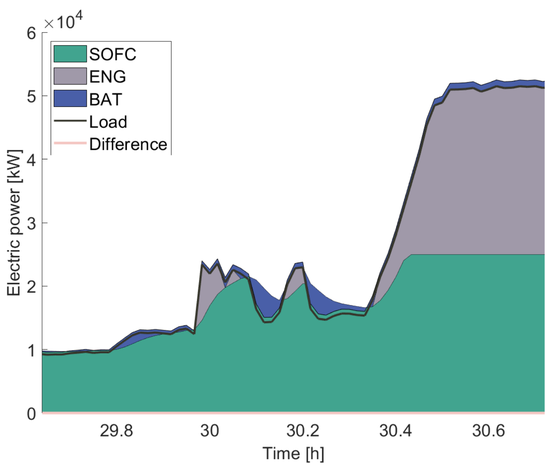
The power plant simulation consists of a component sizing model and a power plant simulation model.

Based on the dedicated hybrid scenario, the component sizing model makes an initial estimation for the installed components based on the ship's requirement. In the simluation model, a state of charge (SOC)-based control strategy distributes the load across SOFCs, gensets, and batteries.

DS	Design scenario
1	DG
2	DFG
3	GG
A	SOFC for hotel
B	SOFC for manoeuvring
C	SOFC for main operations
D	Full SOFC

SOC BASED CONTROL STRATEGY WITH HYSTERESIS CONTROL





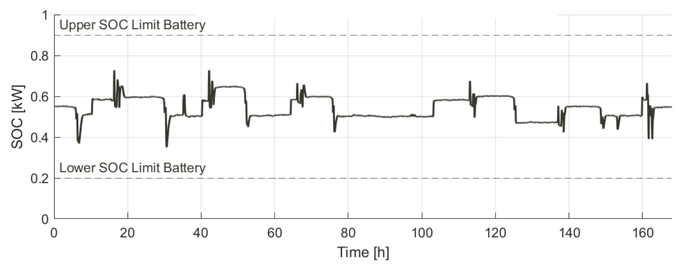
RESULTS

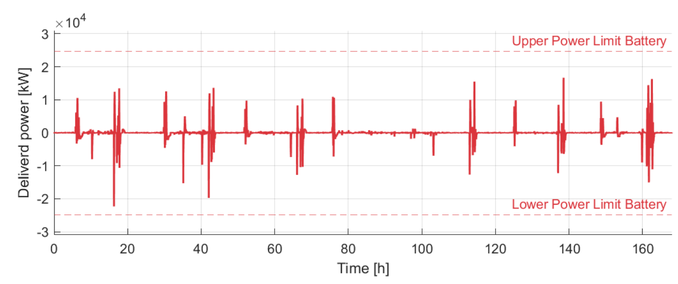
The electric and heat profile are simulated for one week operation of a 200 kGT cruise ship with a 60s timestep.

Employing more SOFCs increases the volume of the power installation. However, the total increase in volume is limited, when fuel storage space is included because of the high conversion efficiency of SOFCs.

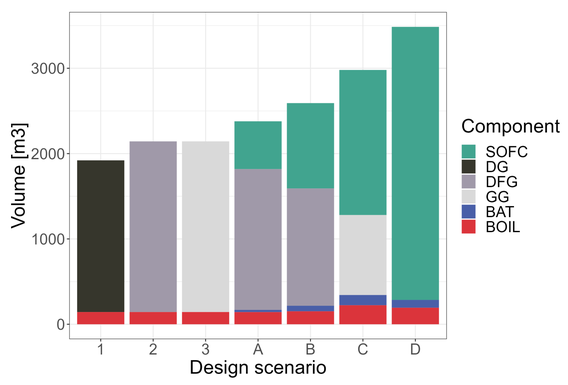
The control strategy works well to keep the SOC within allowable bounds. The GHG emissions increase much with more SOFCs because of the large reduction of methane slip and well-to-tank emissions. Very large emissions of NOx are possible, because SOFCs barely emit pollutant emissions.

BATTERY OPERATION

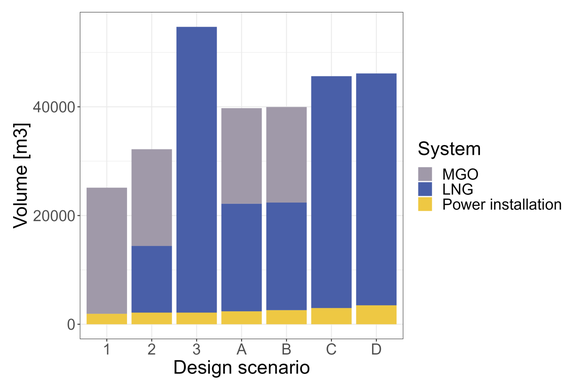




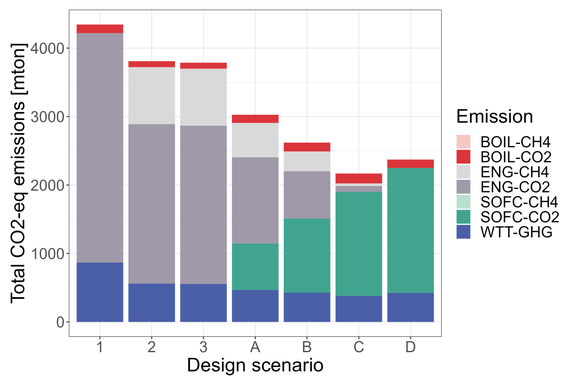
VOLUME POWER INSTALLATION



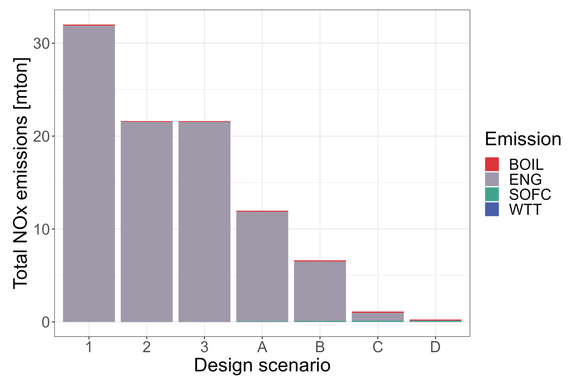
VOLUME POWER INSTALLATION AND FUEL



GREENHOUSE GAS EMISSIONS



NOx EMISSIONS



CONCLUSION

By using SOFCs for the hotel load, a large emission reduction is obtainable with a limited amount of installed SOFC power, because of improved fuel efficiency, methane slip mitigation, and WTT emission reduction.

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