THE GREAT EASTERN INSTITUTE OF MARITIME STUDIES (LONAVALA)

PAPER PRESENTATION

ON

ALTERNATE PROPULSION POWERING FOR MERCHANT SHIPS

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For those of you who I haven't met before, my name is Cdt. Franz Savio Silveira and let me introduce my team members, Cdt. Kuldeep Kumar and Cdt. Zubin Vajifdar. I would like to explain a bit on 'Alternative propulsion system on ships '.

Abstract:

Over the century we have seen the advancement in propulsion system of ships – From wind propulsion to steam engine propulsion to nowadays widely used Diesel engine propulsion system.

The **Diesel Power plant** forms the basis of comparison against which all of the subsequent alternative concepts are evaluated
.Ship powering demands two characteristics: Reliability and Economy.

Due to excellent economy the diesel engine remains predominant. The diesel driveline chosen for most large cargo ships consists of a low-speed two-stroke diesel turning a direct-connected single propeller.

However diesel engines require heavy maintenance in order to avoid nowadays current problems like Water pollution.
A leading manufacturer of diesel propulsion engines are MAN B&W, SULZER (Wartisila).

Introduction:

. During the period of the 1960s the world enjoyed an affair of preference for new and "space age" devices. During this period aero derivative gas turbine engines saw service in some limited merchant shipping activities. It was during this time, for example, that the Golden Gate Ferry district first procured gas turbine-driven high speed ferries to serve San Francisco.

However, the Oil Embargo of 1973/74and the skyrocketing fuel prices associated therewith almost eliminated gas turbines as prime movers for merchant ships because of their inferior fuel economy compared to medium and low-speed diesel engines.
Today however there has been a resurgence of interest in gas turbine propulsion.

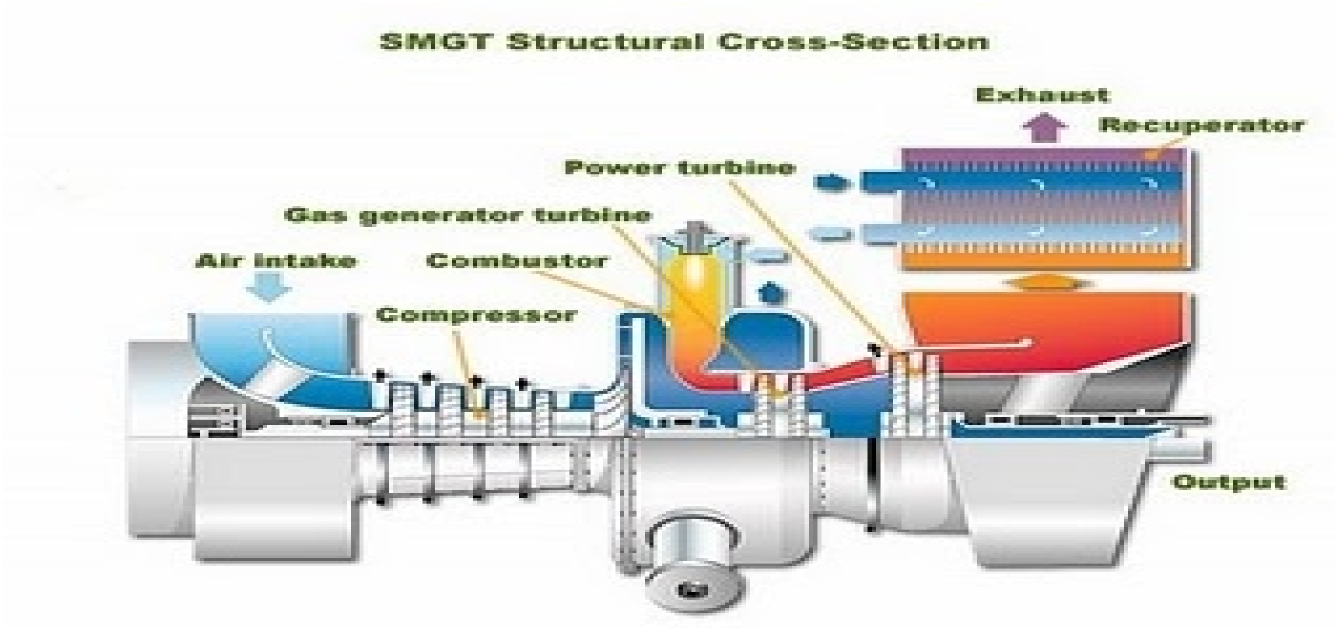
The latest generation of marine gas turbine – including engines which are still slightly “over the horizon” – includes intercooled, recuperated or regenerative gas turbines. These machines capture heat from the turbine exhaust and recover the energy in order to increase the overall thermal efficiency of the machine.

As a result the fuel consumption per unit power generated is reduced and part load efficiencies are increased as well.

Let us discuss about alternative powering options

ALTERNATIVE POWERING OPTIONS

Gas Turbine Engines



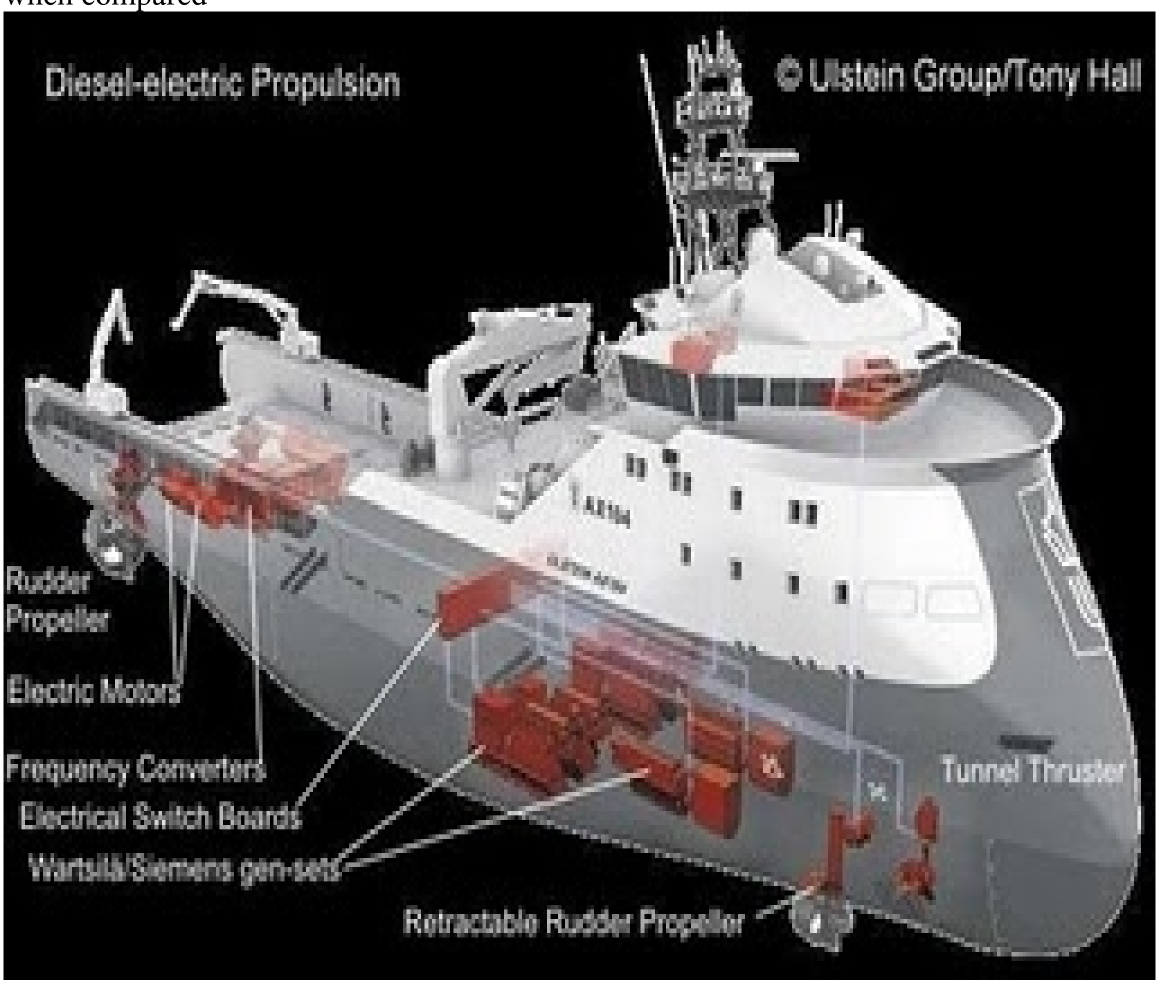
Gas turbines are small and compact for their power level – especially when compared to low-speed diesels. They have recently enjoyed a revival as a prime mover for the growing number of fast ferries that are subject to severe space and weight restrictions and which transport a “cargo” that appreciates reduced traveling time. Gas turbines have also seen success in cruise ships, because their very high operating RPMs result in a nearly vibration-free machinery plant and thus a potentially quieter, smoother ride.

It is not evident, however, that these virtues of the gas turbine are sufficient to qualify it for the propulsion of the greater part of the merchant fleet. Its disadvantage in terms of its preference for high quality fuel and its relatively low fuel efficiency, in particular at part load, surely detract from its acceptability. This is recognized clearly by the turbine manufacturers, and thus a significant part of their efforts is devoted to increasing the fuel efficiency of their gas turbines.

Electric Drive

Electric drive is an alternative prime mover/power generator. This methodology consists of using a steam, diesel, or gas turbine prime mover, or an alternative power generator (fuel cells or nuclear reactor) to drive a large electric power producer (alternator). The electricity is then sent via wiring to a propulsion motor that turns the propeller.

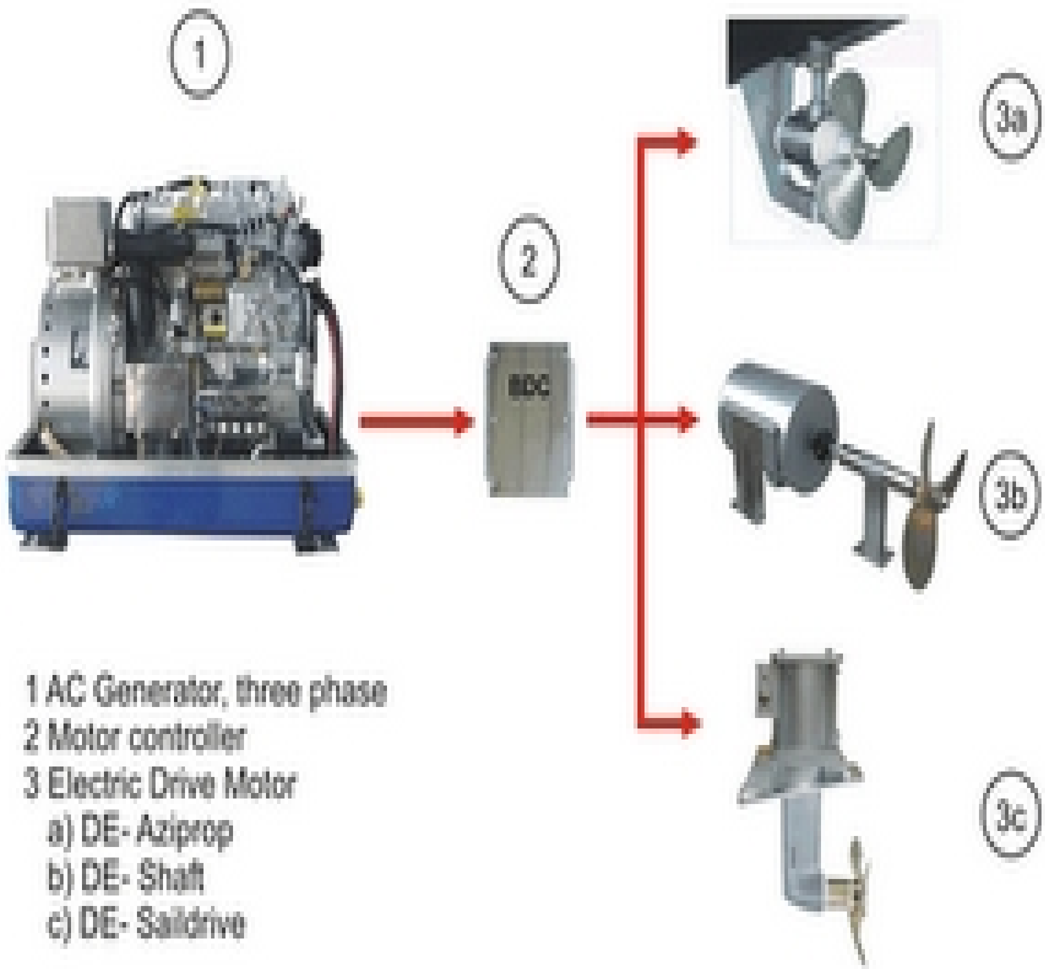
This system would more properly be called an electric transmission, as the prime drive power is still diesel or turbine produced. As may be imagined, the system introduces some losses, as mechanical energy is converted into electricity and then back into mechanical energy. Further, the large alternators and motors required may significantly drive up the weight of the system as compared with a mechanical transmission, especially when compared



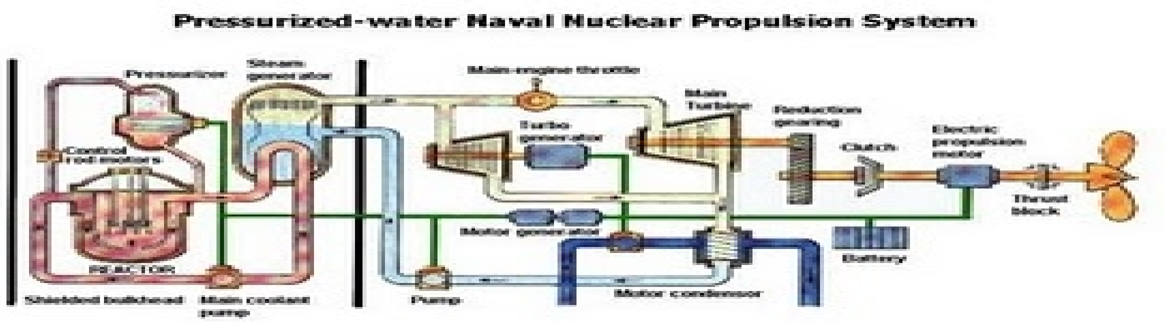
to the directly coupled low speed diesel engine configurations.

The attraction of electric drive lies primarily in the ability to distribute power demand over multiple prime movers. Thus several engines may be working together to drive one propeller. This in turn offers the possibility of adjusting load factors so that the engines operate at their most fuel-efficient points throughout a relatively wide range of ship speeds. Cruise ships are increasingly turning to electric drive, with the Queen Elizabeth II being a notable example.

Electric drive is also of interest for ships with large hotel electric loads, such as cruise ships and warships, because it offers the possibility of having one large machinery “bank”, and tapping power off for propulsion or hotel loads equally.



Nuclear Electric Propulsion:



The first vessel to use nuclear electric propulsion was NS Savannah in early 1950's.

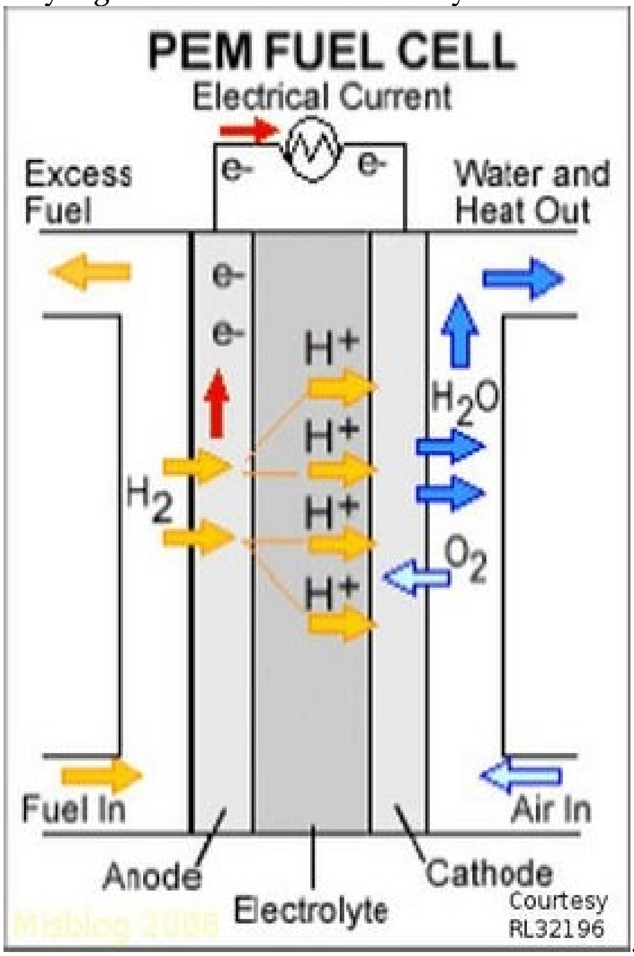
Conceptually the Nuclear-electric propulsion is similar to a gas turbine, except for the existence of a nuclear reactor instead of fuel burners, and the choice of a closed helium cycle, resulting in a decrease in the compression ratio. Helium is heated by the nuclear reaction and expands across the blades of the turbine. The helium is re-condensed and redelivered to the hot side of the reactor. The turning turbine produces torque, and in some cases is directly coupled to a generator (within the containment shell) for direct delivery of electrical power.

The disadvantage of this powering system lies to the fact that it requires very highly skilled labor and thorough maintenance. Secondly nowadays nuclear powered ships are not allowed into ports for various security reasons. And lastly the Helium gas used is very expensive.

Fuel Cell – Electric Propulsion

Fuel cells are an emerging technology. A fuel cell converts hydrogen fuel into electricity directly. There are no moving parts – the electricity is released when the hydrogen molecule is broken up.

As such, a fuel cell may be thought of as an alternative to a diesel generator. It is indeed such an alternative, with the advantage of having no moving parts and a very high fuel conversion efficiency



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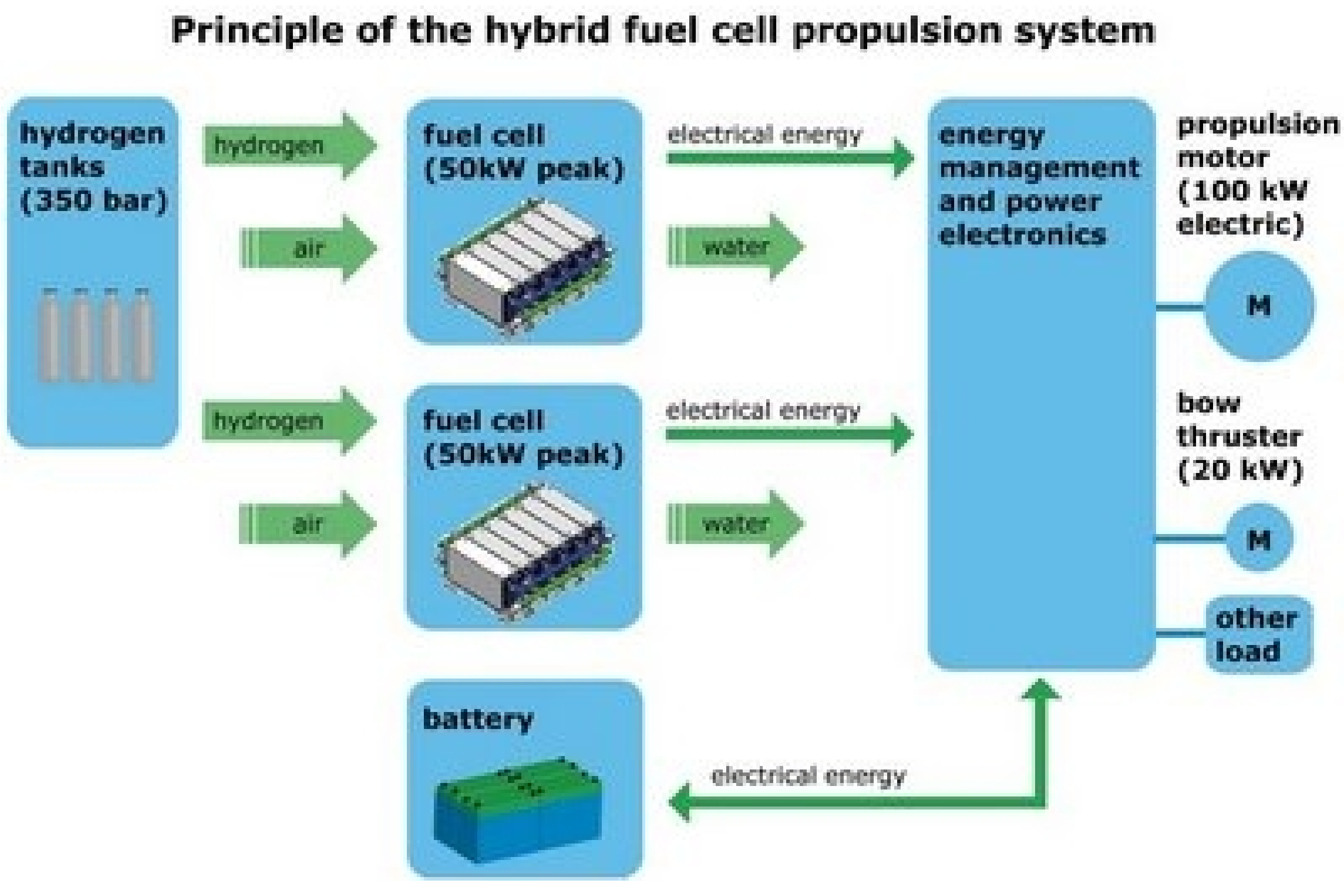
The fuel cell reaction works only on the hydrogen in the fuel. When running a fuel cell with a hydrocarbon liquid fuel it is necessary to first reform the fuel into hydrogen and CO2. As part of or prior to the reformation, it is also vital to remove the sulfur from the fuel before it is used. This process represents an ancillary load on the cell, and requires additional space and weight. Also, the fuel cell reaction is chemically the same as combustion: Hydrogen is combined with oxygen and released as H2O vapor. Fuel cells thus have the same air intake and exhaust uptake requirements as combustion engines. They also produce waste heat, which is dissipated to cooling water. In all these senses the fuel cell is a direct replacement of a diesel generator.

The advantages of fuel cells are that they lack moving parts, which implies reliability. This is only true, however, for the fuel cell itself. The fuel reformer will certainly be mechanically complex. As will be shown below fuel cells also demonstrate high power density and high thermal efficiency. Use of fuel cells may potentially result in a reduction in plant weight, a reduction in plant complexity, and a negligible reduction in fuel consumption. These advantages may be enough to draw electric propulsion into the ranks of container ships.



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The Viking Lady
Norway is investing in environmental friendly technologies. The Westcon shipyard in Rogaland will start testing fuel cells in a couple of months. Use of fuel cells can reduce the climate gas emissions of maritime transport by 50 %.

The gas-driven supply ship "Viking Lady", owned by the ship owner Eidesvik, will be the first test center in the world for use of fuel cells on board a merchant ship. "Viking Lady" is the third supply ship to be run on LNG (Liquid Natural Gas). The gas will also be fuel for the fuel cell that will produce **320 kw**. That is sufficient to function as an auxiliary engine for electricity supply on board, but not to run the ship itself.

Fuel cell technology is, however, presently in the conceptual stage. They can only be utilized in auxiliary machines on the ship while they are not powerful enough to efficiently propel the ship.
However Research is on to develop these types of propulsion systems in near future.

An Understanding of the Comparison chart is essential for comprehending the rest of my presentation

COMPARISON CHART

Concept	Maturity	Weight	Fuel Consumption
Diesel Baseline	Mature	31.7 kg / kW	2800 t
Gas Turbine Mechanical	Mature	1.5 – 3.8 kg / kW	4564 t
GasTurbine /Diesel Electric	Fairly Mature	.5 – 3.8 kg / kW 6.5 kg / kW alternators 6.5 kg / kW motors 14.5 – 16.8 kg / kW total	3700 – 5000 t
Nuclear Electric	Immature	29.5 kg / kW	none
Fuel Cell Electric	Immature	17.6 kg / kW FC 6.5 kg / kW motors 24.1 kg / kW total	<2800t

CONCLUSION:

As we know Diesel engine still dominates the merchant navy sector all over the world. Its because of its excellent economy and reliability.

Gas turbines are also finding their foothold in shipping industry due its excellent results compared to the diesel power plant. Hence many new modern ships have gas turbine propulsion system. It is likely to replace the diesel power plant in near future.

Nuclear electric systems are presently only confined to the defense sector but may someday also find its place in the merchant navy sector.

Fuel cells are still in their construction stage but may prove to be the Future of all ship propulsion system. The reason being it' clean & poses no danger to the environment**.**

Acknowledgement:

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We would also like to thank M/s Meena Shankar, who has trained us, to present our ideas effectively and efficiently

Hope this has been Informative & I would thank you for going through my Presentation"

I'll be happy to answer any Questions!

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