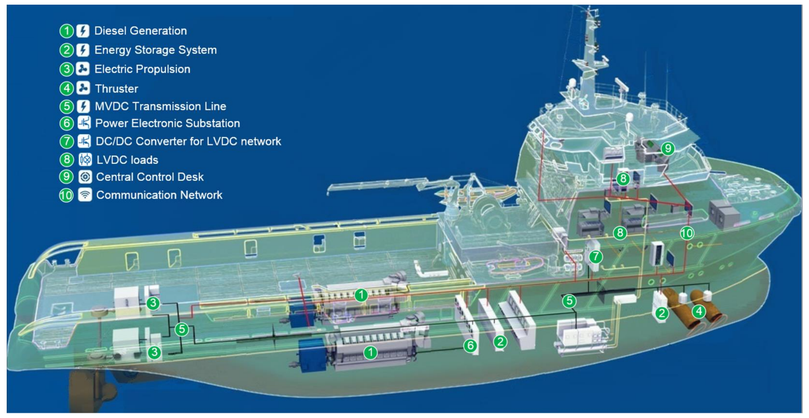
Shipboard Microgrids
Advances in Control, Operation and Management

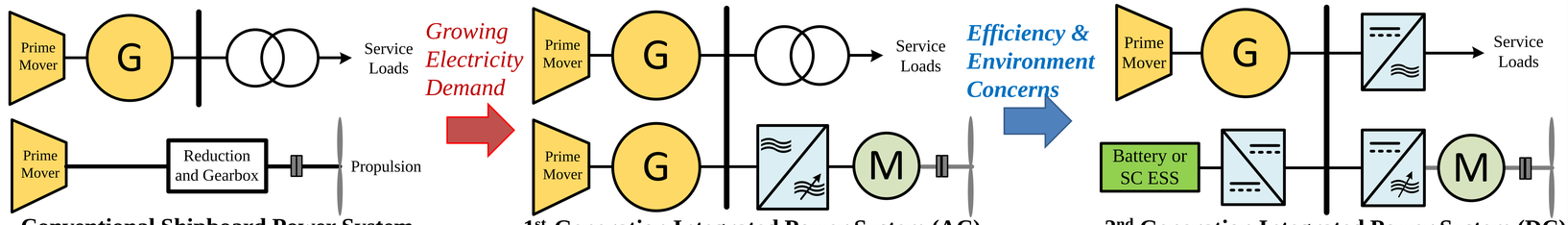
DEPARTMENT OF ENERGY TECHNOLOGY
AALBORG UNIVERSITY

Microgrids RESEARCH PROGRAMME



Introduction

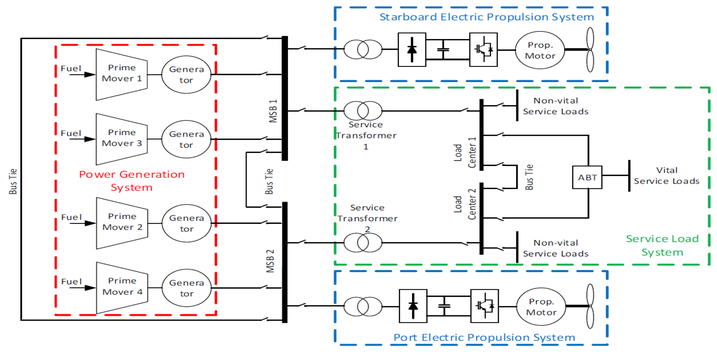
Shipboard power systems are naturally isolated from the utility grid and alternative and renewable power sources are being introduced to reduce the emission and cost. For this reason, they are inherently reasonable to treat as islanded microgrids.

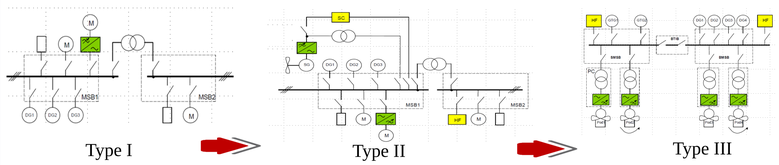


Conventional Shipboard Power System | **1st-Generation Integrated Power System (AC)** | **2nd Generation Integrated Power System (DC)**

AC Shipboard Microgrids

AC Shipboard Microgrid (ACSPM) can be defined as a "packaged" entity of distributed generators, energy storage systems and local electrical loads. The power system of an ACSPM therefore resembles a smart AC microgrid since it is designed to be autonomous, highly reliable, capable of delivering high quality power to all loads, and organized as a flexible distribution network that can be reconfigured depending on need.





Advantages:

- Available standards in control and protection
- Robust and reliable operation of AC transformers
- Availability of industrial equipment in the market

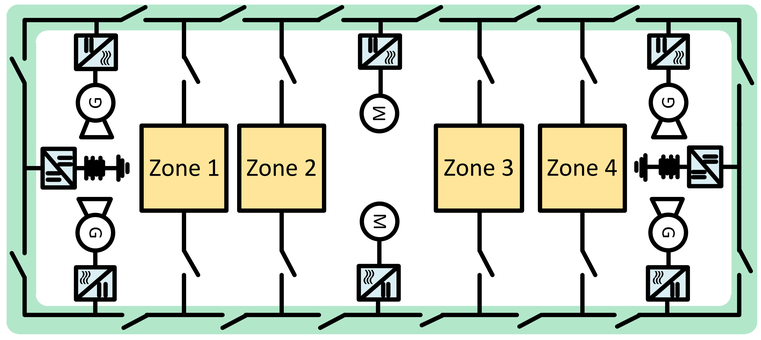
Disadvantages

- Up/down times for generators
- Voltage and frequency synchronization
- Bulky Transformers
- Power quality issues

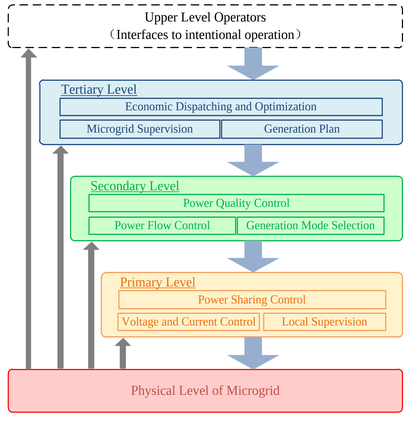
DC Shipboard Microgrids

While there are still advances in AC shipboard architectures, DC distribution technologies have drawn great attention from the major navies and marine industry. In general, DC distribution has a different nature when compared with AC, so that it opens a number of new opportunities, such as:

- Space/weight-saving
- Variable-speed operation of diesel engines
- Reconfigurable architecture
- Easy integration of ESSs
- Efficiency improvement
- Enhanced dynamic response
- Reduced fuel consumption
- Flexible connecting equipment
- "Plug and Play" capability



In addition to the physical-levels, the significant changes also happen in control and automation methods. With the integration of emerging sources such as energy storage, fuel cell and renewables, the system can be much more complex than it ever was. The advanced hierarchical control scheme can be implemented in DC shipboard microgrids to ensure a stable, autonomous and economical operation of a DC distribution based vessel.



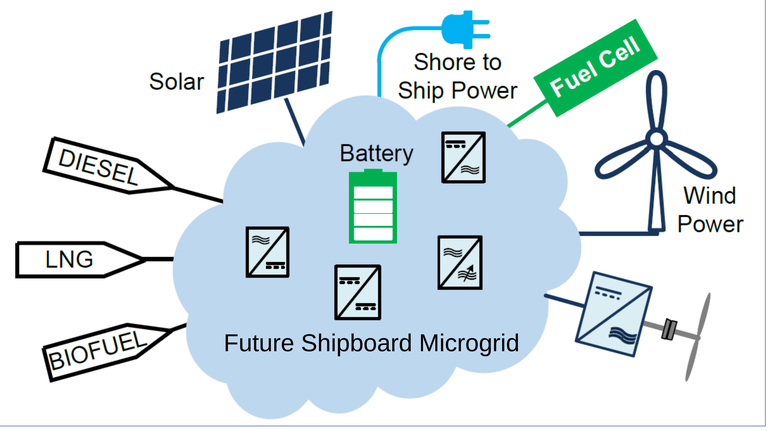
Conclusions and Future Trends

Conclusion:

- Marine applications are calling for more advanced technologies
- The advanced research outcomes can be shifted from terrestrial microgrid
- Power quality issues are the main challenge for AC shipboard microgrid
- DC shipboard microgrid is more disruptive and can further enhance the system performance
- There are still technological challenges and de-risking studies related to the control, protection and management of the system to be performed at the present stage.

Trends:

Driven by the ever increasing need to have eco-friendly vessels, more and more emerging technologies will be integrated aboard a ship in the near future. Shipboard microgrid and its corresponding control methods will be a potential promising solution.



For Further Information

Visit the website of Microgrid Research Programme at AAU:
http://www.microgrids.et.aau.dk