

8th IEVE 국제 친환경 전기 선박 비즈니스 워크숍

친환경 선박용 전기추진시스템의 설계 방향 제언

한국전기연구원

2021.09.09

최 재 학



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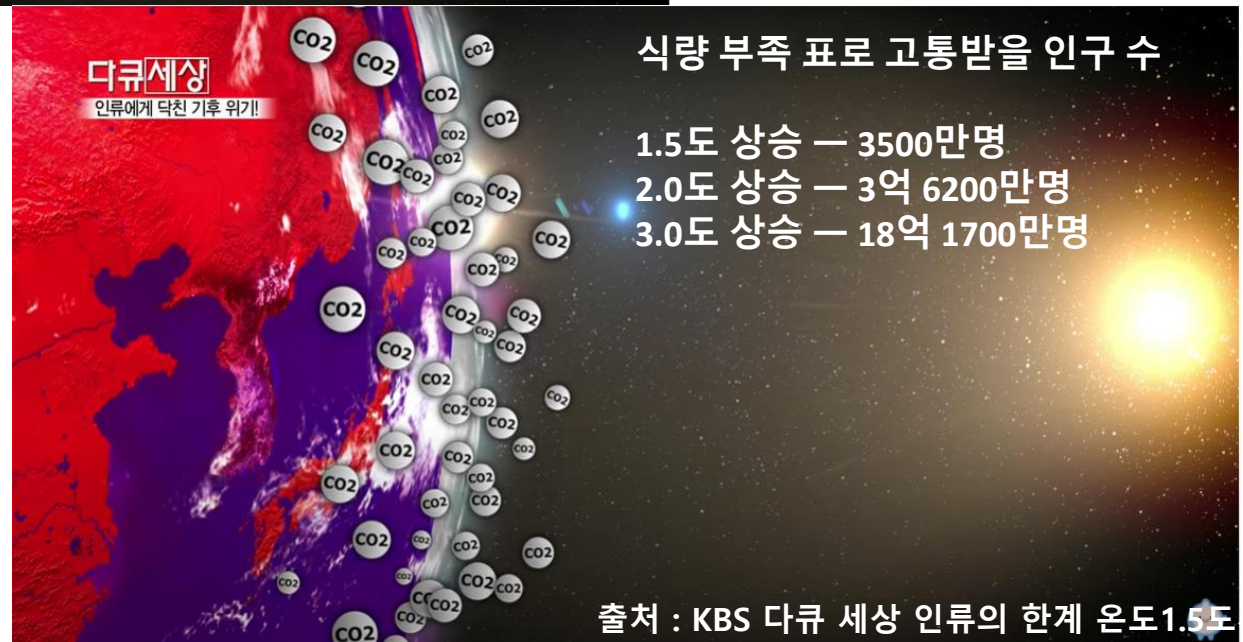
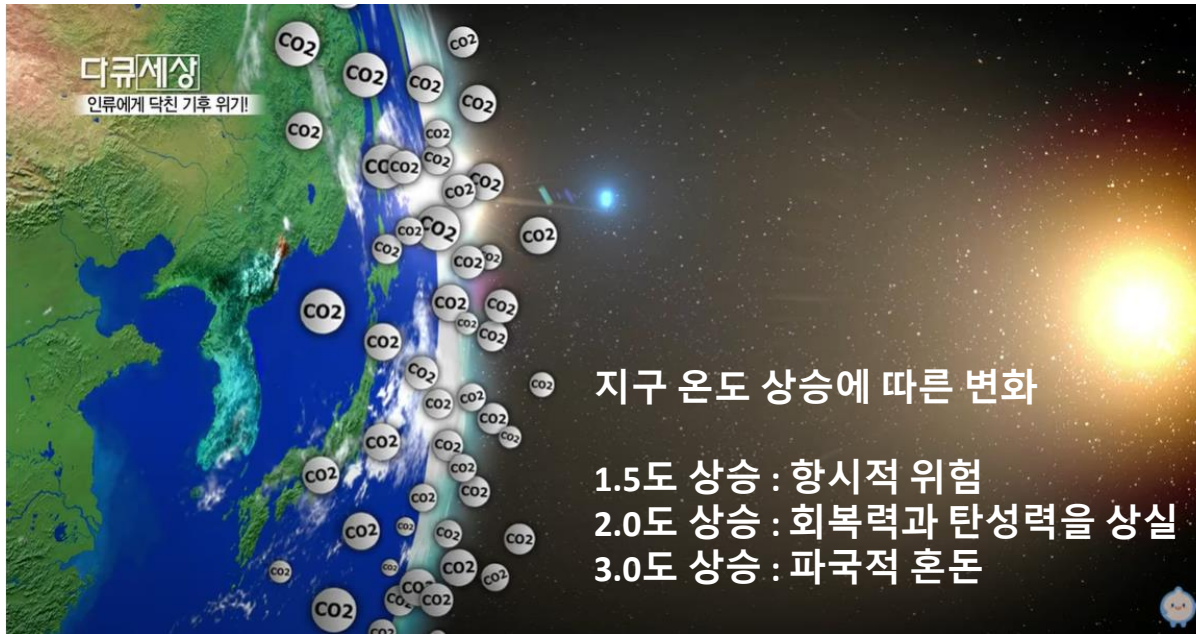


왜 친환경 선박이 필요 할까?



출처 : KBS 다큐 세상 인류의 한계 온도 1.5도씨

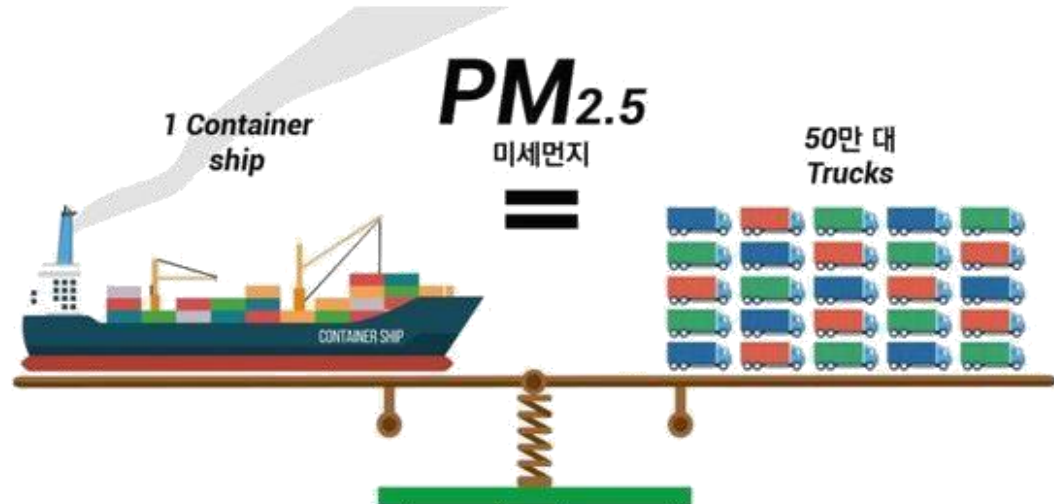
왜 친환경 선박이 필요 할까?



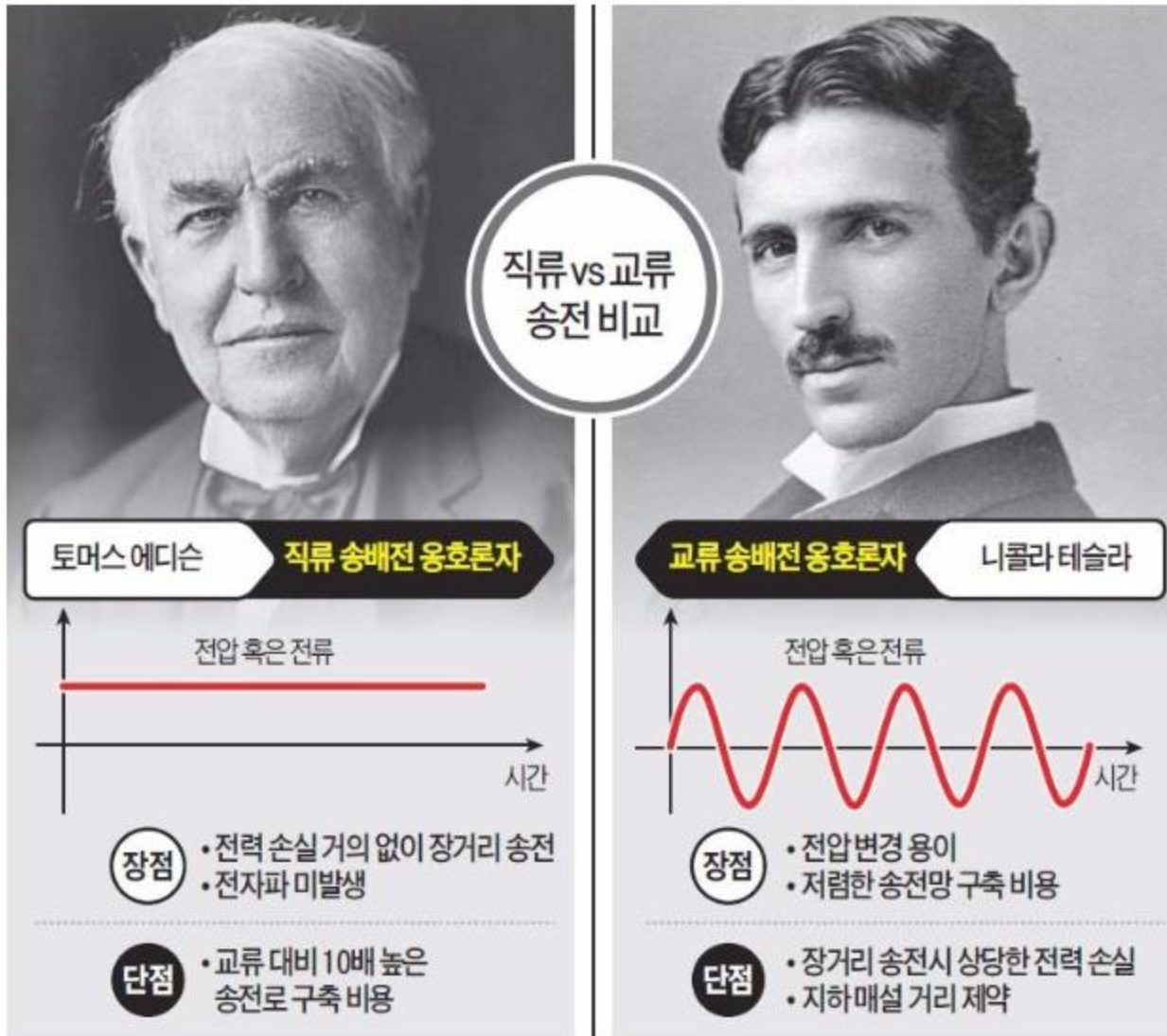
왜 친환경 선박이 필요 할까?



해상 : 12%



대형 컨테이너선 한 척이 트럭 50만대 분량의 미세먼지 및 디젤 승용차 5,000만대 분량의 황산화물 배출 (국제가스조합, 2017)



출처 : 생글생글 474호 2015년 6월 8일

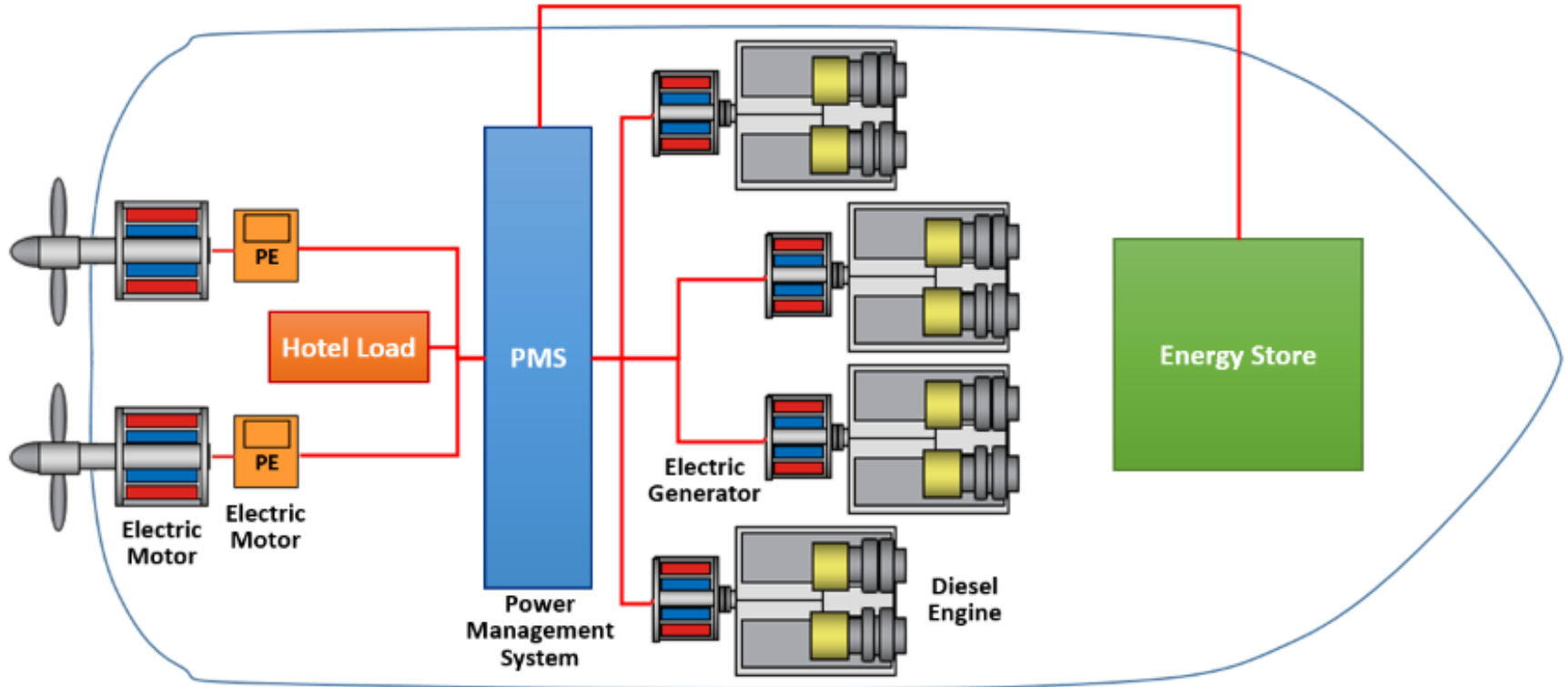
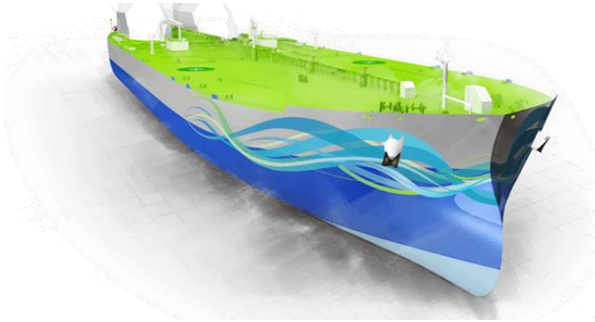
친환경 추진 전원의 특징(교류와 직류)



<https://www.klook.com/ko/activity/12923-niagara-falls-day-tour-new-york/>



▲ 캐나다의 온타리오 주, 나이아가라폴즈시에 있는 테슬라동상
<https://m.blog.daum.net/shkang47/15305214>





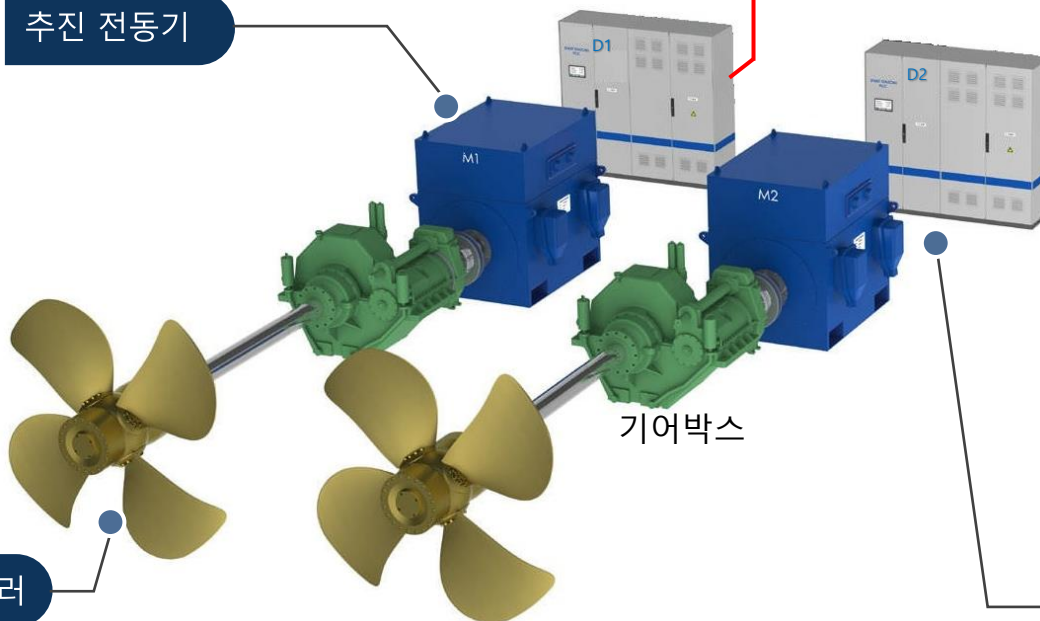
직류 배전반



배터리/연료전지



추진 전동기



추진제어 콘솔

추진 인버터

기어박스

프로펠러

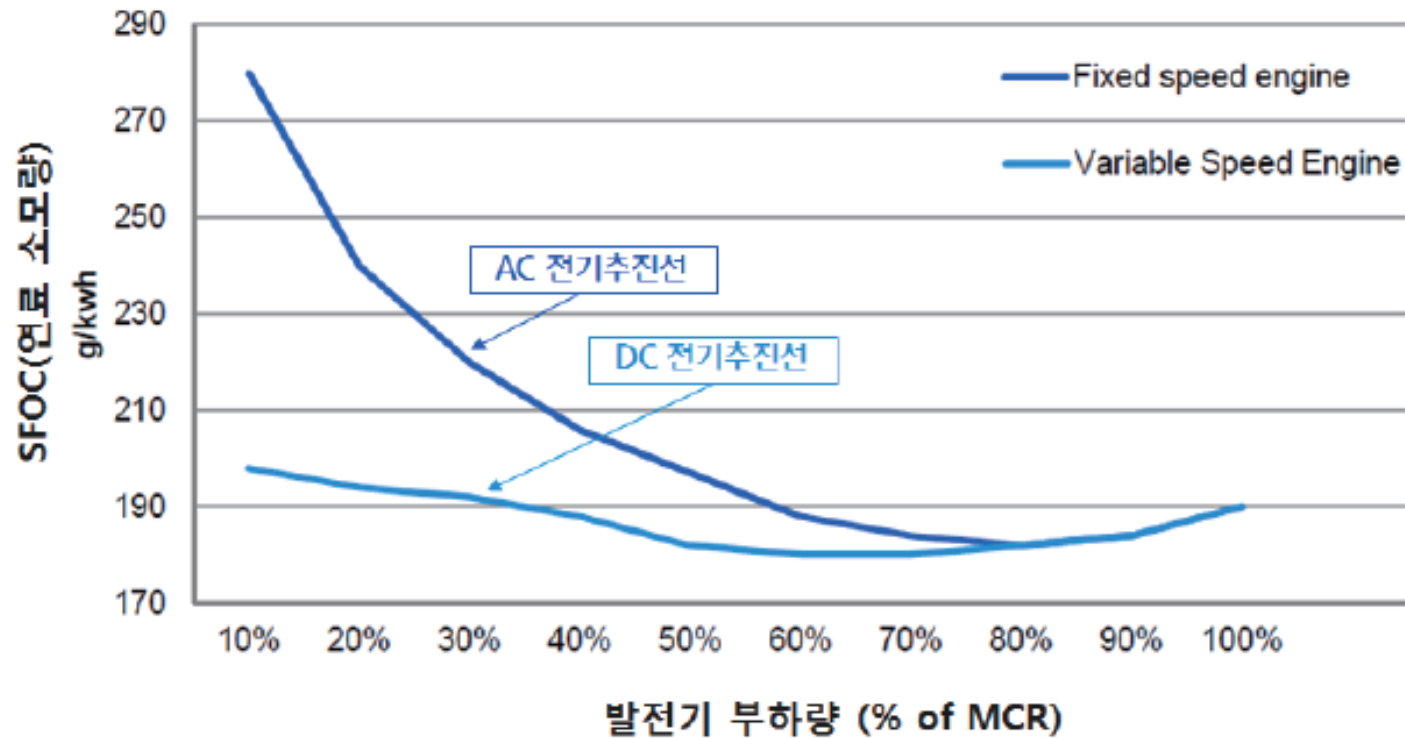


그림 7. 엔진 가변속 운전에 의한 연료 소모량 절감[2]

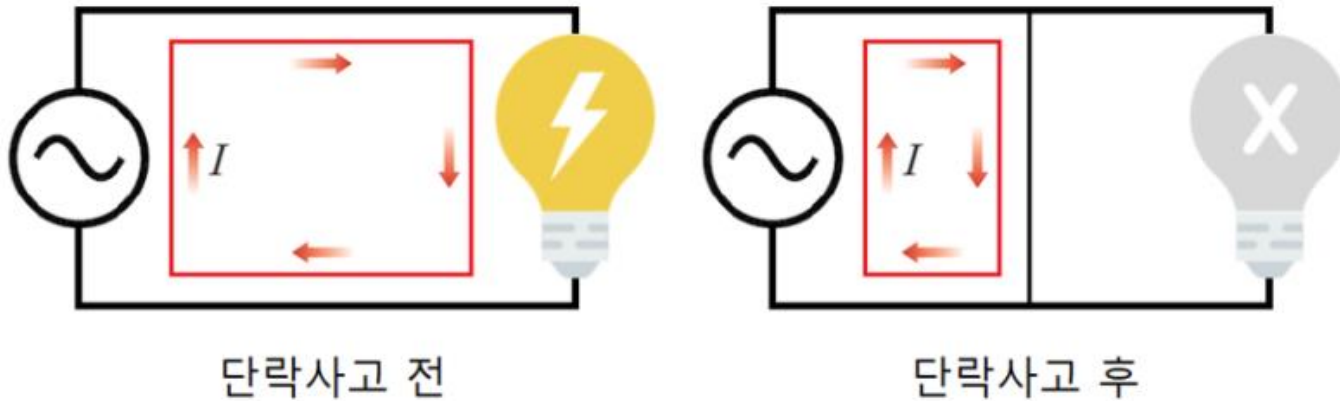
출처 : 전기의세계_김수남 박영호 DC 전기추진선 기술동향_201806

[2] ABB, "Onboard DC Grid, The step forward in Power Generation and Propulsion", 2012

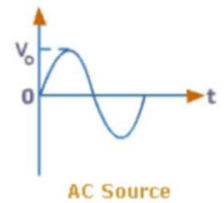
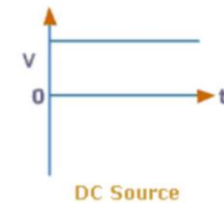
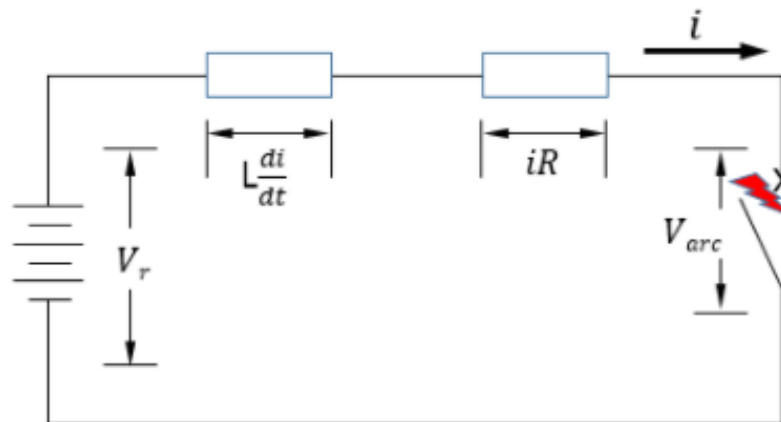
친환경 추진 전원의 특징(교류와 직류)



단락사고는 전기기기 내부 절연불량, 전력설비의 열화, 선간 단락사고, 케이블의 절연파괴에 의한 단락 등



[단락사고_KEPCO 이미지 캡처]





HIGH-SPEED DC CIRCUIT BREAKERS



철도용 HSCB



선박용 DCCB

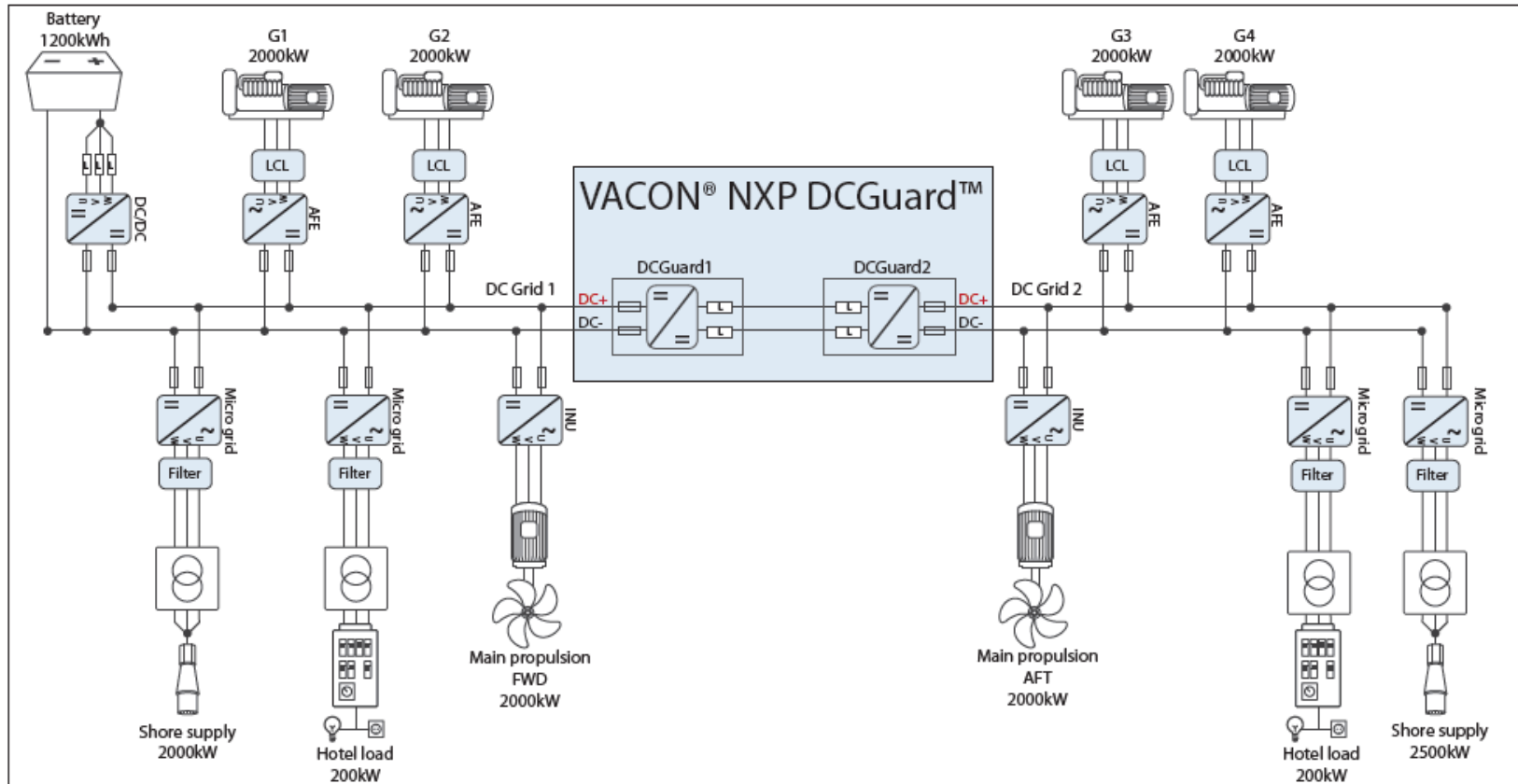
친환경 추진 전원의 특징(교류와 직류)



Current range:

- 465-800 VDC.....3-4140 A
- 640-1100 VDC.....4-3100 A

ENGINEERING
TOMORROW



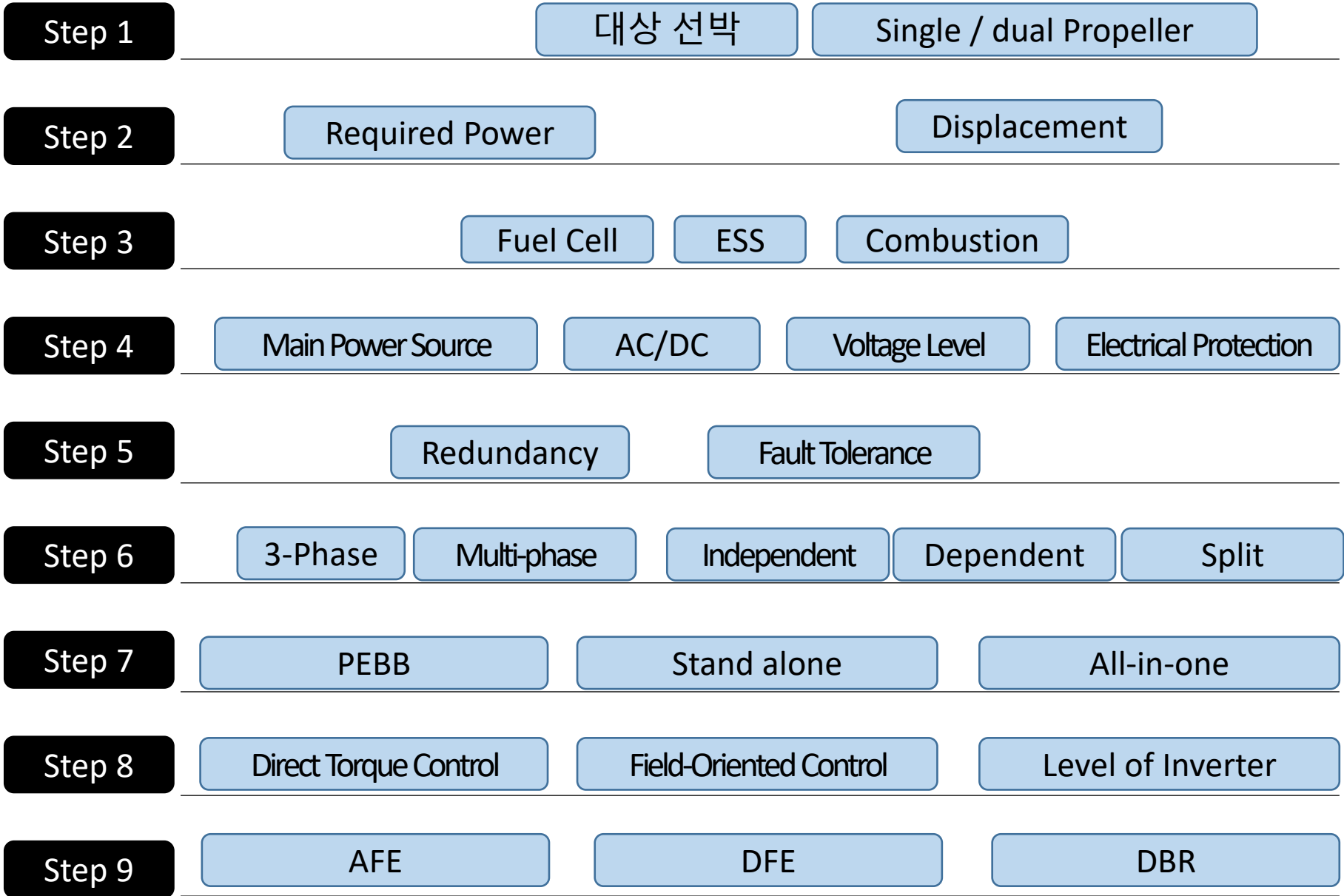
Example of hybrid system where VACON® NXP DCGuard™ ensures the required system selectivity



선박 요구 출력 = 전압과 전류의 곱

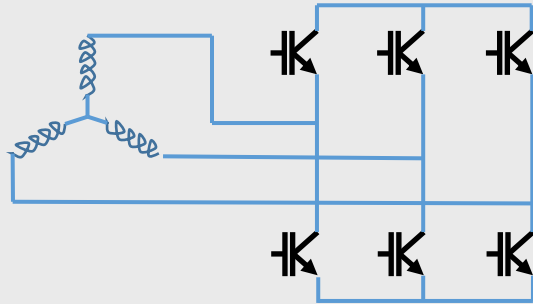
$$\text{출력}(W) = \text{전압}(V) \times \text{전류}(A)$$

$$V(\text{전압}) / R(\text{부하}) = I(\text{전류})$$

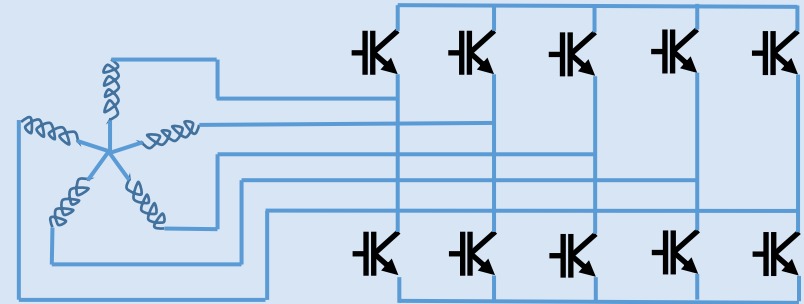




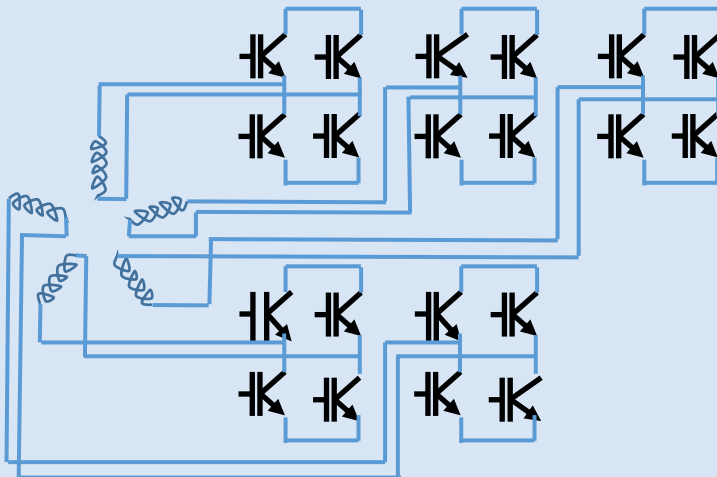
3상 시스템 구성



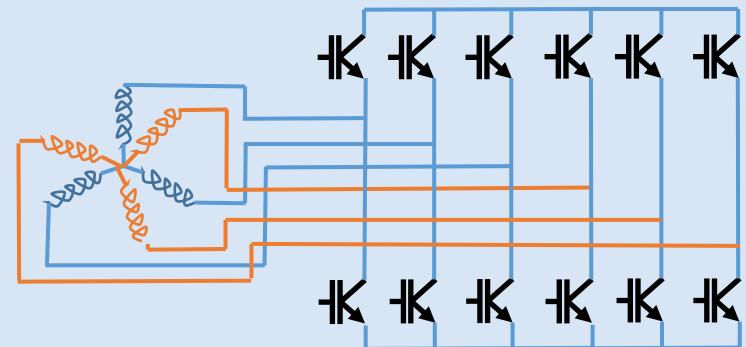
다상 시스템 구성



결합형 다상(Coupling or Dependent Multi-Phase)

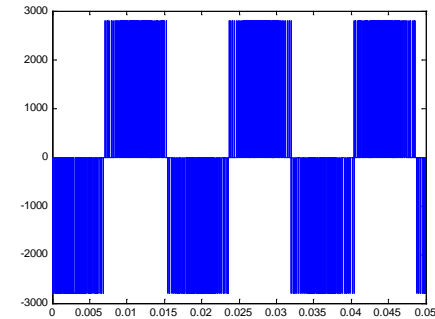
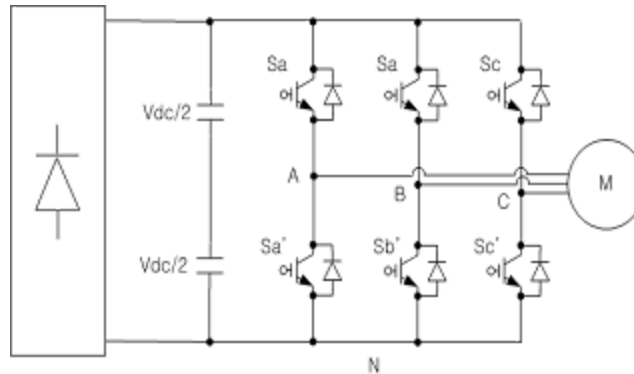


독립형 다상(Independent Multi-Phase)

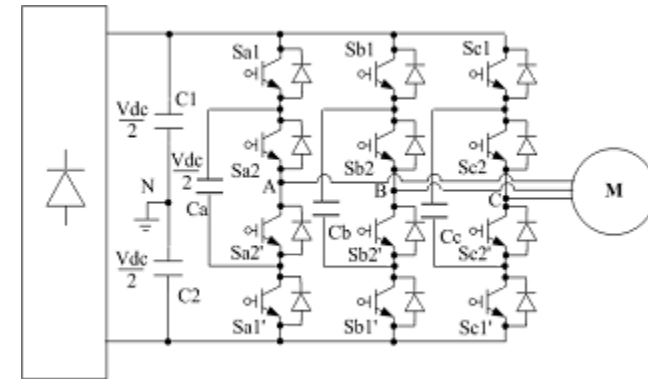
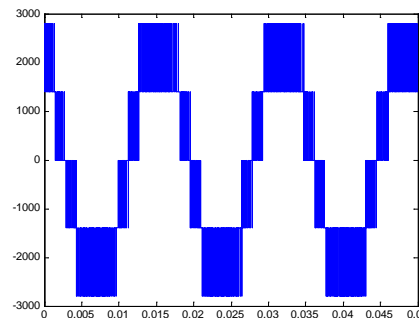
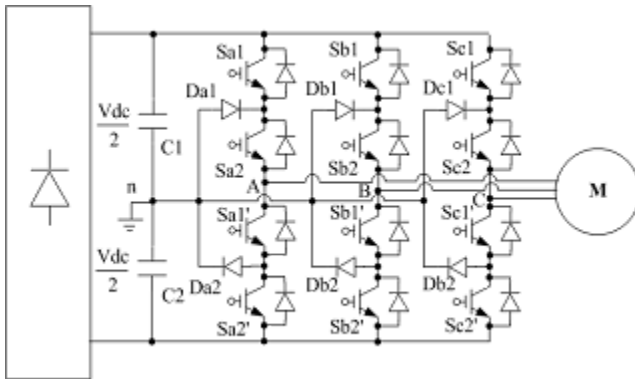


분리형 다상(Split or Multi-Stator Multi-Phase)

● 전기추진 선박용 전력변환장치 기술



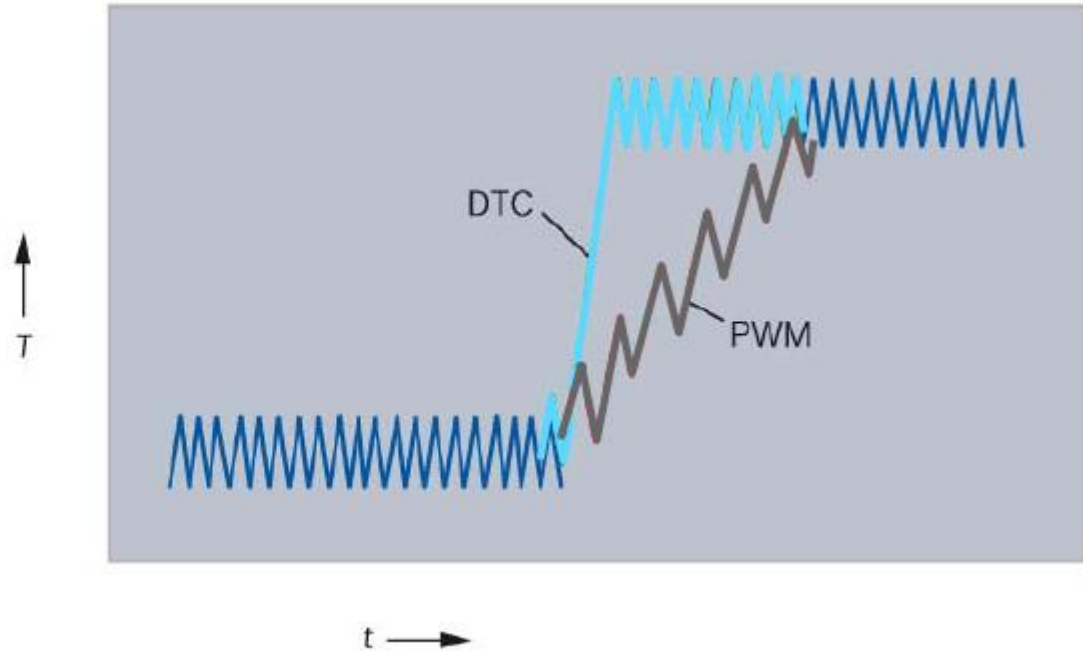
[범용인버터(2-레벨 인버터)의 회로도(좌)와 출력 선간전압(VAB) 파형(우)]



[3-레벨 다이오드 클램프트 인버터의 회로도(좌)와 출력 선간전압(VAB) 파형(중간)과 3-레벨 플라잉 커패시터 인버터]

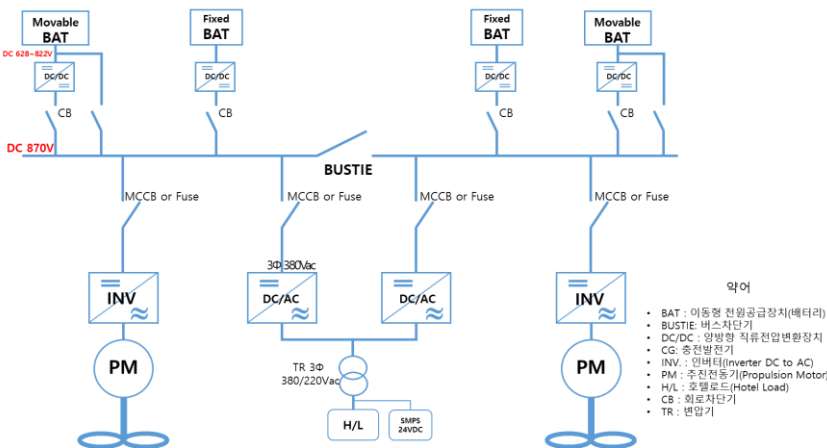


Typical torque response (t) of a DTC drive, compared with flux vector control and open loop pulse width modulation (PWM)





차도선 단선도(Car ferry Single Line Diagram)



대상 선박

Single / Dual Propeller

Required Power : 500kW 2기

Displacement : 16해리 800kWh-2기

Fuel Cell

ESS : Li-ion Battery

Combustion

DC

Voltage Level : 1000V이하

Electrical Protection : Fuse

Redundancy

Fault Tolerance

3-Phase

Multi-phase

Independent

Dependent

Split

PEBB

Stand alone

All-in-one

Direct Torque Control

Field-Oriented Control

2-Level of Inverter

AFE

DFE

DBR



대상 선박

Single / Dual Propeller

Required Power : 450kW 2기

Displacement: 900kWh-2기

Fuel Cell

ESS : Li-ion Battery

Combustion

DC

Voltage Level: 1000V이하

Electrical Protection : Fuse

Redundancy : Hotel Load & UPS

Fault Tolerance

3-Phase

Multi-phase

Independent

Dependent

Split

PEBB

Stand alone

All-in-one

Direct Torque Control

Field-Oriented Control

2-Level of Inverter

AFE

DFE

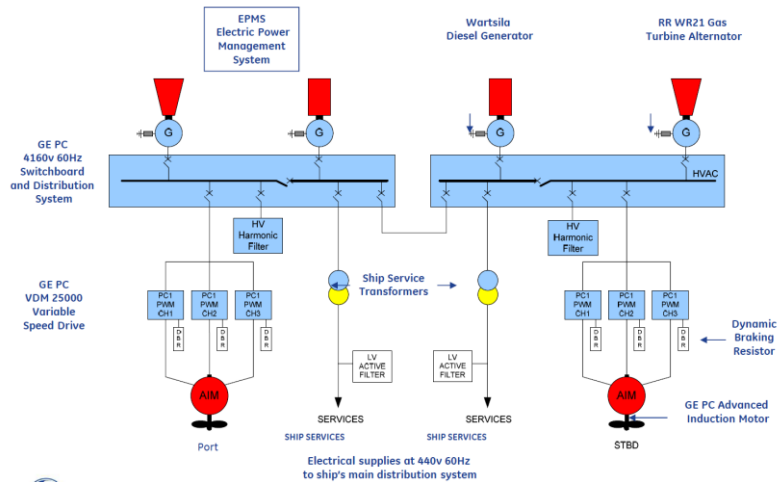
DBR



Future of the Fjords는 피요르드를 위해 건조된 신형 순수 전기 관광선입니다.

<https://www.ship-technology.com>

Type 45 Destroyer Single Line Diagram



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GE Proprietary Information
GE © 2012 - All Rights Reserved



Dual Propeller

Combustion

AC

Voltage Level

Redundancy

Combined

12-phase

Stand alone

Field-Oriented Control

Level of Inverter

DFE

DBR



Single Propeller

Fuel Cell

ESS

Combustion

DC

Voltage Level

Redundancy

Fault Tolerance

Independent

Multi-phase

All-in-one

Field-Oriented Control

2-Level of Inverter





- 직류전원시스템 : ESS/FC 기반 연안 선박
(직류전압 : 1000Vdc → 1500Vdc)
- 교류전원시스템 : 수상함, 대양 선박 (교류전압 : ~4160Vac)
- 대용량 선박의 요구 출력에 대응 방법
: Multi-Phase, Voltage Level, Current Level
- 절연기술 (사용전압 및 인버터 토폴로지와 연계)
- 전력계통 보호협조 기술 (사용전류 및 단락전류와 연계)

Thank you



KERI

The logo features the word "KERI" in a bold, italicized, light blue sans-serif font. A bright yellow swoosh underline is positioned beneath the "E". The text is centered within a large, semi-transparent blue circle. The background is a dark blue gradient with horizontal light blue lines and numerous small, glowing blue dots, creating a futuristic or digital atmosphere.