SY486K MICS Lecture 2

Maritime Electrical Systems

CDR Brien Croteau, USNA Cyber Science Department, January 2023

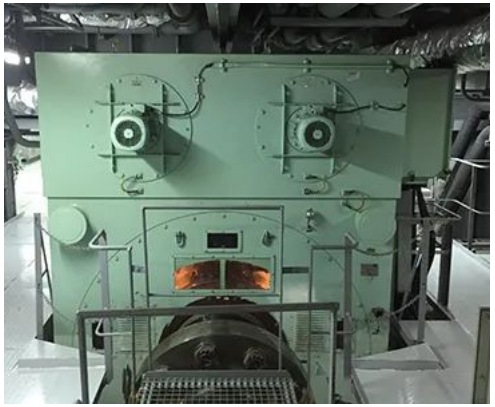
Outline

- Components
  - Generators
  - Switchboards
  - Bus Bars
  - Circuit Breakers
  - Transformers
  - Others (Switches, Fuses, Instruments, Motors, Other Loads)
- Three-Phase Power
- Electrical Safety
- Inside Switch Boards
- Distribution
- Research Topics

Components

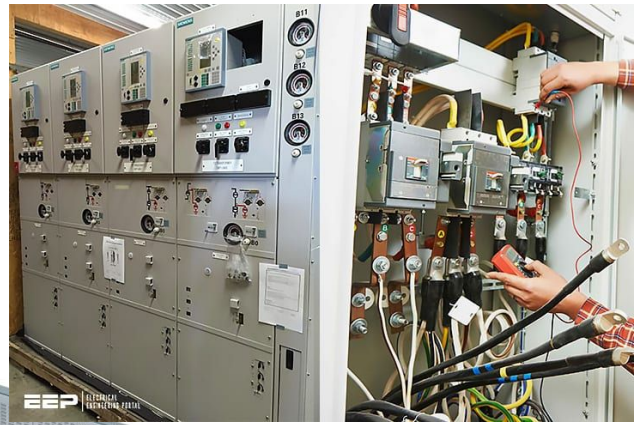
Generators

Shipboard power is generated using a prime mover and an alternator working together. International maritime regulations (e.g. SOLAS), require at least two generators for a ship's main electrical power system. AC power is preferred over DC as it gives more power for the same size. Three phases is preferred over single phase as provides more overall power and in the event of failure of one phase, other 2 can still work.

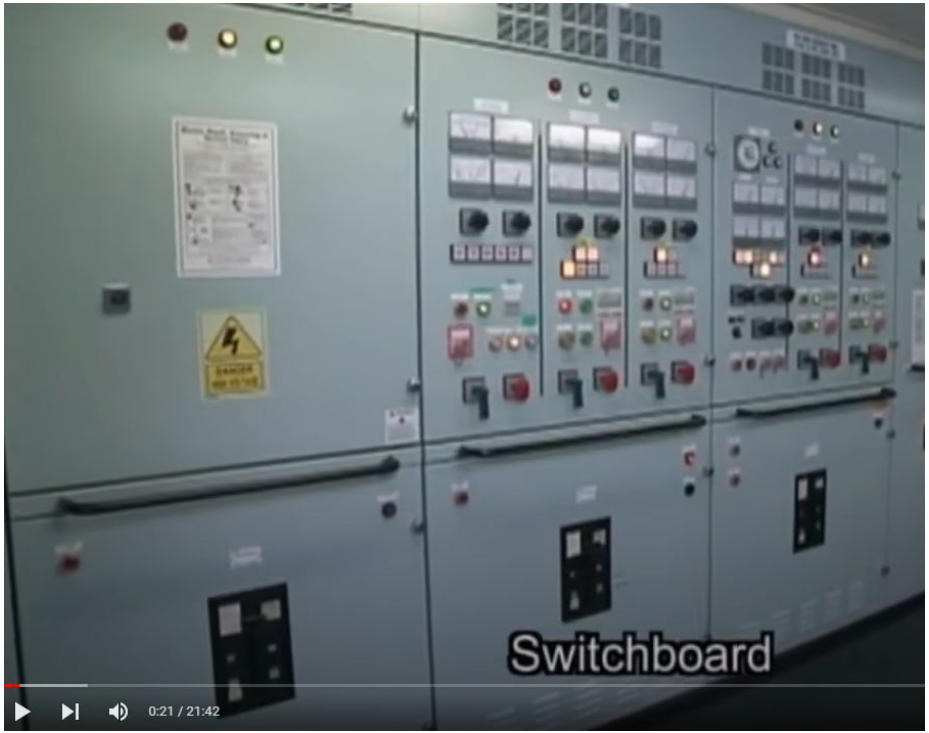


Switchboards

Supply power to onboard electric equipment and protect systems in the case of electrical accidents.



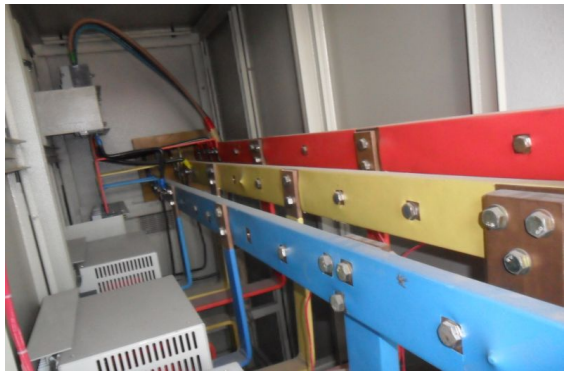
Inside Switchboards

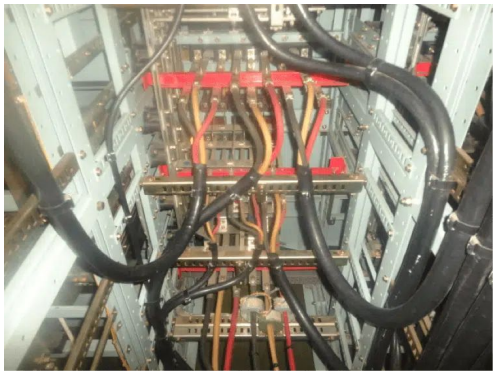


https://www.youtube.com/watch?v=7SrPoI911S8

Busbars (or Bus Bars)

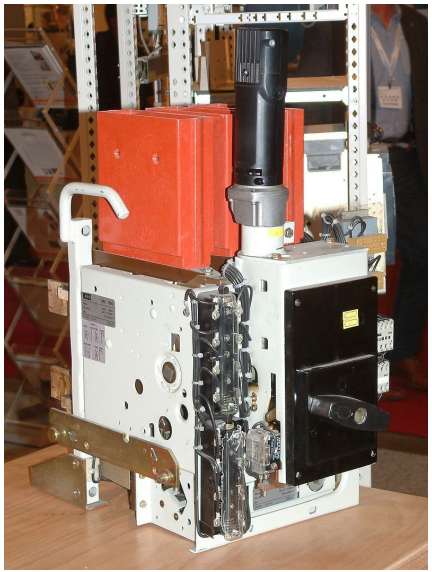
In electric power distribution, a busbar is a metallic strip or bar, typically housed inside switchgear, panel boards, and busway enclosures for local high current power distribution.They are generally uninsulated, and have sufficient stiffness to be supported in air by insulated pillars. These features allow sufficient cooling of the conductors, and the ability to tap in at various points without creating a new joint.

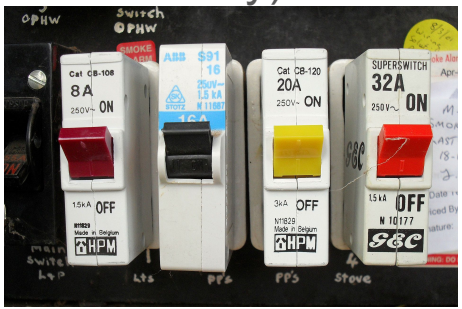


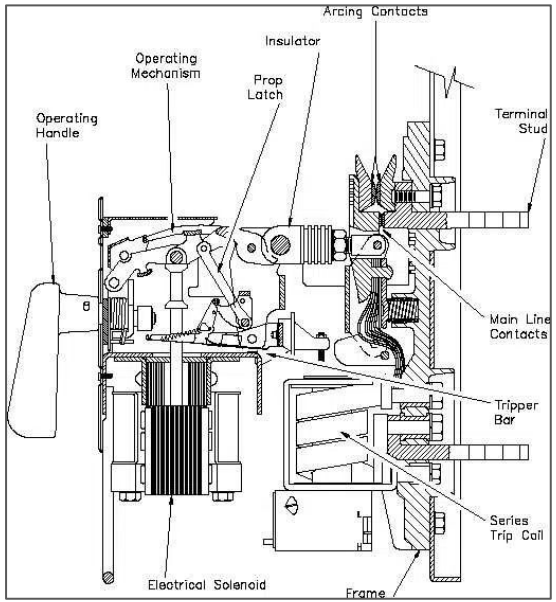


Circuit Breaker

A circuit breaker is an electrical safety device designed to protect an electrical circuit from damage caused by an overcurrent or short circuit. Its basic function is to interrupt current flow to protect equipment and to prevent the risk of fire. Unlike a fuse, which operates once and then must be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation.

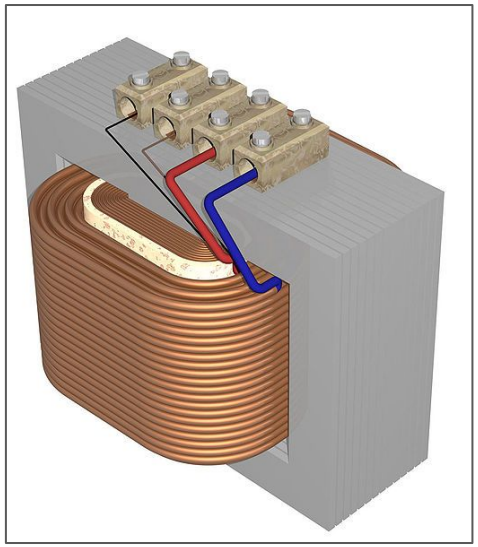






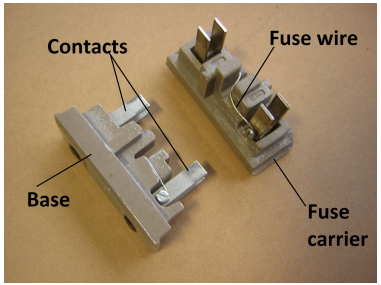
Transformers

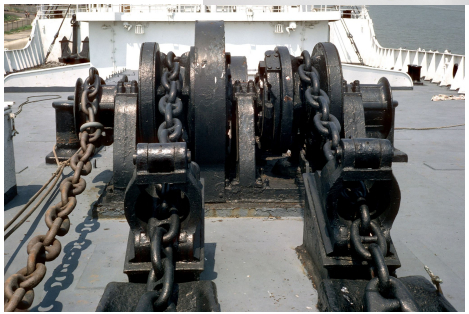
A transformer is a passive component that transfers electrical energy from one electrical circuit to another circuit. A varying current in any coil of the transformer produces a varying magnetic flux in the transformer's core, which induces a varying electromotive force (EMF) across any other coils wound around the same core.



Others

Switches





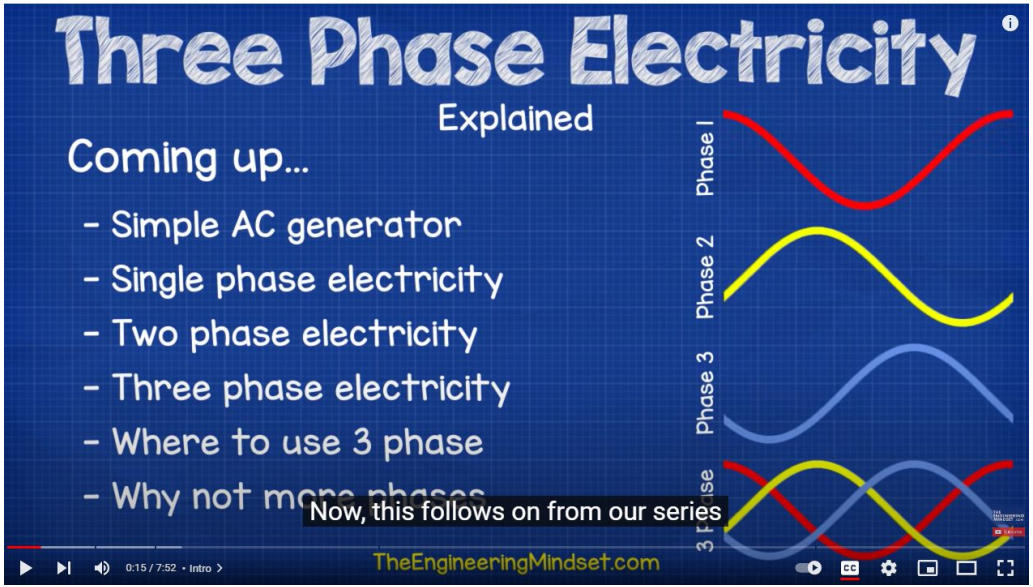
Three-Phase Power

Three-phase power works by the voltage and currents being 120 degrees out of phase on the three wires. As an AC system it allows the voltages to be easily stepped up using transformers to high voltage for transmission, and back down for distribution, giving high efficiency.

A three-wire three-phase circuit is usually more economical than an equivalent two-wire single-phase circuit at the same line to ground voltage because it uses less conductor material to transmit a given amount of electrical power.

Polyphase power systems were independently invented by Galileo Ferraris, Mikhail Dolivo-Dobrovolsky, Jonas Wenström, John Hopkinson, William Stanley Jr., and Nikola Tesla in the late 1880s

https://www.youtube.com/watch?v=MnH_ifcRJq4



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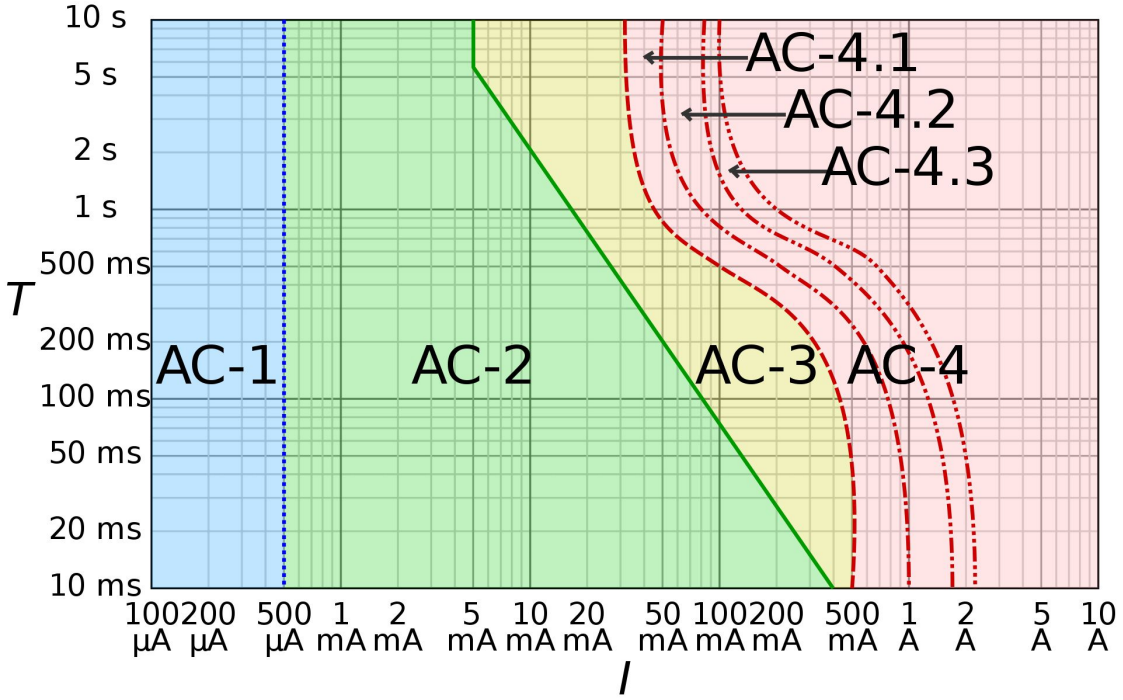
Electrical Safety



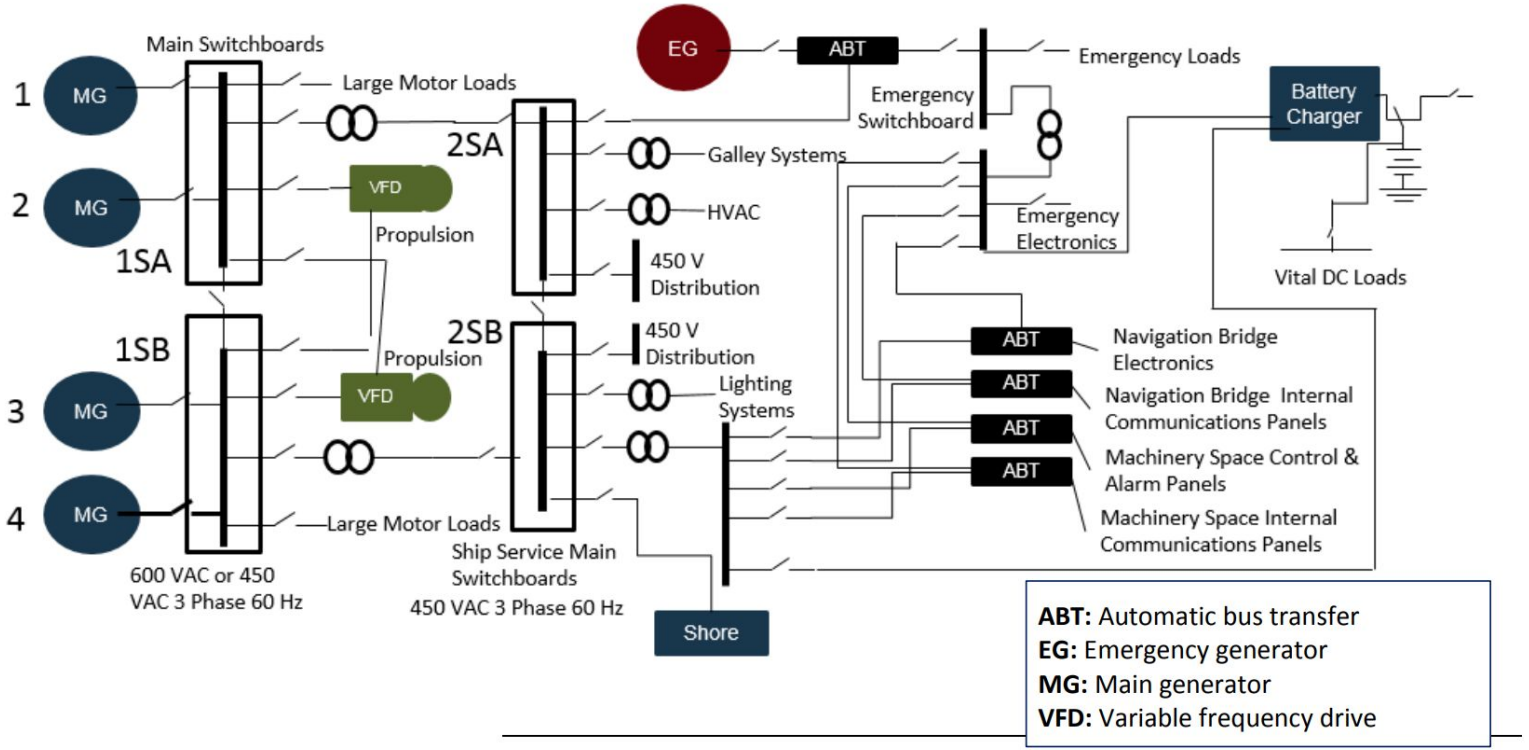
Electrical shocks on humans can lead to permanent disabilities or death. Size, frequency and duration of the electrical current affect the damage. The effects from electric shock can be: stopping the heart beating properly, preventing the person from breathing, causing muscle spasms. The skin features also affect the consequences of electric shock.

Zones	Boundaries	Physiological effects
AC-1	Up to 0,5 mA curve a	Perception possible but usually no 'startled' reaction
AC-2	0,5 mA up to curve b	Perception and involuntary muscular contractions likely but usually no harmful electrical physiological effects
AC-3	Curve b and above	Strong involuntary muscular contractions. Difficulty in breathing. Reversible disturbances of heart function. Immobilization may occur. Effects increasing with current magnitude. Usually no organic damage to be expected
AC-4 [1)]	Above curve c_1	Patho-physiological effects may occur such as cardiac arrest, breathing arrest, and burns or other cellular damage. Probability of ventricular fibrillation increasing with current magnitude and time
	c_1-c_2	AC-4.1 Probability of ventricular fibrillation increasing up to about 5 %
	c_2-c_3	AC-4.2 Probability of ventricular fibrillation up to about 50 %
	Beyond curve c_3	AC-4.3 Probability of ventricular fibrillation above 50 %

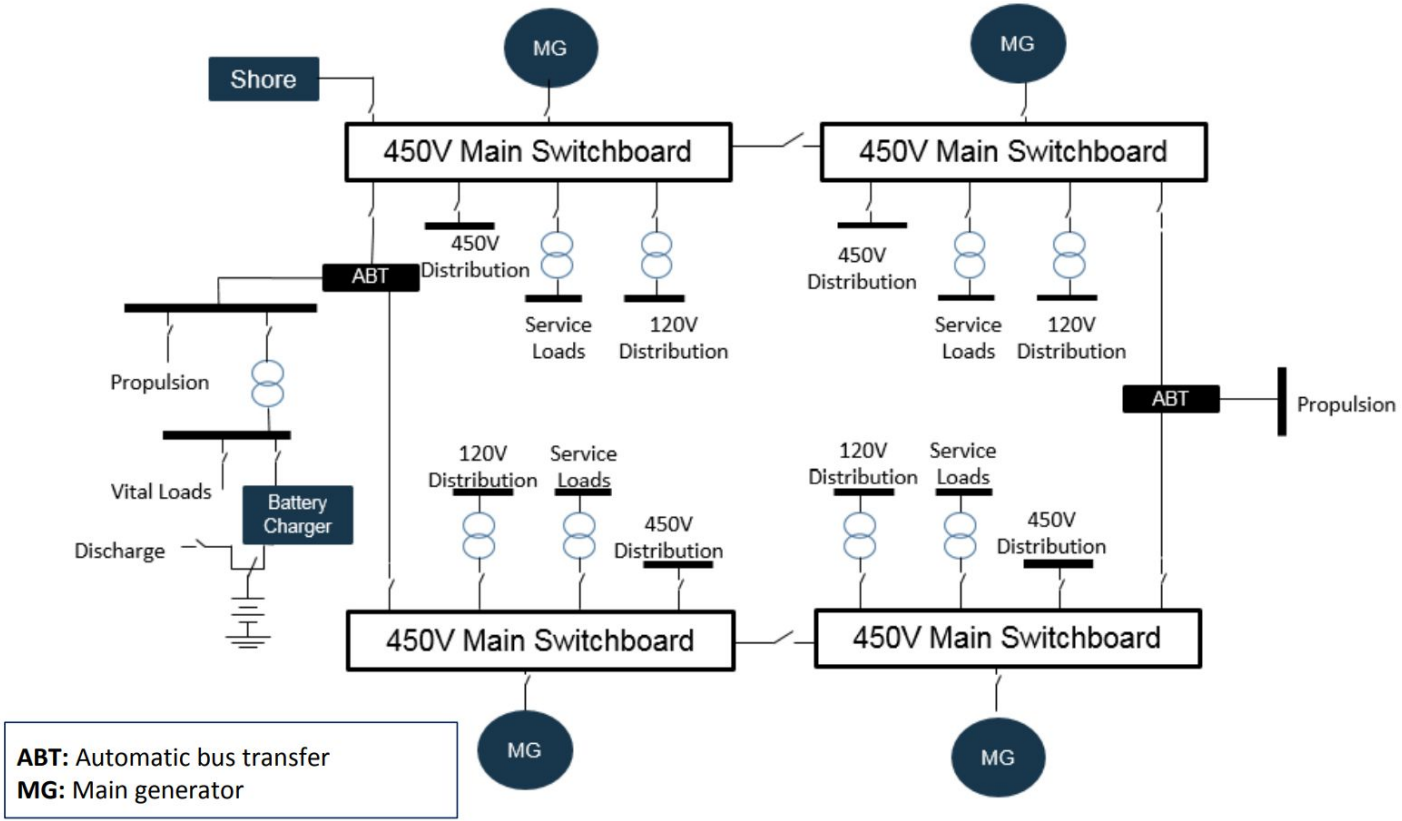
IEC 60479-1

Electrical Distribution - Example 1

Power System: Diesel Electric



Electrical Distribution - Example 2



Research Topics

Potential Research Topics

1. Solar - Ariel
2. Fuel Cell
3. Nuclear - PJ
4. Gas Turbine - Sasha

Example Slides shell