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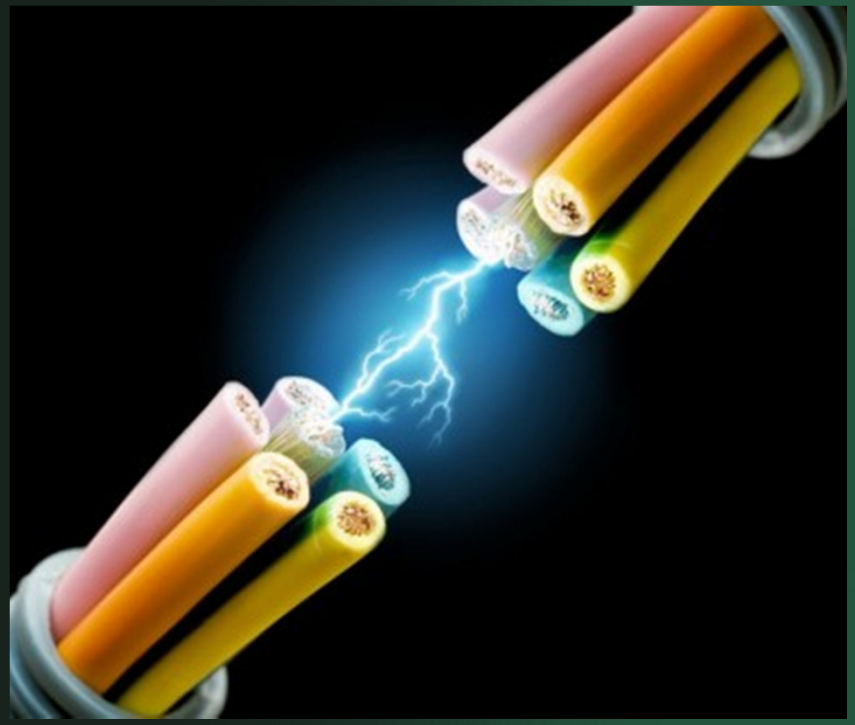


Telkom University

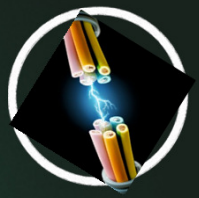
Diploma of Telecommunication Engineering

Bengkel Instalasi Catu Daya dan Perangkat Pendukung

Pengantar Sistem Tenaga Listrik

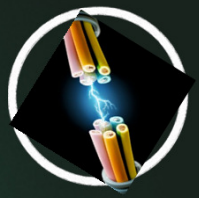
By Dwi Andi Nurmantris

OUTLINE



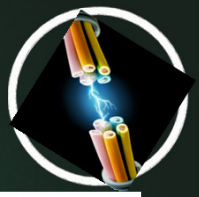
1. Istilah-istilah tentang Listrik
2. Sistem Tenaga Listrik

Istilah-Istilah tentang Listrik



- Tegangan
- Arus
- Tegangan/Arus DC
- Tegangan/Arus AC
- *RMS (Root Mean Square)*
- Frekuensi
- *Asymmetrical Peak*
- *Switching Surges*
- *Power*
- *Energi*
- *Impedansi*
- *Resistansi*
- *Induktansi*
- *Kapasitansi*

Istilah-Istilah tentang Listrik



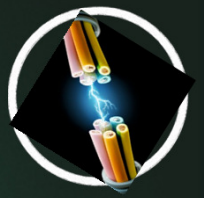
Voltage/Tegangan

- *Voltage* is the potential energy source in an electrical circuit that causes current to flow, work to be performed, and energy to be produced and consumed.
- The symbol "*e*" or "E" (some references use the symbols "*v*" or "V" to represent voltage)

System Operating Voltages

System voltage class	Voltage category
Under 600	Secondary
601–7200	Distribution
15,000	Distribution
25,000	Distribution
34,500	Distribution or sub-transmission
69,000	Sub-transmission
115,000	Sub-transmission
138,000	Sub-transmission
161,000	Transmission
230,000	Extra high voltage (EHV)
345,000	EHV
500,000	EHV
765,000	EHV
Above 1,000,000	Ultra high voltage (UHV)

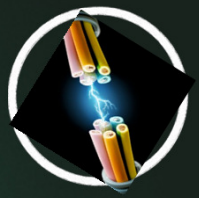
Istilah-Istilah tentang Listrik



Current/Arus

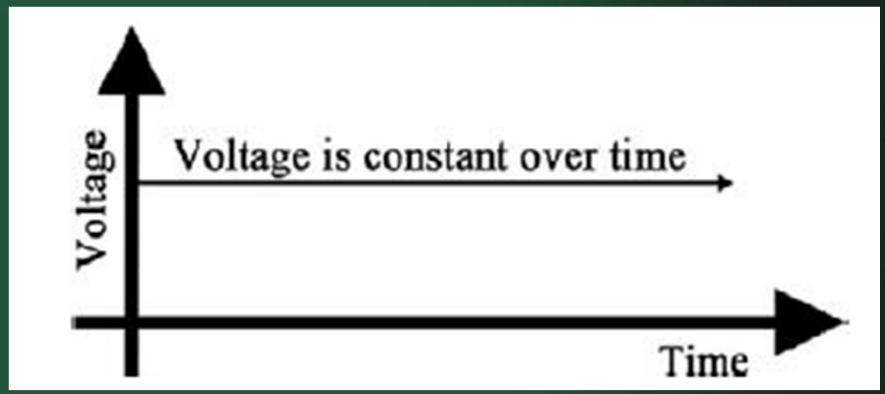
- *Current* is the flow of electrons in a conductor (wire)
- Electrons are pushed and pulled by voltage through an electrical circuit that is sometimes called a closed-loop path, when a complete circuit path or closed loop is provided, voltage will cause current to flow.
- As the electrons flow in a circuit, the potential energy (voltage) is converted into kinetic energy. Kinetic energy is then used by the load (consumption device) where it is converted into useful work.
- The electrons flowing in a conductor always return to their voltage source.
- Current is measured in amperes, usually called amps (one amp is equal to 6.28×10^{18} electrons flowing in the conductor per second)
- The flow of electrons in a conductor produces heat from the conductor's resistance (friction).
- In interconnected power systems, currents can range from a few amps (a residential electrical appliance) to several thousand amps during a power fault short circuit event.
- Short circuit implies a sudden abnormal very low resistance path that allows very high levels of current to flow.

Istilah-Istilah tentang Listrik



Direct Current (DC) Voltage/Current

- DC is the flow of electrons in a circuit path that is always in the same direction
- DC occurs when the voltage is kept constant
- A battery, for example, produces a direct current when connected to a circuit.



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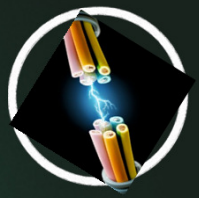
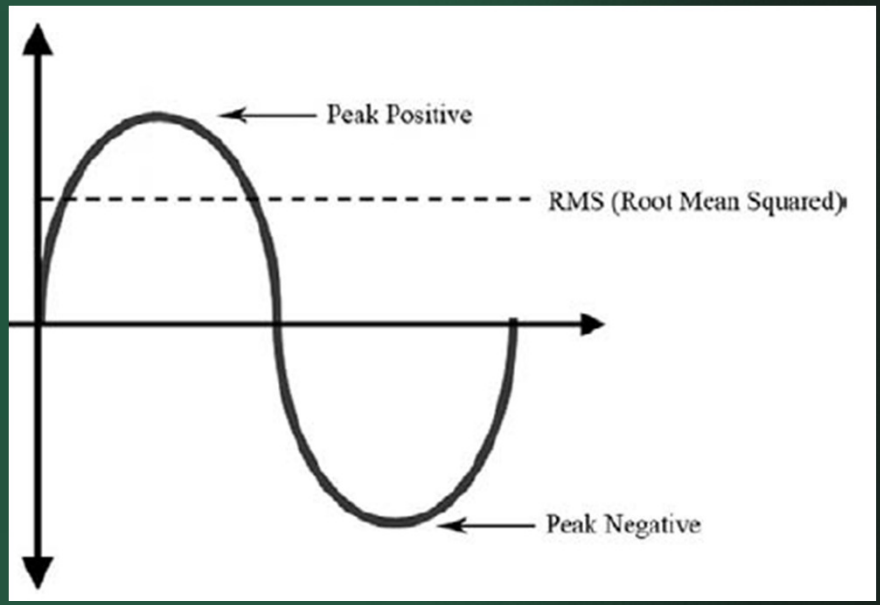


Alternating Current (AC) Voltage/Current

- When the terminals of the potential energy source (voltage) alternate between positive and negative, the current flowing in the electrical circuit likewise alternates positive and negative.
- AC voltage or current happen when the amplitude value increasing over time from zero to a positive peak value, then decreasing through zero to a negative peak value and back through zero again, completing one cycle. The mathematical term for this shape is the "sine wave."



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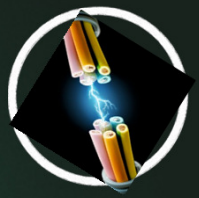
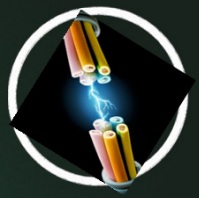


RMS (Root Mean Square)

- Resistive electrical load such as light bulbs, toasters, and hot water heaters can be served by either AC or DC voltage and current.
- DC voltage sources cause continuous heating of the load, while AC voltage sources cause heating to increase and decrease during the positive and the negative parts of the cycle.
- In AC circuits, there are moments when the voltage and/or current are zero and no additional heating occurs.
- An equivalent AC voltage and current that will produce the same heating effect in electrical load as if it were a continuous DC voltage and current are referred to as the "root mean squared" values (RMS).
- This concept of rms versus DC is important to the engineer/technician

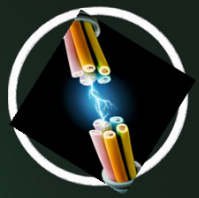
Istilah-Istilah tentang Listrik



Frequency

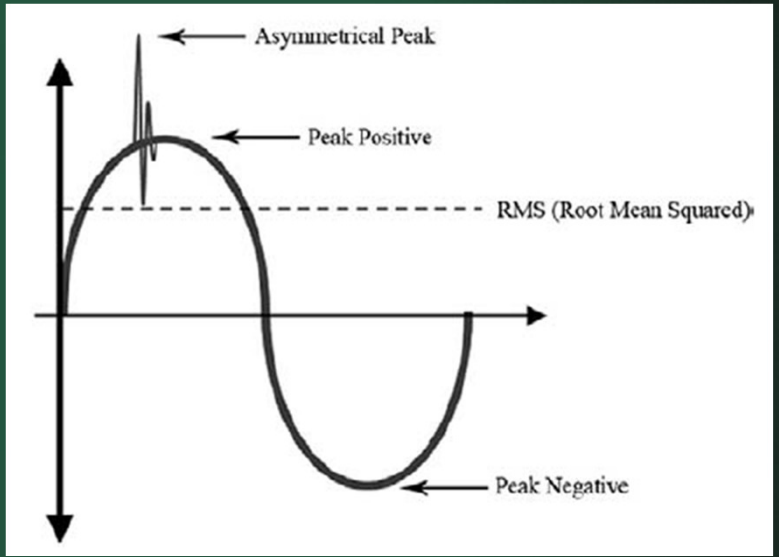
- The number of cycles of sine wave in a second is called frequency, measured in Hertz (or cycles per second).
- DC has no frequency; therefore, frequency is a term used only for AC circuits.
- For electric power systems in the Indonesia, the standard frequency is 50 or 60 Hz.

Istilah-Istilah tentang Listrik



Asymmetrical Peak

- When voltage transients occur on a power system, the sine wave is distorted.
- When the distortion results in a peak voltage that is momentarily greater than the positive peak portion of the sine wave, the condition is called "asymmetrical peak"
- The asymmetrical peak voltage (APV) is considered the highest voltage that occurs on the power system during a transient condition.



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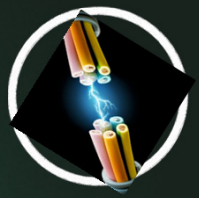

Switching Surge

- High Voltage electric power systems can produce switching surges that can cause voltage and current transients on telecommunications equipment through a concept called induction.
- Transients on power systems are identified as high frequency and short-duration voltage fluctuations having a decaying amplitude characteristic
- The sudden increase in current can induce a voltage onto the telecommunications cable.
- Switching transients can be as high as 1.5–2.5 times the source voltage (and higher).
- Switching transients can have characteristics of frequencies from 200 kHz to 2.9 MHz, with amplitudes of 12 kV and lasting from 10 to 100 ms.

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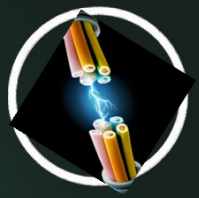
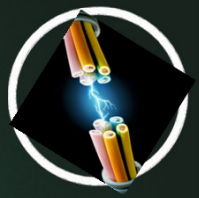


Power

- The product of voltage x current is power ; therefore, power equals zero if either voltage or current is zero.
- Power is used to produce real work
- The basic unit (measurement) of power is the watt
- Electrical power can be used to create heat, spin motors, light lamps, and so on

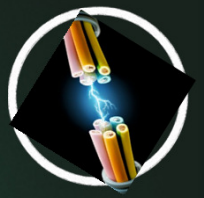
Istilah-Istilah tentang Listrik



Energy

- Electrical energy is the product of electrical power x time
- The amount of time a load is on (i.e., current is flowing) x the amount of power used by the load (watts) is energy
- The common measurement for electrical energy is watt-hours
- The more common units of electrical energy in power systems are kilowatt-hours (kWh) for residential applications and megawatt-hours (MWh) for large industrial or power company applications.

Istilah-Istilah tentang Listrik



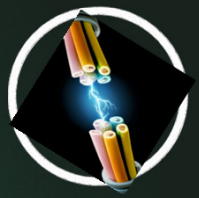
Energy → TDL (Tarif Daya Listrik)

- Rumus Menghitung KWHnya.
  KWH Pemakaian Listrik = daya alat listrik x lama pemakaian (dalam jam)

- kWH pemakaian Mesin cuci sebulan
  = 500watt x 15 = 7500 WH = 7,5 kWH

- Biaya Listrik = Pemakaian (kWH) x Tarif Dasar Listrik
  Biaya Listrik = 7,5 x 1.353= Rp. 10.1475
  *angka 1.353 di dapat dari tabel TDL

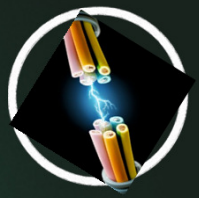
Istilah-Istilah tentang Listrik



Impedance

- Impedance is the term used to describe the total opposition to current flowing in AC circuits that is made up of resistance, inductance, and capacitance
- Impedance of a circuit is represented by the symbol "Z." and measured in ohms.
- When the circuit is DC only, there is no distinction between impedance and resistance
- When the circuit is AC, capacitors and inductors have different resistances for different frequencies. Therefore, the AC impedance of a circuit varies depending on frequency

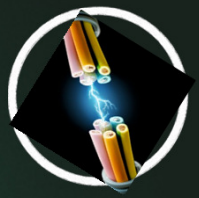
Istilah-Istilah tentang Listrik



Resistace, Capacitance, and Inductance

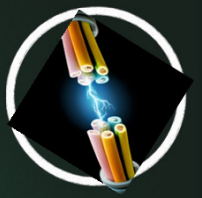
- The electrical resistance of an element measures its opposition to current flow. It is similar to friction in mechanical movement
- There are two common forms of inductance: self-inductance and mutual inductance. Self-inductance is the property of an electrical circuit that causes voltage to be generated proportional to the rate of change of current in a circuit. Mutual inductance describes the voltage induced in an electrical circuit by the rate of change of the electrical current flowing in another circuit
- Capacitance describes the ability of an object to store an electric charge

Catu Daya



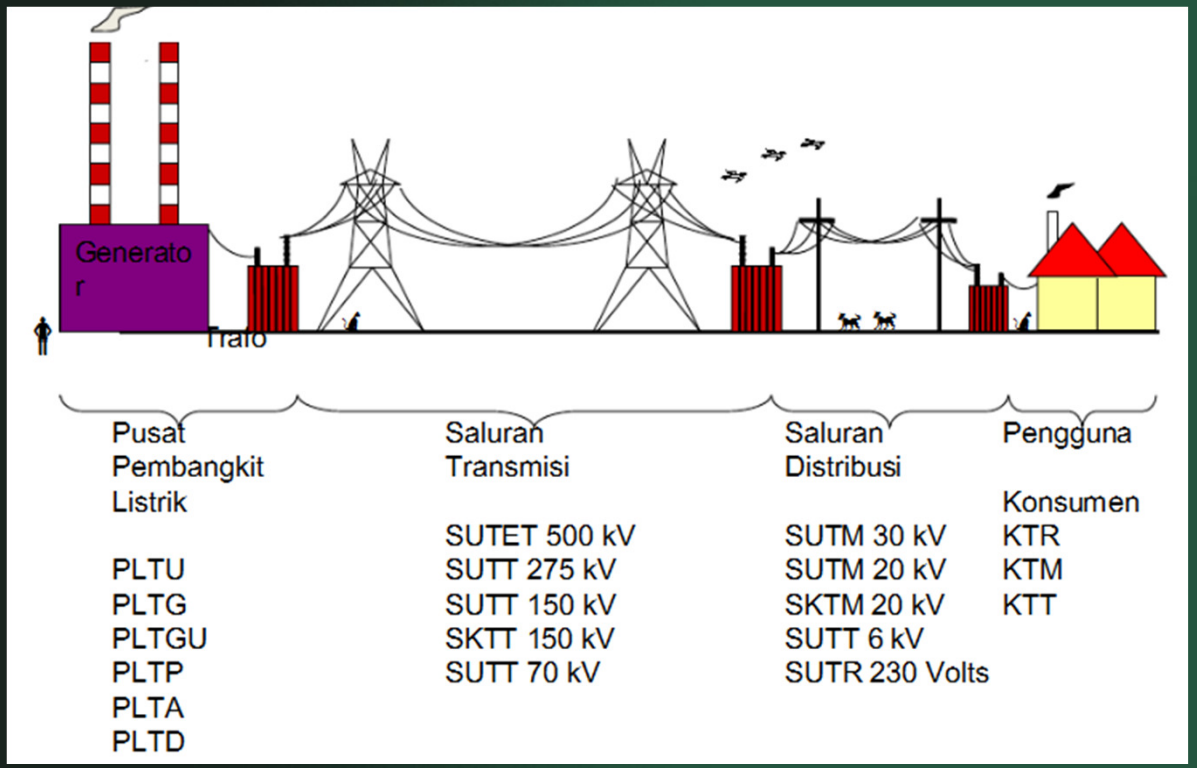
Catu daya : Sumber energi untuk menjalankan suatu perangkat yang membutuhkan energi listrik.

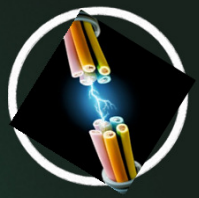
Prinsip Dasar Catu Daya



SUMBER → GENERATOR → TENAGA LISTRIK

Sistem Tenaga Listrik overview

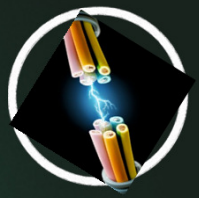




Transmisi Listrik

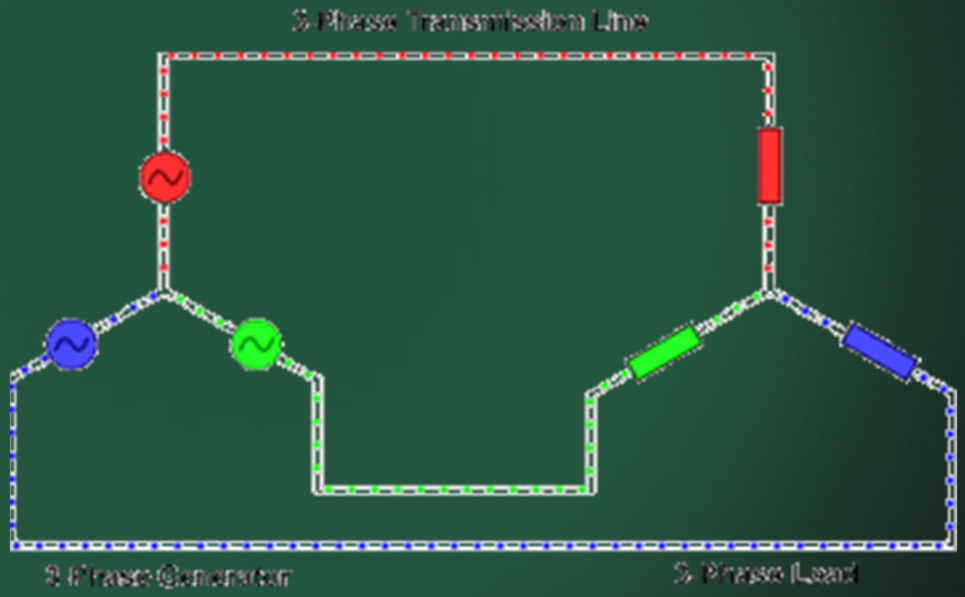
1. SALURAN UDARA TEGANGAN EKSTRA TINGGI (SUTET) 200 KV – 500 KV
2. SALURAN UDARA TEGANGAN TINGGI (SUTT) 30 KV – 150 KV
3. SALURAN KABEL TEGANGAN TINGGI (SKTT) 30 KV – 150 KV
4. SALURAN UDARA TEGANGAN MENENGAH (SUTM) 6 KV – 30 KV
5. SALURAN KABEL TEGANGAN MENENGAH (SKTM) 6 KV – 20 KV
6. SALURAN UDARA TEGANGAN RENDAH (SUTR) 40 VOLT – 1000 VOLT
7. SALURAN KABEL TEGANGAN RENDAH (SKTR) 40 VOLT – 1000 VOLT

Sistem Fasa Listrik

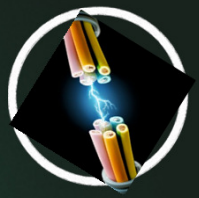


- Fasa adalah istilah dalam kelistrikan yang menyatakan banyaknya arus listrik yang dilewatkan
- Di Indonesia ada 2 jenis :

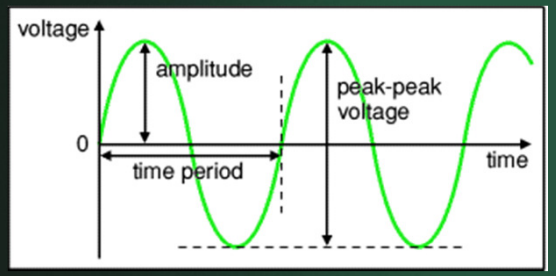
1. sistem 1 fasa
2. sistem 3 fasa



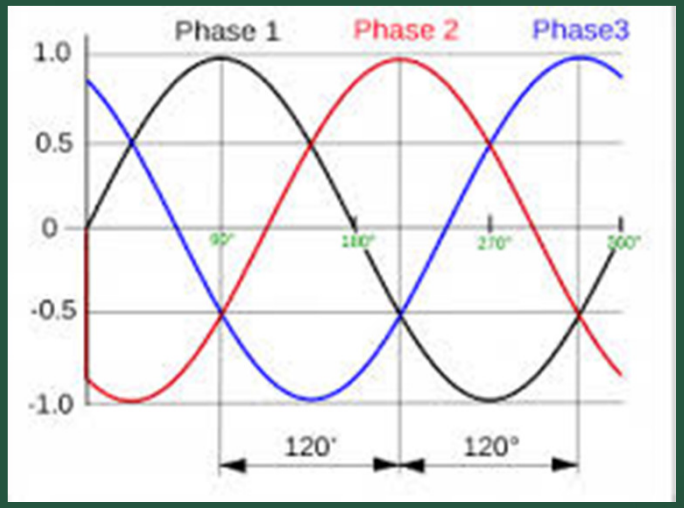
Listrik 3 Fasa



- Adalah listrik AC yang menggunakan 3 kawat penghantar, memiliki nilai tegangan yang sama tetapi berbeda fasa

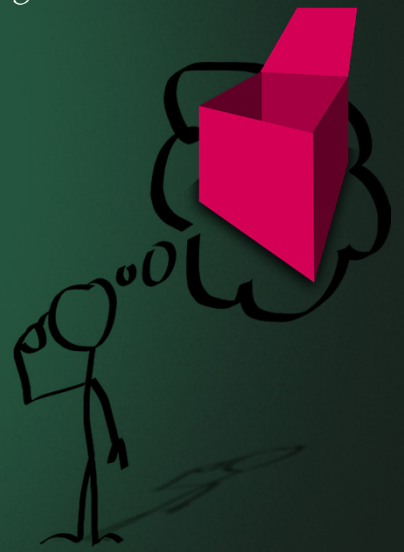


Listrik 1 Fasa

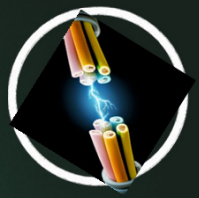


Listrik 3 Fasa

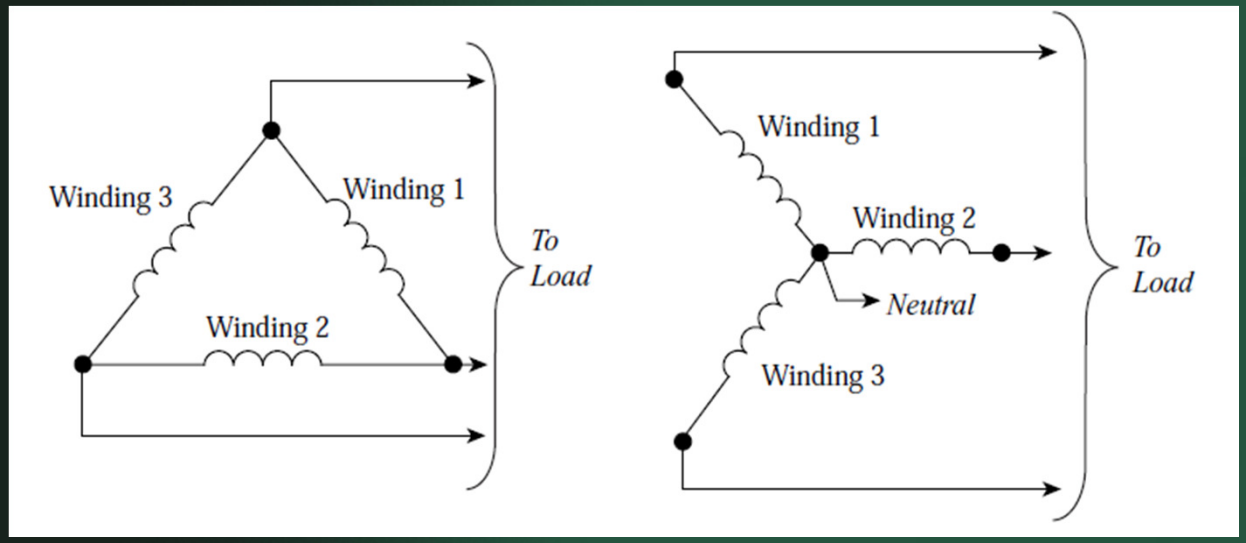
Yang digunakan di rumah-rumah yg mana ya?



Listrik 3 Fasa



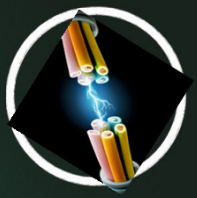
Tipe Hubungan 3 fasa

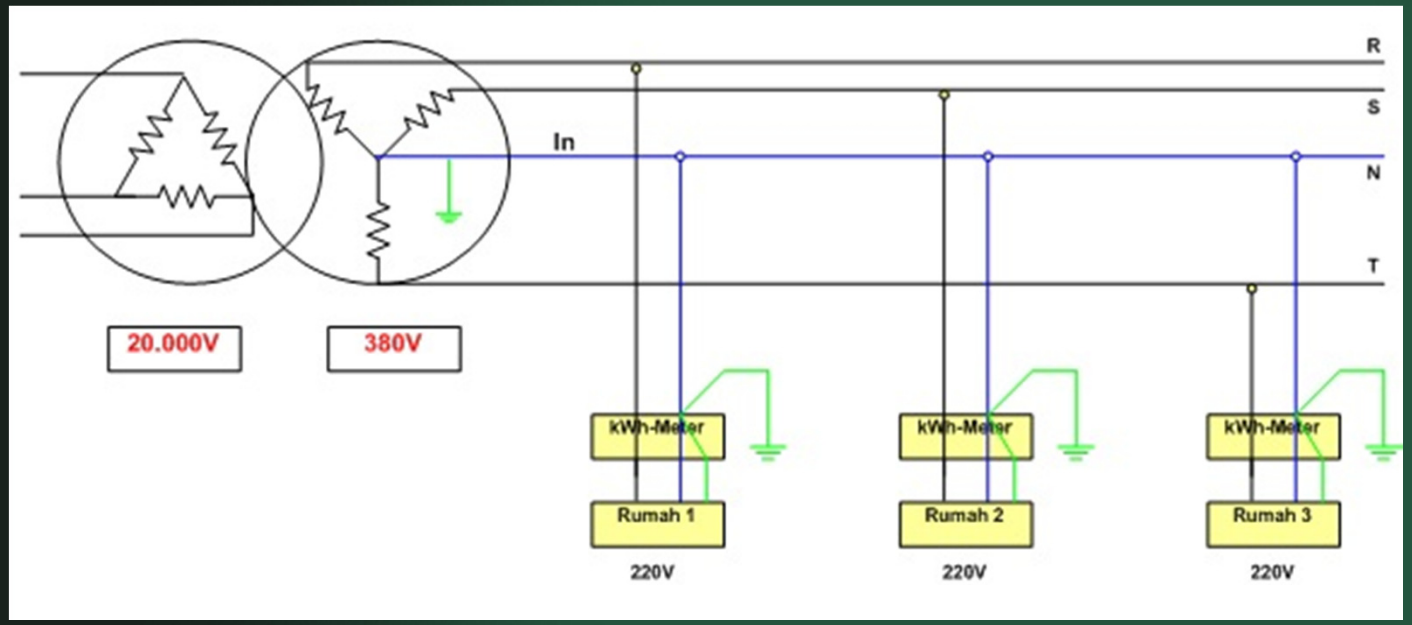


Tipe Delta

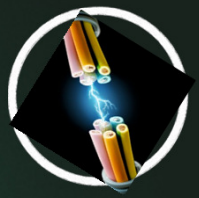
Tipe WYE

Sistem Distribusi Jaringan Listrik 3 Fasa

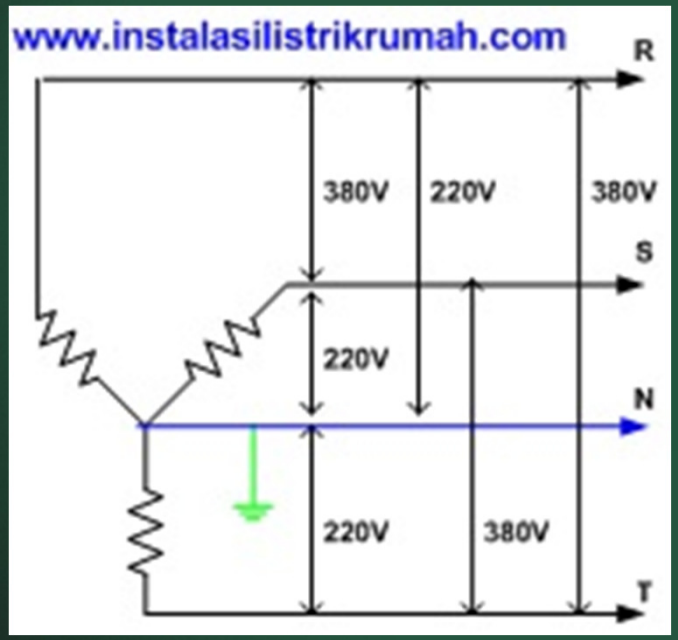




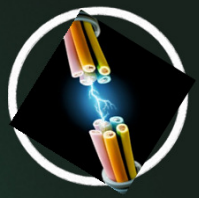
Macam Tegangan Listrik 3 Fasa



1. Tegangan antar fasa
2. Tegangan fasa ke netral

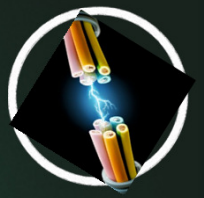


PR !!!



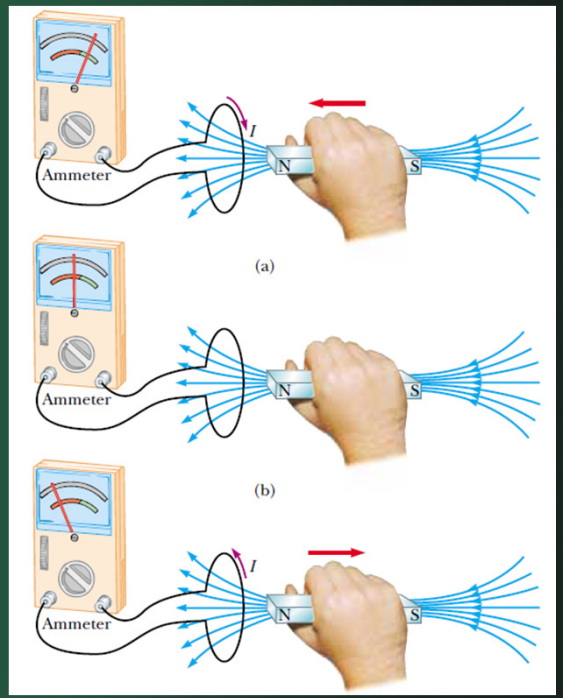
- Sebutkan keunggulan sistem listrik 3 fasa?
- Aplikasi Listrik 3 fasa?
- Perbedaan listrik 1 dan 3 fasa?
- Sebutkan Karakteristik sistem 3 fasa tipe delta dan tipe WYE!

Pembangkit Tenaga Listrik

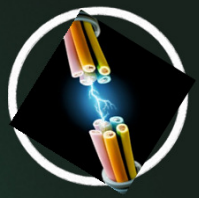


Prinsip Kerja

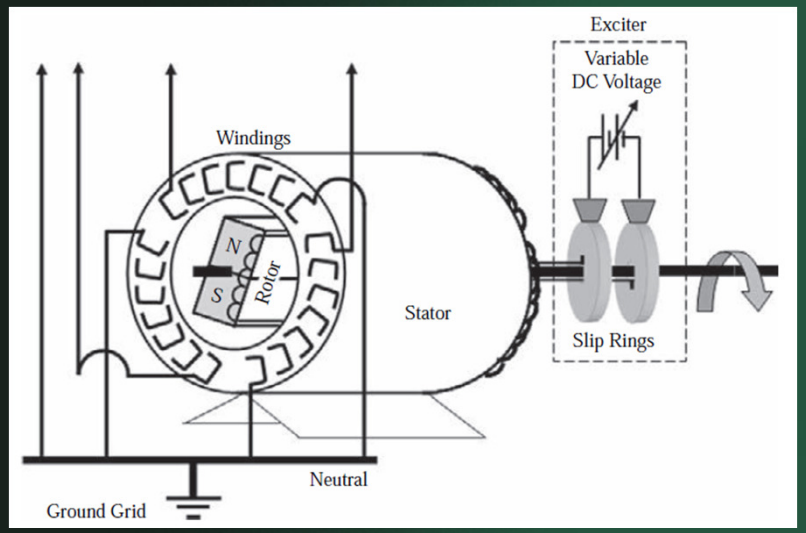
- AC voltage is generated in electric power systems by a fundamental physical law called "Faraday's law"
- Faraday's law states, "A voltage is produced on any conductor in a changing magnetic field"
- Power plant generators in service today have coils of wire mounted on stationary housings, called **"stators,"** where voltage is produced due to the changing (or moving) magnetic field provided by the spinning **rotor**.
- The rotor is spinning by a steam, wind, or hydro turbine.
- The rotor uses an electromagnet as opposed to a permanent magnet
- The amplitude of the generator's output voltage can be changed by changing the strength of the rotor's magnetic field.
- changing the rotor's speed changes the frequency of the sine wave



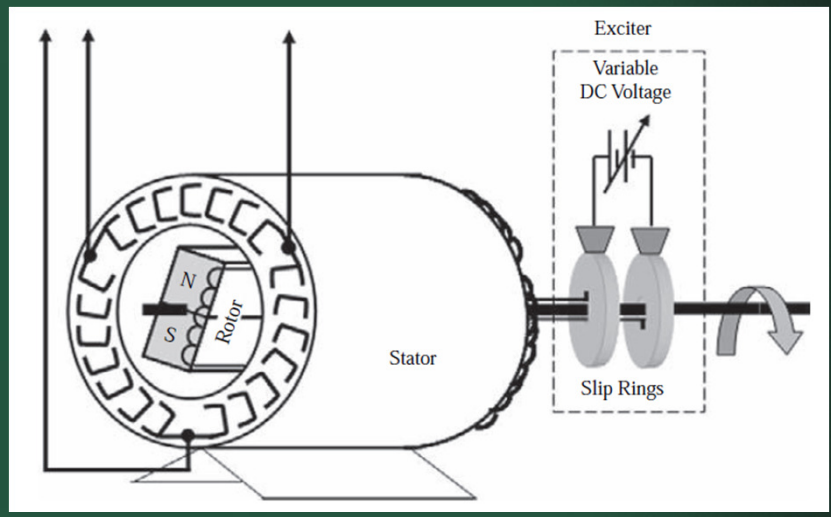
Pembangkit Tenaga Listrik



3 Phase AC voltage Generation

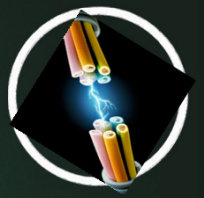


WYE-Connected Generator



Delta-Connected Generator

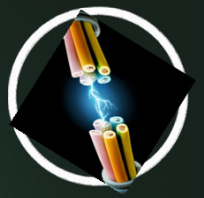
Pembangkit Tenaga Listrik



Sumber Pembangkit Listrik

- Air,
- Uap,
- Panas Bumi,
- Nuklir,
- Surya, dll

Pembangkit Tenaga Listrik

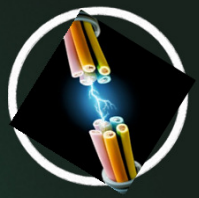


PLTA (Pembangkit Listrik Tenaga Air)

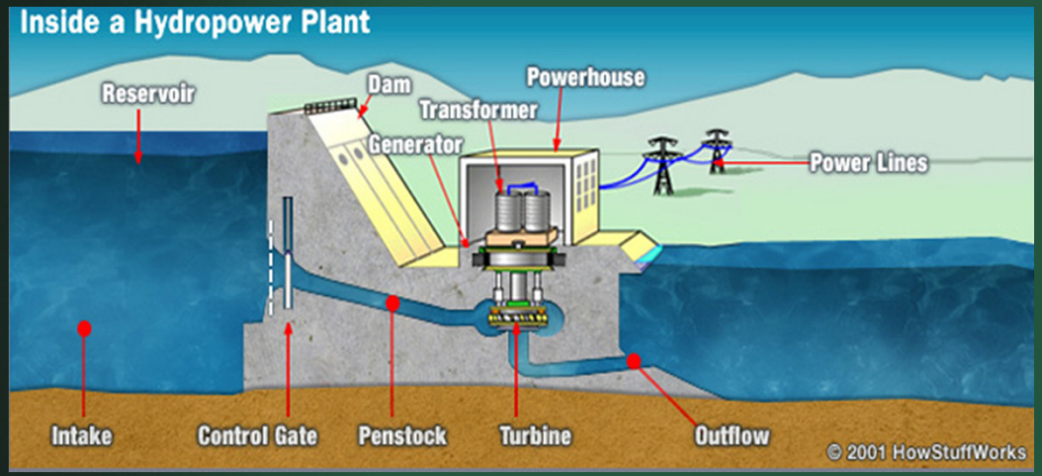
- Salah satu pembangkit yang murah dan populer di dunia adalah pembangkit bertenaga air. Di wilayah yang bergunung-gunung dengan banyak sumber air, di Indonesia berarti wilayah seperti Jawa, Sumatera, atau Sulawesi, pembangkit listrik sangat ideal.

- Pembangkit listrik ini biasanya disatukan dengan proyek waduk yang digunakan untuk pertanian dan penanggulangan banjir. Jangan bayangkan pembangkit listrik ini menggunakan kincir model kuno, yang bentuknya seperti roda dengan air melaju di atasnya. sebagian besar pembangkit listrik menggunakan turbin. Air disalurkan ke bawah. Di sana sudah siap turbin jumlahnya bisa puluhan di satu waduk yang menggerakkan generator.

Pembangkit Tenaga Listrik

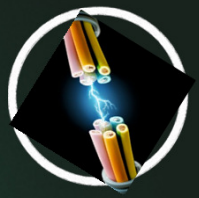


PLTA (Pembangkit Listrik Tenaga Air)

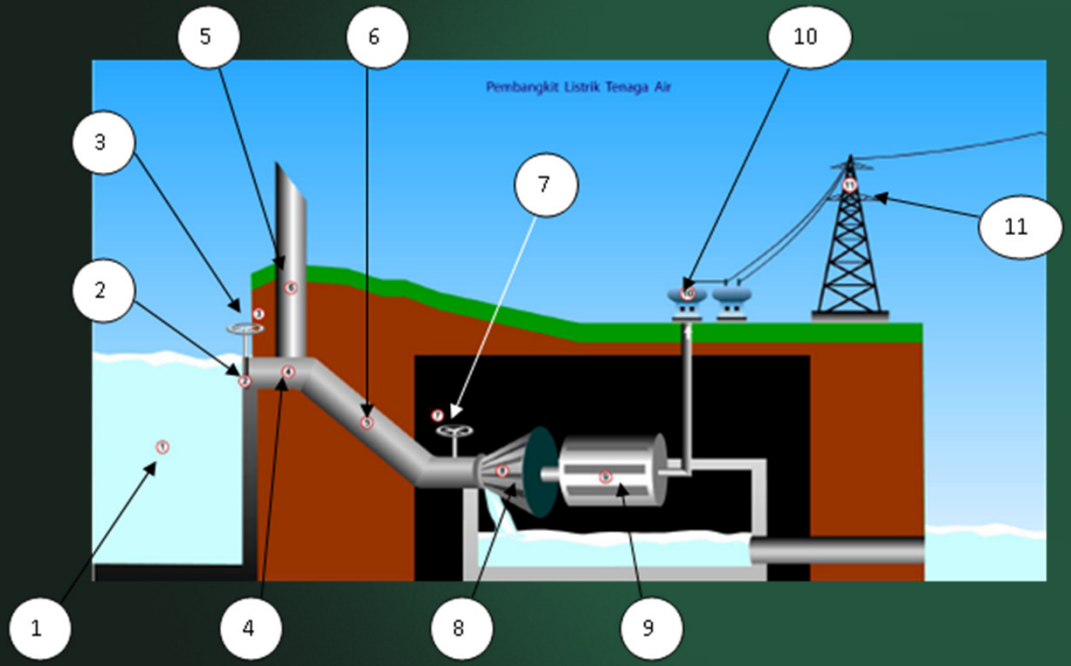


Pembangkit Listrik Tenaga Air (PLTA) merupakan pembangkit tenaga listrik yang mengubah energi potensial air (energi gravitas air) menjadi energi listrik. Mesin penggerak yang digunakan adalah turbin air untuk mengubah energi potensial air menjadi kerja mekanis poros yang akan memutar rotor generator untuk menghasilkan energi listrik.

Pembangkit Tenaga Listrik

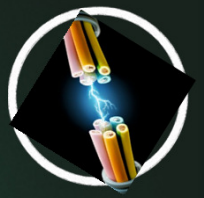


PLTA (Pembangkit Listrik Tenaga Air)



1. Sungai / Kolam: Tempat penampungan air
2. Intake : Sebagai pintu masuk air dari sungai
3. Katup pengaman: Katup pengatur intake
4. Headrance tunnel
5. Surge tank: Pengaman tekanan air yang tiba-tiba naik saat katup pengatur ditutup
6. Penstock
7. Main stop valve
8. Turbin : Berfungsi mengubah energi potensial air menjadi gerak.
9. Generator: penghasil tenaga listrik
10. Main transformer
11. Transmission line : penyalur ke konsumen

Pembangkit Tenaga Listrik

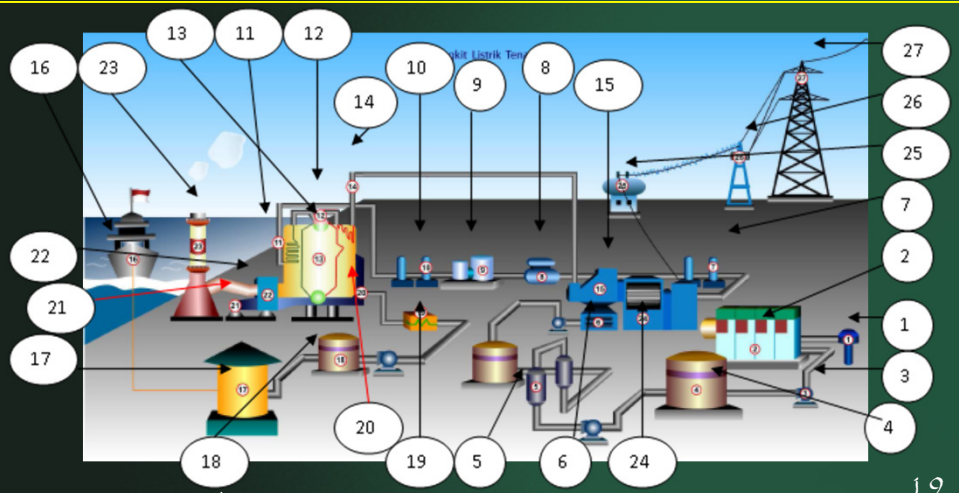


PLTU (Pembangkit Listrik Tenaga Uap)

- Bahan bakar berupa minyak, gas, batubara dibakar untuk memanaskan air yang ada didalam boiler atau ketel sampai menghasilkan uap.
- Uap yang terbentuk ditampung sampai mencapai suhu dan tekanan yang didinginkan kemudian baru dialirkan untuk menggerakkan turbin uap.
- Turbin uap ini akan menggerakkan sebuah generator yang akan menghasilkan tenaga listrik. Uap yang meninggalkan turbin didinginkan dalam kondensor, kemudian air yang meninggalkan kondensor dipompa kembali ke boiler.

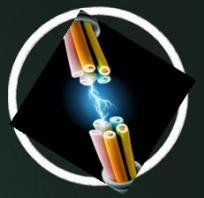
Pembangkit Tenaga Listrik

PLTU (Pembangkit Listrik Tenaga Uap)



1. Circulating water pump : untuk mencampur air
2. Desalination evaporator
3. Destilate pump
4. Make up water tank
5. Denim water tank
6. Condensor : mengembunkan uap menjadi cair
7. Low heater pressure
8. Deserator : untuk mendapatkan tambahan air akibat kebocoran dan juga mengolah air agar memenuhi mutu air ketel ($NaCl$, ClO_2 & PH)
9. Boiler feed pump
10. High pressure heater
11. economizer
12. Steam drum
13. Boiler
14. Super heater
15. Steam turbin
16. Burge / kapak : alat pengangkut bahan bakar minyak
17. Pumping house
18. Fuel oil tank
19. Fuel oil heater
20. Burner
21. Forced draught fan : menghasilkan udara untuk pembakaran
22. Air heater : pemanas udara
23. Smoke stack : membuang sisa gas
24. Generator
25. Main transformer
26. Switch yard
27. Transmission line

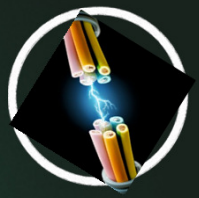
Pembangkit Tenaga Listrik



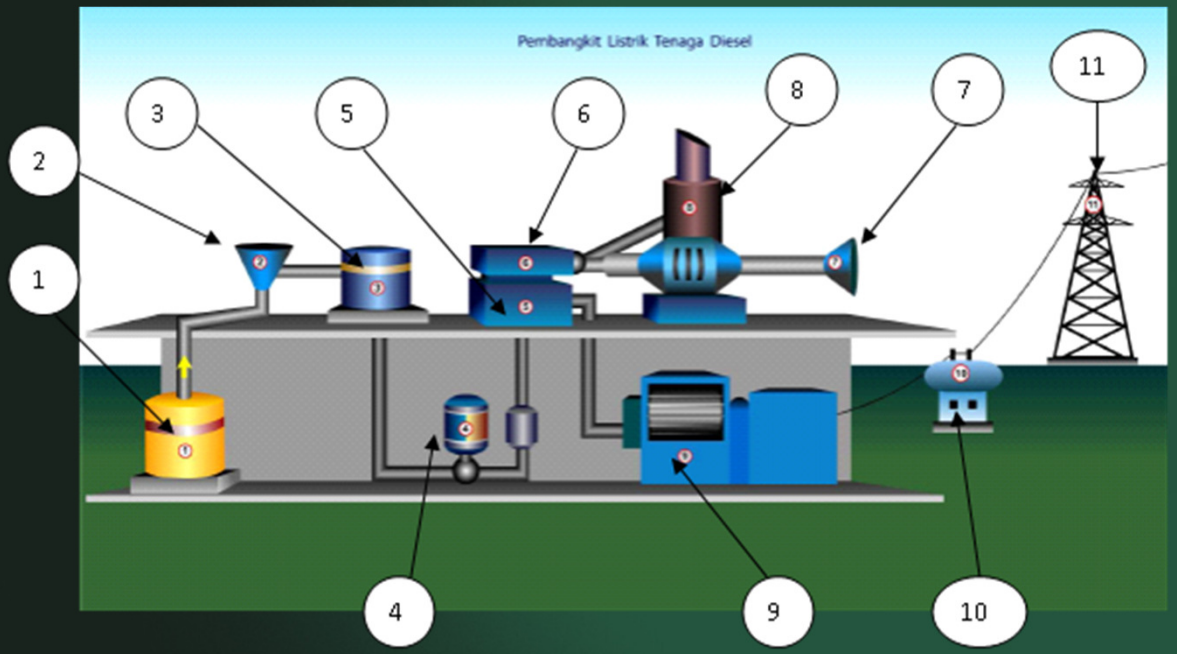
PLTD (Pembangkit Listrik Tenaga Diesel)

- Pembangkit Listrik Tenaga Diesel cocok untuk lokasi dimana pengeluaran bahan bakar rendah, persediaan air terbatas, minyak sangat murah dibandingkan dengan batubara dan semua beban besarnya adalah seperti yang dapat ditangani oleh mesin pembangkit dalam kapasitas kecil serta dapat berfungsi dalam waktu yang singkat.

Pembangkit Tenaga Listrik

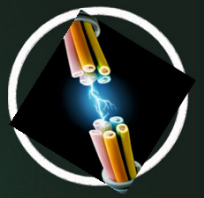


PLTD (Pembangkit Listrik Tenaga Diesel)



1. Fuel tank
2. Fuel oil separator
3. Daily tank
4. Fuel oil booster
5. Diesel motor
6. Turbo charge : menaikkan efficiency udara yang dicampur dengan bahan bakar dan menaikkan tekanan serta temperaturnya
7. Air intake filter
8. Exhaust gas silencer
9. Generator
10. Main transformer
11. transmission line

Pembangkit Tenaga Listrik



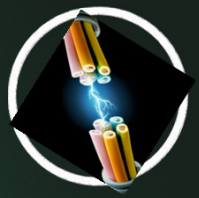
PLTP (Pembangkit Listrik Tenaga Panas bumi)

- Kekayaan alam Indonesia memang melimpah ruah, dari mulai sumber daya alam sampai sumber daya mineral semua tersedia.

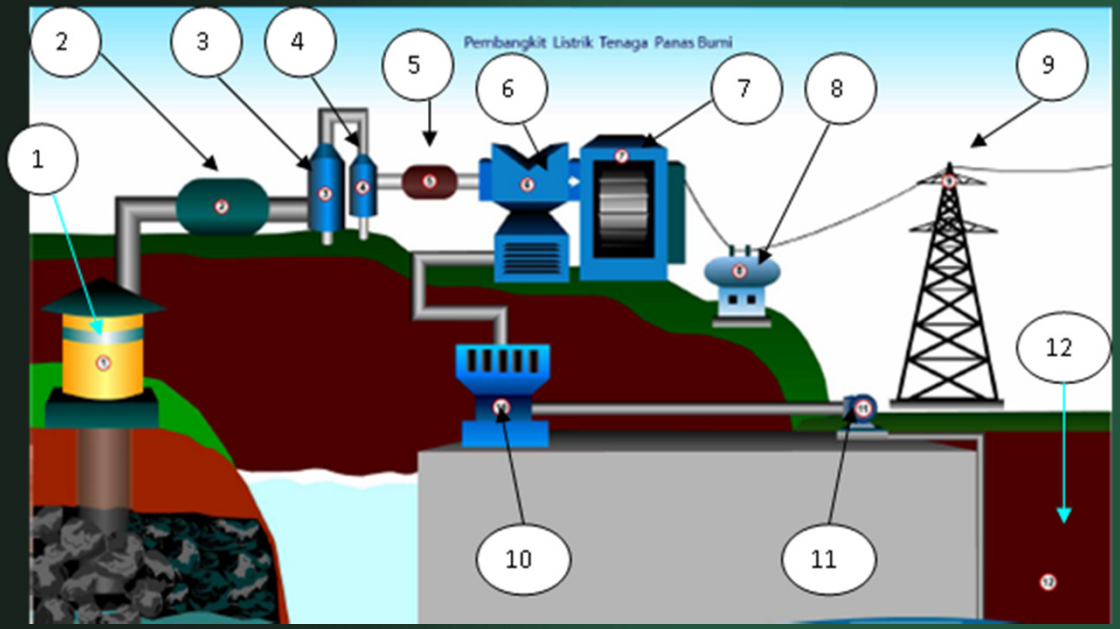
- Panas bumi (*geothermal*) adalah salah satu kekayaan sumber daya mineral yang belum banyak dimanfaatkan.

- Selain sebagai pemanas, panas bumi ternyata dapat juga mengha-silkan tenaga listrik. Air panas alam bila bercampur dengan udara karena terjadi fraktur atau retakan maka selain air panas akan keluar juga uap panas (*steam*). Air panas dan *steam* inilah yang kemudian dimanfaatkan sebagai sumber pembangkit tenaga listrik. Agar panas bumi (geothermal) tersebut bisa dikonversi menjadi ener-gi listrik tentu diperlukan pembangkit (*power plants*).

Pembangkit Tenaga Listrik

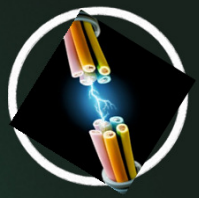


PLTP (Pembangkit Listrik Tenaga Panas bumi)



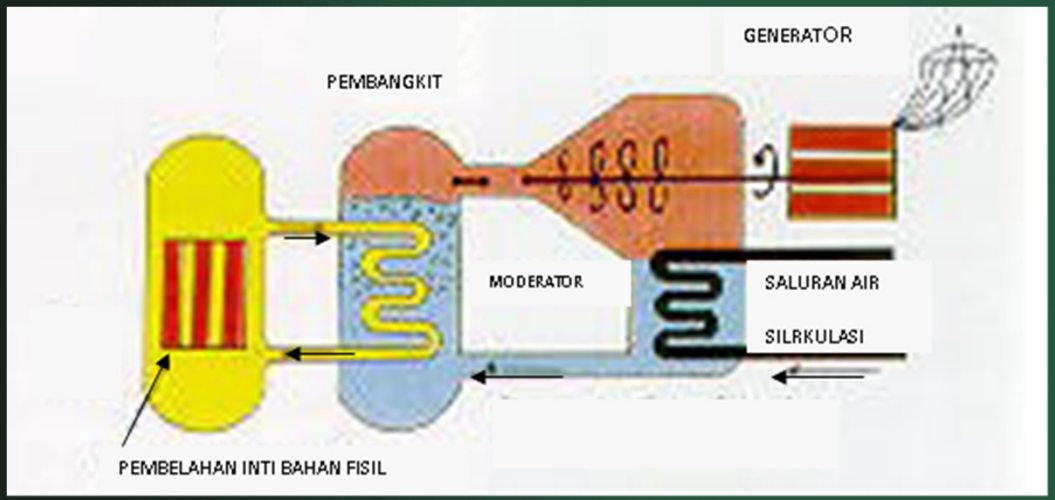
1. Sumur uap mengambil uap panas yang didapat dari kantung uap dari perut bumi
2. Stream receiving header
3. Separator
4. Demister
5. Governing valve
6. Turbin : merubah energi uap menjadi energi gerakl memutar generator
7. Generator
8. Main transformer
9. Transmission line
10. Condensor : mengubah uap menjadi cair
11. Sumur reinjection
12. Tanah

Pembangkit Tenaga Listrik



PLTN (Pembangkit Listrik Tenaga Nuklir)

- Salah satu pemanfaatan teknik nuklir, yaitu dalam bidang energi saat ini sudah berkembang dan dimanfaatkan secara besar-besaran dalam bentuk Pembangkit Listrik Tenaga Nuklir (PLTN), dimana tenaga nuklir digunakan untuk membangkitkan tenaga listrik yang relatif murah, aman, dan tidak mencemari lingkungan.




Thank you