Lec #13: Electricity & Magnetism

LAST: Basics of Electricity (Chap 10)

- Electric & Magnetic Forces and Fields
- Circuits and Ohm's Law; Residential Circuits

TODAY: Electromagnetism (Chap 11)

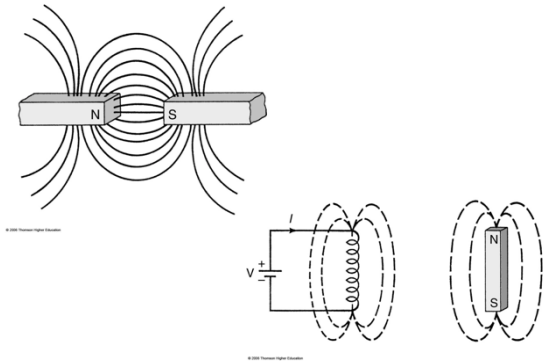
- AC v. DC
- Motors, Generators, Transformers
- Introduction to the Electrical Power "Grid"

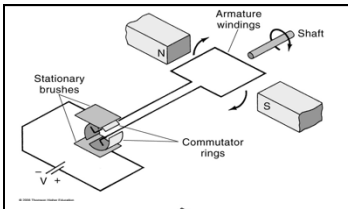
NEXT: Generation, Transmission, & Distribution (Chap 11)

- History of the Electrical Power "Grid"
- Future of the Electrical Power "Grid"

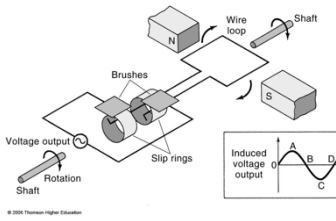
Examples of Electromagnetic Induction (more detail/hands on today in Lab)

- Electrical Current --> Magnetic field
  - compass needle deflection
  - electromagnet
  - planetary magnetic fields (where is the current?)
- Changing Magnetic field --> Current
  - generator
  - motor
- Lenz's Law (no free lunch, except EMR)
  - "Will of Landru" demo
  - jumping rings





DC Motor/Generator



AC Motor/Generator

AC v. DC

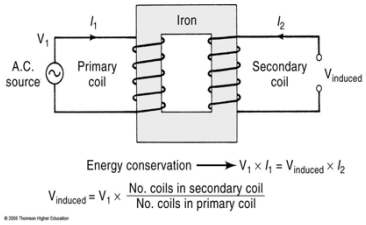
	AC	DC
Source	Generator	Generator Battery Fuel Cell Photocell Natural
Use	Resistive Heating Motor	Resistive Heating Motor Electronics

Is one "better" than the other"? Why do we have/use both types?

Transforming Voltage (AC v. DC)

- 12,000 W @ 120 V, 1Ω Resistance
  - Ohm's Law: V=IR, P=VI=I^2R
  - 12000 = 120 x I --> current 100 Amp
  - 12000 = I^2 x (1) --> loss in line 10,000 W (83%!)
- 12000 W @ 12000 V, 1Ω Resistance
  - 12000 = 12000 x I --> current 1 Amp
  - 12000 = I^2 x (1) --> loss in line 1 W !!
- Changing voltage is easy with AC; not so easy (but not impossible) with DC
- Change voltage with a "Transformer"

Transformers

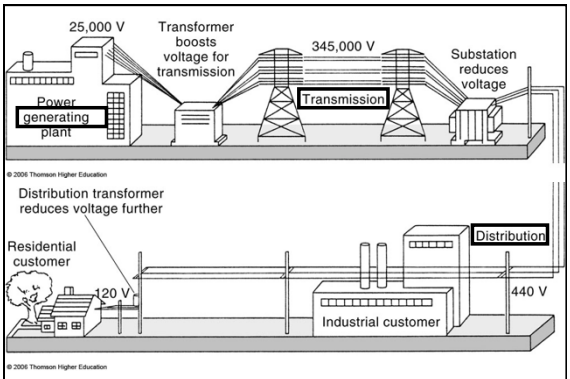


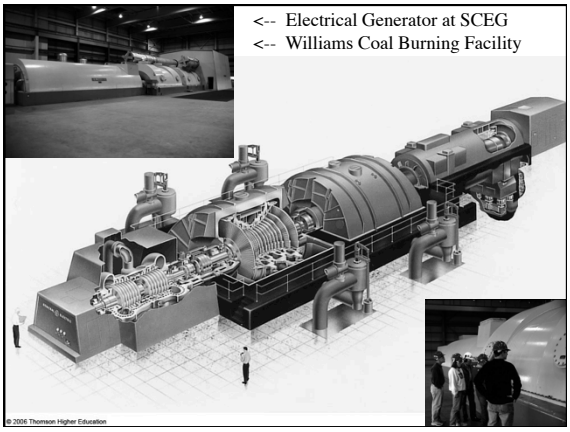
if N_s is large, V_s is large

can "step up" or "step down" voltage by increasing or decreasing the number of coils

some energy is lost, but much less than would be lost through transmission at low voltage

multiple transformers are used





<-- Electrical Generator at SCEG
<-- Williams Coal Burning Facility

Electrical Energy Distribution "Grid"

- transportation sector uses *fuels*
  - manufactured; distributed to point of use
  - mostly liquid, mostly petroleum products
  - petroleum products have many other uses
  - are there viable fuel alternatives?
- commercial, industrial, residential sectors use...
  - on-site production
  - natural gas pipeline "grid"
  - electrical power "grid"
- sources are all <u>local</u> (except, maybe, solar)