

Electrical Power Generation

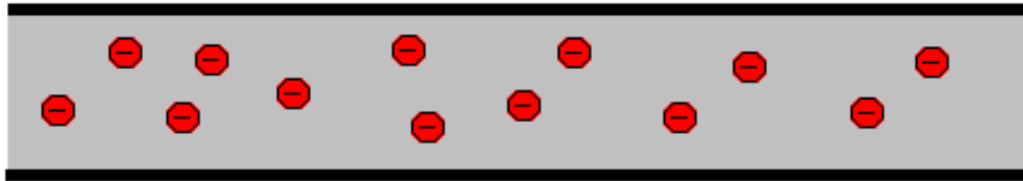
Section A

- ▶ **Introduction**-Energy sources, their availability, recent trends in Power Generation, Interconnected Generation of Power plant.

Electricity

What is Electricity?

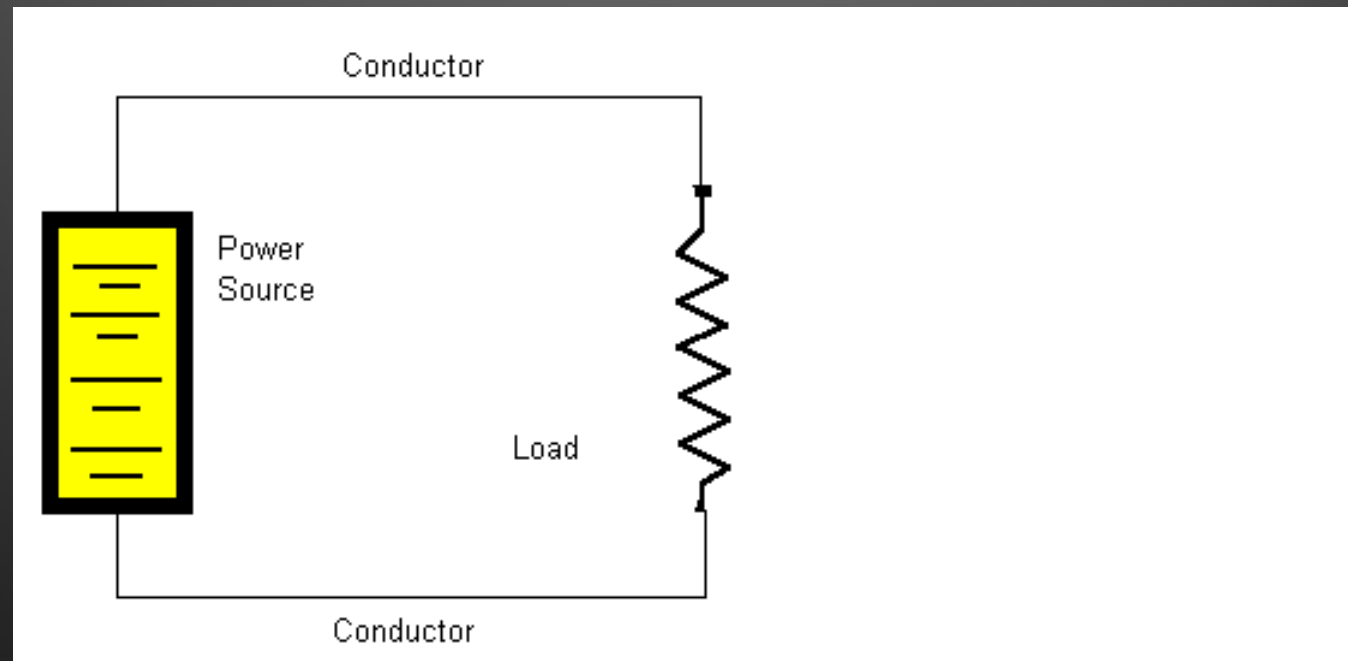
- Movement of charges
- Electron flow
- Secondary energy source
 - Conversion from other sources of energy



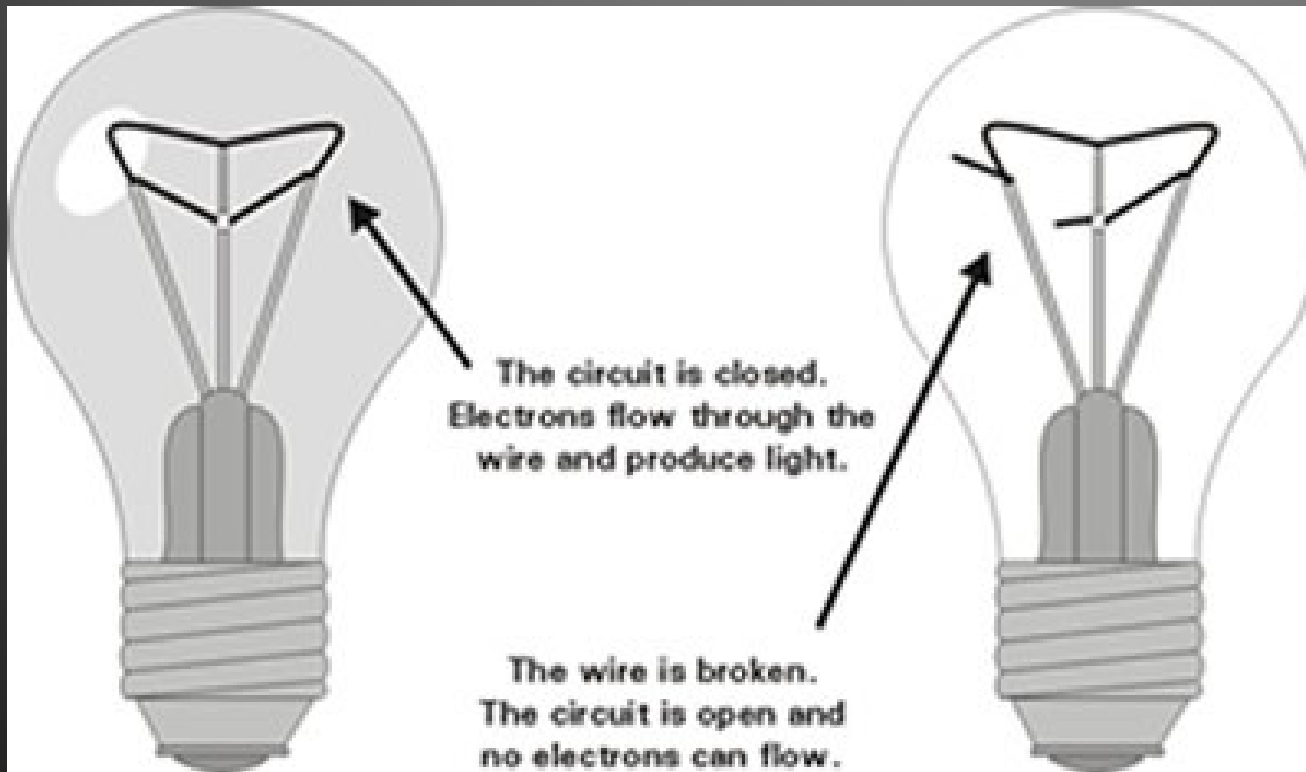
Circuits

The Circuit

- The path a current takes
- Must be a complete loop
- An incomplete circuit will not conduct electricity



Circuits cont.

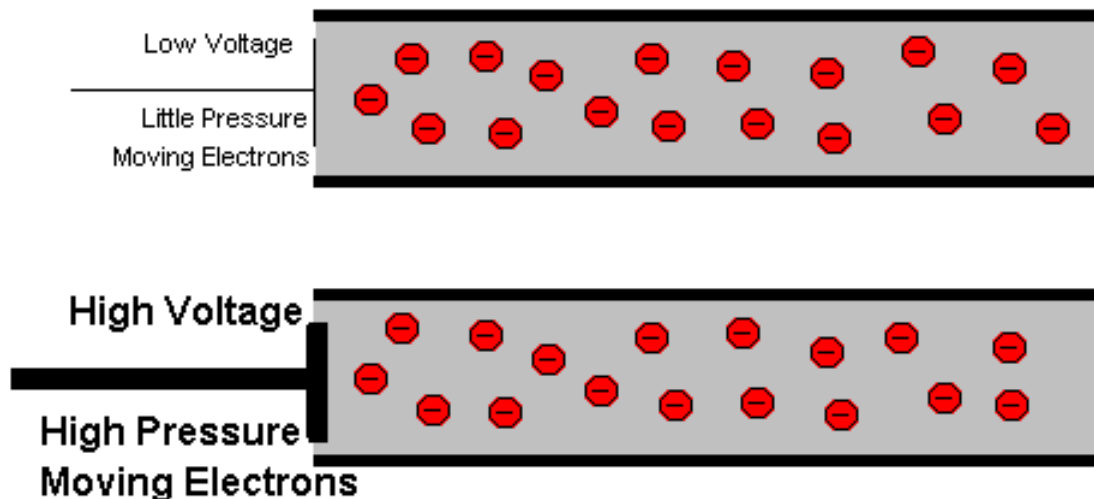


Energy Units – Voltage

- ▶ **Voltage** is electromotive force. It is the force or push on electrons in the circuit
 - It is referred to as potential difference
 - Has the potential to do work, but does nothing by itself
 - It's measured in volts (V or E)

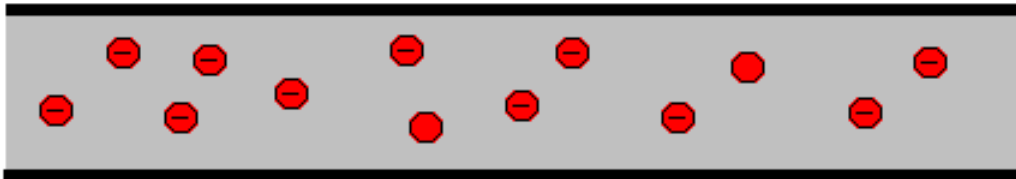


Note: The # of electrons is the same

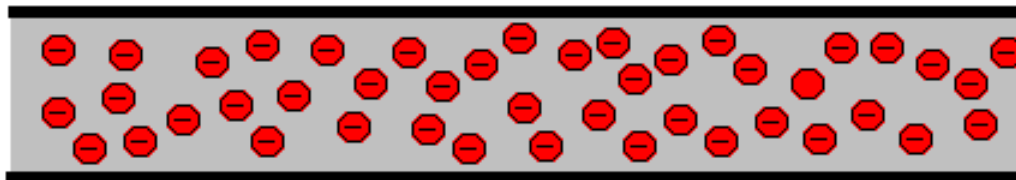


Energy Units – Current

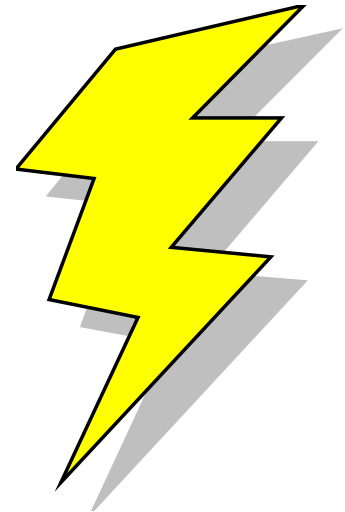
- ▶ **Current** is the amount of electricity that flows in the circuit
 - Current is measured in amperes or amps (I)
 - The more current, the higher the amps
 - Pushed and pulled by voltage
 - Produces heat



Few Electrons Flowing = Low Amps



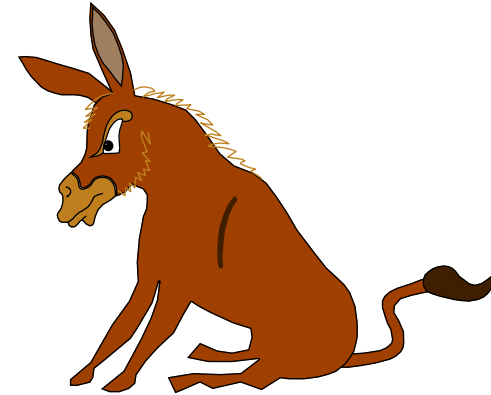
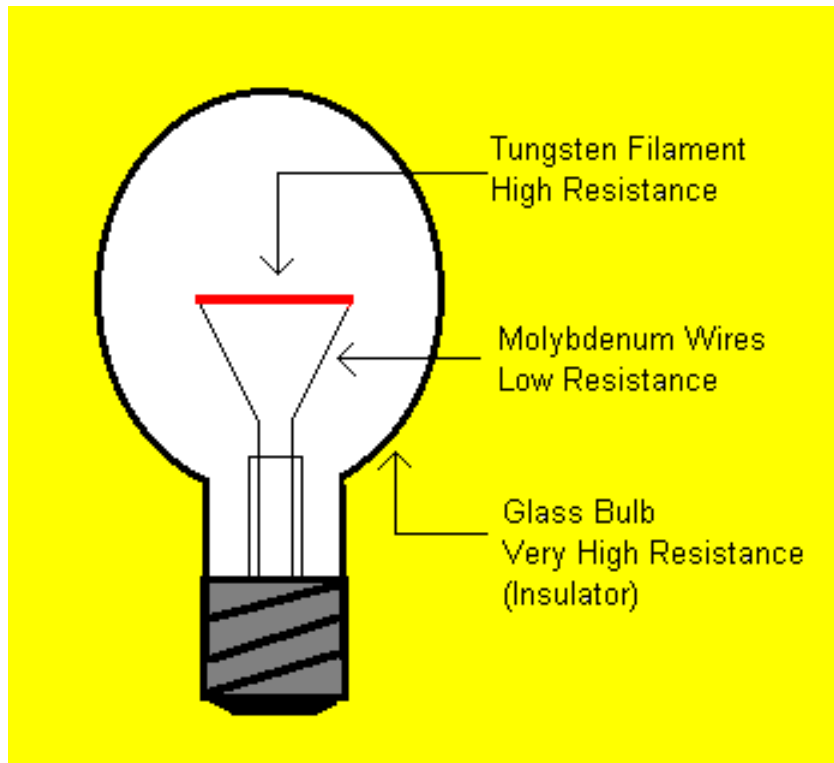
Many Electrons Flowing = High Amps



Lightning is current flowing through air

Energy Units – Resistance

- ▶ **Resistance** is the opposition to current flow in the circuit
 - Resistance is measured in **ohm** (Ω)

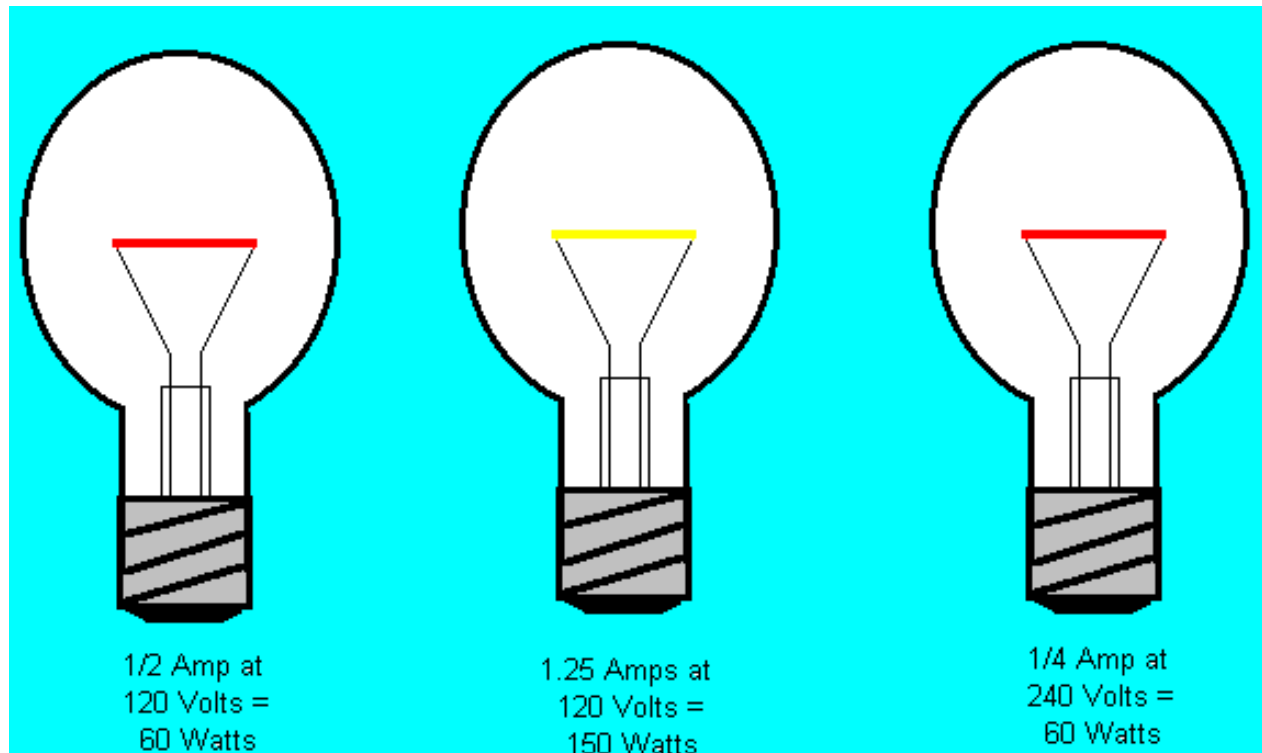


Trivia: What is the units for electrical conductivity?

mho

Energy Units – Power

- ▶ **Power** is the amount of work that is done in the circuit
 - It is measured in **Watts** (P)
 - Depends on the amps and volts
 - $\text{Watts} = \text{Volts} \times \text{Amps}$



Ohm's Law

- ▶ Ohm's law is the relationship between voltage, current, and resistance

$$V = I \times R$$

- ▶ Amount of current that can be pushed through a conductor depends on resistance and voltage

$$I = V / R$$

- ▶ Greater distance means increased resistance

$$R = V / I$$

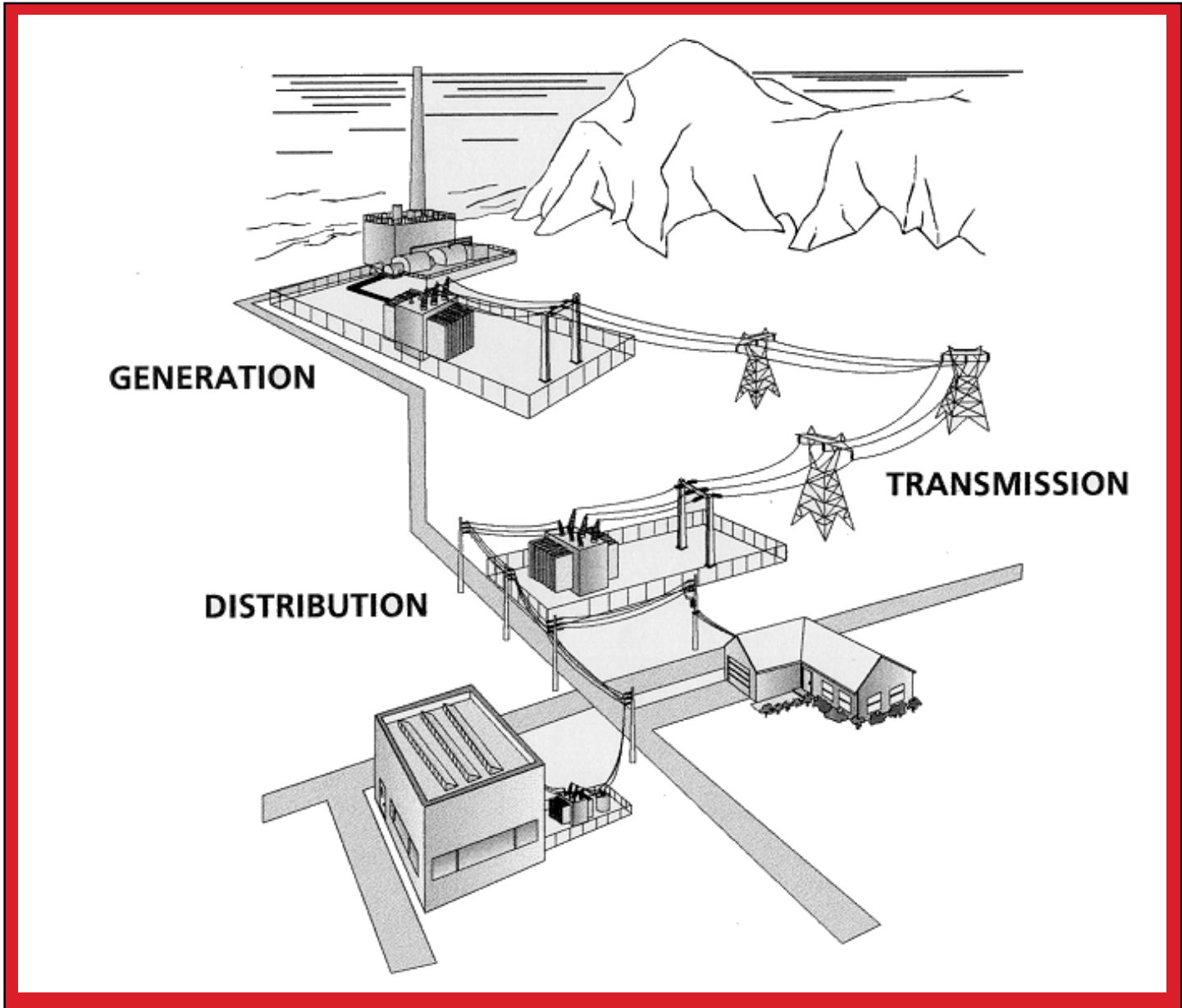
- ▶ Therefore

- Voltage = current x resistance
- Current = Voltage / Resistance
- Resistance = Voltage / Current

Water System Analogy

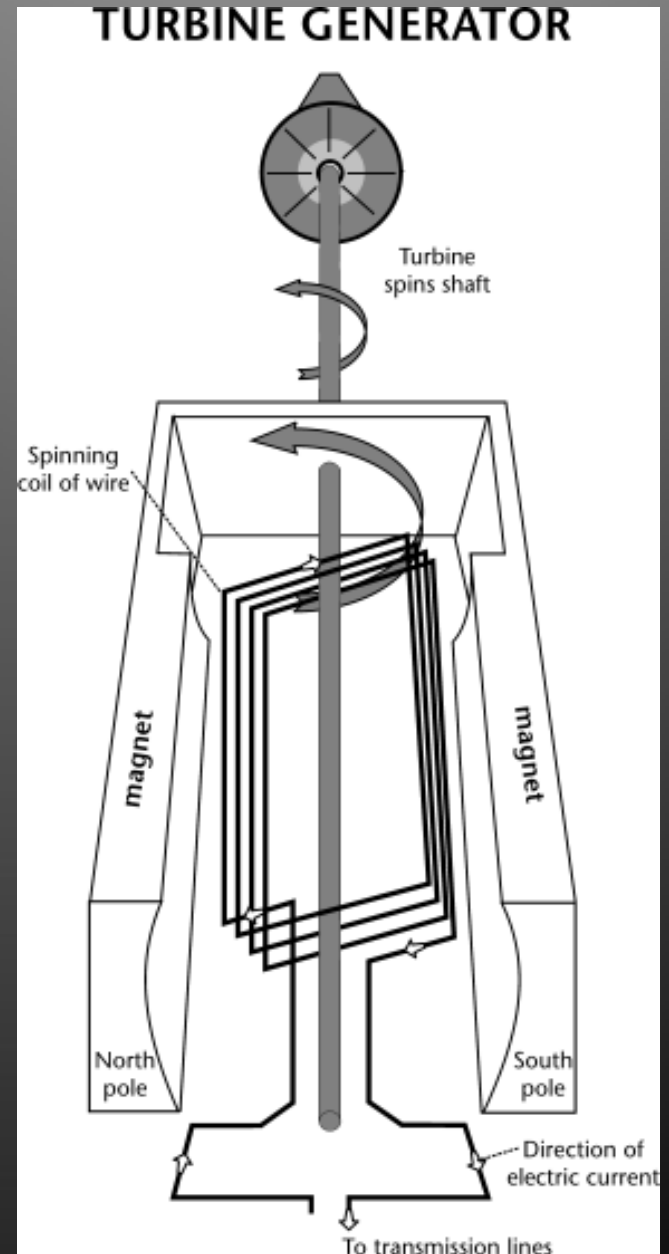
Water System	Electrical System	Function
Pump	Generator	The prime mover. Supplies energy to the system. Converts motion to electrical energy
Pipe	Conductor	Object on which the electrical current flows. The larger the pipe or conductor the more water or current will flow.
Water Pressure	Voltage	The pressure or the push that moves the water or electrical impulse in the system.
Water Flow	Current	The amount of water or electricity that is flowing.
Restriction of the water pipe	Resistance	The characteristic that restricts water and current flow.
Amount of water delivered	Power	This is the rate at which electrical energy is changed into useful work. The quantity of water delivered.

Electric Power System



Generation

- Electricity is produced in generators
- Generators require other sources of energy
- Conversion of mechanical energy into electrical energy
- Electromagnetic Induction
 - Turbine turns coils of wire in a magnetic field to produce a current



Generation – Fuel Types

Thermal Power



Coal



Oil



Natural Gas



Nuclear

Generation – Renewable



Hydro Electric



Wind



Geothermal



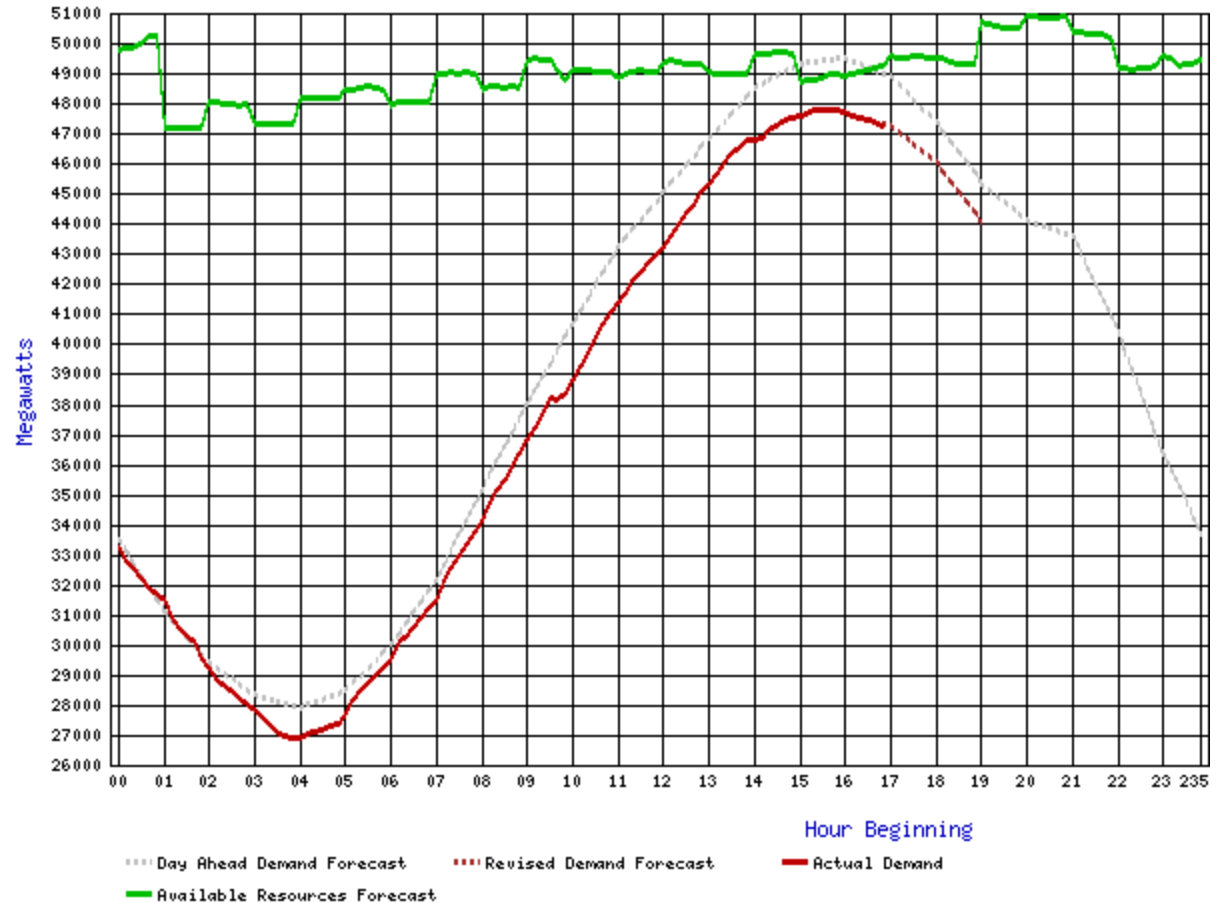
Solar

SCE Power Mix

POWER CONTENT LABEL		
ENERGY RESOURCES	2007 SCE POWER MIX* (projected)	2006 CA POWER MIX** (for comparison)
Eligible Renewables	16%	5%
– Biomass & waste	2%	<1%
– Geothermal	9%	4%
– Small hydroelectric	1%	1%
– Solar	1%	<1%
– Wind	3%	<1%
Coal	7%	29%
Large Hydroelectric	6%	31%
Natural Gas	51%	35%
Nuclear	20%	0%
Other	<1%	0%
TOTAL	100%	100%
<p>* 100% of SCE POWER MIX is specifically purchased from individual suppliers.</p> <p>** Percentages are estimated annually by the California Energy Commission based on electricity sold to California consumers during the previous year.</p>		
<p>For specific information about this electricity product, contact Southern California Edison. For general information about the Power Content Label, contact the California Energy Commission at 1-800-555-7794 or www.energy.ca.gov/consumer.</p>		

Peak Demand

- ▶ Energy Cannot be stored
- ▶ Must be available when needed
- ▶ Programs to reduce peak demand
- ▶ Peaker plants built



Electric Generation Basics

- ▶ Electricity is produced when a conductive wire passes rapidly through a magnetic field
- ▶ Bulk Electricity cannot be stored – it must be produced to match customer needs
- ▶ Generation that matches load demand is the most valuable to the system (midday peaks and summertime)
- ▶ Generating electricity closer to the users load reduces line losses.

SCE's Power Delivery System

Distribution

Construct & Maintain

- 43,776 Switches
- 670,496 Transformers
- 1,448,794 Poles
- 94,854 Circuit Miles
- 317,820 Underground Structures
- 1,300,000 Trees
- 11,873 Cap Banks
- 760,000 Street Lights

Plan Distribution Facilities

- Reliability
- Load Growth
- Automation

Transmission/Substation

Construct & Maintain

- 16,945 Circuit Breakers
- 4,459 Transformers
- 13,585 Circuit Miles
- 42,000 Relays
- 15 UPS Sites
- 4,000 Miles Communication Circuits

Operate

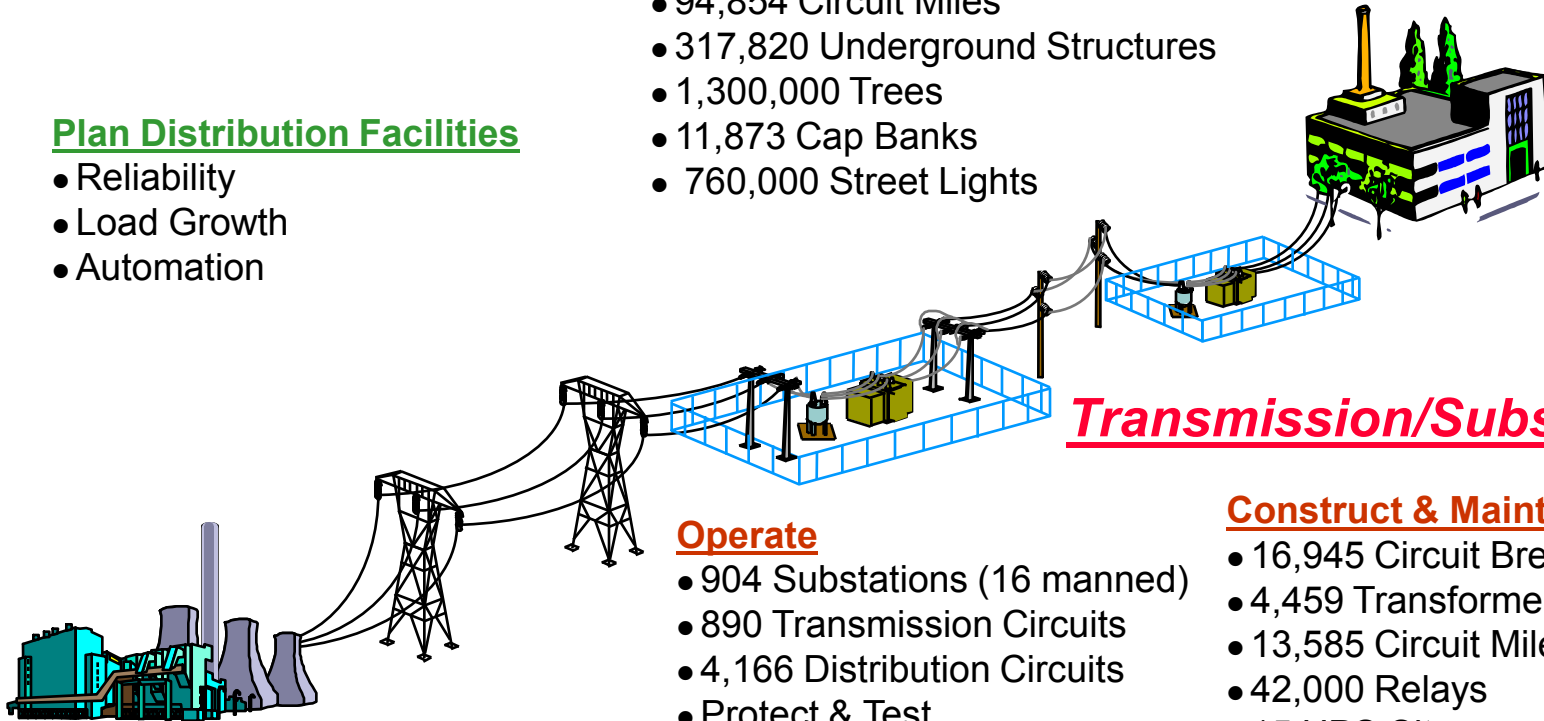
- 904 Substations (16 manned)
- 890 Transmission Circuits
- 4,166 Distribution Circuits
- Protect & Test
- Automate

Administrative Contracts

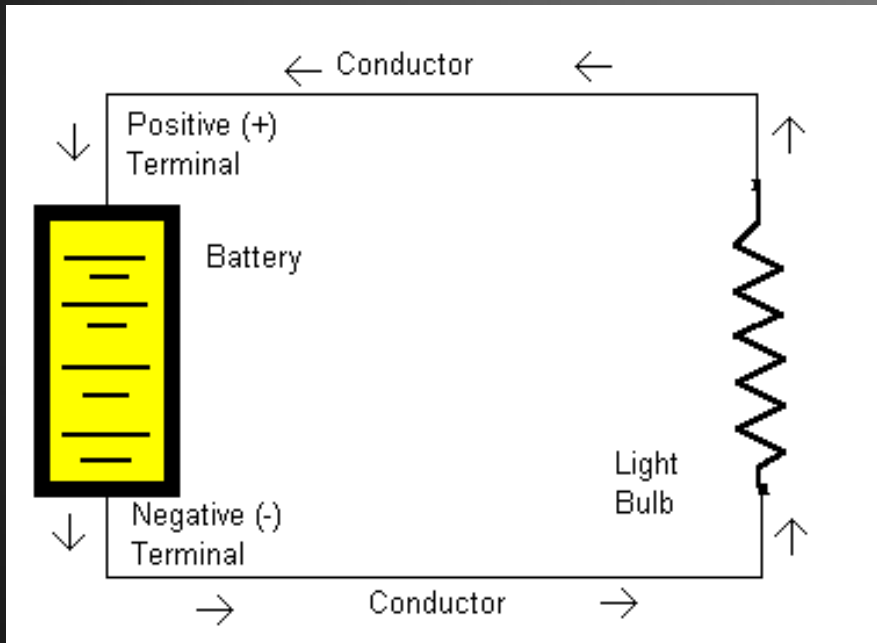
- Over 300 Grid Contracts

Plan Grid Facilities

- Reliability
- Load Growth
- Interconnections

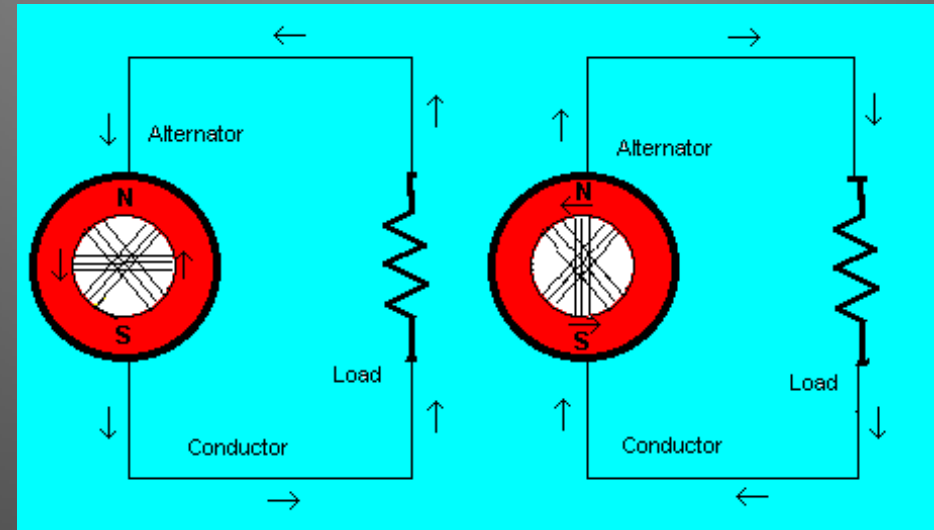


Transmission - AC/DC



Direct Current

Electrons move in one direction



Alternating Current

- Wire rotate past magnet causing a shift in direction
- Happens many times each second
- Cycles per second = Hertz

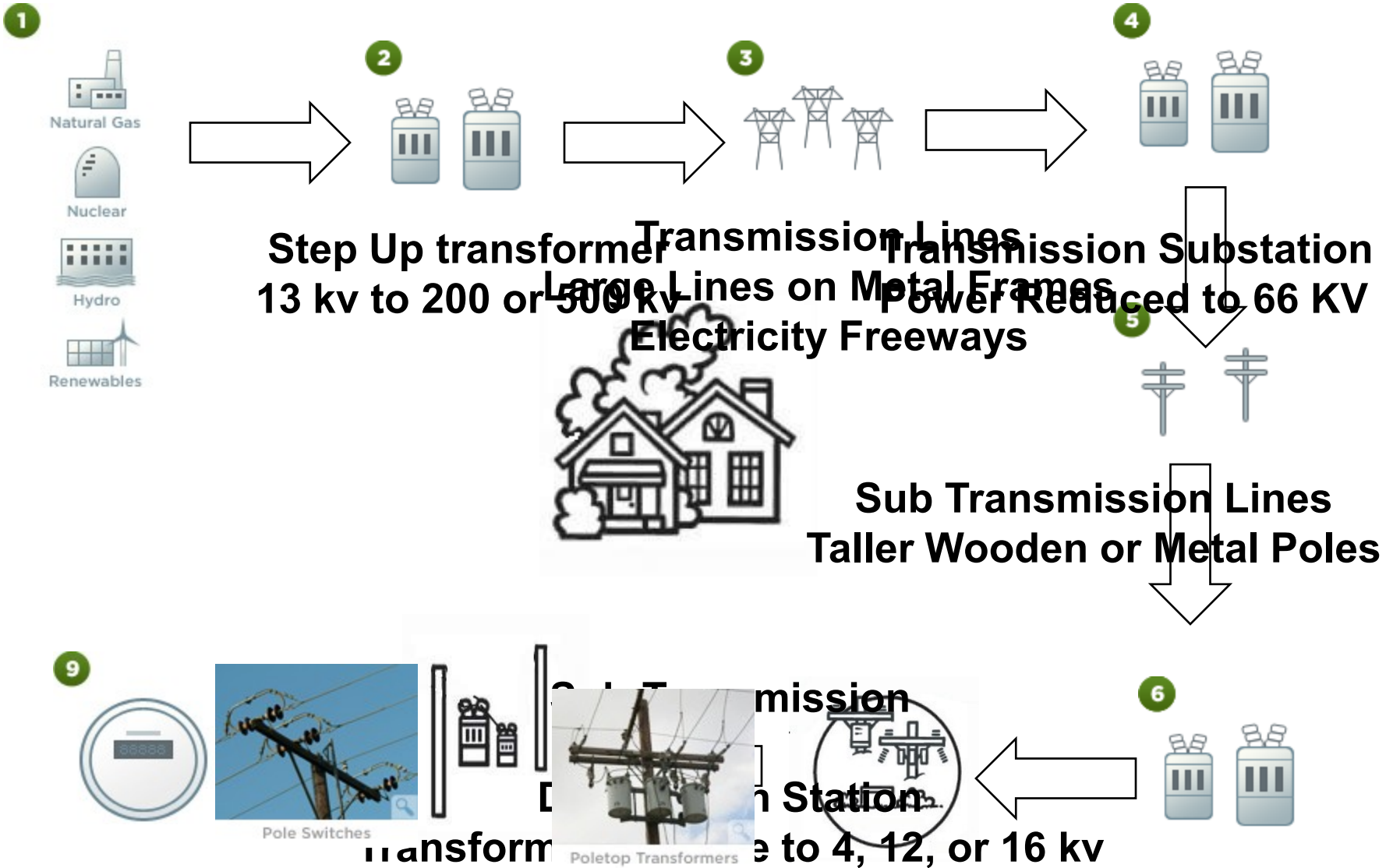
Western States Transmission Map



SCE's Electric System Voltage Classifications

<i>Classification Voltages</i>	<i>Voltage Range</i>	<i>Typical</i>
Transmission	161 kV and above	220 kV and 500 kV
Subtransmission	55 kV to 138 kV	66 kV and 115 kV
Distribution	33 kV and below	12 kV and 16 kV

Transmission



Transmission Lines

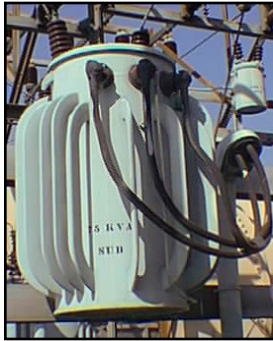


- **Transmission lines:**
 - 500 kv to 161 kV
- **Subtransmission lines:**
 - 55 kV to 138 kV



- **Distribution lines:**
 - 33 kV down

Distribution Devices



■ Distribution transformers

- A device that is used to change one value of voltage and current to another value of voltage and current (33kV to 220 volts)

■ Field capacitor banks

- Capacitive devices located on distribution circuits that raise voltage

Environmental Protection

“The Company shall pursue the protection of endangered, threatened, and rare biological species and their critical habitat and sensitive and unique ecosystems during all phases of facility construction and operation and during management of Company-owned land.”



▶ Biological Resources

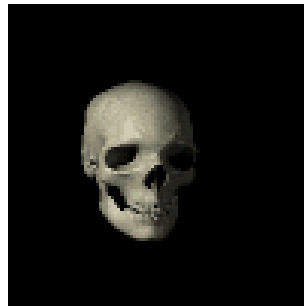
- Endangered Species
 - Approximately 275 endangered species occur within SCE's service territory



- Raptors
- Wetlands

▶ Cultural Resources

- Culture
- History & Pre-history



Marine Mitigation – Wheeler North Artificial Reef



Marine Mitigation – WNR

Phase 1

Construction and Study
Complete

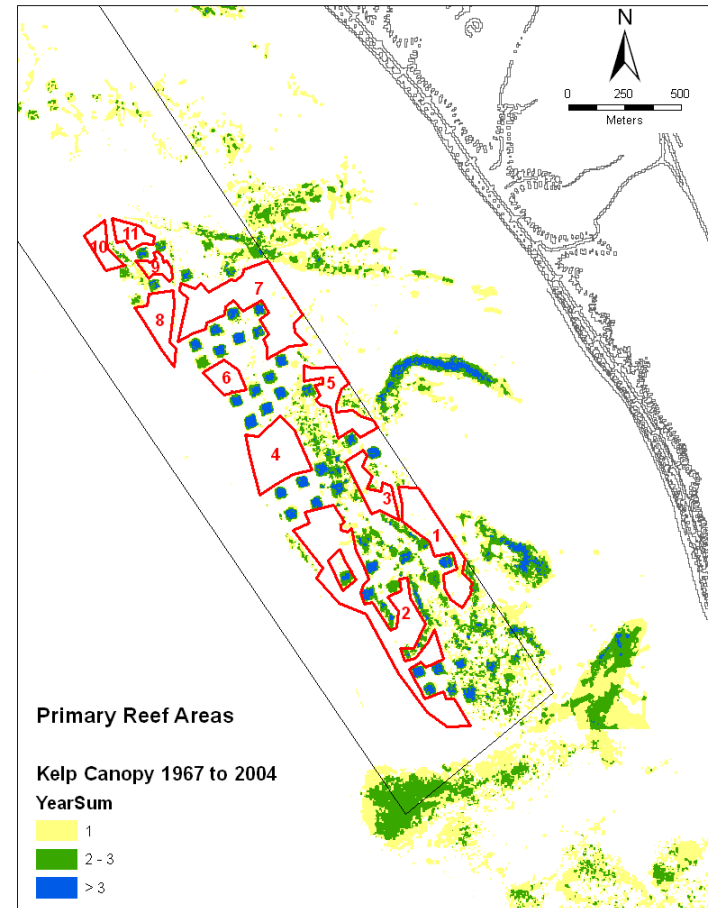
Phase 2 - Preliminary Design

Preliminary Plan: Present
CCC review/approval: July
– Dec. 2005

Phase 2 - Construction

Complete final design:
June 2006
EIR/Permitting: May –
Dec. 2007
Build-out: June – Oct 2008

**Post-Construction
Monitoring/Management**
For op.-life of SONGS



Marine Mitigation – San Dieguito Wetlands



San Dieguito Wetlands – Restoring Tidal Influx

- **Construct berms along river bank**

- Prevent sediment deposition in off-channel tidal basins

- **Facilitate sediment transport to beach**

- Maintain “open” inlet in perpetuity
- 35 acres wetland habitat credit granted by CCC



San Dieguito Wetlands – Habitat Creation

Excavate tidal basins off-channel of main river

- Create wetland habitat acreage (150 acres)



- Increase tidal prism to keep inlet open
- CA Least Tern nesting
- Fish spawning and refuge
- Avian habitat and foraging

