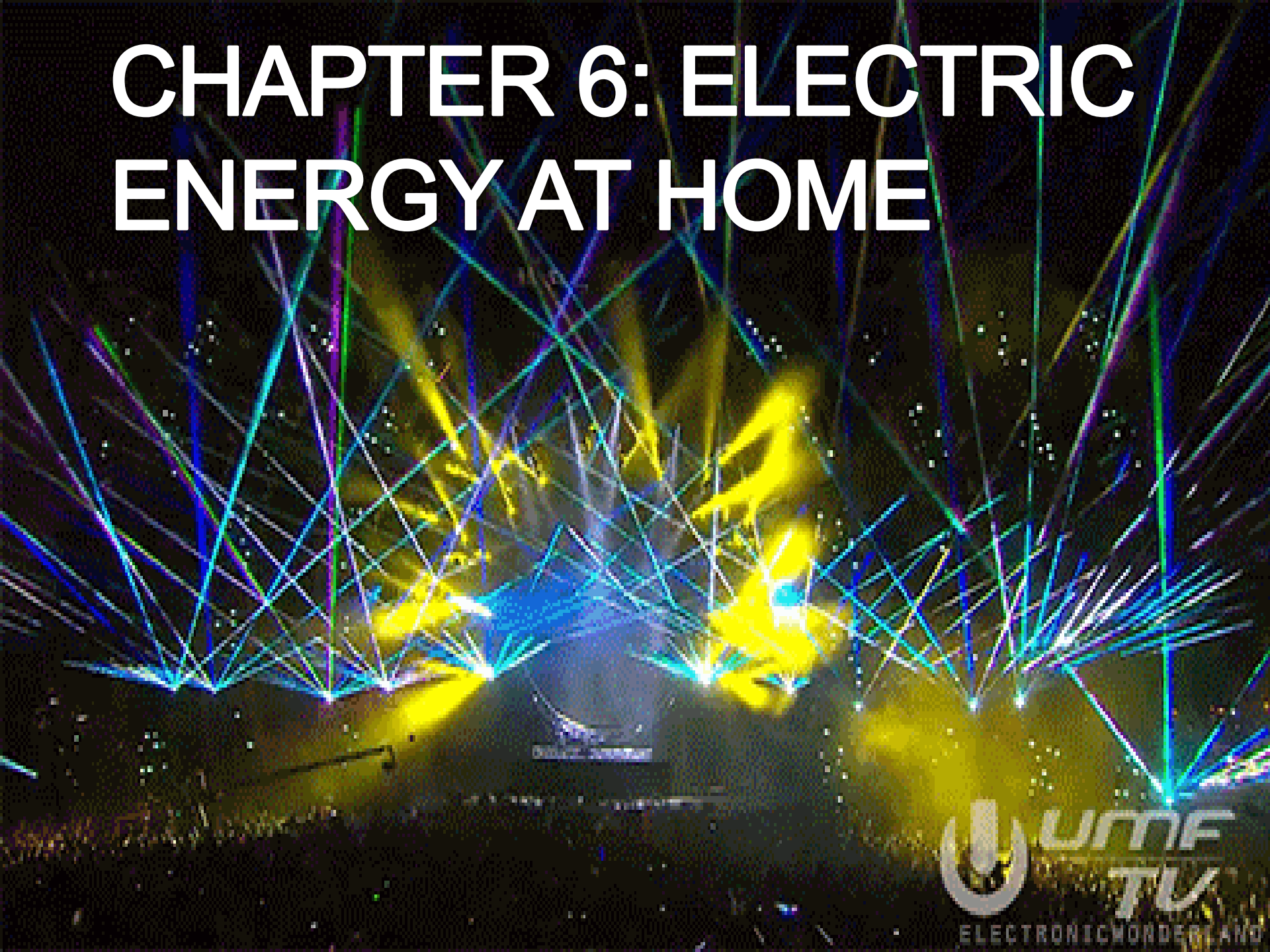
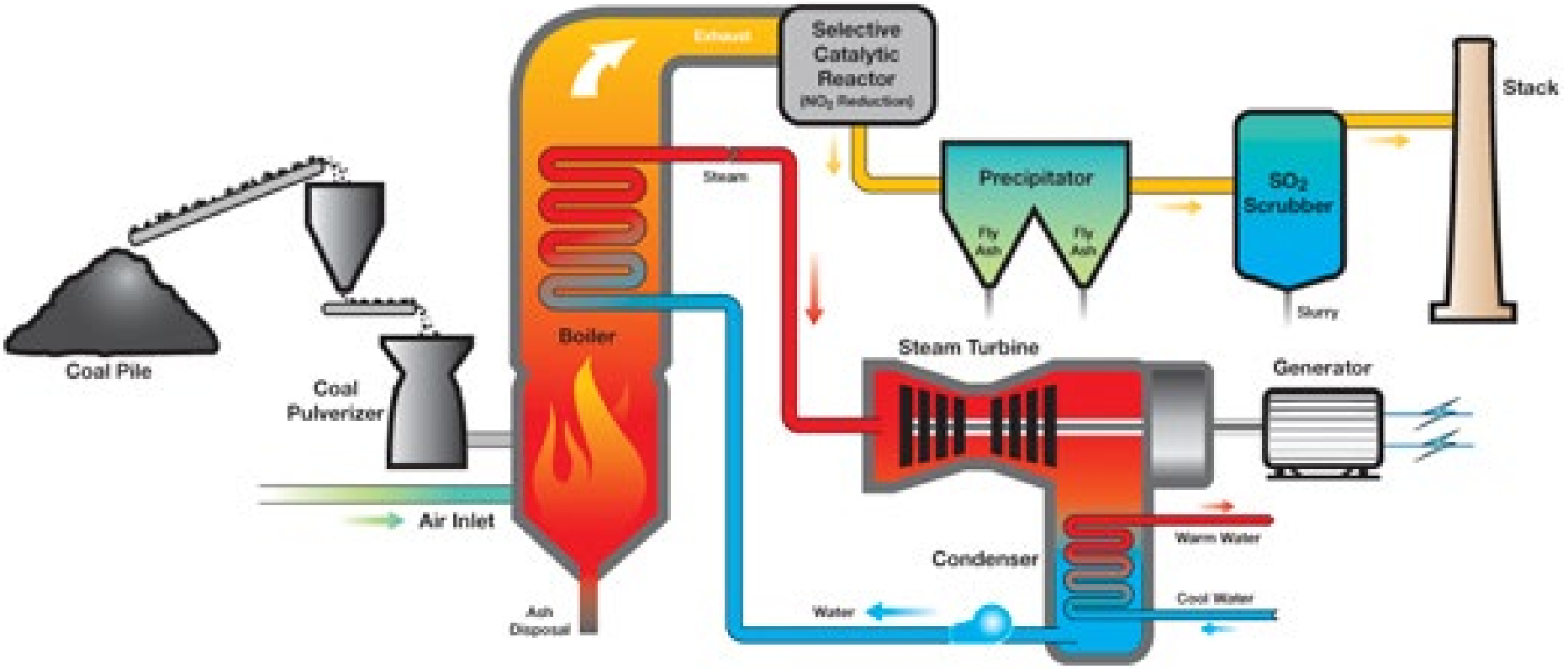
CHAPTER 6: ELECTRIC ENERGY AT HOME



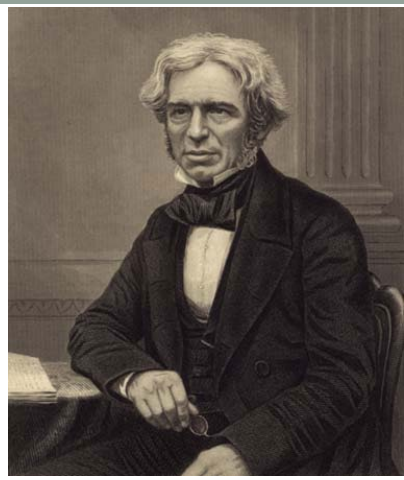
Electrical Energy

- In Alberta most energy we get comes from the combustion of coal
- Energy from burning coal turns a generator, which then produces electricity
- The chemical potential energy in coal is converted to electrical energy

How it Works


Selective Catalytic Reactor
Stack
Precipitator
Fly Ash
Fly Ash
SO_2 Scrubber
Slurry
Steam
Boiler
Steam Turbine
Generator
Coal Pile
Coal Pulverizer
Air Inlet
Condenser
Warm Water
Cool Water
Water
Ash Disposal

Michael Faraday

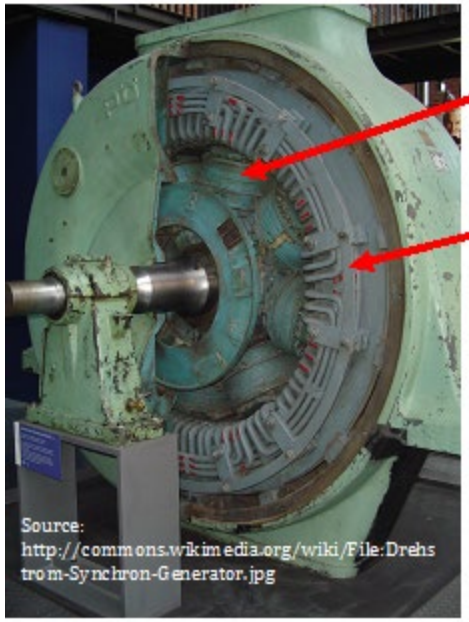


- Created the first **generator** (device that generates electrify) in the 1800s
- Investigated the magnetic field around magnets
- Found that pushing a magnet through a coil of wire generated an electrical current
- Adding more coils or using stronger magnets increase the current

How it Works…Kinda

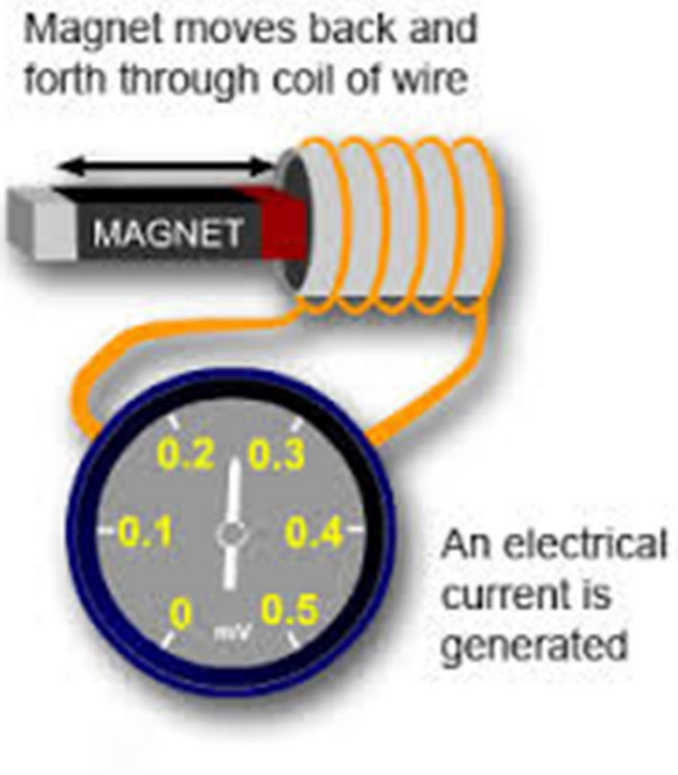
Generating Electricity

- 2 main parts of a generator are a **magnet** and a **coil of wire**
- Moving a wire coil through a magnetic field will produce electricity
- Doesn't matter what component is in motion



Generator

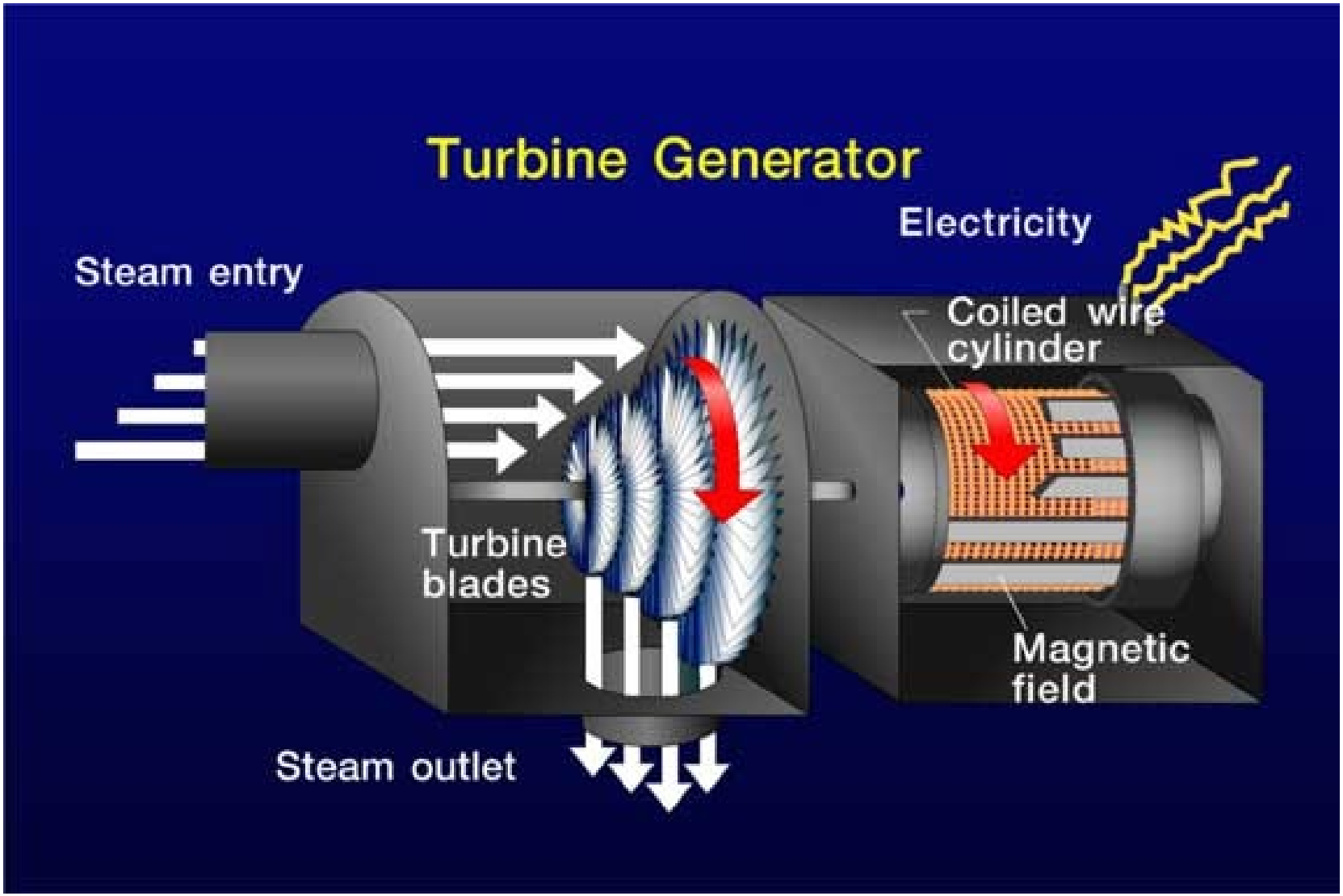
- **Input Energy → Converter → Output Energy**
- **Kinetic Energy → Generator → Electric Energy**



Generation and Distribution

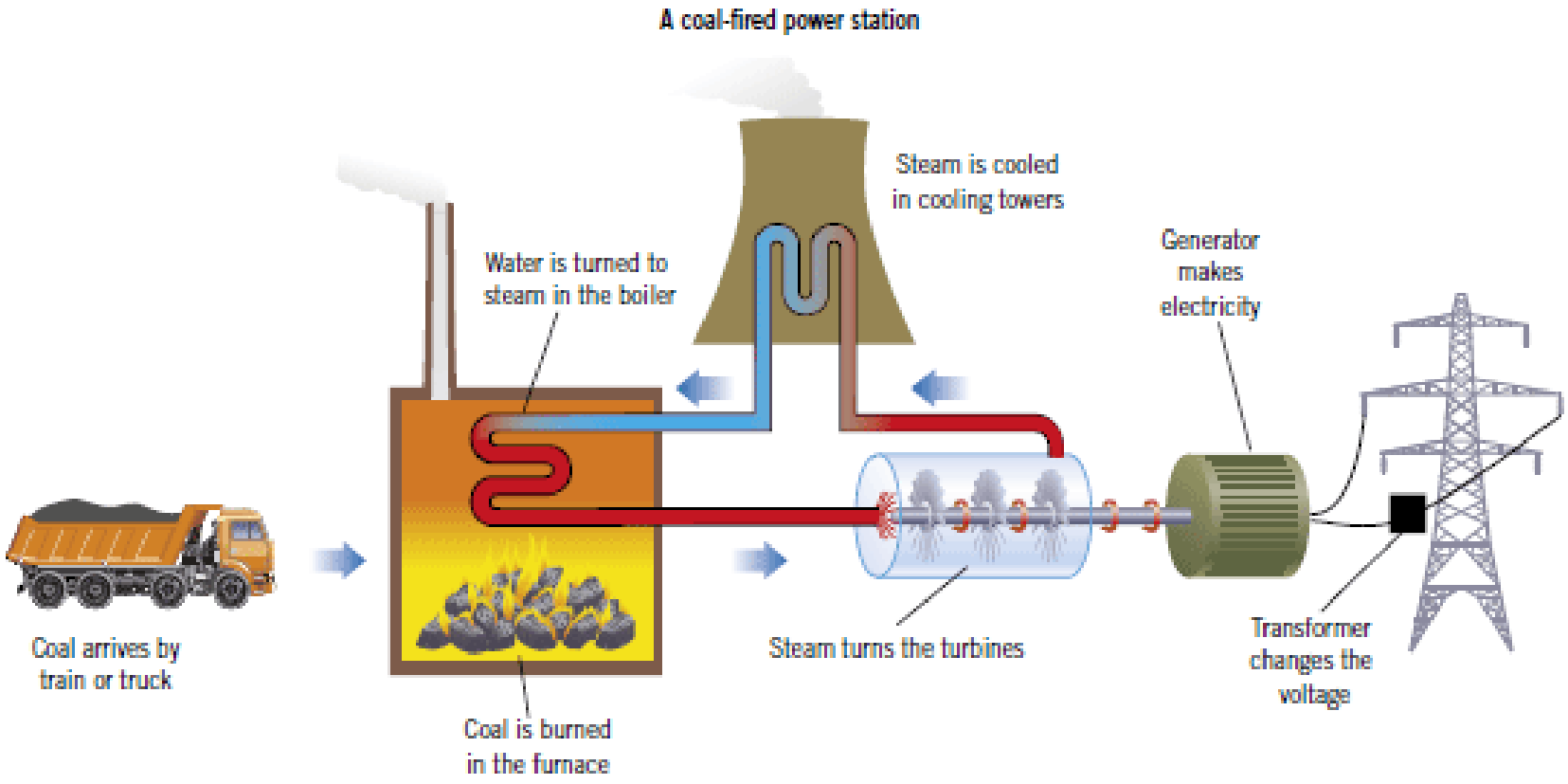
- Most energy is made in a generator, which will contain one or more turbines
- As the blades of the turbine turn, their kinetic energy creates kinetic energy in the generator, which produces electrical energy

How it Works


Turbine Generator
Electricity
Steam entry
Coiled wire cylinder
Turbine blades
Magnetic field
Steam outlet

Coal Power Plants

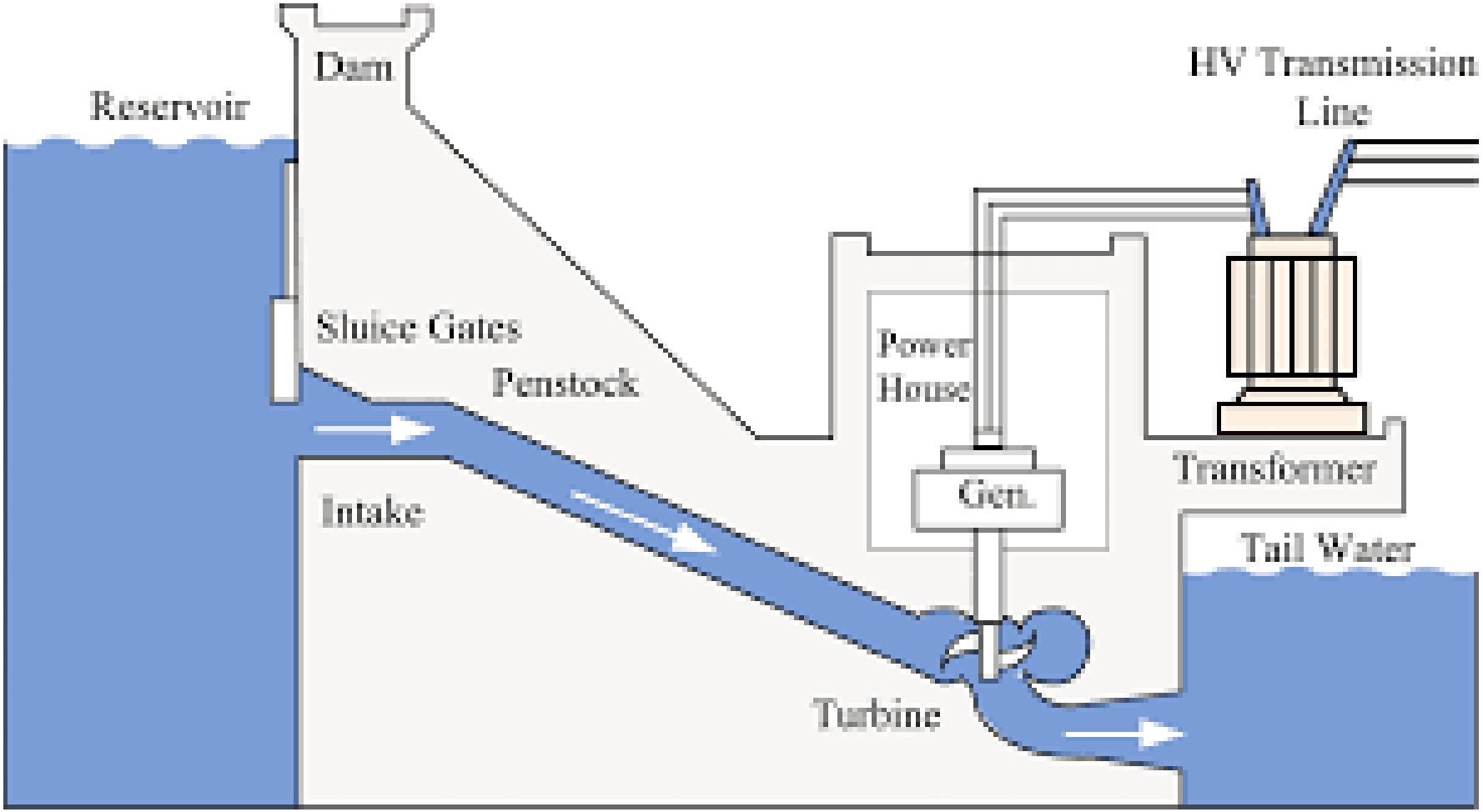
- Use fuel that is cheap and plentiful in Alberta
- Use scrubbers to remove harmful chemicals from output



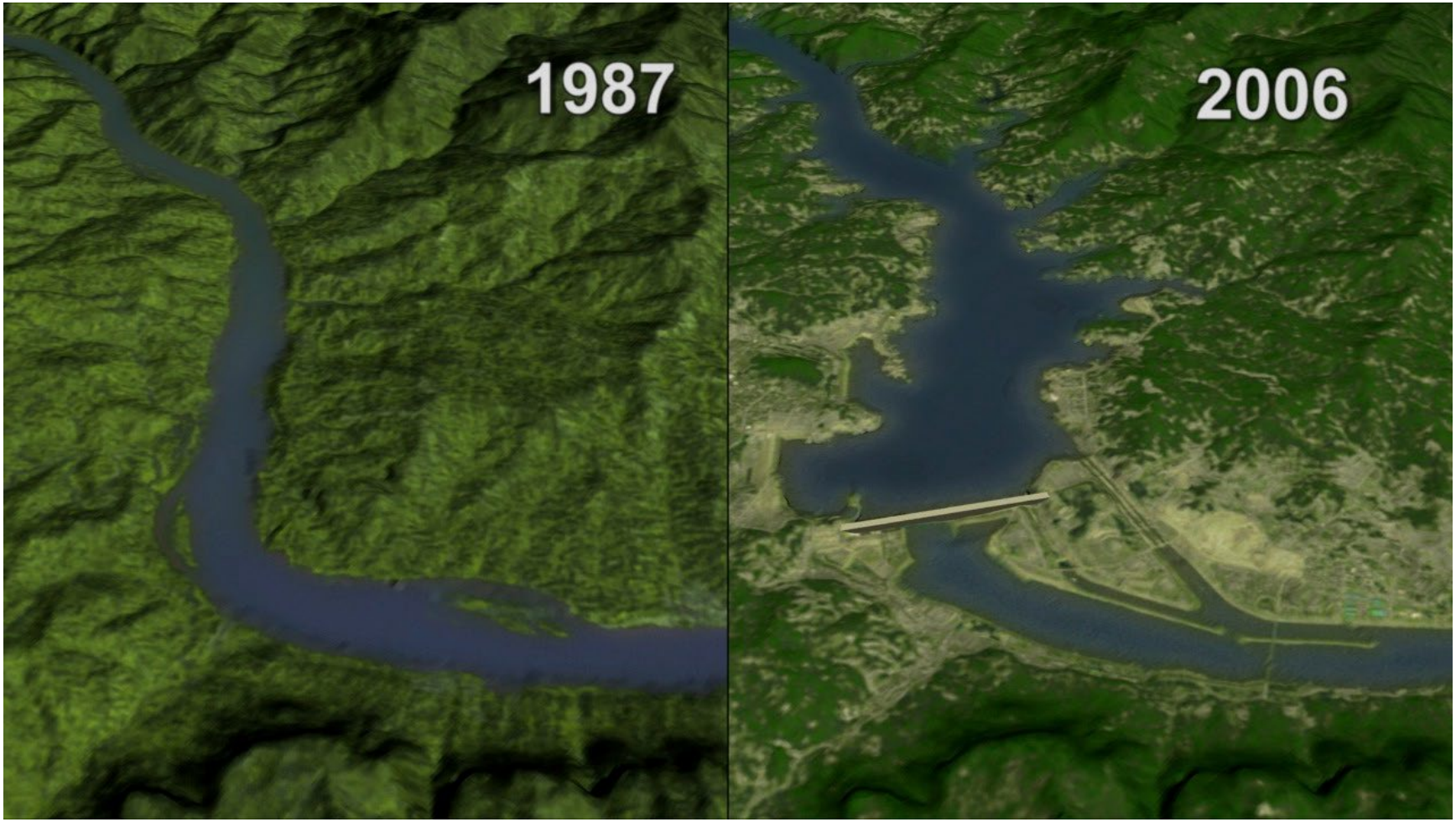
Electric Energy from Water

- Hydro-Electric power plants create a large amount of energy in Canada
- Uses kinetic energy from falling/moving water to generate electricity

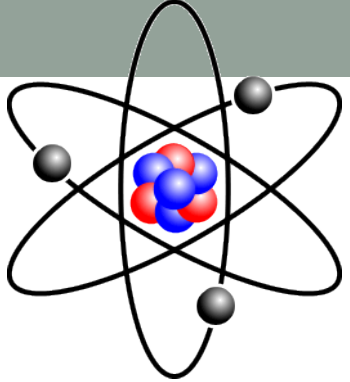
How it Works


Reservoir
Dam
HV Transmission Line
Sluice Gates
Penstock
Power House
Gen.
Transformer
Intake
Tail Water
Turbine

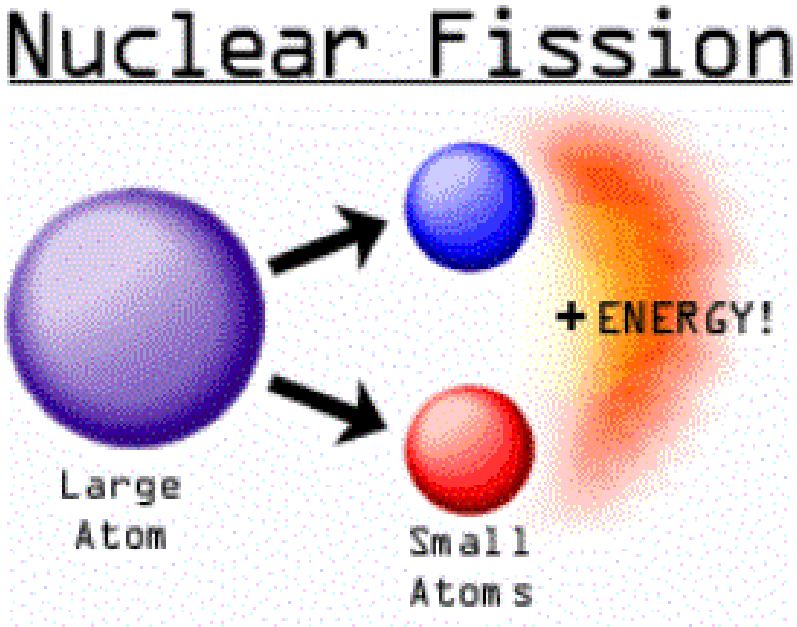
3 Gorges Dam - China



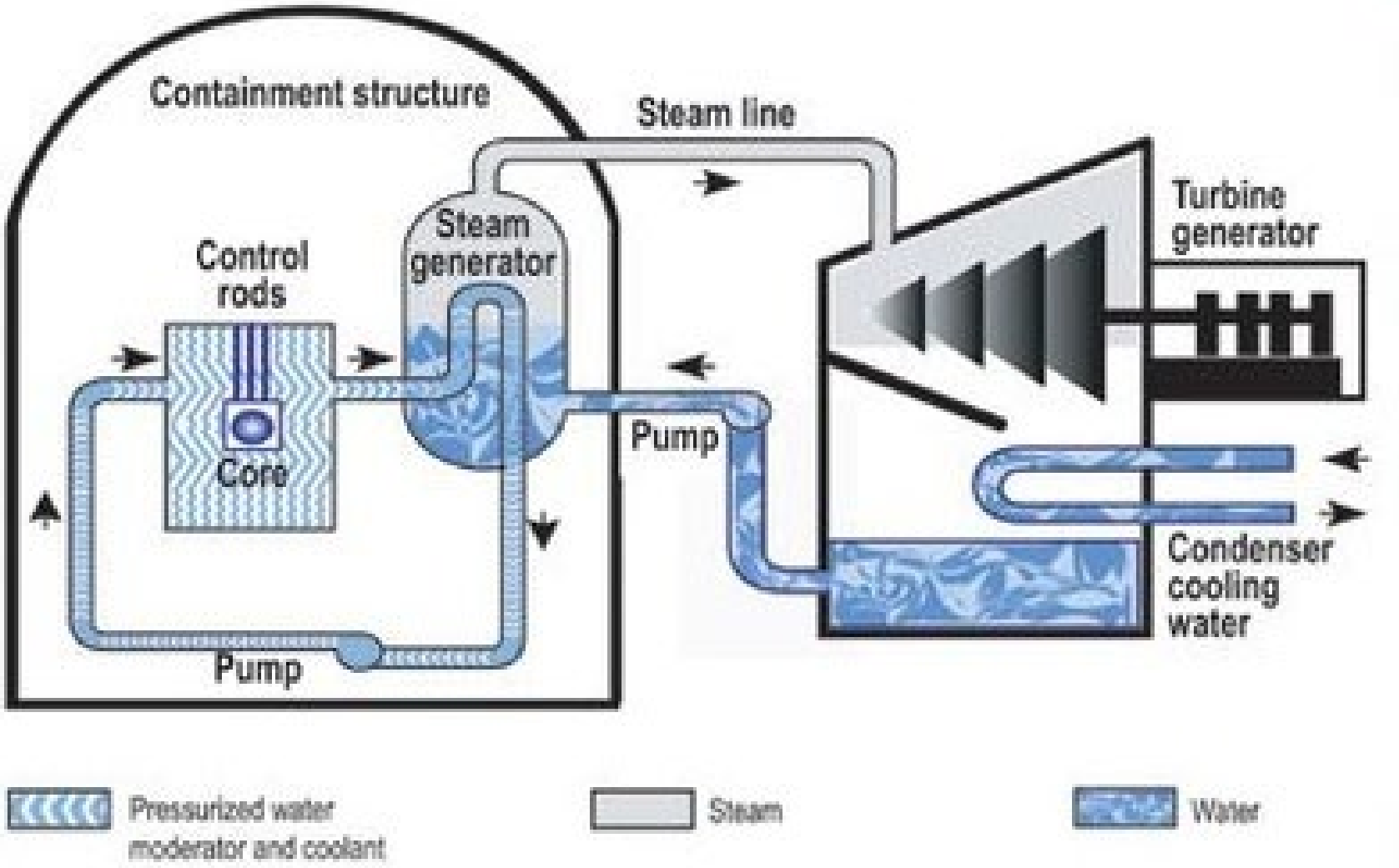
Splitting the Atom



- In thermonuclear generating stations uranium atoms are split by nuclear fission
- This splitting releases a large amount of thermal energy
- This energy is used to create steam, which moves the turbine when under pressure

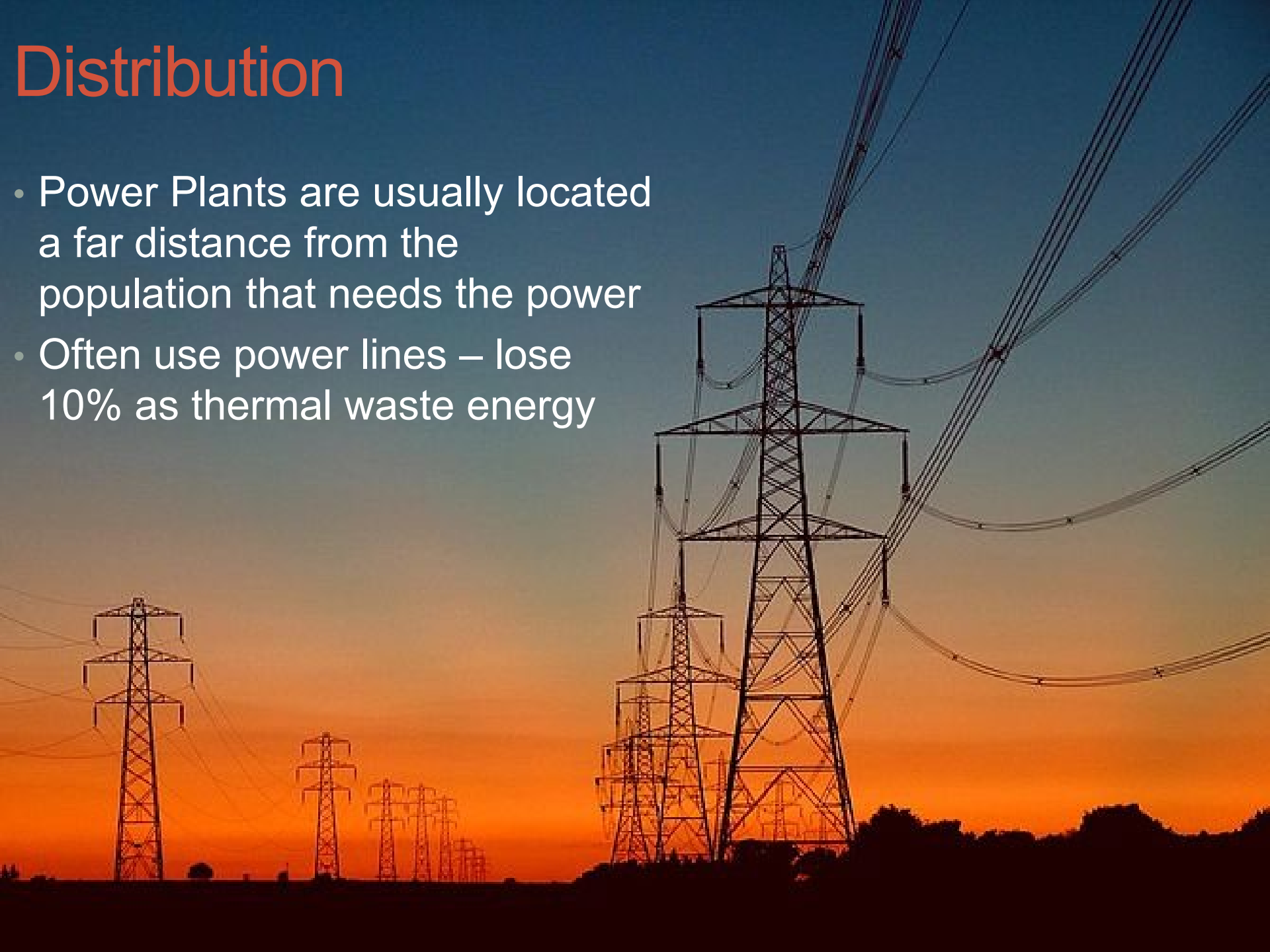


How it Works


Containment structure
Steam line
Turbine generator
Steam generator
Control rods
Core
Pump
Pump
Condenser cooling water
Pressurized water moderator and coolant
Steam
Water

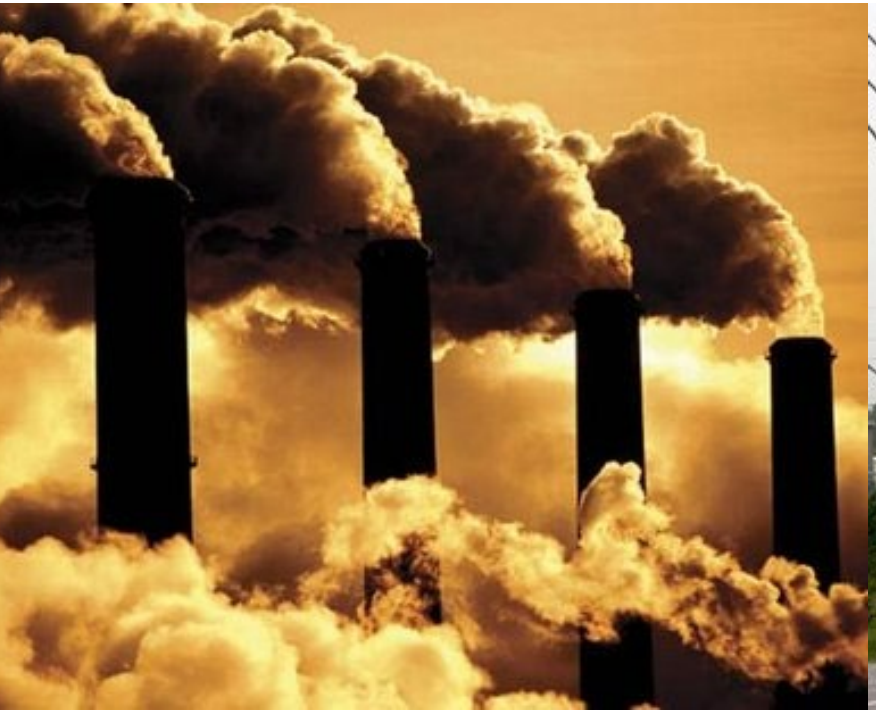
Distribution

- Power Plants are usually located a far distance from the population that needs the power
- Often use power lines – lose 10% as thermal waste energy

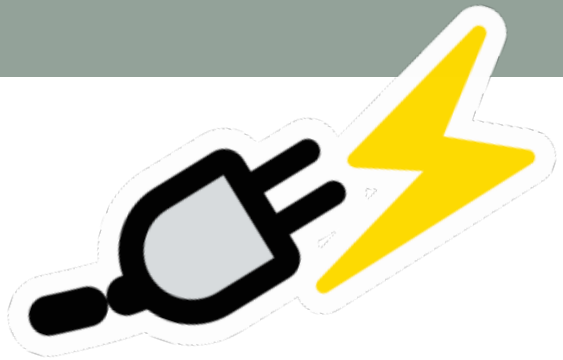


Distribution

- Thermonuclear and thermo-electric plants are usually closer to cities, but lead to environmental problems
- Other factors like poor weather or structural problems can cause damage to power lines and take weeks to repair

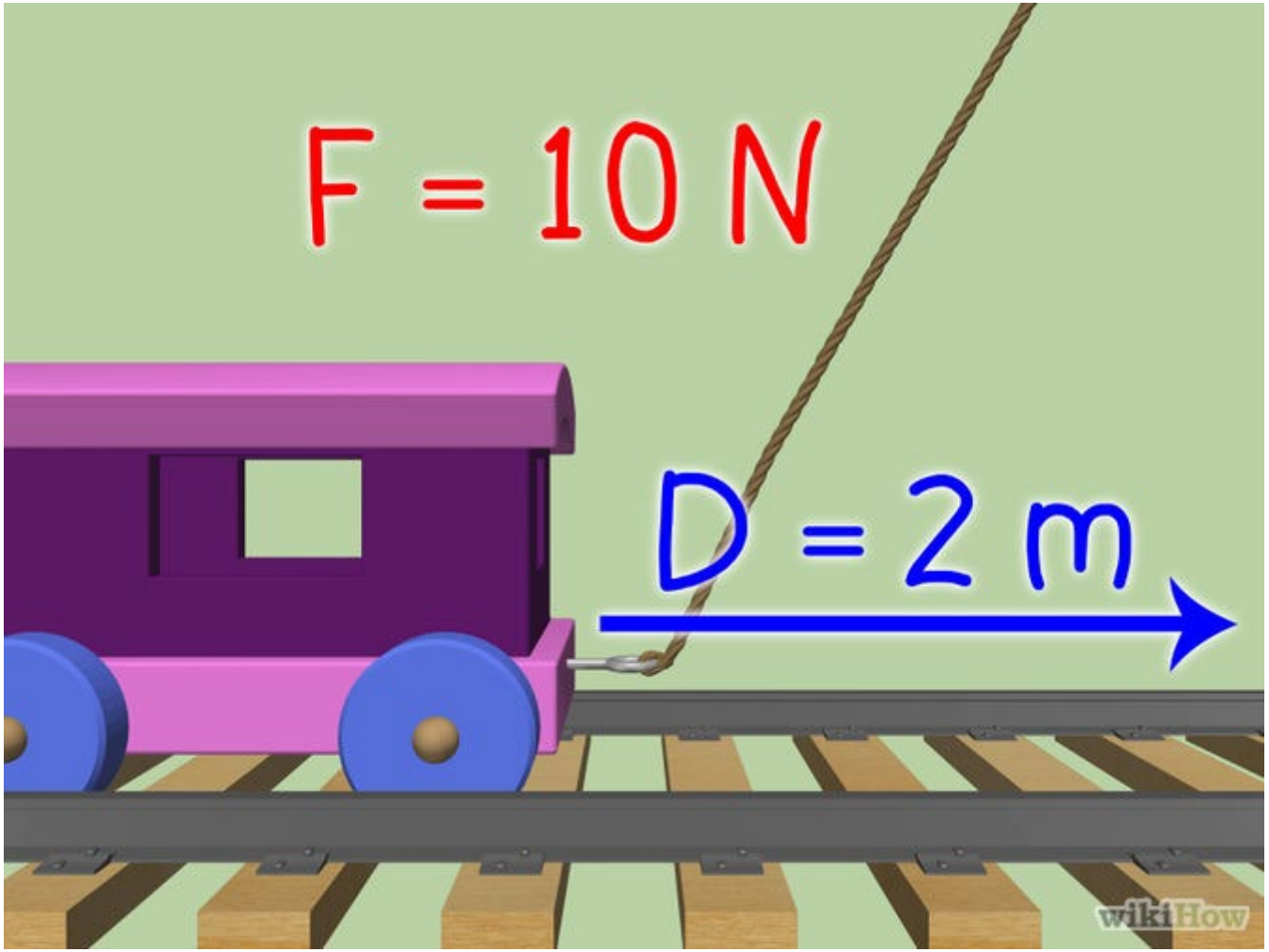


Energy and Power

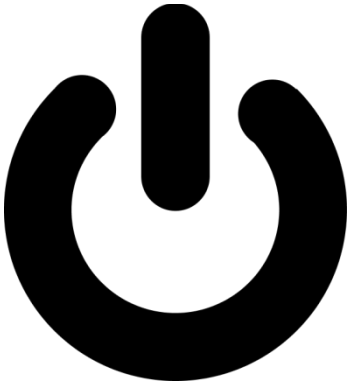


- Energy is the ability to do work
- Work is defined as **force** (F) multiplied by the **distance** (d) to which it is applied
- **Work= Fxd**
- Force is measured in Newtons, and work is measured in Joules (1N·m)
- Electrical Energy is able to preform a range or work – table saw, electric trains, blenders, etc.

Practice



Power



- Power is the rate at which energy is transferred
- Tells how fast energy is used or produced
- If a machine uses 1 watt of energy – it used one joule in one second
- Because work=energy, power is also the rate at which work is being done
- 1 watt = 1J/s

Practice

- A N64 uses 80 J of energy every second. How many watts does it use?
- = 80 Watts

- A go kart uses 1000 J in 1 minute. How many watts does it use?
- 16.7 Watts! (1000 J/ 60 seconds)

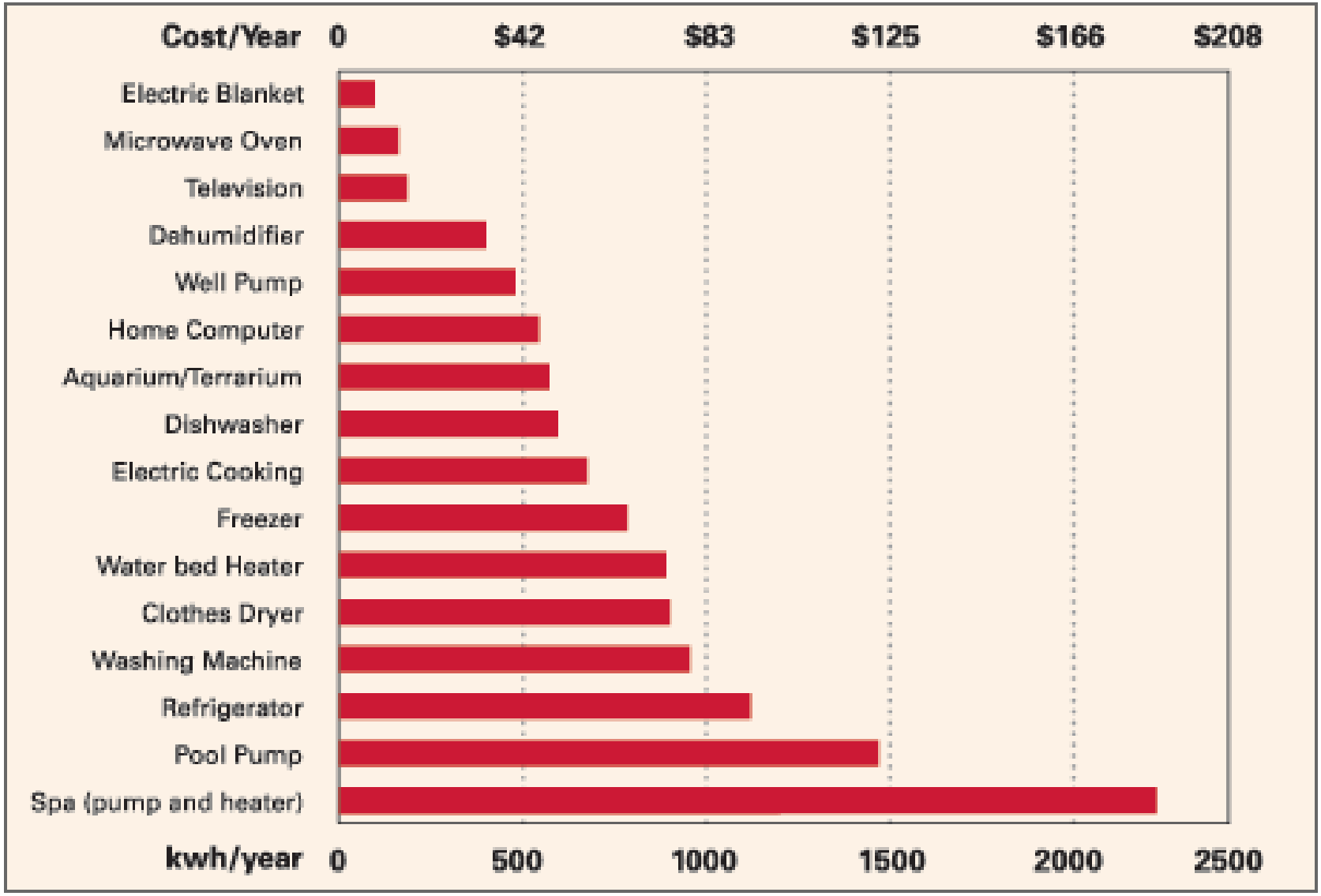
Electricity Companies

- Often called Power Companies
- Consumption is measured in Watts
- Usually the watts are multiplied by the time it takes to use them - usually watt hours
- **Energy = Power x Time**
- **1 watt hour = 1 watt x 1 hour**

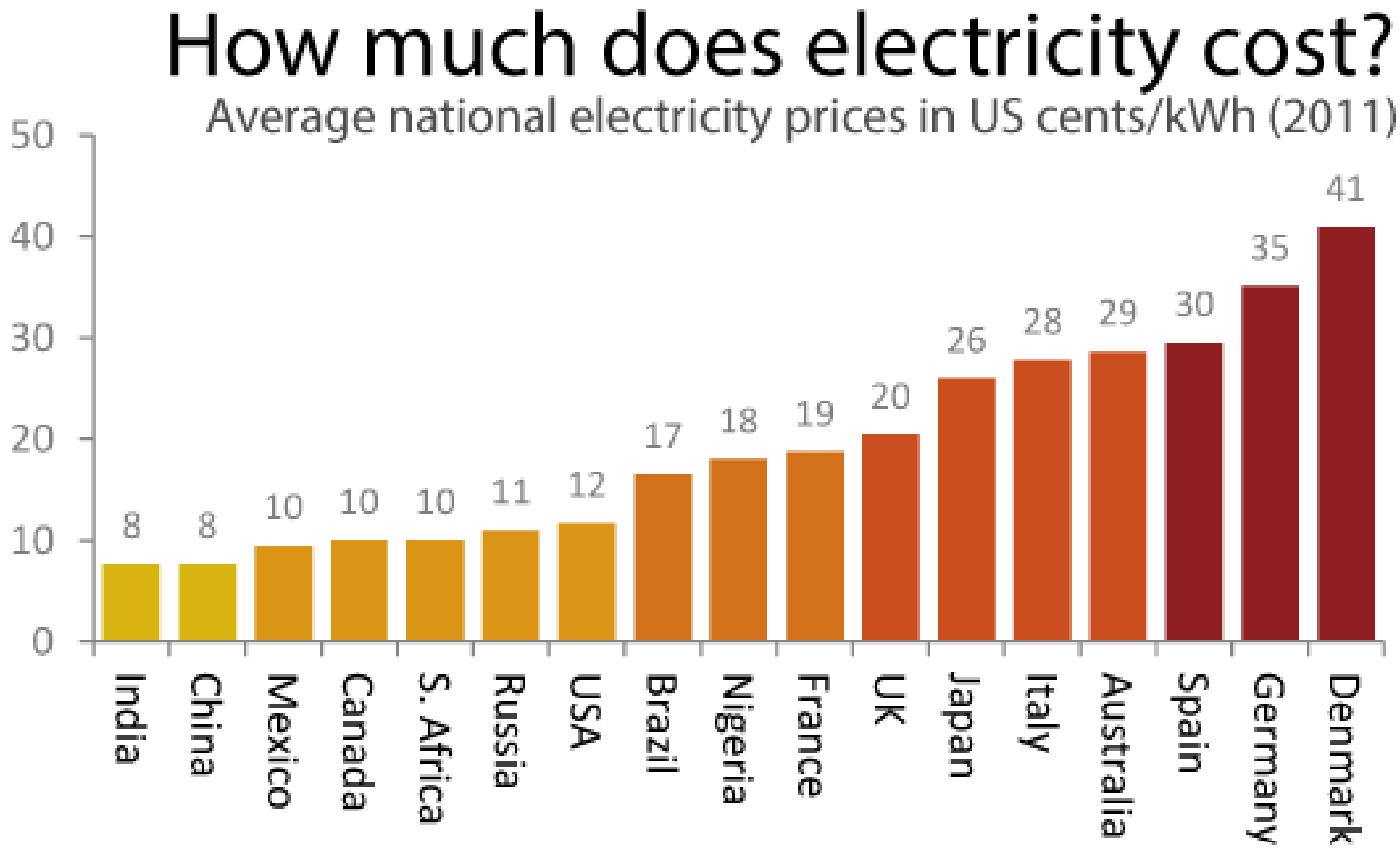
Kilowatt Hours

- A watt hour is a fairly small unit of power
- Electric companies often use kilowatt hours (kWxh)
- 1000x larger than a watt hour

How much is used



Costs



Data: average prices from 2011 converted at mean exchange rate for that year

Sources: IEA, EIA, national electricity boards, OANDA shrinkthatfootprint.com

Efficiency

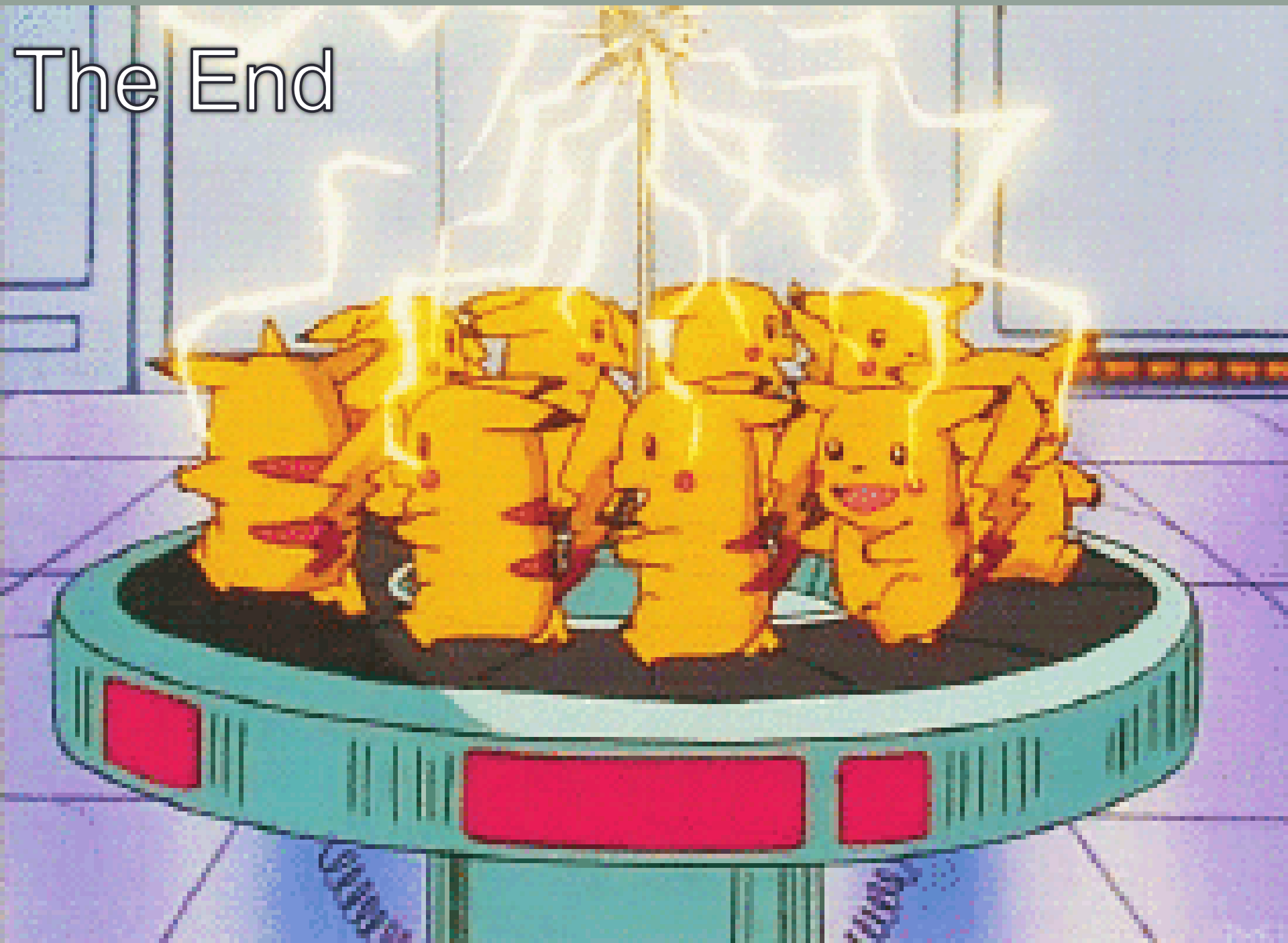
- How much useful energy is produced compared to how much energy was put in
- Incandescent bulbs vs. fluorescent lights
- Incandescent bulbs give off large amounts of heat, and are therefore less efficient
- Efficiency is expressed as a percentage

$$\text{Efficiency (in \%)} = \frac{P_{out}}{P_{in}} \times 100$$

Practice

- A toaster receives **1600 J as input energy** and has a useful output 400 J. What is its efficiency?
- Efficiency = Output/Input x100
- Efficiency = 400J/1600J x100 = ?
- 25 %

Benefits of Efficiency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