How Power Plants Work

Smoke or steam?

Figure: Allegheny Sierra Club

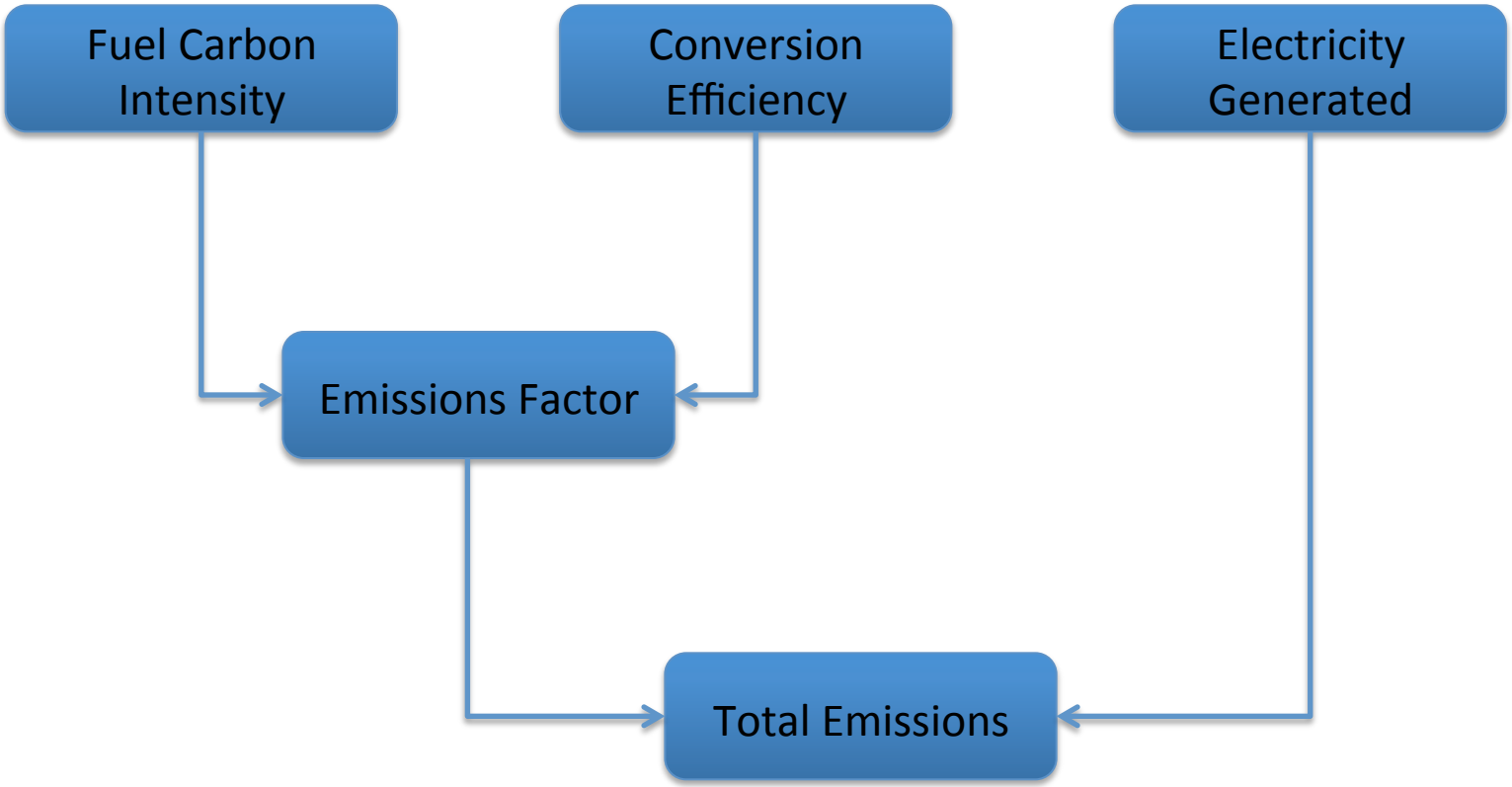
Key Takeaways

1. "This increase [in atmospheric concentration of CO_2 and other GHGs] is primarily the result of burning coal, oil and natural gas…"
2. "To stop serious climate change, we will have to reduce global CO_2 emissions by about 80%. That means an enormous change in the world's energy systems."

Where does electricity come from?

- Power plants (coal, natural gas, nuclear), hydro-dams, wind turbines, solar panels
- Which provides the most electricity for us?
  - Coal
  - Natural Gas
  - Nuclear
  - Hydro
  - Everything else

How to calculate emissions due to electricity produced by different fuel types?



U.S. electric energy mix

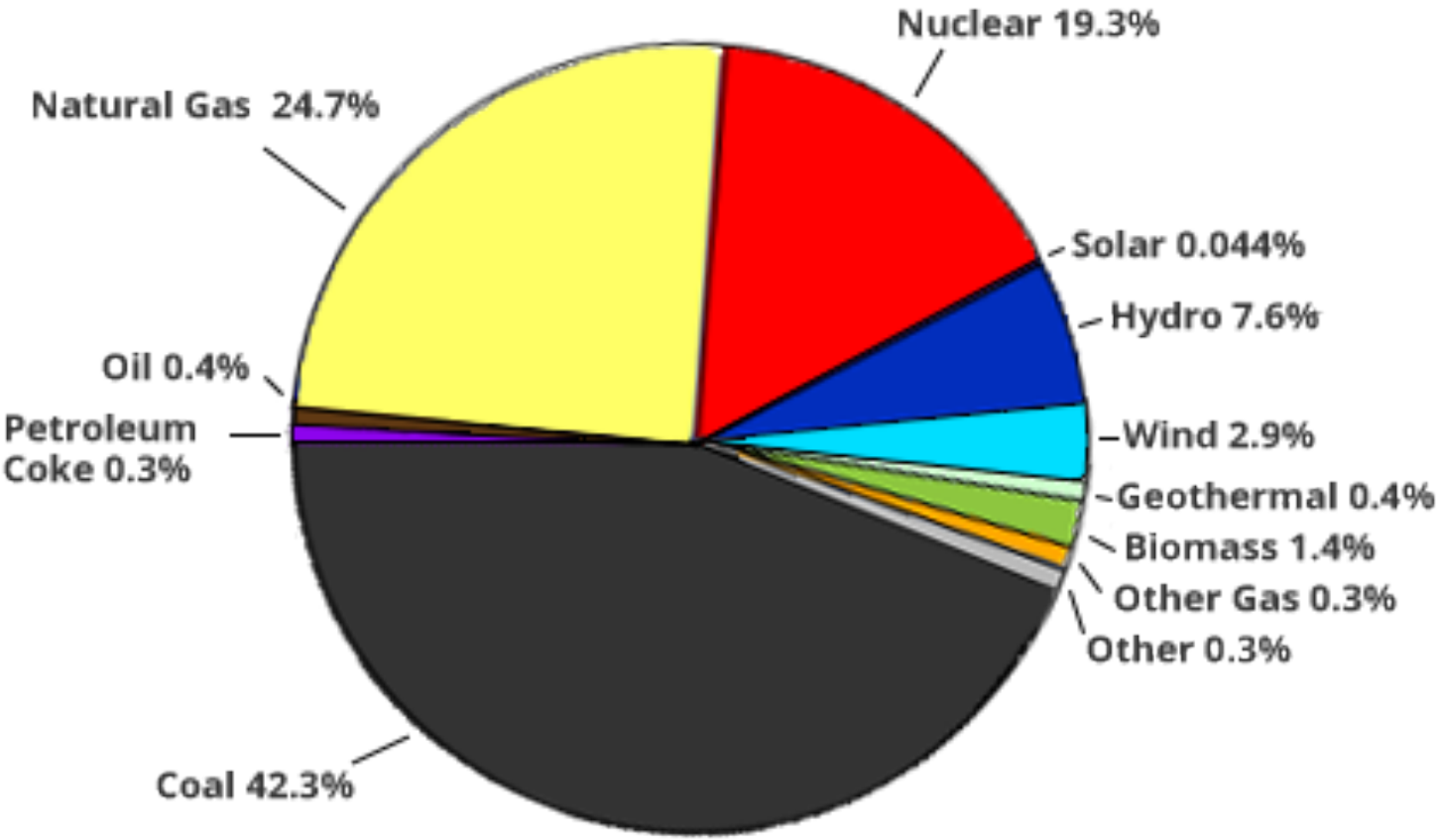


Figure: Environmental Protection Agency

Year 2009 Generation by Fuel Type

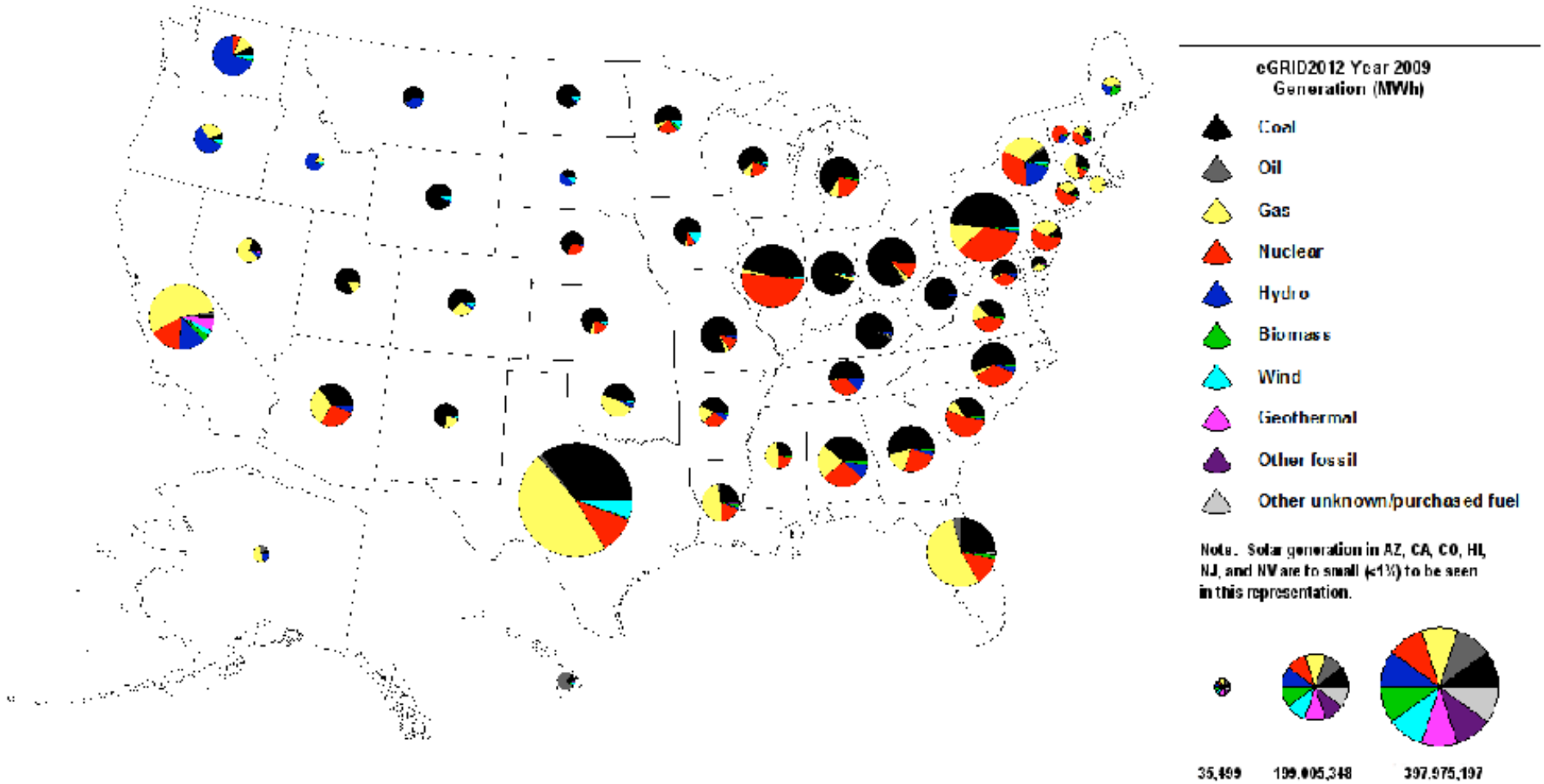


Figure: eGrid 2012

Coal Plants

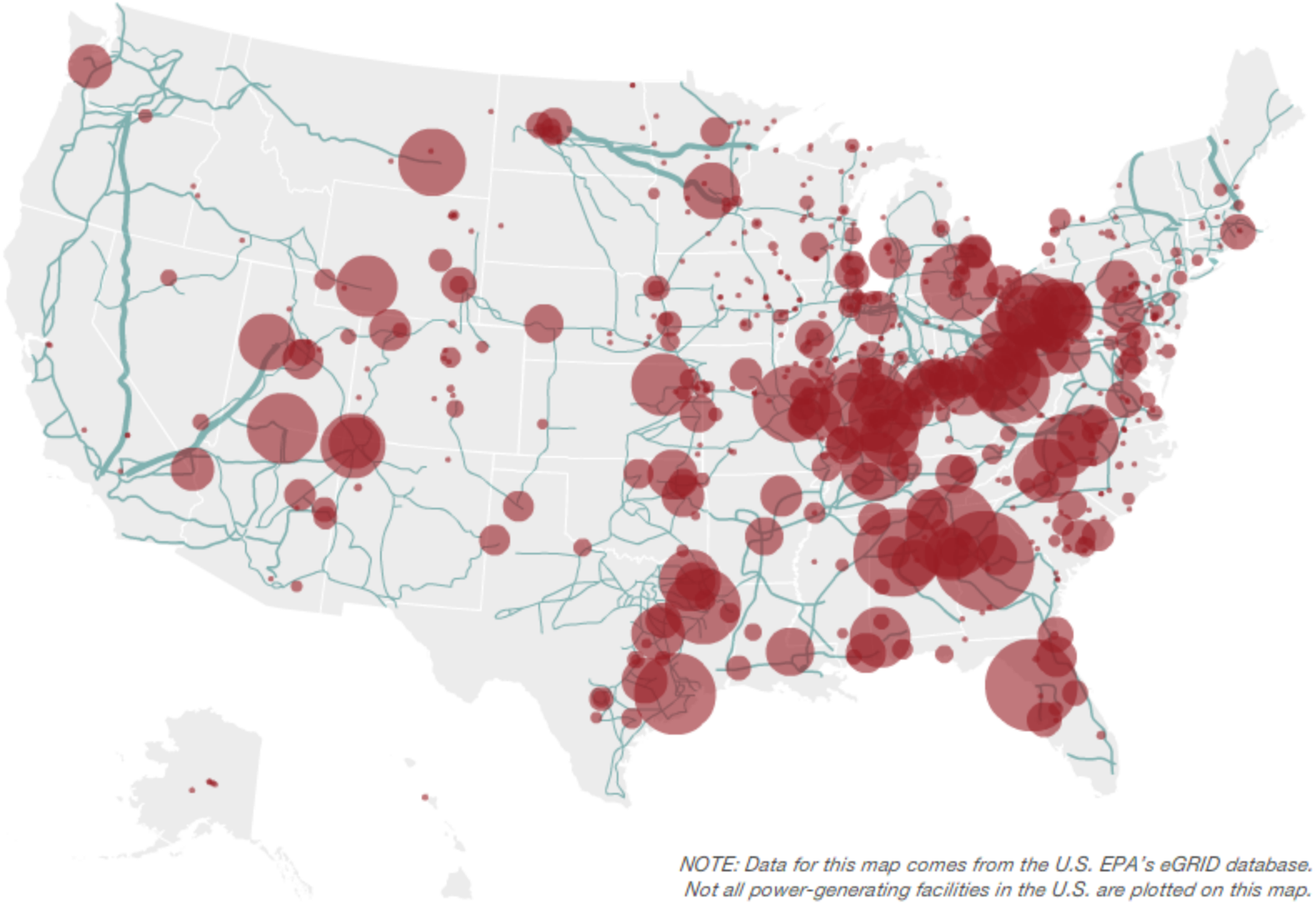


Figure: eGrid 2012

Natural Gas

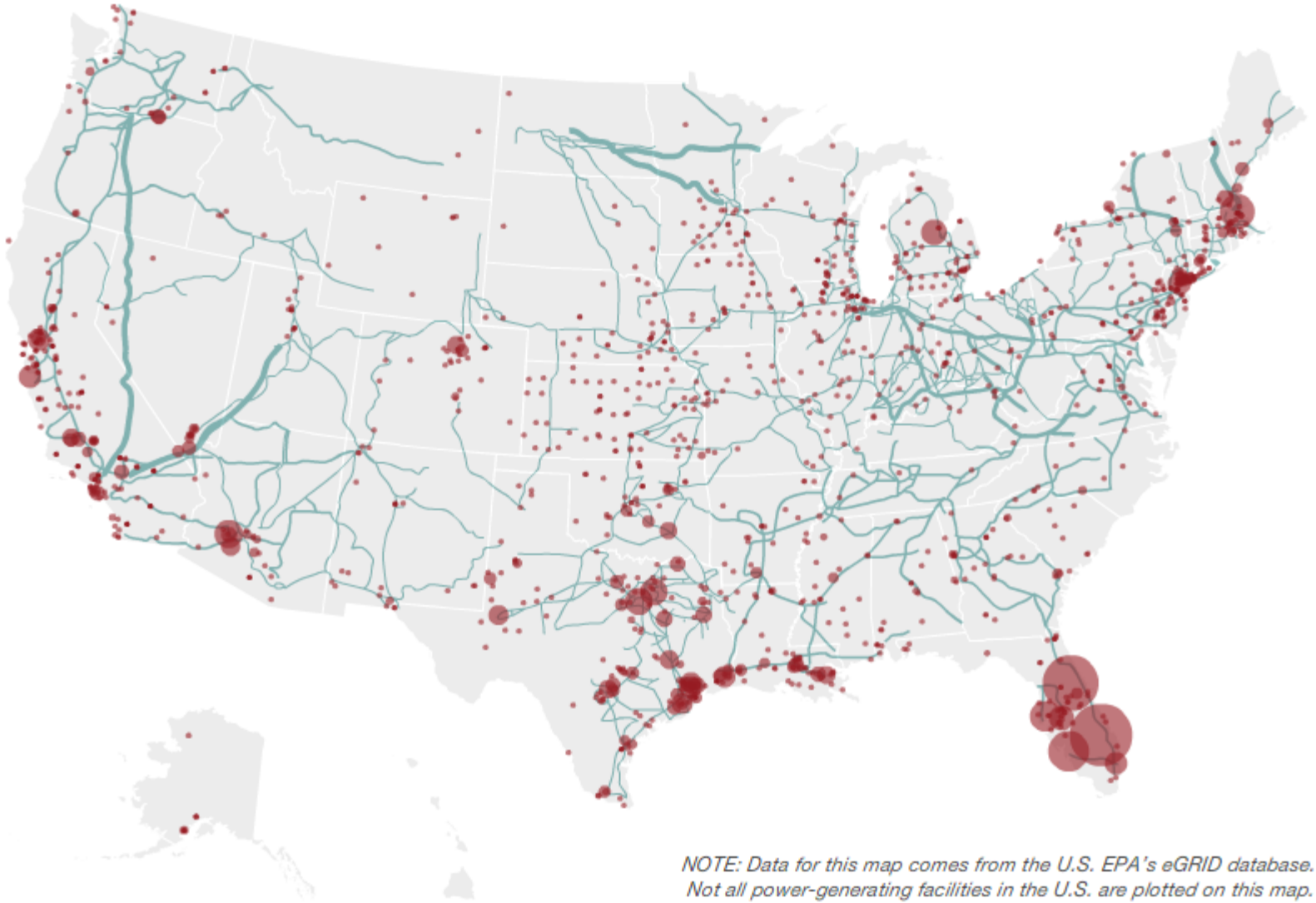
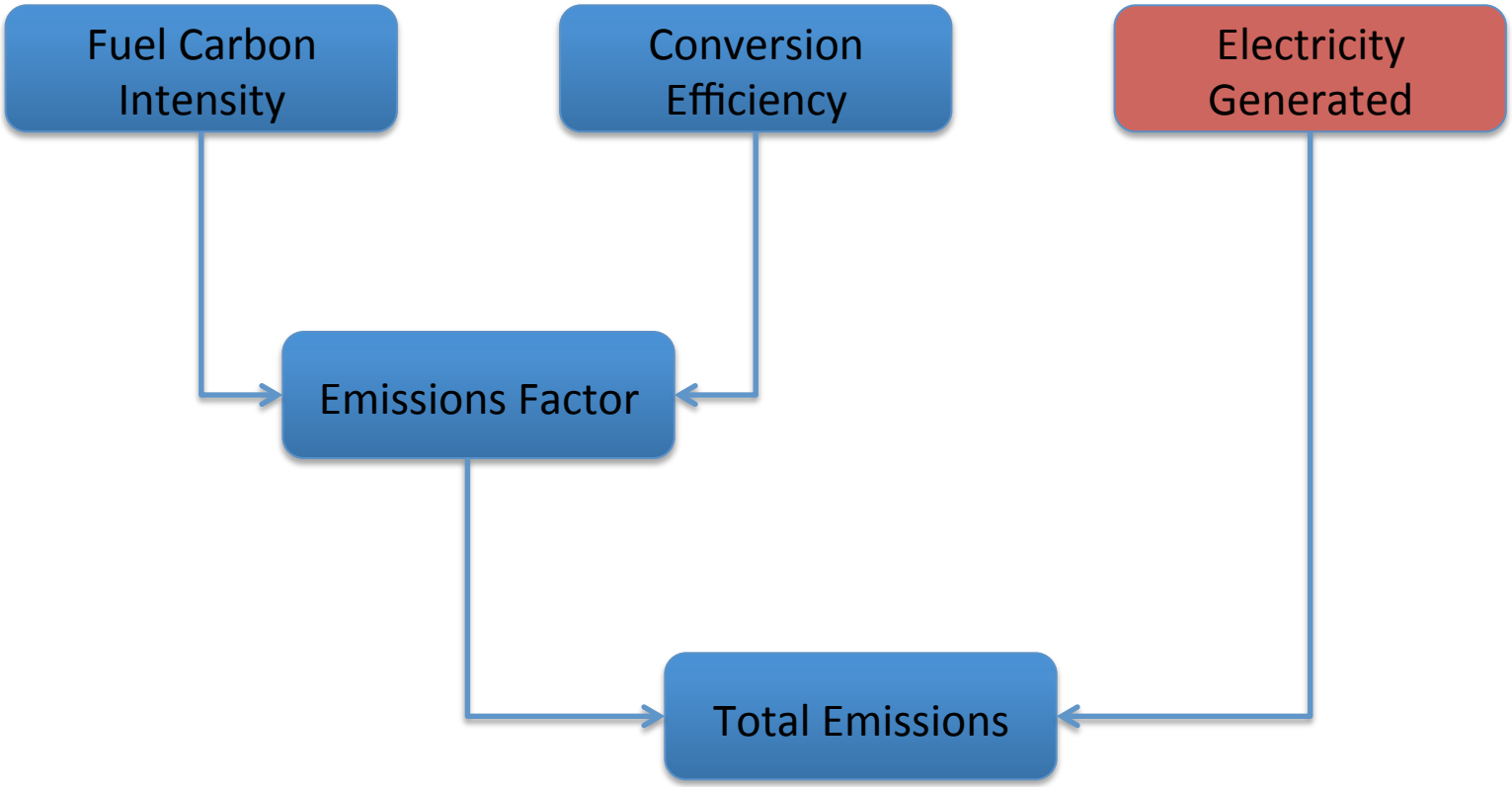
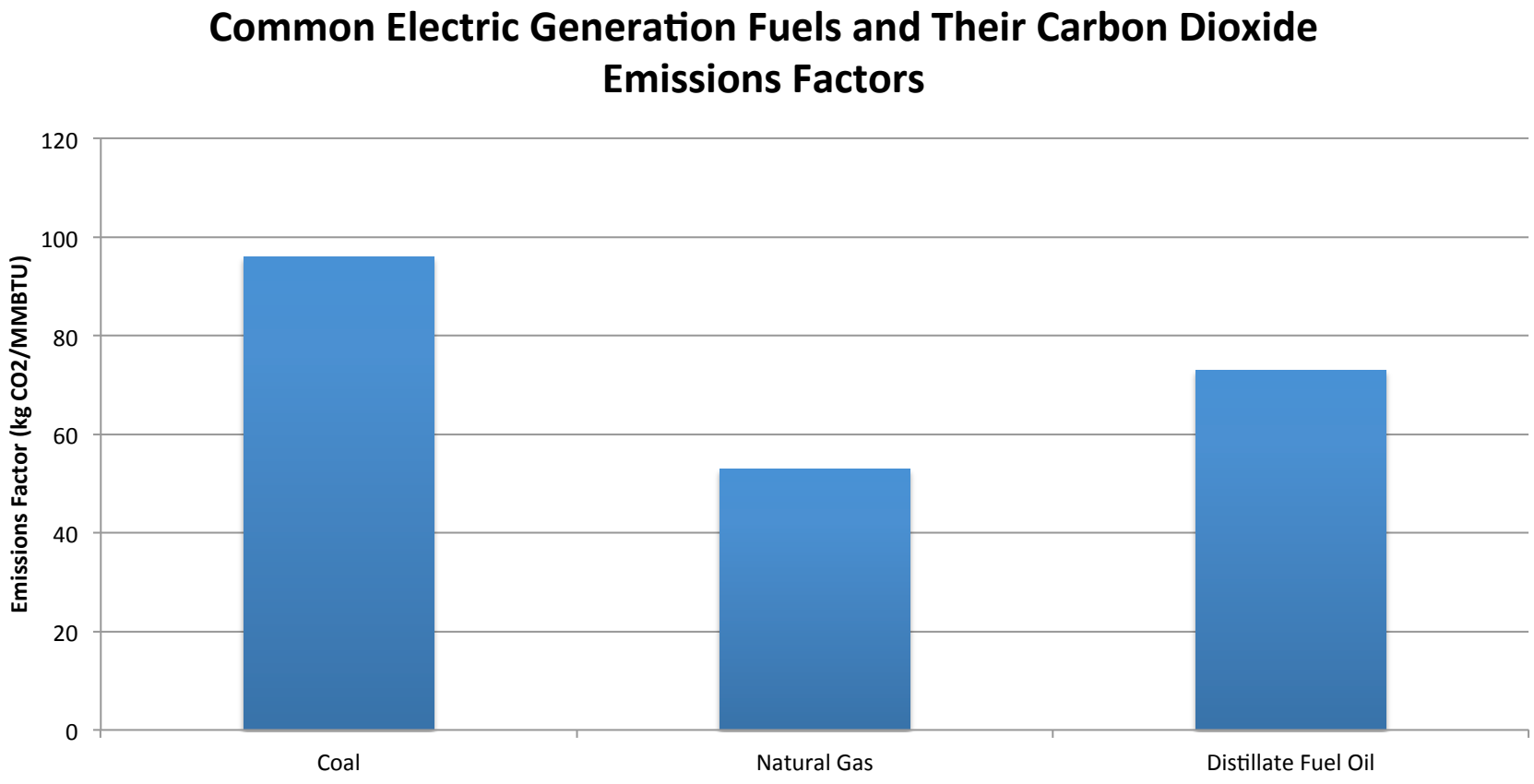


Figure: eGrid 2012

How to calculate emissions due to electricity produced by different fuel types?

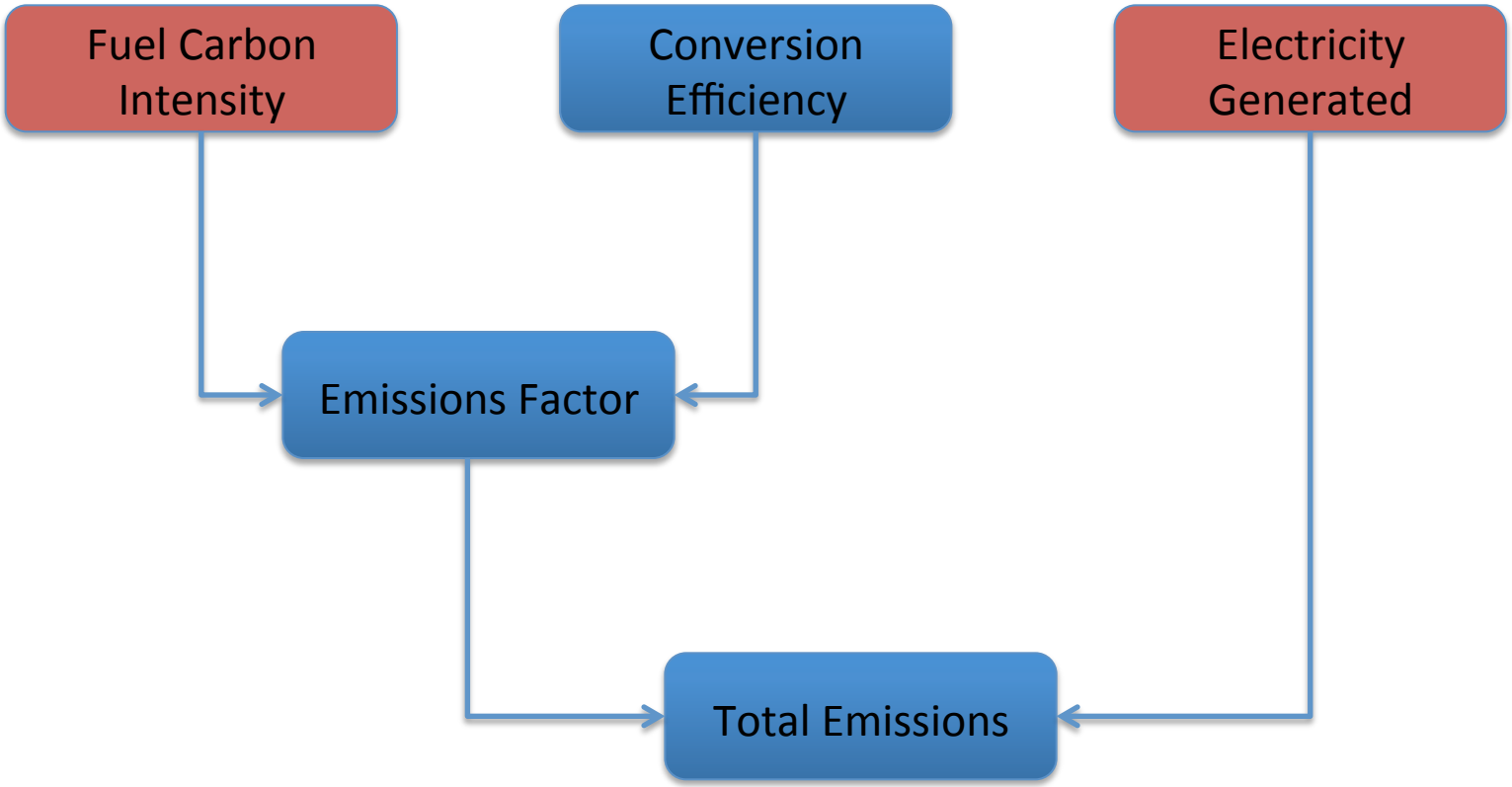


Fuel Carbon Intensity



http://www.eia.gov/oiaf/1605/coefficients.html

How to calculate emissions due to electricity produced by different fuel types?



Demonstration

1. Play around with pinwheels, finding right angle to blow in order to get them spinning fast.
2. Hold two pinwheels in line and blow such that they both spin. Observe speed of second (downwind) pinwheel. Remove first pinwheel and observe change in speed in second. Why does this occur?
3. Is all of the energy in your breath converted into rotational energy of pinwheel?
4. How could you increase the fraction of breath energy converted into rotational energy?
5. What is efficiency and how does it relate to what we have just done?

Steam Turbine (Coal shown here)

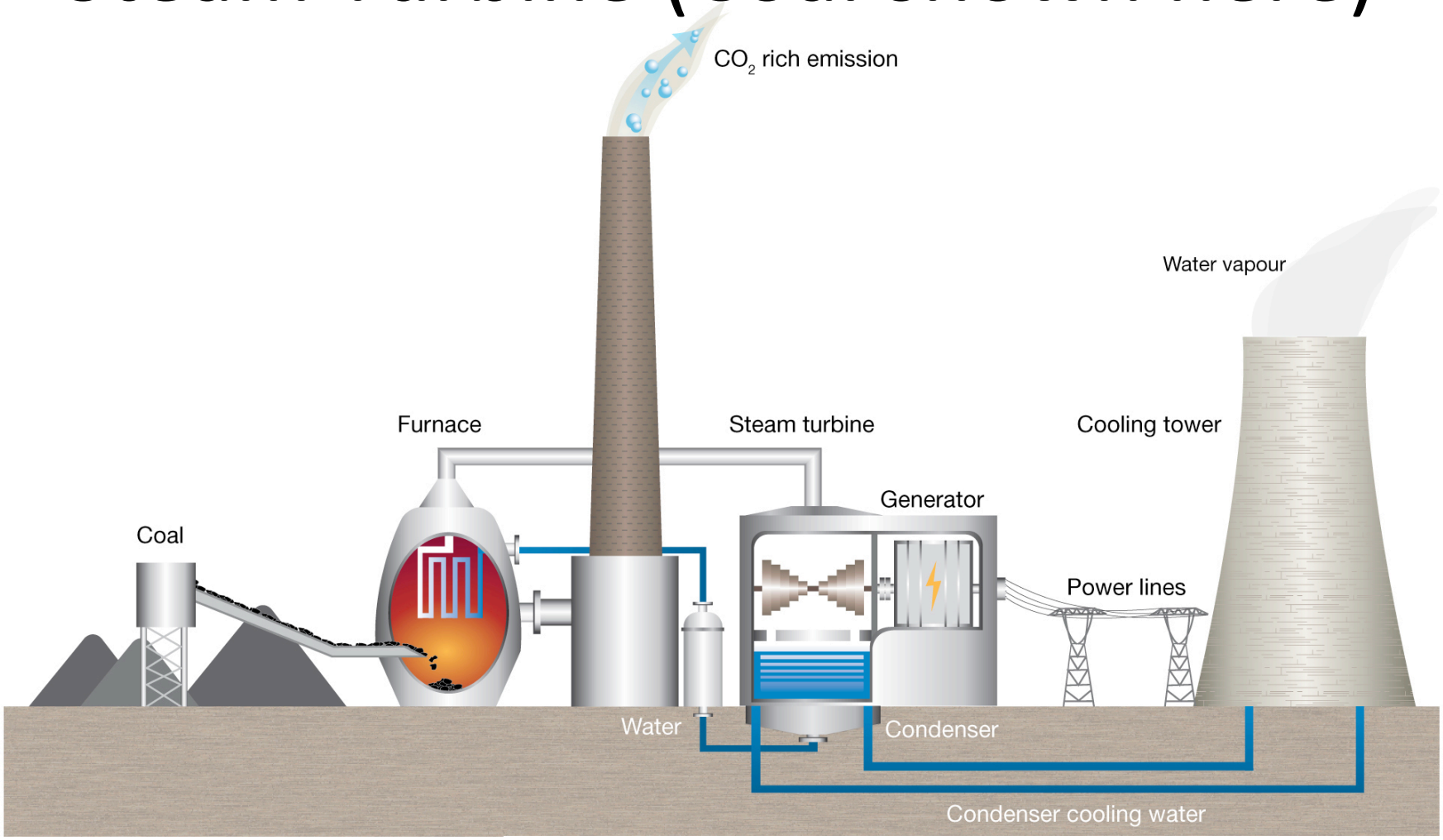


Figure Source: CO2CRC

Gas turbine (college campus)

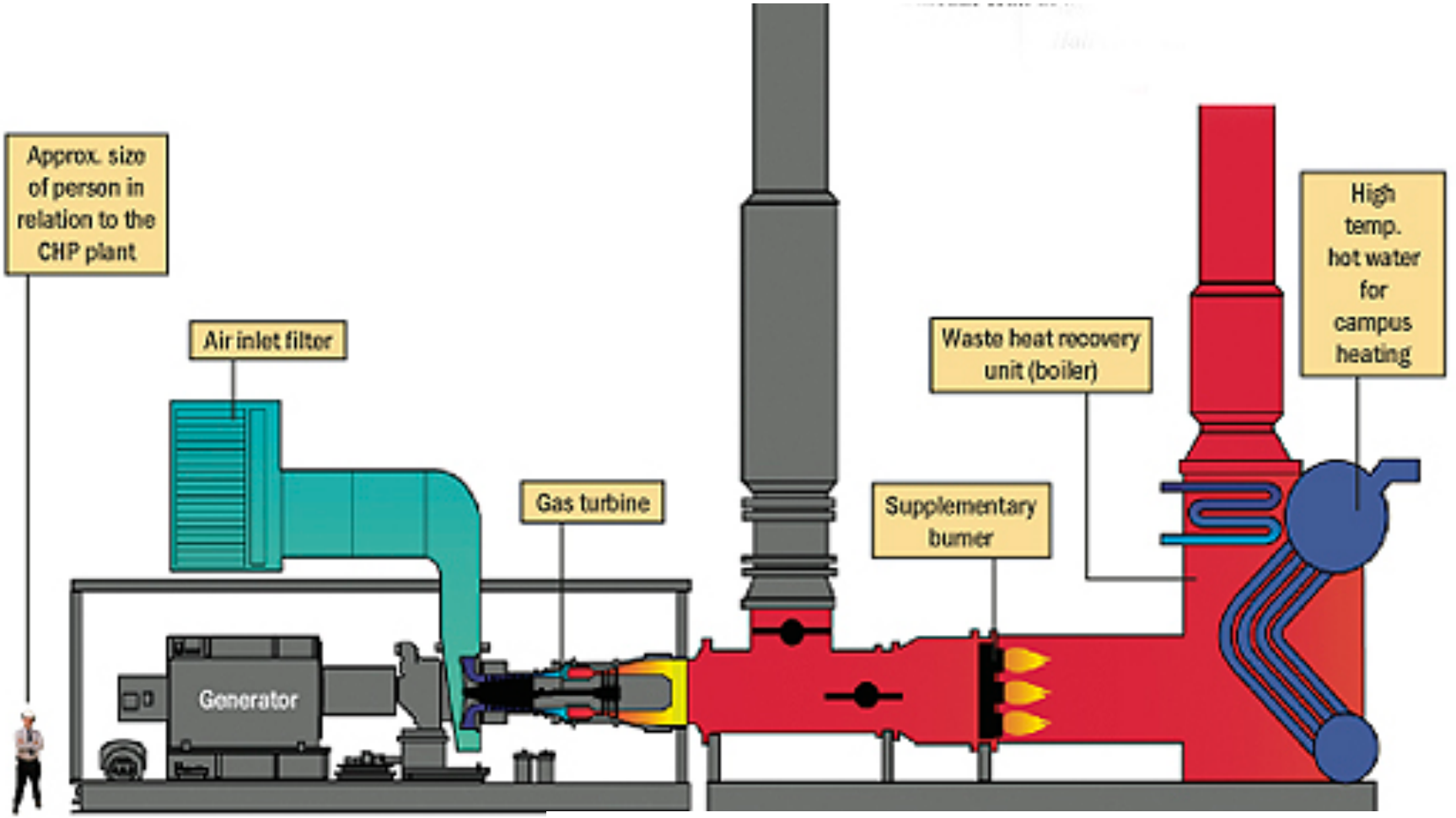


Figure Source: University of Calgary

Natural Gas Combined Cycle Plant

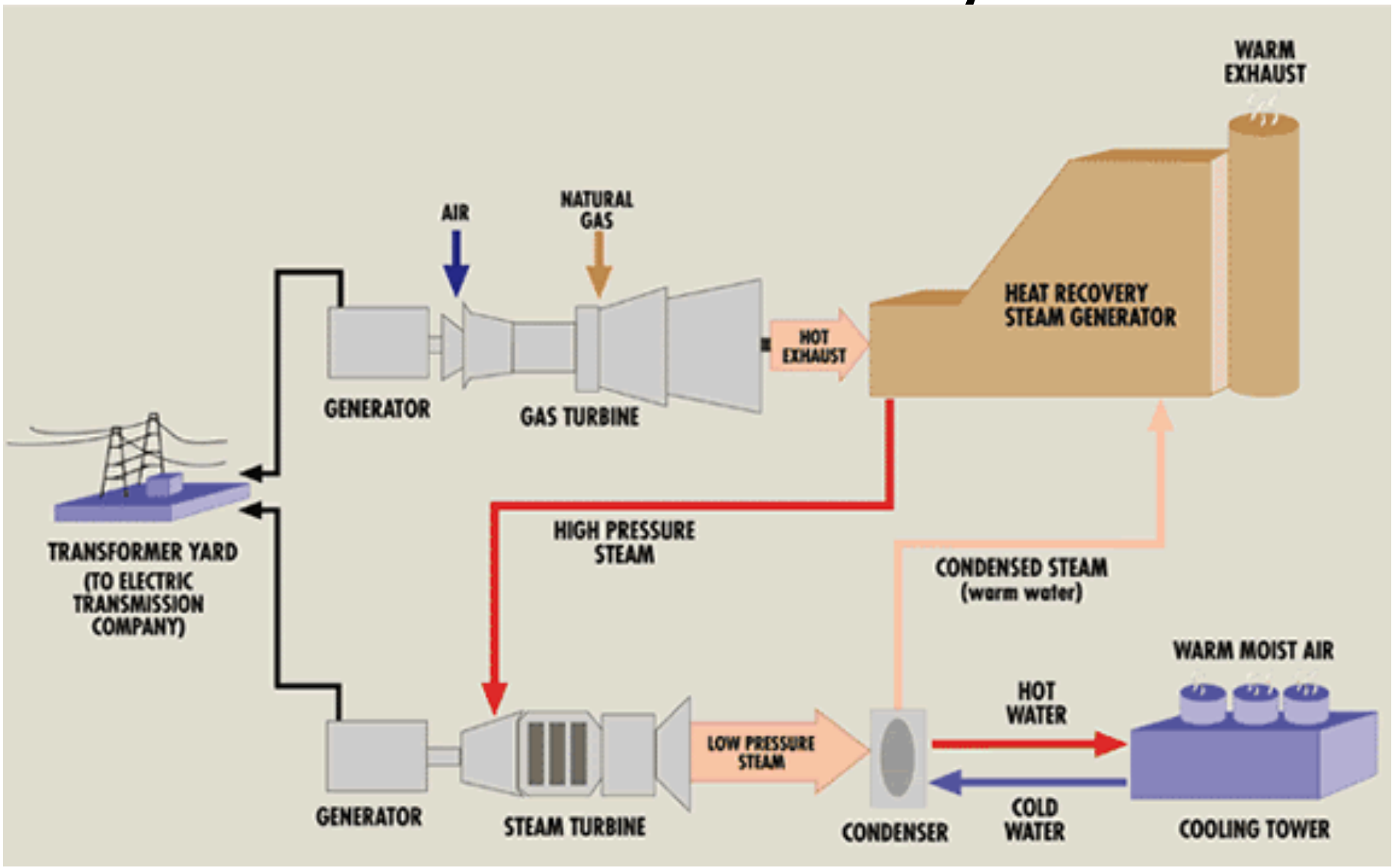
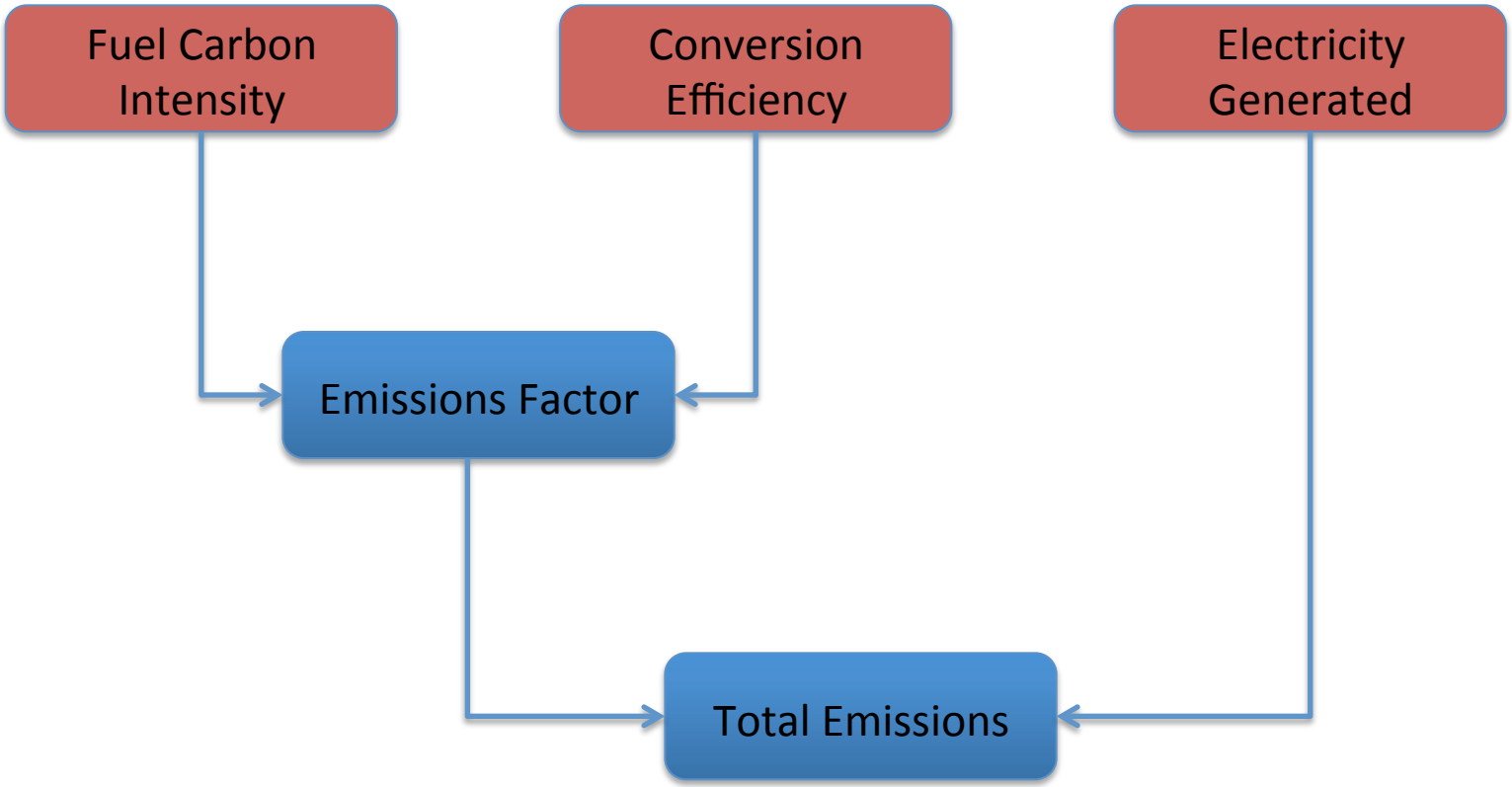


Figure: Northwest and Intermountain Power Producers Coalition

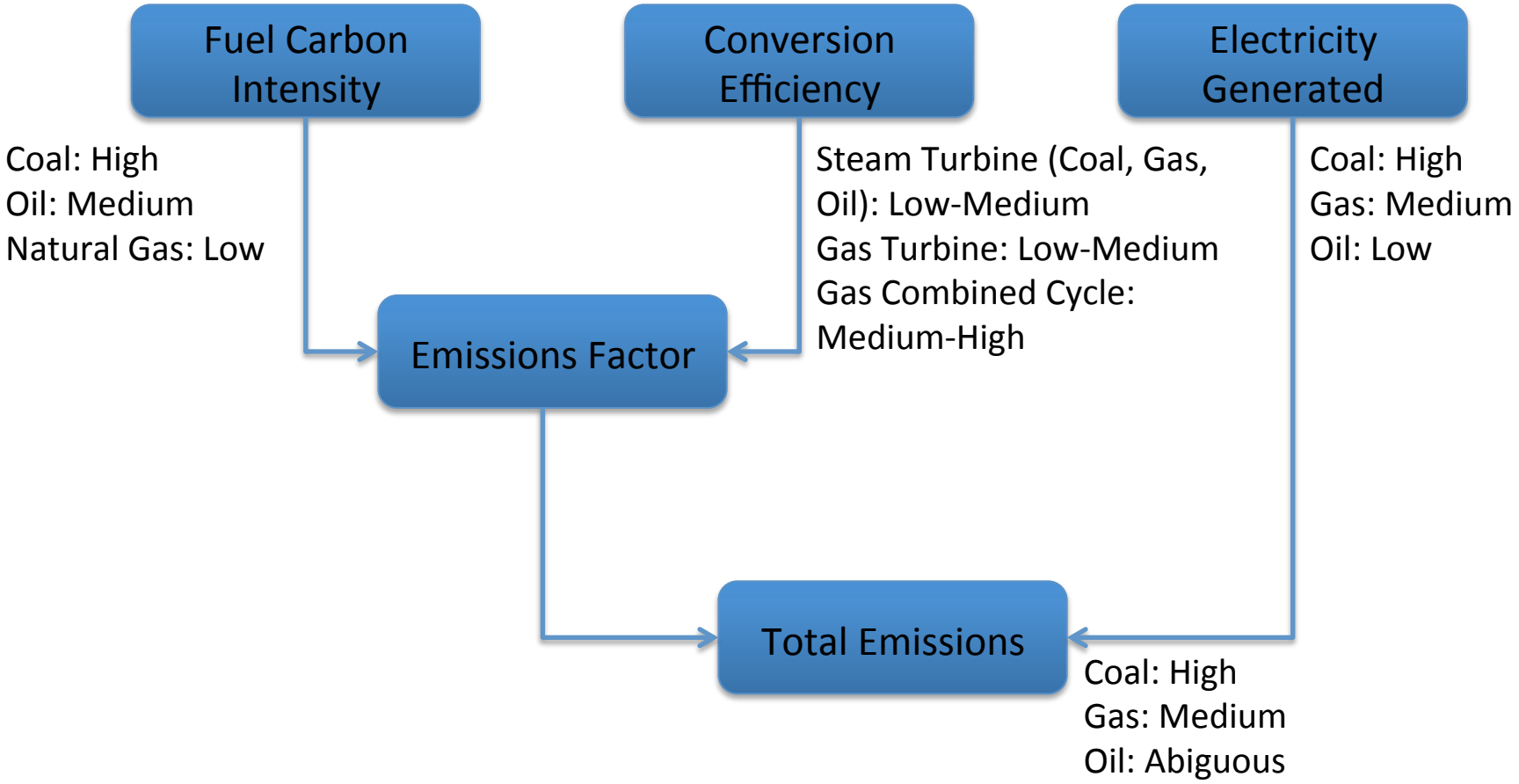
Efficiencies

Type	Efficiency
Steam Turbine (coal, oil, gas)	30%-40%
Gas Turbine	25%-50%
Combined Cycle	45%-70%

How to calculate emissions due to electricity produced by different fuel types?



Summary


Fuel Carbon Intensity
Conversion Efficiency
Electricity Generated
Coal: High
Oil: Medium
Natural Gas: Low
Steam Turbine (Coal, Gas, Oil): Low-Medium
Gas Turbine: Low-Medium
Gas Combined Cycle: Medium-High
Coal: High
Gas: Medium
Oil: Low
Emissions Factor
Total Emissions
Coal: High
Gas: Medium
Oil: Abiguous

Summary

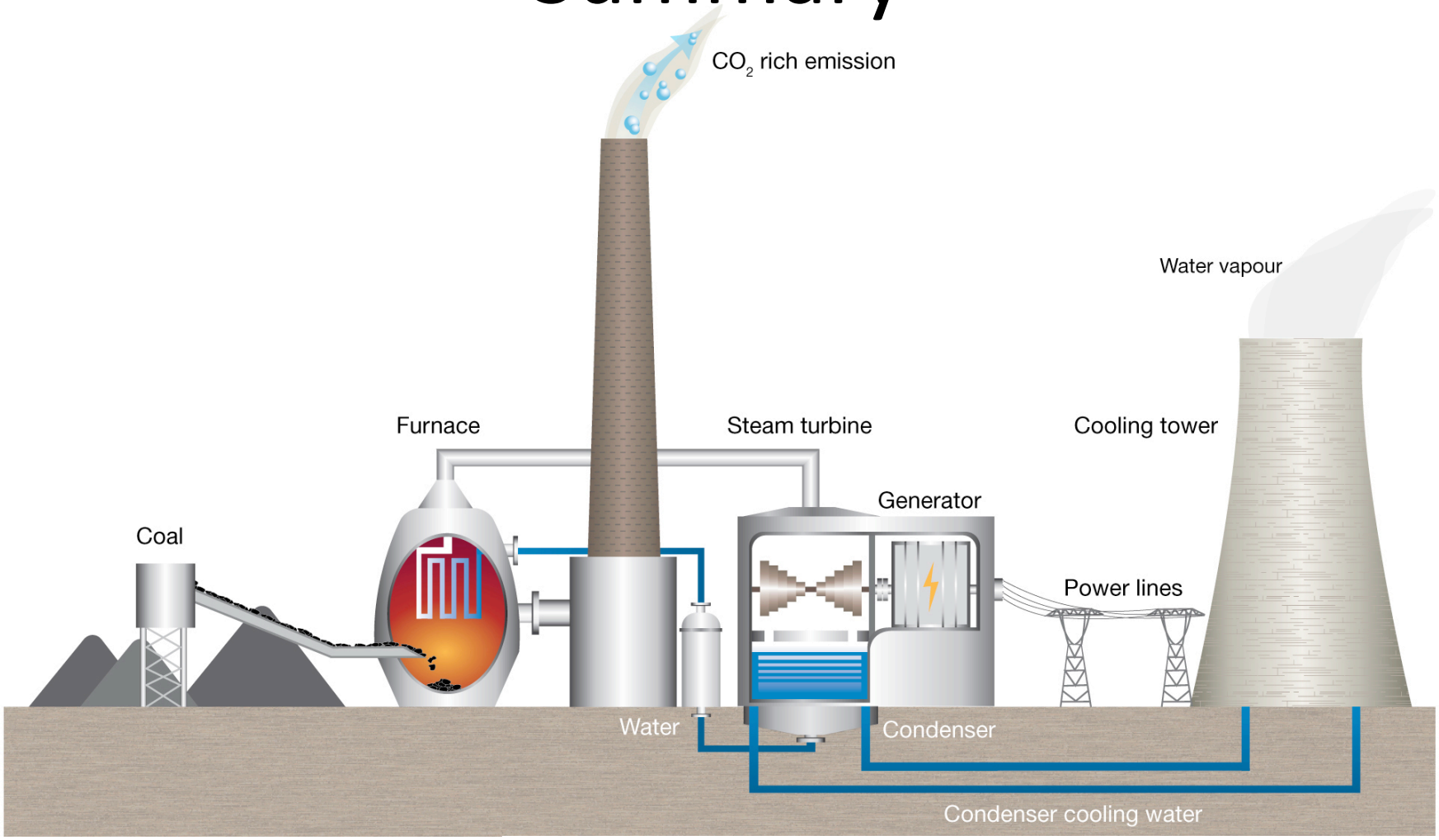


Figure Source: CO2CRC

What do we do?

Some ideas:

- Energy efficiency
- Demand reduction
- CCS
- Renewables