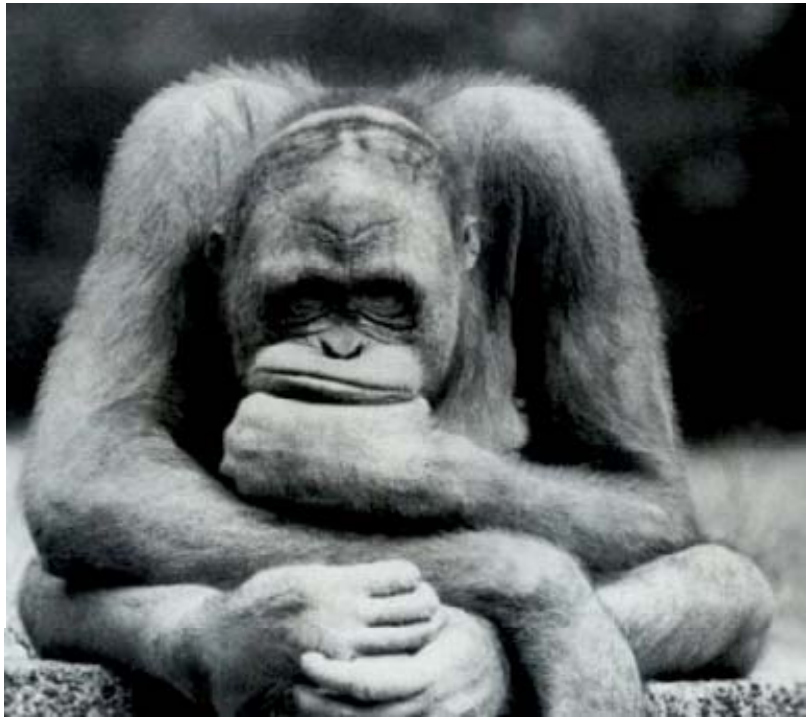
Energy, What now?



Outline for "Energy, Now What?"

- ***Why do we need it and how much do we need?***
- ***How much are we using?***
- ***Where do we get our energy?***
- ***All Fossil Fuels are not created equal: Coal is a real threat***
- ***What are the trends in energy use?***
- ***Who is using all this energy, anyway?***
- ***How can we cover our future needs? A hypothetical scenario.***
- ***Renewables: which ones make sense?***
- ***Efficiency: A revolution waiting to happen***
- ***What is our concept of sustainability?***
- ***Are Eco-freaks protecting the planet?***

How Much energy do we need to survive?

The 100 Watt survival level

The human body needs about 100 Watts of power to run

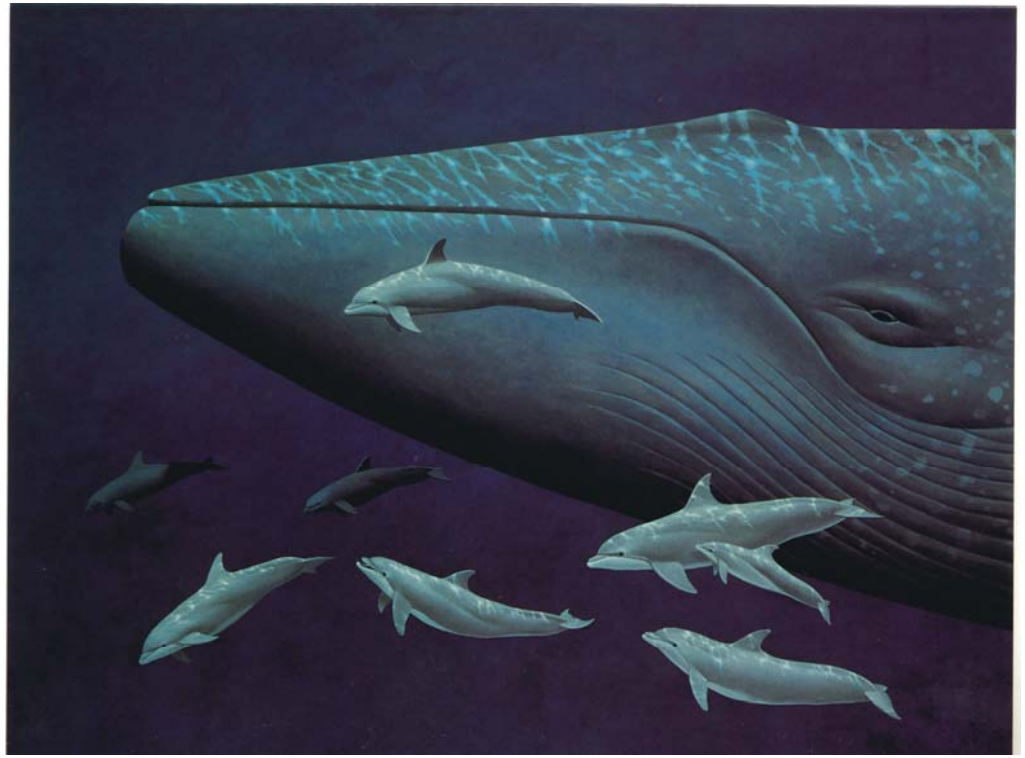
some need more than others...

How Much energy are we using?

The average western energy consumption for an individual is the equivalent of 50-100 human power

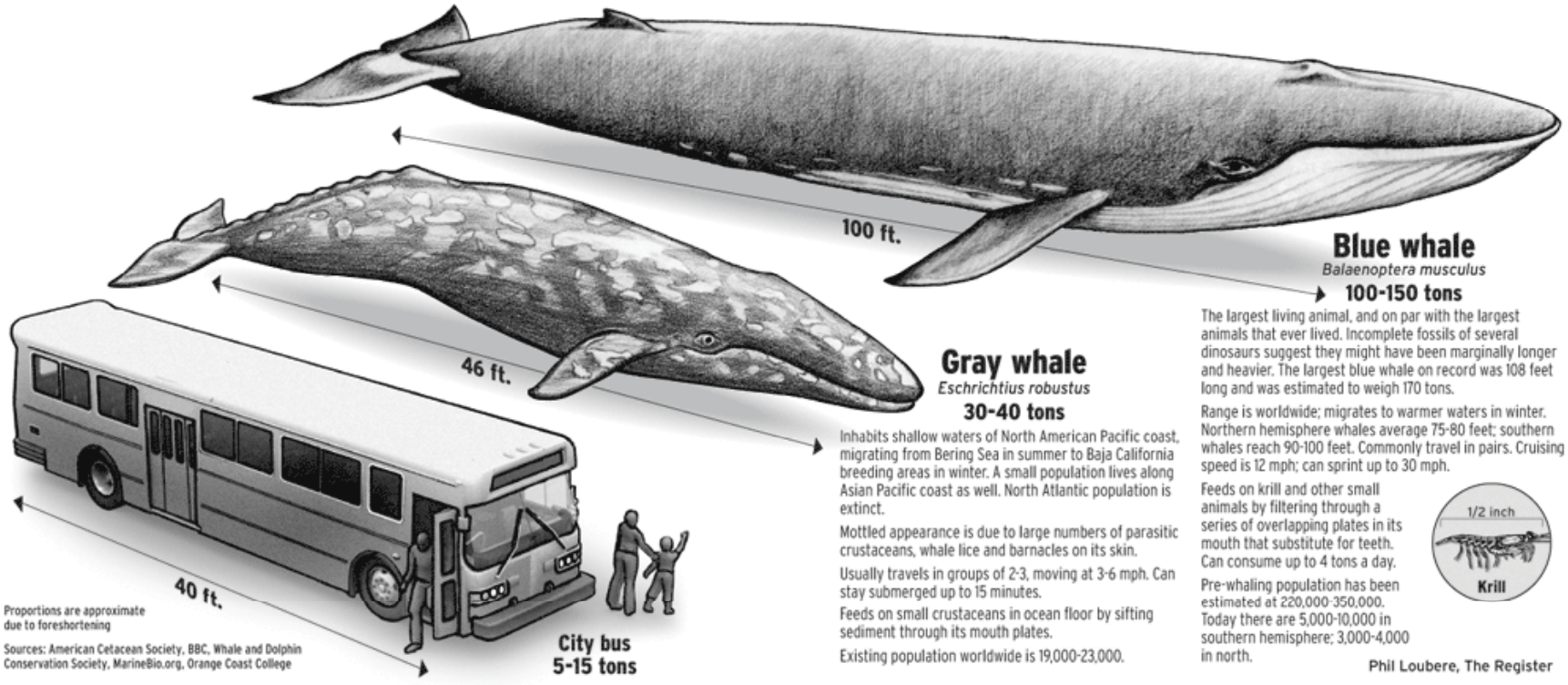
Why do we all need so many slaves?

The mass of coal needed to produce the energy for a family of four for one year in the US today is about the same as that of a healthy blue whale.



This is about the same amount of Carbon pollution produced by that family in one year.

The size of things: An average US family burns a pile of coal equal to the mass of a Blue whale every single year.



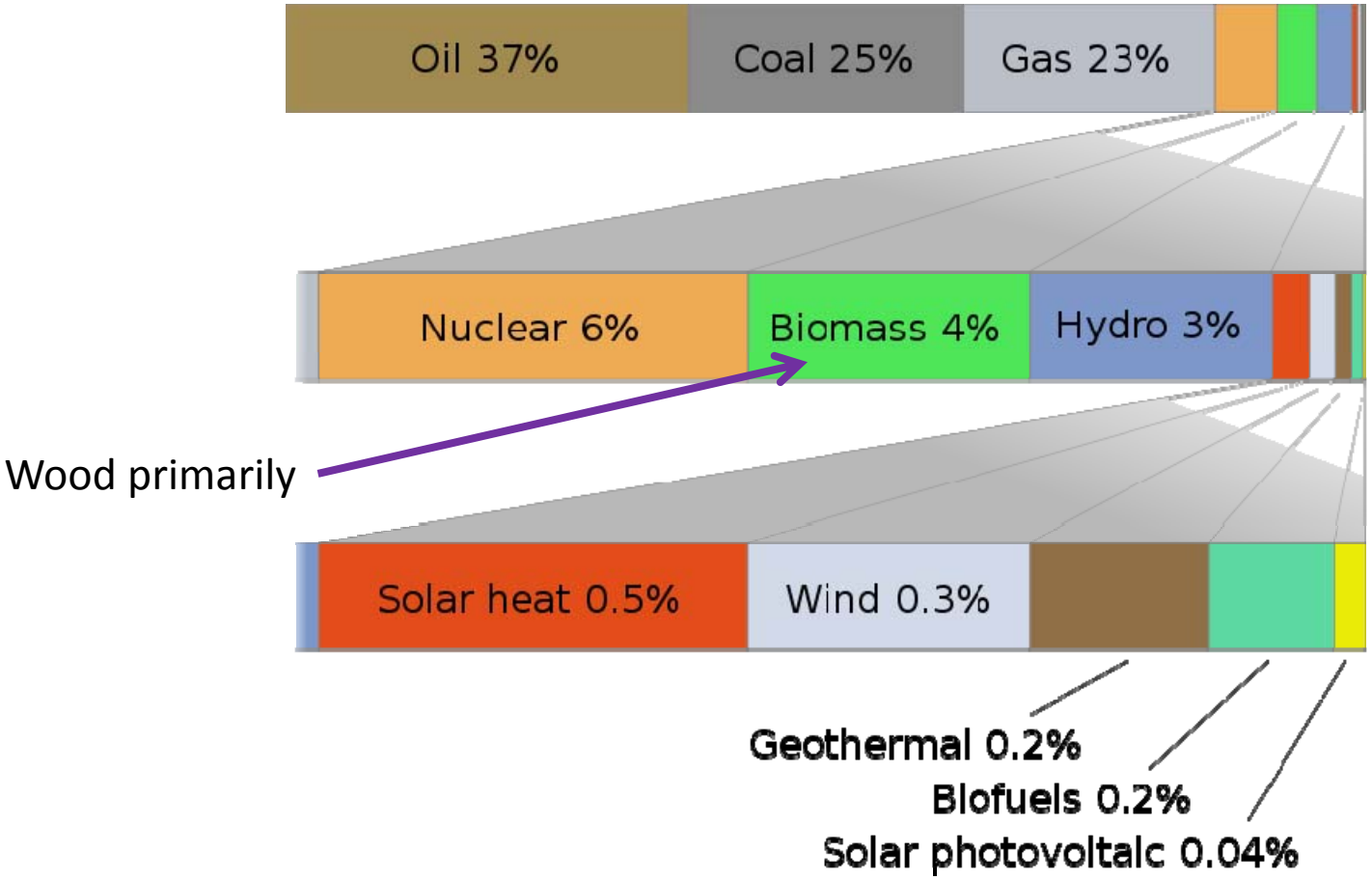
In Germany, energy use is lower and things aren't as bad. It is only a gray whale.

A conversation in a parallel universe where CO_2 sinks

Where does our energy come from?

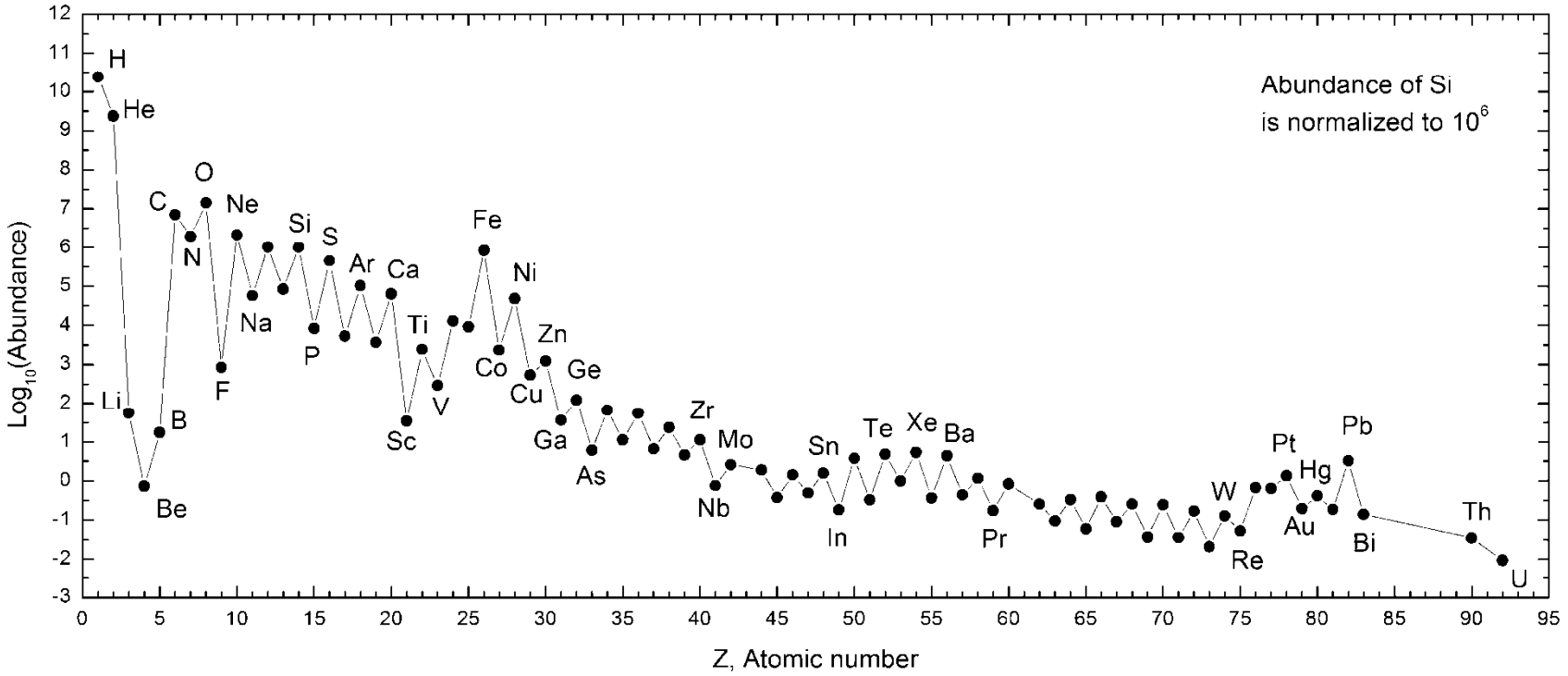
The short answer is: We burn things!

Where does our energy come from?

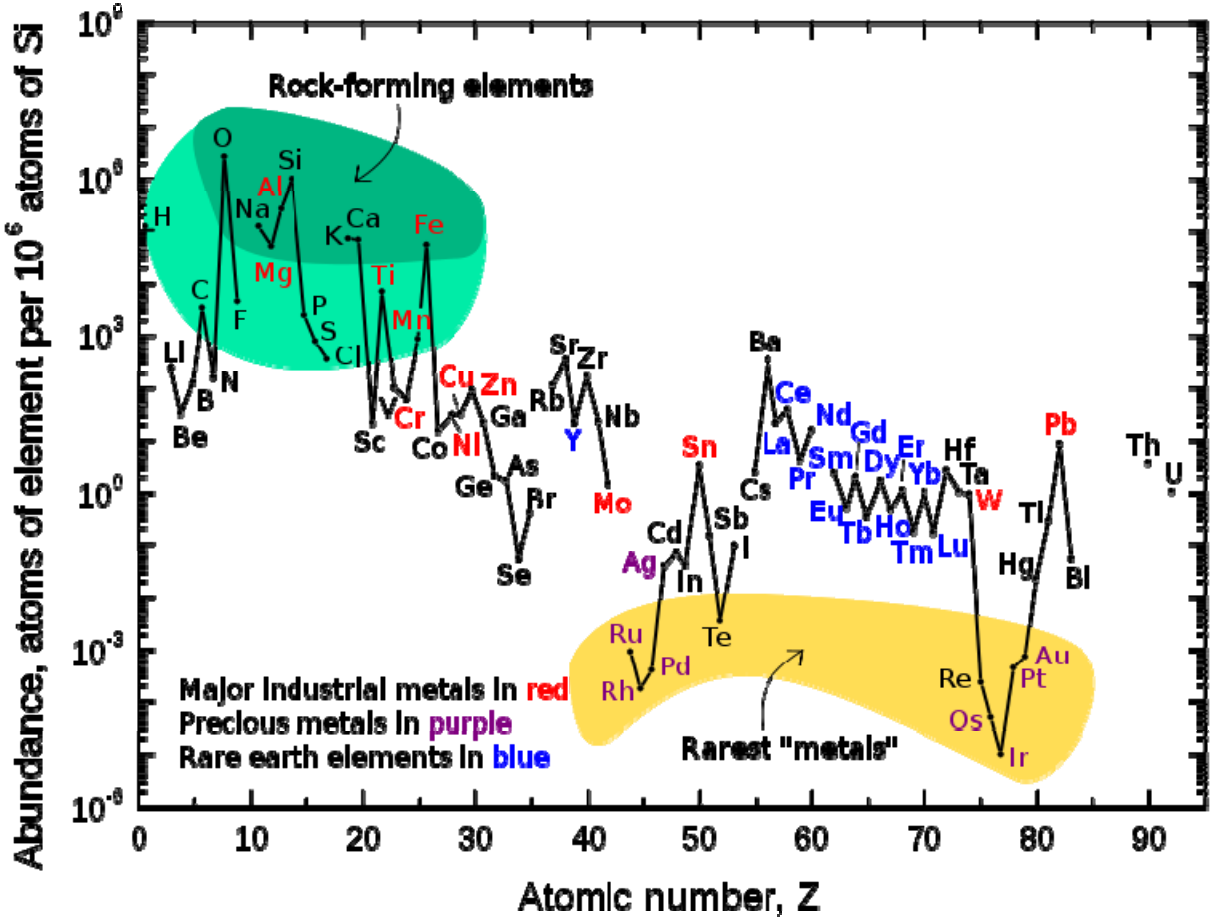


Where does all the carbon come from?

Natural abundance of the elements in the universe



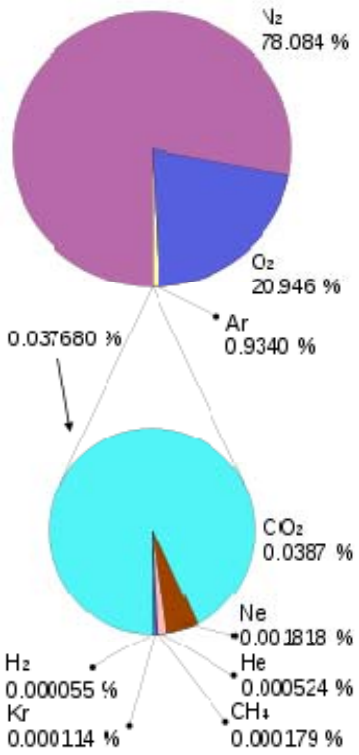
Natural abundance in the Earth's Crust



The Earth's crust is loaded with Carbon

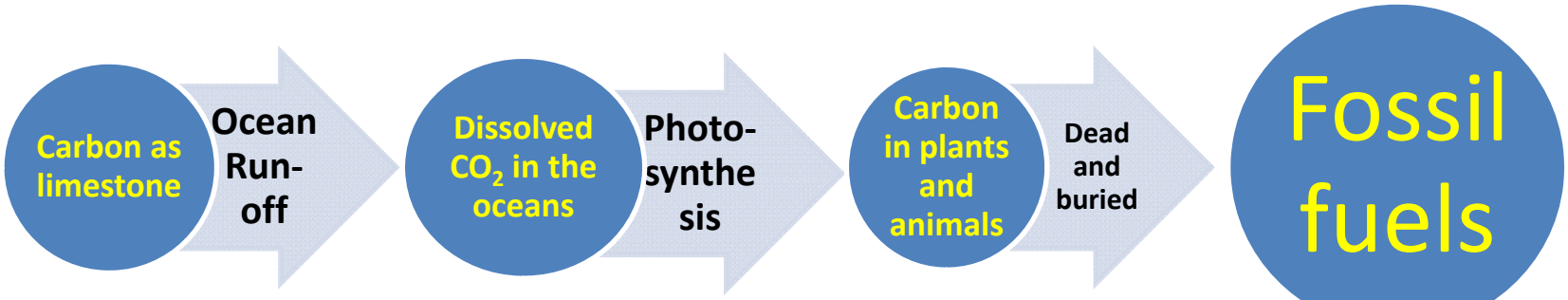
Limestone ($CaCO_3$) Cliffs in Corsica France

The Earth's modern atmosphere containing Oxygen comes from photosynthesis



CO_2 is absorbed
O_2 is emitted
And Carbon is built into the plant's body

Carbon migration over the last 500 million years



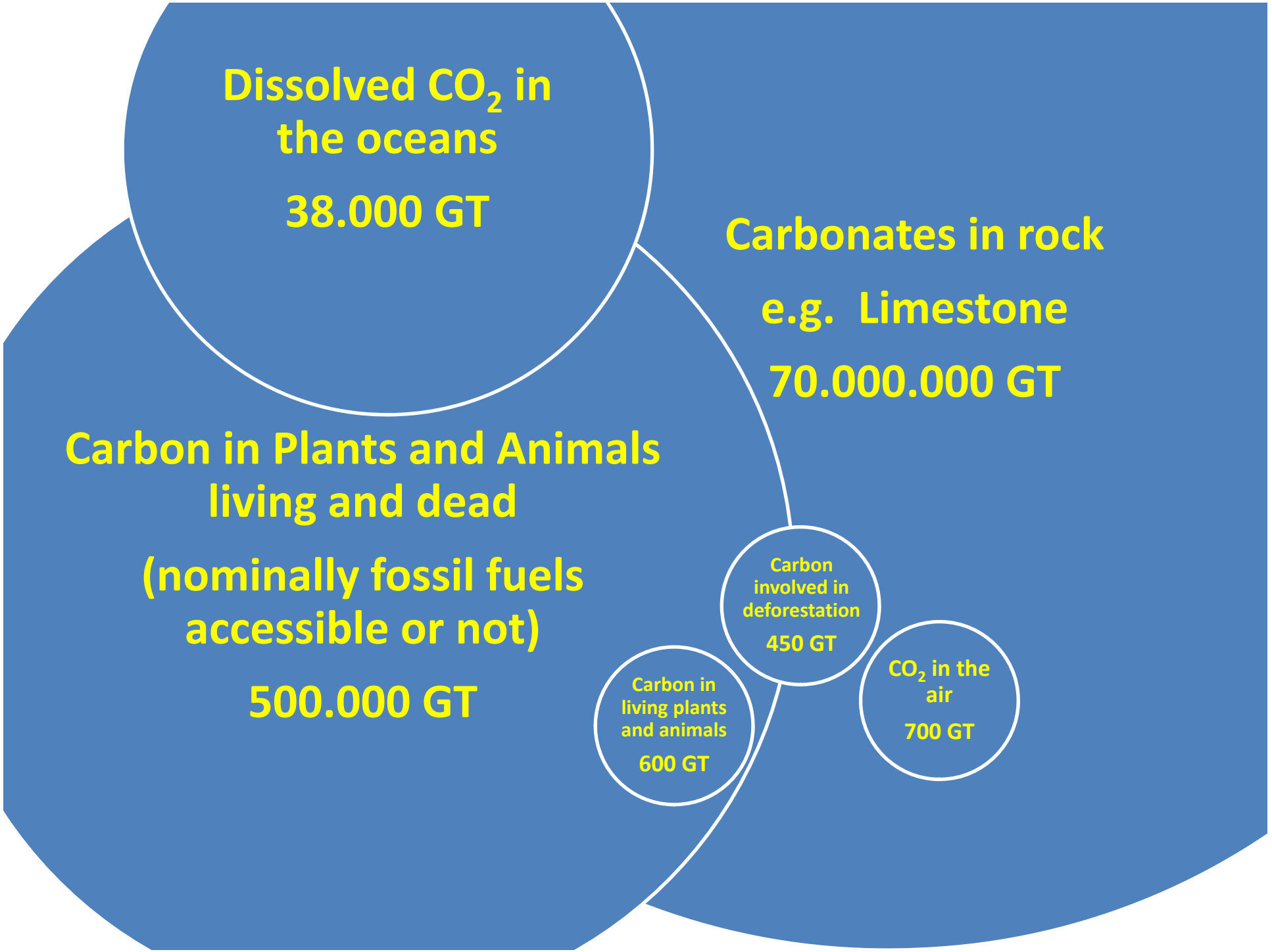
70 million GT

38 thousand GT

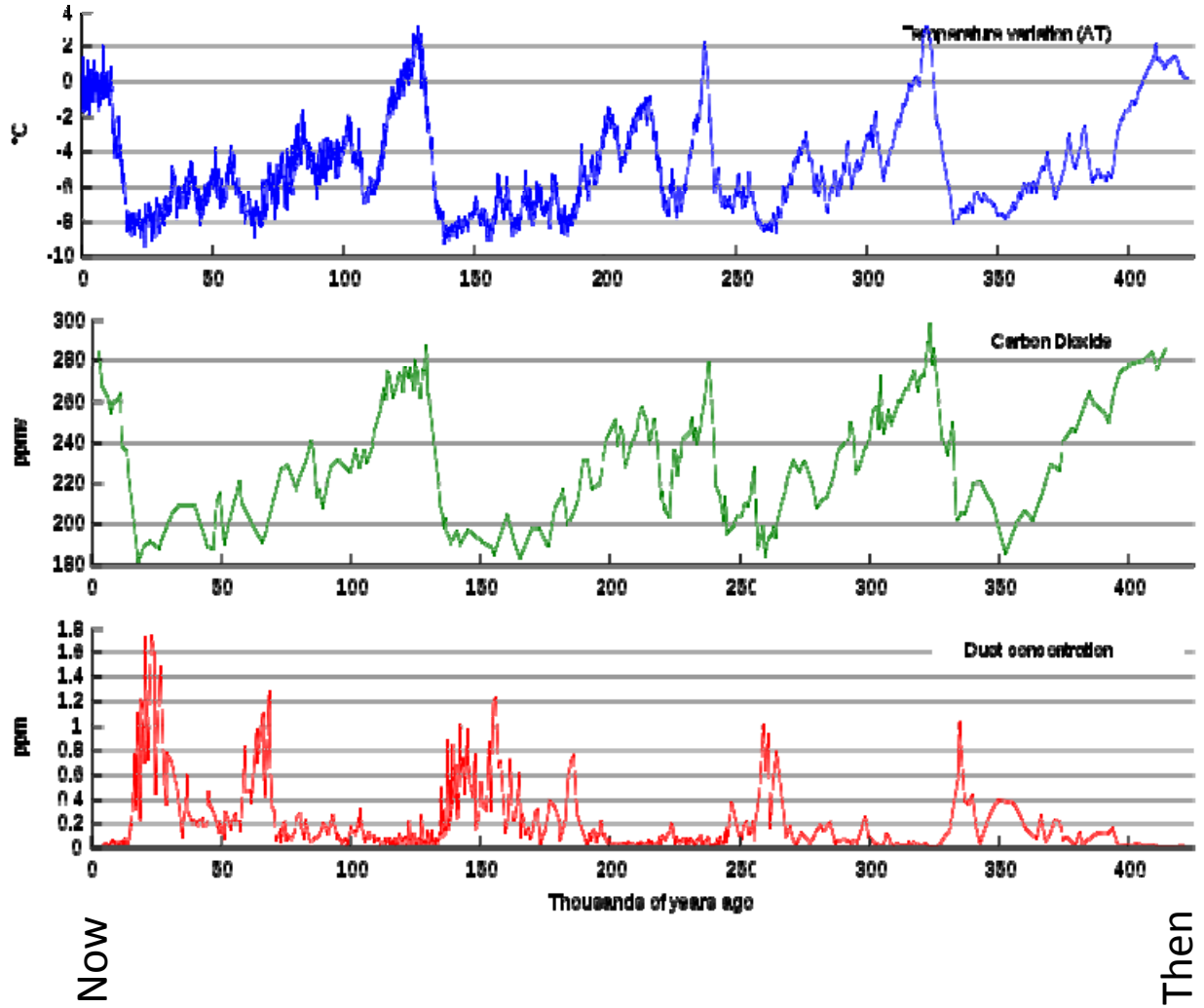
600 GT living

500.000 GT

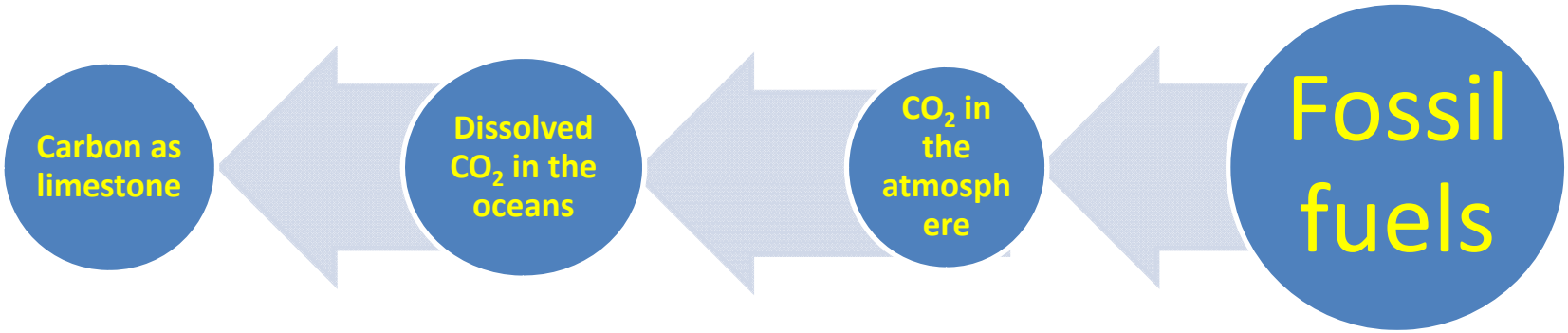
750 GT


Dissolved CO_2 in the oceans
38.000 GT
Carbonates in rock
e.g. Limestone
70.000.000 GT
Carbon in Plants and Animals living and dead
(nominally fossil fuels accessible or not)
500.000 GT
Carbon involved in deforestation
450 GT
Carbon in living plants and animals
600 GT
CO_2 in the air
700 GT

The Carbon record over the last 400.000 years



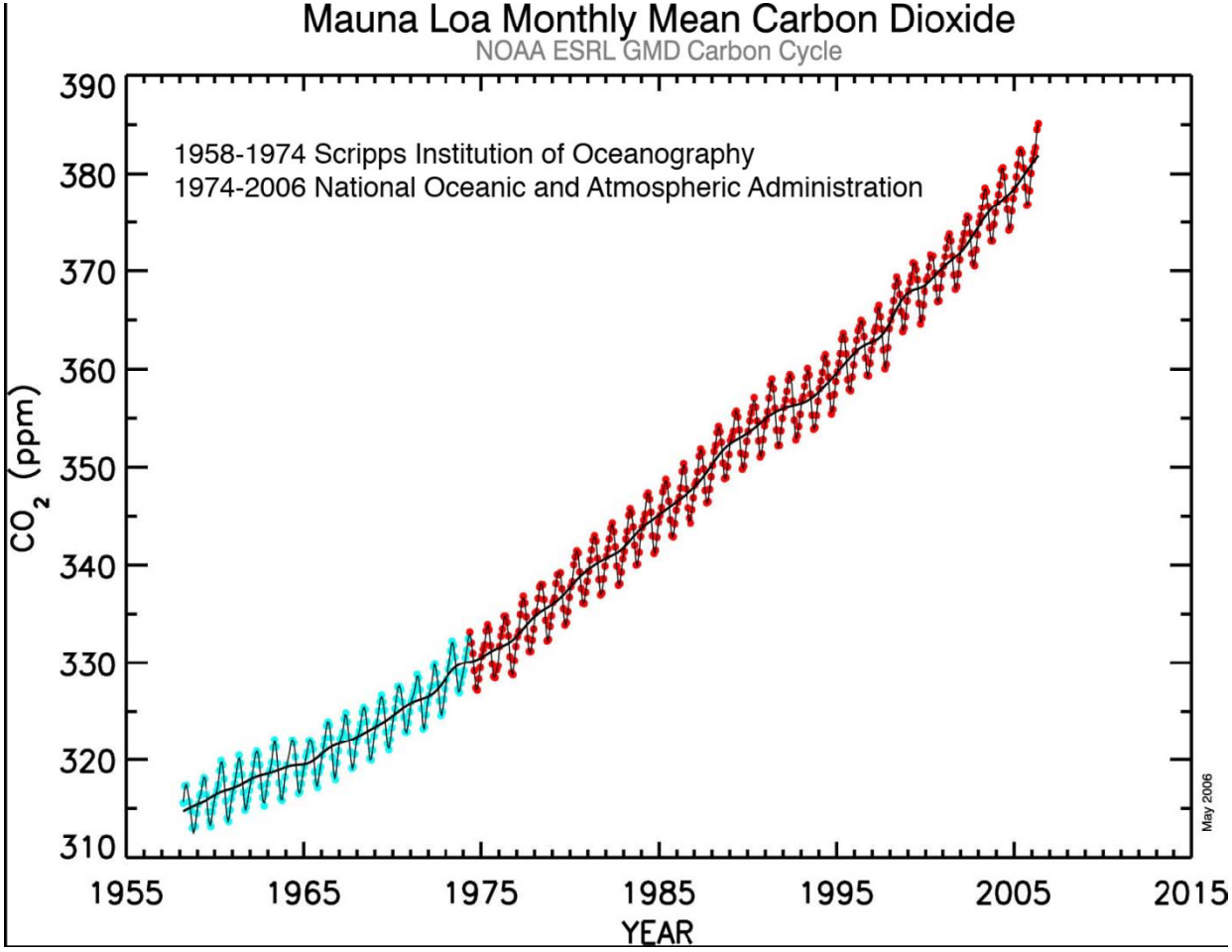
We've reversed the carbon migration direction



500.000 GT

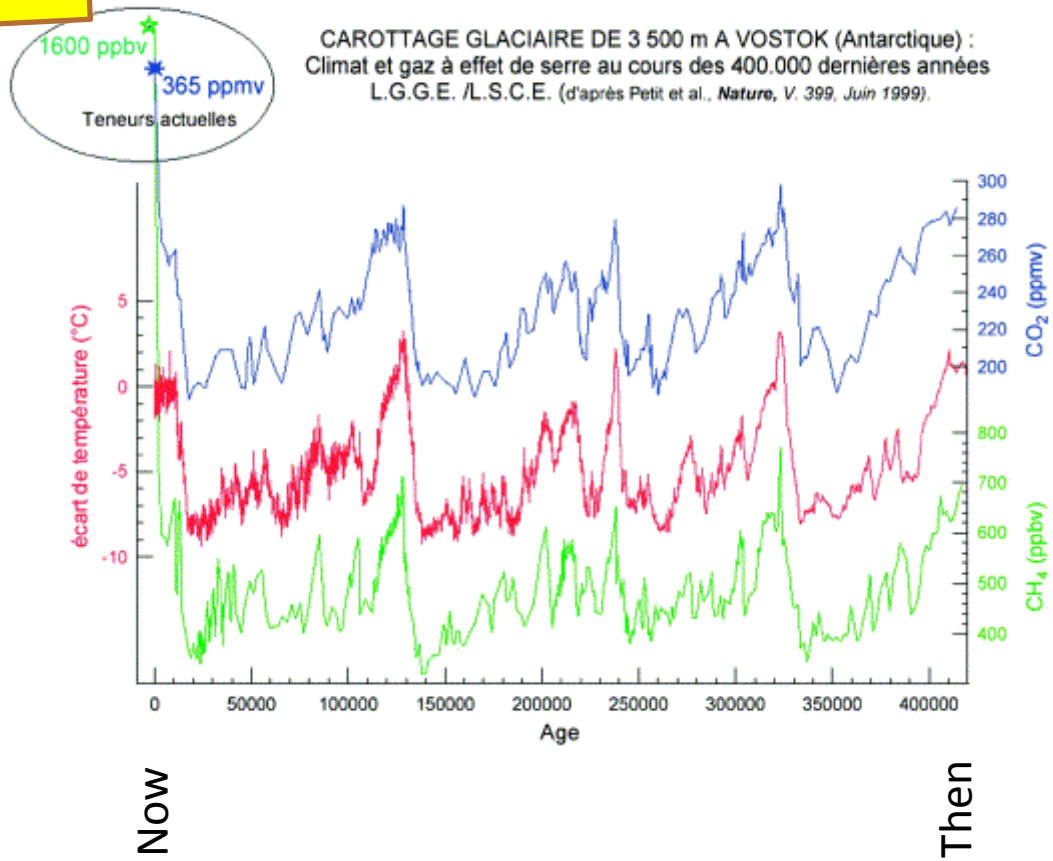
And sped it up by a factor of one million

Modern atmospheric carbon record

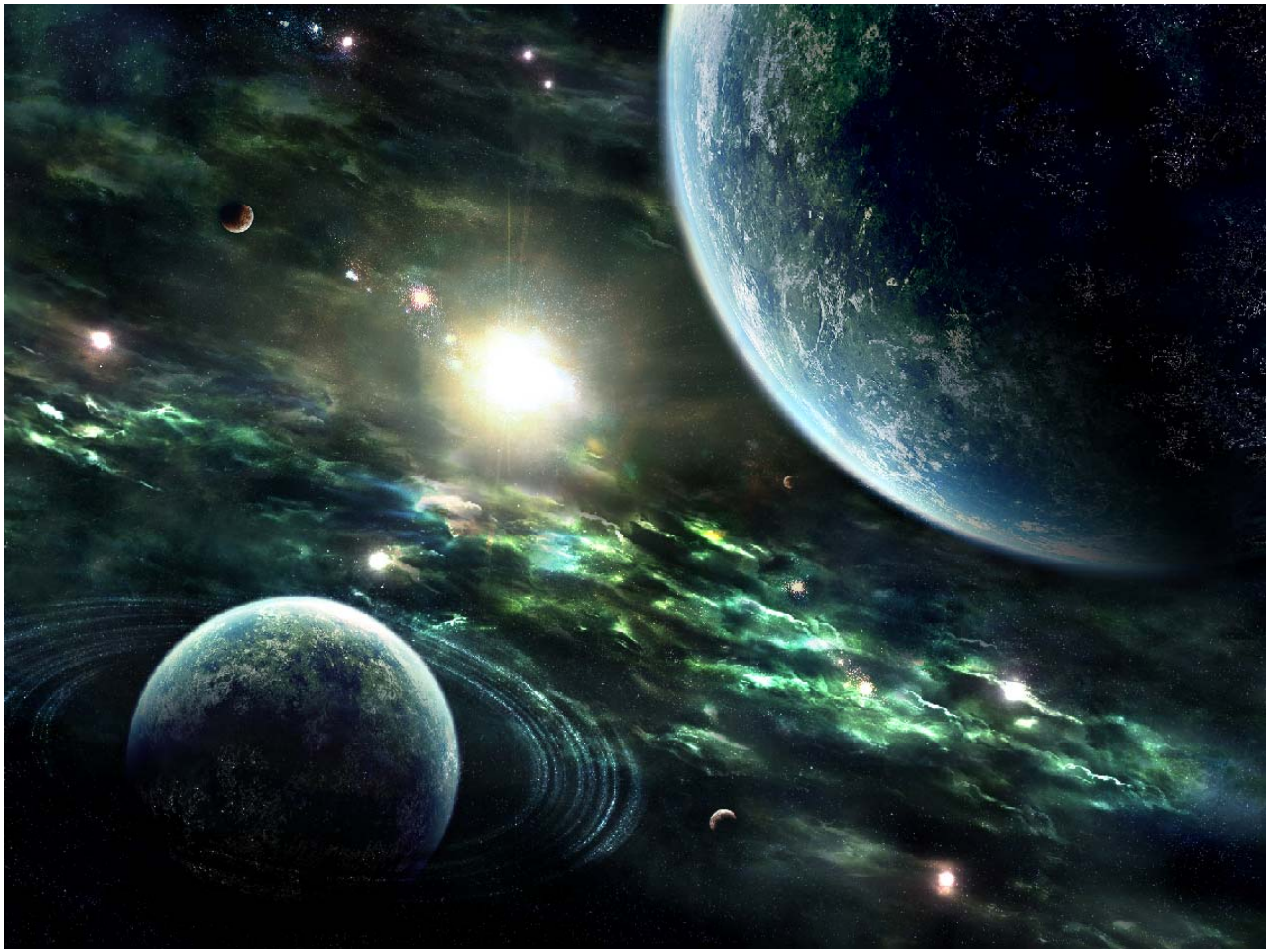


Highest known concentrations of CO_2 and methane in planetary history

Vostok Ice-core Data



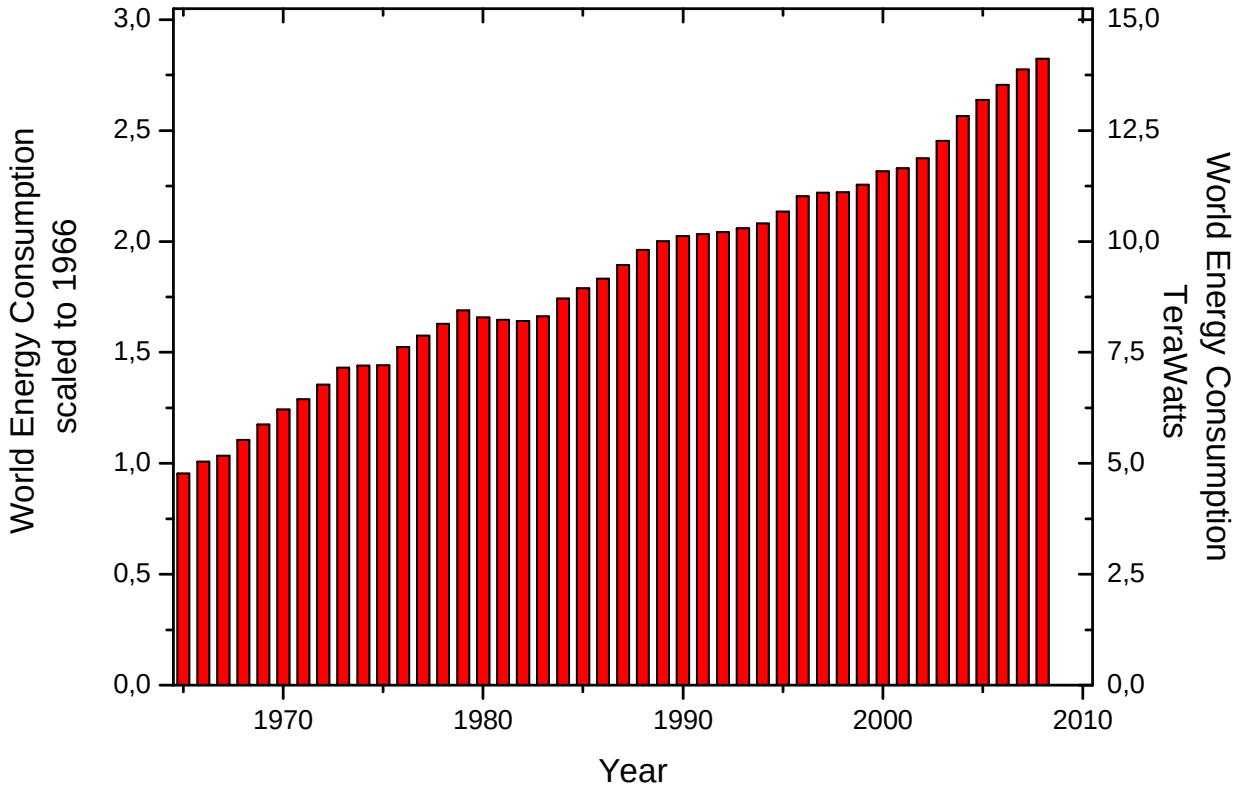
We are doing an experiment on the planet, whose outcome is unknown…



The outcome of this experiment is too uncertain to continue on the only planet we have.

What are the trends in energy consumption

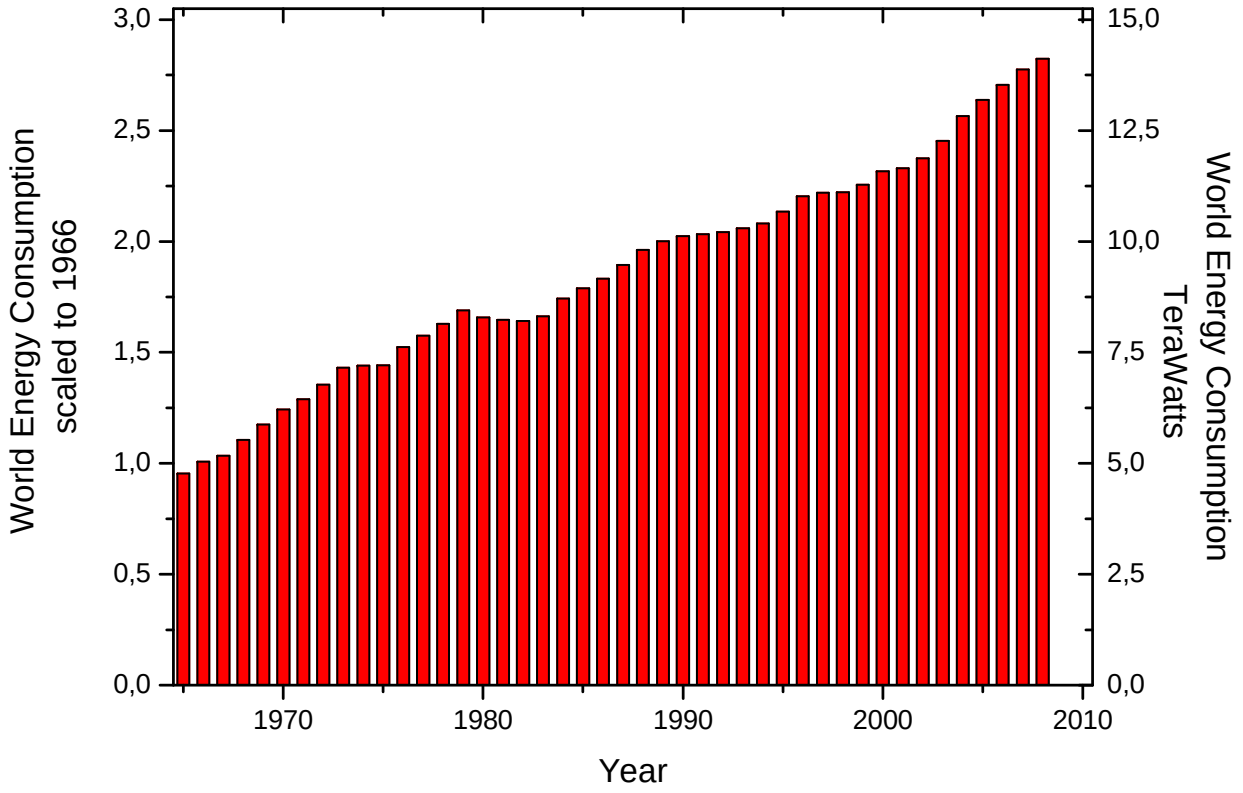
World energy consumption over the last 50 years. Three times increase.



How much is a Terawatt?

If everyone in the world turns on a Color TV that's about a **TeraWatt**. The world uses 15 TWatts and consumption is growing.

World energy consumption over the last 50 years. Three times increase.



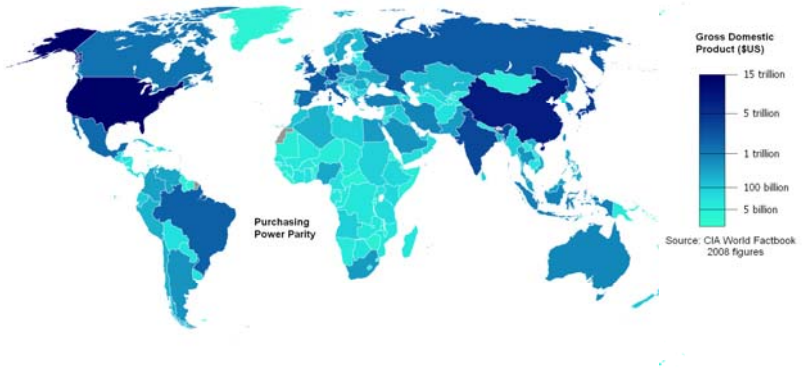
If it takes us 50 years to find a new way and to put into place a plan to produce 15 TWatts of power, will the world be using 25 TWatts by the time we are done?

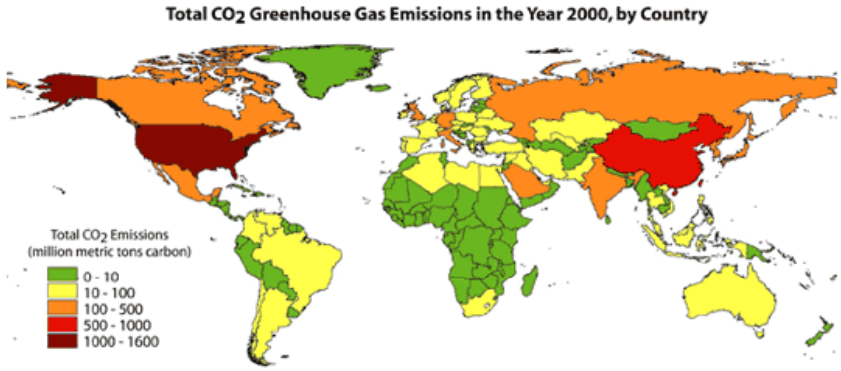
It’s a question of lifestyle, not population

So-called primitive cultures live closer to the 100 Watt survival level than we are accustomed to.

We in the so-called developed countries have a different lifestyle.

Who consumes energy?

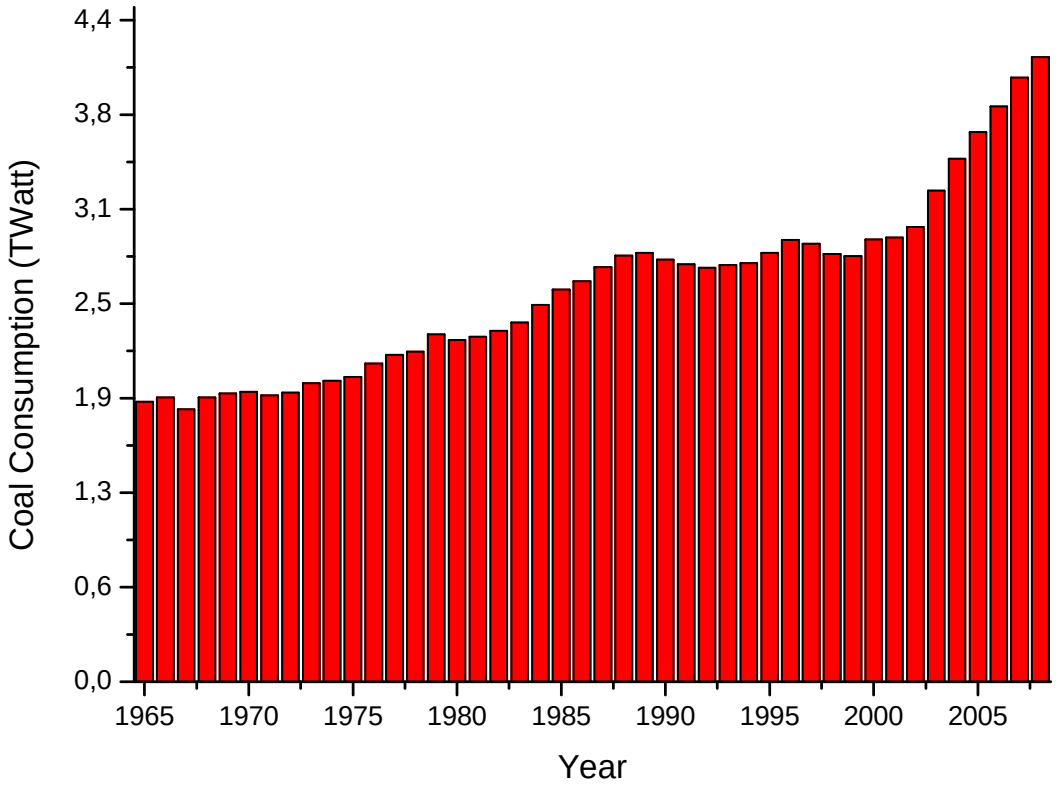




CO_2 pollution roughly correlates with the wealth of a nation.

Its not the "population bomb" we have to worry about. It's the "Affluence Bomb"

Coal – A major threat to the Climate



Coal produces twice as much CO_2 for every unit of energy compared to natural gas. And it is the fastest growing source of power in the world.
An increase of 1.5 TWatts since 2000.

All fossil fuels are not created equal

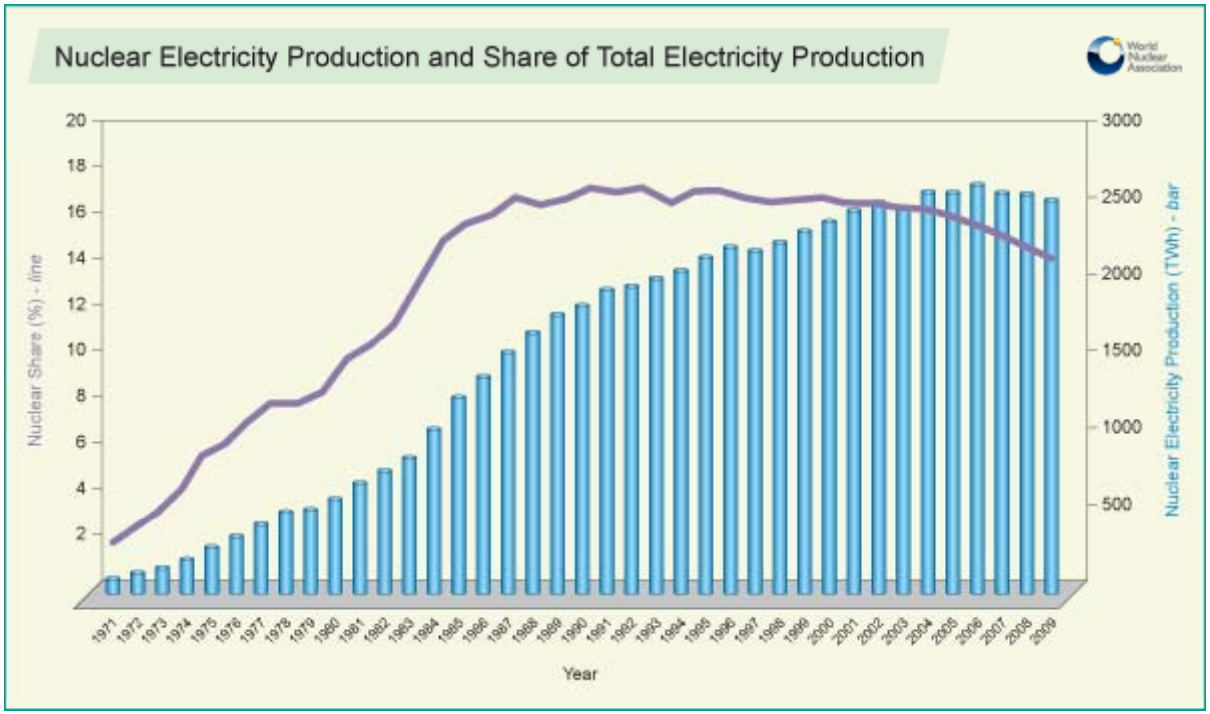
If we manage to convert all coal usage to natural gas, we could reduce Carbon emissions by twice the Kyoto protocol.

How can we cover our future energy needs without fossil fuels?

We would need 15-30.000 new nuclear reactors in the next 50 years

There are presently 500 world wide and 60 under construction

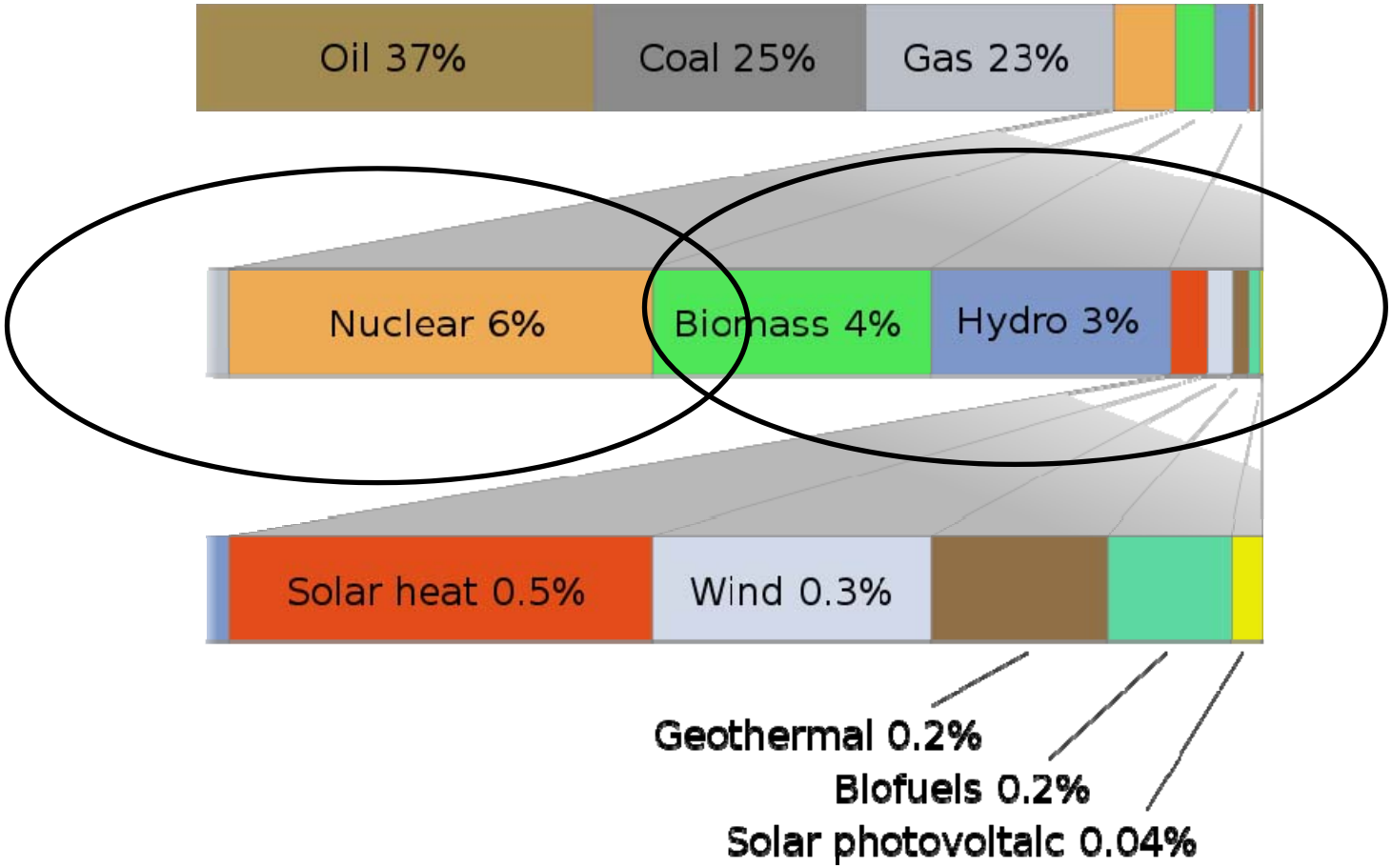
Nuclear power: The only sector of the energy industry that is actually shrinking



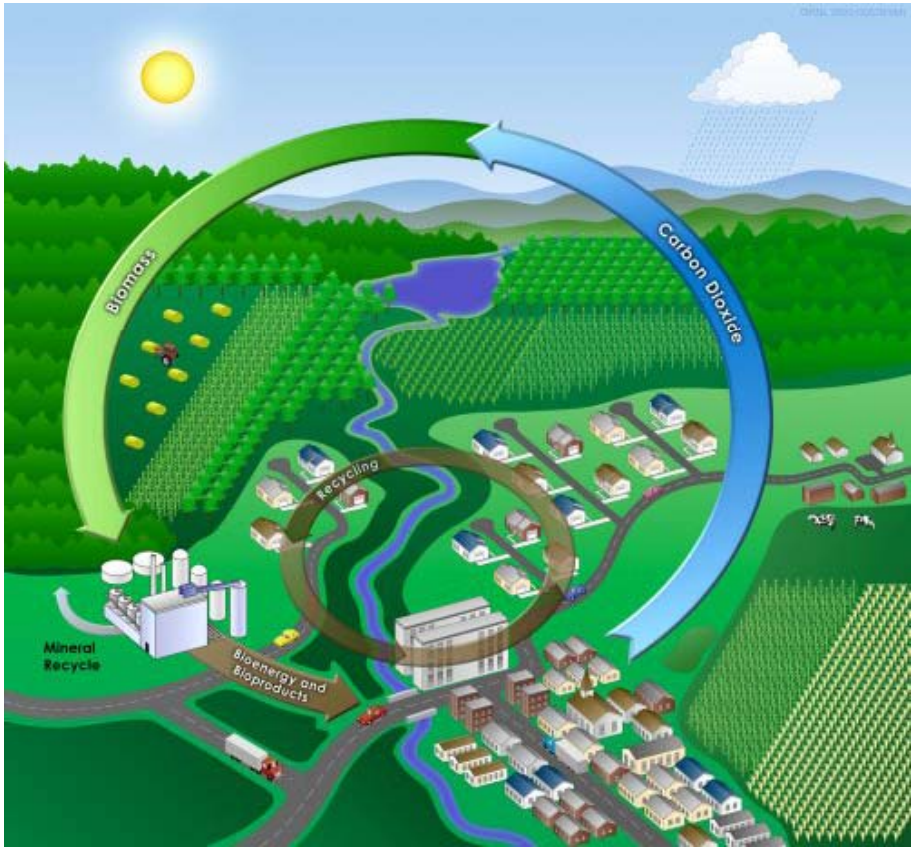
Nuclear powers share of the electricity production has been falling for 25 years and the total [electricity production](#) from nuclear has been falling for 5 years. This during a "Nuclear Renaissance."

The political winds are shifting

Where our energy comes from



In 2011 biomass means burning wood



Reforestation has the potential to remove hundreds of GTons of Carbon from the atmosphere.

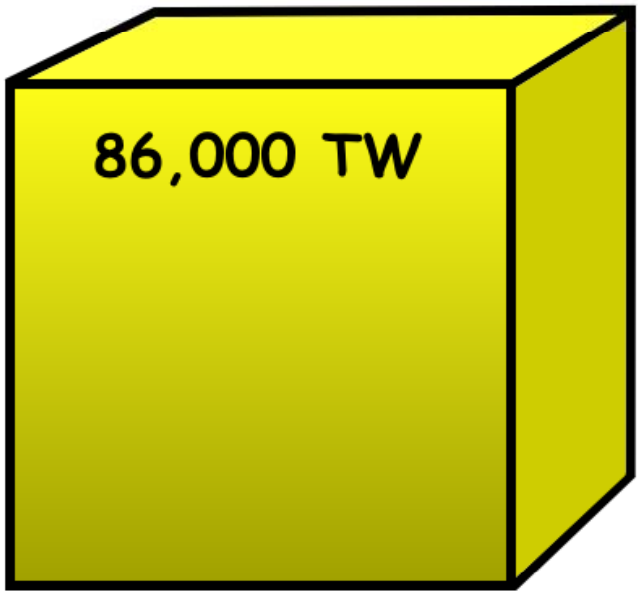
Hydro-electric

No more room to build dams

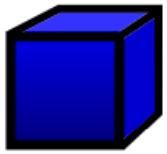
Biofuels are a little less than exciting

If you have to burn fossil fuels to make biofuels, are we really winning?

Where are the big energy pools?



Solar



Wind

Geothermal

Global Consumption

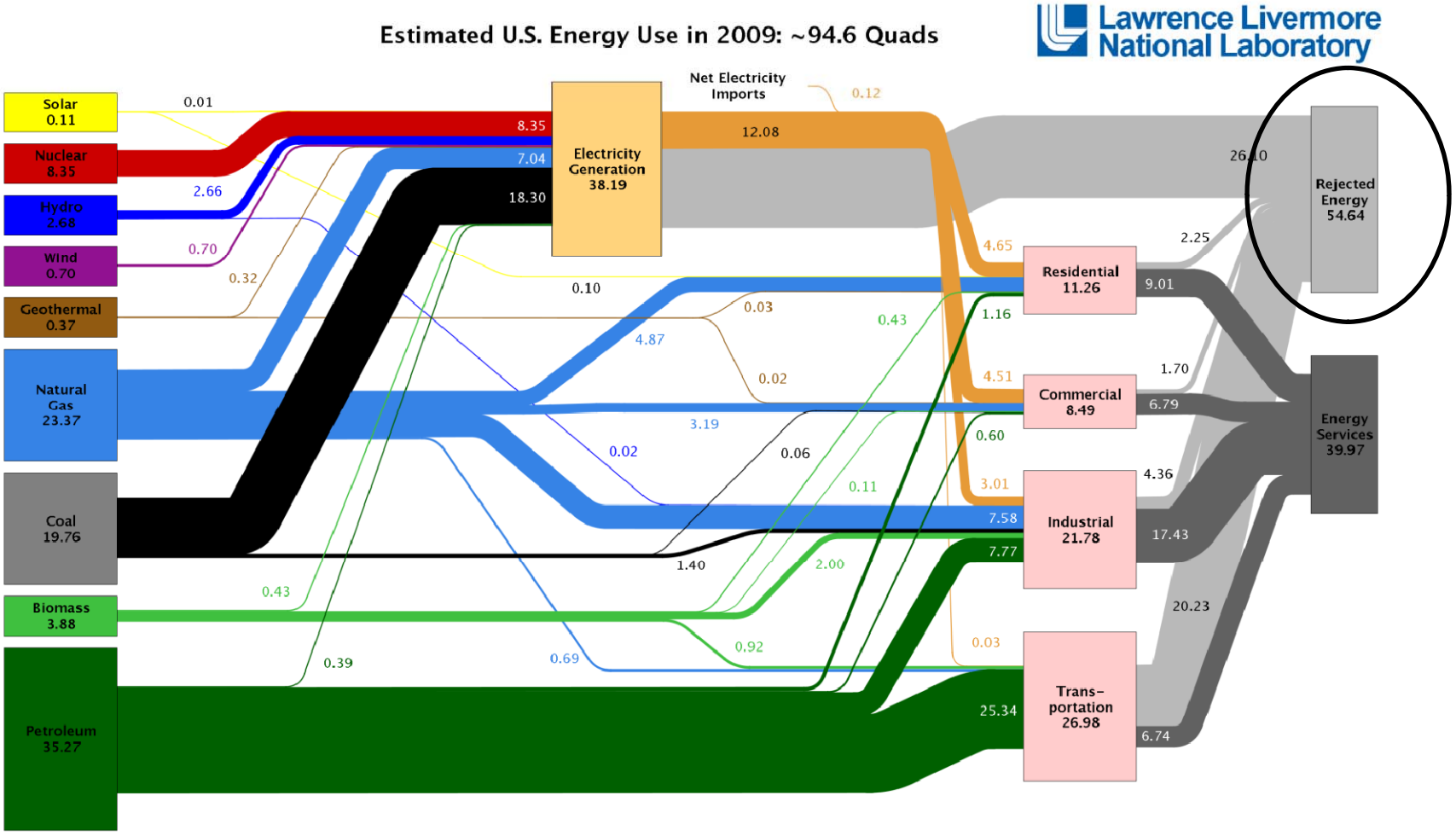
We need 100 x growth in Solar wind and geothermal to cover 15 TWatts. Can we do this in 50 years?

A possible scenario 50 years in the future

- 15 TWatts from Solar thermal, Wind and Geothermal
- 10 TWatts from natural gas
- Major improvements in consumption habits and fuel efficiency
- Liquid Fuels will have run out
- Coal will have been controlled by international agreement like CFCs were.

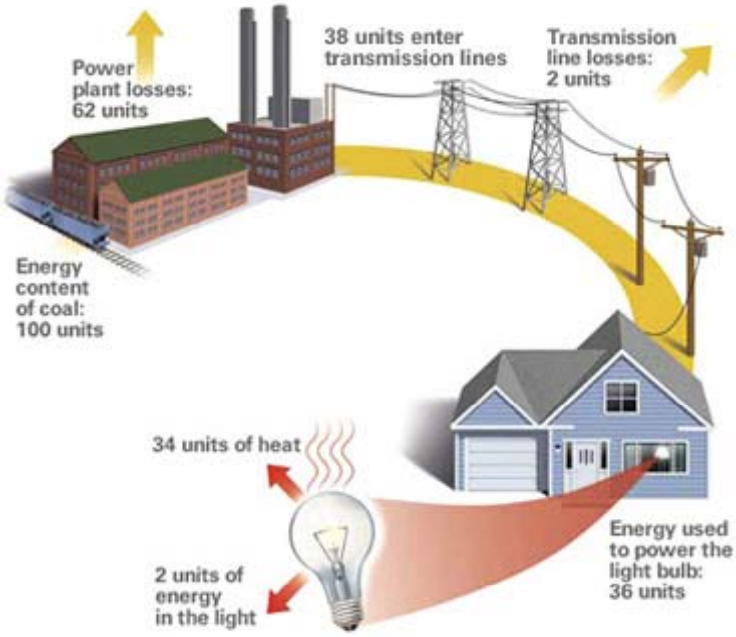
Energy Efficiency

Energy flow in the US



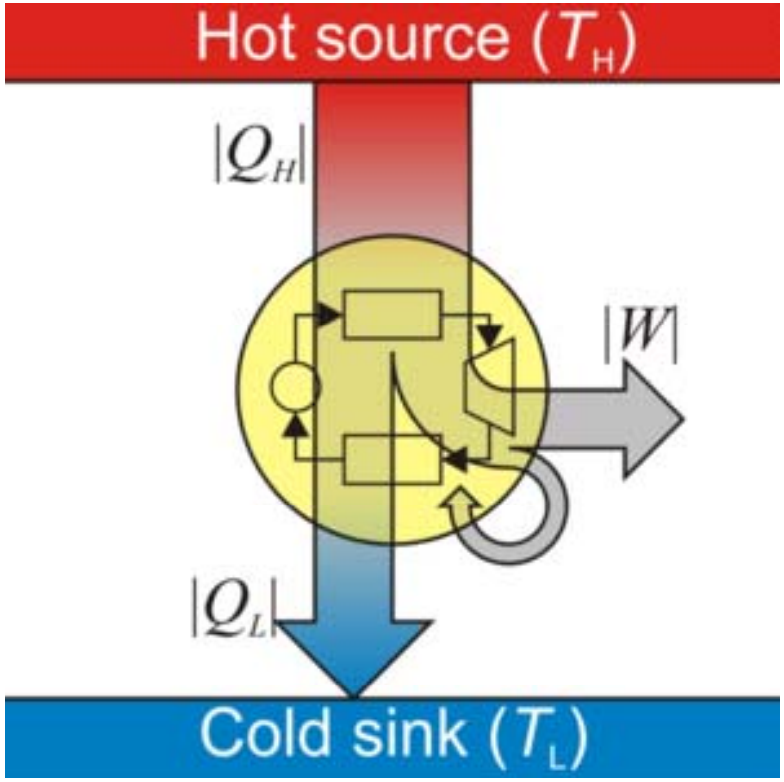
About 60% of the energy consumed in the US in 2009 went up the smoke stack as "rejected energy"

Incandescent light-bulbs are 2% efficient



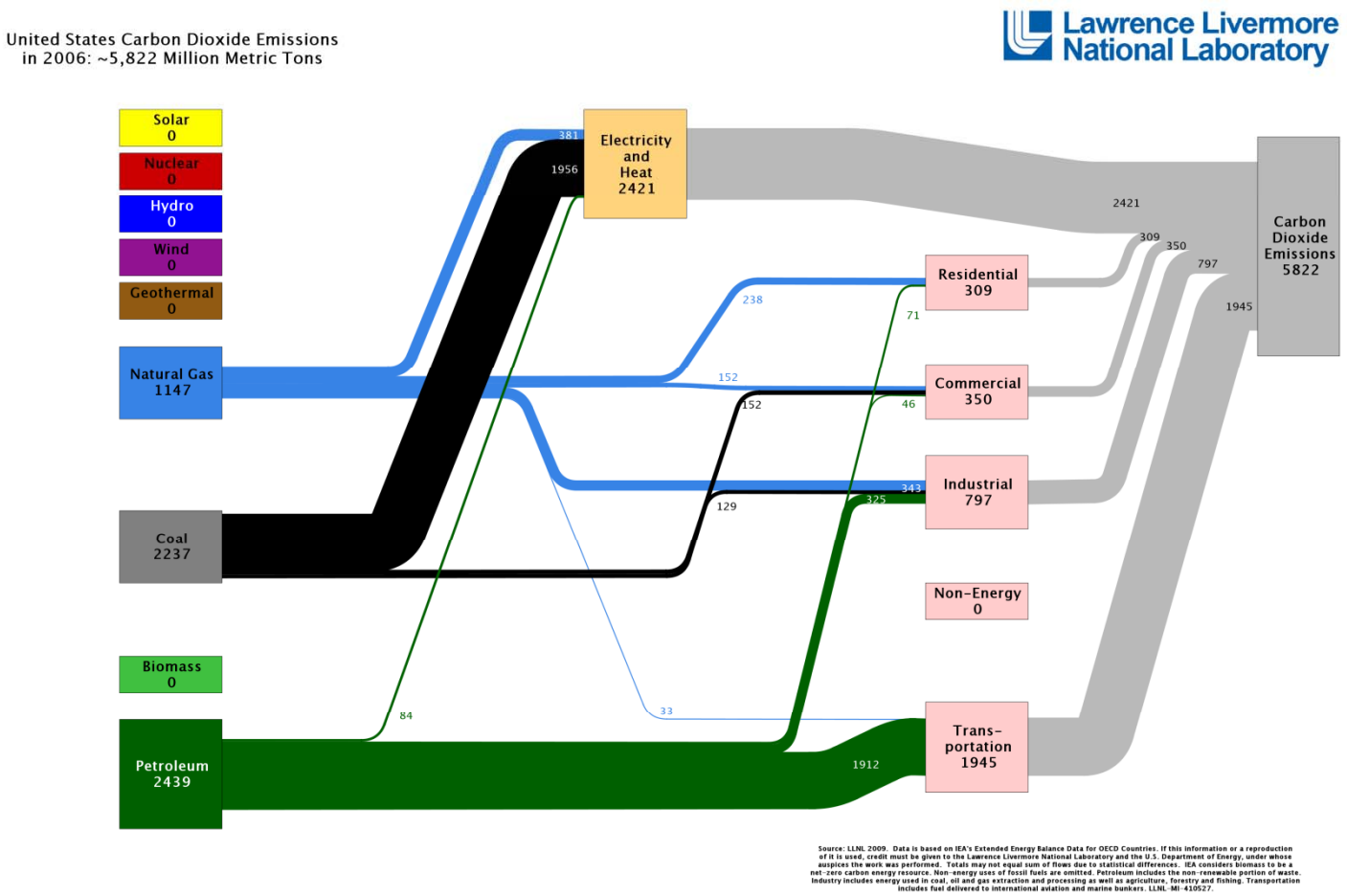
- Production losses burning coal to produce electricity
  - 62% goes up the smokestack
- Transmission losses
  - 2% lost heating the transmission lines
- Incandescence produces heat and light
  - Mainly heat

Natural Laws mean that heat engines have efficiencies of about 35%



And the 65% wasted energy is up the stack as CO_2

Carbon flow tracks the wasted energy flow



The ingredients of a solution 50 years down the road

- 15 TWatts from Solar thermal, Wind and Geothermal
- 10 TWatts from natural gas
- Major improvements in consumption habits and efficiency
  - Especially concerning electricity generation and transportation
- Liquid Fuels will have run out
- Coal will have been controlled by international agreement like CFCs were.
- International agreement and initiative on reforestation to relieve the CO_2 traffic jam in the atmosphere.

Six nations in confederacy

The real Americans

The Iroquois believed in taking into consideration the interests of the 7th generation in making political decisions. This is what a politics of sustainability would look like.

The planet doesn't need saving

Easter Island failed because they could not imagine that they might

Never saw it coming

END