reminders

- homework assignment [Thursday midnight] - 2.75%
  - [image in color on website]
- write your own question [Thursday midnight] - +2 points on exam
- details on the website [greenresistance.wordpress.com]

Let’s talk energy :-)

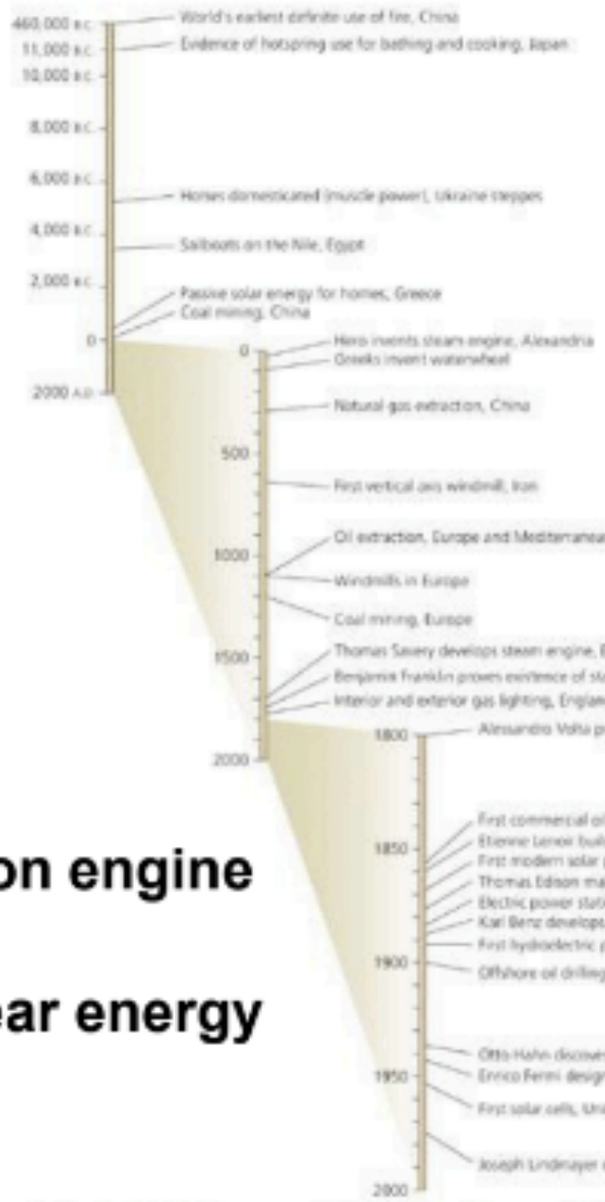
energy
(chapter 2 continued)

- energy sources
- disposable lands; climate change
- energy efficiency
- resistance to fossil fuel extraction / environmental justice
- (The Story of Stuff)

Energy

- **Perpetual**
  - Solar, wind, hydroelectric
- **Renewable, but not on human timescales**
  - Fossil fuels, nuclear
  - Considered **non-renewable**

History of Human Energy Use



Discovery of fire

Agriculture

Muscle power

Use of wind and flowing water

Machines powered by wood, then coal

Internal combustion engine

Nuclear energy

Energy crisis!!

Sources of Energy

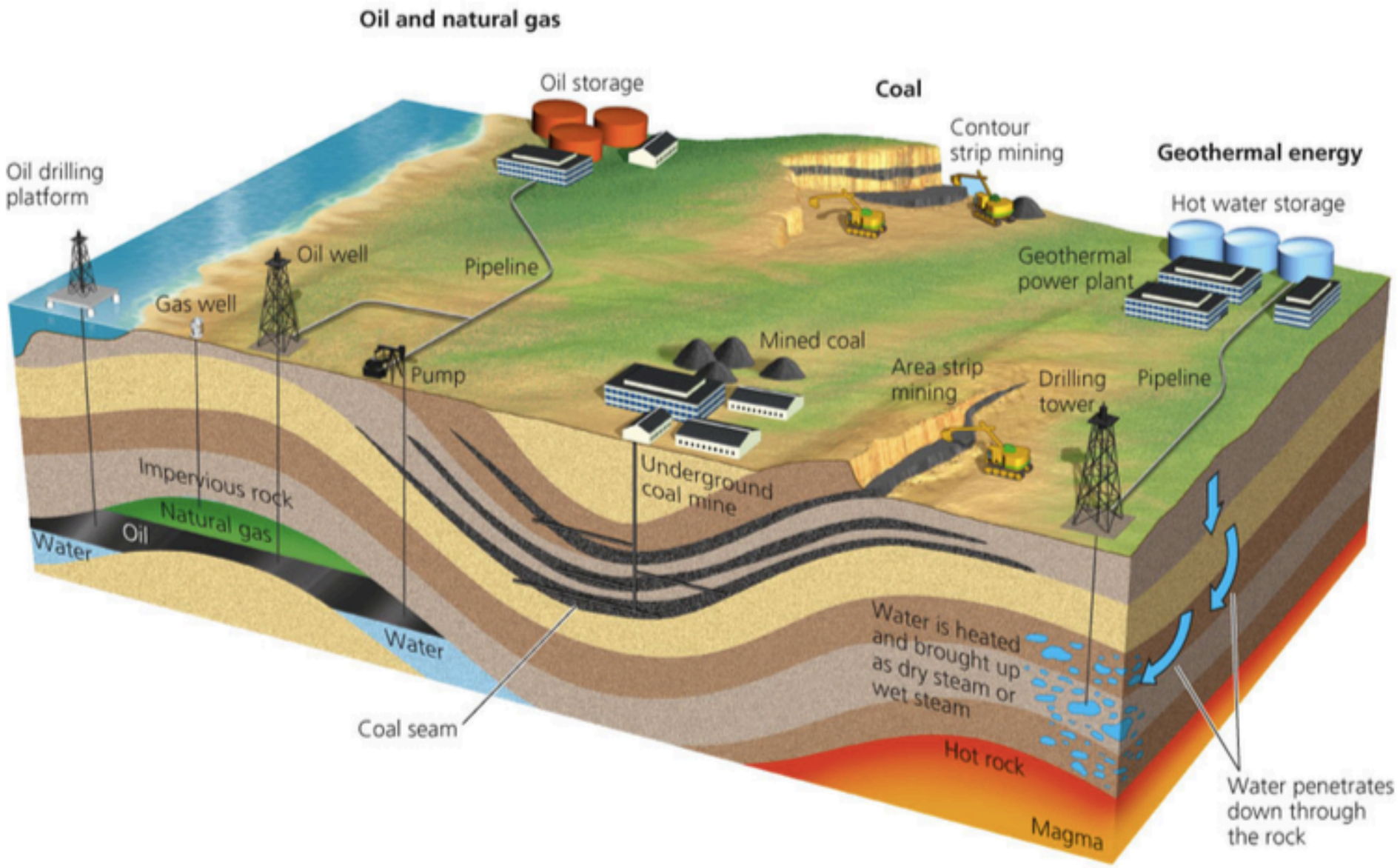
- Solar energy
- Indirect solar energy
  - Wind
  - Hydropower
  - Biomass
- Commercial energy
  - Nonrenewable energy resources such as fossil fuels
  - Renewable energy resources

Sources of Energy

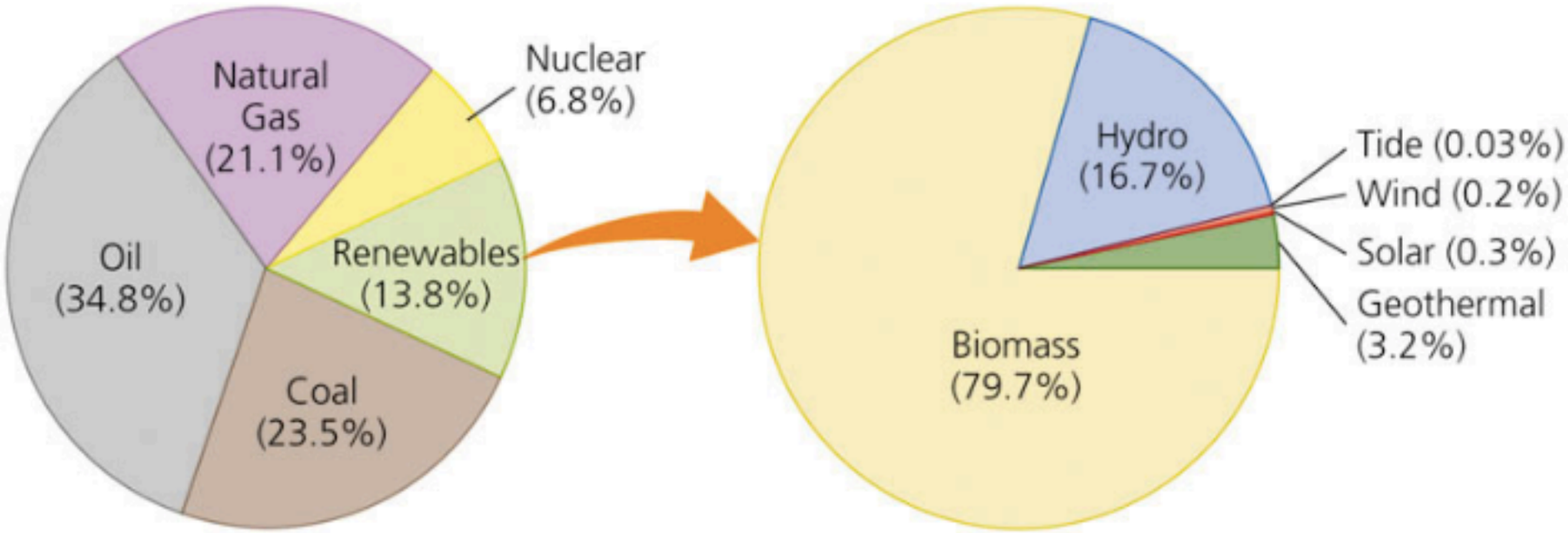
Table 17.1 Energy Sources We Use Today

Energy source	Description	Type of energy
Crude oil	Fossil fuel extracted from ground	Nonrenewable
Natural gas	Fossil fuel extracted from ground	Nonrenewable
Coal	Fossil fuel extracted from ground	Nonrenewable
Nuclear energy	Energy from atomic nuclei of processed uranium mined from ground	Nonrenewable
Hydropower	Energy from running water	Renewable
Solar energy	Energy from sunlight directly	Renewable
Wind energy	Energy from the power of wind	Renewable
Geothermal energy	Earth's internal heat rising from core	Renewable
Biomass energy	Chemical energy stored in plant matter from photosynthesis	Renewable
Tidal and wave energy	Energy from tidal forces and ocean waves	Renewable

Sources of Energy
Non-Renewable Sources



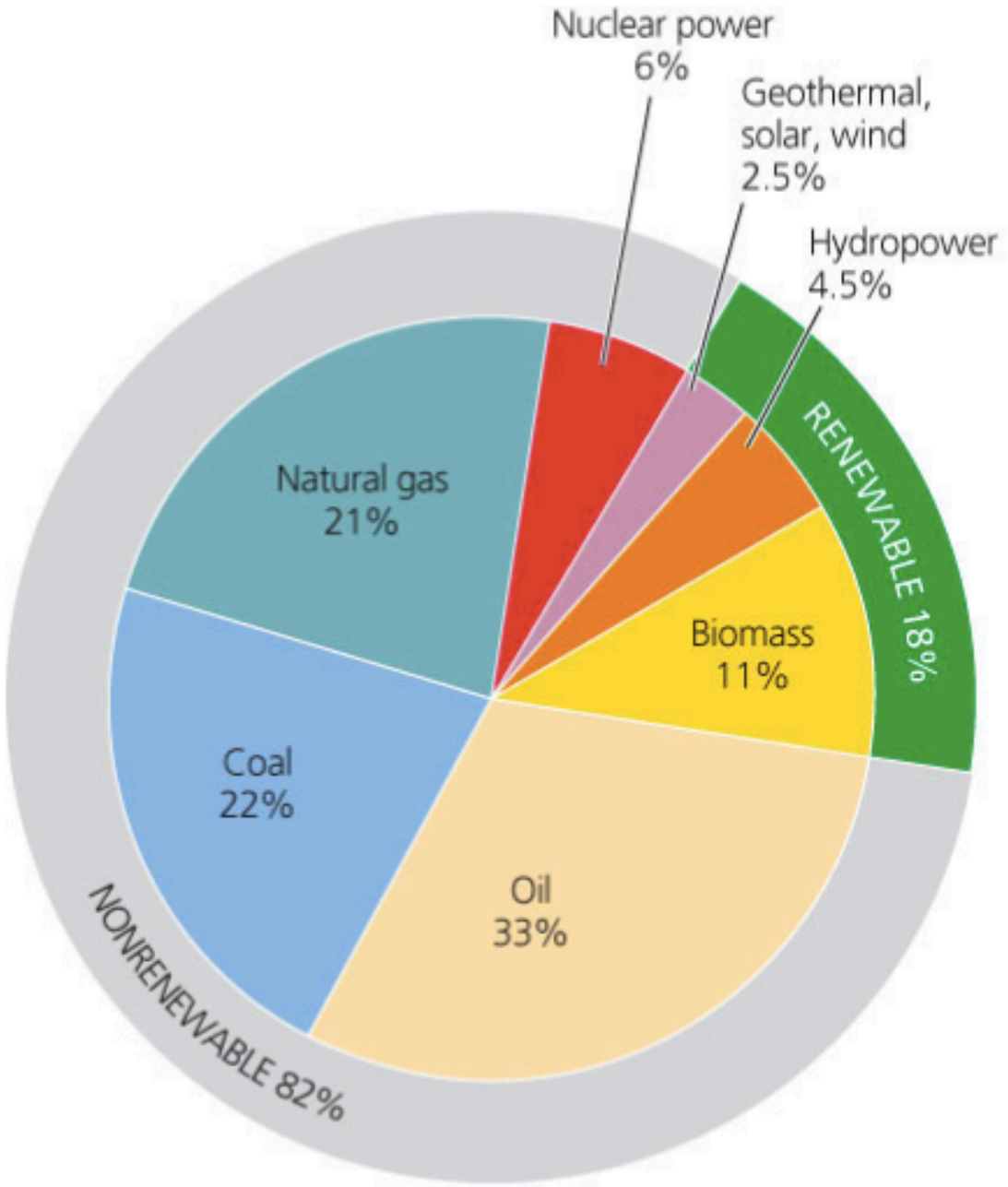
Sources of Energy



World total primary energy supply, 2000

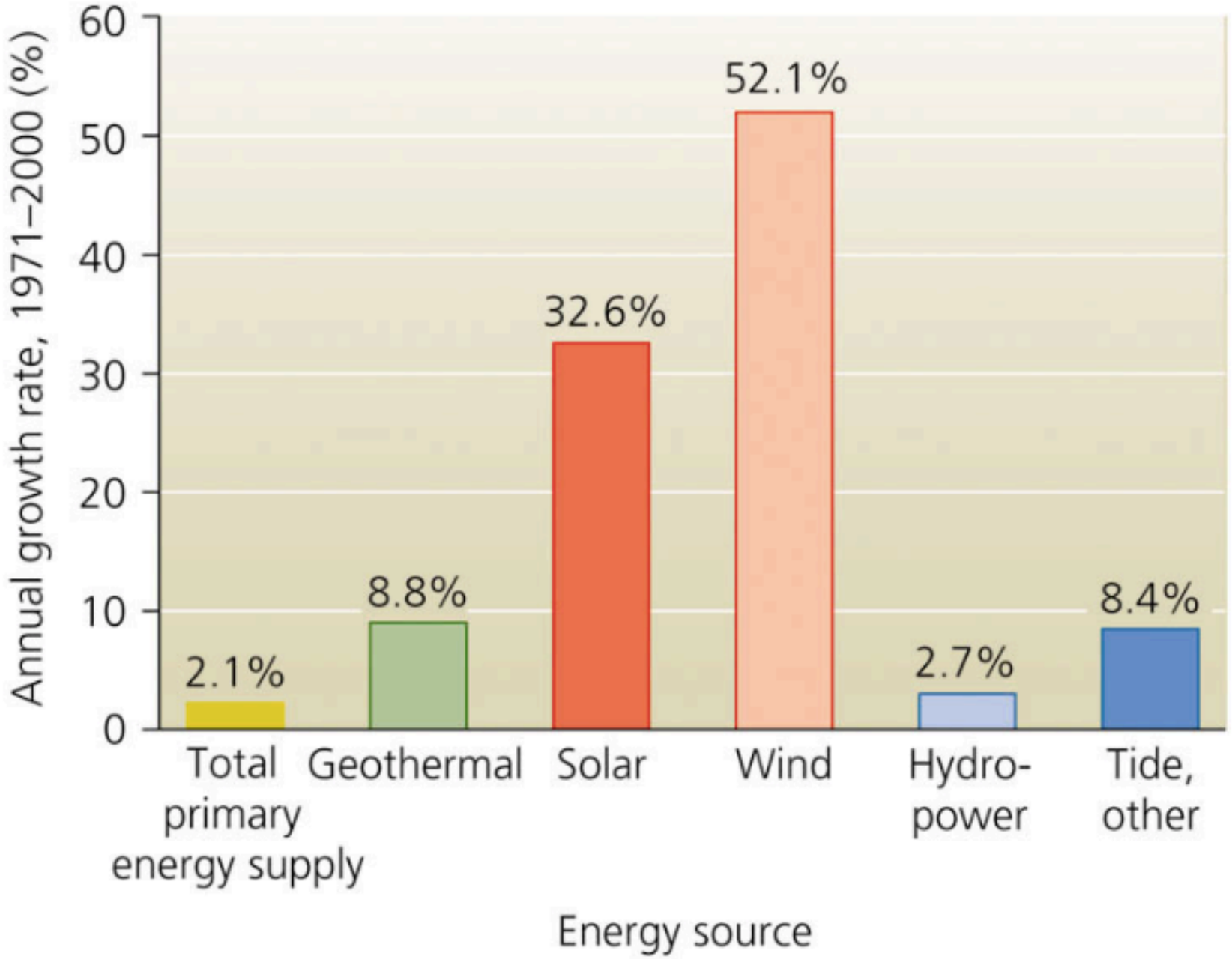
Renewable energy sources

Sources of Energy



World

Energy Consumption



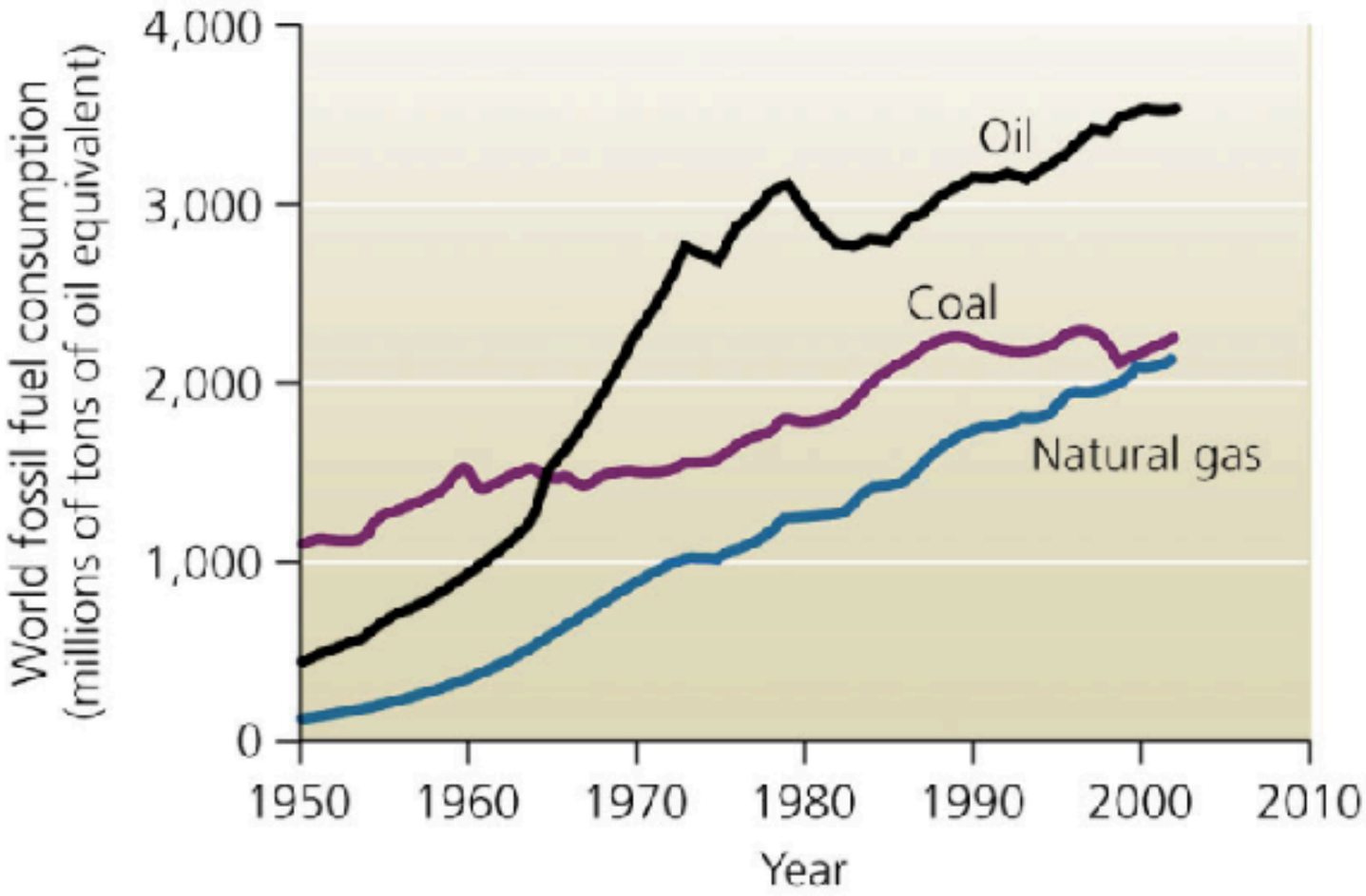
Evaluating Energy Resources

- Supplies
- Environmental impact
- Amount of useful energy provided

Fossil Fuels

- Dominant source of power!!
- High energy content
- Efficient to burn, ship and store

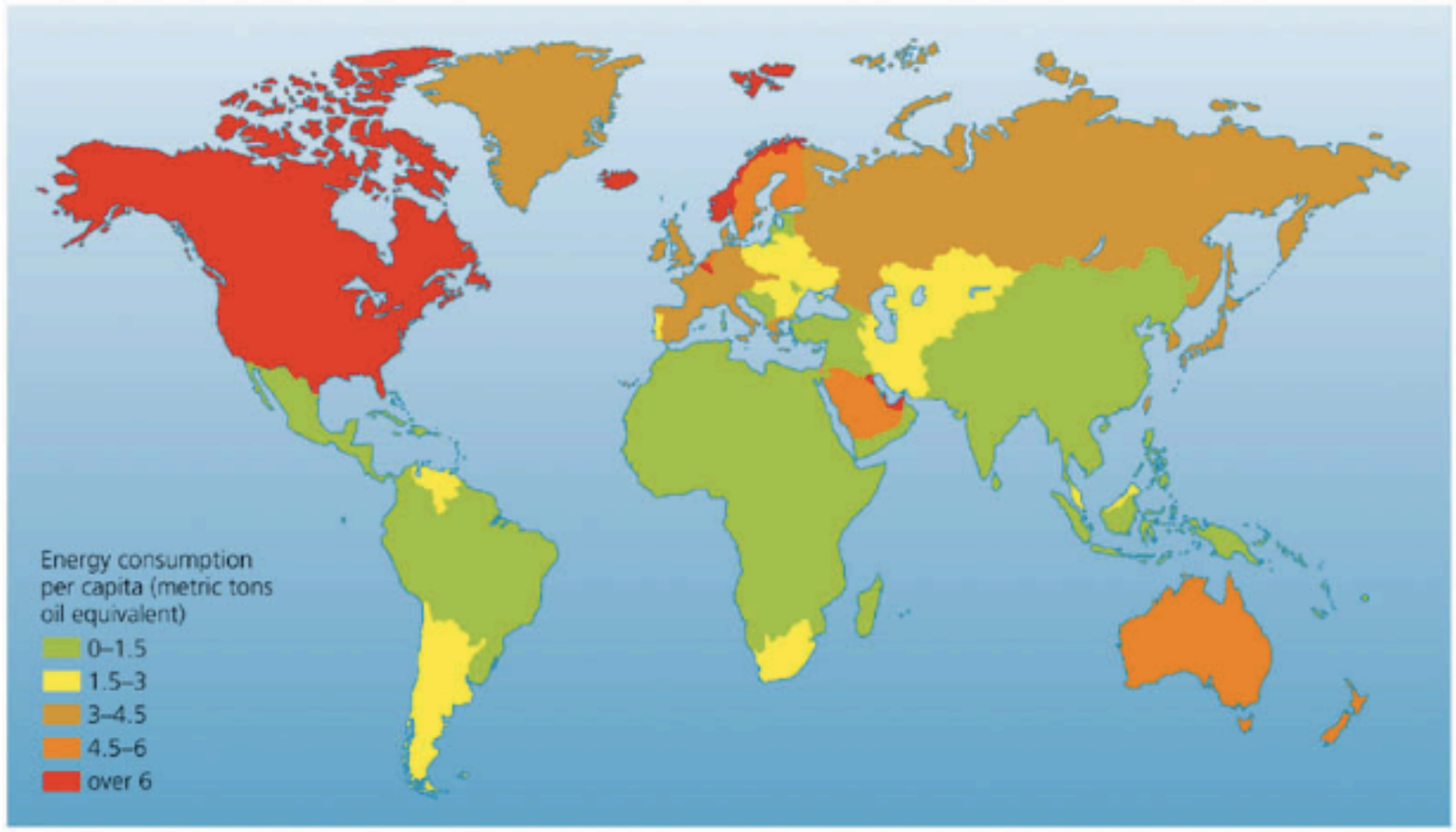
Fossil Fuels



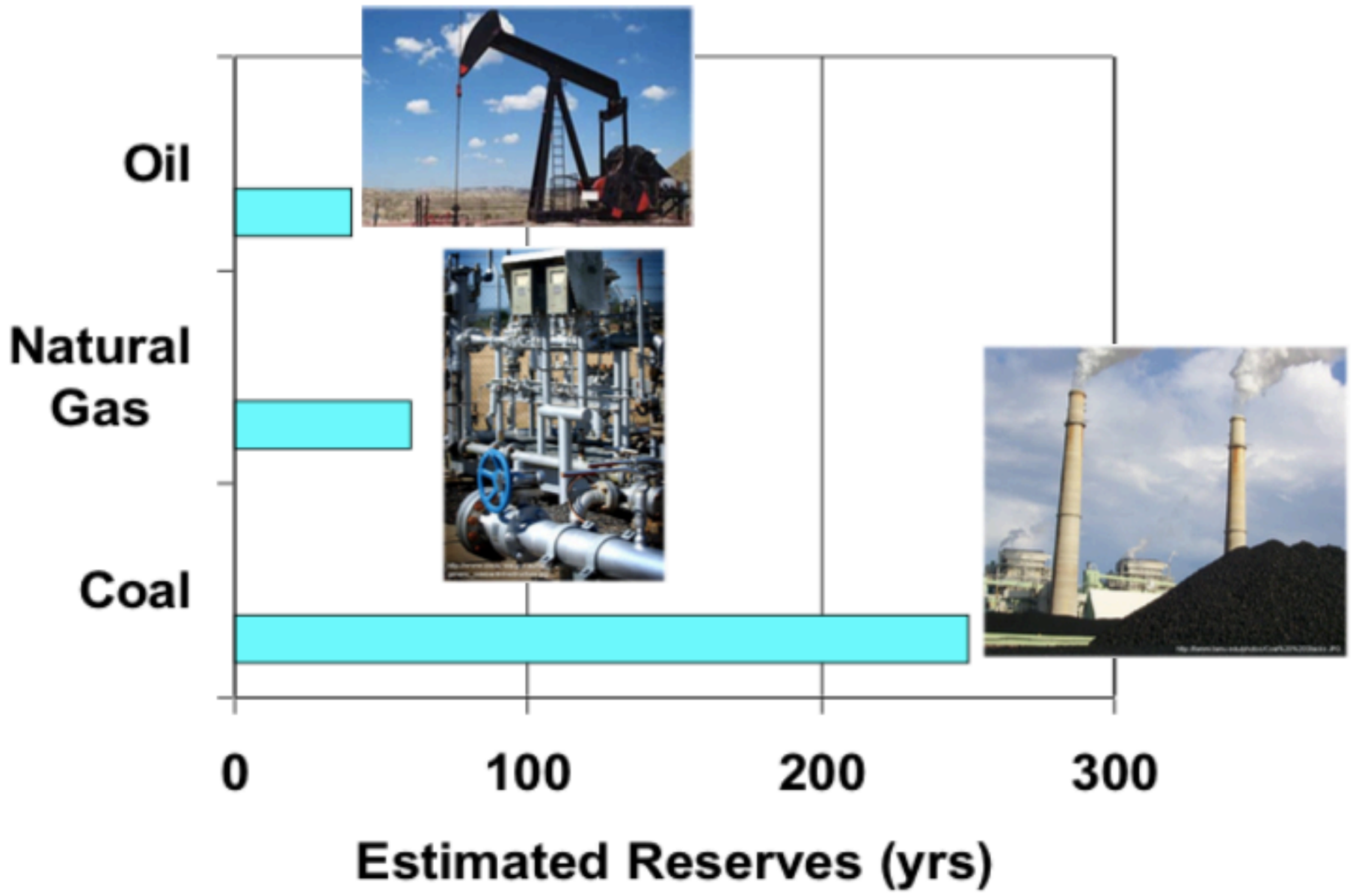
Fossil Fuels

Per capita consumption varies!!

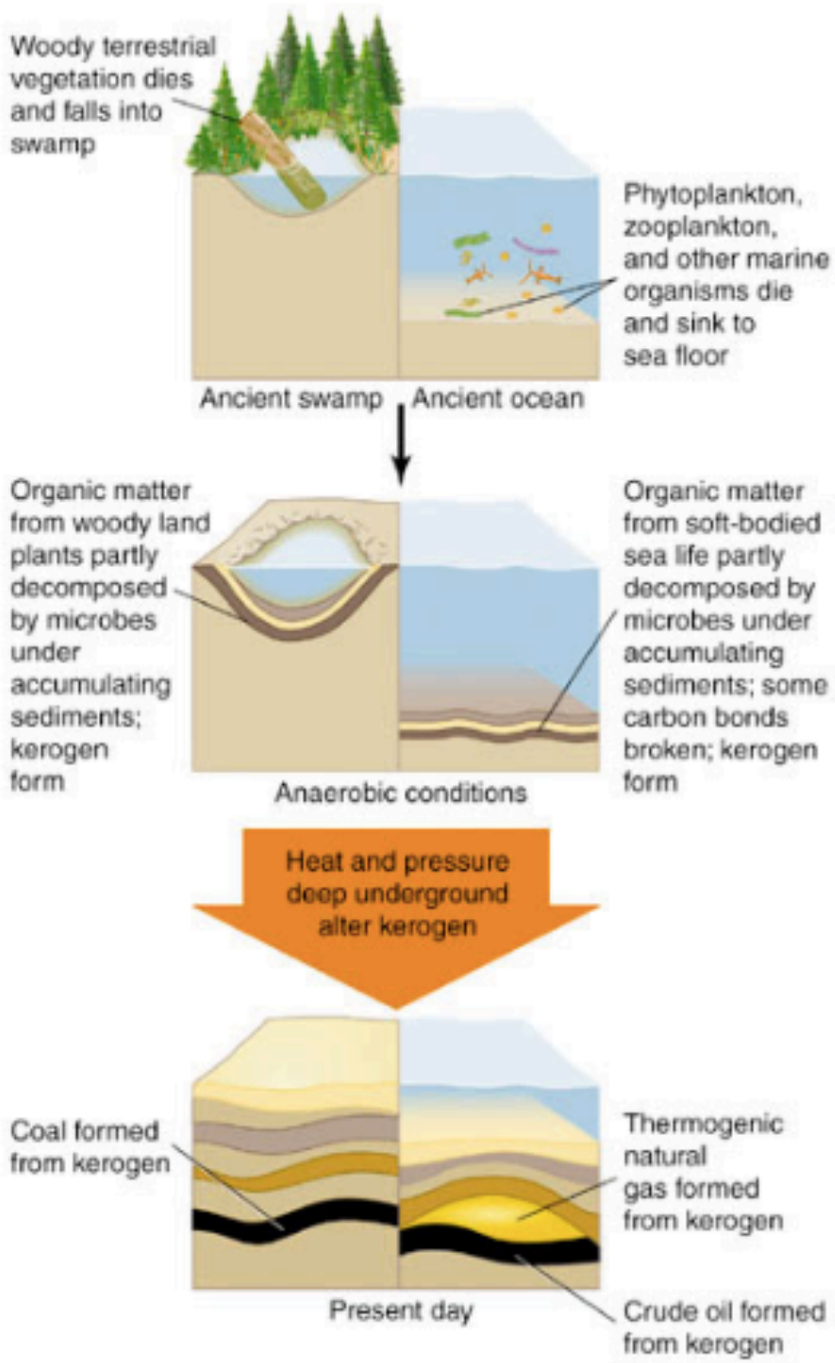
Developed countries use more than developing countries!!



Fossil Fuels
Decreasingly available!!



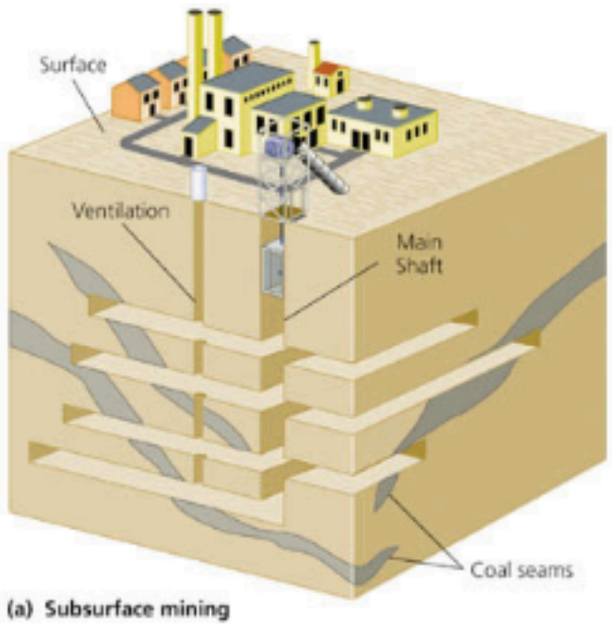
Fossil Fuel Formation



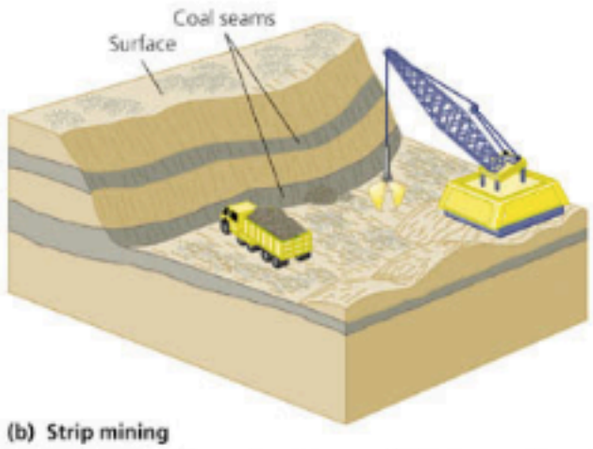
Coal

- Most abundant fossil fuel
- Organic matter (generally woody plant material) compressed under very high pressure to form dense, solid carbon structures
- Burned in 2100 power plants, generates 40% of the world's electricity

Coal



(a) Subsurface mining



(b) Strip mining

Coal

Severe air pollution!!

- Sulfur released as SO_2 **Acid Rain**
- Large amount of soot
- CO_2
- Trace amounts of Hg and radioactive materials

TRADE-OFFS

Coal

Advantages

Ample supplies (225–900 years)

High net energy yield

Low cost

Well-developed technology

Air pollution can be reduced with improved technology

Disadvantages

Severe land disturbance, air pollution, and water pollution

Severe threat to human health when burned

Environmental costs not included in market price

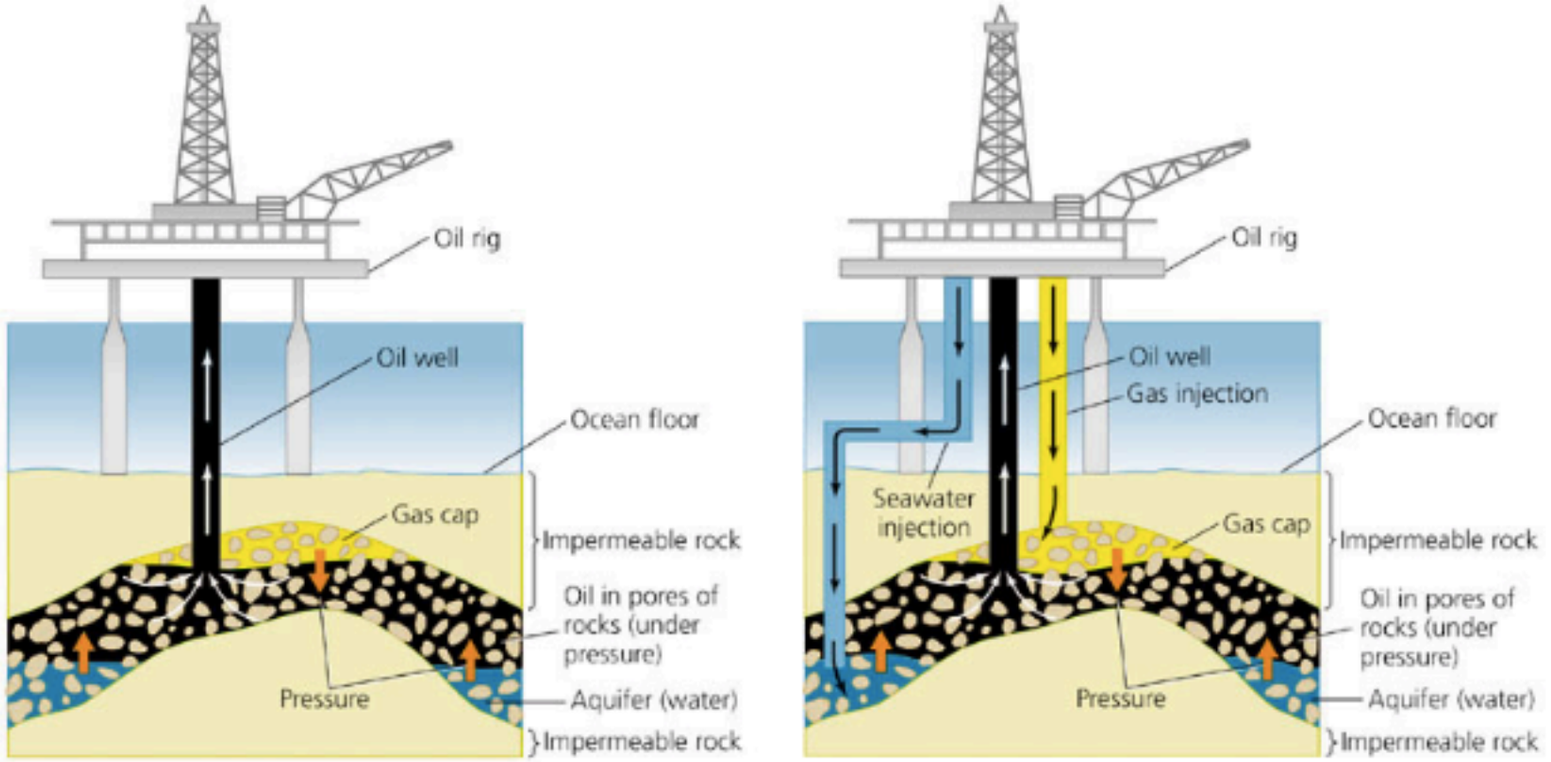
Large government subsidies

High CO_2 emissions when produced and burned

Radioactive particle and toxic mercury emissions

Oil

- Most used fuel since the 1960s
- Accounts for ca. 40% of the world's commercial energy consumption



(a) Primary extraction of oil

(b) Secondary extraction of oil

TRADE-OFFS

Conventional Oil

Advantages

Ample supply for 42–93 years

Low cost

High net energy yield

Easily transported within and between countries

Low land use

Technology is well developed

Efficient distribution system

Disadvantages

Need to find substitutes within 50 years

Large government subsidies

Environmental costs not included in market price

Artificially low price encourages waste and discourages search for alternatives

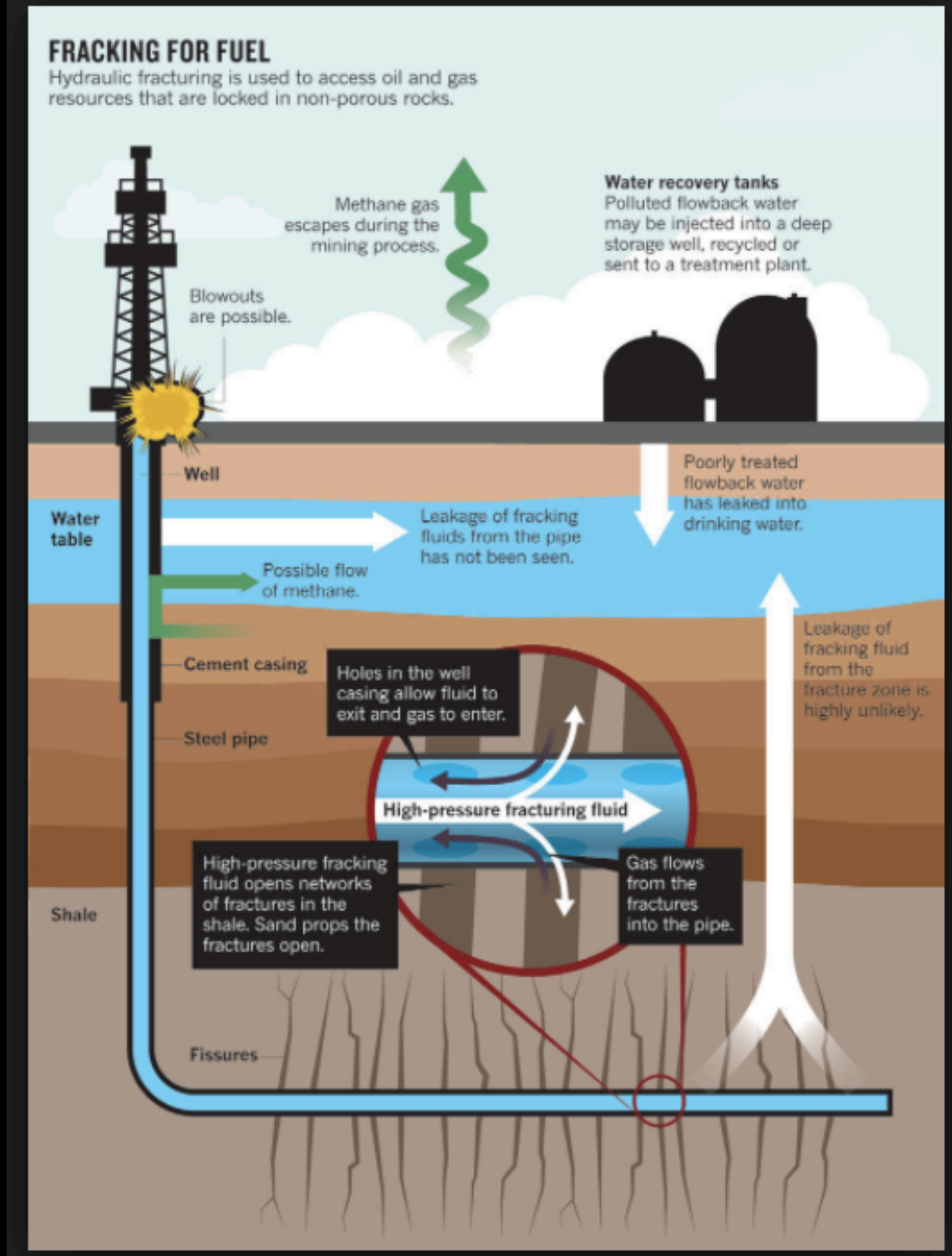
Pollutes air when produced and burned

Releases CO_2 when burned

Can cause water pollution

FRACKING FOR FUEL

Hydraulic fracturing is used to access oil and gas resources that are locked in non-porous rocks.



FRACKING

trucks of water for each well **200**

HYDRAULIC FRACTURING

Fracturing fluid (a mix of water, sand, and chemicals) is pumped into the well

The pressure causes the rock surrounding the pipe to crack

The proppants hold open these cracks to allow the trapped natural gas to escape

Gas flows up the well to be collected

POTENTIAL RISKS
groundwater contamination
air quality degradation

WATER
SAND
CHEMICALS

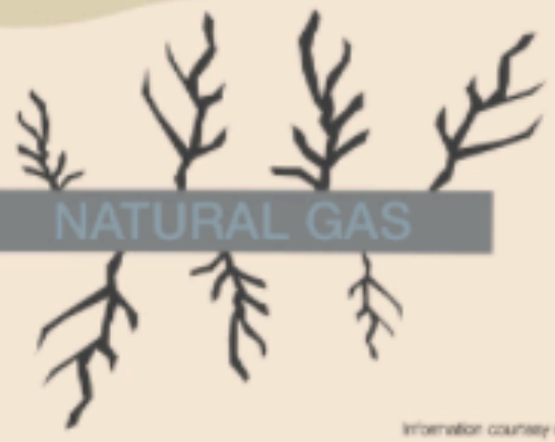
70 to **140 billion**
GALLONS of water used to fracture 35,000 wells in the U.S. each year

equals approximately the **ANNUAL WATER CONSUMPTION** of 40 to 80 cities with population 50,000

(sand or ceramic beads) **300,000** to **4 million** pounds of proppants used per well

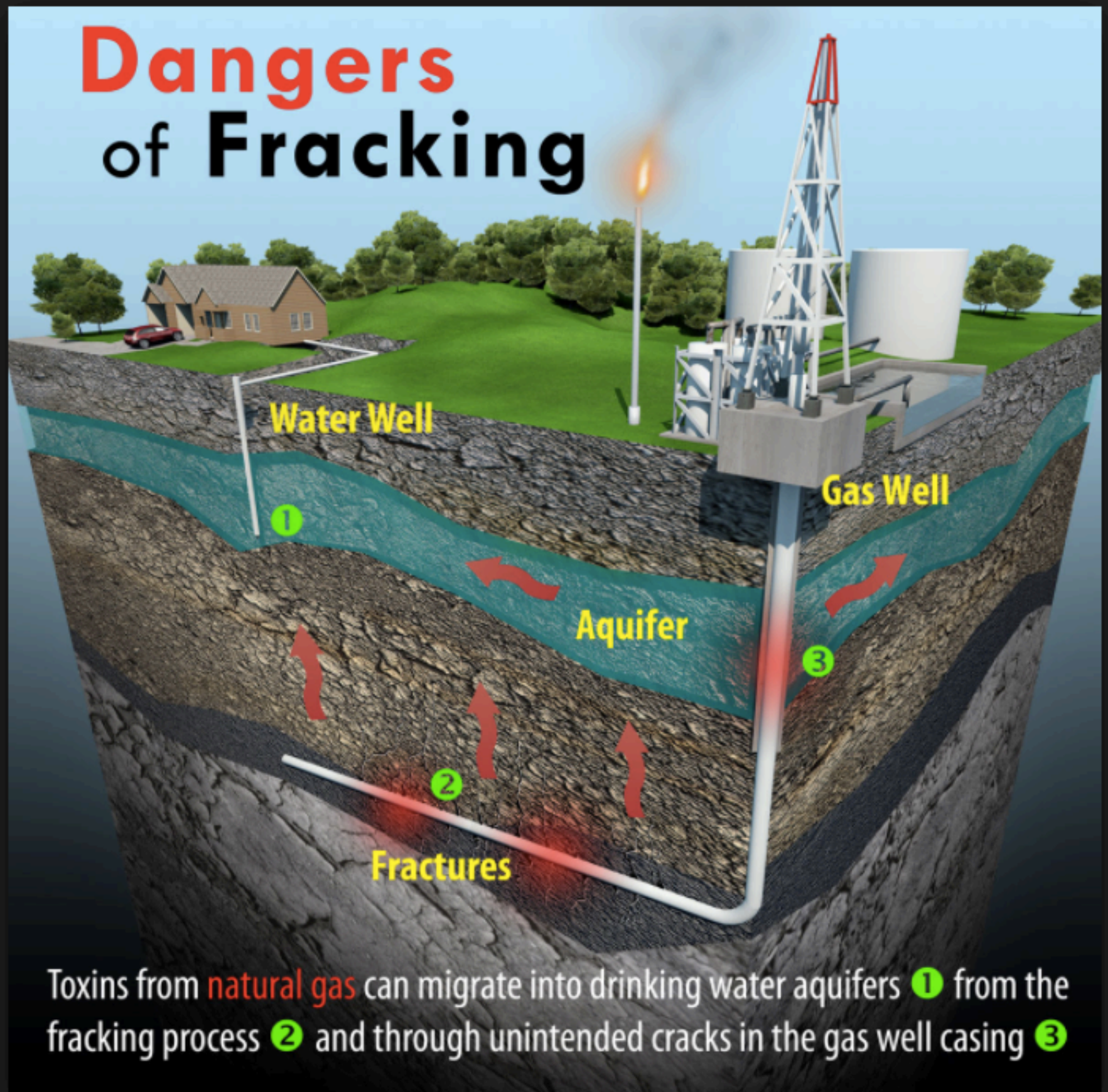
various chemicals make up **0.5%** to **2.0%** total volume of fracturing fluid = up to **330 TONS**

NATURAL GAS



Information courtesy of Earthworksaction.org, design by Hannah Otto, March 2013

Dangers of Fracking



Toxins from natural gas can migrate into drinking water aquifers ❶ from the fracking process ❷ and through unintended cracks in the gas well casing ❸

sacrificial lands

- Naomi Klein. Let them Drown: The violence of othering in a warming world

  - “the thing about fossil fuels is that they are so inherently dirty and toxic that they require sacrificial people and places: people whose lungs and bodies can be sacrificed to work in the coal mines, people whose lands and water can be sacrificed to open-pit mining and oil spills.

  - “Fossil fuels require sacrifice zones: they always have. And you can’t have a system built on sacrificial places and sacrificial people unless intellectual theories that justify their sacrifice exist and persist: from Manifest Destiny to Terra Nullius to Orientalism, from backward hillbillies to backward Indians.”

Yes, I do want you to read the article by Klein

- https://www.lrb.co.uk/v38/n11/naomi-klein/let-them-drown
- (also available in audio)
- on the website

Energy efficiency

- Jevons Paradox - **technological progress increases the efficiency with which a resource is used (reducing the amount necessary for any one use), but the rate of consumption of that resource rises because of increasing demand**
  - named after the 19th century English economist who noticed that as people began to use coal more efficiently, they began to use more coal, not less.
  - Even if our individual energy savings more than make up for our new consumption of energy, greater energy efficiency may lead to faster economic growth, which in turn will lead to a greater demand for energy.

cradle to cradle

A phrase invented by Walter R. Stahel in the 1970s and popularized by William McDonough and Michael Braungart in their 2002 book of the same name.

This framework seeks to create production techniques that are not just efficient but are essentially waste free.

In cradle-to-cradle production, all material inputs and outputs are seen either as technical or biological nutrients. Technical (i.e. synthetic) nutrients can be recycled or reused with no loss of quality and biological nutrients composted or consumed.

By contrast, cradle-to-grave refers to a company taking responsibility for the disposal of goods it has produced, but not necessarily putting products' constituent components back into service.

examples…

- composting toilets … treat human excrement using biological processes, turning it into organic **compost** material that can be **used** to fertilise the soil. They are small-scale, complete waste processing systems

  - “A dry composting toilet uses **no water**, so there is **no plumbing** involved, **no chemicals** needed, **no flushing**, it’s completely **natural and organic**. The toilet is like a mini ecosystem that **separates the liquids** (the pee) and **the solids** (the poo) so the solids can convert into humus” - http://www.gonewiththewynns.com/composting-toilet

  - why? - T**oilets** can use between 2 to 7 gallons of **water** with every flush (we use more water in the bathroom than anywhere else in the house)

homes...

Located in Issaquah Highlands, Washington, zHome is a 10-unit housing development with the mission to "prove that homes that use zero net energy and 60% less water, emit net zero carbon emissions, have clean indoor air and use only low-toxicity materials are possible and scalable to mainstream home production."

Designed by Farr Associates and built by Goldberg General Contracting, the Yannell residence is a single-family, 2,675-square-foot home located in Chicago, Illinois, and owned by Michael Yannell.

The home was completed in 2009 and cost about $1.6 million to build. It produces 40% more energy than it consumes, scoring higher than any other LEED-certified project in history.

energy
(chapter 2 continued)

- resistance to fossil fuel extraction / environmental justice
- (The Story of Stuff)