Energy and Sustainability in Europe

Power Generation

Ed Gatzke

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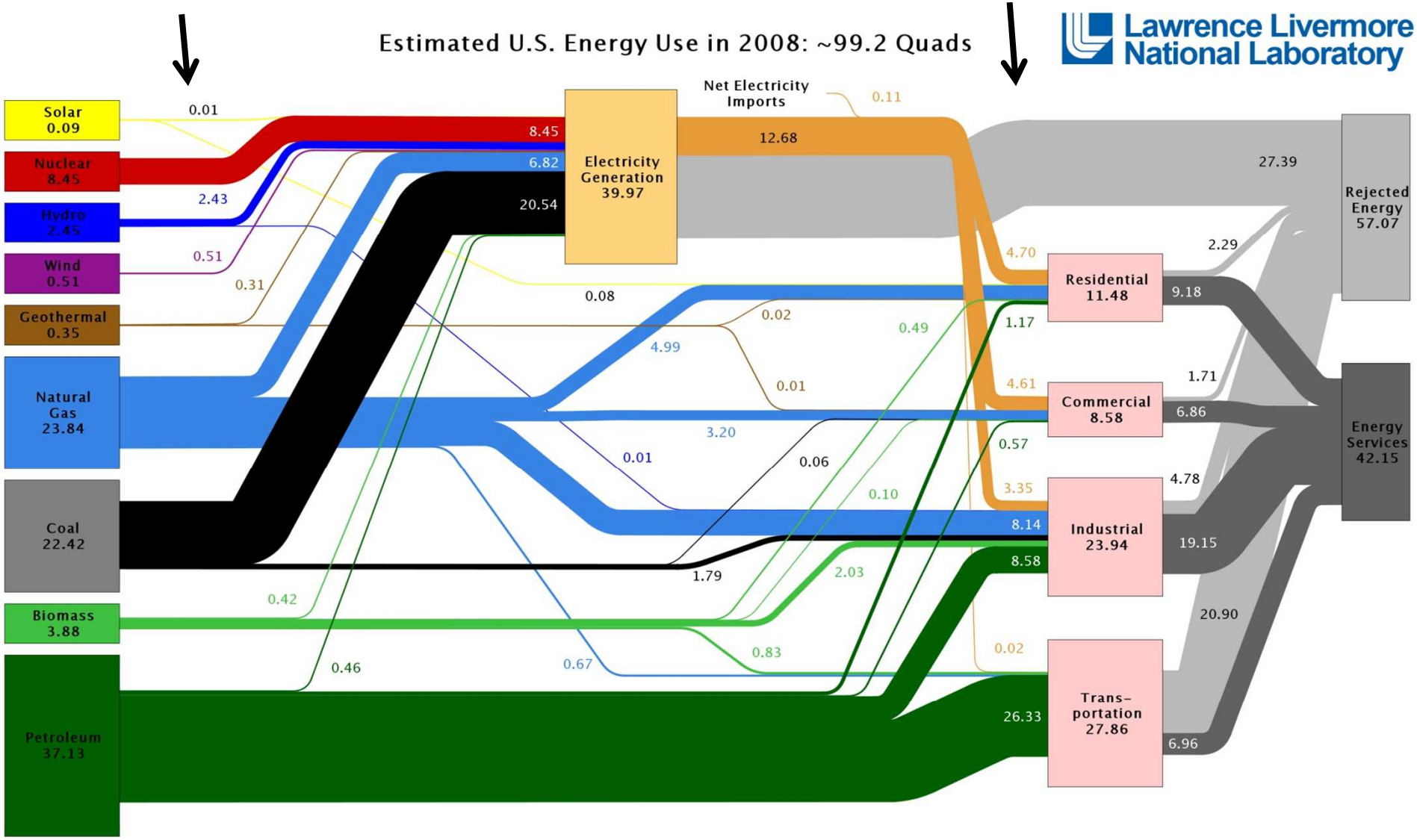
Background Concepts

- Energy production
  - Convert energy into useful form
  - Burn coal to make electricity, convert wind to power
- Energy transportation
  - Power grids, gasoline / coal / CNG distribution
- Energy consumption
  - HVAC, automobiles, lighting
- Efficiency
  - Always have losses
  - Must minimize losses
  - Must balance various costs (capital, production, maint.)

Energy Sources
(scaled lines)

Lost Energy
(light gray)



Source: LLNL 2009. Data is based on DOE/EIA-0384(2008), June 2009. If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports flows for non-thermal resources (i.e., hydro, wind and solar) in BTU-equivalent values by assuming a typical fossil fuel plant "heat rate." The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 80% for the residential, commercial and industrial sectors, and as 25% for the transportation sector. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

Energy and Power

- Energy (J, kWh, BTU, therms, quads)

  1 kWh = 3412 BTU

  Average US home uses 10,000 kWh per year

  1 therm (th) = 100,000 BTU

  1 quad = 10^{15} BTU

  US production around 100 quads/year (world: 500)

- Power (watts, J/s, kW, MW, GW, TW, hp)

  1 hp = 0.75 kW (745 W)

  Average US home requires 1.5 hp (1.1 kW)

  US production is around 3 TW (15 TW world usage)

Some Related Issues in Germany

- Population density
  - 80 million people in area of GA+SC
  - Lack of suburban sprawl (dense development)
- Modern infrastructure
  - Much built since 1945
- Strong environmental regulation
- Limited natural energy resources
- Limited native population growth

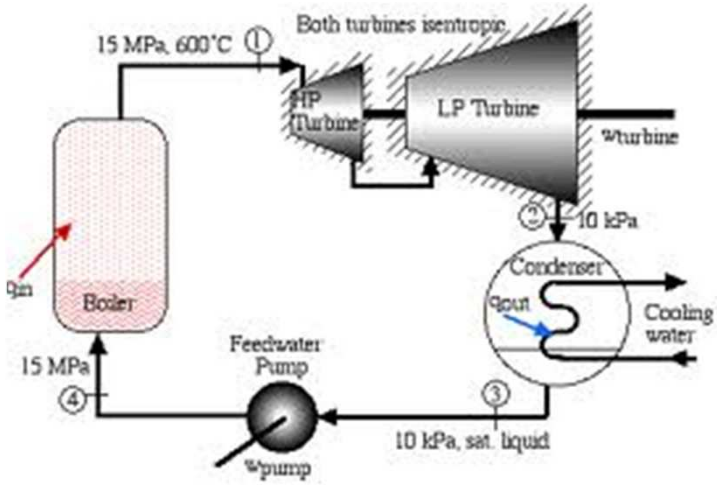
Fossil Fuel Basics

- Oxidize (burn) hydrocarbons to release energy
  - Methane (Natural Gas) $CH_4 + 3\ O_2 \rightarrow CO_2 + 2\ H_2O$
  - Petrol (Octane) $2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$
- Steam cycle (Rankine Cycle)
- Internal combustion engines

- Issues:
  - Low efficiency
  - Limited fuel (??)
  - Emissions (??)

Rankine Cycle

- Close to ideal Carnot cycle
  - Heating cooling isobaric
- Ideal thermodynamic efficiency ~60%
  - Reality: ~40%
- Multi-stage turbines



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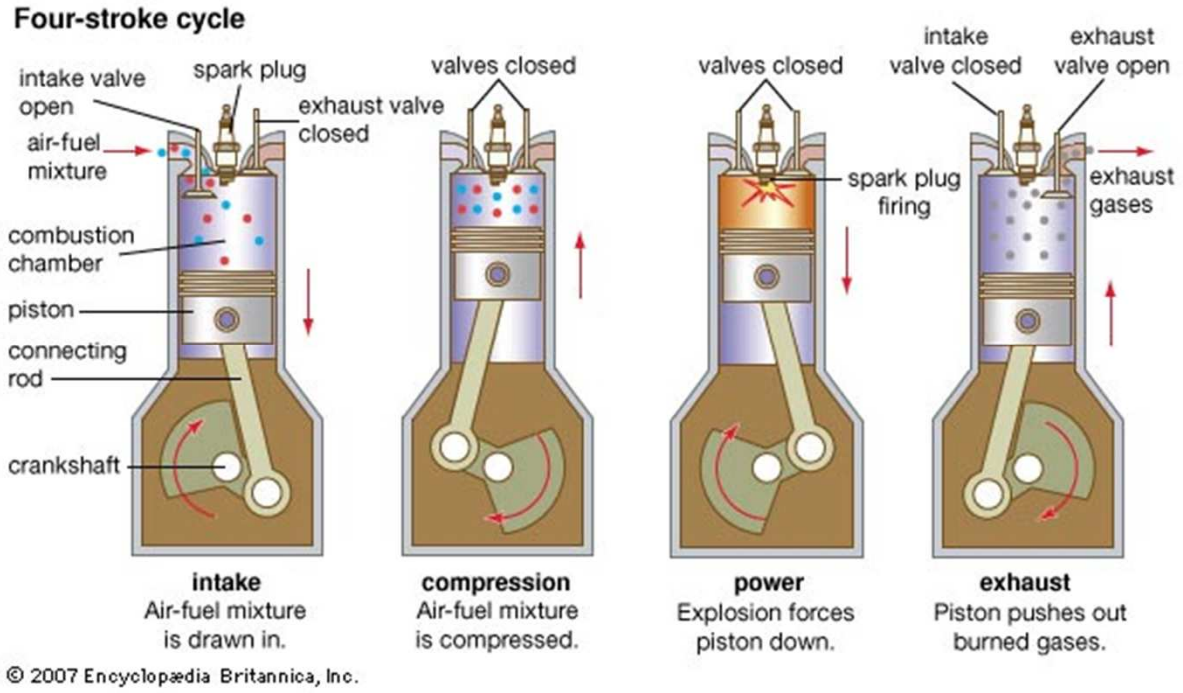
Internal Combustion

- Typical efficiency of 20-30%
  - 2 stroke
  - 4 stroke

    (Otto cycle)

    Wankel config
  - Diesel
  - Gas Turbine

    (Brayton cycle)



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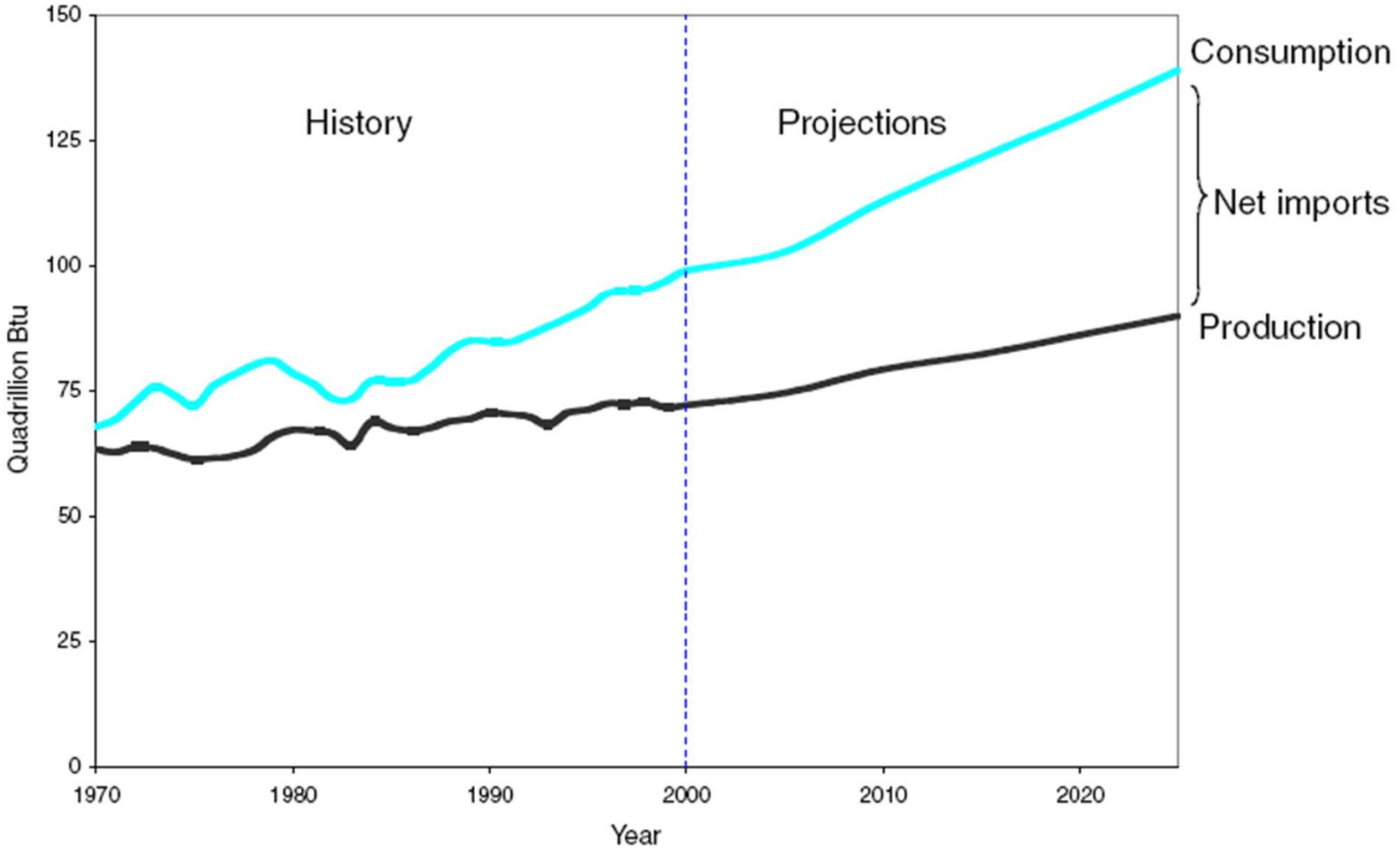


FIGURE 2-4 Total U.S. primary energy production and consumption, historical and projected, 1970 to 2025. SOURCE: EIA (2003).

U.S. Energy Consumption and Production

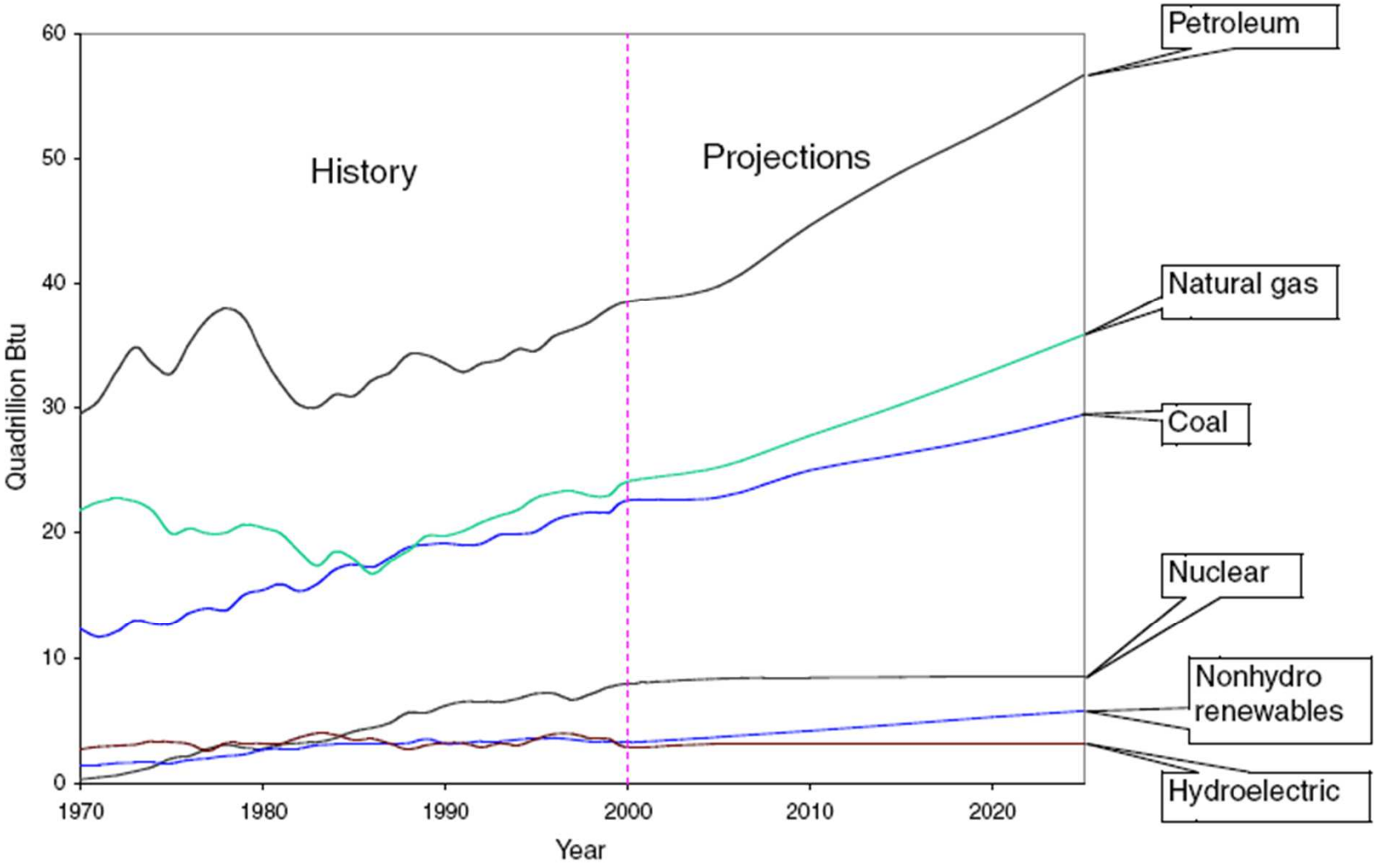
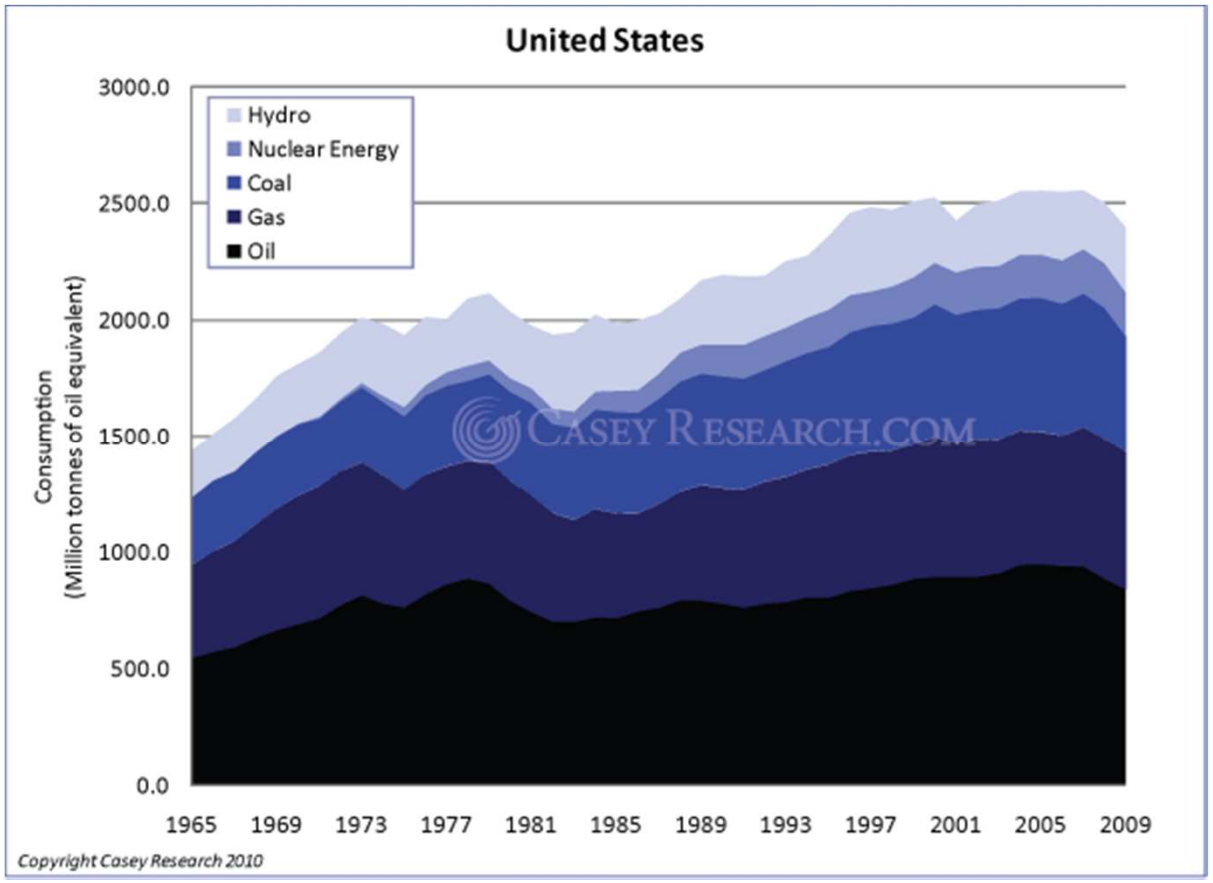


FIGURE 2-3 U.S. primary energy consumption, by fuel type, historical and projected, 1970 to 2025. SOURCE: EIA (2003).

U.S. Energy Consumption by Fuel Type

Updated Energy Consumption by Type



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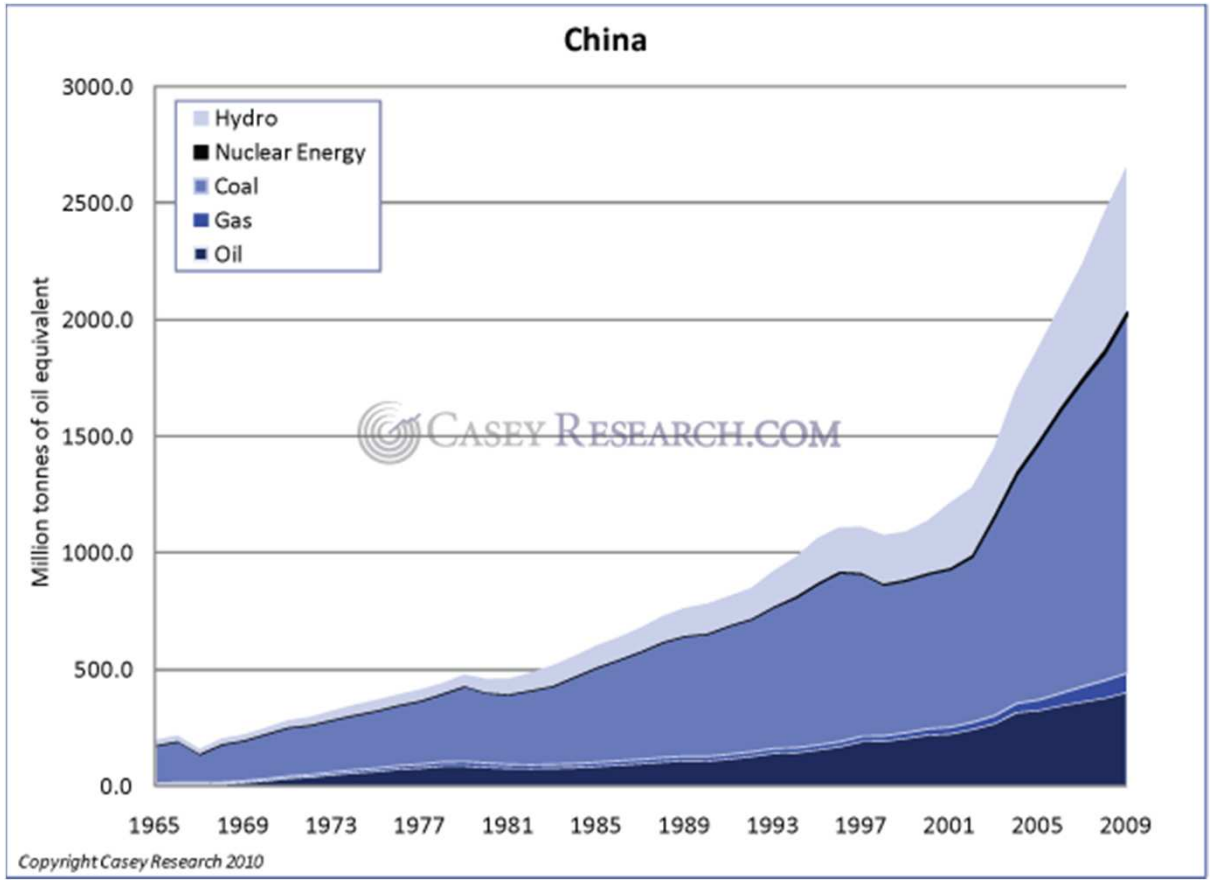
China Energy Usage



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2000 Carbon Emissions by Sector and Fuel

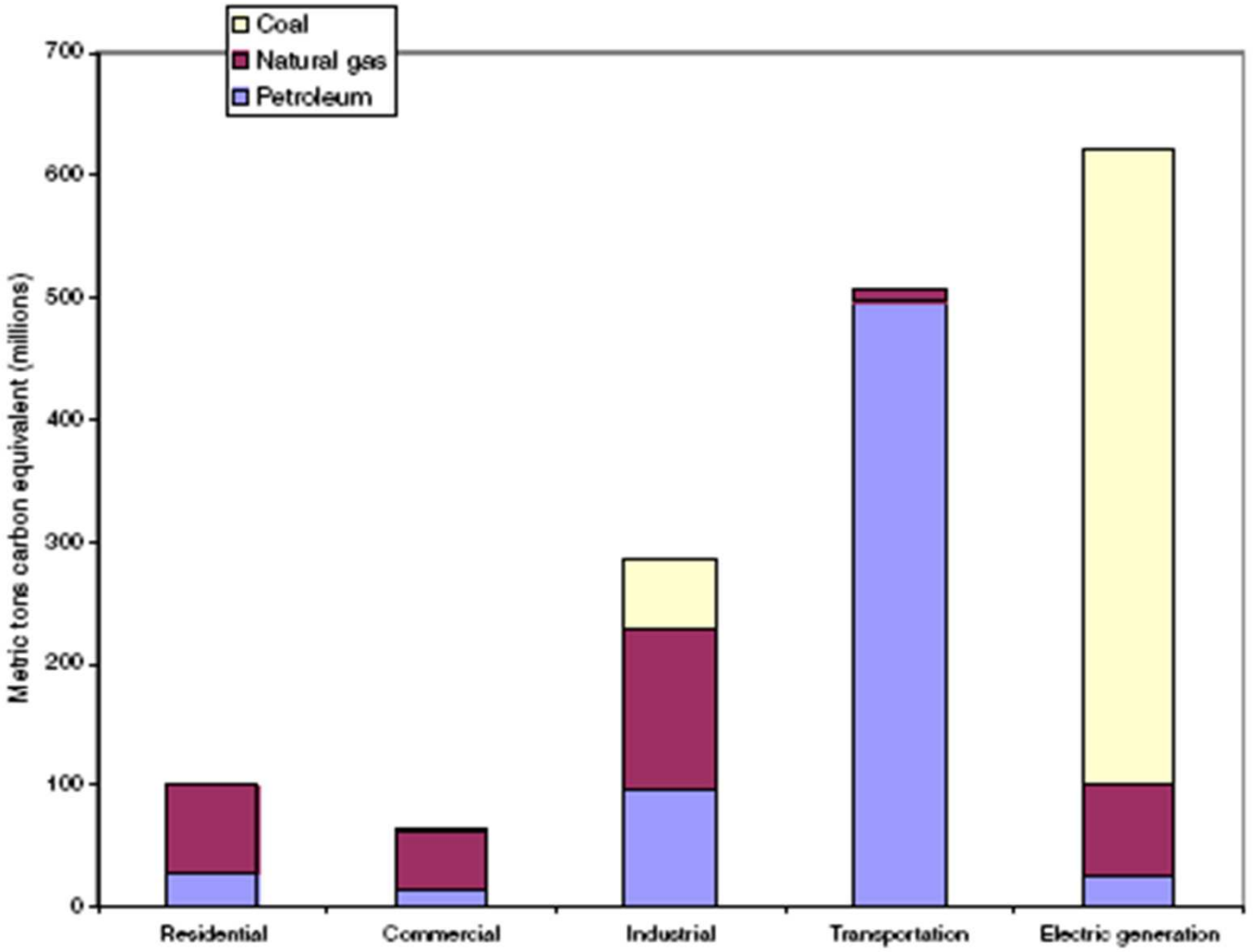

FIGURE 2-7 U.S. emissions of carbon dioxide, by sector and fuels, 2000. SOURCE: EIA (2002).

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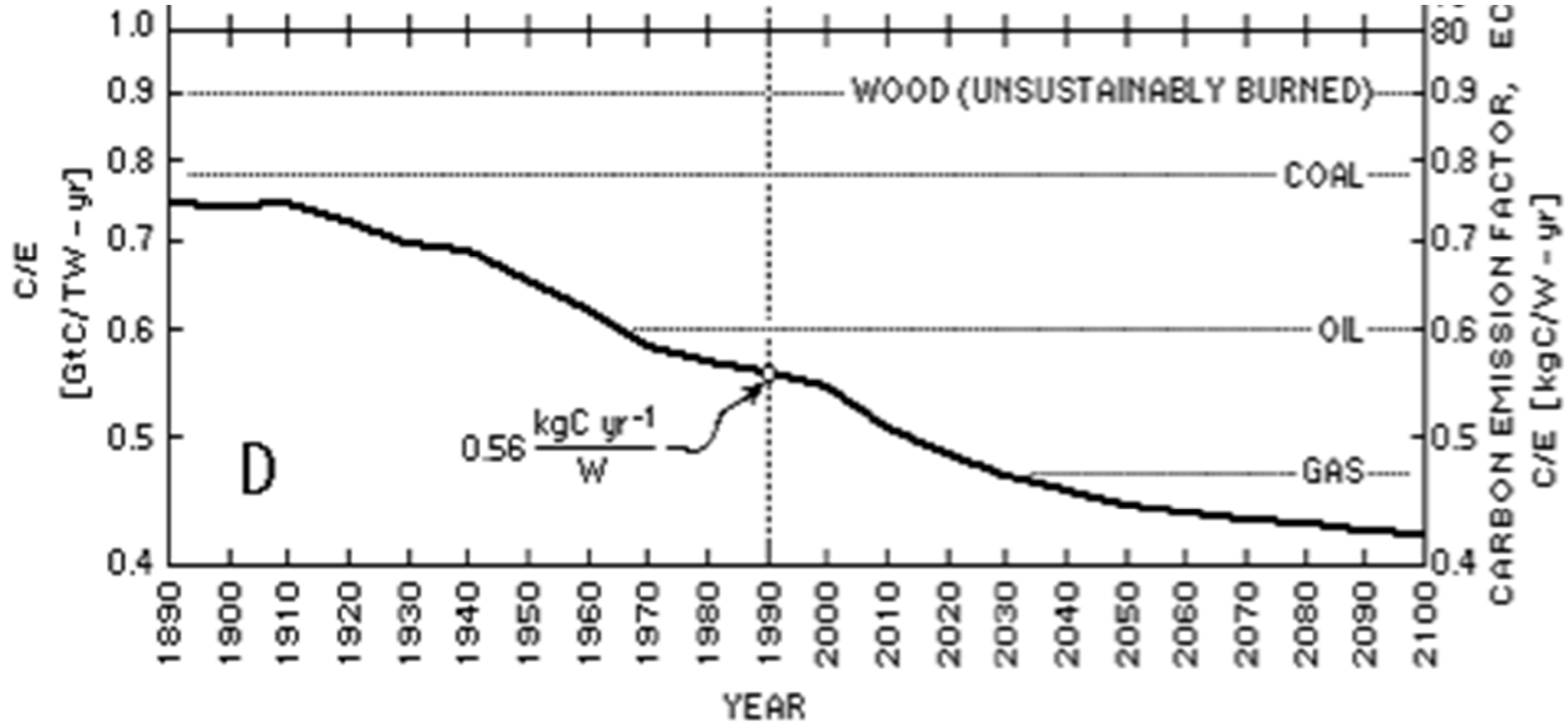
Carbon Intensity of Energy Mix



*M. I. Hoffert et. al., Nature, **1998**, 395, 881*

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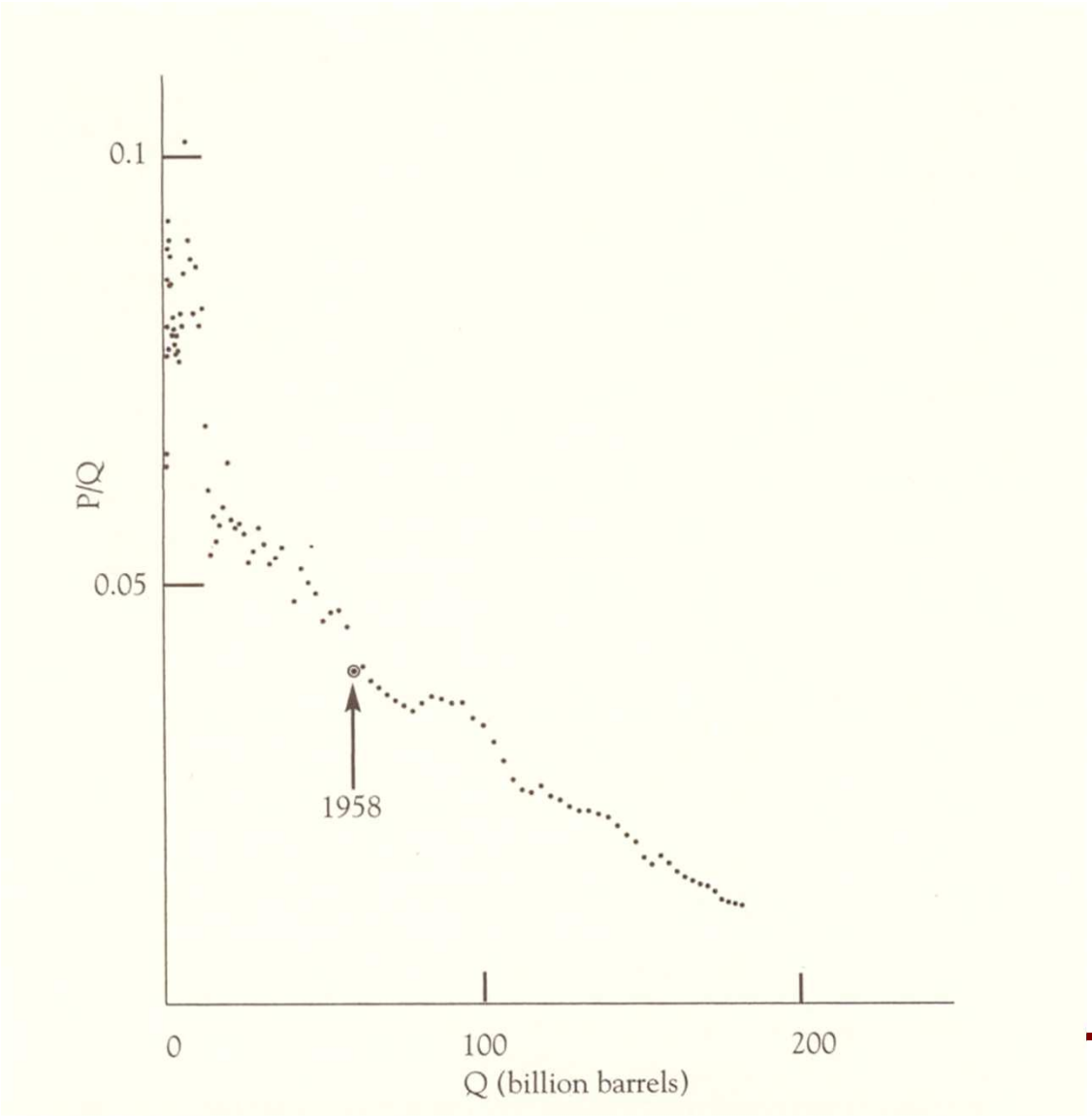
Annual Oil Production



Kenneth S. Deffeyes., *"Beyond Oil: The View from Hubberts Peak"*
Hill and Wang, 2005.

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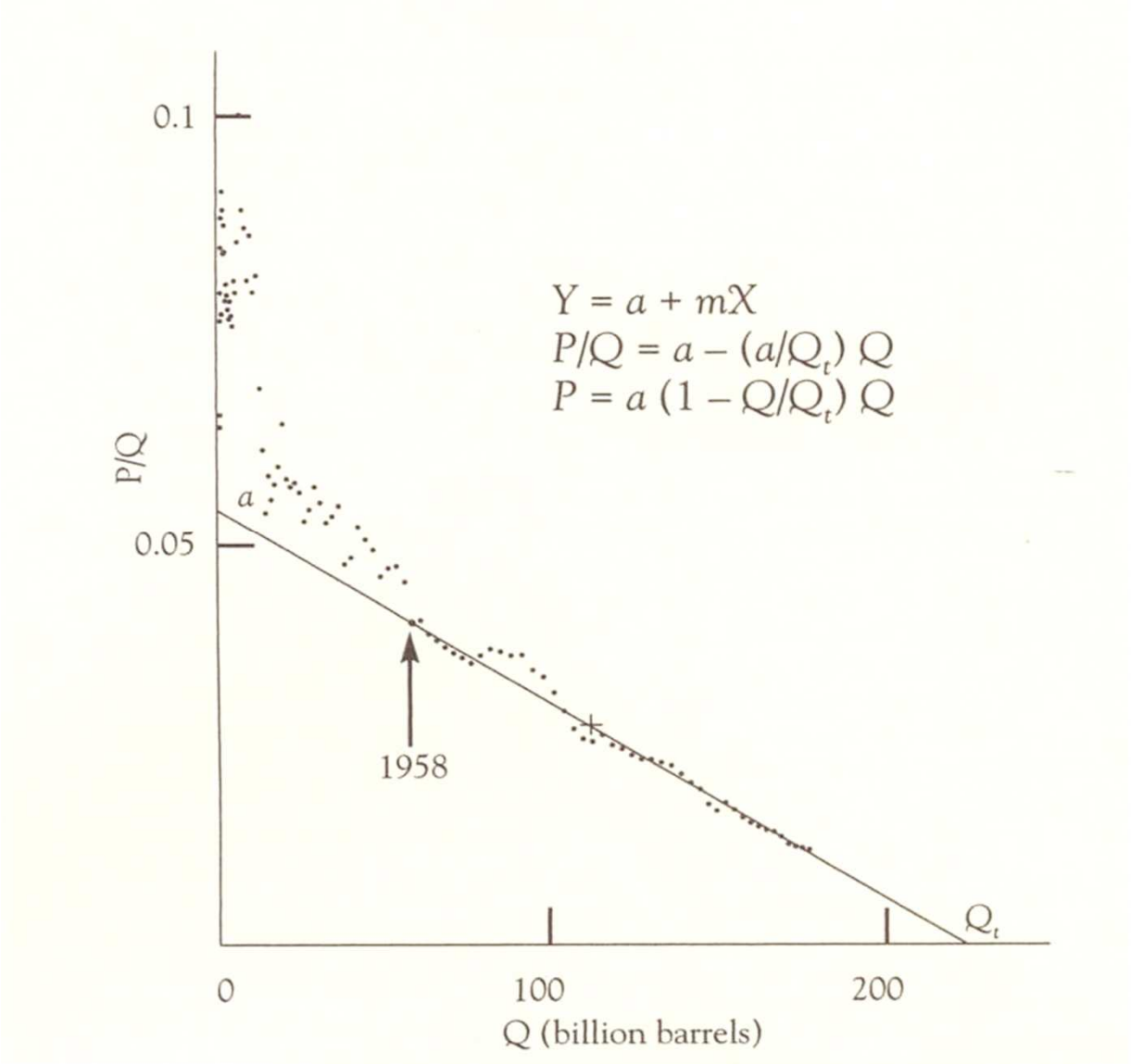
Annual Oil Production



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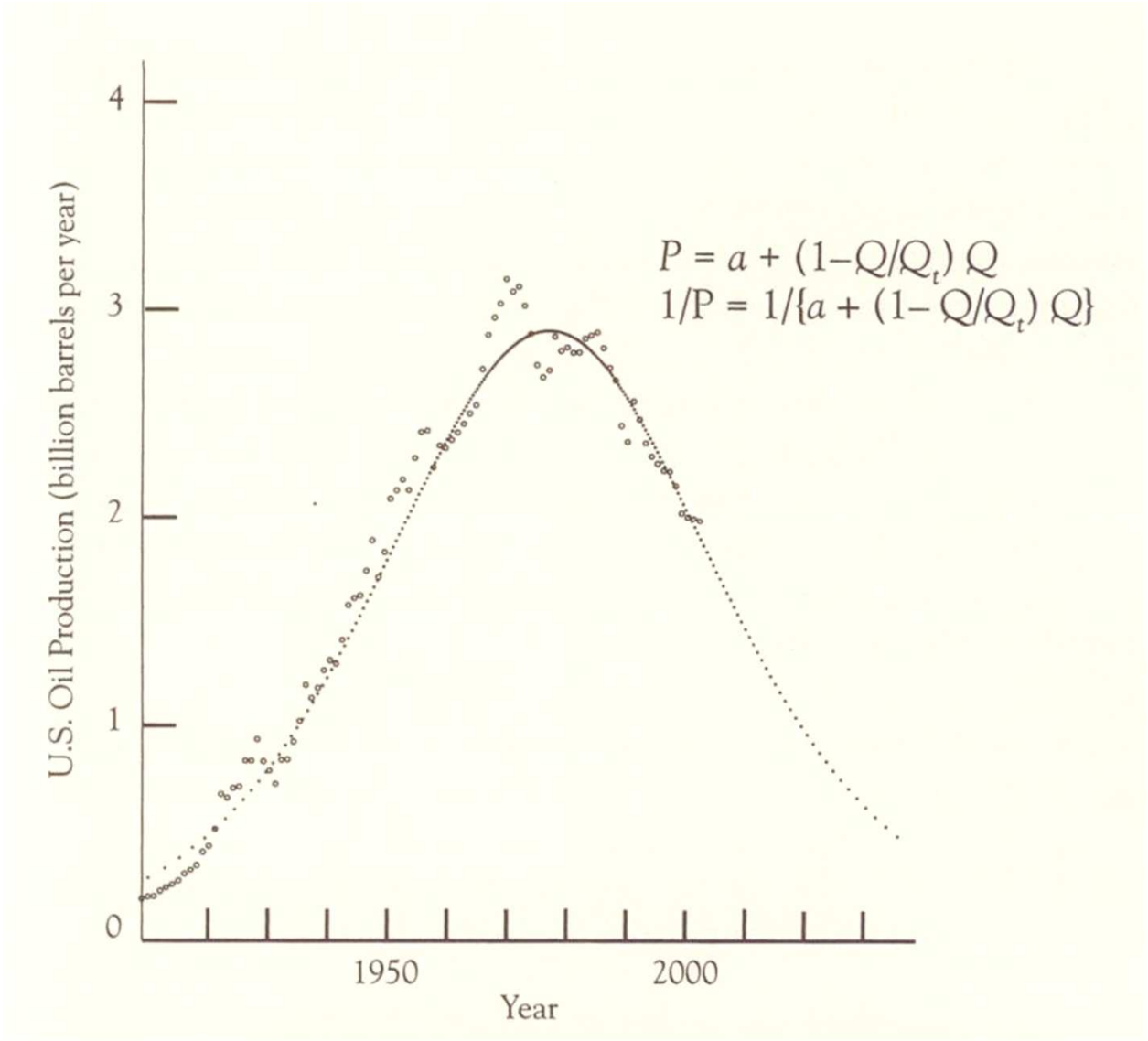
Annual Oil Production



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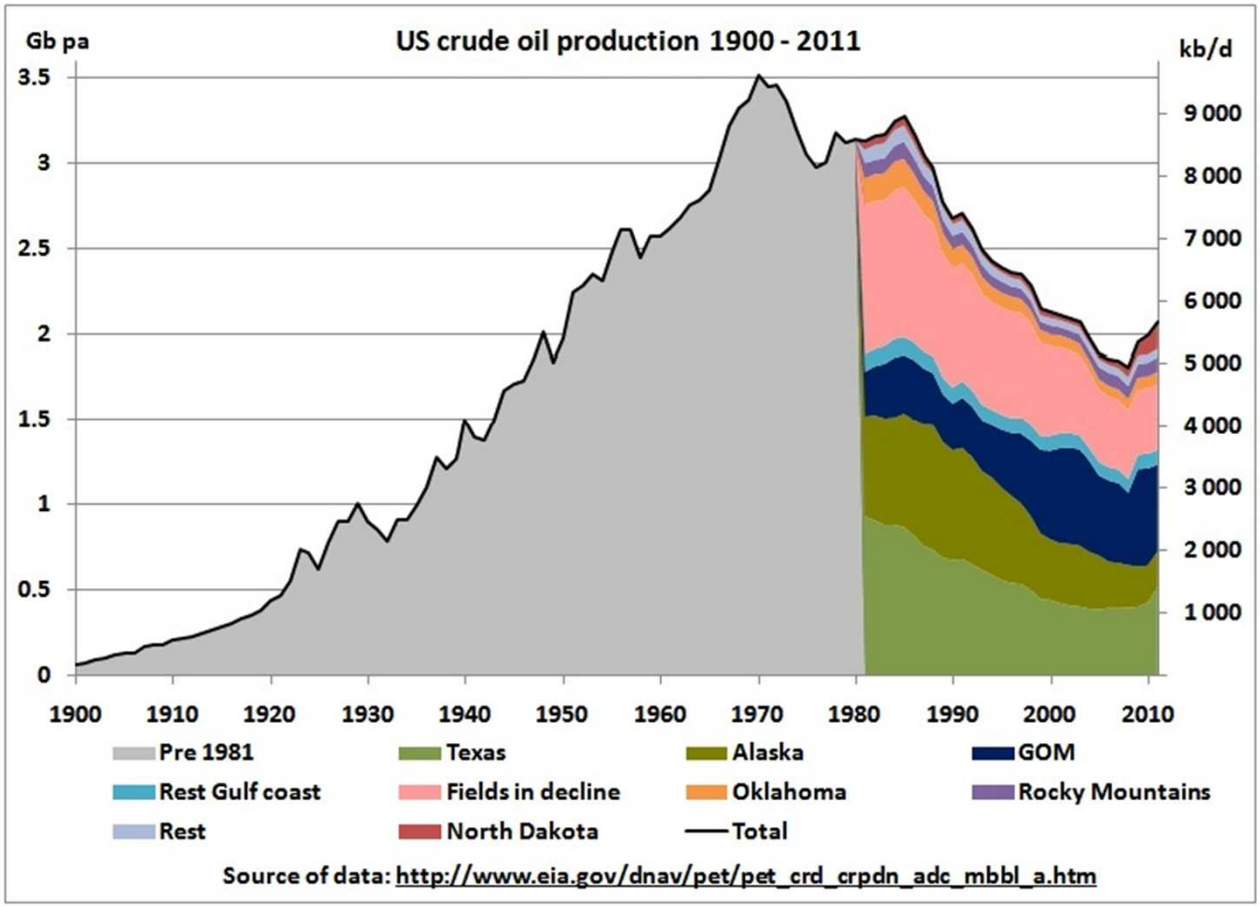
Updated Oil Production



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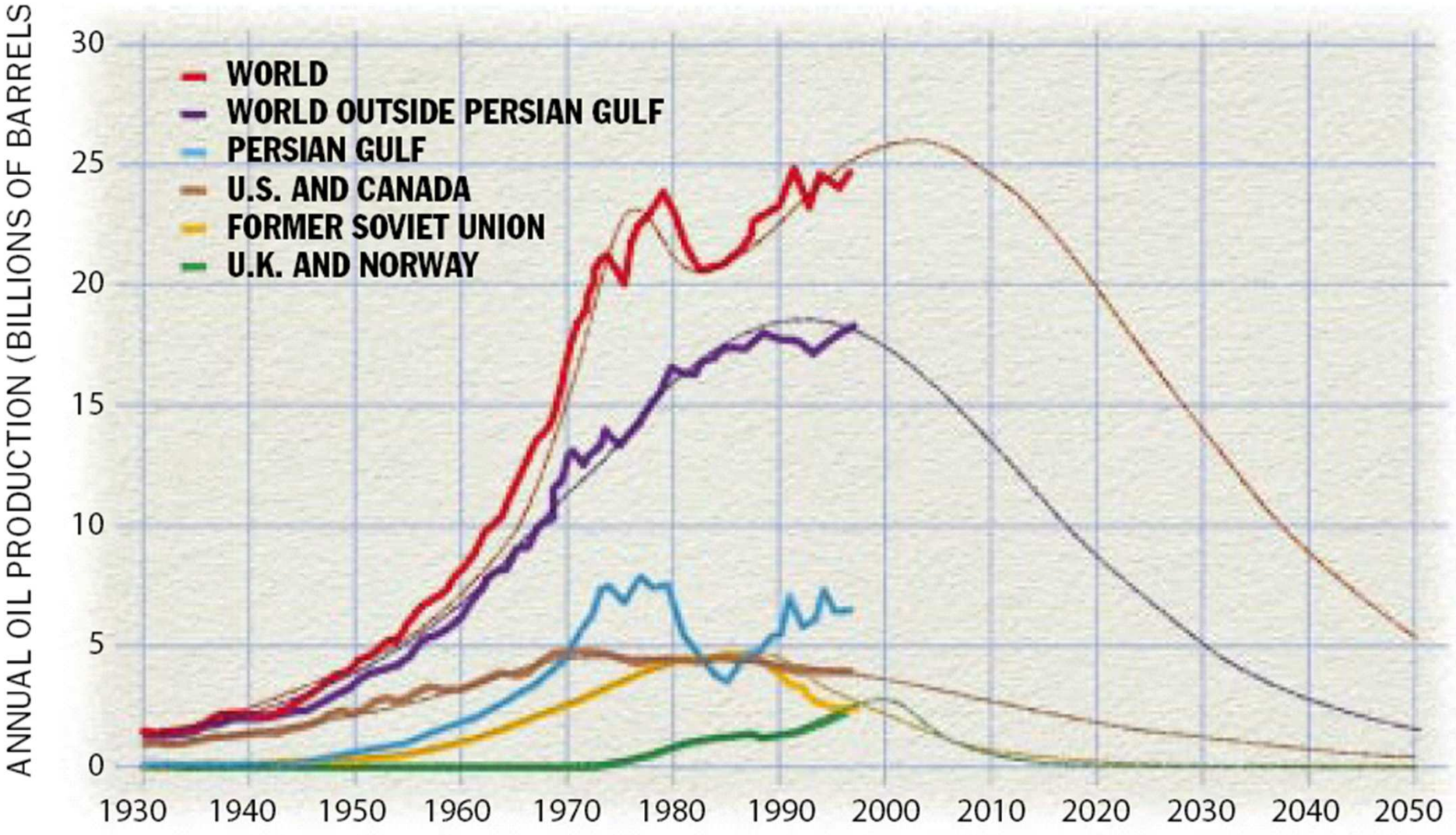
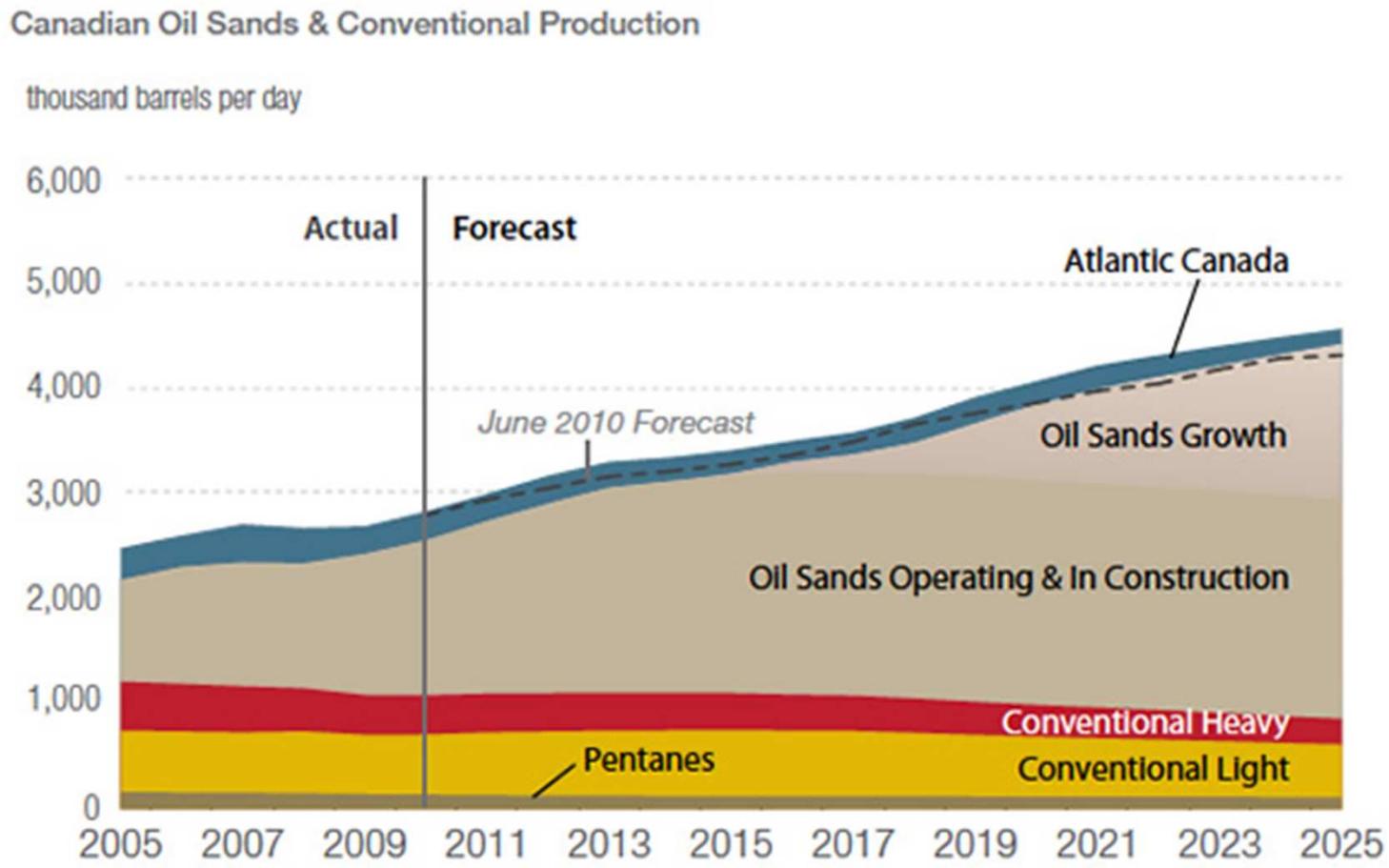
Annual Oil Production



Canadian Oil Sand Production



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Limited Resources: Oil

- ~1,000 billion barrels of oil produced to date.
- ~1,000 billion barrels of conventional reserves.
- ~ 25 billion barrels of annual production.
- U.S. Consumes ~ 7 billion barrels per year.

Colin J. Campbell and Jean H. Laherrere,"The End of Cheap Oil," *Scientific American,* March, 1998.

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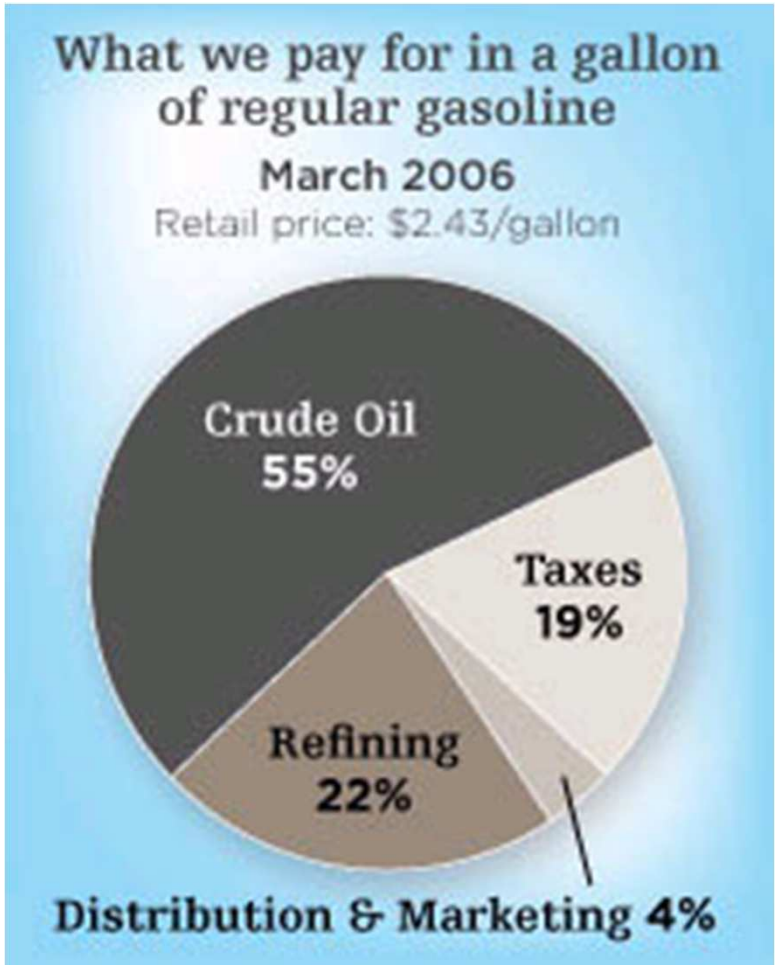
Gasoline Price Breakdown



Retail Price
$2.43/gallon

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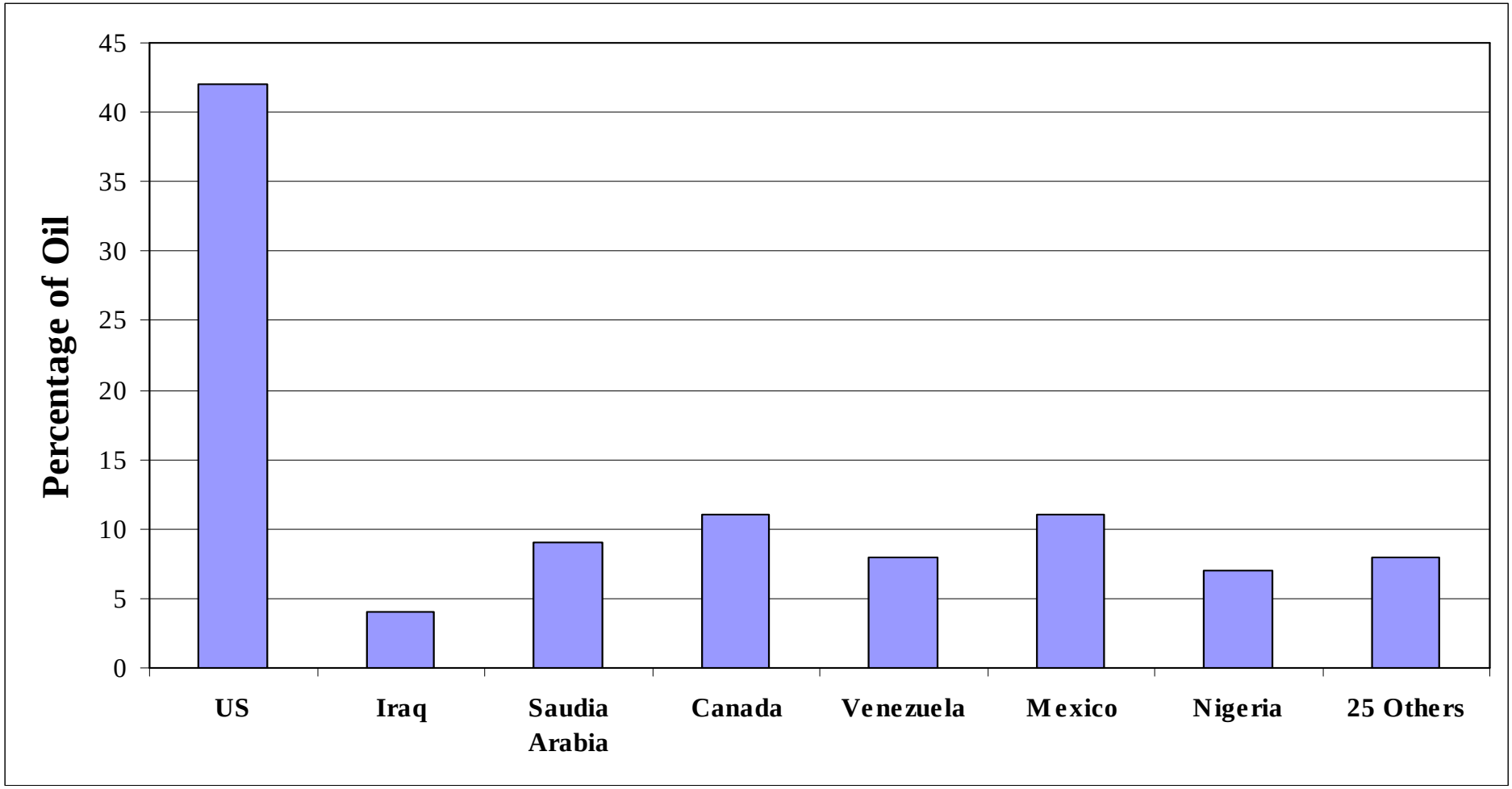
Where does the US get its Oil?



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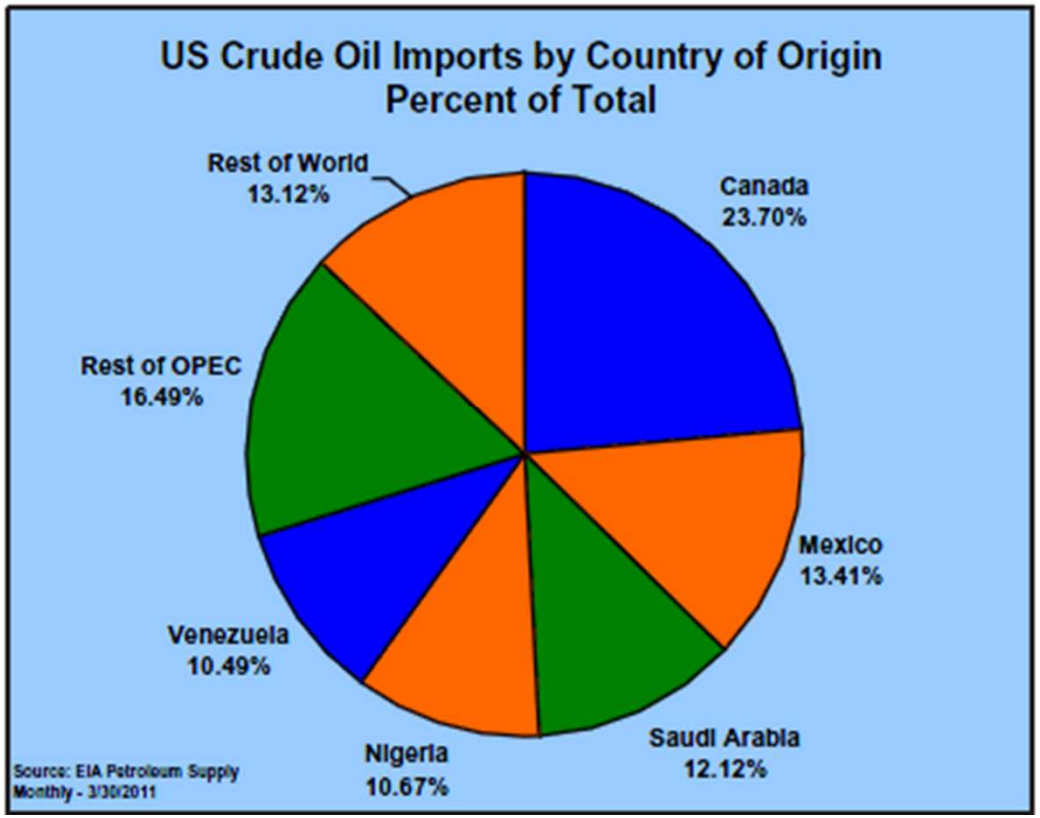
US Oil Imports - 2011

- 50 % of US oil imported in 2010



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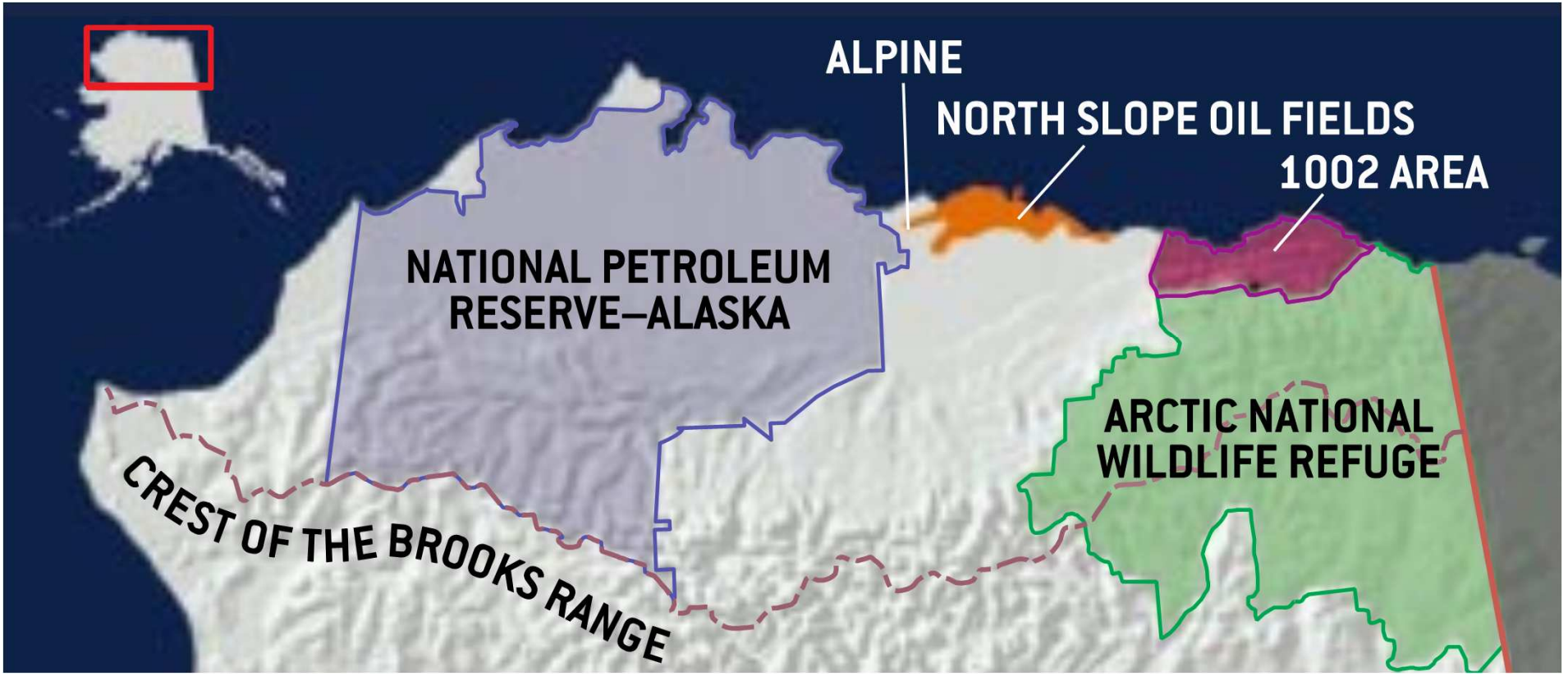
Limited Resources: Oil

- Examples of Conventional Oil Reserves
  - Saudia Arabia has ~300 billion barrels of oil
  - ANWR has ~5-10 billion barrels of oil total
  - Caspian Sea deposits ~50 billion barrels of oil total
  - Gulf of Mexico
    - Depth < 200 m = 0.35 billion barrels of oil
    - Depth > 200 m = 2.8 billion barrels of oil

Arctic National Wildlife Refuge



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Arctic National Wildlife Refuge

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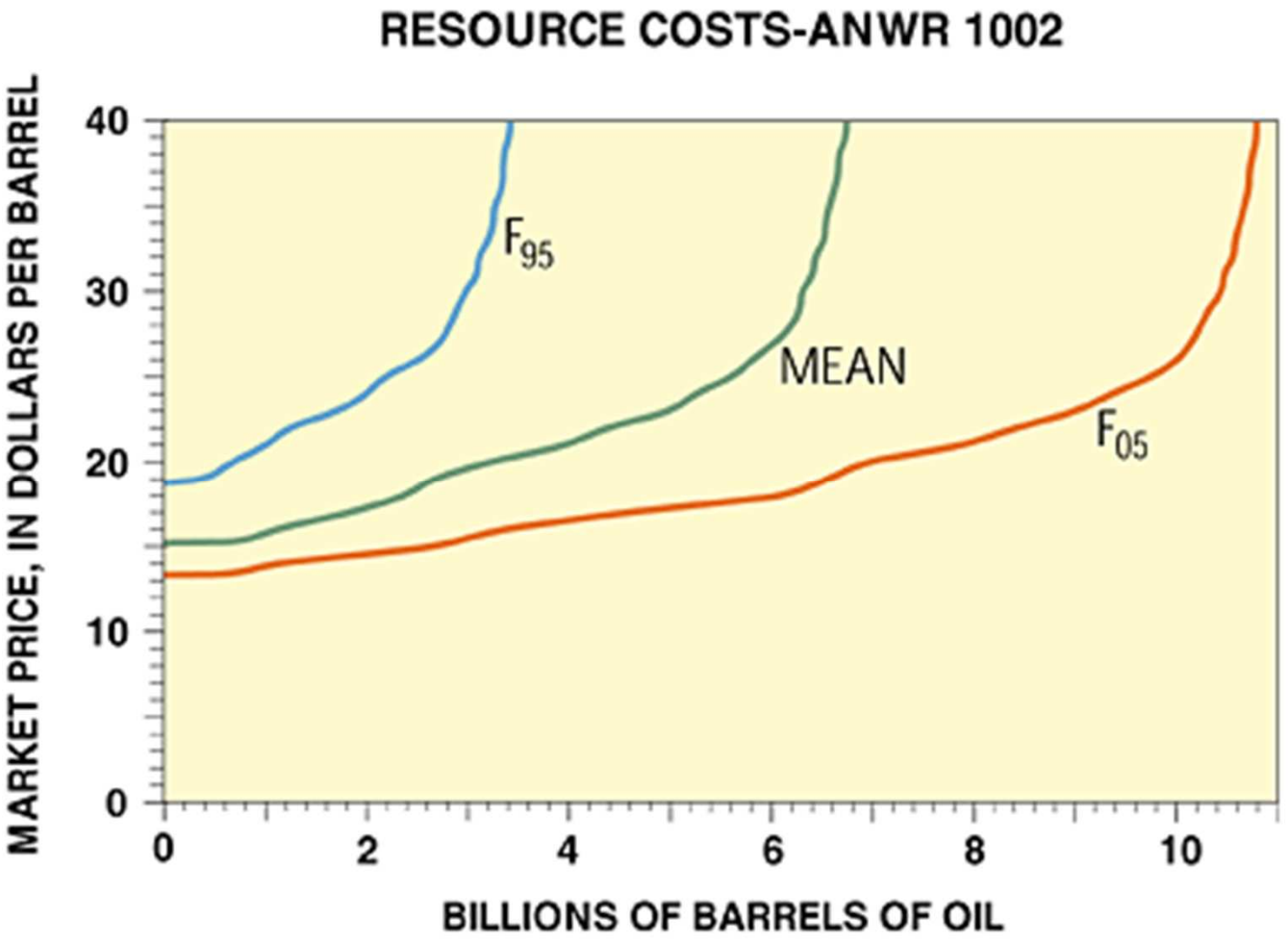

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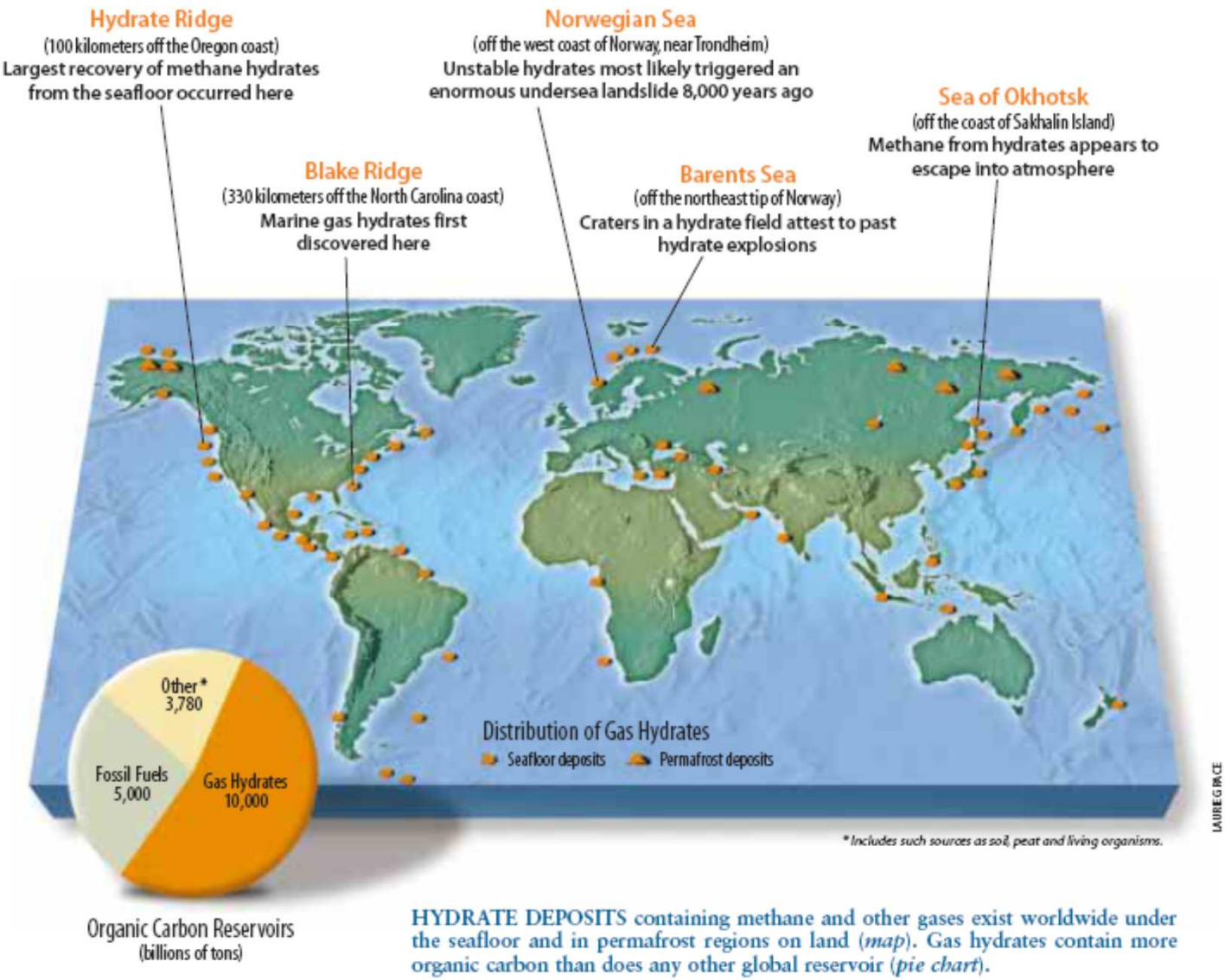
Limited Resources: Oil

- Examples of Unconventional Oil Reserves
  - Orinoco oil belt in Venezuela contains > 1 trillion barrels of sludge called heavy oil
  - Tar sands and shale in Canada and Russia contains the equivalent of 300 billion barrels of oil.
  - The U.S. has the largest proven coal reserves of any nation in the world
- Methane hydrates have more energy potential than all other known fossil fuel reserves combined

Methane Hydrates



HYDRATE DEPOSITS containing methane and other gases exist worldwide under the seafloor and in permafrost regions on land (*map*). Gas hydrates contain more organic carbon than does any other global reservoir (*pie chart*).

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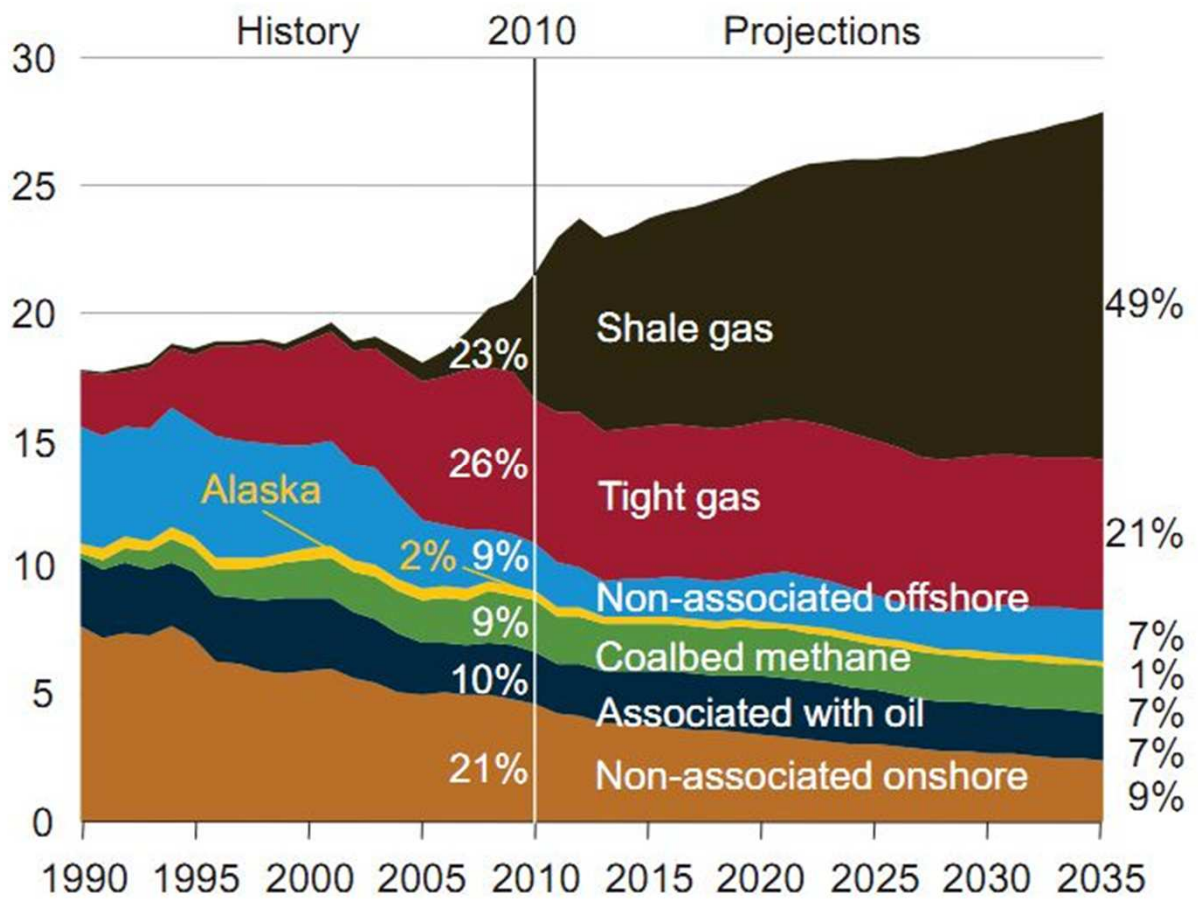
Rise of Natural Gas



http://www.lngworldnews.com/usa-eia-expects-huge-rise-in-natural-gas-production/

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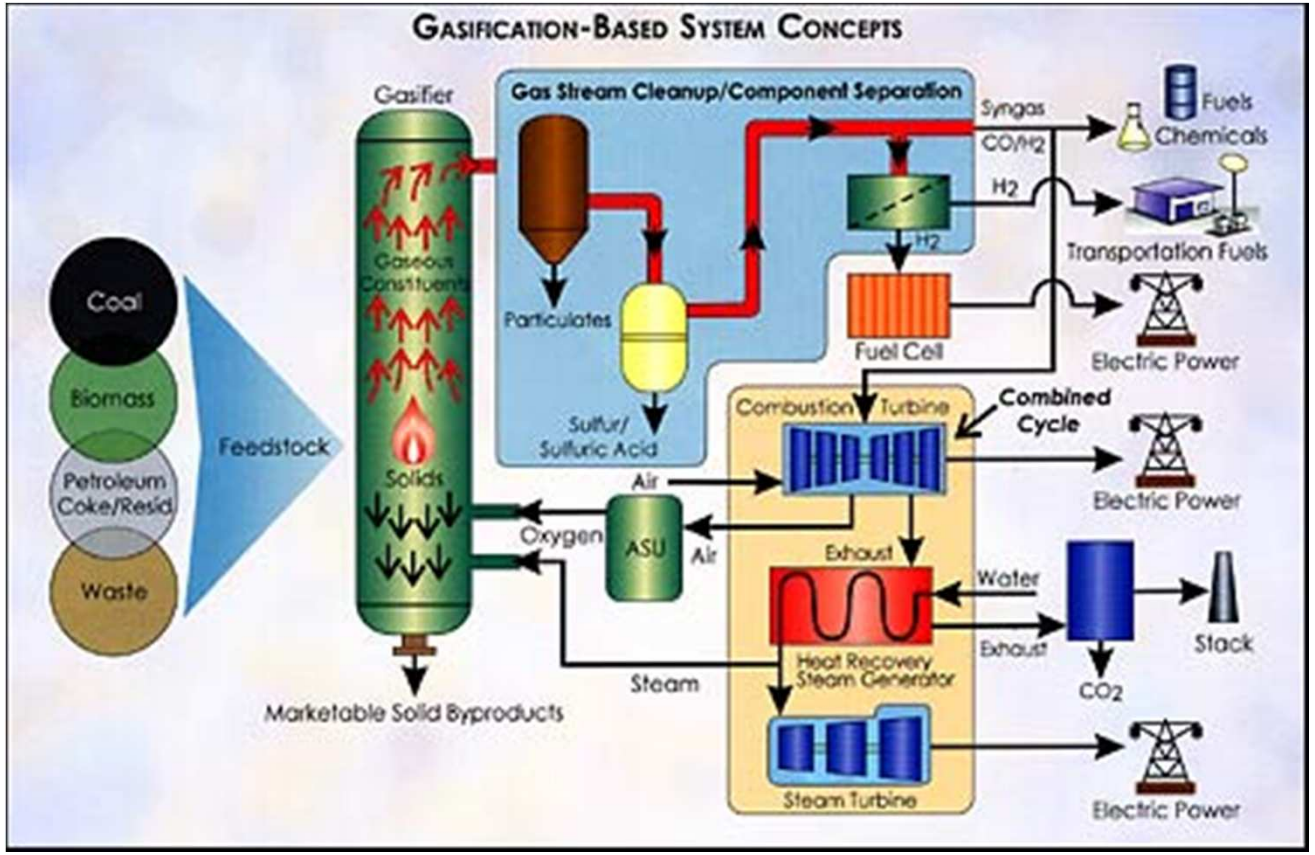
Gasification for Liquid Fuels

Partial oxidation of fuels to release H_2, CO, CH_4



http://www.fossil.energy.gov/programs/powersystems/gasification/howgasificationworks.html

Deutschland

Freiburg

http://tinyurl.com/gatzke1

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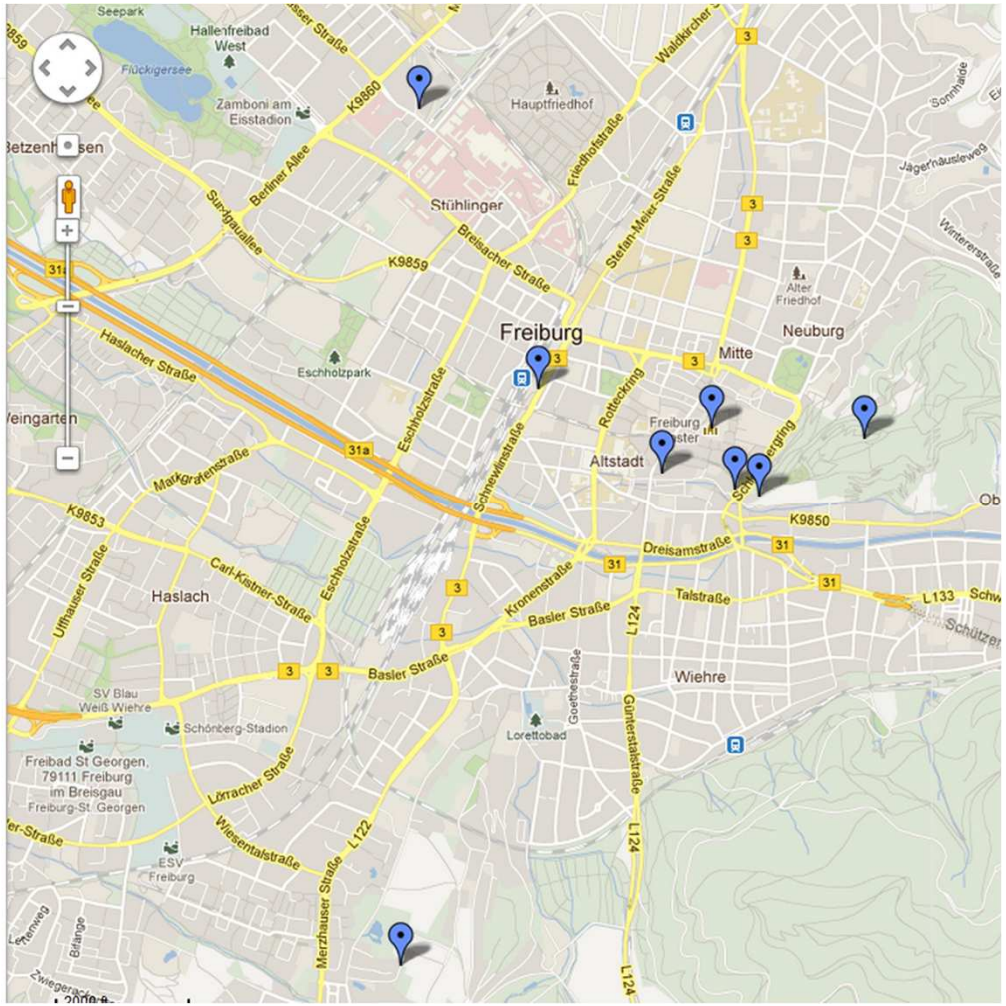
- InterCityHotel Freiburg
- Fraunhofer-Institut für Solare Energiesysteme ISE
- Heliotrop Rotating House
- Freiburg Minster (Church)
- Aussichtsturm Schlossberg (Tower)
  Great view Some history
- Biergarten am Greiffenegg
  On way to tower
- Schwabentor
- Theater am Martinstor



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Stuttgart

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SA-Stuttgart

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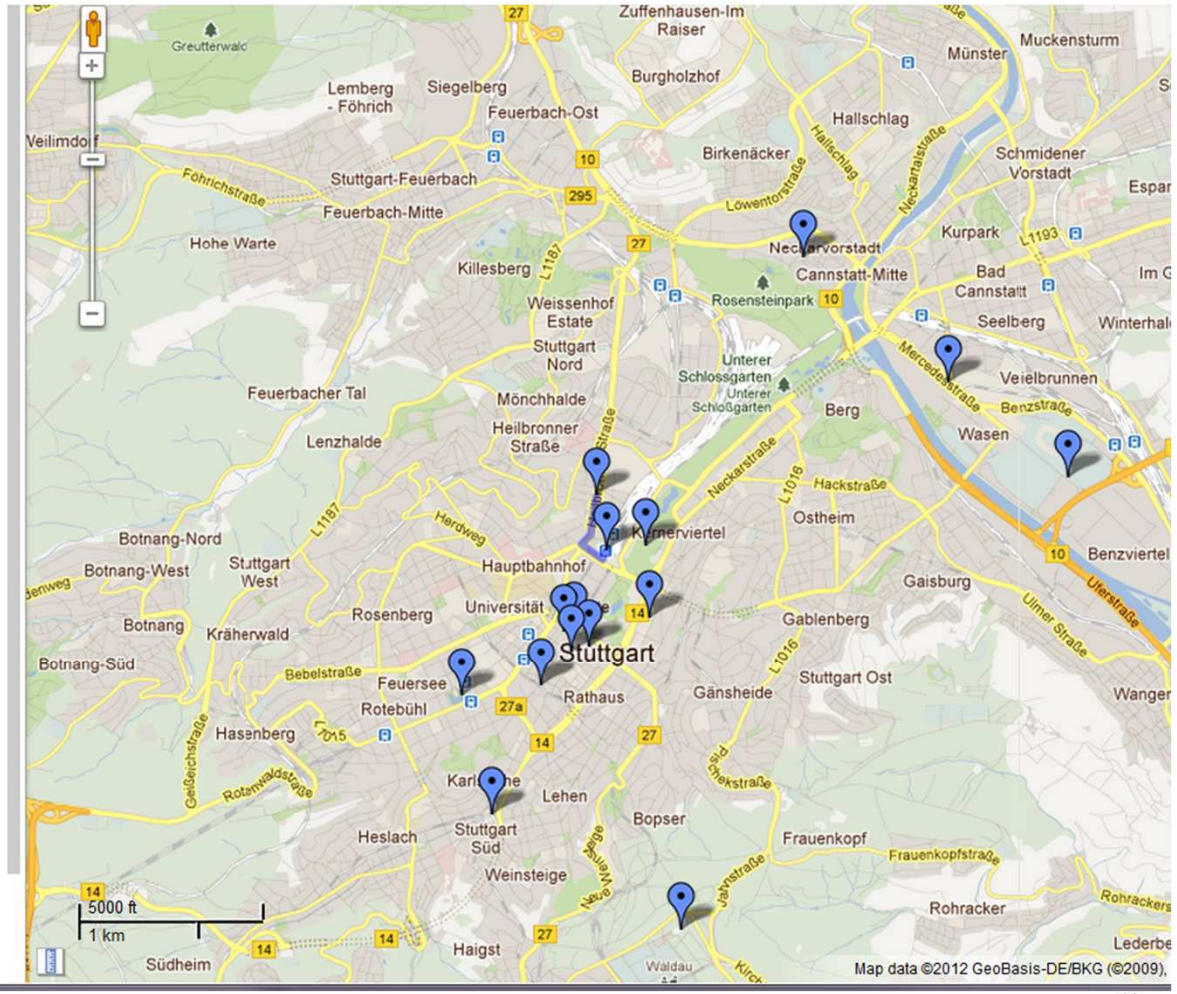
- Arcotel Camino
- Route to hotel
  About half a mile from the train station along busy roads.
- Stuttgart Hbf
- Mercedes-Benz Museum
- Porsche Museum
- Cannstatter Wasen (Spring Festival)
- Wilhelma (Zoo)
- Biergarten im Schlossgarten
  Nice big park with a pleasant biergarten
- Altes Schloss Stuttgart
  "Old Castle" with a decent museum of history. Some Roman stuff, old church art.
- Kunstmuseum Stuttgart (Modern Art)
- Staatsgalerie (State Gallery of Stuttgart)
  70173 Stuttgart, Germany
- Ochs'n Willi (Restaurant)
- Stiftskirche (Church)
- Stuttgart Rack Railway (Cog Train)
- Television Tower Stuttgart
- Feuersee (Church)



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Ulm

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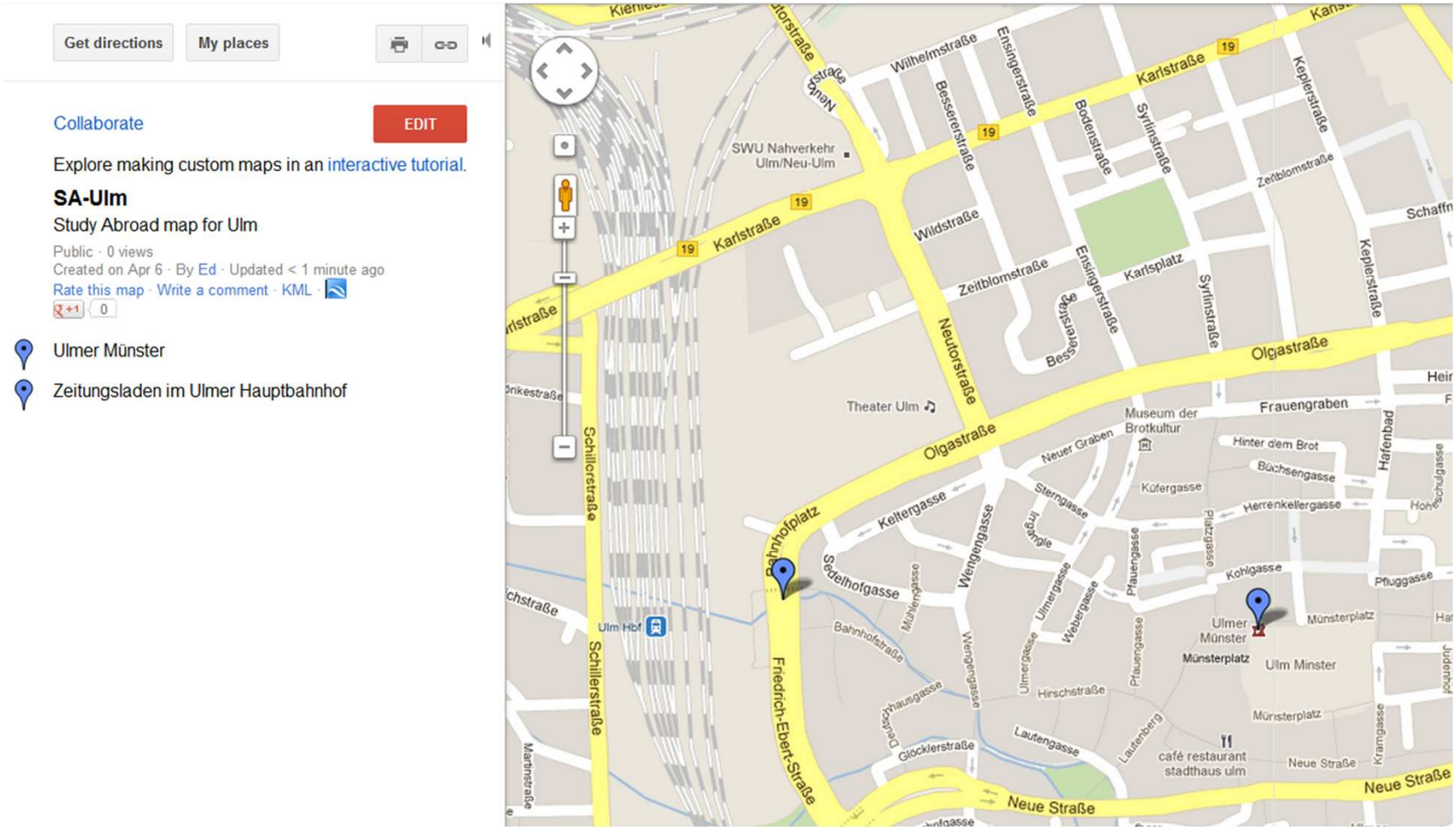

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Munich

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SA-Munich

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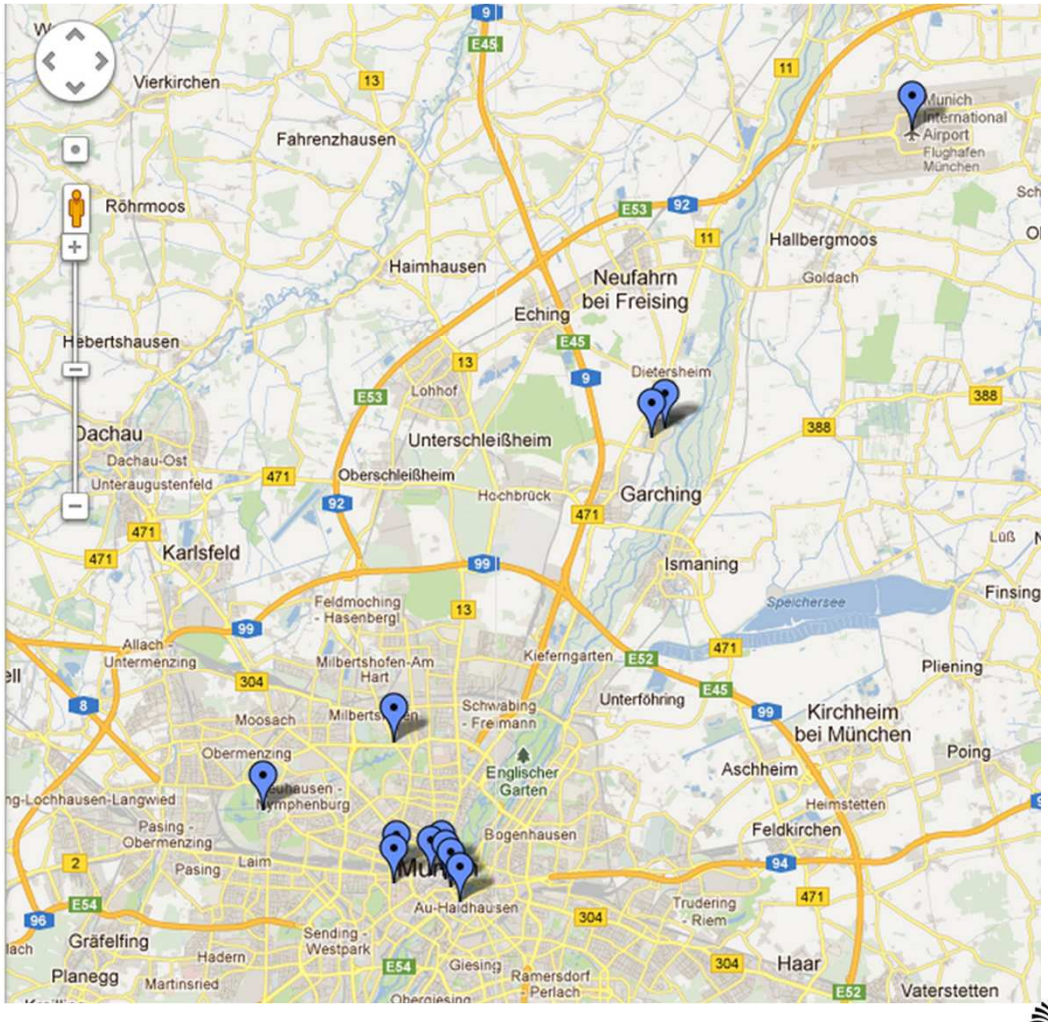
- Best Western Atrium Hotel
- München Hbf
- BMW Welt
- German Museum
- Technical University Munich
- Max-Planck-Institut für Plasmaphysik
- Hofbräuhaus
- Bahnhof München Isartor
- Munich Frauenkirche
- Residenzmuseum
- Nymphenburg Palace
- Munich International Airport



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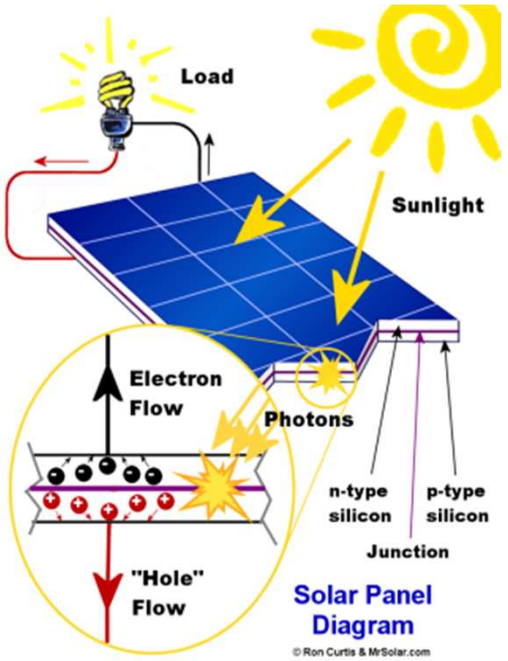
Energy Production Topics

- Solar
  - Traditional
  - Thin-film
  - Focused / Fresnel
  - Thermal approaches
- Nuclear
- Petrochemical
- Biomass
- Wind / Hydro

Solar Energy

Mazin Al Masrouri

- Solar energy is produced using solar panels.
  - Convert sun's energy into electricity
  - Photons hit semi-conducting material
    - n-p junction (positive / negative doped)
    - photons excite electrons in material
- Advantages
  - Environmentally friendly
  - Easy to install
  - Low maintenance
  - It provides power to most remote locations
  - Costs of solar panels are decreasing while efficiency is increasing

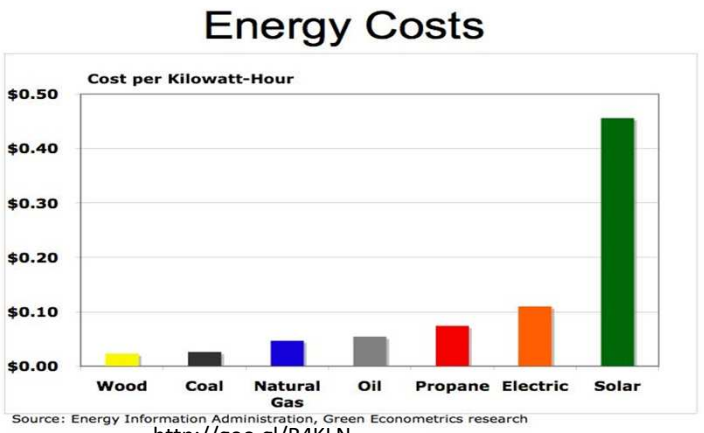


http://goo.gl/612Tt

Solar Energy

Mazin Al Masrouri

- Disadvantages
  - Efficiency relies on the location of the sun
  - Its production is influenced by the weather
  - High initial cost
  - Takes up a lot of space
  - Pollution during manufacture
- Economics
  - $0.38-to-$0.53 per KWH
  - Expensive when you first purchase it, but in the long run you will find yourself saving quite a great deal of money.



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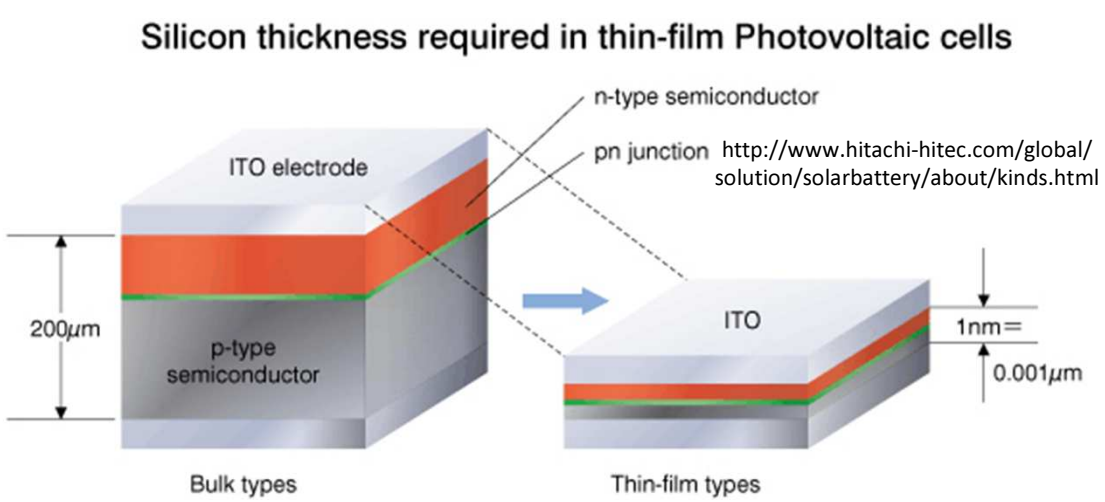
Thin Film Photovoltaic (PV) Cells

Daniel Fischer

- Made by applying thin layers of silicon to substrate base
  - Up to 20% efficiency depending on chosen semiconductor
  - Semiconductor absorbs sunlight and produces voltage in a junction layer
- Advantages
  - Cheaper, lighter, smaller, than traditional PV cells
  - Can be made more efficient by layering several cells to produce power from each cell (multijunction)
  - Very flexible in comparison to traditional cells



Thin Film Photovoltaic (PV) Cells

Daniel Fischer

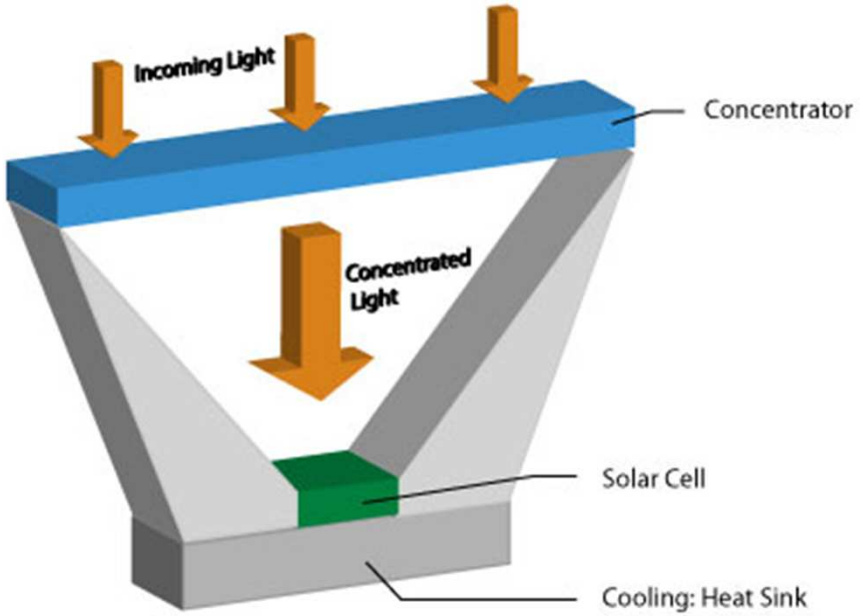
- Disadvantages
  - Less efficient than traditional PV cells (on average)
    - Solutions to improve efficiency are being tested, such as multi-layered cells
  - Can take up large amounts of space
    - Less than traditional though
  - Production of thin film PV cells sometimes produces cadmium that builds up in the cell

http://whitesunsolar.com/243/thin-film-solar-panels/

Focus/ Fresnel PV

Alexander Barr

- Small solar cell with large lens or mirrors
  - Large area of light focused on cell
  - Varying degrees of concentration from 2X - 500X+
  - Largest installation 8MW
- Advantages
  - Smaller solar cell = Less cost
  - Better use of expensive high efficiency multi-junction cells
  - Does not require silicon

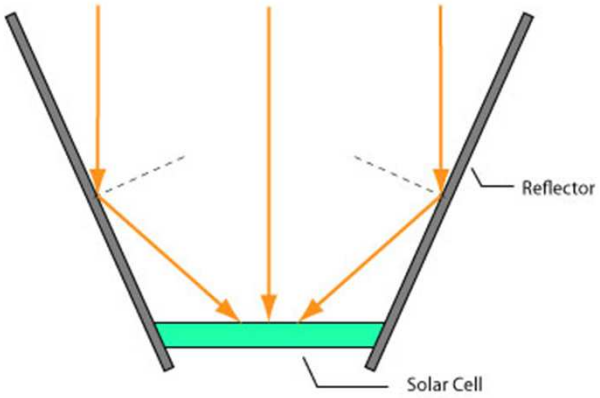


http://www.greenrhinoenergy.com/solar/technologies/pv_concentration.php

Focus/ Fresnel PV

Alexander Barr

- Disadvantages
  - Needs high accuracy sun tracking
  - Requires direct sunlight
  - Higher concentrations need cooling
  - Space/land costs



http://www.greenrhinoenergy.com/solar/technologies/pv_concentration.php

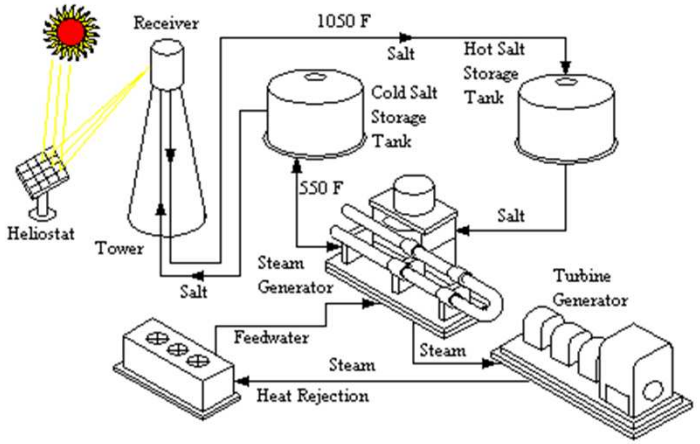
- Economics
  - <$1 to $3 per Watt
  - Stable Multi-junction cell market

http://www.greenrhinoenergy.com/solar/technologies/pv_concentration.php

Solar Power Tower

Shelby Raines

- A large field of sun-tracking mirrors, called heliostats, that direct solar energy onto a receiver on top of a centrally located tower
  - Transfer fluid heated in the receiver is used to generate steam
  - Steam used in turbine-generator to produce electricity
- Advantages
  - Can efficiently store solar energy
  - Does not release green house gases
- Disadvantages
  - High cost
  - Large size of plant
  - Need for a desert type environment
  - High-temperature materials



http://lisas.de/projects/alt_energy/sol_thermal/powertower.html

Solar Trough

Ed Gatzke

- Similar to solar tower concept
  - Parabolic trough warms hot oil pipe
  - Hot oil makes steam

Advantages

- Around 15% efficient
- Low emission
- Low fuel cost

Disadvantages

- Must rotate to follow sun
- Large land-use
- Expensive capital cost

http://www.engineersdaily.com/2011/01/green-energy.html

Stirling Engine for Thermal

Ed Gatzke

- Parabolic mirrors focus sunlight
  - Stirling engine used for higher efficiency
- Advantages
  - High temperatures = better efficiency
  - Stirling cycle = higher efficiency
- Disadvantages
  - Must track sun (2D)
  - Engine is in moving structure
  - High temperature materials
  - Stirling engine difficult to produce in practice

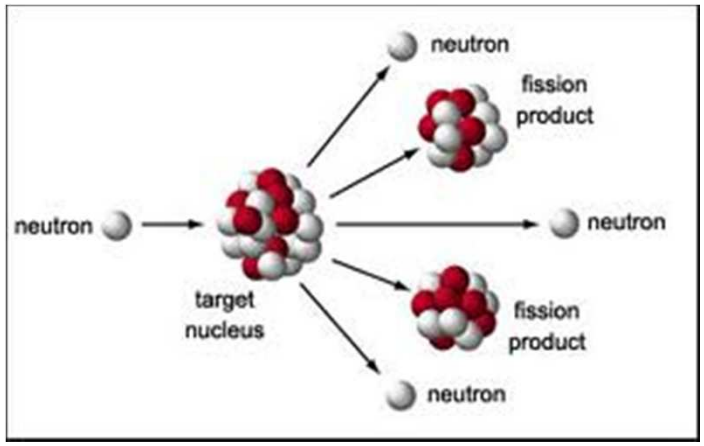
Energy Production Topics

- Solar
- Nuclear
  - Traditional
  - Small-scale
  - High-temperature molten salt
  - Thorium
  - Fusion
- Petrochemical
- Biomass
- Wind / Hydro

Traditional Nuclear

Bradley Harris

- Fission of fissile uranium nuclei to create large amounts of energy and
  - Radiation
  - Smaller particles



http://www.atomicarchive.com/Fission/Fission1.shtml

Advantages:

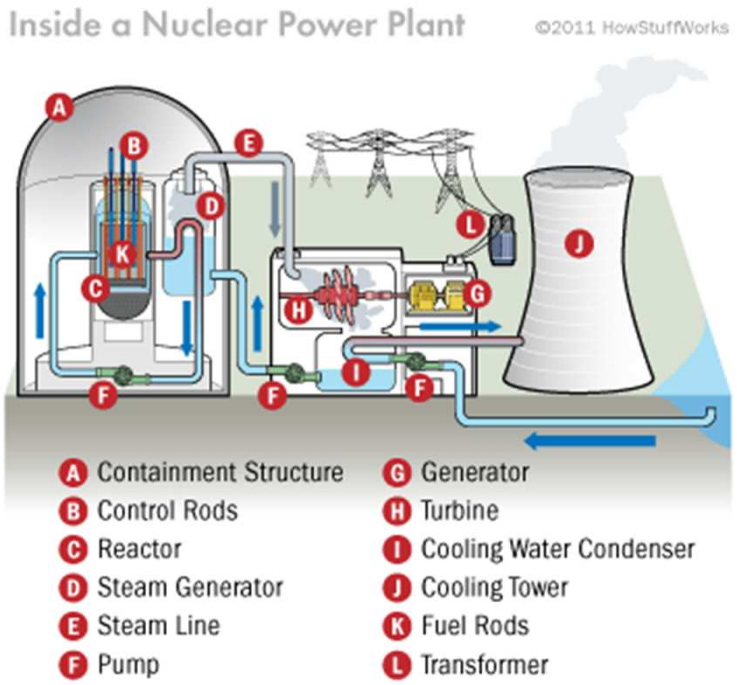
- Low CO_2 emissions
- Low fuel cost compared to fossil fuels
- Very high power output possible

Traditional Nuclear

Bradley Harris

Disadvantages:

- Potential for a catastrophic meltdown
  - Contamination of large
- Spent fuel is radioactive and has a very long half-life
  - Must be stored in a safe location for hundreds of years
- Pollution associated with mining / conversion of ore

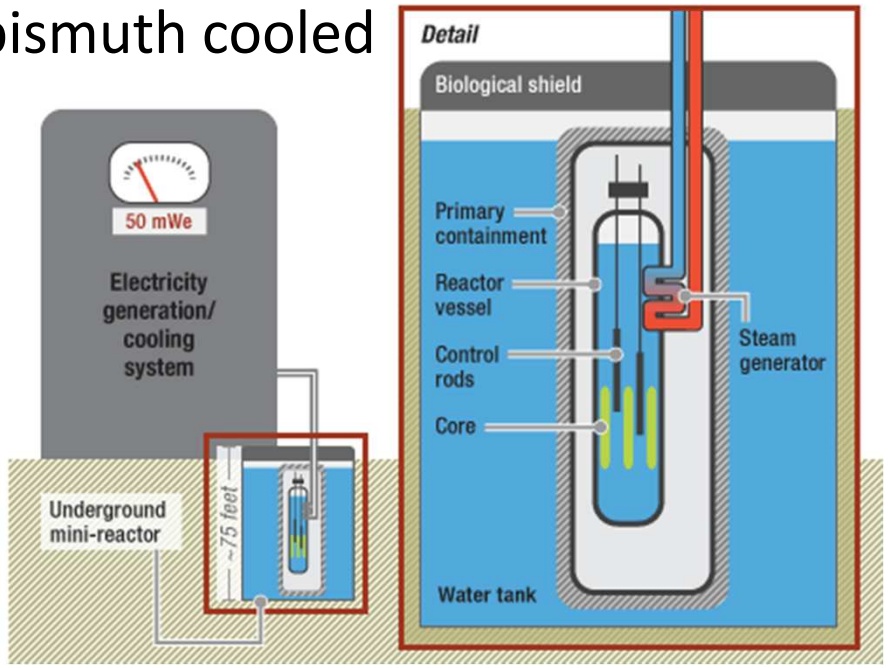


http://science.howstuffworks.com/nuclear-power2.htm

Small Nuclear Reactors

Ed Gatzke

- Traditional fission device with control rods
  - Buried underground, lead/bismuth cooled
  - 20-50 MW
  - Heats water for steam
- Advantages
  - Simple design
  - Underground
  - Low capital cost
  - Easier to dispose of
  - No CO_2 emissions
  - No powered cooling, few moving parts for maintenance



www.npr.org http://goo.gl/Wx9MM

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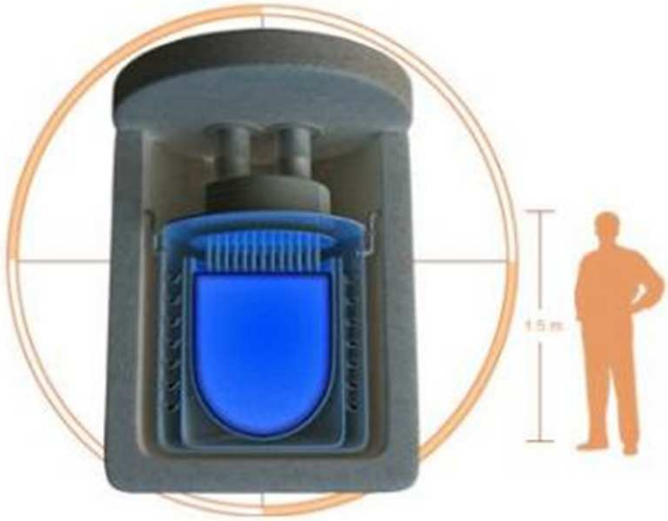
Small Nuclear Reactors

Ed Gatzke

- Disadvantages
  - Potential for accident
  - Nuclear waste
  - Weapons proliferation
  - Permitting process
  - Image / fear of nuclear power
  - Overhyped (5 years out 4 years ago)
- Economics
  - $1 to $4 per Watt ($2,500 / home)
  - Limited production / fuel cost



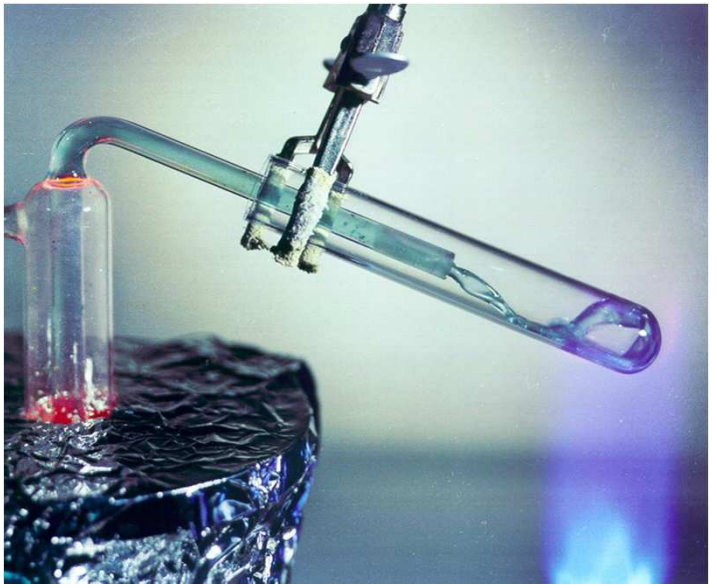
http://www.physorg.com/news145561984.html

High Temperature Molten Salt

Blake Henard

- Molten salt reactor (MSR)= nuclear fission reactor that uses a molten salt mixture for fuel and coolant
- The reactor converts thermal energy mainly to create electricity
- Run at very high temperatures
- Advantages
  - Salts more efficient than water at removing heat
  - High pressure ➔ low stress ➔ safer
  - Small core ➔ fewer materials to absorb neutrons

    ➔ more suitable for fuel cycles
  - More inexpensive
  - Meltdown-proof and easily managed



http://en.wikipedia.org/wiki/File:FLiBe.png

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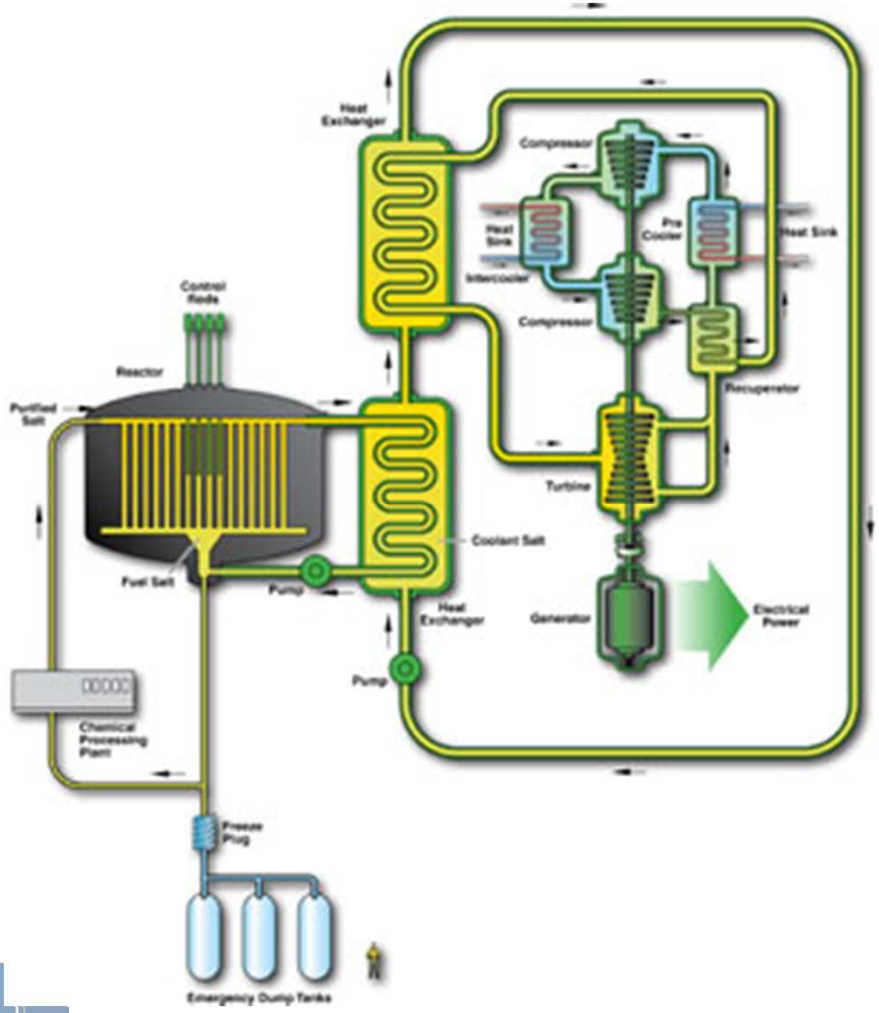
High Temperature Molten Salt

Blake Henard



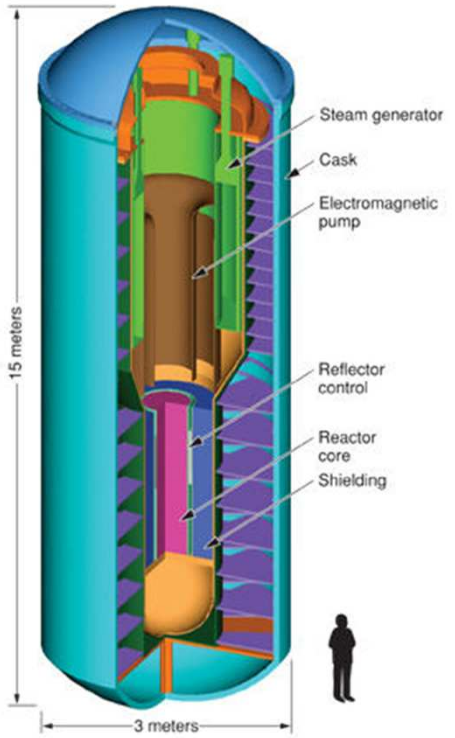
- Disadvantages
  - Little development so far
  - Need chemical plant to manage the salt mixtures
  - May need regular changes to deal with drastically different design features
  - Corrosion may occur over many decades

http://www.inl.gov/research/molten-salt-reactor/

Thorium Reactors

Keith Michaud

- Uses thorium rather than uranium
  - Thorium must be activated
- Advantages
  - Less radioactivity
  - Abundance of fuel (5x uranium)
  - Weapons grade production is difficult
  - 10 to 10,000 times less long-lived isotopes
  - No enrichment necessary
  - Used 100% of fuel from ground
  - Safety – reaction requires priming



http://www.thorium.tv/images/thorium_reactor.jpg

Thorium Reactors

Keith Michaud

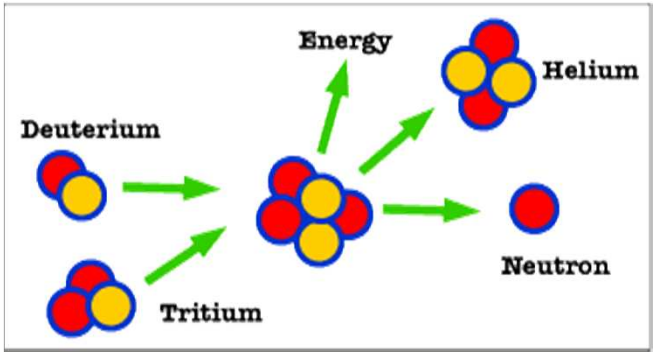
- Disadvantages
  - Expensive material
  - Less energy per mass
  - Limited knowledge
  - ^{233}U produced
- Economics
  - USA 1962-1989
  - India 1980-current
  - Speculative pricing due to lack of use

http://images-of-elements.com/s/thorium.jpg

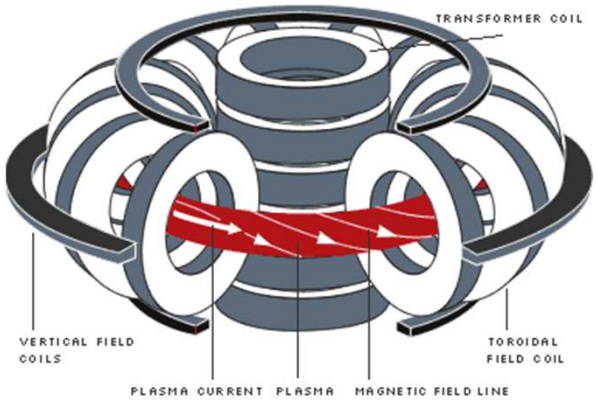
Nuclear Fusion

Allison Tipton

- Fusion Reactors
  - Fusing together deuterium and tritium to produce neutrons, helium, and energy
  - Each fusion releases 17.6 MeV
  - Most Popular Research: Tokamak
    - Magnetic field to confine plasma and charged particles
- Advantages
  - Ultimately limitless fuel supply
  - No CO_2 emissions
  - No long term radioactive waste
  - Reduced environmental impact
  - Safe (impossible to have runaway fusion reaction)



http://www.energyquest.ca.gov/story/chapter13.html



http://pitjournal.unc.edu/volume-1-issue-1/energy-source-tomorrow-benefits-nuclear-fusion-power

Nuclear Fusion

Allison Tipton

http://www.ipp.mpg.de/ippcms/eng/for/bereiche/tokamak/index.html

- Disadvantages
  - The process has not been perfected yet and is still in the research phase
  - Not yet available on a large scale
  - Short Term Radioactive Waste Problems
  - Concerns about release of tritium into environment
- Costs (once perfected and out of research phase)
  - About 7 euro cents/kWh
- 50% more than the cost of fossil fuels but comparable to the cost other sustainable fuel sources

http://www.energyresearch.nl/energieopties/kernfusie/achtergrond/economie/
http://www.world-nuclear.org/info/inf66.html

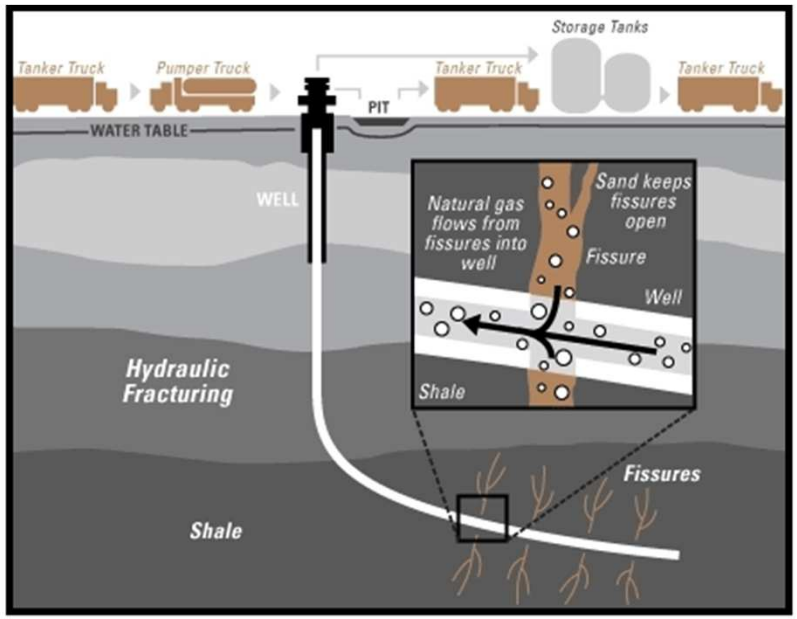
Energy Production Topics

- Solar
- Nuclear
- Petrochemical
  - Fracking
  - Tar sands
  - Clean coal
  - Coal gasification
- Biomass
- Wind / Hydro

Fracking

Meredith Nix

- Method of mining natural gas
  - Water and chemicals pumped into the mine
  - Pressure forces oil up to the surface
  - Amount of natural gas per frac job varies on the site, but a mine can be fracked up to 18 times



http://gestetnerupdates.com/wp-content/uploads/2012/01/Fracking.gif

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Fracking

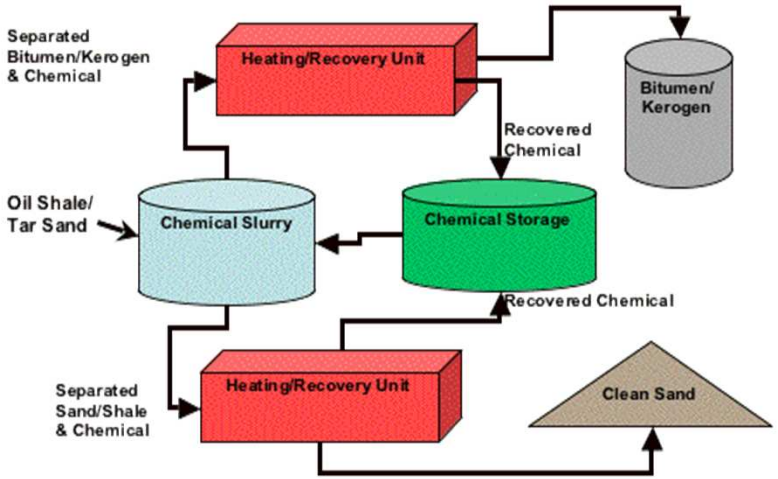
Meredith Nix

- Advantages
  - Fracking companies provide thousands of jobs
  - Safe mining technique for workers
  - Economical way to obtain natural gas
  - Able to obtain gas inaccessible by conventional mining
- Disadvantages
  - Controversial mining method
  - 1 to 8 million gallons of water used per frack
  - Pollutes ground and well water
  - Can occasionally cause earthquakes
  - Fuel produces CO_2

Tar Sands

Tim Barnhill

- Unconventional Petroleum
  - Sands saturated with very heavy crude oil
  - Bitumen separated from sand
  - 2 trillion barrels in existence
- Advantages
  - Large quantity attainable
  - Developed technology
  - Infrastructure already present
  - Located around world (Canada, Venezuela, US, China, etc.)



http://bleedingrock.net/images/process.gif

Tar Sands

Tim Barnhill

http://www.desmogblog.com/sites/beta.desmogblog.com/files/blogimages/Tar-sands-oil-canada-2.jpg

- Disadvantages
  - High energy requirement for production
  - Remoteness of most resources
  - Can be environmentally hazardous
- Economics
  - Production costs $11-27/barrel
  - High transportation costs
  - $20-30/barrel for crude oil refining

Clean Coal

Jennifer Fadimba

- Capturing CO_2 from coal
- Stripping CO_2 before or after burning
- Storage of CO_2
  - Industrial use
  - Oil recovery use
  - Underground storage (carbon sequestration)

Clean Coal

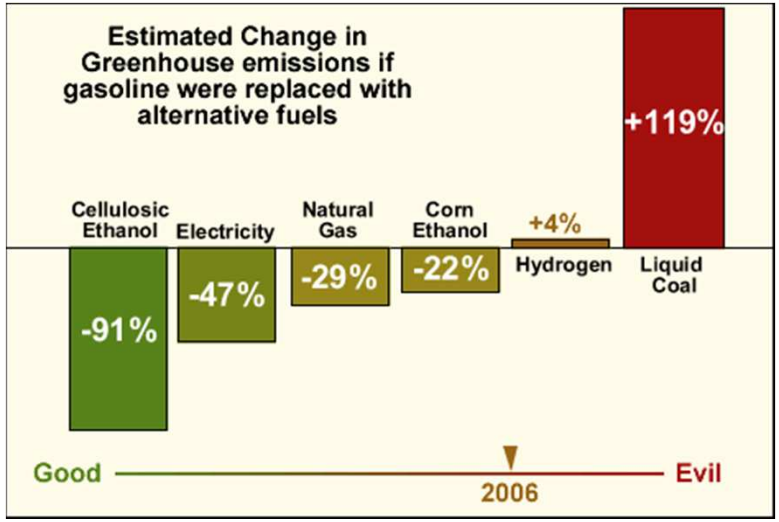
Jennifer Fadimba

Advantages

- Large amounts of coal in developed countries
- Less CO_2 released
- Can encourage international business

Disadvantages

- Expensive
- Not renewable
- Still have coal mining
- Not carbon neutral



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Coal Gasification

Ed Gatzke

- Convert coal to liquid fuels

Advantages

- Large supply of coal
- Low cost MeOH (< $1/gal)

Disadvantages

- Emissions

http://www.ens-newswire.com/ens/nov2007/2007-11-28-091.

Energy Production Topics

- Solar
- Nuclear
- Petrochemical
- Biomass
  - Biodiesel from oil
  - Biodiesel from algae
  - Wood pellets
  - Ethanol from corn / sugar
  - Waste wood conversion
- Wind / Hydro

Diesel History

Leila Miles

- Rudolf Diesel (1858-1913)
  - Developed 1st engine to run on peanut oil
  - World Exhibition in Paris (1900)
- Diesel fuel was cheap
  - However it wasn't a renewable source of power
  - Clean vegetable oil forgotten about
- Fuel shortages in 1970s
  - Developed alternative to petroleum diesel
  - Biodiesel as fatty ester

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What is biodiesel fuel?

Leila Miles

- A variety of ester-based fuels
  - Usually monoalkyl esters from vegetable oils
  - Animals fats can be used through a transesterification process
- Efficient as petroleum diesel
- Powers unmodified diesel engines

Biodiesel from Oil

Victoria Kmiec

- Relies on oil from cooking, plants, or animals
  - Canola, palm, soy, corn, sunflower, peanut, animal fats
- Blend oil with petroleum diesel
  - Grades: B2 (2% biodiesel), B5, B20 or B100
- Advantages
  - Biodegradable
  - Nontoxic
  - Less pollutants than petroleum diesel
  - Domestically produced

http://www.extremebiodiesel.com/about_biodiesel.html

Biodiesel from Oil

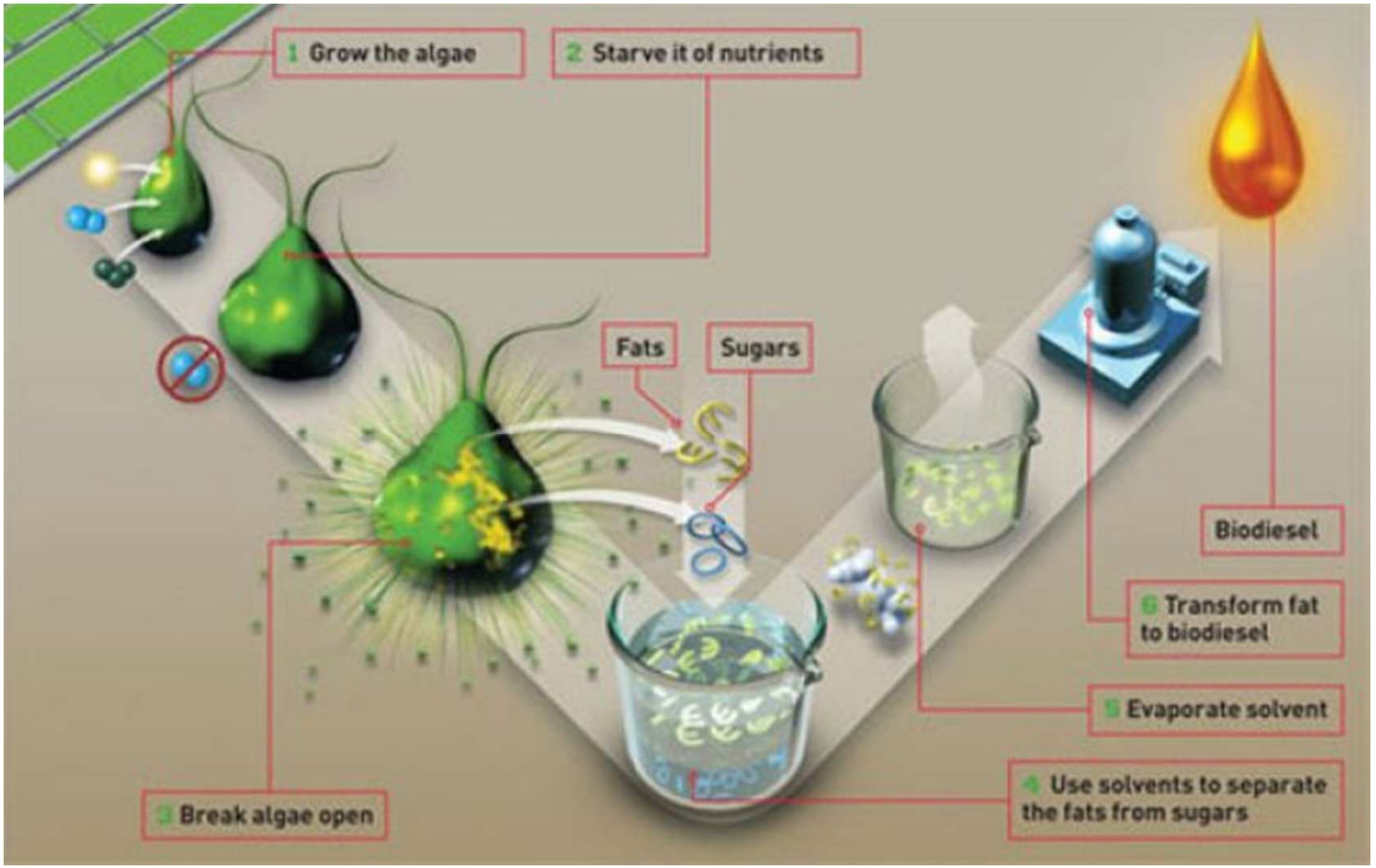
Victoria Kmiec

- Disadvantages
  - Solidifies at high temperatures
  - Greater nitrogen oxide emissions
  - Lower fuel economy and power
  - Automotive industry depends on blends with high concentration of petroleum diesel

- Economics
  - 1.1 gallons of biodiesel = 1 gallon of conventional diesel
  - $$ biodiesel > $ conventional diesel

Biodiesel from Algae

Mac Rogers



http://algae-biofuel-online.blogspot.com/2012/02/algae-biofuels-great-for-co2.html

Biodiesel from Algae

Mac Rogers

- Advantages
  - Recycled waste and ocean water
  - Biodegradable (less harmful when spilled)
  - Energy independence
  - Not location specific
  - Consumes CO_2
- Disadvantages
  - High operating costs
    - Not yet economically viable without tax incentives
  - Still produces CO_2
  - Approximately 15,000mi^2 to replace US fuel usage

    www.washingtonpost.com http://goo.gl/CoKwQ

Wood Pellet Combustion

Andrea Eggleston

- Wood material processed
  - Dough-like mass
  - Squeezed through press
    - Temperature rises – solidifies
  - Burned to produce heat or energy

http://www.tootoo.com/s-ps/wood-pellet--p-3707400.html

- Economic/efficiency
  - Equal to 4,775 kWh electricity
  - $0.04/kWh production

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Wood Pellet Combustion

Andrea Eggleston

- Advantages
  - Low net carbon emission
  - Can operate up to 95% efficiency
  - Easy to switch boilers in house
- Disadvantages
  - Pellets are bulky
  - Transportation required
  - May produce noxious emissions
  - Combustion of particulates is difficult / polluting

Corn to Ethanol

John Clegg

Bioprocess

1. Milling: Corn kernels ground to make high Surface Area
2. Liquefaction: Enzymes and water added, heated and agitated to form glucose from corn
3. Fermentation: Yeast added to turn glucose into ethyl alcohol
4. Distillation: Purifies product

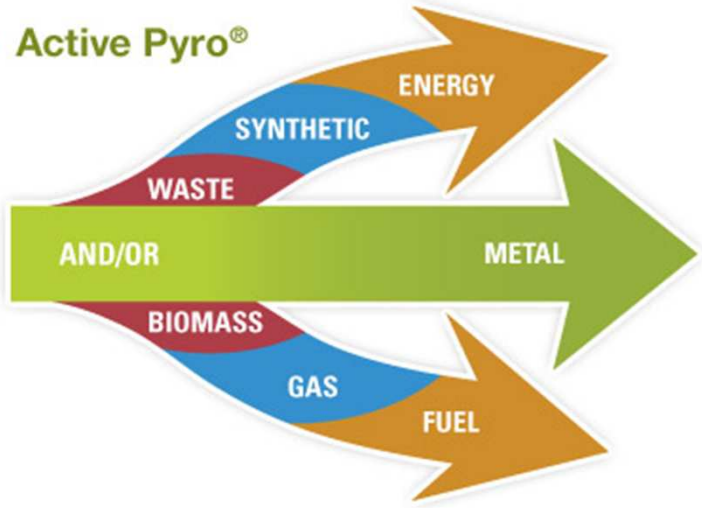
Sugar to Ethanol

John Clegg

- Brazil is a leader in this field
  - 55% of sugarcane produced in Brazil for ethanol
- Does not require a bioprocess involving enzymes
  - Uses yeast to ferment the sugar into ethyl alcohol
- Distillation then used to purify product
  - Goal of 95.1% ethanol by volume
  - Greatest percent that can be easily achieved
  - Distillation requires substantial energy
- Land use efficiency limited

Stover/Wood/Brush Gasification

Gerry Koons



http://chinookenergy.com/secondary.asp?pageID=13

- Organic waste products into component gases
  - Wastes from agriculture, construction
  - RODECS system
  - Active pyrolysis
- Advantages
  - Variety of feed materials, without pre-processing
  - Highly efficient
  - Low operating cost with minimal manpower
  - Versatile application
  - Environmental benefits

Stover/Wood/Brush Gasification

Gerry Koons

- Disadvantages
  - Yield of tar
  - Limitations of feed size
  - Producer gas
  - Slagging potential
  - Moisture sensitivity

http://www.ecomii.com/blogs/building/2009/02/26/gasification-boilers-are-all-the-rage/

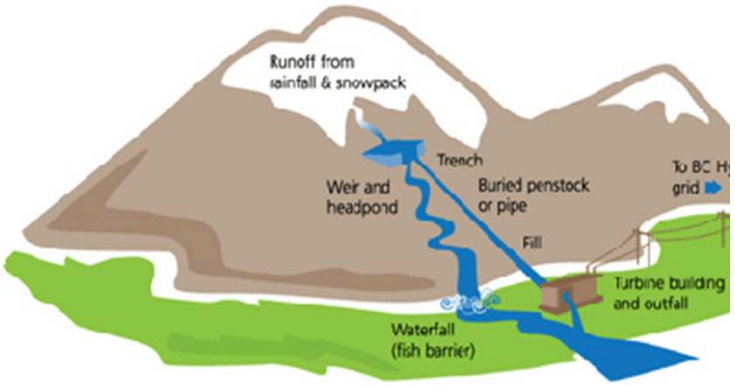
Energy Production Topics

- Solar
- Nuclear
- Petrochemical
- Biomass
- Wind / Hydro
  - Run of river hydro
  - Ocean Thermal
  - Traditional wind power
  - Solar updraft towers

Run of the River Hydroelectricity (ROR)

Zach Flynn

- A river is diverted
  - Trench is dug down
  - Tunnel down side of the mountain
- Tunnel connects to the turbine
- Best with high mountain ranges
  - Nepal with the Himalayan mountain range is ranked #1 in the world for hydropower potential
- ROR plants have little to no storage capability
  - Rely on gravity and present rivers to feed their turbines



http://media.treehugger.com/assets/images/2011/10/run-of-river-hydro-080815.jpg
http://www.energy-consumers-edge.com/run_of_the_river_hydro.html
http://en.wikipedia.org/wiki/Run-of-the-river_hydroelectricity#Advantages

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Run of the River Hydroelectricity (ROR)

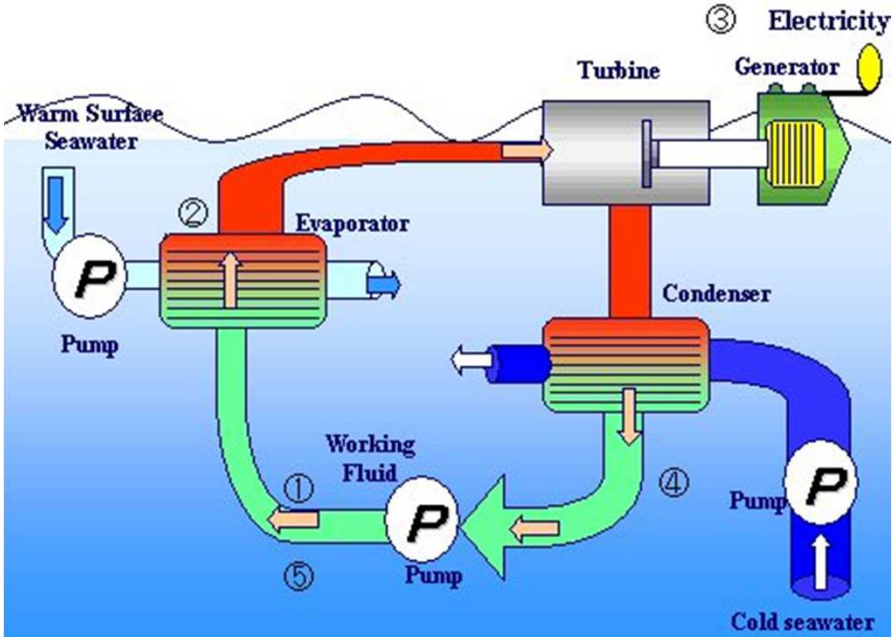
Zach Flynn

- Advantages:
  - Reduces green house gases
  - Eliminates the need for huge dams and severe flooding
  - Does not require flooding of surrounding land
- Disadvantages:
  - The advantage of no huge water storage is also a disadvantage
  - This makes ROR an “unfirm source of power” because it generates more power during summer melt period
  - This isn’t necessarily as true for bigger rivers or in areas where the mountains are constantly giving off large quantities of water
- Since this technology relies on a large velocity to generate the turbines a large steep drop is desirable.
  - This is why the Himalayas have the greatest potential

Ocean Thermal Energy Conversion (OTEC)

Trent Weaver

- Uses temperature differences
  - Located in deep ocean
  - 1-10 MW possible
  - Warm surface water vaporizes ammonia
  - Cold bottom water condenses ammonia
- Advantages
  - Plenty of ocean
  - Can run 24/7
  - Can provide clean water
  - Can power remote islands
  - Clean renewable energy
  - Nutrient loaded bottom water can be used to grow food.

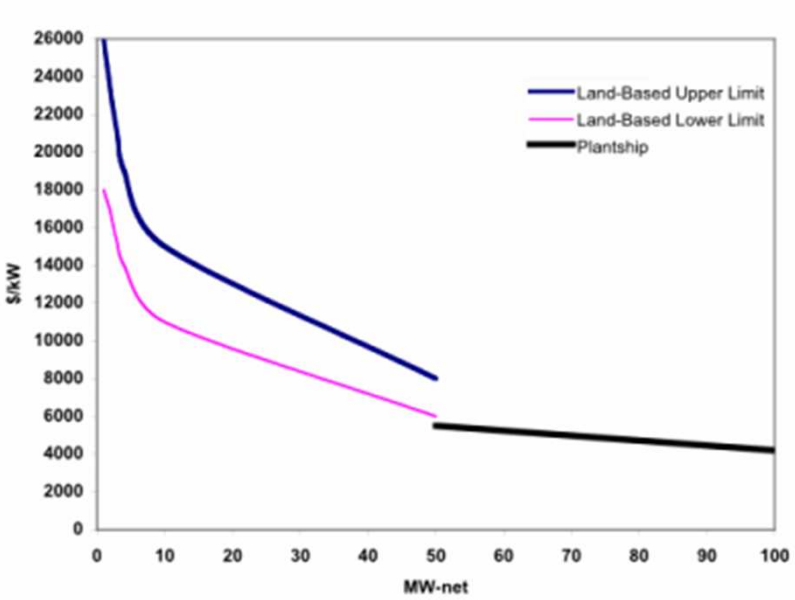


http://www.seao2.com/otec/

Ocean Thermal Energy Conversion (OTEC)

Trent Weaver

- Disadvantages
  - High initial cost
  - Low energy production
  - Hurricanes can destroy them
  - Not proven technology
  - Cost of maintenance
  - Could harm ecosystem by moving nutrients around
- Economics
  - Producing multiple services can make it economical (electricity, clean water, aquaculture, air conditioning)



http://www.otecnews.org/otec-articles/ocean-thermal-energy-conversion-otec-by-l-a-vega-ph-d/#hawaii

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Wind Power

Sultan Al Masroori

- Conversion of wind energy to Energy we could use
- Wind turbines
- Averaging 0.35MW a year

Advantages:

- Wind is free
- Once its built, no CO_2 emissions
- Vary in size, fit anywhere
- Take small space

Wind Power

Sultan Al Masroori

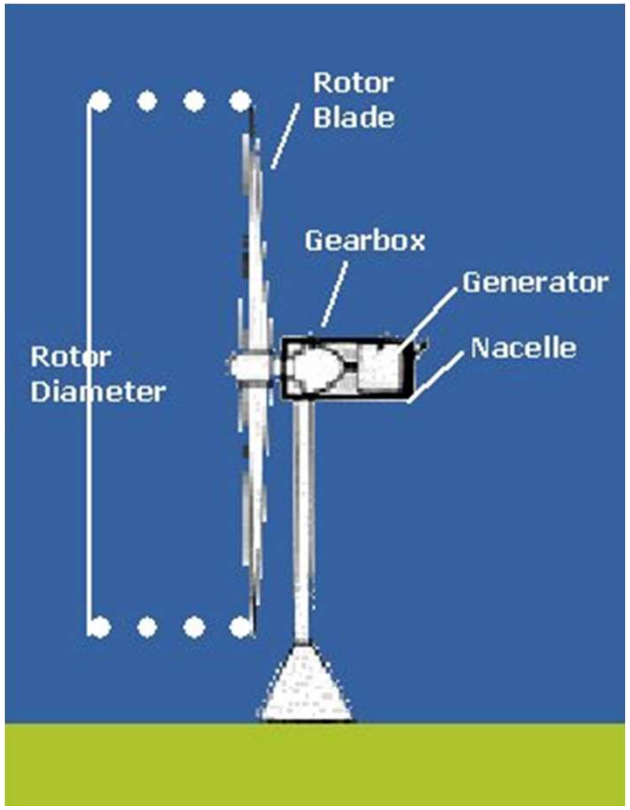
Disadvantages:

- Wind not always constant
- Noise pollution
- Works in certain places only
- Costly to install
- Produces much less energy than fossil fuels

Fun fact: Germany held the top spot in Europe in terms of installed capacity. Now the US (total capacity)

Traditional Wind Farm

- Turbine blades capture energy in the wind
  - Blades rotate = kinetic energy
- Generator converts the energy from the rotation into electricity
- Power capacities between 700 KW and 1.8 MW
- Costs for a commercial wind turbine in 2007 were $1.2 million - $2.6 million, per MW of nameplate capacity installed in 2007.



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Traditional Wind Farm

- Advantages:
  - No harmful emissions
  - Wind is free
  - Technology becoming more efficient
  - Size can be manipulated to support different populations
  - Land around turbine can still be used

- Disadvantages:
  - Unreliable
  - High construction costs
  - Turning blades make a noise
  - Ugly

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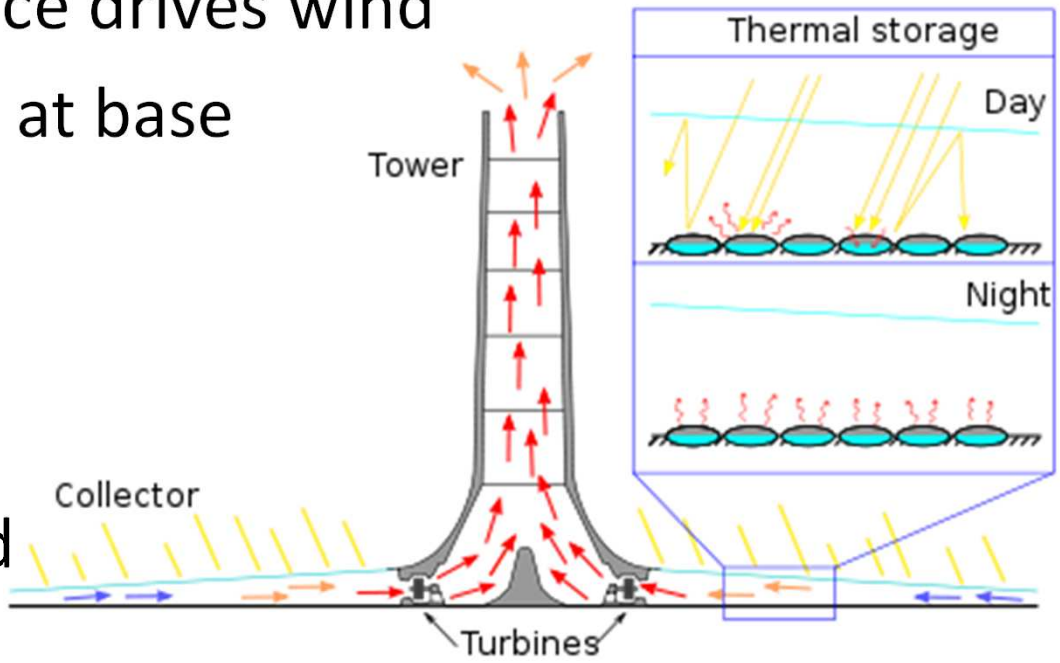
Solar Updraft Towers

Ed Gatzke

- Temperature difference drives wind
- Greenhouse like area at base



http://en.wikipedia.org/wiki/Solar_updraft_tower

Advantages

- No fuel cost
- Turbines not elevated

Disadvantages

- Large capital cost
- Large land area use, low energy density

Behavior in Germany

- Laws / customs / potential issues
  - May be asked for passport / identification
  - Germans sometimes eat fries with mayonnaise (pommes)
  - Tip may be included, Germans maybe tip 10%
  - No ice water, no ice cubes
  - May want to avoid being “loud obnoxious American”

Broadcast porn on TV / Red light district / Zoophilia

- Following are example case studies
  - What would you expect to happen?

Behavior Case Study, Part 1

On the morning of day 8 of 14, one of the junior male students approached the instructor about concerns for his roommate Jared. Apparently Jared had been out late in the world-renowned nightlife district the last few nights. The earliest he had returned was 1 AM. When asked about it, Jared would say, "Don't worry about it, I am a big boy." Rather than address the issue individually and cause stress, the instructors decided to talk it over with the group.

How should this be handled?

Behavior Case Study, Part 2

The morning of day 9, the instructor awoke at 4:30 AM to a loud knocking at his door. The roommate was standing outside the door looking angry. "Jared is throwing up and he has a visitor in his bed." When they got to the room, Jared reeked of alcohol and he was passed out. The visitor was gone.

How should this be handled?

Behavior Case Study, Part 3

Jared missed the next morning of class related activities. At lunch time, Jared woke up and met up with the group. He could not remember much of the previous night. Jared discovered that his cash, credit cards, and passport had all been stolen by his "friend."

How should this be handled?

Behavior Case Study, Part 4

Jared never learned from his previous behavior. The night of day 11, Jared managed to get arrested attempting to buy marijuana and ecstasy. He was released with just a ticket, but many of the students had seen the arrest and told the instructor after Jared was hauled off by the cops.

How should this be handled?

Behavior Case Study, Part 5

Susie had never gone out binge drinking. On day 12, she decided to cut loose. After a few hours, she was dancing on tables. An hour later she was unconscious.

How should this be handled?

Behavior Case Study, Part 6

Susie never made it to her hotel. Her roommate had fallen asleep much earlier and did not realize until morning. The last anyone had seen of Susie was at the bar dancing with complete strangers. The plane leaves for the US in 12 hours. Susie's parents are calling to check on her.

How should this be handled?

Notes and Consideration

- You can be sent home
  - At your own expense. You may also fail course.
- You are bound by the USC code of conduct
  - Page 4: “Scope of Application - The University may take disciplinary action for a violation of the Student Code of Conduct when the offense takes place on University premises or at University sponsored, endorsed, supported or related events which occur off campus, or when an offense which occurs off campus may adversely affect any interest of the University”
  - Compliance with local laws
  - Damage to property / misuse of fire alarms and equipment
  - Possession of weapons / endangering other students or yourself
  - Use of fireworks and explosives / fire hazards
- Consider your classmates
- Drs. Gatzke and Gatzke want to go on tours

Proposals for Code of Conduct

Example Code of Conduct

- Be on time for meetings and activities
  - For safety and security
- Let us know if your roommate is missing or unaccounted for
- Recognize your own limits if/when you consume alcohol
  - Do not let alcohol consumption interfere with your ability to function
- Common sense suggests you travel in groups of 2 or more
- You should learn and observe German customs and laws
- Violation of rules will be dealt with in a three-step process
  - Verbal warning
  - Written warning
  - Suspension (return home)