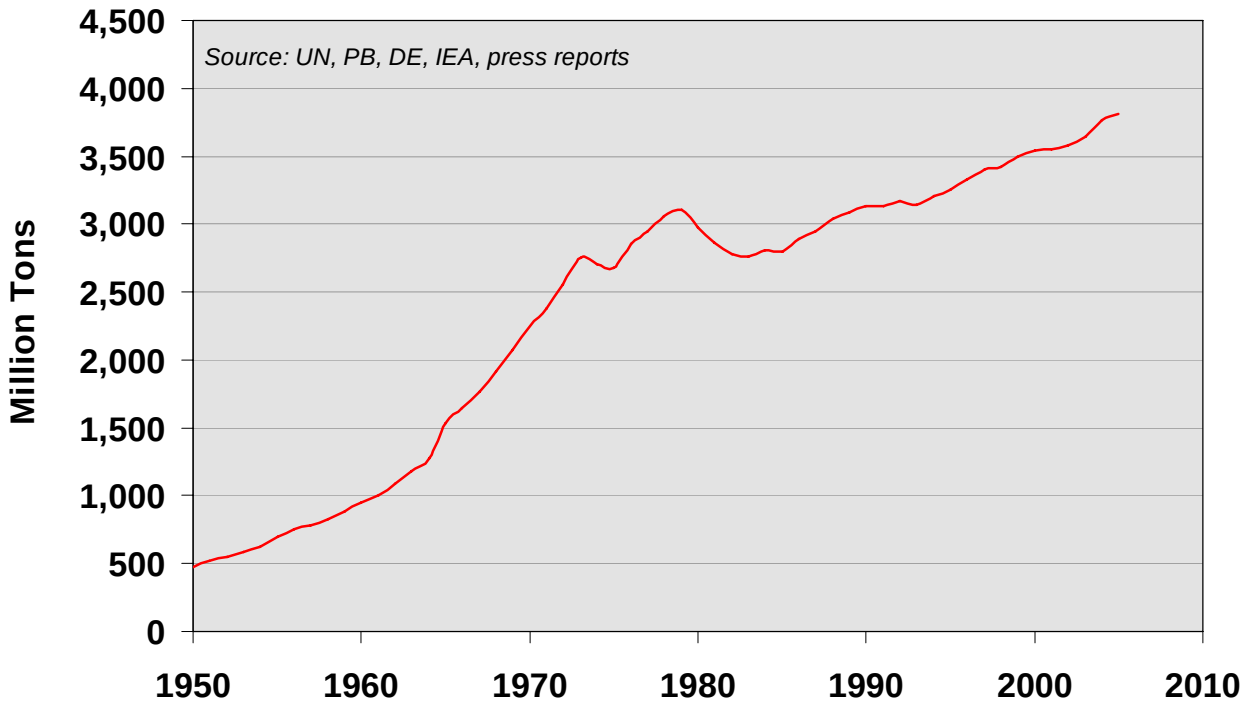
Energy Research

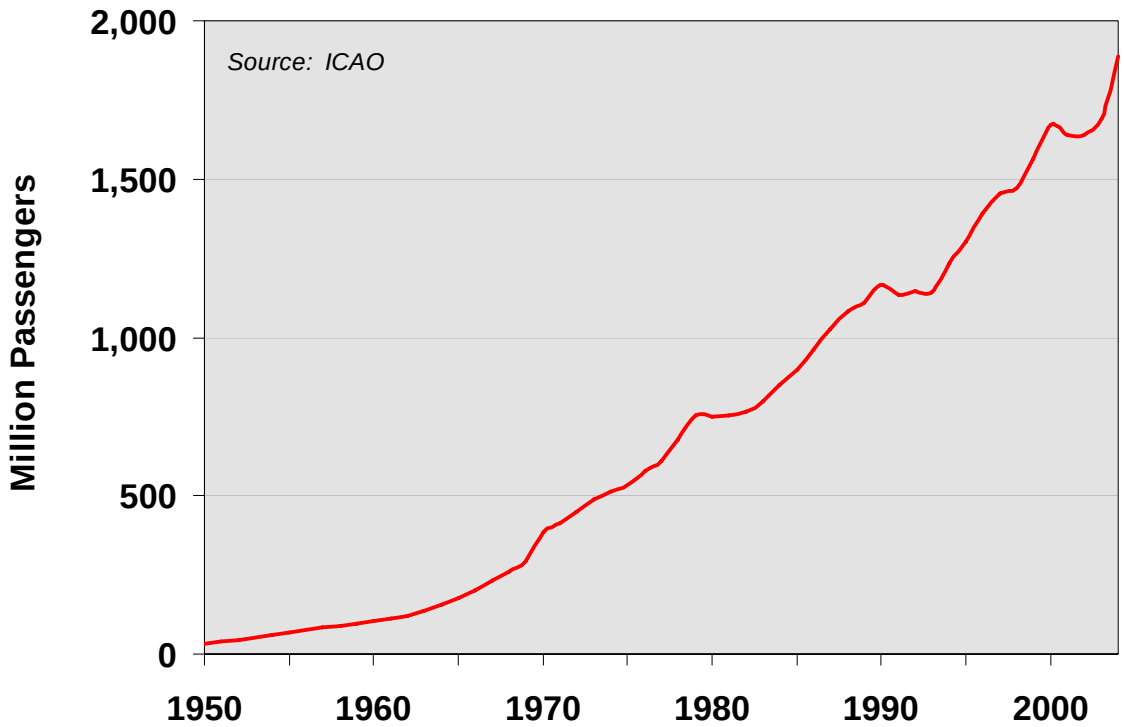
School of Engineering and Applied Science

University of Virginia

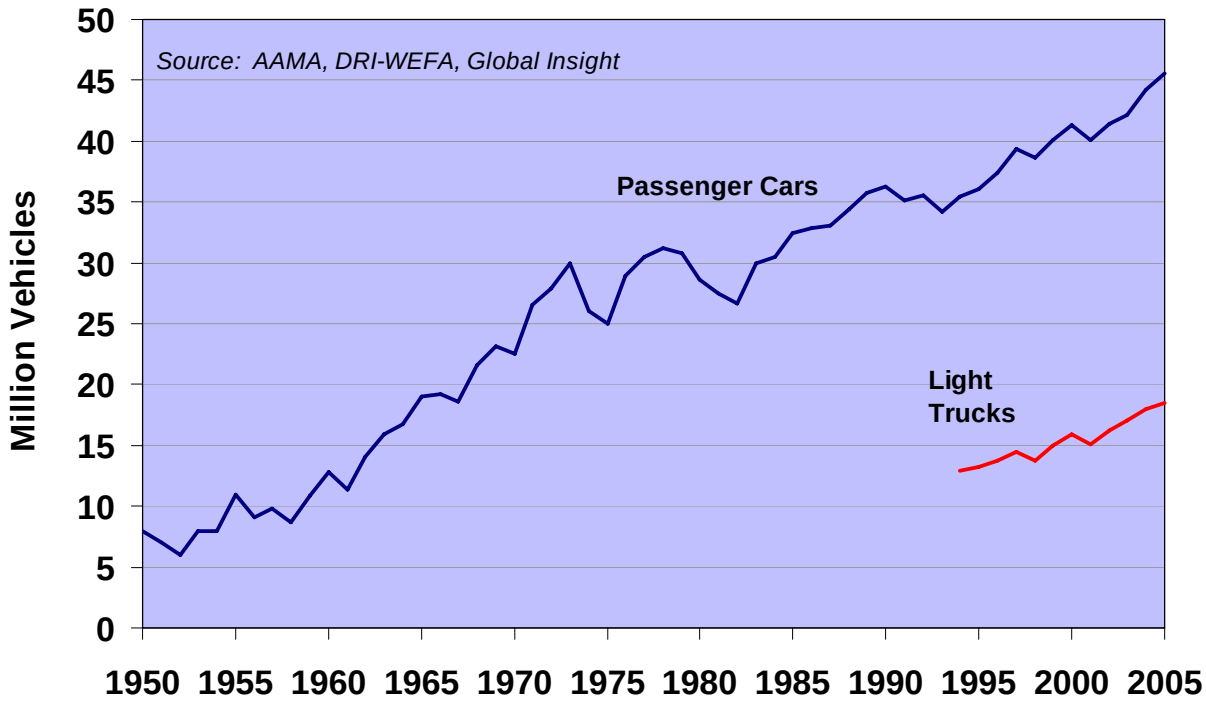
World Oil Consumption, 1950–2005

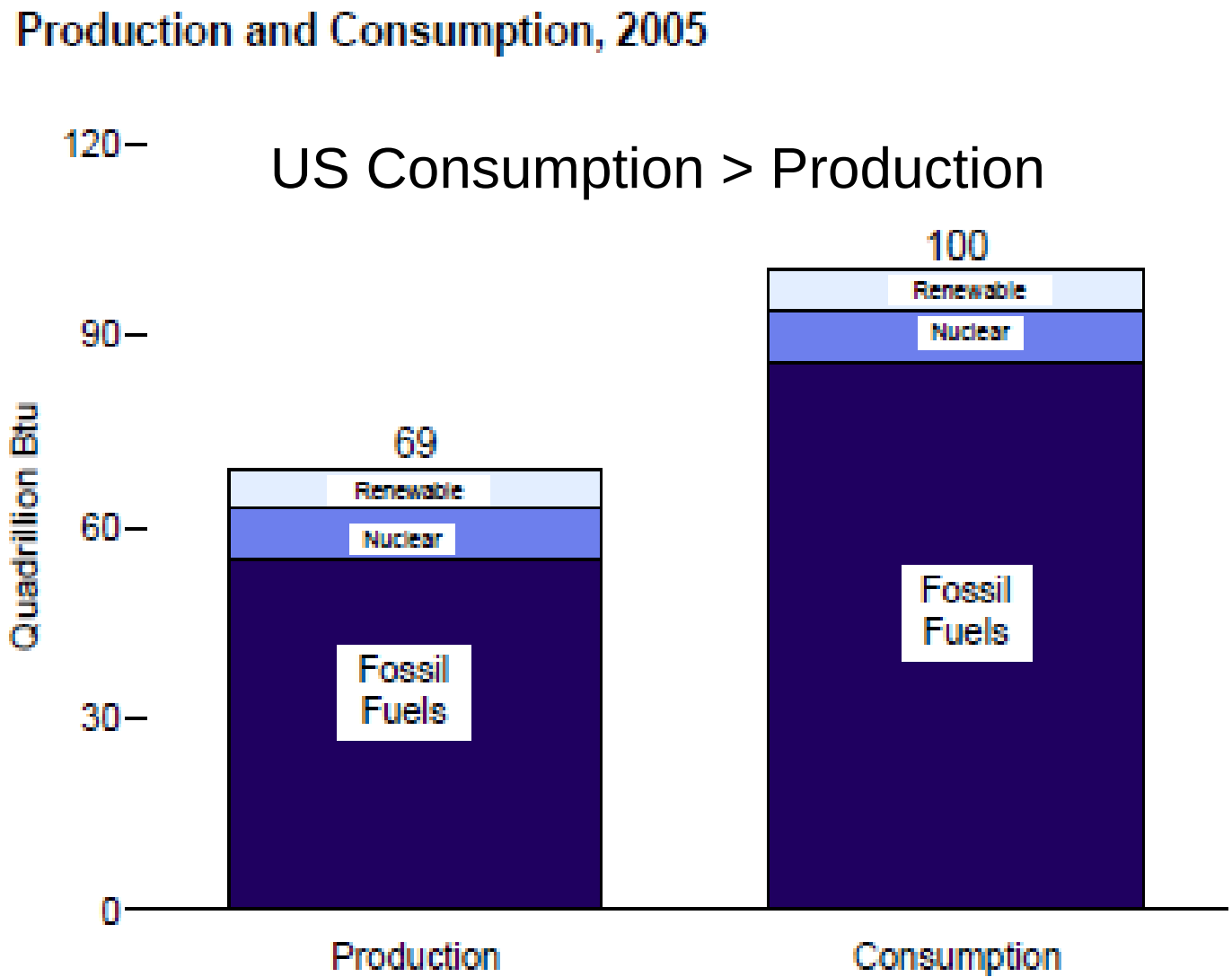


World Passenger Air Travel by Volume, 1950–2004

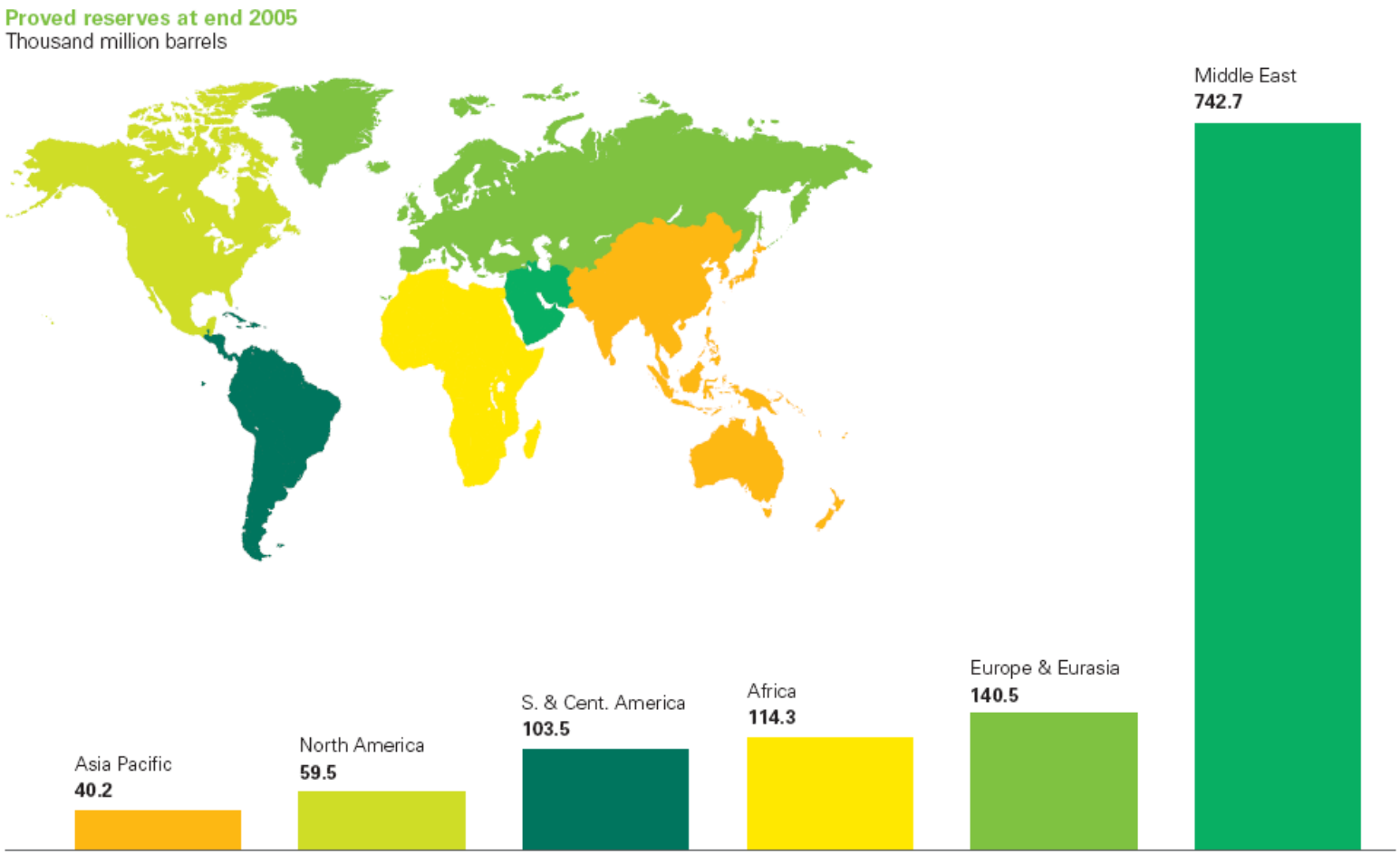


World Automobile Production, 1950–2005

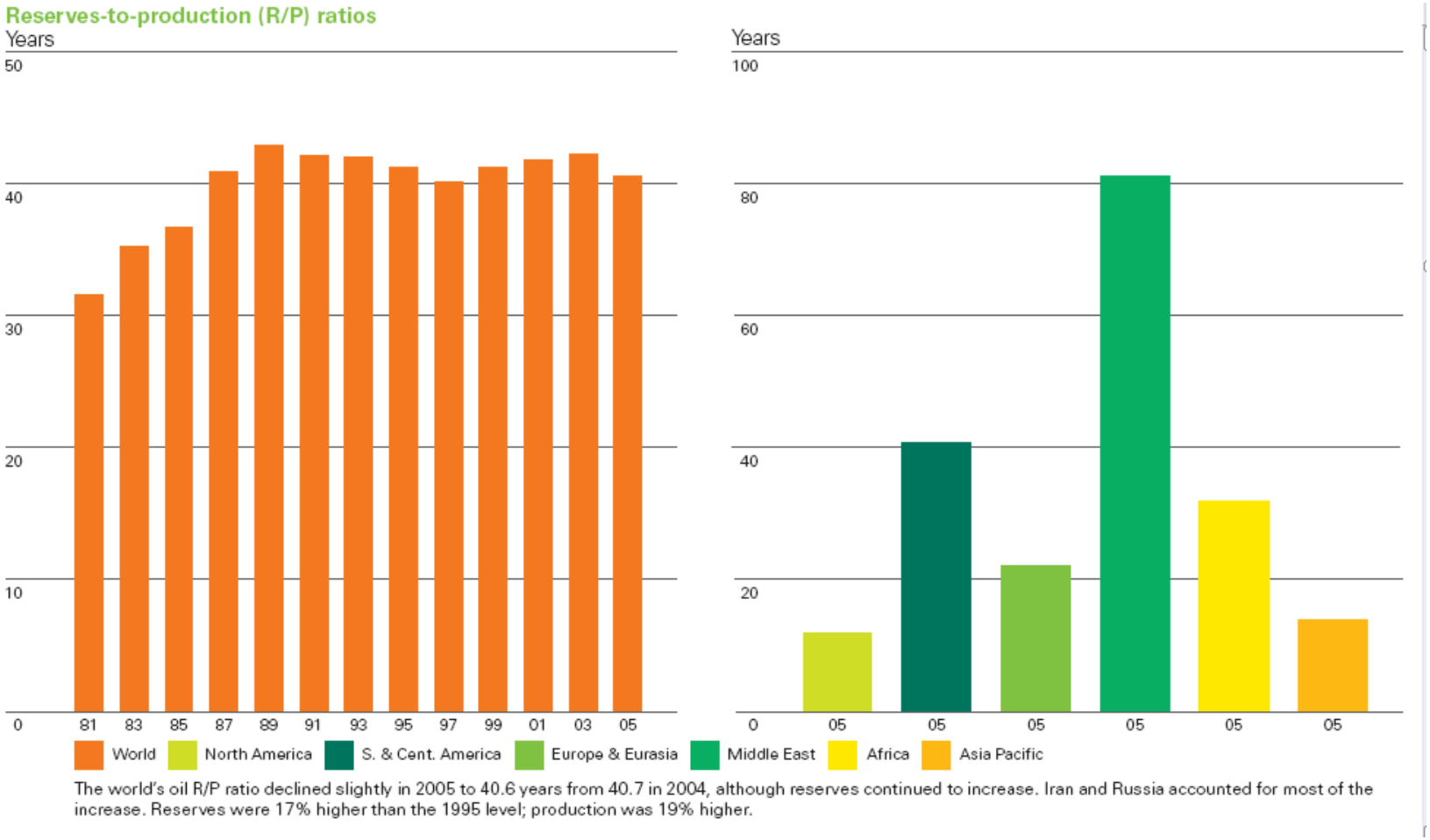



Production and Consumption, 2005
US Consumption > Production
120
90
60
30
0
Quadrillion Btu
69
Renewable
Nuclear
Fossil Fuels
100
Renewable
Nuclear
Fossil Fuels
Production
Consumption

Petroleum Reserves

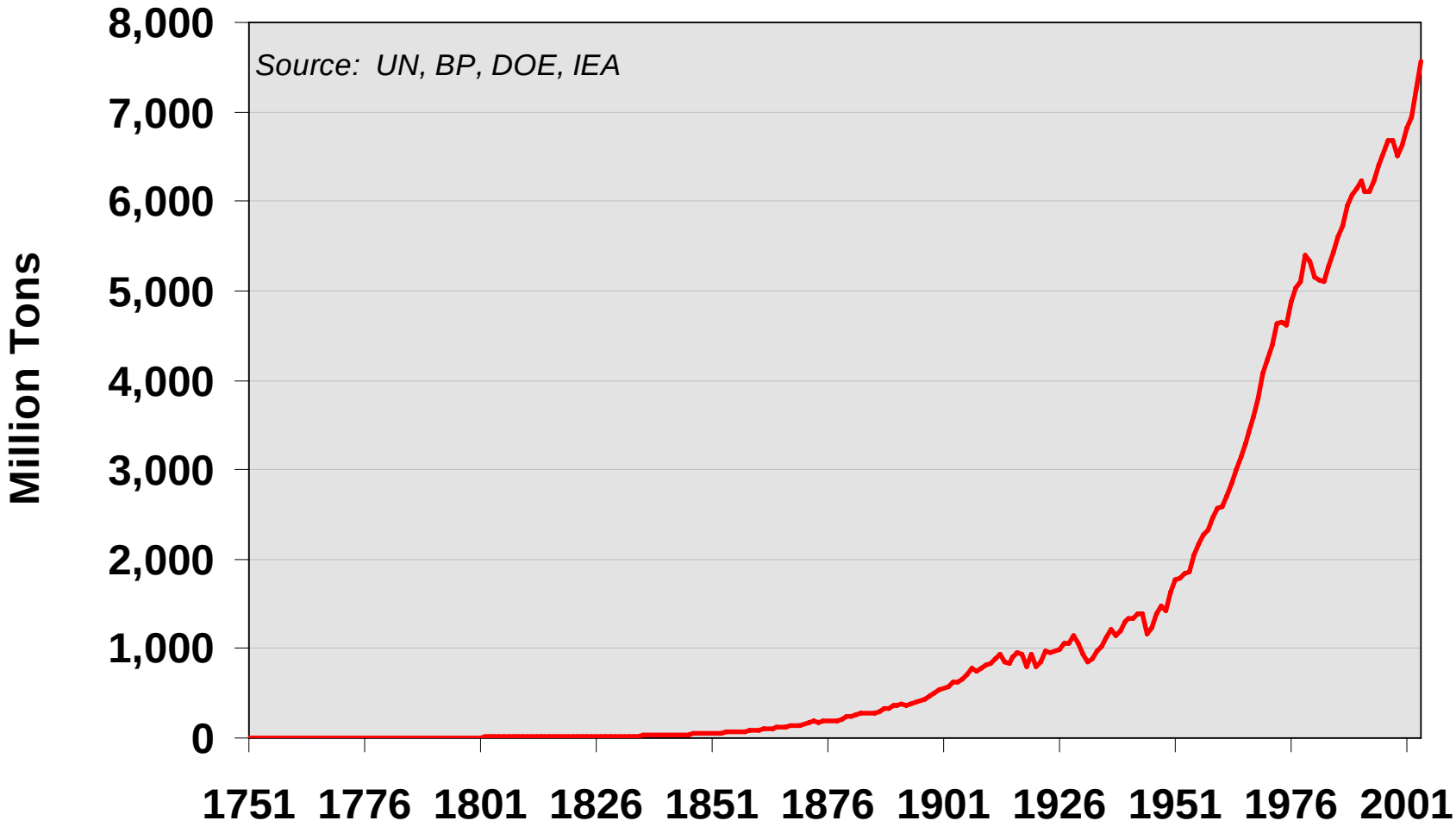


Petroleum Reserves to Production



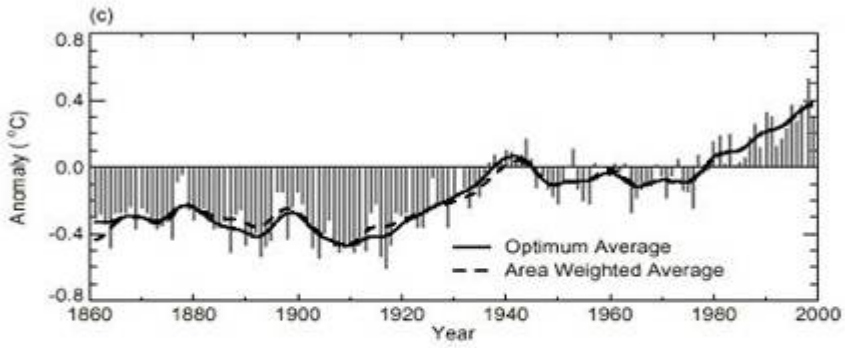
The world's oil R/P ratio declined slightly in 2005 to 40.6 years from 40.7 in 2004, although reserves continued to increase. Iran and Russia accounted for most of the increase. Reserves were 17% higher than the 1995 level; production was 19% higher.

Carbon Emissions from Fossil Fuel Burning, 1751–2004

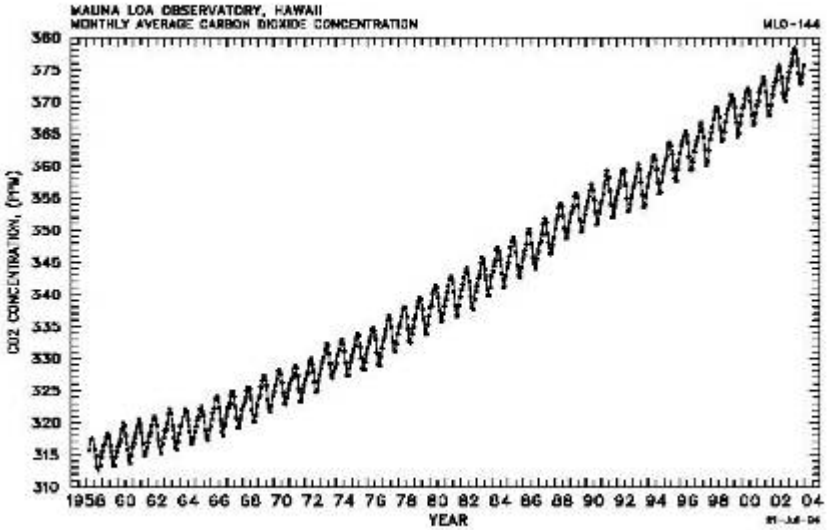


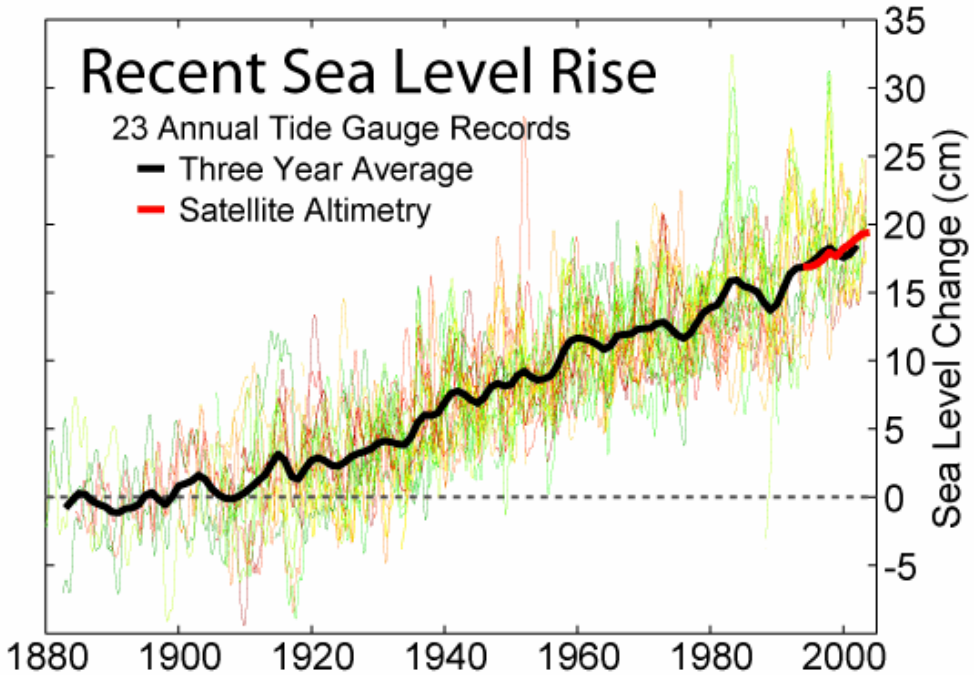
WORLDWATCH INSTITUTE
www.worldwatch.org

Some Evidence



Global warming as measured by surface thermometers between 1860 and 2000.





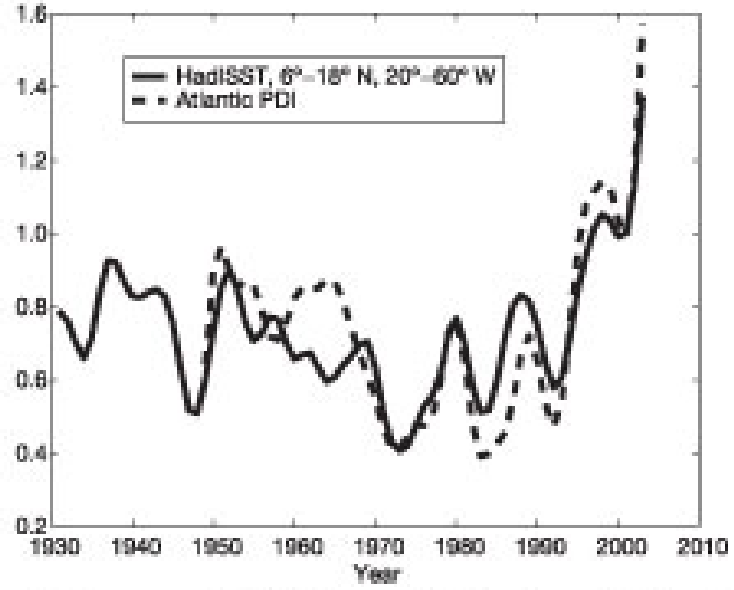


Figure 1 | A measure of the total power dissipated annually by tropical cyclones in the North Atlantic (the power dissipation index, PDI) compared

Biodiesel: *Long chain fatty acid ester derived from vegetable oil or animal fat*

Benefits

Is non-carcinogenic, biodegradable and renewable

Blends easily into conventional diesel fuel

Emits less CO, hydrocarbons and particulates when burned

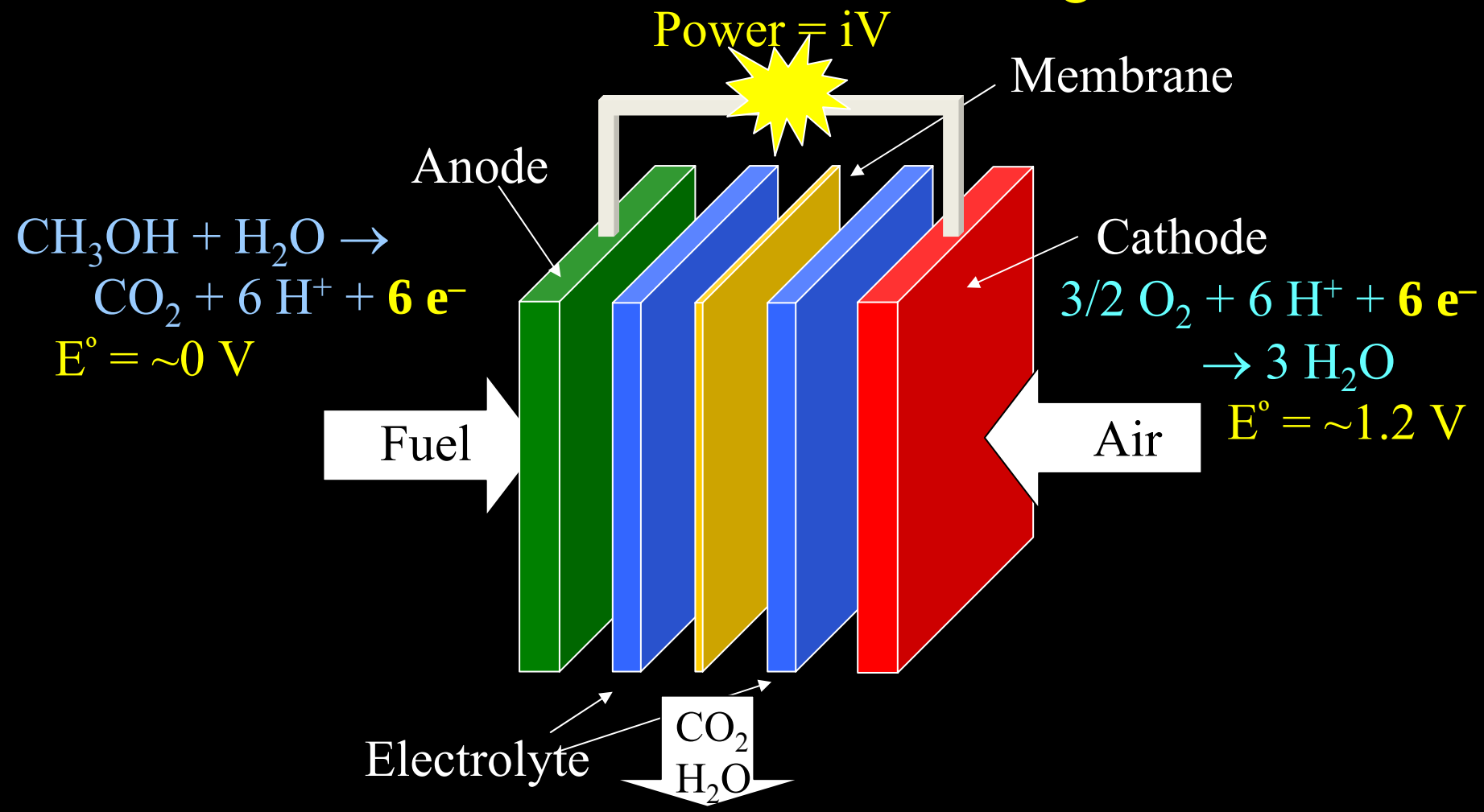
Improves lubricating properties of ultra-low-sulfur diesel fuel

Direct Methanol Fuel Cell (DMFC)

Matthew Neurock (mn4n@virginia.edu)

$CH_3OH + 3/2O_2 \rightarrow CO_2 + 2\ H_2O$ $\Delta G = -7.2$ eV

cell voltage 1.2 V



Solid Oxide Fuel Cells (SOFC)

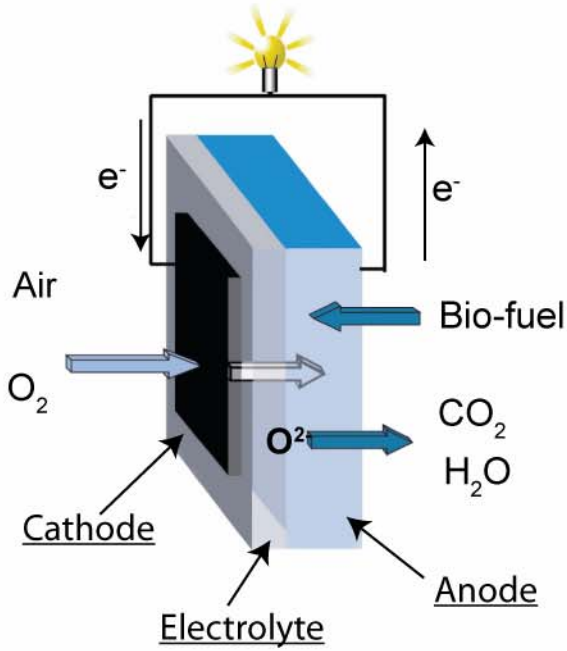
Steven McIntosh (sm3qb@virginia.edu)

SOFC technology may offer efficient power genertion from current fuels.

Current SOFC are limited to hydrogen fuel.

SOFC can theoretically operate on any hydrocarbon fuel, including natural gas, gasoline, diesel, bio-diesel, bio-ethanol and hydrogen.

The challenge in research is to turn this theory into practice.



Cathode

$O_2 + 4e^- \rightarrow 2O^{2-}$

Requires ionic and electronic conductivity and catalysis

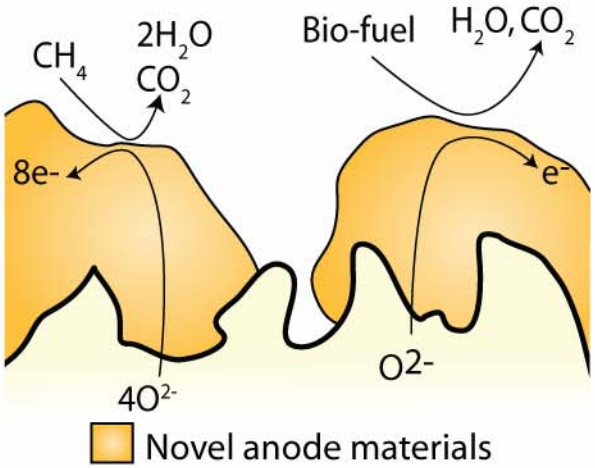
Electrolyte

Selective transport of oxygen anions.

Anode

$C_nH_{2n} + (3n+1)O^{2-} \rightarrow nCO_2 + (n+1)H_2O + (6n+2)e^-$

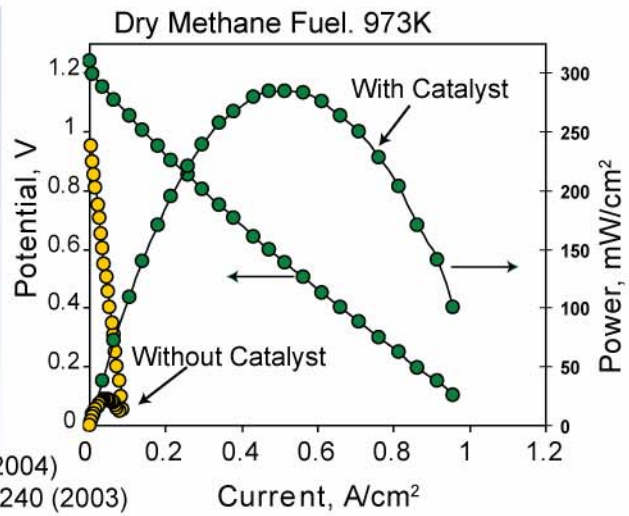
Requires ionic and electronic conductivity and catalytsis.



Mixed ion-electron conducting perovskites are suggested as new anode materials.

Little is known of the anode catalysis.

The catalytic properties dominate the performance of the electrode with hydrocarbon fuels.

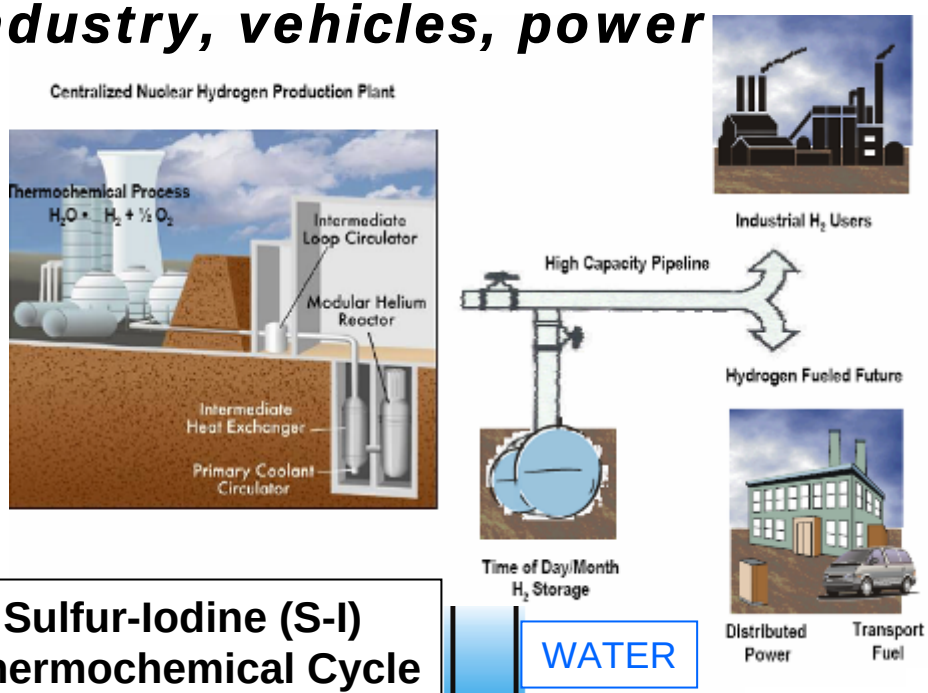


S. McIntosh & R.J. Gorte, *Chem. Rev.*, **104** 4845 (2004)
S. McIntosh, et. al. *Electrochem.Sol.-Stat. Lett.* **6** A240 (2003)

HYDROGEN FROM WATER

J.P. O'Connell, jpo2x@virginia.edu

Hydrogen economy to need huge generation facilities for industry, vehicles, power



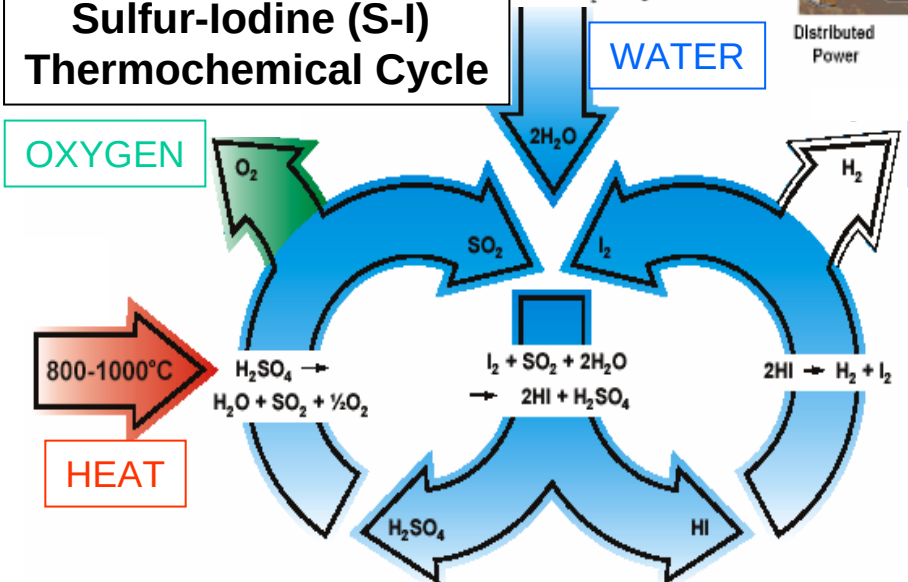
Best option reverses Nature with $H_2O \rightarrow H_2 + \frac{1}{2} O_2$

Uses chemistry & input energy "Thermochemical Cycles"

Based on nuclear heat: No CO_2 Efficiency > Electric power

Size(600MW reactor,$2 billion), Conditions (1000°C,40 bar) require careful, optimal design using CHE simulation software

Sulfur-Iodine (S-I) Thermochemical Cycle



DOE-funded project: UVa, SRNL, Clemson

For experiment, solution property modeling & process simulation of S-I process

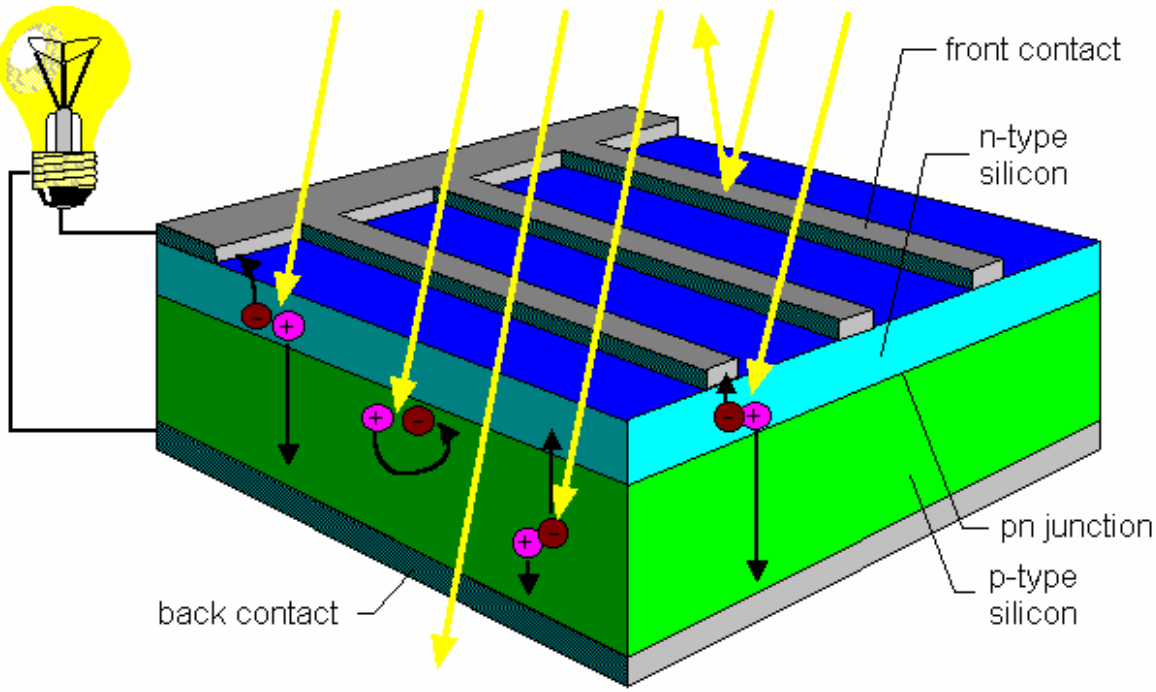
Establish

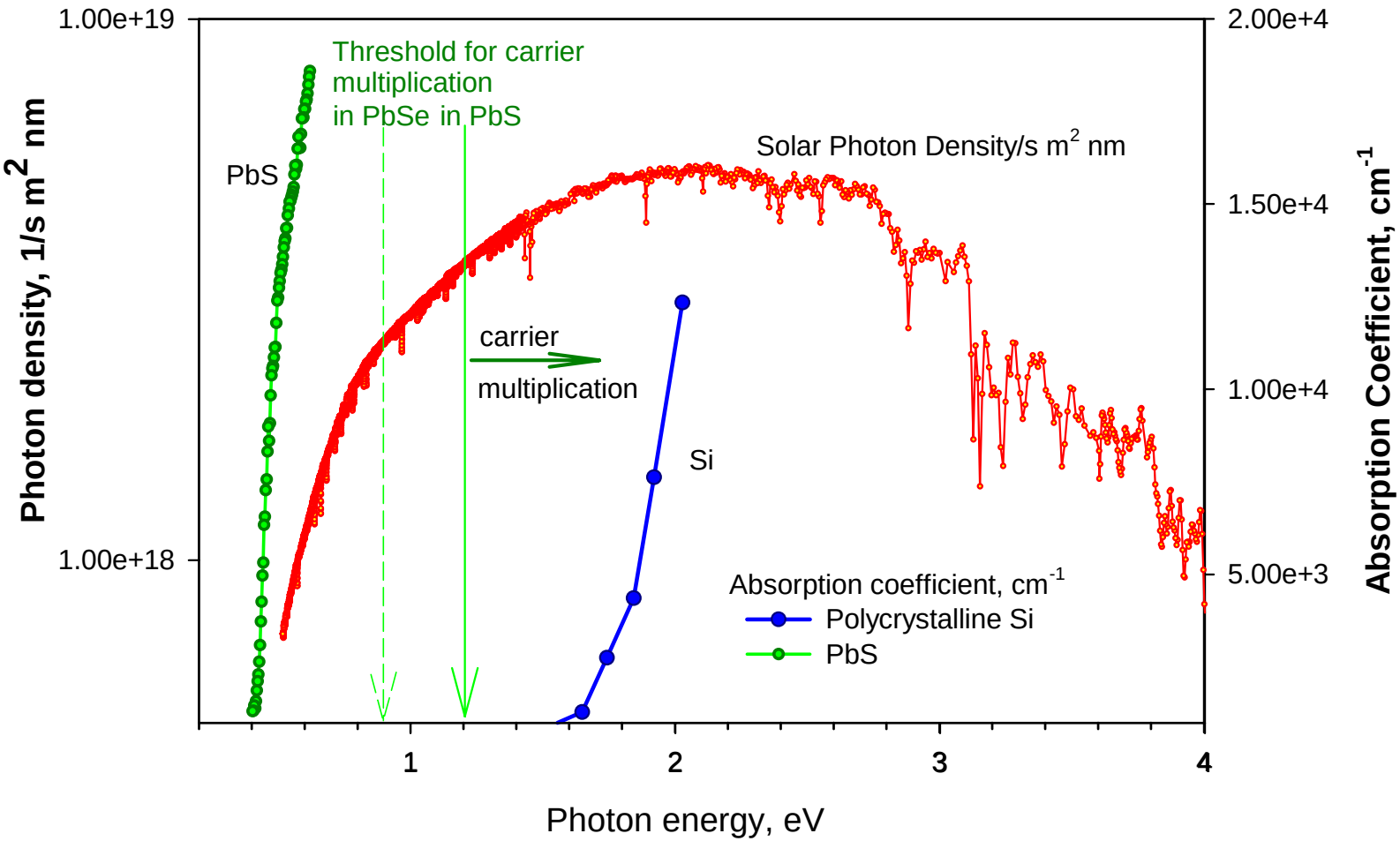
Reliable design & optimization

Global standard for calculating efficiency

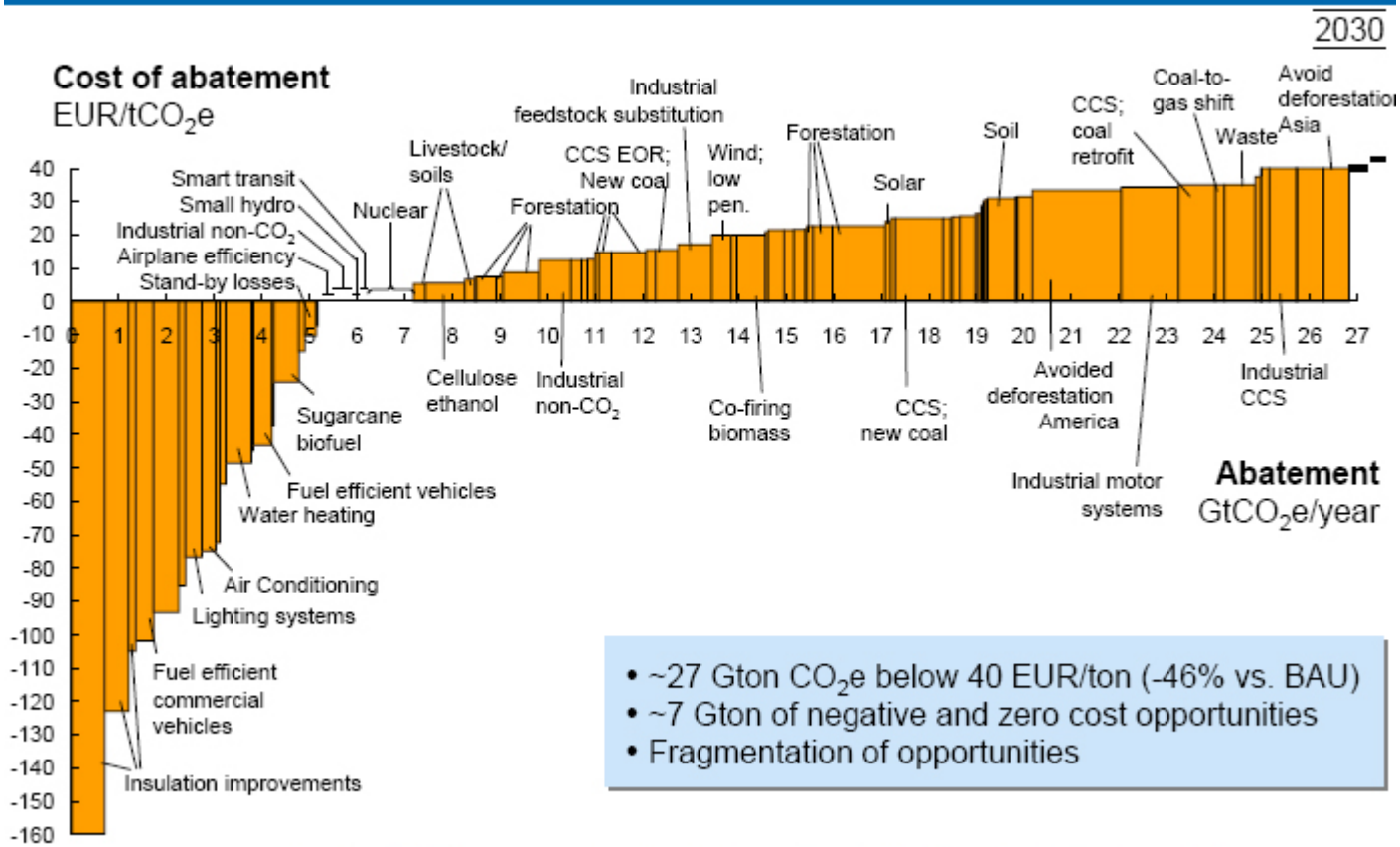
Operation of a Solar Cell

- A photon is absorbed in the active part of the material resulting in electrons being exited to a higher energy potential
- The charge carriers created by photon absorption are physically separated and moved to each side of the cell
- The charge carriers are removed from the cell and delivered to an external load where they perform useful work




1.00e+19
1.00e+18
2.00e+4
1.50e+4
1.00e+4
5.00e+3
Photon density, 1/s m2 nm
Absorption Coefficient, cm-1
Photon energy, eV
1
2
3
4
Threshold for carrier
multiplication
in PbSe in PbS
PbS
Solar Photon Density/s m2 nm
carrier
multiplication
Si
Absorption coefficient, cm-1
Polycrystalline Si
PbS

Global cost curve of GHG abatement opportunities beyond business as usual



- ~27 Gton CO_2e below 40 EUR/ton (-46% vs. BAU)
- ~7 Gton of negative and zero cost opportunities
- Fragmentation of opportunities


design
build
evaluate
The goal of ecoMOD is to demonstrate the environmental potential of prefabricated construction, and to challenge the modular and manufactured housing industry in the U.S. to explore this potential.


WIDE LOAD

Current and Future Work ecoMOD II Gautier, MS

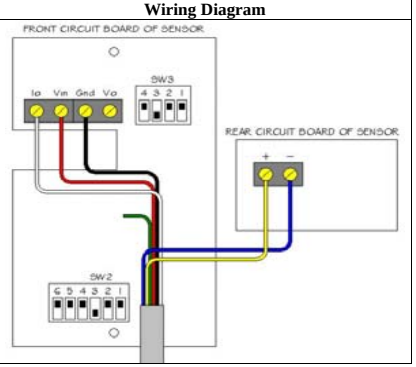
Paxton Marshall’s students prepare to install PV panels on ecoMOD house designed and built by UVA students for a family in Mississippi that lost its house to hurricane Katrina.

Solar Hot Water Heating


•establish criteria to reduce environmental impact of homes and construction processes
•energy efficient strategies and technologies that also improve indoor environmental quality
•place homes in urban infill sites or locations that do not encourage sprawl
•adjustable to site, client and climatic issues
ecological

A monitoring system was designed and installed to provide data on the house's energy performance. Currently, the team is evaluating data from the house to see how all of the installed "energy efficient" features are working!

Sensor Designator	***(Interior) T/H-12***	
Sensor Type	Interior Temperature/Humidity	**Sensor Photograph**
Sensor Output	4-20mA Current Loop	
Sensor Location	2nd Floor, Mounted on the east wall, near the corner where the bathroom wall meets the east wall at the top of the stairs	
Mounting	Mounted on a custom wheat-board stand-off which is adhered to the wall using 3M CommandR removable adhesive tabs	
Mounting Height	+88ÓAFF	
Cable Information	Red/12	
Manufacturer	Automation Components, Inc. (ACI)	
Manufacturer No	RH5-TT100-R	
Notes		

Location Photograph	**Wiring Diagram**
	

evaluate **OUTin**

temperature sensors ecoMOD 1

Flow meter installation

Electric panel with current sensors