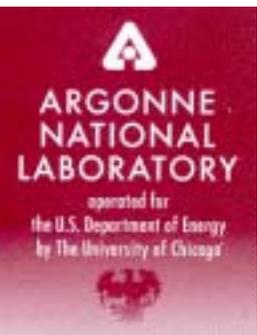
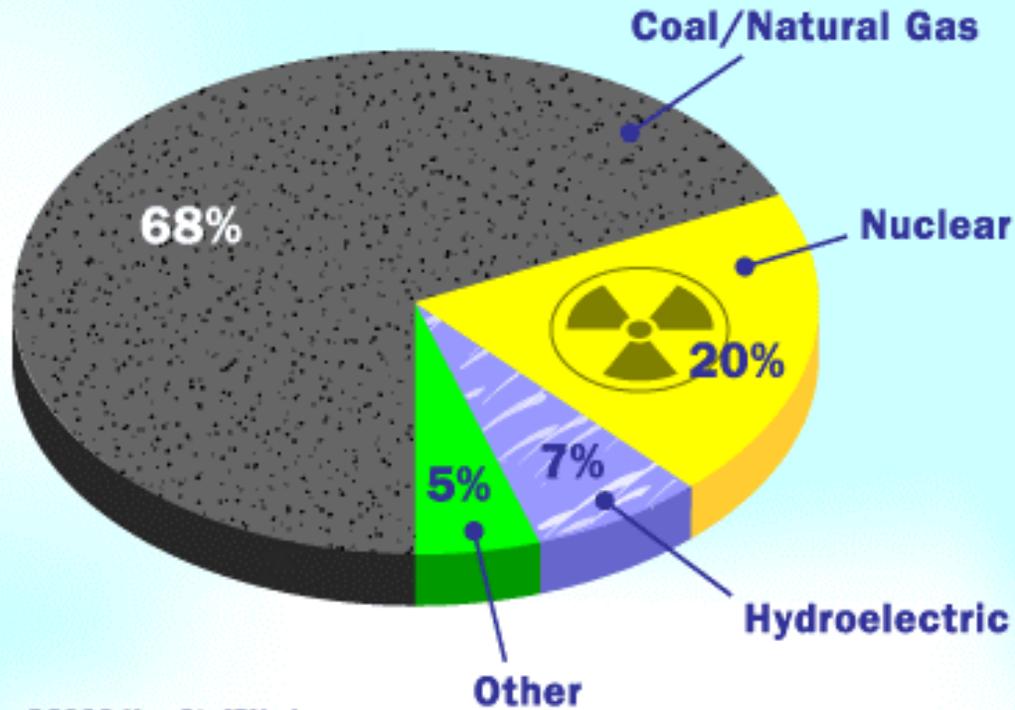


A Hydrogen Economy – Is it a Panacea? What Do We Know About H₂ and the Environment?

Jeff Gaffney



Power Production in the USA



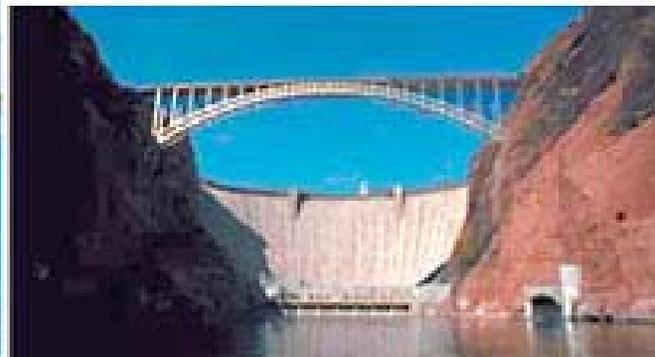
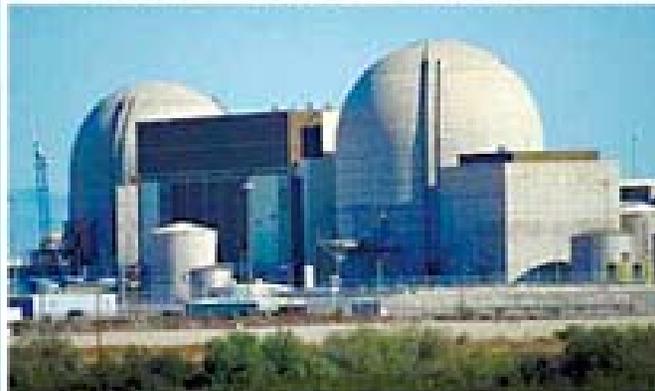
©2002 HowStuffWorks

U.S. RELIES HEAVILY ON OIL AND GAS FOR POWER

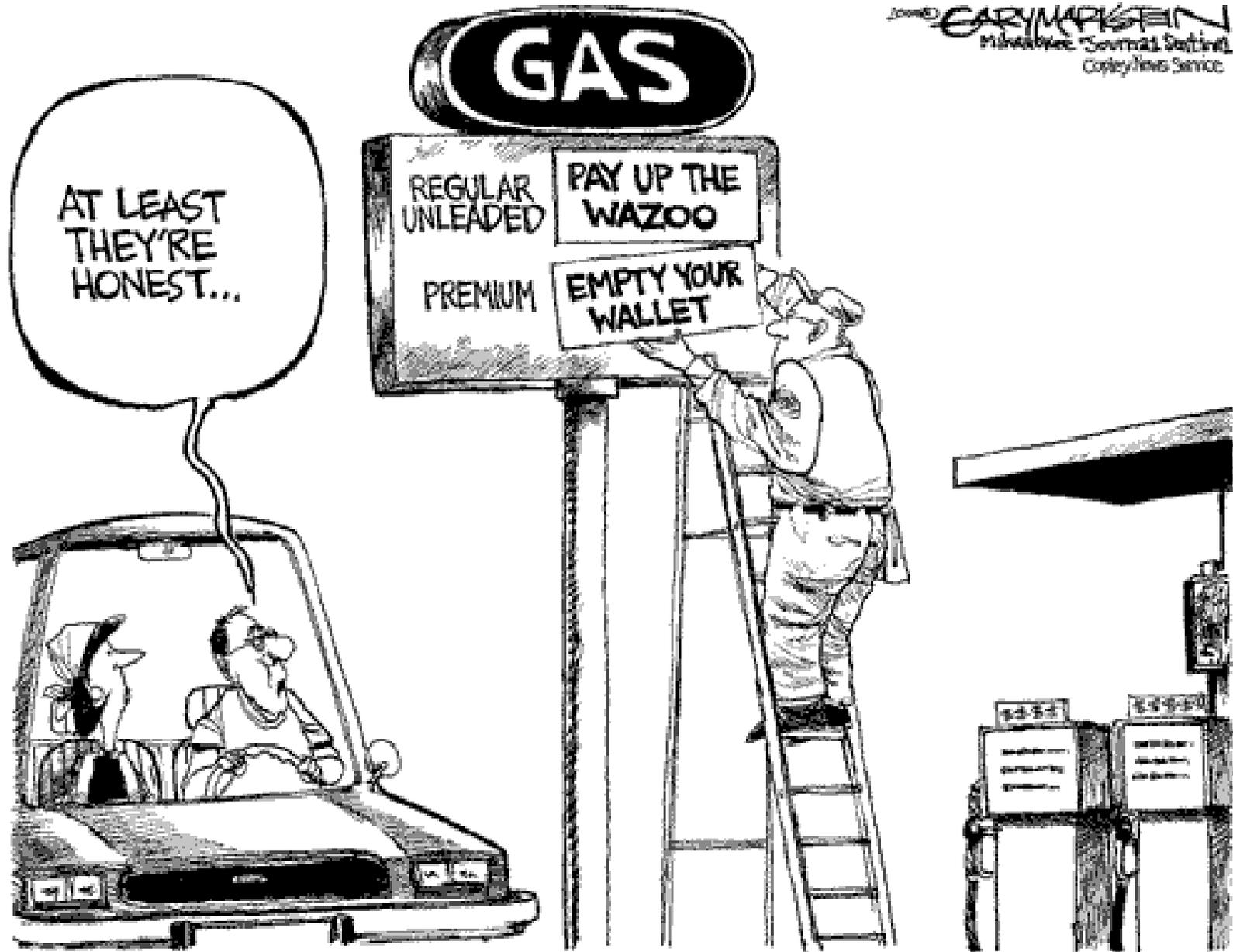
US OIL DEMAND, JANUARY 2002: About 18.5 million barrels per day, = 777 million gallons. If lined up in 1-gallon cans, **they would encircle the earth at the equator almost 6 times (about 147,000 miles of cans) — every day.** 55-60% of US consumption is imported at a cost of \$50 billion+ per year, amounting to **the largest single element of our trade deficit.**



FOR SUSTAINABLE HYDROGEN ECONOMY
HYDROGEN = ELECTRICITY..... So you need...







AT LEAST
THEY'RE
HONEST...

GAS

REGULAR
UNLEADED

PAY UP THE
WAZOO

PREMIUM

EMPTY YOUR
WALLET

4.53

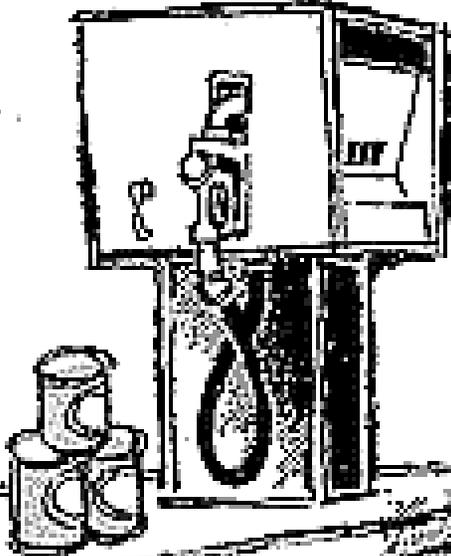
4.53

I thought the pumps only went 'ding' when the gas was flowing...

They used to! That's the price changing...

WALMART
GAS
CASH
MONEY

DING DING DING



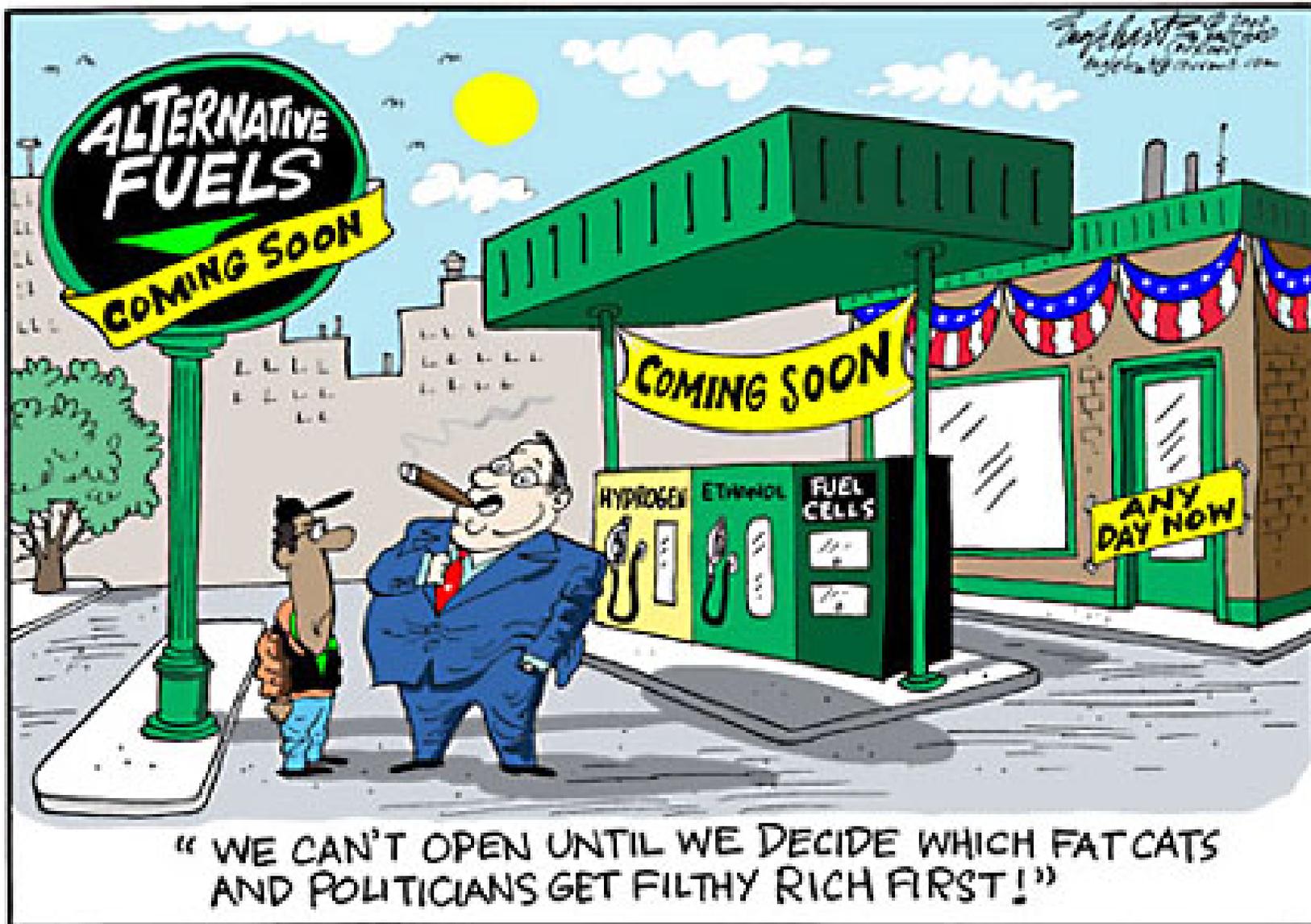


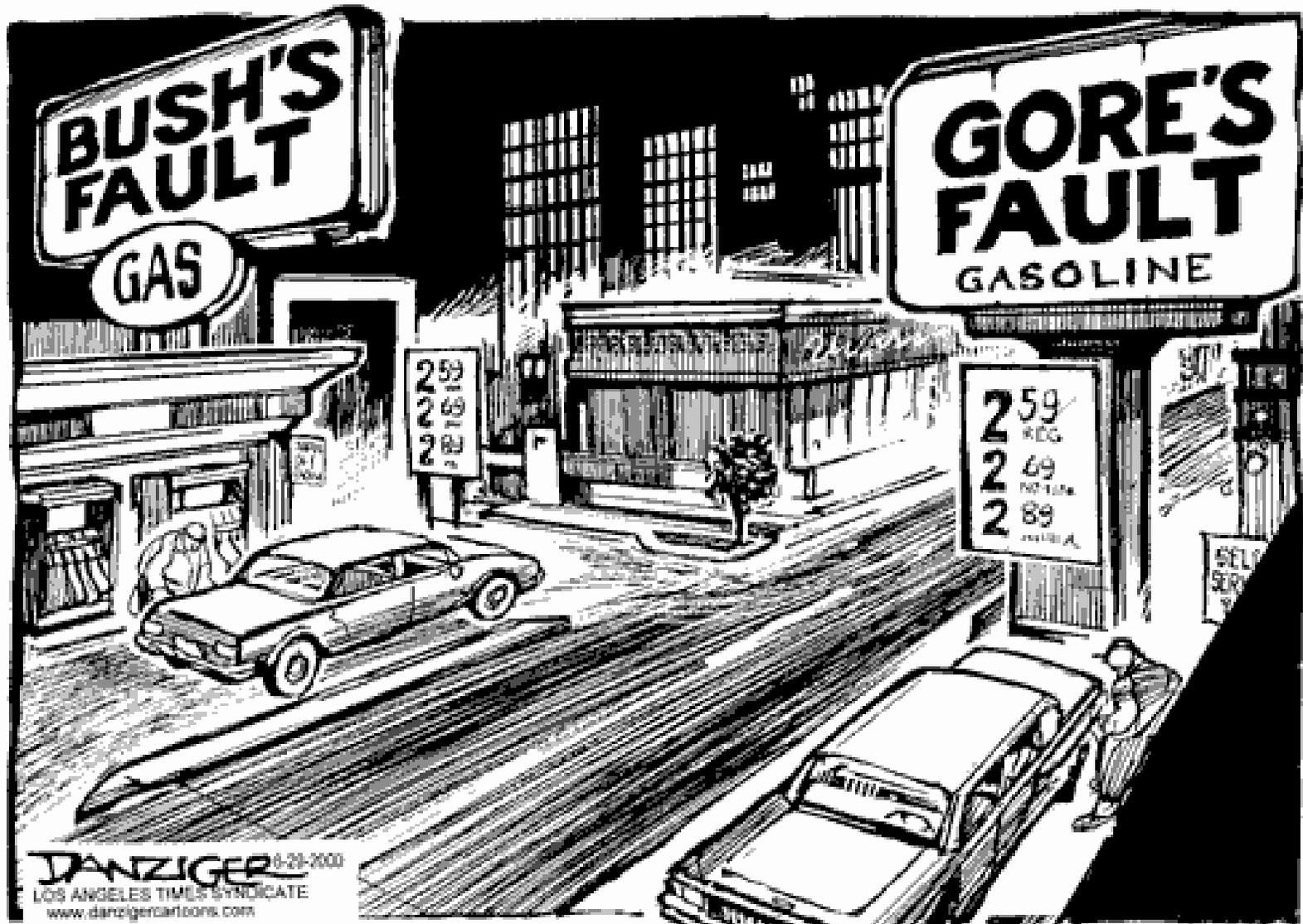
MAJOR OIL

coulda swore I heard a cry...

ALTERNATIVE FUELS

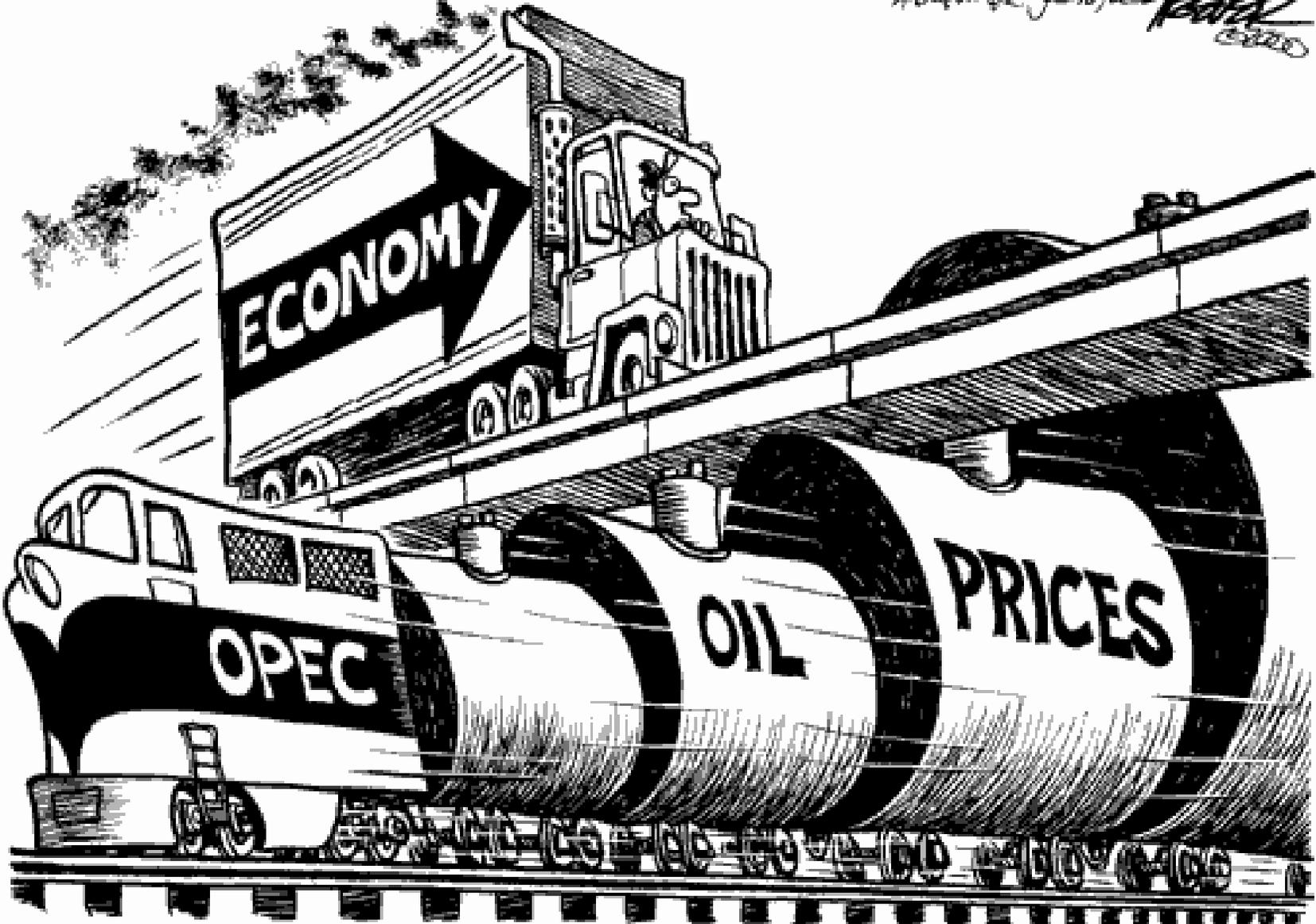
©1999 CHICO TORRES





DANZIGER 8-22-2000
LOS ANGELES TIMES SYNDICATE
www.danzigercartoons.com

NEWSPAPER GRAPHIC *RAW*
© 2000



DESPITE ALL
OUR UPS AND DOWNS,
I STILL LOVE YOU.



© 1997
The
Management
Company



SOURCE of AMISH LAUGHTER.

DUFF

THE DICK KONG READER

6-18-00

THEY WERE CHEAPER
THAN BUYING GAS
FOR THE MOWER.









MILK
\$2.39
A GALLON

ORANGE
JUICE
\$5.90
A GALLON

MAPLE
SYRUP
\$48.84
A GALLON

BEER
\$9.87
A GALLON

SPRING
WATER
\$4.52
A GALLON

GAS
\$1.65
A GALLON

FOOD MARKET

K. J. McMillan
5-10-80

THE AMERICANS
ARE UPSET THAT
GAS PRICES MIGHT
REACH TWO DOLLARS
A GALLON.

BLOODY
WHINERS!!

\$5⁰⁰
A GALLON

DING
DING
DING
DING
DING

EUROPEANS

NEWS
EUROPE

THE STATE
UNIVERSITY OF
NEW YORK
AT BINGHAMTON
© 1994



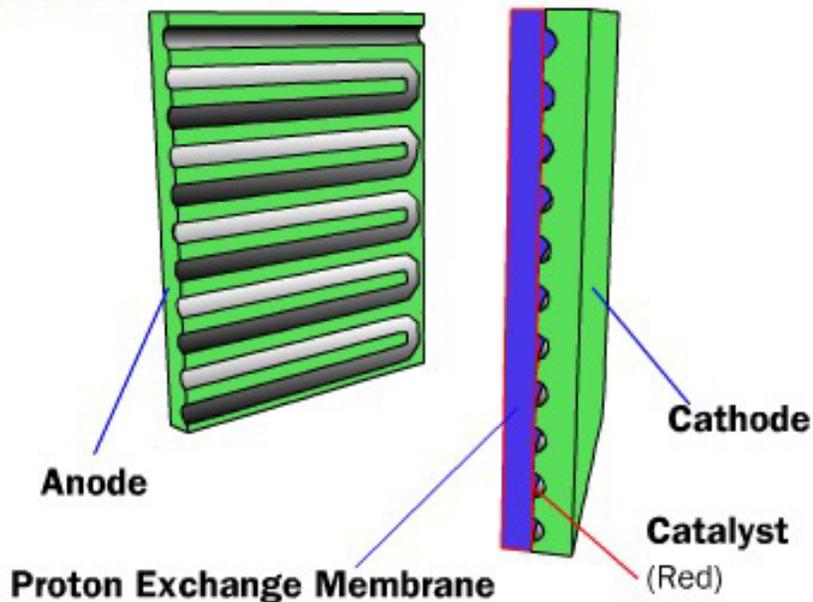




How Hydrogen would work – Motor Vehicles

How Fuel Cells Work

© 2000 How Stuff Works



Chemistry of A Fuel Cell

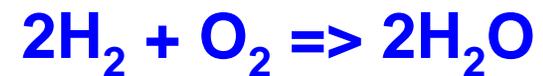
Anode side:

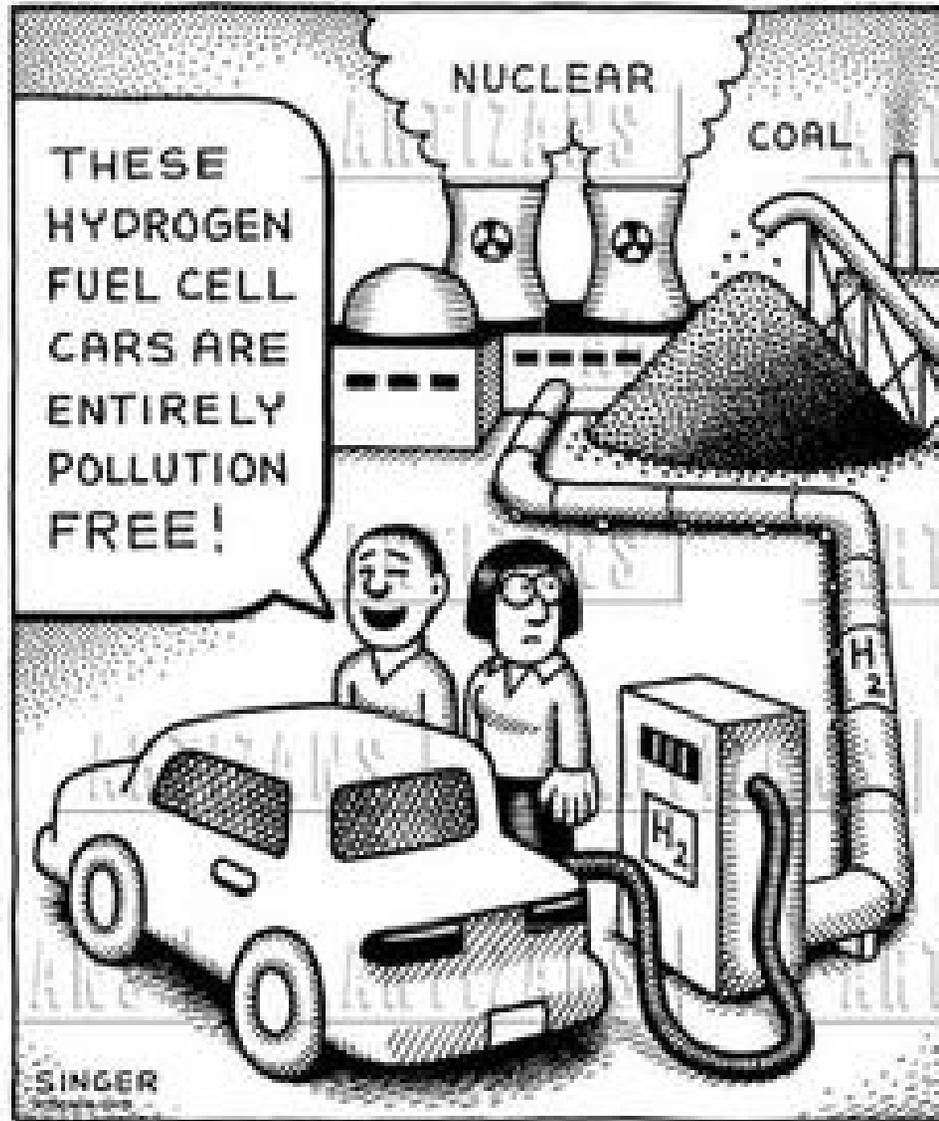


Cathode side:



Net reaction:







Hindenburg Factor!



PROBLEMS WITH HYDROGEN

DIFFUSIONAL LOSS TO ATMOSPHERE

REACTION WITH METALS – METAL
EMBRITTLEMENT

SAFETY ISSUES – NOT MUCH DIFFERENT THAN
GASOLINE...

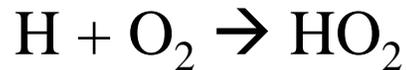
STORAGE OF SIGNIFICANT FUEL LEVELS

HYDROGEN – IT'S A GAS!

METAL HYDRIDES – WEIGHT (BORON HYDRIDES?)

HYDROGEN – ATMOSPHERIC EFFECTS

TROPOSPHERE



STRATOSPHERE

**5-10 YR HALF-LIVE WITH OH → SOURCE OF
WATER IN STRATOSPHERE? →
AMPLIFICATION OF OZONE DEPLETION**

NATURAL SOURCES

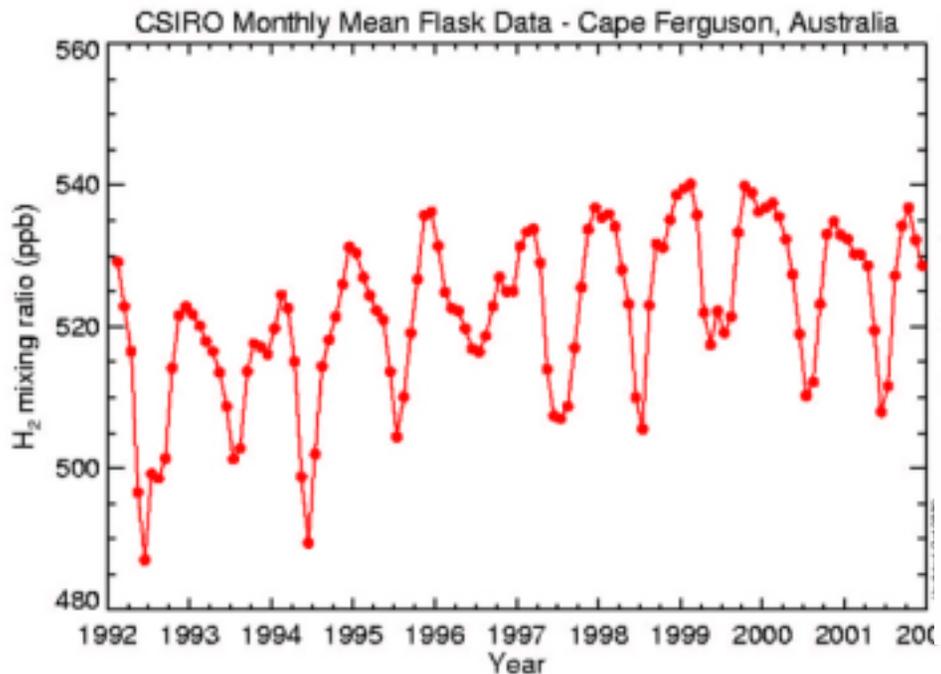
OXIDATION OF METHANE

FORMALDEHYDE

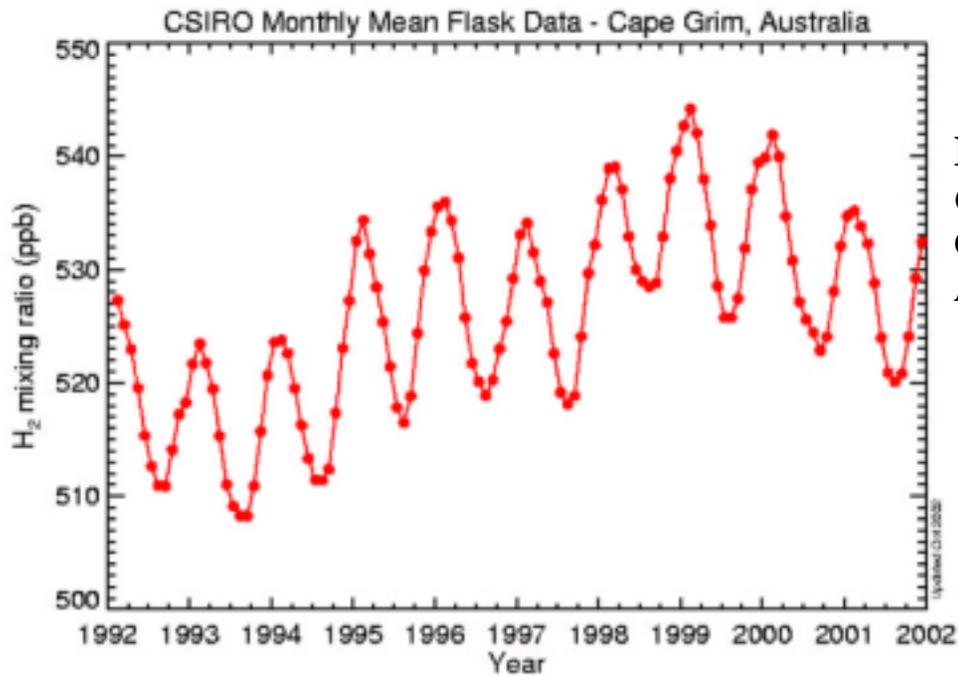
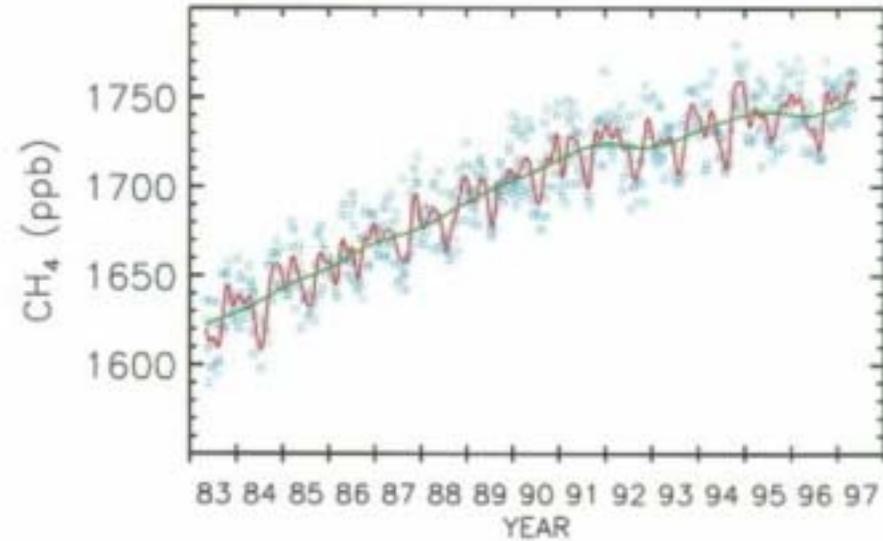


MOLECULAR HYDROGEN IS APPROX. 0.5 PPM
CURRENTLY

INDICATIONS OF INCREASE IN THE
ATMOSPHERE?



Methane Measurements at Mauna Loa



L.P. Steele, P.B. Krummel and R.L. Langenfelds
Commonwealth Scientific and Industrial Research
Organization (CSIRO), Atmospheric Research,
Apsendale, Victoria, Australia, 3195

FORESTS?



ISOPRENE

Oxidation Products → Formaldehyde

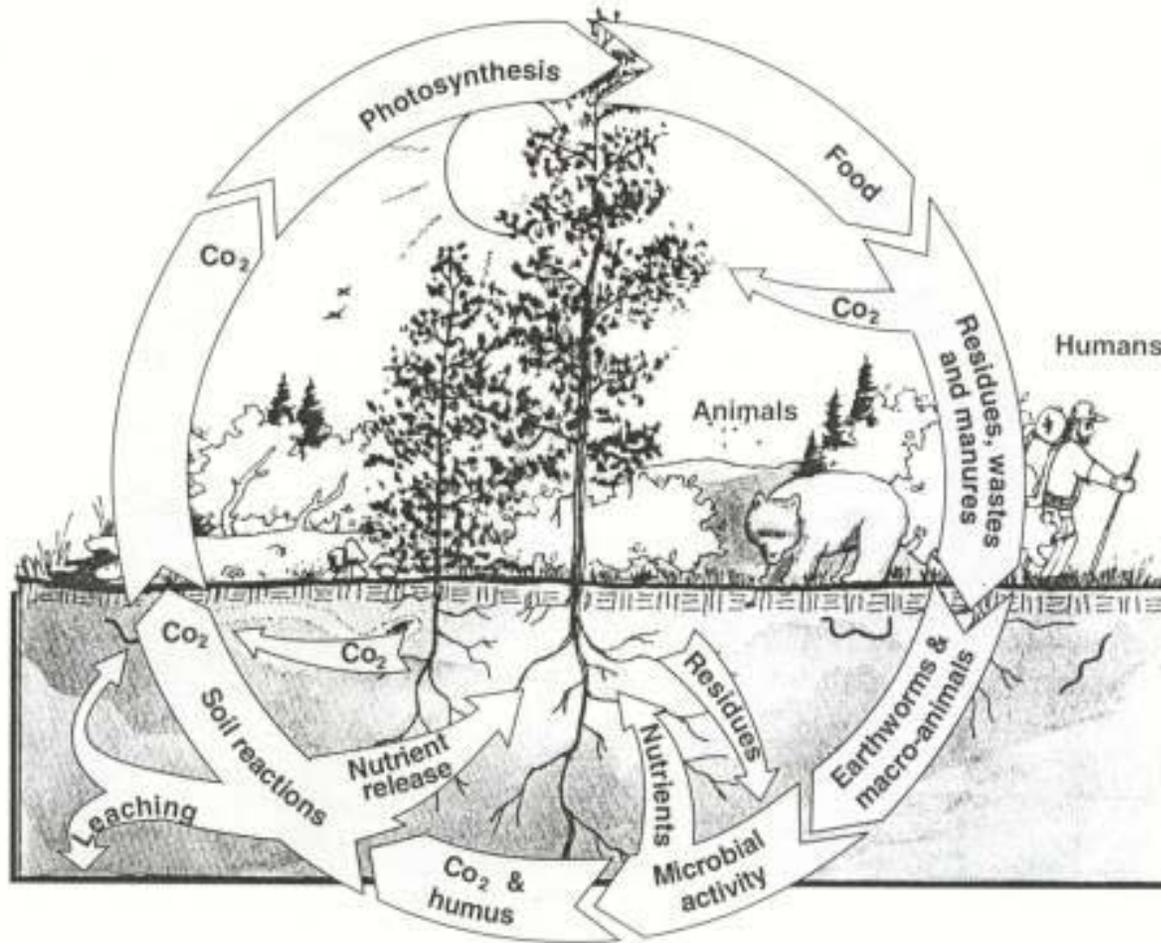
Background Formaldehyde → 0.5 ppb from
methane oxidation

Formaldehyde in Deciduous Forests → 10-50 ppb
in 1982!

Wintertime → 3 ppb

Other VOC oxidations will give Formaldehyde!

Soils major sink... 70%?



H₂ →

So what does that do to the microbes?

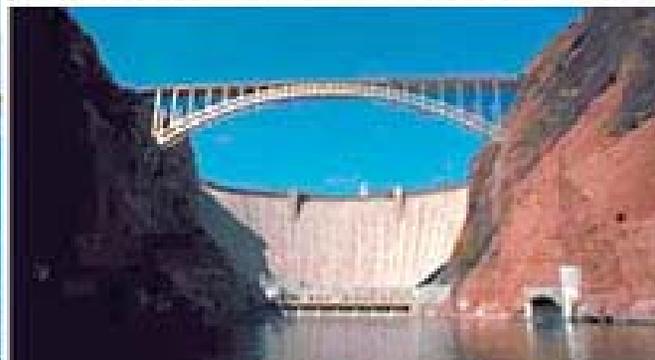
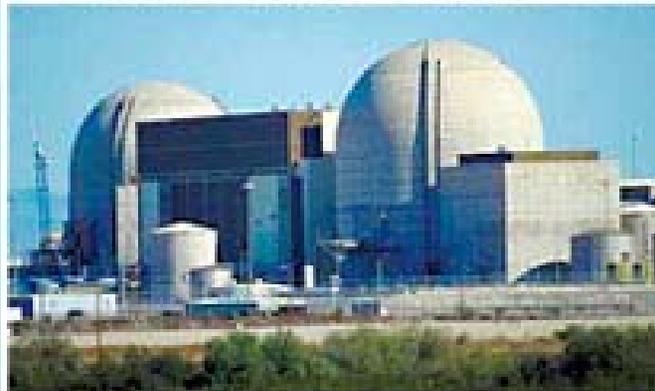


ELECTRIC VEHICLES... Batteries – Lithium polymers?

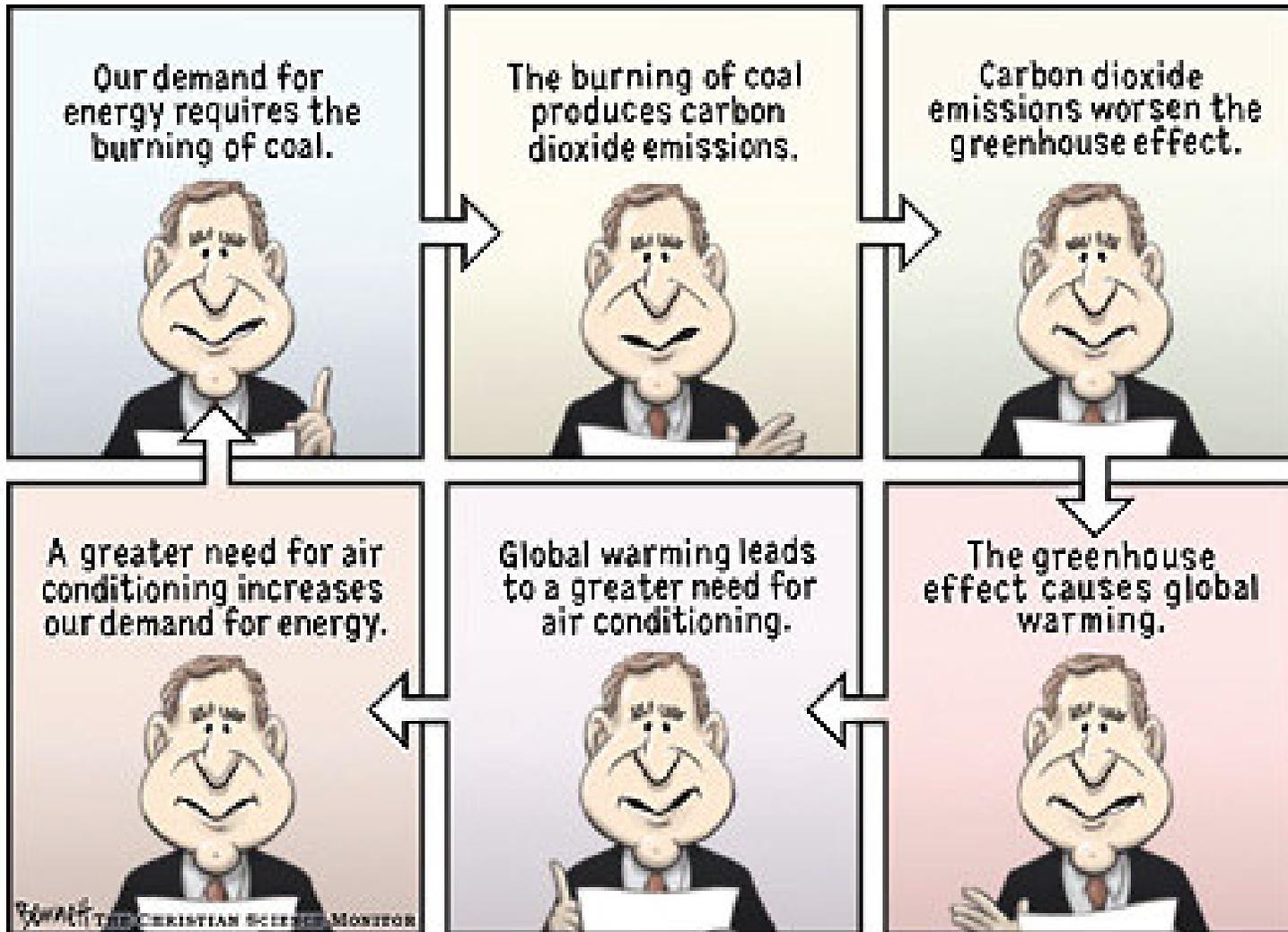
300 miles on a charge? Need to go to higher Voltage systems.

FOR SUSTAINABLE ELECTRIC VEHICLES

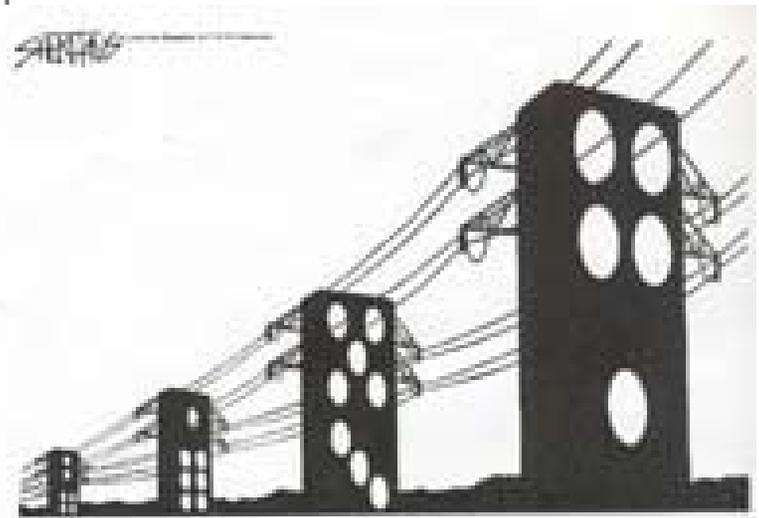
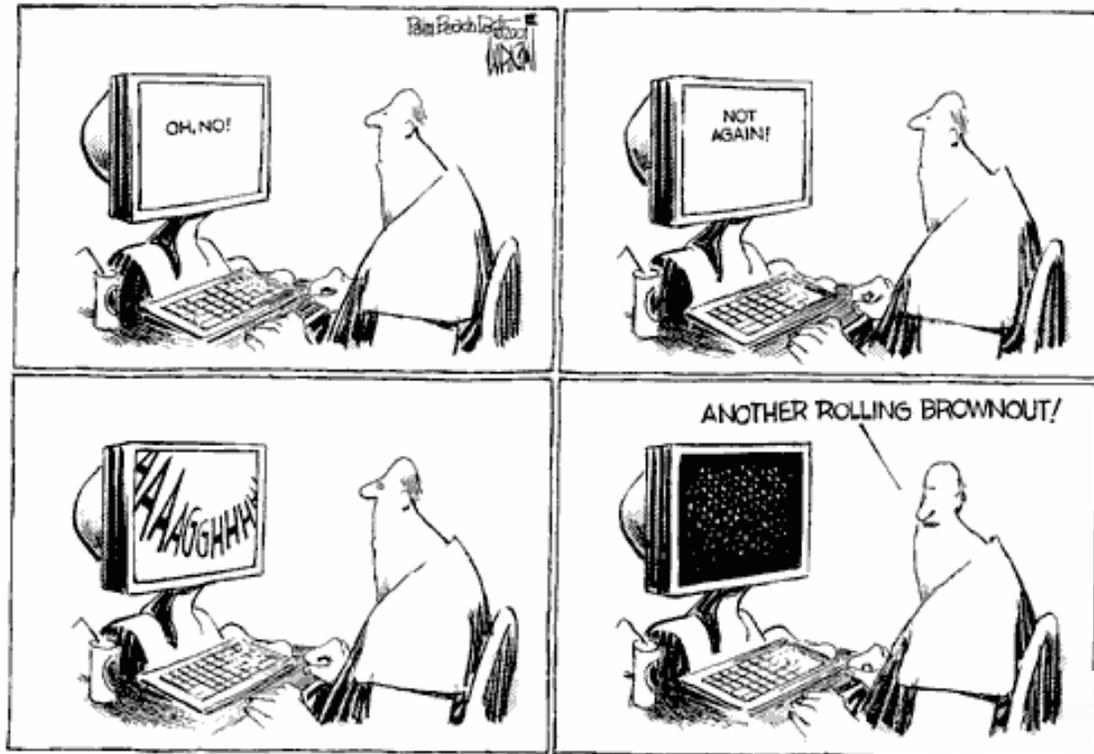
ELECTRICITY..... So you need...



I have focused on the Motor Vehicle energy sources..but...similar conclusions arise from other analyses..



CURRENT CAPACITY and EQUIPMENT IS OLD



HYDROGEN AND FUEL CELLS

TRANSITION TO ELECTRIC VEHICLES

STILL NEED ELECTRICITY

NUCLEAR

SOLAR

WIND

HYDRO

GROWING POPULATIONS WORLDWIDE AND GROWING
DEMAND FOR HIGH QUALITY – HIGH TECHNOLOGY LIFE!

NEED GOOD SCIENCE AND PLANNING – AND
IMPLEMENTATION

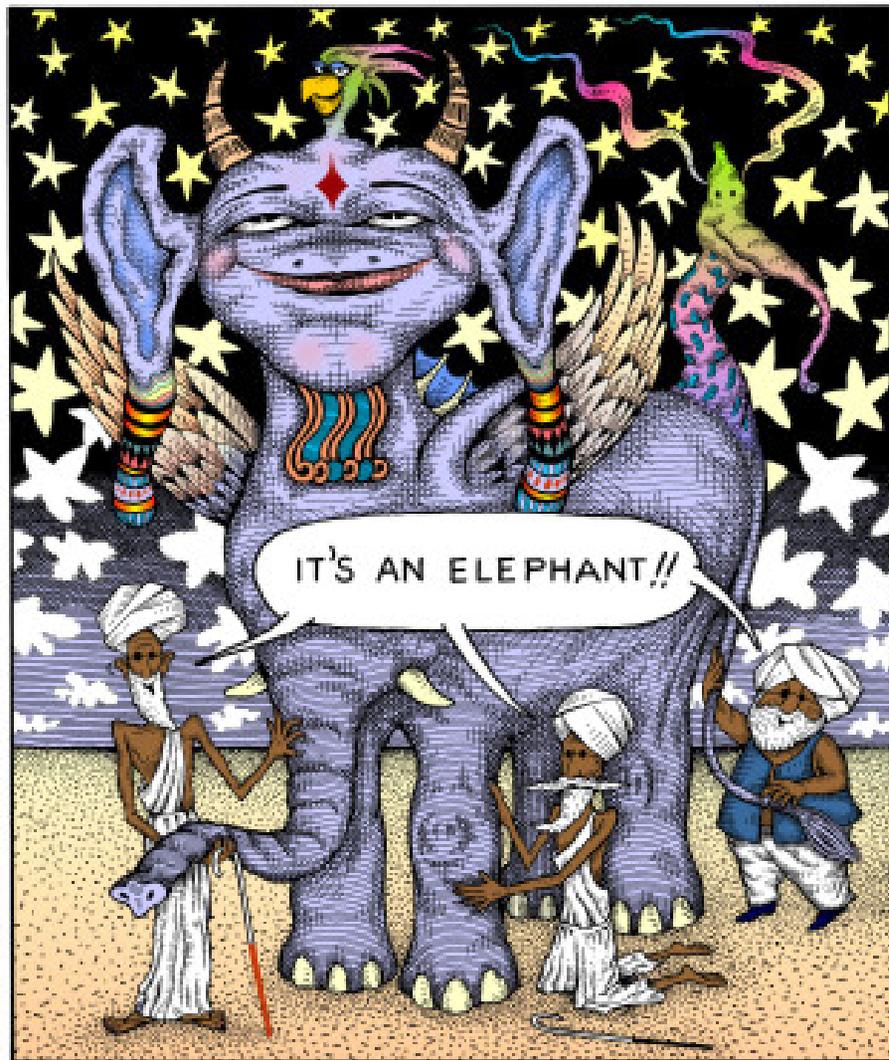
ALL ENERGY SOURCES HAVE THEIR PROBLEMS
SOME MORE THAN OTHERS

NEED TO THINK CRADLE TO GRAVE
ALSO NEED TO LOOK AT ALL OF THE IMPACTS

IMPORTANT FOR THE NEXT GENERATION OF SCIENTISTS
TO GET A BETTER HANDLE ON HOW THE EARTH SYSTEM
REALLY WORKS – AT ALL LEVELS..

CHEMISTS – PHYSICISTS – BIOLOGISTS – ECOLOGISTS, ETC..

AND EVEN THEN WHEN WE THINK WE HAVE THE ANSWER... ITS IMPORTANT TO REMEMBER THAT WE ARE ONLY HUMAN AND LIMITED BY OUR ABILITY TO MAKE OBSERVATIONS AND INTERPRET THEM CORRECTLY!



BLIND MEN AND
THE ELEPHANT?

SO HAVE FUN LEARNING
THIS SUMMER!