


Slowing Climate Change: Options?

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Heating Values of Carbon Fuels



		Heating value	
Fuel	kJ/g	Btu/lb _{mass}	
Wood	17	7700	
Soft coal	23	10000	
Hard coal	35	15000	
Fuel oil, gasoline	44	19000	
Natural gas	54	23000	
Hydrogen	143	61000	

Source: Elementary principles of chemical processes

Wood 17.5-18.3 – 12% moisture

Gasoline, Kerosene 41-48

Methane – 55.6

Propane 50.3

N-Butane- 49.5

Wood, Coal, Gasoline, Natural Gas – MIXTURES.. So they Vary in Heating Content!

Reference: Table 15: Chemistry of the Environment, Bailey et al., Academic Press, 2nd Edition, 2002.

INTERNATIONAL ENERGY AGENCY (IEA) REPORTS...

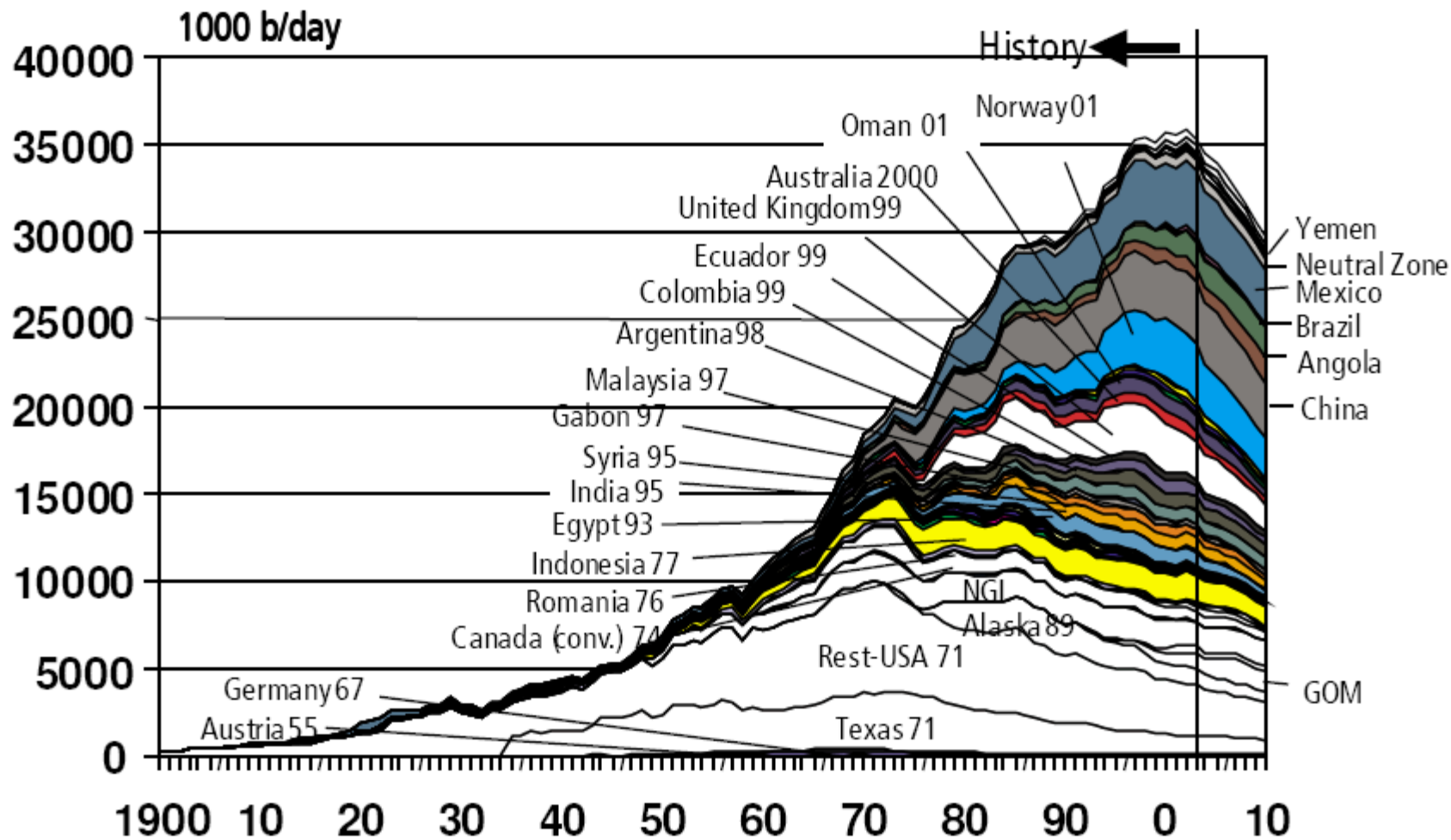
Good source of Information on Energy Reliance and OIL ISSUES

1. EARTH IS A SPACE SHIP
2. IT HAS SIGNIFICANT – BUT NOT UNLIMITED RESOURCES
3. WERE USING UP OUR NON-RENEWABLE RESOURCES FAST
4. THAT USE IS TIED TO POPULATION INCREASES
5. INCREASE IN POPULATION – INCREASE IN ENERGY DEMAND
6. FOSSIL FUELS CAUSE ENVIRONMENTAL PROBLEMS
7. RENEWABLES...LIMITED RESOURCE

http://www.iea.org/Textbase/Papers/2004/High_Oil_Prices.pdf

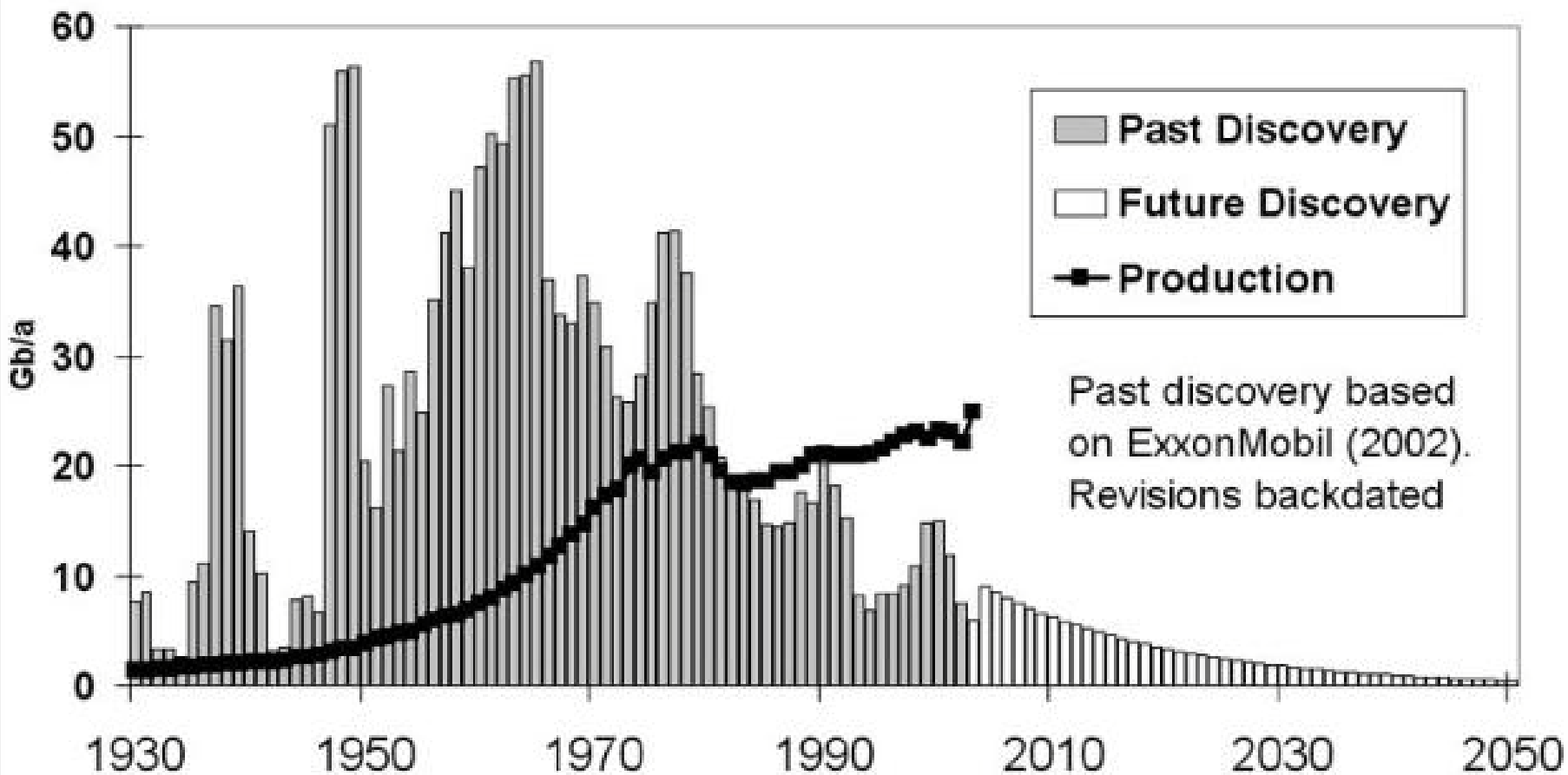
<http://www.iea.org/textbase/nppdf/free/2004/weo2004.pdf>

OIL PRODUCTION IS DROPPING OFF.. Price vs Demand.. \$\$\$\$

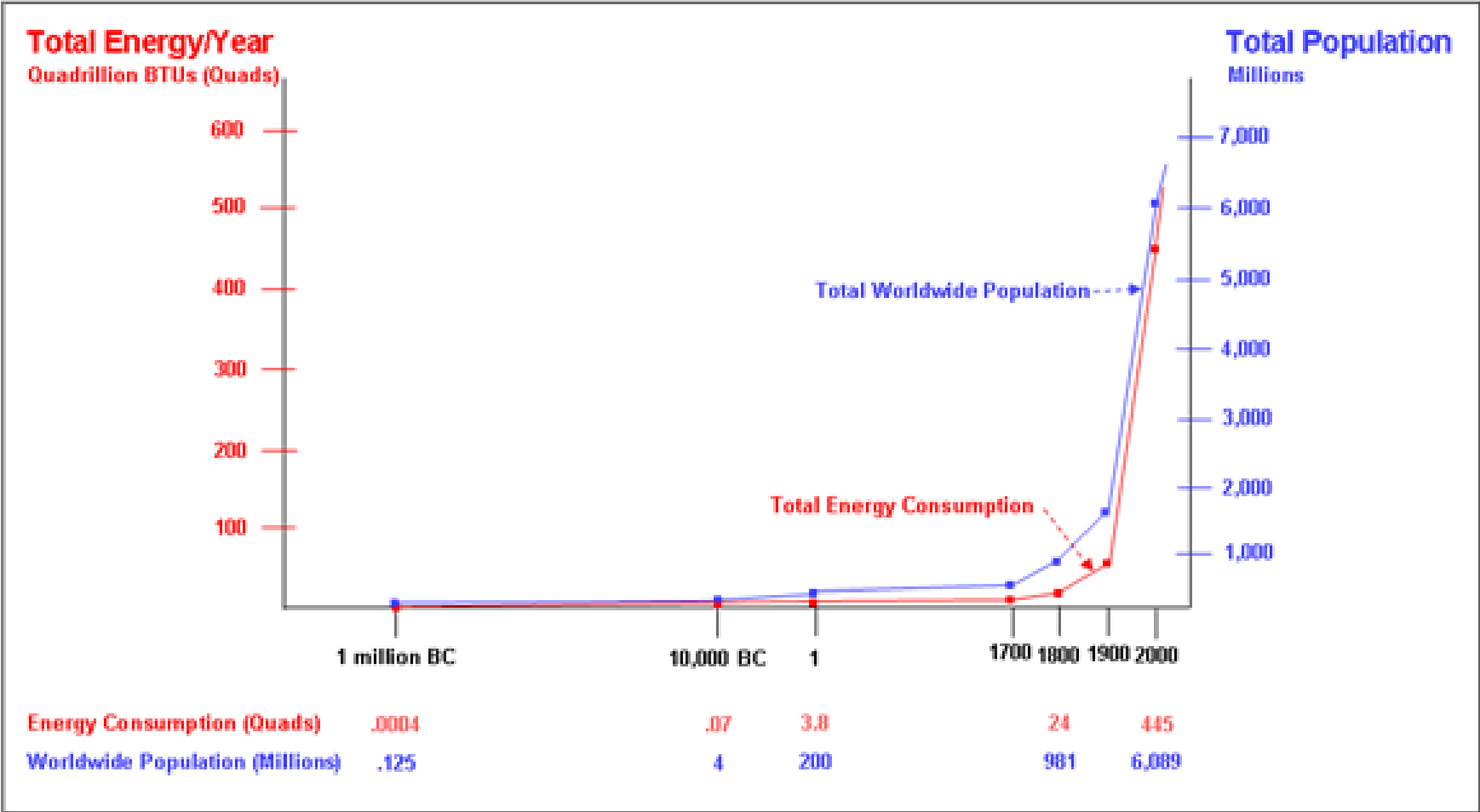


Source: Industry database, 2003 (IHS 2003)
 OGI, 9 Feb 2004 (Jan-Nov 2003)

THE GROWING GAP



ENERGY CONSUMPTION AND POPULATION STRONGLY COUPLED

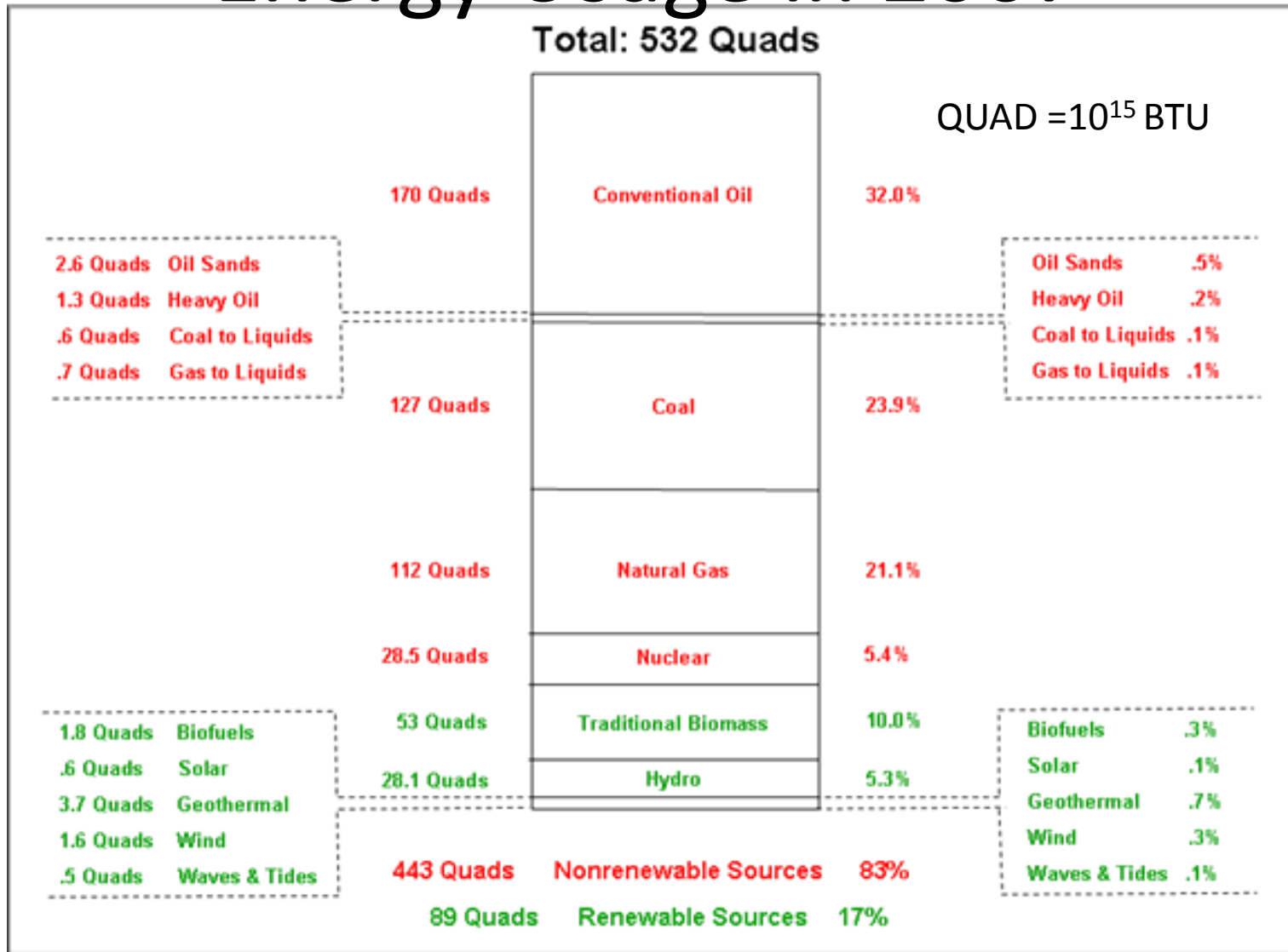


Global Peak Energy Projections – Two Scenarios

Global peak energy: Implications for future human populations

by Chris Clugston Published on 10 Sep 2007 by [Energy Bulletin](#). Archived on 10 Sep 2007.

Energy Usage in 2007



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POPULATION + ENERGY DEMAND Versus Non-Renewable and Renewable ENERGY...

FOSSIL FUELS... Cheap - LARGE SUPPLY AND ENERGY CONTENT - thought to be endless

Like the Buffalo non-renewable supplies have their limits

LARGER POPULATIONS -- MORE DEMAND --- FASTER RATE OF USE.

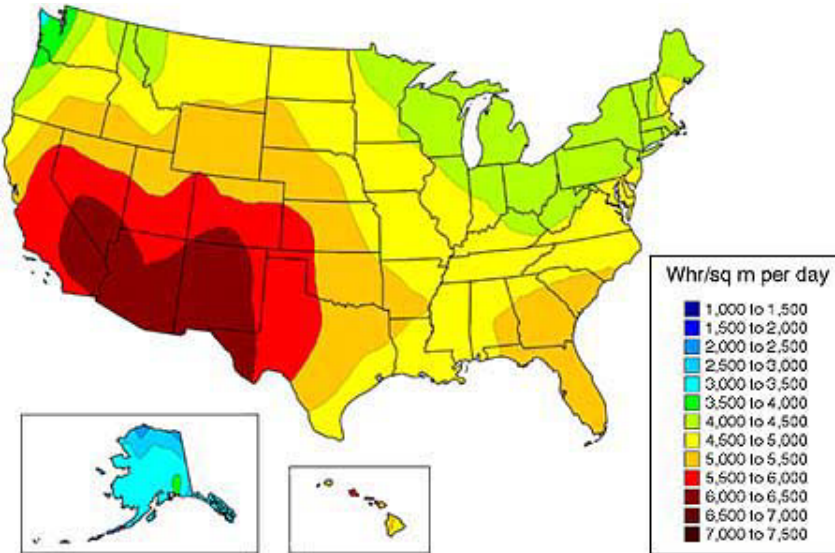
OTHER PROBLEMS... CLIMATE, AIR and WATER POLLUTION, LAND-USE

SO WHERE DO WE GO FROM HERE...

Various Scenarios

- Use Tar Sands and Oil Shale
- Take Coal and Make Synthetic Petroleum
- Use more Coal..
- Natural Gas – similar problem as Oil
- Make Syn-Methane from Coal – requires lots o Water.
- Nuclear Energy – “Regulations” – Started Strong – 107 Nuclear Plants leads the world.. But no new ones since 1978
 - Were Behind World Development
 - France – Sweden – Japan - Germany

Solar Energy



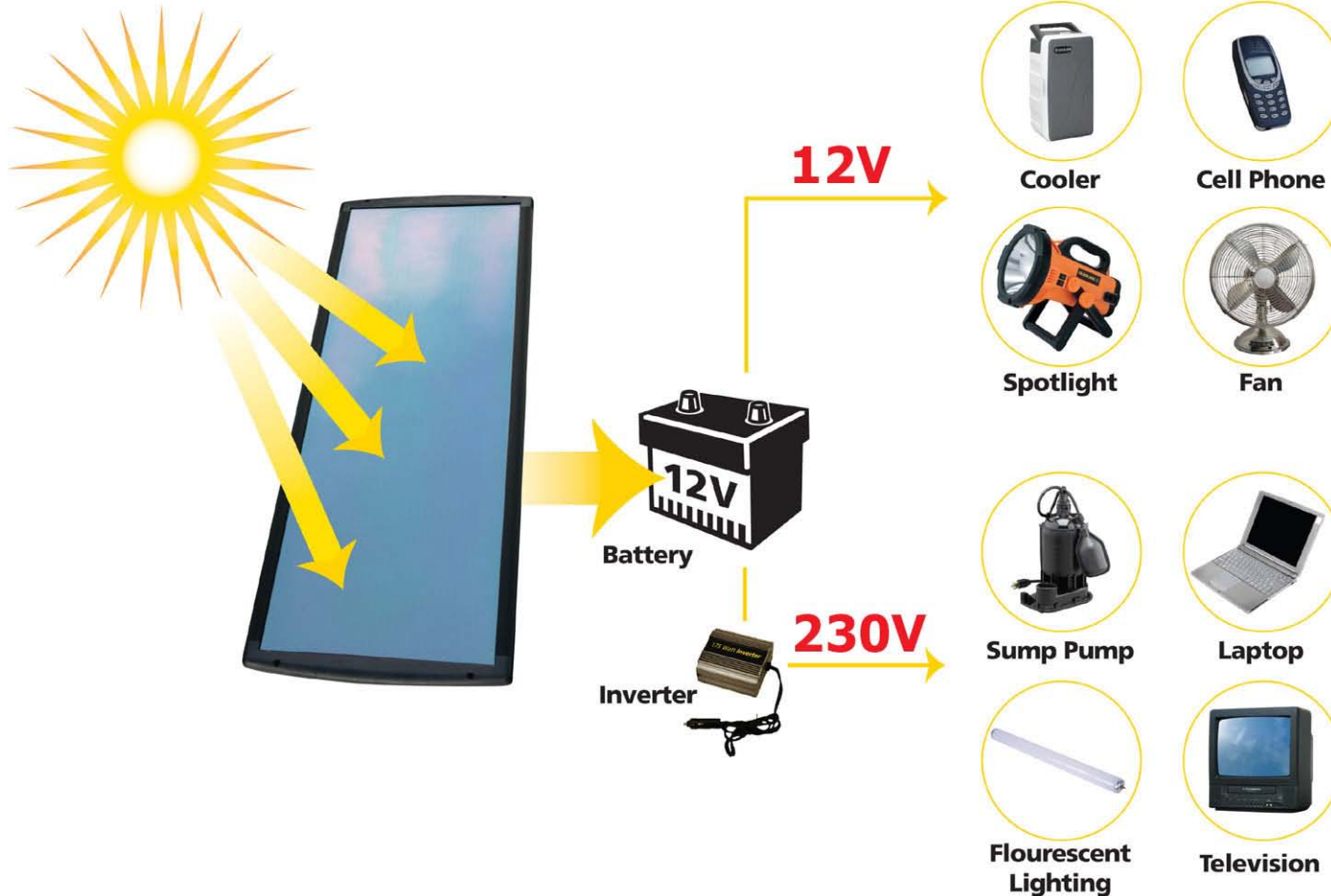
Solar resource for a flat-plate collector

Southwest and Southern U.S.

Solar may Start to Play Role

Better Batteries..Storage...Night

How Solar Works



Drawbacks

- Solar Panels – Mirrors, etc. Require Smelters to process materials – Mirrors or panels susceptible to dirt and dust.
- Processes are still in need of improvement
- SOLAR PANELS IN DESERTS.. Deserts have Sand Storms.. Sand blasted Solar Panels need repair.. And so on.

Sugar Cane vs Corn

- High Sugar Content.. More ETOH
- Search for Enzymes.. Break down cellulose – Switchgrass, Rice Straw

Biomaterials may be workable for materials we currently make from petroleum.. Plastics, synthetic cloths, etc.

TRADE OFF --- Food for Fuel?

AS Discussed earlier this week!

Ocean Currents. Tides. Wind. Geothermal. Hydroelectric

- Local generation. i.e. near hot spots –Iceland..
Now using energy to make Aluminum there
- Need Energy Storage.. Also need to couple
with low loss power transmission to make
larger scale use..
- Super Conductors
- HOT DRY ROCK.. Deep holes –
- Water limiting factor

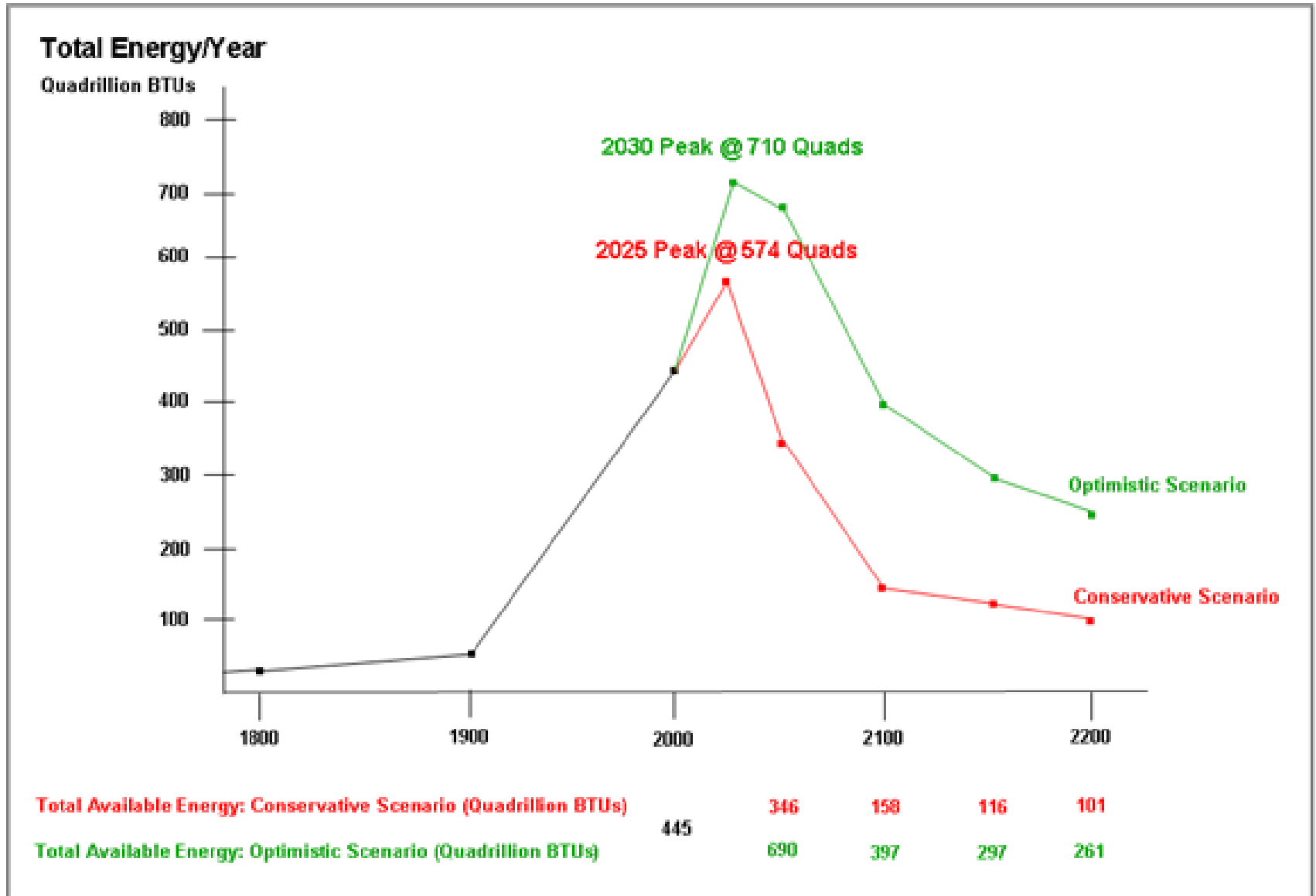
Hydrogen

- It's stored electrons.. Hard to contain.
- Reactive
- Good for quick use in Fuel Cell Technology
- NOTE FUEL CELLS are fairly clean, they typically generate H_2 by cracking fuel and then use the H_2 to obtain Electricity in the fuel cell.
- BURNING Hydrogen in Air will produce NO_x

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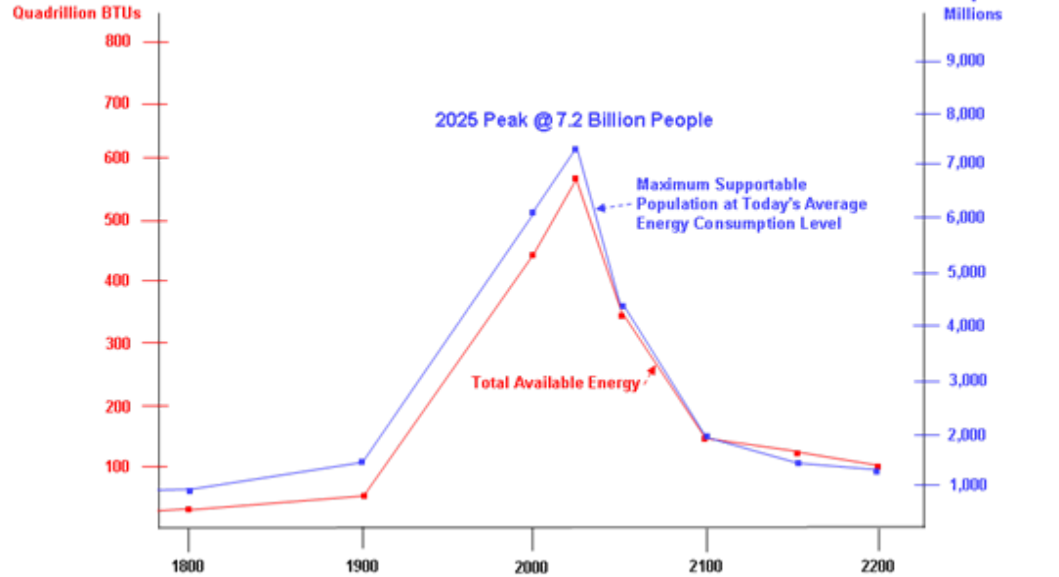
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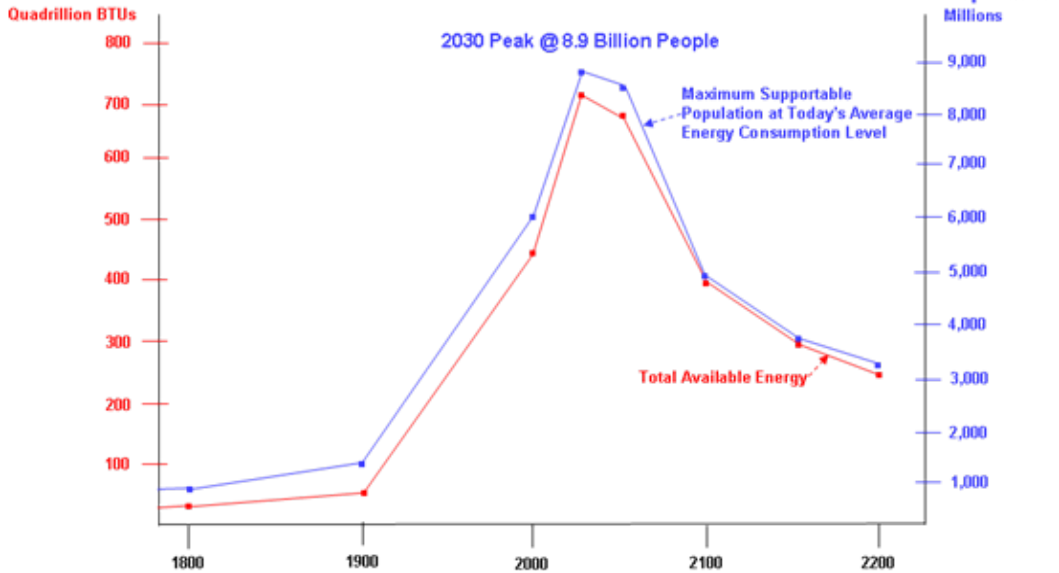
World Peak Populations projections related to energy....

Total Energy/Year



Conservative Scenario

Total Energy/Year



Optimistic Scenario

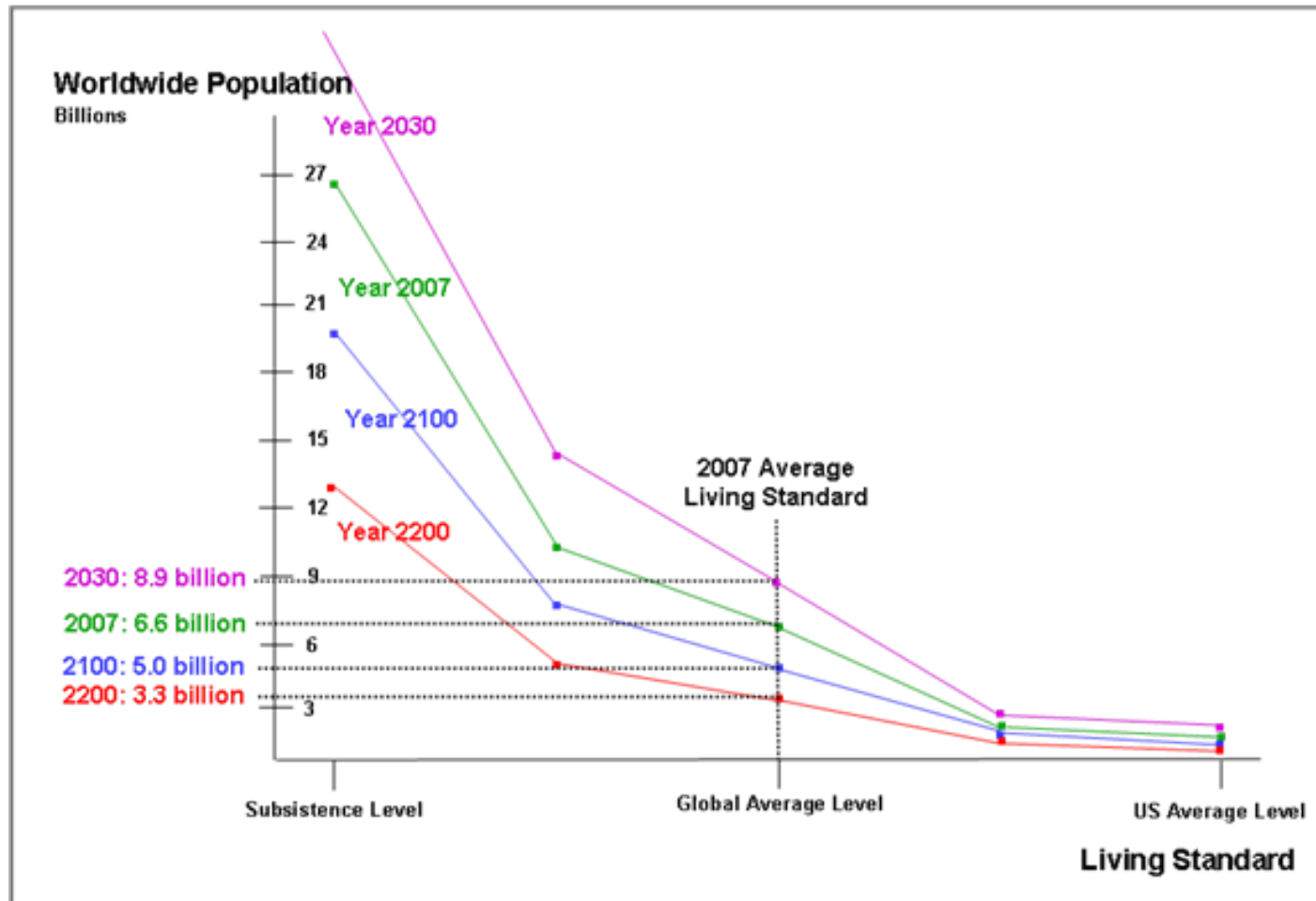
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Supportable Worldwide Population at Today's Global Average Living Standard Optimistic Scenario



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IF WE KEEP BURNING Carbon

- We will add to Regional Ozone Problems

NO_x – Will act as greenhouse gas and also reduce plant and crop growth.

CO₂ increases and other greenhouse gases are tied to lot of other issues such as agriculture.. If we use biomass.. More fertilizers.. More water problems. Nitrate photolyzes to form NO and NO₂ so more regional ozone problems.

Warmer environments favor pests.. Insects, etc. that need to be controlled.. Increased demand by increasing hungry populations will add to that burden.

WATER will be a limiting resource.. So Desalinization methods may help.. But you need energy to get the water clean..

LOTS OF TRADEOFFS .. Difficult Decisions and Need for better, cleaner, and more rational use of fuels and development of sustainable energy strategies at realistic levels..

Conservation.. Also has its problems. As we tighten up homes we move towards indoor air pollution problems such INDOOR RADON and INDOOR AIR QUALITY.

NOTE: Current Energy Usage leads to Food being transported globally.

Local production no longer seasonal

Fresh fruit in stores in Winter

Prices for Food Strongly tied to Energy

Energy Shortage – Food Shortages

Freshwater, etc. tied to energy use.

Were rapidly coming to need for infrastructure evaluations.. And restructuring..

NEED AN INFORMED POPULATION AND POLICY MAKERS ----- BETTER STEM EDUCATION



BEST POLICY IS BASED ON KNOWLEDGE OF THE SYSTEM....

OUR JOB – UNDERSTAND PROCESSES... DESCRIBE THEM IN MODELS... LOOK TO SEE HOW THINGS CAN BE BEST MANAGED..

LOTS OF WORK TO BE DONE

WILL TAKE TIME – AND STRONG COMMITMENT

THERE IS NO ONE ANSWER – SO ENERGY PORTFOLIOS AND BEST USE PRACTICES WILL EVOLVE.

SOLUTIONS WILL NOT BE SHORT TERM IN NATURE.. SO LOT OF OPPORTUNITY FOR INNOVATION..

NEW GENERATIONS OF ENVIRONMENTAL SCIENTISTS – WHO INTERACT AND TALK TO EACH OTHER TO DEVELOP BETTER UNDERSTANDING OF FEEDBACKS AND IDENTIFY POTENTIAL PITFALLS --- BEFORE THEY OCCUR.

YOU'RE THE FUTURE! .. AND WERE GLAD YOU'RE HERE PARTICIPATING IN SURE and GREF!