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Sustainability and an Energy System Approach

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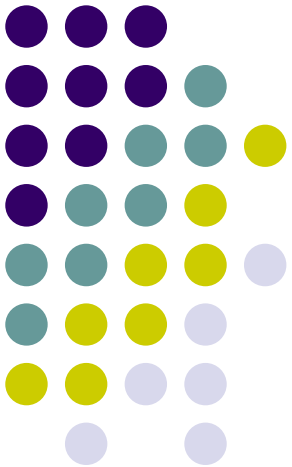
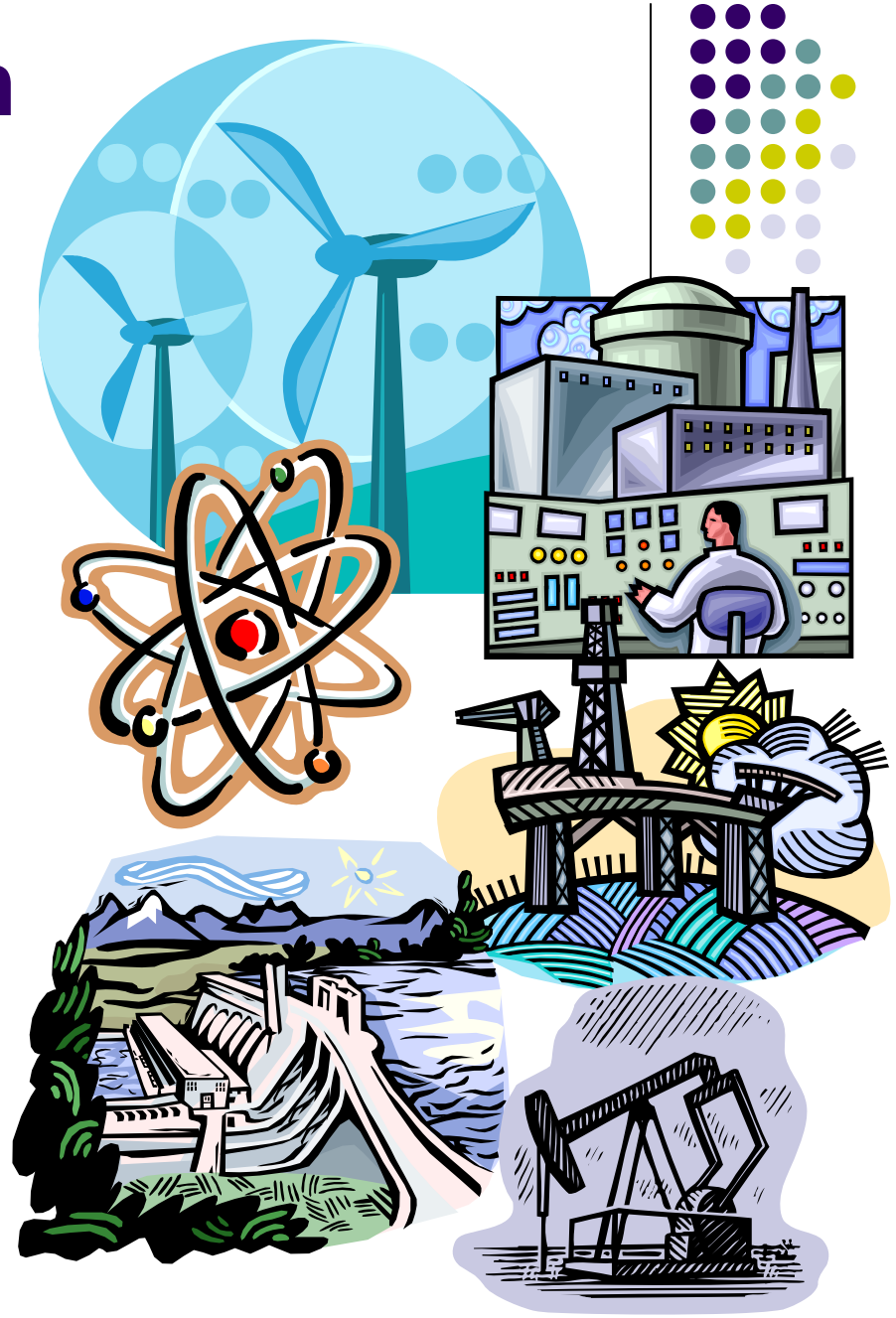


Sustainability and an Energy System Approach

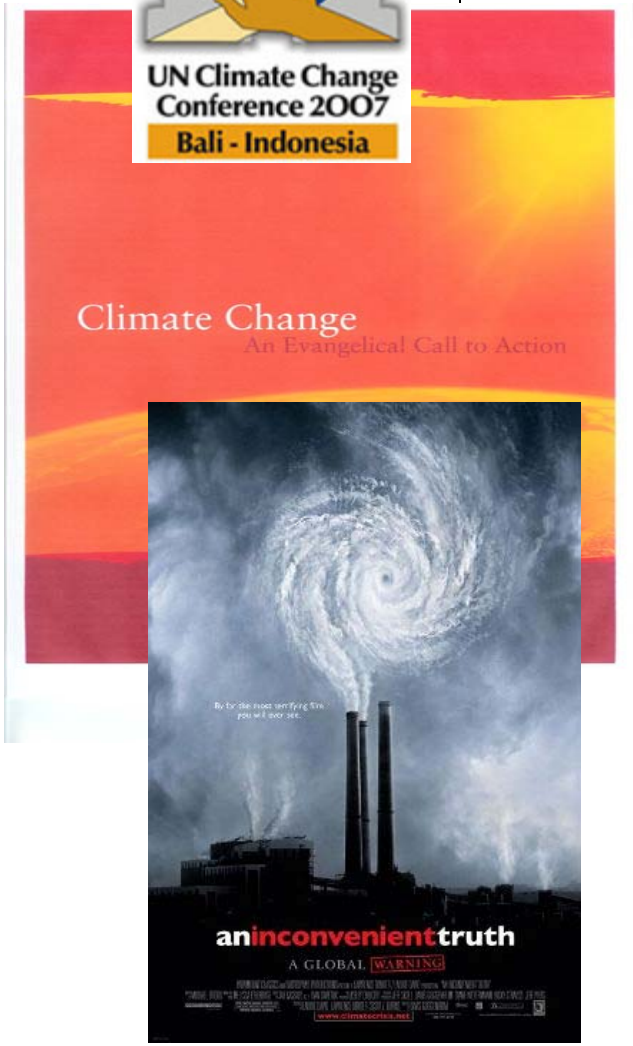


DISCLAIMER:

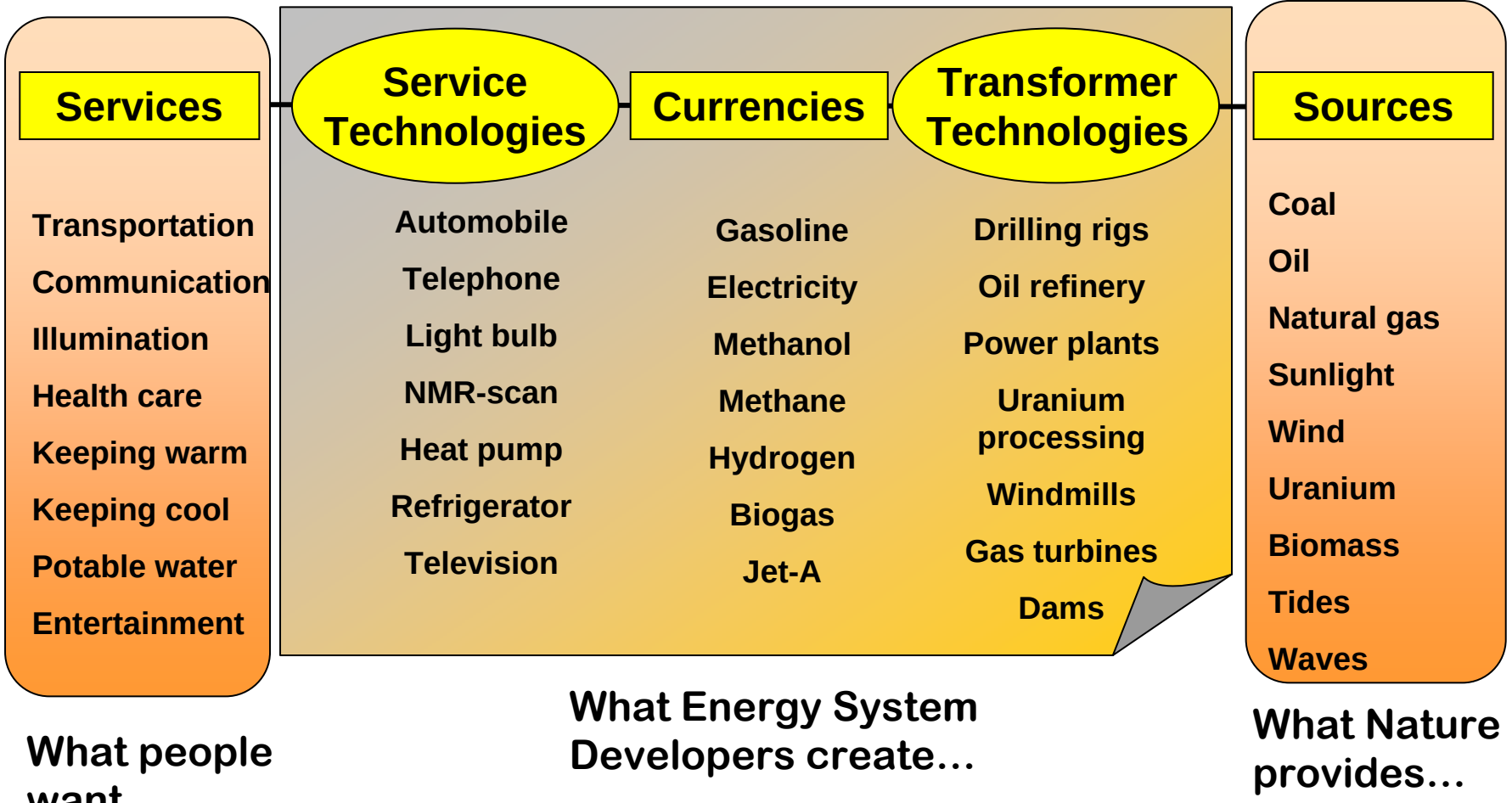
The views presented here are those of the author and do not necessarily reflect those of Pacific Northwest National Laboratory or the Department of Energy. This talk developed from background investigated while the author was at the Idaho National Laboratory.

A lack of consensus?

- Evangelical Climate Initiative (January 2006)
- Cornwall Alliance (response)
- U.N. Bali Conference (Dec ’07)
- G8 – Energy Technology Perspectives 2008 –June 2008 *(Plan of Action – Scenarios & Strategies to 2050)*
- Gore Energy Plan (July 2008)



The Energy System



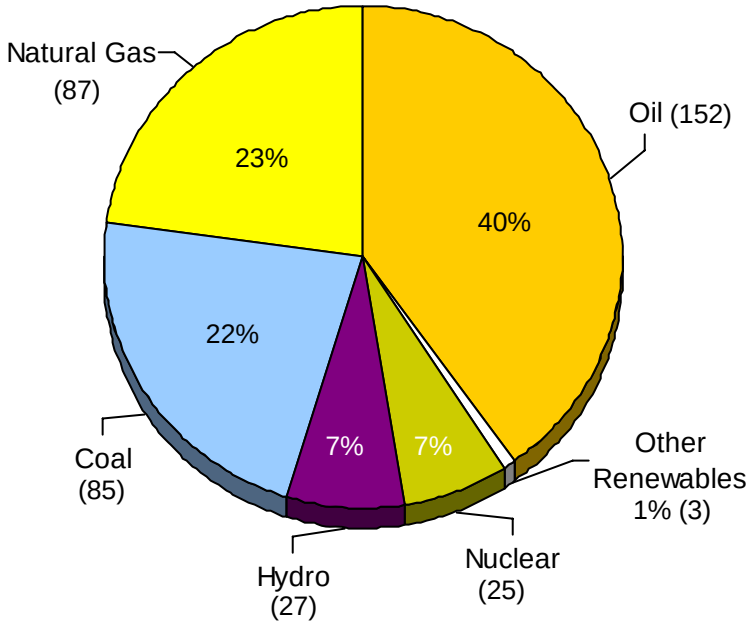
Source: Dr. Geoffrey Ballard, General Hydrogen

Current World Energy Situation

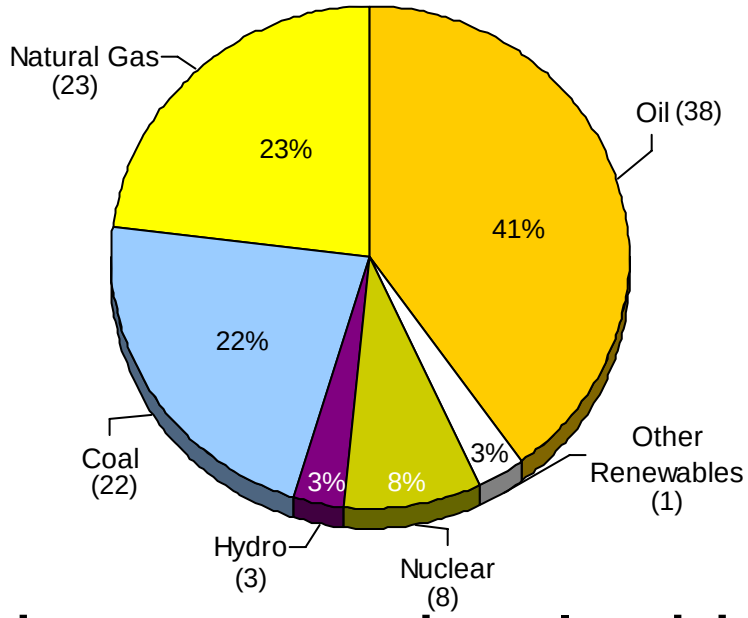
The world uses almost 400 quadrillion Btu of energy each year. This is roughly equivalent to using 180 million barrels of crude oil each day.

280 million people use almost 100 quadrillion Btu of energy each year -- about 25 percent of the world's consumption

Sources of Production - World



Sources of Production - U.S.

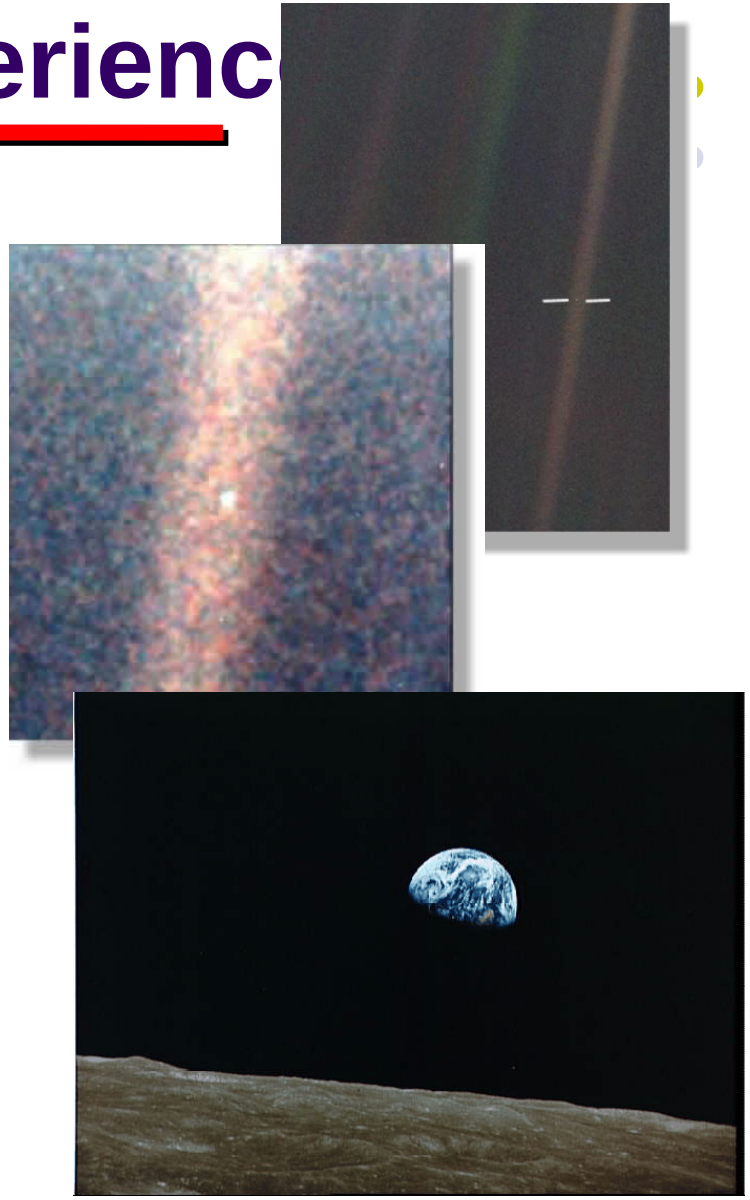


Still, 2 billion people lack access to adequate, convenient electricity

Source - EIA

Earth…..common experienc

Earthrise – Dec 25, 1968 –Apollo 8



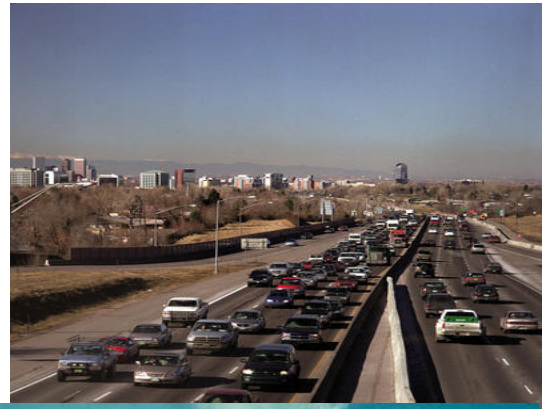
Voyager 1 – 1990 Image of earth: from 4 billion miles

Pale Blue Dot: Carl Sagan Oct.1994 "We succeeded in taking the picture….(the earth).. the only home we will ever know"

"We must work together as the crew if we are to survive on our planet" - *Space Ship Earth* – R. Buckmaster Fuller (1980's)

Man's role in the earth?

- God gave man stewardship: cultivate and guard the garden
  - (Genesis 2:15)
- Fill, subdue and rule the earth (Genesis 1:28)
- "For unto whomsoever much is given, of him shall be much required" Luke 12 V 48.



Man's responsibilities

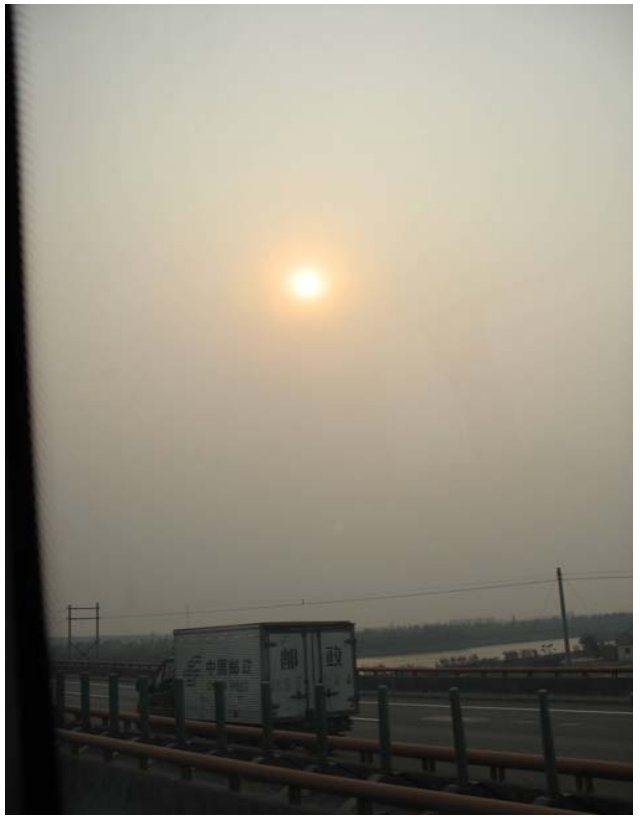
- Man has God given freedom and role as steward
- Christians have a responsibility to care for the poor, sick, widowed, and orphaned: –

  NOT *"just saving souls"*

- God does not give mankind the freedom to *rape and pillage* the earth.

SOME GLOBAL ISSUES

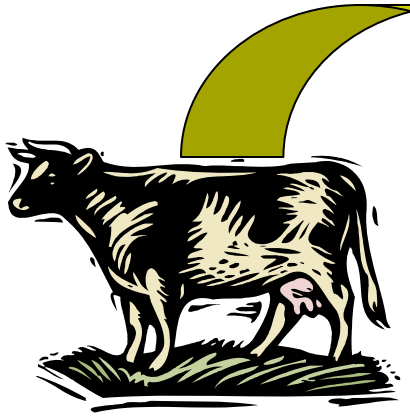
- Linked issues - Energy – Economy – Environment - Education
- 2.0 Billion people no access to electricity
- 2 Billion + no clean water
- 1.5 Billion people live on less than $ 1 per day
- Resource depletion
  - minerals
  - Land: ¼ land forests & ¼ used for agriculture
- Climate change/Global warming – pollution and destabilization?



Asian Brown Cloud

Earth as a sustainable system

- Minerals – finite
- Land area – finite
- Water (fresh limited)
- Ability for “nature” to act as a pollution SINK – finite
- What is a sustainable population “carrying capacity” for the earth AND at what standard of living?



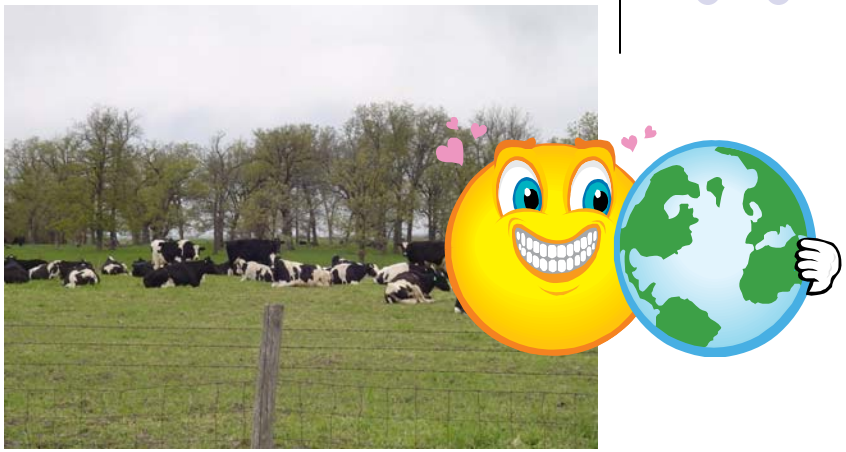
For a self-sustainable farm:
How many cows on a farm?
• how much area?
• how much grass (feed)?
• how much water?
• erosion and damage to land?
• how much waste can be utilized
– e.g. fertilizer?
• other constraints? (smell!!)

One Answer --- Eastern Colorado
– 13 acre for cow-calf unit

Sustainable agriculture

How many cows?

- Right number
  - Happy farmer Happy cows!



- Too Many cows
  - Major impacts on the environment
  - Unhappy cows
  - Not sustainable – without off-site resources

Population and impact

- Paul Ehrlich developed the IPAT Equation where:

$$I = P * A * T$$

where:

I = impact on the environment resulting from consumption

P = the population number

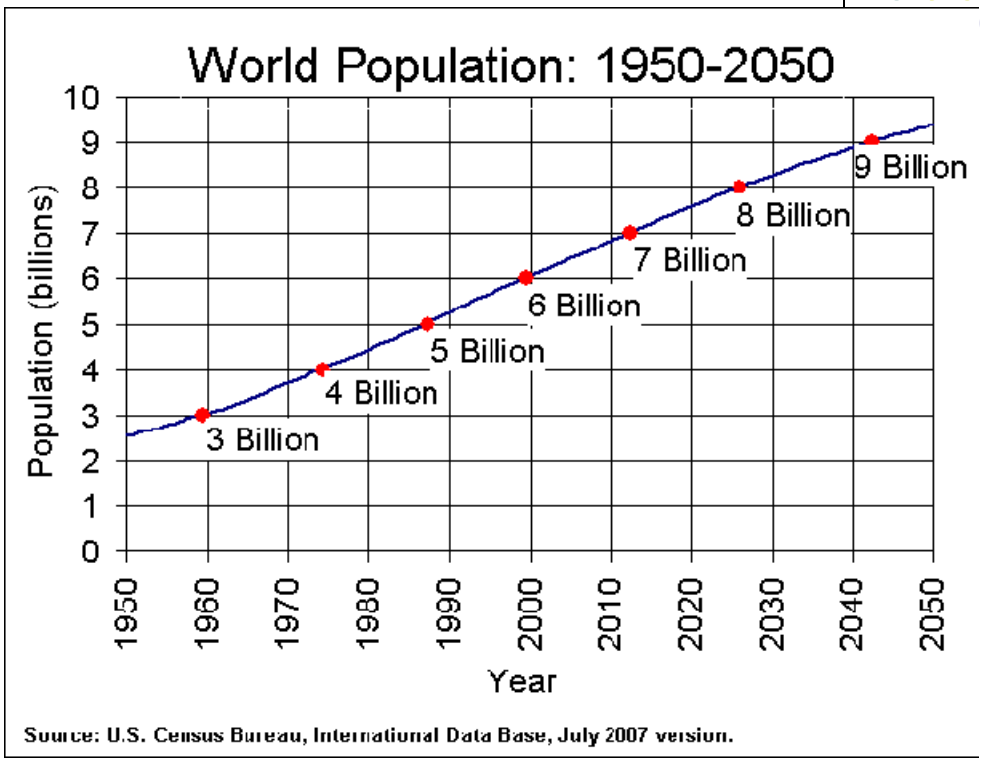
A = the consumption per capita (affluence)

T = the technology factor

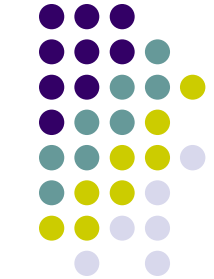
(Ehrlich and Holdren 1971)

Key drivers

- Population
- Energy use
- Economic development



Sustainable Planet?

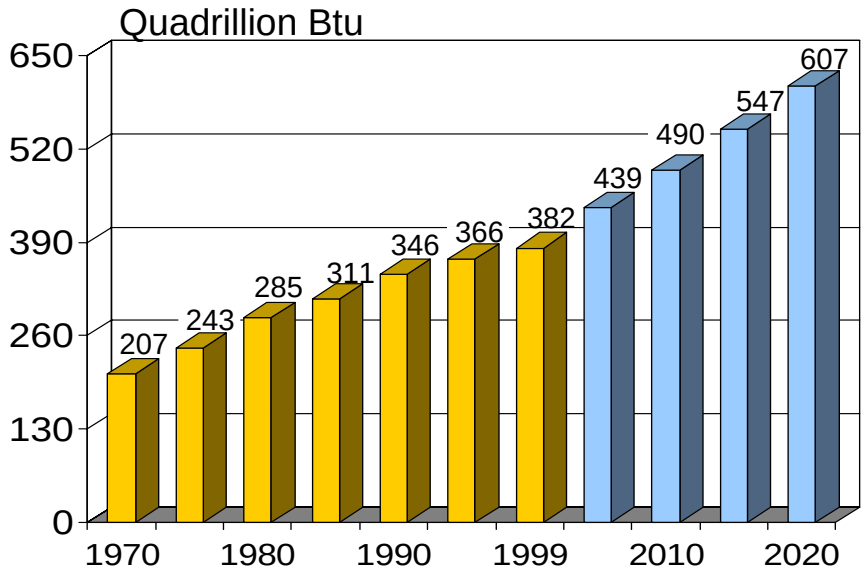


- **Optimal population** (12% land area for bio-diversity) ----- 3-4 Billion (See optimal population web sites)
- **Economic development/Impact** – all with US median life-style - need 3-4 times worlds natural resources (minerals, land area, food production capacity) (See NPR website for your impact calculator/carbon footprint)
- **Energy use:** Major advances needed in agriculture and energy to meet even optimal population (eliminate starvation – have sustainable systems)
- **Technology innovation**– 50% of global population now live in cities: – need stabilized population, new technology (food production & energy systems) and *ELIMINATE* over consumption by "G8."

Energy use:
Future World Energy Consumption

- World energy use may **TRIPLE** in next 50 years.
- Energy consumption driven by developing countries raising their standard of living.
- Energy efficiency and conservation alone cannot stop energy consumption growth.
- All current projections show that significant growth will continue.

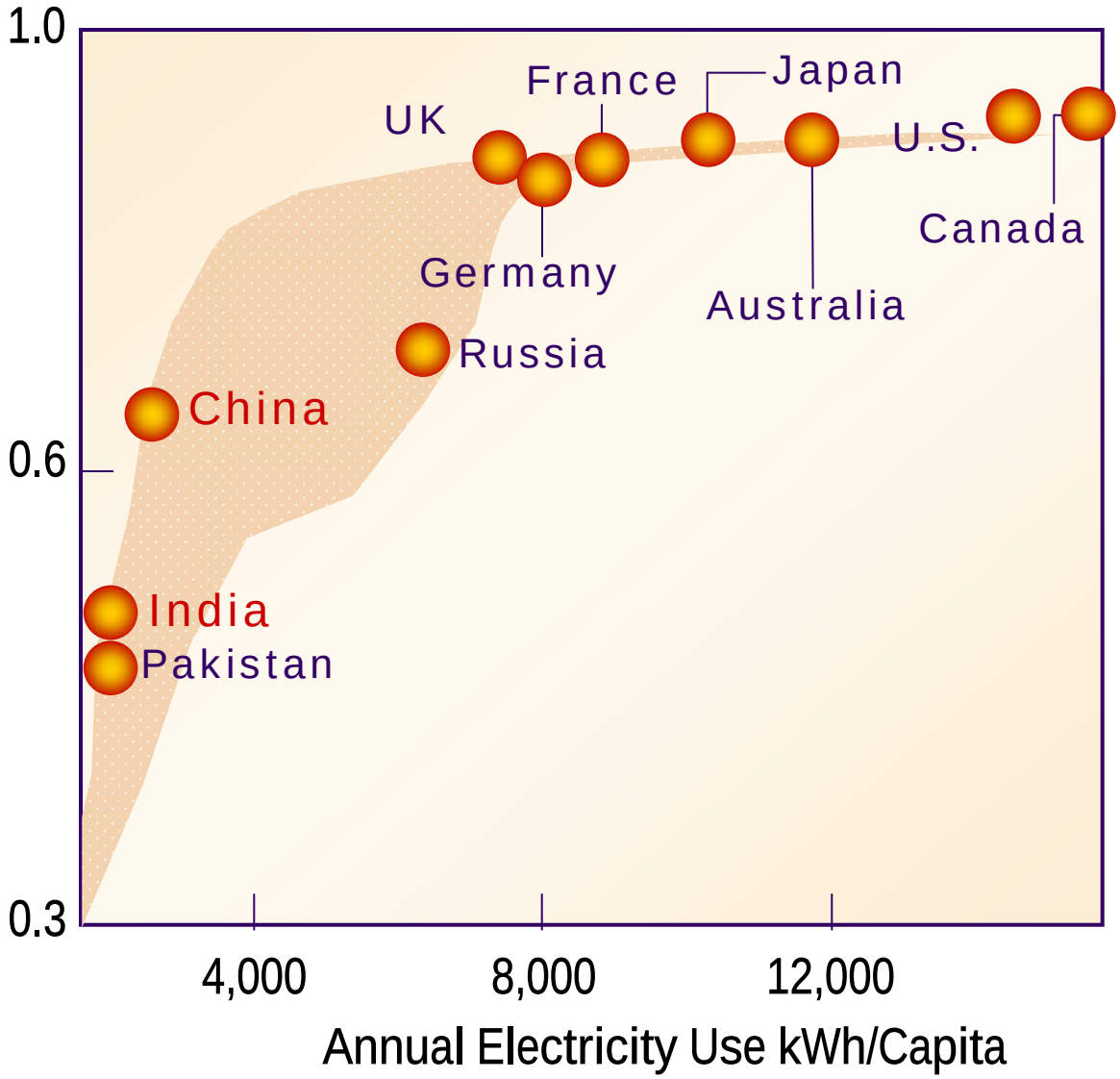
World Energy Consumption 1970-2020



Source: EIA

USA is 5% of world population
WE USE 25%OF WORLDS ENERGY

U.N. Human Development Index



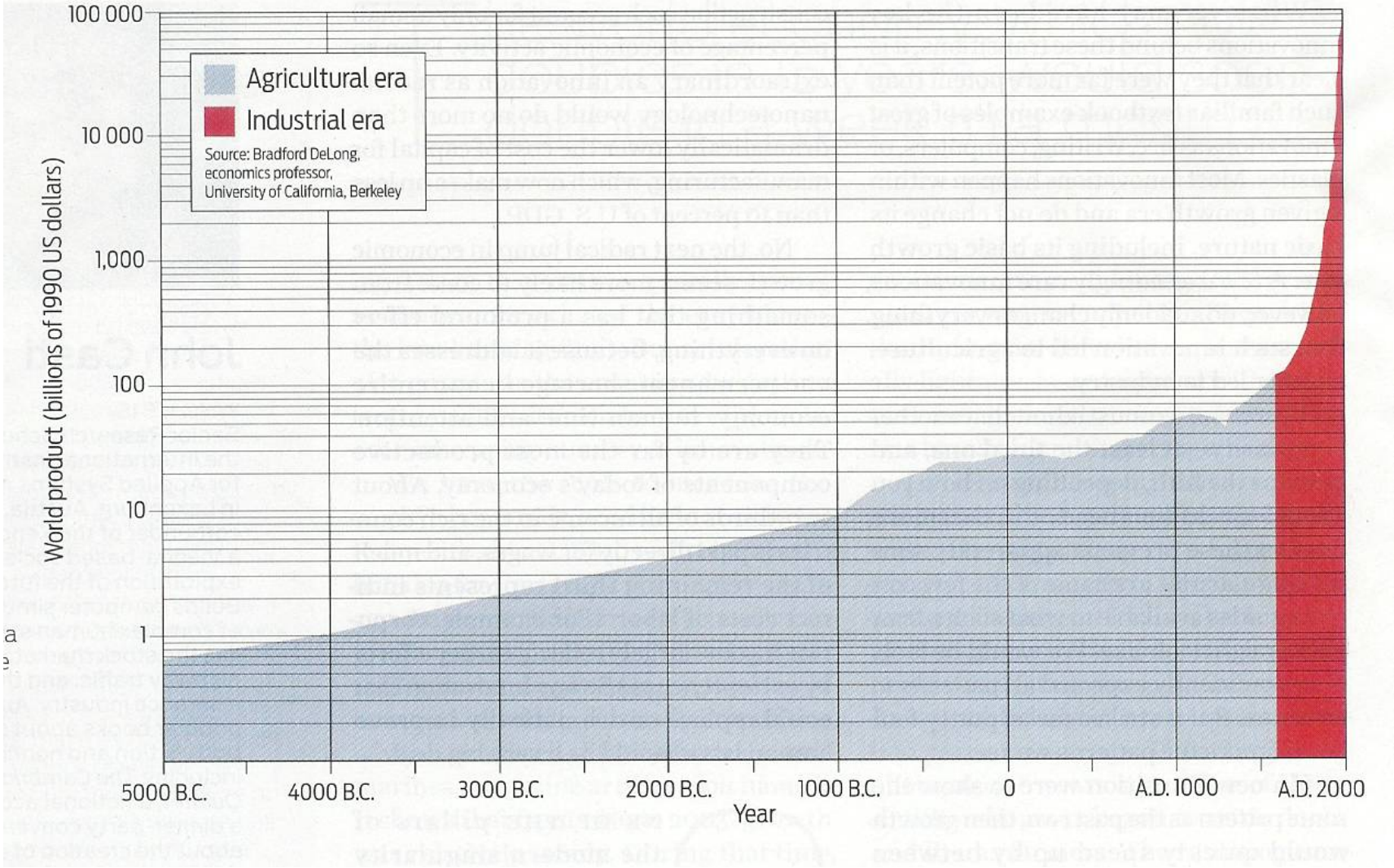
Energy for development

2,300 GWe increase*

- Coal
- Hydro-electricity
- Nuclear

*ANS Fall 2007 Conference Globally next 20 years

Global Economic Product

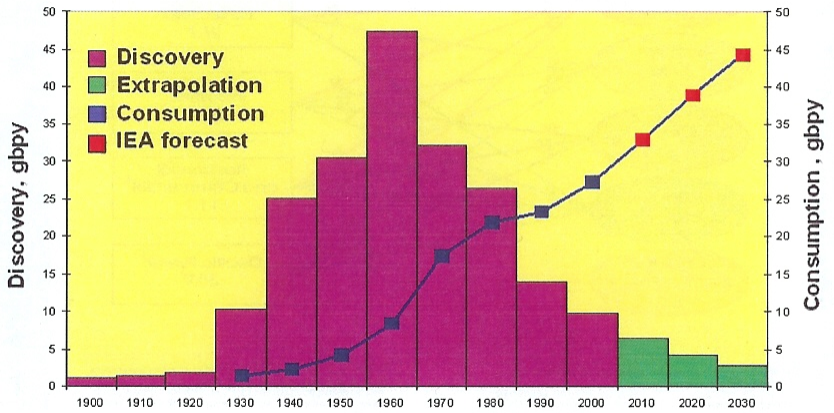


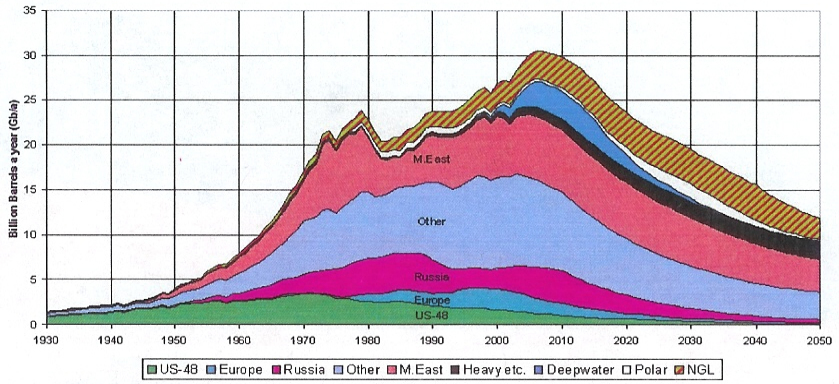
Oil issues

- World is using current oil production capacity
- More oil is being used than new fields discovered
- Oil prices can be expected to rise ($50- $150 barrel crude)
- In 30 years oil production COULD be down by 75%

"The end of cheap fossil fuel will end a whole way of life" says Larry Elliot (2005)*

*Futurist/Guardian



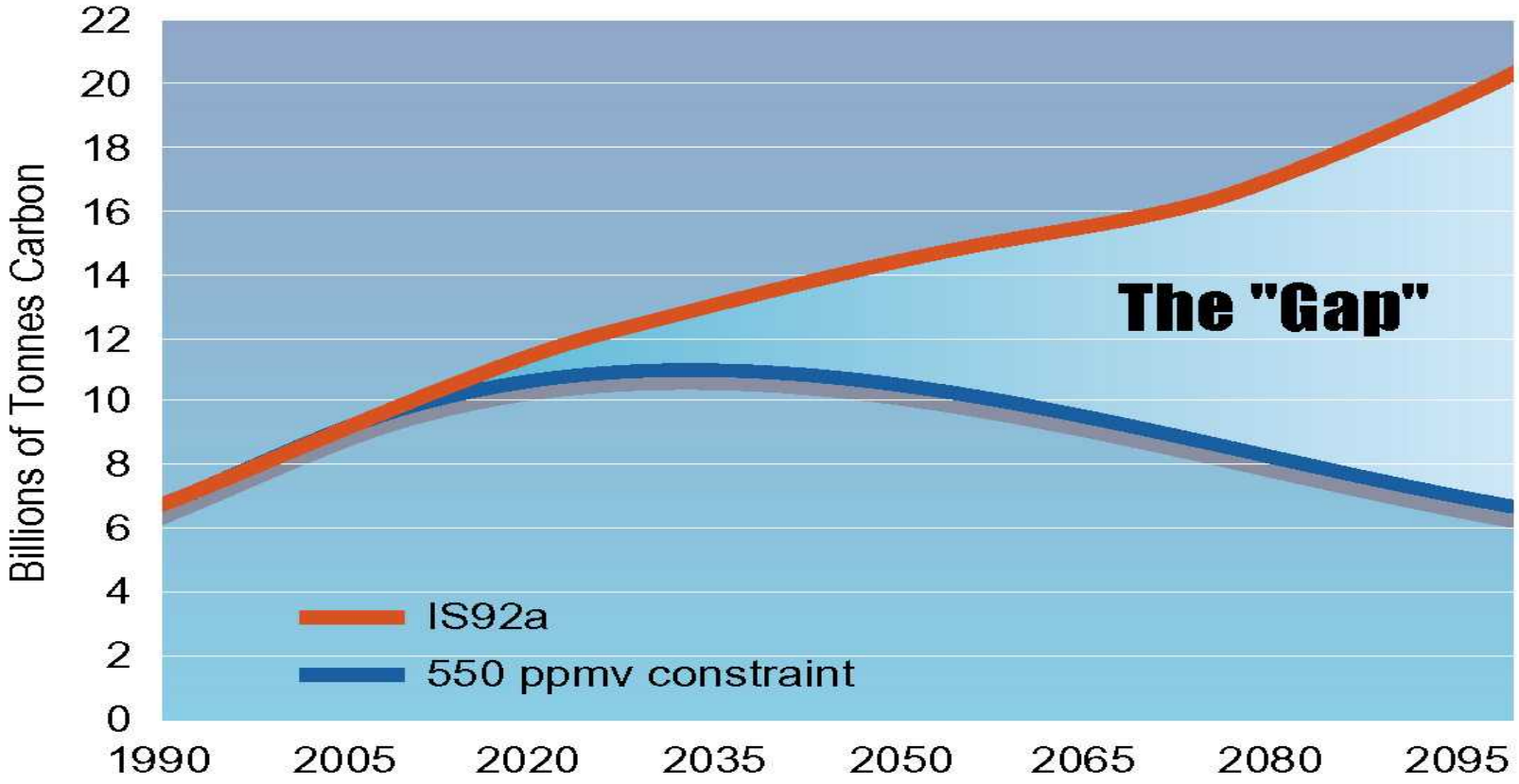


Army Corps, 2005

WORLD ENERGY SUPPLY - The world is not running out of energy – it is running out of the type energy we have used most…

- Petroleum**, a key energy source**
  - 97% of transportation
  - 35% of industrial base load
  - 13% of residential
  - 8% of commercial
- **Hydrocarbons (petroleum, coal, natural gas) provide ~85% of United States energy**
- **Hydrocarbons provide ~70% of electric capacity**
- USA – 5% worlds population and use 25% worlds energy

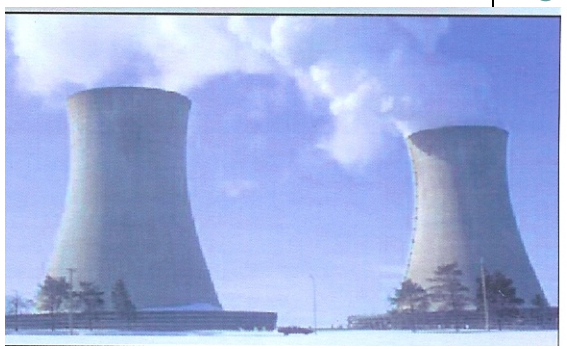
NEW TECHNOLOGY IS NEEDED
- if emission control to be implemented



USA generation capacity: 2025 and beyond

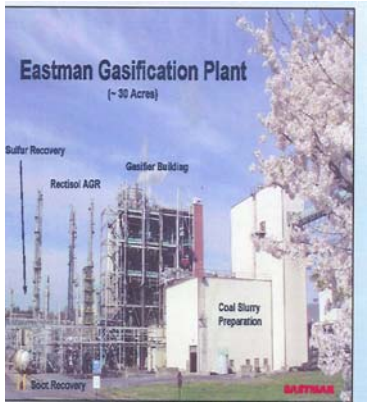
Renewables

- 25 GW(e) added by 2025
- Triple generation by 2050



Coal gasification for electricity

- 80 GW(e) added by 2025
- IGCC technology with carbon sequestration phasing in over next 20 years



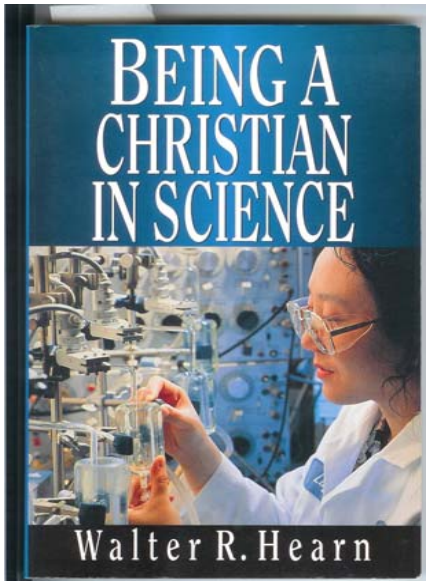
Nuclear

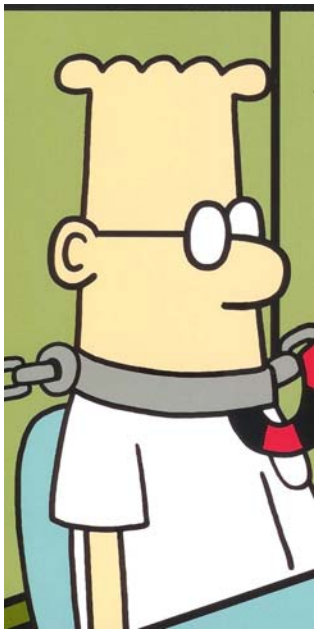
- 25 GW(e) expected to be added by 2025 (or so)
- High-temperature reactors by 2025 for higher efficiency, hydrogen and/or dry cooling
- Breeder reactors and reprocessing by 2050

Source - ORNL - 2006

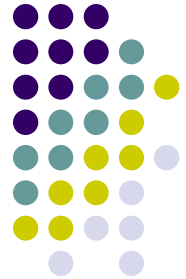
Science VS religion

- Scientific illiteracy
  - Ignorance and prejudice
  - Evolution – creation science
  - Science not “christian”
  - Fear of technology
- Failure to recognize POSITIVE contribution of technology to US life style
- Being a Christian engineer or scientist is a vocation





A Global Energy Future



- Secure, sustainable, affordable energy with limited environmentally impact is possible
  - For example see G8 report (2008)

BUT:

- Population will grow – may be ~9 Billion by 2100
- Energy utilization will increase (could triple in next 50 years: factor of 6 or 7 by 2100)
- Negative impacts on land use due to economic growth
- Water supply an increasing challenge
- Climate change is occurring: needs attention – international coordination of response unclear

A Christian response?

- Business as usual will not work: in society or churches
- Opting out into “End Time Theology:” & assumption that we are in the “End Days” and the “Rapture” **will save** *christians* – is irresponsible
- Mankind MUST act if catastrophe is to be avoided
- Christians have a responsibility for global stewardship of Gods creation
- Science and technology – *if properly directed* can make a difference
- Christians need to ENGAGE and provide leadership
- A solution to the War on Carbon – will solve a plethora of problems (energy, environmental, economic and foreign policy)
- A change in US Christians engagement with the planet through “care for the poor” & education will open a new energy technology mission field.