

Linkages
for a
Sustainable Future



ENERGY

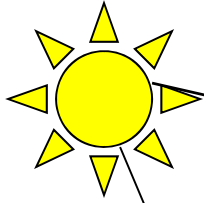
AND

FOOD

CY RICH

Biosphere

Immutable Laws



Climate Change

"Overshoot"

Agriculture

Population

Ground Water

Global Economy

Over Fishing

Economic Theories

Loss of Topsoil

Waste

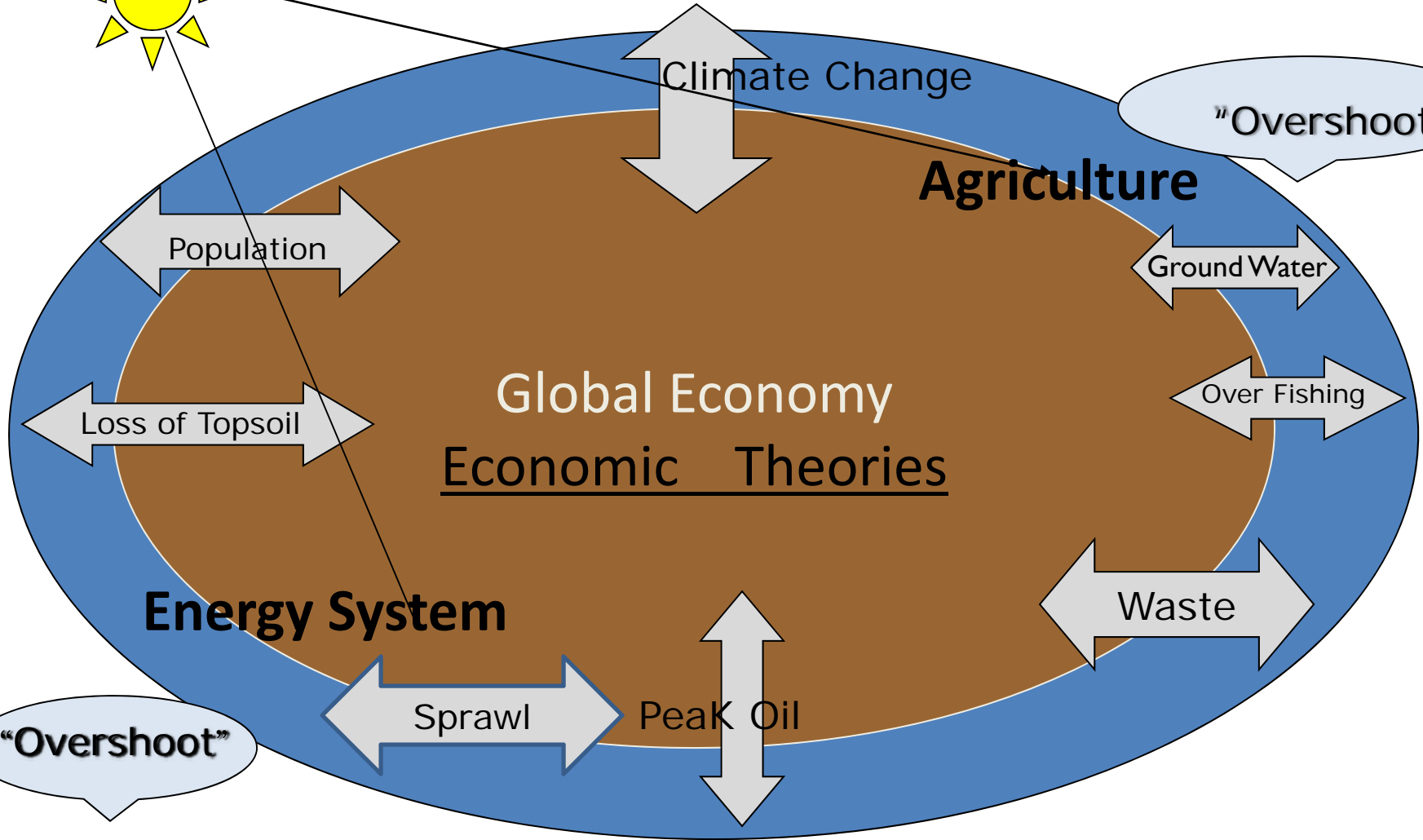
Energy System

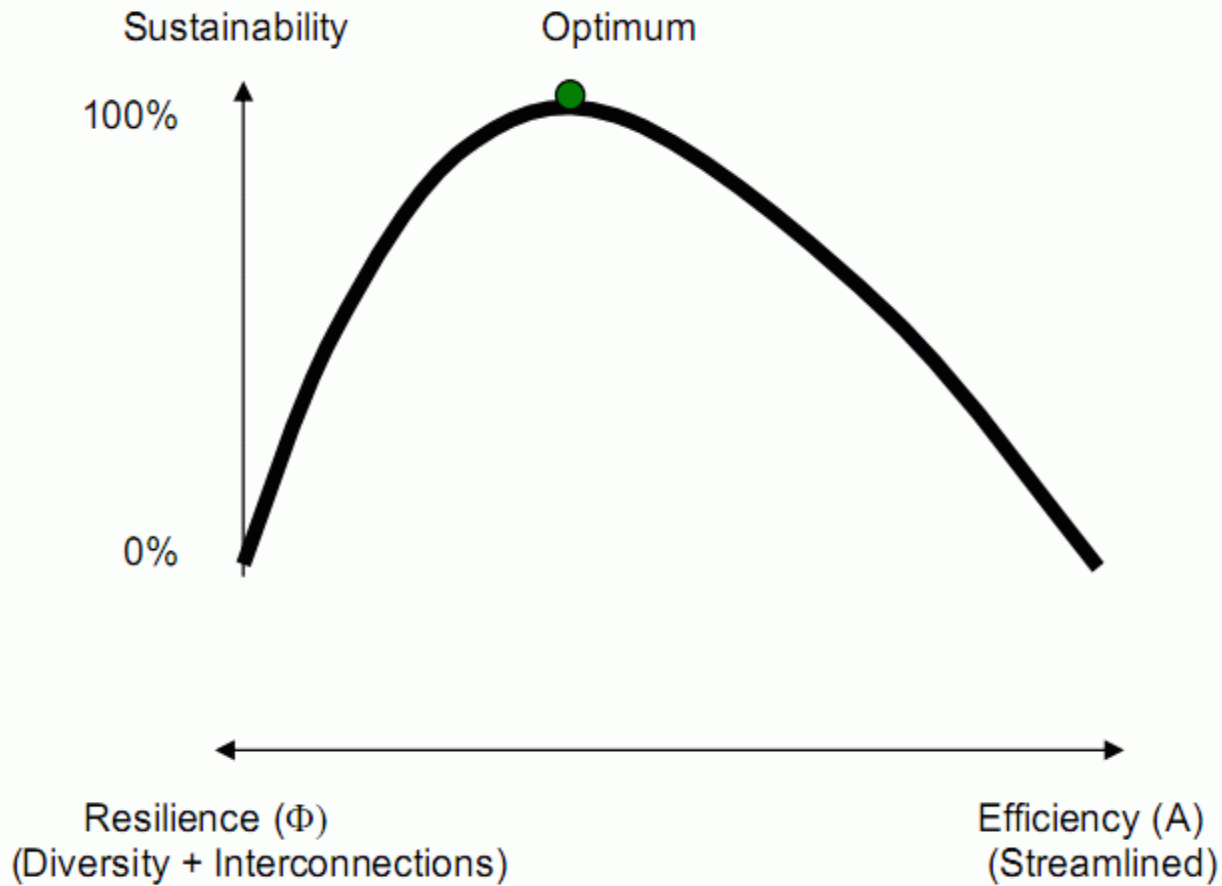
Sprawl

Peak Oil

"Overshoot"

Sustainable ?





Nature Selects for the Optimal Balance

Limits to Growth ?

We must ask the obvious question when our society postulates limitless growth.

Continual Growth is not possible unless the biosphere expands! It does not!

A theory that worked when the world was relatively “empty” simply cannot be compounded into the future.

Can we revise our approach?

The Human Energy Dilemma



- We are the largest consumer of energy to maintain life among living creatures.(1600 cal/day)
- Modern Western Society is the biggest per capita user of energy.
- For the first time since the 18th century when we were seeing our forests decimated by over cutting for fuel , fiber and shelter we are facing the unsustainable nature of our extractive natural resource based society

A Sustainable Energy Future?



- 80% of primary energy in the Global Economy comes from fossil fuels.
- 2/3 of the remaining oil supply is in the Middle East
- All of the CO₂ from this combustion is released directly to the atmosphere.

CO₂ in Atmosphere=

Global Warming

=Climate Change

A Sustainable Energy Future?



- Population growth and rising affluence are driving a staggering rate of increase in energy use!
- **Chindia!**
- Energy efficiency index (GDP/Energy Use) has been increasing at 1% /year in the developed world. Even with this improvement world energy use is projected to increase 4X this century.
- Addressing the problems of resource limits and climate change it is estimated this increased efficiency needs to move to 2%/year just to maintain if we plan to receive the same level of energy services!

A Sustainable Energy Future



- Challenge to all of our natural science and engineering expertise
- Sociopolitical, economical, cultural dimensions confound the landscape
- Twofold dynamic of improving the developing world and converting the developed to sustainable practices
- Human needs vs. economic growth vs. natural capital

Our fossil fuel dependence demands an entirely new trajectory.

A Sustainable Energy Future



- We must know HOW and IF CO₂ from fossil fuel combustion can be economically captured and sequestered or safely stored.
CCS
- Can bio fuels production be increased without diminishing our food supply and further increasing the environmental degradation present in agriculture? **Cellulosic Ethanol ?**
- Can Solar Power's efficiency and economics be improved? **13% ?**
- Can nuclear energy be made safe and the issue of waste storage addressed? **NIMBY ?**

Clean Energy Jobs and American Power Act



- **The New Energy Bill.....**
- **20% by 2020**
- **Cap and Trade /Pollution Reduction and Investment**
- **RPS**
- **How will it Affect Us??**

The Bill and North Carolina



- Reduce the diseconomy of fossil fuel dollars leaving the State
- Energy security because of reduced dependence on outside energy sources.
- An economic revival through the green economy as North Carolina leads the nation in this effort.
- A safer healthier North Carolina for our children and grand children.
- Reduce the economic dislocation as sea level rises on our coast and inner banks.

The Energy Numbers for North Carolina



- We import \$7.4 billion worth of coal and \$9.15 billion of petroleum products. *1
- Energy Efficiency can save North Carolinians \$7.85 billion over the next 20 years assuming only .83% of our annual electric consumption.*1
- We have 55,000MW of potential wind capacity off the coast 130% of our total electric consumption.*4
- Our biomass capacity for electric power and cellulosic ethanol is quite large.

NC Senate Bill 3



- NC is the first state among the 28 states adopting a Renewable Energy Portfolio Standard to include energy efficiency as a component of that standard.
- Energy efficiency is the most economic means to reduce CO2 emissions .
- As North Carolina increases it's renewable power and increases energy efficiency in electric power consumption to 12% envisioned in the bill it reduces the outflow of fossil fuel dollars by a like amount, nearly \$1 billion annually.

Why NC Benefits from this Bill



- Reducing the outflow of the nearly \$17 billion dollars which leave the state each year for coal and petroleum to 1990 levels we will go beyond our Senate Bill 3 and keep billions of dollars at home each year to be used in our communities creating jobs and purchasing local goods and services.
- Our health care costs will decrease as the millions of tons of coal burned each year decreases.

Energy Efficiency



- **Energy Efficiency** is using less primary energy, either electricity or transportation fuel and maintaining the same level of energy services vs. **Energy Conservation** is using less primary energy and receiving less energy services.
- **Energy Efficiency** will be the first and “lowest hanging fruit” in the competition to reduce carbon.
- McKinsey Global Institute reports returns of 17% on dollars invested in energy efficiency.
- North Carolina can reduce energy use 14% by 2017, saving \$1 billion in that period enough to power 880,000 homes.*5
- Energy Efficiency dollars invested will put the building trades back to work and the \$7.4 billion in 20 years referred to earlier will be accelerated by ACE&S.
- EPRI estimates that demand reduction through energy efficiency will equal coal and natural gas generation by 2025 under ACE&S.*2

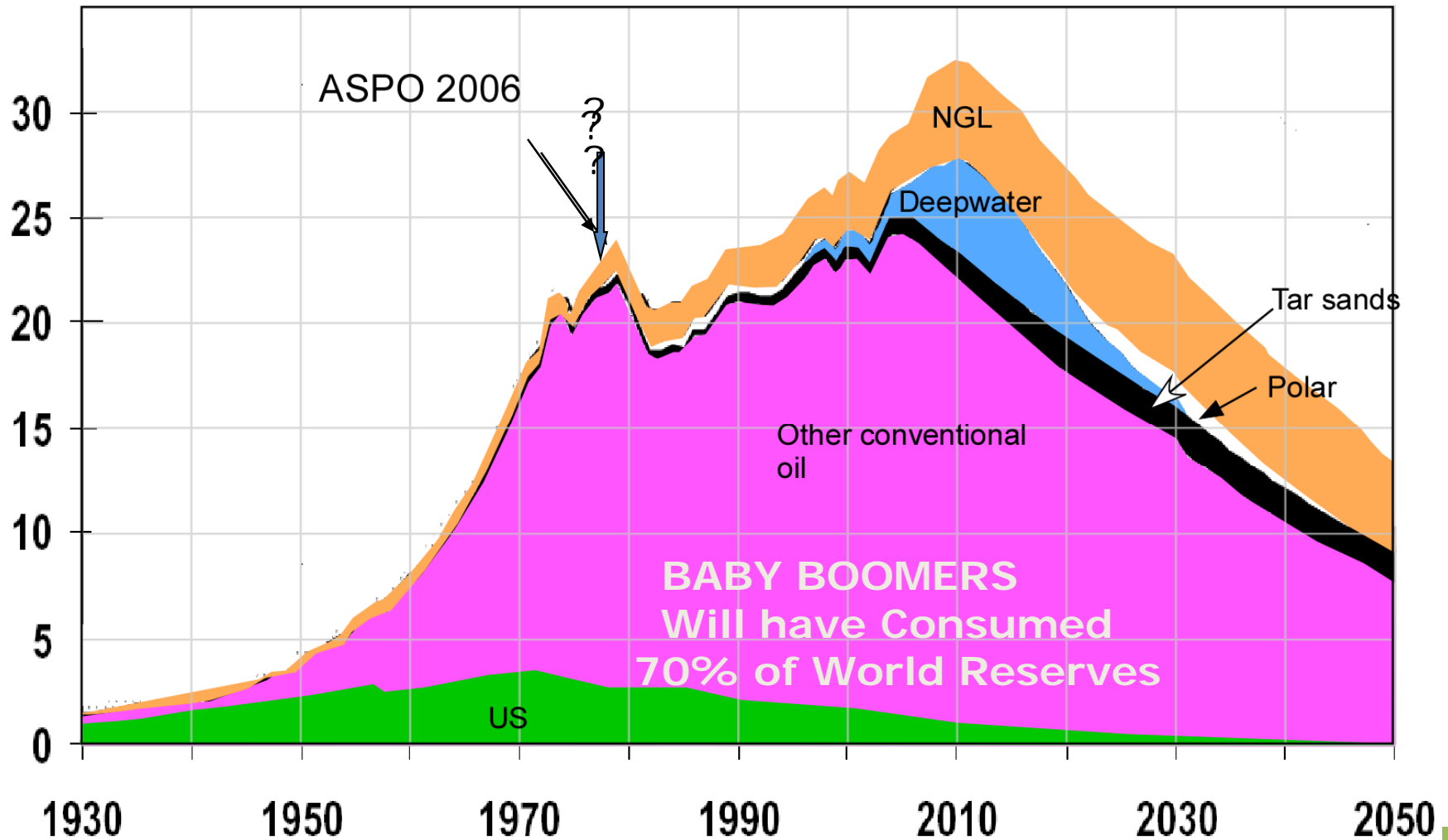
Wind



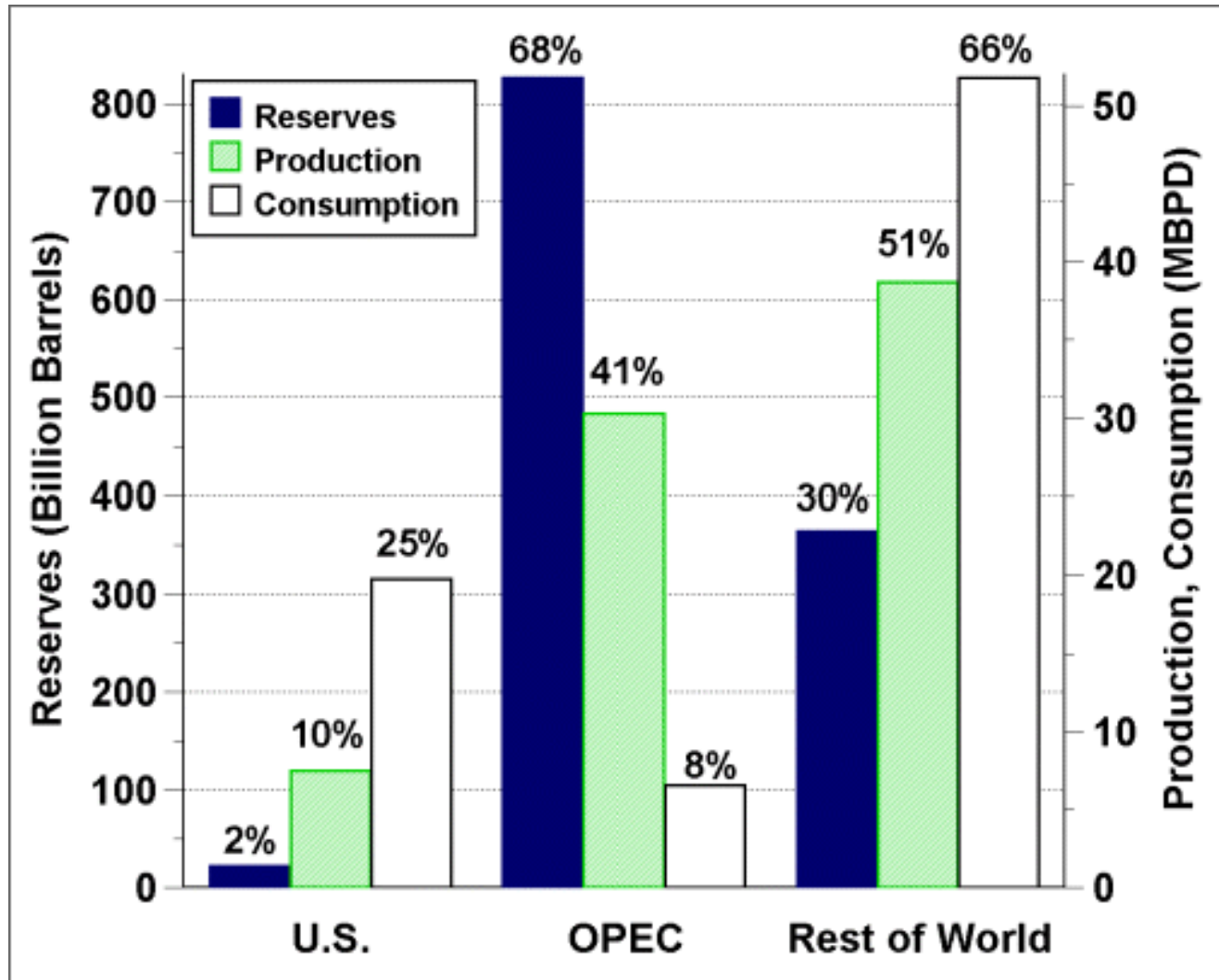
- UNC in there recent wind study presented at Buxton on September 25th indicates a wind resource of 55,000 MW, or 130% of NC present usage.
- Also stating that if we used less than 20% of this resource or 10,440 MW the economic impact over the next 20 years:
- \$22.2 billion
- 45,000 local jobs during construction
- 9,100 local long term jobs.
- 74.7 billion gallons of water & 135 million tons of CO₂.^{*4}

Historical Phenomena!!!!

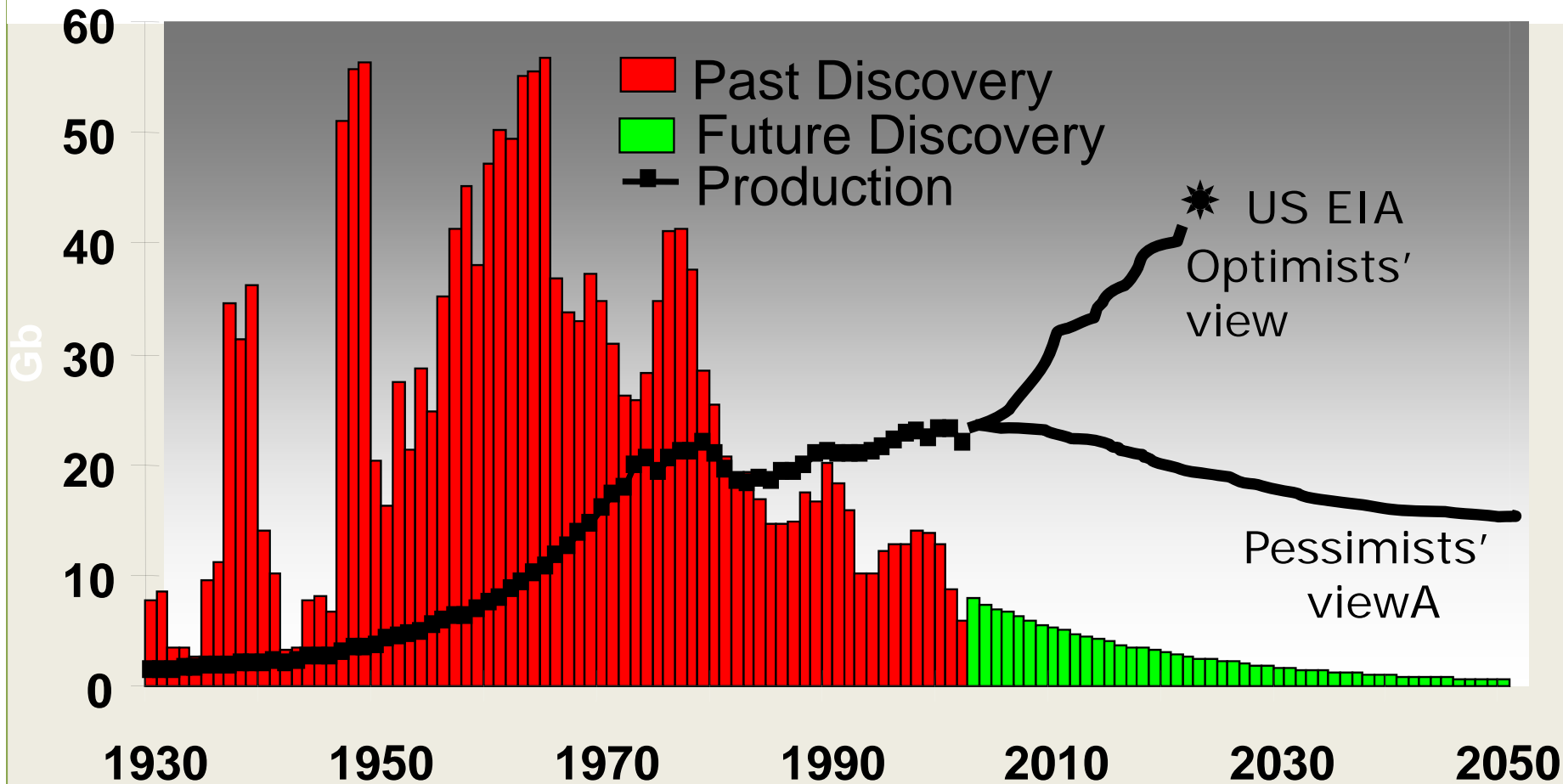
Billions/year



World Oil Reserves, Production, and Consumption



PEAK OIL ??



Agriculture and Energy



- **Green Revolution**
- **New Wheat and Rice Varieties Responsive to Nitrogen**
- Since 1962 the population of Asia has more than doubled from 1.6 to 3.9 billion people
- Rice production has increased by 170%
- Land use for agriculture grown by 30%
- Real price of rice has declined by 50%

Linkage Food and Energy



Guano Island Act of 1857

and

Nobel Prize for Chemistry

in

1918 and 1932

Guano Island Act



Whenever any citizen of the United States discovers a deposit of guano on any island, rock, or key, not within the lawful jurisdiction of any other Government, and not occupied by the citizens of any other Government, and takes [peaceable possession](#) thereof, and occupies the same, such island, rock, or key may, at the discretion of the President, be considered as appertaining to the United States.

Haber-Bosch Synthesis

$N_2 + H_2 = \text{Bio-reactive ammonia}$



- Commercial production of reactive nitrogen (ammonia) begins in 1913
- Early production devoted to explosives in WWI
- Large scale use as fertilizer begins in inter-war years

**Nitrogen Fertilizer Production
&
Population Growth Linked
an
Observable Pattern**

Food Production

and therefore

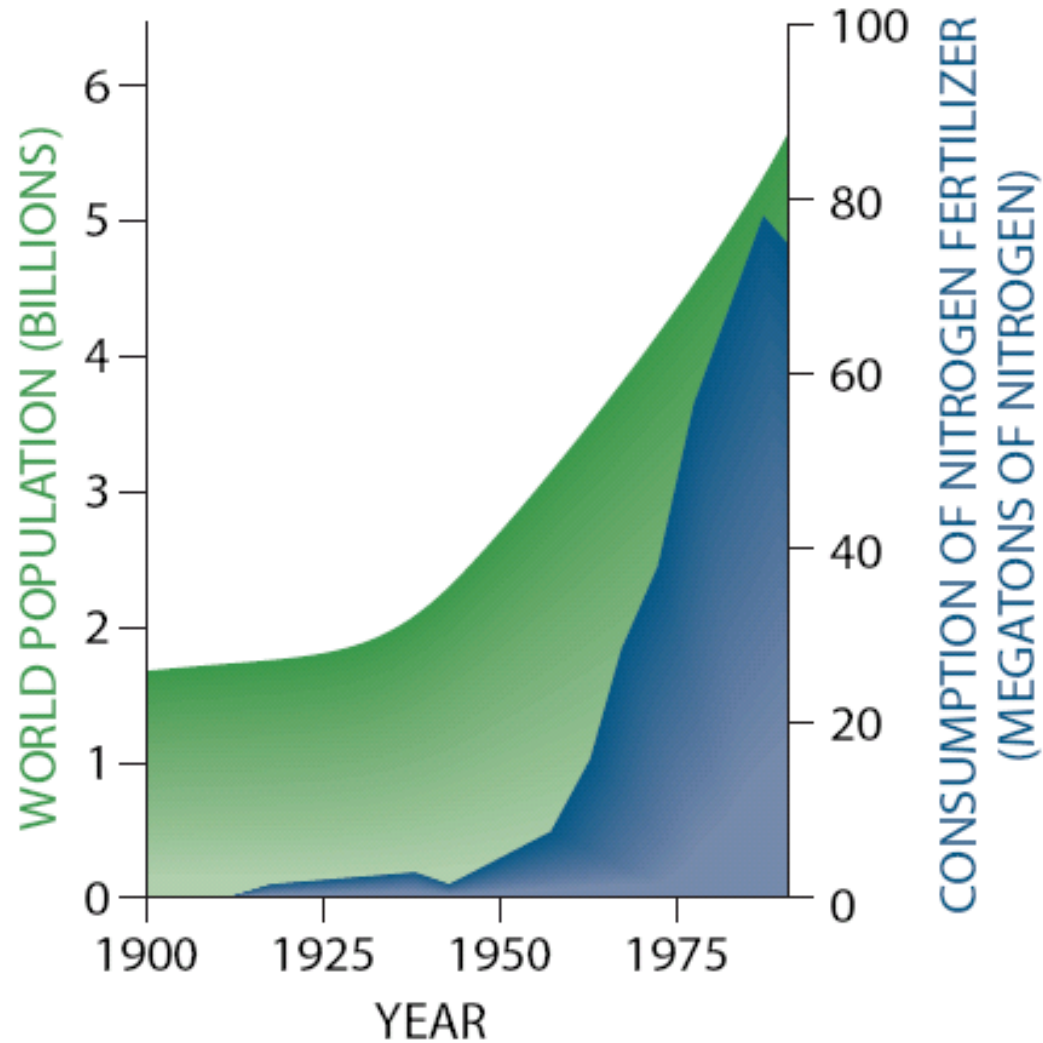
Population

WERE

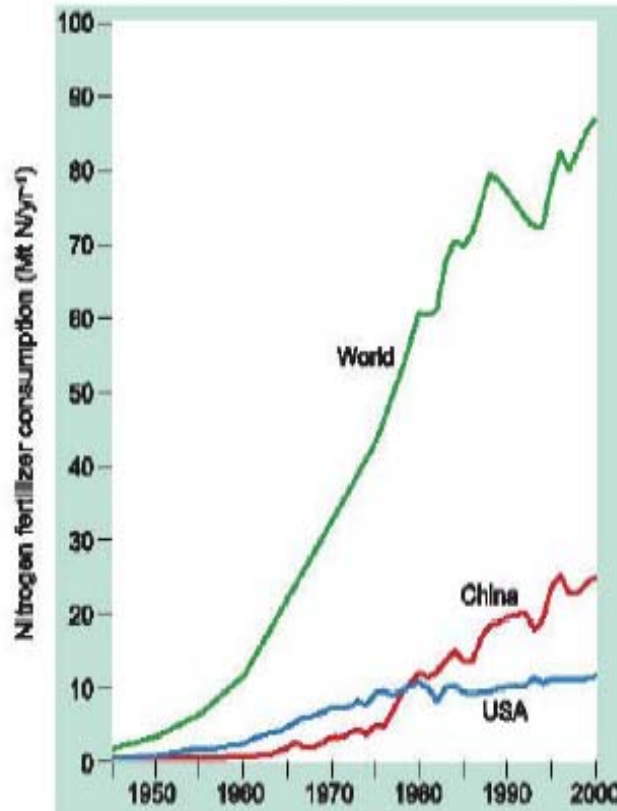
limited by the

Natural Nitrogen Cycle

LINKAGE ENERGY-FOOD-POPULATION



LINKAGE



More than half of the food eaten by the world's people is produced using N fertilizer from the Haber-Bosch process

Smil (2001), in Galloway and Cowling (2002) *Ambio* 31:64-71

**1/3 of the Protein In the Human
Diet Derived Directly from
Nitrogen Fertilizer produced in
the Haber-Bosch Synthesis**

Dependency??



Sustainable??

The Perfect Storm

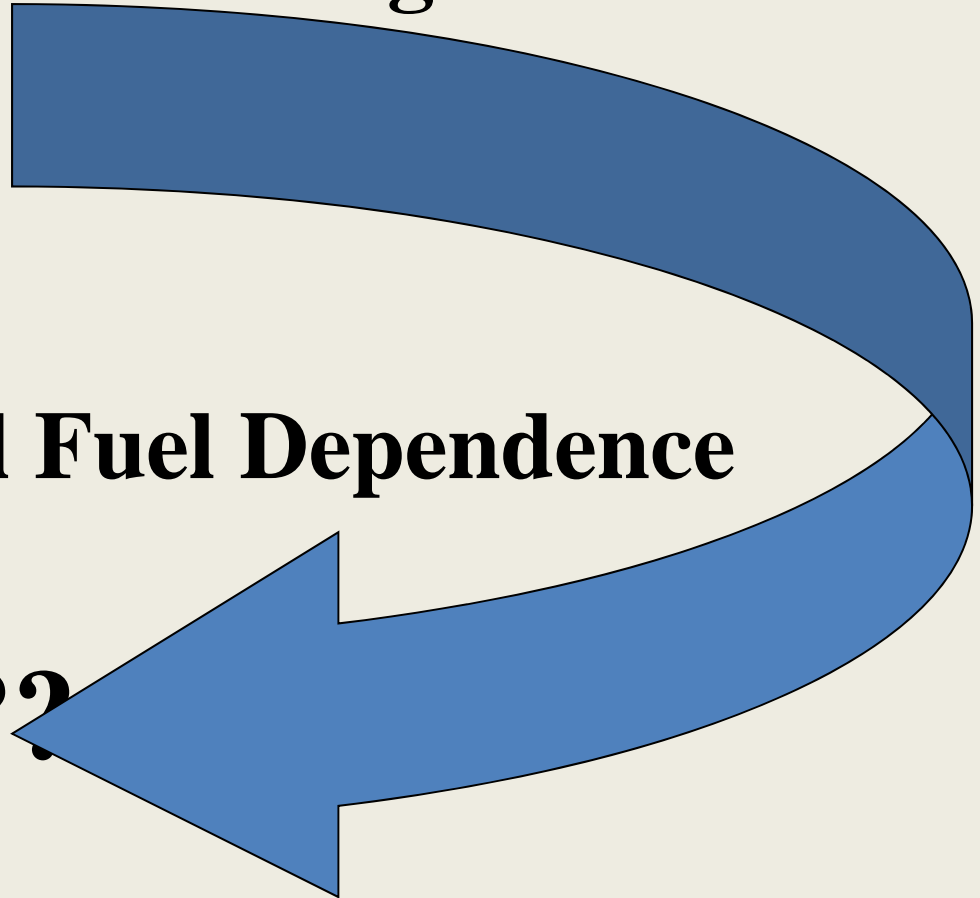


Industrial Monoculture Agriculture

Climate Change

Peak Oil ----- Fossil Fuel Dependence

Unsustainable??



A Marriage of Agriculture and Ecology



***Agriculture is a process approach.
Nature is a whole systems approach.***

*It is possible to have an agriculture which is
managed as a SYSTEM!*

*Valuable sustainable agronomic practices serve as
an intermediate step toward*

Natural Ecosystems



- *low level of soil loss*
- *diverse assemblages of species coexisting*
 - *in dynamic equilibrium*
 - *dominant perennial plant species*
- *are adapted to local soils and climate patterns*
 - *exclusively solar energy source*
 - *internal recycling of nutrients*
 - *net production equal to respiration*
 - *biomass in a steady state*

A New Paradigm?



- **Leadership**
Policy, Business, Education, Church
- **Context Must be Redefined**

Today...narrowly defined to suit short term accounting period
Tomorrow.. A systems approach , must price the externalities,time appropriate to the system
- **Form Circular vs. Linear**
- **Authorizing Focus**

Leadership



- **Policy reforms** which return government to providing for the health and welfare of the citizenry, not the profitability of special interest
- **Education** must foster creativity and the questions.
- **Conservation and Environmental** interest groups must focus on this nexus of Agriculture & Energy
- **Research must be focused** on breaking free of fossil fuel dependence

Context



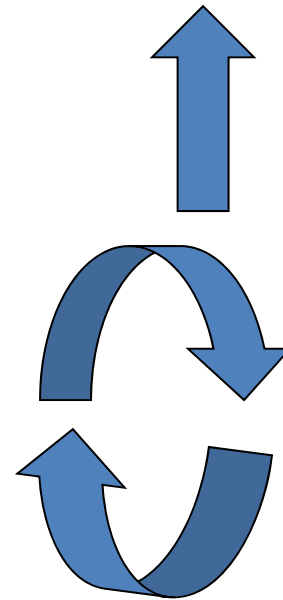
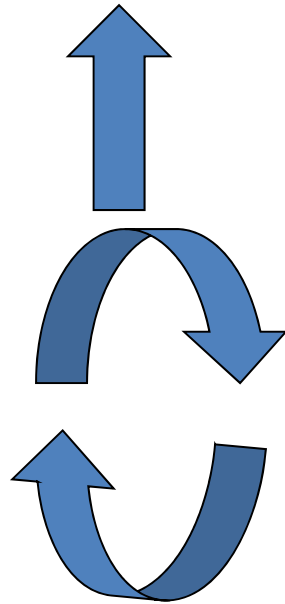
- Challenge Classical Economic Theory
- Internalize the Externalities
- Challenge GAAP accounting
- Expand our definition of property rights. e.g.. air, ground water, the oceans.
- When a scarce resource is free poor decisions around the use of that resource abound.
- Regulation vs Tax

FORM

Bio -cycle

Techno-cycle

Circular



Extract

Dump



Linear Processes

Authorizing Focus



- Properly functioning markets allocate resources efficiently but they can not determine sustainable scale and they must have intelligent regulation
- That can be achieved only through effective public policy

“The prosperity that the first world enjoys at present is based on spending down its environmental capital, calamity could come quickly: A society’s steep decline may begin only a decade or two after the society reaches its peak numbers, of wealth and power”

“Collapse” Jared Diamond

Thank you!