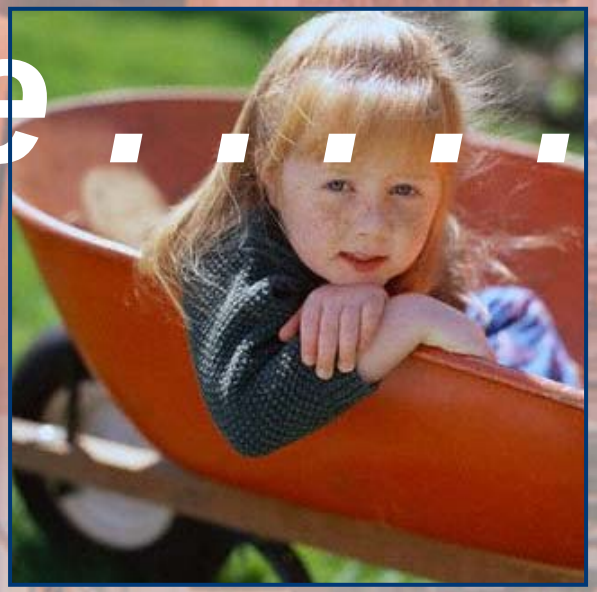
# Building Partnerships

. . . . . Ima . . .


# to Develop Energy Solutions

# A Prosperous Energy Future

Working Together...



# A Prosperous Energy Future



# Increasing Energy Efficiency

## Business and Industry

# Increasing Energy Efficiency in Business and Industry

| | | | |
|---|---|---|---|
| **Hybrid Technology** | **Consumer Goods from Biomass** | **Powered by Fuel Cells** | **Solar Manufacturing** |

# Producing Renewable Energy and Products

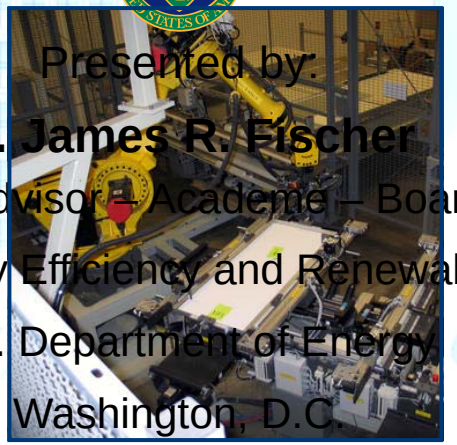



# Producing Renewable Energy: Present Situation, Future Opportunities, & Strategies

Presented to:

**Alternative Energy 2006;**
**Diversifying Risk in a Challenging Environment**

Louisiana State University
Baton Rouge, LA




Presented by:

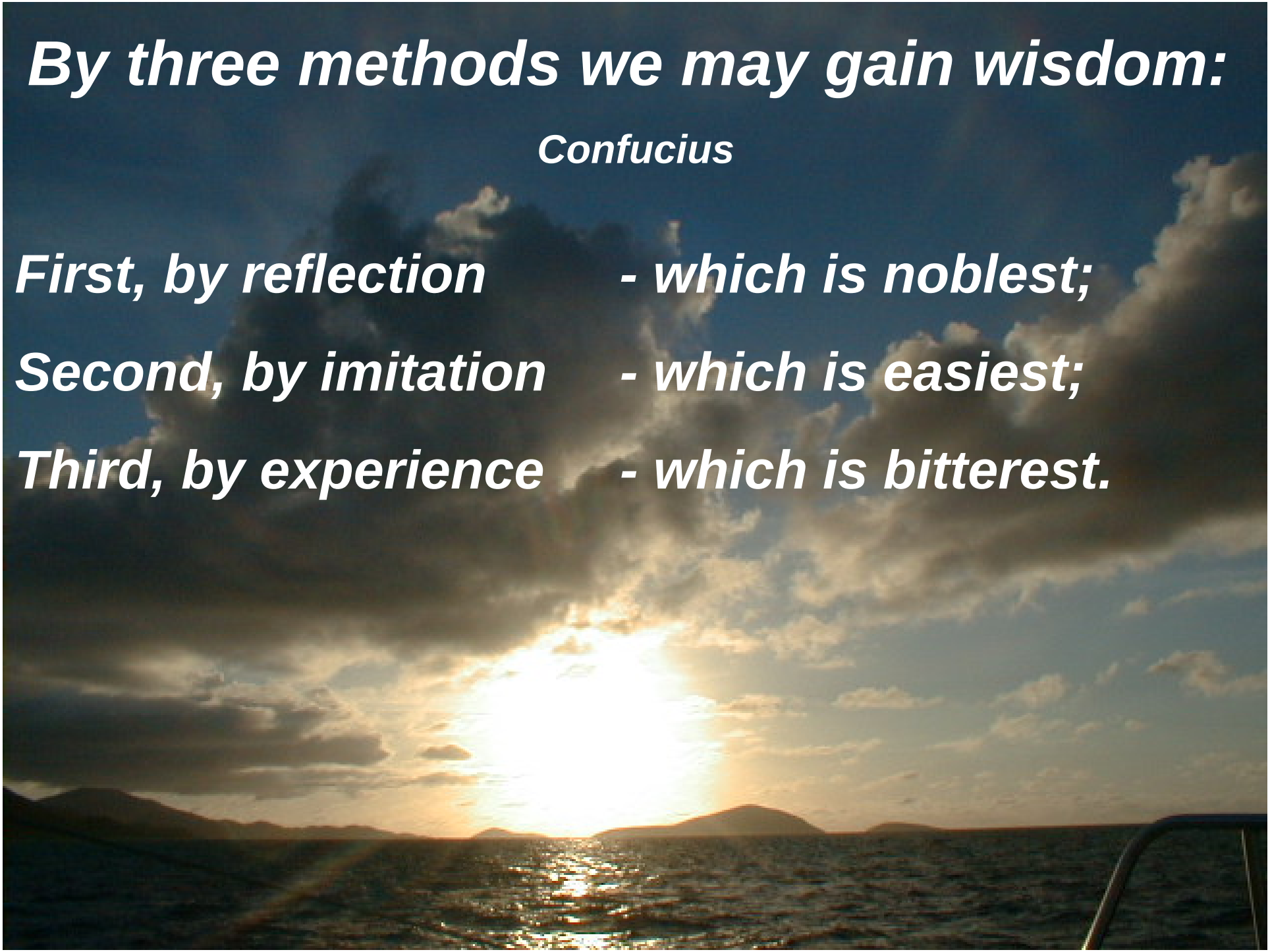
**Dr. James R. Fischer**

Senior Technical Advisor – Academe – Board of Directors

Office of Energy Efficiency and Renewable Energy

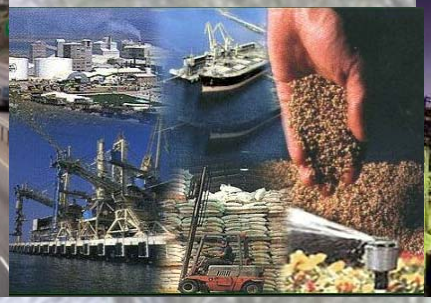
U.S. Department of Energy

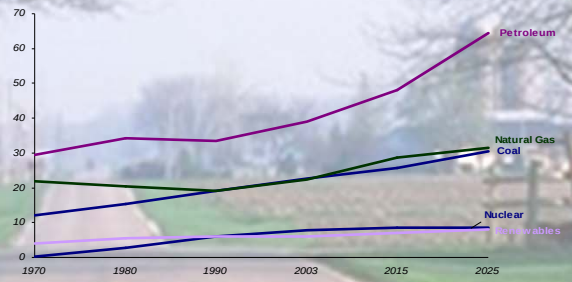
Washington, D.C.


By three methods we may gain wisdom:
Confucius
First, by reflection - which is noblest;
Second, by imitation - which is easiest;
Third, by experience - which is bitterest.

# We Can Gain WISDOM by Reflecting and:

**Exploring the Present Energy Situation**






**Visioning a Prosperous Energy Future**

**Developing Strategies**

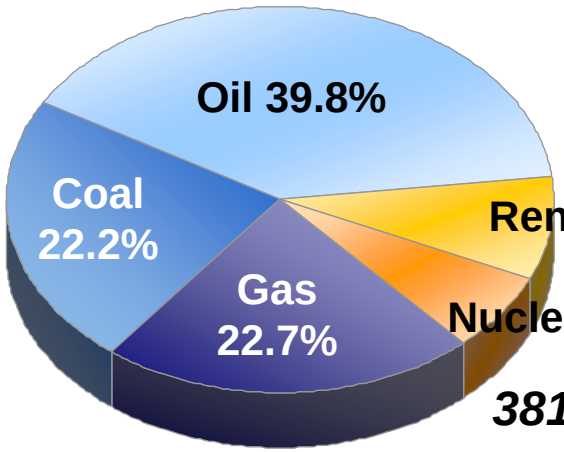
# Exploring the Energy Situation

## World Consumption of Energy Will Increase

**Fossil fuels provide 84.7% of world energy consumption**

**Fossil fuels projected to provide 87.1%**

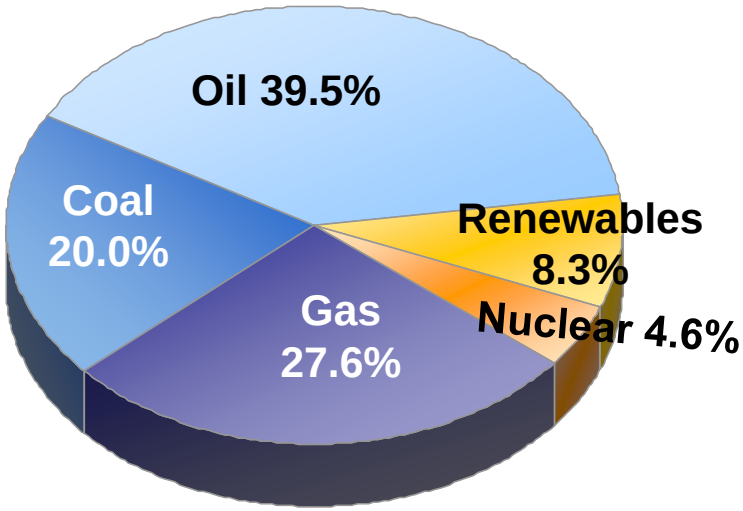
**1999**




***381.9 Quads Total***

**+60%**

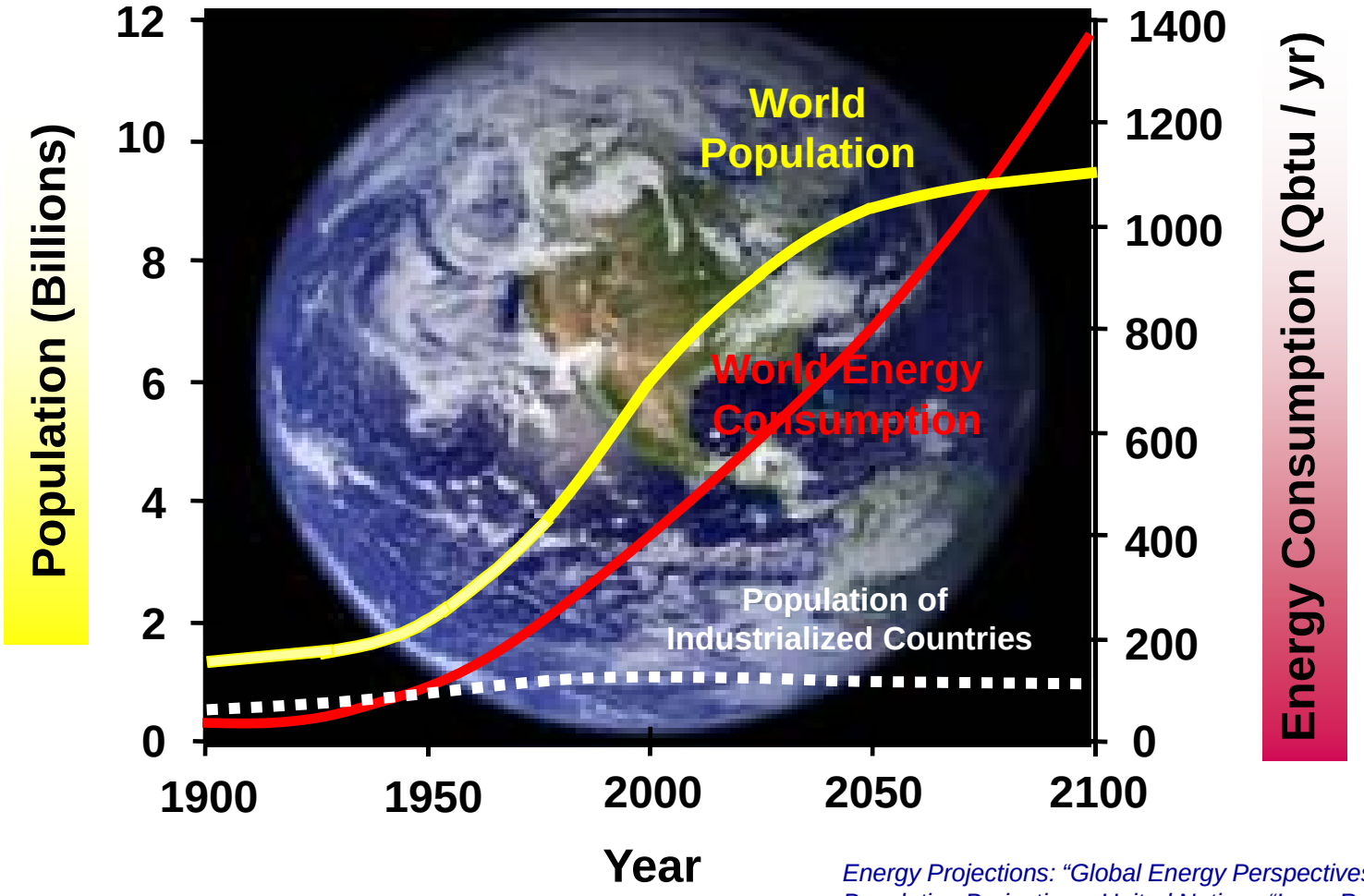
**2020**




***611.5 Quads Total***

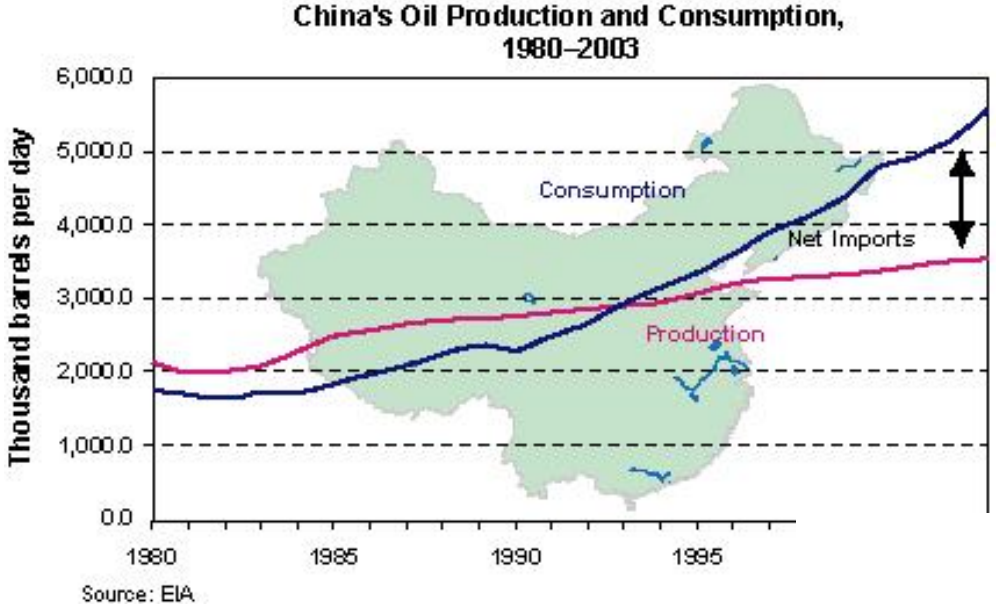
Source: *International Energy Outlook 2002*, Table A-2, p. 181.

# Exploring the Energy Situation




*Energy Projections: "Global Energy Perspectives" ITASA / WEC*
*Population Projections: United Nations "Long-Range World Population Projections: Based on the 1998 Revision"*

# Exploring the Energy Situation



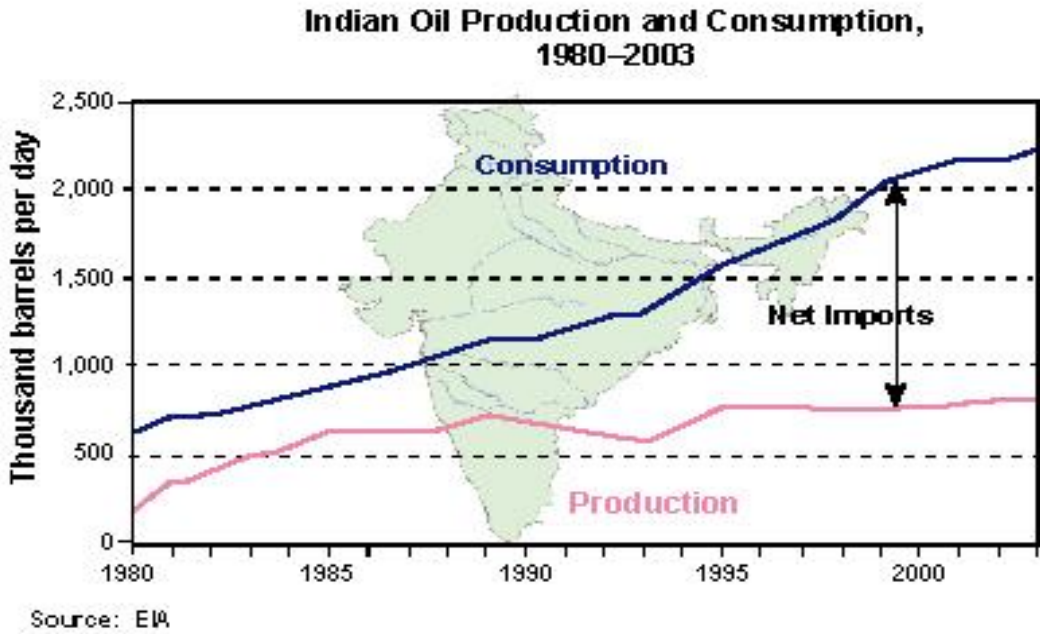

## China

**10.9 (million barrels per day)**

## India

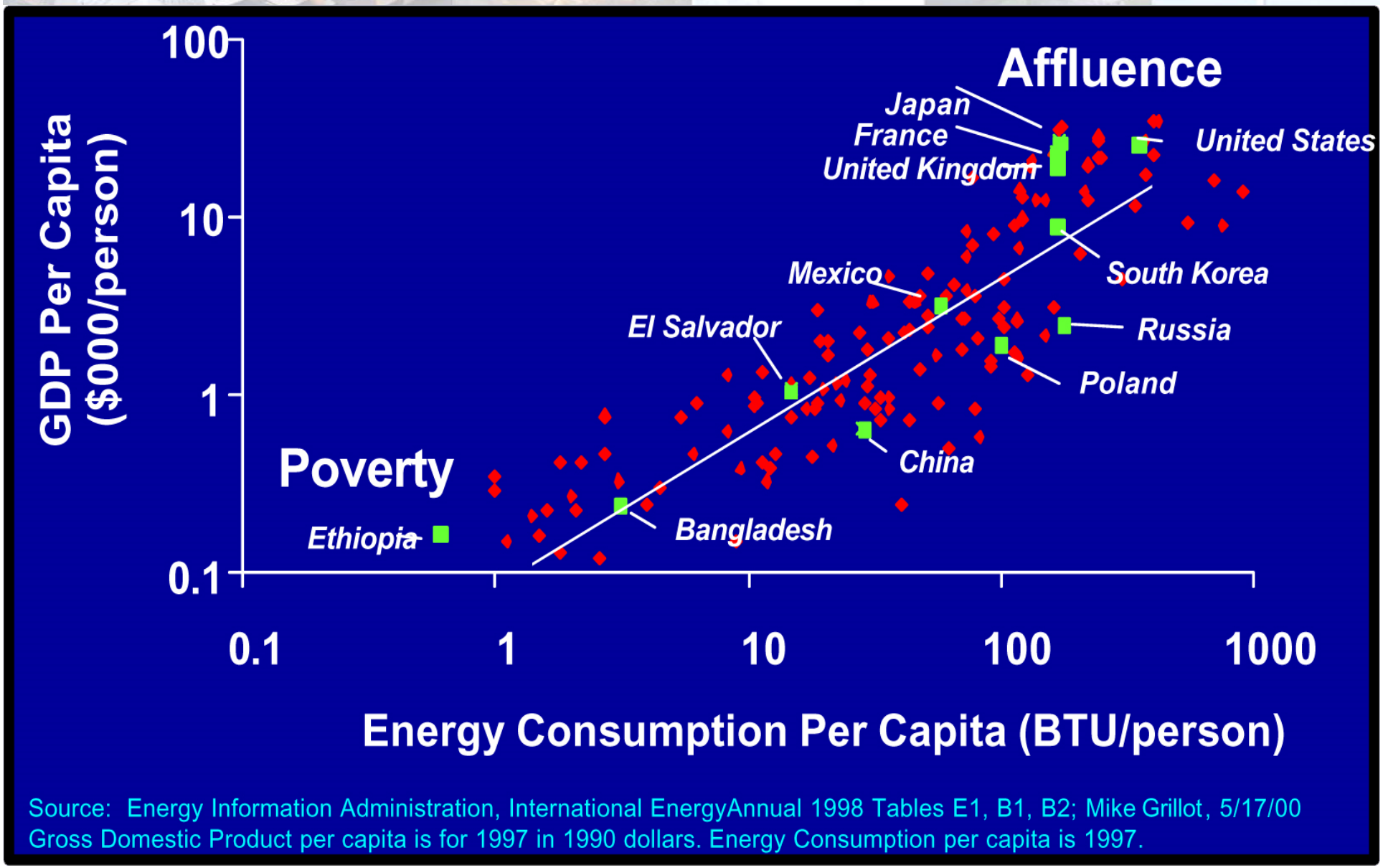
**5.5 (million barrels per day)**

# 2025 Oil Projections China/India



# Exploring the Energy Situation

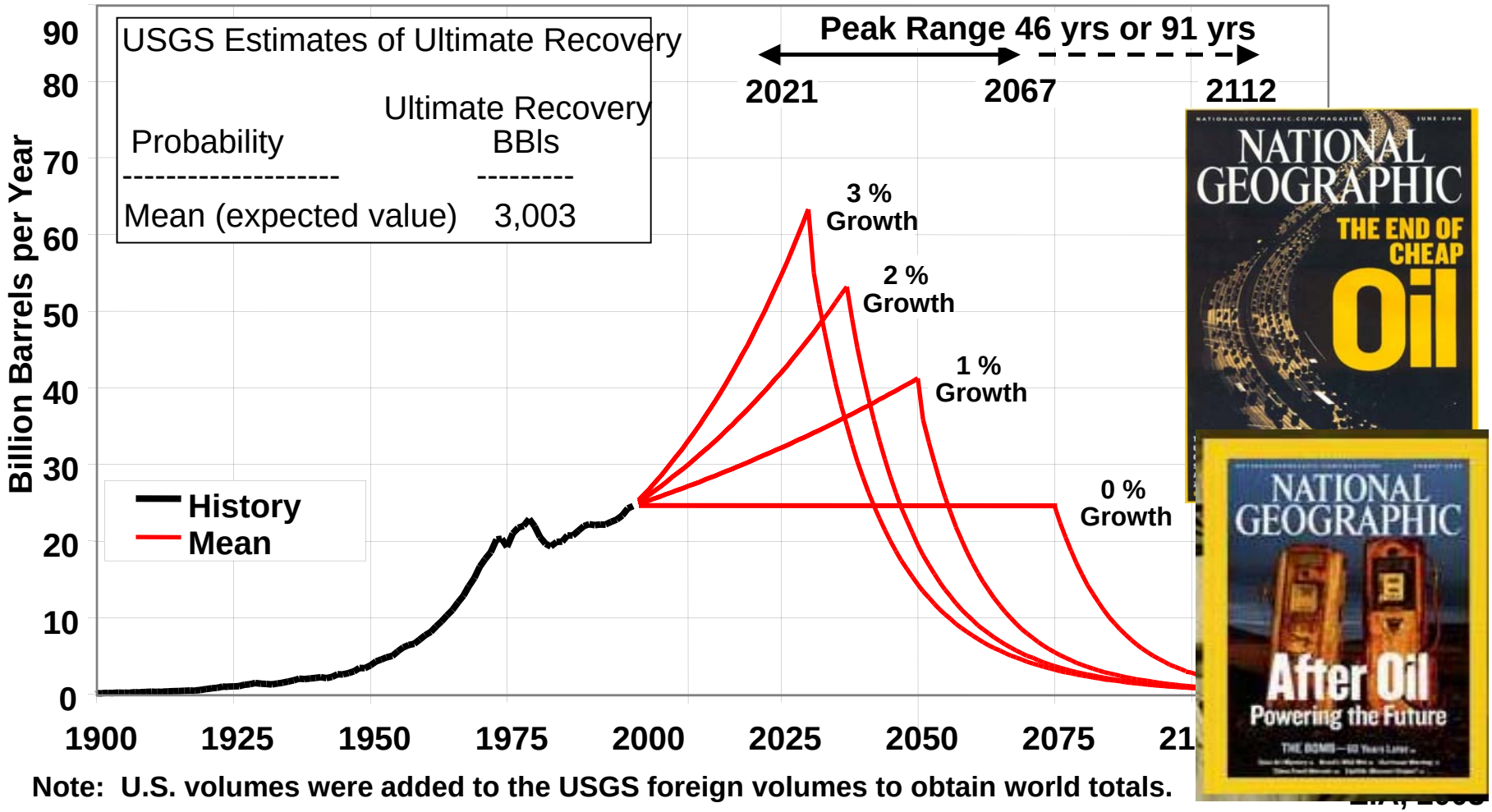
## Energy Consumption and Affluence are Linked




Source: Energy Information Administration, International EnergyAnnual 1998 Tables E1, B1, B2; Mike Grillot, 5/17/00
Gross Domestic Product per capita is for 1997 in 1990 dollars. Energy Consumption per capita is 1997.

# Exploring the Energy Situation

## EIA World Conventional Oil Production Scenarios




**Note: U.S. volumes were added to the USGS foreign volumes to obtain world totals.**

# So why should you care?

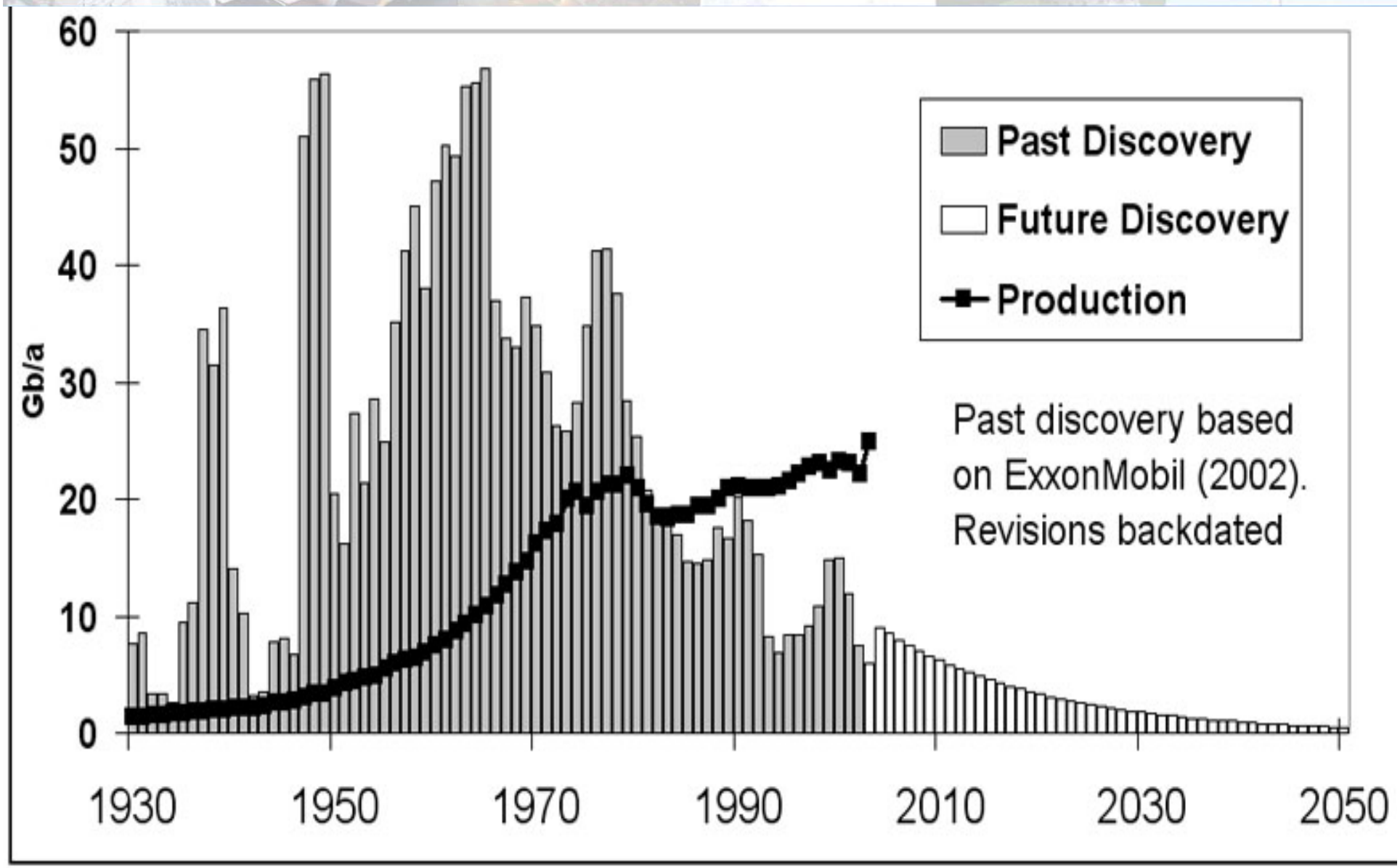
**It took 125 years to use the first trillion barrels of oil, We'll us the next trillion in 30 years.**

**In 20 years the world will consume 40% more oil than it does today.**

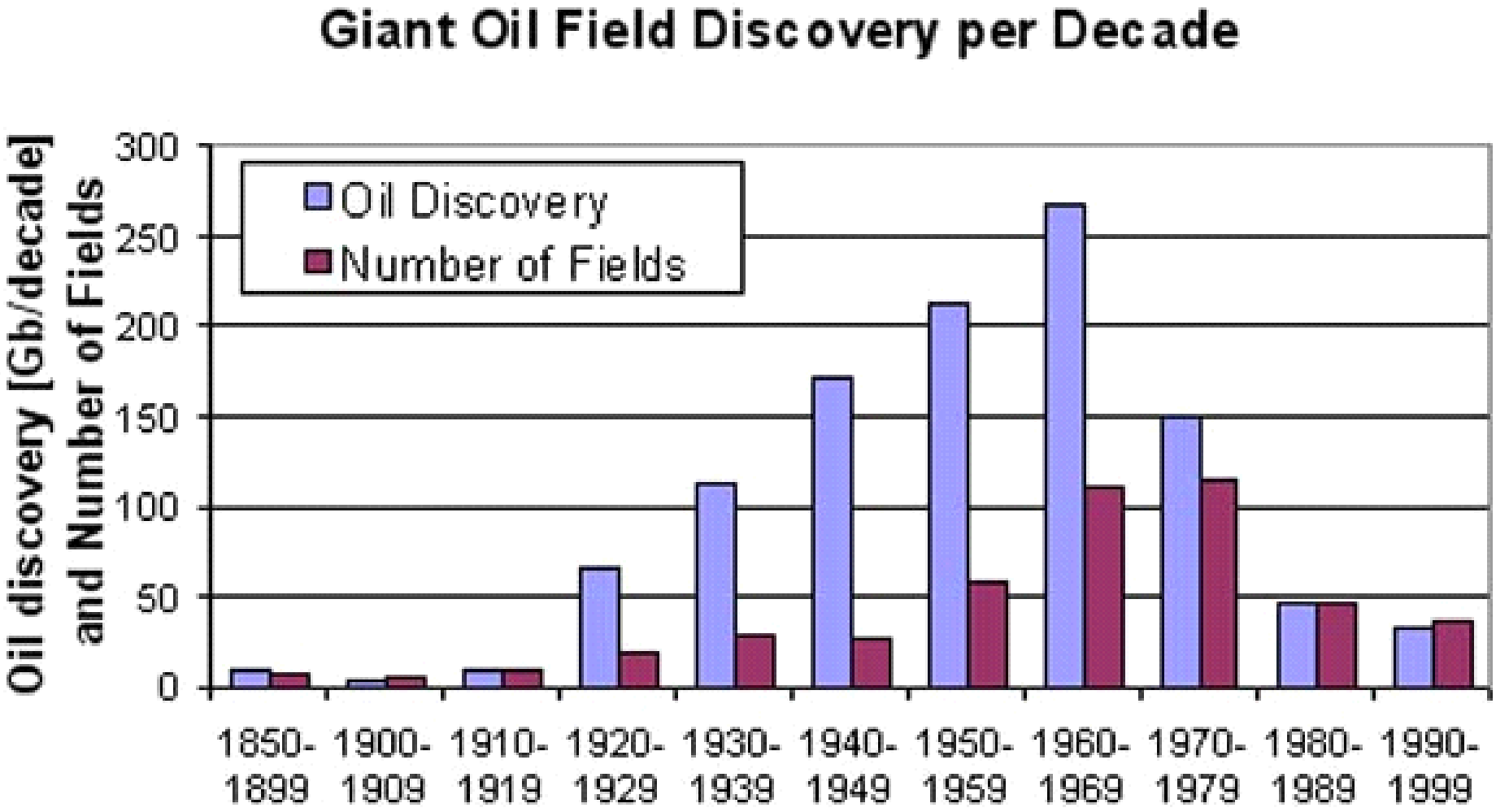
**At the same time many of the world's oil and gas fields are maturing.**

**New energy discoveries are mainly occurring in places where resources are difficult to extract physically, economically and politically.**

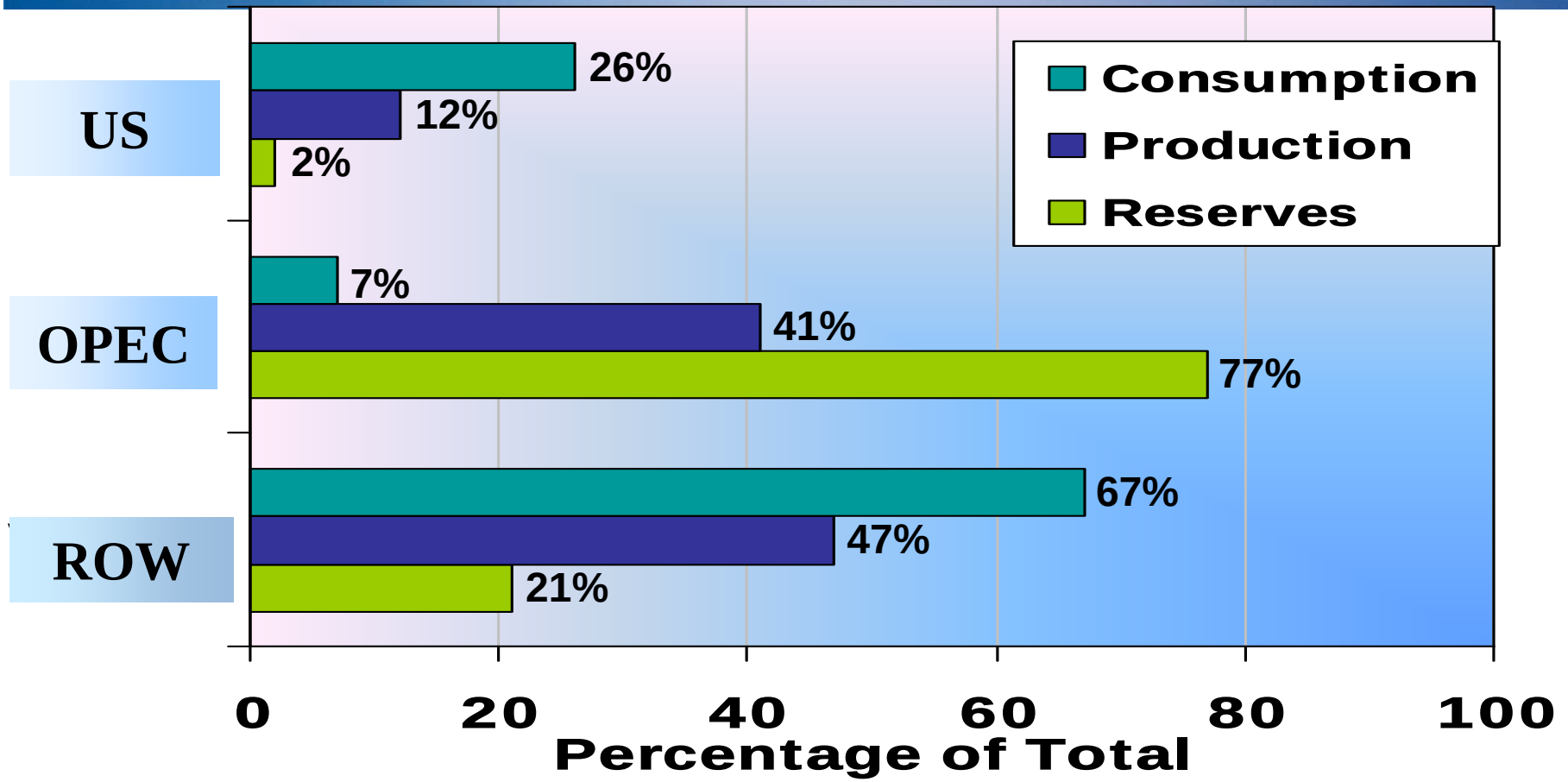
# Exploring the Energy Situation



# Exploring the Energy Situation



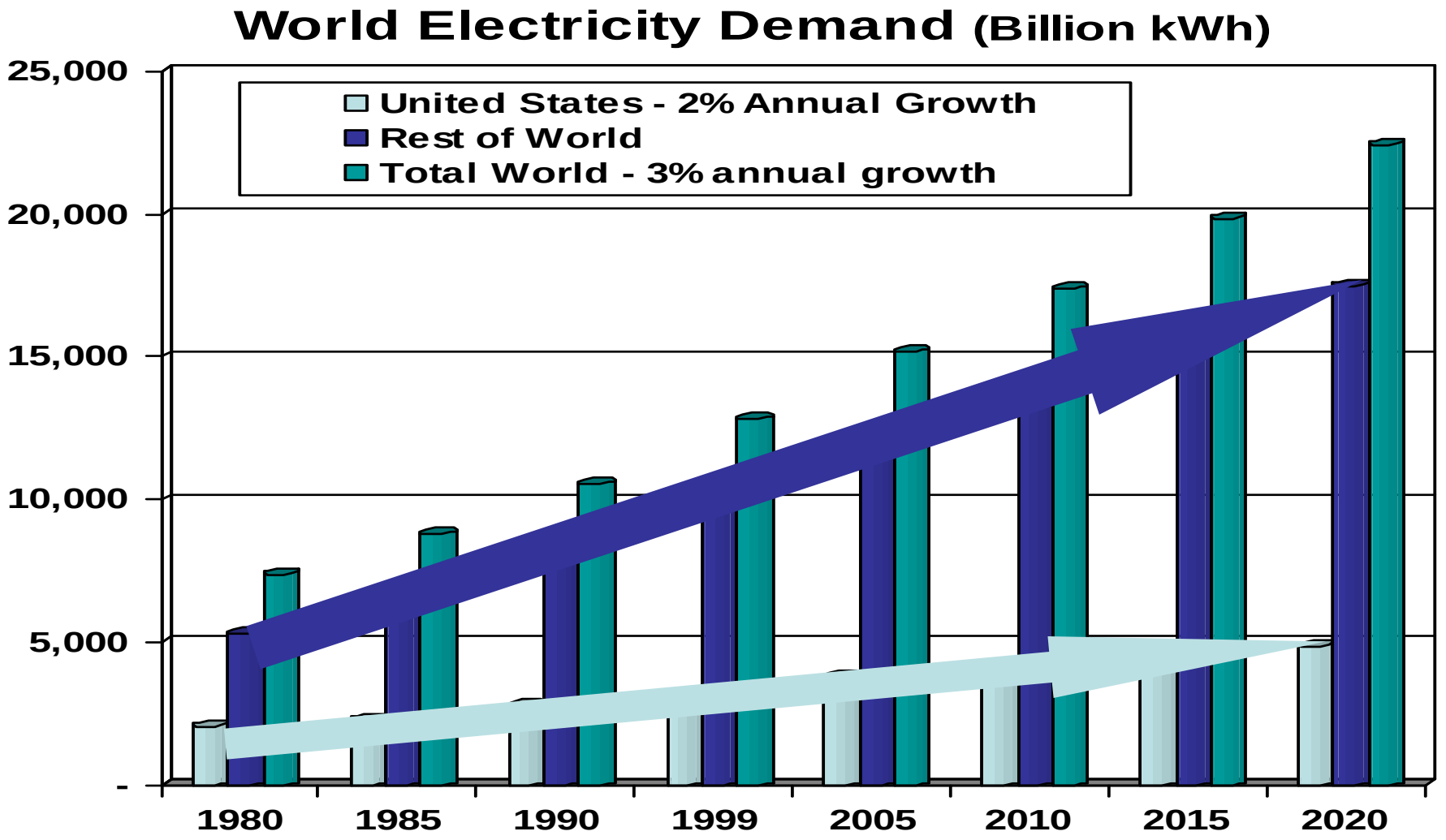
# Exploring the Energy Situation




## Global Oil Reserves are Consolidating in OPEC Nations

**Source: DOE/EIA, International Petroleum Statistics Reports, April 1999; DOE/EIA 0520, International Energy Annual 1997, DOE/EIA0219(97), February 1999.**

# Exploring the Energy Situation




Source: *International Energy Outlook 2002*, Energy Information Administration, Table A-9, p. 188, and http://www.eia.doe.gov/pub/international/iealf/table62.xls

# Oil Tycoon T. Boone Pickens

- Doesn’t think global oil production can be increased more than what it is right now
- Says changes won’t happen overnight but they will happen over time
- Predicts three-digit oil prices in a decade
- Says we are going to have to get more efficient because it is inevitable that the cost of fuel will go up
- Predicts Congress will have to pass CAFÉ standards that will force the automakers to make engines that get more mileage per gallon
- As oil prices rise, no question that other energy sources, like renewables and unconventional forms of oil and gas, will be developed

*Key Points from Interview on Morning Edition, National Public Radio January 16, 2006*

# So is this something you should be worried about?

**The world consumes two barrels of oil for every barrel discovered**

**The world has been finding less oil than it's been using for twenty years now**

**Demand set to soar an estimated 40% by 2025**

**The oil and gas we've been finding is coming from places that are tough to reach.**

**By 2020, the number of cars in the world will increase 50%**

**The world consumes 84 million barrels of oil a day**

**Wind, solar and hydrogen can be more viable parts of the energy equation**

# The U.S. Energy Situation

## The Energy Connection Challenges

Money Isn't All You're Saving

### *Economy*

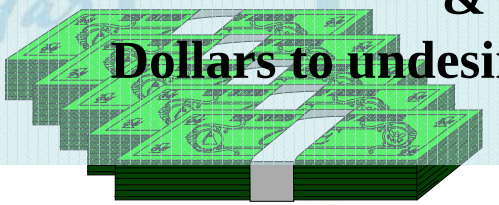
**Economic growth and development**
**Oil Imports cost and volatility**

### *Environment*

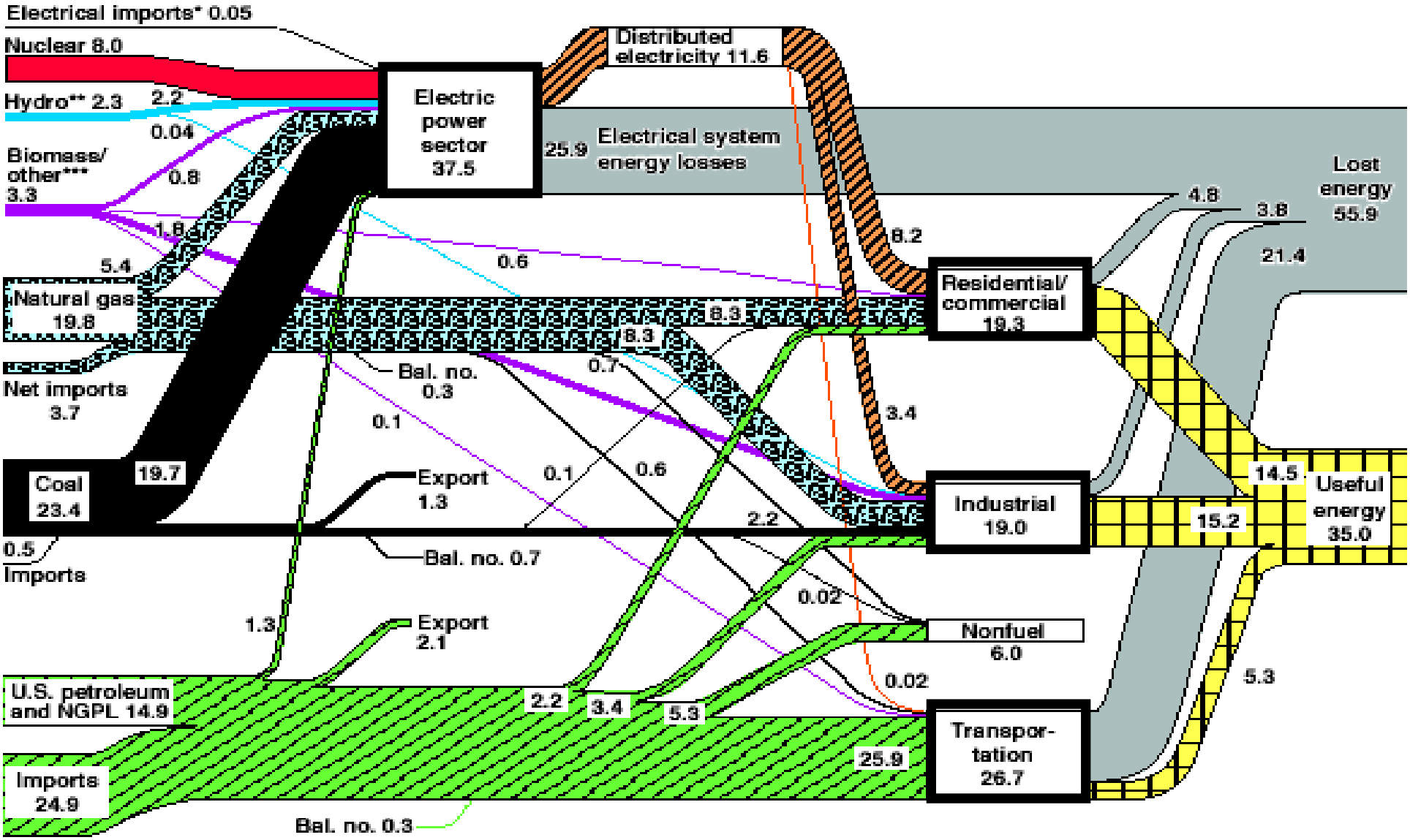
**Air quality—particulates, acid rain**
**Global warming**

### *National Security*

**Dependence on insecure supplies of foreign oil, & increasingly natural gas.**
**Dollars to undesirables. Economic development/political stability**



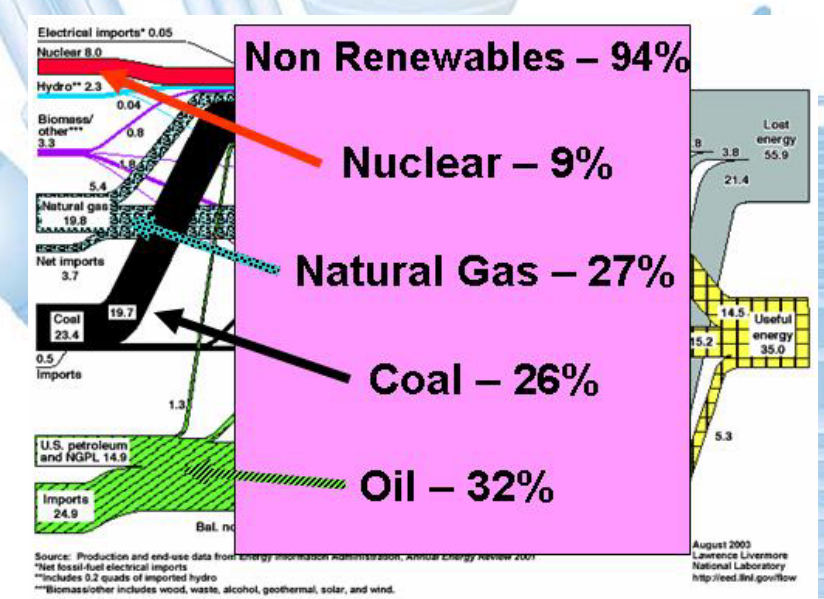
# The U.S. Energy Situation

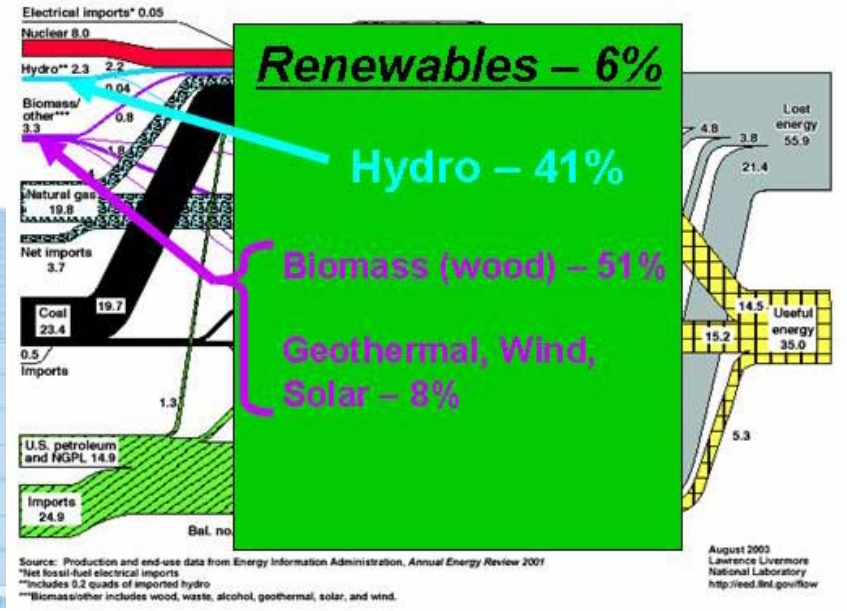


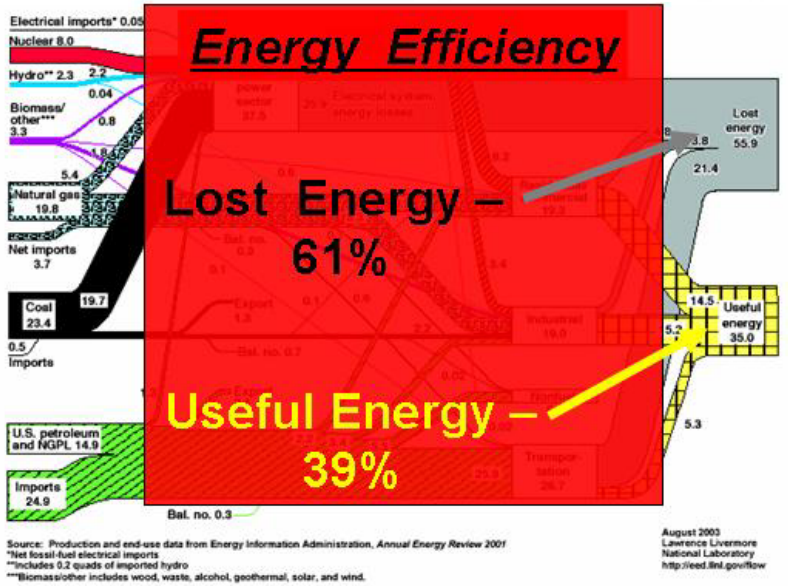

Source: Production and end-use data from Energy Information Administration, *Annual Energy Review 2001*
*Net fossil-fuel electrical imports
**Includes 0.2 quads of imported hydro
***Biomass/other includes wood, waste, alcohol, geothermal, solar, and wind.

August 2003
Lawrence Livermore
National Laboratory
http://eed.llnl.gov/flow

# The U.S. Energy Situation



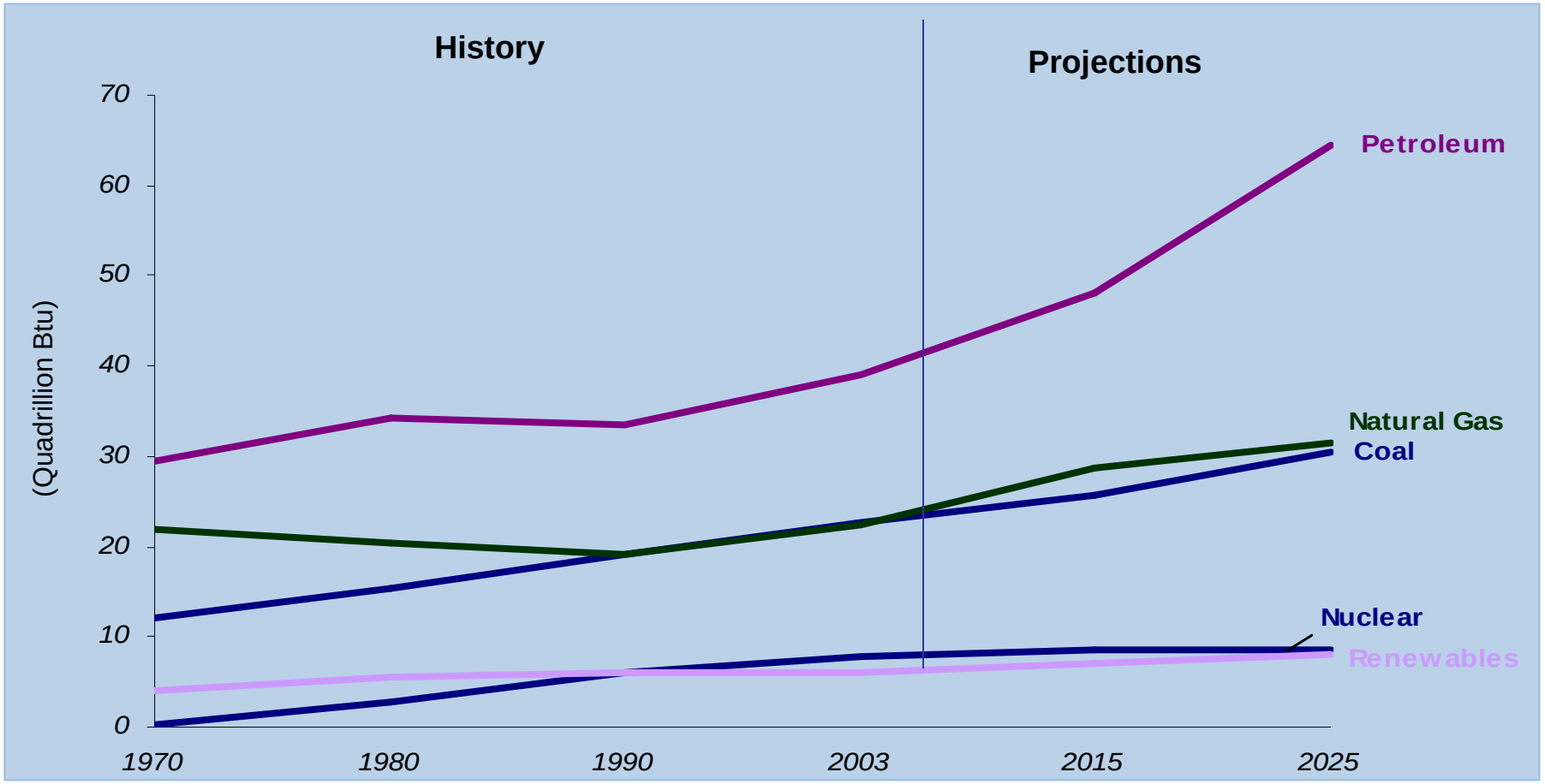



# What Is at Stake?

**"Best-case" scenario is that in the future a number of technologies will be in place that will allow the U.S. to transition from heavy reliance on petroleum to relying more on domestic and renewable resources**

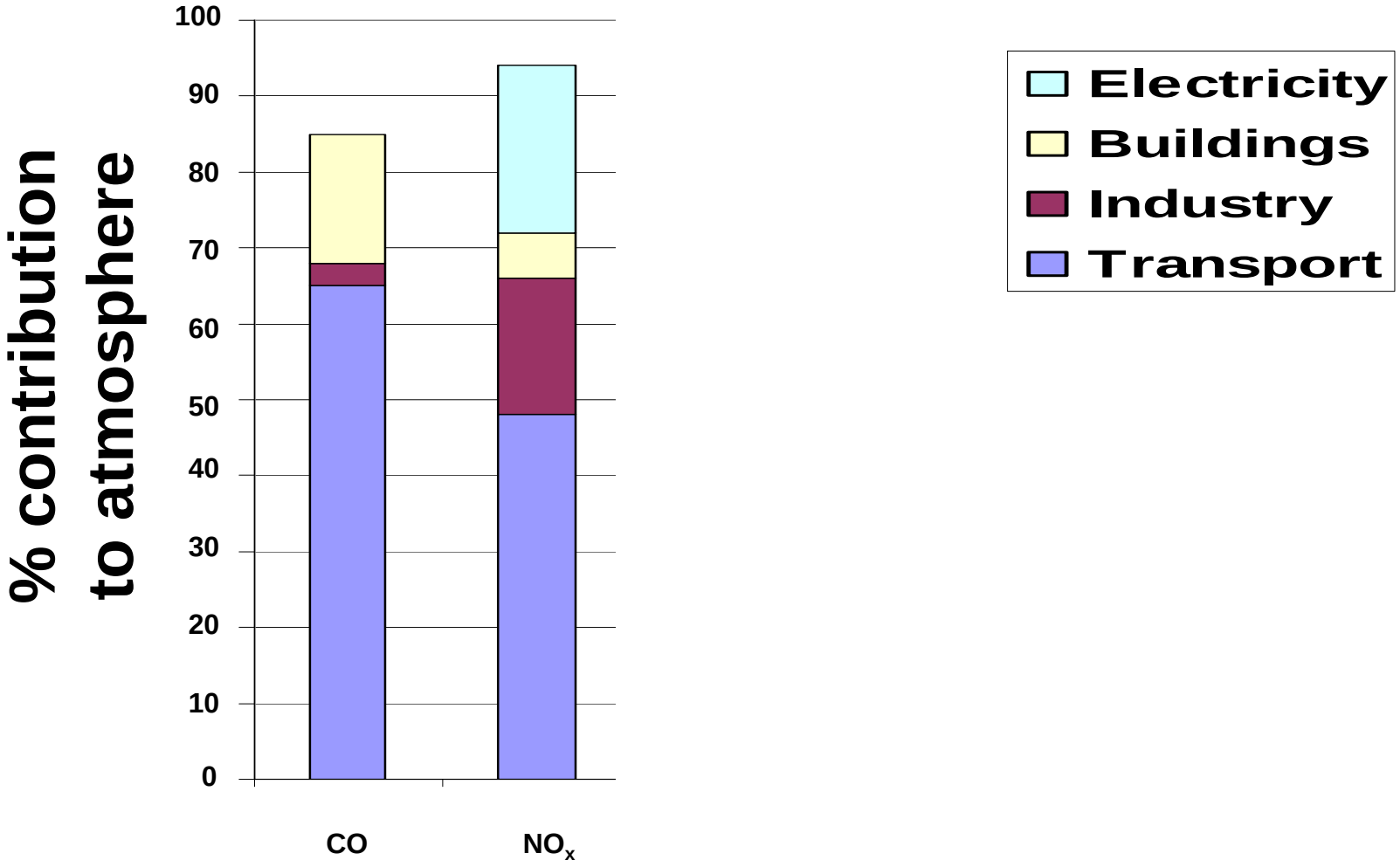
**A "worse case" could mean supply disruptions like we saw in the 1970s, although we are buffered somewhat by Strategic Petroleum Reserve**

# U.S. Energy Consumption by Fuel 1970–2025




Source: EIA Annual Energy Outlook 2005

# The U.S. Energy Situation
# Environmental Impacts of Fossil Energy Use




**U.S. 2001 Energy-Linked Emissions as Percentage of Total Emissions**

# The U.S. Energy Situation
# Carbon Management Technological Options

## Reduce Carbon Intensity

- Renewables
- Nuclear
- Fuel Switching

## Improve Efficiency

- Demand Side
- Supply Side

## Sequester Carbon

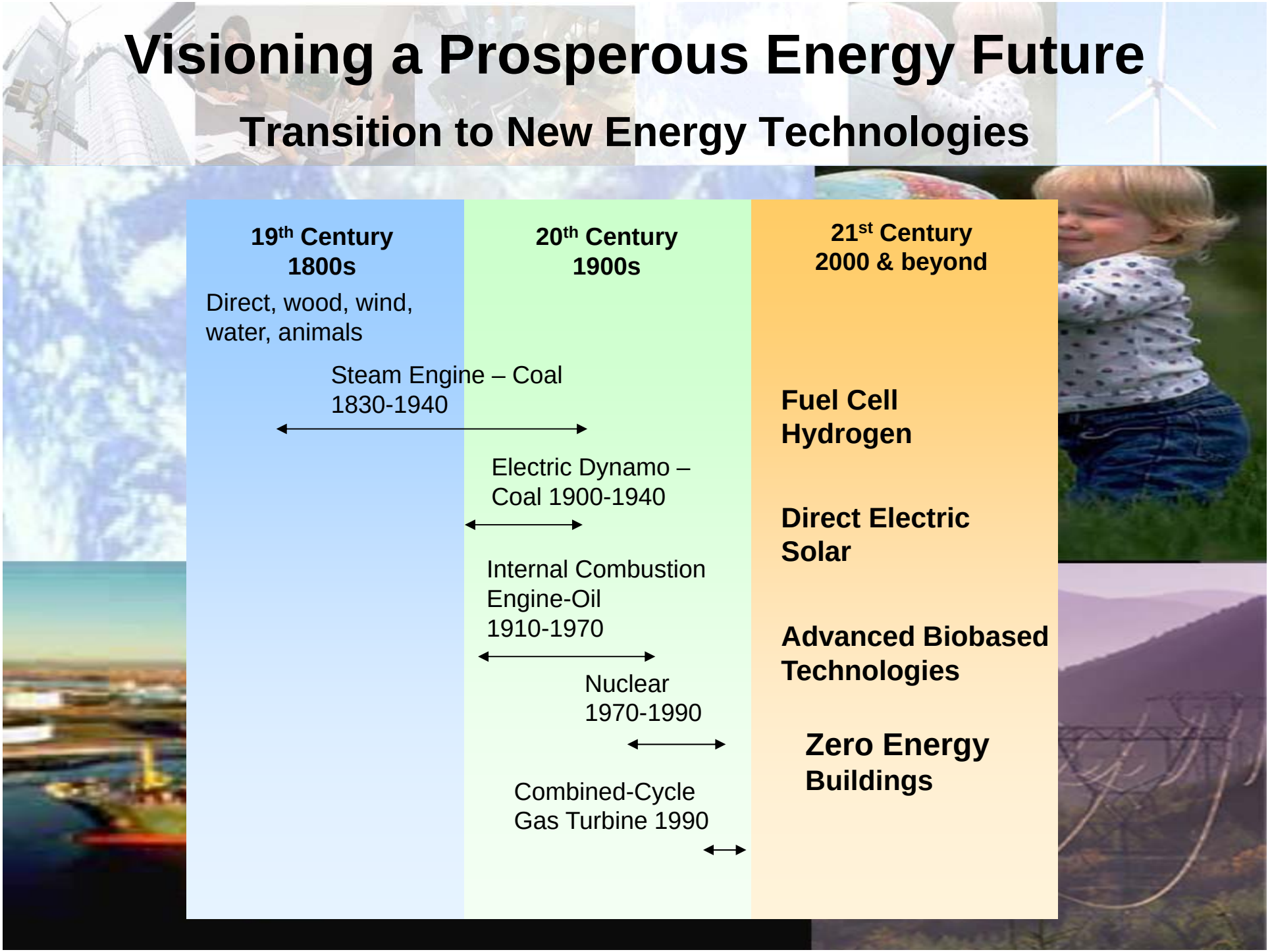
- Enhance Natural Sinks
- Capture & Store

**All options need to:**

- **Affordably meet energy demand**
- **Address environmental objectives**

# Visioning a Prosperous Energy Future

## Transition to New Energy Technologies



| 19th Century 1800s | 20th Century 1900s | 21st Century 2000 & beyond |
|---|---|---|
| Direct, wood, wind, water, animals | | |
| | Steam Engine – Coal 1830-1940 | |
| | Electric Dynamo – Coal 1900-1940 | **Fuel Cell Hydrogen** |
| | Internal Combustion Engine-Oil 1910-1970 | **Direct Electric Solar** |
| | Nuclear 1970-1990 | **Advanced Biobased Technologies** |
| | Combined-Cycle Gas Turbine 1990 | **Zero Energy Buildings** |

# Visioning a Prosperous Future

## Perhaps We Need to Speak a New Language?

***Wind Energy***

***Hydrogen Energy***

***Biorefinery***

***Carbon Sequestration***

***Solar Energy***

***Geothermal Energy***

***Fuel Cells***

***Energy Efficiency***

***Clean, Abundant, Reliable, and Affordable Energy***

# Visioning a Prosperous Energy Future

## Current Initiatives to Develop New Technology

### Short Term Now

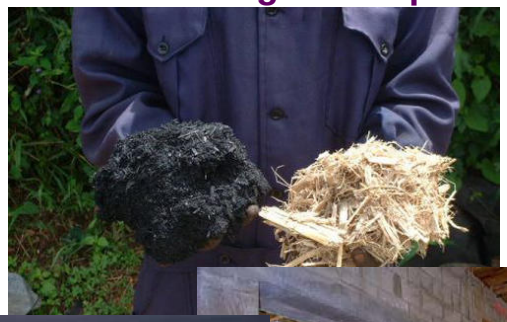
- Hybrid or Clean Diesel Vehicles
- Clean Coal Efficiency
- Energy Efficiency Standards
- Renewable Fuel Standard
- Nuclear Plant Relicensing
- Enhanced Oil Recover
- Biological Sequestration
- Methane to Markets*
- Federal Facility Management Plan
- Fuel Economy Standards
- Wind, Solar Tax Incentives
- Climate Leaders
- Climate VISION
- SmartWay Transportation

### Mid Term

- Hybrid/Clean Diesel Vehicles
- Clean Coal Gasification
- Renewable/Efficiency Partnership*
- Cellulosic Biomass
- Advanced Nuclear
- Geological Sequestration*

### Long Term

- Hydrogen*
- FutureGen*
- Zero Energy Homes & Buildings
- Bio-Energy Systems
- GenIV Nuclear/Fusion*



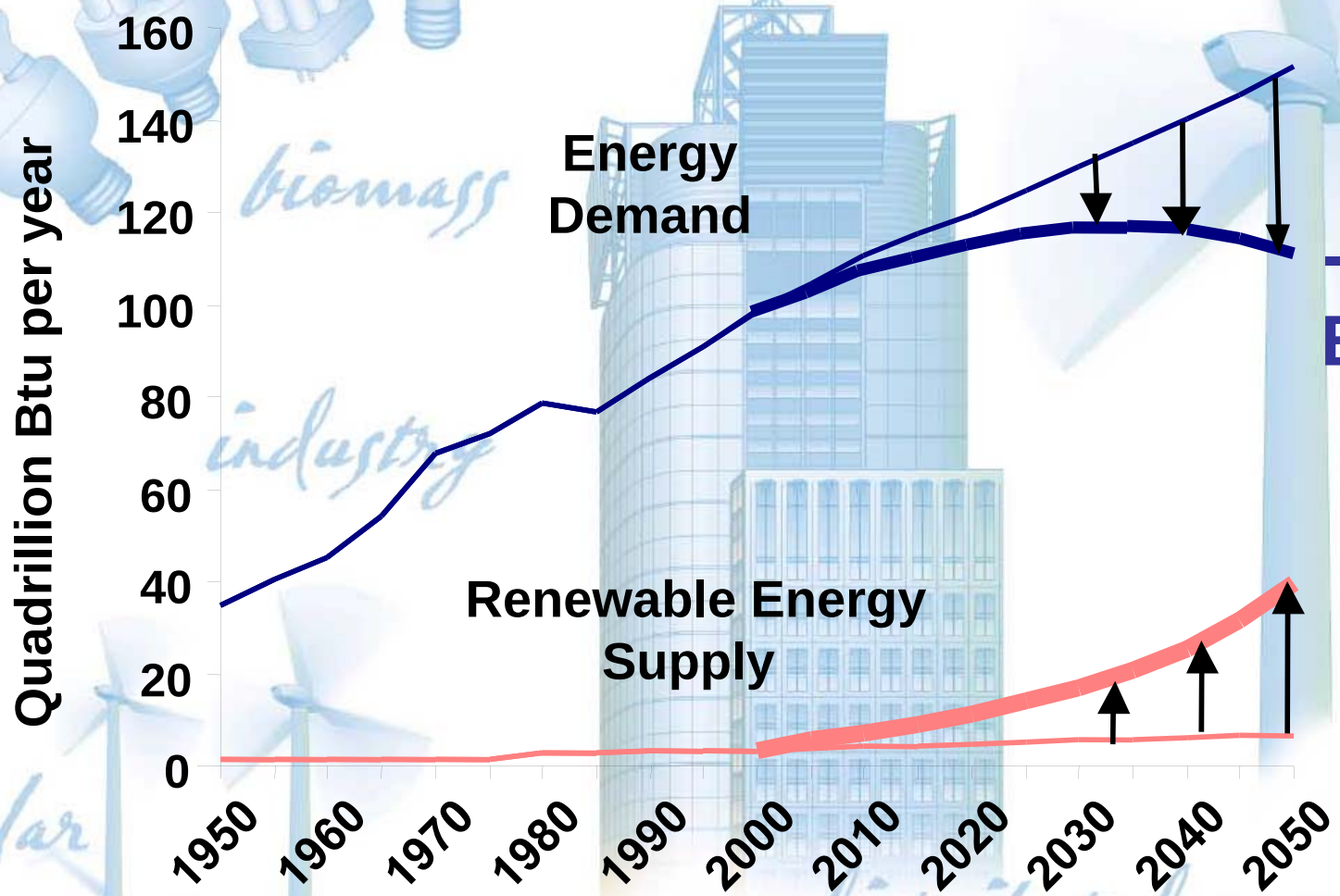
* Denotes International Partnership



Source: June 30, 2005 White House Press Release on G-8 Summit

# Visioning a Prosperous Energy Future

## A Supply and Demand Strategy




- Reduce Demand
- Increase Efficiency

Increase Renewable Energy Supply

# Visioning a Prosperous Energy Future

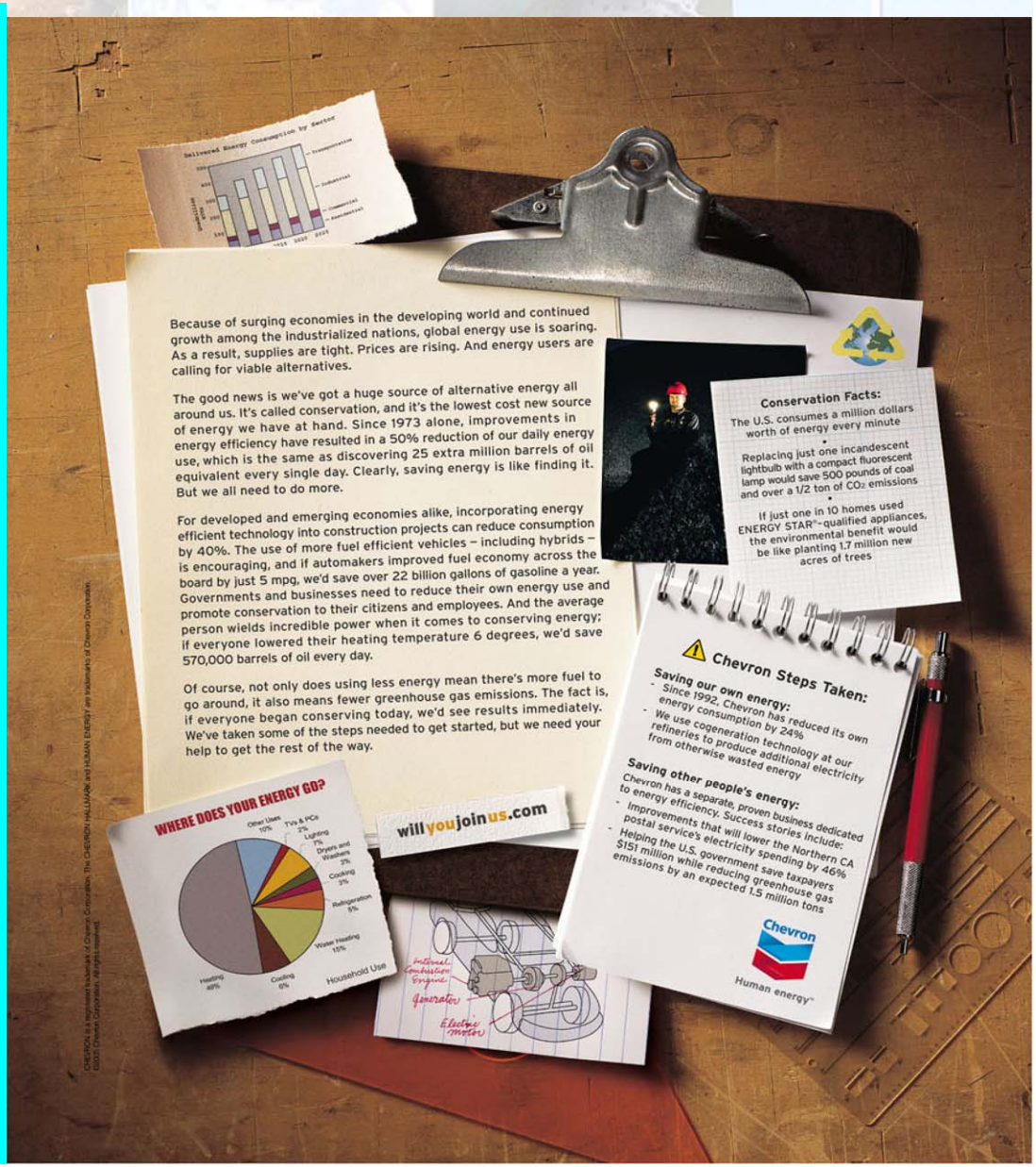
## Energy Efficiency Strategy

**You use 25 barrels of oil a year**

**Since 1973 alone, improvements in energy efficiency have resulted in a 50 % reduction of our daily energy intensity per gross domestic production unit, which is the same as discovering 25 extra million barrels of oil equivalent every day**

**For developed and emerging economies alike, incorporating energy efficient technology into construction projects can reduce consumption by 40 %**

**If everyone lowered their heating temperature 6 degrees, we'd save the energy equivalent of 570,000 barrels of oil every day**



# Visioning a Prosperous Energy Future

## Illustrative Emerging Technologies

| R&D Needed to Meet Goals Associated with Zero Energy Buildings | |
|---|---|
| Lighting | Develop technologies such as light emitting diodes |
| Water Heating | Develop high efficiency, low cost electric heat pump water heaters moving to $CO_2$ as a refrigerant which increased efficiency |
| Windows | Develop highly insulating dynamic windows (e.g., electrotinted windows using ionic liquids) and next generation reflective electrochromatic technology |
| Space Conditioning | Develop high efficiency and low capacity, near zero-loss HVAC systems |
| Building Controls and Appliances | Develop the technologies to control home appliances and equipment connectivity and communication both inside the walls and with external services including utilities and repair services |

# Visioning a Prosperous Energy Future

## Energy Efficiency Windows

**Windows annually are responsible for 3.8 quads of energy in the U.S. in the form of heating and air conditioning loads, at a cost of more than $30 billion.**

**Advanced energy-efficient window technologies can outperform the best-insulated wall or roof in terms of annual energy performance**

**DOE R&D target - save over 4 quads of energy annually in U.S. buildings, by reducing heating, cooling, and lighting loads**

**~ 2 million barrels of oil per day**

# Visioning a Prosperous Energy Future

## Energy Efficiency Vehicle Technologies

### Vehicle Systems
- Aerodynamics
- Rolling Resistance
- Accessory Loads
- Systems Analysis and Modeling
- Non-Highway

### Combustion and Emissions Control
- Combustion R&D
- Emissions Controls
- Clean Combustion

### Fuels
- Advanced Petroleum Based Fuels
- Gasoline/ Diesel Fuels and Blends
- Fischer-Tropsch Fuels
- Non-Petroleum Fuels

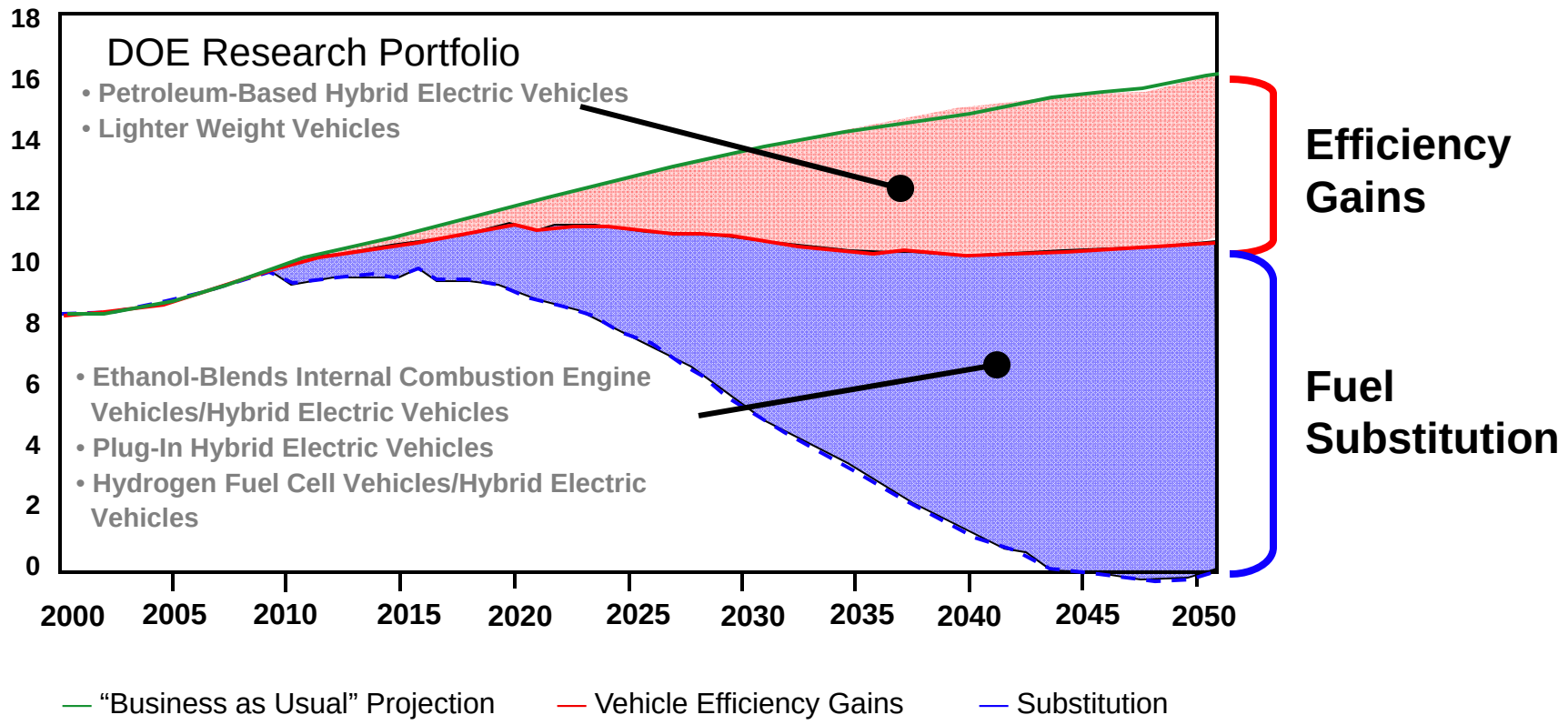
### Hybrid Propulsion
- Hybrid Electric Vehicles
- Electric Vehicles
- Power Electronics
- Batteries (NiMH & Lithium)
- Inverters/Controllers
- Motors
- Ultracapacitors

### Deployment
- EPACT Fleets
- Test & Evaluation
- Vehicle Competitions

### Innovative Concepts
- GATE

### Materials Technology
- Metals
- Composites
- Ceramics
- Propulsion Systems
- High Strength Weight Reduction

# Part 3a: Potential Light-Duty Vehicle Oil Savings



# Visioning a Prosperous Energy Future

## Potential for Combined Heat and Power Systems (CHP)

Beverages

Snack Foods & Peanut Butter

Grain & Oilseed Milling

Meat

Food & beverage processing industry is fifth largest industrial user of energy

**There is an estimated 276 MWe of potential CHP in this industry**

Bakeries & Tortillas

Dairy

Fruit & Vegetable Preserving

Seafood Preparation & Packaging

Sugar & Confectioneries

# Combined Heat and Power (CHP) Application Tool

- DOE has developed a software tool to help industrial users evaluate the feasibility of CHP for heating systems such as fuel-fired furnaces, boilers, ovens, heaters, and heat exchangers.


***Sample CHP tool user screen showing the tool's main menu and available options.***

***For more information:***
***http://www1.eere.energy.gov/industry/bestpractices/software.html#chp***
***or contact EERE Information Center***
***1-877-EERE-INF (1-877-337-3463)***

# What Are Business Executives Saying?

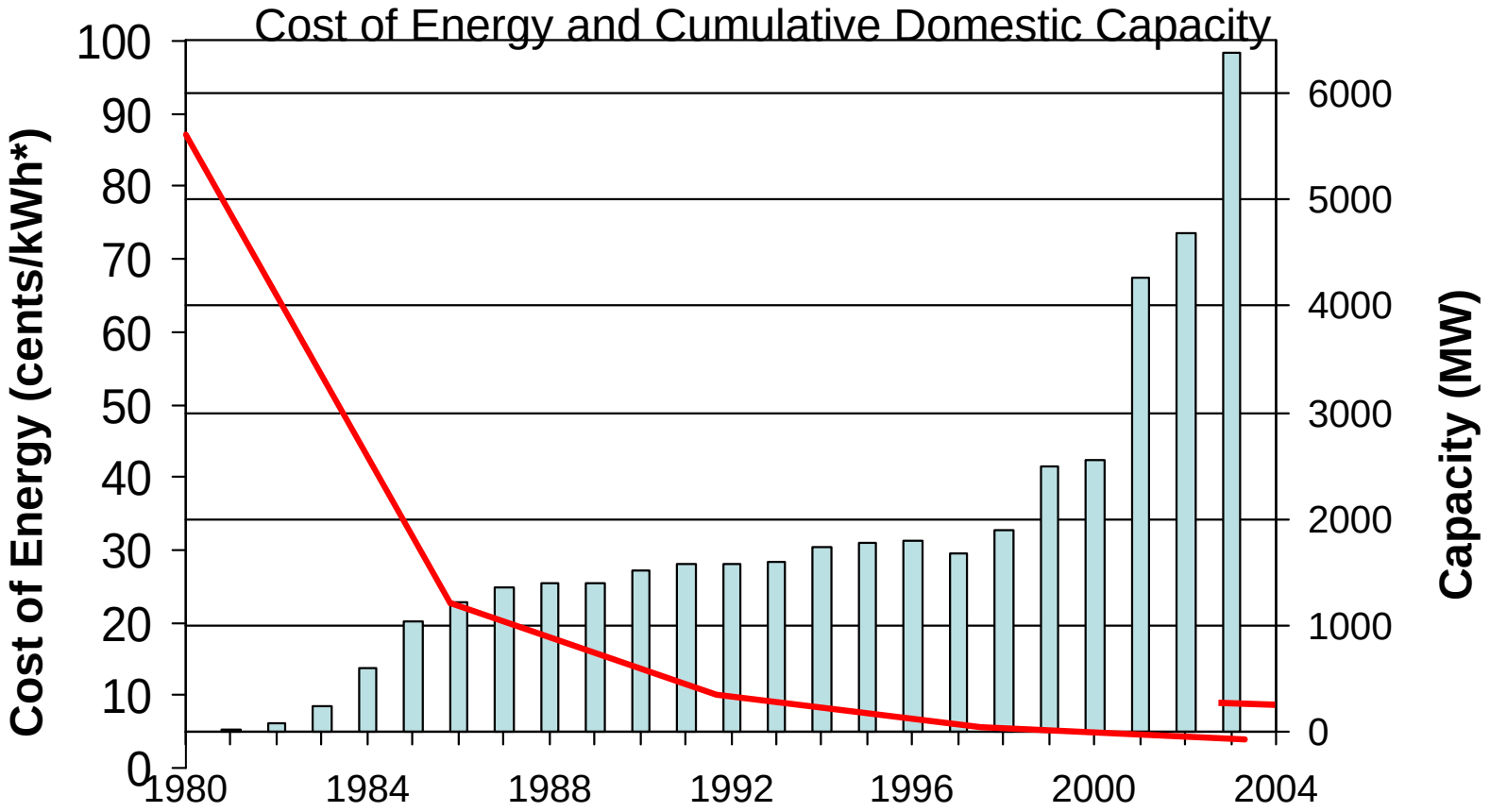
- **Peter Brabeck - Nestle CEO Predicts Rising Energy Costs**
  - **5 – 10% increase in energy related costs – fuel bills, packaging, transportation etc.**
  - **Increased global reliance on nuclear**
  - **Biggest threats to growth in the food industry**
    - **Higher energy prices**
    - **Water shortage**

•Thursday January 26, 2006, Washington Post, Business Section

# Visioning a Prosperous Energy Future

## Renewable Energy – Wind

### Wind Capacity and Cost Trends

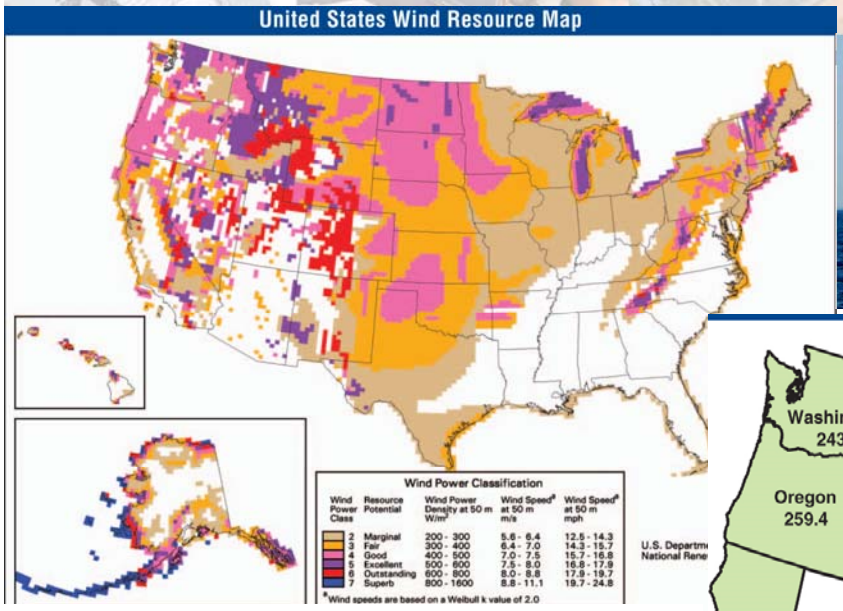


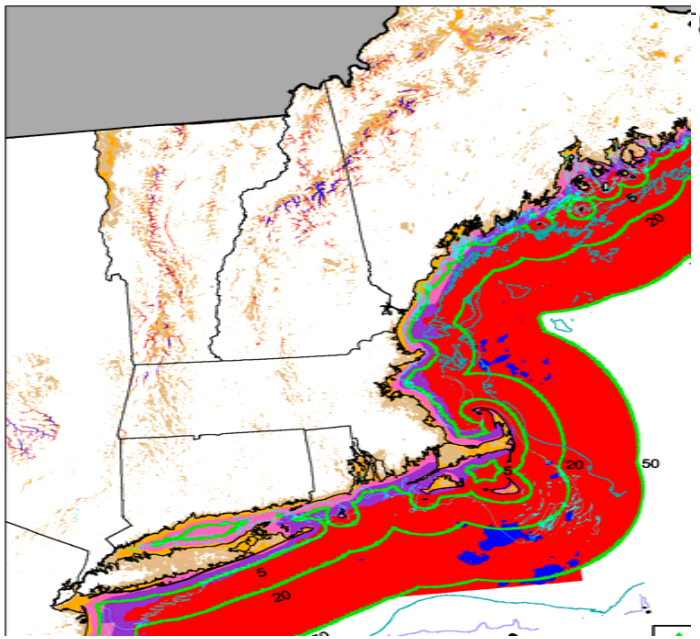

*Year 2000 dollars

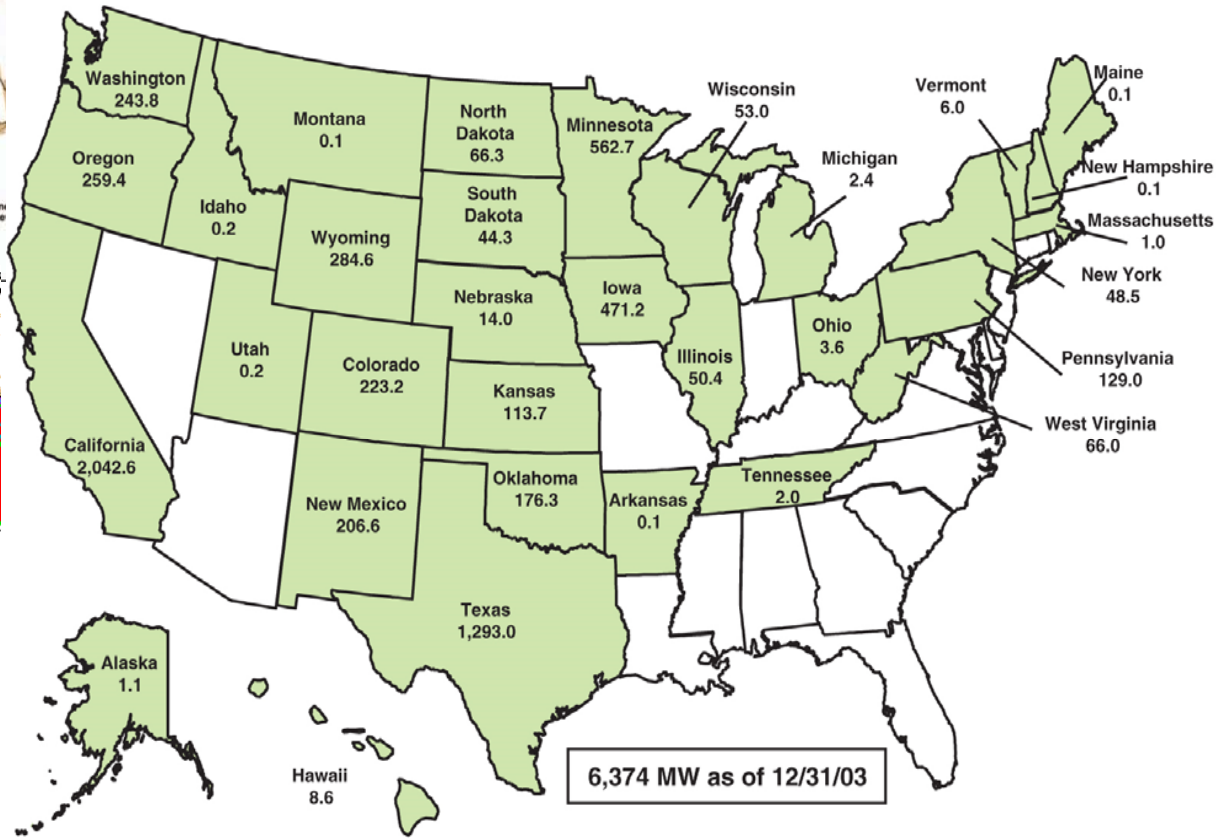
Increased Turbine Size - R&D Advances - Manufacturing Improvements

# Visioning a Prosperous Energy Future

## U.S. Wind Resources and Installed Capacity



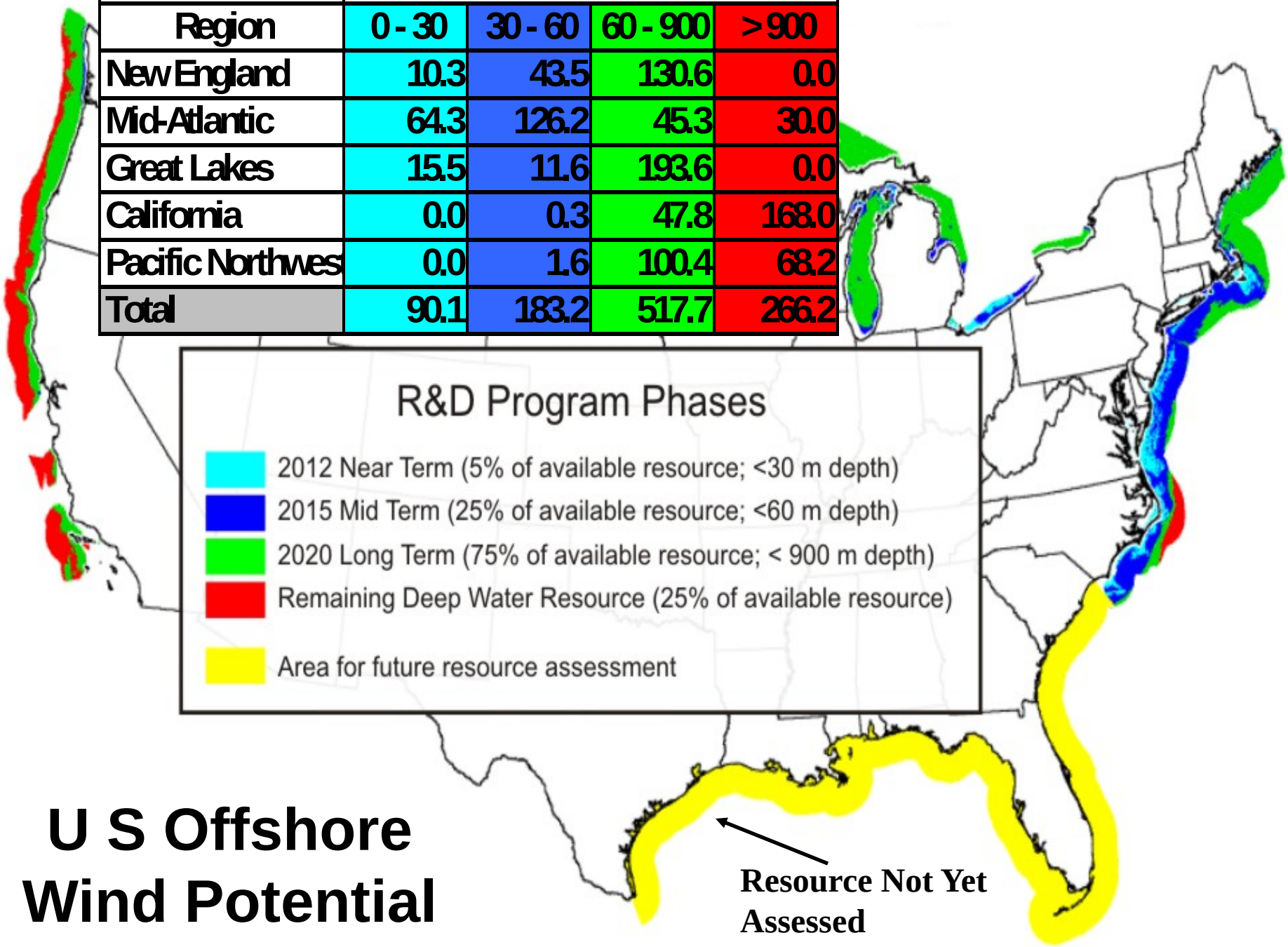






Wind farms of various sizes now operate in 32 states.

# U S Offshore Wind Potential

| | GW by Depth (m) | | | |
|---|---|---|---|---|
| Region | 0 - 30 | 30 - 60 | 60 - 900 | > 900 |
| New England | 10.3 | 43.5 | 130.6 | 0.0 |
| Mid-Atlantic | 64.3 | 126.2 | 45.3 | 30.0 |
| Great Lakes | 15.5 | 11.6 | 193.6 | 0.0 |
| California | 0.0 | 0.3 | 47.8 | 168.0 |
| Pacific Northwest | 0.0 | 1.6 | 100.4 | 68.2 |
| Total | 90.1 | 183.2 | 517.7 | 266.2 |



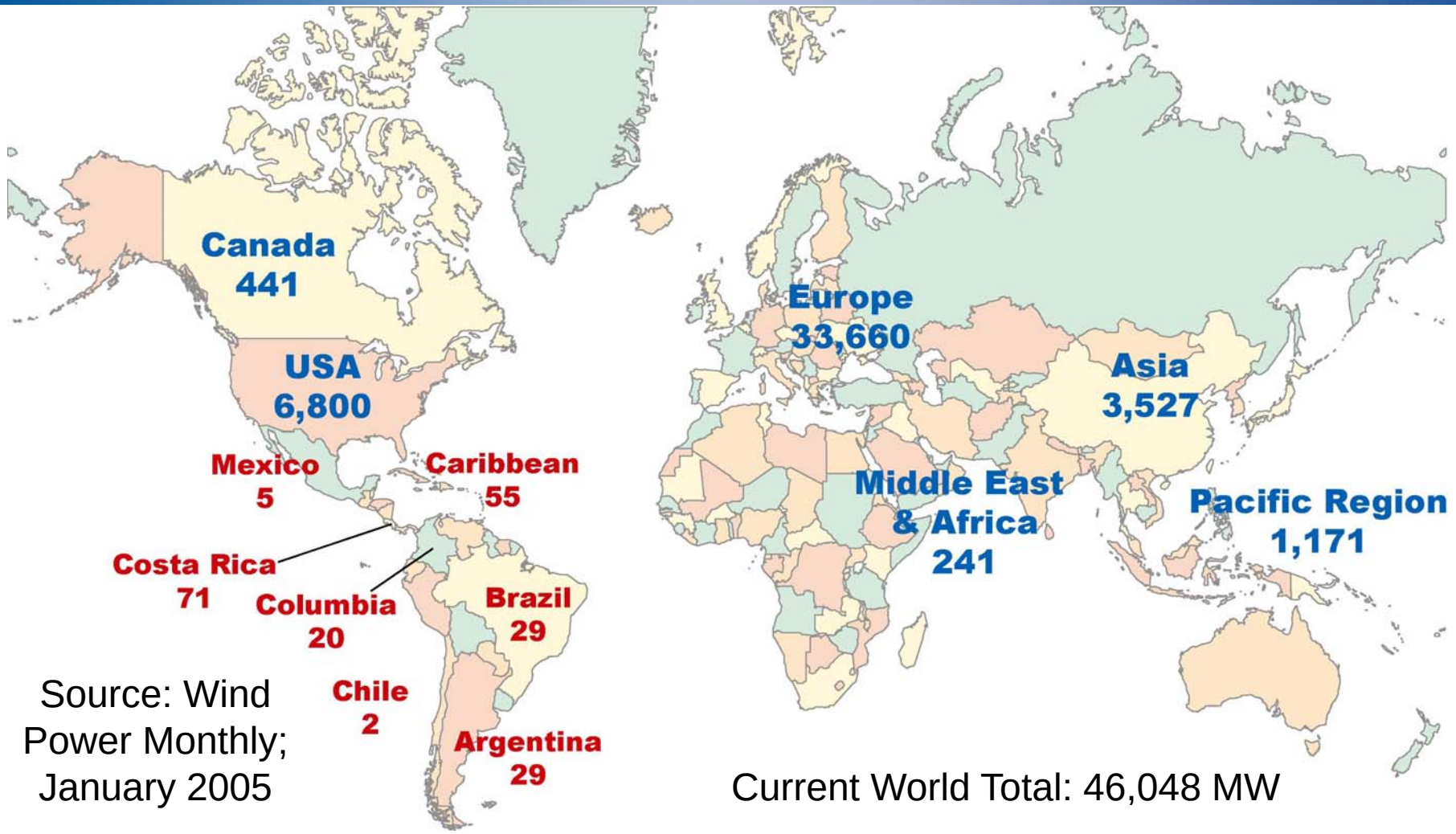
Visioning a Prosperous Energy Future

# Offshore Wind Technology

www.windpoweringamerica.gov

# Visioning a Prosperous Energy Future

## Wind Electricity Generation Installed World Capacity



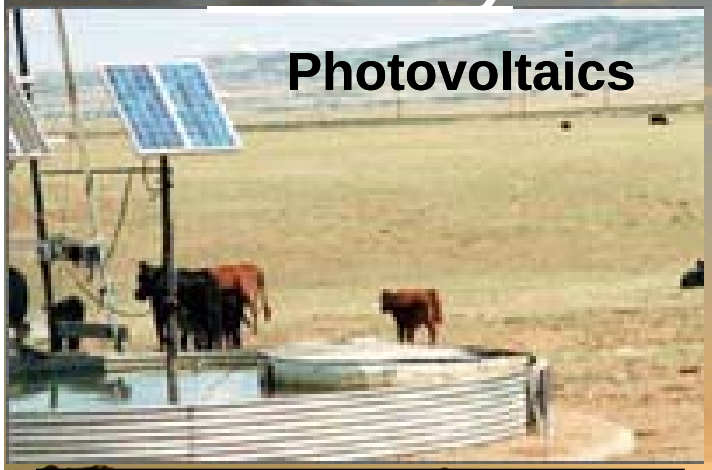

Source: Wind Power Monthly; January 2005

Current World Total: 46,048 MW

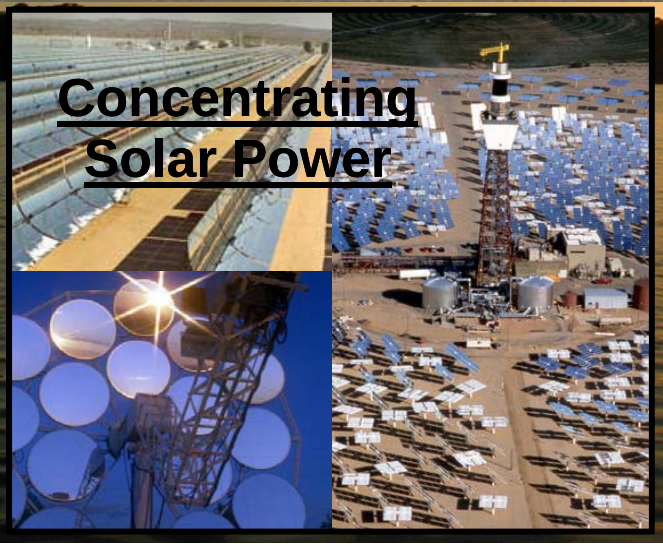
# Visioning a Prosperous Energy Future

## Solar Energy Technologies

### *Electricity*

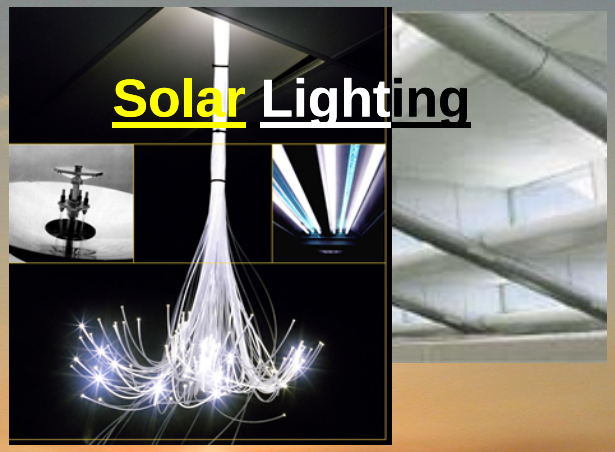


**Photovoltaics**



**Concentrating Solar Power**

### *Lighting*



**Solar Lighting**

### *Thermal*

**Solar Heating**

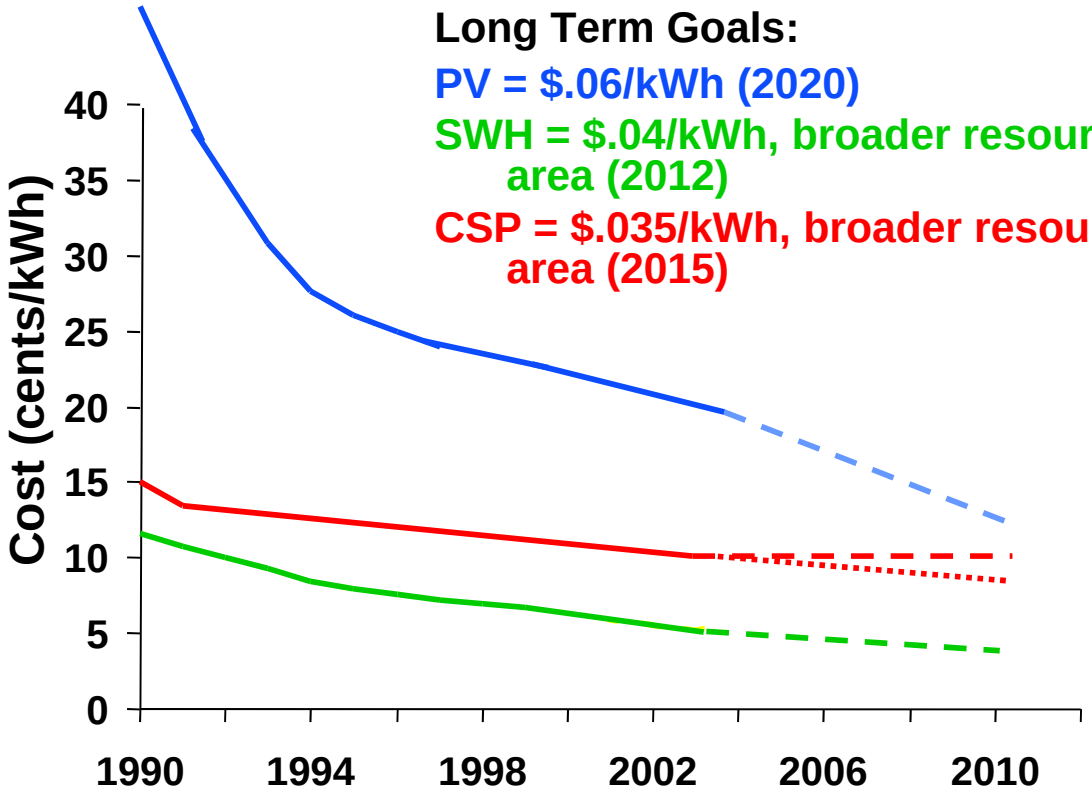
### *Chemical*

**Hydrogen (Electrolysis of Water)**

**Fuel Cells - Cars**

# Visioning a Prosperous Energy Future

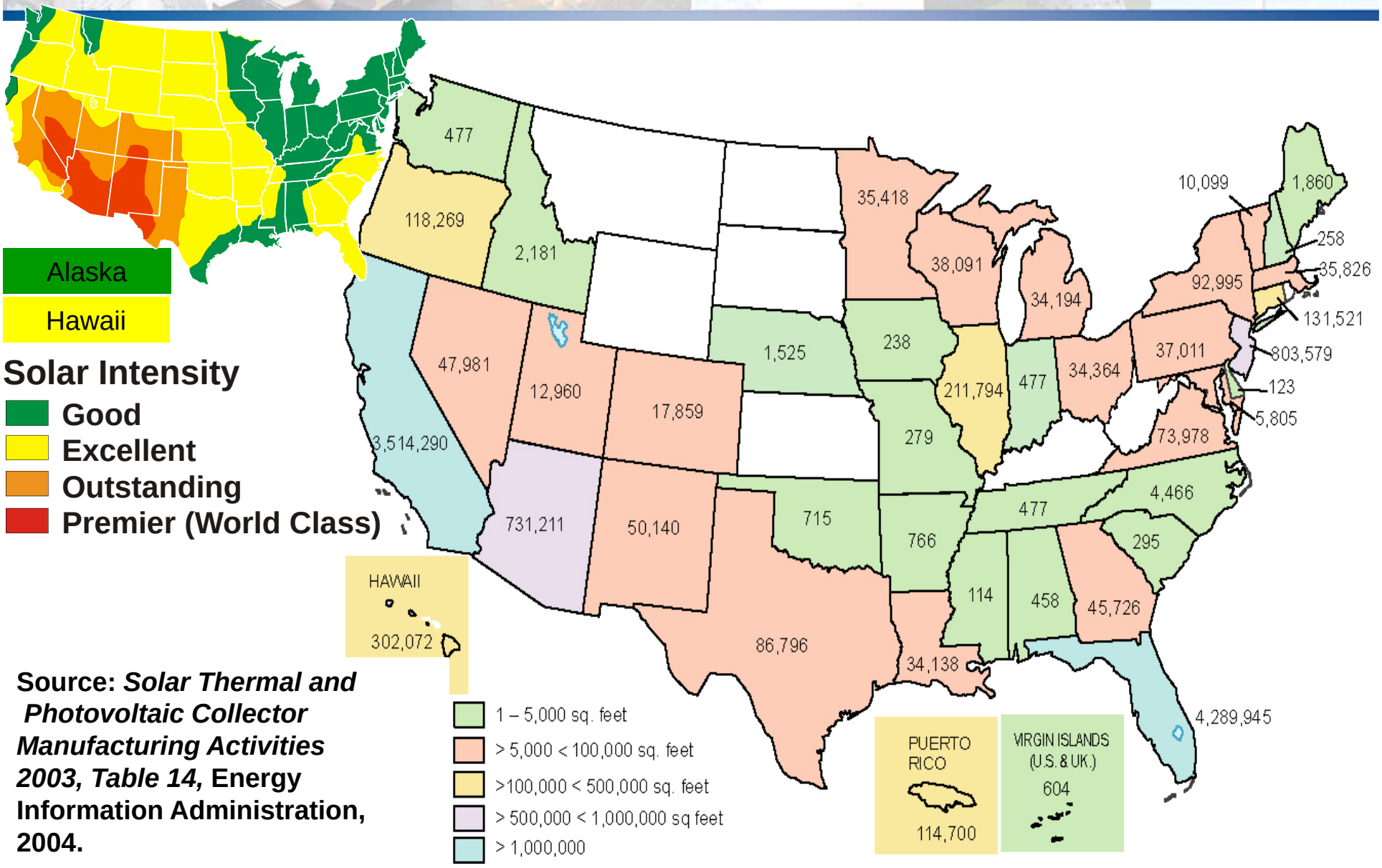
## Solar Technologies Cost Trends




*With **improved technology supported by DOE**, the cost of solar energy in the United States has steadily **declined**.*

# Visioning a Prosperous Energy Future

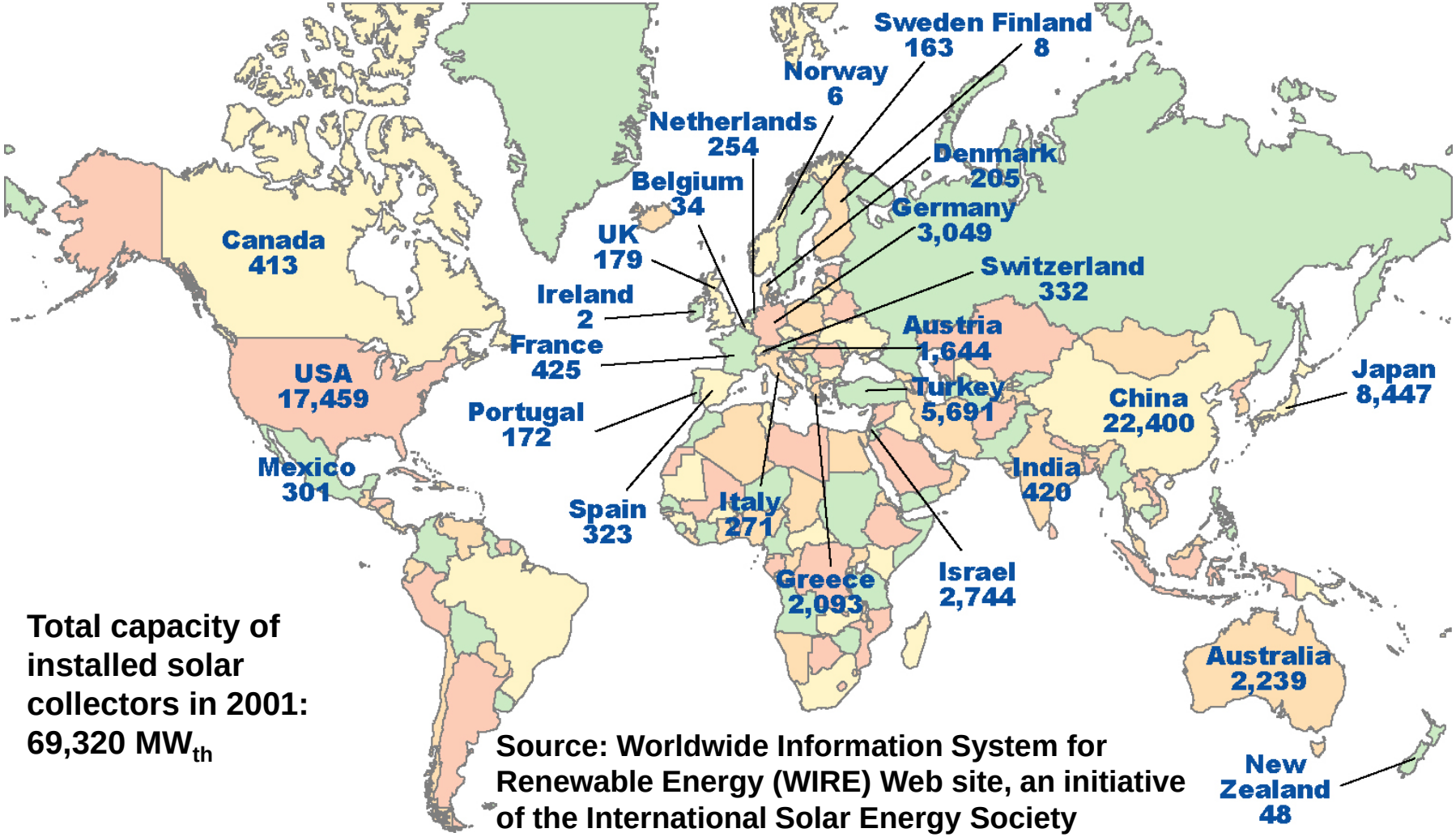
## U.S. Solar Resources and Thermal Shipments (2003)




**Source:** ***Solar Thermal and Photovoltaic Collector Manufacturing Activities 2003, Table 14,*** **Energy Information Administration, 2004.**

# Visioning a Prosperous Energy Future

## Worldwide Solar Thermal Capacity

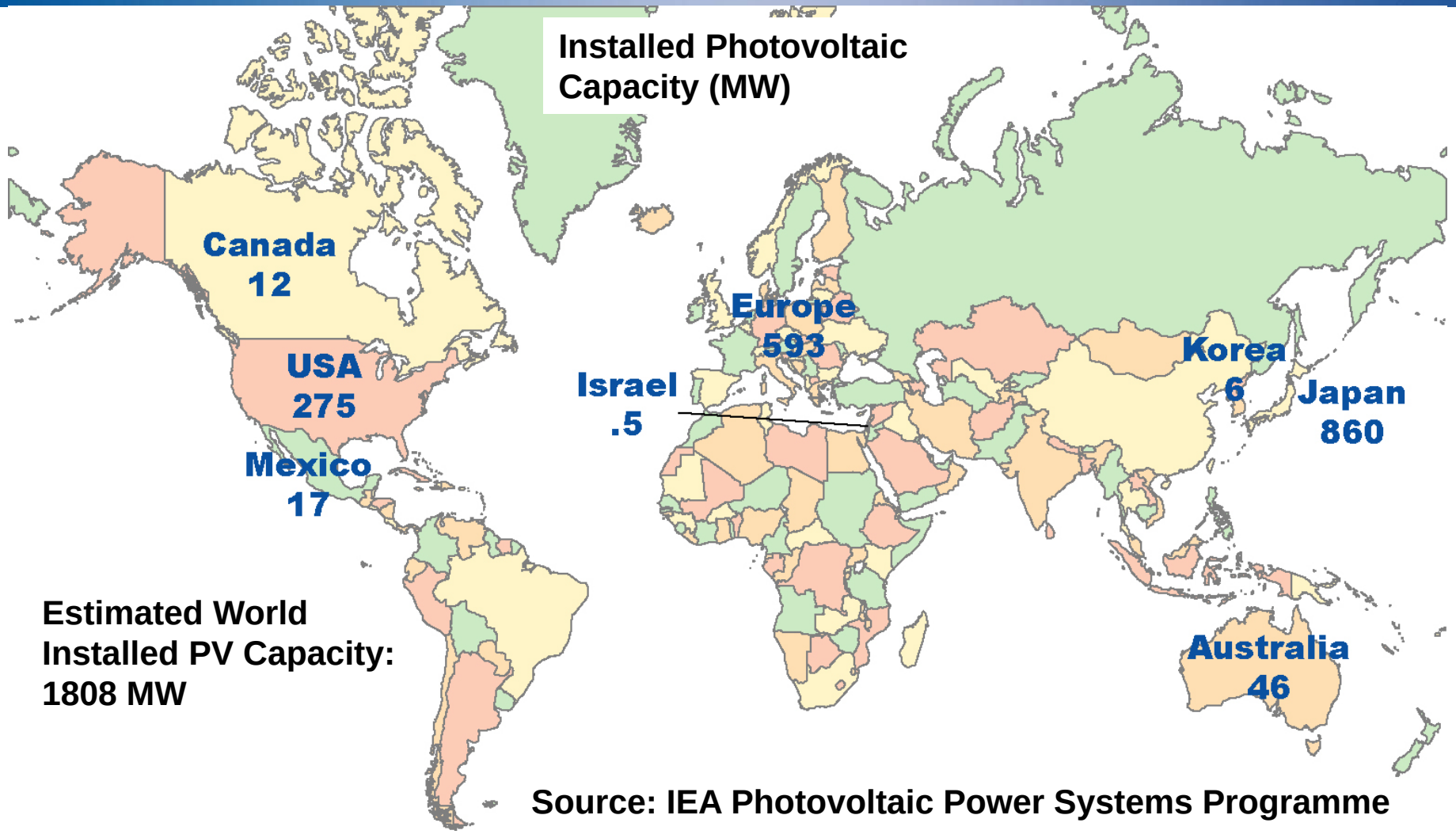



**Total capacity of installed solar collectors in 2001: 69,320 $MW_{th}$**

**Source: Worldwide Information System for Renewable Energy (WIRE) Web site, an initiative of the International Solar Energy Society**

# Visioning a Prosperous Energy Future

## Photovoltaics Installed World Capacity

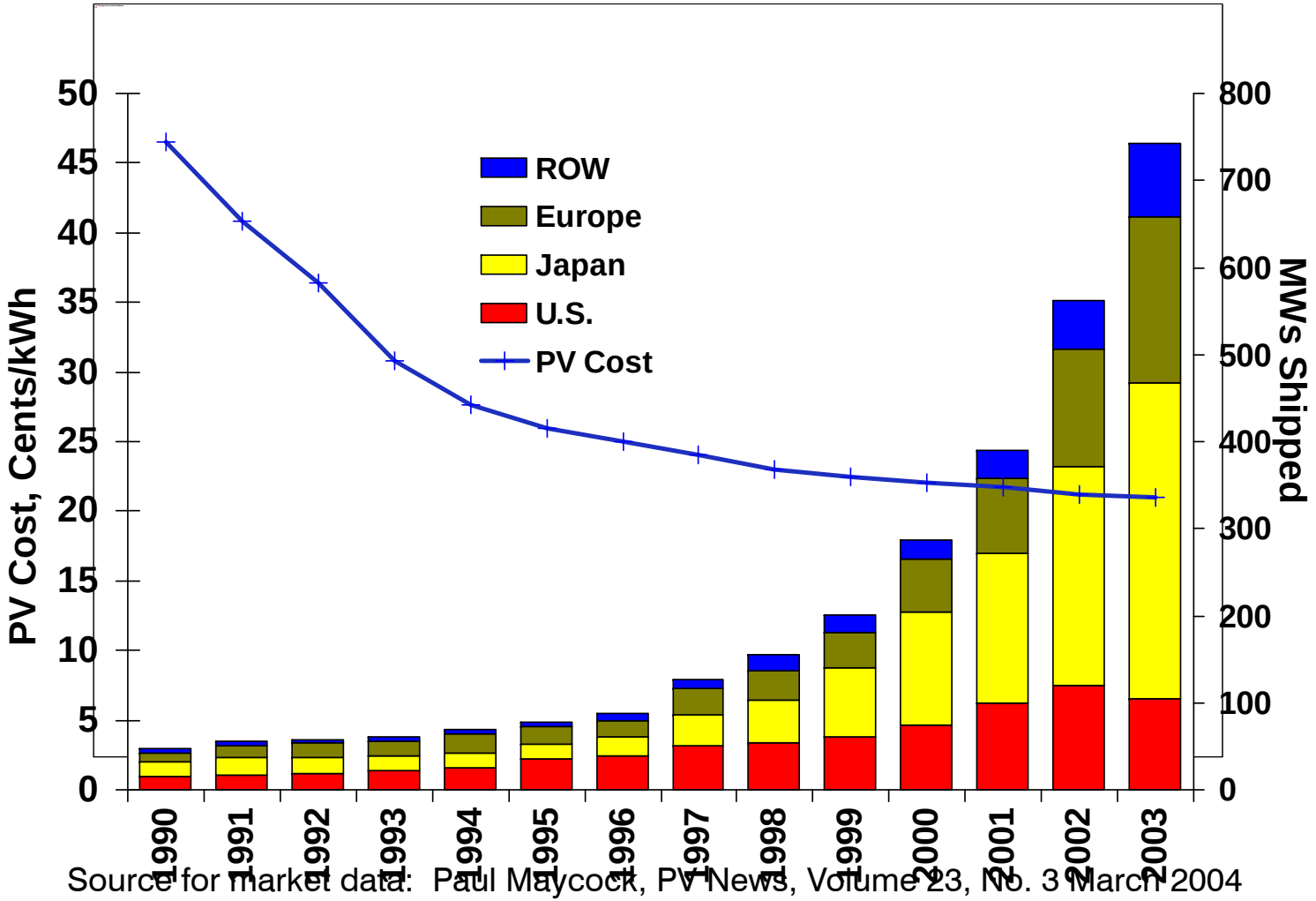



**Estimated World Installed PV Capacity: 1808 MW**

**Source: IEA Photovoltaic Power Systems Programme**

# Visioning a Prosperous Energy Future

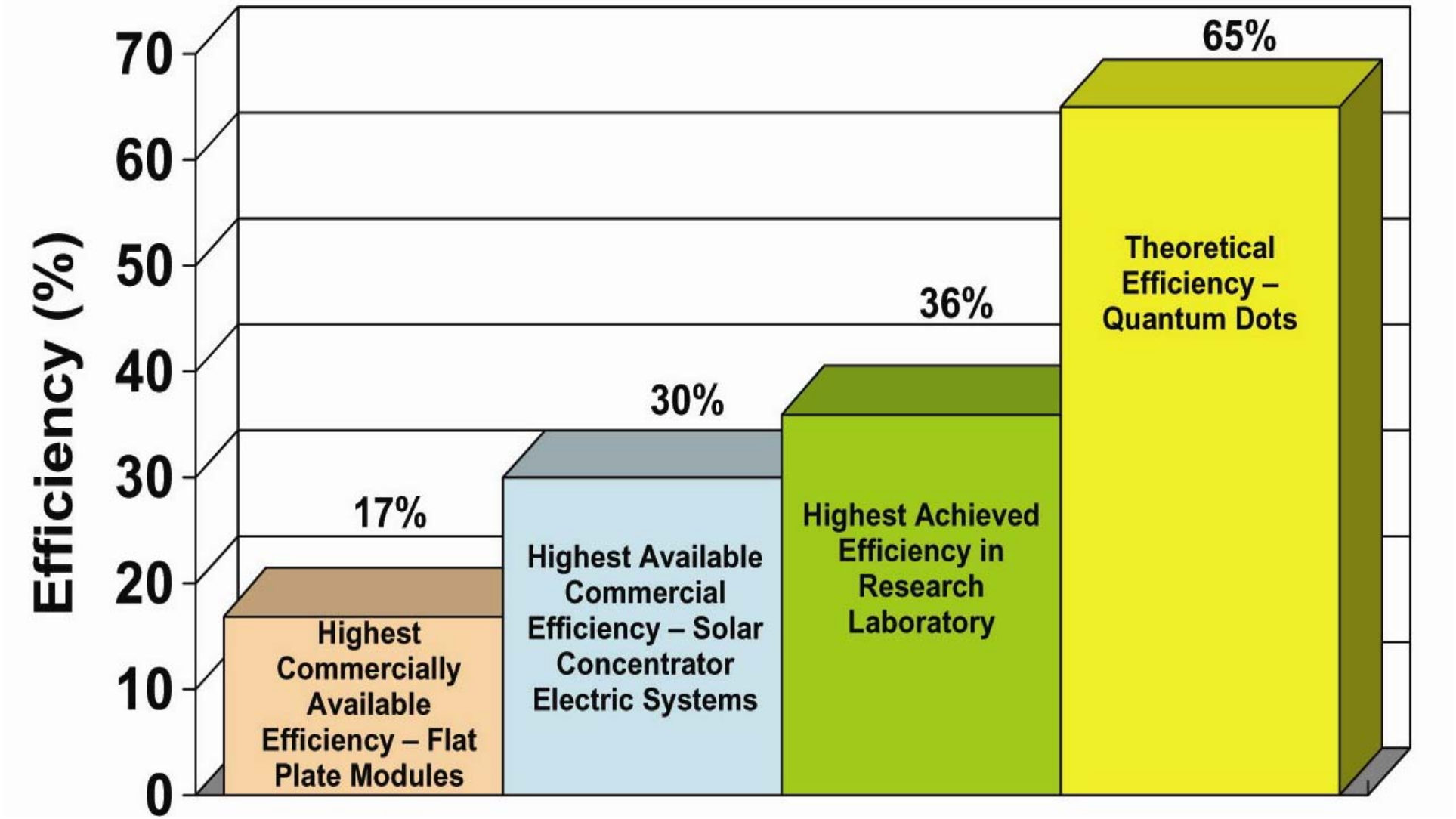
## Photovoltaics (PV) Costs and Shipments




Source for market data: Paul Maycock, PV News, Volume 23, No. 3 March 2004

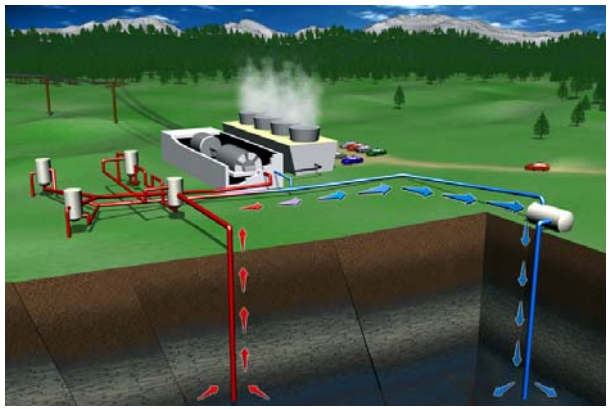
# Visioning a Prosperous Energy Future

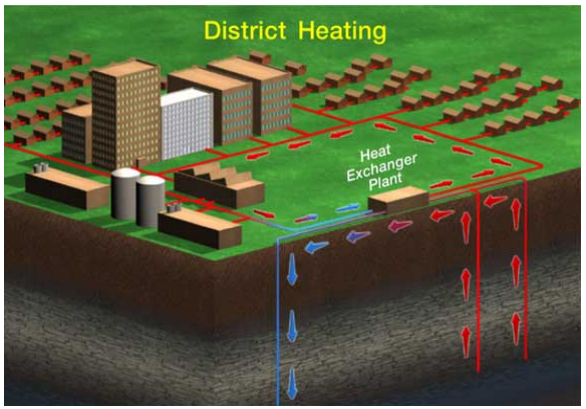
## Ranges of Solar Cell Efficiencies

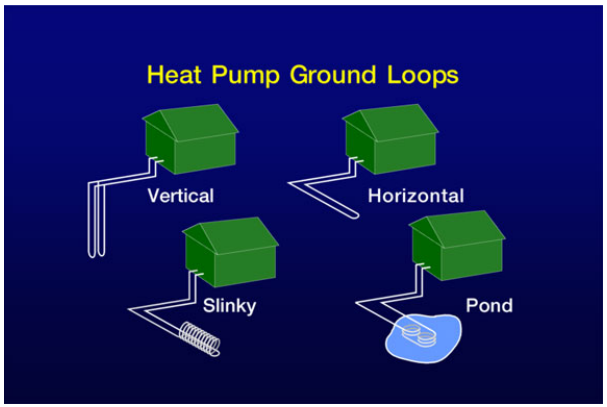


# Visioning a Prosperous Energy Future

## Geothermal Energy Technologies






### Electricity Generation

- Distributed Power
- Central Station Power

### Direct Uses

- District Heating
- Process Heat
- Agriculture (Horticulture)
- Aquaculture

### Geothermal Heat Pumps

- Heating
- Cooling

# Visioning a Prosperous Energy Future

## Geothermal Costs Coming Down

### Geothermal Energy Increasingly Competitive

1980: 10-16 cents/kWh

2000:
5-8 cents/kWh

- Electricity Generation: Current capacity is roughly 2,800 MW in US; 8,000 MW worldwide

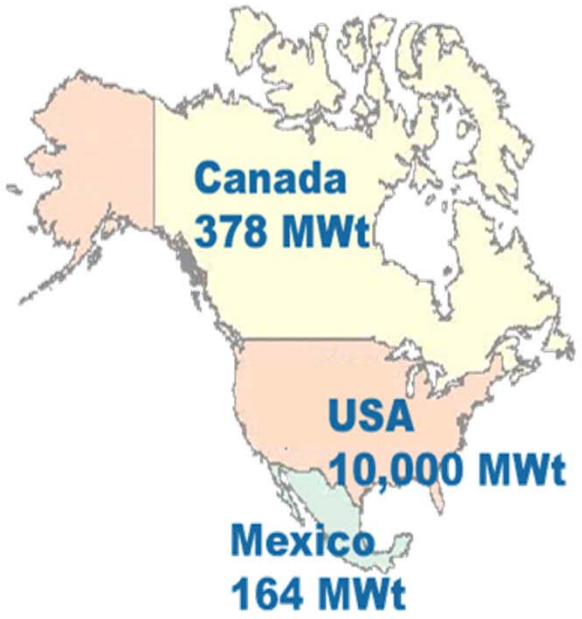
2010 Goal: 3-5 cents/kWh

# Visioning a Prosperous Energy Future

## Geothermal Direct Use – Capacity and Utilization

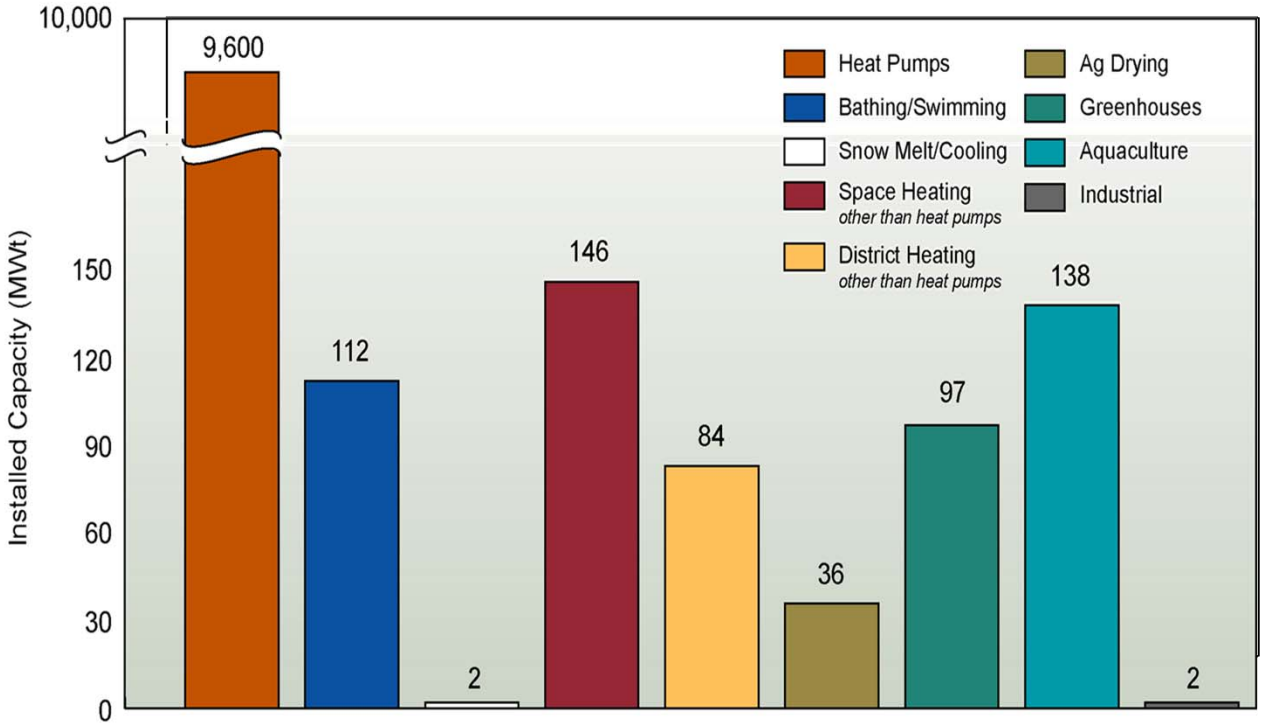
### World and North America

World Total 16,210 MWt




Source: *Direct Heat Utilization of Geothermal Resources,* John W. Lund

Geothermal Energy Thermal Application




Source: John W. Lund, et. al., *The United States of America Country Update*, Proceedings World Geothermal Congress 2005.
*Geothermal Heat Pump Case Studies of the West*, GHC Bulletin, September 2005.

# Visioning a Prosperous Energy Future

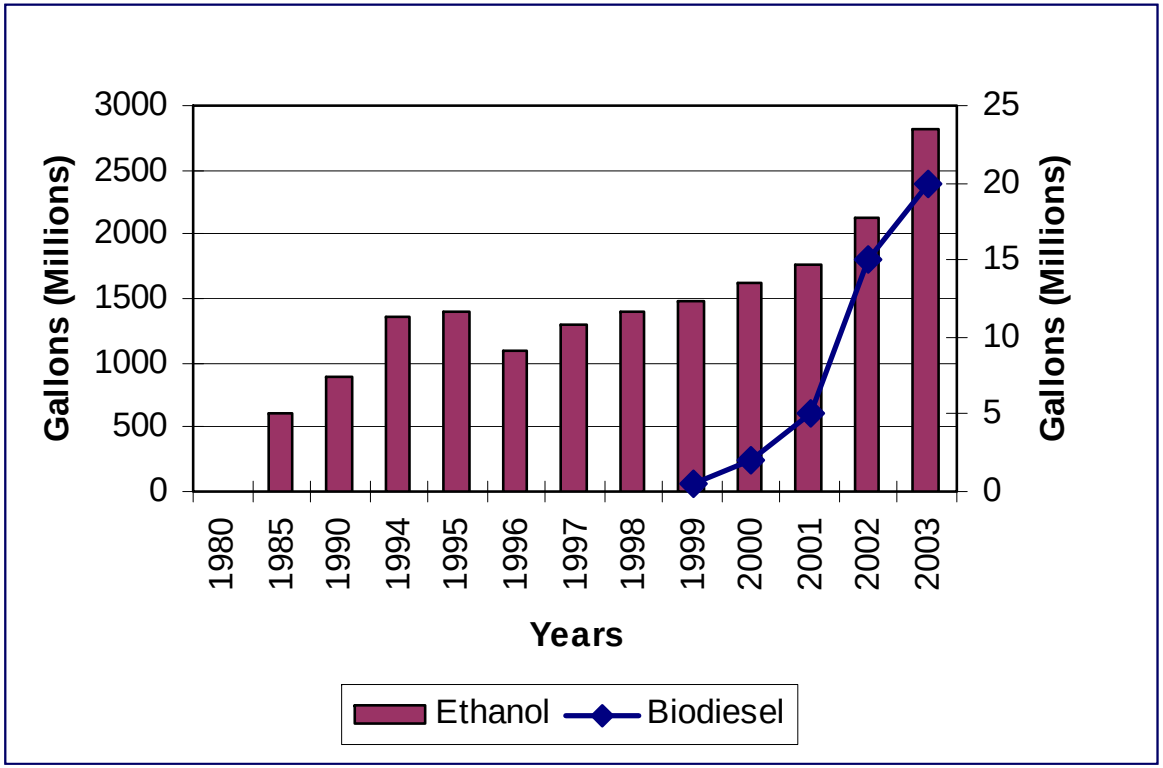
## U.S. Biomass Fuel Production Growing - Ethanol and Biodiesel

### Ethanol

- 82 U.S. ethanol plants operating >16 new plants and 2 major expansions under construction
- Nearly 3.5 billion gallons per year (BGY) capacity; >755 million gallons per year capacity under construction
- 3.35 BGY production estimated for 2004

### Biodiesel

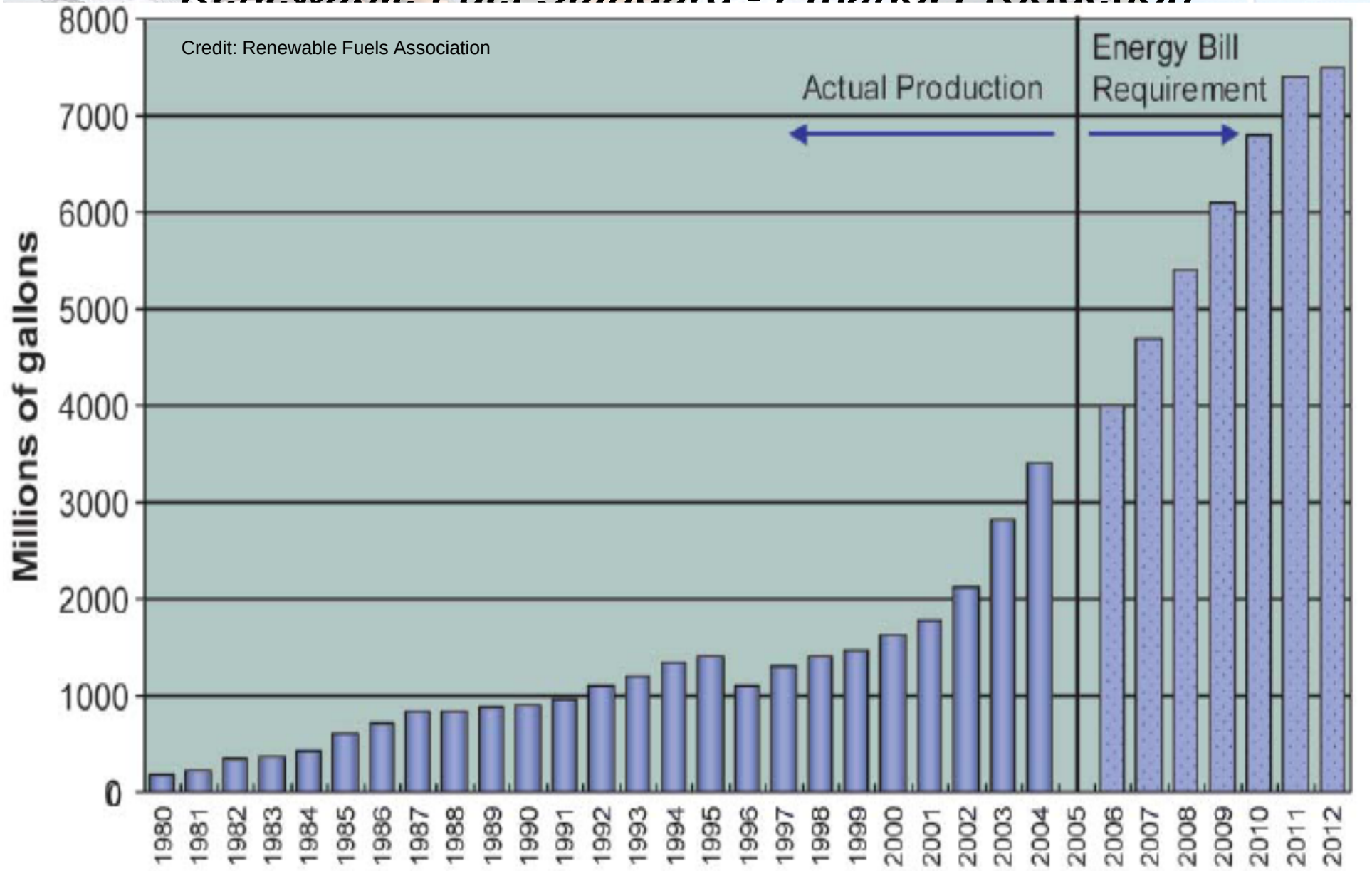
- Production capacity of about 150 million gallons per year (National Biodiesel Board estimate)




*Sources: Renewable Fuels Industry, Industry Outlook 2004, p.4 and National Biodiesel Board, FAQs cited in Eidman, Vernon; "Agriculture as a Producer of Energy," Proceedings – Agriculture as a Producer and Consumer of Energy" June 24-25, 2004, Arlington, VA*

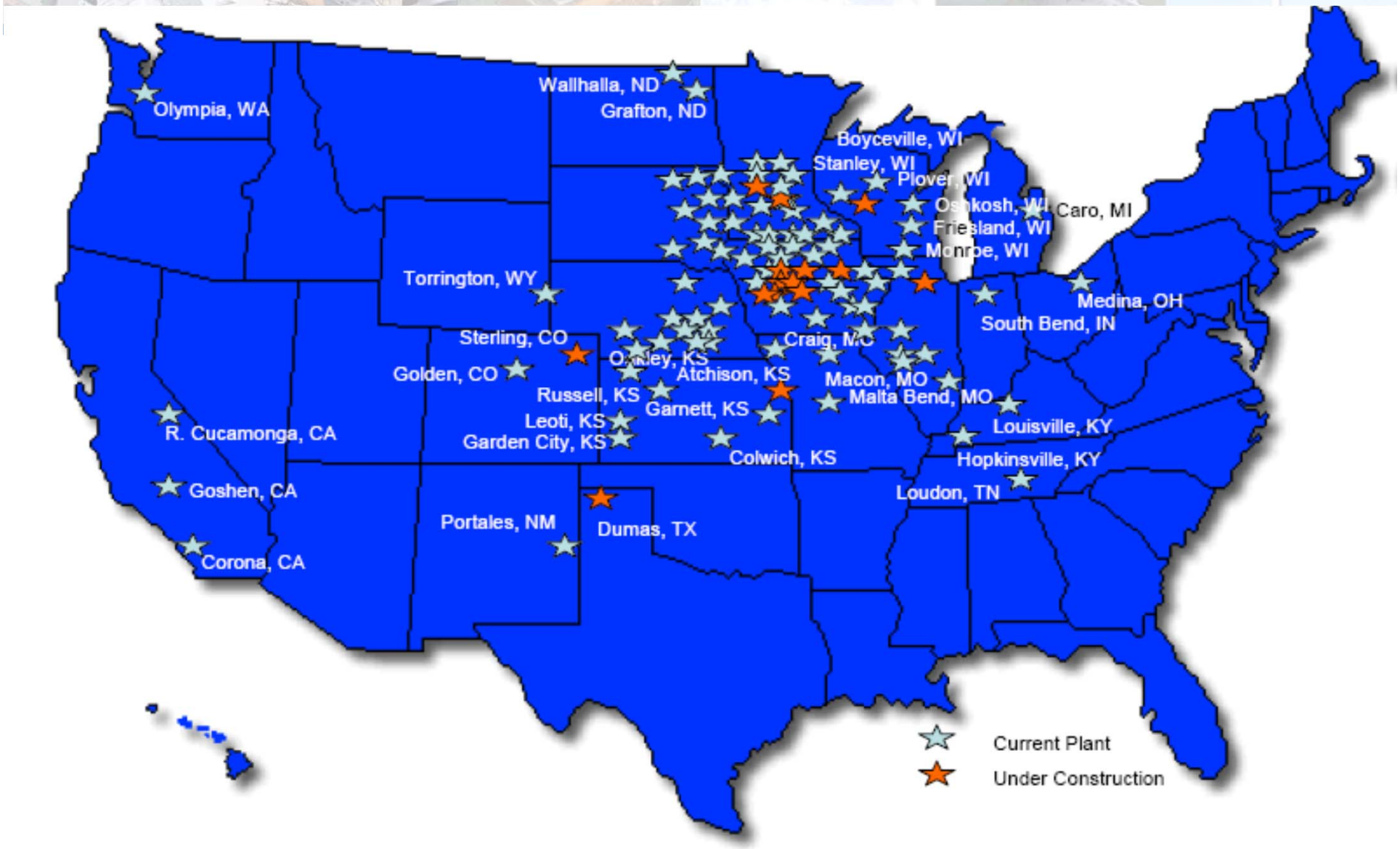
# Visioning a Prosperous Energy Future

## Renewable Fuel Standard - Ethanol Production

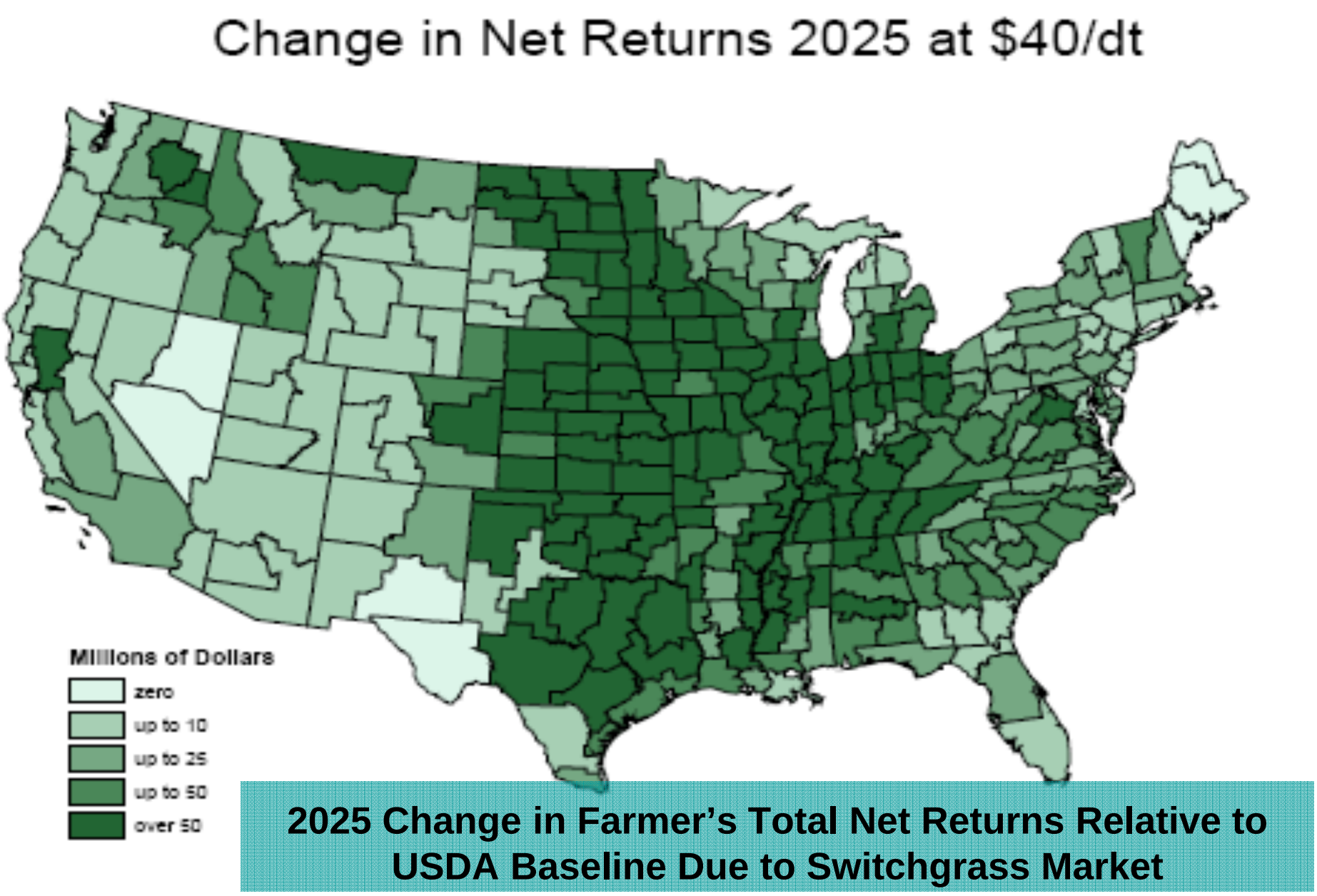


# Visioning a Prosperous Energy Futur

## Location of Ethanol Plants

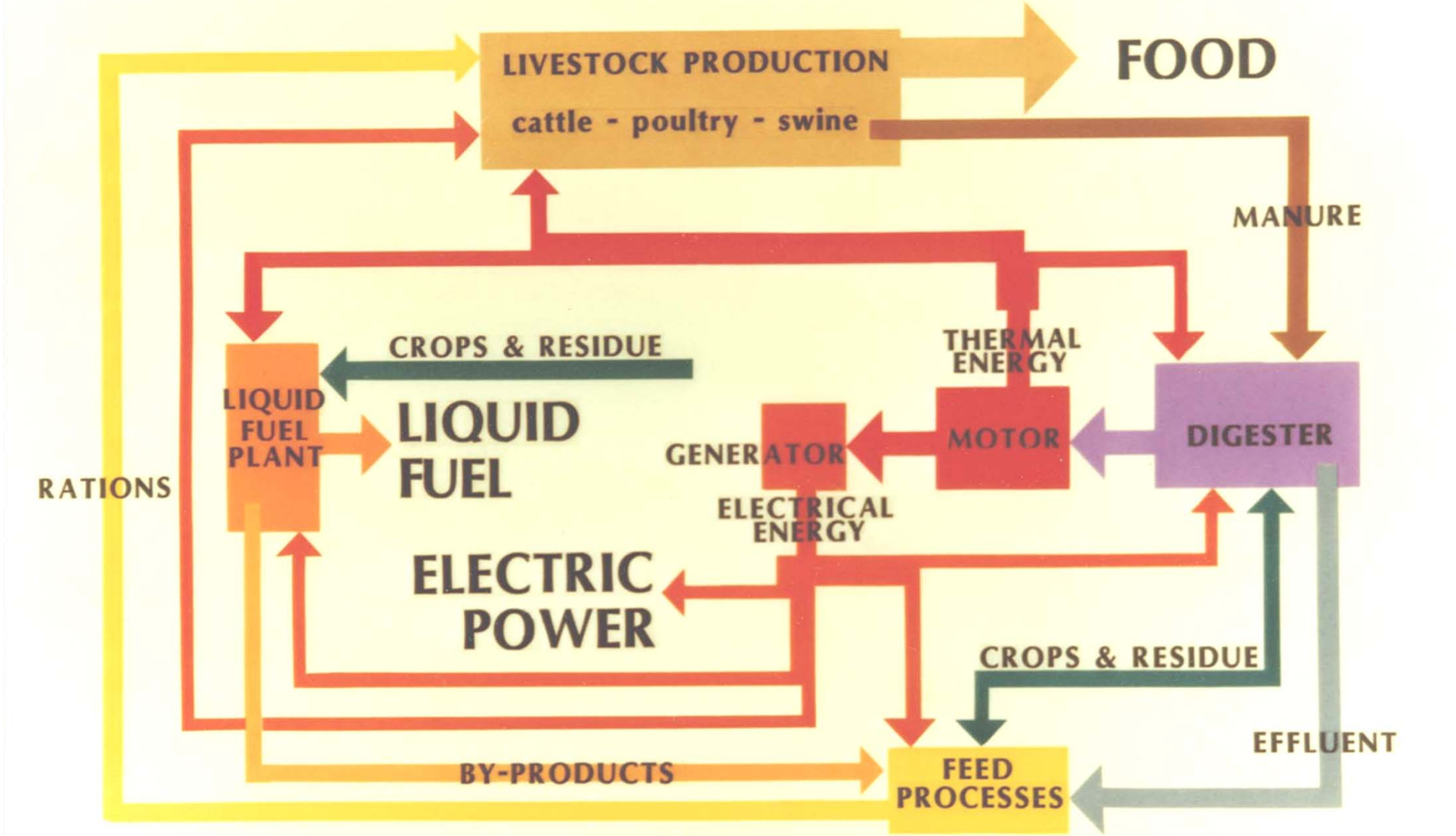


# Visioning a Prosperous Energy Future



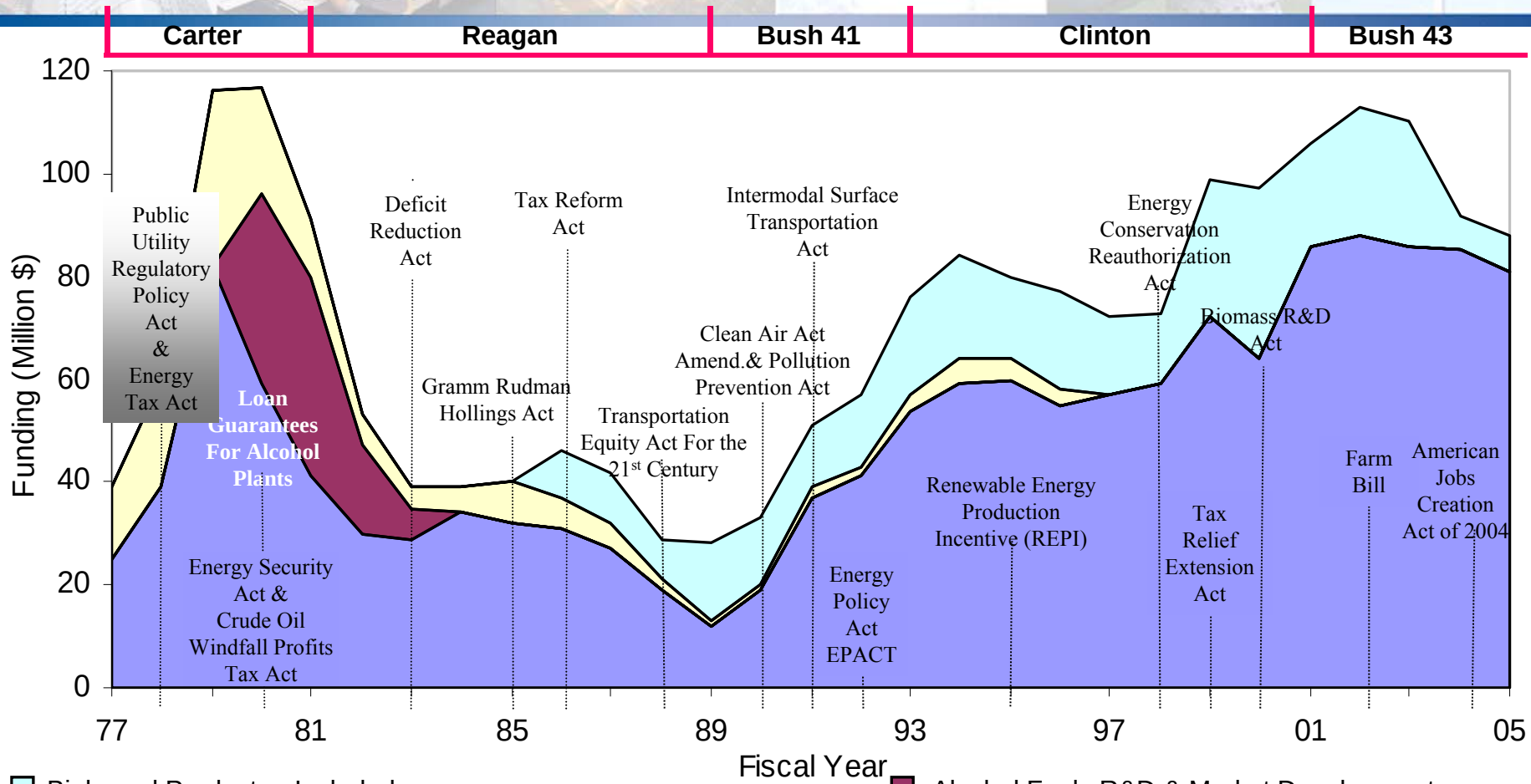

**2025 Change in Farmer's Total Net Returns Relative to USDA Baseline Due to Switchgrass Market**

# Roots




**1974 - - Integrated On-Farm Food/Energy System - - Columbia, Mo**

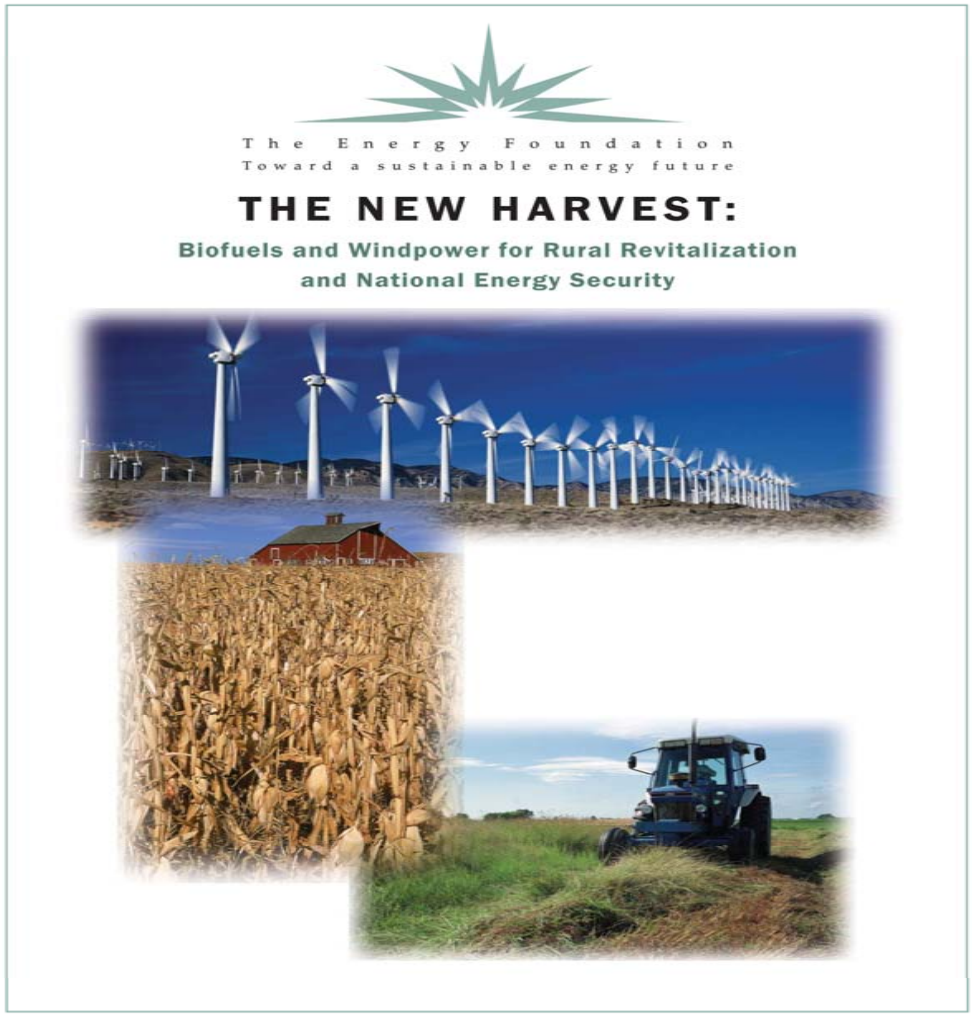
# The Up and Down Support For Biomass



# The Recent Turn Around in Interest Concerning Biomass is a Refreshing Change!

# Visioning a Prosperous Energy Future

## Increasing Role for Agriculture in Supplying Energy



# Visioning a Prosperous Energy Future

## The New Bio-Industry from Plants to Products

**Biomass Feedstock**

– Trees
– Grasses
– Agricultural Crops
– Agricultural Residues
– Animal Wastes
– Municipal Solid Waste

**Conversion Processes**

- Enzymatic Fermentation
- Gas/liquid Fermentation
- Acid Hydrolysis/Fermentation
- Gasification
- Combustion
- Co-firing

**USES**

**Fuels:**
– **Ethanol**
– **Renewable Diesel**

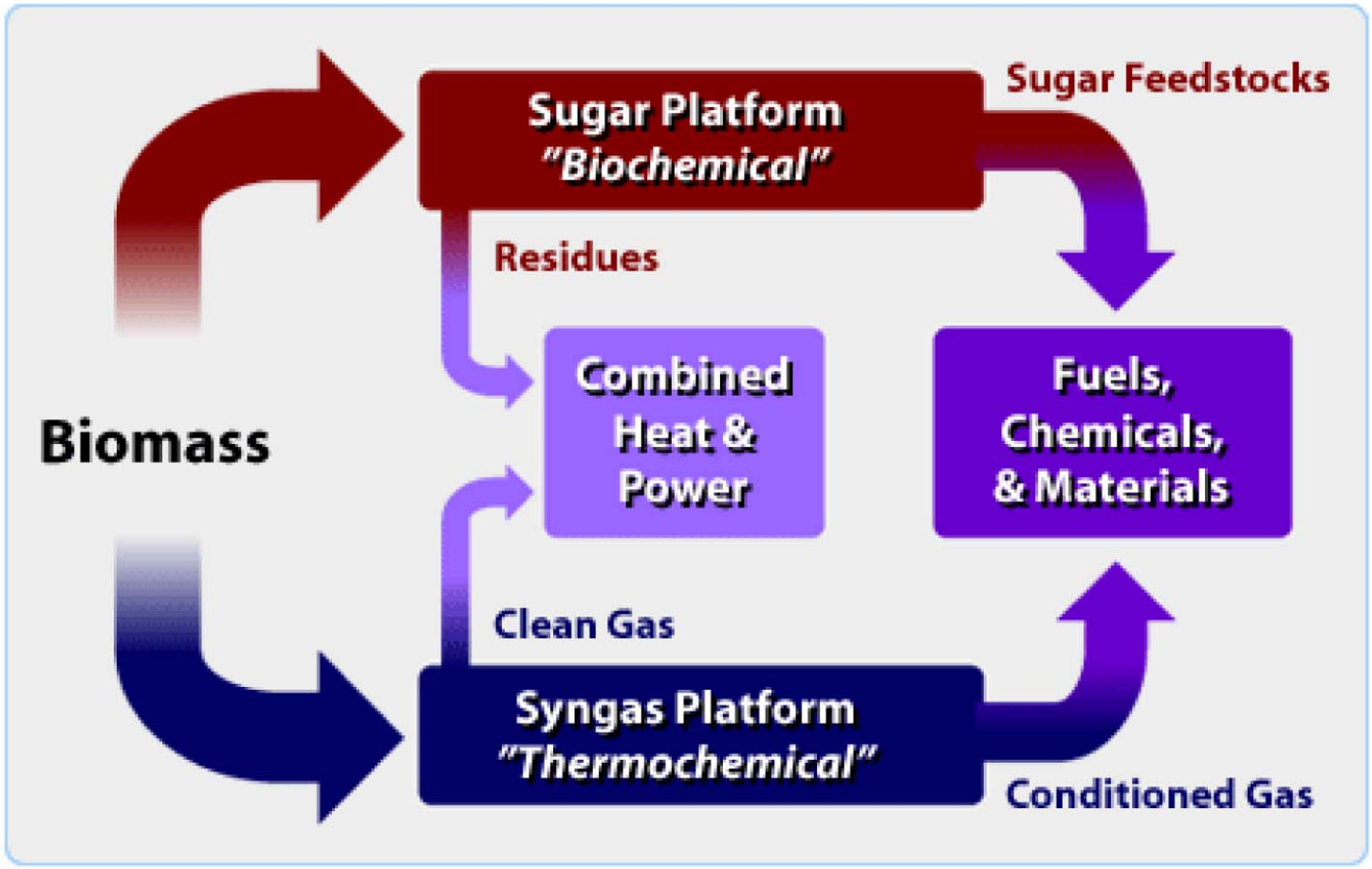
**Power:**
– **Electricity**
– **Heat**

**Chemicals**
– **Plastics**
– **Solvents**
– **Chemical Intermediates**
– **Phenolics**
– **Adhesives**
– **Furfural**
– **Fatty acids**
– **Acetic Acid**
– **Carbon black**
– **Paints**
– **Dyes, Pigments, and Ink**
– **Detergents**
– **Lubricants**
– **Etc.**

**Food and Feed and Fiber**

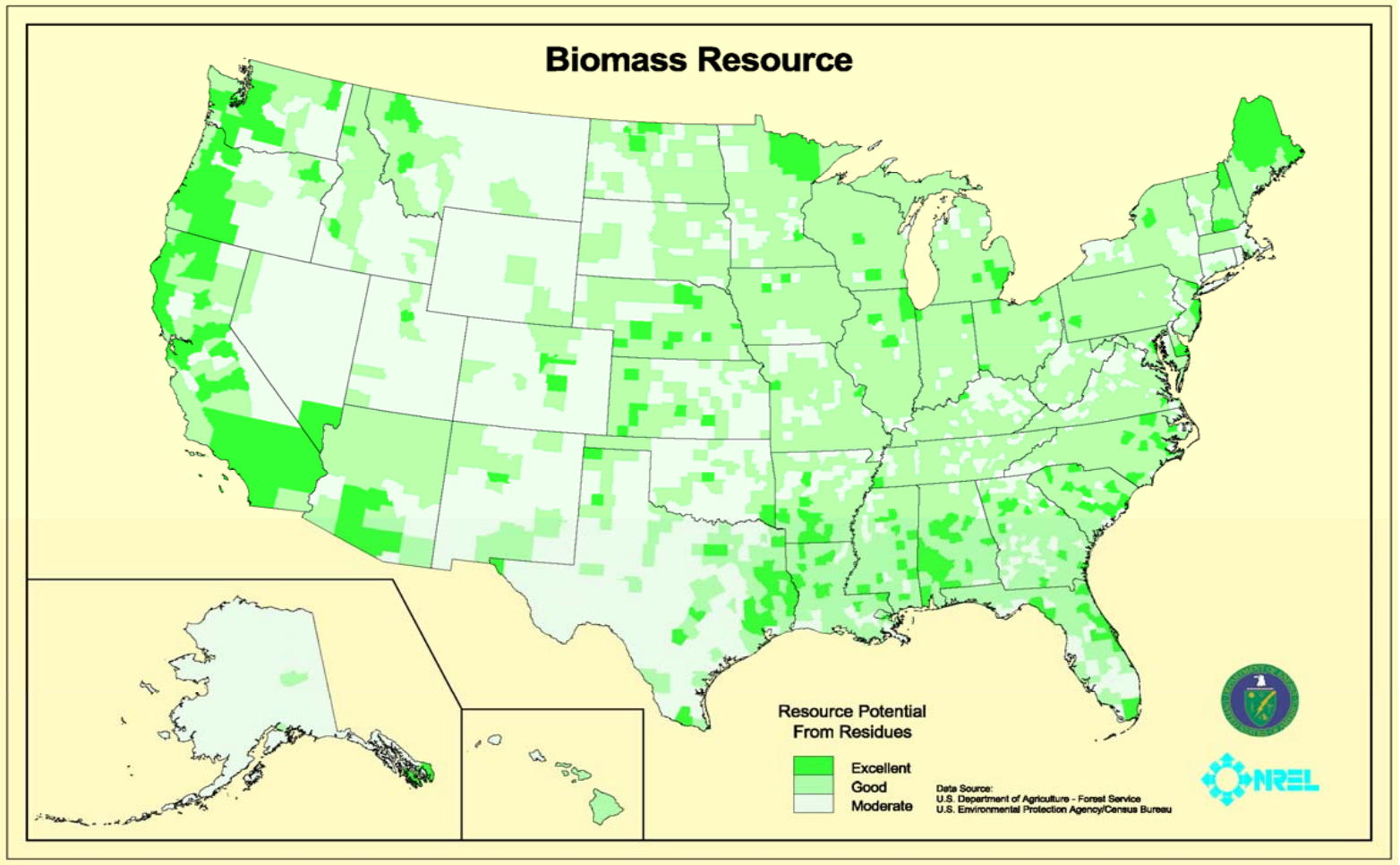
# Visioning a Prosperous Energy Future

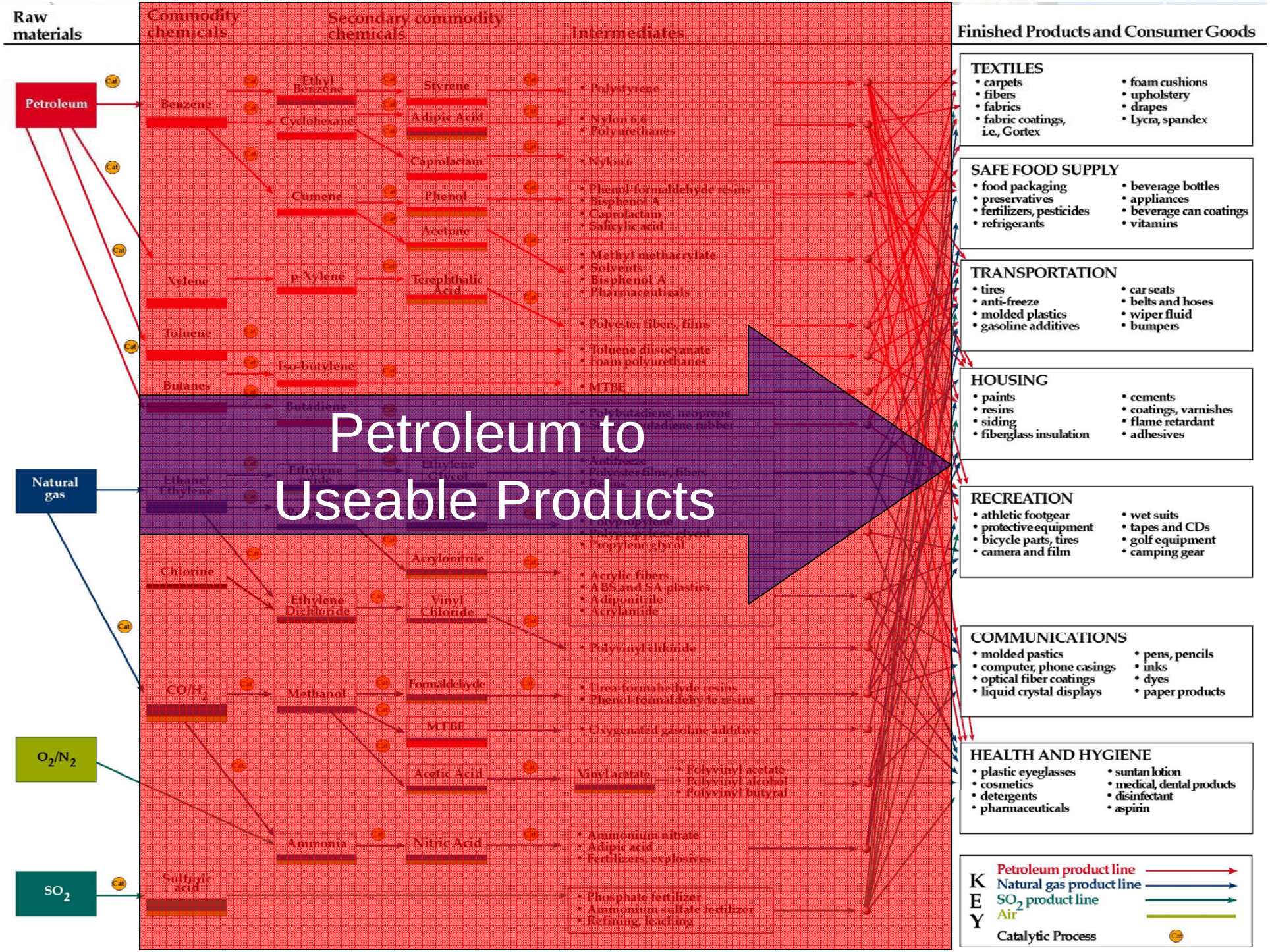
## Biorefinery Technologies

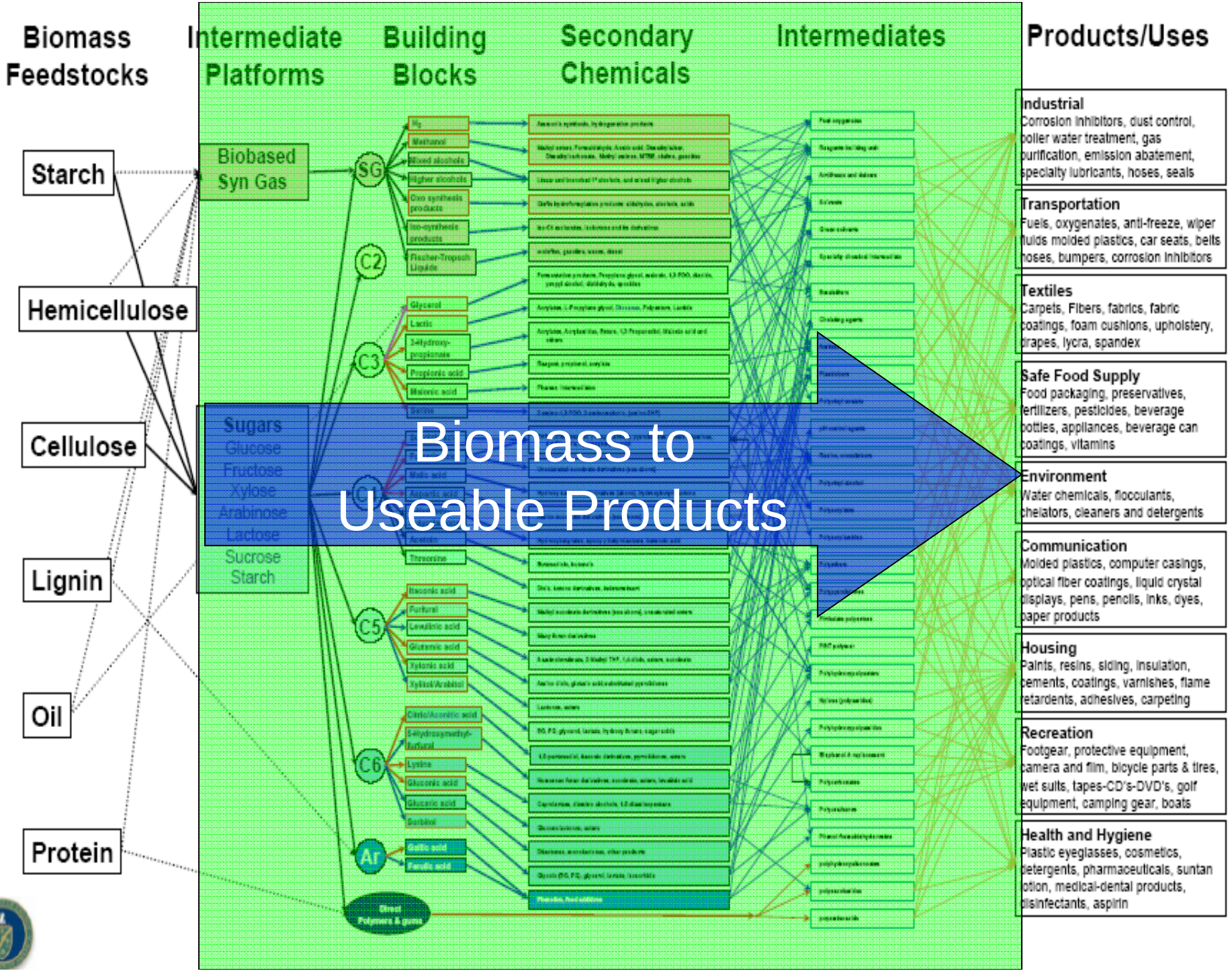


# Visioning a Prosperous Energy Future

## U.S. Biomass Resources



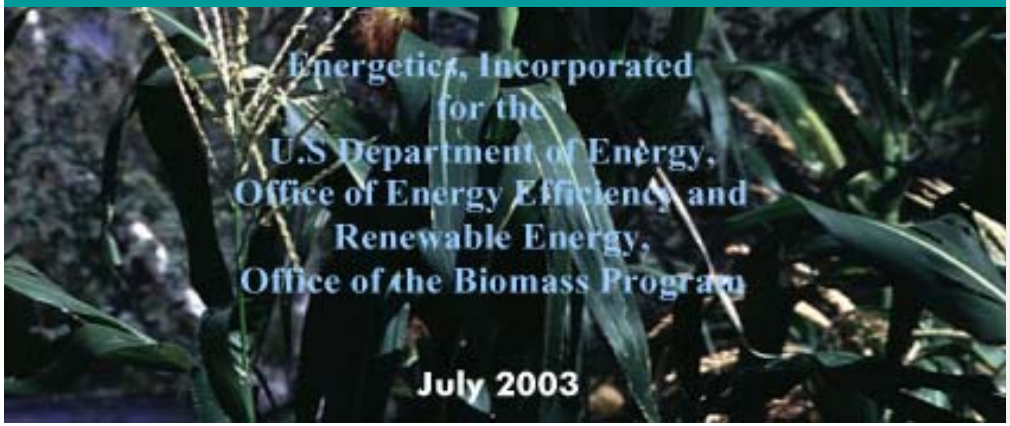

Raw materials
Commodity chemicals
Secondary commodity chemicals
Intermediates
Finished Products and Consumer Goods
Petroleum
Natural gas
$O_2/N_2$
$SO_2$
Benzene
Cyclohexane
Xylene
Toluene
Butanes
Ethane/ Ethylene
Chlorine
$CO/H_2$
Sulfuric acid
Ethyl Benzene
Cumene
p-Xylene
Iso-butylene
Butadiene
Ethylene Oxide
Ethylene Dichloride
Methanol
Ammonia
Styrene
Adipic Acid
Caprolactam
Phenol
Acetone
Terephthalic Acid
Ethylene Glycol
Acrylonitrile
Vinyl Chloride
Formaldehyde
MTBE
Acetic Acid
Nitric Acid
Polystyrene
Nylon 6,6
Polyurethanes
Nylon 6
Phenol-formaldehyde resins
Bisphenol A
Caprolactam
Salicylic acid
Methyl methacrylate
Solvents
Bisphenol A
Pharmaceuticals
Polyester fibers, films
Toluene diisocyanate
Foam polyurethanes
MTBE
Antifreeze
Polyester films, fibers
Propylene glycol
Acrylic fibers
ABS and SA plastics
Adiponitrile
Acrylamide
Polyvinyl chloride
Urea-formahedyde resins
Phenol-formaldehyde resins
Oxygenated gasoline additive
Vinyl acetate
Polyvinyl acetate
Polyvinyl alcohol
Polyvinyl butyral
Ammonium nitrate
Adipic acid
Fertilizers, explosives
Phosphate fertilizer
Ammonium sulfate fertilizer
Refining, leaching
TEXTILES
carpets
fibers
fabrics
fabric coatings, i.e., Gortex
foam cushions
upholstery
drapes
Lycra, spandex
SAFE FOOD SUPPLY
food packaging
preservatives
fertilizers, pesticides
refrigerants
beverage bottles
appliances
beverage can coatings
vitamins
TRANSPORTATION
tires
anti-freeze
molded plastics
gasoline additives
car seats
belts and hoses
wiper fluid
bumpers
HOUSING
paints
resins
siding
fiberglass insulation
cements
coatings, varnishes
flame retardant
adhesives
RECREATION
athletic footgear
protective equipment
bicycle parts, tires
camera and film
wet suits
tapes and CDs
golf equipment
camping gear
COMMUNICATIONS
molded pastics
computer, phone casings
optical fiber coatings
liquid crystal displays
pens, pencils
inks
dyes
paper products
HEALTH AND HYGIENE
plastic eyeglasses
cosmetics
detergents
pharmaceuticals
suntan lotion
medical, dental products
disinfectant
aspirin
KEY
Petroleum product line
Natural gas product line
$SO_2$ product line
Air
Catalytic Process
Cat
Petroleum to Useable Products


Biomass Feedstocks
Intermediate Platforms
Building Blocks
Secondary Chemicals
Intermediates
Products/Uses
Starch
Hemicellulose
Cellulose
Lignin
Oil
Protein
Biobased Syn Gas
Sugars
Glucose
Fructose
Xylose
Arabinose
Lactose
Sucrose
Starch
SG
C2
C3
C4
C5
C6
Ar
Biomass to Useable Products
Industrial
Corrosion inhibitors, dust control, boiler water treatment, gas purification, emission abatement, specialty lubricants, hoses, seals
Transportation
Fuels, oxygenates, anti-freeze, wiper fluids molded plastics, car seats, belts hoses, bumpers, corrosion inhibitors
Textiles
Carpets, Fibers, fabrics, fabric coatings, foam cushions, upholstery, drapes, lycra, spandex
Safe Food Supply
Food packaging, preservatives, fertilizers, pesticides, beverage bottles, appliances, beverage can coatings, vitamins
Environment
Water chemicals, flocculants, chelators, cleaners and detergents
Communication
Molded plastics, computer casings, optical fiber coatings, liquid crystal displays, pens, pencils, inks, dyes, paper products
Housing
Paints, resins, siding, insulation, cements, coatings, varnishes, flame retardents, adhesives, carpeting
Recreation
Footgear, protective equipment, camera and film, bicycle parts & tires, wet suits, tapes-CD's-DVD's, golf equipment, camping gear, boats
Health and Hygiene
Plastic eyeglasses, cosmetics, detergents, pharmaceuticals, suntan lotion, medical-dental products, disinfectants, aspirin

# Visioning a Prosperous Energy Future

## Biorefineries & Bioproducts


- Help farms stay competitive in the global marketplace
- Add vigor to rural American economies
- Decrease reliance on imports
- Environment benefits




### Top Value Added Chemicals from Biomass

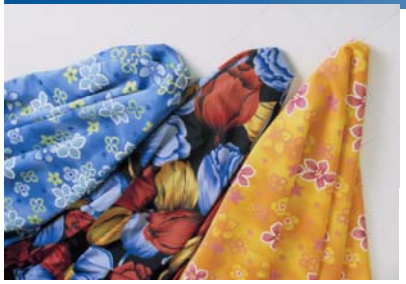
Volume I—Results of Screening for Potential Candidates from Sugars and Synthesis Gas

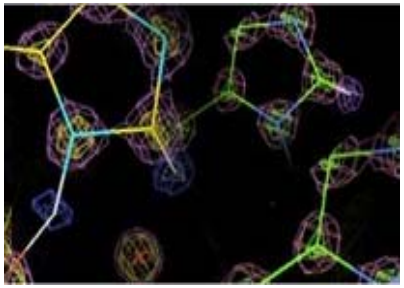
| |
|---|
| 1,4 succinic, fumaric and malic acids |
| 2,5 furan dicarboxylic acid |
| 3 hydroxy propionic acid |
| aspartic acid |
| glucaric acid |
| glutamic acid |
| itaconic acid |
| levulinic acid |
| 3-hydroxybutyrolactone |
| glycerol |
| sorbitol |
| xylitol/arabinitol |

Produced by the Staff at
Pacific Northwest National Laboratory (PNNL)
National Renewable Energy Laboratory (NREL)
Office of Biomass Program (EERE)
For the Office of the Biomass Program
T. Werpy and G. Petersen, Editors

# Visioning a Prosperous Energy Future

## Production of Biochemicals as Intermediates for Bioproducts





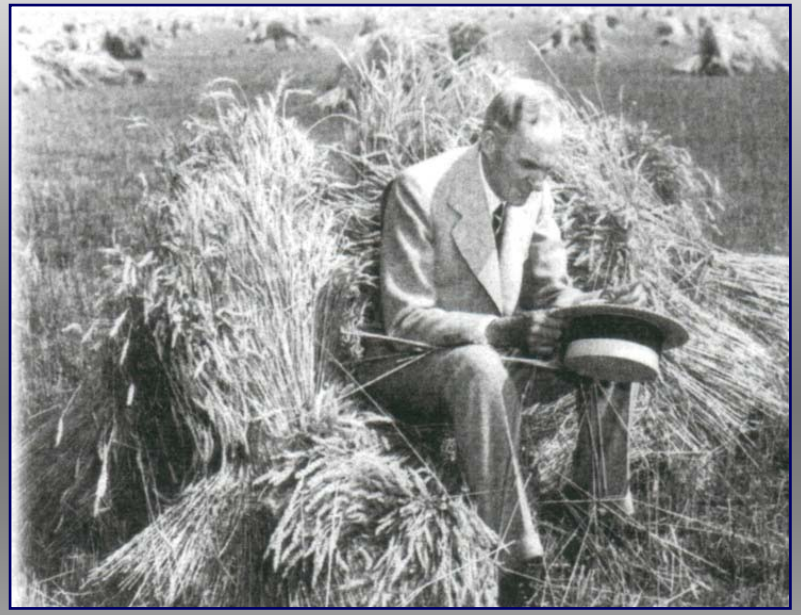
- A DuPont/DOE collaboration will develop a new form of biorefinery
- This New technology will convert corn stover into fermentable sugars for the production of added-value chemicals such as 1,3 propanediol for the high performance polyester, Sorona™.

## Cellulosic Ethanol

- Barriers – cost of enzymes for the production of sugars
- Two U.S. enzyme companies, Genencor & Novozymes have successfully reduced cost of enzymes by ½
- Have cut costs tenfold and are working on further cost reductions to make the production of ethanol from lignocellulosic material economical.

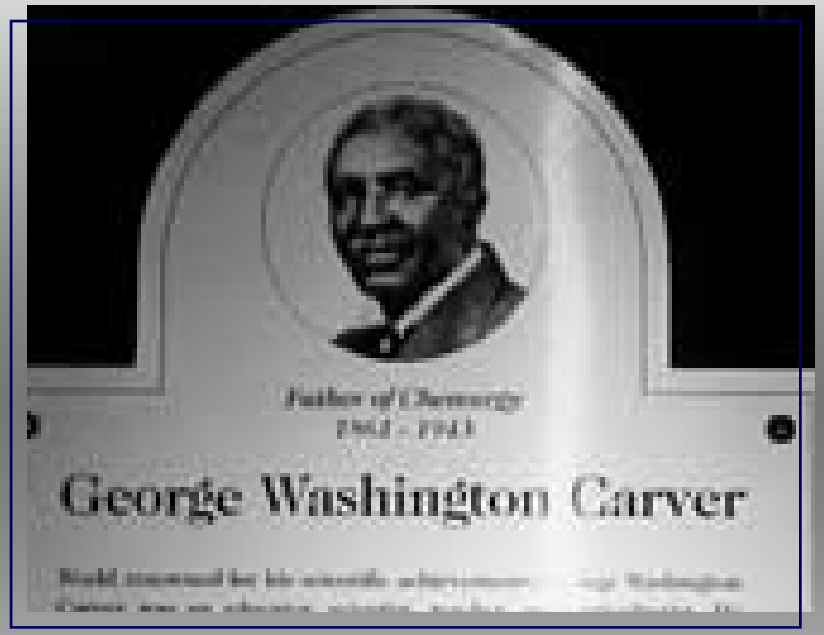
# Visioning a Prosperous Energy Future

## Biomass Technology — Back To The Future?



**Henry Ford wearing a suit made of soy fiber**

*From Harold Brock, The Fords of My Past*




**Renowned botanist George Washington Carver made rubber from sweet potatoes, marble from wood shavings, and ink, dye, and insulating board from peanuts.**

# Visioning a Prosperous Energy Future

## Commercialization of Bioproducts

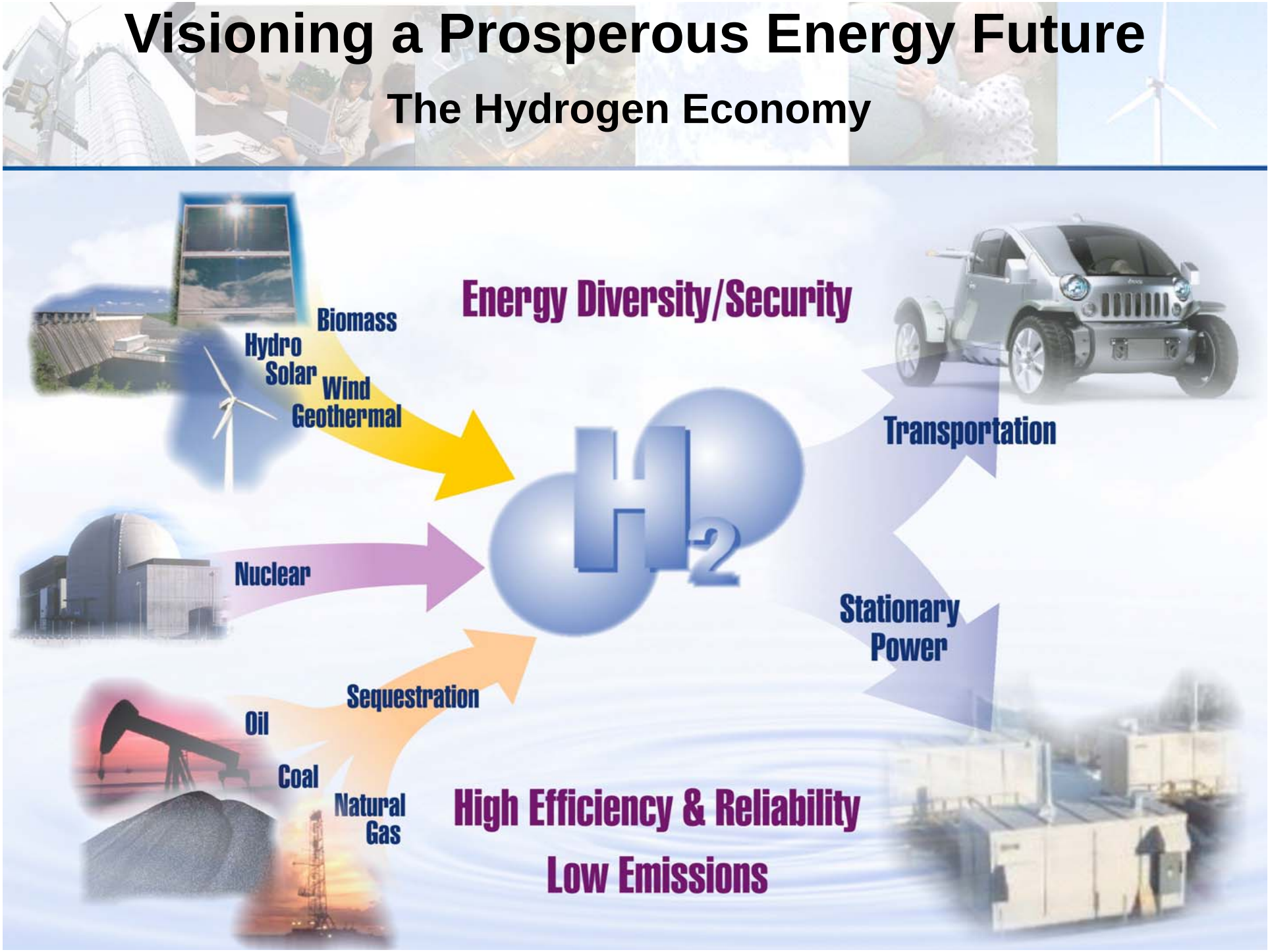
**Source: Toyota Motor Corp.**

### Toyota Motor Corp. Pursuing Bio-plastics

- Bio-plastic (polylactic acid, or PLA) pilot plant with yearly production capacity of 1,000 tons under construction
- First use of bio-plastics for vehicle interior parts on the new Raum and Prius
- Goal: To supply 20 million tonnes of bio-plastics by 2020

# Visioning a Prosperous Energy Future

## The Hydrogen Economy



# Visioning a Prosperous Energy Future

**Biomass**

**Hydro**
**Wind**
**Solar**
**Geothermal**

**Nuclear**

**Coal**
**with Carbon Sequestration**

**Natural Gas**
**(Transition only)**

**HIGH EFFICIENCY & RELIABILITY**

$H_2$

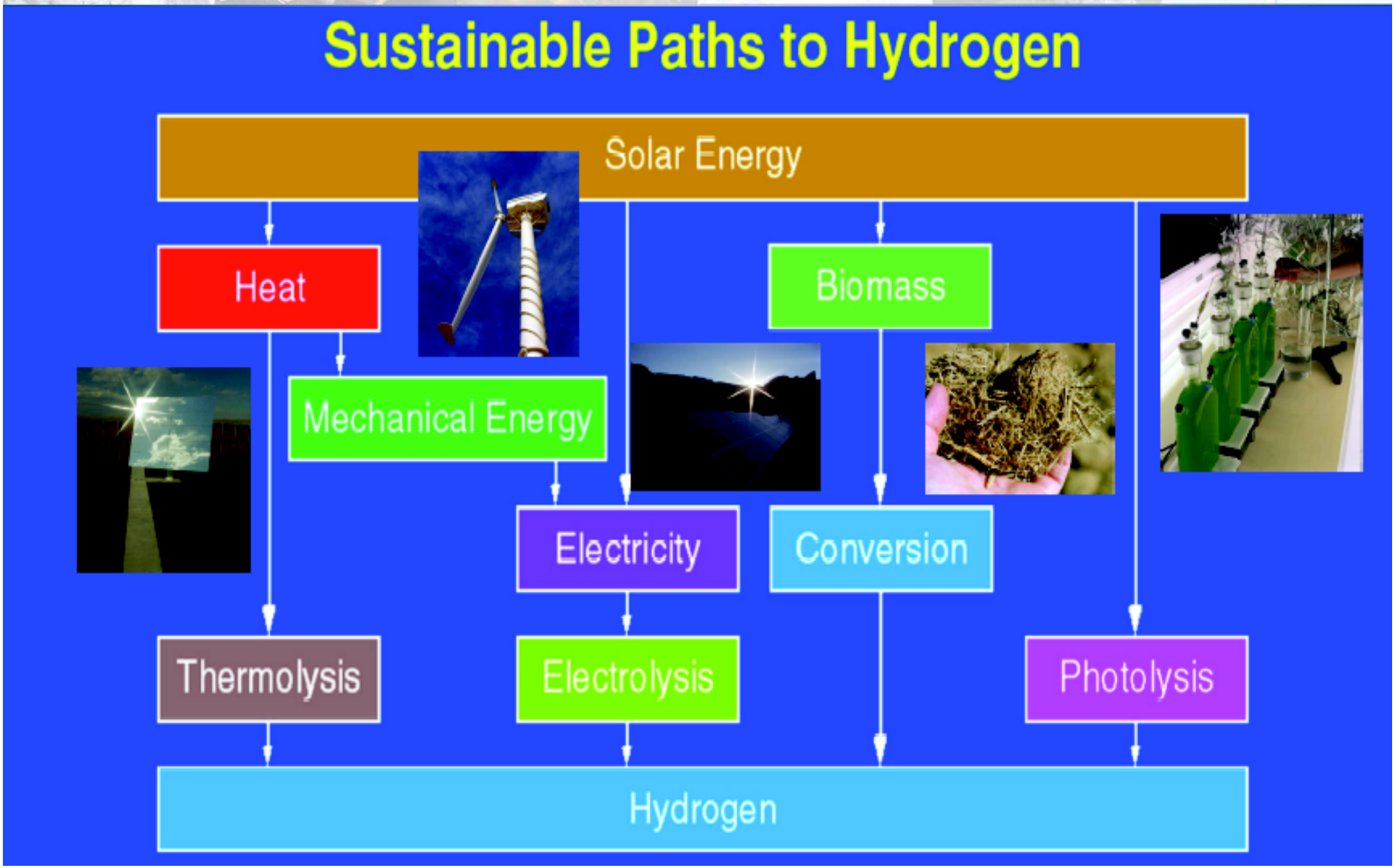
**ZERO / NEAR ZERO EMISSIONS**

**Transportation**

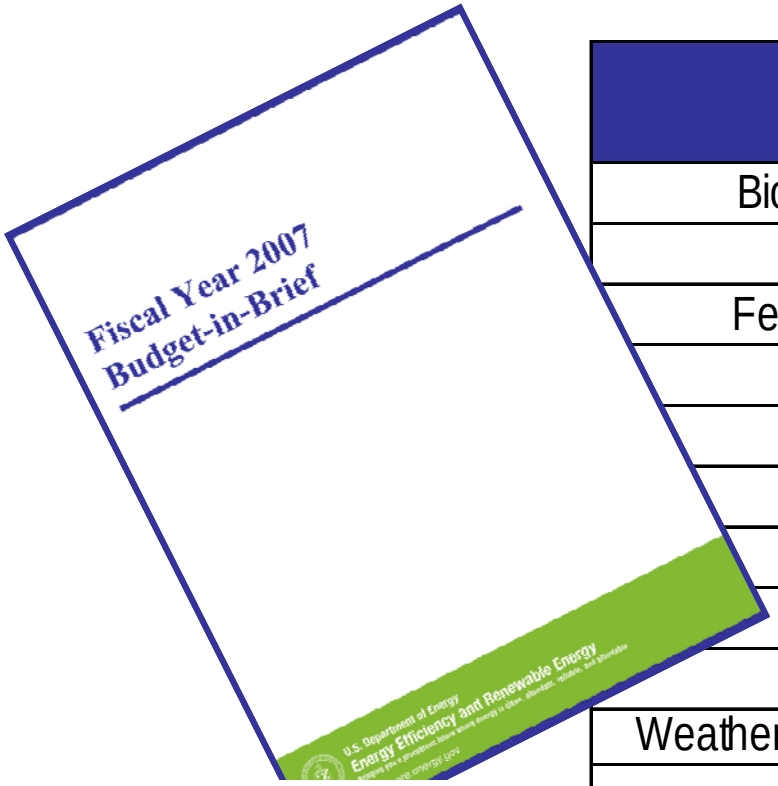
**Distributed Generation**

# Visioning a Prosperous Energy Future

## Renewable Energy Pathways to Hydrogen



# U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) Budget



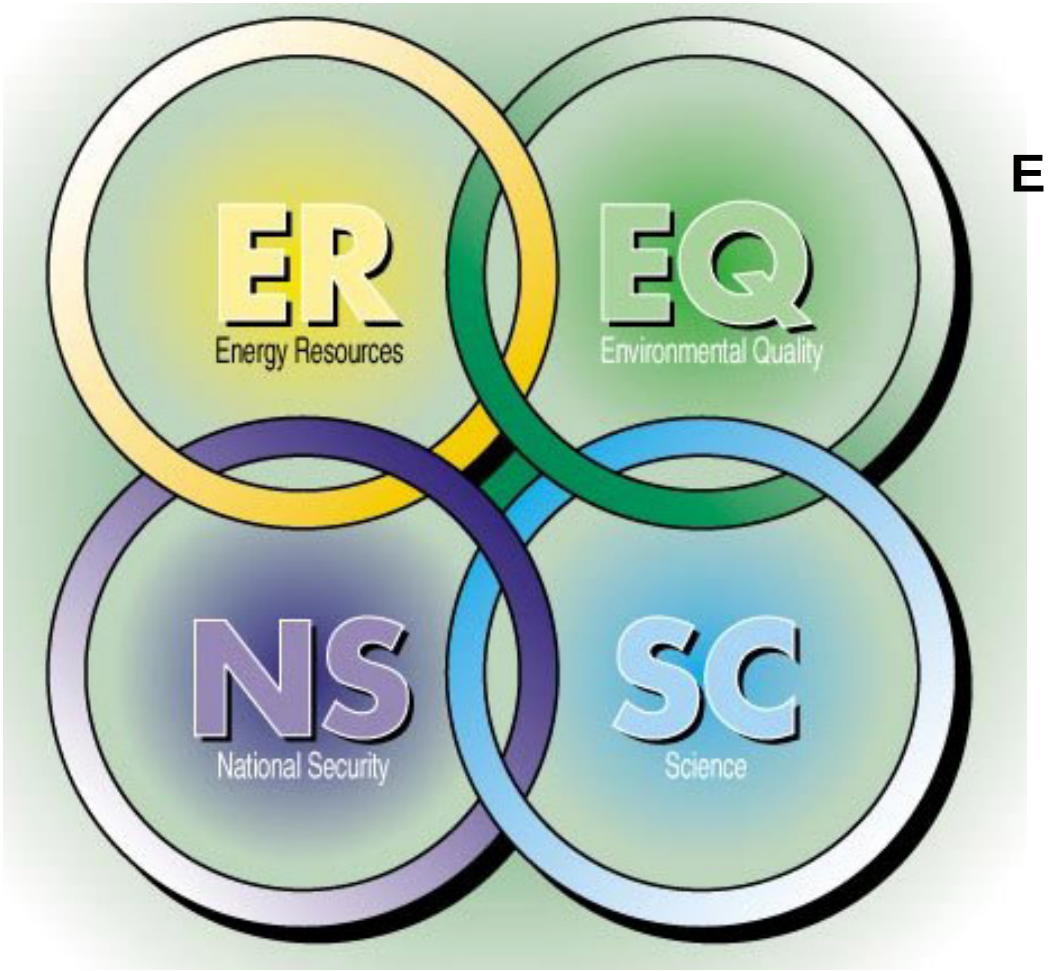

**The Fiscal Year 2007 Budget-in-Brief can be downloaded from *www1.eere.energy.gov/ba/pdfs/FY07_budget_brief.pdf***

| | FY 2006 Approp | FY 2007 Request |
|---|---|---|
| Biomass and Biorefinery Systems R&D | 90,718 | 149,687 |
| Building Technologies | 69,266 | 77,329 |
| Federal Energy Management Program | 18,974 | 16,906 |
| Geothermal Technology | 23,066 | 0 |
| Hydrogen Technology | 155,627 | 195,801 |
| Hydropower | 495 | 0 |
| Industrial Technologies | 56,855 | 45,563 |
| Solar Energy | 83,113 | 148,372 |
| Vehicle Technologies | 182,104 | 166,024 |
| Weatherization & Intergovernmental Activities | 316,866 | 225,031 |
| Wind Energy | 38,857 | 43,819 |
| Program Support | 13,321 | 10,930 |
| Program Direction | 98,529 | 91,024 |
| TOTAL EERE | 1,173,843* | 1,176,421 |

*Congressionally directed activities = $159 million

# Developing Strategies

**Energy Resources**




**Environmental Quality**

**National Security**

**Science**

***DOE is the THIRD largest government sponsor of basic research and FOURTH largest sponsor of applied research in the United States.***

# The Future is Coming at Us Very Fast — What is Your Strategy to Catch It?

# Developing Strategies

## President George W. Bush — State of the Union Address

- **"America is addicted to oil, which is often imported from unstable parts of the world."**
- **"The best way to break this addiction is through technology."**
- **"…. replace more than 75 percent of our oil imports from the Middle East by 2025."**

Capitol,
Tuesday, Jan. 31, 2006
White House photo by Eric Draper

**"By applying the *talent and technology* of America, this country can**

- **dramatically improve our environment,**
- **move beyond a petroleum-based economy, and**
- **make our dependence on Middle Eastern oil a thing of the past."**

# Developing Strategies

## Renewable and Clean Energy Production

- **$281 million for development of clean technologies**
  - **$54 million for the FutureGen program**
    - **zero-emissions coal plant**
    - **with carbon capture capacity**
  - **$148 million for solar energy programs**
  - **$44 million for wind energy programs**

# Developing Strategies

## Renewable and Clean Energy Production



**$150 million for cellulosic ethanol –**

- **"practical and competitive" within six years.**
- **displace up to 30 percent of the nation's fuel use**
- **$60 million above the Biomass and Biorefinery Systems R&D FY 06**

- **$30 million for work to improve battery technology for hybrid vehicles and "plug-in hybrids.**
- **$289 million to speed up development of hydrogen fuel cells and hydrogen-powered cars**

# Developing Strategies

## Technology — Key Energy Efficiency and Renewable Energy Research Goals

| | | |
|---|---|---|
|  | **Hydrogen & Fuel Cell Technology** | **Industry decision by 2015 to commercialize hydrogen-powered fuel cell vehicles** |
|  | **Solid State Lighting** | **Capture at least a 50 percent electricity peak demand reduction in commercial buildings' lighting load** |
|  | **Zero Energy Buildings** | **Enable the design and construction of net Zero Energy Buildings by 2020** |
|  | **Distributed Energy Resources** | **Develop by 2015 a diverse array of integrated distributed generation and thermal energy technologies** |
|  | **Wind Technology** | **Accelerate offshore wind and low wind speed technology**<br>**By 2010, facilitate the installation of a least 100 MW in 16 states (currently 20MW)** |

# Developing Strategies

## Technology

| Key Energy Efficiency and Renewable Energy Research Goals | |
|---|---|
|  **Vehicle Technology** | **Improve engine efficiency for passenger vehicles to 45 percent by 2010 and for commercial vehicles to 55 percent by 2013** |
|  **Solar Technology** | **Developing next-generation PV technologies such as "thin film" PV cells and "leap frog" technologies such as polymers and nanostructures** |
|  | **If photovoltaic (PV) goals are met, industry projects that PV capacity could reach 30,000 megawatts (MW) in the United States by 2020 (currently 100-150 MW)** |
|  **Biorefineries** | **In 2008, complete construction of at least one industrial scale project for a near term pathway such as agricultural residues or oilseeds with validation in 2009** |
|  | **In 2009, complete preliminary design of a least 2 additional biorefineries for longer term pathways such as pulp and paper and perennial grasses** |

# Developing Strategies

## Technology

## Energy Success Stories - Progress IS Underway

Compact Fluorescents

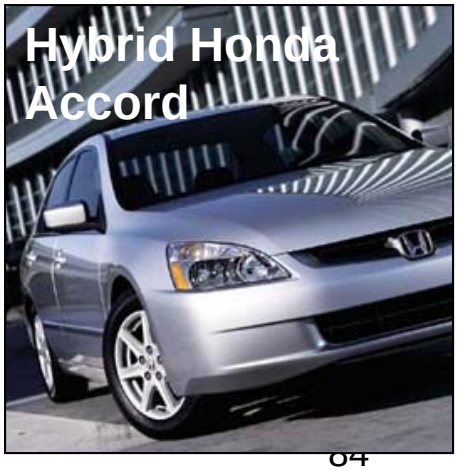

GM's Hybrid Bus

Solar Technology

Wind Technology

Energy Efficient Appliances

Solid State Lighting



Hybrid Honda Accord


# Developing Strategies

## Energy Star

- Voluntary labeling program to help promote energy-efficient products to reduce greenhouse gas emissions;
- More than 8,000 private and public sector organizations as partners;
- Driving force behind the more widespread use of such technological innovations such as:
  - efficient fluorescent lighting,
  - LED traffic lights,
  - power management systems for office equipment, and
  - low standby energy use.
- ENERGY STAR saved businesses, organizations, and consumers about $10 billion in 2004 alone.

# Developing Strategies

## Technology — Advancing Technologies Through R&D

**Soldiers, homeowners, and campers**

L**ightweight, mobile power** source

**Thin-film Copper Indium Gallium diSelenid (CIGS) photovoltaic (PV) modules**

**National Renewable Energy Laboratory, Golden, CO, and Global Solar Energy, Tucson, AZ**

**“Smart windows” that boast a 22 – 42 % gain in energy savings performance over other low emissivity glazings**

**Transition Metal Switchable Mirror (TMSM) coating**

**Lawrence Berkeley National Laboratory**

**Researchers at Oak Ridge National Laboratory developed an advanced heating system for high-performance aluminum forgings that uses less energy than conventional techniques**.

# Developing Strategies

## Technology — Partnering with Industry for Success


### FreedomCAR and Fuel Partnership

- BP America
- ChevronTexaco Corporation
- ConocoPhillips
- Exxon Mobil Corporation
- Shell Hydrogen (U.S.)
- U.S. Council for Automotive Research (USCAR)
- DaimlerChrysler Corporation
- Ford Motor Company
- General Motors Corporation
- U.S. Department of Energy









# Developing Strategies

## Energy Policy Act of 2005

- The Energy Policy Act of 2005 was signed into law by President Bush on August 8, 2005.
- The comprehensive 1,724 page bill provides over $12 billion in tax breaks and other production and conservation incentives for both industry and consumers *(The Table of Contents alone is 19 pages!)*

# Developing Strategies

## Energy Policy Act of 2005 - Major Titles of Energy Act

| | |
|---|---|
| Title I—Energy Efficiency | Title X—Department of Energy Management |
| Title II—Renewable Energy | Title XI—Personnel and Training |
| Title III—Oil and Gas | Title XII—Electricity |
| Title IV—Coal | Title XIII—Energy Policy Tax Incentives |
| Title V—Indian Energy | Title XIV—Miscellaneous |
| Title VI—Nuclear Matters | Title XV—Ethanol and Motor Fuels |
| Title VII—Vehicles and Fuels | Title XVI—Climate Change |
| Title VIII—Hydrogen | Title XVII—Incentives for Innovative Technologies |
| Title IX—Research and Development | Title XVIII—Studies |

# EPAct 2005 Provisions

## Government Procurement Helping to Create Markets for Energy Technologies

- **Federal Government Renewable Purchase Requirement (Sec. 203)**
  - **By 2013, federal government must buy at least 7.5 percent of its electricity from renewable energy sources**
- **Federal and State procurement of fuel cell vehicles and hydrogen energy systems (sec. 782)**
- **Federal procurement of stationary, portable and micro fuel cells (Sec. 783)**
- **Federal procurement of energy efficient products (Sec. 104)**

# EPAct 2005 Provisions

## Financing Incentives

- **Renewable Energy Production Incentive (Sec. 202)**
  - sets a **renewable fuels standard** of 7.5 billion gallons per year by 2012 for increased use of ethanol and biodiesel.
- **Grants for Facilities using Forest Biomass to Produce Energy (Sec. 210)**
- **Grants to Producers of Certain Ethanol (including cellulosic biomass, waste-derived-ethanol, approved renewable fuels (Sec. 1512)**

# EPAct 2005 Provisions

## Tax Incentives

### Renewable Energy

- Extension and Equalization of the Production Tax Credit
- Clean Renewable Energy Bonds (CREBs)
- Extension of Biodiesel Income and Excise Tax Credits
- New Small Producer Biodiesel Credit
- Modifications to the Small Ethanol Producer Credit
- Alternative Fuel Refueling Property
- Residential Solar (heat and electricity) tax credit
- Business Solar Investment Tax Credit


### Energy Efficiency and Conservation Incentives

- High-Efficiency Vehicles
- Residential Fuel Cell Equipment
- Business Tax Credit for Purchase of Fuel Cell Power Plants
- Personal Credit for Energy Efficient Home Improvements
- Credit for Commercial Building Energy Reductions
- Business Tax Credit for Developer Constructing Fuel Efficient Homes
- Manufacturers' Tax Credit for High-Efficiency Appliances

# Setting New Appliance Efficiency Standards

- **By 2030, standards could save 180 billion kilowatt-hours and about $15 billion in utility bills each year (ACEEE)**

## In Process of Setting Appliance Standards On:

- Air Conditioners And Heat Pumps
- Clothes Washers
- Distribution Transformers
- Exit Signs
- Fluorescent Lamp Ballast
- Ice-makers
- Mercury Vapor Lamp Ballast
- Pedestrian Signals
- Pre-rinse Spray Valves
- Refrigerators And Freezers
- Traffic Signals
- Unit Heaters

# Developing Strategies

## Opportunities

- Take advantage of EPACT provisions to leverage efforts and make strides at local, regional, and national level:
  - **Utilities and other agencies** implementing electricity-saving programs could gear their programs to complement these new tax incentives (including enhanced programs to promote efficient new homes; new commercial buildings; appliances; heating, air conditioning, and water heating equipment; and retrofits to existing homes)
  - **State agencies and others** interested in distributed generation could consider policy initiatives and promotions to complement federal incentives for stationary fuel cells and microturbines.
  - **States and others interested** in promoting advanced cars and trucks could use federal hybrid, fuel cell, and advanced diesel vehicle tax credits to support their efforts.

# Developing Strategies

## Additional Information on EPACT 2005

- ***http://aceee.org/pubs/e053.htm***

  Excellent summary of EPACT 2005 energy efficiency provisions from the American Council for an Energy-Efficient Economy (ACEEE)

- ***http://www.ncseonline.org/NLE/CRS/abstract.cfm?NLEid=22053***

  Good material from Congressional Research Service on renewable energy and EPACT 2005

- ***http://energycommerce.house.gov/108/0205_Energy/conference/EnergyConf_report.pdf***

  Full text version of the Energy Policy Act of 2005

# Developing Strategies

## 2002 Farm Bill

**THE FARM SECURITY AND RURAL INVESTMENT ACT - 2002**

***TITLE I – COMMODITY PROGRAMS***
***TITLE II – CONSERVATION***
***TITLE III – AGRICULTURAL TRADE AND AID***
***TITLE IV – NUTRITION PROGRAM***
***TITLE V – FARM CREDIT***
***TITLE VI – RURAL DEVELOPMENT***
***TITLE VII – RESEARCH***
***TITLE VII – FORESTRY***
***TITLE IX – ENERGY***
***TITLE X – MISCELLANEOUS PROVISIONS***

# Developing Strategies

## Title IX Energy

| Section | Name |
|---|---|
| 9001 | DEFINITIONS – (OCE) |
| 9002 | FEDERAL PROCUREMENT OF BIOBASED PRODUCTS – (OCE) |
| 9003 | BIOREFINERY DEVELOPMENT GRANTS – (RD) |
| 9004 | BIODIESEL FUEL EDUCATION PROGRAM – (OCE) |
| 9005 | ENERGY AUDIT AND RENEWABLE ENERGY DEVELOPMENT PROGRAM (RD) |
| 9006 | RENEWABLE ENERGY SYSTEMS AND ENERGY EFFICIENCY IMPROVEMENTS – (RD-RBS) |
| 9007 | HYROGEN AND FUEL CELL TECHNOLOGIES – (OCE) |
| 9008 | BIOMASS RESEARCH AND DEVELOPMENT – (NRE) |
| 9009 | COOPERATIVE RESEARCH AND EXTENSION PROJECTS – (REE-CSREES) |
| 9010 | CONTINUATION OF BIOENERGY PROGRAM – (CCC) |

# Developing Strategies

## Summary of Section 9006 Technology Grants for Energy Efficiency and Renewable Energy

| | 2003 ($) | 2004 ($) | 2005 ($) |
|---|---|---|---|
| Digesters | 7,446,530 | 9,508,946 | 4,813,267 |
| Bioenergy | 2,529,005 | 3,136,132 | 2,118,391 |
| Efficiency, Buildings | 262,037 | 1,635,799 | 783,019 |
| Efficiency, Industrial | 1,242,215 | 177,175 | 187,813 |
| Geothermal | | 285,353 | 94,930 |
| Hybrid | 2,112,977 | 126,992 | 199,863 |
| Solar | 725,566 | 54,822 | 661,855 |
| Wind, large | 6,701,769 | 7,301,540 | 11,251,373 |
| Wind, small | 187,134 | 585,290 | 101,157 |
| Total | 21,207,233 | 22,812,049 | 20,068,246 |

# Developing Strategies

## Summary of National Applications for Past Three Years

| | Grant Applications | | Grant Funds $$ | | Project Funds$$ | |
|---|---|---|---|---|---|---|
| | Requests | Awards | Requests | Awards | Requests | Awards |
| 2003 | 149 | 114 | 24.1M | 21.7M | 733.3M | 498.2M |
| 2004 | 249 | 167 | 37.5M | 22.8M | 825.6M | 165.9M |
| 2005 | 388 | 154 | 62.2M | 22.2 | 1,071M | 202.2M |

# STRATEGIES

## President George W. Bush – State of the Union Address

- **"America is addicted to oil, which is often imported from unstable parts of the world."**
- **"The best way to break this addiction is through technology."**
- **"…. replace more than 75 percent of our oil imports from the Middle East by 2025."**

Capitol,
Tuesday, Jan. 31, 2006
White House photo by Eric Draper

**"By applying the *talent and technology* of America, this country can**

- **dramatically improve our environment,**
- **move beyond a petroleum-based economy, and**
- **make our dependence on Middle Eastern oil a thing of the past."**

# - - A Strategy For the Future - -

## Develop a Partnership

**National Association Of State Universities and Land Grant Colleges**

**The United States Department of Energy**

NASULGC
National Association of State Universities and Land-Grant Colleges

**That will develop the TALENT and TECHNOLOGY to achieve a prosperous future where energy is clean, abundant, reliable and affordable**

# *Research, Outreach and Curriculum Under One Roof*

**Renewables** – *Geothermal, Solar, Hydrogen, Biomass, Wind*


**Energy Efficiency** – *Buildings, Vehicles, Industrial & Distributed Energy*

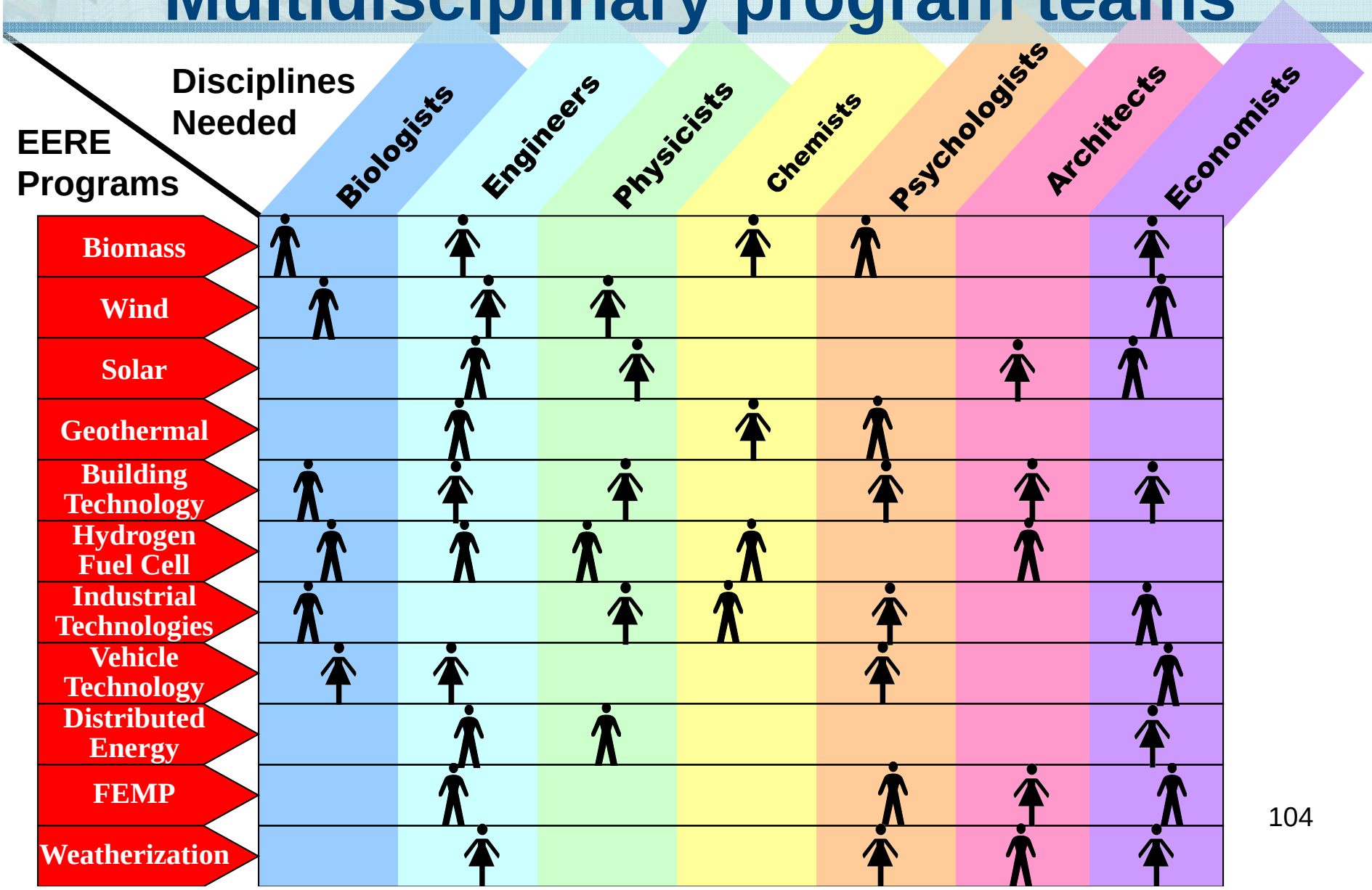
# Renewable Energy and Energy Efficiency Disciplinary Expertise

- Agricultural engineering
- Genetics
- Molecular biology
- Chemical engineering
- Mechanical engineering
- Electrical engineering
- Economics
- Physics
- Chemistry
- Civil Engineering
- Materials Science
- Mechanical Engineering
- Architecture
- Urban and Regional Planning
- Construction Science and Management
- Psychology
- Economics
- Materials Sciences
- Communications and Marketing
- Education
- Finance
- Policy “centers or institutes”—
- Materials Engineering

- Automotive engineering
- Micro, Cellular and Animal biology
- Aerodynamics
- Hydrogeology
- Fluid Dynamics
- Geological Sciences
- Mining Engineering
- Petroleum Engineering
- Reservoir Engineering
- Drilling Engineering
- Industrial engineering
- Metallurgy and material sciences
- Mathematics and artificial intelligence
- Urban and Regional Planning and Landscape Architecture
- Business and marketing
- Extension Education
- Psychology
- Statistics
- Business
- Marketing
- Fluid Mechanics/Aerodynamics
- Meteorology
- Environmental Sciences

# Partnership Benefits

## Multidisciplinary program teams

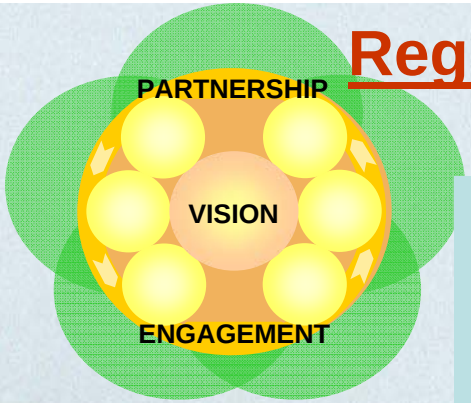


# THE PARTNERSHIP


# Program Plan of Work

***Anticipated Successes And Impacts***

**Three-Year Engagement**
**Fiscal Years 2005-2008**




# Regional Energy Efficiency and Renewable Energy

## Programs for Outreach & Deployment

**GOAL: Facilitate interactions and dialogue between the respective staff of Regional Associations of NASULGC institutions, EERE Program Managers & Offices, and the state energy offices.**

**WHAT:**

- ✓ Increase consumer's knowledge of energy efficiency and renewable energy systems

**HOW:**

- ➢ Conduct train-the-trainer workshops
- ➢ Train local Extension educators
- ➢ Provide technical assistance and education to clientele

**WHO:**

- ❖ 147 Extension Service personnel in the four states
- ❖ Alaska – 32, Washington – 38, Oregon – 42, Idaho – 35

H. Michael Harrington, Ft. Collins
Gary Burch, EERE, Golden, CO
Anthony Nakazawa, Alaska
Tobin Harvey, EERE
Linda Fox, Washington State U
Jake Fey, WSU Energy Program

James Wade, NASULGC
Roy Mink, EERE/DOE
Scott Reed, Oregon State University
Lyla Houglum, Western Extension Exec.
Charlotte Eberlein, University of Idaho

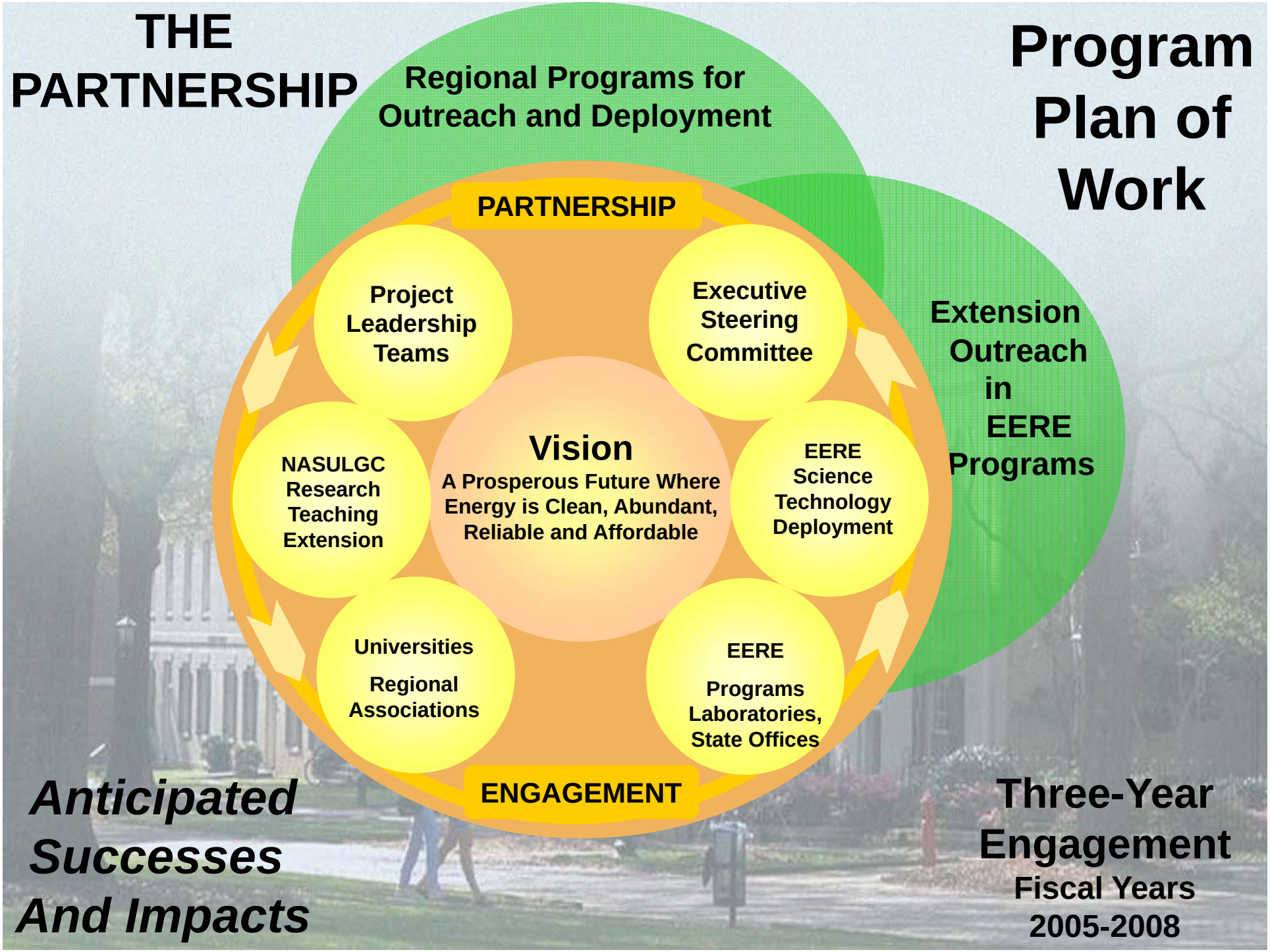
# Pacific Northwest Extension Energy Initiative






U.S. Department of Energy
Energy Efficiency and Renewable Energy

- **Collaborating to provide energy assistance to local governments.**
- **Local Extension offices tap into and direct constituents to one-stop energy resource center — The EERE Information Center**
- **Specific examples of assistance from each state available at: *http://www.energy.wsu.edu/ftp-ep/pubs/assistance/howwehelpedothers.pdf***
- **Pacific Northwest Energy Extension Pilot project,: *http://www.energy.wsu.edu/projects/assistance/***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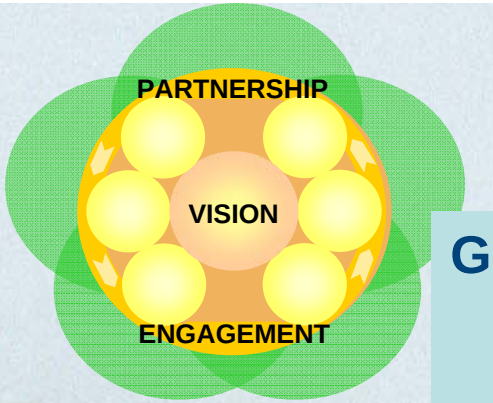



# Extension Outreach Capacity in EERE Programs

**Goal: Develop process, mechanisms, guidelines to link EERE (scientists, engineers; Building America teams) with Extension; later with teaching and research**

**WHAT:**

- ✓ Increase consumer demand for energy efficient housing
- ✓ Increase homebuilder capability to supply energy efficient housing

**HOW:**

- ➢ Develop curriculum and training packages
- ➢ Train local Extension educators
- ➢ Provide technical assistance and education to clientele

**WHO:**

- ❖ 1-2 Extension Service personnel per institution (Southern Region) to participate in a train-the-trainer session focusing on Building America

James Wade, NASULGC
Mark Ginsberg, EERE
Ed Pollock, EERE
George James, EERE
Ronald Brown, Southern Exec. Director

Daryl B. Lund, North Central Exec. Director
Tim Eastling, EERE Southeast Region
Jim Powell, EERE
Lorenza Lyons, Exec. 1890 Extension
Joe Wysocki, USDA/CSREES
Jack Jenkins, EERE Central Reg. Office

# Assisting Regions
## Impacted by Gulf Hurricanes

PARTNERSHIP
VISION
ENGAGEMENT

Building AMERICA
U.S. Department of Energy

NASULGC
National Association of State Universities and Land-Grant Colleges

Southern University
Baton Rouge Campus

ASU
Alcorn
State University

AUBURN
UNIVERSITY

Mississippi State
UNIVERSITY

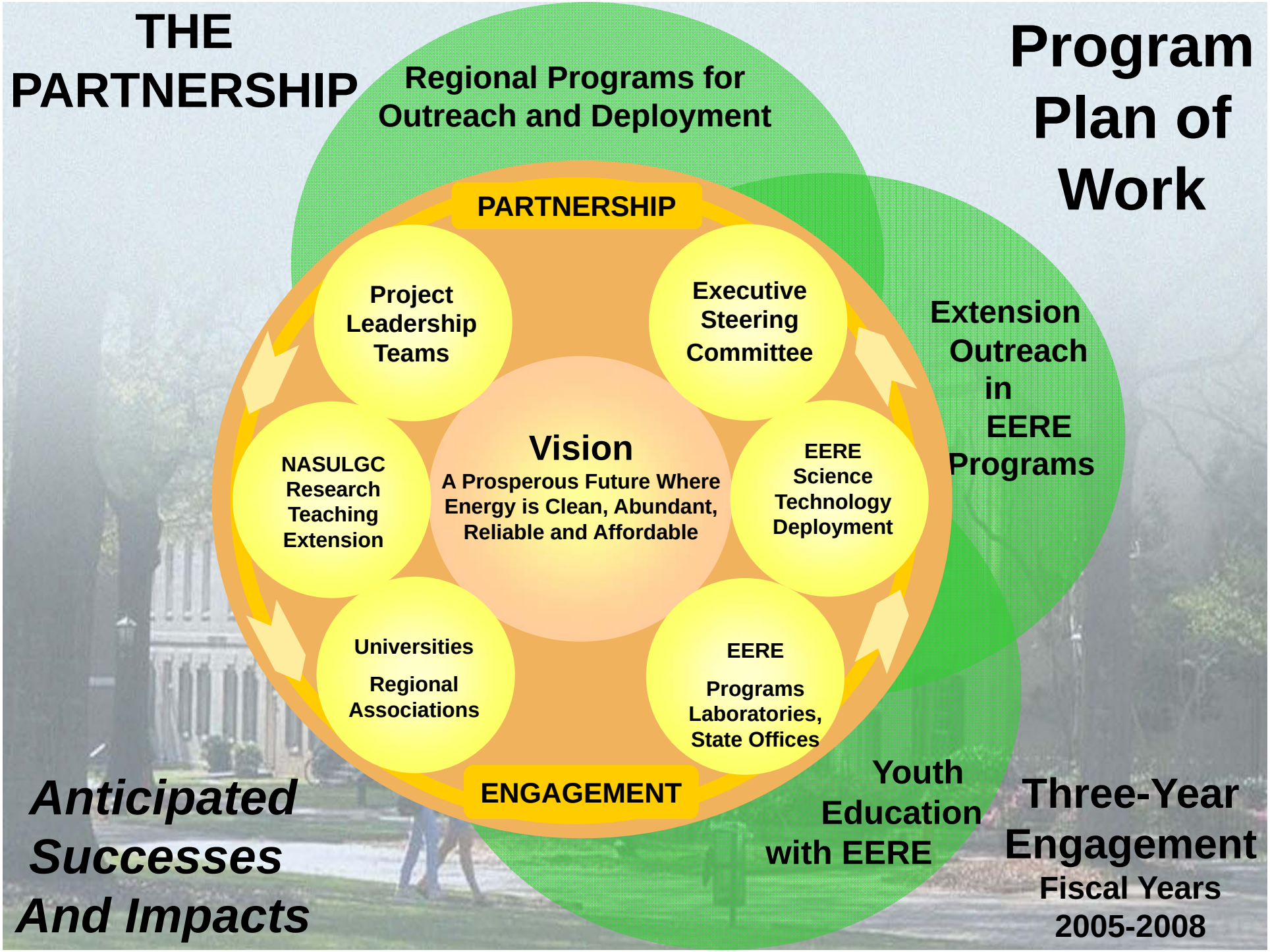
LOUISIANA STATE UNIVERSITY
LSU

Hurricane
Katrina


# A Building Sciences Community of Practice for the Southeast Region

- Capture regionally appropriate DOE Building Sciences information
- Integrate this information into outreach materials targeted to specific audiences
- Conduct Workshop and Distribute outreach products

**The Florida Energy Extension Service (http://www.energy.ufl.edu)**
**North Carolina Solar Center (www.ncsc.ncsu.edu)**
**Louisiana House http://www.louisianahouse.org/**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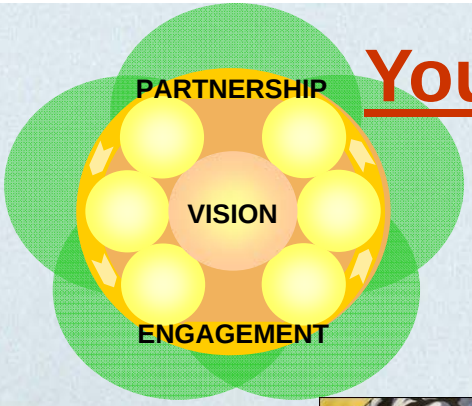



# Youth – Education, Energy, Science & Math

**GOAL – Introduce youth to energy systems and in the process, strengthen their understanding of the practical application of science and mathematics**

**WHAT:**

- ✓ Increase youth's knowledge of energy
- ✓ Excite young people about the applications of math and science

**HOW:**

- ➢ Conduct train-the-trainer program
- ➢ Obtain first-hand knowledge of energy programs at NREL
- ➢ Establish linkages with NREL scientists, engineers and educators

**WHO:**

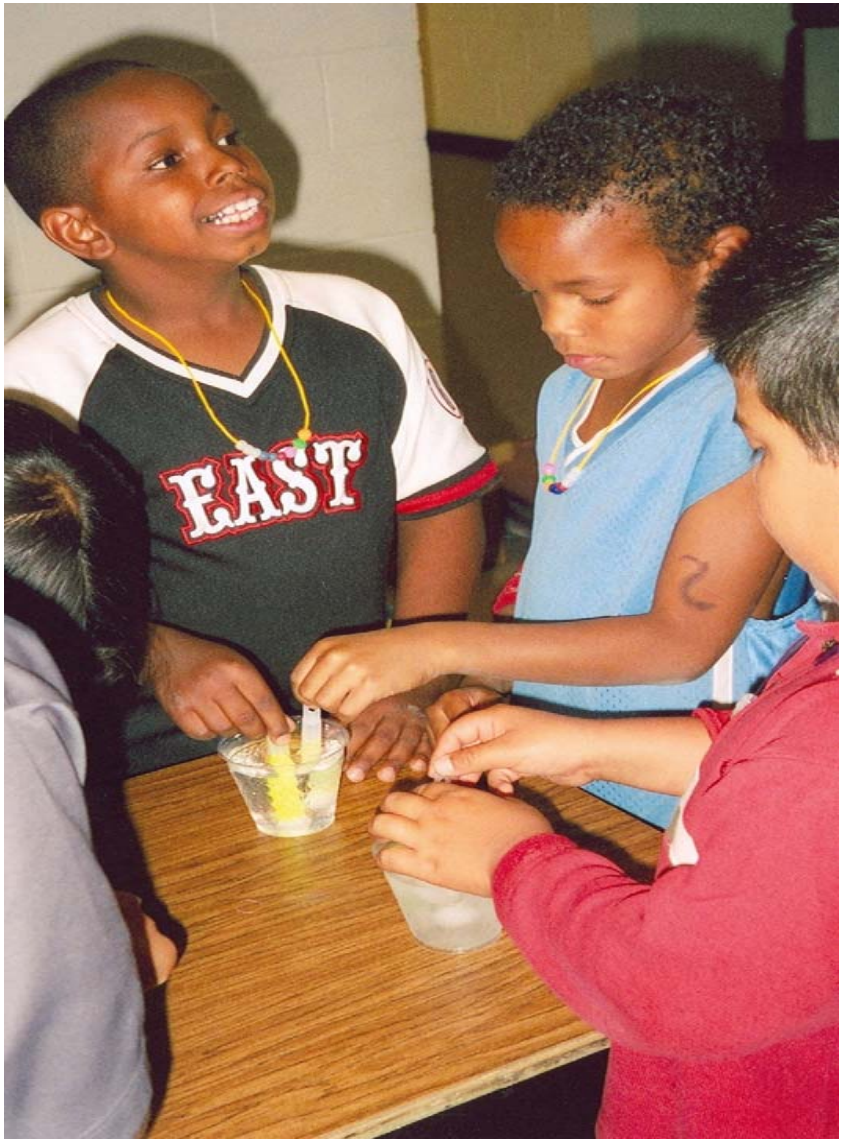
- ❖ NREL Scientists & Engineers and 4 H Educators from all regions

Ian L. Maw, NASULGC
Linda Kay Benning, NASULGC
Samuel L. Donald,1890 LGUs
Peter Faletra, Office of Science/DOE
Susan Halbert, National 4-H Council
Jessie Harris, NREL
Cathann Kress, USDA/CSREES
Carl O' Connor, NC Extension Assoc.
Matthew Seney, EERE/DOE
Mary Spruill, NEED

# Solar Balloon

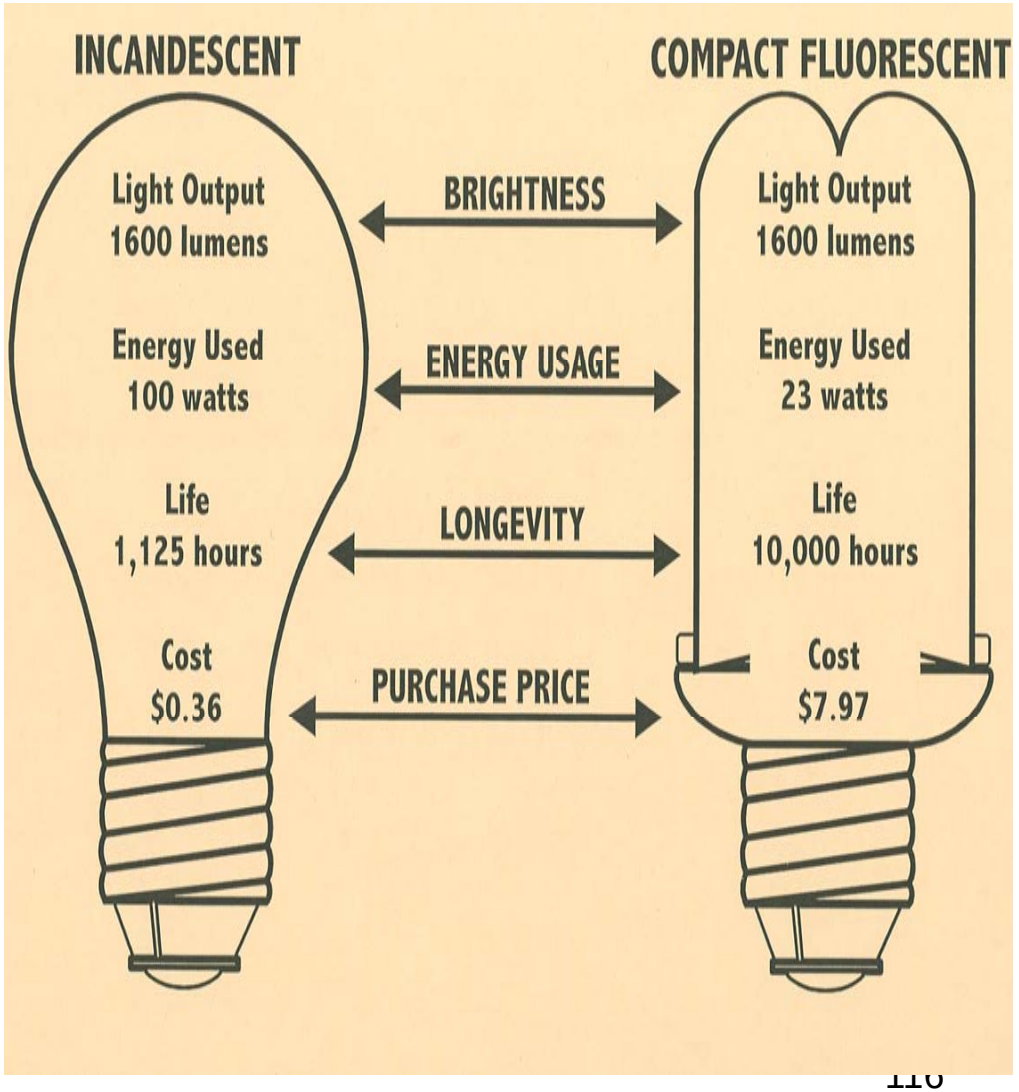

# Light And Chemical Changes

- **Chemical reactions can produce light**
- **Heat can speed chemical reactions; cold can slow them down**



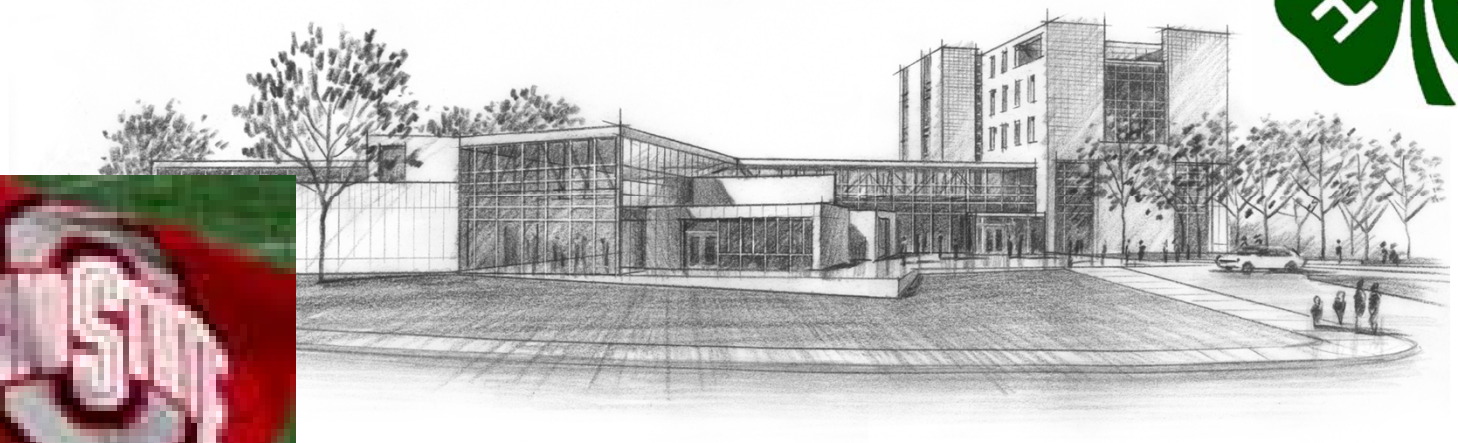
# It Takes Energy to Make Light

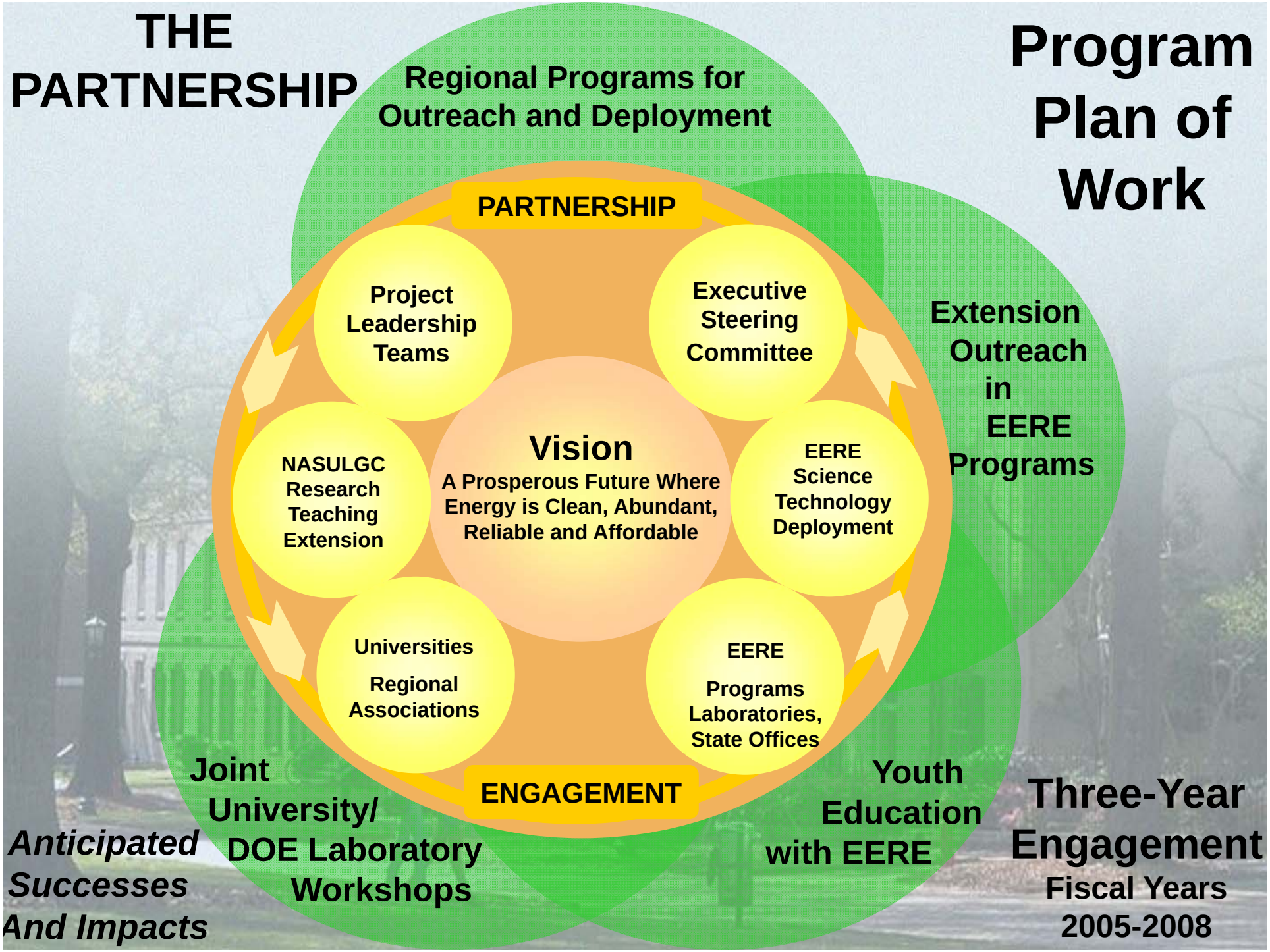
- **Life cycle cost is the total cost of using an appliance and is a more important measure than purchase price**



# OSU 4-H Center Goes “Green”

- Nationwide and Ohio Farm Bureau 4-H Center on OSU campus, to be completed in 2005
- “Green” design – high-performance, sustainable building that is healthful, environmentally responsible, and energy efficient

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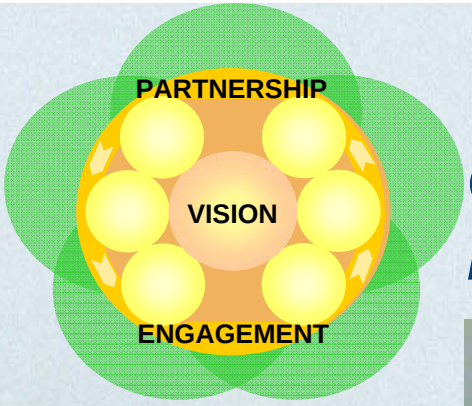


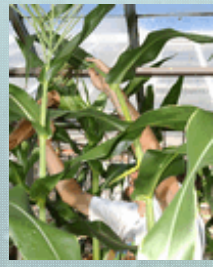

# Joint University/DOE Laboratory Workshops

## *Goal – Increase working relationships between DOE/EERE scientists/engineers and faculty*

**WHAT:**

- ✓ Increase knowledge of laboratory's research & education needs and capacity
- ✓ Excite faculty and lab scientists/engineers about opportunities to work together

**HOW:**



- ➢ Conduct Two Workshops
  - ➢ Building Technologies at ORNL on Feb. 14 – 15, 2006
  - ➢ Wind Energy at NREL on April 12 – 13, 2006
- ➢ Obtain first-hand knowledge of programs at ORNL and NREL
- ➢ Establish linkages with ORNL & NREL scientists, engineers and educators
- ➢ Conduct Biomass Listening Session

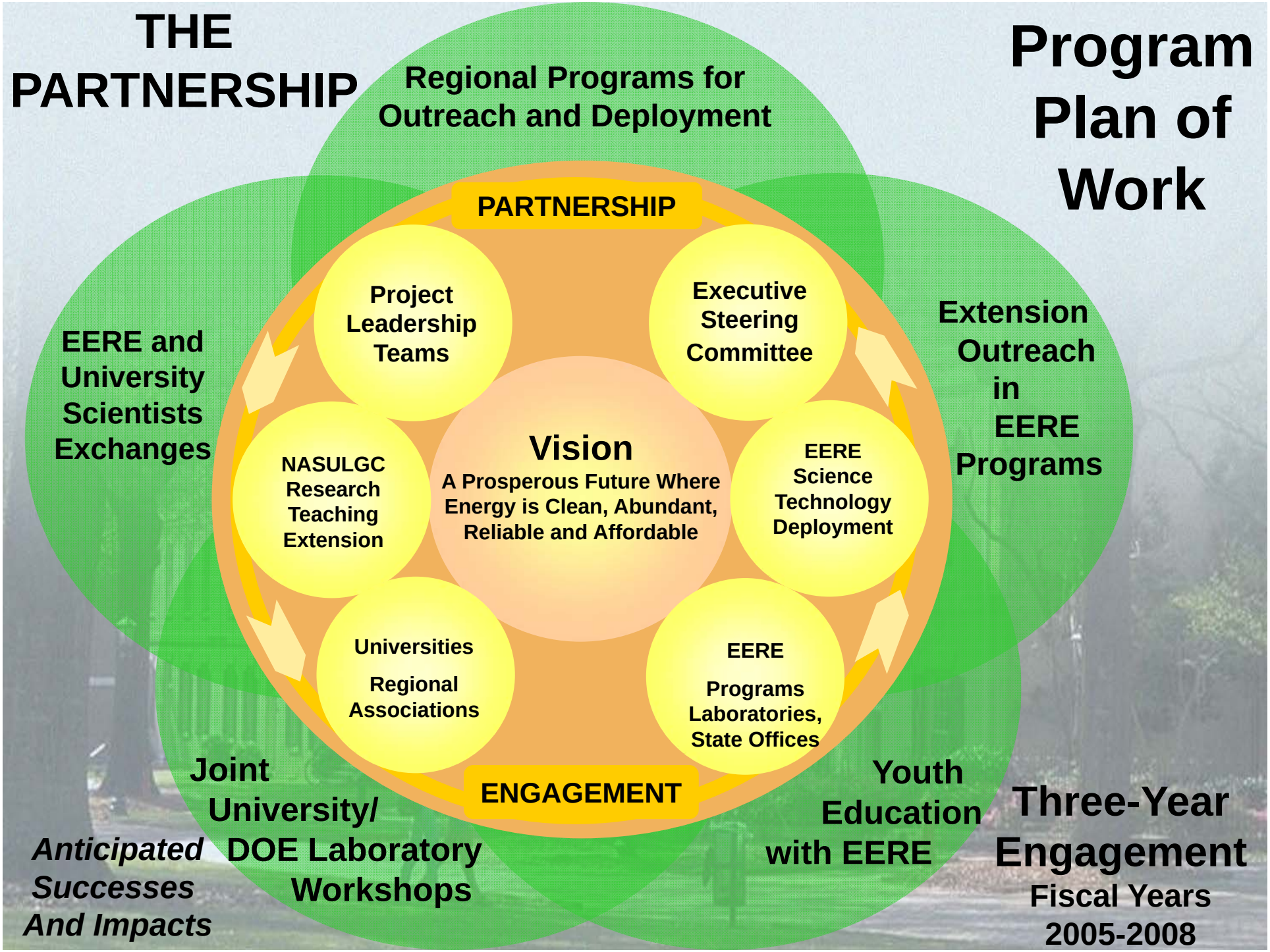
**WHO:**

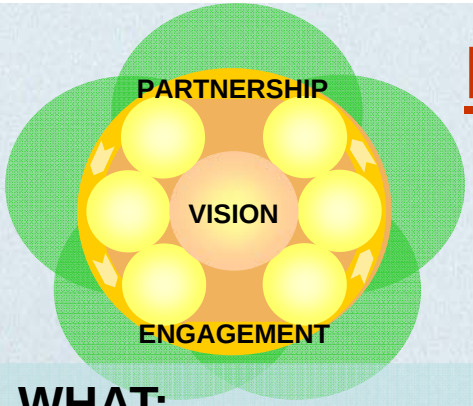
- ❖ Faculty in Colleges of Engineering, Architecture, Sciences, Agriculture
- ❖DOE Laboratory Scientists and Engineers

Stan Bull, Co-Chair, Associate Director, NREL
H. Michael Harrington, Exec. Director, Western Assoc.
Eric Young, Co-Chair, Exec. Director Southern Assoc.
Robert Shelton, Interim Director, ORNL

NASULGC
National Association of State Universities and Land-Grant Colleges


# Building Technologies Workshop
# Oak Ridge National Laboratory
# Oak Ridge, TN
# February 14, 2006


THE PARTNERSHIP
Program Plan of Work
Regional Programs for Outreach and Deployment
PARTNERSHIP
Project Leadership Teams
Executive Steering Committee
EERE and University Scientists Exchanges
Extension Outreach in EERE Programs
NASULGC Research Teaching Extension
Vision
A Prosperous Future Where Energy is Clean, Abundant, Reliable and Affordable
EERE Science Technology Deployment
Universities
Regional Associations
EERE
Programs Laboratories, State Offices
ENGAGEMENT
Joint University/ DOE Laboratory Workshops
Youth Education with EERE
Anticipated Successes And Impacts
Three-Year Engagement
Fiscal Years 2005-2008




# EERE and University Relationships

## GOAL: Build Linkages between EERE and Universities in Education, Recruitment and Scientists Exchange

**WHAT:**

- ✓ Determine partnership opportunities with universities i.e. curriculum development
- ✓ Establish mechanisms to identify key graduates for professional positions
- ✓ Develop Methods to Improve formal Exchanges Between DOE-EERE and University Scientists/Engineers

**HOW:**

- ➢ Establish education programs and new types of cooperation with EERE such as internships and graduate fellowships with joint participation at universities occurring today
- ➢ Determine communication mechanisms for recruitment purposes
- ➢ Explore and develop a number of alternative approaches for expanding DOE-NASULGC collaborations among scientists and DOE Program Directors

**WHO:**

- ❖ Faculty in Colleges of Engineering, Architecture, Sciences, Agriculture

Jill Long Thompson, Exec. Director
Jerry Bellows, Associate Director, NREL
Ian Maw, Director, NASULGC

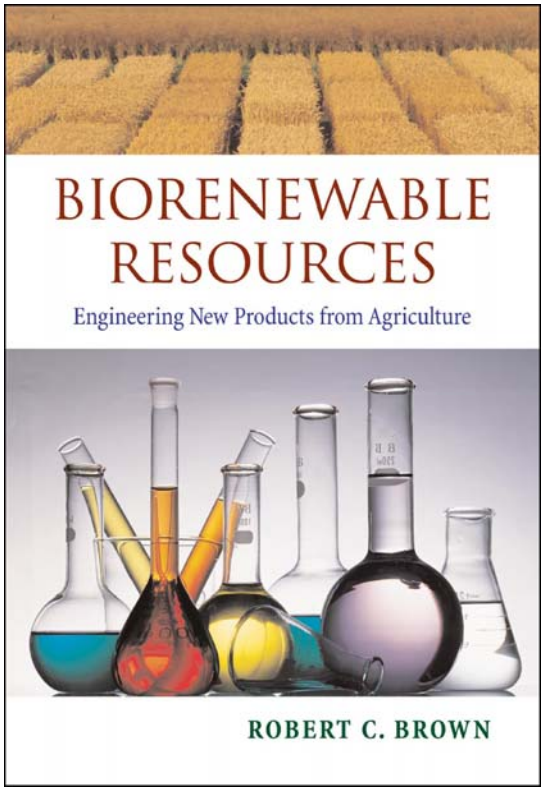
Michael Mills, DOE/EERE
Steven Lee, Director, DOE/EERE
Tom Fretz, Exec. Director-Northeast

# Curriculum Development

## University Curriculum Development in Bio-Based Products

# IOWA STATE UNIVERSITY

Biorenewable Resources and Technology Graduate Program




### M.S. and Ph.D. Degrees

**Engineering**

- Agricultural and Biosystems
- Civil and Construction
- Chemical
- Mechanical

**Sciences**

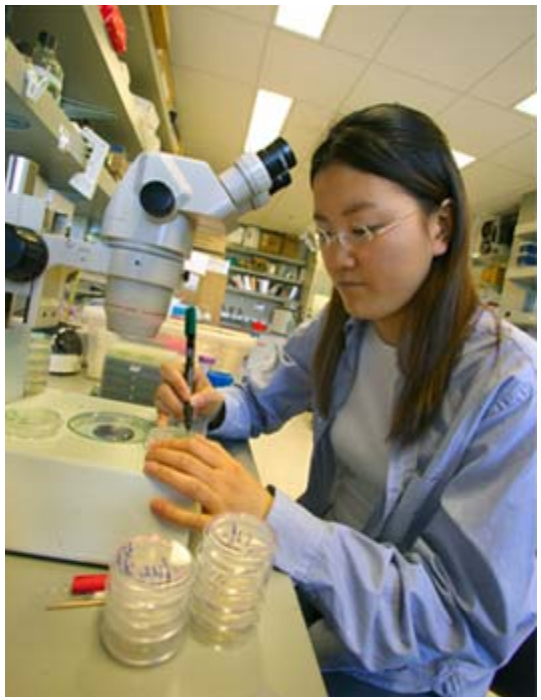
- Agronomy
- Biochemistry
- Biophysics
- Molecular Biology
- Botany
- Chemistry
- Food Science and Human Nutrition
- Forestry

# Integrative Graduate Education and Research Traineeship (IGERT)

IGERT
Integrative Graduate Education and Research Traineeship
NATIONAL RECRUITMENT PROGRAM

- IGERT is a program developed by the National Science Foundation to provide interdisciplinary graduate training for students who wish to pursue careers in the sciences, mathematics, engineering or technology.

- Approximately 20 new IGERT programs are funded each year, and there are now over 100 IGERT programs at universities across the United States.



# Fishing For The Wisdom To Build a Prosperous Energy Future

not by experimentation

*but through reflecting*

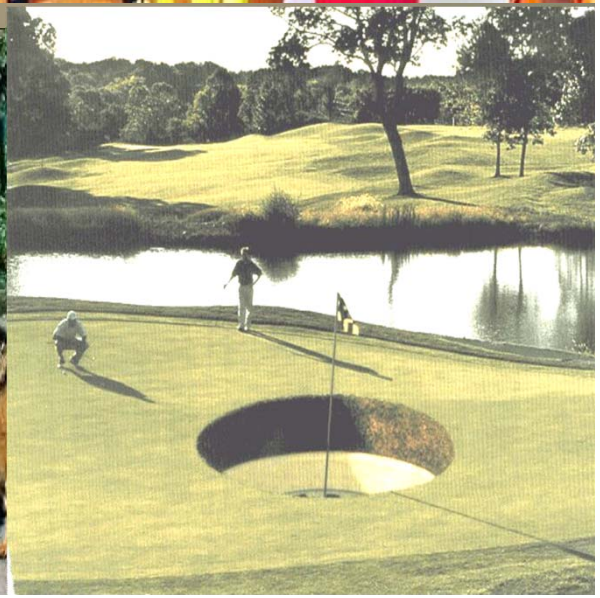
*on how to catch the big one ! ! !*

# How Much Time?

TIME CONSTANTS

| | |
|---|---|
| • Political consensus building | ~ 3-20+ years |
| • Technical R&D | ~ 10+ |
| • Production model | ~ 4+ |
| • Financial | ~ 2++ |
| • Market penetration | ~ 10++ |
| • Capital stock turnover | ~ 10-100 |
| – Cars | ~ 15 |
| – Appliances | ~ 10-20 |
| – Industrial Equipment | ~ 10-30/40+ |
| – Power plants | ~ 40 |
| – Buildings | ~ 80 |
| – Urban form | ~ 100s |
| • Lifetime of Greenhouse Gases | ~ 100s-1000s |
| • Reversal of Land Use Change | ~ 100s |
| • Reversal of Extinctions | Never |

# As We Reflect on Our Energy Future
# We Will Gain The Wisdom To Develop a Prosperous Future
# If We - - -




Together – we will build a prosperous future
where energy is clean, abundant, reliable and affordable


where energy is clean, abundant,
reliable and affordable