Policies and Strategies for Increased Biomass and Bioenergy Use in the United States

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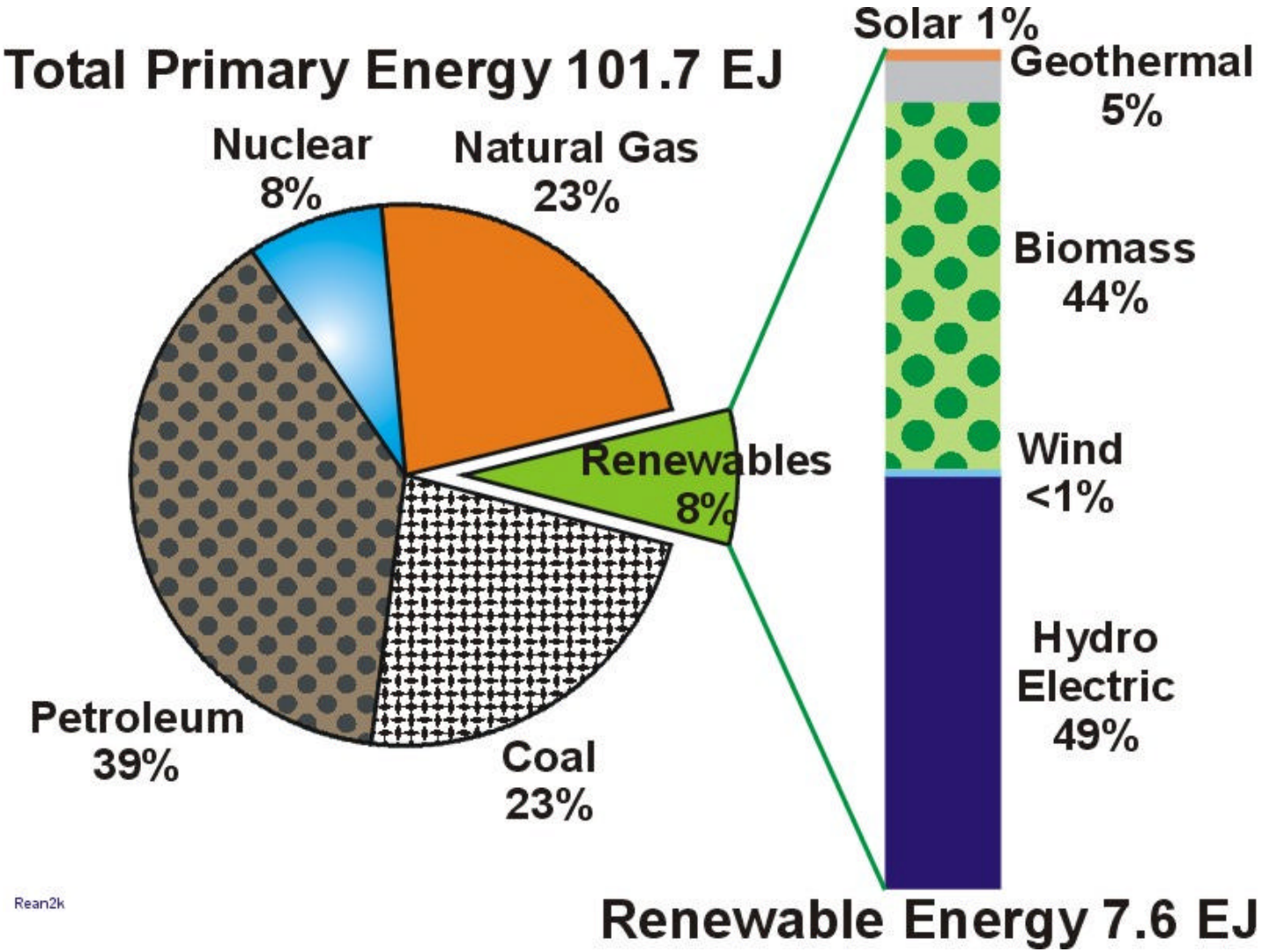
Conference on Sustainability in Energy Production and Utilization in Brazil: The Next Twenty Years,
UNICAMP, Sao Paulo, Brasil

Outline

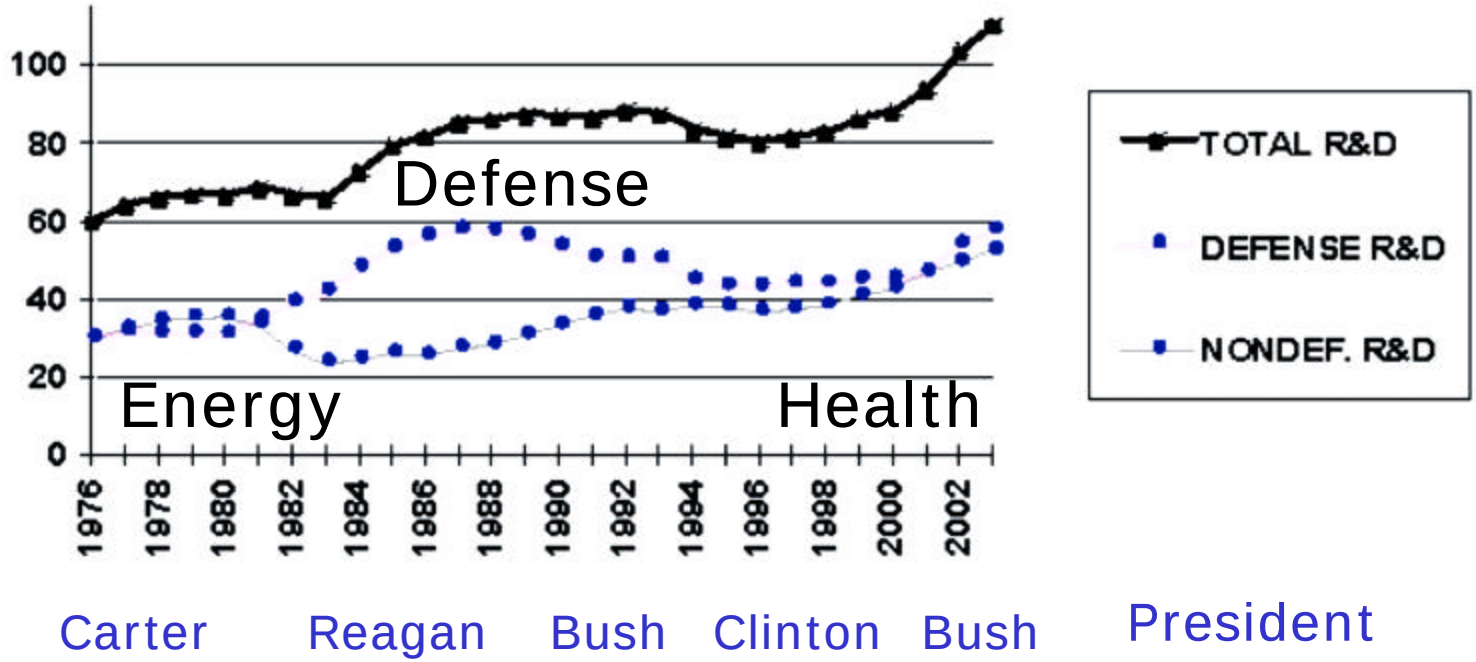
- Context
  - R&D
  - Portfolio of incentives
- Retrospective of 25 Years
- Role of Biomass, Bioenergy and Biobased Products for a Sustainable Future

USA Renewable Energy 2000



Trends in Federal R&D, FY 1976-2003

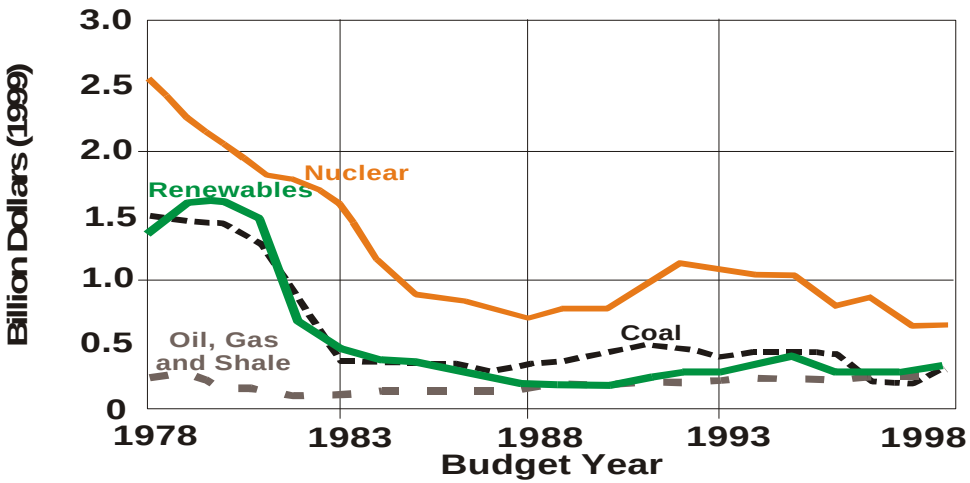
In billions of constant FY 2002 dollars

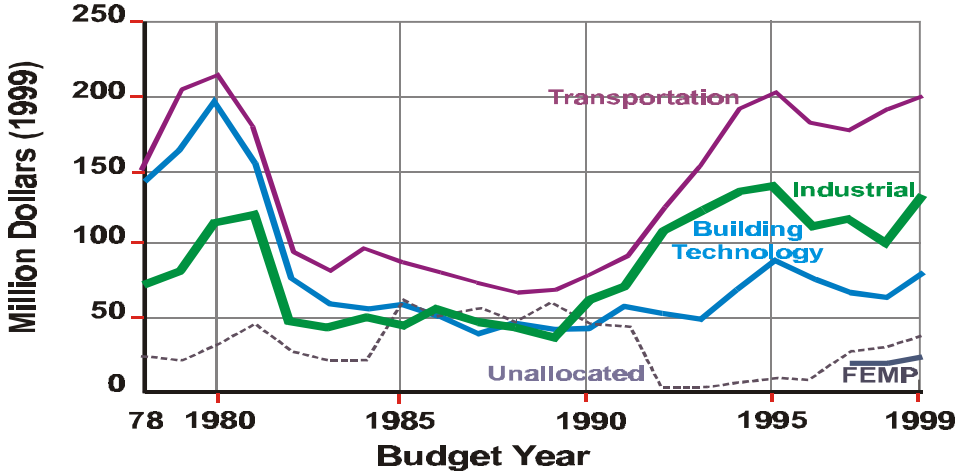


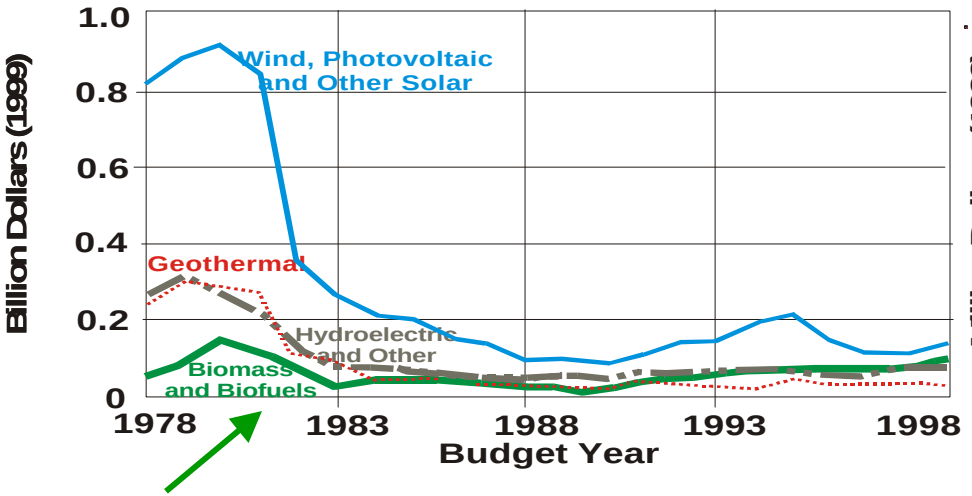
Source: AAAS analyses of R&D in *AAAS Reports VII-XXVII*. FY 2003 figures are President's request; FY 2002 figures are latest estimates.
FEB. '02 PRELIMINARY © 2002 AAAS

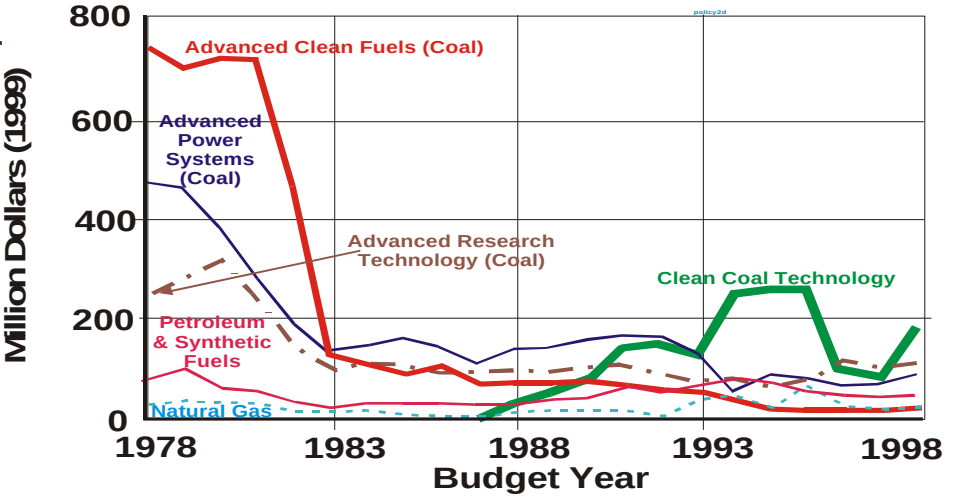
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Comparative U.S. DOE R&D Funding for Energy Technologies





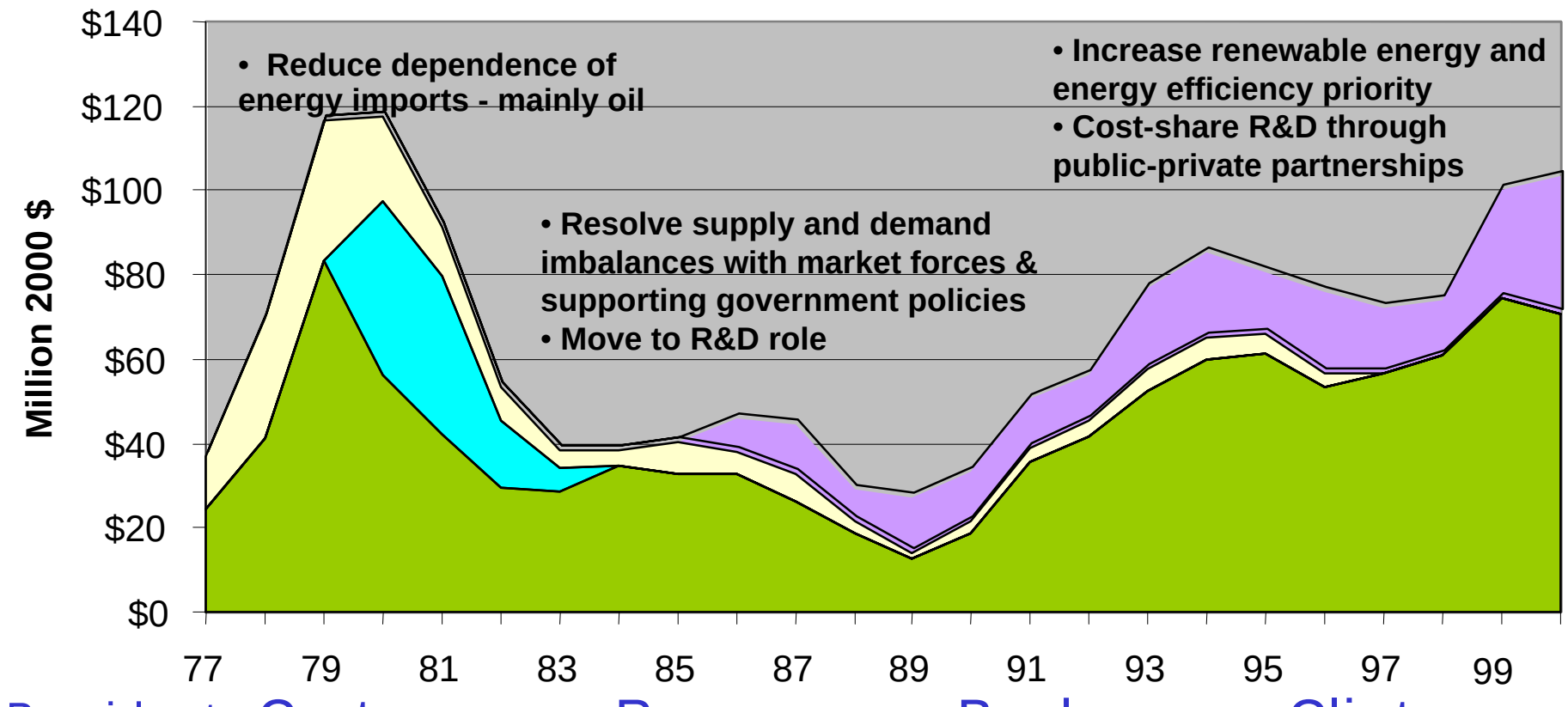


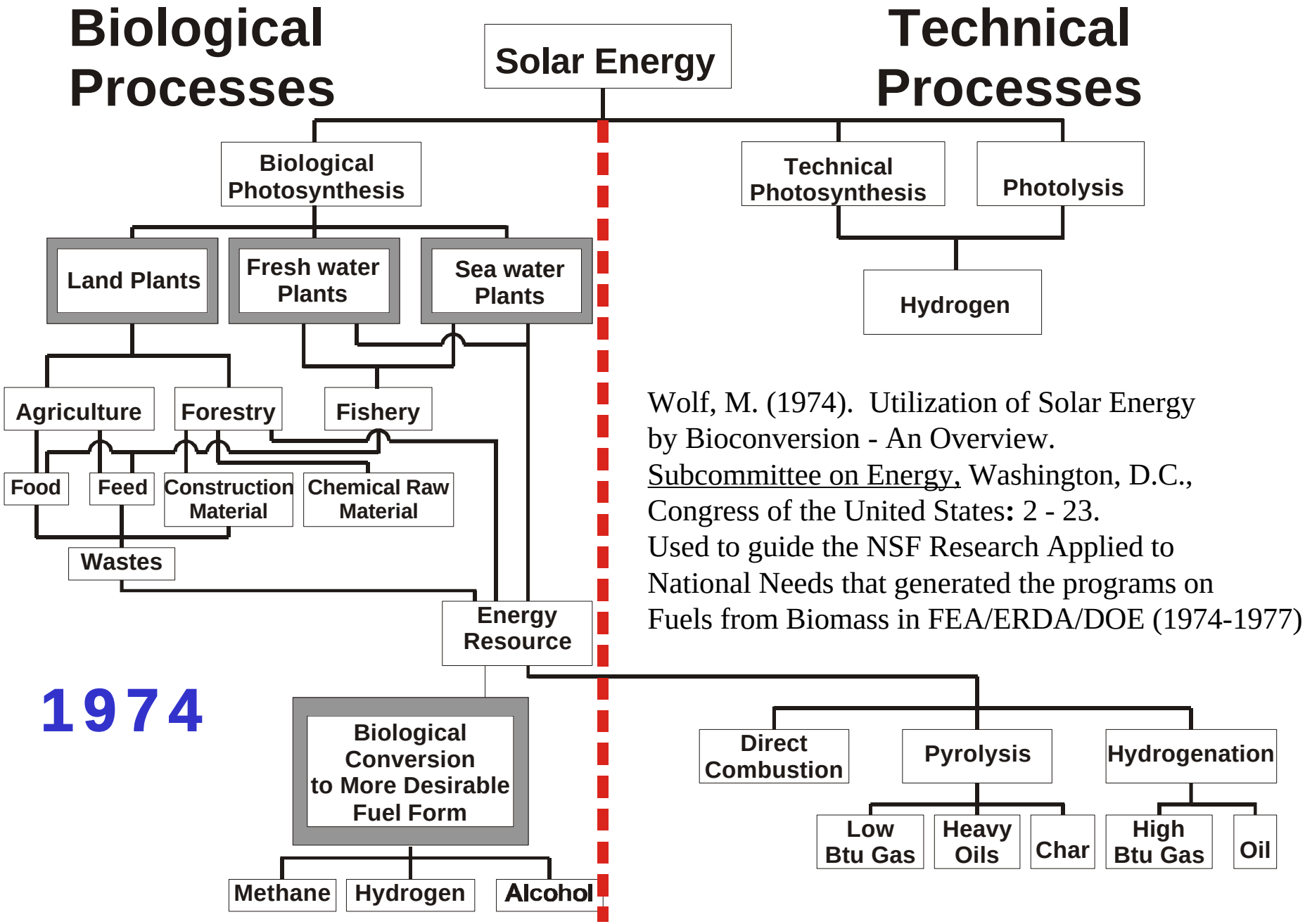


12%
RE $

Federal Financial Interventions and Subsidies in Energy Markets: Primary Energy. SR/01AF/99-03 Washington D.C., USA, Energy Information Administration, 1999. (www.eia.doe.gov/fuelrenewable.html); Federal Financial Interventions and Subsidies in Energy Markets1999: Energy Transformation and End Use. SR/01AF/2000-02 Washington D.C., USA, Energy Information Administration 2000. (www.eia.doe.gov/fuelrenewable.html)

DOE Bioenergy and Biobased Products
Key policies shifted periodically

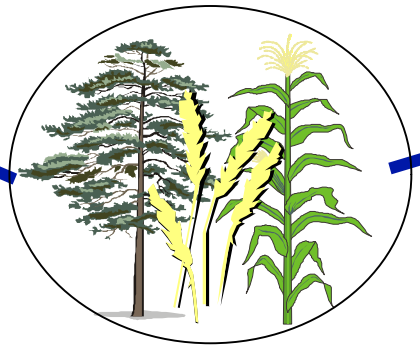




Wolf, M. (1974). Utilization of Solar Energy by Bioconversion - An Overview. Subcommittee on Energy, Washington, D.C., Congress of the United States: 2 - 23.
Used to guide the NSF Research Applied to National Needs that generated the programs on Fuels from Biomass in FEA/ERDA/DOE (1974-1977)

Biomass: 2000

Chemical Products Forest/ Paper Products

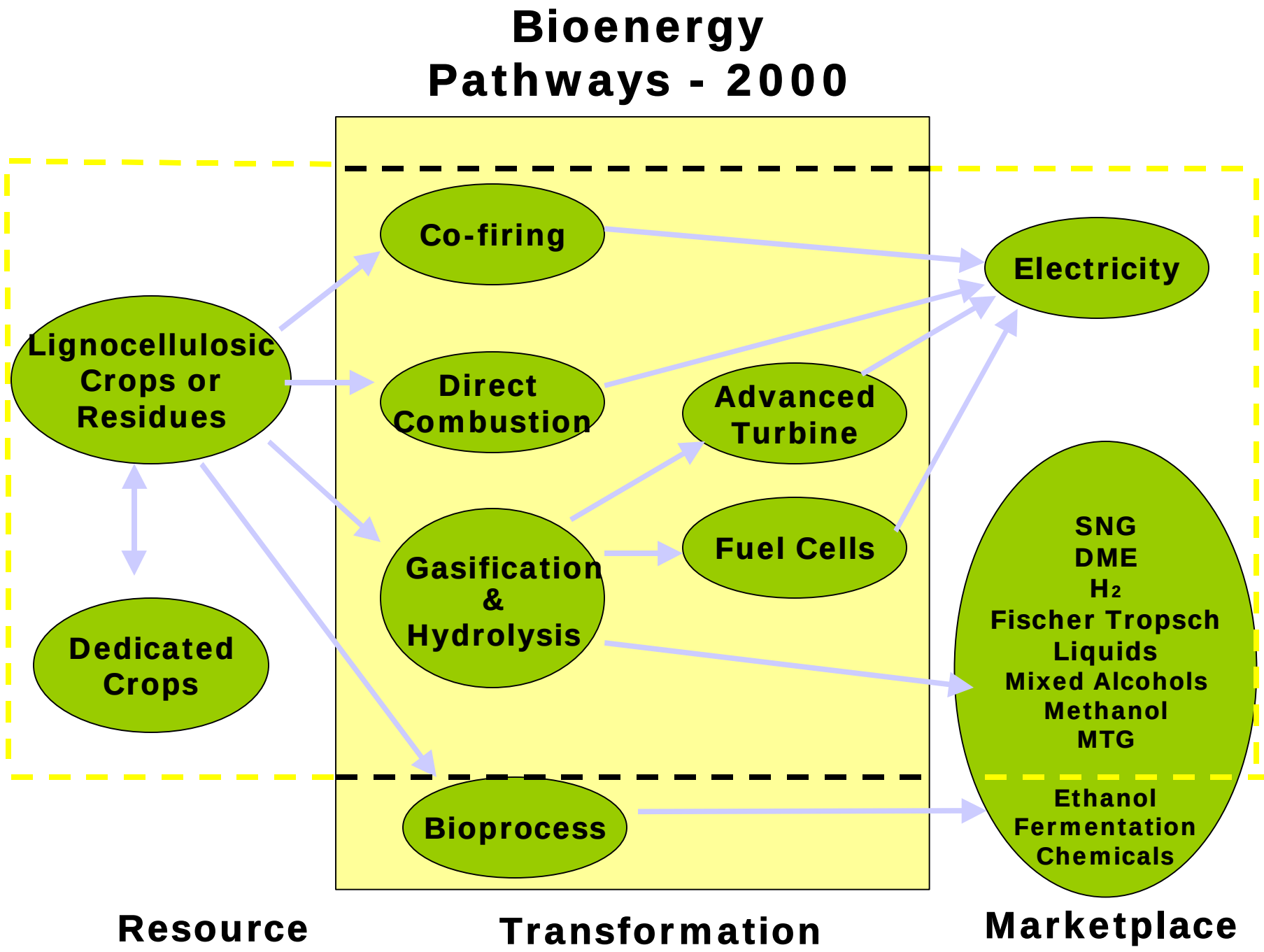


Fuels

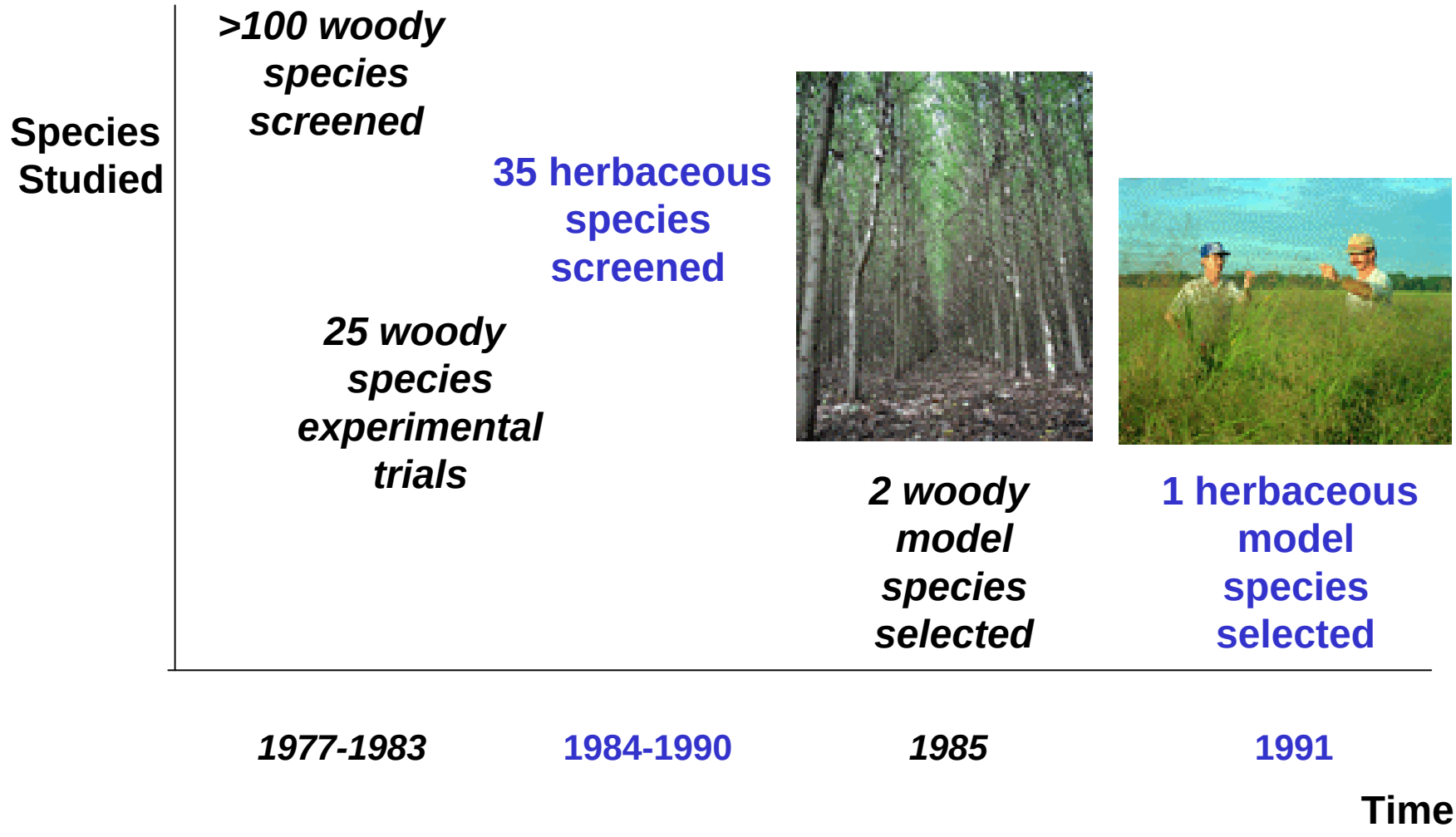
Primarily Ethanol from lignocellulosic

Heat, Electricity, Combined Heat and Power

Hydrogen from Renewables a Separate Program


Bioenergy
Pathways - 2000
Co-firing
Direct
Combustion
Gasification
&
Hydrolysis
Bioprocess
Advanced
Turbine
Fuel Cells
Electricity
SNG
DME
H2
Fischer Tropsch
Liquids
Mixed Alcohols
Methanol
MTG
Ethanol
Fermentation
Chemicals
Lignocellulosic
Crops or
Residues
Dedicated
Crops
Resource
Transformation
Marketplace

Biomass Feedstocks – DOE/ORNL and Collaborators

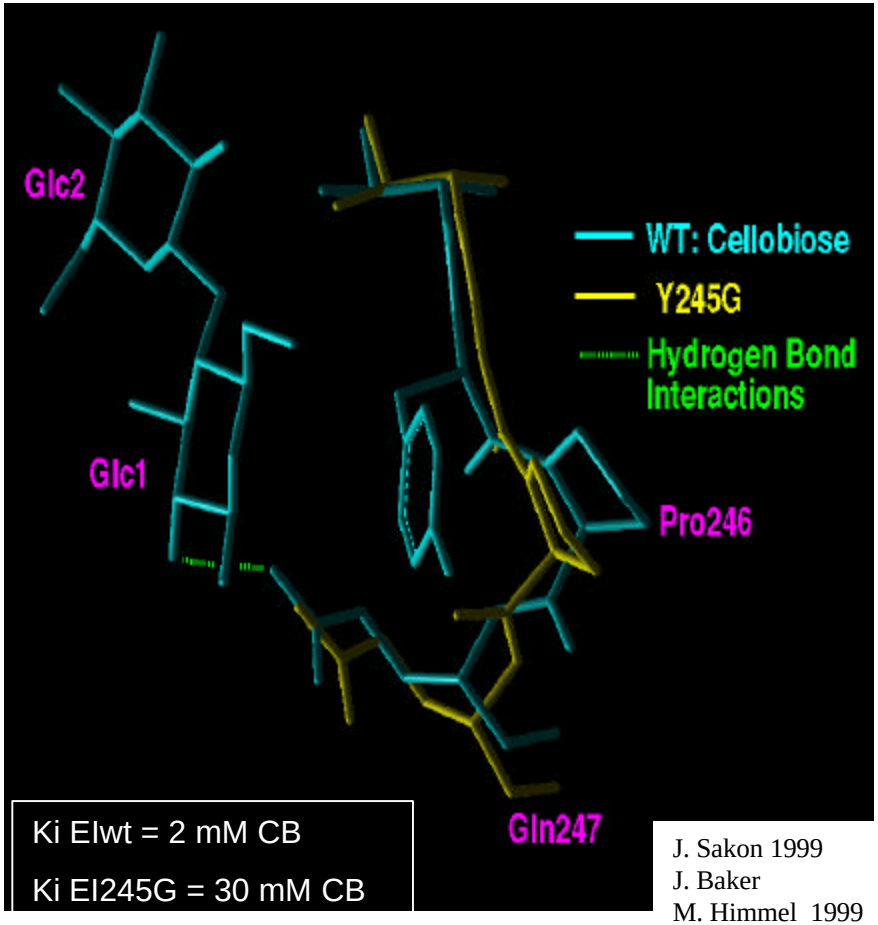


Protein Engineering at DOE/NREL

More than 200 peer reviewed papers
20 patents and applications
Several awards

•Site Directed Mutagenesis

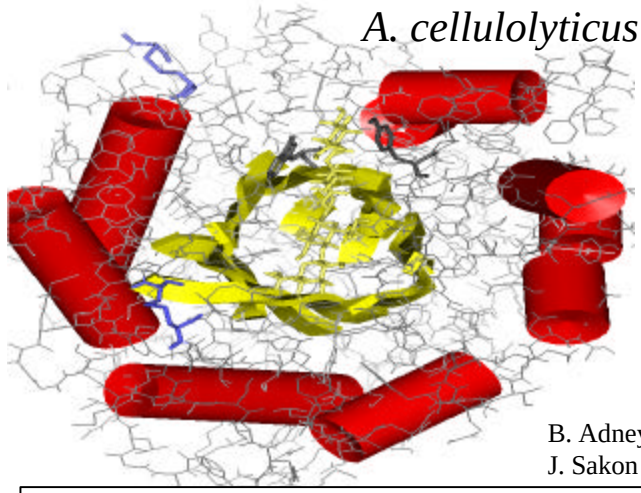
–*Acidothermus* EI and *T. reesei* CBH I



J. Sakon 1999
J. Baker
M. Himmel 1999

•Discovery of thermal tolerant enzymes: cellulases and xylanases

A. cellulolyticus EI



B. Adney, M. Himmel 1996
J. Sakon 1997

- 2 - endoglucanase patents
- 1 - β-D-glucosidase patent
- 1 - dextranase patent
- 1 - exoglucanase patent (filed)

Yellowstone Natl Park
Prospecting early '80s
Permit #2621YELL

Systems Approaches

The Salix Project

Location: Dunkirk and Geneva NY

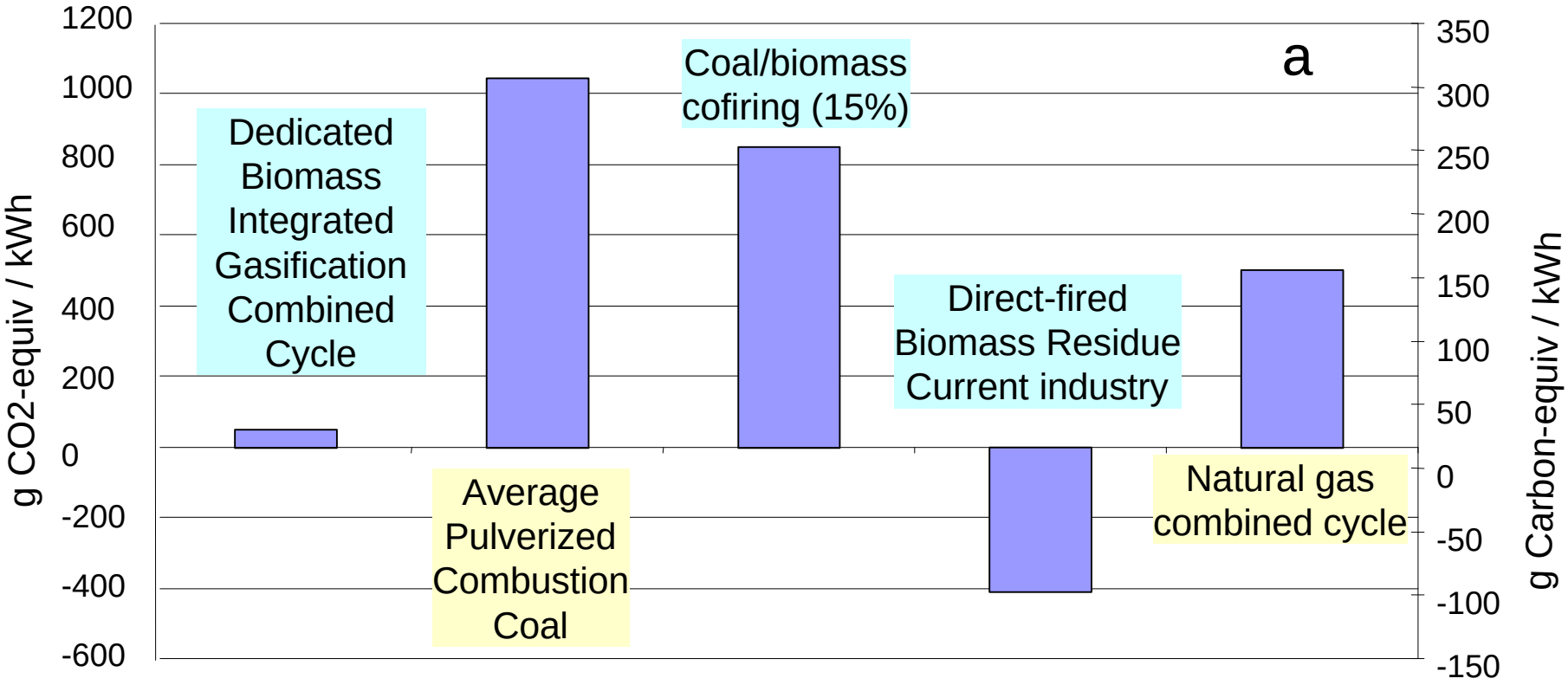
Project Details 2 x 10.0 MW biomass additions to 100 MW coal fired boilers

Feedstocks: urban and wood residues increasing contribution of *salix* dedicated feedstock supply - hundreds of acres

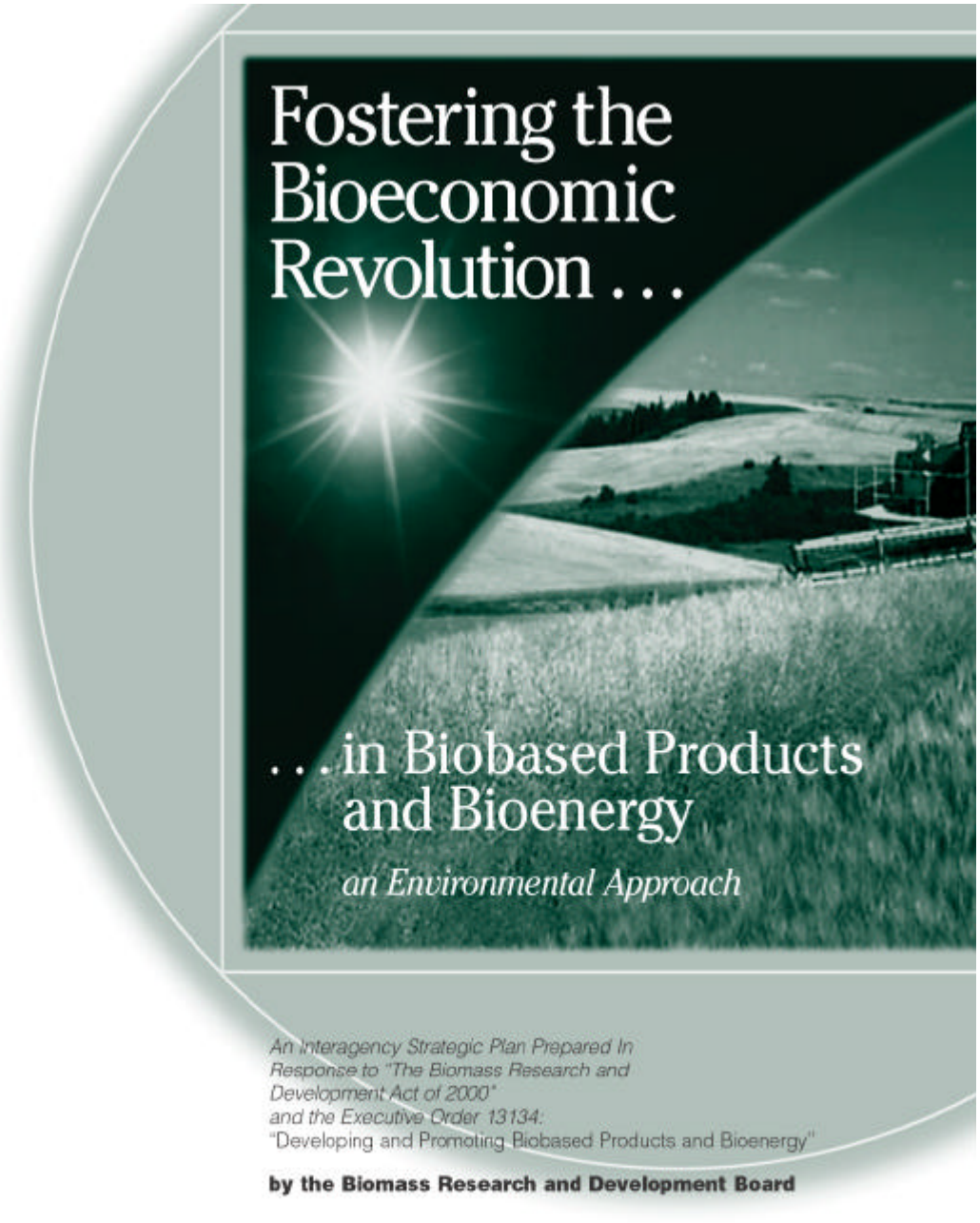
NREL

Environmental, Ecological, Institutional and Life Cycle

Biomass Power Life Cycle Greenhouse Gas Emissions



Mann, M. K.; Spath, P. L. (2001). Comparison of the Environmental Consequences of Power from Biomass, Coal, and Natural Gas. Kyritsis, S., et al., eds. 1st World Conference on Biomass for Energy and Industry: Proceedings of the Conference held 5-9 June 2000, Sevilla, Spain. London, UK: James & James Ltd.; Vol. I: pp. 65-68



Increased Federal Government Coordination

Biomass Research And Development Board

Created in 1999 in response to Executive Order and the Biomass Research and Development Act of 2000.

Biomass R&D Technical Advisory Panel started in 2000

See http://www.bioproducts-bioenergy.gov/

Key Agencies

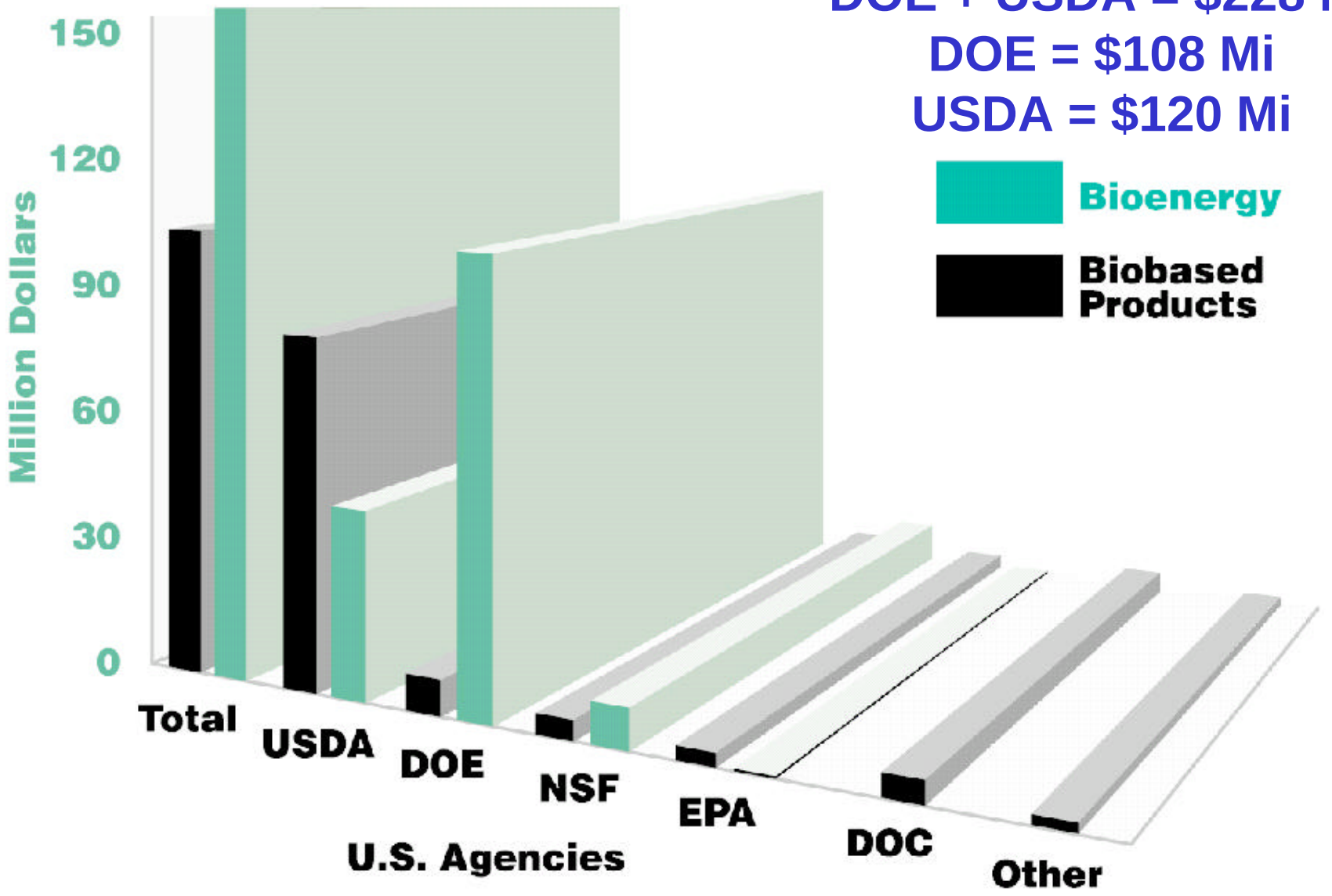
From Inventory of FY98

R&D Activities: $253 Mi

DOE + USDA = $228 Mi

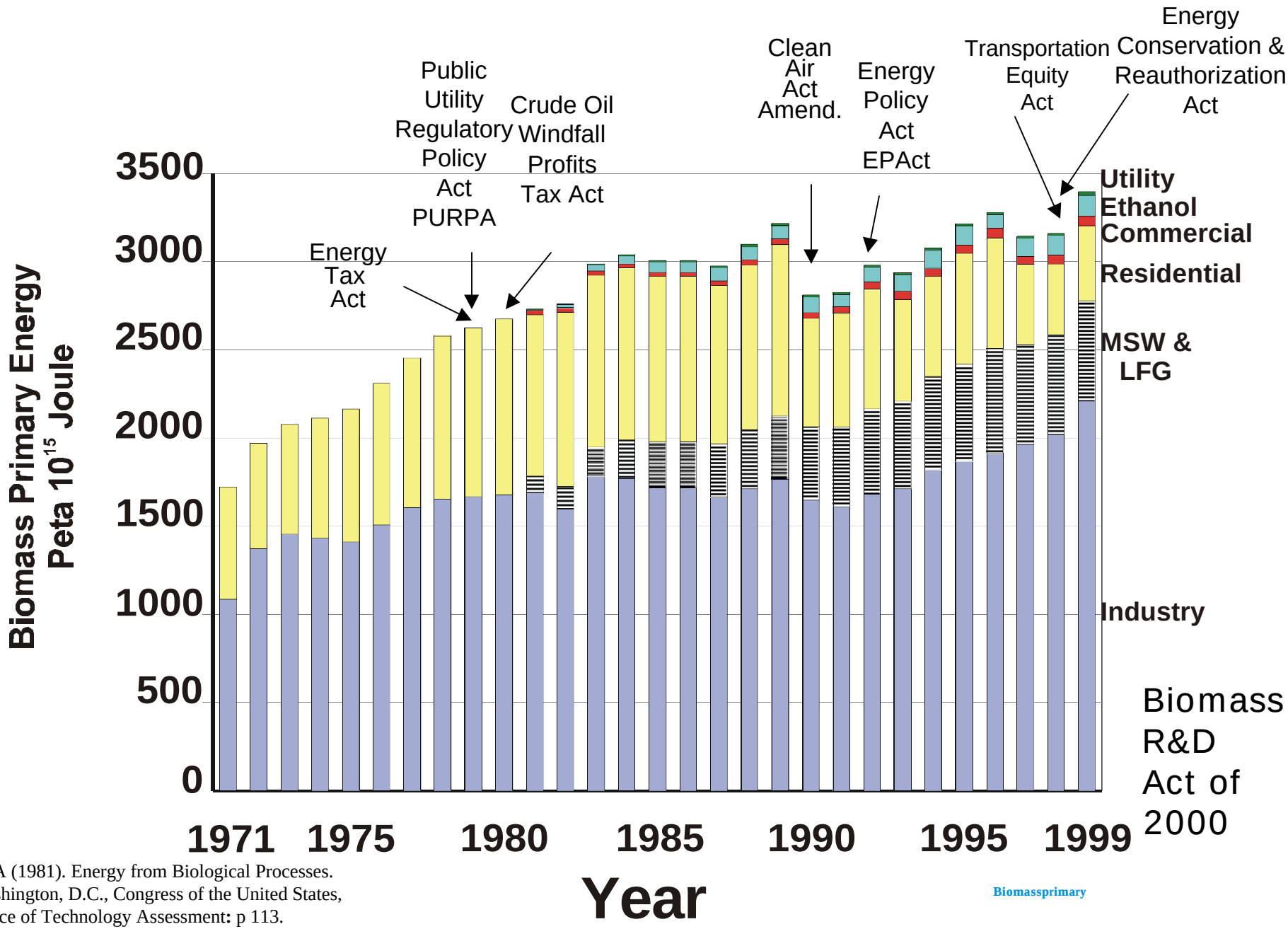
DOE = $108 Mi

USDA = $120 Mi



Portfolio of Non-R&D Actions

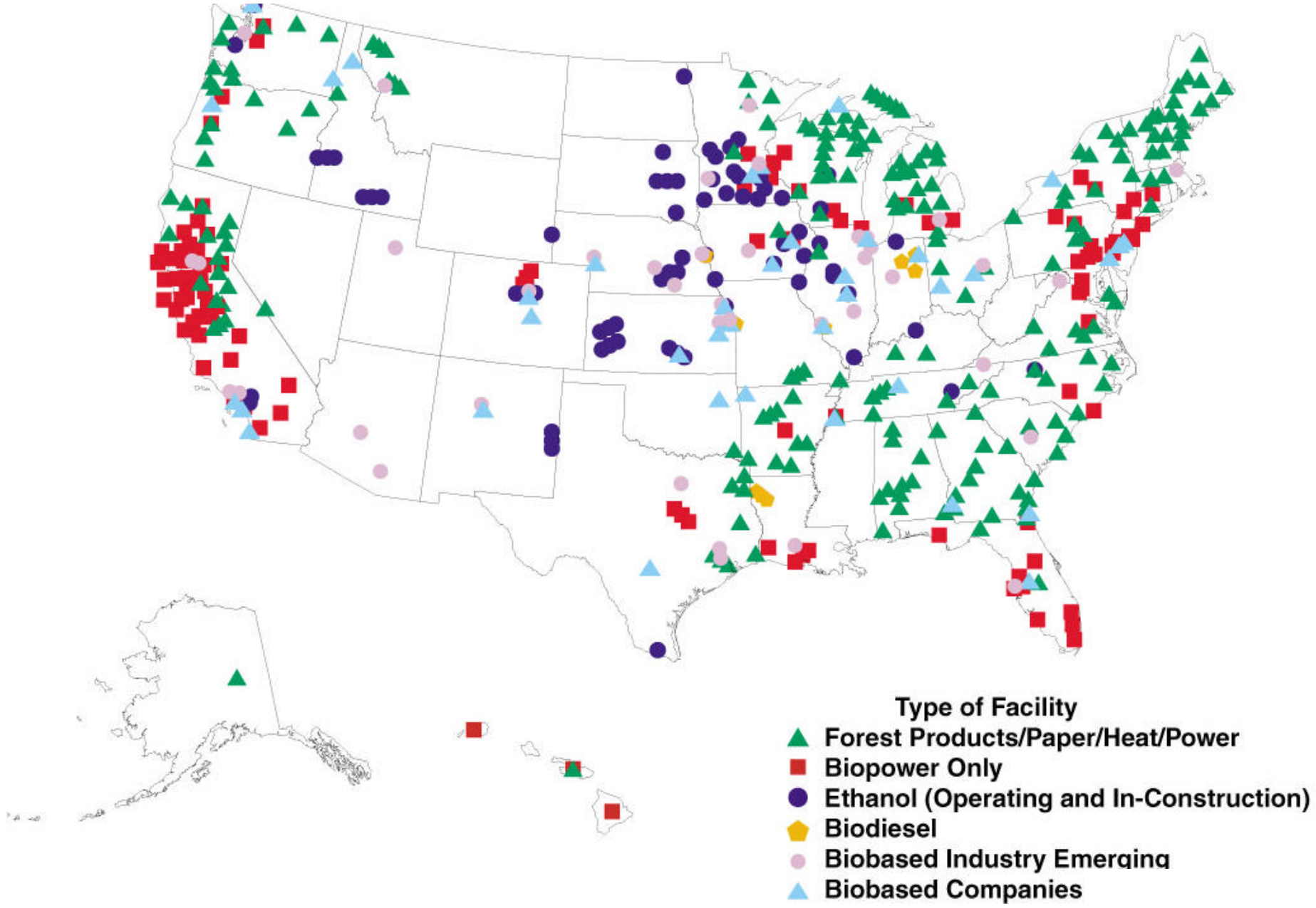
- Payments either directly to consumers or producers or indirectly through energy excise taxes foregone;
- Reduced taxes through preferential tax rates, tax credits (R&D expenses offsetting taxes), tax deferrals, and income-reducing measures;
- Investment incentives such as accelerated capital depreciation;
- A variety of loan programs;
- A number of voluntary programs with industry;
- Use of the federal government purchasing power to increase biomass and bioenergy use.



OTA (1981). Energy from Biological Processes. Washington, D.C., Congress of the United States, Office of Technology Assessment: p 113.
EIA (2000). Renewable Energy Annual 1999. DOE/EIA 0603(99) Washington D.C., USA, 117. (www.eia.doe.gov/fuelrenewable.html)

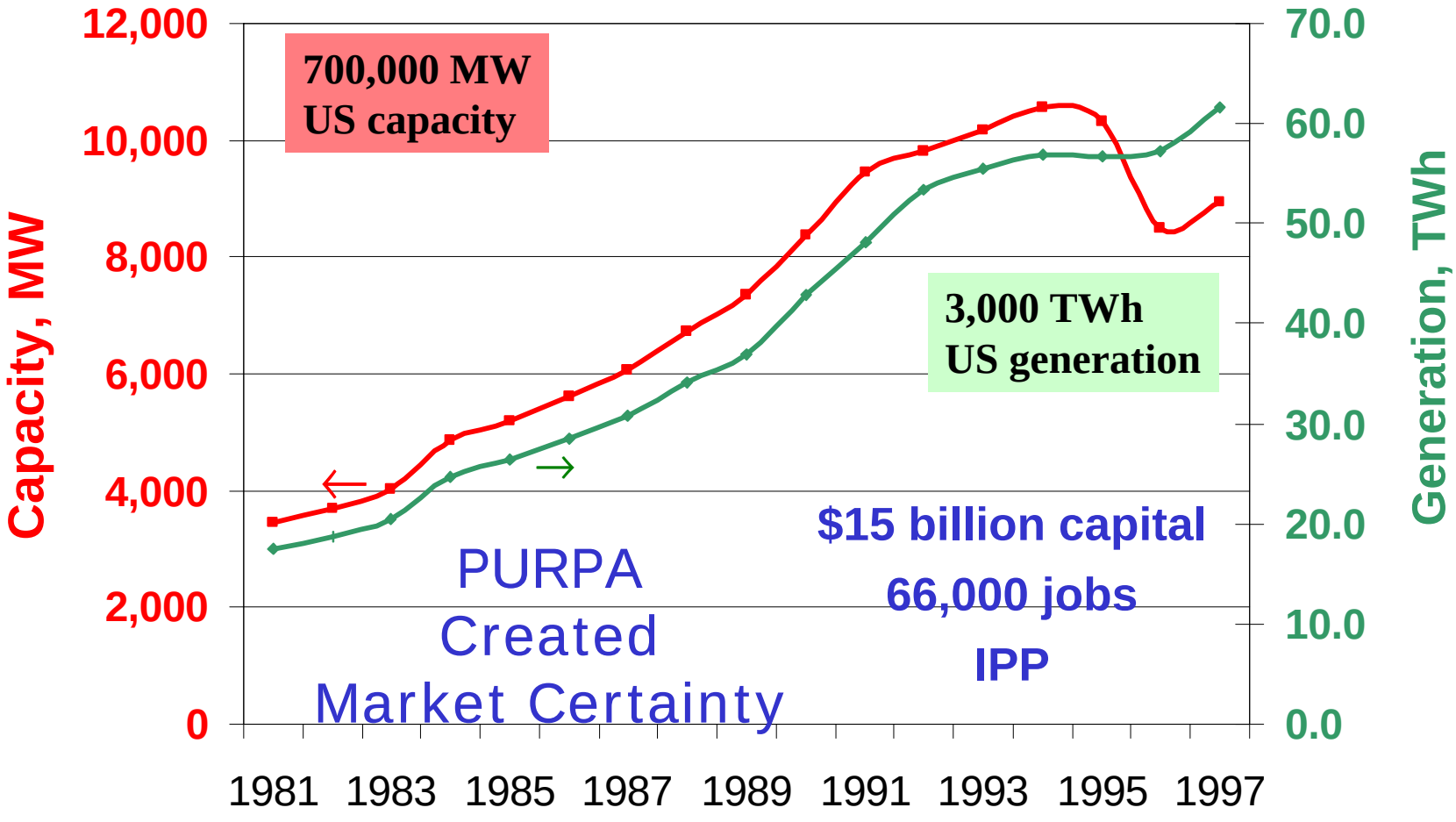
1000 Peta Joules = 1 Exa Joule =0.95 Quads

Examples of Bioenergy and Biobased Products Facilities



Bi kWh = TWh

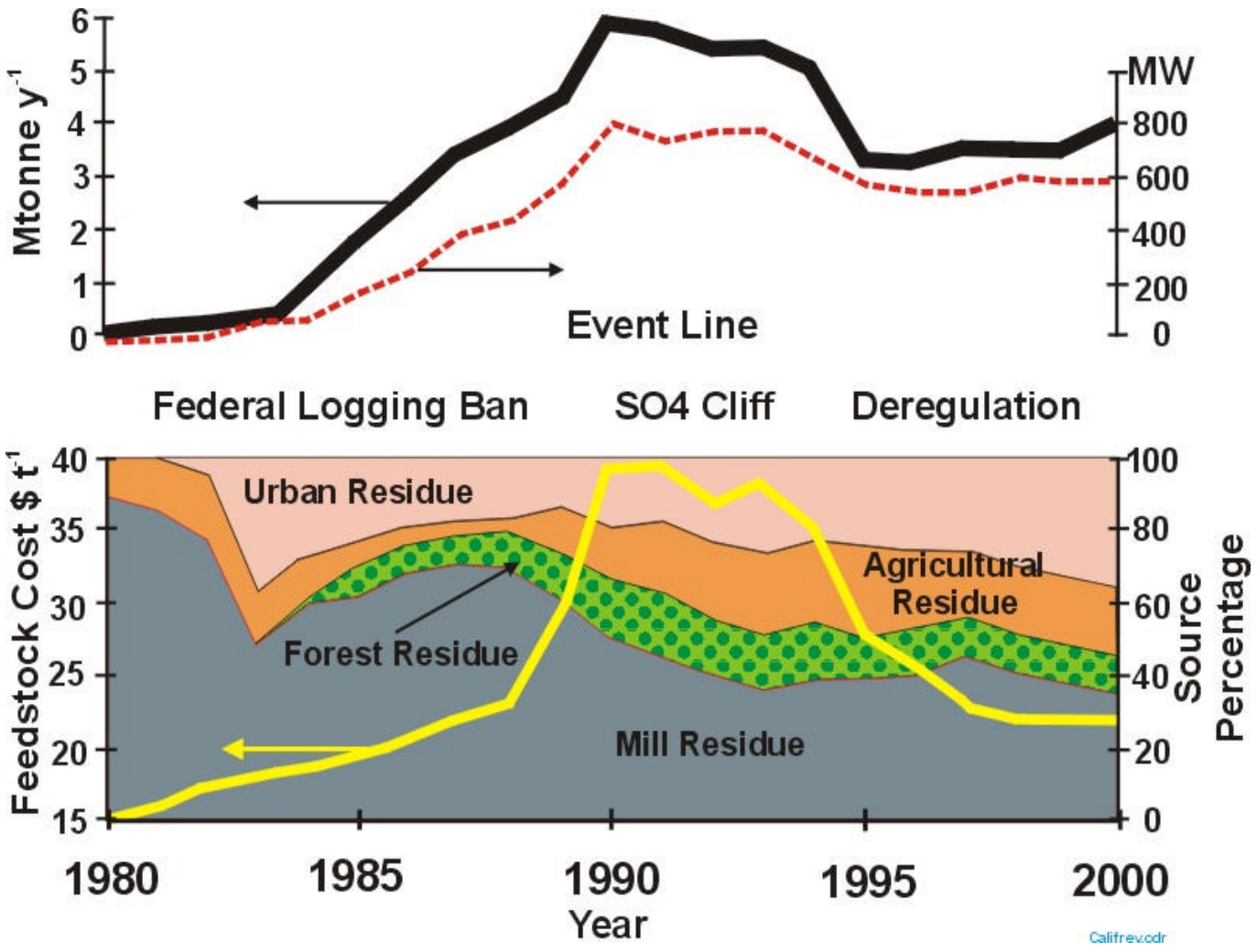
Bioenergy Electricity Generation, 1981 - 1997



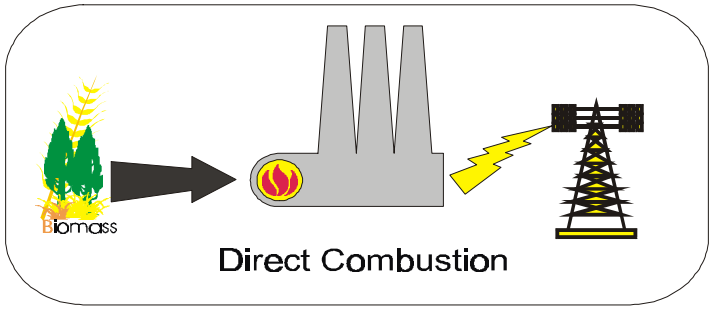
Ref: EIA, Annual Energy Review 1997, Renewable Energy Annual 1995

Brazil: 350 TWh; Portugal: 39 TWh; UK: 343 TWh

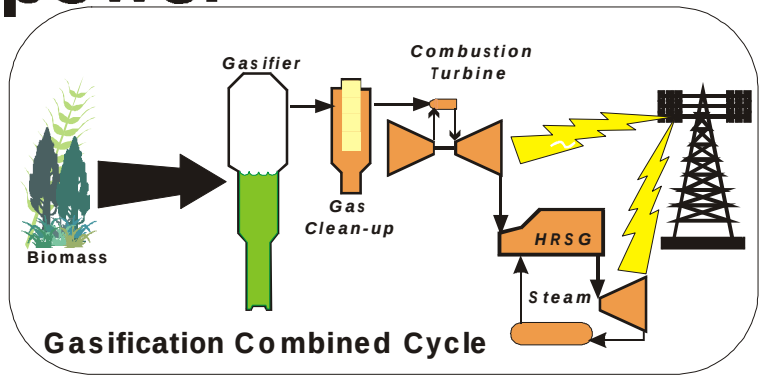
California's 20 years of BioPower



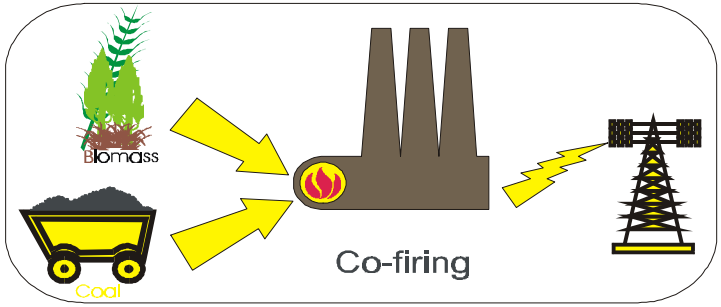
Paths to Biopower



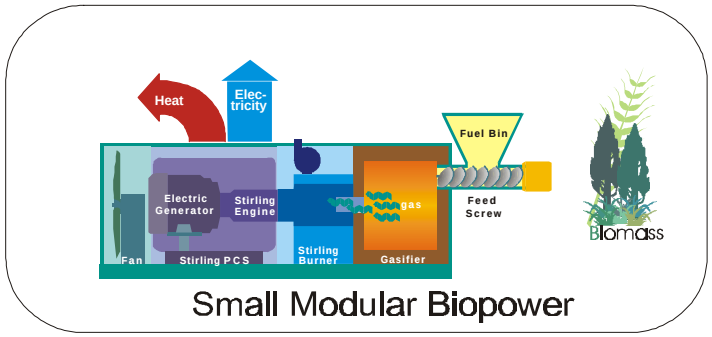
Existing Industry
7,000 MW
Average 20% Efficiency
100% Residue Based



High Efficiency Options
Gas Turbines, Fuel Cells
40+% Efficiency
Significant Interest by Cogenerators
e.g. Pulp & Paper industry
Small Demo's in Europe& U.S.

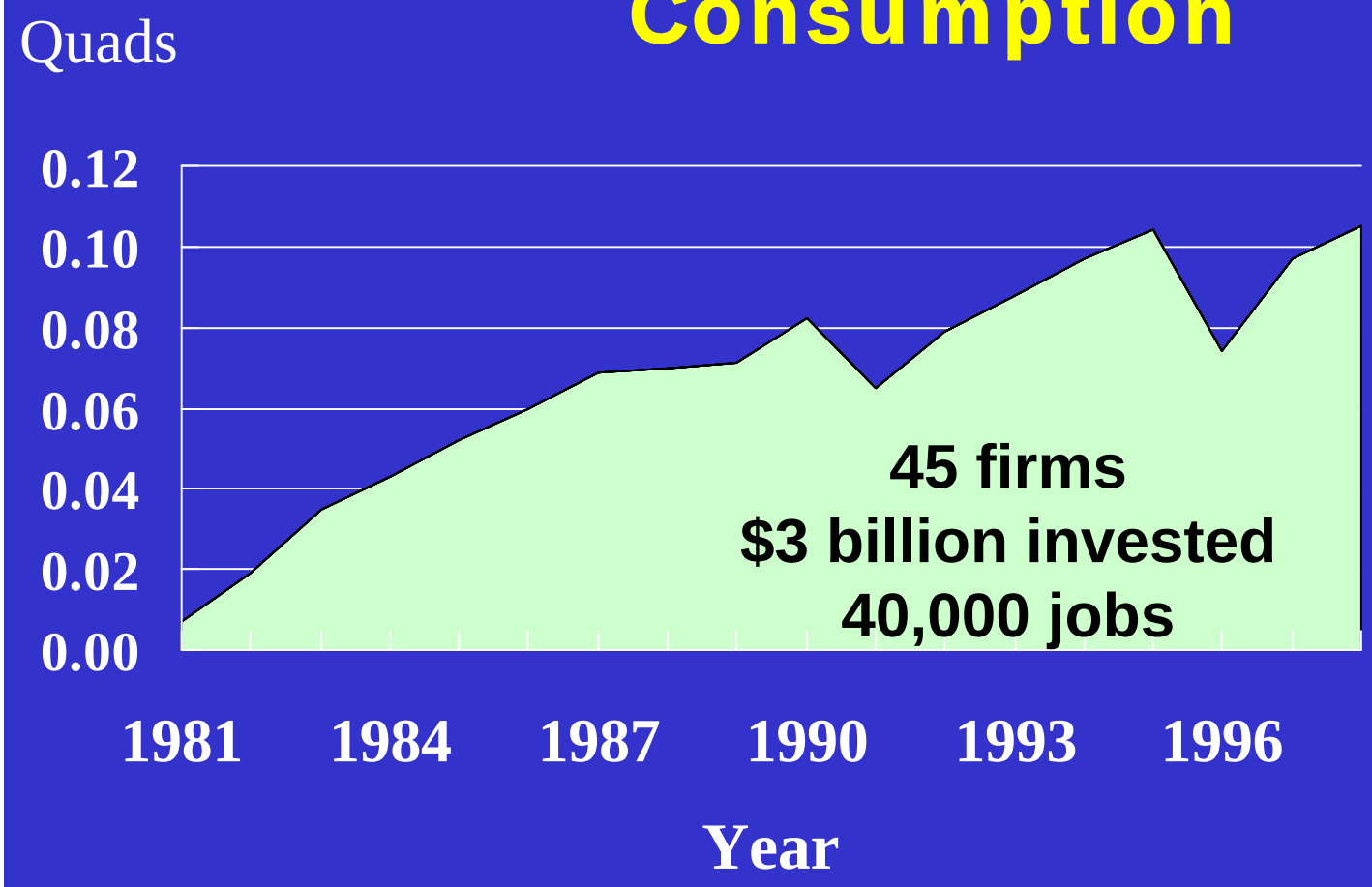


Offsetting Emissions of Existing Fossil Generation - A Low Cost Option
Several successful Demo's
35% Efficiency
SOx and Some NOx Reduction
Market Encourages Energy Crops
Results in No Capacity Addition



Distributed Generation/Village Power
Micro-Turbines, Fuel Cells, Stirling Engines
Fuel Flexible; Efficient
Simple to Operate
Minimal Environmental Impacts

Historical U.S. Ethanol Consumption



6-7 billion Liters
1% gasoline

- **Capacity 2000**
  9 billion Liters

- **2010 projected capacity**
  12 billion Liters

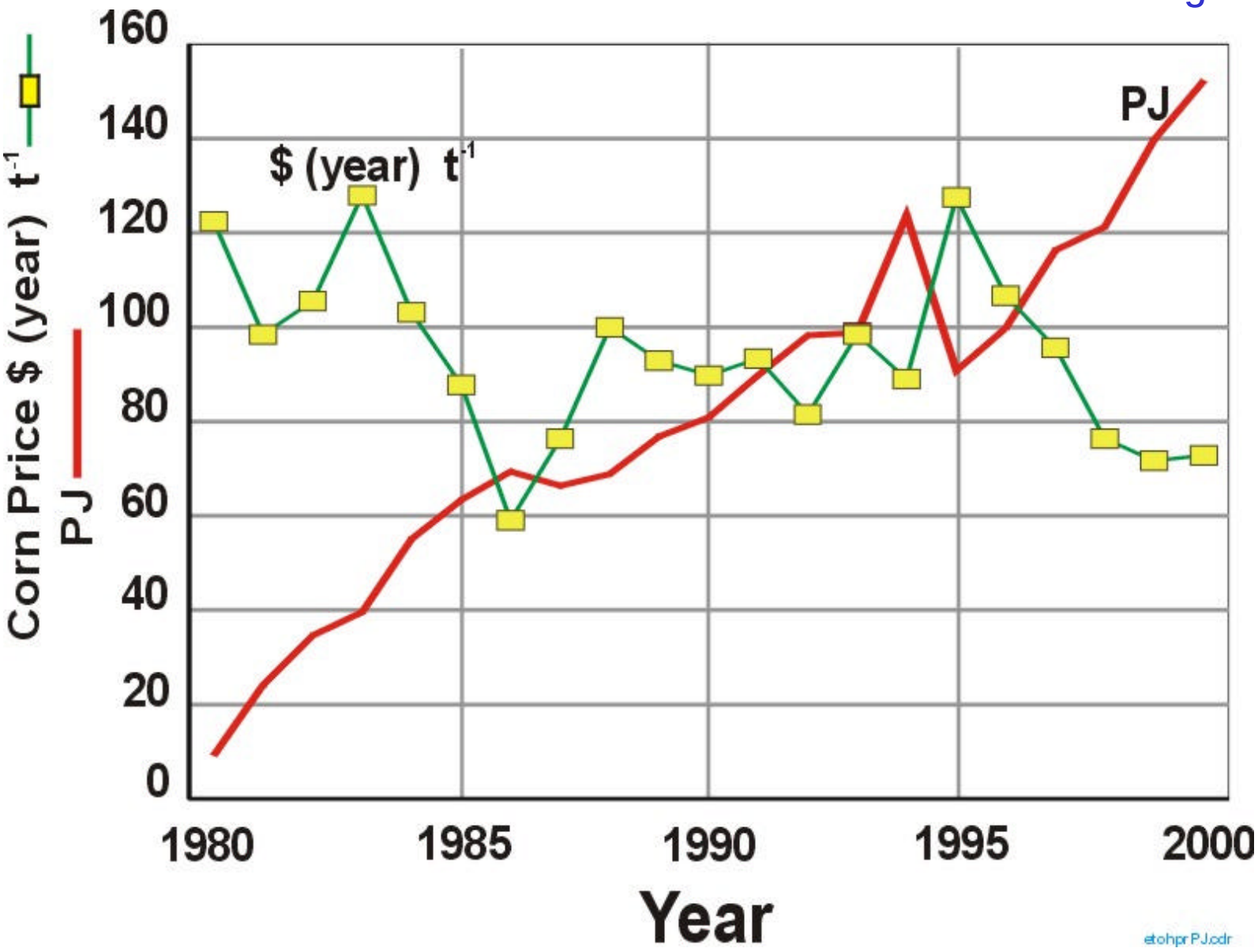
Replace MTBE?

Ref: Energy Information Administration, http://www.eia.doe.gov/pub/energy.overview/aer98/txt/aer1003.txt

Ethanol in Brazil
10-15
billion Liters

Ethanol and Corn Trends

Partial Waiver of Excise Taxes Continues Through 2007



Bioethanol Production

"Cooking"
catalyst
+
heat
+
time

=

sugars
and
residual
solids
(lignin)

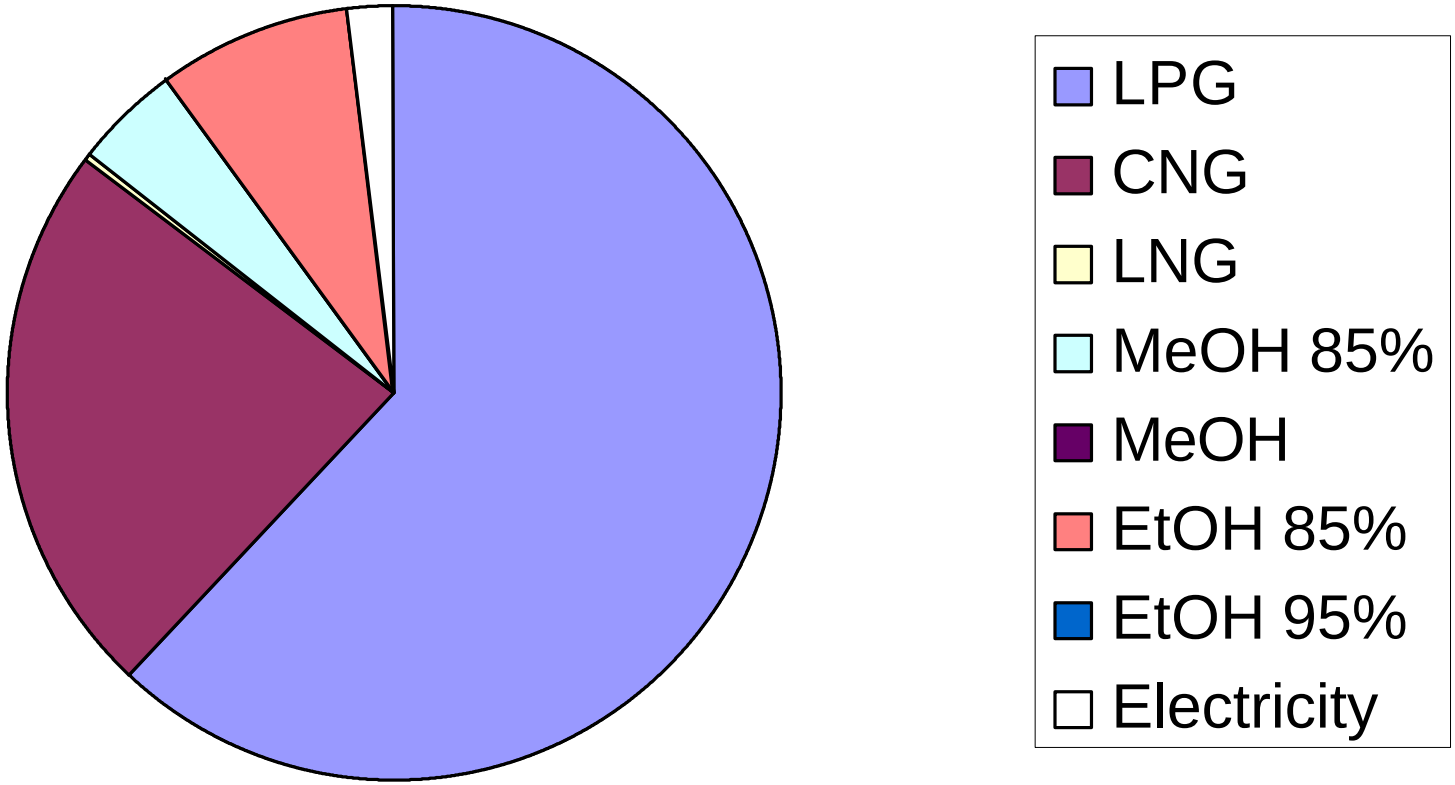
ethanol
fermentation
and recovery

lignin
utilization
(boiler fuel)

Decouple sugar cost from commodity food market
Lower production cost

Alternative-Fueled Vehicles by Type - Year 2000

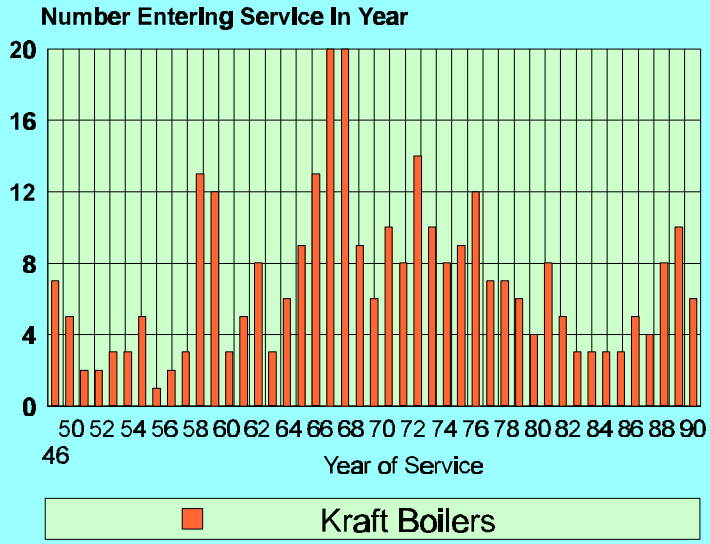
EPAct 1992



Total Number: 432,000/220 million vehicles

USA-kraft Boilers in service

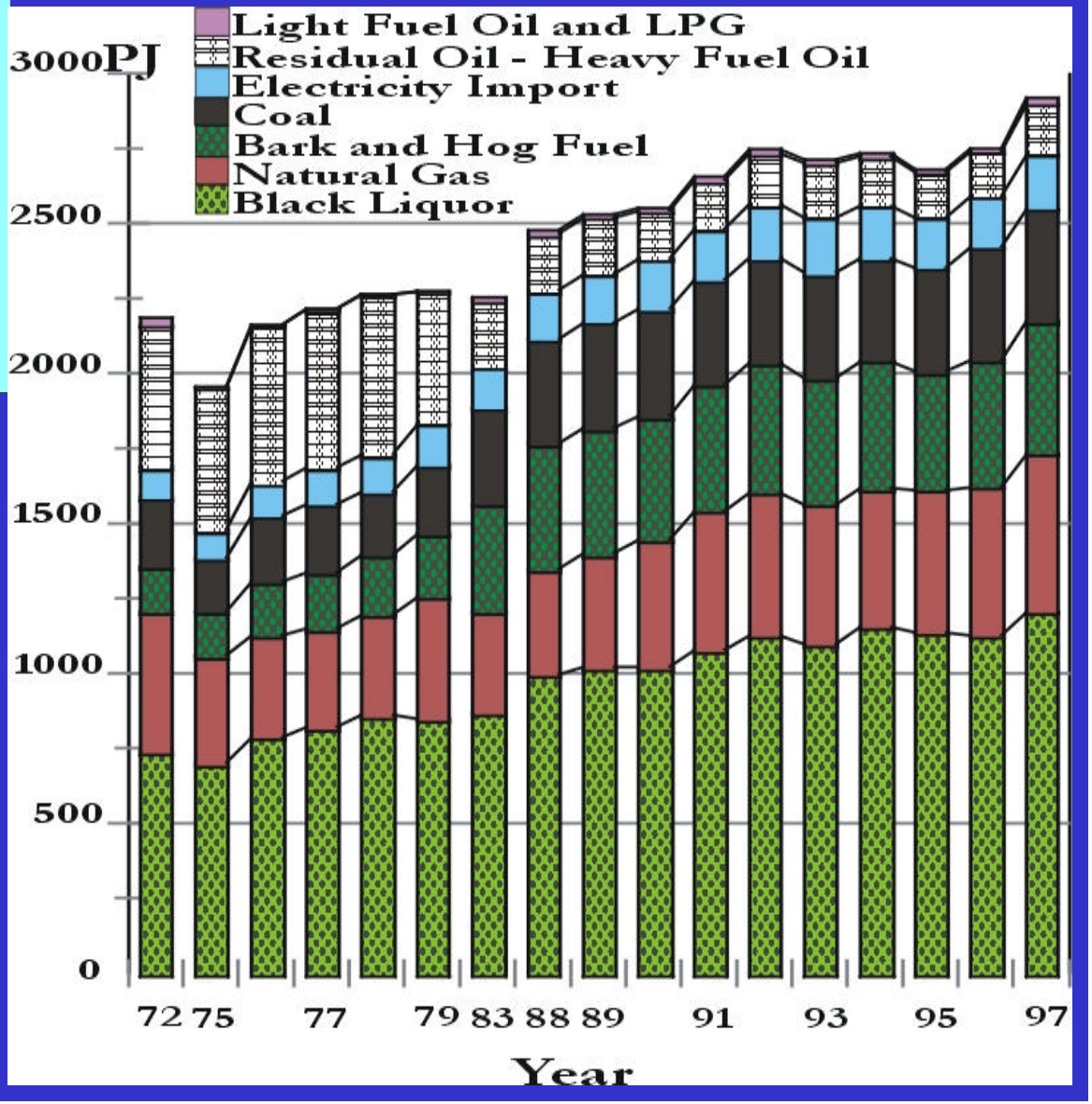
AF&PA Data

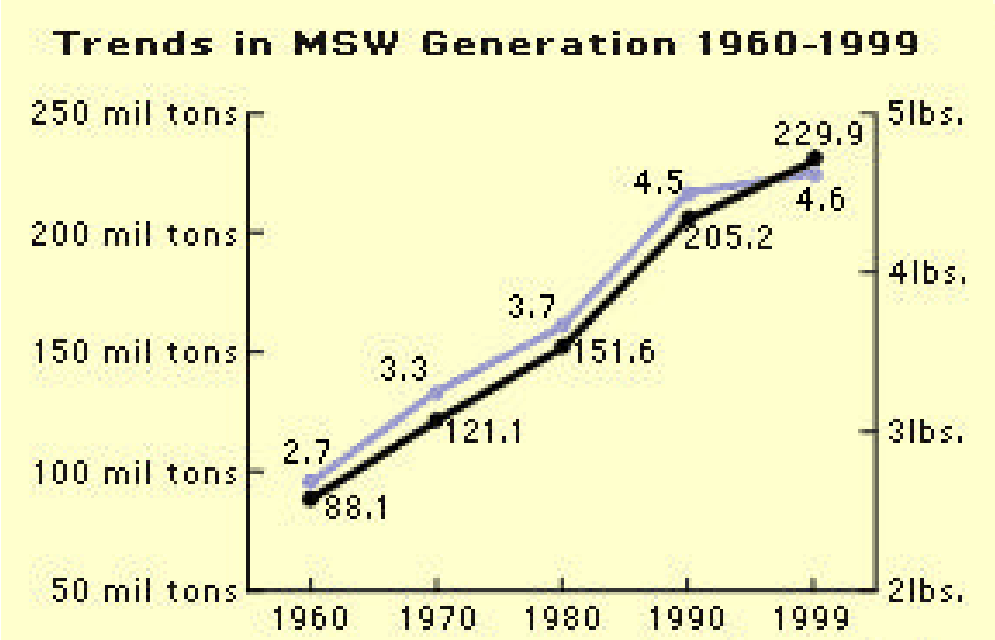


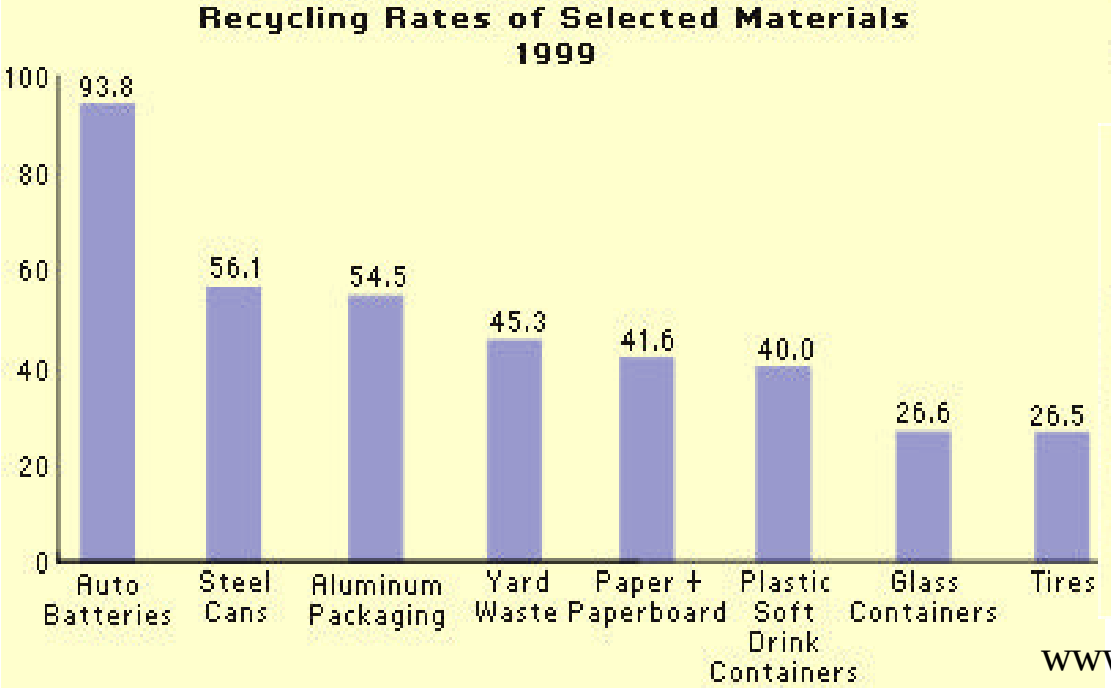
- RD&D
- support of demonstration
-1st of a kind commercial
  -Several concepts
- Lower cost learning curve

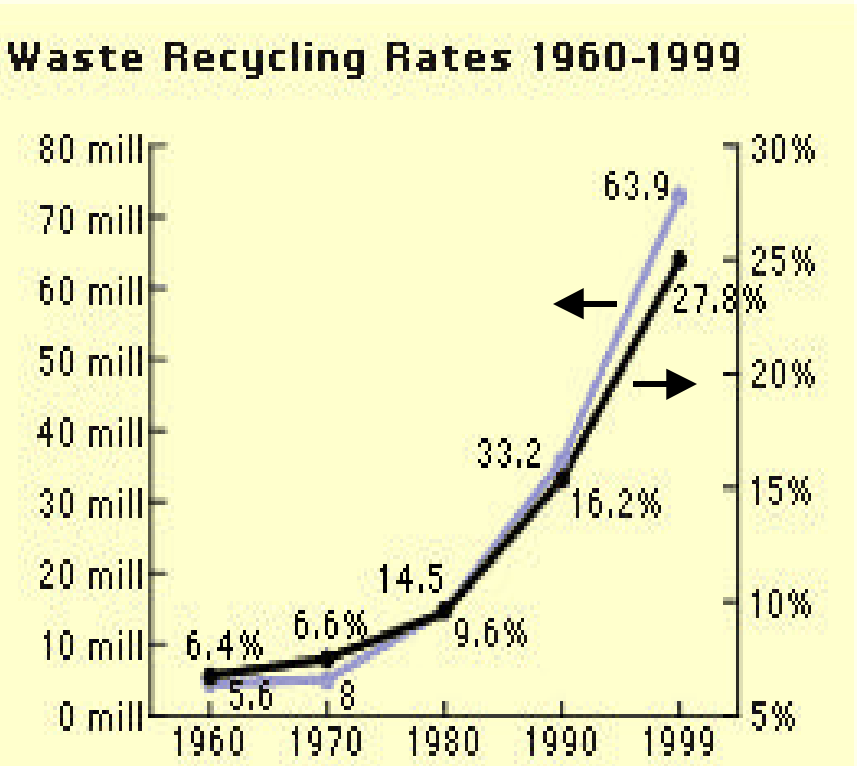
Agenda 2020
American Forest & Paper Association

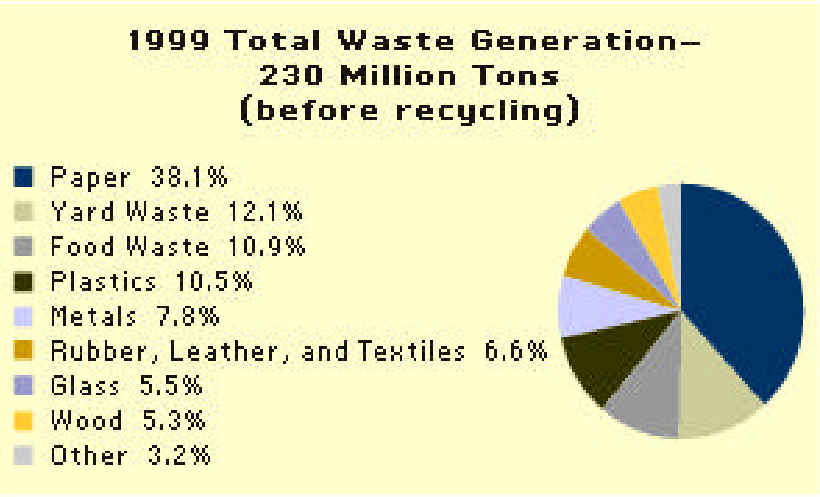
Replacement of boilers at the equipment replacement time with integrated gasification combined cycle could make the industry an exporter of up to 30GW by 2030











www.epa.gov/epsoswer/non-hw/muncpl/facts.htm

EPA (2001). Basic Facts - Municipal Solid Waste, Office of Solid Waste Information. 2001.

Summary of Key Bioenergy Federal Subsidies -- 1999

Type	Amount, million 2000 $	Use/ Uptake by Private Sector*
Renewable Energy Production Incentive (direct expenditure)	$2.6	Wood residues & landfill gas. Year to year appropriation – considered less effective than others
Internal Revenue Code, Section 29 Tax Credits	$4.0	Alternative fuel (non-conventional) production credit - effective
Alcohol Fuel Credit	$15	-- Somewhat effective production credit
Revenue loss estimate for the partial exemption from Excise Tax for Alcohol Fuels	$680-$725	Primarily used for ethanol – very effective in driving increased production. This revenue loss is offset by less direct govt payment to farmers due to increased grain consumption

*EIA/SR/01AF/99-03, Federal Financial Interventions and Subsidies in Energy Markets 1999: Energy Transformation and End Use, 2000; Renewable Energy 2000: Issues and Trends, Feb 2001, DOE/EIA –0628 (2000).
GAO/RCED-00-301R Tax Incentives for Petroleum and Ethanol Fuels, 2000

Tax Incentives for Ethanol Fuels Created Market Certainty

	Tax Incentive Expressed as Federal Outlay Equivalents	Summed over Years	Adjusted to 2000$
	Ethanol – Partial exemption from the excise tax for alcohol fuels	1979-2000	$7.5 to $11 billion (Treasury or Joint Committee on Taxation calculations). This revenue loss is offset by less direct govt payment to farmers due to increased grain consumption
	Income Tax Credits for Alcohol Fuels	1980-2000	$198-$478 million (Treasury or Joint Committee on Taxation calculations)
Fossil Fuels	Petroleum industry excess of percentage over cost depletion	1968-2000	$82 billion
	Petroleum industry expensing of exploration and development cost	1968-2000	$42-$54 billion (Treasury or Joint Committee on Taxation calculations)
	Alternative (non-conventional) Fuel Production Credit	1980-2000	$8.4-$10.5 billion (Treasury or Joint Committee on Taxation calculations)

GAO/RCED-00-301R Tax Incentives for Petroleum and Ethanol Fuels, 2000

Create targeted markets to increase investment

- **Commercial Market Potential**
  - Renewable Portfolio Standard (RPS) for Electricity Proposals at Federal level (not enacted) could establish a % of renewable electricity required by any company selling electricity in a competitive market (to have or buy from a company that has excess renewables -- tradable obligation)
  - RPS enacted at several states http://www.eren.doe.gov/state_energy/policy_content
  - Renewable Fuel Standard proposals at the Federal level (not enacted) could establish % renewable fuel in the pool

States with Renewable Portfolio Standard

State	Portfolio Standard
Connecticut	New Renewables: 0.5% by 7/1/2000 increasing by 0.25 % each year through 7/2009.
	Existing renewables increase from 5.5 percent to 7% by 2009.
Maine	30% standard.
Massachusetts	1% starting in 2003, increasing by 0.5% through 2009, and an additional 1% per year thereafter.
Nevada	0.2% and increasing to 1% by 2010, half of which is to come from solar power.
New Jersey	2.5% in 2000 increasing to 6.5% by 2012.
Pennsylvania	2% increasing by 0.5% annually subject to cost limitations.
Texas	2000 megawatts new renewable generating capacity by 2009 with 400 MW to be installed by 2003.

Arguments for Renewable Portfolio Standard

- Helps to diversify a state's energy supply.
- Promotes environmentally-benign forms of electricity.
- Creates initial market demand to help make fledgling industries viable.

Arguments Against Renewable Portfolio Standard

- Increases costs to consumers.
- Customers and the market should be able to select what types of electricity are produced, not mandates.
- The environmental benefits often accrue elsewhere rather than in-state.
- Provides an unfair market advantage to renewable energy technologies.

Outcomes of Government Actions 25 Years

- Primary Energy – **doubled in 20 years**
- Electricity Production – **tripled in 10 years**
- Ethanol Fuels Production – increased a factor of **16 in 20 years**
- Forest Products Energy Self-sufficiency **increased by nearly 50% in 20 years**.
- Forest Products/Pulp and Paper Energy Intensity decreased initially and resumed increase in the 1992-1998 period.
- Overall Agriculture/Energy Interactions – **complex** (somewhat negative for soybean and cattle; somewhat positive for poultry)
- Municipal solid waste management **--**
  - Safe and responsible.
  - Recycling rates **tripled in 30 years**.
  - Primary energy from MSW/landfills increased by a factor of **6 in 20 years**.
- Significant emissions reductions, including carbon, and landfill reduction were achieved.
- Significant economic development including rural.

National Renewable Energy Laboratory

Bottom Line

- Bioenergy - Biopower – Biofuels - Bioproducts
  - Intersection of
    - Energy
    - Agriculture
    - Forestry
    - Environment
    - Regional/Municipal Residue Management
    - Chemical Industry Feedstocks
    - Economic Development
  - Understanding and fostering important and productive interactions is key.
  - Outstanding scientific/technological progress can help design sustainable integrated systems.

Policies, with multiple objectives to be achieved simultaneously, science, and technology can lead to sustainable use of the resource

References

- Helena L. Chum & Ralph Overend, “Biomass and Bioenergy in the United States”, in press Advances in Solar Energy Conversion (2002)
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