

THE COMBINED HEAT AND POWER CHALLENGE

**COMBINED
HEAT AND
POWER
CHALLENGE**

Stephen L. Sargent

USDOE-Denver Regional Office

**Combined Heat and
Power Conference**

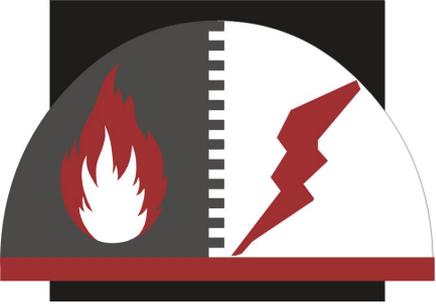
Denver, Colorado

April 19, 2001

BACKGROUND & INTRODUCTION

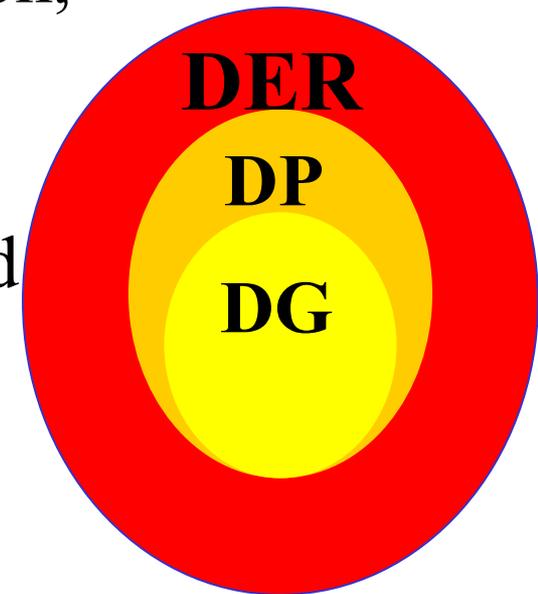


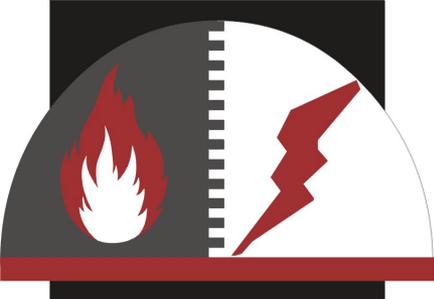
DER
**DISTRIBUTED
ENERGY
RESOURCES**



Definition of Terms

- **Distributed Power (DP)**--local distribution, storage, and inter-connection systems
- **Distributed Energy Resources (DER)**--local supply and demand side measures and delivery infrastructure
- **Distributed Generation (DG)**-- “prime movers” such as solar, wind, fuel cells, microturbines, advanced turbines, reciprocating engines
- **Combined Heat and Power (CHP)**--the most efficient form of DG with low emissions





Office of Power Technologies

Robert K. Dixon, Deputy Assistant Secretary
William Parks, Associate Deputy Assistant Secretary

Power Program Operations
Supervisor - TBD

Solar Energy
Jim Rannels,
Director

Biopower &
Hydropower
Don
Richardson,
Director

Hydrogen &
Superconductivity
Jim Daley, Director

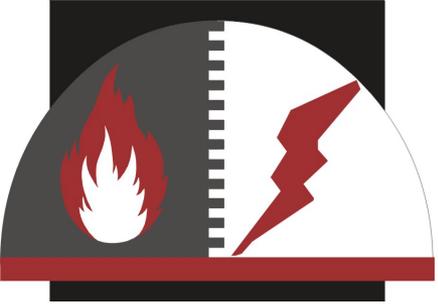
Wind &
Geothermal
Peter
Goldman,
Director

Technology
Access,
Thomas
Sacco,
Director

Distributed
Energy
Resources
William Parks,
Acting Director



- ◆ **Our Vision -- The US will have the cleanest, most efficient and reliable energy system in the world.**
- ◆ DER Programs will promote a diverse and competitive energy marketplace where OPT's (Office of Power Technologies) portfolio of renewable and natural gas energy systems are widely implemented.

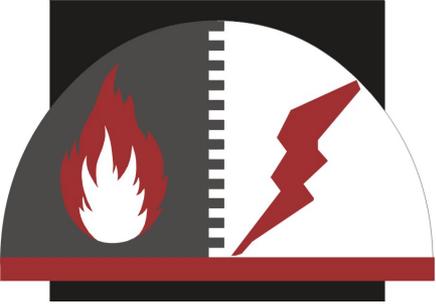


Rationale for DER Program

OPT Goal 1 -- Enhance the use of renewable energy, triple the installed U.S. capacity of non-hydroelectric renewables by 2010, and maintain the viability of hydropower.

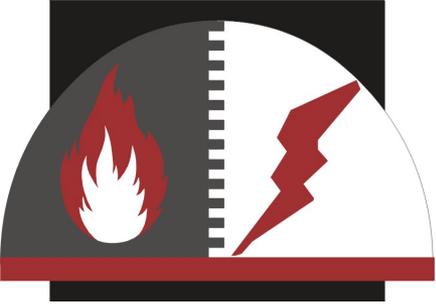
OPT Goal 2 -- Enable distributed energy resources to achieve 20%+ of new generation capacity by 2010.

OPT Goal 3 -- Maintain the present high reliability of the nation's electricity system.



DER Supports and Unifies Existing Goals

- **Renewable goal to triple installed capacity by 2010**
- **Distributed Generation goal to achieve 20% of new installations by 2010**
- **CHP goal to double installed capacity by 2010, reduce CO₂ emissions.**
- **Reliable, quality electric power**
- **Federal energy use reduction goal - 35%**



Distributed Energy Resources Office

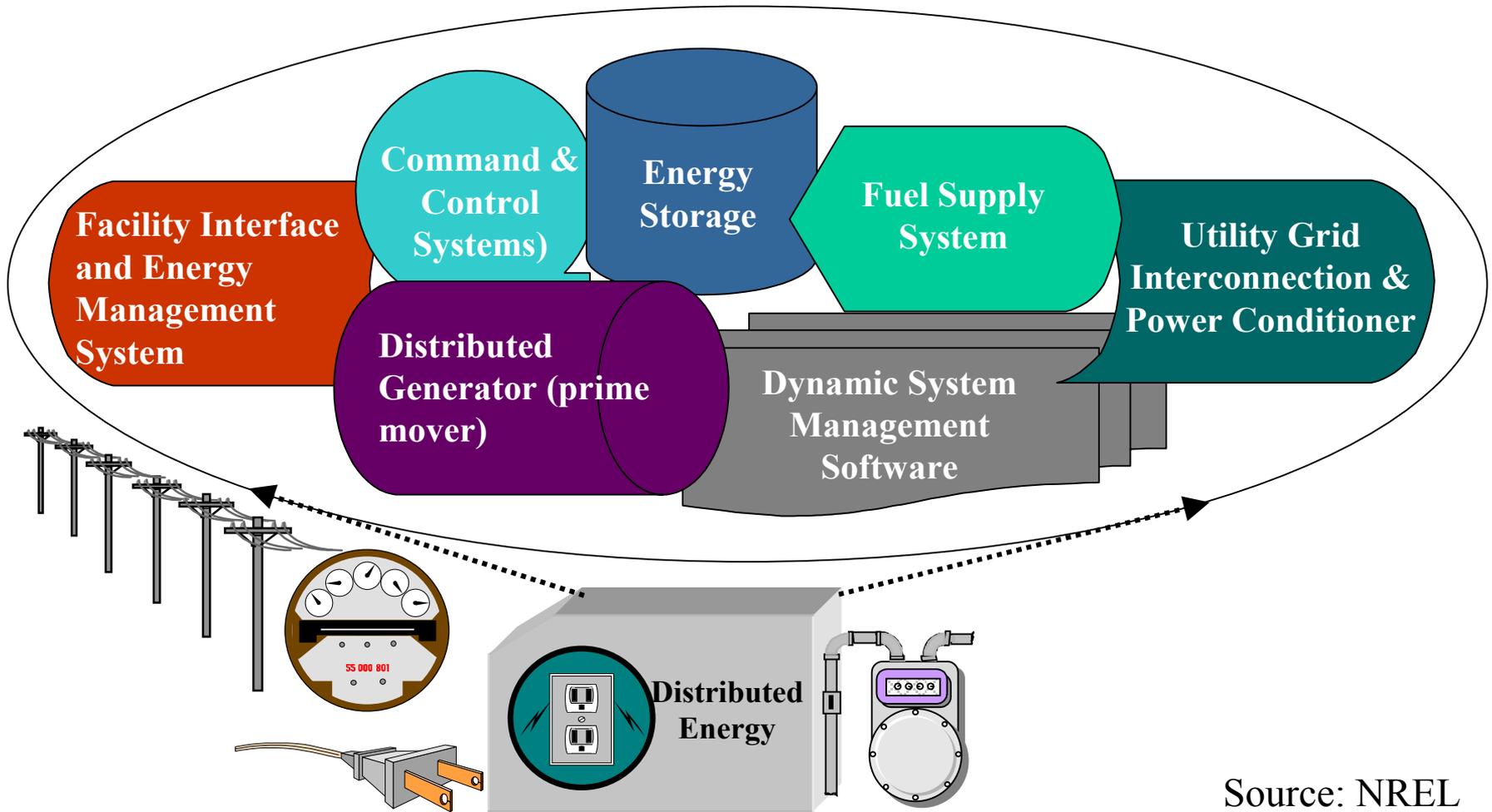
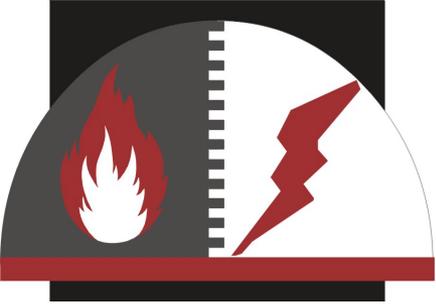
- Integrates renewable energy and natural gas DER programs
- Responds to changes in the marketplace and stakeholder requests
- Provides coordination for all Office of Energy Efficiency and Renewable Energy (EERE) DER activities
- Established March 2000



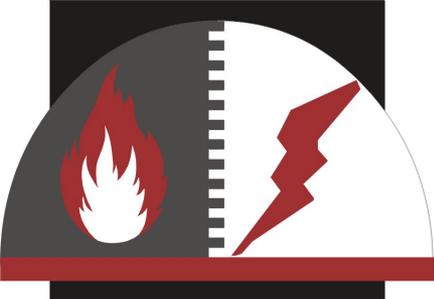
Top 5 DER Challenges

- Integrating natural gas and renewable DER systems
- Lack of well documented analysis of “national” DER cost/benefits
- Sustaining support for cross cutting R&D e.g., sensors, controls, materials, communications
- Partnering better with the electric power industry, gaining more more support for CHP/DER
- Transition to a new Administration: uncertainties regarding funding and priorities

Portfolio of DER Technologies

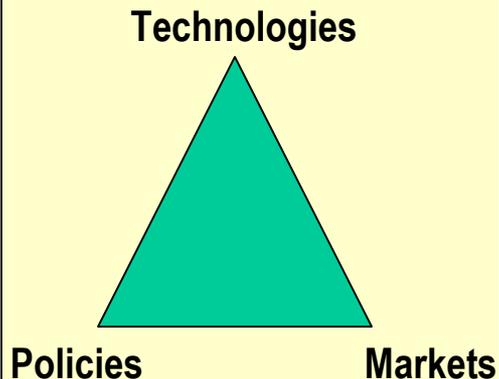


Source: NREL

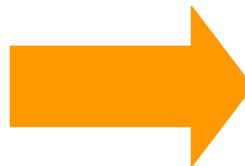


The Federal Role

An Integrated Approach



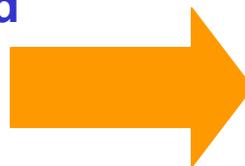
Support RD&D in advanced energy technologies



Address regulatory and institutional barriers

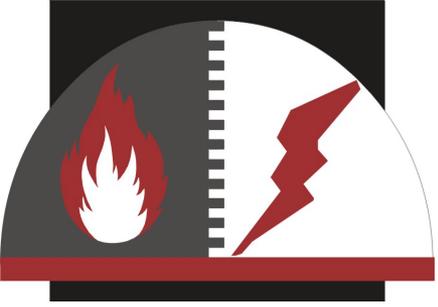


Establish cost-shared RD&D partnerships with industry and others

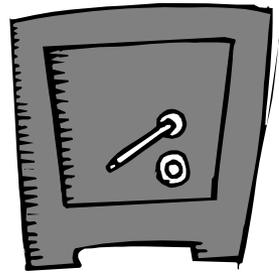


The Ultimate Goal

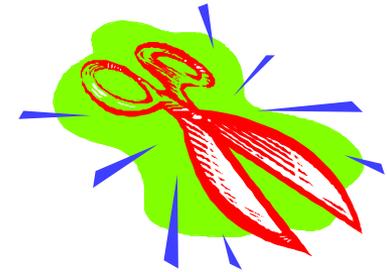
A competitive marketplace for the expanded use of clean, efficient, reliable, and affordable energy resources



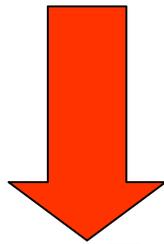
Why is CHP Important?



Reliability



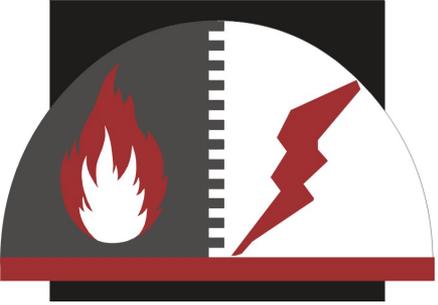
Cut Energy Costs



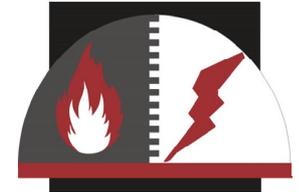
Reduce Emissions



Opens Doors to Retail Power



UNDERSTANDING OF Industrial CHP



1

Applies to industrial and process industries.

2

Focuses on heating and power technologies (shaft & electrical) for industrial and process industries.

3

Leads research to develop advanced microturbines, advanced gas turbines, advanced IC engines, stationary power generation and integration with industrial and process technologies.



UNDERSTANDING of Buildings CHP



1

Applies to buildings (commercial, institutional, multi-family, communities and eventually homes).

2

Focuses on integrating cooling, dehumidification, ventilation, heating and power (shaft & electrical) for buildings.

3

Leads research to develop advanced thermally activated HVAC equipment, stationary fuel cells, energy recovery technologies, thermal transport & storage and CCHP system integration technologies for buildings.

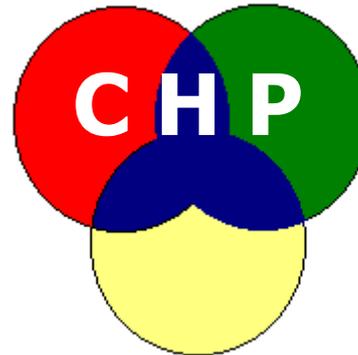


Technology Relationships

**DISTRICT
ENERGY**

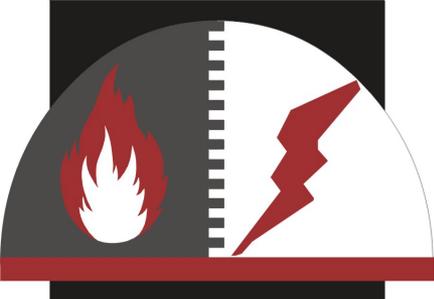
*(aggregate
thermal loads)*

**DISTRIBUTED
ELECTRICITY
GENERATION**



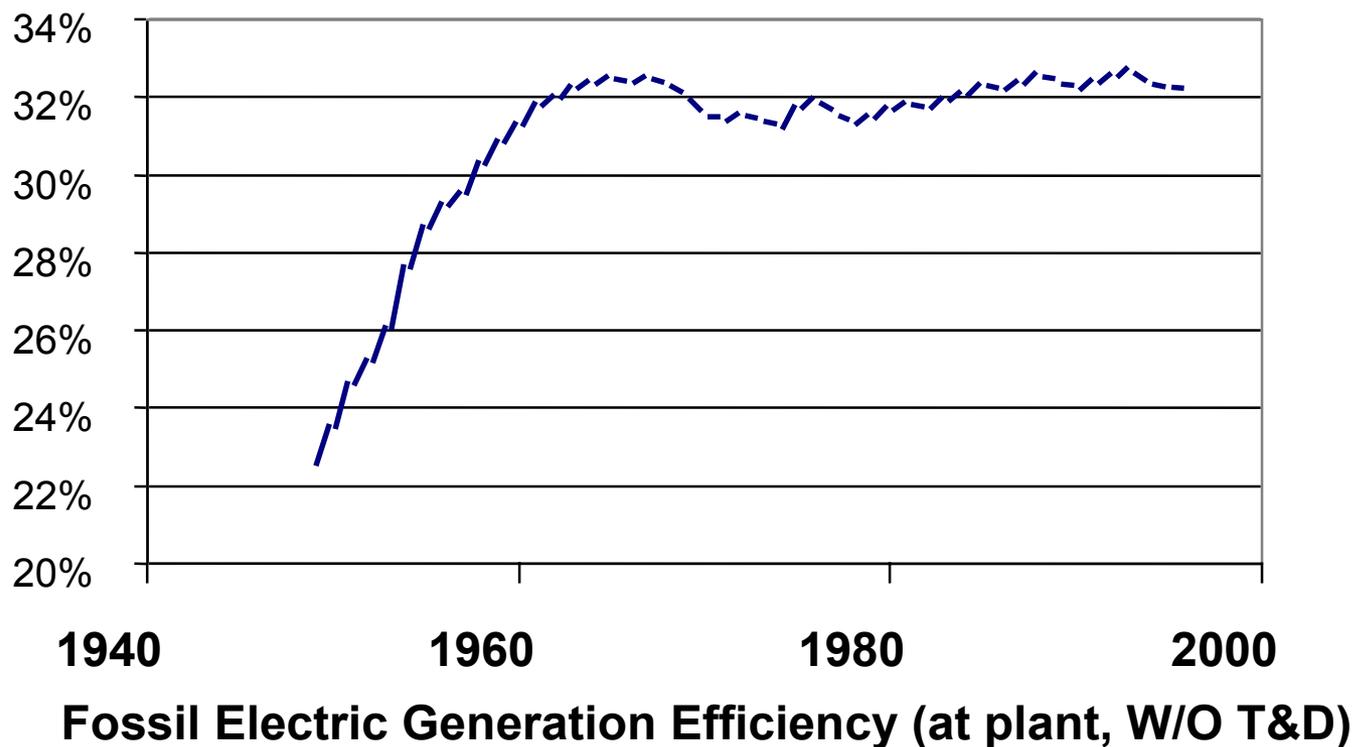
**ADVANCED
ENERGY
TECHNOLOGIES**

*(turbines, fuel cells,
ICE's, renewables)*



The Need For CHP

Stagnant Efficiency of U.S. Electric System

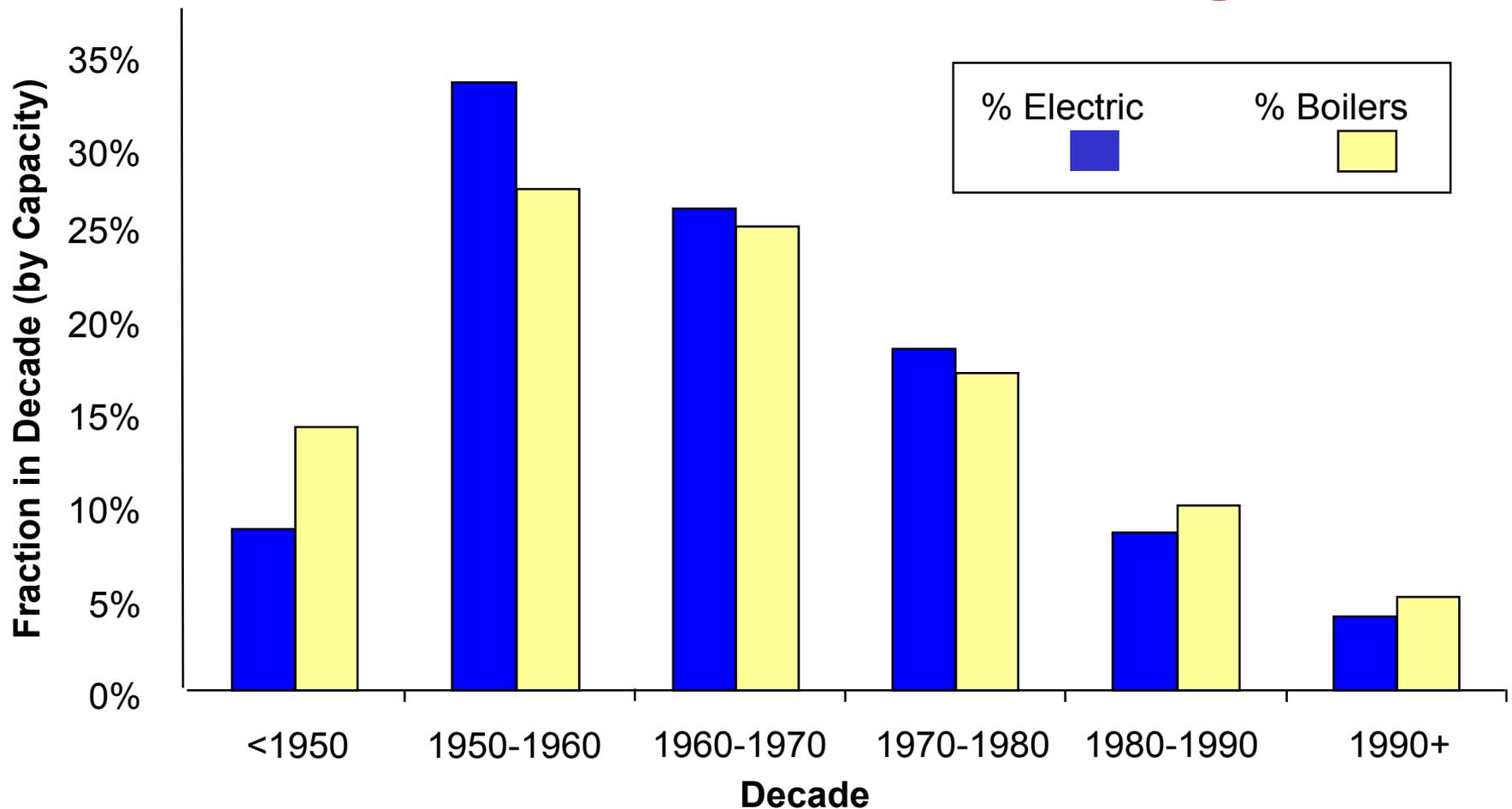


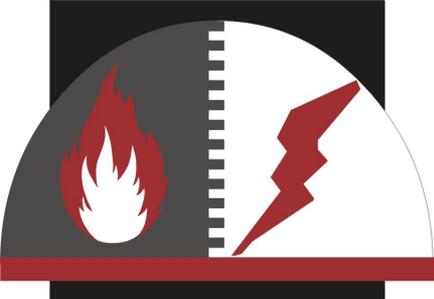
Source: EIA, Annual Energy Review 1996



Aging Infrastructure

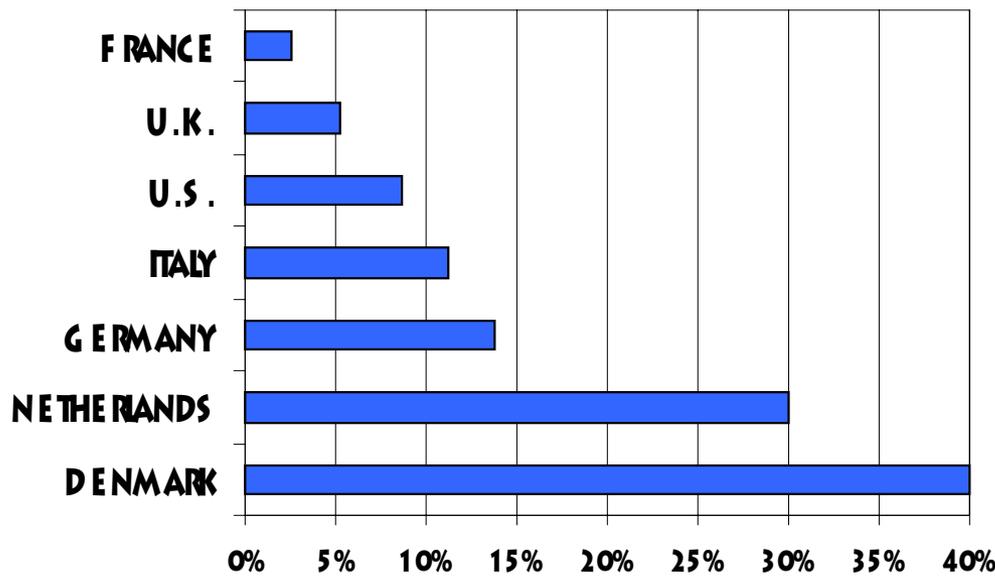
Boilers and Electric Plant Vintage





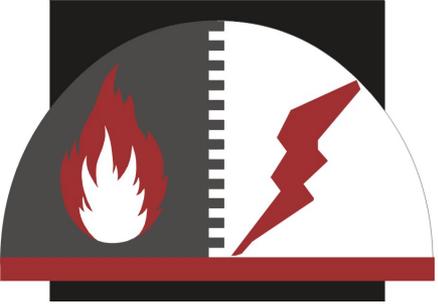
International Comparisons

CHP as a Share of National Power Production

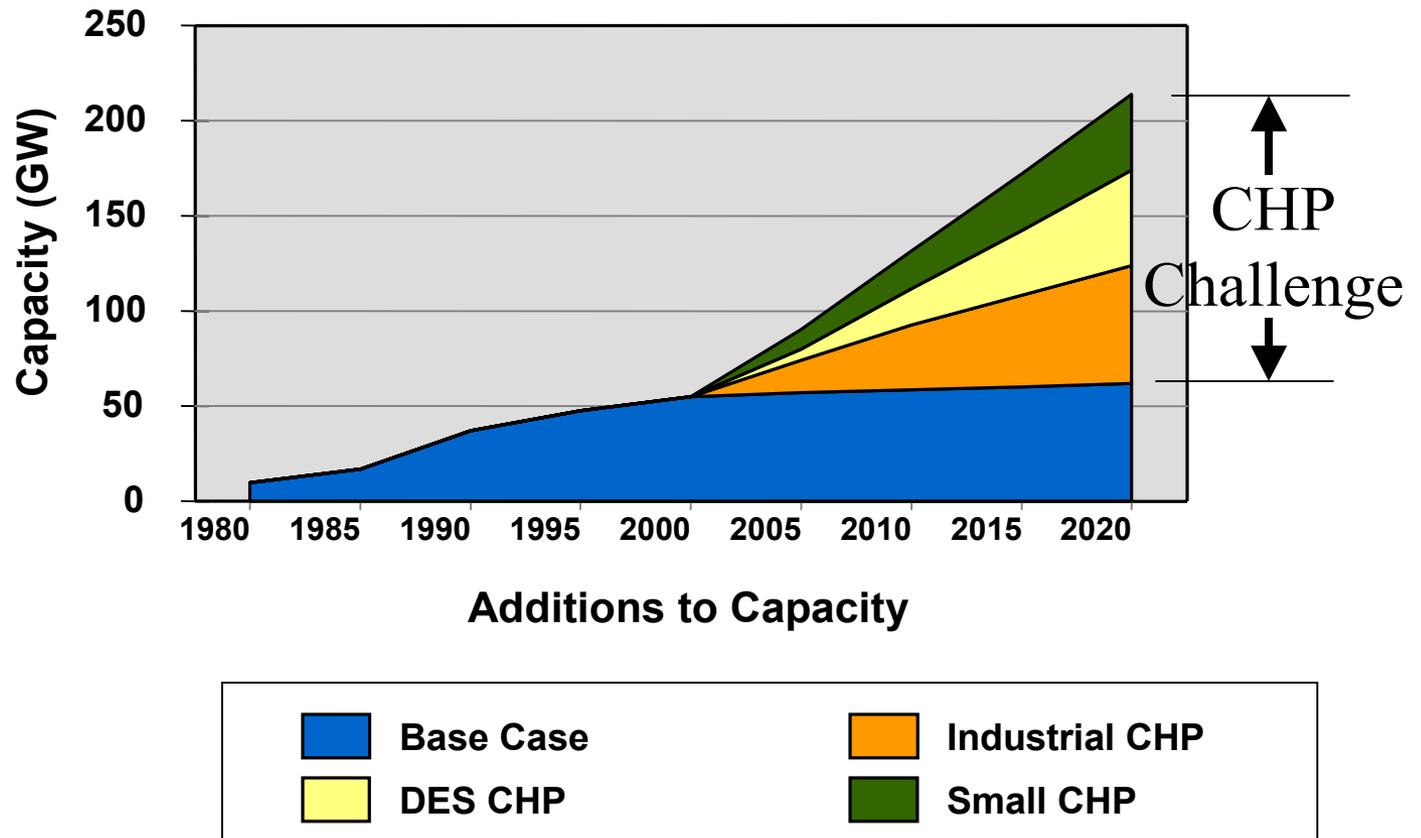


- ◆ EU goal to double CHP share from 9% to 18% by 2010
- ◆ UK goal to increase CHP capacity by 35% by 2000

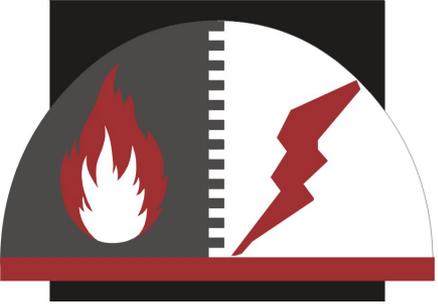
Sources: European Cogeneration Review, 1997;
Cogen Europe, 1997; Annual Energy Outlook, 1997



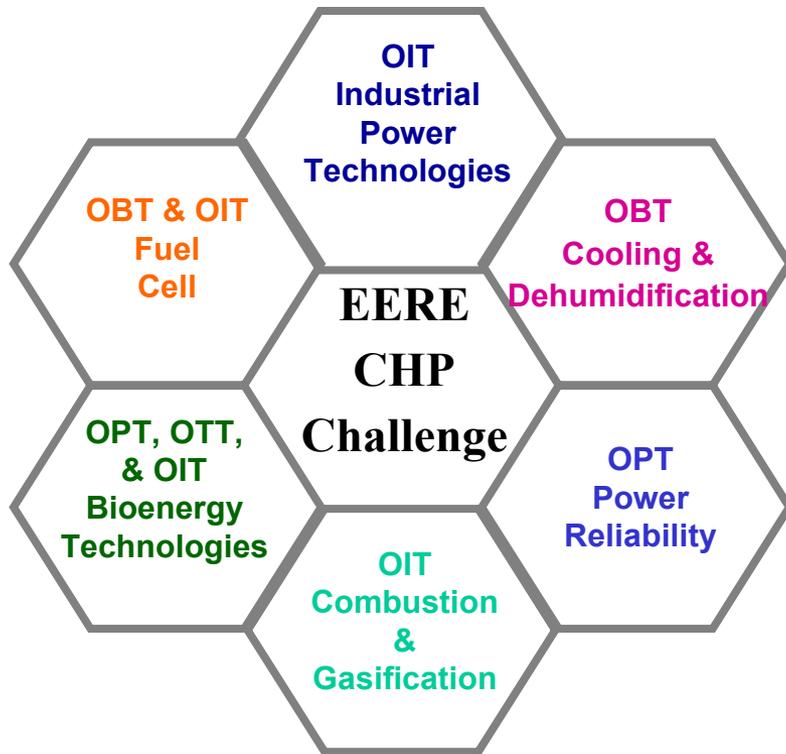
National CHP Goal



Source: American Council for an Energy-Efficient Economy



CHP Technology Coordination in EERE



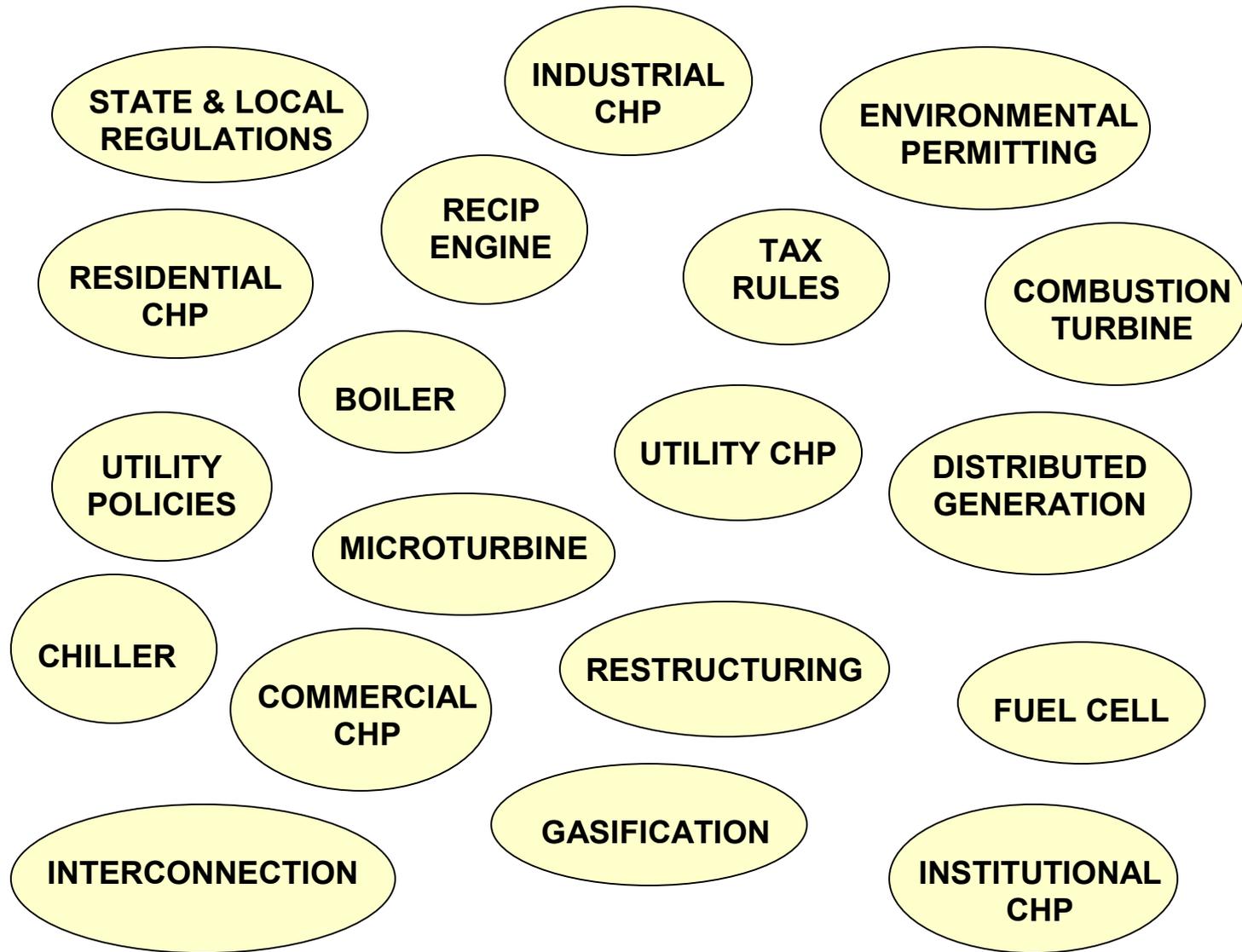
Crosscutting technology from **BTS**,
OIT and **OPT** to **FEMP**

Power generation technology from
OIT, **OPT** and **OTT** to **OBT**

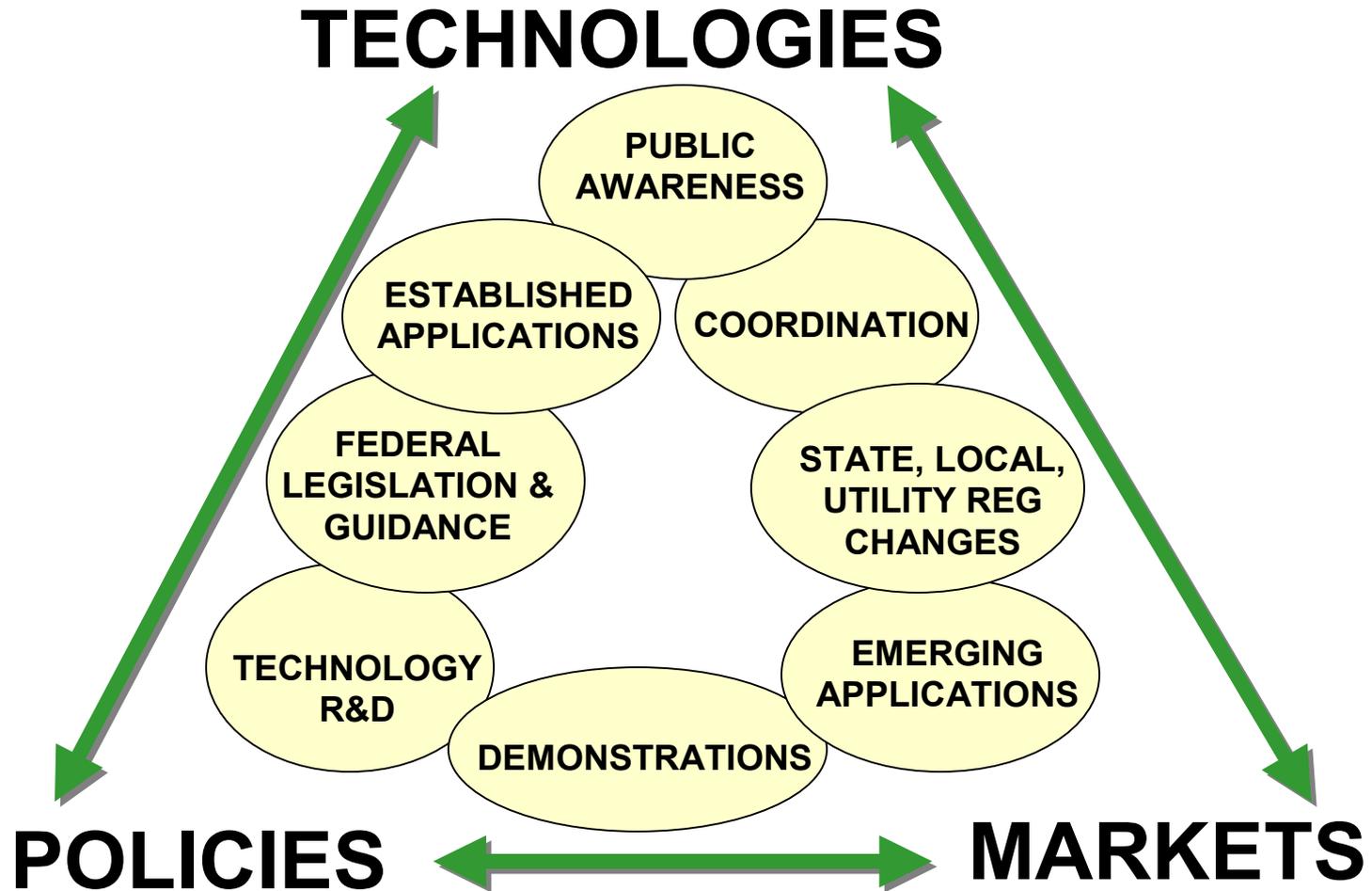
Cooling, dehumidification and
stationary fuel cell technology from
BTS to **OIT** and **OPT**

GRID related technology from **OPT**
to **OIT** and **BTS**

Need for Improved Integration

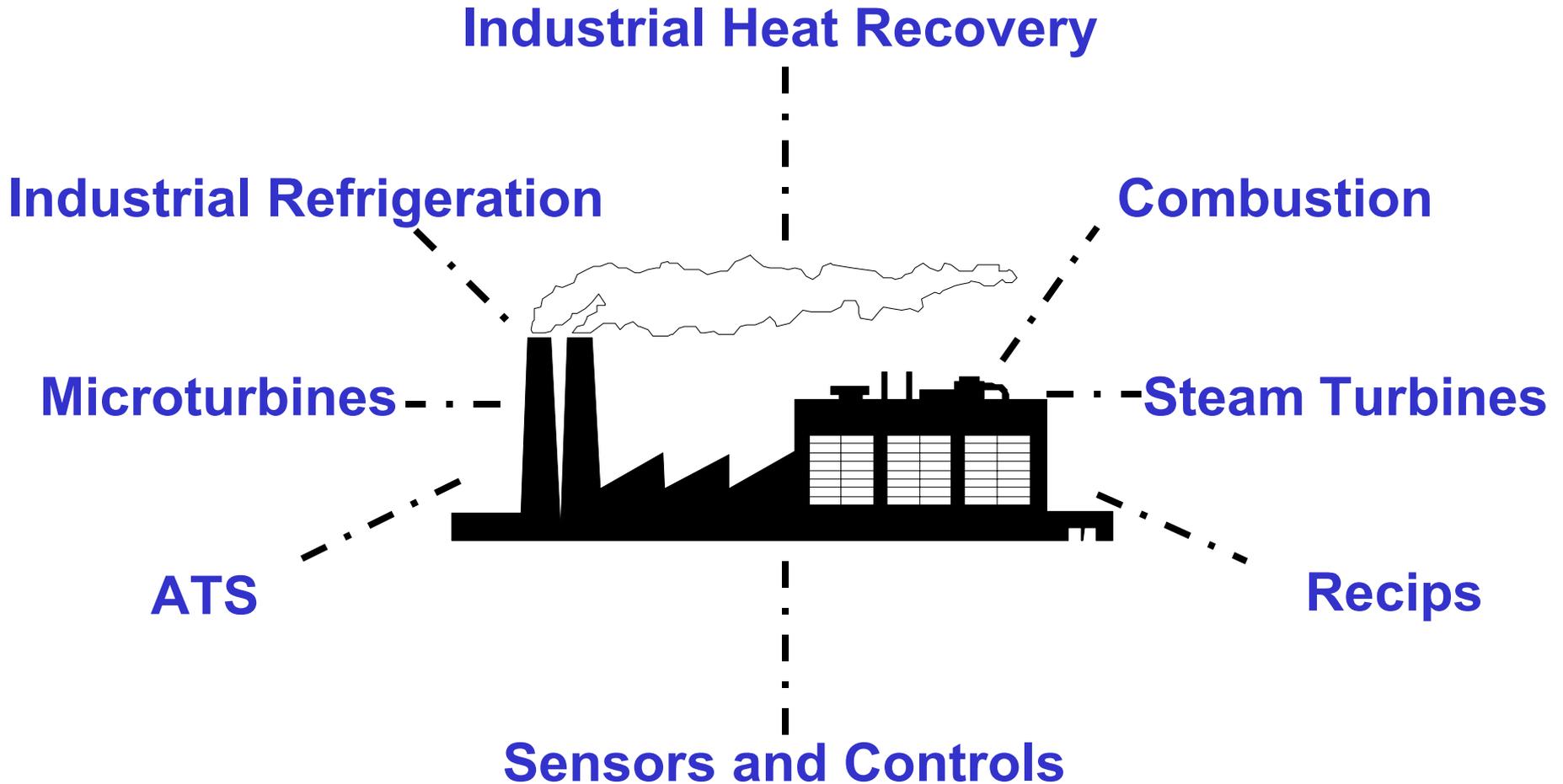


An Integrated Effort

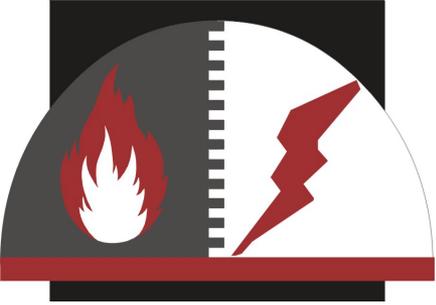




Industrial CHP Technologies

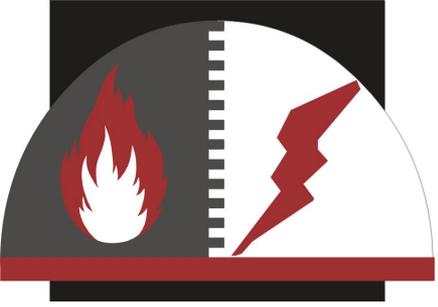


BARRIERS & ISSUES



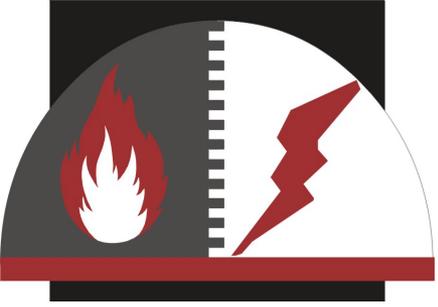
Barriers to CHP

- ◆ **Lack of awareness of CHP**
- ◆ **Complex, time-consuming and costly siting and permitting**
- ◆ **Inadequate regulatory credit for emission reductions**
- ◆ **“Anti-CHP” utility practices**
 - ◆ costly stranded cost recovery fees
 - ◆ complex, costly interconnection
 - ◆ costly back up power rates



Policies

- ◆ **Utility**
- ◆ **Environmental**
- ◆ **Financial**
- ◆ **Federal, State, Local**



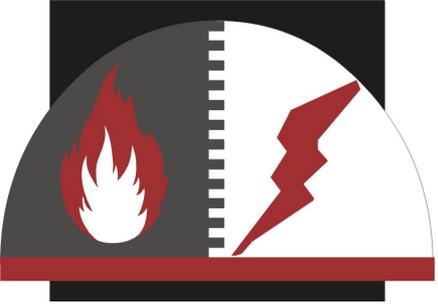
Utility Policies

- ◆ **Exit fees**
- ◆ **Interconnection standards**
- ◆ **Streamlined process for small, clean technologies**



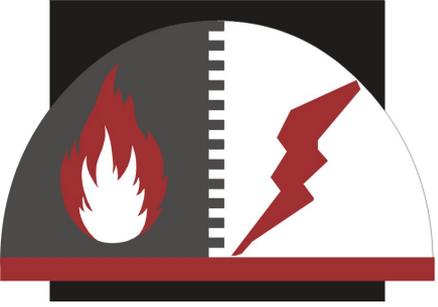
Environmental Policies

- ◆ **Output-based standards**
 - ◆ SIP Call (NO_x trading)
 - ◆ New Source Performance Standards
- ◆ **New Source Review**
- ◆ **Uniform standards for small, turnkey technologies**
- ◆ **Streamlined state permitting**



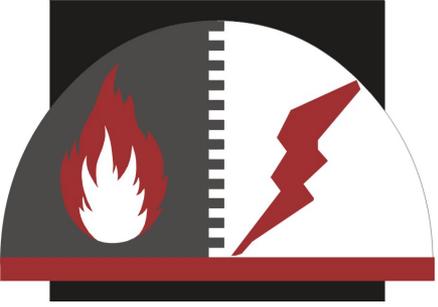
Financial Policies

- ◆ **Tax credit**
- ◆ **Depreciation schedules**
- ◆ **Industry-leveraged government R&D funding**



Federal, State and Local Policies

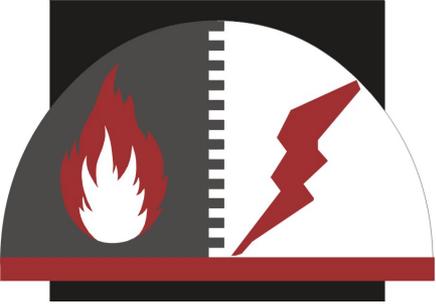
- ◆ **Labor**
- ◆ **Safety**
- ◆ **Zoning**
- ◆ **Siting**



Climate Change

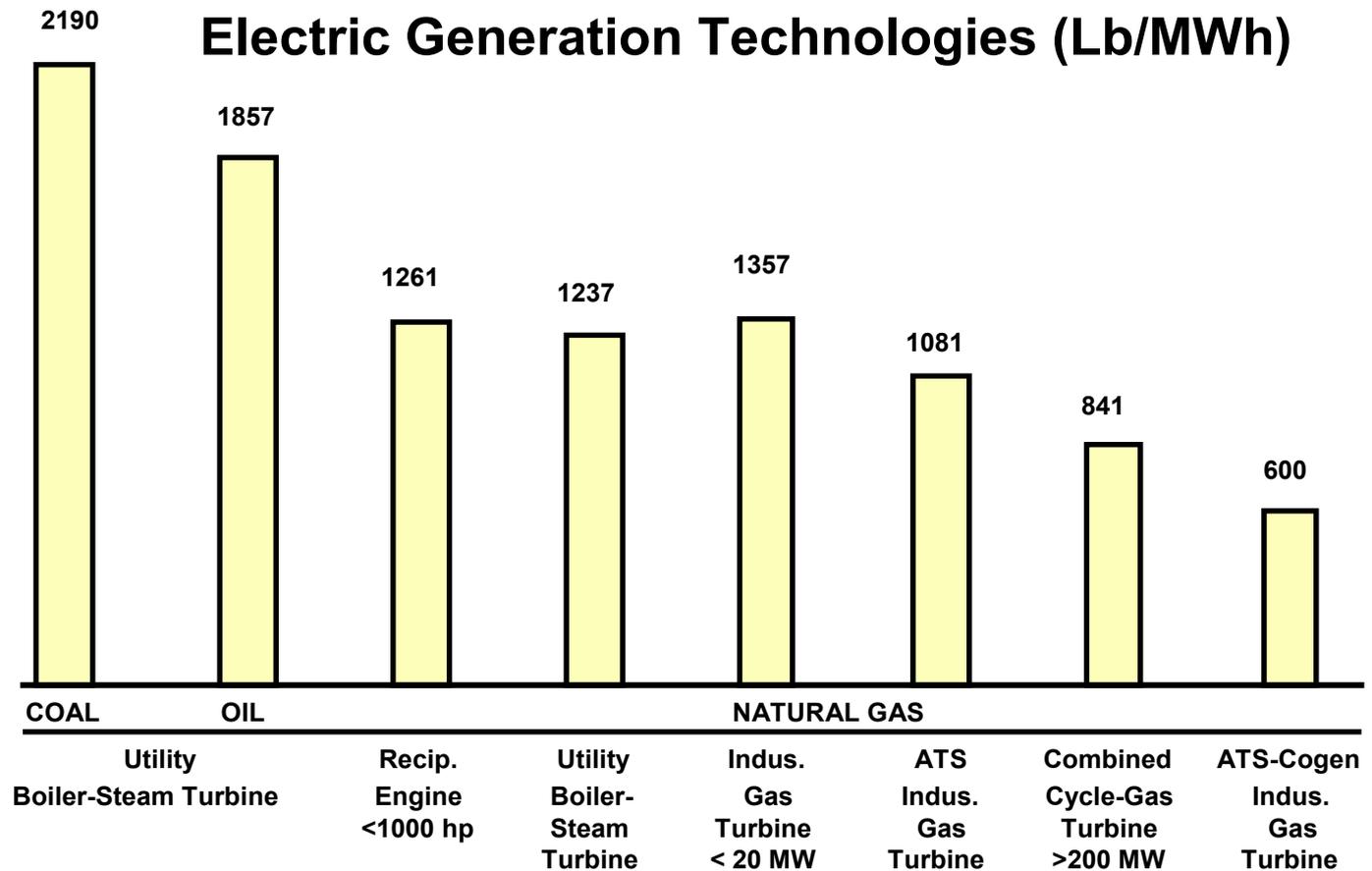
- ◆ **Kyoto Consensus* that Earth's Climate is Changing due to Human Interference**
- ◆ **Technology is a solution.**
- ◆ **Electricity Generation produces 1/3 of US GHG emissions**

*** (Subject to change)**

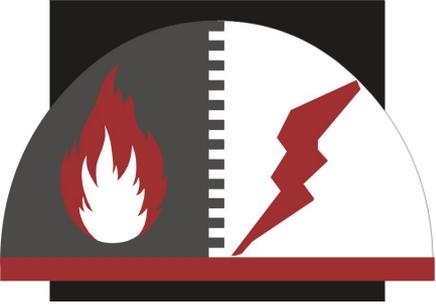


Carbon Emissions

Carbon Dioxide Emissions for Several Electric Generation Technologies (Lb/MWh)



Source: GRI Report Light Duty Vehicle Full Fuel Cycle Emissions Analysis, 1994
 Gas Turbine Environmental Analysis and Policy Considerations, Onsite Energy, 1997



EPA Actions



- ◆ **Output based standards for NSPS**
- ◆ **CHP Team Established at EPA-HQ**
- ◆ **CHP Eligible for Set-Aside in Sip Call**
- ◆ **Developing Permitting Handbook**
- ◆ **Studying CHP Triggering of NSR**
- ◆ **Technical Assistance to States**
- ◆ **Implement Energy Star**



Steps to Achieve the Goal

Competitive Elect. and Nat. gas Markets

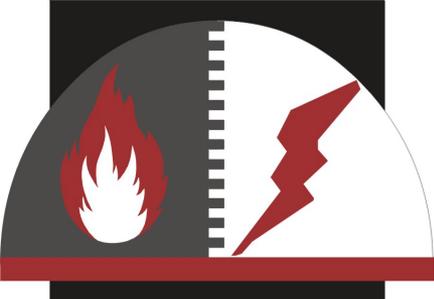
Interconnection Standards

Streamlined Environmental Permitting

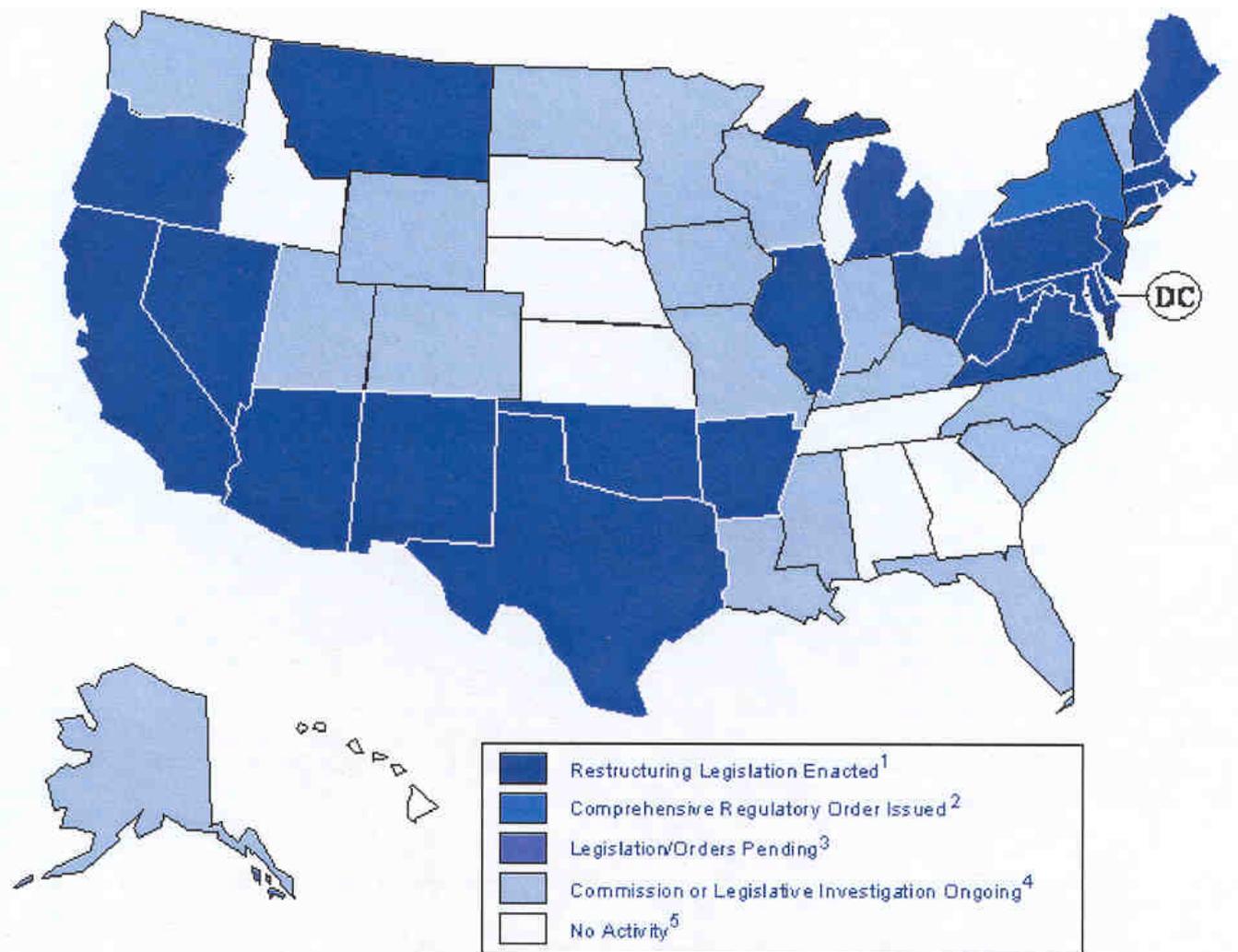
Commercialized Advanced Technologies

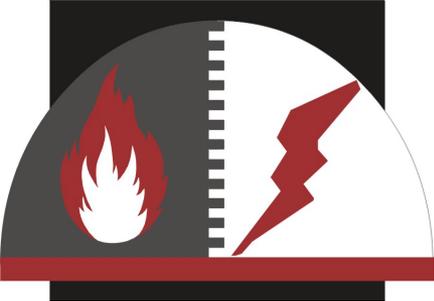
Consistent Tax Treatment

CHANGING MARKETPLACE



State Restructuring Status-March 2001





New Electricity Marketplace

◆ Pricing

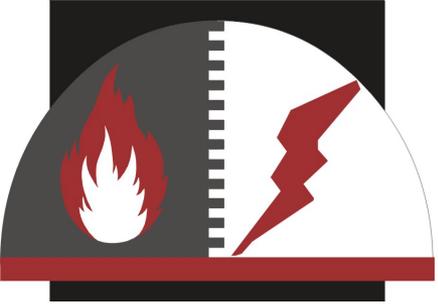
- Lower costs per kWh
- Longer contract term lengths
- Risk management- hedges, options, swaps

◆ Suppliers

- Power
- Energy services
- Technologies (e.g., efficiency, self-generation, CHP)

◆ Procurement Mechanisms

- Outsourcing
- “Energy islands”
- Performance contracting



Energy Service Provider of the Future

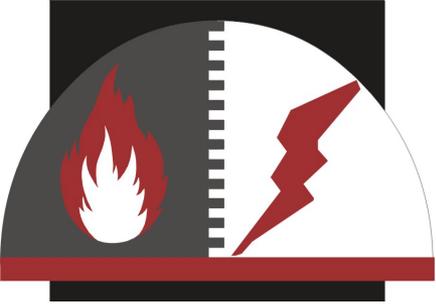
- ◆ **Not vertically integrated**
- ◆ **Reduced incentive for long-term investment**
- ◆ **Expanded/changing client base**
- ◆ **Market place driven - Real time power availability**
- ◆ **Fuel and price interactive**
- ◆ **Load management**



New Choices For Industrial Customers

- ◆ **Focus on “core” business -**
divest energy, assets, sign long-term contracts, outsource
- ◆ **Energy as profit center -**
self-generate, use CHP, sell electricity and steam
- ◆ **Stay-the-course -**
no major changes, wait & see

CHP CASE STUDIES

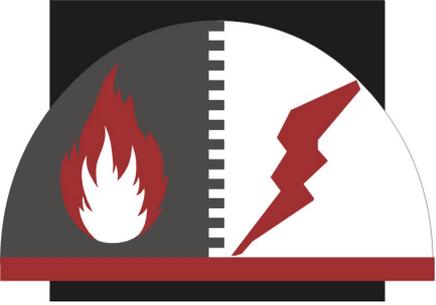


Malden Mills

Textile mill spent more than four years challenging state environmental regulations requiring the use of cost-prohibitive pollution control equipment



- ◆ **Two 4.3 MW combustion turbines installed late 1998**
- ◆ **Ceramic liners will reduce NO_x emissions to less than 15 ppm**
- ◆ **Expected system efficiency of 70%**
- ◆ **System will meet company's growing demand for reliable, economical steam and electricity service**

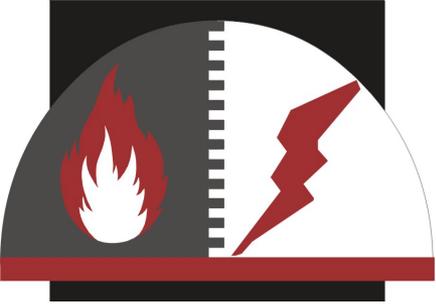


MIT

University overcame utility resistance to install on-site CHP system that will meet 94% of power, heating and cooling needs and will cut electric bills by 40%

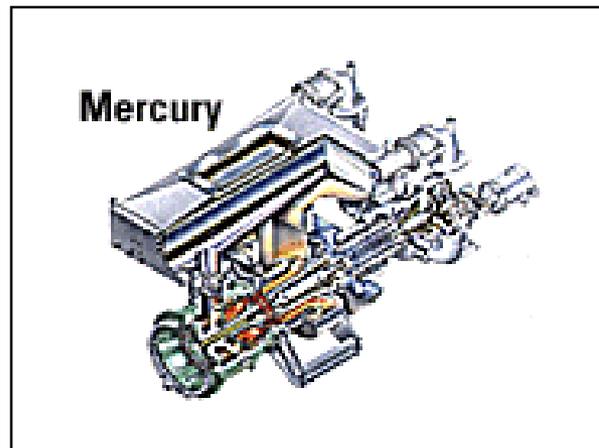


- ◆ **State restructuring legislation exempted MIT from local utility's \$3,500 a day "customer transition charge"**
- ◆ **22 MW gas-fired combustion turbine is 18% more efficient than the technology it replaces**
- ◆ **System has reduced annual pollutant emissions by 45%**



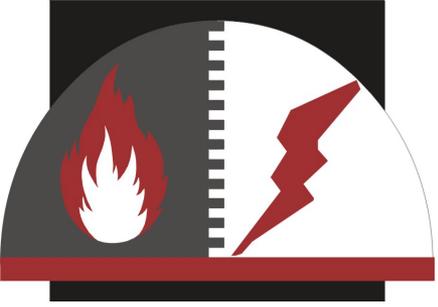
Rochelle Municipal Utilities

Power, steam and water utility in Illinois purchased a 4.2 MW gas turbine to supply grid connected electricity and steam service to industrial customers



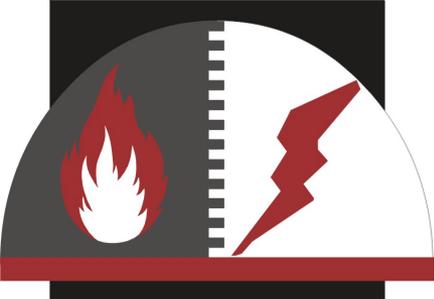
- ◆ **First ATS Demo of Solar Turbine's Mercury 50 technology. Installation is scheduled for mid-1999**
- ◆ **Will be used in economic dispatch mode to reduce electricity costs and improve reliability**
- ◆ **System is 80% efficient and will reduce NO_x emissions to less than 9 ppm**

CHP CHALLENGE INITIATIVE



USCHPA Vision for 2020

“ Industry and government have worked together to create conditions that allow CHP use in the U.S. to flourish and contribute 200 GW to the nation’s energy portfolio.”



USCHPA Vision Goals

| | 2005 | 2010 | 2020 |
|--|---|--|----------------------------|
| Technical Performance | Efficiency >65% | Efficiency >75% | Efficiency> 80% |
| Environmental Performance | <0.5lb/MW _(t+e) NO _x | <0.1 lb/MW _(t+e) NO _x | Near 0 emissions |
| Interconnection Standards & Systems | Uniform interconnection standards | “Smart” interconnection equipment | -- |
| Regulatory Framework | Output-based standards | Streamlined permitting | Export barriers eliminated |
| Market Deployment | 25% of existing federal facilities have CHP | CHP challenge goal achieved | USCHPA vision achieved |
| Application Development | Small-scale CHP | Plug&play packages available | DE load aggregation |
| Education & Awareness | Federal and State policy makers | Consumers | -- |



The CHP Challenge Initiative will:

- ◆ **Raise awareness of the benefits of CHP**
- ◆ **Identify and remove barriers limiting the implementation of CHP technologies in the U.S.**



The CHP Summit

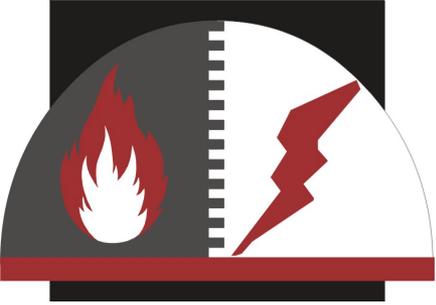
On December 1, 1998, 150 members of the CHP community met to hear presentations on the following topics:

- ◆ **Environmental Protection Agency Outlook**
- ◆ **The Congressional Perspective**
- ◆ **Industry Response**
- ◆ **The Market for CHP**
- ◆ **Barriers to the Use of CHP and Strategies for Overcoming Them**
- ◆ **The Role of Technologies in Fostering CHP**
- ◆ **State and Local Perspectives on CHP**
- ◆ **Informal Discussion**



The CHP Challenge

By 2010, double the amount of power generated with CHP



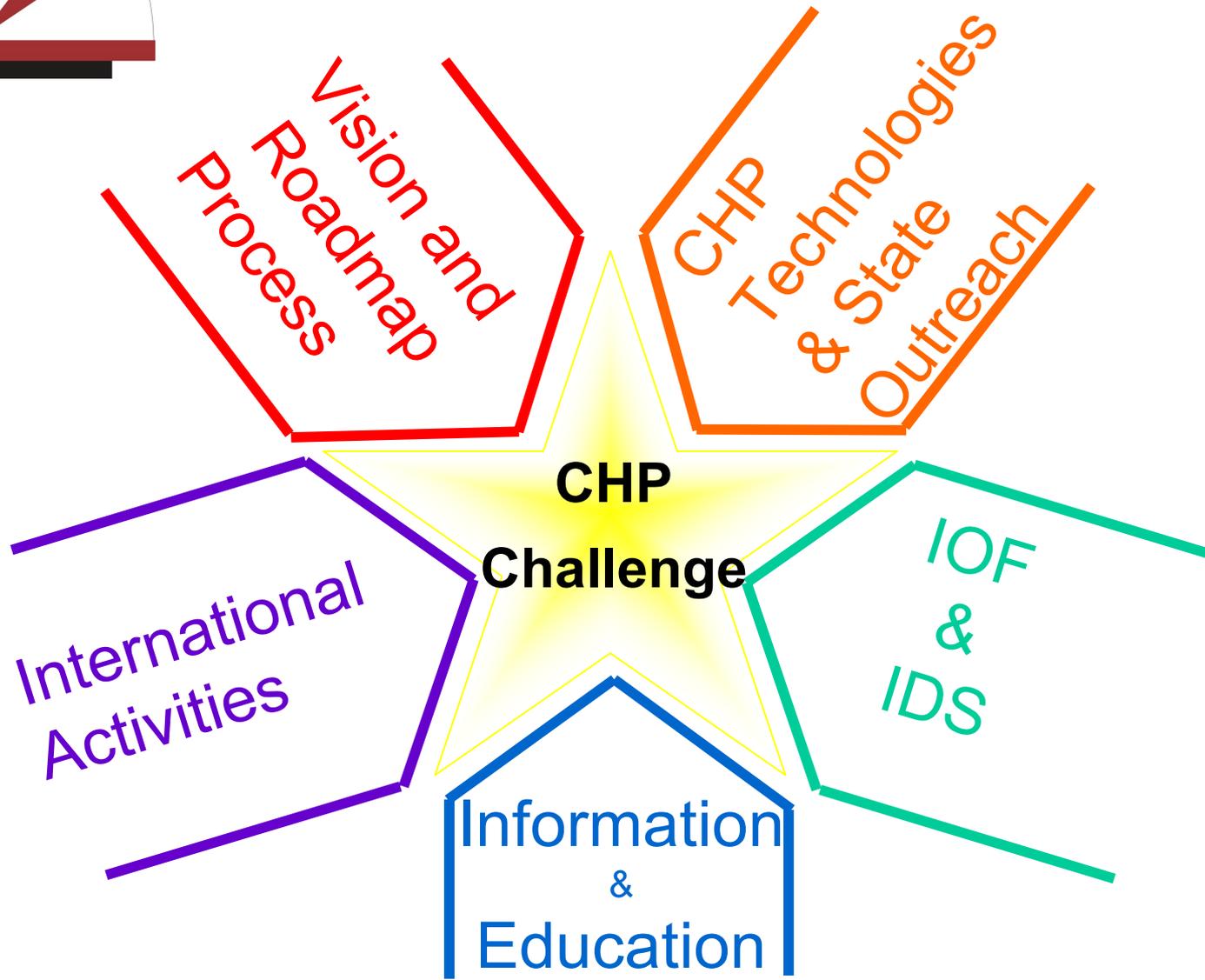
Potential Benefits

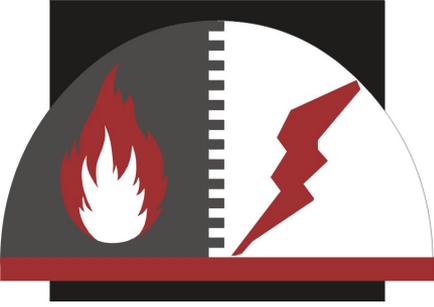
A doubling of U.S. CHP Capacity Means:

- ◆ **Net energy savings of 1,276 TBtus**
- ◆ **Carbon reductions of 37 MMT**
- ◆ **SO₂ reductions of 0.94 million tons**
- ◆ **NO_x reductions of 0.42 million tons**
- ◆ **Economic savings of \$5.5 billion**

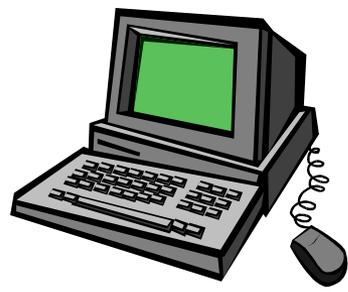


Industrial CHP Initiative





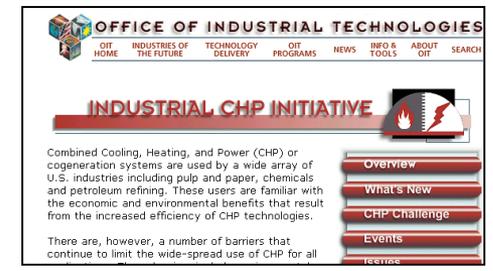
Information & Education



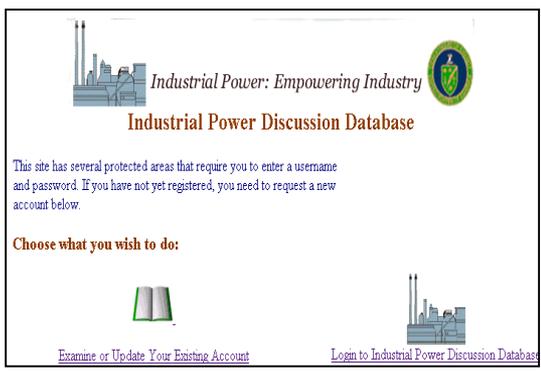
Registry



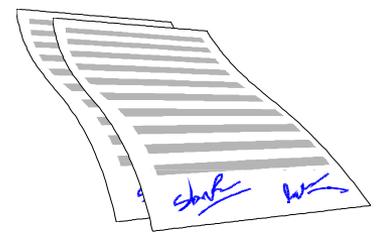
Data Analysis Workshops



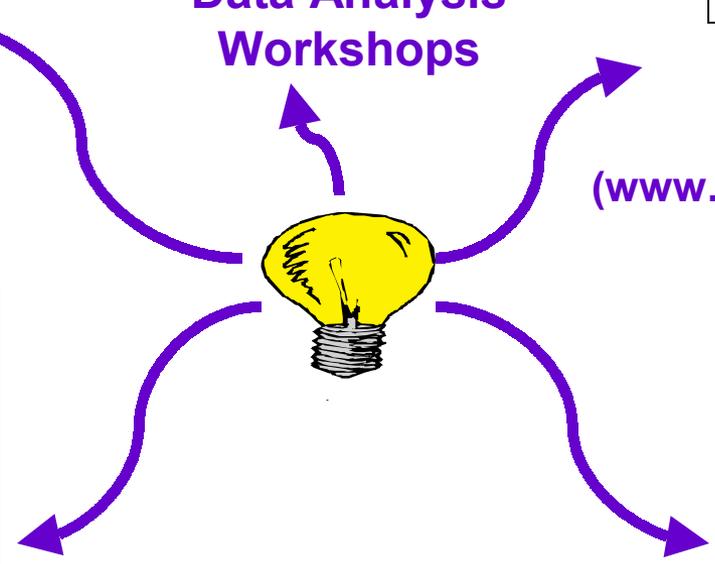
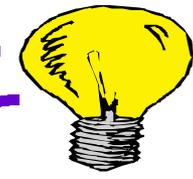
CHP Challenge Website
(www.oit.doe.gov/chpchallenge)



Discussion Database



Fact Sheets





CHP
Summit
Dec. '98

OIT Expo.
Feb.
'99

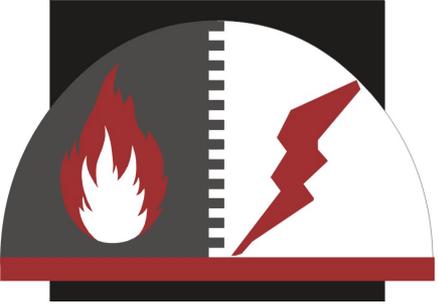
Vision
Workshop
June '99

Vision
Published
Sept. '99

Regional
Roadmap
Workshops



USCHPA Vision & Roadmap Process

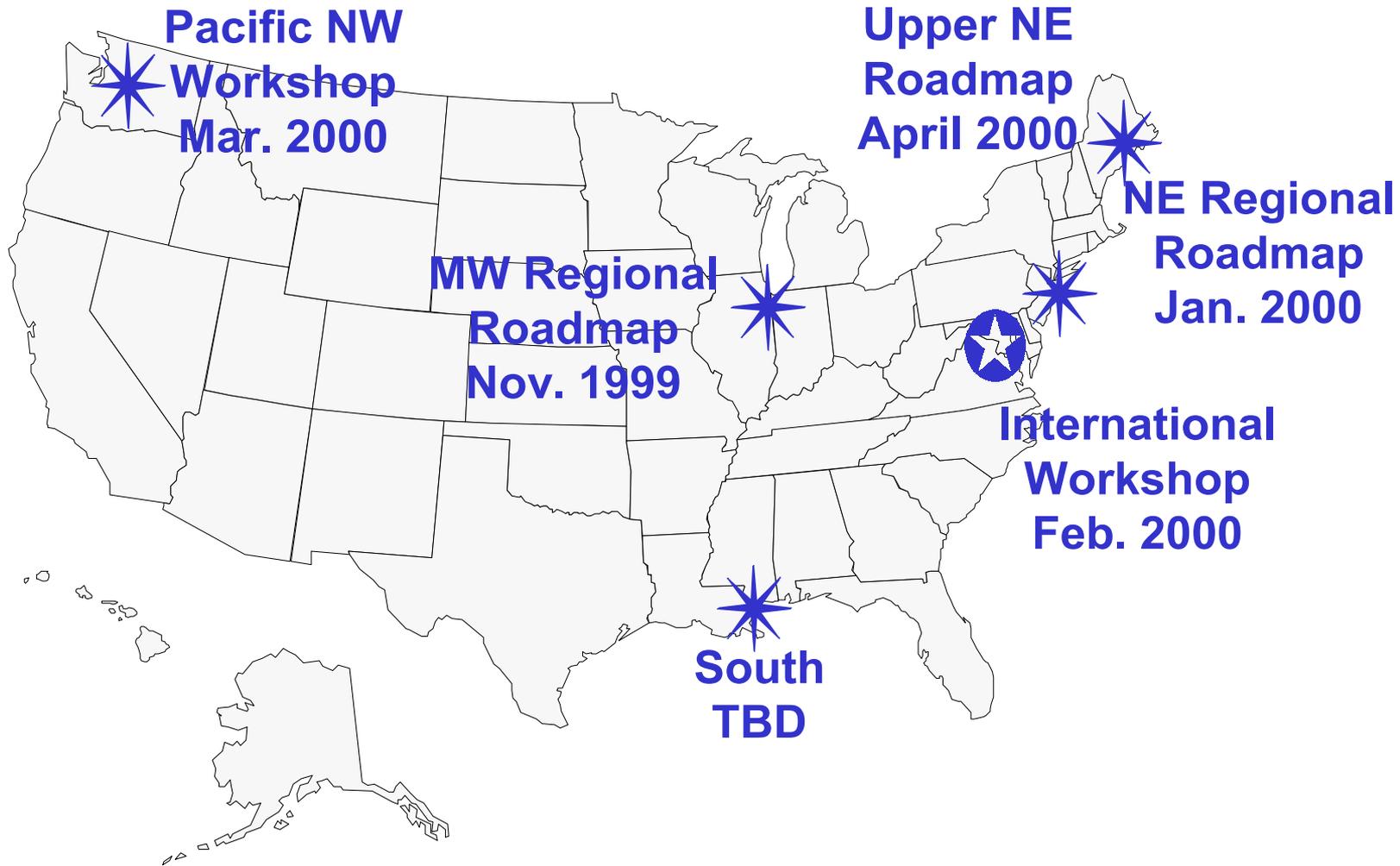


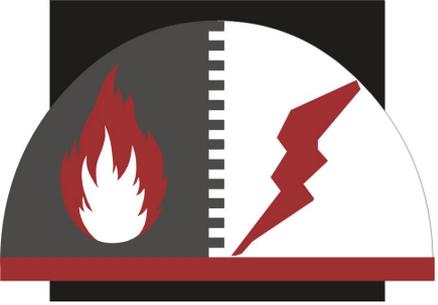
CHP Vision and Roadmap

- ▶ On February 8, 1999, the U.S.CHPA officially accepted DOE's goal of doubling CHP Capacity by 2010
- ▶ The U.S.CHPA is launching a vision and roadmap process to identify the most productive pathways for industry and government to work together to achieve this goal



USCHPA Roadmap Workshops





Communications and Outreach

- ▶ **Case study brochure**

18 case studies representing a broad range of applications and technologies

- ▶ **Seven fact sheets**

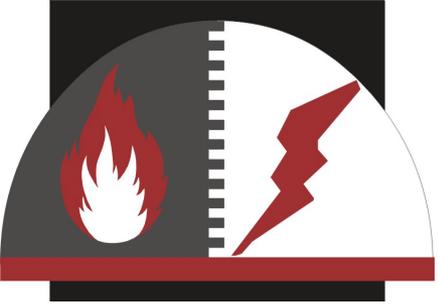
CHP Challenge initiative, CHP technology, economic development, utility restructuring, air emissions and district energy

- ▶ **Web Site**

www.oit.doe.gov/chpchallenge

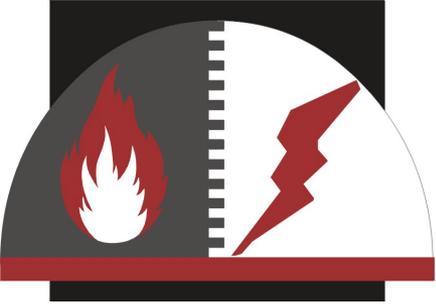
- ▶ **Information Databases**

CHP equipment manufacturers, case studies and contacts



States Can Play a Critical Role

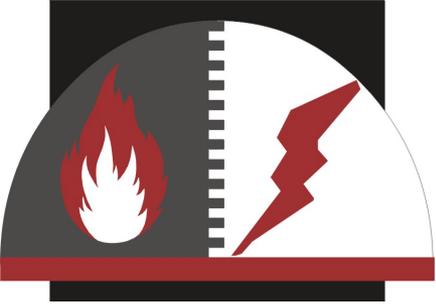
- ◆ **Publicize CHP technologies**
- ◆ **Streamlined permitting**
- ◆ **Eased Interconnection**
- ◆ **Competitive electric and gas markets**



State Visits

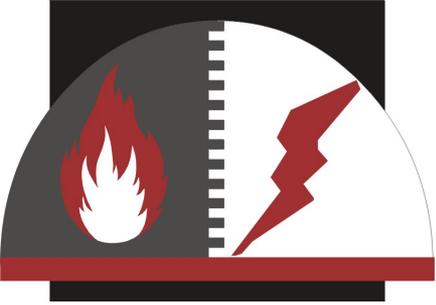
CHP Challenge is conducting visits to state regulators and CHP facilities and manufacturers to encourage communication and collaboration between state and federal agencies

- ▶ Indiana, December 1998 (state energy and commerce departments)**
- ▶ Planning meetings to California, Illinois, Vermont and Maryland in Spring and Summer 1999**
- ▶ Planning meetings on issues specific to communities and local governments**



SEP Special Project Grants for CHP

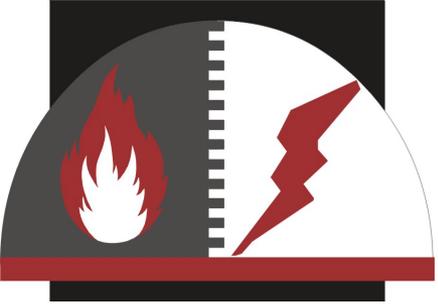
- ◆ **California Energy Commission with Onsite Energy and Solar Turbines**
- ◆ **Indiana Department of Commerce with Allison Engine and Stone&Webster**
- ◆ **Vermont Department of Public Service with Burlington Electric, University of Vermont, Agency of Natural Resources, and Department of Economic Development**
- ◆ **Washington State Department of Community, Trade and Economic Development with Washington State University's Cooperative Energy Extension Program**



California

- ▶ **Assess CA markets for CHP systems and estimate energy, environmental, and economic benefits**
- ▶ **Examine utility interconnection requirements as possible barriers to CHP**
- ▶ **Produce CHP guidebook**
- ▶ **Conduct market transformation activities by working with key state groups on:**
 - ◆ *Remedies to relevant environmental regulations and barriers*
 - ◆ *Remedies to relevant utility regulations and barriers*

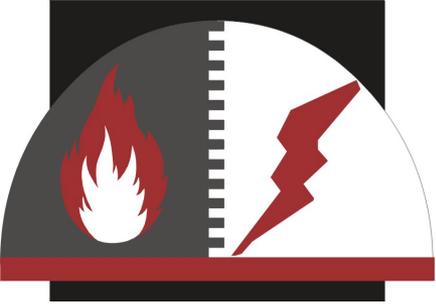




Indiana

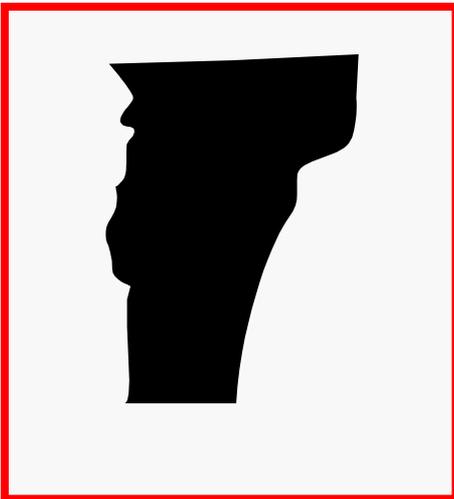
- ▶ **Determine the potential for CHP in the state**
- ▶ **Identify five potential CHP sites and do detailed, on-site feasibility assessments**
- ▶ **Conduct more extensive life-cycle costs studies of the five sites and disseminate results**

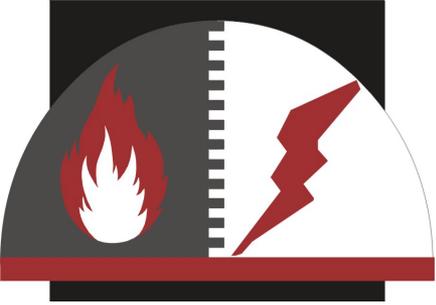




Vermont

- ▶ Determine feasibility of CHP using wood wastes at forest product industry and manufacturing sites at the state
- ▶ Determine feasibility of wood waste CHP for community district heating in collaboration with
 - ◆ *Greater Burlington District Energy*
 - ◆ *Montpelier Community Energy*
- ▶ Explore Use of agriculture wastes for CHP applications in the state
- ▶ Demonstrate biogas CHP facility at the University of Vermont





Washington

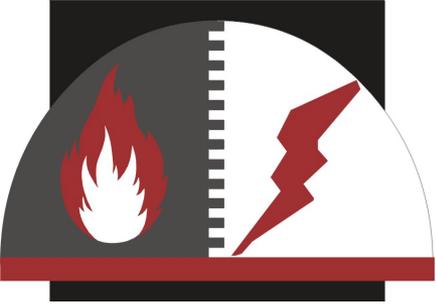
- ▶ **Develop and test CHP software product**
- ▶ **Provide CHP siting assistance to local governments in the state and develop siting criteria and guidelines**
- ▶ **Encourage thermal sales from CHP facilities and develop a “model” thermal sales contract**





International Activities

- ⚡ **IEA Annex on DE**
- ⚡ **Coordination with
CANMET**
- ⚡ **International CHP
Conference**
 - ★ **CHPA UK**
 - ★ **Cogen Europe**



Partners

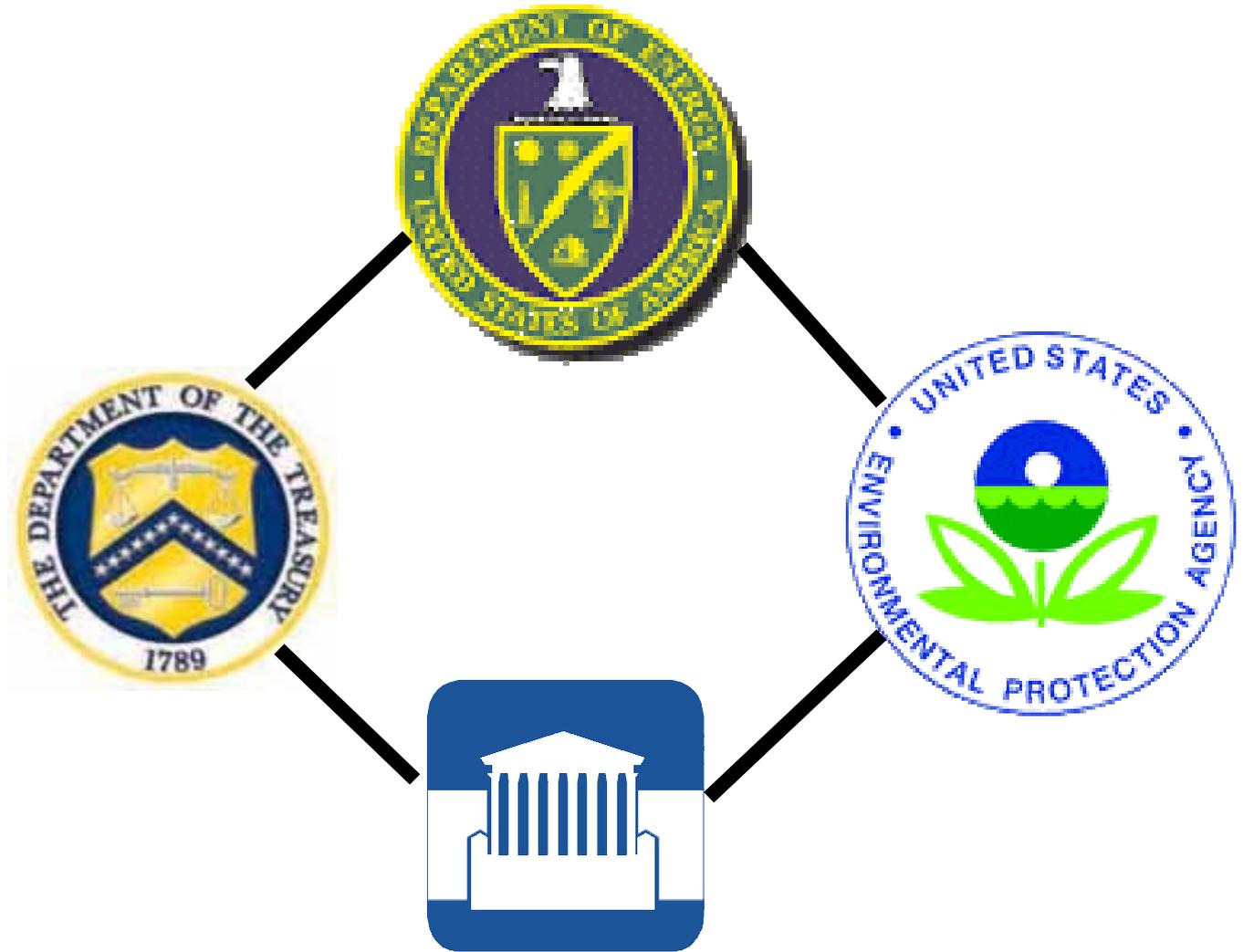
The Challenge is working with

- ◆ other DOE offices
- ◆ EPA and other federal agencies
- ◆ state and regional officials
- ◆ industry stakeholders (U.S.CHPA)

to coordinate efforts and leverage resources



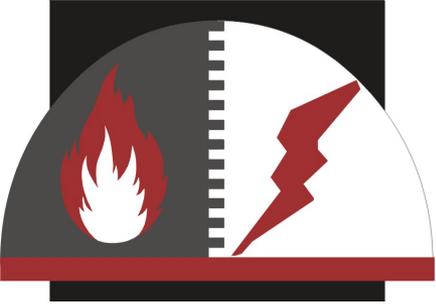
CHP Federal Players



Office of the President

Key EERE Drivers

- ◆ Economic Competitiveness
- ◆ Electricity Restructuring
- ◆ Environmental Quality
- ◆ Energy Security
- ◆ Climate Change



EERE Activities

◆ Office of Industrial Technologies

CHP Challenge, Microturbines, Recip Engines, ATS Program, Industries of the Future

◆ Office of Power Technologies

Restructuring policy, interconnection, renewable technologies

◆ Office of Building Technology, State and Community Programs

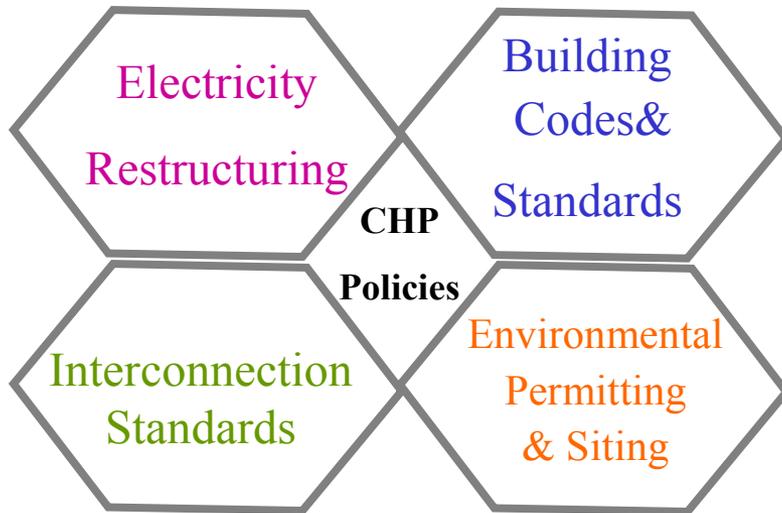
Combined Cooling, Heating & Power for Buildings Initiative

◆ Federal Energy Management Program

Supporting CHP in federal facilities



CHP Policy Coordination in EERE

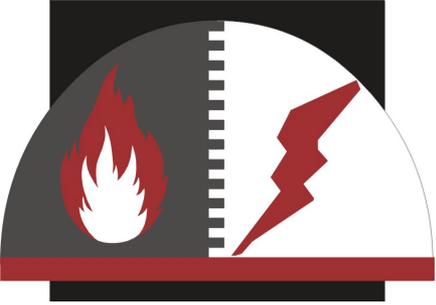


National electricity restructuring -
OPT

State outreach CHP barriers and
State IOF - **OIT**

Coordination with EPA on
permitting and siting - **OIT**

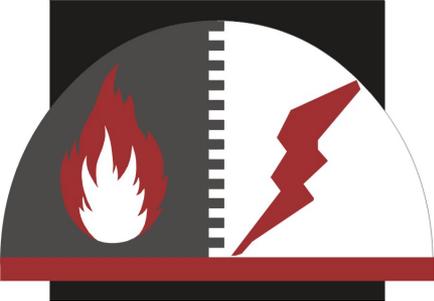
Building codes and standards -
OBT



EPA Collaboration

The EPA has accepted the goal to double CHP Capacity and is working with CHP Challenge in the following areas:

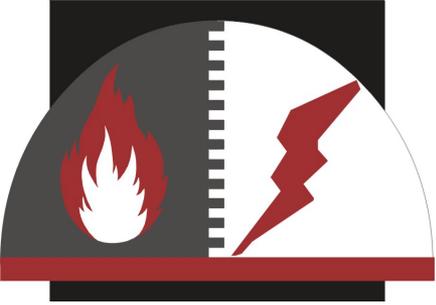
- ◆ **Developing output-based standards**
- ◆ **Review of NSR procedures**
- ◆ **Data collection**
- ◆ **Market projection analysis**



Interagency Coordination

The CHP Challenge Initiative is working with various agencies on CHP-related efforts:

- ▶ Interagency Working Group developing restructuring legislation**
- ▶ FY 2000 budget includes an 8 percent investment credit for qualified CHP systems**
- ▶ Effort to change rules for CHP equipment depreciation through Treasury Department**



Upcoming Priorities

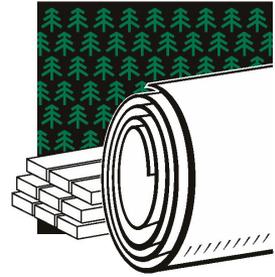
The CHP Challenge Initiative will focus its efforts in the following priority areas in the future:

- ◆ **Supporting U.S.CHPA vision and roadmap effort**
- ◆ **Continuing outreach activities with additional state workshops and visits**
- ◆ **Collaboration with government, industry partners to accurately track new and existing CHP installations**

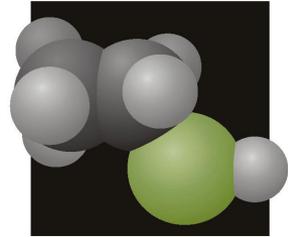


CHP in Energy-Intensive Industries

Pulp and Paper accounts for 40% of all cogenerated electricity. In 1994, the industry cogenerated 51 TWh, up 12% from 1991.

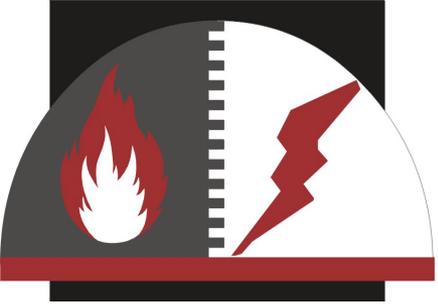


Chemicals is next accounting for 35% of cogenerated electricity. In 1994, the industry cogenerated 44 TWh.



Petroleum Refining is third accounting for 11% of cogenerated electricity even though it accounts for only 5 % of electricity overall.





Department of Treasury Involvement



- ◆ **Depreciation Allowances**
- ◆ **Proposed 8% Tax Credit**

Industrial CHP Initiative *Brings It All Together*

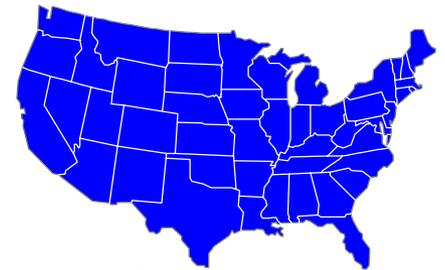
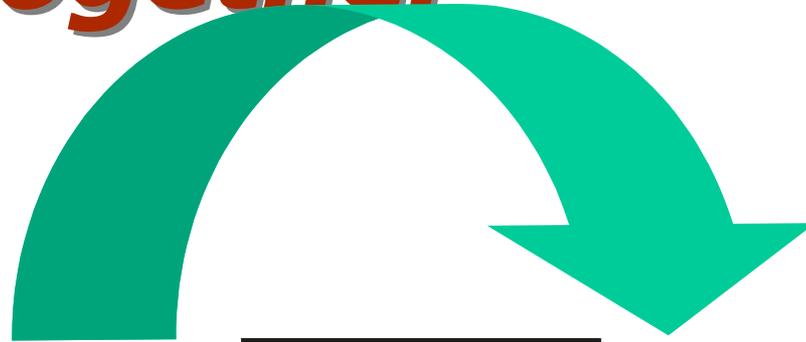


UNITED STATES COMBINED
HEAT & POWER ASSOCIATION

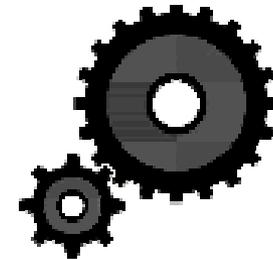
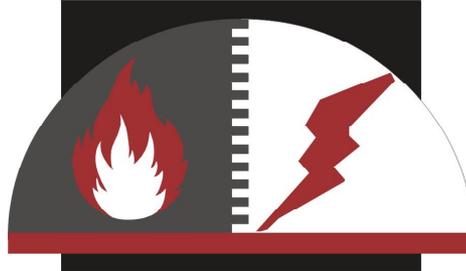
Vision



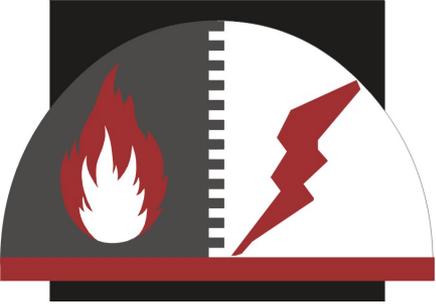
Federal & State
Government



States



Technologies



Conclusions

- ▶ **CHP has substantial public benefits**
- ▶ **There still exist regulatory and institutional barriers to CHP commercialization**
- ▶ **CHP needs competitive markets to grow**
- ▶ **Joint government/industry partnerships can help**