



Gas Technology Options to Increase Global Resource Efficiency in Green Buildings

Fueling a Cleaner Environment
The Energy Component in Green Building Design
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Outline

- > **GTI End Use Technology Overview**
- > Green Building Initiatives
- > Carbon Management Issues and Strategy

WHO WE ARE

Gas Technology Institute

- > Leading U.S. research, development, and training organization serving the natural gas industry and energy markets
 - Independent, 501c (3) not-for-profit



Serving the Energy Industry Since 1941

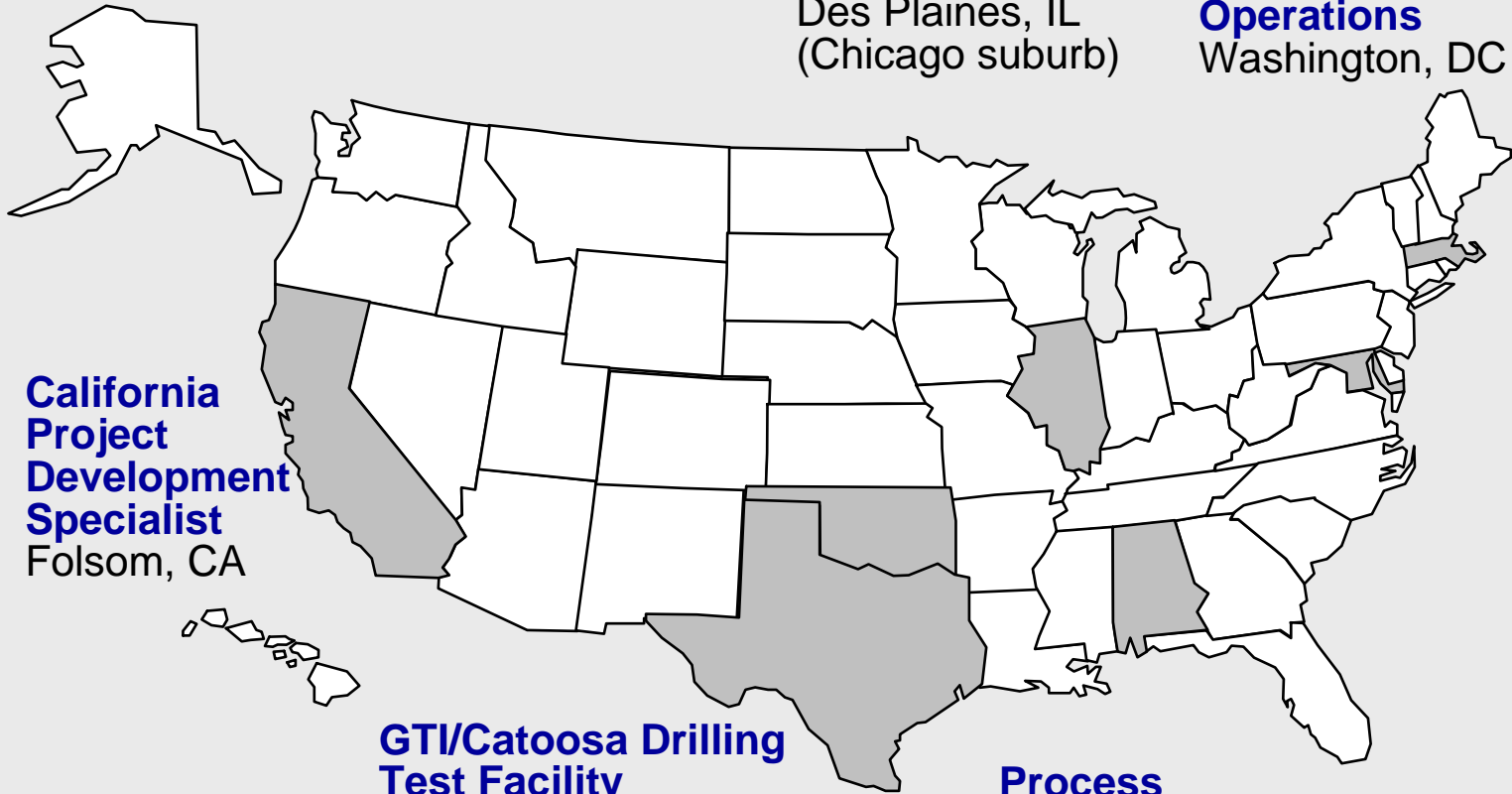
- > Over 1,000 patents
- > Nearly 500 products commercialized

GTI Locations

Strategic Account Management
Needham, MA (NGA)

Headquarters
Des Plaines, IL
(Chicago suburb)

Washington Operations
Washington, DC



California Project Development Specialist
Folsom, CA

GTI/Catoosa Drilling Test Facility
Catoosa, OK
(near Tulsa)

Houston Office
Houston, TX

Process Research and Evaluation Group
Birmingham, AL



Facilities & Staff

- > Main Facility: 18-Acre Campus Near Chicago
 - Over 200,000 ft² of laboratory space
 - 28 specialized laboratories and facilities
- > More than 225 employees
 - 70% are scientists and engineers



**Flex-Fuel
Test Facility**



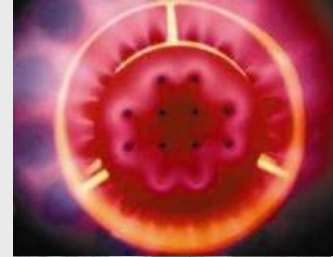
**Offices
& Labs**



Energy & Environmental Technology Center

GTI End Use Solutions

- > Develop clean, efficient and cost-effective technology & products with value-added benefits to our partners
 - **Industrial processes**
 - > Metals, glass, petrochemicals, paper, food, others
 - **Power and steam generation**
 - > Industrial boilers
 - > Engines, turbines, fuel cells
 - **Residential/commercial appliances**
 - **Transportation**
 - > Alternative fuel vehicles & infrastructure



Complete Lab Facilities

Industrial Labs



Residential/Commercial Labs



Distributed Generation Labs



Fuel Cell and Hydrogen Labs



Over 60 engineers, scientists, and technicians

Specialized Testing ♦ System Modeling ♦ Emissions measurement ♦ High-speed data acquisition

GTI Super Boiler Technology

- > Maximizing efficiency in steam & power generation
 - Over 94% HHV for industrial boilers
 - Captures heat and flue water products
 - Multiple field testing underway
 - Patented technology also captures water from flue gases



**Commercializing Partner:
Cleaver-Brooks**

Commercial Food Service Low Oil Volume Fryer

- > Developing low oil volume (LOV) fryer with Pitco, Frymaster
- > Driven by move from away from trans fat oils due to health concerns
- > Technology reduces annual costs for oil, energy, and reduces oil disposal requirements



NovelAire ComfortDry™ 400 Desiccant Dehumidifier

- Natural gas or propane-fired for residential and small commercial applications
- Solution for high-humidity environments
- Improves indoor air quality and comfort
- Part of a mold and dust mite risk reduction strategy



Solid Oxide Fuel Cells

- > Working to enable highly efficient, clean power
- > Partnered with Versa Power Systems (VPS) and other partners
 - Residential, Commercial, and Industrial power
- > Other value-added strategies:
 - Cogeneration
 - Thermal-driven cooling



Internally Manifolded Stack Building Block Design



VPS Prototype SOFC System

Renewable Energy

> Bio-methane (or bio-gas)

- Landfills
- Wastewater treatment
- Dairy and other farm byproducts
- Projects to produce LNG, fuel cell power



> Solar thermal – natural gas hybrids

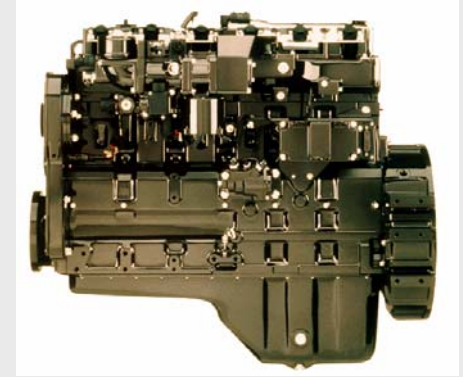
- Hot water/steam generation
- Thermal-driven gas cooling



Transportation

> Cummins Westport 8.9 Liter L Gas Plus Engine

- Lowest emission heavy duty engine in the world



> Natural Gas to Hydrogen Fueling Stations

- Working with GreenField Compression



> Onsite Liquefaction

- Working with Linde-BOC
- Includes efforts on bio-methane recovery



Builder's Guide to Reducing Mold Risk

- > Provides guidance on reducing the risk of mold formation and growth in new homes
- > With few exceptions, the guidance is not required by code
- > Elimination of all risk is economically and culturally impractical
- > Least expensive, biggest benefit first
- > Three-part strategy:
 1. Keep the water away - reducing the water load
 2. Keep the water out - limiting water availability
 3. Limit growth until moisture dries out

Example of Recommendations in Builder's Guide



Roof overhangs **reduce** risk

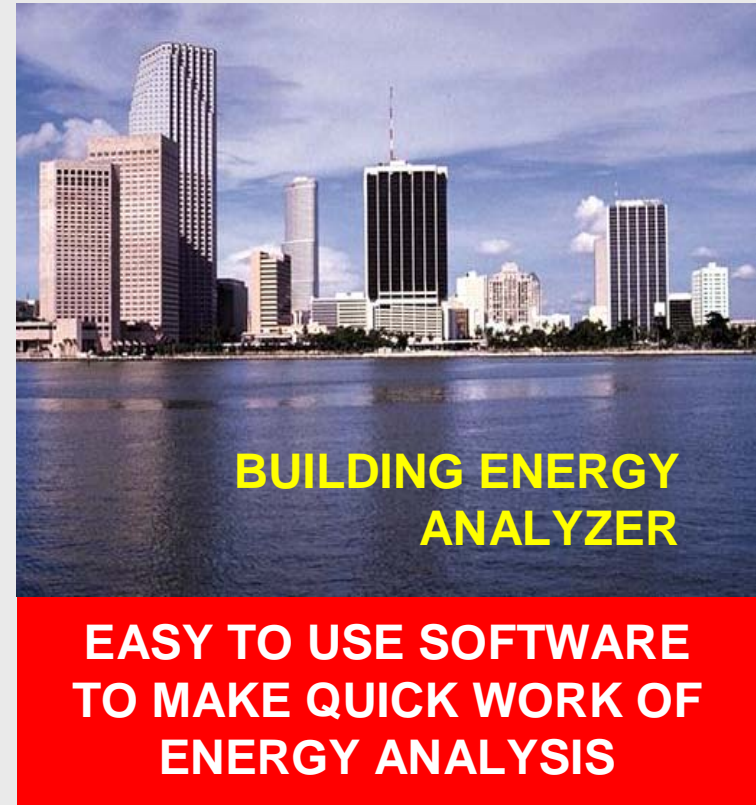
Excellent drainage **reduces** risk

Foundation plantings **increase** risk

Lush irrigation **increases** risk

Building and Community Energy Analysis

- > GTI energy analysis tools and capabilities
- > Helps identify range of energy efficiency opportunities in buildings and communities
- > Active in community planning for Chula Vista, CA



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- > **Green Building Initiatives**
- > Carbon Management Issues and Strategy

Buildings Have a Significant Environmental Impact

U.S. BUILDINGS IMPACTS ON RESOURCES

39% of total energy consumption

71% of electricity consumption

39% CO₂ emissions

30% of raw materials use

30% of waste output

12% of potable water consumption

Green Building Initiatives

- > US Green Building Council
 - Leadership in Energy and Environmental Design (LEED®)
- > Green Building Initiative
 - ANSI 01-2008P for Commercial Bldgs, Green Globes™
- > ASHRAE
 - GreenGuide, Advanced Energy Design Guides, Std. 189p
- > NAHB
 - National Green Building Standard
- > AGA
 - Naturally Green Natural Gas Home Guidelines
- > EPA/DOE
 - Energy Star® Appliances, Homes

USGBC LEED Rating and Certification Program

- > Six areas of focus
 - Sustainable sites; water efficiency; energy and atmosphere; materials and resources; indoor environmental quality; innovation and design process
- > Nine versions (some in pilot or draft phase)
 - New Construction; Existing Buildings; Core and Shell; Schools; Healthcare; Retail; Commercial Interiors; Homes; Neighborhood Development
- > Four levels of certification
 - Certified; Silver; Gold; Platinum
 - Prerequisites, credits for points

LEED Level Requirements

- > Meet minimum prerequisites in each area
- > Obtain credits in version selected
 - LEED New Construction Version
 - > Certified - 26-32 points
 - > Silver - 33-38 points
 - > Gold - 39-51 points
 - > Platinum - 52-69 points
- > Different total points for each version
 - E.g., LEED CI has up to 57 possible points
 - Credit options vary
 - Points required for each level vary

Role of Energy Efficiency and CO₂ in LEED Programs

- > Prerequisites linked to other standards
 - E.g., comply with ASHRAE Standard 90.1
- > Energy credits are only a portion of total
 - Optimizing HVAC performance - 2 points
 - Optimizing equipment and appliances – 2 points
 - Optimizing lighting power – 3 points
 - Site energy cost basis with like energy source
- > Challenges and opportunities for innovation
 - CHP, hybrids, fuel substitution, renewables
 - 5 points for innovation and design process
- > No CO₂ baseline emissions or direct credits

AGA Naturally Green Natural Gas Home Guidelines

- > Adapted from NAHB's Model Green Home Building Guidelines
 - Tailored to gas appliances
 - Additional site uses qualify for points, e.g., gas range, dryer, on site NGV fueling
- > Currently in draft review
 - Spring 2008 launch planned

Naturally Green Natural Gas Home Guidelines

Points Awarded Check-Off List

(Make as many photocopies of this list as needed.)

Product Category	Climate Zone			Utility Check-Off
	Hot	Mixed	Cold	
Gas Central Furnace				Fill in points earned
90 < AFUE < 92	4	8	12	
92 < AFUE < 94	6	10	14	
94 < AFUE	8	12	16	
Gas Boiler				
Without Water Heater				
85 < AFUE < 90	3	7	11	
90 < AFUE < 94	5	9	13	
94 < AFUE	8	12	16	
With Indirect Water Heater				
85 < AFUE < 90	5	9	13	
90 < AFUE < 94	7	11	15	
94 < AFUE	10	14	18	
Gas Pool or Spa Heater	3	7	11	
Gas Storage-Type WH				
0.58 < Energy / Factor < 0.62	1	3	5	
0.62 < Energy Factor < 0.66	2	4	6	
0.66 < Energy Factor	3	5	7	
Gas Instantaneous WH	5	7	9	
Gas Logs and Room Heaters				
B-Vent	0	0	0	
Direct Vent	3	4	5	
Unvented	4	6	8	

Product Category	Climate Zone			Utility Check-Off
	Hot	Mixed	Cold	
Gas Range				Fill in points earned
Cooktop and Oven	2	2	2	
Gas Cooktop (only)	1	1	1	
Gas Oven (only)	1	1	1	
Gas Oven (two ovens)	2	2	2	
Gas Clothes Dryer	2	2	2	
Gas Garage Heater				
Apart from a conditioned space	0	0	0	
Adjacent to a conditioned space	1	1	1	
Adjacent to and below conditioned spaces	2	2	2	
Gas Generator				
Standby	8	12	16	
Base Load	24	36	48	
Gas Outdoor Lights				
Without On-Off Switch	1	1	1	
With On-Off Switch	2	2	2	
Gas Outdoor Outlets	1	1	1	
Total Points Possible	124	191	258	
Total Points Achieved				

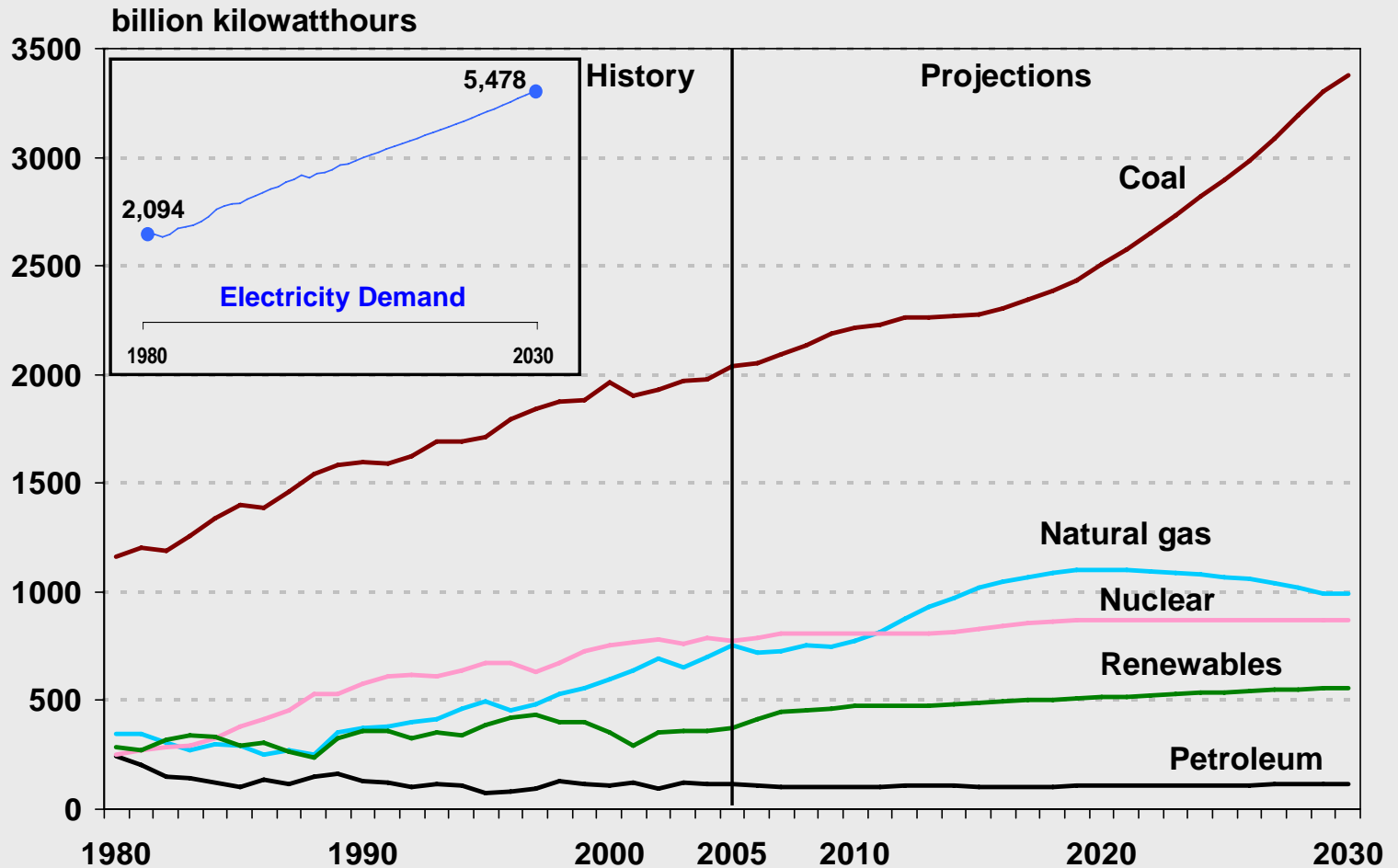
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CO₂ Emissions...the nexus of fuels and technology

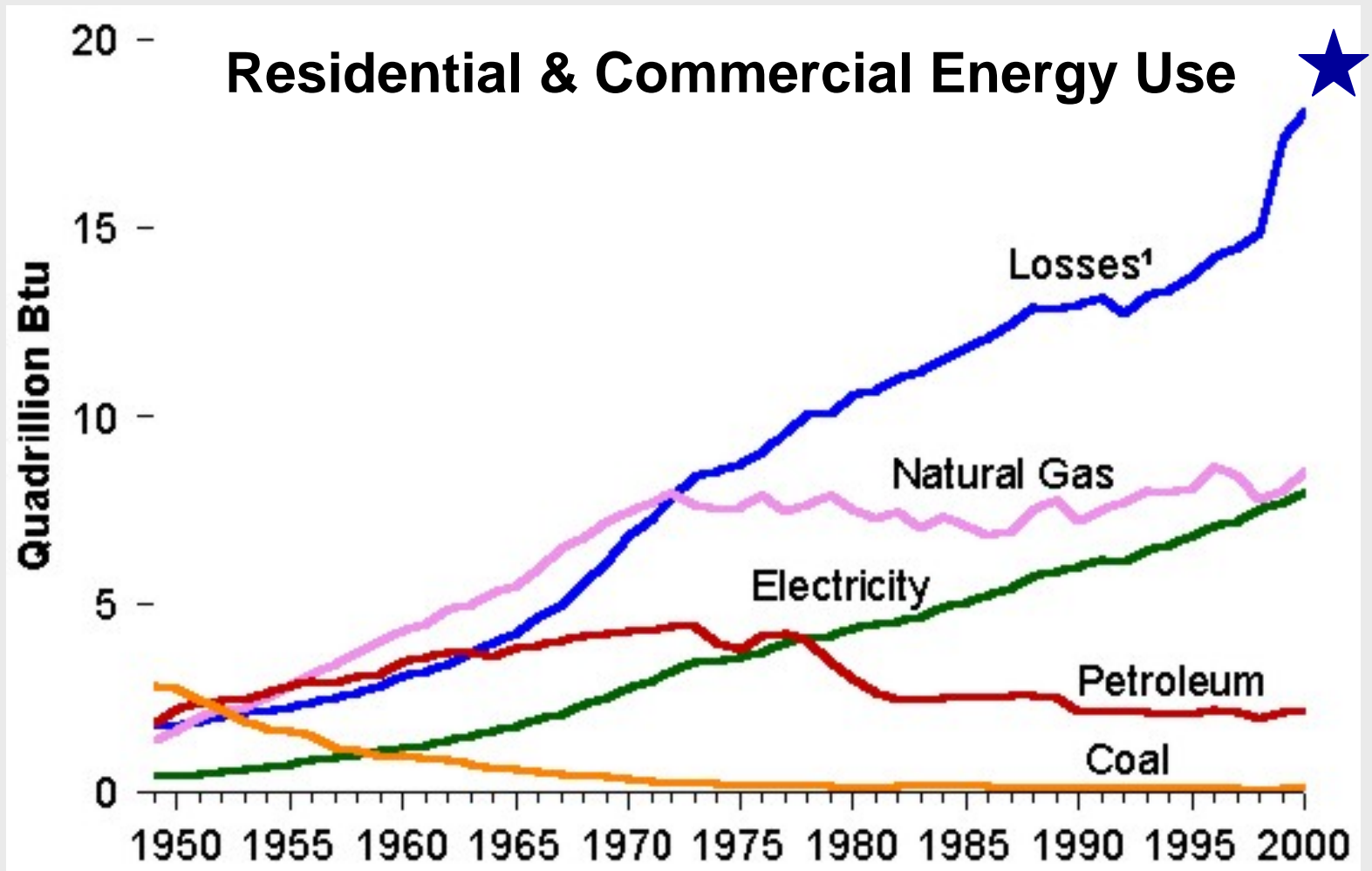
- > Electricity generation and transportation vehicles are – BY FAR – the major sources of CO₂ emissions in US
- > In the power sector, its all about:
 - Use of coal...largest carbon emitting fossil fuel
 - And relatively high energy losses in power generation
- > For vehicles, its all about:
 - Use of petroleum...second highest carbon source
 - And relatively inefficient reciprocating engine technology

Electricity Generation Forecast



Opportunity for no carbon & low carbon fuels in place of coal, and implementing carbon capture and sequestration

Energy Use and Losses in Buildings



(1) Energy lost during generation, transmission, and distribution of electricity

CO₂ Emissions and Growth by Sector

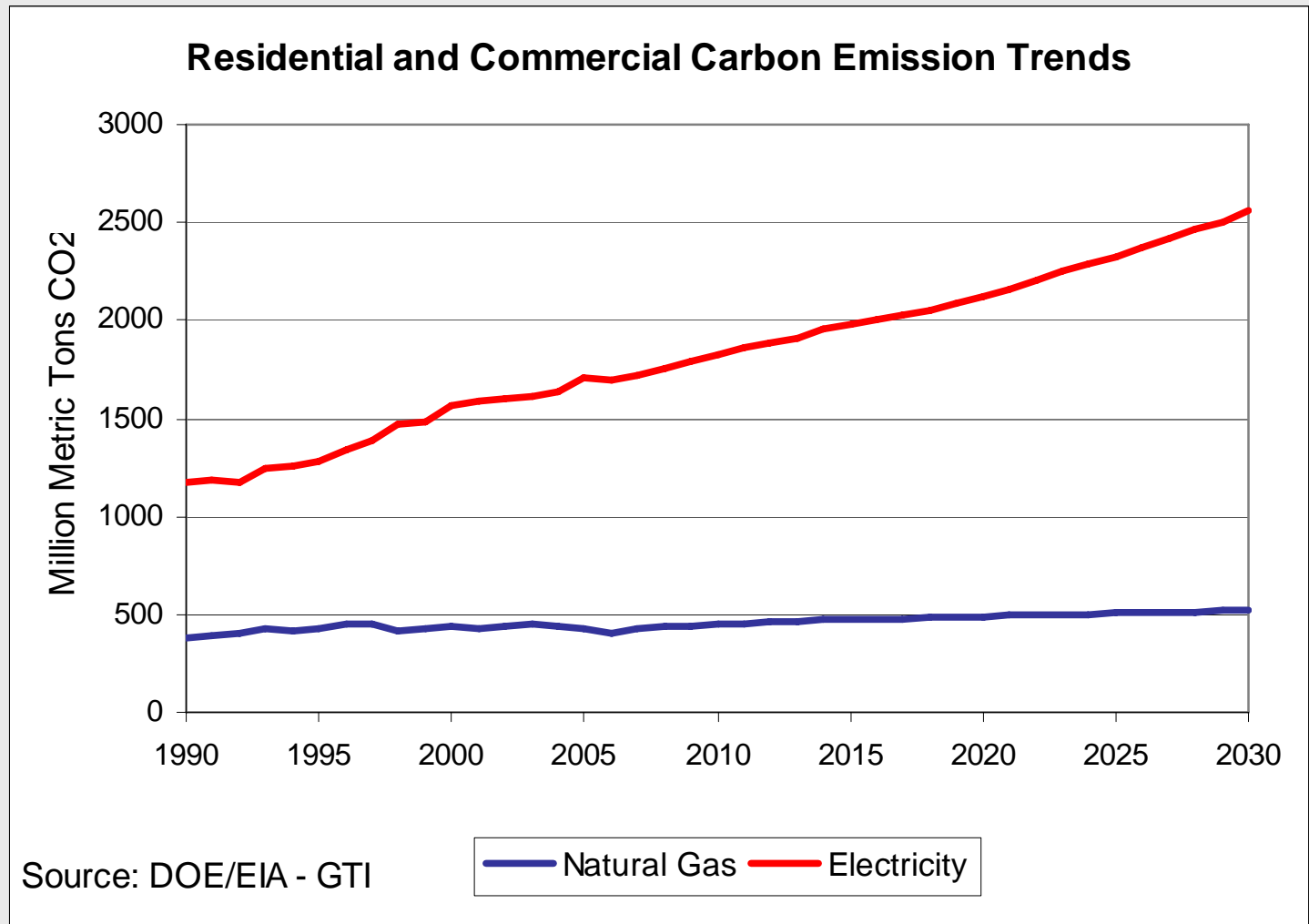
Energy End-Use Sector Sources of U.S. Carbon Dioxide Emissions, 1990-2005

Sector	Million Metric Tons Carbon Dioxide		Percent Change	
	1990	2005	1990-2005	2004-2005
Residential	953.7	1,253.8	31.5%	3.3%
Commercial	780.7	1,050.6	34.6%	1.6%
Industrial	1,683.6	1,682.3	-0.1%	-3.1%
Transportation	1,566.8	1,958.6	25.0%	1.0%

Note: Electric power sector emissions are distributed across sectors.

Mainly attributed to growth in electricity usage!

Gas and Electric CO₂ Emission Trends for Res/Com Sectors



CO₂ Mitigation Options

Reduce

Energy Efficiency
New Technology
Fuel Choice
Stop Leaks, Flares
Venting

Dispose

Saline Aquifers
Depleted Reservoirs
Coal beds
Deep Ocean

Use

EOR
EGR
ECBM
Agriculture
Forests
Chemicals

“Negative Cost” Abatement Options in Buildings

- > Several near term options with net life cycle savings per ton of CO₂ abatement
 - Lighting, electronic equipment, combined heat and power, building shell, residential water heaters, heating fuel substitution
 - Buildings (especially homes) are still inefficient
- > Policy support required
 - “Potential for energy efficiency is real and large, but without a change in policy or approach, this potential will remain out of reach.”
 - Numerous disconnects, options “time-perishable”
 - Explore/promote regulatory and other initiatives

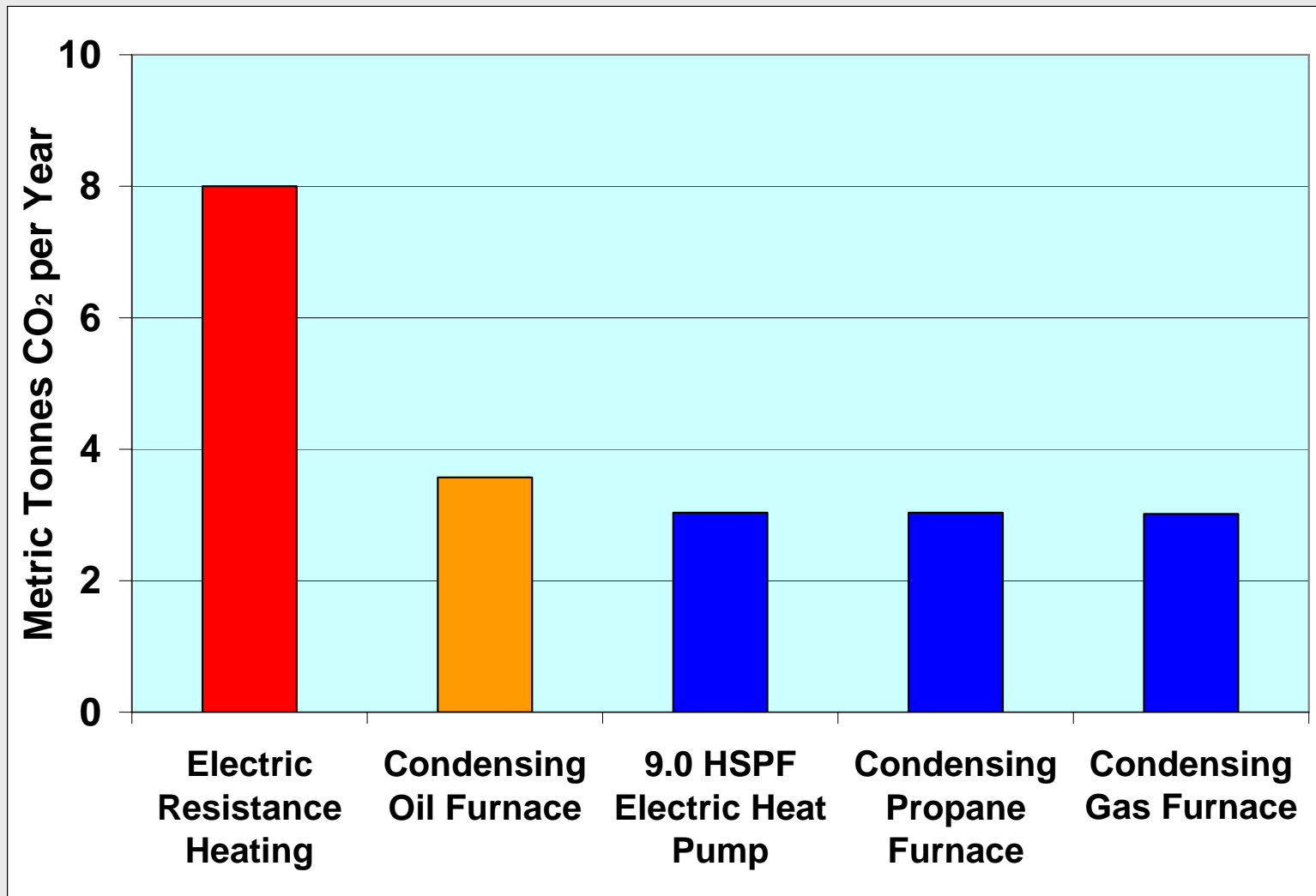
Evolving Policies

- > Several local, state, and regional activities
- > Federal strategies under consideration to reduce CO₂ and other GHG emissions
 - Current focus is to reduce emissions by sector
 - Superior approach is to take a global resource efficiency view and utilize appropriate energy sources for most efficient applications
 - > Requires full fuel cycle energy and carbon analysis

Low Cost CO₂ Emission Reduction by Increased Natural Gas End Use

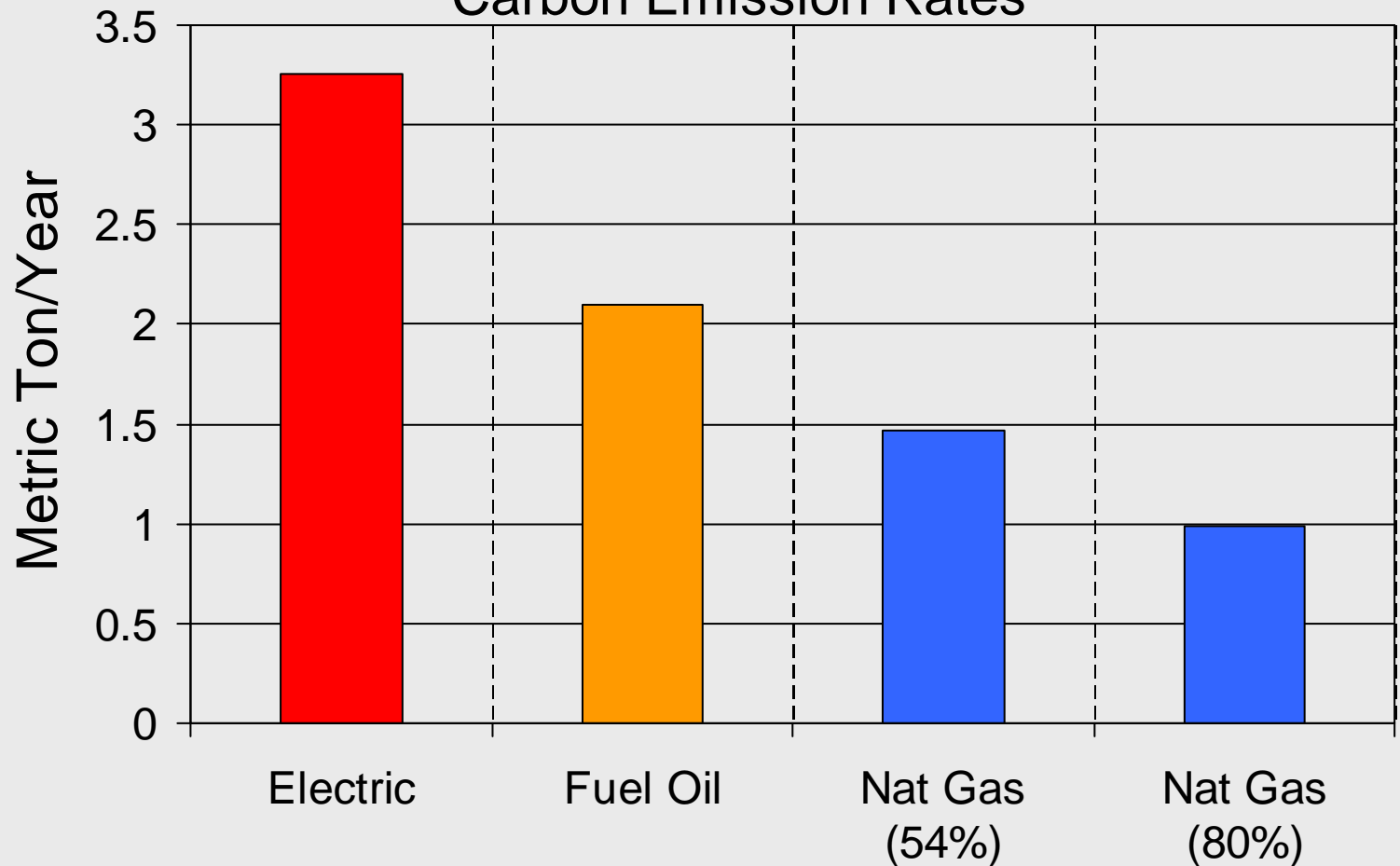
- > Natural gas provides the least-cost option for major reductions in carbon emissions compared to electric and oil equipment on a full fuel-cycle (“source-to-site”) basis
- > Shifting several point-of-use electric and oil technologies to natural gas can provide:
 - Significant reduction in global carbon emissions
 - Lower total source energy use
 - Lower life-cycle costs to consumers

Residential Space Heating Full Fuel Cycle CO₂ Emissions

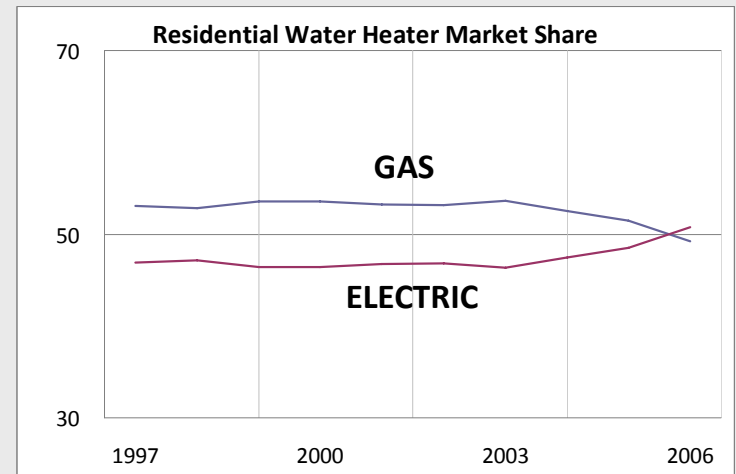
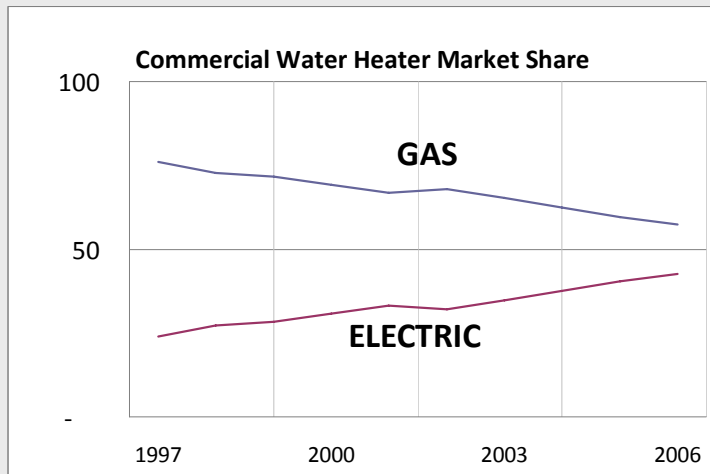
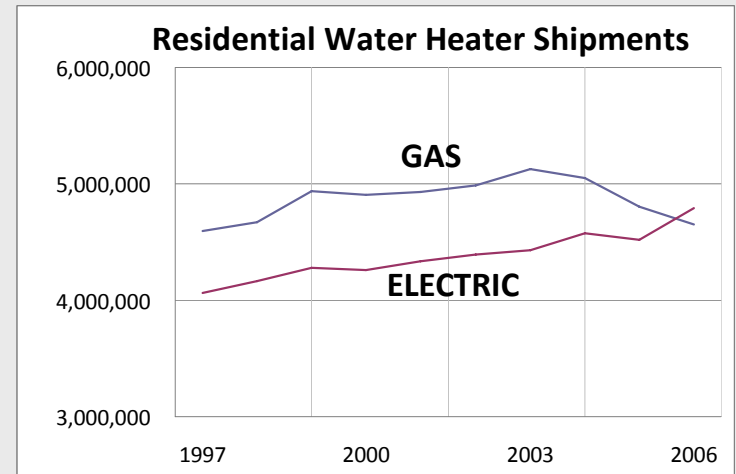
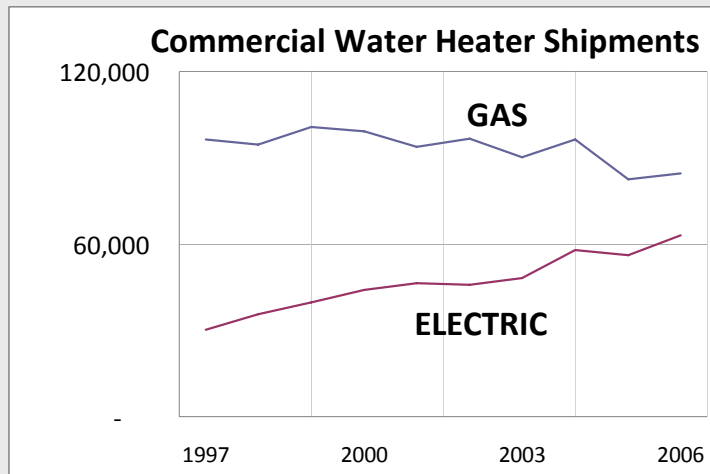


Water Heating Full Fuel Cycle CO₂ Emissions

Average Single Family Water Heating System
Carbon Emission Rates



And Yet, Electric Water Heater Market Share is Growing



GTI Carbon Management Information Center

> Objectives

- Serve as a clearinghouse for relevant carbon management information
- Develop credible information products and functional tools to meet the needs of investors and their customers

> Scope

- Develop an online information resource
- Conduct technology and market assessments
- Provide technical input to voluntary standards and regulatory initiatives

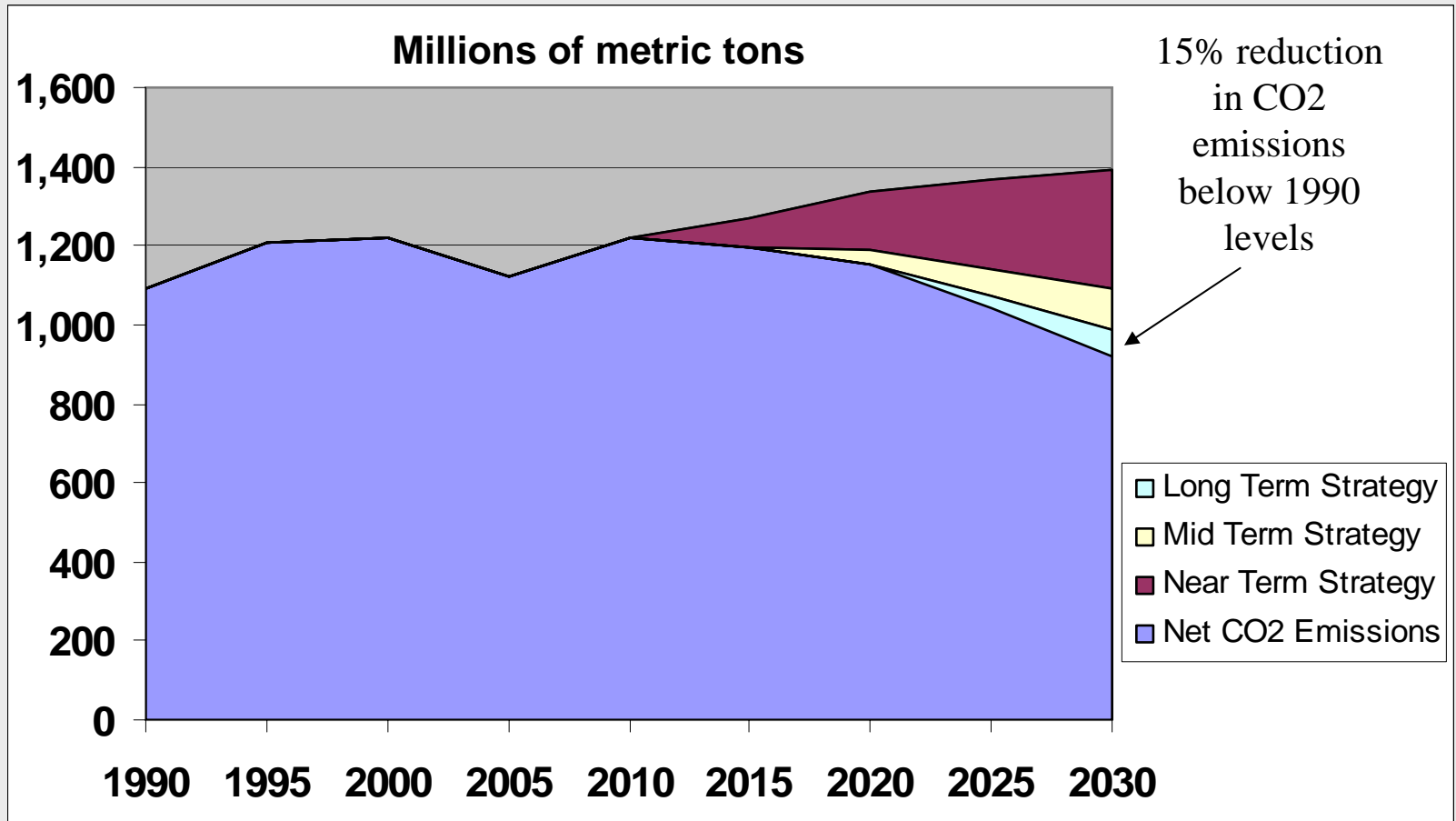
Natural Gas Carbon Management Solutions

- > Manage gas carbon emissions
 - Increased efficiency in End Use products
 - Building/community energy planning
 - Increased bio-methane resource use
 - Hybrid solar thermal/natural gas technologies
 - Reduce methane emissions
- > Displace less resource efficient practices
 - Promote efficient natural gas products in place of:
 - > Resistance or oil-fired water heating, space heating, dryers, cooking
 - > Potential for 55% or more source carbon emission reduction
 - > Policies needed for alignment of credits

Near-, Mid-, and Long-Term CO₂e Management Strategy

- > In the near term, aggressive deployment of high-efficiency natural gas equipment in the nation's homes, offices, and industries can achieve substantial CO₂ savings
- > In the midterm, achieve additional GHG savings by reducing methane leakage from the nation's natural gas production, transmission, and distribution systems
- > In the long term, renewables-based gas can be fed into the pipelines to create a sustainable, net-zero-carbon option

Cumulative Impact of Proposed Strategies on CO₂ Emissions



Summary

- > Advanced gas end use technologies have energy efficiency and environmental focus
 - Residential and commercial appliances
 - Industrial process technologies
 - Power and steam generation
 - Transportation vehicles
- > Environmental concerns creating increased interest in green building initiatives
- > Carbon management critical in green buildings
 - Significant emissions, especially from electricity
 - Lowest life cycle cost solutions with efficient gas options
 - Sound regulatory and voluntary initiatives needed