the Energy to Lead

Emerging Technologies: What's Next for Gas Programs

ACEEE EER Conference
September 27, 2011

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GTI Overview

- Not-for-profit research, with 65+ year history
- Facilities
  - 18 acre campus near Chicago
  - 200,000 ft^2, 28 specialized labs
  - Other sites in Oklahoma and Alabama
- Staff of 250
- Experiencing substantial growth

Offices & Labs

Flex-Fuel Test Facility

Energy & Environmental Technology Center

Emerging Technology Program (ETP)

- GTI ETP-type projects total about $1.15 million in revenue in 2011
  - Sector split
    - Industrial ($850K)
    - Res/Com ($300K)
  - Customer split
    - Utilities ($375K)
    - Government ($775K)
- Look to ramp up ETP-type activities and industry collaborative during 2012-2014

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ET's Place in Commercialization Process

Utility Energy Efficiency Programs

AGA CEE

ESC Energy Solutions Center

The Flame of Innovation
SMP

SMP builds a strong technology base for new technologies, product concepts, and related solutions through the "proof of concept" stage for gas utility members and their customers

ETP
Emerging Technology Program

ETP helps companies assess the benefits of new energy efficiency products and integrated solutions for use in near- to mid-term energy efficiency program implementation

UTD
Utilization Technology Development

UTD and its 15 members serve over 20 million gas consumers in 33 states & Canada. These companies work together on technology developments that meet their end-use customer energy efficiency and environmental needs

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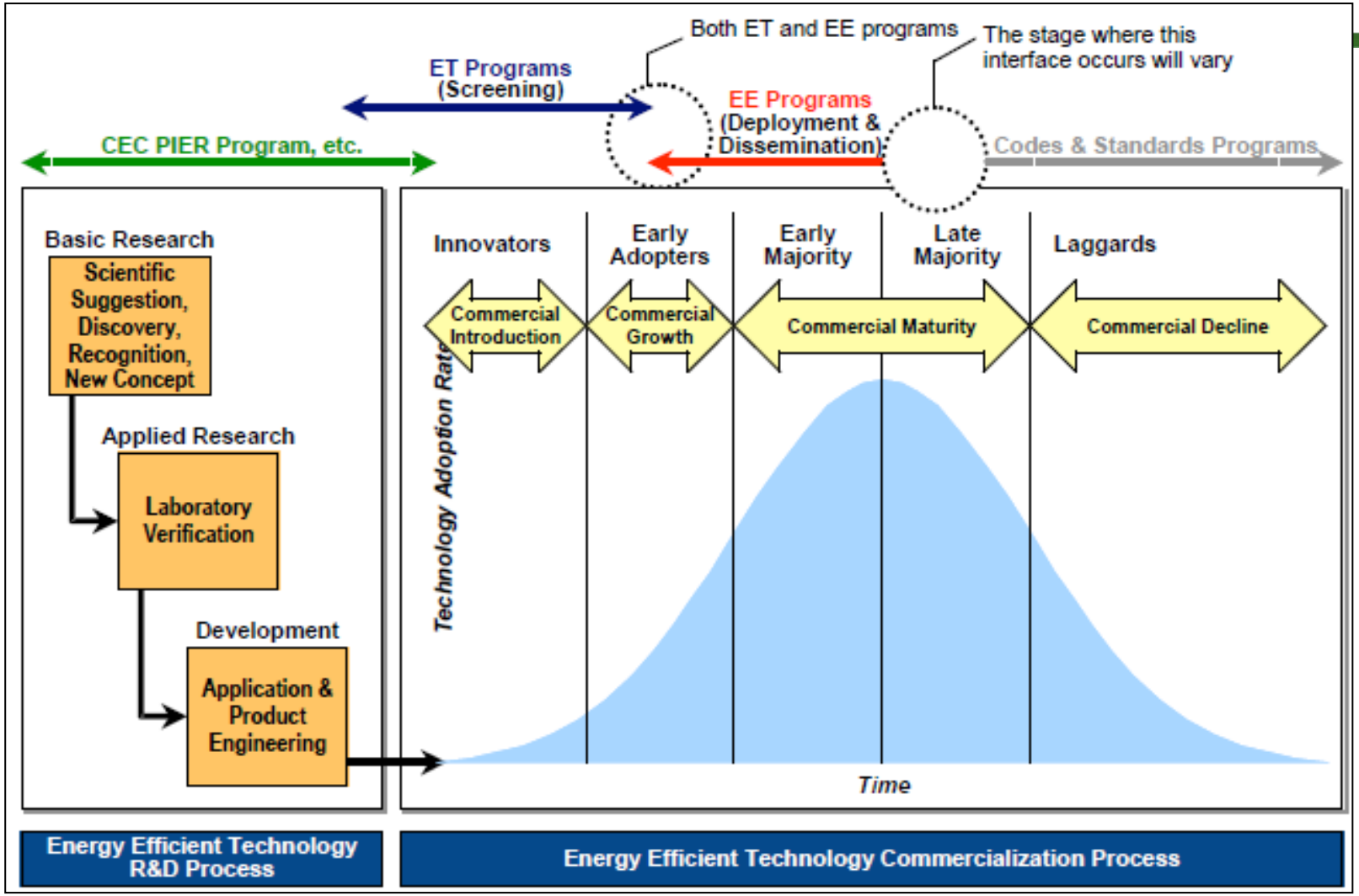
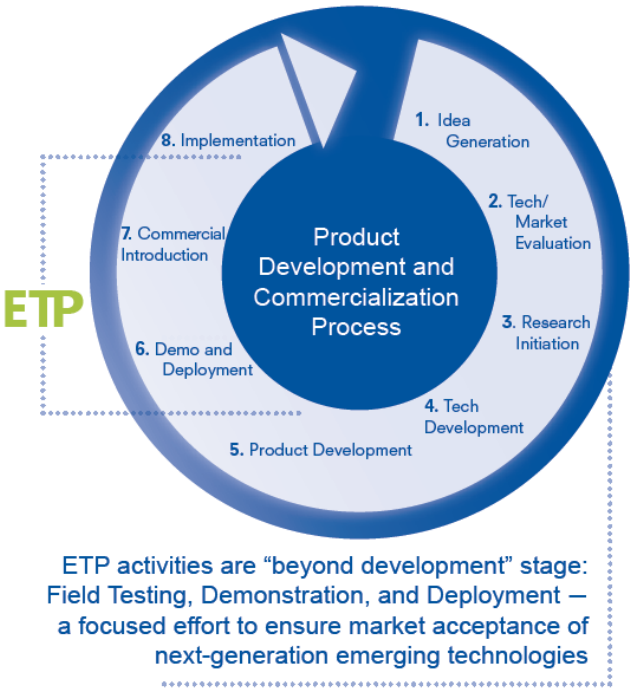
ET's place in State Policy Context



Role of R&D and ET

- R&D focus: new technology & product development, lab validation, alpha/beta field tests (Stage 4 and 5)
- Emerging Technology Program (ETP) activities are “beyond development” stage
  - Data development: cost and energy data for creating program savings goals/metrics for tech manuals
  - Market transformation: information and infrastructure (training guidelines, delivery channels, contractor familiarity)
  - Developing program models: where incentives are most valuable and how much?



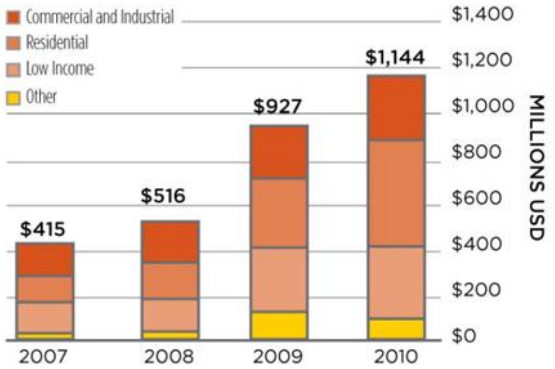
Market Transformation

> Barriers beyond first costs

- Information or search costs
- Performance uncertainties
- Asymmetric information and opportunism
- Hassle or transaction costs
- Hidden costs
- Access to financing
- Organizational practices or custom
- Misplaced or split incentives
- Product or service unavailability
- Price gouging
- More…

Enabling Gas Utility ETP Participation

- Seek to expand North America gas utilities with emerging technology resources
  - Require expanded regulatory approval
- Target small portion of EE program funds
- Leverage, where possible, with gov't and manufacturer funds



Examples: Existing and New ET Program Activities
• California- Roughly 2.5% of total IOU EE and DSM budgets under 2010-2012 Portfolios
• New York- (NYSERDA) Roughly 5% of total program budget
• Pacific Northwest (NEEA)- 10% of total budget 2010-2014
• Illinois- 3% of Gas EE and DSM Program Revenue

Technologies

> (1) Residential Example

> (1) Commercial Example

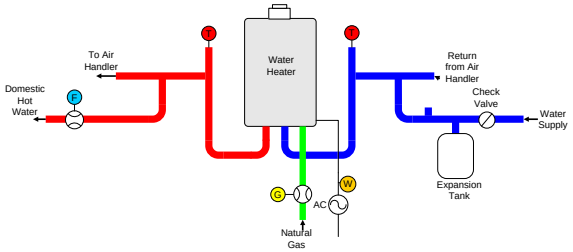
> (1) Industrial Example

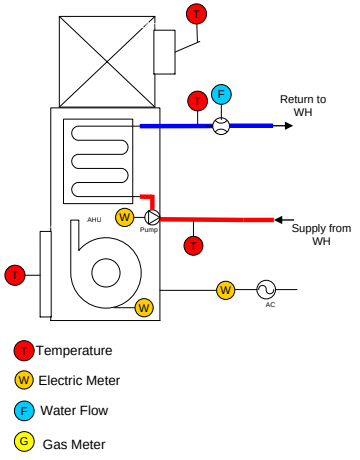
Residential Integrated Space & Water Heat System: The Basics

- High efficiency tank or tankless water heater (90 EF+), combined with hydronic air handler
- Technology ‘concept’ has been around for years, but only recently have major manufacturers begun manufacturing truly integrated systems at cost-competitive prices
- For purpose components, DHW prioritization
- Currently available in marketplace, few takers

Residential Integrated Space & Water Heat System: EE Programs Perspective

- Integrated ‘Combo’ Residential Space and Water Heating System
  - Addresses both major residential natural gas end use loads
  - Appropriate for integration with weatherization, HPwES, new construction, and existing homes
  - Opportunity for significant energy savings (> 200 Therms/year)
  - Improves utility/customer value proposition for water heating by piggy-backing on larger space heating load
  - Technology ready for market, but need large scale demo to create awareness, collect validating data, and breakdown market barriers



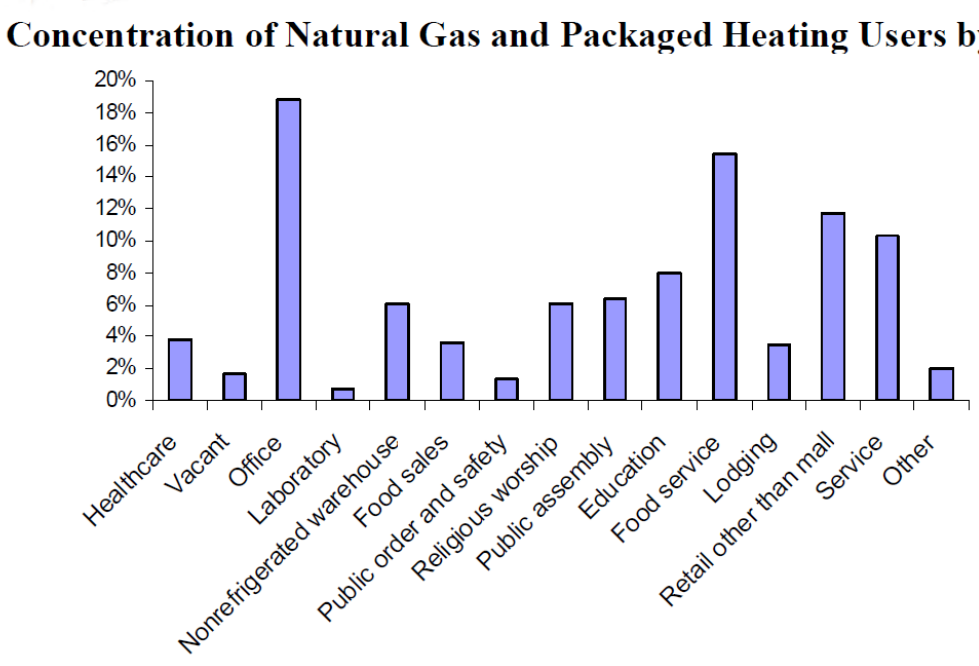


High-Efficiency Rooftop Packages & Unit Heaters for Commercial/Industrial Buildings

- GTI is working with public-private partners to expand the availability and adoption of high-efficiency:
  - Rooftop space conditioning units
    - Packaged space heating and air conditioning units (Gas PACs)
    - Dedicated outdoor air systems (DOAS)
  - Unit space heaters
  - Achieving greater than 90% efficiency
    - Compared to conventional ~80% efficient products

Gas PAC Market Attributes

> Gas PAC equipment used extensively in commercial and industrial building segments



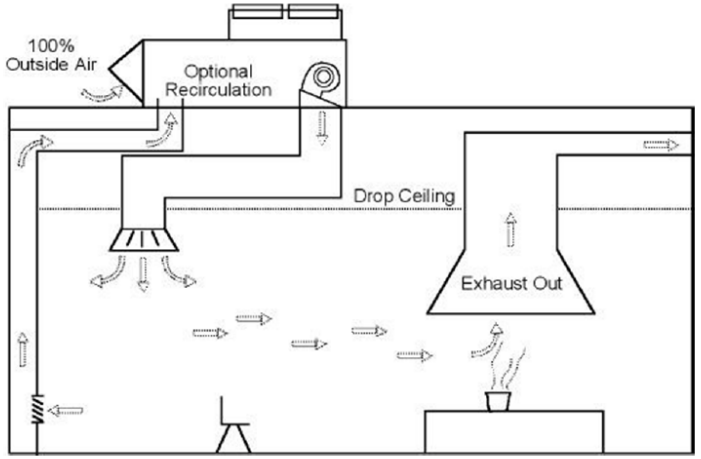
343 Trillion Btu of energy

465,000 commercial buildings

- Office
- Foodservice

Dedicated Outdoor Air Systems (DOAS)

- ASHRAE requirements point to need for fresh air supply to commercial buildings
- Dedicated outdoor air systems, or DOAS, provide a “neutral” source of fresh air



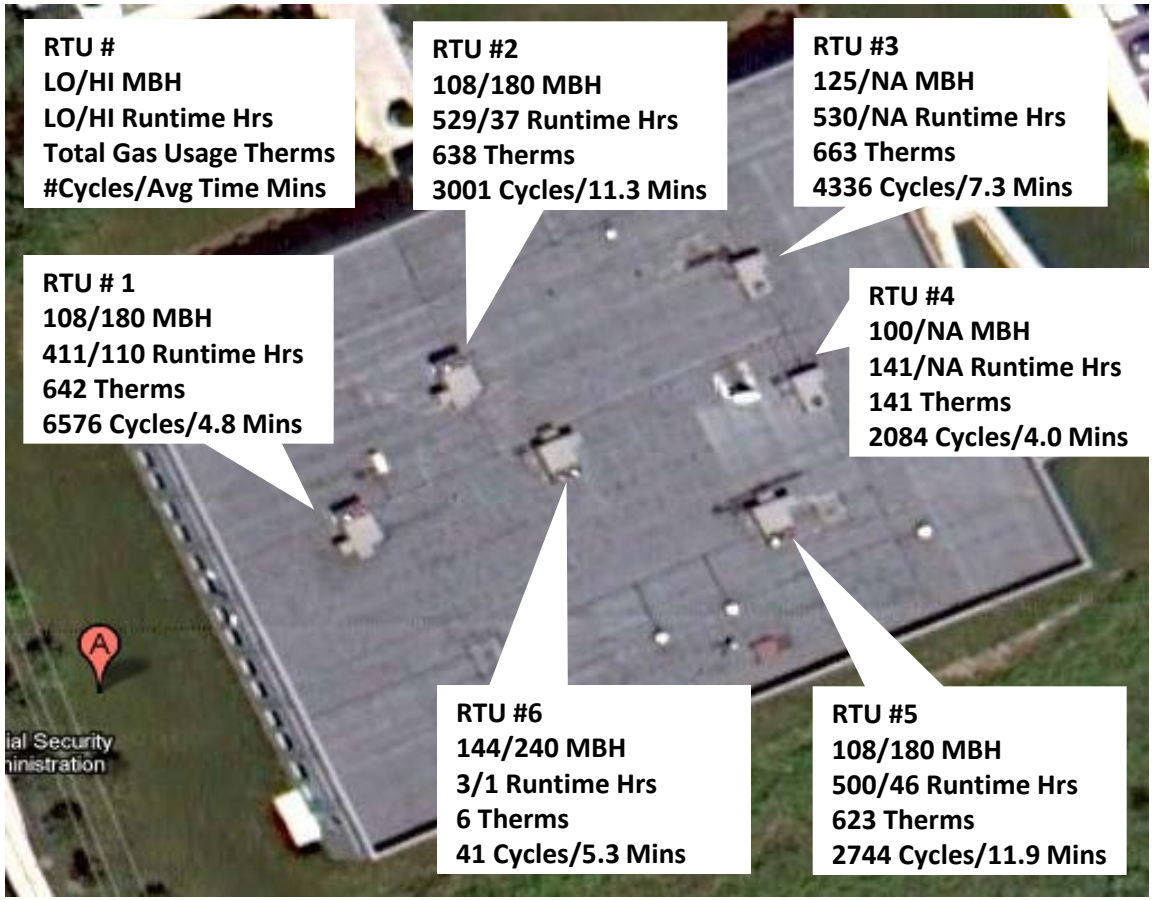
Commercial Space Heating Feedback
GTI National Account (NA) Interviews

- One-on-one discussions with several major NA's
  - None specifying condensing heating equipment (no gas PACs available but high efficiency unit heaters in market)
  - Many use a combination of gas rooftop and unit heater equipment in the same retail building (e.g., SuperCenter)
  - DOAS coupled w/no outside air (OA) gas PACs have most promising net operating cost savings
  - Large numbers of HVAC retrofits peaking in next few years yields opportunity for cost effective, high efficiency heating entry

Gas PAC Field Monitoring

- GTI Conventional Gas PAC Field Monitoring
  - Over 105 gas PAC units in 11 Chicago area commercial buildings
  - Ranging in size from 2,000 to 200,000 sq ft
  - 1 small office
  - 3 quick service restaurants
  - 3 drug/convenience stores
  - 3 clothing/home goods stores
  - 1 retail “super” store

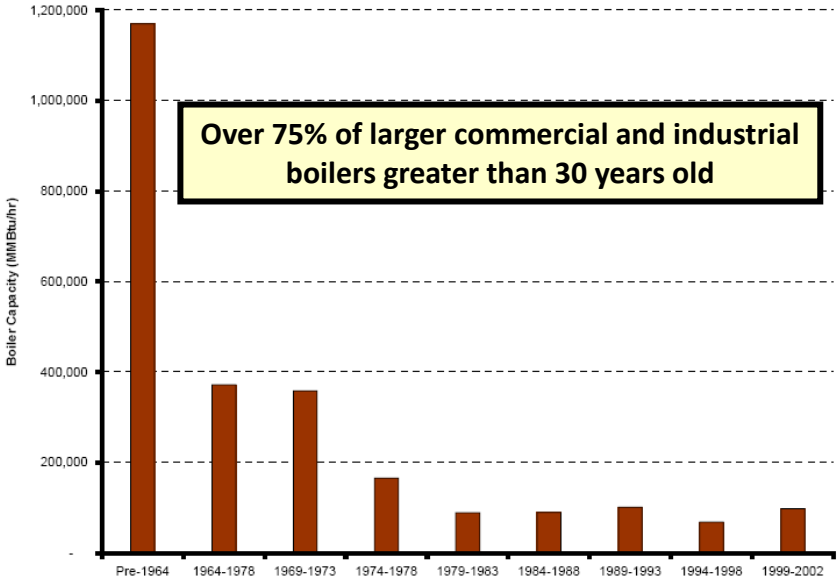
Sample Rooftop Monitoring Results



- Social Security Admin 12,500 sq ft bldg with 6 RTUs
- Preliminary results 10/29/10 - **2/23/11**
  - Great diversity in total RTU runtime: perimeter **>>** core
  - Average heating cycle times range from 4-12 minutes

Commercial & Industrial Boilers

- Large population of outdated commercial/industrial boilers
  - New options for improved efficiency



Commercial

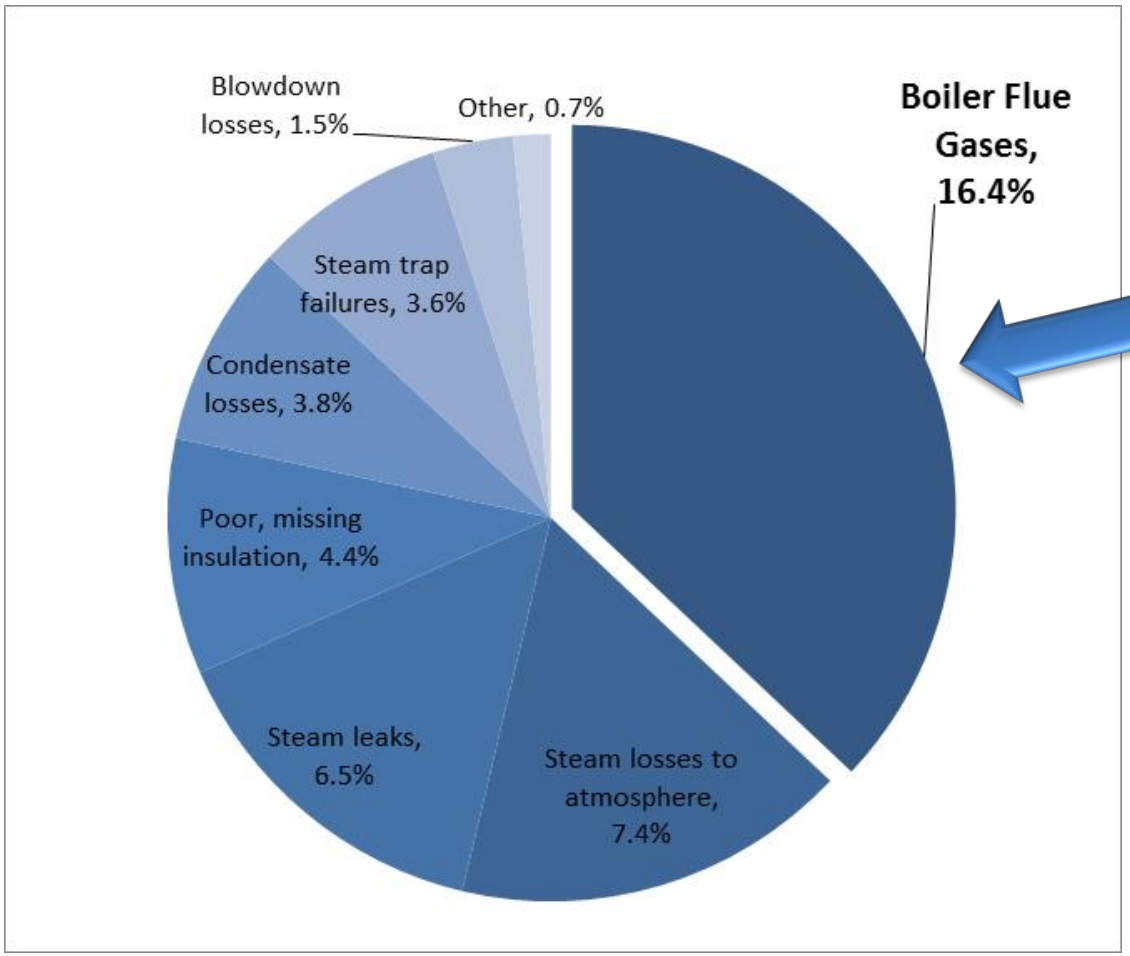
Building Type	Number of Boilers	Total Boiler Capacity (MMBtu/Hr)	Average Capacity per Facility (MMBtu/hr)
Education	35,895	128,790	3.6
Office	28,030	297,090	10.6
Health	15,190	317,110	20.9
Other	11,900	88,970	7.5
Lodging	10,545	140,830	13.4
Public Assembly	7,280	55,205	7.6
Retail	5,585	47,230	8.5
Warehouse	5,365	72,385	13.5
Total	**119,790**	**1,147,610**	**9.6**

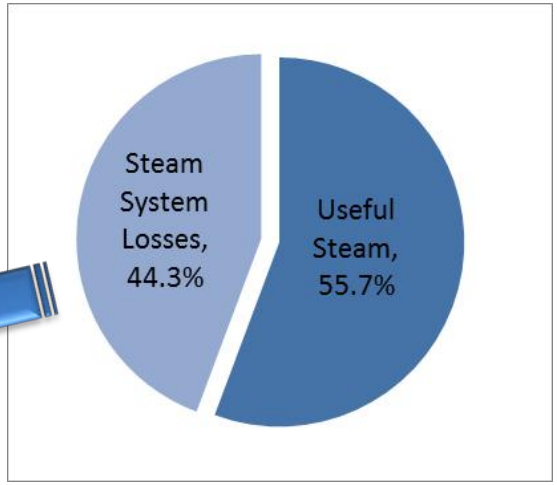
Industrial

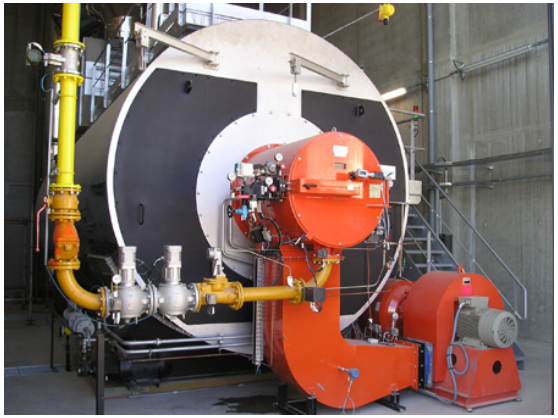
	Food	Paper	Chemicals	Refining	Metals	Other Industrial	Total
< 10 MMBtu/hr	6,570	820	6,720	260	1,850	7,275	23,495
10-50 MMBtu/hr	3,070	1,080	3,370	260	920	3,680	12,380
50-100 MMBtu/hr	570	530	950	260	330	930	3,570
100-250 MBtu/hr	330	540	590	200	110	440	2,210
>250 MMBtu/hr	70	490	350	220	120	110	1,360
Total Units	**10,610**	**3,460**	**11,980**	**1,200**	**3,330**	**12,435**	**43,015**

Source: EEA/ORNL (2005)

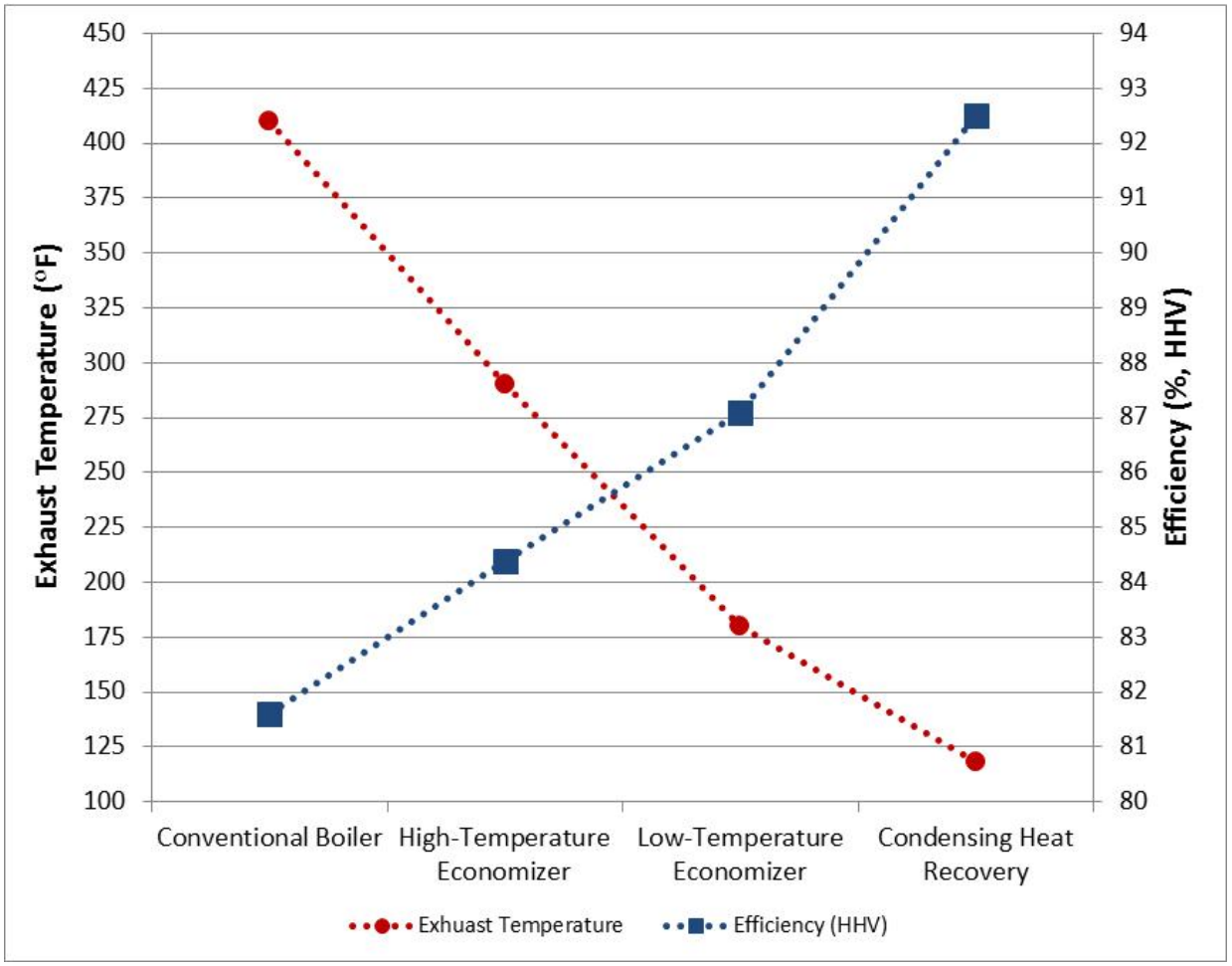
Steam Systems and Energy Efficiency Improvement Opportunities







Example Boiler Efficiency Improvement Options

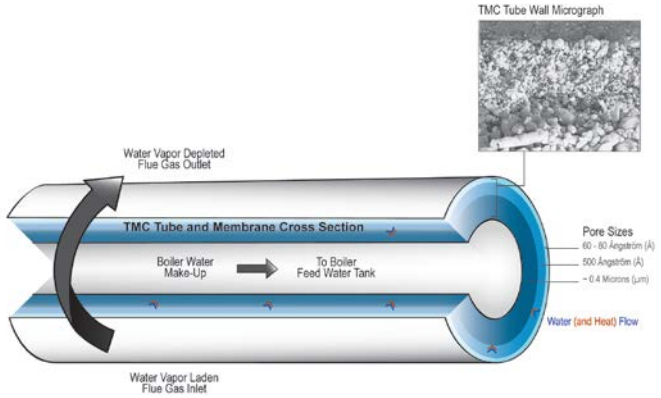


High and low temperature economizers may be made of carbon or stainless steel

Condensing economizers often use stainless steel to resist corrosion

Simultaneous Sensible & Latent Heat Recovery & Water Separation

- GTI-developed Transport Membrane Condenser (TMC) technology
- TMC uses a robust nanoporous membrane to selectively remove pure water from natural gas combustion byproducts
  - Saves water and avoids corrosive condensation problem
- Successfully developed for C&I boilers with Cannon Boiler Works
  - Retrofit or new units



TMC tubes in a bundle assembly

Ultra-High Efficiency Boiler

Advanced Heat Recovery System at Baxter Healthcare

- Field test of TMC-based heat recovery systems
- 13-15% energy and carbon savings
  - Total efficiency ~92.5%
- Over $40,000 annual savings at Baxter
  - Over $80,000 at higher hours & firing rates
- More than 250,000 gallons saved yearly

cbw Cannon Boiler Works, Inc.

Southern California Gas Company

A Sempra Energy company

Baxter

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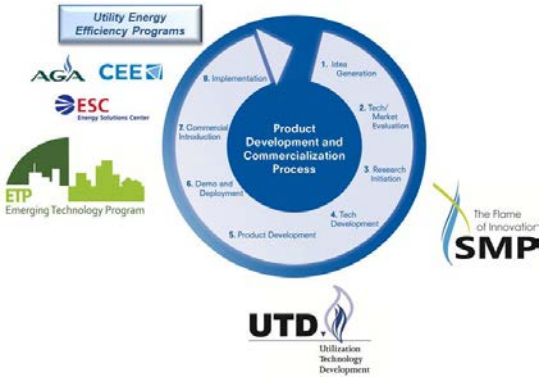
Summary and GTI Activities

- Expanding emerging technology resources helps gas utilities “prime the pump” for future energy efficiency measures
  - Increase the pipeline of new programs, while reducing risk
  - Leverage significant R&D investment across country
  - Expedite the introduction of new technologies into the market
- With several LDC champions, GTI is working with gas utility partners to assess interest in a national collaborative of some form
  - FYI: EPRI also developing this type of program
- Pursuing individual ETPs with targeted gas and combined utilities



Thank You

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ETP
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Emerging Technology Program (ETP)

Addressing implementation barriers and associated risks related to market acceptance and adoption of emerging technologies.

Improved energy efficiency is a shared policy goal around the world; it is often the most economic and readily available means of improving energy security and reducing carbon emissions. New technology is essential to further energy efficiency improvements and to move toward a cleaner, more sustainable energy future.

Emerging Technology Program (ETP) —
A newly established collaborative program managed by Gas Technology Institute (GTI) — is focused on accelerating the commercialization and adoption of the latest energy efficient technologies. The program is designed to help companies identify and evaluate the most promising products and integrated solutions and assess their suitability for future use in utility energy efficiency programs.

GTI's industry-leading expertise provides the information and resources required to help advance market acceptance of emerging technologies for near- to mid-term implementation. ETP strives to create market pull by deployment of natural gas solutions at a desired scale, leading to self-sustaining commercial viability and impact.

Effective Industry Collaboration
Collaborative ETP initiatives provide an opportunity for companies to share insights, leverage energy efficiency funds and help increase the transfer of technology between upstream innovations and the marketplace.

ETP also offers access to GTI services and capabilities for energy efficiency program planning, implementation and assessment. GTI and its partners can work with your company to tailor or modify initiatives to address company or regionally specific needs and opportunities. We can also support a regulatory submission for ETP authorization. GTI has a long history of working collaboratively with utility companies, regulatory agencies, local state/federal government, non-government organizations, manufacturers, channel partners, trade allies and other stakeholders to reduce the time and cost of getting new technology to market.

ETP activities are "beyond development" stage: Field Testing, Demonstration, and Deployment — a focused effort to ensure market acceptance of next-generation emerging technologies