the Energy to Lead

High Efficiency Gas PACs: The Road to Market

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Presentation Outline

- *Quick GTI and ETP Overview*
- *R&D Phase*: Technology and Market Focus
- *Baseline Development Phase*: Large-scale data collection in the field
- *Demonstration Phase*: Working with industry partners to explore early market entry points through targeted ‘showcase’ projects

GTI Overview

- Not-for-profit (501c3) RD&D organization with 70 year history
- Facilities
  - 18 acre campus near Chicago
  - 200,000 ft^2, 28 specialized labs
  - Other sites in California, D.C., Texas, Alabama,Massachusetts
- Staff
  - Approximately 250
  - 170 engineers, scientists covering all fields

CHP and Renewable Energy Lab

Residential & Commercial Lab

Flex-Fuel Test Facility

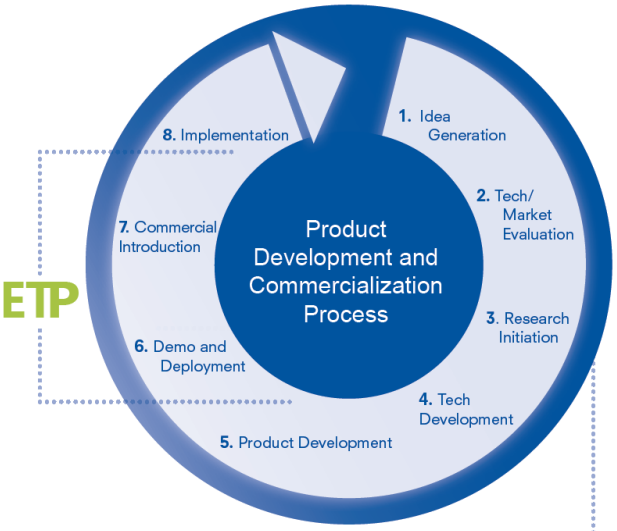
Natural Gas Industry Collaboration

Emerging Technology Program

> Gas Technology Institute led, utility supported, **North American collaborative** targeting **residential, commercial and industrial** solutions

> ETP's principle goal is to **accelerate** the **market acceptance** of emerging gas technologies

AGL Resources
Alagasco AN ENERGEN COMPANY
APGA Research Foundation
ATMOS energy
CenterPoint Energy
CNG
DTE Energy
ENBRIDGE
etic ENERGY TECHNOLOGY & INNOVATION CANADA INNOVATION ET TECHNOLOGIE DE L'ÉNERGIE CANADA
INTERMOUNTAIN GAS COMPANY
National Fuel
Nicor Gas An AGL Resources Company Energy Efficiency Program
NYSEG
Pacific Gas and Electric Company
QUESTAR Gas
uniongas A Spectra Energy Company
Southern Connecticut Gas Service First! A UIL HOLDINGS COMPANY
Southern California Gas Company A Sempra Energy utility
Yankeegas A Northeast Utilities Company



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

2013 Members Listed Above

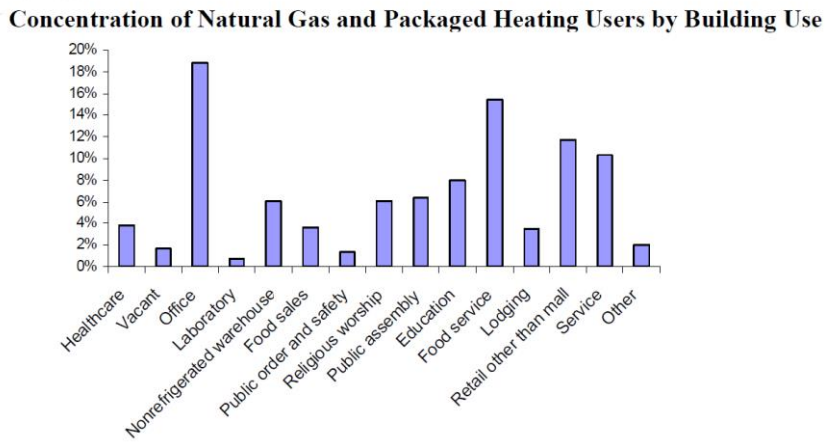
Gas PAC Market/Program Attributes

ETP Emerging Technology Program

- Non-major, second tier HVAC companies introducing HE products
- Small commercial buildings/businesses a challenge for many EE programs- low cost of gas makes this even harder
- Gas PACs are final frontier for condensing gas heating equipment (e.g. residential gas furnaces)
- Gas PAC equipment used extensively in commercial and industrial building segments

343 Trillion Btu of energy
465,000 commercial buildings

- Office
- Foodservice



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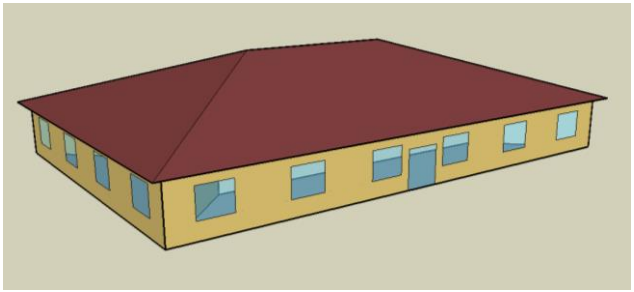
Conflicting Building Models



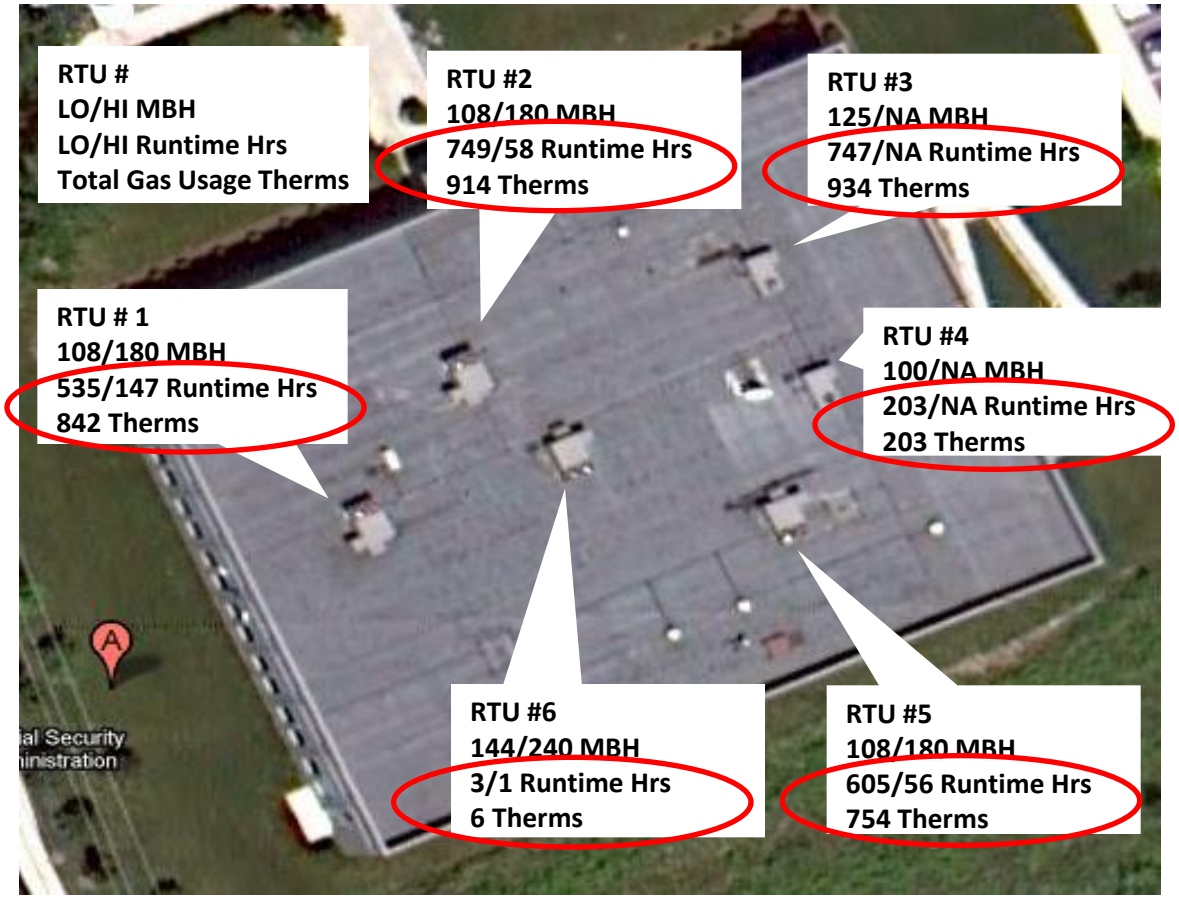
16 Locations	Installed Heating Capacity (Btuh)	Annual Heating Load (MMBtu)	Annual Fan Motor Heating (MMBtu)	Remaining Annual Heating Load for Gas Heating (MMBtu)	Annual Gas Energy for Heating (therms)
Miami	173691	37.46	37.25	0.21	2.65
Houston	178566	52.32	36.24	16.08	201.03
Phoenix	172960	47.58	38.24	9.34	116.77
Atlanta	166519	55.82	33.62	22.20	277.52
Los Angeles	131493	29.39	27.09	2.30	28.72
Las Vegas	145642	43.31	31.02	12.28	153.45
San Francisco	134803	41.67	26.92	14.76	184.45
Baltimore	186310	82.17	37.27	44.90	561.30
Albuquerque	143909	61.14	34.11	27.03	337.99
Seattle	146185	71.73	28.61	43.12	539.03
Chicago	195398	107.83	39.07	68.76	859.58
Boulder	159603	83.54	37.34	46.20	577.51
Minneapolis	203441	135.10	41.42	93.68	1171.03
Helena	178163	113.97	38.99	74.97	937.20
Duluth	198258	156.84	41.70	115.14	1439.17
Fairbanks	245337	259.75	52.17	207.58	2594.75

- Chicago Small Office Model Example
- EnergyPlus Simulation Results for 80% AFUE/TE RTU in 5500 ft2 stand alone, single story building
- Space Heating Gas Therms/Year
  - **860 therms/year** from 10/09 DOE Reference for ASHRAE 90.1-2004 New Construction
  - **364 therms/year** from ASHRAE Baseline presented at 10/09 CEE RTU Workshop for ASHRAE 90.1-2004 New Construction

GTI Baseline Testing

- **1 small office**
- 3 quick service restaurants
- **3 drug/convenience stores**
- 3 clothing/home goods stores
- **1 retail “super” store**

Small Office Monitoring



- GSA leased Social Security Admin 12,500 sq ft bldg with 6 RTUs
- 2010/2011 heating season results
  - Great diversity in total RTU runtime: perimeter **>>** core
  - Average heating cycle times range from 4-12 minutes

Small Office Modeling vs. Monitoring

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Emerging Technology Program

Chicago Small Office Building	Gas Heating Load (therms/ft^2)
DOE/NREL Modeled 11/08 5,500 ft^2 Compliant 90.1-2004	0.165
DOE/NREL Modeled 5/09 5,500 ft^2 Compliant 90.1-2004	0.226
ASHRAE/PNNL Modeled 10/09 5,500 ft^2 Compliant 90.1-2004	**0.066**
DOE/NREL Modeled 10/09 5,500 ft^2 Compliant 90.1-2004	**0.156**
DOE/NREL Modeled 9/10 5,500 ft^2 Compliant 90.1-2004	0.121
GTI Monitored 10/10-6/11 12,500 ft^2 Completed 2007	**0.292**

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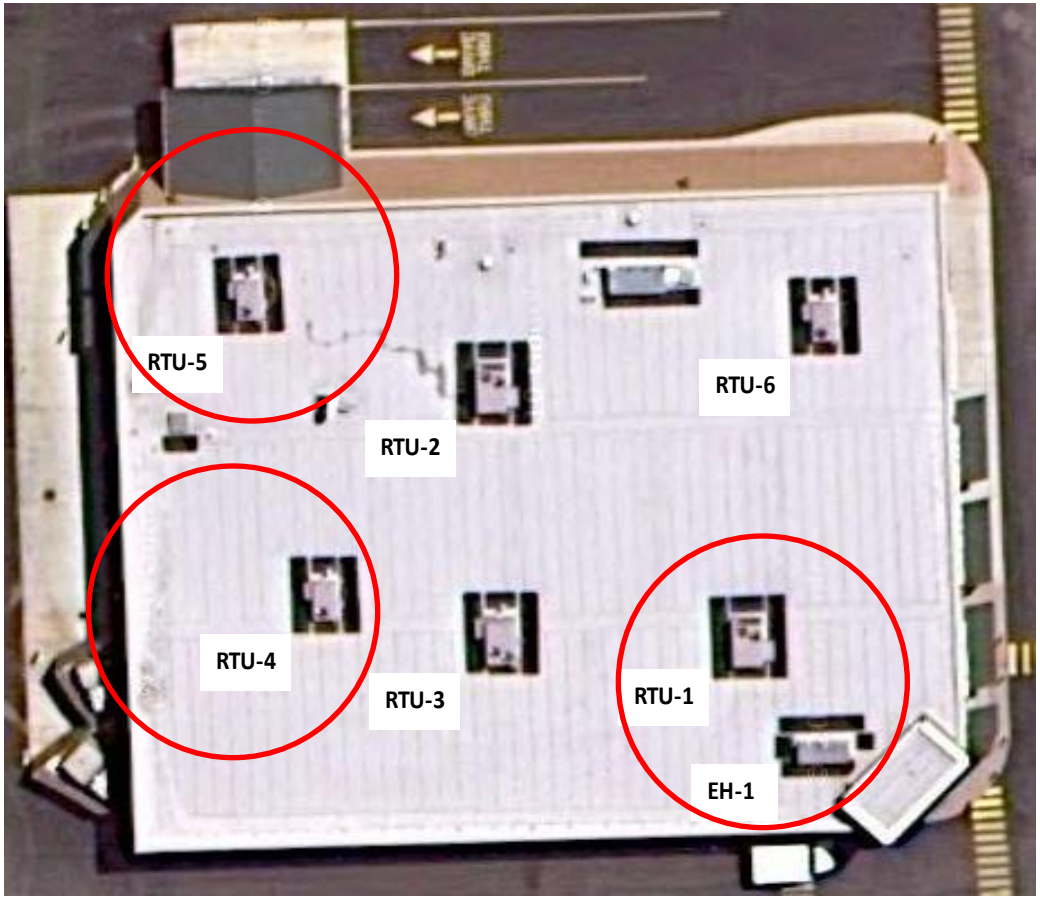
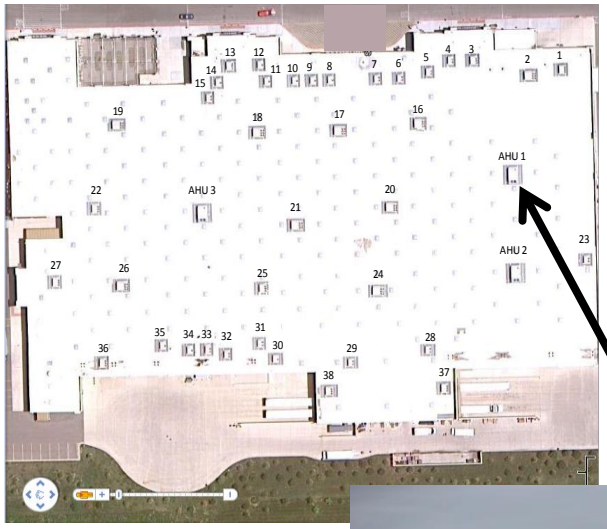
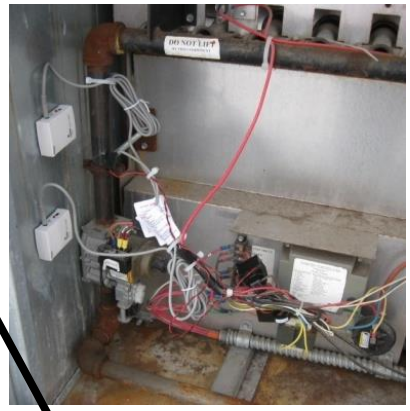
Small Retail Store Monitoring



- 3 ~15,000 sq ft stores same 7 RTU layout
- 2010/2011 heating season results
  - Runtimes up to 1600 hrs in high load zones
    - RTU-1/EH-1: Vestibule
    - RTU-4: Stockroom
    - RTU-5: Drive thru pharmacy
  - Same layouts = same higher runtime RTUs

Large Retail Store Monitoring





- 200,000 sq ft big box
  - Dozens of RTUs and unit heaters
  - 3 DOAS account for ~50% of gas usage
- Annual projections from 2011 monitoring for single DOAS
  - 800 MBH_{input} capacity
  - 20,000 therms/year

What we learned…

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Emerging Technology Program

- Excess RTU heating capacity on buildings (sized for AC)
- Usage pattern highlighted by diverse runtimes from perimeter to core
- High RTU runtimes and high percentage of outdoor air key to generating high net operating cost savings for high efficiency payback
- DOAS provides best early market payback scenario
  - "big box" retail accounts with established DOAS vendors
  - high heating degree day (HDD)/heating load locations
  - 24/7 retail stores
  - Retail partner projected $4,400 premium, = 4.1 years ROI @ 90%TE
  - Northern climates see up to 3,000 therms/saved per year per unit!
- Mainstream condensing RTU transition hinges on
  - Progressing incremental pressure drop below 0.2"WG
  - Broadening RTU use of staged blowers
  - Achieving consensus on building heating loads

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ETP Collaborative Medina Demo

> 'Big Box Retail' store in Medina, MN with single DOAS to be retrofitted with 2 condensing heating modules

> Status

- System retrofitted Spring 2013
- DAS equipment installed
- Data collection continuing through 2013/2014 heating season
- Early returns show expected savings

CenterPoint Energy
DTE Energy
uniongas
A Spectra Energy Company

Nicor Gas ETP
Walmart Pilot Project

> 3 step condensing heating module retrofit process over late September through mid-October of 2012

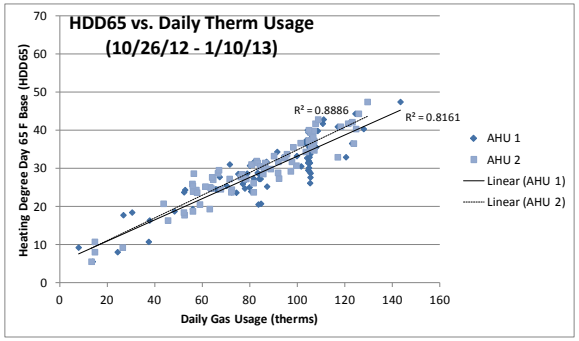
1. Installation of condensate piping with neutralizer
2. Replacement of non-condensing heating modules
3. Completion of data acquisition system

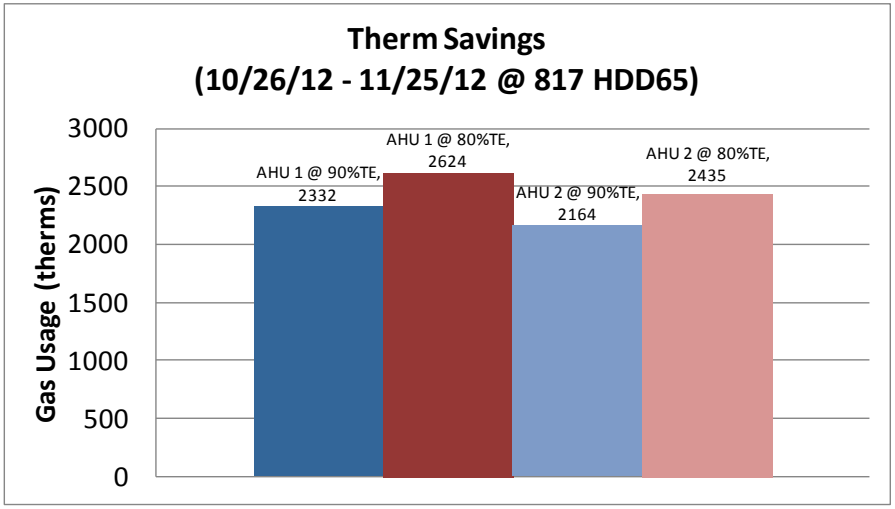
Walmart Pilot Project - results to date

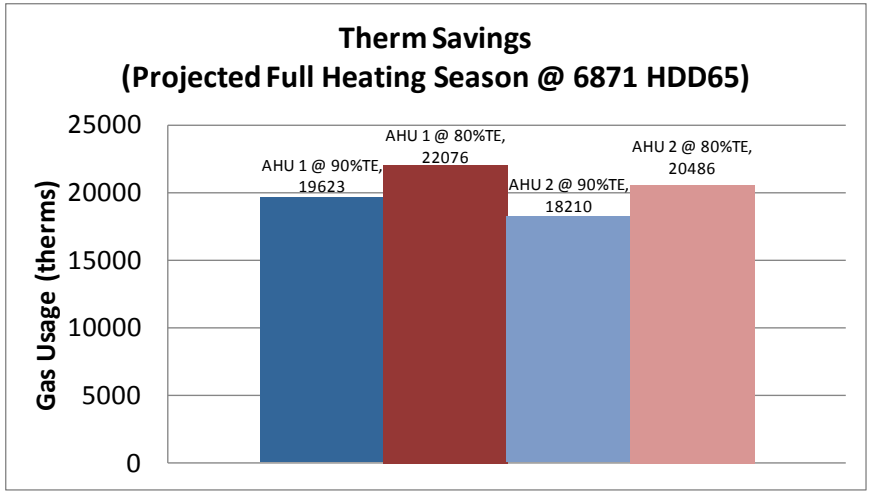
ETP Emerging Technology Program

> Therm savings to date can be projected with statistical confidence to a full heating season

- AHU 1 – 2453 therms saved per year
- AHU 2 – 2276 therms saved per year







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ETP Project Outcomes

- Project market analysis will help define early markets for larger ventilation air/make-up air applications by building type
- Combined with results from Illinois and Minnesota demos, a white paper will provide ETP members with the ability to:
  - establish their own service territory calculations
  - identify local targeted applications
  - determine their therm savings potential
  - recommend appropriate incentive levels for EEP
  - generate work paper to propose a new EEP measure, preferably for a prescriptive measure

Active Manufacturers

Manufacturer	Availability	Heating Module Specifications w/Hot Link (subject to change)
Engineered Air	now	90%TE, 100 – 1,400 MBH input, 15:1 turndown, 1,000 to 44,000 CFM www.engineeredair.com/pdf/DJX%20Brochure.pdf
Modine	now	90%TE, up to 500 MBH input, 7:1 turndown, up to 12,000 CFM www.modine.com/download/1/MCP15-110.pdf
Reznor	now	91%TE, up to 350 MBH input, 8:1 turndown, up to 6,000 CFM http://www.rezspec.com/en/products/product-air-handler-rhh
Munters	now	90%TE, up to 800 MBH input, 10:1 turndown, up to 16,000 CFM http://www.munters.us/en/us/Products--Services/Dehumidification/Energy-Recovery/Packaged-Energy-Recovery1/?Product=87392AFD-C031-4BC7-AED9-65E508651504 (product literature does not currently show condensing option)

Next Steps

- GTI Commercial Reference Building Model Project
  - Participating utility “billing analysis” for heating EUI
  - Influence DOE/ASHRAE model heating loads
- GTI R&D project working to enhance RTU thermal efficiency, getting beyond 90%
- Mainstreaming Actions for Condensing RTUs
  - Foster condensing gas heating specifications, i.e., Commercial Building Energy Alliance RTU Challenge, and joint gas/electric driven market analysis of advanced RTU economics in heating dominated climates
  - Demos for other early market entry points (e.g. 24/7 drug stores with high runtime RTUs)

Thank You!

> Acknowledgements

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