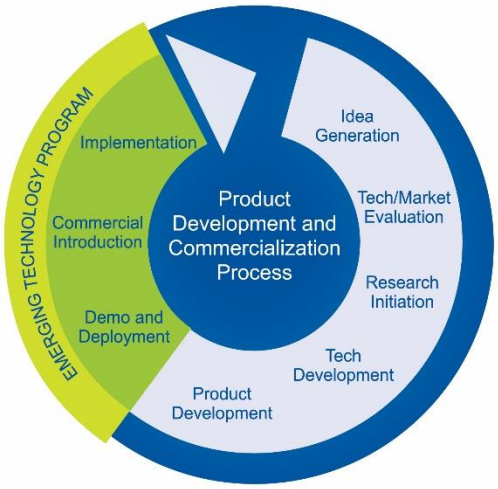
the Energy to Lead

Current and Future Opportunities for Advanced C&I HVAC Systems



High Efficiency Heating RTUs

2017 National Symposium on Market Transformation

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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

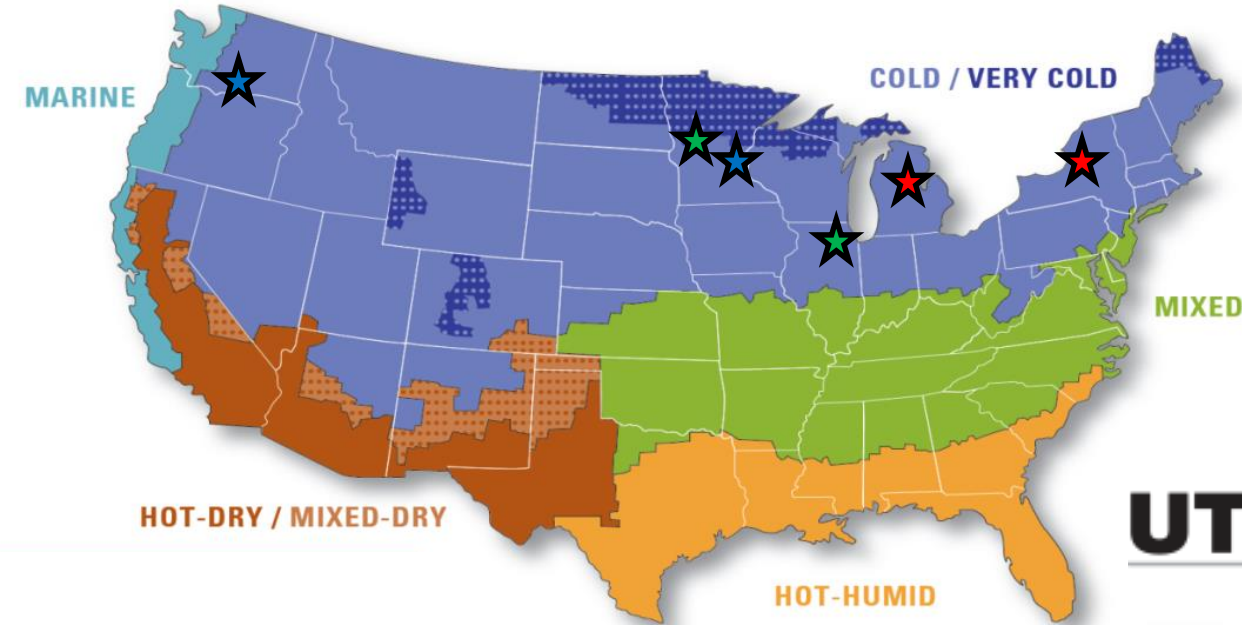
High Efficiency RTUs
Overview

- Condensing RTUs have the potential to make a large therm savings impact on the commercial sector in our programs, similar to condensing furnaces in the residential sector
- Market development is still in its early stages, but we've made progress over the past few years
  - baselining RTU system energy use and runtimes across multiple commercial building types
  - introducing condensing furnace modules for RTUs
  - piloting with pioneering condensing RTU packagers
  - defining the most effective market entry points
  - addressing condensate codes & best practices

High Efficiency Heating RTUs:
Condensing Technology's Final Frontier

ETP Emerging Technology Program

For the past 5 years, GTI has been leading an industry-wide effort to assess the technical and market potential of high efficiency heating (condensing) RTUs, this work has included several regional demos and pilots.



DTE Energy

neea

Nicor Gas™
An AGL Resources Company
Energy Efficiency Program

CenterPoint® Energy

UTD Utilization Technology Development

uniongas
A Spectra Energy Company

gti®

Past RTU Project Findings

- Very diverse heating runtimes for RTUs on a given building, but patterns emerge
  - Perimeter zone RTUs see longer runtimes than interior zone RTUs
  - RTU layouts in “identical” buildings show consistency in RTU runtime patterns with opportunity for selective higher efficiency heating upgrades for high runtime RTUs
- DOAS (or other high ventilation/make-up air fraction RTUs) exhibit highest heating/gas loads and present the most promising early market entry point for condensing RTUs
- Conventional RTUs with ≤30% outdoor air present challenges with diverse heating loads & runtimes

Present Market Situation

- Non-major, second tier HVAC companies offer product lines and provide early market entry point with
  - 100% outside air (OA), such as dedicated outside air systems (DOAS) and make-up air systems (MUAS)
  - Applied by key “big box” retailers and other end users
- Major HVAC companies mostly on the sidelines for now, with exception of Trane Creative Solutions and York targeted efforts

Early Market Entry Points

ETP Emerging Technology Program

- 100% outdoor air with high heating load & runtimes
- specialized RTU segment w/~5% commercial floor area & ~7.5 to 15% RTU heating capacity (climate dependent)
- DOAS (ventilation air)
  - retail stores (“big box”)
  - schools
  - healthcare facilities
  - theaters
  - sports arenas
  - day care centers
- MUAS (make-up air)
  - hotels, multifamily buildings, senior living facilities (corridors)
  - commercial kitchens
  - health club facilities
  - industrial production facilities

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Energy Efficiency Programs

- Should programs focus on incentivizing 100% outdoor air applications?
- How should incentive offerings be structured?
- Let's look at two sample incentive offerings
  - Nicor Gas 100% outdoor focused measure
    - State TRM therm savings calculation methodology
    - Custom therm savings valuation for rebate
  - Questar Gas broad condensing RTU measure
    - Prescriptive rebate based on capacity

Nicor Gas Custom Rebate

- Illinois TRM measure applies to constant volume (CV), dedicated outside air system (DOAS), make-up air system (MUAS), or any unitary HVAC system providing indirect gas fired100% outdoor air (OA) at ≥ 90% TE
- **Step 1** *Estimate therms saved using IL TRM measure*
  - Tables of outside air loads (Q_{OA}) based on climate zone, building schedule, balance point, and supply air temperature
  - For 5000 cfm, 93%TE DOAS, 24/7 operation, 95 °F supply, 55 °F base, Q_{OA} for Chicago O'Hare AP = 303,268 BTU/cfm

Δtherms = 2650

Nicor Gas Custom Rebate

> **Step 2** *Annual net savings using GTI pilot study data*

Annual Gas Savings	$0.65/therm * 2,650 therms	+ $1,722.50
Annual Fan Energy Penalty	1,285 kW-h X $0.08/kW-h	- $102.80
Annual Maintenance	$65	- $65
Net savings	$1,723.50 - $65 – $102.80	$1554.70

> **Step 3** *Apply custom Nicor Gas rebate*

- $0.75/Therm * 2650 therms/year = **$1,987.50**

> **Step 4** *Determine payback period w/ & w/o rebate*

- $6,069 for 668 kBtuh input condensing DOAS (including condensate drainage system w/neutralizer)
- ***3.9 year payback reduced to 2.6 years w/rebate***

Questar Gas Prescriptive Rebate

ETP Emerging Technology Program

> Same 668 kBtuh, 93% TE condensing indirect fired RTU

Incentive Details	Incentive Amount

• $5.00 per kBtuh input
• condensing RTU
  • ≥ 50 kBtuh input
  • ≥ 90% TE
	668 * $5.00 = $3,340.00

> GTI Pilot Study: $6,069 for 668 kBtuh input DOAS (including condensate drainage system with neutralizer)

> Payback period

- **3.9 years without rebate**
- **1.8 years with prescriptive rebate**

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Market Transformation Path

- GTI ETP members working together, coordinated with CEE
- Initial focus on 100% outdoor air units in mixed, cold, and very cold climates
- Initial DOAS/MUAS market development focus
  - Identifying key building segments and savings potential
  - Supporting utility EE and MT activities
    - TRM measures, work papers, utility incentive design, spec?
    - Trade ally initiatives (training & education)
    - End user promotions (targeted building types, end users)
  - Coordination with manufacturers showing a united approach with broad US/Canada coverage