



UTD IMPACT

Utilization Technology
Development

October 2022

UTD develops and demonstrates economical new products, systems, and technologies to save energy, reduce GHG emissions, save customers money, integrate renewable energy (including renewable natural gas and RE-derived hydrogen), and help customers maintain safe, reliable, resilient operation with superior environmental performance.

UTD thanks the leading researchers, entrepreneurs, universities, governmental agencies, manufacturers, and others that partner with UTD as a 501(c)(6) not-for-profit organization of gas utilities to develop and demonstrate affordable new energy-efficient solutions for end users — accelerating the transition to a lower-carbon future.

Please contact us if you have any questions about UTD.

Ron Snedic (1.847.768.0572)

Rich Kooy (1.847.768.0512)

UTD's 20 member companies serve more than 37 million natural gas customers in North America.

UTD helps utilities create exciting new products for their customers and maximize the impact of their energy-efficiency programs.

Together we're shaping the energy future with clean, efficient end-use technologies.

Visit www.utd-co.org for more information.

COMMERCIALIZED PRODUCTS



Dedicated Outside Air System/Rooftop Unit

Condensing heating versions of Munters Dedicated Outside Air System (DOAS) and other rooftop unit (RTU) products increase heating efficiency from 80%-81% to 90%-93%. Multiple RTU manufacturers are now offering DOAS with 90+% efficiencies, facilitated by the availability of condensing duct furnace modules first developed with UTD support.

Munters Corporation

Larry Klekar
210-249-3883
larry.klekar@munters.com
www.munters.com



Condensing Duct Furnace Modules

High-efficiency condensing heating modules developed with UTD support are now available from Beckett Gas and other OEMs, including Heatco, and are being applied to DOAS and other products including Make-Up Air Units available from multiple manufacturers including Aaon, Daikin, and RuppAir.

Beckett Gas, Inc.

Joel Mohar
440-783-7610
jmohar@beckettcorp.com
www.beckettgas.com

COMMERCIALIZED PRODUCTS (continued)



CleanO2 CarbinX™ Carbon Capture

CleanO2's revolutionary CarbinX unit captures CO₂ from the flue gas of boilers and furnaces to reduce GHG emissions, and turns it into a beneficial consumer product. UTD's members provided technology development expertise and support to CleanO2 since 2018 to refine early prototypes and partner with CleanO2 to identify and make product improvements.

CleanO2, Inc.

Jaeson Cardiff
 carbinX@cleano2.ca
 www.carbinx.com



Yanmar 3-Pipe Engine-driven Gas Pump

Yanmar's 3-pipe, 14-ton Gas Heat Pump (GHP) with variable refrigerant flow (VRF) offers an important energy-efficiency option for the North American market by combining heat recovery with simultaneous heating and cooling. In a 2018-20 field test, UTD validated equipment performance and produced a public summary of results. More UTD field tests will occur during 2022.

YANMAR America Corp.

Eddie Caton
 770-877-7733
 eddie_caton@yanmar-es.com
 www.yanmar-es.com



GRIDIRON PowerPlant™ H24 and HA65

The PowerPlant HA65 from GRIDIRON (formerly M-Trigen) provides high-efficiency microCHP with integrated cooling to homeowners, small businesses, and other users. UTD is providing technical support for a notable demonstration by partnering with NYSERDA, National Grid, NJNG, and PERC to independently validate performance. UTD is also supporting GRIDIRON in its optimization of PowerPlant HA65 to minimize emissions, and its development of PowerPlant H24.

GRIDIRON

Alan Thomas
 713-574-4506
 alant@gridironenergy.com
 www.gridironenergy.com



Sierra™ Engine-driven Gas Heat Pump

Sierra's (formerly NextAire™) 11-ton packaged GHP can efficiently heat and cool commercial buildings (up to 1.4 COP) while reducing electric demand. Also available are 8- and 15-ton GHPs with VRF multizone capabilities. UTD's field studies are supporting best practices for siting. UTD is partnering with NYSERDA and National Fuel in a field test in NY state.

Blue Mountain Energy

Tom Young
 702-339-7395
 tyoung@bluemountainenergy.com
 www.bluemountainenergy.com



Cannon Boiler Works Ultramizer®

The Ultramizer is an advanced heat-and-water recovery system for larger commercial and industrial boilers, of which there are more than 140,000 in the U.S. It increases boiler efficiency from 80% to 93%—saving customers 15% in energy while also reducing water demand.

Cannon Boiler Works, Inc.

Chris Giron
 724-335-8541 x414
 sales@cannonboilerworks.com
 www.cannonboilerworks.com



iGEN Self-Powered Furnace

The innovative iGEN furnace generates its own electric power and contains an integrated battery, providing homeowners with continuous heating even during electricity outages. UTD supported the technical refinement of this product with laboratory testing, validation, and recommendations.

iGen Technologies

Michael Chatzigrigoriou
 letstalk@igentechnologies.ca
 www.igentechnologies.ca

COMMERCIALIZED PRODUCTS (continued)



ENERGY STAR® Fryers

Royal Range introduced the high-efficiency RHEF-75 fryer in 2019 - building on the success of the smaller-capacity, high-efficiency RHEF-45 fryer that received the National Restaurant Association's Kitchen Innovation Award and GFEN's Blue Flame Product of the Year Award. Independent testing showed 63% heavy-load cooking energy efficiency.

Royal Range of California

Robert Lutz
951-360-1600
robert@royalranges.com
www.royalranges.com



Low-Oil-Volume Fryers

Marketed by Frymaster as Protector® fryers, this equipment increases energy efficiency while also extending cooking-oil quality and life to provide significant customer savings. Field demonstrations completed by UTD have shown an average savings of \$4,800 per year per fryer.

Frymaster

Linda Brugler
318-866-2488
lbrugler@frymaster.com
www.frymaster.com



ENERGY STAR Conveyor Oven

ENERGY STAR rated conveyor ovens from Lincoln include an advanced energy-management system to reduce energy consumption up to 38%.

Lincoln, a division of Manitowoc Foodservice

260-459-8200
www.lincolnfp.com



ENERGY STAR Convection Oven

This unit showed improved efficiency and 40% energy savings compared to a standard oven during field testing and achieved an ENERGY STAR rating.

Garland

905-624-0260
www.garland-group.com



High-Efficiency Broiler

This broiler features infrared burners and an energy-saving hood that showed an average of 23% energy savings during field testing. It offers more efficient cooking as well as reducing heat gain to the kitchen.

Royal Range of California

800-769-2414
www.royalranges.com



ENERGY STAR Countertop Steamer

A compact, gas-fired countertop steamer for commercial foodservice offers enhanced cooking rates while providing energy savings and reduced water consumption. It was the first gas-fired boilerless steamer on the market and received an ENERGY STAR rating.

Market Forge Industries Inc.

617-387-4100
866-698-3188
custserv@mfi.com
www.mfi.com



Gas Quality Sensor

The Gas Quality Sensor (GQS) uses solid-state infrared light absorption spectroscopy to measure Btu content and composition of natural gas and bio-methane fuels. It provides faster response at much lower cost than a gas chromatograph. It was developed with UTD support and was commercially introduced by CMR Group in 2019.

CMR Group

Jon Stendebach
724-452-2200
918-407-4005
jon.stendebach@cmr-group.com
www.cmr-group.com

COMMERCIALIZED PRODUCTS (continued)



L9N

Cummins Westport 8.9L Near-Zero Emission NGV Engine

This 8.9L 320-HP NGV engine is widely used, with 50,000+ engines sold for transit, refuse-collection, and regional hauling applications since 2007. In 2016, it was advanced to become the first engine certified in North America to meet the 0.02 g/bhp-hr optional Near Zero (NZ) NO_x emissions standard (i.e. 90% lower than the current EPA NO_x limit of 0.2 g/bhp-hr).

Cummins Westport Inc.

Yemane Gessesse
812-377-5000
yemane.gessesse@cummins.com
www.cumminswestport.com



B6.7N

Cummins Westport 6.7L Medium-Duty NGV Engine

This 6.7L 240-HP natural gas vehicle (NGV) engine is used in school buses, shuttle buses, medium-duty trucks, and other vocational uses. It went into full commercial production in December 2016. It meets U.S. 2017 EPA GHG requirements as well as NZ NO_x emissions standard of 0.02 g/bhp-hr.

Cummins Westport Inc.

Yemane Gessesse
812-377-5000
yemane.gessesse@cummins.com
www.cumminswestport.com



ISX12N

Cummins Westport 11.9L Near-Zero Emission NGV Engine

This 11.9L 400-HP NGV engine is used in large trucks, buses, and refuse vehicles. Engine sales since 2013 are approaching 10,000 units and 25,000+ engines will likely be sold in N.A. by 2020, yielding emissions reductions and \$600+ million in annual fuel sales. In Model Year 18, it became CWI's second engine certified to meet NZ NO_x emissions standard of 0.02 g/bhp-hr.

Cummins Westport Inc.

Yemane Gessesse
812-377-5000
yemane.gessesse@cummins.com
www.cumminswestport.com



S.U.N. Equinox Solar-Assisted Heating System

The Equinox system is a combination solar/natural gas water heating system that uses an efficient evacuated tube design. It can be used in residential, commercial, or industrial locations and is capable of meeting 100% of domestic hot-water and space heating needs. UTD validated its energy performance in a field demonstration.

Solar Usage Now, LLC

Thom Blake
260-657-5605
tblake@solarusagenow.com
www.solarusagenow.com

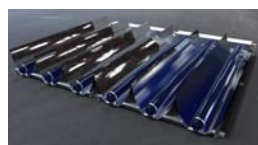


Heat Sponge Economizer for Industrial/Commercial Boilers

In either condensing or non-condensing configurations, this heat recovery system for commercial and industrial boilers (over 140,000-unit market in U.S.) increases boiler efficiency from 80% to a range of 85%-93% (validated by UTD lab testing). It also saves customers 5%-15% in annual energy costs. UTD completed a field test in Utah to validate energy savings.

Boilerroom Equipment, Inc.

866-666-8977
www.heatsponge.com



External Concentration Parabolic Collector

This patented, non-tracking, extremely-low-profile concentrator can achieve 200°C (392°F) solar thermal energy to economically serve commercial and industrial facilities and reduce GHG emissions. It can also be integrated with natural gas as a supplemental energy source. UTD provided technical and product development support and experimental validations over a seven-year period.

Artic Solar Inc.

Bill Guiney
904-513-4638
bill@articsolar.com
www.articsolar.com

KEY INFORMATION & ANALYTICAL TOOLS



Reliability, Cost and Environmental Impacts of Standby Generation Systems

Generac's website provides technical information related to emissions, reliability and costs of natural gas generators that was developed with UTD's support. For example, UTD researchers published a white paper that provided new data on the reliability of natural gas service and assisted in the development of a Total Cost of Ownership calculator that compares emissions and costs of natural gas vs. diesel-fueled standby generators.

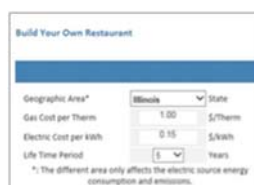
Available on-line at <https://www.gti.energy/wp-content/uploads/2019/02/Assessment-of-Natural-Gas-Electric-Distribution-Service-Reliability-SummaryReport-Jul2018.pdf> and <https://www.generac.com/Industrial/all-about/natural-gas-fuel>

U.S. DOE Building America



Under five separate UTD projects from 2011 to 2021, UTD has developed key information and tools to support the U.S. DOE's Building America research, development, and demonstration program, which helps accelerate use of best practices by residential builders, remodelers, installers, code officials, designers, raters, teachers, and others. Most recently a simplified combustion safety protocol was introduced.

Available on-line at <https://www.gti.energy/BuildingAmerica> and <https://basc.pnnl.gov/library>



Commercial Foodservice (CFS) Equipment Calculator

This website provides the restaurant industry and others with information and tools to determine the economic and environmental benefits of using new, more advanced and efficient CFS equipment. The website was developed with UTD support and has been showcased at several restaurant trade shows. Further enhancements are underway in 2022.

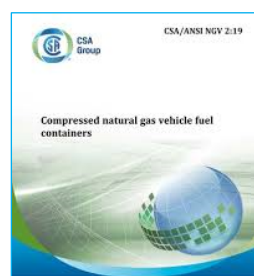
Available online at <http://cfscalc.gastechology.org>. For more information, contact Frank Johnson; fjohnson@gti.energy



Virtual Test Home

A Virtual Test Home (VTH) in a laboratory was developed with UTD's support. Leveraging the VTH, UTD has helped Navien and iFLOW demonstrate that an advanced forced-air condensing tankless water heater combi system can achieve 30-50% energy savings relative to best-in-class condensing furnaces and water heaters. The VTH is also developing data to help accelerate adoption of advanced gas technologies (such as GHPs, combis and modulating furnaces) in U.S. DOE's EnergyPlus™ and other energy software.

For more information, contact Tim Kingston; tkingston@gti.energy

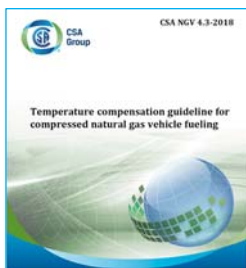


CSA NGV2 CNG Vehicle Fuel Containers Standard Technical Committee Support

The sixth edition of CSA NGV2 issued in 2019 and contains updated information and requirements for the material, design, manufacture and testing of serially-produced, refillable Type NGV 2 containers intended only for the storage of CNG for vehicle operation. The 2019 revision includes localized fire tests and conformable storage topics. UTD supported participation to lead the Technical Task Force that created the Standard.

Available online at www.csagroup.org. For more information, contact Ted Barnes; tbarnes@gti.energy

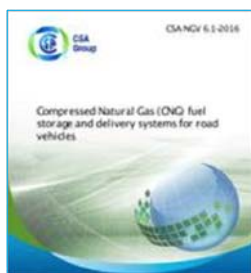
KEY INFORMATION & ANALYTICAL TOOLS (continued)



CSA NGV4.3 NGV Storage and Delivery Standard Technical Committee Support

CSA NGV4.3 issued in 2018 and specifies the performance requirements for temperature compensation control used to prevent compressed natural gas (CNG) dispensing systems from exceeding a safe fill level of vehicle fuel storage container(s). It contains safety performance guidelines and field evaluation methods for existing dispensing systems. UTD supported participation to lead the Technical Task Force that created the Standard.

Available online at www.csagroup.org. For more information, contact Ted Barnes; tbarnes@gti.energy



CSA NGV6.1 NGV Storage and Delivery Standard Technical Committee Support

CSA NGV6.1 was introduced in 2016 and defines the requirements for the balance of systems and equipment onboard a NGV, which is not otherwise defined by NGV1 for the receptacle or NGV2 for the storage containers. UTD supported participation on the Technical Committee.

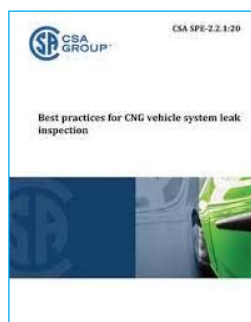
Available online at www.csagroup.org. For more information, contact Ted Barnes; tbarnes@gti.energy



CSA NGV5.1 and NGV5.2 Fueling Appliance Standard Technical Committees Support

CSA NGV5.1 was introduced in 2015 and updated in 2016, and provides mechanical, physical, and electrical requirements for residential fueling appliances (RFAs) that dispense natural gas for NGVs, including indoor and outdoor fueling appliances that connect to residential gas piping. A complimentary standard, NGV5.2 for vehicle fueling appliances (VFAs) in non-residential locations, has been developed and was published in late 2017. UTD supported participation on both of the Technical Committees.

Available online at www.csagroup.org. For more information, contact Ted Barnes; tbarnes@gti.energy



CSA SPE-2.21.1:20 Best Practices for CNG Vehicle System Leak Inspection Standard Technical Committee Support

In 2020, the first edition of CSA SPE-2.21.1 was published. It provided additional specific guidance and best practices to enhance user safety and mitigate potential leaks. Recommendations regarding in-service leak detection, inspection and repair are provided, including leak detection methods. UTD supported participation on the Technical Committee.

Available online at www.csagroup.org. For more information, contact Ted Barnes; tbarnes@gti.energy



Source Energy and Emissions Analysis Tool

The Source Energy and Emissions Analysis Tool (SEEAT) calculates source energy and greenhouse-gas emissions related to point-of-use (site) energy consumption by fuel type for each energy-consuming device. The source-energy and carbon-emission calculation methodology used accounts for primary energy consumption and related emissions for the full fuel cycle for residential and commercial buildings, industrial applications, and light-duty vehicles. SEEAT data is also used in the Energy Planning Analysis Tool (EPAT), a publicly available resource to help end users assess and minimize their total source energy use.

Available online at www.cmictools.com and www.epat.gastechology.org. For more information, contact Erin Bonetti; ebonetti@gti.energy

TECHNOLOGY ADVANCEMENTS



SMTI Gas-fired Absorption Heat Pump for Space Heating and/or Water Heating

A field test of four prototype Gas Absorption Heat Pumps (GAHP) for space heating or water heating applications was successfully completed in WI and TN during 2019 with a prospective manufacturing partner and support from U.S. DOE, UTD and others. Results demonstrated an Annual Fuel Utilization Efficiency of 140% (45% gas savings), ultra-low NO_x emissions of ≤14 ng/J, and continued operation under extreme cold weather conditions in WI during the Jan-Feb 2019 Polar Vortex. Initial production by the developer is anticipated in 2022-23.

Project Manager: Paul Glanville



SMTI Gas-fired Absorption Heat Pump Residential Water Heater

A field test of five prototype units of this efficient residential Gas-Fired Heat Pump Water Heater was successfully completed in Southern California during 2020, with support from CEC, UTD, SoCalGas and a prospective manufacturing partner. The unit has a projected Uniform Energy Factor (UEF) of 1.20-1.30 and ultra-low NO_x emissions of ≤10 ng/J. A significantly larger and wider field test of prototype commercial production units is being evaluated.

Project Manager: Paul Glanville



Ultra-Low NO_x Burner

This innovative firetube boiler technology has more than three years of proven successful operation at a Mission Linen Supply facility in California. It improves efficiency and achieves NO_x emissions below 9 vppm, while avoiding the significant efficiency, capital cost, and/or operating cost penalties if conventional Selective Catalytic Reduction or burner enhancements such as external Flue Gas Recirculation and/or High Excess Air firing were used.

Project Manager: David Cygan



Low NO_x Ribbon Burner System

A new combustion system reduces NO_x emissions by 50% in food processing, thermoforming, and other industrial applications and also saves energy. The system was evaluated in bench-scale, pilot scale, and full-scale production settings and has demonstrated transparent operation at an industrial bakery in California. In 2022, commercialization activities are in progress.

Project Manager: Yaroslav Chudnovsky



FlexCHP High-Efficiency Ultra-Clean Power and Steam Package

This innovative CHP package allows flexible steam production while meeting stringent California emission levels without a SCR system and across the full range of firing rates — achieving NO_x levels 50% below CARB limits. An installation in California operates with 84+% system efficiency and system emissions well below 9 ppm NO_x. UTD has provided long-term support, including efforts to apply the technology to broader application sizes (e.g. to 400 kW / 400 BHP).

Project Manager: David Cygan



Boostheat Thermal Compression Heat Pump

UTD researchers are collaborating with a European developer of a novel high-efficiency thermal compression-based heat pump, to help accelerate its potential introduction into North America. Leveraging global technology developments and partners can speed time to market for new technologies for end users, and help address key North American needs such as optimizing application with forced-air distribution systems, and potential integrated air conditioning capability.

Project Manager: Alex Fridlyand

TECHNOLOGY ADVANCEMENTS (continued)



Gas-Fired Warewasher

A new prototype gas-fired warewasher is being developed in conjunction with a leading OEM. The estimated annual savings for restaurant, cafeteria, and other commercial food service operators is \$1,100-\$9,000 per warewasher (depending on size and type) while also saving energy and chemicals, when compared to electrically-heated warewashers that operate at lower temperature and thus require one-time use and environmental impact of chemicals.

Project Manager: Shawn Scott



Cost-Effective Small-Scale Compressor for Natural Gas Vehicles (NGVs)

A cost-effective small-scale compressor could significantly change the NGV fueling market. With UTD cost share and U.S. DOE funding, GTI and the University of Texas, Austin developed a novel approach using a linear motor with only one moving piston and operated a prototype successfully in the lab. The technology was recently scaled up to 50 SCFM capacity with UTD funding, and other applications (e.g. gas expansion) are being developed.

Project Manager: Jason Stair



On-Demand Heat and Power System

This unique new technology has received a remarkable three rounds of funding from U.S. DOE ARPA-E, along with UTD and other co-funding support. This technology captures and stores renewable energy (or other resources, including waste heat), augments it with natural gas as needed, and delivers heat and power on-demand to commercial, industrial, and other users. In 2021, the technology moved to a pilot field scale-up demonstration in California.

Project Manager: David Cygan



CARB-Compliant Engine-Based Micro-CHP System

UTD researchers are collaborating with the CEC and SoCalGas to advance and commercialize the first-ever engine-based micro-CHP system that complies with California Air Resource Board requirements. This system is offered by a major manufacturer and UTD is demonstrating its application for multi-family building applications.

Project Manager: Tim Kingston



Energy Recovery Heat Exchanger

UTD researchers collaborated with CEC to demonstrate in California an advanced recuperator to increase energy efficiency at an aluminum die casting operation. Test results (independently audited) demonstrated 6-16% energy reduction. A technology transfer plan to introduce this technology from Europe to North America was developed to take next steps.

Project Manager: David Rue



ENERGY STAR® Residential Gas Dryer

UTD worked with a major manufacturer to develop one of the first commercially-available gas-fired ENERGY STAR clothes dryers (included at energystar.gov/products/appliances/clothes_dryers). UTD is currently investigating next-generation technologies and developing an early-stage prototype residential gas dryer to substantially further increase operating efficiency.

Project Manager: Shawn Scott

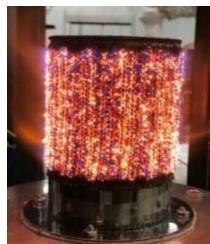
TECHNOLOGY ADVANCEMENTS (continued)



HeatAmp Adsorption Thermal Heat Pump

The product development effort couples a proprietary triple-state sorption technology with a novel product design integration that is expected to yield a family of cost-effective, high-efficiency, robust appliances with few moving parts. Example applications are water heating or combination water/space heating. UTD is helping HeatAmp develop its new product with laboratory testing, validation, design recommendations, and a review of applicable N.A. engineering standards.

Project Manager: Paul Glanville



Ultra-High-Efficiency, Combination Heating/Cooling Vuilleumier Cycle Heat Pump

Vuilleumier cycle-based heat pumps could provide a step-change efficiency improvement over vapor absorption- or compression-based cycles, achieving cooling COP > 1 and heating COP > 2. UTD is working with a leading developer to advance key system components using both computational and experimental analysis, to help achieve performance goals in alpha prototype testing funded by DOE, UTD and others.

Project Manager: Alex Fridlyand



Next Generation Liquid Desiccant-based, Heat-Driven HVAC System

Liquid desiccant-based systems can efficiently remove moisture from air and reduce the amount of mechanical energy and water required by conventional HVAC technologies that de-humidify, condition, and re-humidify space air. In cooperation with NYSERDA and others, UTD is testing a novel new non-corrosive, non-toxic desiccant in a gas-driven system that offers a potential 30% increase in COP on a seasonal basis over conventional HVAC technologies.

Project Manager: Rich Swierczyna



Self-Powered Tankless Water Heater

Tankless water heaters yield higher levels of efficiency than storage-type water heaters but require the added expense of an electrical connection and are susceptible to power outages unless a separate battery back-up system is installed. UTD researchers have assessed leading thermoelectric generator (TEG) technologies, and in 2022 are further analyzing opportunities to economically integrate TEGs and other technologies into a prototype water heater design.

Project Manager: Sandeep Alavandi



Emerging Fuel Cells

UTD researchers are experimentally testing and evaluating several fuel cells that are entering (or exploring entry into) the North American market in order to serve residential and light commercial end users. UTD research is also working to identify and optimize the applications that can maximize the benefit of the high efficiency and reliability of these units.

Project Manager: Tim Kingston



High-Efficiency Gas-Fired Thermal Vacuum Heat Pump for Food Processing

UTD partnered with CEC, SoCalGas, and others to demonstrate an innovative high-efficiency, thermal-vacuum, gas-fired heat pump technology for food drying applications at a commercial food processing company. It has the potential to be about twice as efficient as conventional processes. A prototype system at a field host site generated performance data during 2021. Other applications of this technology for agricultural applications are underway by UTD in 2022.

Project Manager: Yaroslav Chudnovsky

TECHNOLOGY ADVANCEMENTS (continued)



High Efficiency Commercial Clothes Dryer

An advanced natural-gas-fired commercial clothes dryer is being created and demonstrated at laboratory scale that has the potential to save at least 50% of the energy used in the commercial clothes drying sector. It is being developed in partnership with Oak Ridge National Laboratory and others, with financial support from U.S. DOE and UTD.

Project Manager: Yaroslav Chudnovsky



Next Generation Infrared Burner

In partnership with a leading U.S.-based manufacturer, UTD-funded researchers are testing a variety of unique metal foam materials in a laboratory to evaluate their potential performance as next-generation, high-efficiency, rapid-response, low-emission infrared burners that are directly fired with natural gas or renewable natural gas. Field tests are planned.

Project Manager: Sandeep Alavandi



Residential Furnace Retrofit for High-Efficiency Heating and Humidification

Tests of a patented Transport Membrane Humidifier (TMH) technology in four homes in Minnesota demonstrated a 14% increase in furnace efficiency while providing humidification without water supply. Interested licensees should contact Rich Kooy at rich.kooy@utd-co.org.

Project Manager: Dexin Wang



Low NO_x Advanced 3D-Printed Nozzle Burner

A novel design for next-generation retention nozzles leverages new additive manufacturing capabilities and equipment. In 2022, UTD is evaluating applications for boilers, water heating and air heating. Laboratory tests have demonstrated a robust, high-efficiency (3-6% increase), ultra-low emissions burner, with >10:1 turndown. It achieved 50%-75% reduction in NO_x emissions compared to current burners, with the potential to reach <5 ppm NO_x.

Project Manager: Sandeep Alavandi

WORKING WITH PARTNERS TO CO-FUND UTD INITIATIVES

In 2021, each \$1.00 in new UTD funding was leveraged by \$2.8 of direct funding from government and industry partners for related end-use R&D. GTI Energy secured \$9 million from federal and state government partners and \$10 million from manufacturing partners and other gas industry resources (outside of UTD). Manufacturing partners also provided significant additional in-kind co-funding.

Examples include:

- California Energy Commission (CEC) funding of three new projects totaling \$8.0 million. These efforts advance low carbon fuels for industrial applications, new building envelope technologies, and zero emission transportation.
- U.S. Department of Energy (DOE) funding of almost \$1.0 million for advanced space conditioning technologies using novel technologies to achieve very high space heating efficiencies, as well as technical innovations to improve building envelopes.
- Northwest Energy Efficiency Alliance (NEEA) funding of \$0.6 million to demonstrate high-efficiency residential water heating and space conditioning in order to spur market transformation.
- More than \$9.5 million in other gas industry funding for a range of emerging technology efforts aiming to support the commercial readiness of new high-efficiency natural gas technologies.