



gti[®]



Addressing energy from all angles



27th WORLD GAS CONFERENCE WASHINGTON DC JUNE 25-29 2018



2018 annual report

Environmental, social, economic, and technological forces are reshaping the way we think about energy production, transport, and use — in the U.S. and around the globe.



Decarbonization

Concerns about global warming are motivating the transition to low-carbon energy. We have entered a new era of energy abundance in which affordable natural gas supplies have helped reduce emissions from power generation and at the same time offer reliable electric supply, revitalize manufacturing, and radically shift parameters of energy security and geopolitics.



Innovation

Technological innovation continues to upend expectations regarding availability of energy supplies and the impacts of energy consumption on other natural resources. A new wave of innovation—driven by the convergence of automation, artificial intelligence, advanced manufacturing, and big data analytics—will revolutionize the way energy is produced, transported, consumed, and stored.



Energy access and consumption

Globally, we will need more energy as population growth, urbanization, and advances in standards of living worldwide drive greater demand. As developing countries around the globe are gaining greater access to energy, they are also learning to manage their carbon footprint as they use the energy resources most accessible, clean, and affordable to them. Increasingly, the goals of energy affordability and sustainability can be met with common solutions.



To shape solutions that meet the world’s growing energy needs, GTI is addressing energy from all angles. We are considering all aspects—environmental, social, economic, and technological—as we develop next-generation innovations for safe, efficient, and responsible energy.

GTI has a solid business foundation and we continue to flourish with substantial revenue growth and new business contracts from a diverse portfolio of technologies and clients.

We have executed groundbreaking projects internationally while maintaining a solid safety record. Continuing an upward trend, our intellectual property portfolio added 14 new U.S. patents and 48 new foreign patents in 2018. Our overall customer service satisfaction rating and Net Promoter Score® (NPS) is top tier. GTI remains focused on assisting our customers in achieving their business strategies and providing the tools and technology pathways for governments to achieve their policy objectives.

We are very proud of the work performed by our dedicated and talented team that is advancing energy technology development and commercialization around the globe. We are building on our deep expertise in unconventional gas, energy conversion, natural gas delivery, and utilization. GTI is growing our energy efficiency business, expanding our alternative transportation portfolio, and increasing capabilities in renewables, hydrogen, and low-carbon fuels.

GTI’s multi-faceted technology-based solutions are expediting a managed carbon future, enabling our customers’ continued success, creating savings for consumers, and addressing climate change concerns.

This report captures examples of GTI’s innovative and viable technology approaches that we think will have a meaningful impact on how energy is produced and consumed in the coming decade.



*David Carroll
President and CEO*



*Bret Lane
Chairman of the Board*

Efficient and Responsible Production

Unlocking abundant shale gas resources cost-effectively. Lowering production costs. Minimizing environmental footprint of unconventional gas. Managing produced water.



Maximizing efficiency and increasing production in an environmentally responsible way

GTI is performing cost-shared research and development on hydraulic fracturing efficiency at a second Permian Basin field test with funding from the U.S. Department of Energy National Energy Technology Laboratory (DOE-NETL). Multiple experiments to evaluate well completion, optimize design, and quantify environmental impact will be carried out at HFTS2–Delaware. Work began in late 2018 at an Anadarko Petroleum Corporation-operated location with co-host Shell Exploration and Production Company. Twelve other industry partners have been secured, and others are invited to join the project.

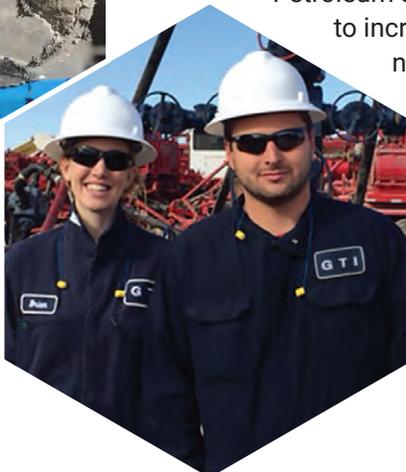


This second field test site follows HFTS1 in the Wolfcamp formation of the Midland portion of the Permian Basin. A first-of-a-kind through-fracture core sample from HFTS1–Midland documents the physical properties of hydraulic fractures and provided comprehensive data for understanding fractures, validating and developing models, and assessing how predictive analytics can improve the process. Air and water samples were taken to evaluate environmental impacts.



Phase 2 of HFTS1–Midland, currently underway at the Laredo Petroleum site, is exploring enhanced oil recovery (EOR) to increase production yields. This would reduce the number of wells that need to be drilled, leaving a smaller environmental footprint.

By optimizing well spacing, fewer wells are needed to increase resource recovery while reducing the environmental footprint of production



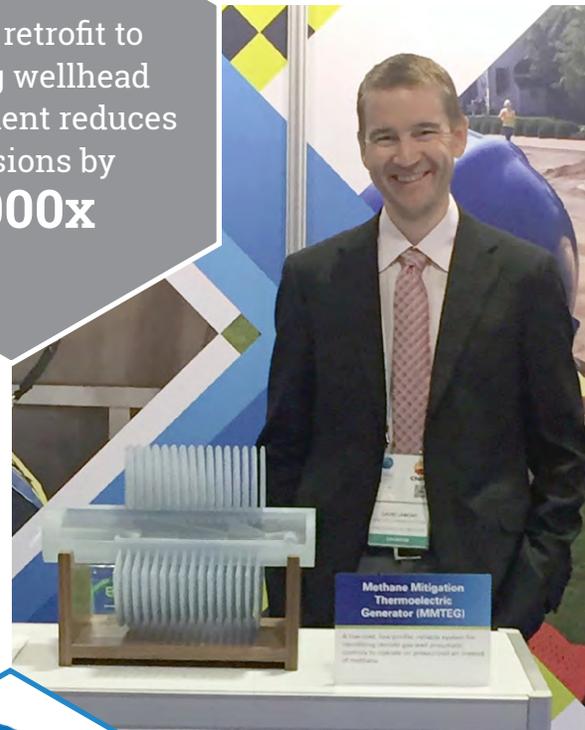
Mitigating methane emissions in oil and gas field operations

With DOE funding, GTI and Jet Propulsion Laboratory are developing and testing an integrated thermoelectric generator burner system for oil and gas field operations. The thermoelectric generator will provide power to compress air—instead of natural gas—that is used to operate the pneumatic controllers, resulting in greatly reduced methane emissions. Initial experiments to simulate heat transfer to the thermoelectric generators have been completed. Preparations are underway for integrated system testing in advance of testing in the field.

Delivering transparent data to evaluate the most effective methane emissions reduction strategies

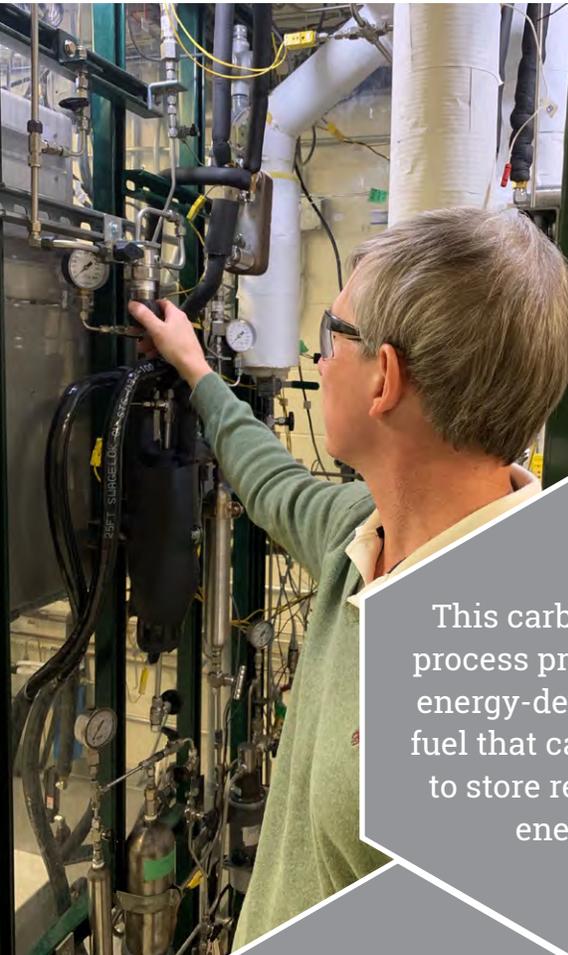
GTI was selected to serve as the program administrator for a new industry-led collaborative research consortium named the Collaboratory for Advancing Methane Science (CAMS). The consortium, established by leading industry companies Cheniere, Chevron, Equinor, ExxonMobil, and Pioneer Natural Resources, will work to advance methane science to better understand global natural gas methane emissions and the need for additional solutions. CAMS will pursue studies addressing methane emissions along the natural gas value chain, from production through end use, and deliver factual data to help stakeholders identify the most effective reduction strategies. The first research project was awarded to the University of Texas-Austin to develop an open access oil and gas operations emission calculator.

Simple retrofit to existing wellhead arrangement reduces emissions by **1,000x**



Carbon Capture and Use

Developing energy efficient processes. Mitigating emissions. Reducing capital and operating expenses. Offsetting costs for CO₂ capture. Enabling wider scale commercial deployment of CO₂ capture. Utilizing CO₂ for valuable products.



This carbon reuse process produces an energy-dense liquid fuel that can be used to store renewable energy

Beneficial uses for CO₂ that help offset the cost of its capture



Cool GTL—a low-cost system for converting CO₂-rich gas to fungible liquids

GTI is leading a team on a DOE project to build and operate a Cool GTL demonstration unit that converts CO₂-containing biogas to biojet fuels efficiently and affordably. The process integrates a new lower-temperature gas reforming process (cool reforming) with a novel Fischer-Tropsch (F-T) reactor and can also be used with natural gas.

Creating DME from hydrogen, CO₂, and water to store and transport renewable energy

GTI is working on an Advanced Research Projects Agency-Energy (ARPA-E) project to develop a catalytic membrane reactor for synthesis of diesel fuel substitute dimethyl ether (DME) from hydrogen, CO₂, and water. This carbon reuse process takes captured carbon dioxide and combines it with hydrogen to produce an energy-dense liquid fuel that is compatible with the pipeline infrastructure and end-use devices. The liquid fuel can then be used to store renewable energy that is easily transportable via pipeline or truck to sites with the greatest demand. Next steps are to build a prototype at a scale of 1 kg/day for long-term testing of fuel production.

Dry reforming of methane to produce syngas and reduce CO₂ emissions

A dry reforming process under development will utilize CO₂ captured from fossil resources for fuels and chemical synthesis. In the process, a novel nano-engineered catalyst on hollow fiber tubes will create a compact reactor to produce syngas from methane. Laboratory-scale research to demonstrate proof of concept is underway. This effort is focused on reducing emissions while developing beneficial uses for CO₂ that can offset increases in the cost of electricity due to the need for carbon capture.



Converting CO₂ and natural gas to liquid fuels

A new reformer process can take CO₂-laden natural gas and convert it to precisely proportioned hydrogen and carbon for optimal liquids production. This process is free of any emissions because all CO₂ captured is reused and incorporated into liquid fuel. GTI has completed 500 hours of bench-scale reformer testing which showed excellent catalyst stability to directly produce synthesis gas with a 2:1 H₂ to CO ratio.

New reformer process promises **35%** lower cost than today's standard technology

Producing hydrogen with inherent CO₂ separation

GTI's compact hydrogen generator technology is being refined in a project funded by DOE. It is used for production of hydrogen and significantly reduces the cost of CO₂ capture. The pilot plant, which will be located at GTI's 18-acre headquarters in metro Chicago, will perform testing to demonstrate higher purity hydrogen production at a 20% lower cost than conventional steam methane reforming methods.



Novel integrated hardware + advanced solvents = economically viable carbon capture system for flue gas

Next-generation lower-cost carbon capture technology

With funding from the DOE Office of Fossil Energy, GTI and Carbon Clean Solutions USA Inc. (CCSUS) are developing and testing a potentially transformational carbon capture technology for power generation. ROTA-CAP is a scalable, integrated system that could provide a major reduction in both capital cost and equipment size, enabling wider-scale commercial deployment of carbon capture systems. It works by using novel horizontal rotating packed beds (RPBs) and advanced solvents to intensify the CO₂ capture process.

Low-Carbon Fuels and Chemicals

Increasing efficiency. Lowering capital, operations, and maintenance costs. Process optimization. Converting low-cost and renewable resources into valuable end products. Managed carbon footprint.



Breakthrough gasification technology to provide significant economic and environmental benefits in China

GTI is maturing a compact gasification technology for coal conversion to liquid fuels and chemicals, as well as power generation.

Construction of the R-GAS™ demonstration project with Global Fortune 500 company partner Yangquan Coal Group, located at the largest coal-to-chemicals plant in Shanxi Province, is advancing towards commissioning scheduled to begin by the end of the year. GTI's innovative R-GAS process has been proven to achieve >99% carbon conversion, even with the low-rank anthracitic coal common in China.

R-GAS™ consumes up to **30%** less water, minimizing environmental impact

Capital expenditures ~**15–25%** lower than the most economical entrained flow technology



Quantifying the opportunity to produce low-carbon renewable natural gas (RNG) from wood wastes

GTI led a team of engineers and scientists to produce a blueprint for converting an existing biomass power plant in Stockton, California, into an RNG production site, using the wood waste feedstock and some of the existing infrastructure. In addition to providing data about the process technologies, the integrated plant, and production costs, the study highlights the many environmental benefits and confirms the ability to produce large quantities of low-carbon RNG for use in all energy sectors.

The engineering design study, *Low-Carbon Renewable Natural Gas (RNG) from Wood Wastes*, was funded by several West Coast utilities, California Air Resources Board, and the Sacramento Municipal Utility District to better understand the value, benefits, and cost of utilizing wood wastes to reduce greenhouse gas emissions.

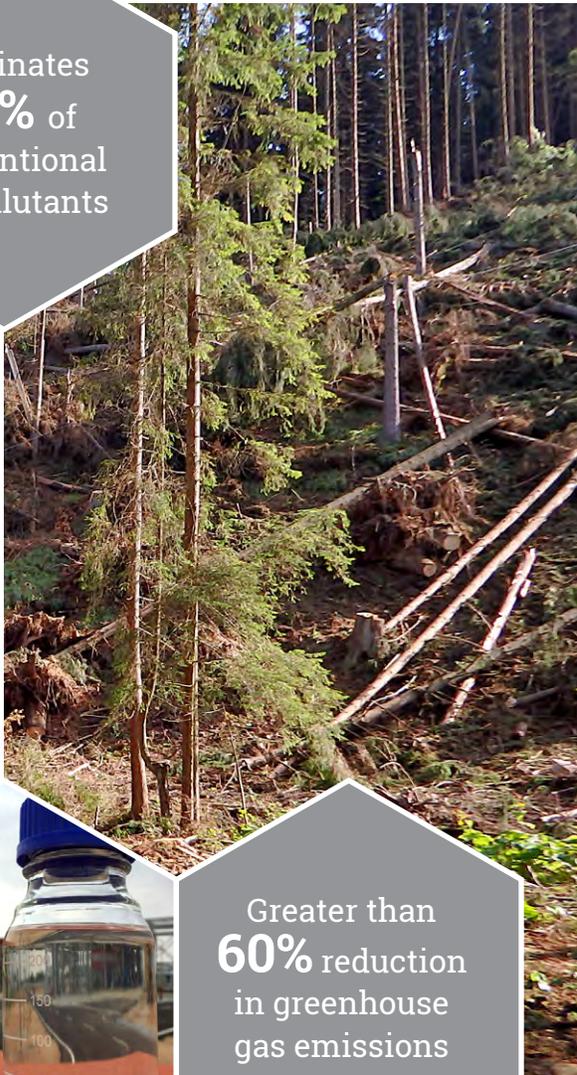
One integrated RNG production plant

could displace ~170,000 tons

of CO₂ vehicle emissions per year

equaling the emissions from 400 million vehicle miles

Eliminates 99% of conventional air pollutants



Producing transportation fuels from renewable resources

Test operations of the 5 TPD IH²® process demonstration plant continued at the new Shell India Markets Pvt Ltd (SIMPL) Technology Center in Bangalore, India, converting municipal and agriculture wastes into liquid transport fuel.

GTI invented, tested, and patented the fully integrated IH²® technology, a catalytic thermochemical process that converts non-food biomass feedstocks—such as wood, agricultural residues, algae, aquatic plants, and municipal waste—directly into gasoline, jet, and diesel drop-in transportation fuels. GTI researchers are providing ongoing technical and commercialization support at GTI's IH²® process pilot plant in Des Plaines as well as the Bangalore site.

Shell Catalysts and Technologies (formerly CRI Catalyst Company) is the exclusive worldwide licensor for the IH²® technology. Ten U.S. and 90 international patents have been awarded on this technology.



Greater than 60% reduction in greenhouse gas emissions



Advanced Power Generation Cycles

Lowering emissions profile. Increasing industrial efficiency.
Significantly reducing size to create a compact footprint.



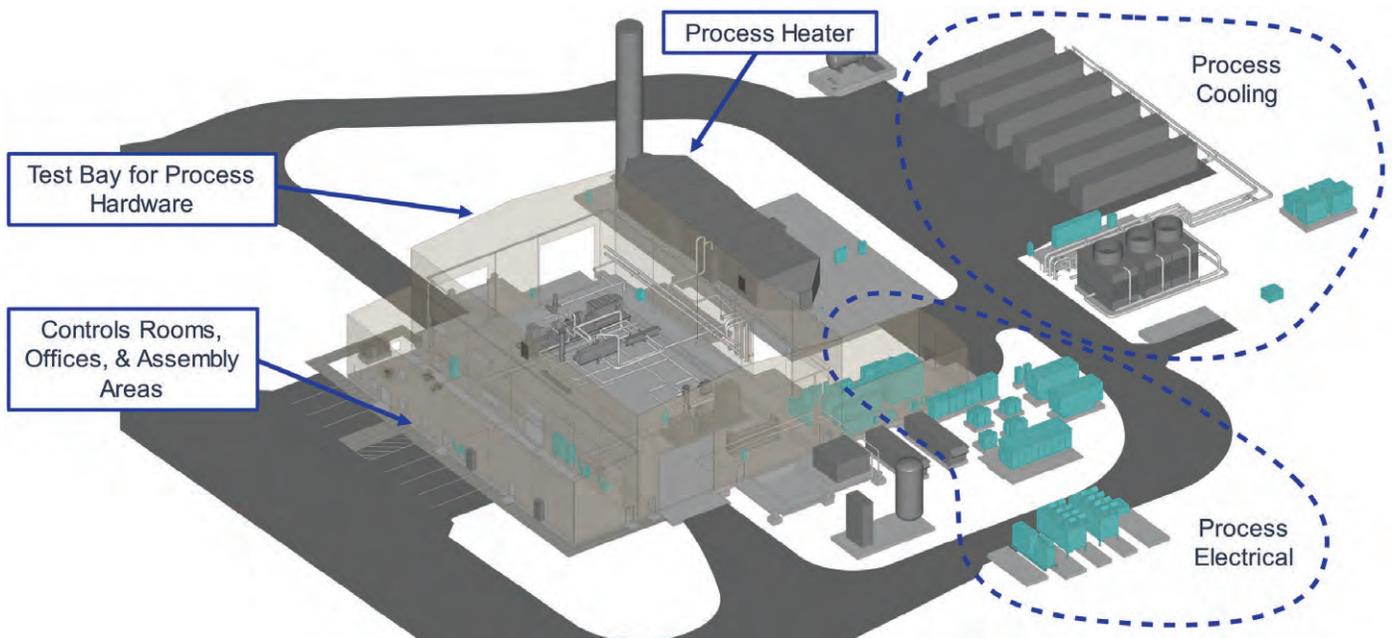
Breakthrough clean, compact, and high-efficiency sCO₂ technology to lower costs and reduce emissions

Revolutionizing future power generation

With DOE-NETL funding, GTI, leading a team including Southwest Research Institute, General Electric Global Research, and partners Korea Electric Power Company, National Resources Canada, Southern Company and American Electric Power, broke ground on the 10 Megawatt-electric supercritical CO₂ pilot power plant located in San Antonio, TX.

This first-of-a-kind pilot power plant will demonstrate a fully integrated functional electricity generating power plant using transformational sCO₂-based power cycle technology with dramatically improved efficiencies, economics, and environmental performance. Industrial waste heat recovery is an attractive application as well.

The demonstration plant will be among the largest demonstration facilities for sCO₂ technology in the world.



Improving power generation energy savings with heat and water recovery

GTI's patented Transport Membrane Condenser (TMC) technology can recover water vapor from high moisture content flue gas and add it to the boiler feed water loop to replace costly fresh makeup water and improve energy efficiency in power generation. With funding from DOE-NETL and utility partners, testing in conjunction with oxy-combustion systems has demonstrated that recovered waste heat can boost boiler system efficiency by up to 14%. Additionally, flue gas water vapor volume percent was reduced from 50% to below 1%, facilitating lower-cost CO₂ capture and compression.

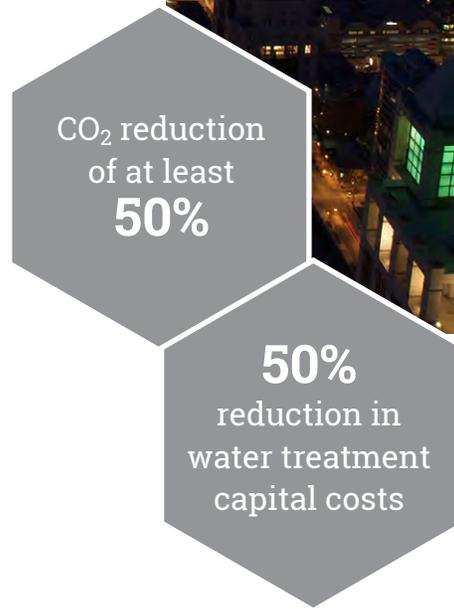
Decarbonizing natural gas and producing electricity and hydrogen

A hydrogen-to-power project, funded by DOE, will create a modular heat engine for the direct conversion of natural gas to hydrogen and power with intrinsic CO₂ separation, combining hydrogen produced from GTI's compact hydrogen generator (CHG) with a turbine. The modular system can be used for distributed power generation and units may be grouped together for added capacity. It also has far-reaching applications in the oil and gas, transportation, and agriculture sectors.

GTI initiated the project in 2018 and secured key partners Pacific Gas & Electric, Siemens, and Southern Company to advance the technology toward construction of piloting and demonstration.

Testing a co-generation wastewater treatment system

GTI is leveraging our expertise in the re-use of produced water in a DOE Fossil Energy project to demonstrate a 12 Megawatt-thermal co-generation wastewater treatment system to treat flue gas desulfurization (FGD) wastewater. The system produces steam for auxiliary power production while filtering out contaminants. The technology also has application for the purification of produced water in unconventional oil and gas production. It would use associated gas to produce power while separating and concentrating brines to enable reuse of the cleaned produced water.



Delivery

Improving natural gas infrastructure safety. Enhancing reliability and resiliency of natural gas systems. Reducing risk to people and property. Addressing global climate change concerns.



Enhancing gas customer safety

With Operations Technology Development (OTD) funding, GTI's research team partnered with OPW to create an award-winning breakaway disconnect/shut-off fitting safety device. It is intended to protect above ground meter set assemblies (MSAs) against damage from outside forces such as vehicular damage or snow and ice falling from building roofs. The technology received a National Association of Regulatory Utility Commissioners (NARUC) Natural Gas Innovation Award in November 2018.

GTI completed a major field testing program on off-the-shelf residential methane detectors (RMDs) to evaluate their performance in a variety of residential settings. The exhaustive testing and benchmarking provided a better understanding of accuracy of detection levels, airborne chemical interference, and hurdles to home deployment. Results led to the launch of a significant field trial effort in New York City by ConEd to augment existing safety programs and add another layer of protection for the detection of leaks.

Creating advanced tools to help operators predict asset performance, calculate system risk, maximize safety, and optimize investment

GTI developed a sophisticated multi-dimensional risk assessment tool for underground gas storage assets, and deployed it on WEC/Peoples Gas' Manlove underground natural gas storage facility.

In addition, GTI researchers are reviewing quantitative risk assessment methods for LNG operations, as well as performing gap analysis on LNG process safety management standards and regulatory requirements.

Numerous new projects underway with U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (DOT PHMSA) support will focus on pipeline threat and leak prevention as well as anomaly detection characterization.



Methane emissions: insights, measuring, monitoring, and mitigating

The fifth annual CH₄ Connections conference in late September 2018 shared the latest research and insights on natural gas emissions. Presented by GTI and the Energy Institute at Colorado State University, the event featured presentations and panel discussions on the key issues and innovative solutions under development, in testing, or in use by gas utilities across the U.S.

GTI's research team is continually developing new tools and evaluating new technologies to stay at the forefront of market innovations. A methane emissions monitoring tool, which creates a wireless network of sensors intended to provide full situational awareness of the location and concentration of leaks at multiple points via smart-phone or tablet, was developed by GTI with support from OTD. SENSIT Technologies has licensed the technology to bring it to market. Field testing and demonstrations are underway with first responders, and a utility measurement use case is assessing semi-permanent, longer-range wireless access to monitor leaks over time.

GTI has extensive experience measuring and quantifying methane emissions from a variety of facilities, from underground pipelines to gas meters. A project to evaluate and field demonstrate stationary continuous methane emissions monitoring systems for potential use at facilities such as compressor stations, terminals, gas storage facilities, city gates, and metering and regulating (M&R) stations began late in the year.



Delivery

Improving safety. Integrating artificial intelligence, communications within the Internet of Things (IoT), and other leading-edge technologies. Facilitating the use of renewable resources. Lowering carbon footprint.



Leveraging information technology tools to help utilities effectively manage and improve day-to-day operations

GTI's solution-based focus helps operators collect the right information, in real time, with a high level of accuracy. We incorporate state-of-the-art technologies to collect high-quality data that supports risk analysis to drive effective organizational decision-making.

Tools intended to provide advanced warning and improved accuracy to locate and identify potential underground conflicts and third-party damage are being developed and commercialized. A cutting-edge excavation encroachment notification (EEN) system was developed to allow real-time feedback and alerts during digging activity is being commercialized and will be marketed as UtilAlert™ by Hydromax USA, LLC.

Smart Pole Technology is an automated system to capture high-accuracy Global Navigation Satellite Systems (GNSS) locating data. The GNSS smart automation (GSA) equipment developed by GTI with OTD support promises a dramatic reduction in operator errors in the field data collection process. A second phase is underway, working closely with a number of utilities on field demonstrations and technology enhancements as the hardware is being optimized for the marketplace.

Fostering the introduction of renewable gas into the natural gas infrastructure

Blending renewable resources into our energy supply mix will help to lower carbon footprint and build a renewable portfolio, but knowing their effects on pipeline materials is important for maintaining a safe and reliable distribution network. GTI has completed in-depth hydrogen blend studies for a consortium of natural gas operators and National Renewable Energy Laboratory (NREL). These projects focused on the life cycle assessment of hydrogen blending as well as the safety, leakage, durability, integrity, and environmental impacts. Researchers are also looking at the impact of hydrogen blends on end use equipment.

Sponsored by the Northeast Gas Association, GTI developed an interconnect guidance document for introducing renewable natural gas (RNG) into the natural gas distribution pipeline network in New York State. The user-friendly technical framework provides critical information to help reduce overall operational risk for both the developer and pipeline operator, thereby minimizing potential impacts to consumers.

Energy Efficiency

Efficiently using natural gas. Achieving greenhouse gas emission reductions. Lowering operations costs. Saving consumers money. Meeting future CO₂ reduction goals for residential and commercial buildings.



Bringing high-efficiency, low-cost technology for space conditioning and water heating systems to homes and businesses

GTI is supporting the development of a family of residential and light commercial thermally-driven gas heat pump technologies for high-efficiency water heating (GHPWH) and combined space and water heating systems.

They are being integrated into homes and businesses to lower energy consumption, reduce energy costs, and minimize environmental footprint.

Collaborating with several start-up companies, HVAC and heating equipment manufacturers, and university partners, GTI is leading numerous development efforts and field trials across the country, with funding support from DOE, California Energy Commission, Utilization Technology Development (UTD), Southern California Gas Company (SoCal Gas), and other utilities and partners. These demonstrations verify equipment durability and performance and provide consumers with knowledge and confidence to buy.

Updating codes and standards to optimize building performance, lower the amount of energy consumed, reduce costs, and minimize environmental impacts

GTI International (GTII) subsidiary Frontier Energy is highly knowledgeable about energy efficiency and building systems, and has been active in California Title 20 and Title 24 codes and standards activities for over 20 years. The Frontier Energy team has completed code revisions for the 2019 Energy Code in the California State Building Codes (Title 24, Part 6) slated to go into effect on January 1, 2020 to reduce energy use and move towards Zero Net Energy (ZNE) ready residential new construction in 2020. In addition, the team won the contract for revising the 2022 Energy Code for single-family housing.

Frontier Energy is also working on a multi-year contract from Sonoma Clean Power to demonstrate and deploy cutting-edge energy technologies such as phase change materials, radiant heating and cooling ceiling panels, or mini-split heat pumps in single-family homes. The team recruited its first 14 demonstration sites, which is paving the way for ongoing technology demonstration and deployment activities.

GHPWH
estimated Uniform
Energy Factor (UEF)
is more than
2x standard
gas water
heaters



GHPWH lowest
operating cost and
cost of ownership,
50% energy
savings



Energy Efficiency

Efficiently using natural gas. Achieving greenhouse gas emission reductions. Lowering operations costs. Saving consumers money. Meeting future CO₂ reduction goals for residential and commercial buildings.



51%
gas savings,
41% electricity
savings, and **81%**
water savings

Developing and deploying advanced cost-effective and efficient energy solutions for buildings, onsite generation, and resilience for DoD

GTI initiatives aim to help the Department of Defense (DoD) reduce their need for facility energy, while also enhancing onsite energy reliability and resilience. A side-by-side assessment of a gas engine heat pump (GHP) and electric cold climate heat pump for heating/cooling compared to an existing conventional HVAC system is underway at Naval Station Great Lakes. At Garrison Presidio of Monterey, the demonstration of a high-efficiency commercial food service dish machine produced noteworthy results including 51% gas savings, 41% electricity savings, and 81% water savings.

GTI received new contracts to undertake additional multi-phase RD&D projects at DoD facilities in Illinois and Mississippi. A comprehensive slate of emerging technologies using higher efficiency cycles, improved controls, energy recovery, and other enhancements are being evaluated for their ability to cost-effectively reduce energy use and improve energy resilience. The equipment includes combined heat and power or distributed power generation, hybrid non-condensing/condensing boilers, destratification fans, and similar hardware.

Creating a suite of high-efficiency natural gas commercial foodservice equipment and appliances

In conjunction with gas industry partners, the California Energy Commission, and others, GTI is working to creating a suite of higher-efficiency natural gas appliances for commercial kitchens that improve cooking performance, cost, and emissions. Technology innovations being funded by UTD are exploring new burner materials such as metal mesh and metal foam for replacing standard drilled or punched port burners. Researchers are converting standard atmospheric burners to power burners for better control of air-to-fuel ratios and improved efficiency and emissions. In a California initiative, low-flow rinse valves are being tested for more efficient use of water in dish machine cleaning and rinsing to conserve this critical natural resource. More efficient and better insulated burner designs are being tested in a wok to eliminate the need for cooling water.

Delivering quantitative data to support natural gas standby and emergency generators

GTI, along with UTD, OTD, the American Gas Association (AGA), and other market players, is working to ensure natural gas service reliability is properly incorporated into emergency and standby power supply codes and standards through technical studies and interactions with industry associations.

One example is the GTI report on assessment of natural gas and electric distribution service reliability. It analyzes factual data and presents quantified metrics that illustrate that natural gas distribution systems are resilient and operate at exceptional levels of service, particularly during extreme weather events and other major grid disruptions. GTI also worked with Generac, a major generator set manufacturer, to create a total cost of ownership calculator tool—www.generatorTCO.com—to help customers looking at onsite standby generators make a decision.

Exploring residential natural gas and electrification scenarios in leading low-CO₂ regions

GTI received an Innovation Award at the World Gas Conference 2018 for development of the Energy Planning Analysis Tool (EPAT) and complementary paper comparing direct gas use and electrification in California and New York. The publicly available EPAT software provides regional U.S. estimates of site and full-cycle energy consumption, as well as capital and operating costs, for a wide range of residential energy applications and full-cycle emissions. It allows the user to pair technologies and compare home energy baseline and alternative use scenarios.

Eliminating barriers to market entry by validating performance, efficiency, and reliability of new natural gas equipment

Nicor Gas renewed a multi-year agreement for GTI to provide program support and implementation of the emerging technology program component of their overall energy efficiency program. GTI helps identify and bring to market new products and processes that could be rolled into Nicor's program and then made available to their customers for rebates and/or incentives.

With 26 North American company participants, GTI's Emerging Technology Program (ETP) enables the validation and successful commercialization of promising new natural gas technologies.



Alternative Transportation

Creating sustainable alternative vehicles and fueling stations.
Lowering costs. Improving air quality. Increasing the efficiency of vehicle fueling. Fostering the adoption of NGVs. Driving increased use of renewable natural gas.



Deploying FAST TRACK hybrid heavy-duty trucks

The California Air Resources Board (CARB) awarded GTI and team a project for the rapid deployment of fuel cell/electric hybrid trucks in Southern California at the Port of Los Angeles and the San Diego region. This project will help provide performance data and analysis to assess the impact of zero-emission Class 8 trucks on local air quality in the test regions. These trucks are scheduled to enter daily operational service in California in 2019.

Developing a heavy-duty hybrid electric cargo transport (HECT) truck

GTI is leading a project to design and demonstrate a heavy-duty hybrid truck that combines an electric vehicle with a near-zero compressed natural gas (CNG) engine to extend its range. Extensive operational testing of the HECT truck is underway.

End users, support staff, and first responders were trained and the truck is in service at the ports of Los Angeles and Long Beach. Support for the project has been provided by the DOE Office of Energy Efficiency and Renewable Energy (EERE), South Coast Air Quality Management District (SCAQMD), and SoCal Gas.

Improving cost and efficiency of hydrogen vehicle fueling infrastructure with a free-piston expander

DOE is providing funding to GTI to develop a new technology to drastically improve the cost and efficiency of hydrogen vehicle fueling infrastructure. The free-piston expander for hydrogen cooling counteracts heating effects that occur when fuel cell vehicles are fueled. The expander approach is expected to result in substantial capital and operating cost savings compared to conventional pre-cooling technologies. Low maintenance cost is also a key benefit of this technology as there is only one moving part.



Achieving a full NGV fill with an advanced dispensing system

GTI developed an advanced compressed natural gas (CNG) dispensing system that was shown to safely and accurately achieves full natural gas vehicle (NGV) fills, especially for large-capacity trucks and buses. These improvements increase the range and safety of natural gas vehicles, while minimizing the cost and weight. Funding for the project is being provided by the California Energy Commission with support from UTD and SoCal Gas. Initial technology development was completed and steps are underway to move towards commercialization.



Creating a sustainable alternative fuel corridor

In the Michigan to Montana (M2M) Corridor project along I-94, GTI is building community-based partnerships and providing leadership to create a successful and sustainable alternative fuel corridor for clean vehicles. With a nearly \$5 million award from DOE and \$15 million in partner support, GTI worked with Clean Cities Coalitions and other industry leaders to facilitate the deployment of new electric charger, CNG, and propane fueling stations and accelerate the adoption of alternative fuel vehicles (AFVs). In addition, training is being provided to critical stakeholders to establish a sustainable market and continue growth beyond the project's end.



Leading market introduction of fuel cell vehicles and hydrogen stations in California

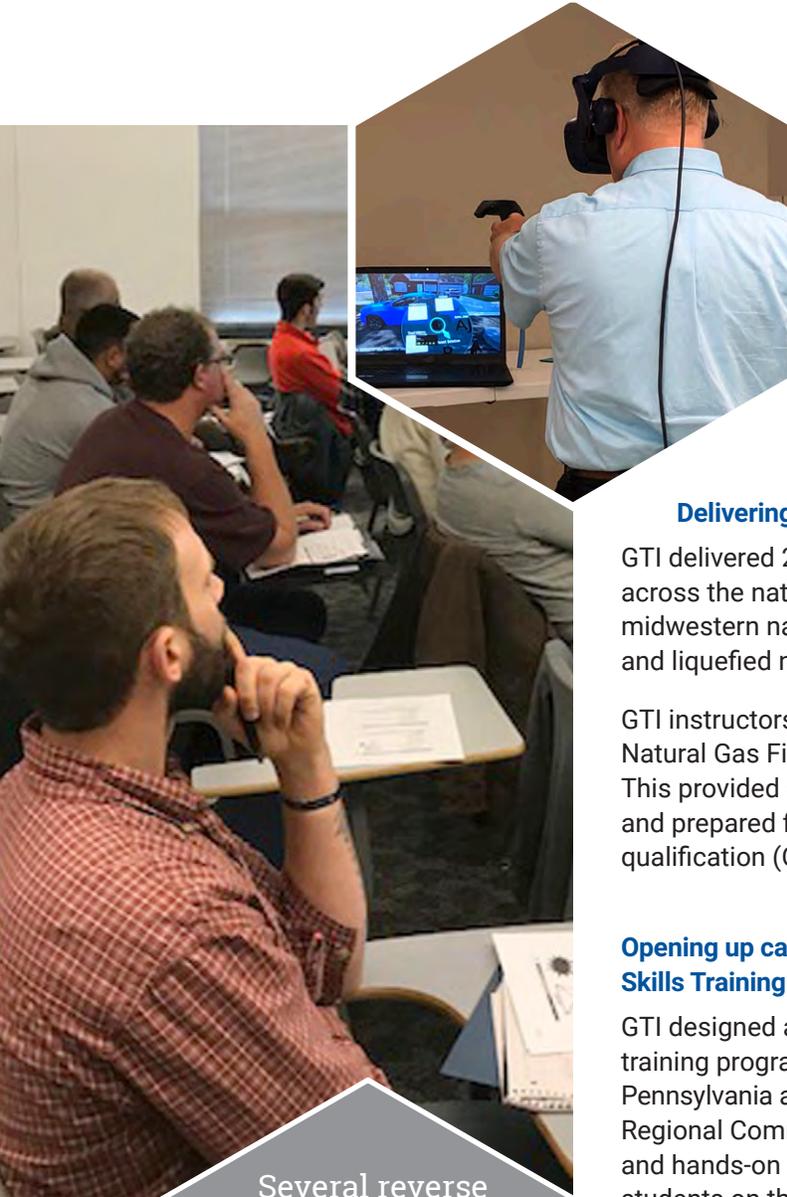
The California Fuel Cell Partnership (CaFCP) is a public-private collaborative focused on bringing fuel cell electric vehicles (FCEVs) powered by hydrogen to the commercial market and creating a sustainable future for zero-emission cars, trucks, and buses in the state.

Frontier Energy is spearheading a Regional Zero Emission Vehicle (ZEV) Strategy with Sacramento Metro Air Quality Management District (AQMD), along with developing a Sacramento Electric Vehicle (EV) Blueprint to define code changes, incentives, and strategies to encourage adoption of 75,000 zero-emission vehicles in the city by 2025. The Frontier Energy team is also working with GTI on fuel cell truck pilot projects.



GTII subsidiary Frontier Energy has managed the California Fuel Cell Partnership (CaFCP) since inception 20 years ago

Training and Events



Developing virtual reality (VR) training for emergency natural gas leak response

GTI is working with PIXO VR to develop VR training for first responders to natural gas leak calls. To improve emergency response effectiveness and coordination, trainees will search through a fully immersive 3D simulation of a residential neighborhood to find and respond to a natural gas leak. Development is being funded by OTD and it will be available in July 2019.

Delivering onsite training across the U.S.

GTI delivered 24 onsite transmission and distribution courses at utilities across the nation, including the creation of a customized course for a midwestern natural gas utility tailored to their specific needs in underground and liquefied natural gas (LNG) storage.

GTI instructors went onsite to train students on specific tasks from the Natural Gas Field Skills Training modules at two east coast organizations. This provided a consistent approach to safety, quality, and compliance, and prepared field workers to meet regulatory requirements for operator qualification (OQ) assessments.

Opening up career opportunities with Natural Gas Utility and Pipeline Field Skills Training Program

GTI designed and implemented a targeted “From Black to Blue” field skills training program, presenting eight classes to students in southwestern Pennsylvania and southeastern Ohio. Funded by a grant from the Appalachian Regional Commission (ARC), it included four weeks of blended classroom and hands-on sessions, with a graduation celebration and job fair for students on the final day.

The pre-employment training program introduced individuals to natural gas utility and pipeline operations careers and enabled them to become stronger job candidates. It also helped to build public awareness of opportunities in the energy industry. GTI is now working to bring the performance-based skills training model to local training venues across the country.

Several reverse trade missions organized by GTI introduced foreign delegates to product and service providers across the nation

Financial and Business Overview

GTI solves important energy challenges, turning raw technology into practical solutions that create exceptional value for our customers in the global marketplace.

Our Values

Safety: Nothing is more important than the safety of our employees and our customers.

People: We provide opportunities and a stimulating environment for creative employees to learn, grow, and make a difference.

Integrity: We obey the law and conduct business in a straightforward, transparent manner.

Teamwork: GTI's ultimate success depends on our ability to work together in a manner that delights our customers.

Quality: We have an obligation to our customers to deliver the very best product GTI can provide.

Market Focus: We must bring solutions to customers that enable their continued success.

Subsidiaries



On January 1, 2018, CDH Energy in Cazenovia, New York and Frontier Associates in Austin, Texas were merged into Frontier Energy. With the addition of these two locations, Frontier Energy, a subsidiary of GTII, now has

seven U.S. offices and more than 110 employees that provide professional services in energy efficiency, market transformation, and advanced transportation.



LocusView Solutions (LVS), another wholly owned subsidiary of GTII, was sold to NortecView, Ltd. effective January 1, 2018. The LVS start-up was

launched in 2014 to help bring advanced commercial-scale mobile geospatial products and services to natural gas operators, leveraging technology developed with industry support. NortecView is a software company and long-standing partner that developed the mobile application platform utilized by LVS. This positions the team to accelerate the pace of product development and rapidly scale deployment of the technology throughout the U.S.

2018 Financials

In Millions

Project Revenue	\$ 131.9
Royalty/Other Revenue	\$ 5.6
Total Revenue	<u>\$137.5</u>
Total Assets	\$ 131.2
Total Liabilities	\$ 46.5
Net Assets–Unrestricted	<u>\$ 84.7</u>



GTI Offices

- Des Plaines, IL
- Washington, DC
- Woodland Hills, CA
- Davis, CA

Frontier Energy Offices

- Austin, TX
- Cazenovia, NY
- Davis, CA
- Los Angeles, CA
- Oakland, CA
- San Ramon, CA
- West Sacramento, CA

Rebuilding and reinvigorating our team

Across the enterprise,
34 new employees
were hired, adding up
to a staff of **365+**
employees at the
end of 2018



GTI's Board of Directors regrouped in mid-2018 when Terry McCallister stepped down from his role as Chair in conjunction with his retirement as Chairman and CEO, WGL Holdings, Inc. and Washington Gas. Bret Lane, Chairman and CEO, Southern California Gas Company, was elected to serve as GTI's Chair, and Rebecca Ranich, President, Exenico LLC, was re-affirmed for Vice Chair.

Coming off the loss of our dear colleague Eddie Johnston, GTI's Senior Vice President of Research and Technology Development, late in the year, we have rebuilt our senior leadership. In early 2019, we added new officers to our executive team. Two well-respected industry leaders with deep experience have joined GTI—Dr. Paula Gant took on a new position as Senior Vice President, Corporate Strategy and Innovation, and Michael Rutkowski came on board to fill the role of Senior Vice President, Research and Technology Development. In addition, Quinton Ford was promoted to Vice President, General Counsel and Secretary.

GTI is reinvigorating our workforce, adding key talent at all levels and developing our existing team with critical training to enhance their skill sets and prepare them for career advancement opportunities.

Leadership

Executive Team

- David C. Carroll, President and CEO
- Quinton B. Ford, Vice President, General Counsel and Secretary
- Dr. Paula A. Gant, Senior Vice President, Corporate Strategy and Innovation
- James F. Ingold, Senior Vice President of Finance, Treasurer, and CFO
- Michael A. Rutkowski, Senior Vice President, Research and Technology Development
- Ronald N. Snedic, Senior Vice President, Corporate Development and President, GTI International

Business Leaders

- Vann Bush, Vice President, Technology Development and Commercialization
- Richard M. Kaelin, Vice President, Government Affairs
- Neil Leslie, Senior Director, Utilization
- Anthony T. Lindsay, Managing Director, Delivery
- William E. Liss, Vice President, Managing Director, Delivery and Utilization
- Jeremy M. Otahal, Executive Director, Education/Training and Human Resources
- Kent F. Perry, Executive Director, Supply
- Rodney C. Rinholm, Executive Director, International Business
- Donald S. Stevenson, Vice President, Managing Director, Supply and Conversion
- Larry Brand, President, Frontier Energy, Inc.

Board of Directors

- Carlos A. Cabrera, Executive Chairman, Genomatica, Inc.
- David C. Carroll, President and CEO, GTI (Ex Officio Director)
- Adrian P. Chapman, President and CEO, WGL Holdings, Inc. and Washington Gas
- Arthur C. Corbin, President and CEO, Municipal Gas Authority of Georgia
- Marc J. Florette, Executive Digital Advisor, ENGIE (retired)
- John D. Hofmeister, CEO, Citizens for Affordable Energy
- J. Bret Lane, Chairman and CEO, Southern California Gas Company (Chair)
- Steven L. Mueller, Chairman and CEO, Southwestern Energy Company (retired)
- Rebecca Ranich, President, Exenico LLC (Vice Chair)
- David F. Smith, Chairman, National Fuel Gas Company
- John W. Somerhalder II, Chairman, President and CEO, AGL Resources (retired)
- Nick Stavropoulos, President and COO, Pacific Gas & Electric Company (retired)
- Lori S. Traweek, Chief Operating Officer, American Gas Association

In honor of Eddie Johnston

January 17, 1964 - December 20, 2018

The GTI team lost of one of our key senior leaders, Edward "Eddie" Johnston, on December 20, 2018 after a valiant year-long battle with a rare form of cancer. Eddie led research initiatives and directed the organization's entire research staff. He was essential in driving strategic direction and securing a successful future for the organization.

With an energy career spanning over 30+ years, he was a friend to many and well-regarded across the company and among our customers, and he will be remembered with great respect and admiration.

Eddie was a lifelong learner with immense drive, and he was extremely proud of being a Mississippi State (MSU) alumnus. Always looking to the future, he spearheaded an effort to create a novel collaborative environment at MSU. In his memory, GTI made a substantial contribution to create the Edward "Eddie" Johnston Mechanical Engineering Student Leadership Suite, where student leaders can enhance their interaction and learning experience regarding research and other matters. In addition, GTI is also supporting an undergraduate seminar series, connecting mechanical engineering students with experts from the energy research industry and other sectors of the broader economy.

Eddie's contributions will have an enduring impact on GTI and the industry, and his legacy will live on.



Community service and environmental sustainability



Beautifying our campus and providing a haven for butterflies and bees

Eliminating waste and minimizing what goes into landfills with employee electronics recycling events



Gathering food for the Self-Help Closet & Pantry of Des Plaines to feed the hungry in our local community



Giving the gift of hope to others through our annual Blood Drive

Collecting Toys for Tots to provide happiness and the simple joy of the holidays to disadvantaged children



Veterans Day service project to assemble and donate bags with basic toiletry supplies to needy veterans



GTI

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