



Dawn of a New Decade

Vision for Low-Cost,
Low-Carbon
Energy Systems

Annual Report 2019



Dawn of a New Decade

2020

GTI solves important energy challenges worldwide, turning technology and insights into solutions that create exceptional value for our customers in natural gas and broader clean energy systems.

Excelling by:

- Expanding supplies of affordable and clean energy
- Ensuring safe, efficient, resilient and reliable energy infrastructure
- Delivering solutions for efficient and environmentally responsible use of energy
- Reducing and managing carbon emissions
- Advancing energy systems innovations that protect air, land, water and communities while enhancing economic growth

Over the past decade, technological innovation has produced an unprecedented abundance of affordable and clean energy supplies, with natural gas, efficiency and renewable resources each playing essential roles in this dramatic transition. We are looking to the decade ahead as another one in which technology will enable an even greater transformation in our energy systems.

In 2019, we explored some of the trends that will drive this evolution, how those trends might affect our customers' business operations, and where we should invest to deliver solutions that enable our customers to lead these advancements. How we focus our innovation system to build those solutions will be driven by dual imperatives—the need to deeply decarbonize energy systems and supply the energy needed to support economic growth around the world.



David Carroll
President
and CEO



Bret Lane
Chairman of
the Board

2030

2040

2050

Vision for Low-Cost, Low-Carbon Energy Systems

As we invest to help shape these transitions, GTI is focusing on the roles that gases, fuels, and infrastructure will serve in low-carbon, low-cost energy systems now to mid-century—and how these resources can be leveraged to make these shifts safely, reliably, affordably and with deliberate speed.

This year we gathered expertise from across GTI together in a new Hydrogen Technology Center with world-class R&D capabilities for enabling expanded use of hydrogen and other low-carbon gases economy wide. We launched SunGas Renewables Inc. to commercialize GTI technologies for producing renewable methane, hydrogen, or other fuels and chemicals from biomass resources. We expanded our energy efficiency solutions to better serve industrial customers with the acquisition of Minnesota-based Energy Insight by our subsidiary Frontier Energy, Inc. And we advanced our Cool GTLSM technology toward our goal of producing carbon-neutral liquid fuels and chemicals from methane.

As we start this new decade, we are actively bringing solutions to our customers that we expect to deliver meaningful value well through the coming decade and beyond.

Unsettled Times, Stable Values and Mission

With the onset of the COVID-19 pandemic, we pivoted quickly to remote work to safeguard our team and mitigate the spread of the coronavirus. As we adapt in real-time to new ways of doing business, we are also

working closely with our customers to deliver digital and virtual solutions as they adjust their businesses to a “next normal”.

In 2019, GTI exceeded our revenue and new business contract goals and achieved significant growth across all business lines and from a balanced mix of funding sources. We added to our intellectual property portfolio with 56 new patents, and grew our employee base to over 400 professionals.

We are honored to have been recognized as a Chicago 2019 Top Workplace and proud of the contributions our team makes to delivering every day on our mission to turn technology and insights into valued solutions for our customers.

GTI’s success will continue to rely on this strong team of professionals to leverage deep understanding of energy systems, ranging from operational efficiencies to breakthrough transformative technology, as we craft low-carbon and low-cost solutions for accelerating clean energy systems transitions.

From the historically strong financial health of our organization, through the important work we are doing to shape progression of energy systems, to the responsibilities we have to our local communities, we are grateful for the trust and support of our partners.

We look forward to navigating this transformation together, continuing to collaborate in making a positive difference in our world, and delivering on our mission.

Enabling a Hydrogen Economy

Decarbonizing the global energy mix with world-class R&D and technology deployment.

GTI is exploring how we can leverage the existing natural gas infrastructure to facilitate introduction of low-carbon and renewable energy technologies.

GTI has unified our top-tier subject matter experts, recently upgraded labs and facilities, and the experience of decades of successful hydrogen projects in a new **Hydrogen Technology Center** to propel a cleaner, more sustainable energy future and enable a hydrogen economy. The Center has capabilities for testing, modeling, and designing across the entire value chain to increase hydrogen generation, storage and delivery, end use in buildings, transportation, and industry.



Kristine Wiley,
Director, Hydrogen Technology Center

GENERATION



With funding from the UK government, GTI is partnering in an international **HyPER (Bulk Hydrogen Production by Sorbent Enhanced Steam Reforming) project** to test an innovative

DELIVERY

Assessing compatibility, developing and testing materials and components, and optimizing operating conditions for introducing hydrogen to the natural gas pipeline for transport and storage.

END USE

Testing equipment and appliances to provide critical information regarding H₂ interchangeability, performance, safety, reliability, and process efficiency for using hydrogen in power generation as well as building and industrial uses.

TRANSPORTATION



Development and deployment of fuel-cell vehicles and hydrogen fueling station infrastructure will help pave the way for the use of hydrogen in



HYDROGEN TECHNOLOGY CENTER

hydrogen production technology that substantially reduces greenhouse gas emissions. The team will build a pilot plant based on GTI technology that inherently captures carbon dioxide

(CO₂) during production, potentially lowering costs by up to 30% compared to conventional methods.



Incorporating hydrogen as an energy carrier can leverage the nation's widespread and robust infrastructure for delivery and large-scale energy storage, facilitating the transition to a low-carbon future.



Assessing varying hydrogen blends and demonstrating solutions to utilize high-hydrogen blends (>50% H₂ by volume) in residential and commercial combustion equipment, and quantifying the ability of appliances to retain normal emissions, efficiency, and cycling operations.

shipping, railroads, trucks, buses, passenger cars, and off-road vehicles. To help to reduce air pollution, the **FAST TRACK** heavy-duty alternative

transportation truck project is deploying plug-in hybrid fuel cell-electric Class 8 trucks throughout the Los Angeles region.

The California Fuel Cell Partnership (CaFCP) is a flagship effort coordinated by GTI subsidiary Frontier Energy working with vehicle manufacturers, fuel suppliers, government agencies, and fleet operators to expand the market for fuel cell electric vehicles powered by hydrogen.



A joint initiative led by and funded through GTI and EPRI, the **Low-Carbon Resources Initiative (LCRI)** will reveal pathways to advance low-carbon technologies for large-scale deployment through 2030 and beyond.

The five-year collaboration aims to improve the strength, efficiency, and resiliency of the U.S. energy grid and reduce impact on the environment.



GTI is creating pathways for safe, reliable, affordable energy and working collectively to reduce the impact on the environment with low-carbon fuels and power.

Digital Transformation

As energy systems transition, information technology, data analytics, and digitalization trends will continue to have a greater impact across the energy value chain to drive informed decisions.

Forward-thinking companies are looking to integrate machine learning, artificial intelligence (AI), data analytics, digital platforms, and other technologies to simulate, understand, and predict outcomes.

From unconventional gas production, through pipeline operations to monitoring equipment performance and connected homes, a growing mass of data enabled by cutting-edge technology is being analyzed and integrated to create robust models that are easy to interpret and use. Analytical tools organize vast and detailed data sets in an effective way to offer insights and make information easily accessible and actionable.

These actions help users better understand performance, quantify energy and cost savings, manage environmental impacts, and make informed decisions.

GTI tested and proved the Reach RS2, a low-cost, real-time kinematic (RTK) device that is a great alternative to more expensive high-accuracy global navigation satellite systems (GNSS) equipment.



Methane Emission Reductions

GTI serves as the program administrator for the **Collaboratory for Advancing Methane Science (CAMS)**, a consortium established by leading energy companies to help the natural gas and oil industry continue to improve its environmental performance by delivering transparent data to help stakeholders identify the most effective methane emissions reduction strategies across all sectors. A Methane Emission Estimation Tool (MEET) being developed by the University of Texas-Austin for the consortium will improve tracking of methane emissions from oil and gas production.



The energy industry is focused—from upstream all the way through end use—on addressing methane emissions and minimizing greenhouse gases. GTI is developing, validating, and integrating technologies and serving as a proving ground to operationalize methane emission technology solutions at scale.



Through a major new award from the DOE, GTI will design, build, and test a **novel, low-cost linear compressor** to capture leaks from the ventilation systems at legacy and newly installed transmission, storage, gathering, and processing facilities, and deliver compressed methane back into the pipeline. Other efforts include:

- A suite of studies examining emissions from residential, commercial, and industrial facilities.
- Methane emissions monitoring and detection tools to help utilities locate and identify leaks needing repair in person and remotely.
- Providing technical input to help establish nationally recognized standards for residential methane detectors (RMDs).



In mid-September, GTI and the Energy Institute at Colorado State University hosted the sixth annual CH₄ Connections conference looking at “Solutions at Scale”— highlighting the key methane emissions issues facing the natural gas community and sharing innovative solutions being explored across the U.S. The next **CH₄ Connections** conference has been scheduled to take place virtually on November 17–19, 2020 to introduce the most current insights, exchange ideas, and promote collaboration.

Clean Fuels, Power, and Chemicals

Energy resources to produce clean fuels, power, and chemicals are available in plentiful supply, and GTI is developing innovative technology to unlock their potential in an environmentally and economically sustainable way.

Shale gas is readily available, and GTI is providing new tools, data, and practices to ensure its safe, economical, and responsible development around the world.

A versatile portfolio of energy options helps assure that the economy has the accessible and acceptable resources needed for growth, and blending low-carbon resources into our energy supply mix will help to lower carbon footprint.



With the support of government and industry, GTI is leading a high-profile program in unconventional gas that is minimizing environmental impacts and increasing recovery rates.

The **Hydraulic Fracturing Test Sites (HFTS)** are field-based research experiments in the Midland and Delaware Basins of the Permian to improve the design and execution of fracture treatments and provide an advanced scientific understanding of hydraulic fracturing to reduce the number of future wells drilled.

A technical **interconnection guidance document** released in 2019 outlines the ways that renewable natural gas (RNG) can be safely and effectively incorporated into New York State's natural gas pipeline network to reduce carbon emissions, support local economic development, and utilize local supply resources.

GTI's **PerfExtra**® is a patented method for achieving higher efficiencies in perforation breakdown during hydraulic fracturing with simple and low-risk implementation and is available for license.



SunGas Renewables Inc. was established in 2019 as a wholly-owned subsidiary of GTI International that deploys large-scale proven commercial technologies to optimize production of renewable natural gas (RNG), hydrogen, and liquid transportation biofuels from wood waste.



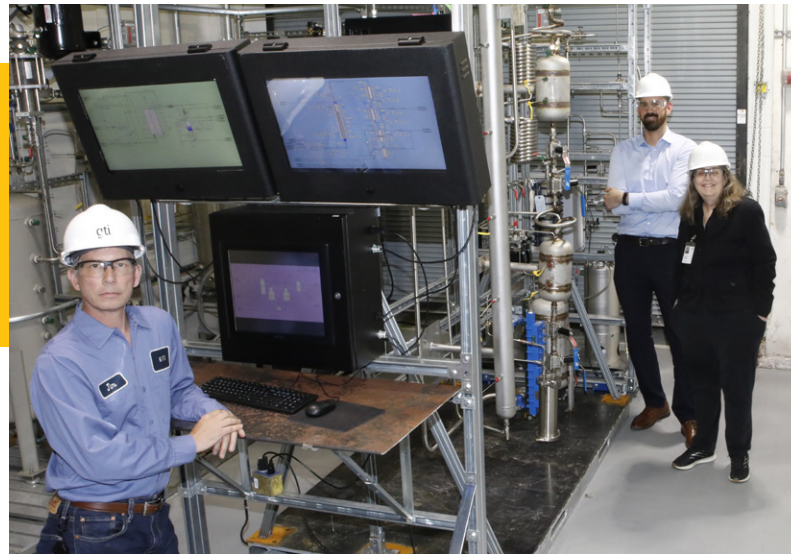
Transformational technology is being demonstrated at facilities all around the world where low-cost and renewable resources are being converted into valuable end products.

Shell Catalysts and Technologies is making great strides toward commercialization of the IH² process licensed from GTI. The fully integrated IH² technology is a catalytic thermochemical process that converts non-food biomass feedstocks directly into gasoline, jet, and diesel drop-in transportation fuels.

GTI's innovative R-GAS™ process is being demonstrated with Yangquan Coal Group in China. In 2019, construction was completed and commissioning was initiated for the facility that will showcase breakthrough gasification technology to lower costs and minimize environmental impacts. It has been proven to achieve >99% carbon conversion, and can be used for coal conversion to liquid fuels and chemicals, as well as power generation.



Utilizing CO₂ for valuable products turns a negative into a positive. GTI is developing energy efficient processes to convert CO₂ into fuels and chemicals while offsetting costs for capture and reducing emissions and costs.



GTI is developing and testing a number of different processes using reformers and catalysts to convert natural gas into liquid fuels, reduce emissions, and utilize captured CO₂ to synthesize fuels and chemicals, including dimethyl ether (DME), a substitute for diesel fuel.

- **Cool GTLSM**—a low-cost system for converting CO₂-rich gas to fungible liquid fuels
- **Dry reforming** of methane to produce syngas and reduce CO₂ emissions
- Using **captured CO₂** to store and transport renewable energy and create DME
- Next-generation **lower-cost carbon capture** technology for power generation

>99%

carbon conversion

The Future of Power Generation

Abundant, clean energy is the foundation of a healthy economy. GTI is optimizing processes to minimize emissions and lower costs of power generation.



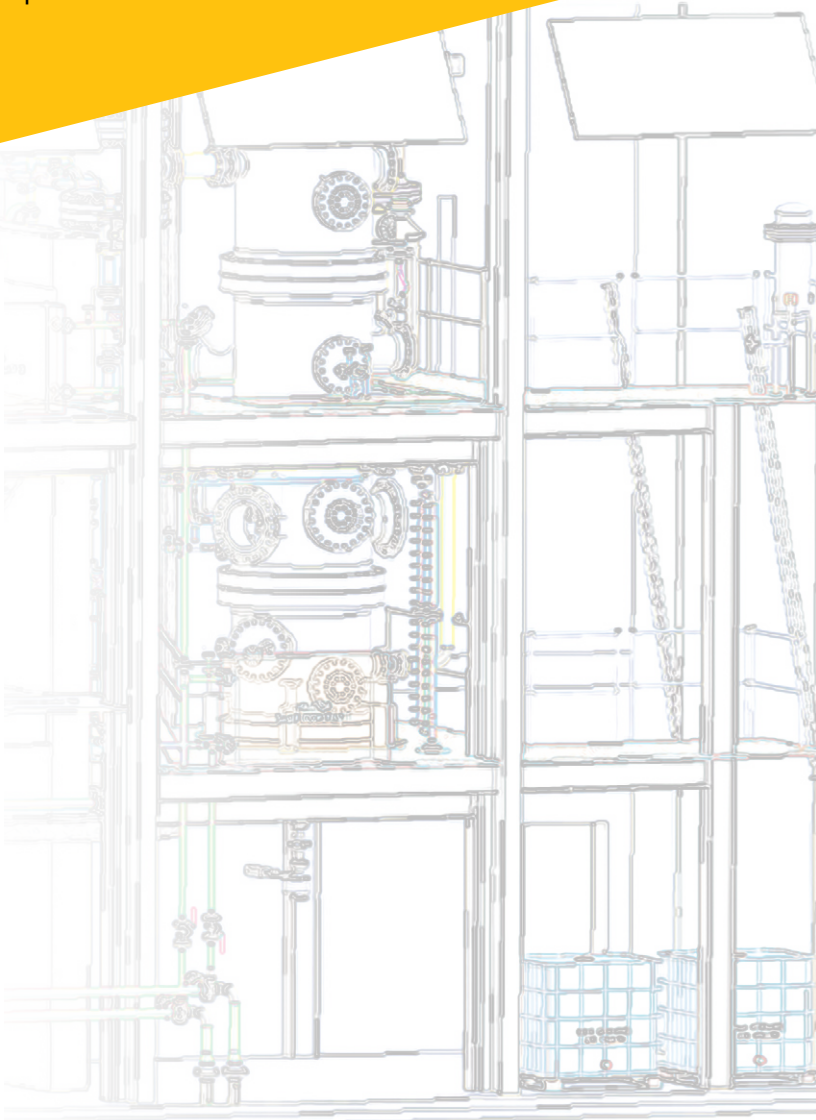
GTI and partners Southwest Research Institute (SwRI) and GE Research are revolutionizing future power generation with design and construction of the **10 MWe Supercritical Transformational Electric Power (STEP)** pilot plant known as STEP Demo. The project is being funded by the U.S. Department of Energy/National Energy Technology Laboratory (U.S. DOE/NETL) and numerous other industry partners.

Construction of the building on SwRI's campus in San Antonio, TX is complete, and component manufacturing and equipment installation is progressing. The project will advance the sCO₂ Brayton power cycle and demonstrate a next-generation, fully integrated functional electricity generating power plant with dramatically improved efficiencies, economics, and environmental performance.





GTI and Korea Electric Power Research Institute (KEPRI) are exploring opportunities for joint research to develop new power generation systems and advance **sCO₂ technology** toward commercial adoption. We are also developing **oxygen-fired pressurized fluidized bed combustor (Oxy-PFBC) technology** that economically captures greenhouse gases for smaller power plants with reduced emissions.



Project Team



Industry Partners



Academic Partners



Pushing the Envelope of Efficient Building Performance

The movement to decarbonize buildings is strong and growing, and GTI is developing system-level solutions to minimize life-cycle costs.

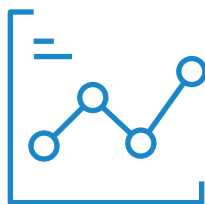
GTI is finding ways to use all forms of energy more effectively and developing an integrated approach to enable increased efficiency, maximize resilience, ensure affordability, and minimize GHG emissions reduction.

The performance of gas and electric space and water heating systems is being evaluated in a variety of settings in GTI's **Virtual Test Home (VTH)**. Combining test results with savings quantified through modeling and validated in the field provides a comprehensive understanding that can be used to assess energy impacts of residential appliances.



GTI established a dedicated residential **Integrated Systems Lab** where we perform system-level whole-building and microgrid component research integrating electric, renewable, and gaseous fuels along with energy storage and other energy efficiency technologies to form the basis for connected energy systems.

GTI is working to improve technology, prove feasibility, and reduce costs of **micro-combined heat and power (micro-CHP) technology**. The Lochinvar XRGi25 system met stringent emission regulations in the lab, and it is on the path to become the first California Air Resources Board (CARB) DG certified micro-CHP system in North America.



GTI International subsidiary Frontier Energy is monitoring the performance of **distributed energy (DE)** and other clean microgrid technologies, using an advanced web-based monitoring platform to collect, process, and analyze data from hundreds of energy systems. The detailed verification, measurement, and reporting they provide helps stakeholders understand performance, quantify energy and cost savings, and assess environmental impacts.



Maximizing the use of energy resources will fuel economic growth at minimal impact to the environment and offer alternatives to electrification. GTI develops energy-efficient technologies to lower energy consumption and reduce energy costs and emissions, while keeping consumers comfortable in their homes and businesses.

Natural gas is the preferred fuel for thermal comfort in North America, and gas heat pumps offer simple efficiencies of more than 100%. GTI is supporting development of a family of **thermally-driven gas heat pump technologies** with pre-commercial installations to provide consumers with emission and energy-cost savings. GTI is engaged in efforts to bring residential combined space and water heating systems and heat pump water heaters to market by 2022.



The Gas Heat Pump Collaborative, a Joint Industry Program (JIP) has been created to deliver technology and initiate market transformation efforts targeting new gas product categories, including residential and commercial heat pump water heaters, heat pump boilers, and combined space and water heating heat pump systems.

The GTI team is also active in modernizing industry codes & standards, improving the accuracy of building energy modeling tools, and reducing installation barriers through innovative controls and infrastructure solutions.

GTI is evaluating systems to improve **energy efficiency and resiliency** for the Department of Defense.



The team is assessing a comprehensive slate of emerging technologies that incorporate higher efficiency cycles, improved controls, energy recovery, onsite power systems for resiliency, and other enhancements at an Illinois Army National Guard facility and the U.S. Army Engineer Research and Development Center (ERDC) in Mississippi for their ability to cost-effectively reduce energy use and improve energy resiliency.

Safe, Reliable, Resilient Infrastructure

A safe, reliable, and resilient infrastructure is critical to match abundant energy supplies with growing demand to maintain the public's confidence in the nation's energy delivery systems.



Gas utilities need optimized tools and technologies to effectively manage and improve day-to-day operations, prevent damage, reduce risk, and enhance safety.



Tools

GTI provides information technology and digital platform solutions to help utilities automate their collection of high-quality data to inform effective decision making. We are helping increase the understanding of infrastructure threats and enabling operators to improve the accuracy of inspections, predict asset performance, and calculate system risk.

Collaborating with Esri to develop electronic field data collection forms using [Survey123](#) to streamline record-keeping workflow

Creating [Smart Pole Technology](#) that uses automation to increase the quality and consistency of location data collected using Global Navigation Satellite System (GNSS) receivers

Developing and commercializing a probe that can be inserted inside of a [live gas pipeline to map](#) underground pipes in 3D, provide accurate locations, and download data directly to a Geographic Information Systems (GIS) platform

GTI is leading collaborative efforts to develop a myriad of exciting new tools and techniques for system installations, repairs, and rehabilitation. The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (DOT PHMSA) continues to grant significant funding to GTI and Operations Technology Development (OTD) to support projects on gas operations safety. In one example, to more effectively locate subsurface utility assets and prevent excavation damage, GTI and 3M are optimizing the manufacturing process of [intrinsically locatable polyethylene \(PE\) pipe materials](#) for cost-effective large-scale production and field-testing the product.

Investment in the Future



GTI International subsidiary Frontier Energy has decades of experience in program management, engineering, software, and customer engagement. The team provides exceptional programs, services, and tools that encourage the intelligent use of energy.

Frontier Energy wrapped up a California Energy Commission-funded project to assess the energy reduction potential of replacing current unventilated plug-load equipment used for cooking and warming in commercial kitchens with new appliances that include smart controls, better materials, and advanced technologies. This will help to establish **new standards for the industry** to realize energy savings, reduce CO₂ emissions, and lower operating costs.



For many years, Frontier Energy has managed countless ongoing energy efficiency rebate and incentive programs across the nation to encourage consumer energy savings.

The Bay Area Regional Energy Network (BayREN), a **Multifamily Building Enhancements Program** designed and managed by Frontier, has completed projects for 37,130 housing units, with an average of 16% in energy savings and over \$27.8 million in rebates processed.

Frontier Energy acquired **Energy Insight, Inc.**, a Minnesota-based professional services firm that provides energy efficiency program management and engineering services, in September 2019. With a mission to deliver energy savings that make business sense, Energy Insight works with utilities as well as directly with commercial/industrial, agricultural, and institutional customers, helping them identify tangible action steps and practical upgrades that save energy.



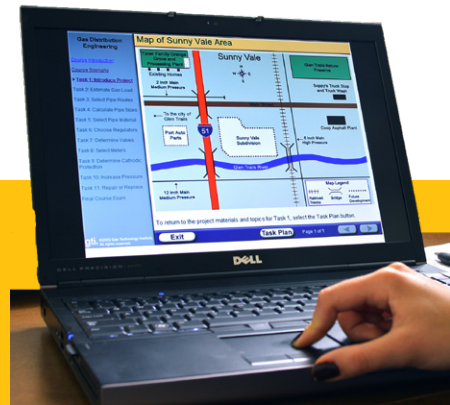
**Program
Portfolio
Portal**

Utilities throughout Louisiana, Arkansas, Texas and other states are successfully using Frontier's **Program Portfolio Portal (P3)** software to streamline participation, management, reporting, and evaluation across energy efficiency and load management portfolios.

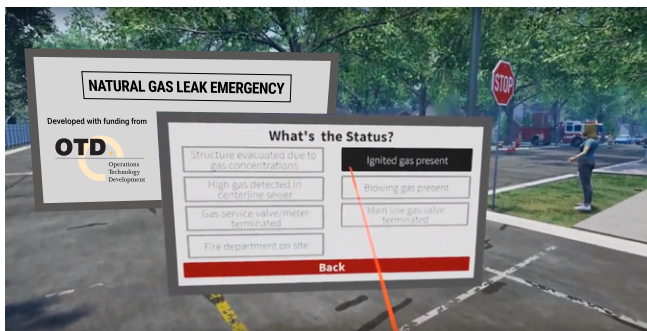
Training and Events



tcbiomassplus2019, the International Conference on Thermochemical Conversion Science, was hosted by GTI in early October, showcasing real world solutions through green technology. The event highlights science and commercial opportunities for technology deployment and unites R&D laboratories, industry, government agencies, and academia. Since the inaugural event in 2009, tcbiomass has become a hallmark conference in the world of bioenergy and draws presenters and attendees from around the globe.



In 2019, GTI delivered 70 classroom courses across a slate of topics to a record 1,100 participants from across the nation.



A new **virtual reality (VR) training module** for natural gas leak emergency first responders introduced last year received overwhelming response. With funding from OTD, GTI worked with PIXO VR to develop the dynamic interactive training simulation with randomized scenarios. A new suite of cutting-edge training modules including inside leak investigation, outside leak investigation, pipeline right-of-way patrolling, facility locating and marking, and appliance inspection has recently been released.



GTI has created an assessment-based **Competent Engineer Education & Assessment Program** to help utility distribution and transmission professionals become more proficient with natural gas system design. Students will gain a foundational understanding of systems and regulations, develop technical skills, and learn how to apply this knowledge to operator-specific requirements and O&M processes. The training covers natural gas utility engineer competencies recommended by AGA and identified by the NGA Gas Engineering Design Review Guideline.



Community Service and Environmental Sustainability

From promoting the recycling of household fire extinguishers, to assembling bags of essentials for veterans in need, to beautifying our campus on Earth Day, building homes with Habitat for Humanity, and donating to our local food pantry, we are proud of the efforts our employees put toward serving the community.



Leadership

Executive Team

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

Business Leaders

- Richard M. Kaelin, Vice President, Washington Operations
- Anthony T. Lindsay, Managing Director, Delivery
- William E. Liss, Vice President and Managing Director, Delivery and Utilization
- Jeremy M. Otahal, Executive Director, Corporate Development
- Scott Reeves, Executive Director, Exploration and Production
- Donald S. Stevenson, Vice President and Managing Director, Supply and Conversion
- Larry Brand, President, Frontier Energy, Inc.
- Vann Bush, President, SunGas Renewables Inc.

Board of Directors

- Carlos A. Cabrera, Executive Chairman, Genomatica, Inc.
- David C. Carroll, President and CEO, GTI (Ex Officio Director)
- Arthur C. Corbin, President and CEO, Municipal Gas Authority of Georgia
- Marc J. Florette, Member of the National Academy of Technologies of France
- Kimberly S. Greene, Chairman, President and CEO, Southern Company Gas
- John D. Hofmeister, CEO, Citizens for Affordable Energy
- J. Bret Lane, 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, utility and gas industry executive (retired)
- Nick Stavropoulos, Chief Safety Advisor, Columbia Gas of Massachusetts
- Lori S. Traweek, Chief Operating Officer, American Gas Association
- Dr. Michael E. Webber, Chief Science and Technology Officer, ENGIE



Our Values

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

People. We provide a diverse and inclusive 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. Our 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.

Financial and Business Overview

2019 Financials

In Millions

Project Revenue	\$ 150.8
Royalty/Other Revenue	\$ 5.7
Total Revenue	\$156.5
Total Assets	\$152.5
Total Liabilities	\$ 53.4
Net Assets–Unrestricted	\$ 99.1



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

Energy Insight Office

- Chanhassen, MN

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