



GTI ENERGY

solutions that transform

Transforming lives, economies, and the environment

Annual Report 2021

GTI Energy develops innovative solutions that transform lives, economies, and the environment



LIVES

GTI Energy's transformations for deep decarbonization seek to benefit people at every level in all regions of the world today and far into the future. Increasing equitable access

to energy, protecting public health, and supporting rising standards of living will help to meet the urgent challenges presented by climate change and global energy access.

ECONOMIES

GTI Energy is leading efforts to deliver a versatile portfolio of affordable low-carbon options that can help assure that people in all



communities have access to clean and affordable energy and economies worldwide have the resources needed for growth.

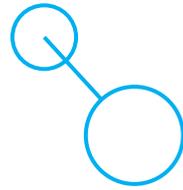
ENVIRONMENT

The energy transition demands low-cost, environmentally friendly, flexible, and resilient solutions, and GTI Energy is accelerating actions to protect the planet for future generations.

Producing, moving, storing, and using energy responsibly to meet carbon emission reduction goals is core to all that we do.

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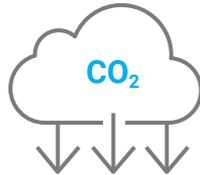
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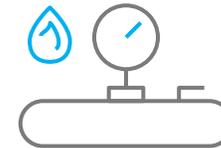
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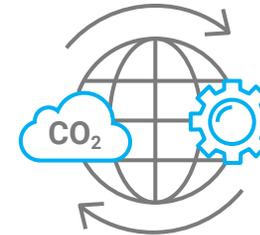
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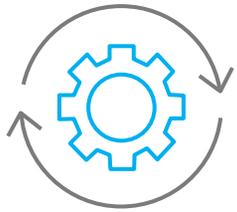
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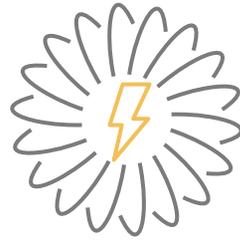
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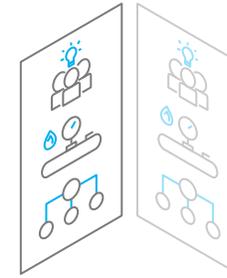
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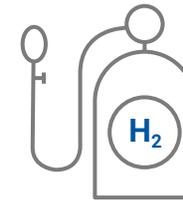
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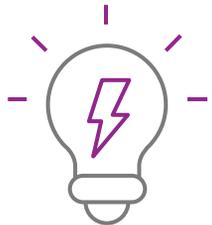
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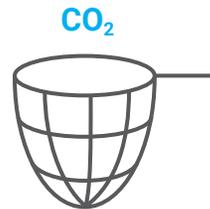
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The GTI Energy team is working diligently and passionately on transforming lives, economies, and the environment, and this year's annual report showcases some of our more than 400 trusted experts who are tackling this essential work. Through interviews with people from across the organization, we're highlighting how GTI Energy addresses the needs of our clients and of a changing global economy.

Our business continued to grow despite the pandemic and we exceeded our new business goals, expanding our initiatives into new areas of the energy ecosystem and adding 12 U.S. and 41 foreign patents to our intellectual property portfolio in 2021. We were once again recognized as a Top Workplace in the Chicagoland area, and ranked among the top ten mid-size companies in 2020 and 2021.

We also embarked on an important initiative to refresh our brand with a new name and logo to reflect the evolution of our business and express our new vitality as we work to shape energy transitions.

We are grateful for the resilience and determination of each member of the GTI Energy team and our dedicated partners, committed board members, and visionary clients as we experienced these unprecedented times together. We look forward to putting the important—and imperative—potential of gases, liquids, and infrastructure into action to improve the quality of life worldwide.



David Carroll
President and CEO



Rebecca Ranich
Board Chair

IN MEMORIAM

With great appreciation for a remarkable man, we mourn the passing of John D. Hofmeister—our friend, colleague, and member of the GTI Board of Directors—in June 2021.

John shared many valuable energy and policy insights, and we are thankful that we had the opportunity to work with him. We will endeavor to carry on his legacy by “thinking big”.



John D. Hofmeister,
CEO, Citizens for
Affordable Energy



DIVERSITY, EQUITY, AND INCLUSION

“Our goal is to create and sustain a culture where all employees feel included, valued, and respected in a productive environment,” said Amy Russell, GTI Energy’s newly appointed Director of Diversity, Equity, and Inclusion. “Creating an inclusive workplace is imperative—not just because it is the right thing to do, but because it is at the crux of who we are.”

Our workforce has substantially changed and is trending younger and more diverse. “These new additions mean that our team represents a wide range of diverse thoughts, backgrounds, and experiences that will lead to innovative ideas and stronger business results,” Amy said.

In 2022, we will continue to focus on institutionalizing diversity, equity, and inclusion into our culture. “We want everyone to feel a sense of belonging,” Amy said. “We’re making a greater effort to recruit and retain employees with diverse backgrounds and expand community engagement and impact.”



Amy Russell
Director of Diversity, Equity,
and Inclusion

“We embrace diverse perspectives, question norms, and collaborate to develop creative and powerful solutions.”



EXPLORING THE PROMISE OF HYDROGEN



Hydrogen is a versatile low-carbon gas that can play a critical role in decarbonizing hard-to-abate sectors. Integrating hydrogen into our energy system and strategically using it to reduce emissions in parts of our economy is vital to a resilient, reliable, and sustainable clean energy future.



“It is a very exciting time in the energy industry,” said Kristine Wiley, Vice President, **Hydrogen Technology Center**. “As we navigate through this energy transition, many new options that will have a lasting impact on our energy system are emerging, and hydrogen is one that stands out. At GTI Energy we are working to advance hydrogen as a potential means to achieve net-zero emissions. Within the Hydrogen Technology Center we are performing over \$50M of research to advance hydrogen solutions at scale across the make/move/store/use energy value chain. With GTI Energy’s deep expertise in hydrogen—along with our technical resources and testing facilities—we are shaping hydrogen markets and ensuring this low-carbon fuel is affordable and accessible to economies of all sizes and maturities.”

An important element of advancing hydrogen markets is the deployment of hydrogen at scale, moving beyond singular technology demonstrations. “With our **DOE H2@Scale in Texas and Beyond project**, in partnership with Frontier Energy, University of Texas Austin, and dozens of industry stakeholders and sponsors, we are building an integrated renewable hydrogen network spanning production from wind, solar, and renewable gas; on-site storage; and end use in power generation, vehicle use, and drone applications,” said Kristine. “It is the makings of a ‘prototype hydrogen hub’ in which we are creating a hydrogen ecosystem and laying the foundation for expanding hydrogen’s role in decarbonizing the Gulf Coast Region.”

“GTI Energy is creating a framework to support the development of regional hydrogen hubs where supply and demand are matched regionally or locally while leveraging existing infrastructure to foster a clean hydrogen market at the pace needed to meet aggressive decarbonization goals.”

— Kristine Wiley, Vice President, Hydrogen Technology Center



Complete end-to-end demonstration of an integrated hydrogen network in low-carbon energy systems

A young child with dark hair, wearing a red long-sleeved shirt, is looking out of an airplane window. The child's hand is resting on the window frame. The background is a soft, warm light coming from the window. The image is partially obscured by a white diagonal shape that contains the title and text.

CREATING LOW-CARBON FUELS, POWER, AND CHEMICALS

Looking to mid-century, we see continued robust demand for low-carbon gases and liquid fuels. Energy feedstocks are available in plentiful supply and offer a versatile portfolio of low-carbon options that can provide the economy the resources needed for sustainable growth.



“I love that we can produce clean, cost-effective alternative transportation fuels by converting waste feedstock into valuable end products.”

— Dr. Pedro Ortiz-Toral,
Bioenergy Program
Manager



Transformational technologies that produce low-carbon fuels from renewable resources are being demonstrated at facilities all around the world, and clean liquid biofuels offer unique solutions for carbon neutrality across different sectors of the economy.



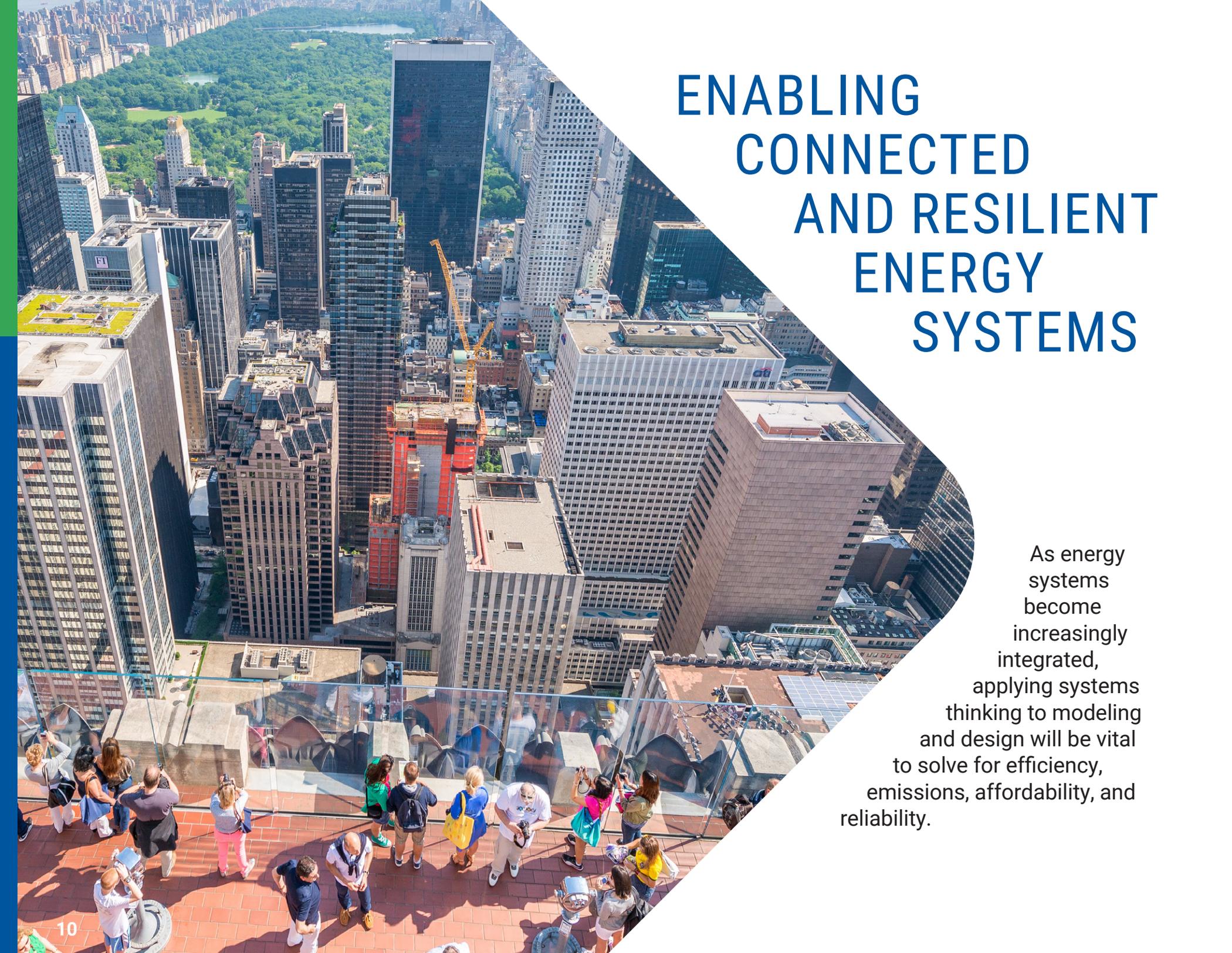
The GTI Energy-patented **IH²® technology** converts biomass directly into low-carbon gasoline, jet, and diesel drop-in transportation fuels, helping to increase the supply of renewable transportation fuels with favorable economics. Shell Catalysts and Technologies licensed the process and is demonstrating it at their five-ton-per-day demonstration plant in Bangalore, India.

“IH²® is a simple, self-sufficient production approach that offers low capital and operating costs. It converts non-food biomass feedstocks—such as wood, agricultural residues, algae, aquatic plants, and municipal waste—with greater than 60% reduction in greenhouse gas emissions,” said Dr. Pedro Ortiz-Toral, GTI Energy Bioenergy Program Manager. “Nearly 100 U.S. and international patents have been awarded on the technology, and it is attracting many interested project developers.”

GTI Energy is demonstrating large-scale conversion technologies to minimize greenhouse gas emissions from aviation, a traditionally difficult-to-decarbonize sector. “We were awarded two Department of Energy contracts for **sustainable aviation fuels**,” said Pedro. “We will develop and scale up technologies and processes that meet the demands for sustainable aviation fuels while reducing costs. Major U.S. airlines have committed to carbon neutrality, and projects like these will help meet those goals.”

Addressing significant growth in the biofuels market, our subsidiary SunGas Renewables Inc., also provides systems for production of renewable gasoline and low-carbon biofuels to drive decarbonization.



An aerial photograph of a dense urban skyline, likely New York City, showing numerous skyscrapers and buildings. In the foreground, a rooftop terrace with a glass railing is visible, where several people are standing and taking photos. The background shows a large green park area, possibly Central Park, with a lake and trees. The overall scene is bright and sunny.

ENABLING CONNECTED AND RESILIENT ENERGY SYSTEMS

As energy systems become increasingly integrated, applying systems thinking to modeling and design will be vital to solve for efficiency, emissions, affordability, and reliability.

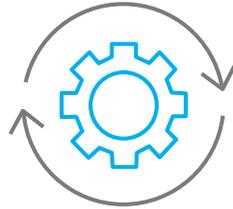


“Pathways to decarbonization will differ by climate zone and region, and will change as the energy grid evolves. It’s important to develop and maintain models, like the Energy Planning and Analysis Tool (EPAT) to support our partners.”

– Paul Glanville, R&D Director, Energy Utilization



– Tim Kingston, R&D Director, Energy Utilization



“Whole-system thinking and new approaches are necessary to unlock deep decarbonization and ensure energy reliability for consumers,” noted Tim Kingston, R&D Director, Energy Utilization. “We need to account for and analyze the ways that disparate building energy systems interact with the energy grid and analyze how varied components interface. This will provide the framework for smart choices as we accelerate transitions to low-carbon, low-cost energy systems.”

GTI Energy’s new **Integrated Systems Laboratory (ISL)** develops system-level solutions to minimize lifecycle costs of GHG emissions reductions from buildings, focusing on behind-the-meter and community-scale solutions. “In the ISL, we can demonstrate how a building or community responds to changes in supplied energies and energy system configurations,” Tim said. “We perform research that integrates electric, renewables and low-carbon fuels; on-site power generation; energy storage; and other energy efficiency technologies to form connected energy systems.”

“Although the technologies exist, they are commonly developed and rated in isolation, so this work should provide clarity on how to properly integrate them,” added Paul Glanville, R&D Director, Energy Utilization. “For example, to assess energy impacts of hybrid heating equipment in homes and businesses, we demonstrated that advanced approaches to heating, such as integrating efficient fuel-fired technologies with electric technologies, can achieve up to 50% energy savings.”

With a more-comprehensive view of how components will work together, stakeholders can better align their decisions with strategic goals for sustainability, energy access, reliability, and overall system cost-effectiveness.

With subsidiary Frontier Energy, we launched a comprehensive buildings program that applies integrated systems RD&D to promote efficient residential and commercial building and equipment performance to lower power consumption, costs, and emissions.



REVOLUTIONIZING FUTURE POWER GENERATION

 **STEP
DEMO** Supercritical
Transformational
Electric Power

CORNELL

CORNELL

Compressor
skid

STEP
DEMO Advancing the Promise
of Low-Carbon Power

STEP
DEMO Increasing Efficiency
with eCO_2 Power Cycles

The energy transition is driving demand for low-cost, environmentally friendly, flexible, and resilient power generation. GTI Energy's collaborative research is uncovering myriad ways to achieve deep decarbonization.



“The **STEP Demo project** will revolutionize power generation, a sector that is one of the most difficult to decarbonize,” said Scott Macadam, Institute Engineer, Energy Supply & Conversion. “The technology utilizes supercritical CO₂ to generate power more efficiently and effectively than steam, and uses less fuel and water, which adds to its strong environmental performance. In addition, the turbomachinery size is reduced by 85%.”

GTI Energy, Southwest Research Institute, and GE Research finished construction of a facility to house a 10 MWe Supercritical Transformational Electric Power (STEP) pilot plant in San Antonio, Texas. “The team has been making great strides in manufacturing and installing the components that will make the plant operational, and we are closing in on commissioning,” Scott said. “We are excited to demonstrate clean, compact, and high-efficiency power generation.”

The 22,000-square-foot plant is the first built to commercial scale. “It will first operate at about 500°C—the temperature needed to turn waste heat from a cement plant into usable energy,” Scott explained. “Then we’ll move toward operating at 700°C to produce 240 MW-hr per day of carbon-free electricity.” The goal is to collect data that will facilitate commercial deployment of the closed sCO₂ Brayton power cycle.

The STEP Demo project is funded by the U.S. Department of Energy’s National Energy Technology Laboratory and numerous partners from around the globe, including American Electric Power, Southern Company, Natural Resources Canada, Korea Electric Power Corporation (KEPCO), Electricity Generating Authority of Thailand (EGAT), Australia’s Commonwealth Scientific and Industrial Research Organisation (CSIRO), and French multinational electric and gas company ENGIE.



“The level of enthusiasm from government and energy industry partners is exciting. It’s great working at GTI Energy and having a role in changing the future of energy.”

— Scott Macadam, Institute Engineer, Energy Supply & Conversion

PREDICTING THE FUTURE THROUGH SMART DATA

Disruptive innovations will help integrate energy systems more intelligently at scale. Predictive analytics help in understanding existing systems and simulating change so we can forecast the impacts on energy systems and communities.



“Previous energy systems transitions occurred over generations. The transition we are in will need to occur over a few decades. That speed to scale requires that we leverage digital tools and engage in massive collaborations converging data science and physical science.”

– Shannon Katcher, Executive Director, Digitalization & Data

– Shadi Salahshoor, GTI Energy Principal Engineer

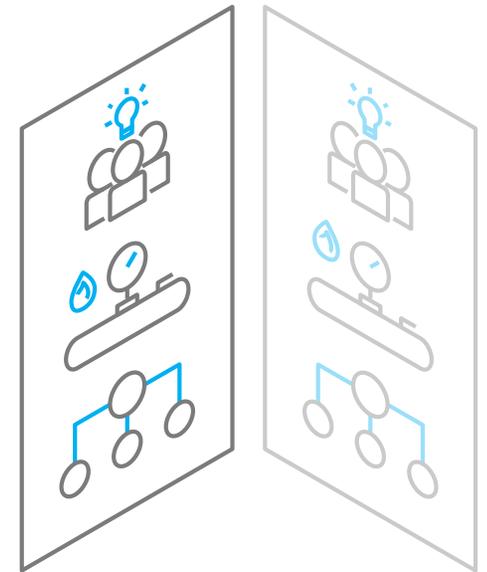
“We use data to understand what happened and why,” said Shannon Katcher, GTI Energy’s Executive Director, Digitalization & Data. She leads a team of data scientists and technology specialists who build out **digital solutions** to better enable energy transitions.

“We are developing methods and platforms to reduce the complexity of change and provide actionable insights throughout the entire energy supply chain.”

To determine how to make technologies interoperable, GTI Energy develops various digital twins and simulations to assess what will happen as disparate elements of energy systems are integrated. “Digital twins are digital representations of physical assets and processes and can be implemented at a variety of scales, which helps us evaluate systems at many levels,” Shannon explained. “Through digital twins, we can identify opportunities to save costs and potentially mitigate unintended consequences.”

“We’re working to develop a **hydrogen sensor network**,” said Shadi Salahshoor, GTI Energy Principal Engineer in the Hydrogen Technology Center. “We’ll build a digital twin of a hydrogen facility with data from vibrations and other sensors so we can simulate the location and severity of leaks. This helps optimize sensor placement.”

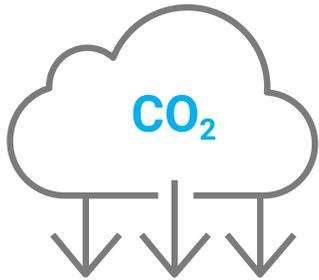
“At GTI Energy, I can get involved in different projects and think about things from different perspectives, which broadens my scope and skills to provide value to society. It makes my passion flourish and develops my aptitude. It is very challenging and rewarding as I further my knowledge of the energy industry,” Shadi said.



A photograph of a man and a young child in a laundry room. The man, wearing a plaid shirt, is kneeling and looking into a front-loading washing machine. The child, wearing a white tank top, is leaning over the open door of the machine, also looking inside. A white laundry basket filled with clothes is in the foreground. The scene is brightly lit, suggesting a clean and modern environment.

REDUCING OUR CARBON FOOTPRINT

The clean energy future must be diverse, reliable, and affordable. As we move toward carbon-neutral power and transportation, natural gas plays a vital role. GTI Energy helps to harness the promise of gas-based energy to deliver clean and cost-effective energy to communities worldwide.



“Our collaborative teams are forward thinking—
ahead of the curve—to make energy affordable and
more environmentally sustainable.”

– Amanda Harmon, Project Manager, Energy Delivery

A versatile portfolio of energy options helps assure that the economy has the accessible and acceptable resources needed for growth around the globe. Natural gas is abundant and versatile, able to partner with renewable energy sources to address energy intermittency issues and meet increasing demands for energy.

“Gas utilities and consumers have good options readily available to **reduce greenhouse gas emissions**—specifically **energy efficiency** and **methane emission reductions**,” said Amanda Harmon, R&D Manager in Energy Delivery. “Natural gas can be greener by choosing more-efficient appliances, tracking down and eliminating methane leaks, integrating renewable gases, and capturing carbon.”

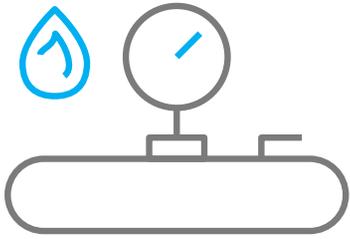
“Our team at GTI Energy is full of experts at the forefront of creating high-efficiency gas equipment and appliances to conserve our resources and enable the potential for renewable methane and hydrogen energy supplies.”

Methane measurement capabilities made significant headway in recent years, and more plentiful and accurate data about methane emissions is now becoming available. New technology developments and demonstrations help to validate tools that can more effectively detect and fix leaks in the near-term.

“GTI Energy brings utilities together to find the optimal tools and insights for natural gas operations,” Amanda said. “With collaborative organizations Utilization Technology Development (UTD) and Operations Technology Development (OTD), we’re always looking ahead to see what is coming next.”

PRIORITIZING INFRASTRUCTURE SAFETY

Today's infrastructure offers reliable, resilient, long-distance energy transport, direct-to-customer delivery, and vast storage capacity. It gets energy to where and when it is needed in an affordable and safe manner to serve a diverse set of customers.



“Energy and climate security present enormous challenges. Working at GTI Energy, we’re deep into the science because we know it will make a difference in the way people live in the future. Nothing is more interesting—or more important—to be working on.”

— Marta Guerrero Merino, Principal Engineer, Energy Delivery

Throughout the U.S., there are three million miles of natural gas pipelines delivering energy. These systems—vast and connected, needed but often unnoticed—are expected to operate reliably, safely, and affordably. At GTI Energy, our work focuses on meeting those expectations.

The energy infrastructure is fundamental to enabling grid-scale energy transport and storage, and understanding how to leverage these existing networks is critical. In addition to moving natural gas, our pipelines offer great potential for transporting and storing renewable energy, but we need assurance that new resources are compatible.

That’s where people like Marta Guerrero Merino come in. She is a Principal Engineer in the Energy Delivery group, **performing materials testing** in GTI Energy’s labs. She is one of the researchers hard at work evaluating the performance of steel, cast iron, and polymers that pipes are made of.

Now, Marta and the team are performing **life cycle assessments of hydrogen blending** and evaluating its effects on safety, leakage, durability, and integrity for metallic and non-metallic materials, building off of extensive knowledge on how to inject renewable gas safely and effectively into the infrastructure.

Marta explained, “We ask questions like ‘can we build a new pipe inside a deteriorated cast iron pipe?’ And ‘will steel pipes become more brittle when we blend hydrogen?’ We’re trying to find the answers, and I’m lucky to work with the smartest people I know to figure it all out.”

“As we transition to low-carbon, low-cost energy systems, leveraging the infrastructure we already have in place makes a lot of sense and takes advantage of investments that have already been made.”



PREPARING TOMORROW'S WORKFORCE

GTI Energy professionals are breaking new ground in training and knowledge transfer by using immersive training, targeted webinars, and can't-miss conferences.



— Gira Joshi, Supervisor,
Training Program
Operations



“Imagine hiring a person that has virtually fixed this widget 20 times and in 20 different circumstances. It exponentially increases a new employee’s safety and efficiency.”

— Ray Deatherage,
Director of Training

“With a dynamic workforce, changing culture, and the transformation of the energy industry, it’s vital that **education and training** is in lockstep with the new world of work,” said Ray Deatherage, Director of Training. “The new workforce wants mobile, interactive, real-life learning, and GTI Energy is rising to the challenge.”

We pivoted our conferences online, and then to a hybrid model. The 2021 CH4 Connections Conference was our biggest ever with participants in person and online from desktops around the country.

“Virtual training is opening new doors,” said Gira Joshi, Supervisor, Training Program Operations. “Last year, we taught a course in the Dominican Republic and used interpretation channels and closed captioning in Zoom to help break down language barriers and offer greater understanding.”

“What’s really new and exciting is immersive learning,” stated Ray. “Virtual reality allows people to practice a series of complex tasks, like inspecting a pipeline, with multiple variations that usually take years of on-the-job experience to learn.”

GTI Energy offers **virtual reality** (VR) training to our clients and in partnership with colleges and technical schools. “Instead of watching a presentation or memorizing a binder,” Ray said, “we put people in the action and let them learn a skill in five minutes.” It’s quick, easy, and available on any smart phone.



EXPANDING OUR CAPABILITIES AND ROLE IN THE ENERGY TRANSITION

GTI International (GTII) is a holding company and wholly owned subsidiary of GTI Energy. GTII is investing in an efficient, clean energy future to meet ever-escalating energy, operational, and environmental challenges. The portfolio of companies in which GTII holds equity strives to provide exceptional stakeholder value via innovative solutions and client focus.

GTI International Subsidiaries



Frontier Energy partners with utilities, government, and private businesses to help them conserve energy, make strides toward decarbonization, and evaluate the effectiveness of large-scale initiatives.

Frontier completed integration of the Energy Insight acquisition and expanded its growing commercial building and industrial process audit expertise into markets in the South and West. The team also launched a new electric vehicle-focused business practice leveraging over 20 years of experience in transportation programs, attracting \$1 million in new EV program investment in the first year.



Established as a GTI Energy spin-out in 2019, **SunGas Renewables** drives decarbonization by deploying systems for production of renewable gasoline, RNG, hydrogen, and low-carbon biofuels.

SunGas' proven technology enables the conversion of woody biomass and other renewables capable of negative carbon intensity (CI) scores. These projects will provide renewable gases and fuels at scale converting 1000 tons per day of biomass for each gasification train.

The experienced SunGas team is working with several well-financed developers to advance projects throughout the U.S. and Canada, with potential global impact.



In January 2022, we deepened our capabilities in sub-surface technologies with the acquisition of **Projeo Corporation**, a professional energy services firm that develops geologic resources to store carbon in sub-surface wells across the U.S.

Projeo delivers geotechnical and operational/management services for public and private clients, specializing in managing CO₂ and gas storage, ground water resources, and geothermal projects.

The company leads activities that range from performing seismic studies, to drilling test wells and installing monitoring equipment, to managing sites and regulatory reporting and support.

GTI Energy Subsidiary



To accelerate disruptive technology innovation needed to achieve deep decarbonization, **Rev Innovations Inc.**, was incorporated as a benefit corporation and wholly owned subsidiary of GTI Energy in June 2021. This bold new platform will provide a collaborative vehicle for investing in, demonstrating, and scaling technology-based businesses that enable low-carbon, low-cost energy systems.

Rev will serve as a proving ground to scale integrated solutions for gases, liquids, and infrastructure, invest in promising early-stage businesses, and provide industry-leading technical expertise and test facilities to unlock greater impact and accelerate technology deployment timelines to meet net-zero emissions commitments.

LEVERAGING TALENT AND RESOURCES FOR GREATER IMPACT

GTI Energy is a trusted partner for developing, demonstrating, and deploying solutions in the transition to low-carbon, low-cost energy systems. We lead collaborative R&D organizations and programs that offer unique opportunities to combine interests, expertise, and resources to address common challenges.

For nearly 20 years, GTI Energy has managed **Operations Technology Development (OTD)**, a member-controlled collaborative of natural gas distribution companies that are enabling a safe, resilient, and sustainable energy infrastructure. The not-for-profit represents 28 member companies who serve over 70 million natural gas consumers in the U.S., Canada, and France. OTD's research helps members address the challenge of dramatically reducing greenhouse gas emissions through integration of low-carbon fuels and the expansion of methane mitigation technologies and practices.

GTI Energy also operates an end-use focused collaboration, **Utilization Technology Development (UTD)**, which is shaping the energy future by developing and enabling new technologies. The organization represents 20 natural gas distribution companies that direct a program of near-term applied research to benefit their 37+ million gas customers. UTD's innovative customer solutions maximize the environmental performance, affordability, efficiency, and safety of equipment and processes that use natural gas and renewable energy resources.

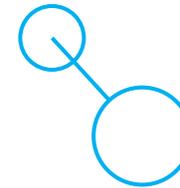
GTI Energy's **Emerging Technology Program (ETP)** is a North American, membership-based utility collaborative targeting residential, commercial, and industrial solutions. The program accelerates the market introduction and acceptance of efficient emerging technologies by helping companies assess the benefits of new energy efficiency products and integrated solutions for use in near- to mid-term energy efficiency program implementation.

With resounding industry support, the **Low Carbon Resources Initiative (LCRI)** was launched to enable the pathway to economy-wide decarbonization. The five-year industry collaborative R&D program co-directed by GTI Energy and EPRI has raised more than \$131 million in funding from a diverse group of 52 sponsoring companies.

LCRI will accelerate developments needed to produce, store, deliver and use low-carbon alternative energy carriers and the cross-cutting technologies that enable their integration at scale.



GTI ENERGY COLLABORATES ON H₂ INITIATIVES ACROSS THE ENERGY VALUE CHAIN



MAKE



HyPER will demonstrate GTI Energy's high-efficiency hydrogen production technology that inherently captures high rates of CO₂ at low-cost for near-zero hydrogen. A state-of-the-art 1.5 MWth pilot plant is being constructed at Cranfield University in the UK.

MOVE

GTI Energy is coordinating industry participation and funding in HyBlend™, a National Renewable Energy Laboratory (NREL) project which will develop and publish publicly accessible tools to characterize the opportunities, costs, and risks of blending hydrogen in the natural gas pipeline network.

STORE

Understanding geologic systems is a critical skill set to maximize geologic storage capacity and make a hydrogen economy possible.

GTI Energy is performing preliminary research into the challenges and opportunities for **large-scale, seasonal storage of hydrogen below ground**. Geologic storage of hydrogen in porous media such as depleted reservoirs and/or aquifers offer a promising sub-surface solution.

MAKE/STORE

GTI Energy and partners are evaluating a system to produce and store low-carbon, low-cost hydrogen with inherent CO₂ capture in an **asset-integrated hydrogen production and storage project**. Integrating hydrogen can improve level-loading of the electric grid and help meet growing U.S. market demand for cleaner electricity.

Based on positive techno-economics and environmental performance from this Phase 1 project, the team has been awarded DOE Phase 2 funding to perform a Preliminary Front End Engineering Design (Pre-FEED) study at a natural gas combined cycle (NGCC) power plant operated by Southern Company subsidiary Alabama Power.

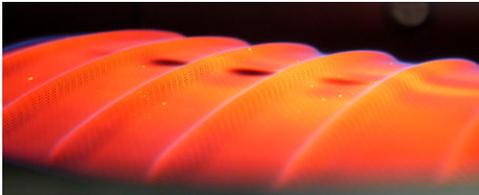


OPEN HYDROGEN INITIATIVE

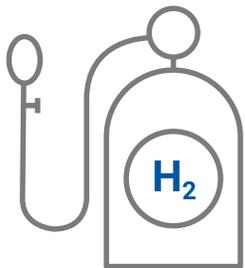
In February 2022, the **Open Hydrogen Initiative (OHI)** was launched. This new collaboration to assist in better defining the carbon intensity for hydrogen at the asset level and enabling further transparency is being led by GTI Energy and S&P Global Platts with expertise from National Energy Technology Laboratory (NETL).



USE



We are researching and testing conventional and advanced equipment and appliances to determine if **existing appliances** can be used as-is with a hydrogen/natural gas blend, need different components, or will need to be replaced with new appliances.



GTI Energy and partners are leading the **Sierra Northern Hydrogen Locomotive project** to design, build, and demonstrate a fuel cell switcher locomotive that is expected to reduce air pollutants.



In multiple pilot programs, GTI Energy and partners are demonstrating **Class 8 trucks** that combine fuel cells and batteries to help reduce costs.



Ted Barnes, R&D Director,
Transportation and Advanced
Energy Systems

“The rail and ports are challenging applications for low-carbon energy because they often require near-continuous operation and high power levels,” said Ted Barnes, R&D Director, Transportation and Advanced Energy Systems. “The Hydrogen Fuel Cell Demonstrations in Rail and Marine Applications at Ports (H2RAM) project with Sierra Railroad partially funded by California Energy Commission will directly address those issues.”

GTI ENERGY HELPS PRODUCE CLEANER ENERGY WORLDWIDE



Patrick Littlewood, Principal Scientist, Energy Supply & Conversion

Cool GTLSM converts CO₂-containing biogas into biojet fuels efficiently and affordably, with zero byproduct.

GTI Energy's **Cool LPG** technology is producing Bio LPG using renewable resources and waste. The first project aims to reduce pollutants with cleaner cooking fuels.

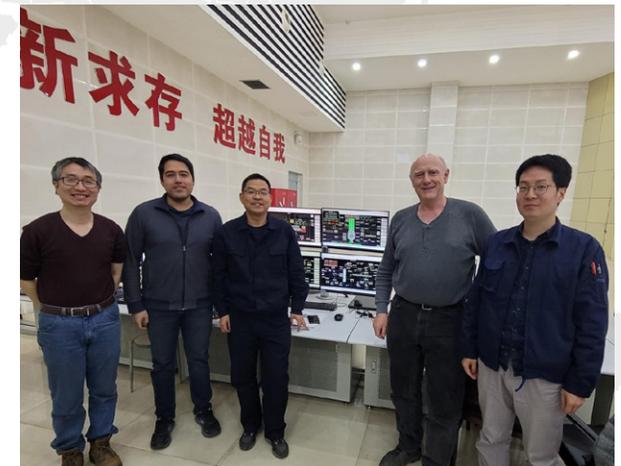
"Bio LPG could transform energy use worldwide," said Patrick Littlewood, Principal Scientist, Energy Supply & Conversion. "It is a clean-burning, drop-in, renewable fuel that is chemically identical to liquid petroleum gas (LPG). Bio LPG is produced with a significantly lower carbon footprint than leading alternatives by utilizing waste biomass as a feedstock."

Using Bio LPG as a cooking fuel will improve public health outcomes, support cleaner air, expand access to affordable clean energy, and raise standards of living in developing nations.

"I am very proud to be advancing actionable research and real-world technologies that support global decarbonization and expanded access to low-cost, clean energy in both developing and developed nations."

The **Hydraulic Fracturing Test Sites (HFTS)** in the Permian Basin are improving the design and execution of fracture treatments and providing an advanced scientific understanding to reduce the number of future wells drilled.

The **R-GASTM gasifier** with the Huayang New Material Science Technology group in China was successfully ignited. The plant will lower costs and minimize environmental impacts and can achieve >99% carbon conversion even with low-rank coal.





GTI ENERGY MITIGATES METHANE EMISSIONS AT SCALE

In 2021, we introduced **Veritas, a GTI Energy Differentiated Gas Measurement and Verification Initiative**. While an array of new measurement technologies and solutions are increasingly available, the market lacks a consistent, credible, verifiable, and transparent methodology for verifying emissions reductions.

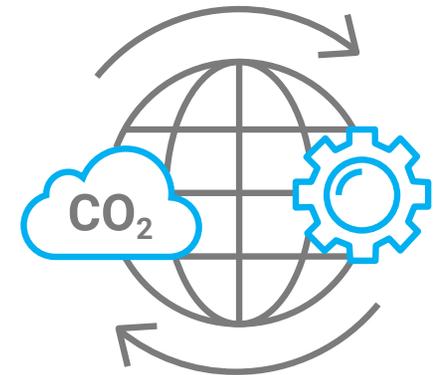
Veritas is developing technical protocols for six segments of the natural gas supply chain, ranging from upstream to downstream, to produce a trusted methodology to quantify methane emissions. These measurements can then be widely used to inform actions that drive emissions reductions. We are now testing each of these protocols with over a dozen demonstration projects that launched in March 2022 and will continue throughout the summer.

Throughout this process, we will maintain a diverse group of stakeholders as partners: academics, NGOs, companies, investors, policymakers, and vendors. We will continually incorporate their input through expert panels, comments, and briefings to ensure our methodology is widely accepted—and, most importantly, widely adopted.

“The project is moving along rapidly, and we have nearly 20 sponsors on board,” said Dr. Margaret (Meg) Coleman, Executive Director of GTI Energy’s Veritas Initiative and Director of Digital Transformation. “Veritas has a lot of moving parts, and things are progressing well and staying on schedule. It is such a great collaborative effort among the partners and within GTI Energy. Everyone involved is incredibly enthusiastic and hard working.”



Dr. Margaret Coleman,
Executive Director of GTI
Energy’s Veritas Initiative
and Director of Digital
Transformation



GTI ENERGY ACCELERATES EFFICIENCY THAT FUELS ECONOMIC GROWTH

Building Envelopes

We're retrofitting existing homes with high-performance envelopes and using them in new construction, paired with high-efficiency, low-capacity HVAC systems, to drive down load.

Building Assessments

We're assessing buildings as a system and using advanced simulation tools to characterize end-use energy technologies.

End-use Equipment

We're optimizing performance in homes, business, and industry and using low-carbon fuels to reduce carbon intensity.

Space and Water Heating

We're advancing a family of thermal heat pump (THP) technologies with pre-commercial installations, product demonstrations, accelerating codes and certification standards, and identifying manufacturing partners.

Military Base Efficiency

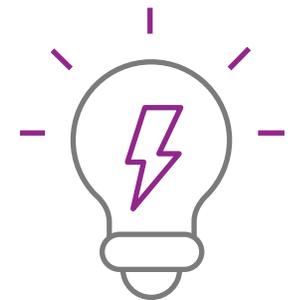
We're evaluating a slate of emerging technologies that incorporate improved controls, energy recovery, and onsite power systems, to enhance the energy efficiency and resiliency of multiple Department of Defense (DOD) facilities. A new project will demonstrate a micro-CHP technology to create greater resiliency in military bases.

ENERGY EFFICIENCY RESEARCH



Pat Rowley, R&D Manager, Energy Utilization

“The work that we are doing with the DOD is really impactful,” notes Pat Rowley, R&D Manager in Energy Utilization. “For example, high-efficiency natural gas equipment demonstrated at Illinois Army National Guard facilities reduced energy use by over 40%—that’s a big reduction in both energy costs and GHG emissions.”



GTI ENERGY ADVANCES CARBON CAPTURE, UTILIZATION, AND STORAGE

Laboratory Scale

Our **carbon reuse process** combines captured carbon dioxide with hydrogen to produce an energy-dense dimethyl ether, a drop-in fuel that is compatible with the pipeline infrastructure and end-use devices, and can be used to store renewable energy. DME is easily transported via pipeline or truck.

GTI Energy is exploring options for distributed **carbon capture at the point of use**. We are working towards evaluation of an innovative point-source technology that captures carbon from building heating system exhaust for Canadian company CleanO2.



Osman Akpolat, R&D Manager,
Energy Supply & Conversion

Engineering Scale

We're working with Ohio State University, Wyoming Integrated Test Center, and Trimeric Corporation on a DOE-NETL project to advance **Ohio State's transformational membrane technology** that will reduce CO₂-capture cost and energy penalties.

Pilot Scale

ROTA-CAP™ is a scalable, integrated industrial carbon capture system that uses novel horizontal rotating packed beds and advanced solvents to intensify the CO₂ capture process. Our novel mobile development skid is at the National Carbon Capture Center for full-scale testing through a partnership with Carbon Clean Solutions Ltd.

"The best feature of ROTA-CAP is its size because it is modular and can fit on an 18-wheeler! It makes transportation to the site much simpler and more cost-effective," said Osman Akpolat, R&D Manager, Energy Supply & Conversion. "By advancing a super-efficient, economical carbon capture technology that works with power generation and industrial manufacturing settings, we can have a significant impact on reducing CO₂ emissions."

Commercial Scale

We're redeveloping an existing gasification site in Indiana with Wabash Valley Resources, LLC to be a first-of-a-kind **flexible-fuel power plant** that will use bio-oil and petroleum residential waste along with carbon capture and sequestration to produce hydrogen with net-negative carbon emissions.

Maximizing geologic storage capacity is critical for CO₂ storage to become a truly universal element of the low-carbon energy transition. GTI Energy is examining new **geographic areas and geologic formations for large-scale storage of CO₂**, such as previously untested deep saline aquifers and in depleted unconventional wells.



GTI ENERGY USES DIGITAL TOOLS AND ROBOTICS TO DELIVER INFRASTRUCTURE SAFETY

Live Gas Mapping 3D Technology

A **smart probe** that can be inserted inside a live pipeline will map buried utilities, provide accurate utility locations, and directly download data to a GIS platform to help mitigate third-party pipeline damage.



ARPA-E REPAIR

The **REPAIR program** is focused on developing technologies to address leaks from legacy and outdated gas pipes and working to reduce the cost of replacement per mile by 10–20x. GTI Energy, as a part of a multi-institutional team, will develop a comprehensive data-driven framework of physical testing and modeling to enable the gas industry to better evaluate products it uses to rehabilitate aging pipelines.

Digital agents

Digital agents embedded into new technologies can automate actions, either presenting information to human agents or taking autonomous action based on trained conditions, such as enabling a valve to close without human interaction when the appropriate conditions are presented.

Applying AI

GTI Energy is integrating the use of **artificial intelligence (AI)** to connect field sensors into networks that can detect and pinpoint pipeline leaks, providing a solution that can be automated and implemented remotely to reduce emissions. Other stationary sensors that are installed can communicate specific messages regarding right-of-way disturbances, based on trained data sets.

Smart shutoff safety system

The **smart system** integrates sensors, shut-off valves, network communications, and user interface software for homes and residential/commercial multi-unit buildings to help reduce risks.

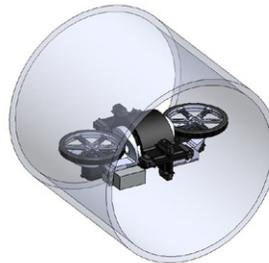
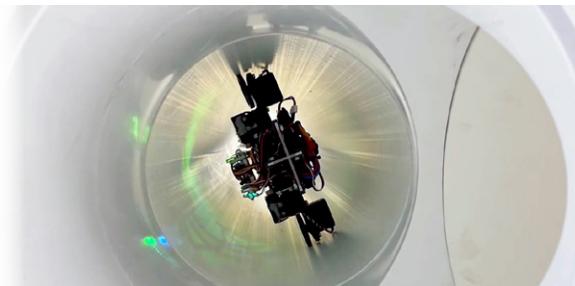
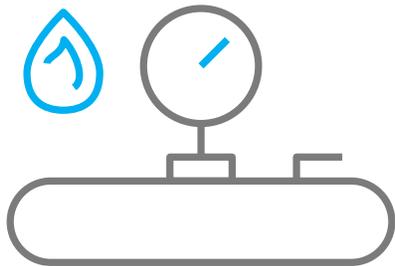


Tracking and traceability

GTI Energy has developed standards, guidelines, and software for **automating data collection** on pipelines and other system components based on a consensus industry marking standard. Partnering with utilities, pilot projects on digital supply chains are helping to establish consistent methodology and implementation protocols.

Leak detection technologies for gas transmission lines

GTI Energy delivered a **recommended practice** for selecting and evaluating performance of leak detection systems to the U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (U.S. DOT PHMSA). With co-funding from OTD, we're following up by implementing the results to evaluate unmanned aerial vehicle platforms for emissions.



PipeRider

Gas utilities will be able to use this versatile platform technology to map pipeline infrastructure. It will be capable of using cameras for visual inspection and anomaly detection. **PipeRider** can enable safer, faster, and more efficient inspection at lower cost.



Jim Louis,
Associate Engineer,
Energy Delivery &
Utilization

"We have watched technology get smaller and more amazing over the last 15 years, and pipeline operators have long awaited in-line inspection (ILI) technology to do the same," said Jim Louis, Associate Engineer, Energy Delivery & Utilization. "GTI Energy will partner with academia and the government to push the limits of how small we can make a fully functional autonomous mobile robot (AMR) platform to access 4-to-6-inch diameter lines."

LEADERSHIP

Executive Team

- David C. Carroll, President and CEO
- Quinton B. Ford, Senior Vice President, General Counsel and Secretary
- James F. Ingold, Senior Vice President of Finance, Treasurer, and CFO
- Paula A. Gant, PhD, Senior Vice President, 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

- Larry Brand, President, Frontier Energy, Inc.
- Nick Malkewicz, President, Projeo Corporation
- Robert Rigdon, CEO, SunGas Renewables

Business Leaders

- Erin Blanton, Executive Director, Future Energy Systems
- Richard M. Kaelin, Vice President, Government Affairs
- Shannon Katcher, Executive Director, Digitalization & Data
- Anthony T. Lindsay, Managing Director, Delivery
- William E. Liss, Vice President and Managing Director, Delivery and Utilization
- Jeremy M. Otahal, Vice President, People and Client Services
- Scott Reeves, Executive Director, Exploration and Production
- Duncan Robinson, Vice President, Commercialization
- Donald S. Stevenson, Vice President and Managing Director, Supply and Conversion
- Kristine Wiley, Vice President, Hydrogen Technology Center

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- Carlos A. Cabrera, Executive Chairman, Genomatica, Inc.
- David C. Carroll, President and CEO, GTI Energy (Ex Officio Director)
- Arthur C. Corbin, President and CEO, Municipal Gas Authority of Georgia (Vice Chair)
- Scott Drury, CEO, Southern California Gas Company
- Marc J. Florette, National Academy of Technologies of France
- Kimberly S. Greene, Chairman, President and CEO, Southern Company Gas
- Rebecca Ranich, President, Exenico, LLC (Chair)
- Lauren Riley, Managing Director, Global Environmental Affairs and Sustainability, United Airlines
- David F. Smith, Chairman, National Fuel Gas Company
- John W. Somerhalder II, Vice Chairman and Executive Director, FirstEnergy
- Nick Stavropoulos, President and Chief Operating Officer, Pacific Gas and Electric Company (retired)
- Lori S. Traweek, Chief Operating Officer, American Gas Association (retired)
- Dr. Michael E. Webber, Josey Centennial Professor in Energy Resources, Walker Department of Mechanical Engineering, University of Texas at Austin

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.

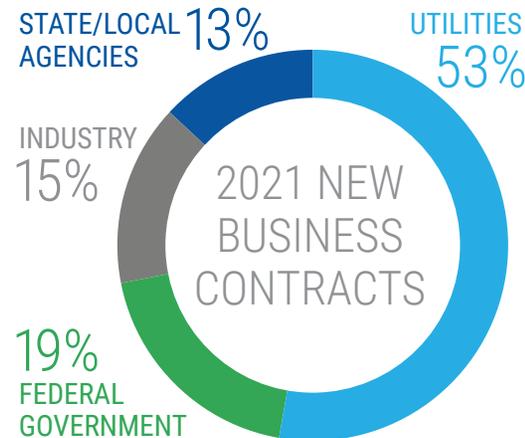
Quality. We have an obligation to our customers to deliver the very best product GTI Energy can provide.

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

FINANCIAL AND BUSINESS OVERVIEW

FINANCIALS

In Millions	2020	2021
Project Revenue	\$ 120.9	\$ 130.6
Royalty/Other Revenue	\$ 5.5	\$ 5.8
Total Revenue	\$ 126.4	\$ 136.4
Total Assets	\$ 153.0	\$ 162.1
Total Liabilities	\$ 55.7	\$ 63.3
Net Assets–Unrestricted	\$ 97.3	\$ 98.8



GTI Energy Offices

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

Projeo* Office

- Champaign, IL

SunGas Renewables Office

- Houston, TX

*Acquired January 1, 2022

Frontier Energy Offices

- Austin, TX
- Cazenovia, NY
- Chanhassen, MN
- Davis, CA
- Oakland, CA
- San Ramon, CA
- West Sacramento, CA

Rev Innovations Office

- Des Plaines, IL



ENVIRONMENTAL IMPACT AND COMMUNITY SERVICE

GTI Energy's Environmental Sustainability Committee sponsors events that divert waste from landfills. Over 70 pairs of shoes were collected to share with underserved locations worldwide, recycled into athletic turf, or converted into low-grade textiles, and nearly 3,680 pounds of electronic waste was collected to be refurbished or broken down for parts.

We have also established a standard to assess and harmonize our overall environmental footprint, evaluating the technologies that we help to deliver, as well as the impact of our offices' energy, water, and fuel use and the amount of waste we generate.

GTI Energy is committed to making an impact in our communities. Through an annual payroll deduction campaign, we support the United Way, Wounded Warrior Project, and the American Red Cross, and gather gifts for children as part of the U.S. Marine Corps "Toys for Tots" campaign. We have made a corporate donation to the Ukraine Crisis Relief Fund to help people with essentials such as shelter, food, clean water, medical, and psychological support.





GTI ENERGY

solutions that transform

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www.gti.energy

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