

# Managing Carbon, Growing Economies



## Transitions to Low-Cost, Low-Carbon Energy Systems Leveraging Gases, Fuels, and Infrastructure

### Objectives

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- Rise to the challenge of economy-wide deep decarbonization post-2030—beyond homes, buildings, and light-duty transport—and develop a longer-term vision that allows opportunities for new solutions to short-term problems
- Provide the low-cost, low-carbon energy needed to raise standards of living around the globe
- Identify the factors needed for successful transitions to low-cost, low-carbon energy systems and the technology pathways where we see opportunity to shape those transitions
- Invite like-minded partners to work with us to accelerate investment and innovations in low-cost, low-carbon options, leveraging GTI's experience and research capabilities

### Why This Matters

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- We are motivated to shape and accelerate clean energy transitions that protect the planet while also enabling a better quality of life for the people that inhabit it.
- GTI is uniquely situated to contribute to these energy transitions by leveraging low-carbon gases, liquid fuels, and infrastructure and by applying systems thinking.

### Key Messages

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- **Deep decarbonization post-2030, with continued economic growth, requires disruptive innovation at scale.**
- **GTI is curious about and investing in the roles that gases, fuels, and infrastructure will play in these low-cost, low-carbon energy systems.**
- **We believe global demand for gases (such as hydrogen) and liquid fuels will be robust well through mid-century.**
  - Innovations are required regarding how we produce, transport, store, and use gases and liquid fuels in ways that both reduce emissions and lower cost while ensuring safety, resilience, and reliability.
  - We expect hydrogen to emerge as a significant energy carrier by 2040 across a variety of sectors and end-use applications, including industrial processes, transportation, buildings, and power generation.
  - Research is needed (and underway) to overcome these challenges, including how hydrogen is used, transported or stored, and produced cost-effectively.

## Key Messages

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- **Gases will be particularly impactful in addressing today's hard-to-decarbonize sectors, such as industry and heavy-duty transport.**
  - GTI's state-of-the-art technologies—including Supercritical CO<sub>2</sub>, U-GAS, and R-GAS—reduce the carbon emissions of industrial processes.
  - Integrating carbon capture into conversion processes offers the opportunity for overall savings and utilization of captured emissions. Sequestering carbon dioxide into concrete, plastics, or other products that create value can reduce carbon emissions in the atmosphere, compared to post-combustion capture.
  - Carbon-neutral methane and hydrogen, along with fuel cells, will play leading roles in decarbonizing heavy-duty transport.
- **Continued, robust demand for liquid fuels worldwide will require decarbonization of both fossil and synthetic fuels.**
  - Liquid fuels will need to be carbon-neutral, cost-effective, reliable, and scalable.
  - GTI's Cool GTL technology has the potential to lower the production costs of converting CO<sub>2</sub>-rich gas to fungible liquids.
  - GTI's IH<sub>2</sub> technology converts non-food biomass feedstocks including waste, wood, and algae into lower-carbon gasoline, jet, and diesel drop-in fuels.
- **Leveraging existing infrastructure can facilitate a more affordable and resilient transition to low-cost, low-carbon energy systems. Understanding the impacts of more low-carbon gases and fuels on existing infrastructure will continue to be important.**
  - Existing U.S. gas infrastructure is well-suited to meet the demands of increasingly integrated, low-carbon energy systems in a cost-effective manner.
  - Gas systems can help solve the challenge of large-scale energy storage—with a vast, safe network and proven ability to deliver interseasonal storage.
  - Natural gas systems have a long history of safety and reliability—and represent hundreds of billions of dollars of investment alone.
  - Leveraging this reliable, resilient infrastructure in the U.S. will be vital to ensuring transitions to low-carbon energy systems are more economical for communities around the country.
- **As energy systems become increasingly integrated, applying systems thinking to modeling and design will be vital as we solve for multiple criteria—including emissions, reliability, affordability, and resilience.**
  - Building on GTI's expertise in systems operation and analysis, our Integrated Systems Laboratory offers the tools necessary to provide a system-wide overview and modeling to help build data-driven frameworks for decision-making.
  - These tools will be needed to enable smart, community-level decisions.
- **GTI envisions a carbon-managed future in which integrated energy systems leverage low-carbon gases, liquid fuels, and infrastructure to reduce carbon dioxide in the atmosphere.**
  - By deploying hydrogen, carbon-neutral liquid fuels, and chemicals in ways that build on existing infrastructure and systems, we can reduce costs, lower risk, and provide pathways to economy-wide deep decarbonization that supports growing economies worldwide.