



# Creating low-carbon, low-cost energy systems

Leveraging gases, fuels and infrastructure

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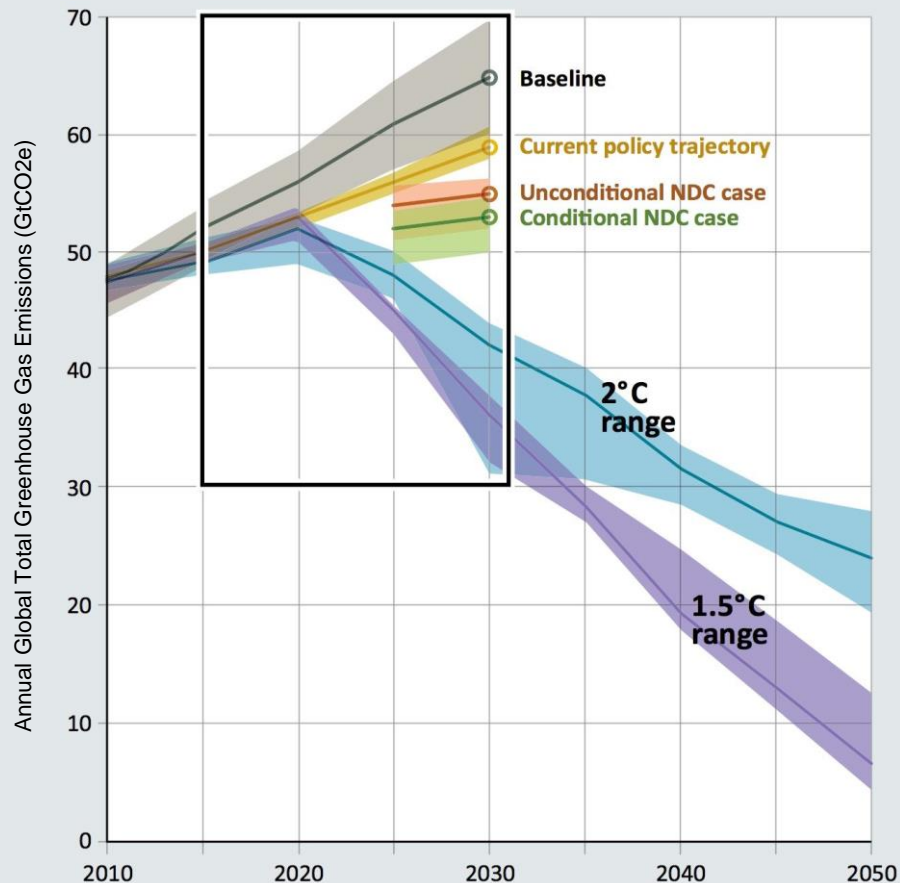
# 75-year history of turning raw technology into practical energy solutions



# DUAL IMPERATIVES

## Decarbonize Energy Systems

Global greenhouse gas emissions under different scenarios and the emissions gap in 2030

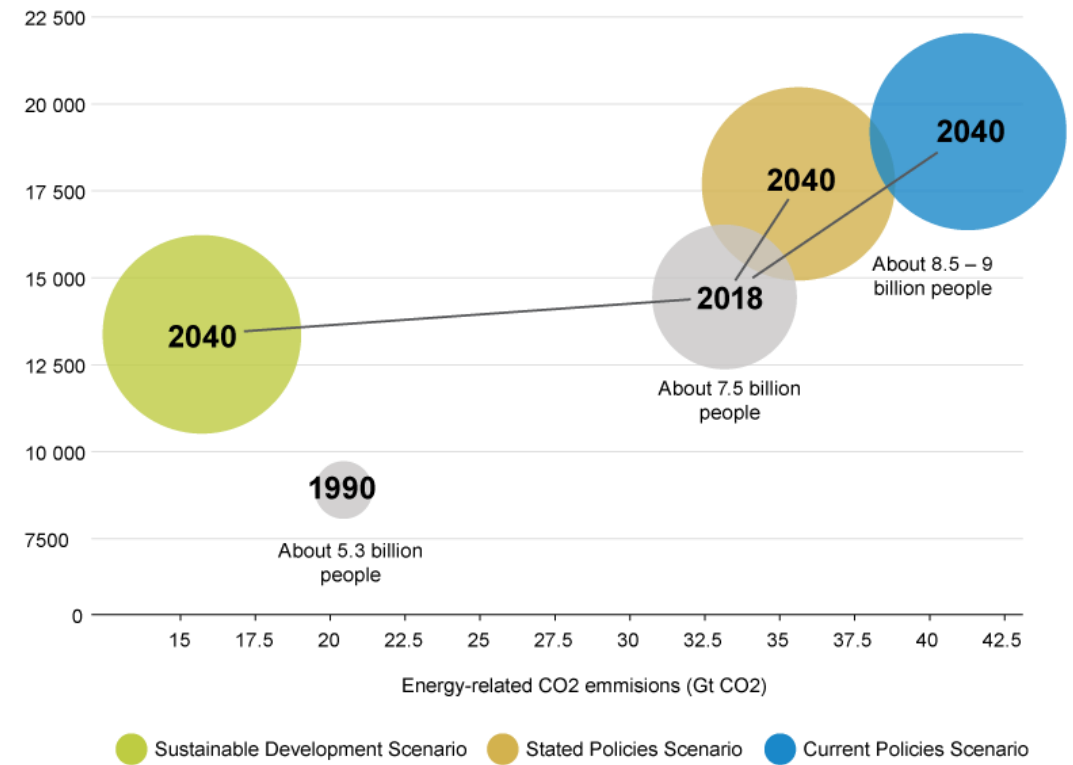


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## Provide Economies with the Energy Needed to Grow

World Primary Energy Demand and Energy-Related CO<sub>2</sub> Emissions by Scenario

Bubble size represents size of global economy



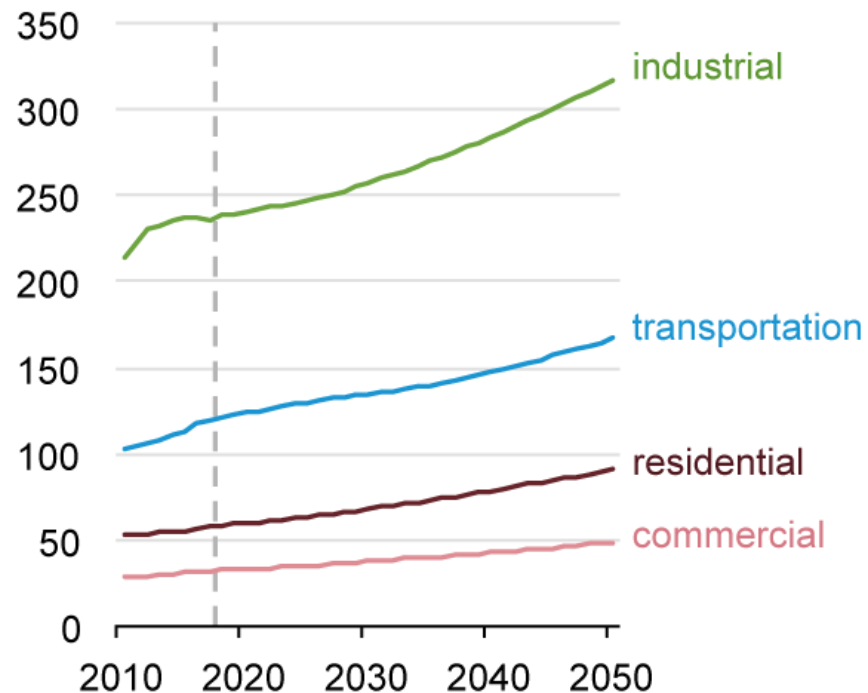
Sources: United Nations Environment Program (UNEP) 2017 Emissions Gap Report (left); International Energy Agency (right)

# Economy-wide transformation required

## Robust, long-term demand for gases and fuels

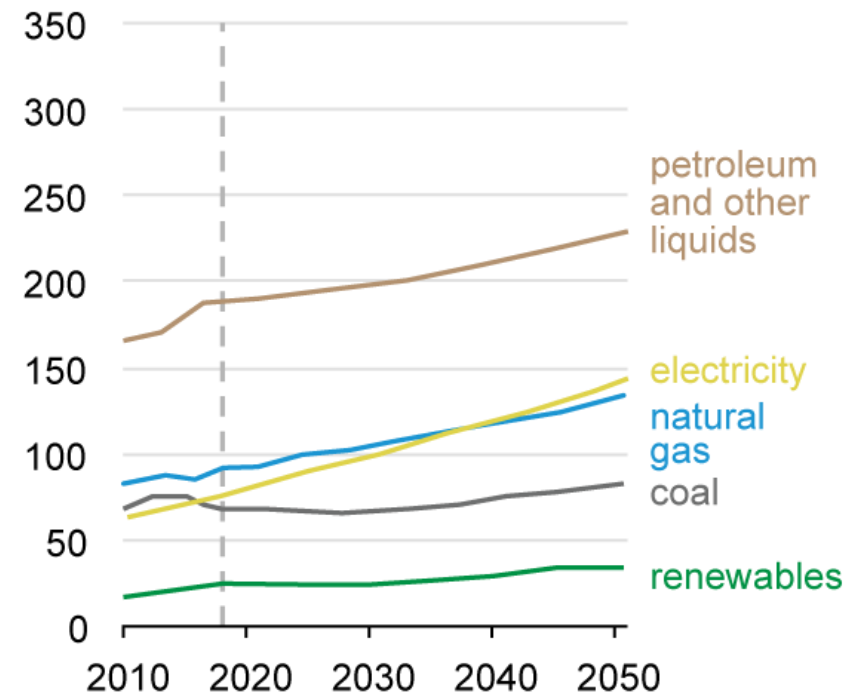
**End-use energy consumption by sector, world**

quadrillion British thermal units



**End-use energy consumption by fuel, world**

quadrillion British thermal units

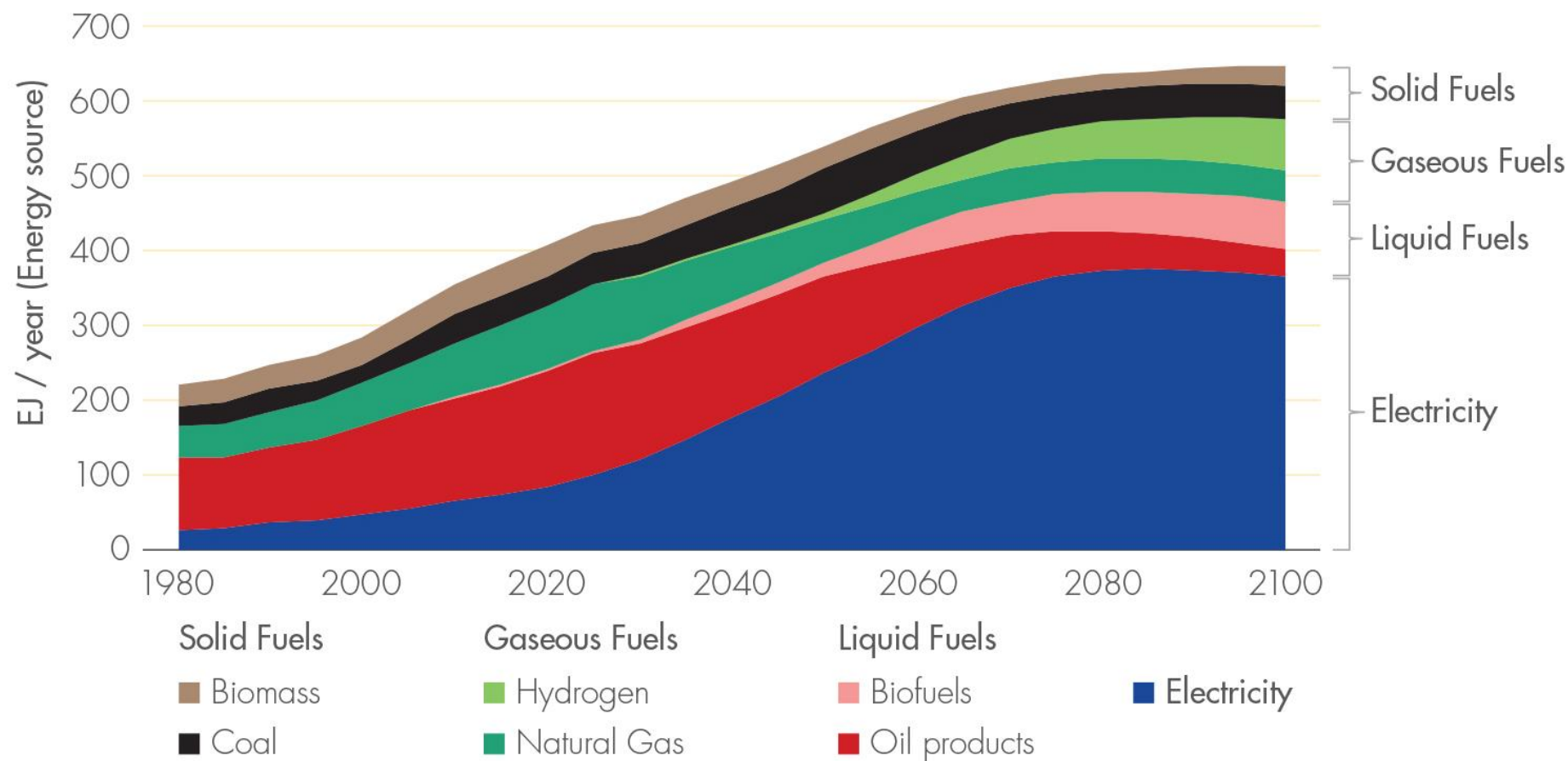


Source: U.S. Energy Information Administration



# Hydrogen emerges as an energy carrier by mid-century

Global End-Use Energy Consumption



Source: Shell Analysis, Sky Scenario; Meeting the Goals of the Paris Agreement









# Existing gas infrastructure provides vast energy storage

Hydrogen can be injected into existing natural gas infrastructure for storage

## Opportunities

- Low/no carbon emissions
- Proven reliability and affordability
- Over 2 million miles of pipeline
- Serves energy-intensive end uses

## Challenges

- Production cost of “green”  $H_2$
- Infrastructure integrity compatibility
- End use equipment compatibility

# GTI Hydrogen Technology Center

## World-class R&D capabilities to enable the hydrogen economy

### Low-carbon Production

- Compact Hydrogen Generator
- Liquid phase reforming
- Biomass gasification
- Using ammonia



### Compatibility with Natural Gas Delivery Infrastructure

- Material impacts of blending
- Blending technology and standards

### Use in Industry and Buildings

- End-use equipment testing
- Codes and standards

### Use in Transportation

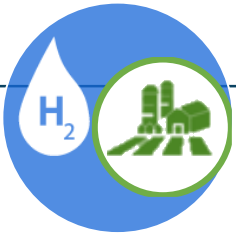
- California Fuel Cell Partnership
- Fueling station technology
- RNG-to-hydrogen fueling
- Quality sampling



# LCRI conceptual overview

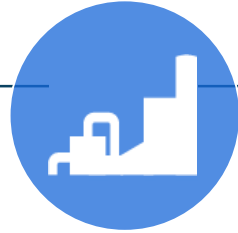
...to 2050

The **Low-Carbon Resources Initiative** will be a five-year, focused R&D commitment to reveal the pathway to advance low-carbon technologies for large-scale deployment approaching **2030**. Led by and funded through **EPRI and GTI**, the vision is to enable a risk-informed understanding of options and technologies for deep, economy-wide decarbonization, and advance these through applied engineering and technology acceleration.



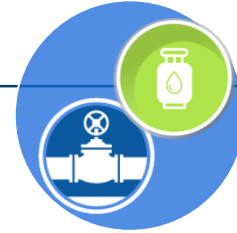
## Low-Carbon Resource Production

Reduce production costs of low-carbon resources to competitive levels



## Low-Carbon Power Generation

Advance CCUS, hydrogen turbines, and other technologies as cost-competitive low-carbon power generation alternatives



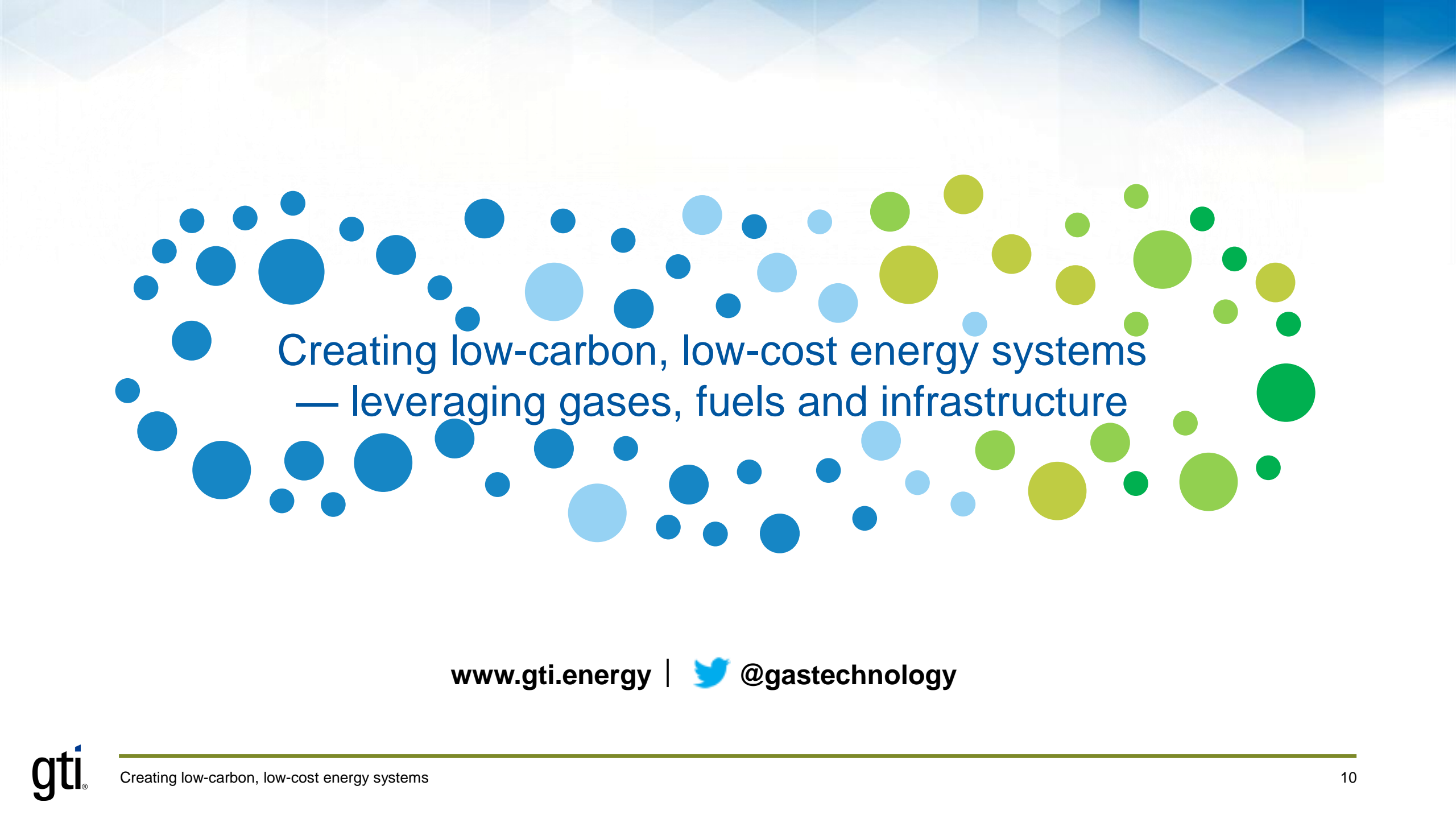
## Transmission, Delivery, and Storage

Develop cost-effective, safe, and reliable low-carbon energy infrastructure (existing and new)



## End Use

Provide customer-driven low-carbon energy end use alternatives for transportation, heavy industry, and res./comm. buildings



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— leveraging gases, fuels and infrastructure

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