

# Natural Gas to Hydrogen Conversion

*Combustion Considerations for Existing  
Duct Burners and Boilers*

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# Outline

- LCRI Overview
- Duct Burner and Boiler Project Areas
- Q&A





# Low-Carbon Resources Initiative

## FOCUS

**Multiple options and solutions** to establish viable low-carbon pathways

**Technologies for hard-to-decarbonize** areas of the energy economy

**Affordable, reliable, and resilient** integrated energy systems for the future

## RESEARCH AREAS

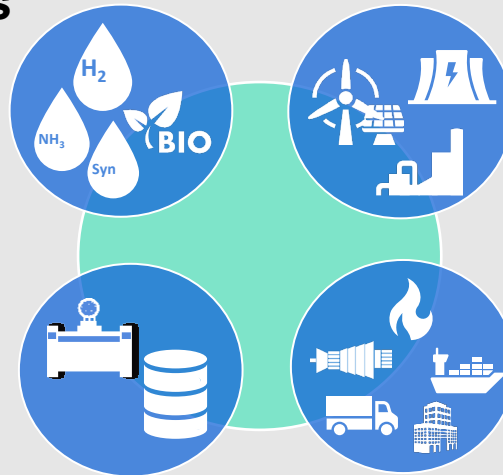
**Hydrogen**   **Ammonia**   **Synthetic/  
Derivative Fuels**   **Biofuels**

**Production  
Pathways**

**Integrated  
Energy  
Systems**

**Storage &  
Delivery**

**End Use  
Applications**



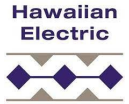
## VALUE

**Independent, objective research** leveraged by global engagement and collaboration

**Comprehensive approach** to low-carbon value chain and technology analyses

**High-impact results** from technology evaluations, and safety, environmental, and economic assessments

# LCRI Sponsorship

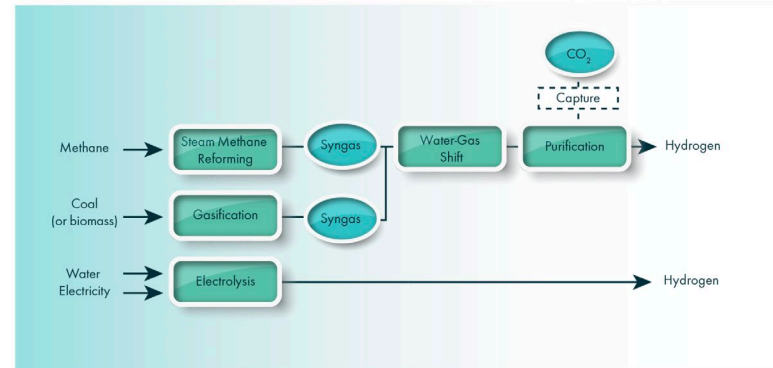


# An Introduction to Low-Carbon Fuels – Published

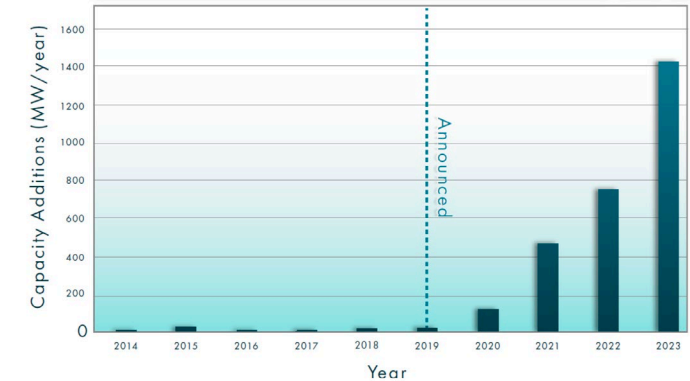


<https://www.epri.com/research/products/000000003002020041>

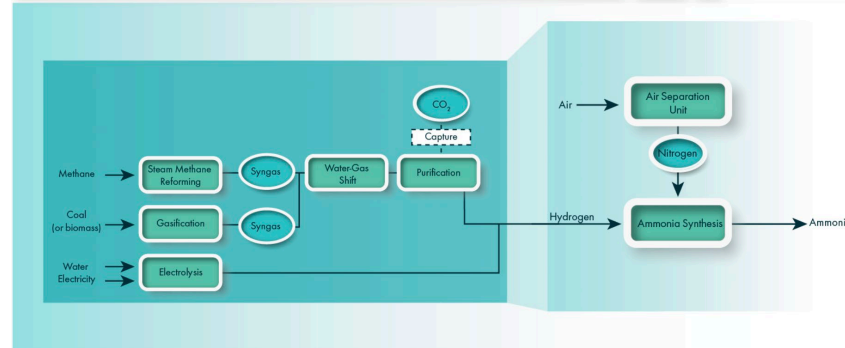
## Key Hydrogen Production Pathways



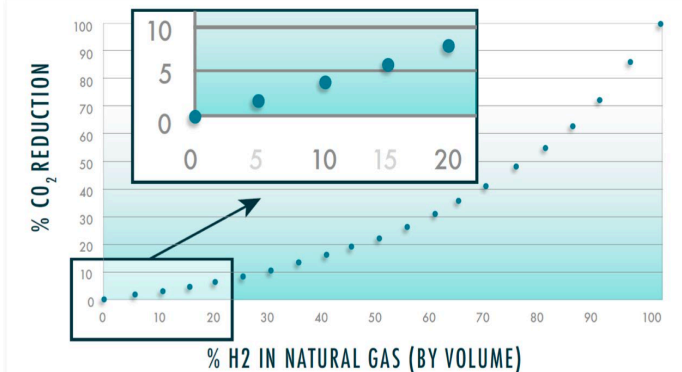
## Global Electrolysis Capacity Coming Online Annually



## Ammonia Production Pathways



## CO<sub>2</sub> Reduction for Hydrogen-Natural Gas Blends






# EPRI and LCRI Technical Briefs – Published




<https://www.epri.com/research/products/000000003002017544>

<https://www.epri.com/research/products/000000003002020043>



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RESOURCES INITIATIVE

## TECHNOLOGY INSIGHTS

*A Report from EPRI's Innovation Scouts*

### HYDROGEN-CAPABLE GAS TURBINES FOR DEEP DECARBONIZATION

#### THE TECHNOLOGY


Recent innovations in burner design and fuel staging enhance the capability of gas turbines to accommodate fuels with high hydrogen content. More work is needed to develop and validate turbine components and systems suitable for 100% hydrogen combustion.

#### THE VALUE


Robust low-NO<sub>x</sub> gas turbines capable of producing power from low-carbon fuels such as hydrogen could enable natural gas assets and infrastructure to be leveraged as a resource for decarbonization within the integrated energy network.

#### EPRI'S FOCUS

EPRI is tracking progress by gas turbine manufacturers in developing high-hydrogen-capable components and systems and is exploring opportunities for research, collaborative technology evaluations, site assessments, and demonstrations.



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## TECHNOLOGY INSIGHTS

### AMMONIA AND HYDROGEN FUEL BLENDS FOR TODAY'S GAS TURBINES: COMBUSTION CONSIDERATIONS

#### THE TECHNOLOGY

As potential fuels for gas turbine (GT) combustion, hydrogen and ammonia independently have combustion challenges compared to natural gas. However, ammonia-hydrogen fuel blends show promise for mitigating some of these issues. To accommodate these blends, extensive research efforts will be needed to develop commercially available, low-NO<sub>x</sub> GT combustors for new and retrofit applications.

#### THE VALUE

Flexible, low-NO<sub>x</sub> GTs capable of producing power from low-carbon fuels, such as hydrogen and ammonia, could enable natural gas assets and infrastructure to be leveraged as a resource for decarbonization.

#### LCRI'S FOCUS

The Low-Carbon Resources Initiative (LCRI)<sup>1</sup> is exploring opportunities for research, development, and demonstration of low-carbon fuels for GTs, including optimized hydrogen-ammonia blends.

# Power Generation Technical Subcommittee

- **Scope:**

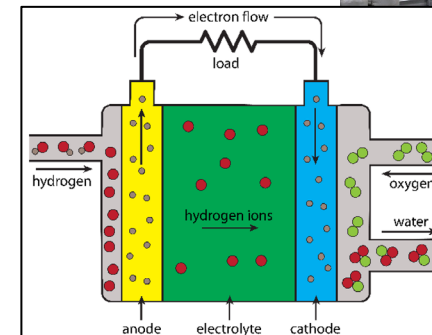
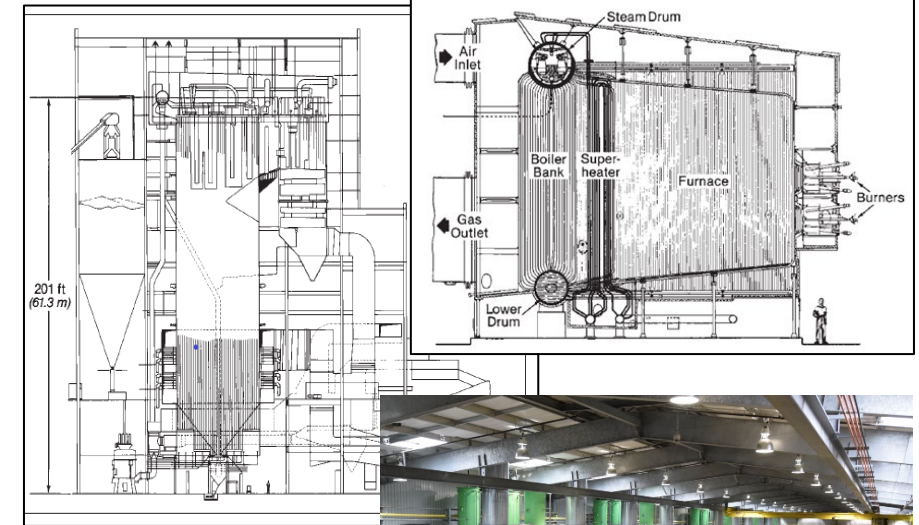
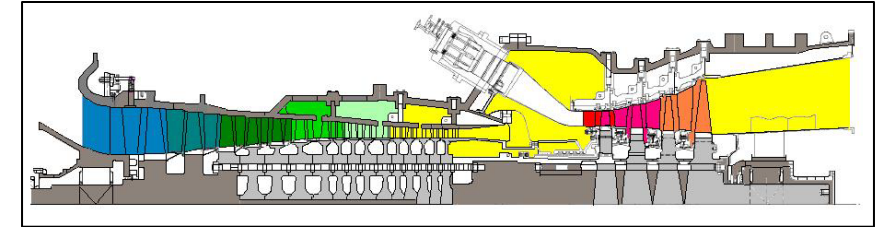
- Gas Turbines, HRSGs (duct burners) and boilers, reciprocating engines, fuel cells

- **Objective:**

- Confirm the viability of low-carbon fuels for power generation, both in pure or blended forms

- **Approach:**

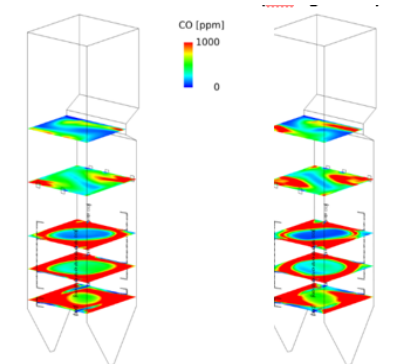
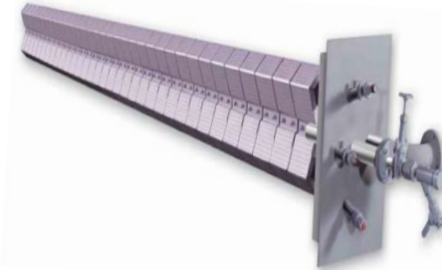
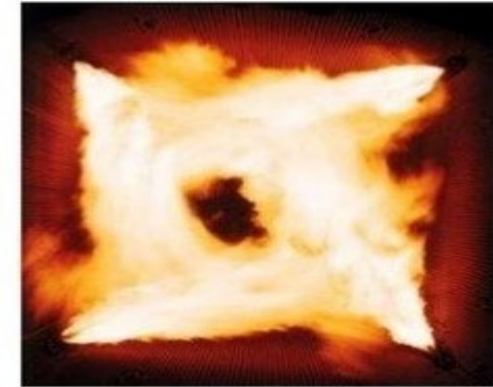
- Review and assess low-carbon fuels with emphasis on hydrogen and ammonia
- Identify worldwide players (OEMs, universities and research organizations) and current projects
- Identify R&D gaps and collaboration opportunities
- Develop and execute projects



# LCRI Project Development

## *Duct Burners and Boilers*

1. H<sub>2</sub> Co-firing and Conversions: Duct Burners and Industrial Boilers
2. Ammonia Combustion Issues for All Applications
3. Post-Combustion NO<sub>x</sub> and CO Catalyst Impacts





# H<sub>2</sub> Co-firing and Conversions: Duct Burners and Industrial Boilers

- **Issue:**

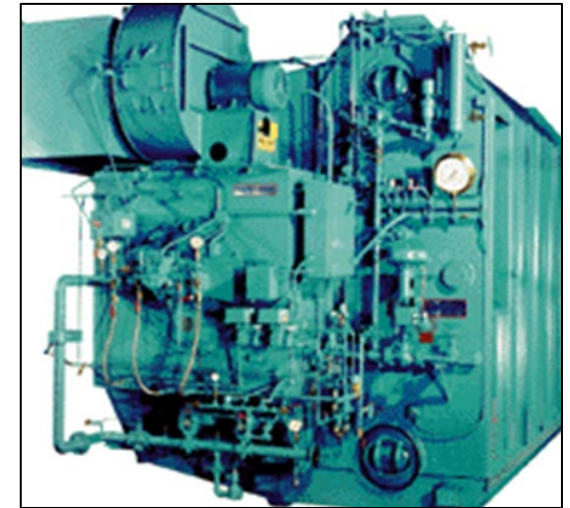
- H<sub>2</sub> applications currently exist (originally designed for H<sub>2</sub>)
- Examples of conversion of existing NG duct burners and smaller industrial boilers to H<sub>2</sub>, along with performance impacts, are lacking

- **Objectives:**

- Examine key issues (e.g., NO<sub>x</sub>, materials, I&C, HRSG impacts, safety, etc.)
- Develop guidance for H<sub>2</sub> co-firing and conversions

- **Approach:**

- Acquire/assess available data
- Perform engineering analyses (NO<sub>x</sub>, temps, heat dist., etc.)
- Assess required modifications, associated cost and scheduling requirements
- Collaborate with system owners and OEMs



# Ammonia Combustion Issues for All Applications

## ■ Issue:

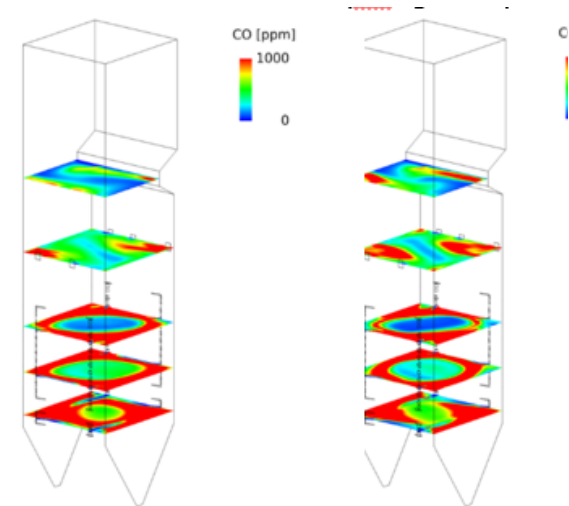
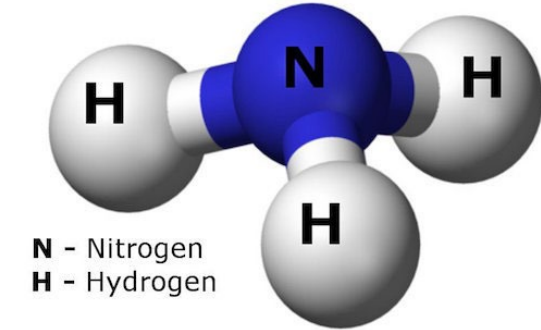
- Ammonia combustion is early in its development; there are many unknowns

## ■ Objective:

- Improve understanding of combustion challenges and seek methods to overcome

## ■ Approach:

- Evaluation of work by other R&D organizations
- Engineering analyses to better understand key issues (NO<sub>x</sub>, flammability limits, radiant heat transfer, etc.)



# Post-Combustion NOx and CO Catalyst Impacts

## ■ Issue:

- GTs, duct burners and boilers modified to fire  $H_2$  and/or  $NH_3$  may generate higher NOx relative to natural gas
- SCR design parameters and potential system modifications must be considered
- No need for CO catalyst when firing 100%  $H_2$  and/or  $NH_3$

## ■ Objectives:

- Define key parameters (reagent use, catalyst volume,  $NH_3$ /NOx distribution, AIG design)
- Examine potential options and costs for modifying existing SCR systems

## ■ Approach:

- Develop projects addressing key concerns
- Collaborate with system owners and OEMs





# LCRI

LOW-CARBON  
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Enabling the Pathway  
to Economy-Wide Decarbonization