

# The Advantage of Public Private Partnerships

## GTI Hydrogen Conference

September 28, 2020

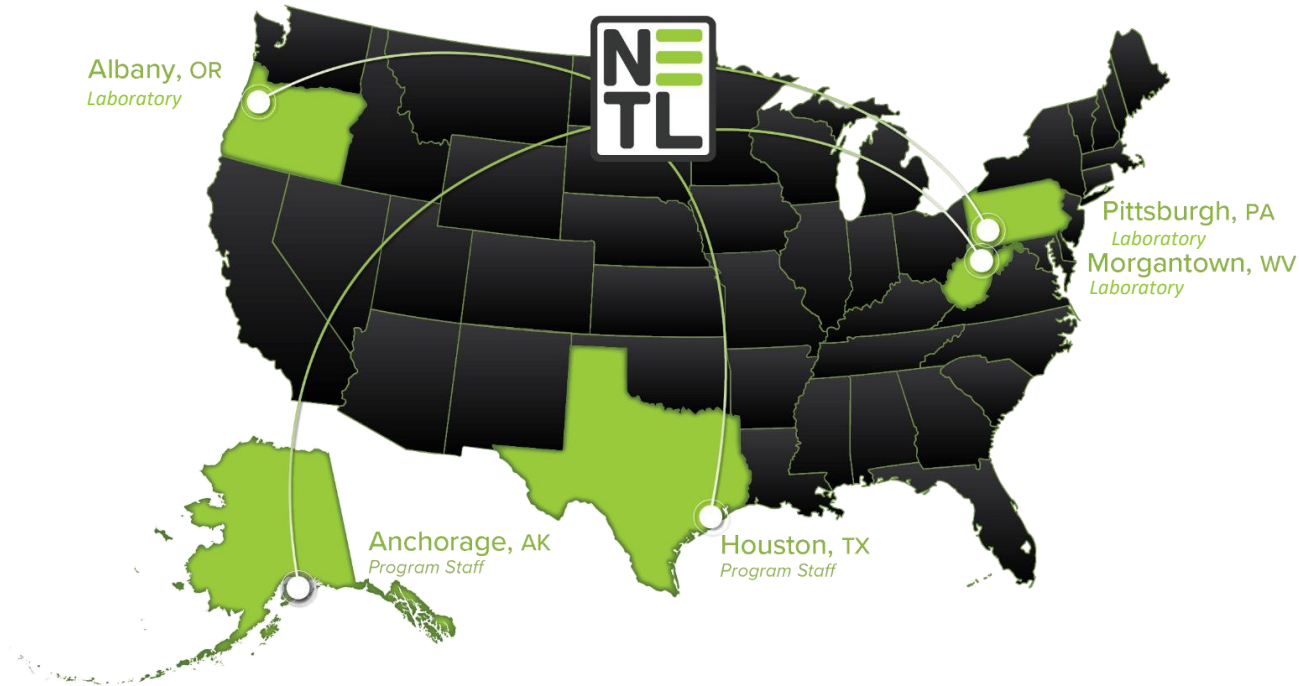


Solutions for Today | Options for Tomorrow

# Driving Innovation, Delivering Solutions



National Energy Technology Laboratory (NETL) is **one of 17** U.S. Department of Energy (DOE) national laboratories; producing technological solutions to America's energy challenges.



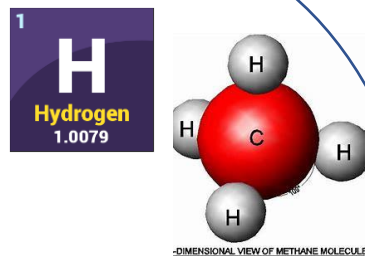
- NETL has **five locations**
- Only National Lab **dedicated carbon research**
- Government owned & operated
- **One of three applied** national labs
- Flexible **Intellectual Property**

## MISSION

**Discover, integrate, and mature** technology solutions to **enhance** the nation's energy foundation and **protect** the environment for future generations.

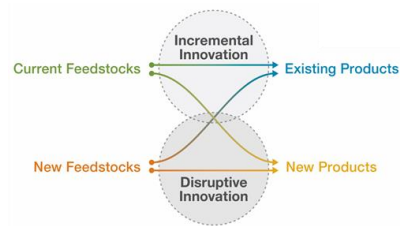
# Innovative Solutions for the Industrial Sector

*NETL's Center for Sustainable Fuels & Chemicals technical offerings*



## Developing Lower Carbon Footprint Feedstocks

Select **feedstocks** for a more agile supply chain.



## Increasing Processing Efficiency

Enhance materials, conversion and separation, microwave matched with **scale up**.



## CO<sub>2</sub> Management

Manage the engineering, integration, and policy to **economically transition**.



## Disposition & Recycling

Manage the product **Life cycle** to collect, move, disassemble and re-create.



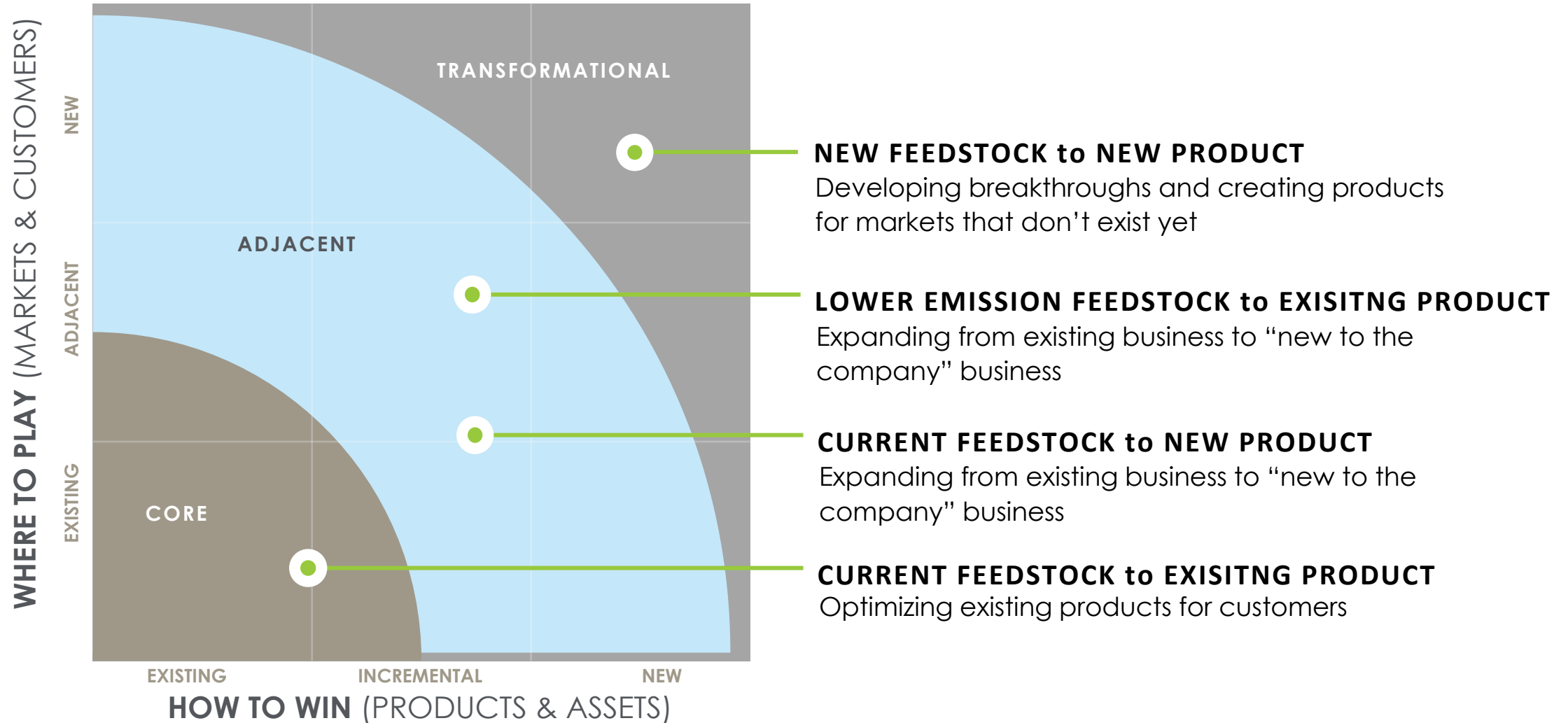
## Cross-Cutting Decision Making

Quantify emissions and evaluate benefits of investment options via **LCA**.



# Selecting the *right* innovation pursuits

Navigating the transition to a lower-emissions future requires a portfolio of R&D pursuits



# A suite of tools for today and tomorrow

Equipped with decades of Fossil Energy experience and cutting-edge carbon capture technologies, NETL is a natural partner in enabling cleaner, sustainable energy systems.



## INDUSTRY NEEDS

The below illustrates what we've heard as **industry needs in Hydrogen:**



Materials and Process Modeling



Lower CO<sub>2</sub> Emissions in heavy industry sectors



Innovative approach to transportation challenges



Cost-effective Research & Development

With decades of experience in hydrogen-adjacent technologies and demonstrations of new technologies, **NETL is ready to leverage their CLEAN HYDROGEN expertise to industry partners.**

## NETL CLEAN HYDROGEN CAPABILITIES

**Leader in materials and extreme environments** to combat hydrogen material challenges

Materials

Experienced in multiple conversion methods including **gasification, chemical looping, & pyrolysis.**

Conversion

Tools to explore blending hydrogen into our nation's large **natural gas infrastructure** to reduce hydrogen pipeline transportation costs and expand use in power applications.

Natural Gas

Successful, innovative **CO<sub>2</sub> separation, capture, and conversion technologies.**

CO<sub>2</sub>

New methods using **microwave catalysis** and advanced **process modeling**

Process Modeling & Efficiency

A robust **solid oxide fuel cell** program generating efficient, low-cost electricity through **electrolysis**

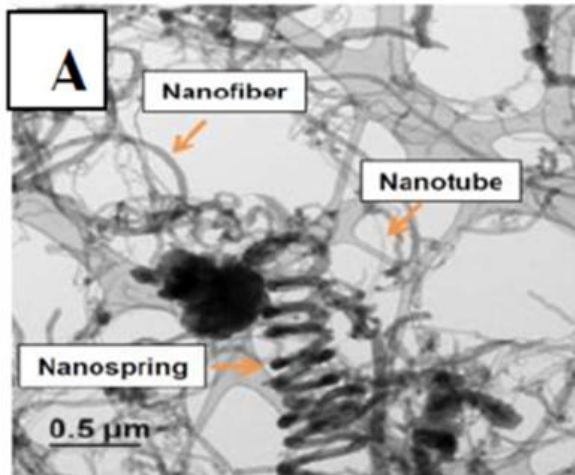
Fuel Cells



U.S. DEPARTMENT OF  
**ENERGY**

# NETL Has Already Begun to Demonstrate Hydrogen Technologies

## Natural Gas Pyrolysis



Solid carbons recovered from a catalytic natural gas pyrolysis process

Natural gas pyrolysis using high-performance, NETL-developed catalysts **co-produces hydrogen, carbon fibers and carbon nanotubes** to yield very low hydrogen production costs, even with a low carbon selling price of \$2/kg

## Modular, Flexible Ammonia Production



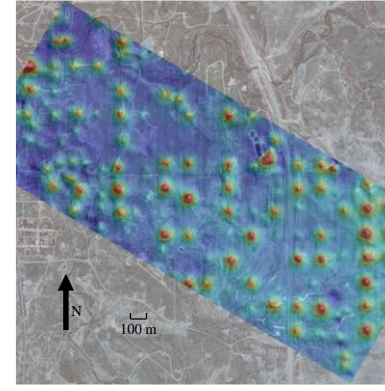
Developed and demonstrated **hydrogen carrier production** (e.g., ammonia) that is inherently modular and virtually instantaneous at startup

## Hydrogen Utilization



NETL's Rotating Detonation Combustors operate best on hydrogen, and have the potential to provide a 4-7% step change in **gas turbine efficiency**

# NETL Core Competencies in Hydrogen R&D



NETL R&D on Hydrogen	COMPUTATIONAL SCIENCE & ENGINEERING	MATERIALS ENGINEERING & MANUFACTURING	GEOLOGICAL & ENVIRONMENTAL SYSTEMS	ENERGY CONVERSION ENGINEERING	STRATEGIC SYSTEMS ANALYSIS & ENGINEERING
Production	✓	✓		✓	✓
Transport		✓	✓	✓	✓
Storage	✓	✓	✓	✓	✓
Utilization	✓	✓		✓	✓

# Long History of R&D, building end-to-end solutions to enable the hydrogen economy



## What value can NETL bring to industry partners?



### LEADERS IN DISCOVERY SCIENCE

NETL has deep research in 25+ relevant technology offerings, in early TRL stages, applicable to the industrial sector



### KEY STAKEHOLDER IN SCALING UP SOLUTIONS

Key stakeholder in a signature scale-up facility geared towards moving hydrogen technology at TRL 4 to TRL 7 or greater



### PIONEERS OF VIRTUAL PROCESS DESIGN

Proven success in utilizing virtual process design to reduce the technical risks through computational science, modeling, and uncertainty quantification



### COMPREHENSIVE HYDROGEN CAPABILITIES







Suite of technical and virtual process design to support planning, roadmap development, techno-economic analysis and technology development along the value chain.

- Unparalleled insights in Hydrogen technologies in **TRL 2-6**
- Potential engagement in the U.S. **industrial sector** hydrogen hubs
- Key stakeholder to serve as intermediary **between hydrogen and CO<sub>2</sub>** transport and storage entities



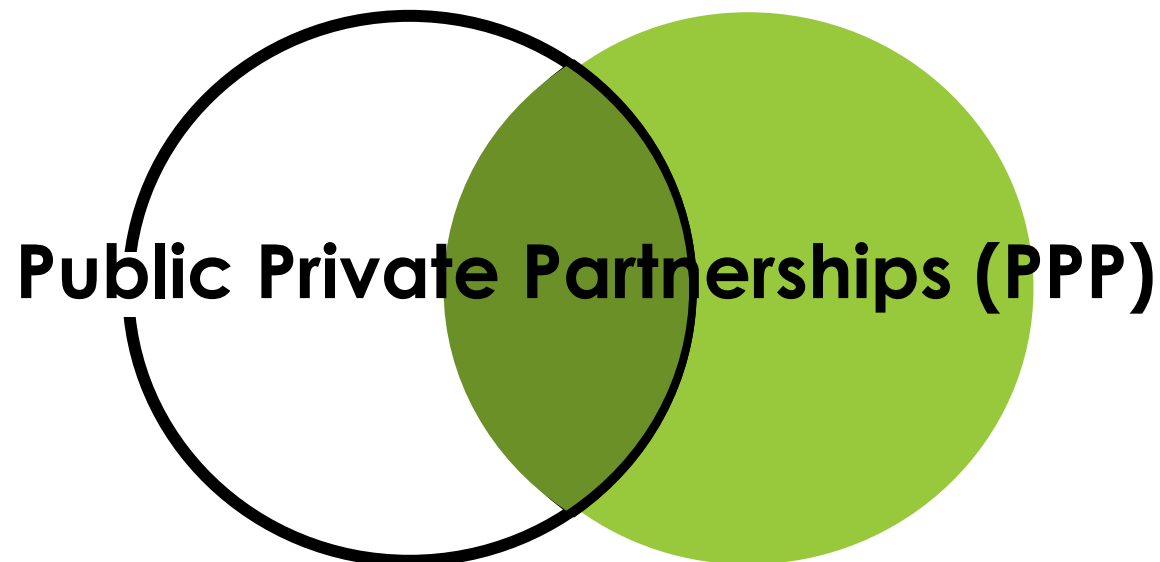
# We're better together.

Strong collaboration between publicly funded R&D organizations, like NETL, and private industry is necessary to understand innovation dependencies. With a robust partnership, both parties will reap the strategic benefits:

-  **Accelerated technological advancement** via access to top researchers and scientists
-  **Creative solutioning** by engaging diverse backgrounds and organizational viewpoints
-  **Risk Mitigation** through modeling and simulation technologies to drive better decisions
-  **Faster project completion** with scale up and equipment/facilities access
-  **Expertise is engaged and shared** freely with minimal competing interests
-  **Risks** are fully appraised and **shared** amongst the group

# Mitigating Risks Through Partnerships

PPP's have a high track record of success, but there is always risk in R&D



## Risks faced by chemical industry:

**Financial**

**Market Desirability**

**Technical Viability**

- Uncertainty quantification
- Robust optimization
- Sequential design of experiments

**Regulatory**

**Time Constraints**

# THANK YOU!

VISIT US AT: [www.NETL.DOE.gov](http://www.NETL.DOE.gov)



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