Advanced Manufacturing Office Technical Partnerships Programs

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U.S. DEPARTMENT OF ENERGY
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

EERE's Advanced Manufacturing Office (AMO)

U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Advanced Manufacturing Office

BUDGET

$396M

FY21

WHAT WE DO

Partner with industry, academia, states, and National Laboratories to catalyze R&D and the adoption of advanced manufacturing technologies and practices

STAFF

~70

Feds, contractors, and fellows

GOLDEN, CO AND DOE HEADQUARTERS

R&D Projects

FY21 = $218M

R&D Consortia

FY21 = $133M

Technical Assistance

FY21 = $45M

Technical Partnerships Highlight: Overview

Better Plants
U.S. DEPARTMENT OF ENERGY

U.S. DEPARTMENT OF ENERGY
CHP Technical Assistance Partnerships

Industrial Assessment Center
U.S. DEPARTMENT OF ENERGY

50001 Ready
U.S. DEPARTMENT OF ENERGY

Superior Energy Performance®
U.S. DEPARTMENT OF ENERGY

- Five great programs
- Free technical assistance and workforce training
- Access to National Laboratory resources, software, and instrumentation
- Customized assistance for small- and medium-sized manufacturers
- Expertise in energy management (based on ISO 50001)
- CHP and Waste Heat Recovery
- Technology Validation
- National Recognition

DOE Priorities: Deploying the Clean Energy Revolution

BIDEN ADMINISTRATION CLIMATE GOALS

A carbon pollution-free power sector by 2035

Net-zero emissions by 2050

Make basic science breakthroughs

Turn that science into deployable technologies

Fund deployment of clean energy technologies

- **CREATE GOOD-PAYING JOBS**
  associated with the fast-growing global market for products that reduce carbon emissions
- **COMMITMENT TO ENERGY JUSTICE**
  and target disadvantaged communities for new clean energy investments, jobs, and businesses
- **ENCOURAGE ROBUST COLLABORATION**
  across the federal government, the fifty states, and the private sector

Priorities to Strengthen U.S. Manufacturing

Industrial Decarbonization	Supply Chains for Energy Technologies and Manufacturing	Energy Storage
Accelerate emerging and transformative technologies needed to approach net-zero GHG emissions in the industrial sector by 2050 through a multi-year robust portfolio of industrially-relevant applied RD&D and technical assistance activities.	Strengthen supply chains for critical materials for clean energy technology. Focus on balanced approach including diversifying supply, developing substitutes, driving reuse/recycle/more efficiency use.	Pursue and scale up innovative technologies to reduce manufacturing costs and address manufacturing barriers across the supply chain to reduce the cost and improve the performance of energy storage systems.
Agile Manufacturing	**Water**	**Education and Workforce Development**
Develop flexible manufacturing capabilities and dynamic supply networks to meet rapidly changing demands and address market needs, while reducing energy impact and costs.	Develop technologies that decarbonize water treatment processes and address key water and wastewater infrastructure issues.	Train the next generation of manufacturing workforce. Reskill workers in disadvantaged communities.

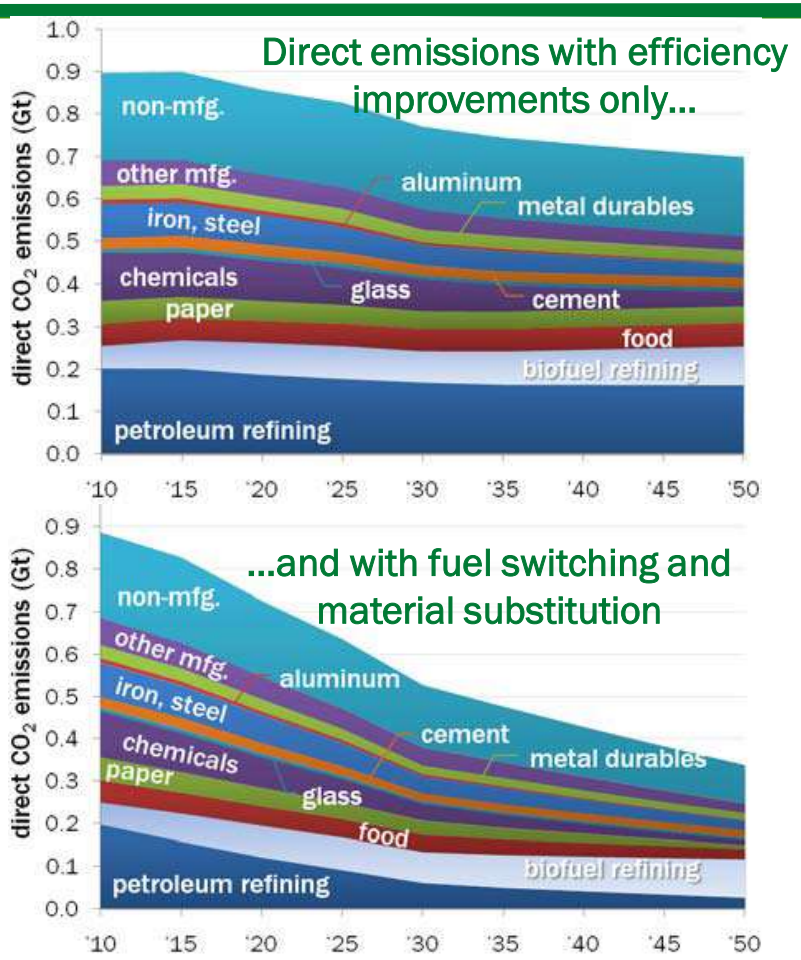
Spotlight: Industrial Decarbonization

- AMO was directed by Congress to "develop decarbonization roadmaps to guide R&D at the DOE…to phase out net GHG emissions by 2050" and to highlight opportunities to increase U.S. competitiveness in the industrial sector
- A multi-lab effort (National Renewable Energy Lab, Lawrence Berkeley National Laboratory, Argonne National Laboratory, Oak Ridge National Laboratory) in consultation with key stakeholders; external workshops held spring 2020
- Roadmap focuses on cement, iron & steel, food, chemicals, and petroleum refining, the top emitting manufacturing subsectors

FINDINGS

- **Energy efficiency alone is insufficient to meet net-zero Greenhouse Gas emissions by 2050**
- Crosscutting barriers can be address by Research Development & Demonstration (RD&D) and include:
  industrial heterogeneity ♦ high costs
  incumbent technology and practices ♦ scale up
- Identified RD&D needs and opportunities center on around three decarbonization pillars:

energy efficiency	electrification & low-carbon fuels	carbon capture, utilization, & storage



Example analysis based in part on bandwidth SOTA & PM potential, and EIA Annual Energy Outlook (AEO) forecast as baseline.

Technical Partnerships Response to Decarbonization Goals

Better Plants
U.S. DEPARTMENT OF ENERGY

→ Low Carbon Pilot
Increased outreach to energy-intensive industries

U.S. DEPARTMENT OF ENERGY
CHP Technical Assistance Partnerships

CHP fueled by RNG/Hydrogen

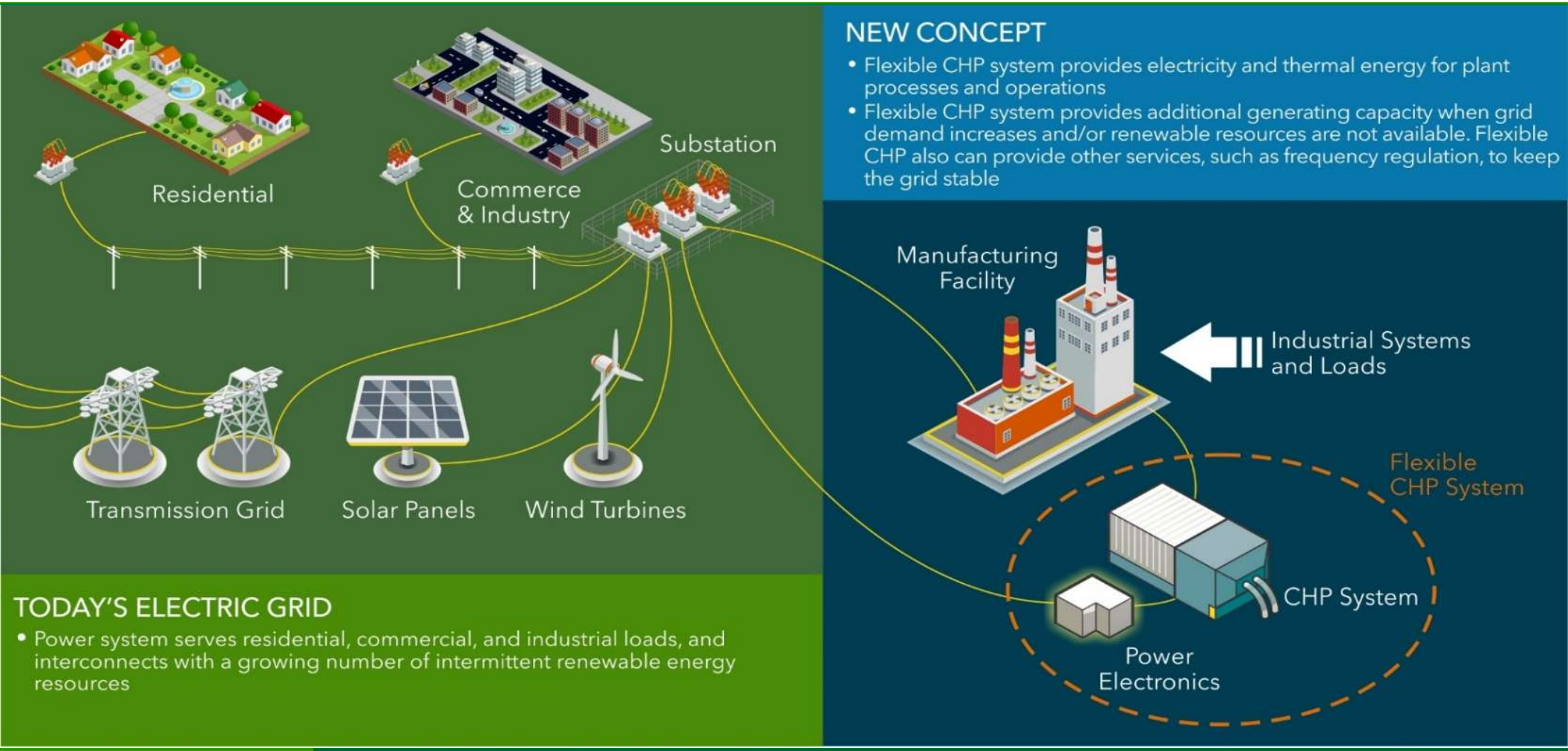
Industrial Assessment Center
U.S. DEPARTMENT OF ENERGY

→ Recommendations for carbon reductions during IAC assessments

50001 Ready
U.S. DEPARTMENT OF ENERGY

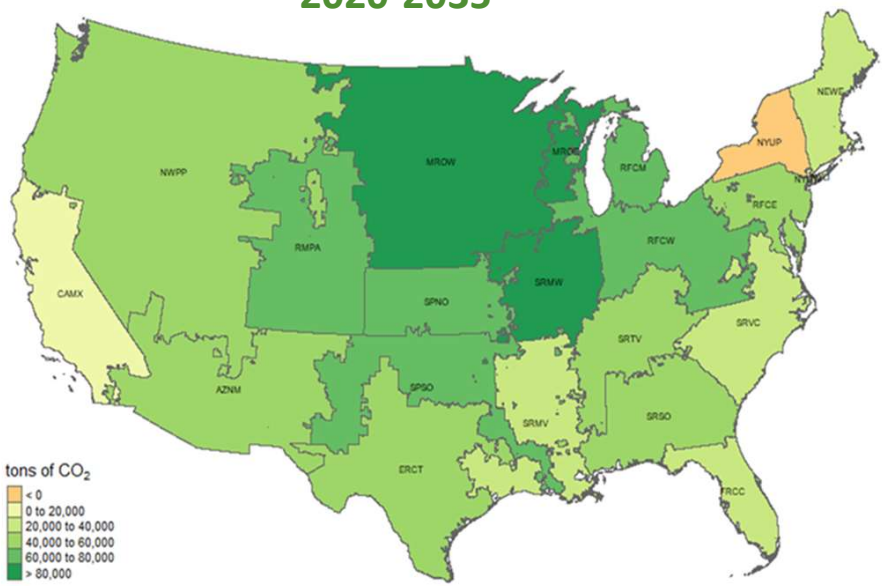
→ Carbon-enhanced 50001 Ready Navigator

Flexible Combined Heat and Power Systems

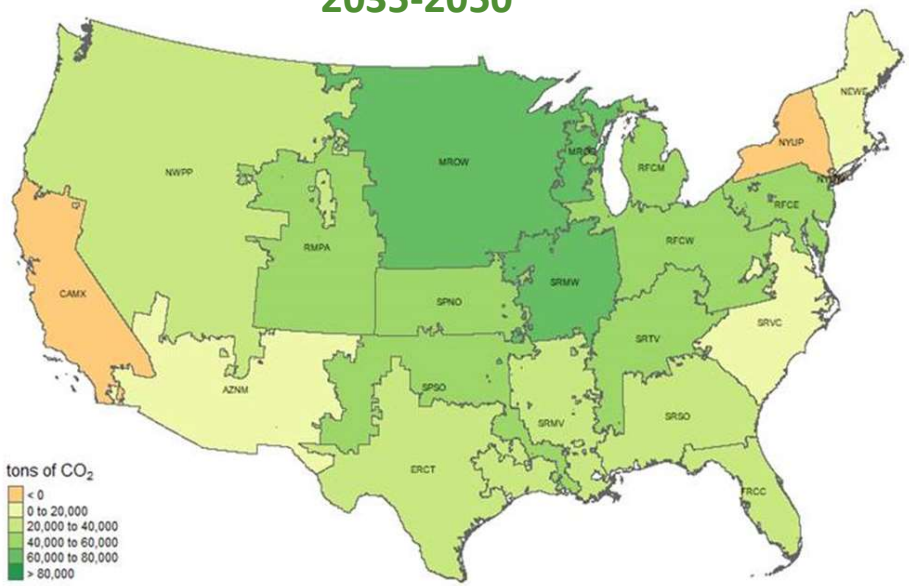


Lifetime Carbon Emission Reductions for CHP Systems

2020-2035



2035-2050



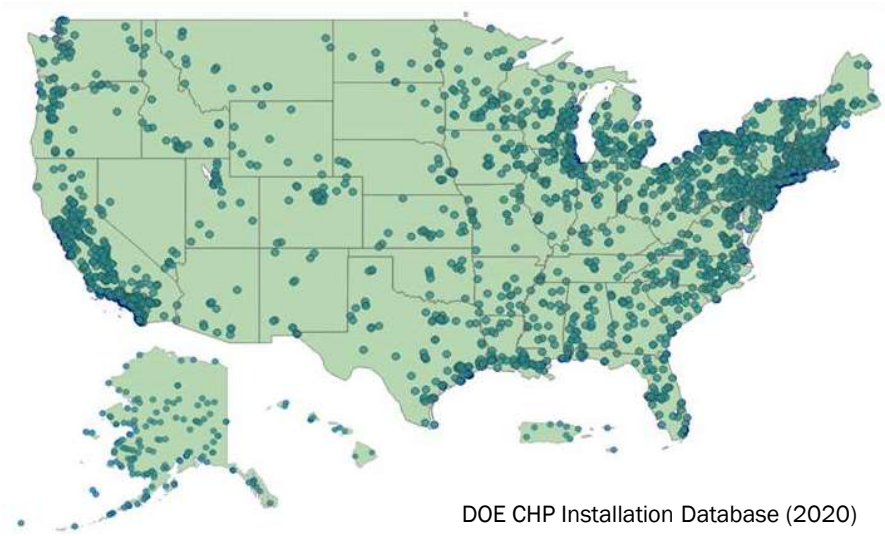
- Natural gas CHP will continue to reduce emissions in most U.S. locations through 2050
- Emission reduction potential depends on location and timing
- Conversion to renewable/hydrogen fuels will increase the emissions reduction potential

Source: "Combined Heat and Power Potential for Carbon Emission Reductions", ICF for Energy Solution Center, July 2020

CHP and Long Term Decarbonization

- Renewable/hydrogen fueled CHP can **decarbonize thermal end-uses in industrial and commercial facilities that will be difficult to electrify**
- Renewable/hydrogen fueled CHP can **decarbonize critical facilities that need on-site power for resilience and operational reliability**
- Renewable/hydrogen fueled CHP offers an **alternative to expensive process and building conversions** to electric technologies
- CHP's high efficiency **can extend the supply of renewable and low carbon fuels**

CHP Installations in the U.S.



DOE CHP Installation Database (2020)

RNG Technologies and Feedstocks

- *Food Waste*
- *Animal manure*
- *Wastewater Treatment (WWTP)*
- *Landfill gas (LFG)*

- *Agricultural residue*
- *Forestry and forest product residue*
- *Energy crops*
- *Municipal solid waste (MSW)*

- *Green Hydrogen from renewable electricity*
- *Blue Hydrogen from natural gas with carbon capture*

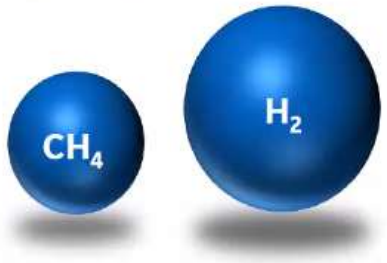
Source: AGA Foundation, Renewable Sources of Natural Gas: Supply and Emissions Reduction Assessment, 2019

Use of Hydrogen (H2) as a Fuel will Require System Changes

Use of hydrogen as a gas turbine fuel requires system changes

Fuel System

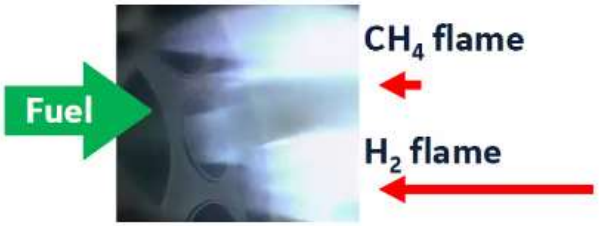
Methane (CH_4): 912 lb/ft^3
Hydrogen (H_2): 275 lb/ft^3



To deliver the same energy content, hydrogen requires 3X more volume flow

Combustion System

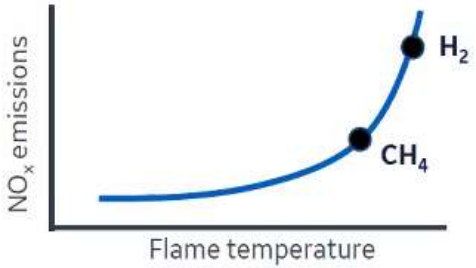
Methane (CH_4): ~30–40 cm/sec
Hydrogen (H_2): ~200–300 cm/sec



Hydrogen flames may increase risk of damage to combustion hardware

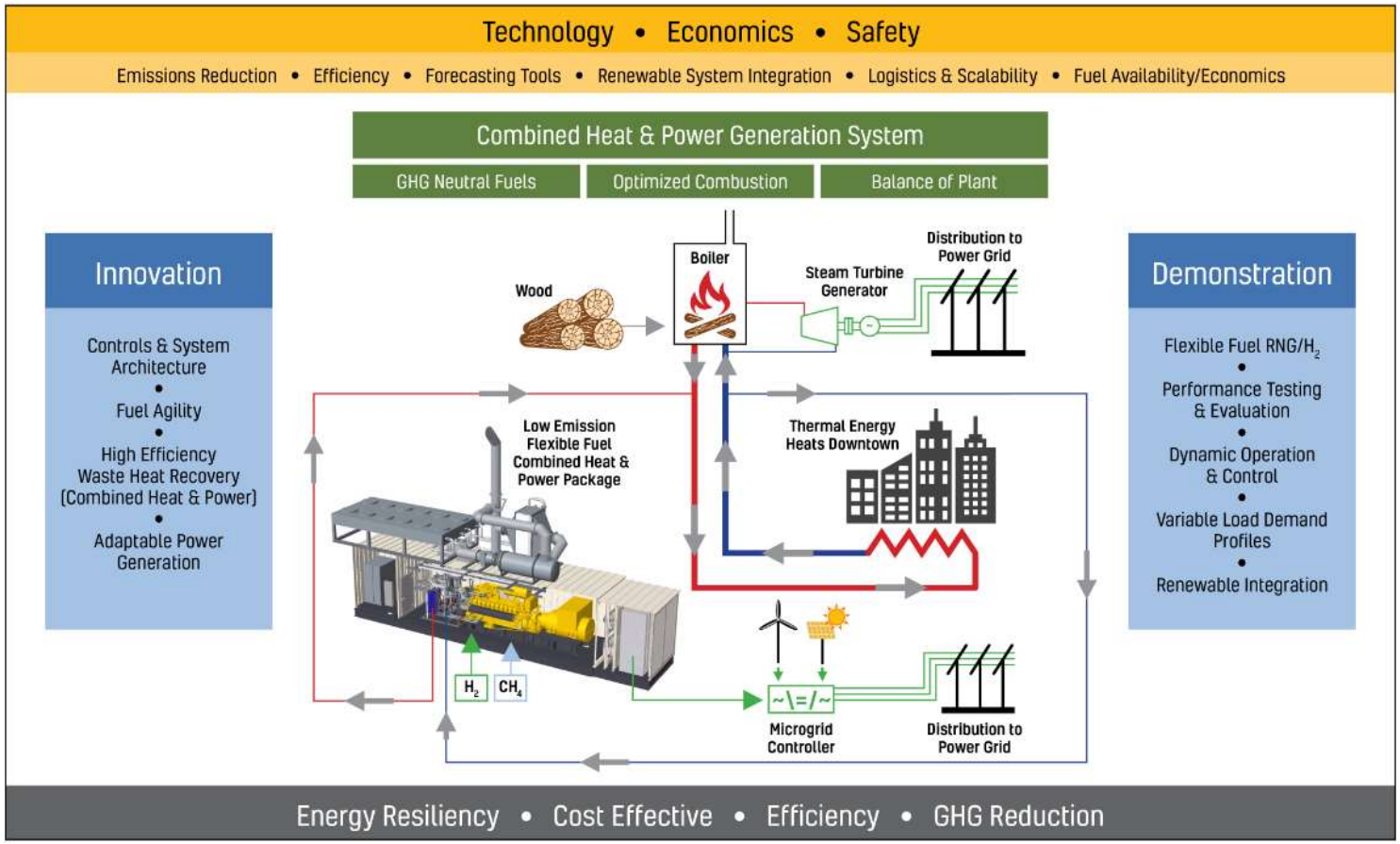
Emissions Aftertreatment

Methane (CH_4): ~3,565 °F
Hydrogen (H_2): ~4,000 °F



Operating on hydrogen may increase NO_x emissions

CHP R&D Example: Hydrogen Blending



Project Summary

Caterpillar Inc., the National Renewable Energy Laboratory, and District Energy St. Paul will demonstrate a **2MW flexible natural gas/hydrogen combined heat and power (CHP) system** at a municipal generating station.

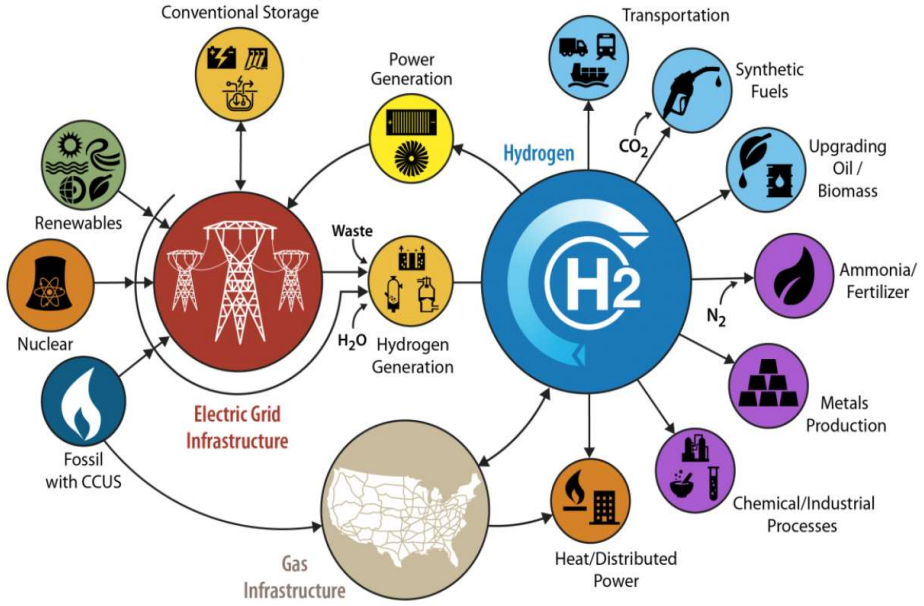
Technology Impact

This project will seed effort in adding natural gas/hydrogen flexible fuel CHP systems to the wide options space for stationary power applications.

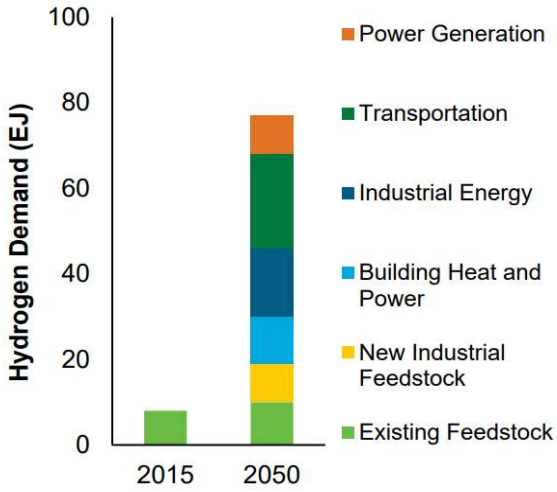
H2@Scale

- DOE initiative that brings together stakeholders to advance affordable hydrogen production, transport, storage, and utilization.
- Includes DOE funded projects and national laboratory-industry co-funded activities to accelerate the early-stage research, development, and demonstration of applicable hydrogen technologies.

Schematic of H2@Scale Supply Sources and Demand Applications (DOE 2020)



VALUE PROPOSITION[2]



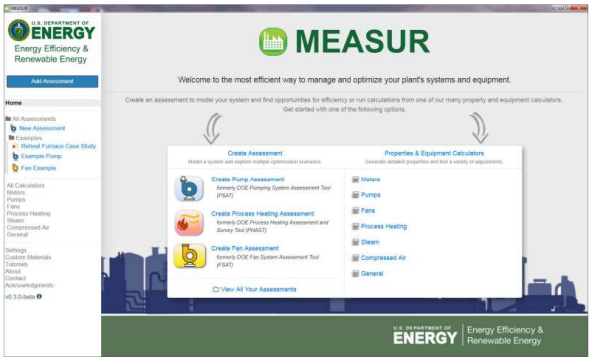
2. Source: "Hydrogen Scaling Up." Hydrogen Council. November 2017. http://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-scaling-up-Hydrogen-Council.pdf

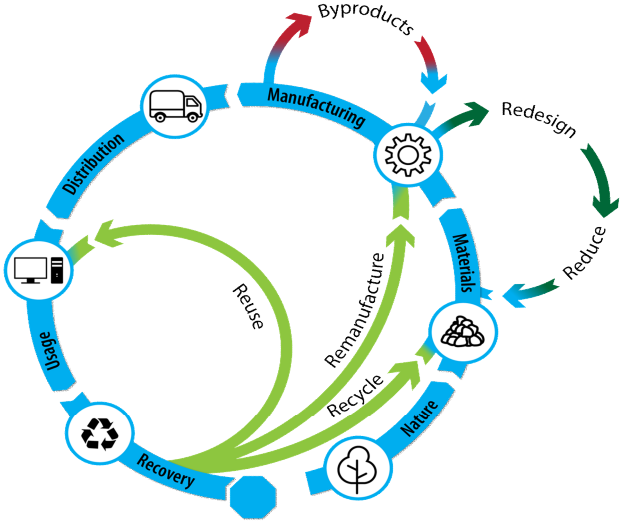
Hydrogen and Fuel Cell Technologies Office

- **July 2020 – DOE announced $64 million of funding for 18 projects that will support the H2@Scale vision for affordable hydrogen production, storage, distribution, and use.**
  - Advance carbon fiber for compressed hydrogen and natural gas storage tanks
  - Electrolyzer manufacturing R&D
  - H2@SCALE new markets demonstrations
  - Training and workforce development for emerging hydrogen technologies
- **December 2020 – $33 million in new funding to support innovative hydrogen and fuel cell research & development (R&D), infrastructure supply chain development and validation, and cost analysis activities.**

Technical Partnerships Looking Forward

- **Workforce Training**
  - Virtual versions of In Plant trainings
  - Fundamentals of Energy Management
- **Tools and Resources**
  - VERIFI – dashboard tool
  - MEASUR – system assessment tool – upgrade of SSAT
- **Low Carbon/Waste reduction Pilots**
  - Currently pilots, may become permanent
  - Focus on sharing best practices, defining low carbon pathways, circular economy, and waste/energy nexus
- **External Partnerships (potentially)**
  - Partnership structure for industrial associations
  - Provide "seat at the table" to inform AMO Tech Partnership programs





Thank you

Questions?

For More Information:

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