



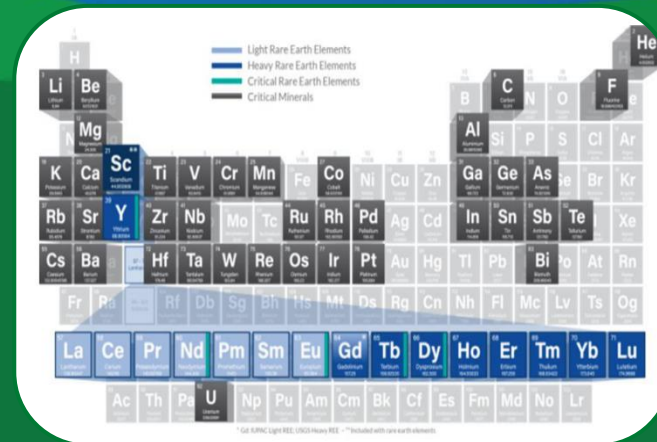
U.S. DEPARTMENT OF
ENERGY

Fossil Energy and
Carbon Management

US DOE Efforts in Decarbonizing Dispatchable Power Generation Assets

Bob Schrecengost
Office of Fossil Energy and Carbon Management

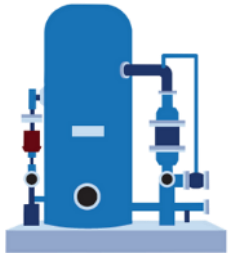
October 10, 2023



FECM Strategic Vision



Justice, Labor,
and Engagement



Technologies that
Lead to Sustainable
Energy Resources



Carbon Management
Approaches toward
Deep Decarbonization

FECM Role Achieving Net-Zero Greenhouse Gases

FECM's *Strategic Vision* will enable DOE to make strategic carbon management decisions to ensure that fossil fuel usage is put into proper context with climate change and is designed for a future that achieves and maintains net-zero greenhouse gas emissions.



Read FECM's Entire Strategic Vision
by Scanning the Code Above

Opportunities for the Entire Value Chain: Bipartisan Infrastructure Law (BIL)



Regional Hydrogen Hubs

- Hydrogen Hubs: \$8 billion (OCED)
- Clean Hydrogen Electrolysis: \$1 billion (EERE)
- Clean Energy Manufacturing and Recycling: \$500 million (EERE)



Industrial and Power Plant Carbon Capture

- CCUS Integrated Demos: \$2.5 billion (OCED)
- Carbon Capture Large Pilot: \$1 billion (OCED)



Direct Air Capture

- Regional Direct Air Capture Hubs: \$3.5 billion (FECM)
- DAC Technology Prize Competition: \$115 million (FECM)



Carbon Dioxide Transport, Utilization and Storage

- Carbon Storage Validation and Testing: \$2.5 billion (FECM)
- Carbon Utilization Program: \$310 million (FECM)
- FEED Studies for Transport Systems: \$100 million (FECM)
- CIFIA – Loans and Future Growth Grants: \$2.1 billion (FECM/LPO)

Project Applications Require New Components:

- Community and Stakeholder Engagement
- Diversity, Equity, Inclusion, and Accessibility
- Justice40 Initiative
- Quality jobs

Bipartisan
Infrastructure Law
Programs at
Department of Energy

Recent Industry Advanced Turbine Awards

FY 22 Industry Awards (\$28 M) – Hydrogen Combustion Focus

- Develop combustion modules for F-class, aeroderivative and industrial scale turbines
- Develop retrofit technologies
- Apply to 100% hydrogen & natural gas / hydrogen blends
- Assess ammonia fuels
- Advance application of rotating detonation combustion systems for power generation
- Advance hydrogen combustor technology to next stage of testing & demonstration

Performer	Title	Total Funding (\$M)
Solar Turbines	Development of a Retrofittable Dry Low Emissions Industrial Gas Turbine Combustion System for 100% Hydrogen and Natural Gas Blends	5.6
GTI	Investigation of Ammonia Combustion for Turbines (IACT)	4.1
General Electric Company	Advanced Mixed Mode Combustors for Hydrogen F-Class Retrofit	15.0
GE Research	Demonstration of a Gas Turbine-Scale RDC Integrated with Compressor and Turbine Components at 7FA Cycle Conditions	8.7
Raytheon Technologies	Development of Hydrogen Burner for FT4000 Aeroderivative Engine	6.0
Raytheon Technologies	Low-NOx, Operable Ammonia Combustor Development for Zero-Carbon Power (LOAD-Z)	4.2

Recent UTSR Advanced Turbine Awards

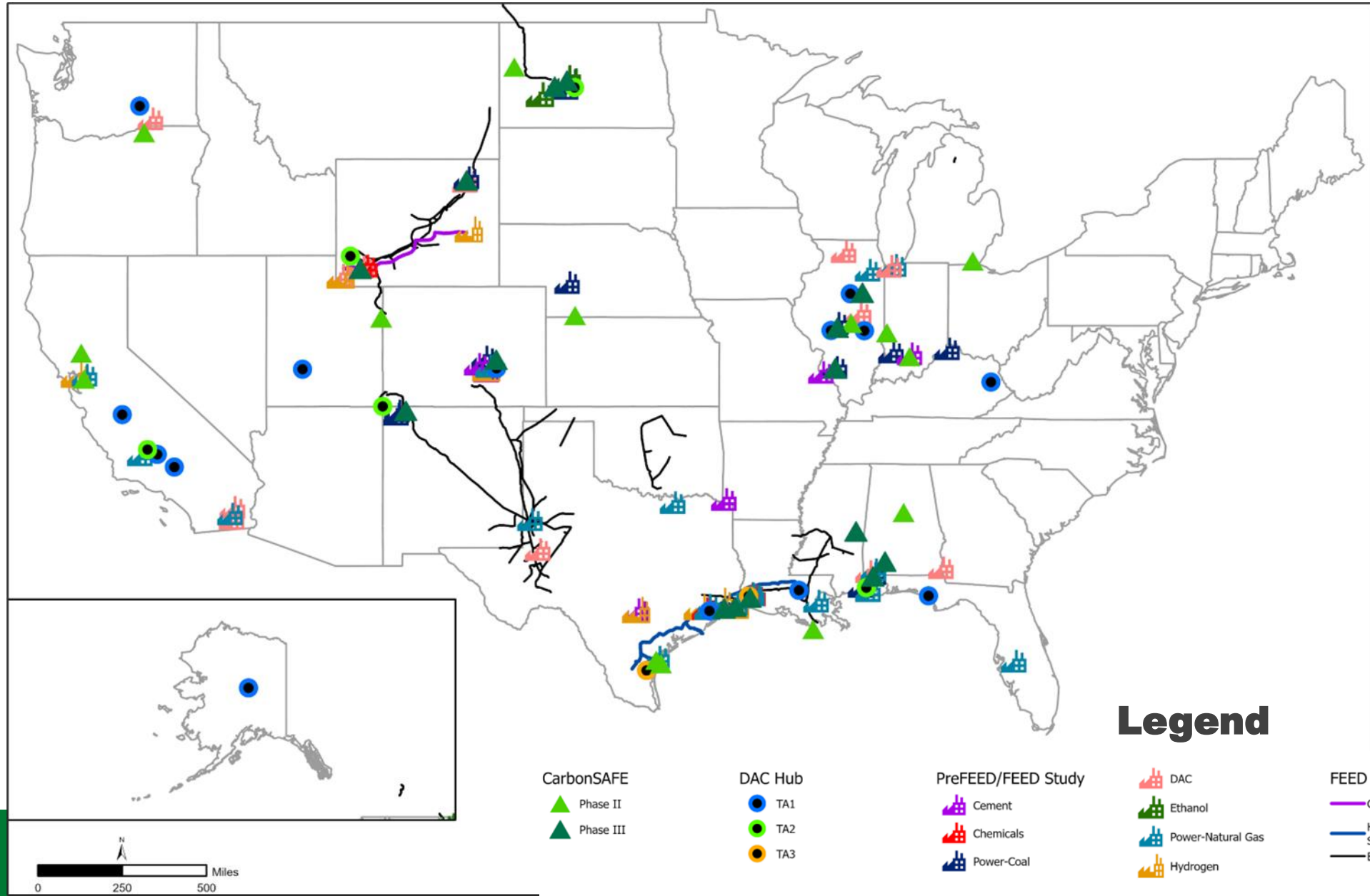
FY 21 UTSR Awards (\$6.2 M) – Hydrogen Combustion Focus

- Hydrogen Combustion Fundamentals for Gas Turbines
 - *Georgia Tech Research Corporation*
 - *The University of Central Florida*
 - *San Diego State University*
- Hydrogen Combustion Applications for Gas Turbines
 - *Purdue University*
 - *The Ohio State University*
 - *University of California, Irvine*
- Hydrogen-Air RDE
 - *The University of Alabama*
 - *Purdue University*

What will be done:

- Explore chemical kinetics
- Investigate NO_x & flame strain rate
- Investigate ignition delay times
- Measure flame speed
- Evaluate existing fuel injectors
- Flame structure and combustion dynamics for H₂ & NH₃ fuels
- Assess RDE combustion modes
- Develop design rules for micromixer injectors
- Develop CFD design tools

Industrial Decarbonization FEEDs & CarbonSAFE



Pre-Commercial – H₂ FEEDS

Steam Methane Reforming



Linde-BASF technology using OASE® blue solvent

Advanced CCS Systems for SMR



Svante VeloxoTherm™ solid adsorbent at Linde SMR H₂ plant

- ▶ ~1,100,000 tonnes/year net CO₂ capture
- ▶ **90% Capture Efficiency**
- ▶ **Production of “blue” H₂ with 99.97% purity**



Gen 1 CCS technology at Phillips 66 refinery in Rodeo, California

- ▶ **Separate & store ~190,000 tons/year net CO₂ from hydrogen production unit with >90% carbon capture efficiency**

Advanced CCUS +for ATR



CO₂ Capture Unit at Tallgrass MLP Operations LLC's Planned Blue Bison ATR Plant

- ▶ **Separate and store 1.66 million tonnes/year of 95% pure CO₂ with >97% carbon capture efficiency**
- ▶ **System combining carbon capture, H₂ production (220 MMSCFD at 99.97% purity), and H₂ combustion in auxiliary burners**



CCS system at the Painter Gas Complex, WY

- **100 million SCF per day of 99.97%-pure hydrogen**
- **Capture 90–99% of CO₂ emissions.**
- **Three design cases implementing the subsystems and equipment of the 8RH2 ATR technology and a CO₂ separation unit, are being evaluated.**

FEED Studies on Existing Energy Assets

Electric Power Research Institute, Inc. (Palo Alto, CA)

Gasification of Coal and Biomass: The Route to Net-Negative-Carbon Power and Hydrogen

Integrated design study on an oxygen-blown gasification system coupled with water-gas shift, pre-combustion CO₂ capture, and pressure-swing adsorption working off a waste coal/biomass mix to yield high-purity hydrogen and a fuel off-gas that can generate power.

- Nebraska Public Power District Sheldon Station coal fired plant
- CO₂ Storage: enhanced oil recovery and saline sequestration
- Co-feed corn stover, possibly other biomass and waste plastics



Wabash Valley Resources, LLC (West Terre Haute, IN)

Wabash Hydrogen Negative Emissions Technology

Complete system integrated design study for redeveloping the existing Wabash Valley Resources coal gasification site in West Terre Haute, Indiana, into a 21st century power plant for flexible fuel gasification-based carbon-negative power and carbon-free hydrogen co-production.

- Facility: Wabash Gasification Facility
- CO₂ Storage: Saline sequestration
- Co-feed woody biomass and/or agricultural residue and waste plastics



Financing to Enable Deployment at Scale



Loan Programs Office (LPO) has \$40 Billion in Available Debt Capital

LPO announced loan guarantee conditional commitments for 2 clean hydrogen projects

MONOLITH
HALLAM, NEBRASKA

Employing innovative carbon black reactor technology, Monolith is a pioneering clean hydrogen and carbon utilization project.

LOAN GUARANTEE: CONDITIONAL COMMITMENT

FINANCED BY U.S. DEPARTMENT OF ENERGY

ADVANCED CLEAN ENERGY STORAGE
DELTA, UTAH

First-of-its-kind hydrogen production and storage facility capable of providing long-term seasonal energy storage.

LOAN GUARANTEE: CONDITIONAL COMMITMENT

FINANCED BY U.S. DEPARTMENT OF ENERGY

\$1.04B for the first-ever commercial-scale project to deploy methane pyrolysis technology. Will enable 1,000 construction jobs and 75 operations jobs.
(December 2021)

\$504.4M for large-scale hydrogen energy storage, 220 MW electrolysis and turbine. Will enable up to 400 construction jobs and 25 operations jobs.
(April 2022)

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Thank You!

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