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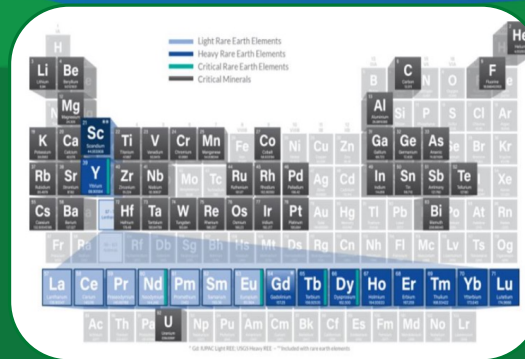
Fossil Energy and
Carbon Management

OVERVIEW OF DOE/FECCM CLEAN HYDROGEN /SYNGAS PRODUCTION PROGRAMS

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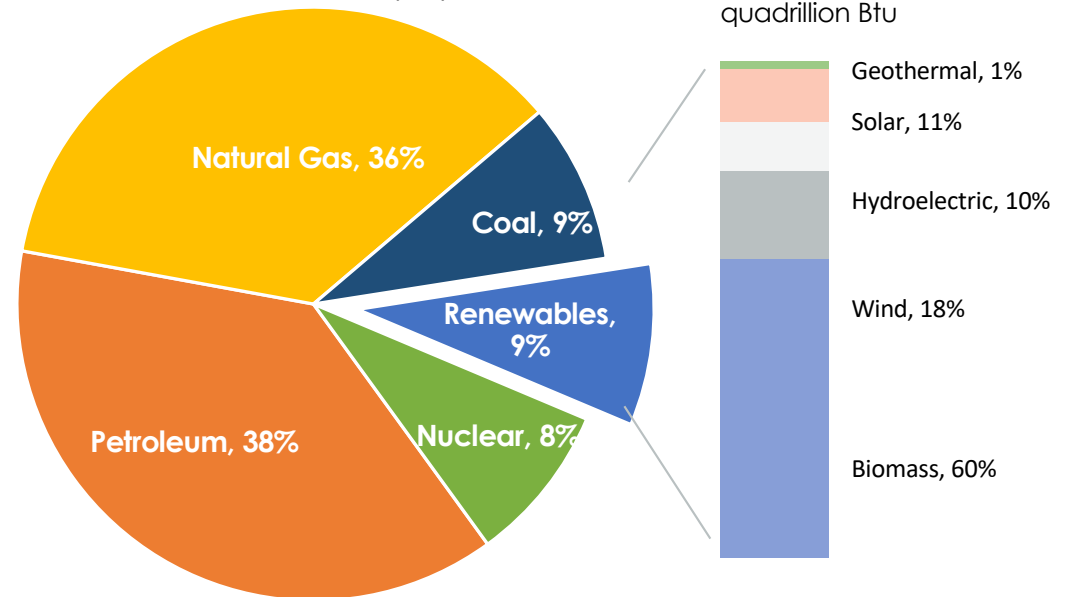
Fossil Energy and Carbon Management (FECM)

Office of Fossil Energy and Carbon Management

- Administration Goals:
 - 50% emissions reduction by 2030
 - CO₂ emissions-free power sector by 2035
 - Net zero emissions economy by no later than 2050

U.S. Primary Energy Consumption by Energy Source, 2023

Total = 93.551 quadrillion
British thermal units (Btu)



Note: Sum of components may not equal 100% because of independent rounding

Source: Data collected from U.S. Energy Information Administration, June 2024, *Monthly Energy Review*, preliminary data



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2

DOE Hydrogen Program

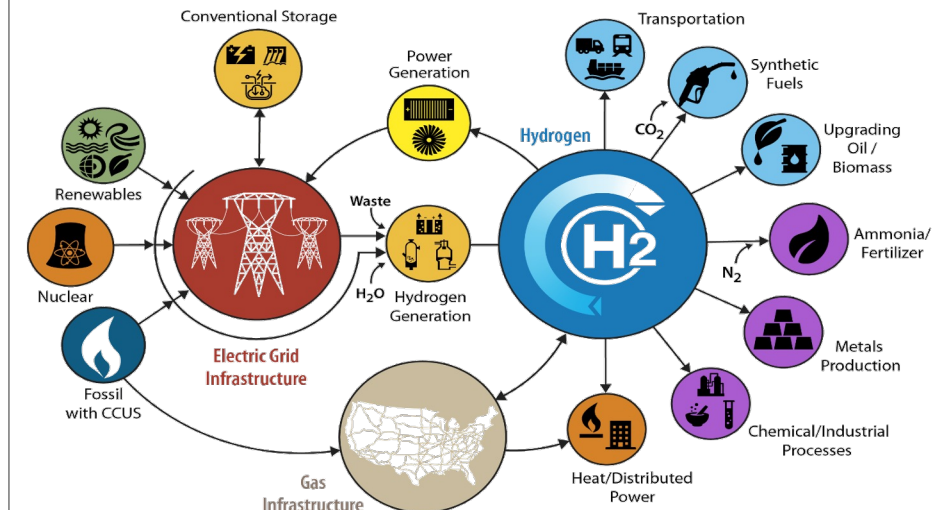
Hydrogen is a key element of a portfolio of solutions to decarbonize the economy.

Hydrogen Program

Coordinated across DOE on research, development, demonstration, and deployment (RDD&D) to address:

- The entire H₂ value chain from production through end use
- H₂ production from all resources (renewables, nuclear, and fossil + CCS)

H2@Scale vision: Enable clean-energy pathways across sectors



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3

DOE Efforts on Hydrogen Programs

EERE HYDROGEN

Feedstocks:

- Renewables and Water

Technologies:

- Electrolysis – Low- and High-Temperature
- Advanced Water Splitting – Solar/High-Temp Thermochemical, Photoelectrochemical
- Biological Approaches

FECM HYDROGEN

Feedstocks:

- Fossil Fuels, Solid Wastes and Water

Technologies:

- Gasification, Reforming, Methane Pyrolysis
- Electrolysis – High temperatures (RSOFC)
- Natural Gas to Solid Carbon plus Hydrogen

NE HYDROGEN

Feedstocks:

- Nuclear Fuels and Water

Technologies:

- Electrolysis Systems for Nuclear
- Advanced Nuclear Reactors
- Systems Integration and Controls – LWRs and Advanced Reactors

Areas of Collaboration

Reversible Fuel Cells, Biomass, Municipal Solid Waste, Plastics, Polygeneration including Co-Gasification with Biomass, High-Temperature Electrolysis, Systems Integration

Cross-Cutting R&D Offices: Office of Science (SC) and ARPA-E

Foundational research and innovation; user facilities and tools, materials and chemical processes (e.g., catalysis, separations), artificial intelligence/machine learning, databases and validation, high risk-high impact R&D, and other crosscutting activities



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Hydrogen Energy Earthshot Initiative (HEEI)

Cost of Clean Hydrogen to \$1 per 1 kg in 1 Decade (1-1-1)

- Goal to accelerate innovations and spur demand of clean hydrogen
- Enable decarbonization of high-polluting heavy-duty transportation and industrial sectors, while delivering good-paying clean energy jobs and realizing a net-zero economy by 2050.

Goals for Clean Hydrogen Production Systems of FECM

- Gasification of biomass, waste streams, and recovered coal waste with CCS for net-zero carbon
- Reforming with CCS for near net-zero carbon
- Methane emissions reduction in the upstream natural gas supply chain
- Renewable natural gas sources
- Solid Oxide Electrolysis Cell (SOEC) or Reversible Solid oxide fuel cell (R-SOFC)

HEEI Goals:

- \$1/kg H₂
- One decade (i.e., 2030)
- “1, 1, 1”



1 Dollar



1 Kilogram



1 Decade



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Hydrogen Provisions in Recent Legislation

Bipartisan Infrastructure Law

- **Covers \$9.5B** for clean hydrogen:
 - \$8B for at least four regional clean hydrogen hubs
 - \$1B for electrolysis research, development and demonstration
 - \$500M for clean hydrogen technology manufacturing and recycling R&D
- **Aligns with Hydrogen Shot priorities by directing work to reduce the cost of clean hydrogen to \$2 per kilogram by 2026**
- **Requires developing a National Hydrogen Strategy and Roadmap**



President Biden Signs the **Bipartisan Infrastructure Bill** on November 15, 2021.
Photo Credit: Kenny Holston/Getty Images

Inflation Reduction Act



Includes production tax credit for clean Hydrogen



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Selected Regional Clean Hydrogen Hubs-\$7B



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Inflation Reduction Act – 45Q Modifications

	Old	New
Commence Construction	January 1, 2026	January 1, 2033
DAC Facility	100,000 metric tons/year*	1,000 metric tons/year
Electric Generator	500,000 metric tons/year*	18,750 metric tons/year
All other facilities	100,000 metric tons/year*	12,500 metric tons/year
Saline Storage Credit	\$50/metric ton	\$85/metric ton (industry and power); \$180/metric ton (DAC)
EOR and Conversion Credit	\$35/metric ton	\$60/metric ton (industry and power); \$130/metric ton (DAC)

* Non-EOR Conversion facilities were previously 25,000 metric tons/year regardless of facility/source.

Notes: New Modifications allows up to 5 years for direct pay (up to 12 years certain entities)



Inflation Reduction Act – Clean H2 Production Tax Credit

Commence Construction	January 1, 2033
kg of CO2 per kg of H2	Credit Value (\$/kg)
<i>4 to 2.5</i>	<i>0.60</i>
<i>2.5 to 1.5</i>	<i>0.75</i>
<i>1.5 to 0.45</i>	<i>1.00</i>
<i>0.45 to 0</i>	<i>3.00</i>

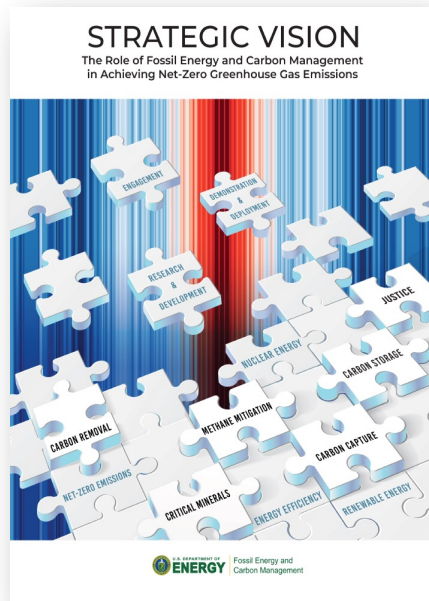
Clean hydrogen: lifecycle greenhouse gas emissions rate of no greater than 4 kilograms of CO2 equivalent (“**CO2e**”) gas per kilogram of hydrogen. Section 45V of the Act creates a new tax credit for the production of qualified clean hydrogen (the “**Clean Hydrogen Production Credit**”).

As an alternative to the Clean Hydrogen Production Credit, taxpayers may elect the Section 48 Investment Tax Credit (the “**ITC**”) with respect to clean hydrogen production facilities, receiving an ITC of up to 30% depending on the carbon intensity of the production process.

The Clean Hydrogen Production Credit is not available, however, for clean hydrogen produced at a facility that also includes carbon capture equipment for which the Section 45Q carbon capture tax credit is allowed to any taxpayer.



FECM Priorities with New Strategic Vision



[FECM Strategic Vision](#)



Point-Source Carbon Capture (PSC)

Reduce the cost, increase the efficacy, and advance the deployment of commercial-scale point source capture technologies in the power and industrial sectors, coupled to dedicated and reliable storage.



Carbon Dioxide Removal (CDR)

Invest in a diverse set of CDR approaches to support DOE's Carbon Negative Shot of just, sustainable and scalable CDR at costs below \$100/net metric ton of CO₂-equivalent.



Reliable Carbon Storage and Transport

Make advancements in storage technologies and transport mechanisms, provide technical assistance in Class VI well permitting and support large-scale transport and storage facilities and regional hubs.



Carbon Dioxide Conversion

Accelerate capabilities for large-scale conversion of CO₂ into products that advance net-zero goals, facilitated by markets that use CO₂ as a feedstock.



Methane Mitigation

Develop technologies and deploy regional initiatives to quantify and reduce methane emissions from fossil fuel infrastructure including coal, oil, and gas.



Domestic Critical Minerals (CM) Production

Support demonstrations for extraction and remediation to processing and refining for building a strong CM supply chain while creating jobs.



Hydrogen with Carbon Management

Hydrogen production coupled with CCUS using sustainably sourced carbon-based feedstocks. Invest in the advancement of hydrogen storage, fuel cells, and 100 percent hydrogen-fired turbines, supporting DOE's Hydrogen Shot target.



Justice, Labor, and Domestic and International Collaboration

Collaborate with domestic and international partners to create a sustainable energy infrastructure with equity and justice at the core of FECM's work.



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FECM Hydrogen Program R&D

- Clean hydrogen production using gasification, natural gas reforming, methane pyrolysis and solid oxide electrolysis cell technologies (SOEC/RSOFC)
- Hydrogen end use in electricity and other energy sectors
 - Solid Oxide Fuel Cells
 - Hydrogen Turbines
- Safe and reliable hydrogen production, transport, storage and utilization
- FECM also collaborates with EERE's Hydrogen and Fuel Cell Technologies Office and Bioenergy Technology Office.

Hydrogen with Carbon Management

- Program elements include Advanced Gasification, Advanced Turbines, and Reversible Solid Oxide Fuel Cells, Sensors and Controls, Computational Science

Methane Mitigation Technologies

- Focus areas for the program include advancing technologies for the carbon-neutral production, transport, and storage of hydrogen sourced from natural gas



Gasification Systems Program Goals

FECM Gasification Systems Goals

- **Cost-effective clean hydrogen production for fuels synthesis and decarbonization (especially industry)**
- **Remediate/utilize wastes (unrecyclable plastics, MSW, coal waste)**
- **Blend carbon-neutral biomass: reduce GHG emissions**
- **Modular gasification in disadvantaged areas: provide jobs, remediate legacy sites**
- **Reduces disposal burden of wastes in landfills**
- **Gasification with capture: carbon neutrality/negative carbon potential**



Gasification Systems Approach

Modular Technology: Helping Gasification Access New Markets

Smaller, modular gasifier



- Faster development
- Lower capital investment
- Lower financial risk

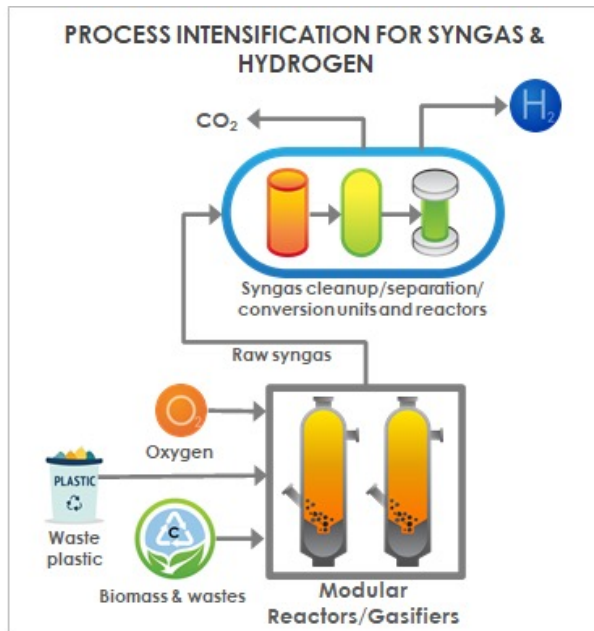
→ **New Markets**

Business Impacts:

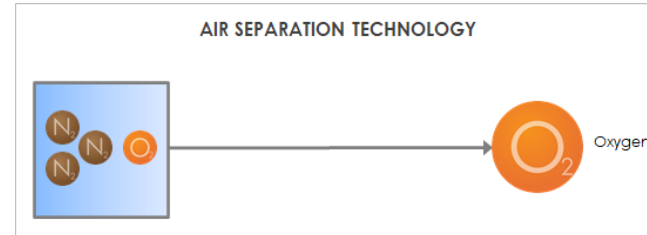
- **CapEx/OpEx reduction:** through process intensification, plant-wide cost reduction opportunities
- **Reduce investment risk:** reduce the cost of functional prototypes
- **Regional opportunities:** enable local markets to quickly and cost-effectively utilize local feedstocks (including biomass and wastes)



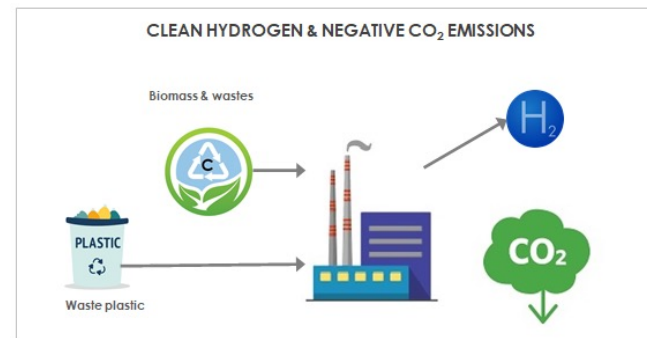
Gasification Systems Program Areas



Innovative gasifiers and zero emissions systems



Efficient ASUs for any net-zero system scale



Biomass blending enables Bioenergy with Carbon Capture & Storage (BECCS)

Feedstock-flexible systems accommodate seasonal/limited supply of biomass and MSW/plastics



FECM Funding Opportunities – FY24

Gasification of Alternative Feedstocks (FOA3394)

- R&D Towards Demonstration of Entrained Flow Gasification Technologies for Alternative Feedstocks
- R&D Towards Demonstration of Fluidized Bed Gasification Technologies for Alternative Feedstocks

- **Issue Date:** 9/20/2024
- **Application Submittal Deadline:** 11/22/2024
- **Selection Notifications:** February 2025
- **Awards:** TBD

<https://www.energy.gov/fecm/funding-notice-gasification-alternative-feedstocks>



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15



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Questions?

Thank You!

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