



U.S. DEPARTMENT
of **ENERGY** | Office of Critical Minerals
and Energy Innovation

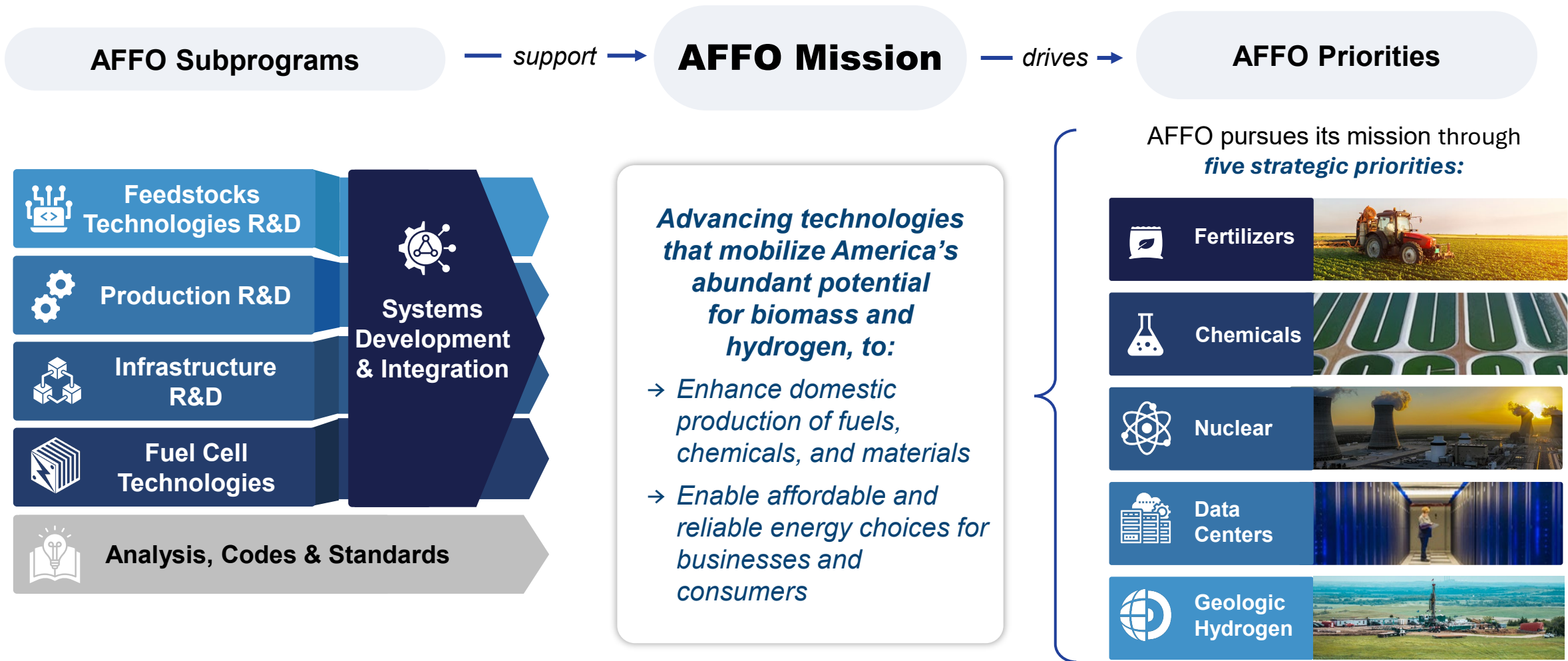
Alternative Fuels and Feedstocks Office

Alternative Fuels and Feedstocks Office (AFFO) – Overview and Priorities

Dr. Valerie Reed, AFFO Director

August 25, 2026

AFFO Overview



Ending Reliance on Foreign Fertilizers



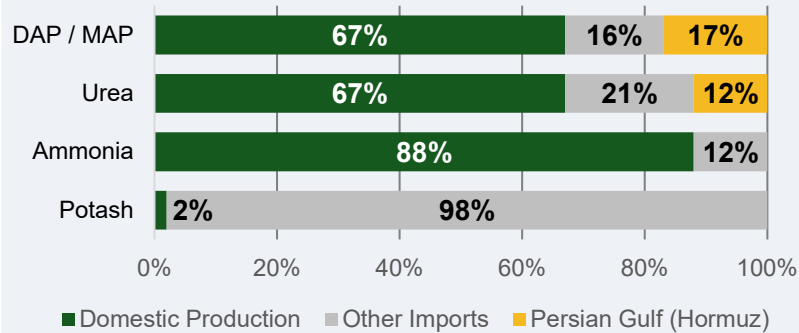
Challenge



Opportunities

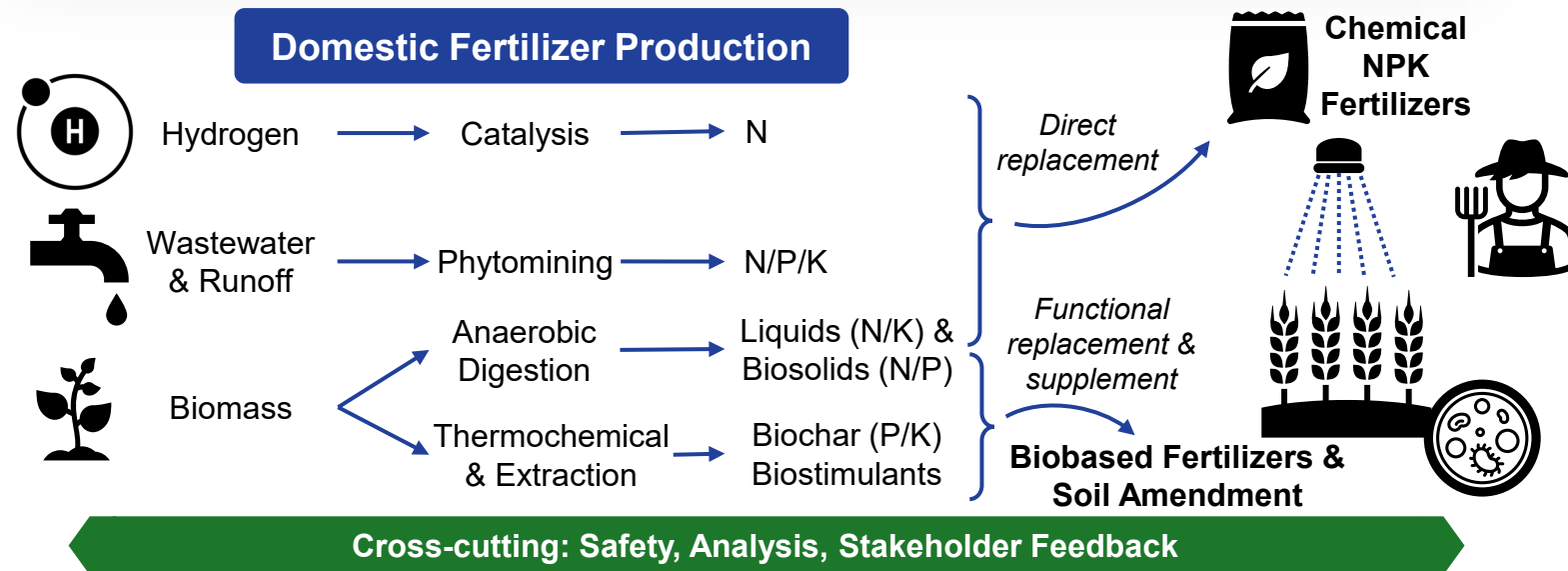
U.S. Agriculture Faces Fertilizer Supply Crisis

U.S. Fertilizer Supply by Source in 2023
(Nutrient Basis)



- **Reliance on fertilizer imports** creates vulnerability to price spikes and shortages
- **70%** of farmers cannot afford fertilizer to get through the year
- Fertilizer supply is consolidated in 5 multinational companies, limiting transparency and competition

- Develop **innovation-driven** chemical and biobased fertilizer production technologies to **enable domestic affordable and resilient supply chain**
- Use **AI to guide catalyst and materials R&D** that reduces cost of distributed fertilizer production
- Improve efficacy of fertilizers and soil amendments via **functional design**
- Develop **safety, training, and permitting resources** for new, small, and aging facilities



Strategic Goals



Potential RD&D Areas

- Expand **domestic fertilizer production** capacity.
- **Reduce N&P fertilizer imports** by 50% by 2035.
- Improve **affordability** and farmer access.
- Advance **environmentally responsible** fertilizer technologies and supply chains.
- Strengthen **partnerships**.

- **Analysis & Technoeconomic Assessment**
- **Biobased NPK fertilizer production**
- **Direct Production of Chemical Fertilizers**
- **Novel production pathways**
- **Nutrient Extraction and Recovery**



AFFO Highlight: Takachar Advances Domestic Biochar Production

Small Business Innovation Research (SBIR) Project:

Takachar is developing portable biochar technology that transforms woody biomass into fertilizer inputs while reducing production costs.

Key Highlights:

- Converts woody biomass into biochar using AI-driven portable system.
- **10x increase in processing throughput.**
- **50% reduction in operating costs.**
- Supports domestic fertilizer production and reduces waste.

Lower-cost scalable biochar production can reduce reliance on foreign conventional fertilizer while creating value from agriculture and forestry residues.



Strengthening Domestic Chemicals Production



Challenge



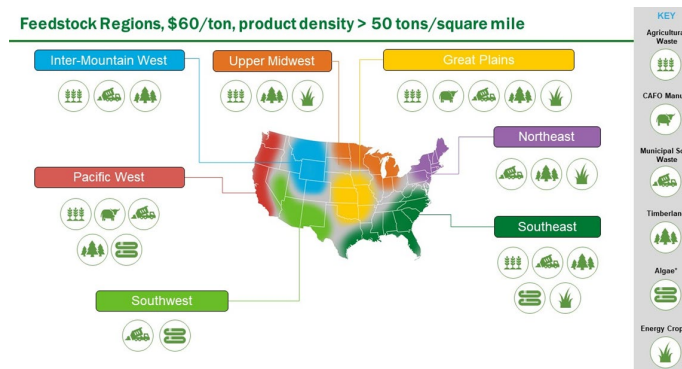
- Organic chemicals are essential to products across the U.S. economy, but face growing global competition and supply chain risks.
- Leveraging domestic biomass/waste feedstocks and modern biotechnologies will help America sustain dominance in chemicals production.
- The U.S. must accelerate domestic chemical innovation to maintain global leadership and supply chain resilience.

Opportunities

Transform American supply chains through biotechnology innovation

- Abundant** – estimated >1 billion tons biomass potential — enough to double the total U.S. domestic chemicals production volume

- Reduced import dependence
- Supply chain resiliency
- Job creation, economic growth
- Consumer preference for safer products and enhanced performance
- Reduce waste



Billion-Ton Report

- Biomass resources identified **across the U.S.**
- Potential for **agricultural residues, forestry residues, organic wastes, and energy crops**
- Deliver economic and environmental benefits across the U.S.

Strategic Goals



Potential RD&D Areas

Advance U.S. chemical manufacturing by:

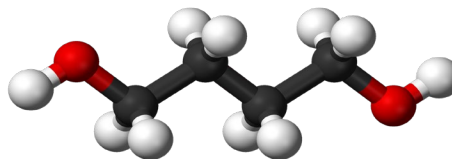
- Expanding **domestic production**
- Prioritizing **scalable, cost competitive pathways** for high-volume (≥ 1 million tones/year) chemicals.
- Reducing reliance on **import-dependent** chemicals through alternative feedstocks.
- Advancing **performance-enhanced chemicals** for high-value applications.
- Strengthening **U.S. supply chains** and **global competitiveness**.

- Prioritize imported **critical chemicals** with strong export potential and rapid market adoption.
- Develop **Performance-Advantaged Products** with superior properties to conventional products and materials.
- Advance scalable, cost-competitive **manufacturing pathways** using biomass, algae, waste resources
- Accelerate **commercialization** through technologies that integrate with existing manufacturing and supply chains.

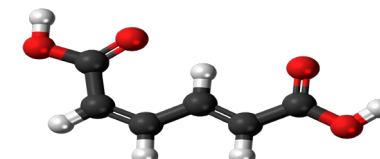
Diversify Supply Chain

Cost effective intermediates

Advantaged Products and Materials



1,4-Butanediol: plastics, polyurethanes, elastics



Muconic Acid: 6,6-nylon, polymers, resins

AFFO Highlight: Scaling Successfully – Genomatica & BDO

1,4 Butanediol (BDO)

High-volume industrial chemical used in plastics, polyurethanes, elastics.

Bio-BDO

- Cost-competitive with traditional BDO
- Eliminates acetylene and formaldehyde
- Genomatica currently produces **4% of global BDO** via its bio-BDO process
- **50% of production based in U.S.**



AFFO-supported innovation helped commercialize a bio-based chemical that is now cost-competitive and produced at global scale.

From Lab to Global Scale:

- 1998** Genomatica founded
- 2008** First Bio-DBO produced in California lab
- 2012** **DOE/AFFO investment** to increase feedstock types at lab scale
- 2016** First commercial facility in Italy
- 2026** 2026 Global Scale Production



Just Announced -- Recent Milestone: \$58M ASPECT NOFO

First Chemicals Funding Under the Office of Critical Minerals and Energy Innovation

96% of manufactured goods rely on products from the U.S. chemical sector

AFFO's new \$58M ASPECT NOFO supports technologies that strengthen domestic chemical manufacturing through alternative biomass and waste feedstocks.

NOFO Highlights

- \$58M federal investment
- Strengthening U.S. manufacturing
- Supports domestic supply chains
- Accelerates commercialization of emerging chemical technologies

Funding Topic Areas

Bench ASPECT

- Advance technologies from proof-of-concept to bench/pre-pilot scale

Pre-Pilot ASPECT

- Accelerate pilot development and market readiness

**TURN INNOVATION
INTO IMPACT**



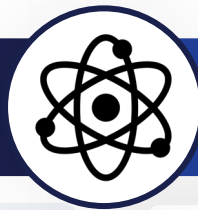
APPLY NOW
QR CODE PLACEHOLDER

NOFO GOAL: Increase the TRL of four (4) to eight (8) novel technologies and pilot at least one (1) technology to increase speed to market of emerging chemicals

Enabling Nuclear Energy Abundance with H₂ & Chemicals



Challenge



Opportunities

Underutilized nuclear resources:

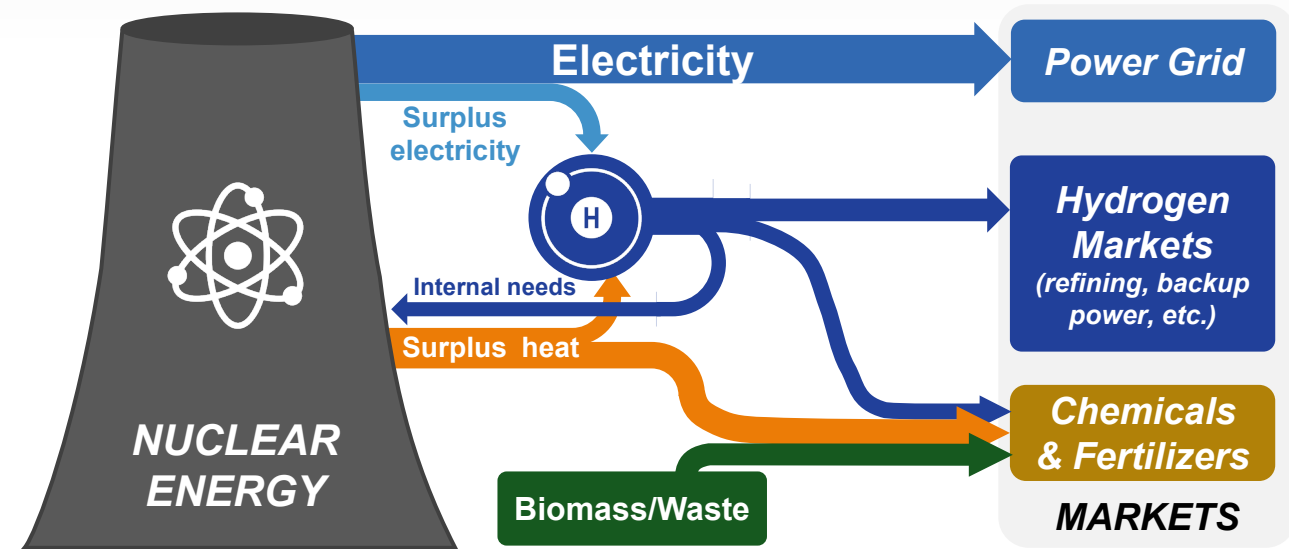
- **Difficult for nuclear plants to ramp up & down** to match demand
- Average thermal efficiency of nuclear plant is 33% — **majority of the energy is lost as surplus heat.**
- Cooling is often the limiting factor in power production.

High investment risk for nuclear:

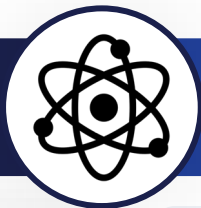
- **Single product** (electricity) & single customer (utilities)
- **Volatile demand & electricity prices** can force plants to operate at a loss (since they can't easily ramp up / down)

Nuclear plants can produce / sell hydrogen & chemicals to enhance flexibility & increase profitability

- Enables nuclear plants to **dynamically participate** in electricity markets
- Leverages **free waste-heat**—which greatly expands opportunities for profitable biomass conversion--generating **more value** and reducing cooling needs
- **Lowers long-term investor risk** through product / market diversification
- Enables pathways for transforming **electrons to high-value molecules** and converting **waste to useful products**



Strategic Goals



Potential RD&D Areas

Expanded Nuclear Power



- 8GW 300 GW+ of **new and updated nuclear power** plants in operation by 2030 and 300 GW by 2050
- Nuclear plants **selling multiple products**
- Nuclear plants **increasing overall efficiency from 33% to 50%**

Increased Domestic Production of H₂ and Chemicals *(including performance enhanced chemicals and fertilizers)*



- Lower costs and/or increased supply options (diversified supply pathways)
- Multiple long-term offtake agreements for hydrogen and chemical products
- Bio feedstock carbon utilization for ammonia and polymer production

- **Analysis and Design:** Analysis and system designs for *integrated energy systems* (IES)
- **R&D:**
 - **H₂ Production & Infrastructure:** R&D of catalysts and advanced manufacturing for electrolyzers; advanced infrastructure (storage and transport), R&D to enable safety/permitting
 - **Biomass Pre-Processing:** R&D to produce carbon & oxygen
 - **Chemical & Fertilizer Production:** RD&D of innovative ways to produce chemicals from hydrogen and bio-derived carbon
- **System Integration:** kW- & MW-scale nuclear-H₂ systems (electrical & thermal)
- **Demonstrations:** Validation of IES operational scenarios; demonstrations in partnership with NE

Examples of Key Objectives:

- **Reduce energy consumption for h₂ production:**
 - 46 kWh/kg H₂ (*low temp*)
 - 35 kWh/kg H₂ (*high temp*)
- **Increase energy utilization at nuclear plants to 50%** through use of waste heat
- **Demonstrate world's first** small modular reactor integrated with H₂ electrolyzer

AFFO Highlight: Nation's First Nuclear-to-H₂ Facility

Constellation's Nine Mile Point Nuclear Station in Oswego, NY.
Partners: INL, NLR, ANL, Nel Hydrogen



Proved H₂ production can **provide a new way for nuclear plants to *dynamically* participate in organized electricity markets**

- **\$800,000 annual savings** by providing in-house H₂
- Prompted Constellation to **pursue large-scale nuclear H₂ production**
- **Set precedent for Nuclear Regulatory Commission (NRC) licensing of H₂ production at nuclear sites**



Winner of the
**2023 Top Innovative
Practice Award**
from the NEI



**What
industry
is saying**



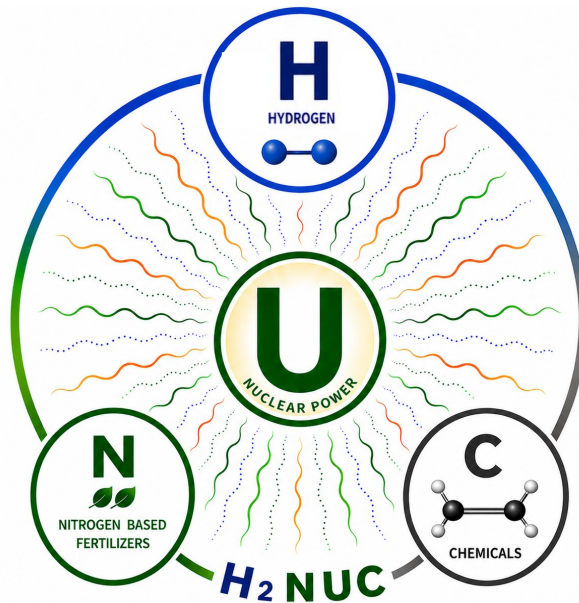
"This technology is going to be incredibly important."

– Constellation Energy CEO Jose Dominguez

"Today's hydrogen market already exceeds \$100 billion and is expected to grow significantly ... represents an opportunity for current and new nuclear plants alike."

– Nuclear Energy Institute

AFFO Highlight: Focusing Lab Expertise on Nuclear-to-H2 Opportunities



Participating Labs: NLR, INL, ANL, LBNL, LLNL, LANL, NETL, ORNL, PNNL, SNL, SLAC

H₂NUC—New national lab consortium focused on:

- **Key enabling technology:** electrolysis, which allows utilization of nuclear waste heat & surplus electricity
- Ensuring electrolysis technologies are ready for **deployment alongside nuclear buildout**
- **Reducing cost** through high-throughput material testing, cell design / fabrication, design for manufacturing, etc.
- Can **enable many potential applications beyond nuclear**, such as **upgrading stranded NG** to liquids from productive wells with no pipeline or market access (potential FY27 focus)
- **Dispatchable / modular technology** to break C-H bonds in favor of C-C bonds (**don't need full chemical plant**)

Meeting the Demands of Energy and Water for the AI Revolution



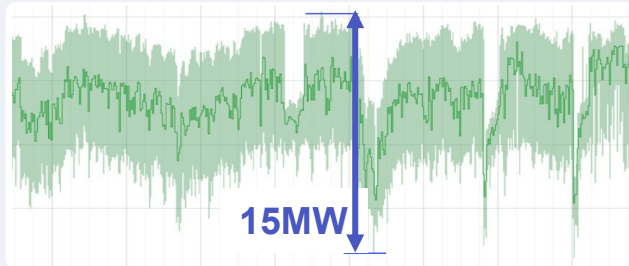
Challenge



Opportunities

AI is driving **extreme** changes on the grid:

- Significant increase in **power demand**
- Extreme/rapid **demand fluctuations**



Google's
"Call to
Action"
Paper from
Feb. 2025

Data centers create issues with water consumption and waste generation

Obstacles to accommodating these changes:

- **New Grid Connections:** long wait times
- **Turbines:** back-ordered: 3–7years
 - Difficulty meeting sub-second fluctuations
 - Pollutants and noise impede/delay permitting
- **Small Modular Reactors:** 2031+

Fuel Cells can provide prime/backup power with:

- **Speed to power** – quicker permitting (low noise/pollutants) and faster equipment delivery
- **Grid-independence, fuel-flexibility** (natural gas, biogas, H₂, etc.)
- Enhanced **instant power-response** and **load-following**
- High **modularity** (build/expand to any scale); **efficiency** (>60%) and **reliability** (enables N+1 redundancy)
- **Greatly reduced water consumption** – including net-positive **water-production** when using H₂ as fuel

Biotechnology can address water issues, create value:

- Utilize wastewater and heat to grow **algae feedstock**
- **Treats wastewater** on site, **creating value** (minerals, feedstocks, etc.)
- **Alleviates bottlenecks** from managing contaminated cooling water
- Potential for: **increased** revenue, **reduced** water consumption, **reduced** operational costs

Strategic Goals



- Develop and demonstrate fuel-flexible **fuel cells** that are **efficient, durable, and cost-competitive**
- Demonstrate fuel cells that can provide **reliable and affordable speed-to-power**
- Integrate and demonstrate **algae systems** for data-center waste management and utilization
- Develop biomanufacturing capabilities for algae-derived **performance-enhanced chemicals, biobased fertilizers, and mineral recovery**

Potential RD&D Areas

Fuel Cell RD&D
(materials, components, subsystems)

Reduce cost, improve durability, efficiency & reliability, alleviate critical mineral dependence, and enable fuel flexibility

System Design, Integration, Operation

Innovative solutions for data center power and cooling demands

Manufacturing RD&D

Boost domestic capacity, improve supply-chain security

Safety R&D and Stakeholder Assistance

Enable ease of permitting

Algae and Data Center Co-location RD&D

Address water cleanup, waste management, and resource recovery

AFFO Highlight: Hydrogen Fuel Cell for Data-Center Backup Power

DOE funded **first-of-its-kind** demonstration of a MW-scale hydrogen fuel cell for backup power at **Microsoft data center in Wyoming**—proved **technology works** and **can be cost-competitive**.

“
**What
industry
is saying**
”

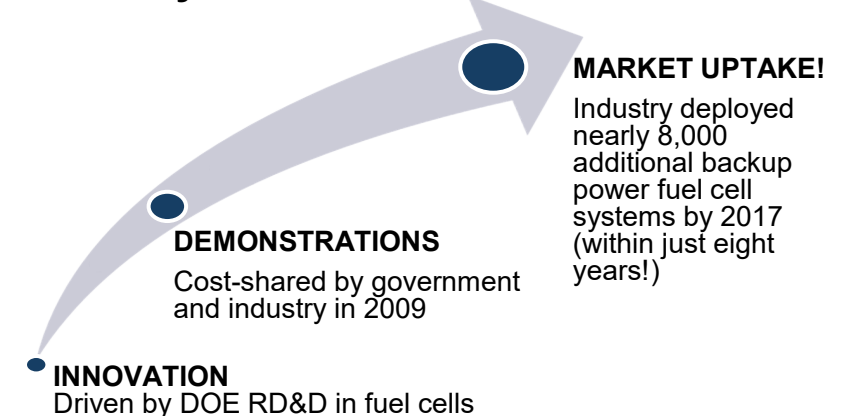
“What we witnessed was, for the data-center industry, a moon landing moment ... It’s mind-blowing.”

– Microsoft’s Director of Data Center Research Sean James, on a related project demonstrating fuel cells for data centers

- Provided 48 hours of backup power
- **Microsoft very pleased with results** – boosted confidence in the technology
- **Partners:** Microsoft, Caterpillar, Ballard Power Systems, NLR



DOE has de-risked innovations and catalyzed markets for fuel cell tech



Geologic Hydrogen – Opportunity for a *New* Primary Source of American Energy



Challenge

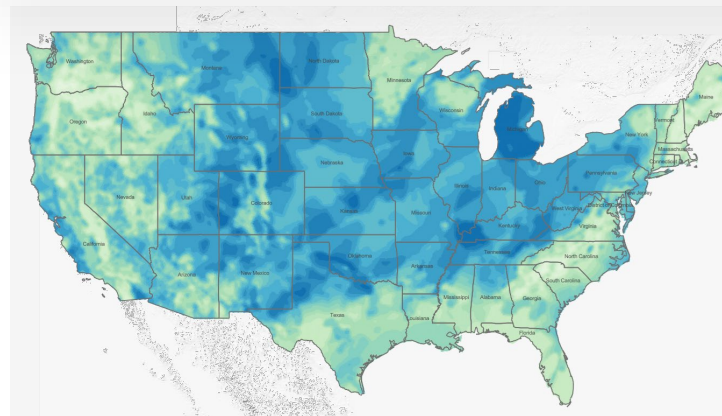


- As demand for energy grows, American **consumers and businesses face rising costs** and supply bottlenecks
- Harnessing new sources of energy—**energy addition** not **subtraction**—will help address energy poverty at home and abroad (through exports)
- **Abundant American energy** will sustain energy security and enable continued exports, strengthening our economy and maintaining a strong global posture

Opportunities

Transform American energy by adding a new domestic energy source

- **Abundant** – estimated >5 trillion tons globally — enough energy for ~1000 years of current global needs
- **Affordable** – potentially <\$1/kg H₂ (comparable to <\$1/gallon of gasoline)
- **Leverages existing expertise** – generations of U.S. drilling experience



USGS geologic H₂ "prospectivity" map—a relative scale of viability of H₂ resources (dark blue = largest potential)

- Geologic H₂ resources identified **across the U.S.**
- Potential for **natural, stimulated,** and **bio-induced H₂**
- Often found with valuable **Helium**
- Potential for co-exploration with **critical minerals & geothermal**

Strategic Goals



Potential RD&D Areas

- Demonstrate viable domestic geologic H₂ production as **cost-effective energy resource**
- Improve high-fidelity **prospectivity maps and tools**, in partnership with USGS and state geological surveys
- Accumulate field data for **accurate technoeconomic analysis to validate projections** of achieving $\leq \text{\$}50 - \text{\$}1.50/\text{kg H}_2$
- Demonstrate **operational promising pilot-scale integrated geologic H₂ sites** (natural and/or stimulated)

Key activities to build the foundation:

GeoH₂ Workshop



Hosted by NLR to identify industry needs

Gap Analysis



Key RD&D areas to focus on

GeoH₂ Roadmap Document



Strategy to enable GeoH₂'s success

Cost Analysis



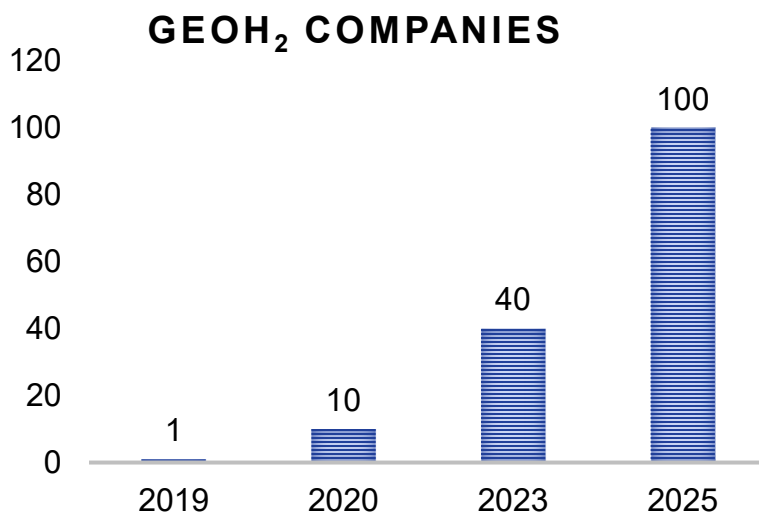
Understand impact of purity, flow rate, depth

-  Focus on **H₂ infrastructure** (e.g., pipelines, material compatibility, compressors, bulk storage)
-  **Safety, permitting, underlying analysis**
-  Develop **testing and reporting standards** for geologic H₂ production
-  Evaluate **economic potential** of enhanced rates of H₂ production from geological resources
-  **AFFO-HGEO coordination** working group with regular meetings

AFFO Highlight: Impact on U.S. Economy

“Even if a small fraction of the potential – say 2% – can be recovered, it could yield around 100,000 megatons of usable hydrogen... that would be enough to supply the world’s energy needs more than 18 times over.”

– EFI Foundation



Economic Potential:

- U.S. extraction of even 0.1% of estimated global GeoH₂ represents ~**\$4.5 trillion** in value
- **Low-cost hydrogen:** by 2030, projected GeoH₂ recovery costs expected to equal or less than conventional SMR production costs

Just Announced — AFFO Notice of Intent for *Multi-Topic NOFO*

Leveraging Domestic Infrastructure and Resources to Unleash Alternative Chemicals, Fuels, and Feedstocks

AFFO's expected new \$60M potential notice of funding opportunity (NOFO) will support RD&D of innovative technologies that harness existing domestic biomass, hydrogen, and pipeline resources to expand domestic energy production and distribution.

NOI Highlights

- \$60M federal investment
- 3- to 5-year award duration
- Advances multiple alternative fuel and feedstock technologies



Topic Areas

Biointermediate Depots: Pilot production of intermediates from biomass and waste

Refinery Integration: Process alternative feedstocks using existing refinery infrastructure

Hydrogen/Natural Gas Blending: Pilot hydrogen blending in simulated gas distribution networks

GOAL of Expected NOFO: Leverage existing U.S. biomass, waste, refinery, hydrogen, and pipeline resources to accelerate domestic production and commercialization of alternative fuels, chemicals, and feedstocks

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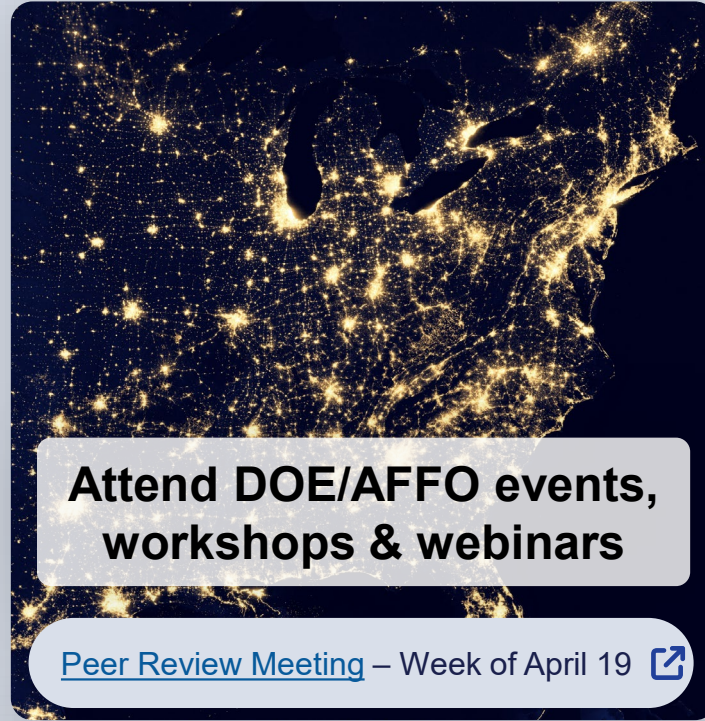
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- [Notice of Funding Opportunities](#)
- [Partnership Intermediary Agreements](#)



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workshops & webinars

[Peer Review Meeting](#) – Week of April 19



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