Energy & Environmental Research Center (EERC)

Hydrogen Opportunities in North Dakota

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OUR FACILITIES

254,000 SQ FT OF FACILITIES

DOE-DESIGNATED NATIONAL CENTER FOR HYDROGEN TECHNOLOGY®

- 15,000-ft^2 NCHT facility.
- Hydrogen production, separation–purification, storage, and integrated fuel cells testing.
- Special materials lab for development of materials, advanced joining techniques, and application evaluations.
- Fuel cell test facility: flexible test center capable of testing low- and high-temperature fuel cells; customizable fuel delivery system.
- Pilot systems: high-pressure fluidized-bed gasification system; pressurized lab-scale entrained-flow gasifier; hydrogen purification; and other systems for developing hydrogen, alternative fuels, and chemicals.

Multicell Test Station

Button Cell Test Station

1-kW Syngas/NG SOFC Stack Test Station

WHY HYDROGEN?

- High energy content. On a mass basis, H_2 beats all conventional fuels.
- Numerous feedstocks/production scenarios:
  - Reform natural gas, natural gas liquids/condensates, light oils, other hydrocarbons
  - Gasify coal and/or biomass
  - Electrolyze water using fossil fuel or renewable electricity
- Clean – whether combusted or converted to electricity in fuel cell, emission is water:

$$2H_2 + O_2 \rightarrow 2H_2O$$

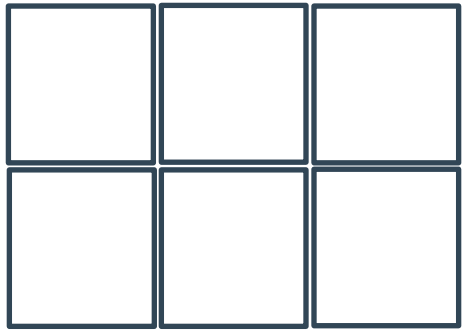
- In addition to energy/electricity generation, numerous uses include:
  - Petroleum, renewable fuel, and metals refining.
  - Feedstock for production of ammonia, methanol, and other commodity and higher-value products.
- When produced using renewable energy or fossil energy with CO_2 capture, near-zero life cycle carbon emissions.

WHY HYDROGEN?

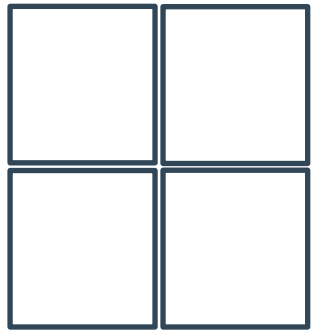
ENERGY CONTENT

Mass-based energy content vs. volume-based energy content

1 kg of H_2 contains about the same amount of energy as 1 gallon of gasoline.



1 kg H_2, compressed to 1000 psig

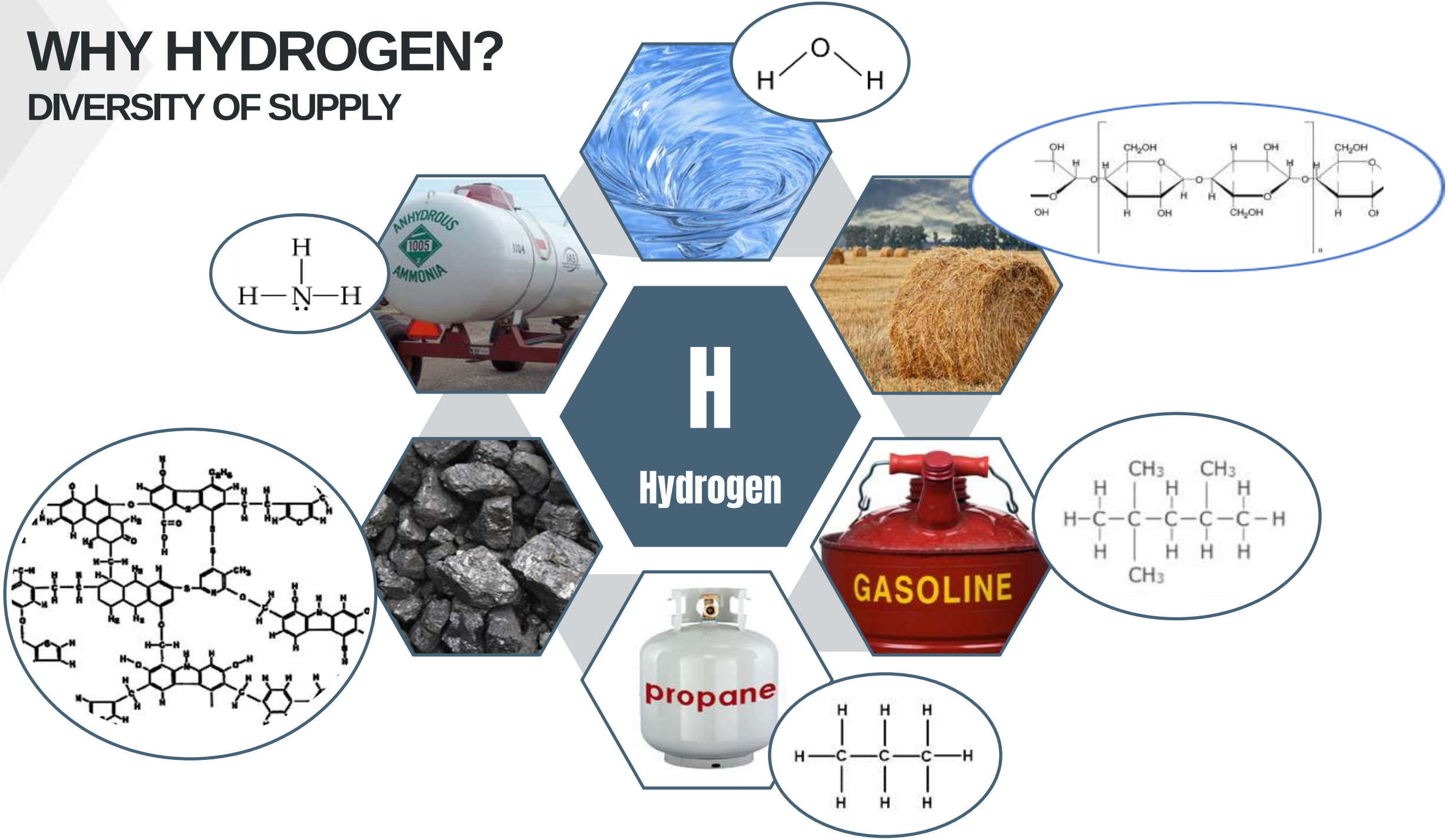


1 kg H_2, liquefied

1 kg H_2, as ammonia

WHY HYDROGEN?

DIVERSITY OF SUPPLY



Source: H2@Scale | Department of Energy

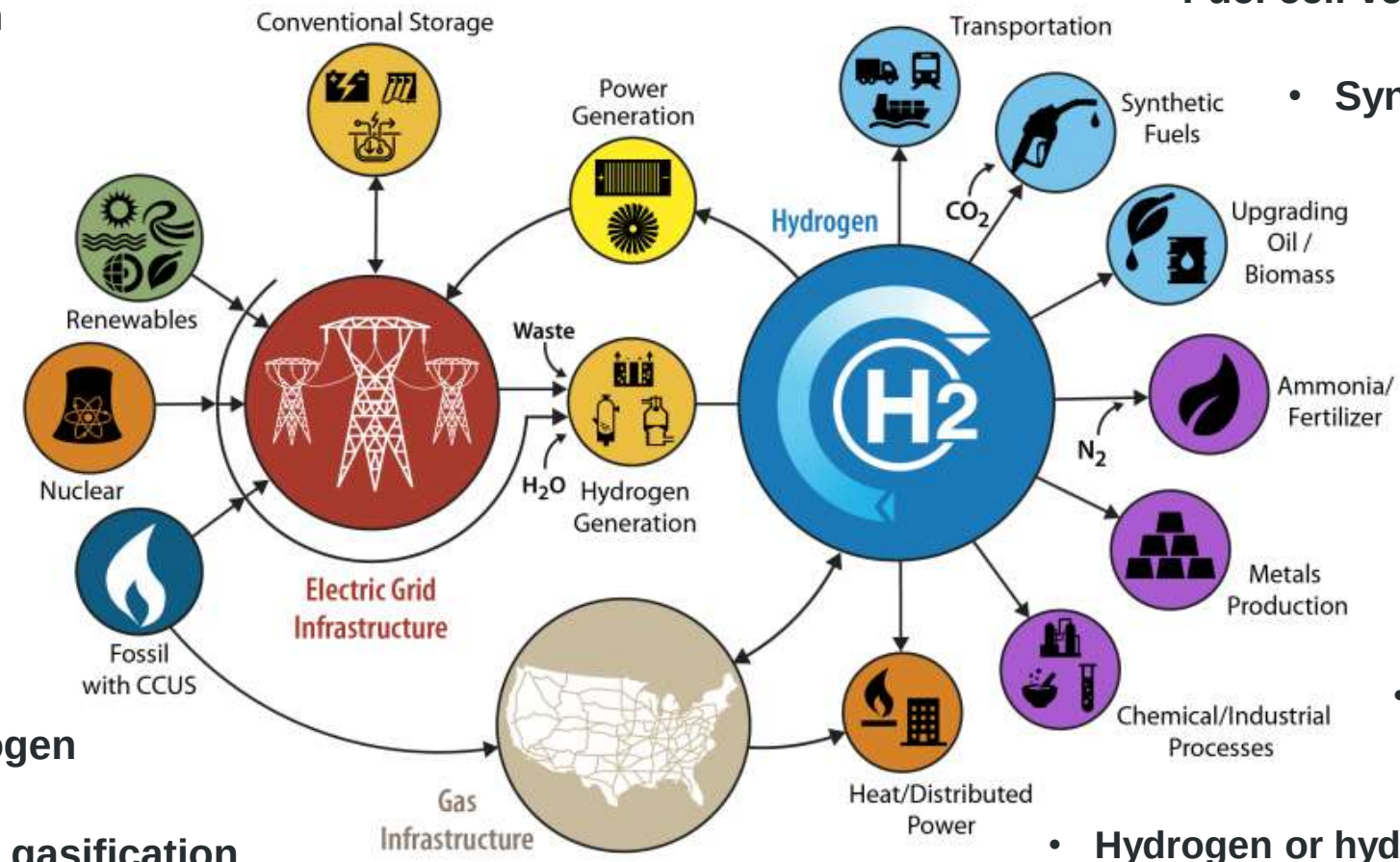
HYDROGEN OPPORTUNITIES IN NORTH DAKOTA

Hydrogen and Power Production

Electrolysis-based hydrogen production

Fossil and renewable power production

- Coal
- Natural gas
- Wind
- Hydro



Syngas-based hydrogen production

- Coal and biomass gasification
- Natural gas reforming/pyrolysis

- Pipelines inter- and intrastate

Hydrogen Uses

- Fuel cell vehicles
- Syngas conversion to fuels
- Refining: petroleum and renewable oil
- Fertilizer manufacture
- Rare-earth elements and critical minerals manufacture
- Petrochemical manufacture
- Hydrogen or hydrogen–natural gas mix for industry or building applications

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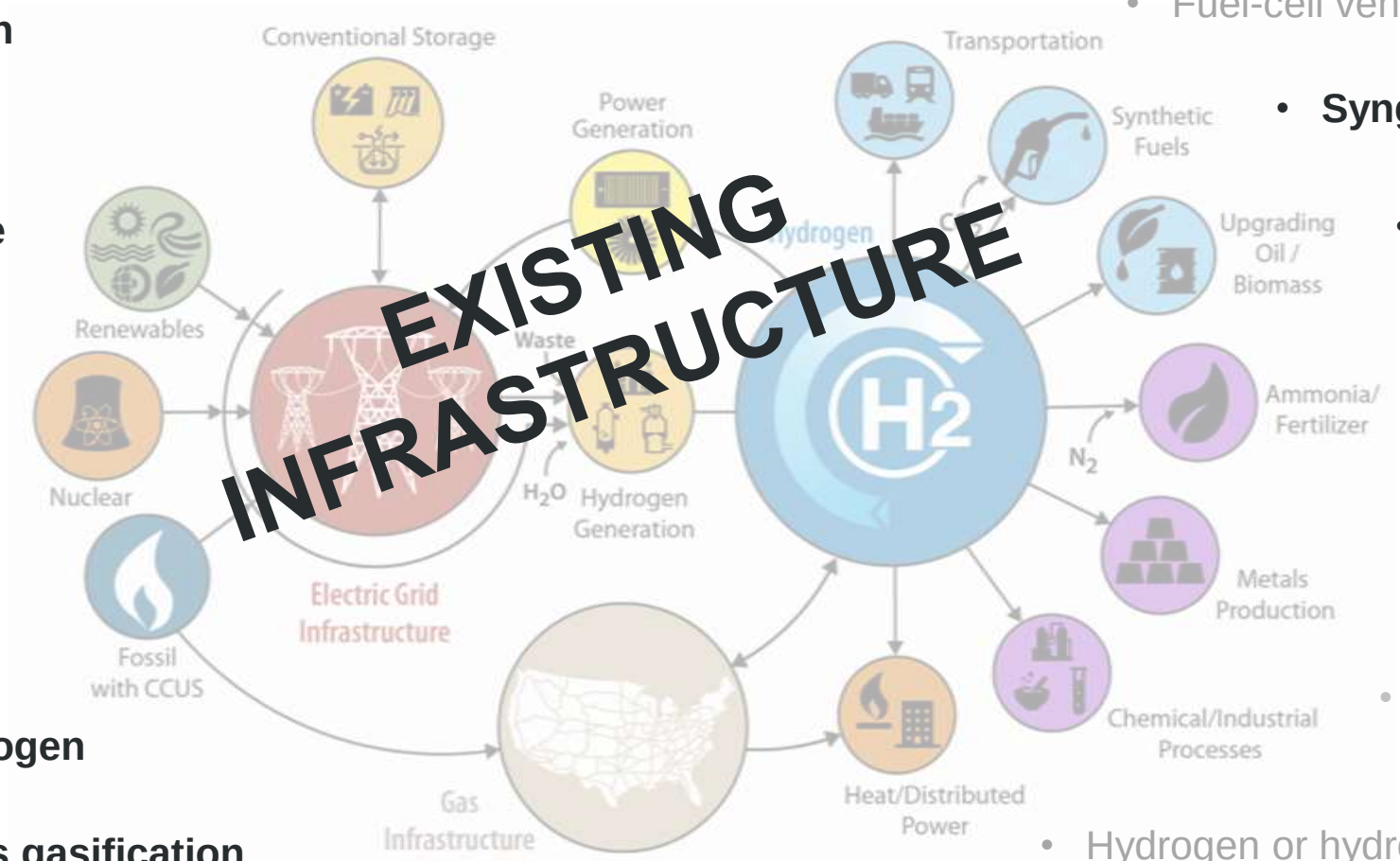

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HYDROGEN ENERGY ROAD MAP FOR NORTH DAKOTA

State-funded study began in August 2021. Project scope includes:

- Identification and quantification of scale:
  - Magnitude of hydrogen production from North Dakota's resources
  - Possible demand from various sectors, near- and long-term
  - Magnitude of infrastructure needed: storage and transport
  - Impacts of hydrogen use on emissions
- Notional timeline and cost for commercial deployment of various hydrogen energy technologies and approaches.
- Assessment of opportunities to grow North Dakota hydrogen energy economy by leveraging and adding value to agriculture, oil and gas, and electrical generation industries while preserving land, water, and air resources for future generations.

OTHER EEEC HYDROGEN ACTIVITIES

- Hydrogen policy, pricing, and performance modeling – how do you incorporate hydrogen into our energy economy?
- Integration with CCS
- Salt cavern storage – identification of suitable sites for development
- Electro- and thermochemical process development for hydrogen production and use
- Fuel cell development:
  - Fuel cell material, component, and systems
  - Low- and high-temperature fuel cells
- Vehicle development – balance of plant support
- On-demand hydrogen production – optimization of previously developed technology

DOE SUPERTRUCK (PROPOSED)

A proposed $53M project to demonstrate a hydrogen-fueled freight corridor in North Dakota

EERC

Coca-Cola Bottling Company HIGH COUNTRY

Argonne NATIONAL LABORATORY

HNEI Hawai'i Natural Energy Institute University of Hawai'i at Mānoa

IVYS Energy Solutions

NREL Transforming ENERGY

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North Dakota Industrial Commission

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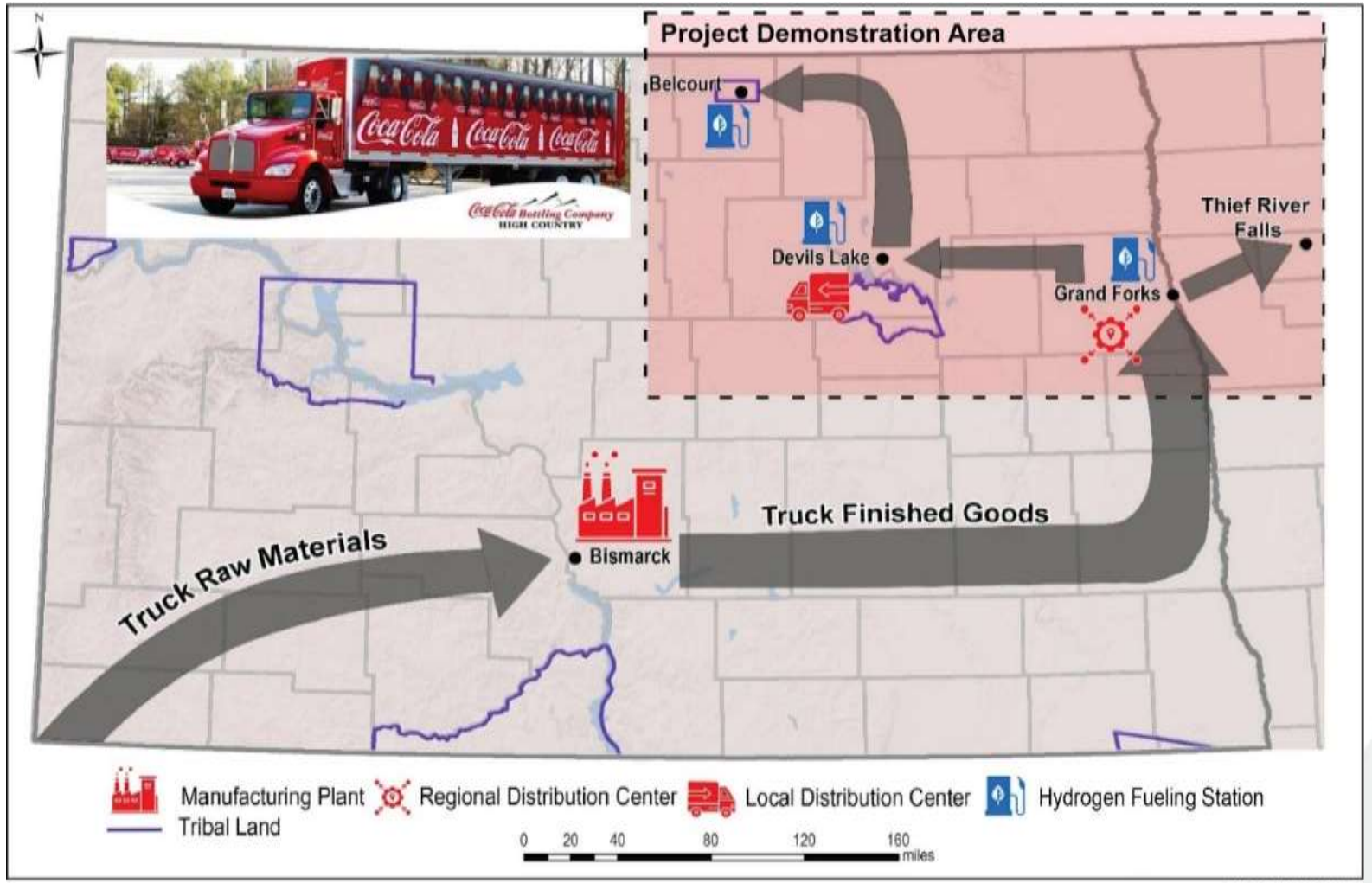
quèt•ica

TEVVA

XOS



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THANK YOU

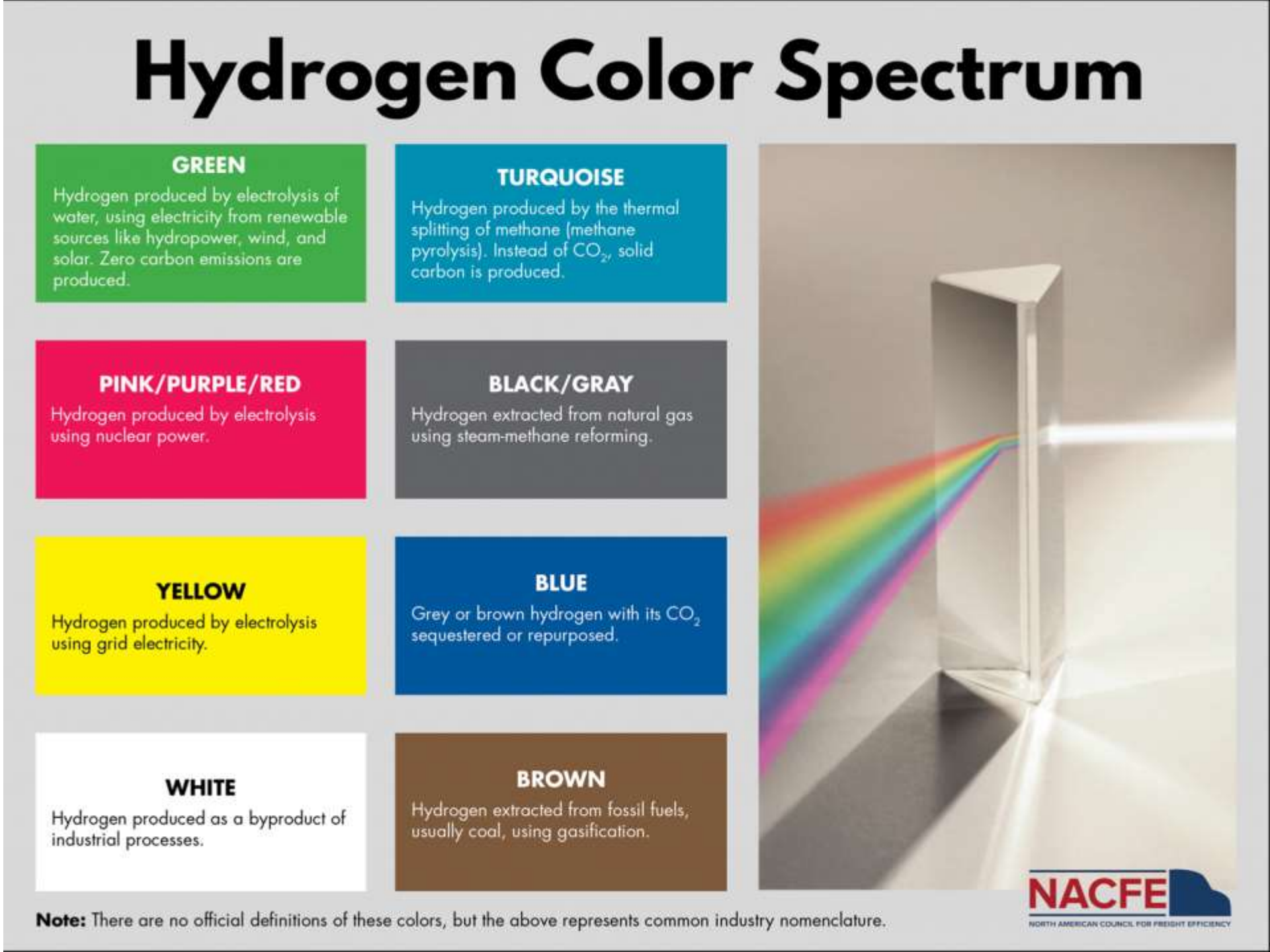
Critical Challenges. Practical Solutions.

The Colors of Hydrogen

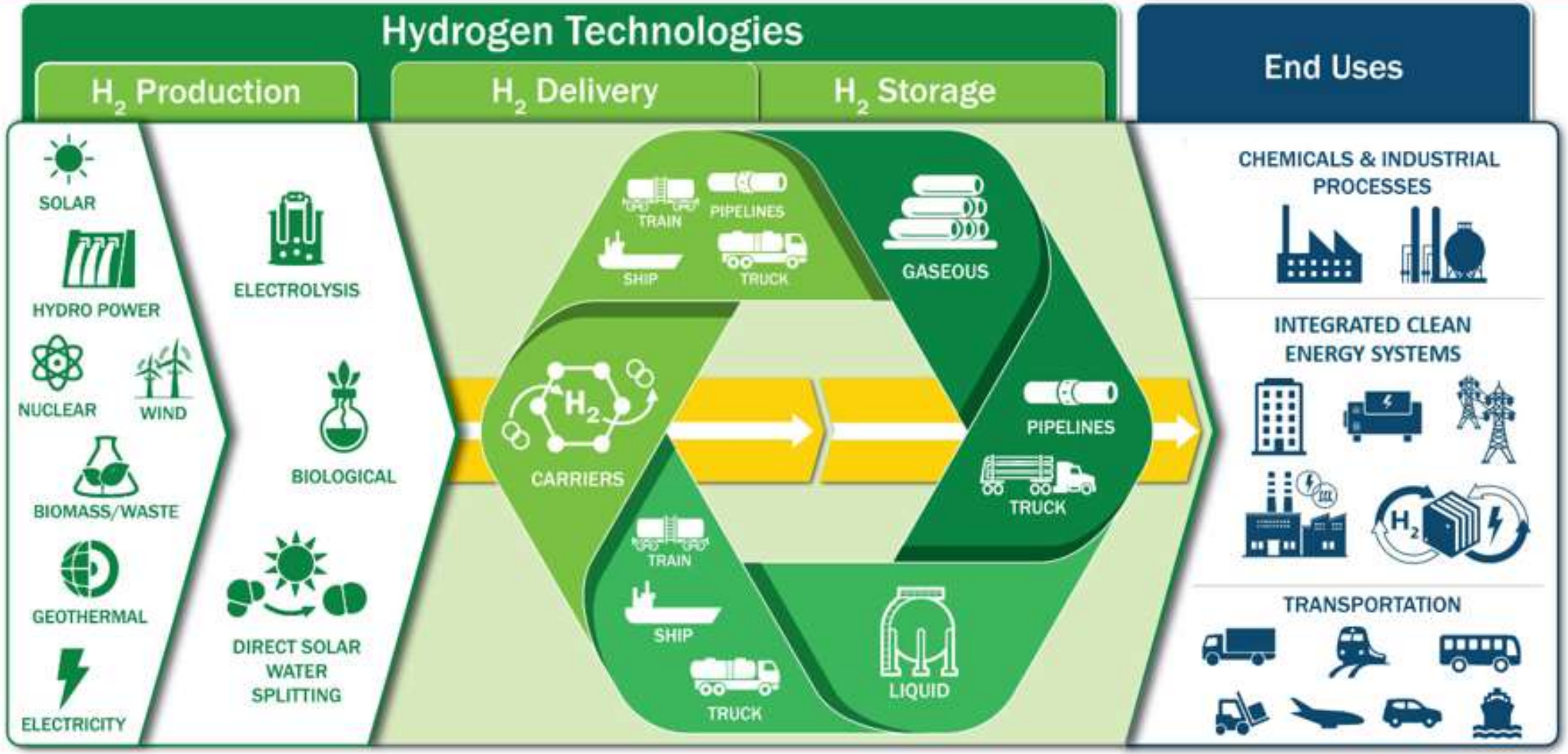
- Unofficial definitions have been developed for hydrogen, based on the production method.

Image from:

https://nacfe.org/wp-content/uploads/2020/12/Hydrogen-Color-Spectrum-HiRes-2.png



Hydrogen Technologies Program



From producing hydrogen molecules through dispensing to end-use applications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North Dakota Industrial Commission
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University of Alaska Fairbanks
UNIVERSITY OF WYOMING
School of Energy Resources
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ADVANCED GEOTECHNOLOGY
AIR PRODUCTS
Alberta Energy
AES
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ALLETE clean energy
ALLETE
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Los Alamos NATIONAL LABORATORY
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Manitoba Hydro
MarathonOil
MBI Energy Services
MEG ENERGY
Melzer Consulting
metso
MidwestAgEnergy
MIDWEST GENERATION
Minnesota Pollution Control Agency
MINNESOTA PUBLIC UTILITIES COMMISSION
Minnkota Power COOPERATIVE
MISSOURI DEPARTMENT OF NATURAL RESOURCES
MISSOURI RIVER
MONTANA-DAKOTA
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MTR MEMBRANE
NATIONAL COMMISSION ON ENERGY POLICY
Natural Resources Canada
Nebraska Public Power District
NSG
Nexant
NEXTSTREAM
NORTH AMERICAN COAL
NORTH DAKOTA'S
North Dakota Petroleum Council
North Dakota Environmental Quality
NDPA North Dakota Pipeline Authority
North Dakota Public Service Commission
NDSU
NorthWestern Energy
Nuverra
OXY Occidental Petroleum
ONEOK
OPPD
OTTER TAIL POWER COMPANY
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