

# Decarbonization Technologies & Opportunities

September 9, 2024



**NGA**  
NORTHEAST GAS ASSOCIATION

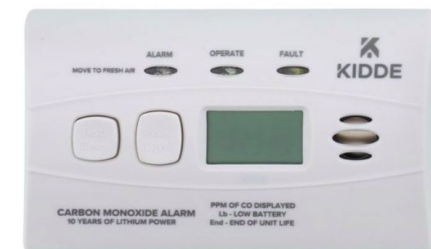


# Safety Moment



# Install / Inspect CO Monitor

- Natural gas boiler failure
  - Obstruction in exhaust overheated condensing boiler
  - Overheating severely damaged flue gas exhaust seal
  - Boiler trouble code, so cover temporarily removed
  - Technician measured high concentration of CO near damaged seal
- Local CO monitor unplugged, and battery removed
  - Spouse did in middle of night while traveling for business...
- Need to ensure ENTIRE family understands the serious aspect of a CO alarm



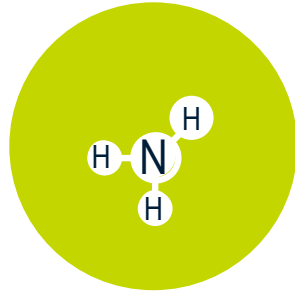
# Agenda



**Legislative and Legal  
Update**



**Carbon Capture &  
Storage**



**Hydrogen & Ammonia**



**Data Centers**



**Northeast Natural Gas  
Generation Market**

# Burns & McDonnell – At a Glance

**113K**  
YEARS OF  
EXPERIENCE

**\$6B**  
REVENUE

**14,000**  
EMPLOYEE  
OWNERS

**65**  
GLOBAL  
OFFICES

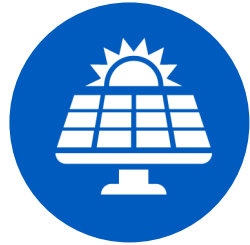
**1898**  
FOUNDED

**SAFE**  
INDUSTRY  
LEADING SAFETY

# Decarbonization Technologies



Wind



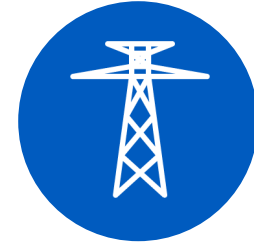
Solar



RNG/H<sub>2</sub>/Biofuels



Coal with CCS

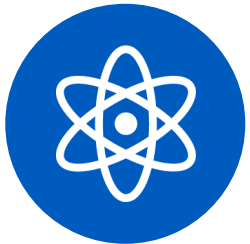


Transmission of  
curtailed power

## Decarbonization



Battery Energy  
Storage Systems



Nuclear



Geothermal



Gas with CCS



Hydro

# Legislative and Legal Update



# The Decarbonization Investment

**IIJA**

Infrastructure Investment and Jobs Act

+

**IRA of 2022**

Inflation Reduction Act of 2022

**Jump-start Investment**

**Economic Engine**





# IIJA Jump-start Investment

- Grants distributed by Department of Energy
  - Prevailing wage, apprenticeship requirements, Buy American
  - Requires implementation of Environmental Justice and Justice 40 initiatives
- Hydrogen
  - Funding of 7 hydrogen hubs as core strategy
- Carbon Capture
  - Funding of pilot (80%) and demonstration projects (50%)
- Direct Air Capture
  - Funding of 2 direct air capture hubs
- Loan Program Office (LPO)
  - Significant authorizations to support commercial deployment strategies
  - Program designed for First of a Kind (FOAK) risks



# Inflation Reduction Act of 2022 (IRA of 2022)

- Funds distributed through tax code
  - Investment Tax Credits & Production Tax Credits
  - Direct payment for non-profit, government companies, cooperatives
  - Treasury provides guidance on credit eligibility
- Hydrogen
  - Up to \$3 / kg production tax credit
  - Tax credits yearly inflation adjust....starting in 2026
- Carbon Capture
  - Up to \$85 / ton for geologically sequestered CO<sub>2</sub>
  - Carbon credits constant for duration of applicability (12 years once operational)
- Direct Air Capture
  - Up to \$180 / ton for geologically sequestered CO<sub>2</sub>
  - Carbon credits constant for duration of applicability (12 years once operational)



# IIJA Update

- Extremely slow progress by DOE in distributing grants
- Hydrogen
  - Hydrogen hub funding for 7 hubs in year-long negotiations
  - Awarded at 15% cost match, not 50% as many potential projects assumed
  - After inflation, very few projects reported as “in the money”
- Carbon Capture
  - Pilot and demonstration projects awarded and in negotiations
- Direct Air Capture
  - DOE struggling to award as first planned
- Loan Program Office (LPO)
  - Active outside of nuclear loans



# IRA of 2022 Update

- Values included in bill based on DOE “cost of production” models
  - Considered CHEAP renewables or curtailed power for hydrogen
  - Aspirational DOE direct air capture value (\$180/ton versus \$800+/ton actual)
- Hydrogen
  - Treasury issued guidance requiring only new renewables and no nuclear
- Carbon Capture
  - Coal potential to clear \$85 / ton threshold, but plants still targeted by EPA
  - Gas generation was already marginal as flue gas concentration 1/3 of coal
- Inflation, inflation, inflation
  - Projects now mostly “out of the money”



# What Could Make a Difference?

- Congress adjusting the Production Tax Credit (PTC) values for inflation
  - H<sub>2</sub> PTC starts adjusting in 2026, but approx. 40% capital cost increase since 2022
  - Need new baseline and ongoing inflation adjustment for carbon capture
  - Potential for bipartisan support regardless of election
- Local and regional incentives
  - California Low Carbon Fuel Standard (LCFS) great example
- Treasury revising hydrogen guidance
  - Harris admin – trash published guidance and rewrite
  - Trump admin – very tough to make more restrictive than already done...
  - Little real impact in Northeast region as renewables simply not CHEAP enough for H<sub>2</sub>



# Chevron Deference

- Rule-making process versus Congressional legislative direction
  - Deference embraced by Clinton administration after Clean Air Act amendment died
  - Used extensively by all administrations since
  - EPA established regulations solely through rule-making process (e.g. Mercury)
- Removed 6-year statute of limitation
  - Now only need to show harm within past 6 year
- Similar outcome to lawsuits regardless of election
  - Harris admin – courts will determine acceptable adjustments
  - Trump admin – settle lawsuits with “adjusted” rules



# Carbon Capture & Storage



# Elements of Successful CCUS Project

**Capture Facility**



**+**

**CO<sub>2</sub> Pipeline**

**+**

**Sequestration**

Geological or Enhanced Oil Recovery



# Capture Facility

- Capture technology has been proven at near scale
  - Petro Nova facility in Texas (suspended operations for years based on economics)
- Large process systems have minimal cost decline for  $n^{\text{th}}$  of kind



Source: U.S. DOE



# CO<sub>2</sub> Pipeline Challenge

- Permitting, permitting, permitting
  - Stakeholder support challenged even in Midwest (Iowa)
- Environmental community
  - Mixed local support for CO<sub>2</sub> sequestration
  - Still involves burning of a fossil fuel
  - Methane emissions during production and transport of natural gas



# Class VI CO<sub>2</sub> injection well permitting

- Marching forward with federal EPA and state Class VI programs
  - Primacy granted to North Dakota, Wyoming, and Louisiana
  - Other including West Virginia, Texas, New Mexico in process
  - State permitting authority supporting – varies by region
- Permitting durations
  - North Dakota targeting 8 months
  - Wyoming targeting 12 months
  - Federal EPA targeting reduction to 24 months
- Primacy coupled with new laws by state legislatures
  - Accepting state liability and/or ownership (after 10 years) of sequestered CO<sub>2</sub>
  - Protecting state revenue from oil and gas development
  - Challenging for similar consideration in Northeast states



**Regionally...**

# EPA NSPS Requirements for New NGCC

- New Source Performance Standard (NSPS)
  - Applicable for new fossil generation
  - Existing unit strategy delayed till 2025
- Natural Gas Combined Cycle (NGCC)
  - If >20% capacity factor then Carbon Capture & Sequestration required
- Lawsuits in process
  - Even Edison Electric Institute (EEI) challenging after supporting prior Clean Power Plan

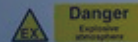
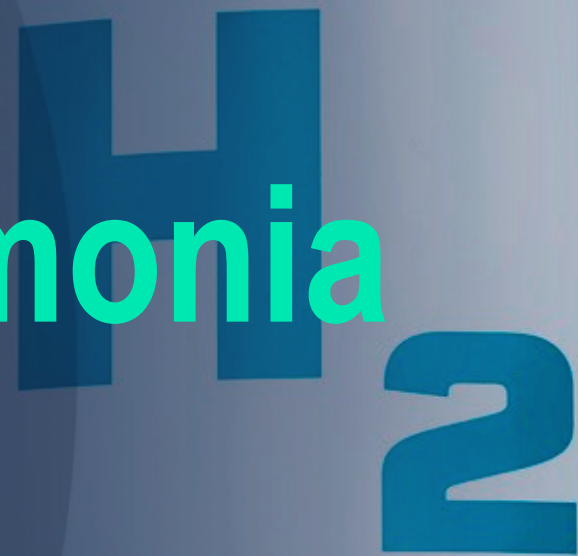


# NSPS for Gas Generation Unlikely to Survive

- Simply too expensive
  - EPA cost modeling assumed unprecedented reducing cost curve for process equipment
  - \$2 billion in control equipment on a \$1.3 billion combined cycle plant
  - 20-30% of CCGT output to power carbon capture equipment
  - Single project would exceed market cap of most U.S. utilities
- Production Tax Credit (PTC) unlikely to be extended
  - Precedence is promoting only “new” investment
  - Exception was existing nuclear in IRA of 2022
- 12-year window to recover entire capital investment
  - Carbon capture credits don’t inflation adjust
  - After PTC, 30-35% higher fuel and CO<sub>2</sub> disposal costs compared to existing units
  - Typically financed with 20-year loan for a 40+ year asset
- Public Utility Commissions (PUC) can always choose to rate-base investment

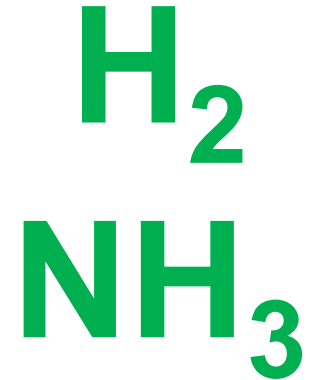


# Hydrogen & Ammonia



# Green H<sub>2</sub> and Green Ammonia Update

- Hundreds of announced mega-projects for “Green Hydrogen”
  - Many GW of power needed
  - Using electrolysis of water using power to produce hydrogen
  - Developers just “piled on” to announcements without developing a viable pro forma
- Unreasonable power cost assumptions
  - Competition for curtailed power not considered
  - Assuming stranded asset pricing
  - Electrical transmission upgrades debottlenecking renewables
  - 40-60% of “Green Hydrogen” production costs is power
  - Treasury delivered the “dagger to the heart”
- Fuels markets developing slowly as a potential hydrogen off-take
  - Sustainable aviation fuel production was originally targeted for green H<sub>2</sub>
  - Hydrogen for fuel cell vehicles is decades to fully mature demand
  - Few niche projects continuing to progress



# BIG Winner thus far is “Clean” Ammonia!!!

- Japan, Korea, Singapore
  - Seeing highly bankable long-term contracts
  - 20-year vision – extensive public/private collaboration
  - Alternative fuels are substantially more, so reasonable choice
- “Blue” hydrogen production
  - Natural gas SMR/ATR w/ carbon capture + Fischer Tropsch process
- E.U. expressing interest too
  - “Gaming” production method means less bankable contracts
- Minimal reliance on IRA of 2022 tax credits to continue





# Hydrogen Blending in Northeast

- Industrial or power generation dedicated off-taker
  - Good application technically (blended or even 100%)
  - Coupled with a purpose-built pipeline
  - Provides producers a needed “step-change” in hydrogen demand volumes
  - Industrial likely coupled with protectionist foreign market policies
  - Financial recovery of entire investment in 12-year production tax credit period
- Competition from residential / commercial electrification
  - Gas / H<sub>2</sub> competes against heat pumps with cold-weather heating system
  - “Perfect” solution for environmental community
- Blue hydrogen cheaper than Green, but requires carbon capture & sequestration
- Local mandates required to move market forward

H<sub>2</sub>



# Data Centers



# Is the New Data Center Load “Real”?

- AI requires 10-20 times more power than traditional search
- Electric Power Research Institute (EPRI)
  - 9% of total U.S. electricity by 2030 (more than double current)
  - Equivalent of 360 large combined cycle or 465 large combined cycles with carbon capture
  - \$468 billion investment if dominated by gas (\$1.5 trillion if CCGT with carbon capture)
- AI data center would be easier to curtail and participate in a market incentive
  - Could move AI computation to a location with renewables
  - No real incentive to do so if only the cost of power



# What is the Reality?

- Power is big component of operational costs
  - Relatively insignificant in overall data center economics
- Efficiency improvements not driven by power costs
  - Traditional data center reduction in power driven more by reliability and equipment costs
- Can AI deal with reduced energy supply capacity?
  - Per a venture fund research group, likely 60% reduction is low-hanging fruit
  - Driven by unavailability of power, not power costs
  - 40% of predictions is still a whole LOT!!!
- Quantum computing coming
  - Disruptive technology starting 2035 with MUCH lower power requirements

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# Northeast Natural Gas Generation Market



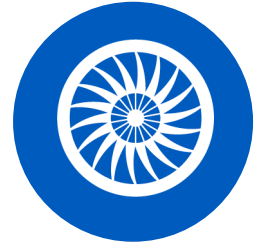
# Demand Drivers for Natural Gas

- Assume ½ of 2030 data center load in Northeast
  - Over ½ of current data center load in Virginia
  - 234 GW of new fossil baseload and peaking required
  - Equivalent of 180 combined cycle gas turbines (without carbon capture)
- PJM recent capacity auction 10X prior
  - Fossil (coal, gas, fuel oil) retirements being delayed if possible
- Natural gas is only legitimate option for resiliency coupled with renewables
  - Battery Energy Storage System (BESS) short-term operations (typically 4 hours) is excellent and entirely unavailable for long-term operations
  - Revival of nuclear simply too far out



# Peaking Generation will Dominate Northeast

- Prediction: **Combined cycle risky, peaking safe investment long-term**
- Off-shore wind is coming
  - Fuel displacement technology (offsets needed natural gas)
  - Higher capacity factor than on-shore wind or solar
  - Could strand some of a combined cycle plant's capacity factor once wind on-line
- Battery Energy Storage Systems (BESS)
  - Great help with wind / solar ramp rates while waiting for natural gas generation to catch up
- Natural gas supply delivery system reliability will be crucial



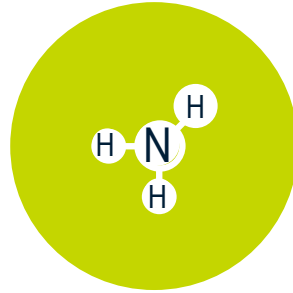
# Summary



**IIJA and IRA impact  
challenged by inflation**



**Regional Carbon  
Capture & Storage  
will proceed**



**Hydrogen challenged,  
but ammonia emerging  
as winner**



**Data center demand  
huge, but potential to  
be limited to 40%**



**Big gas demand,  
peaking generation  
likely to dominate**



# Q&A



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