

KeyState

Natural Gas
Synthesis &
Carbon Storage

PUBLIC TESTIMONY
Senate Environmental Resources
and Energy Committee
3.10.21

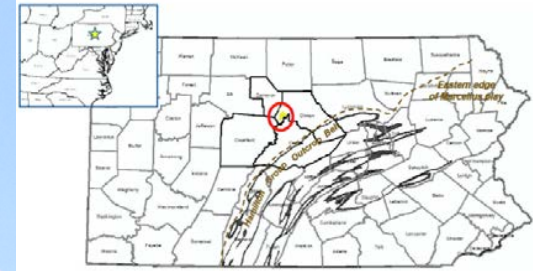
Application & Implications
of Carbon Capture Use & Storage
For Pennsylvania

KeyState Natural Gas Synthesis & CCUS
Clinton County, Pennsylvania
Perry Babb, Chariman & CEO

KeyState

Natural Gas
Synthesis &
Carbon Storage

CCUS Application & Implications



**Integrating Natural Gas Production
and Natural Gas Synthesis with
Carbon Capture Use and Storage**

Displacing
Higher-Carbon-Higher-Cost
Products with
Lower-Carbon-Lower-Cost
Products

Result =
High Paying Job Creation
with
Dramatic Emissions Reduction

Pennsylvania's
Next Energy Revolution

KeyState Natural Gas Synthesis & CCUS

Clinton County, Pa.

\$410,000,000 Capital Project

Low-Carbon Products:

- CO2 Emissions Reduced by 50 to 80% per ton
- Blue Hydrogen
- Blue Ammonia

Emissions Reduction Products:

- Diesel Exhaust Treatment (DEF)
- Power Plant Exhaust Treatment (NH3)

CO2 Use & Stored

- Used In DEF Production = 170,000 tpy
- Stored Process CO2 = 104,000 tpy
- Post Combustion CO2 Capture Potential
+ 85,000 tpy

CCUS - Application & Implications

JOBS CREATION



CLIMATE CONCERNS

ECONOMIC DEVELOPMENT



EMISSIONS REDUCTIONS

FOSSIL ENERGY ECONOMY



HYDROGEN ECONOMY

KeyState

Pennsylvania's
Next Energy
Revolution

CCUS - Application & Implications



Pennsylvania's NEXT Energy Jobs

Direct use of natural gas as feedstock and power source in onsite manufacturing
...with carbon capture use and storage

**800 Construction & Permanent Jobs
+ Indirect + Induced Jobs**
www.pamanufacturers.org/nepanatgas

KeyState

Pennsylvania's
Next Energy
Revolution



ECONOMIC IMPACT ANALYSIS:

NATURAL GAS SYNTHESIS MANUFACTURING PLANTS

Presented by: Carl A. Marrara
Vice President of Government Affairs, Pennsylvania Manufacturers Association

Study of Potential New Manufacturing Facilities

DURING CONSTRUCTION

Total economic output: construction of natural gas synthesis plants combined

Location	Labor Income	Value Added	Total Economic Output
Clinton County	\$137,977,974.67	\$180,842,342.55	\$364,962,192.10

Total jobs related to construction of natural gas synthesis plant combined

Location	Direct	Indirect	Induced	Total
Clinton County	800	78	143	1,021

DURING OPERATIONS

Total economic output: combined-permanent jobs from natural gas synthesis plant

Location	Labor Income	Value Added	Total Economic Output
Clinton County	\$83,009,918.22	\$118,909,211.18	\$260,995,083.52

Total jobs related to completion of natural gas synthesis plant (combined-permanent)

Location	Direct	Indirect	Induced	Total
Clinton County	150	144	232	526

“Based on the results, it’s clear that these projects would be transformative to northeast Pennsylvania, and the commonwealth as a whole. Entire economies are centered around this type of economic activity and will sustain regions for generations to come. Attracting and retaining natural gas synthesis manufacturing ought to be a priority of policymakers at the state and federal level to ensure this prosperity occurs in our commonwealth as opposed to a competitor state.”

DAVID N. TAYLOR, PRESIDENT & CEO - PMA



full report: www.pamanufacturers.org/nepanatgas

<http://www.pamanufacturers.org/NEPANatgas>

- Major Rural Economic Impact
- Multi-County Impact
- The New Energy Jobs
- Industry Breakthrough
- Manufacturing Breakthrough
- Generational Workforce Development

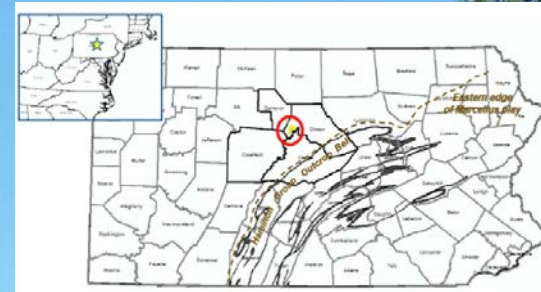
KeyState

Pennsylvania's
Next Energy
Revolution

CCUS - Application & Implications

PENNSYLVANIA NATURAL GAS DILEMMA :

- **CONSTRICTED GAS MARKETS**
- **SHORT-TERM ENERGY JOBS**
- **NARROW ECONOMIC IMPACT**
- **AVOIDABLE CLIMATE IMPACTS**



**KeyState
Natural Gas Partner**



**On The Path to a
Carbon-Neutral-Economy**

**250 bcf of Stranded Natural Gas
7,000 Acre, Winner Tract
Clinton County, Pa.**

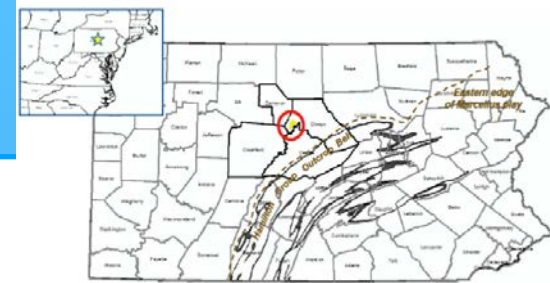
Vertically Integrated Business Case

Natural Gas Resource + Manufacturing + Carbon Storage

- **On-Site Natural Gas Supply**
- **20 Year Gas Supply Agreement**
- **Onsite Carbon Sequestration**
- **Gas Provided 'At-Cost-of-Production'**
- **No Gas Pipeline Transportation Costs**
- **Structural Competitive Advantages**

CCUS - Application & Implications

Petrochemicals Supply Chain



KeyState's Integrated, On-Site Gas Supply Eliminates Mid-Stream Costs and Emissions

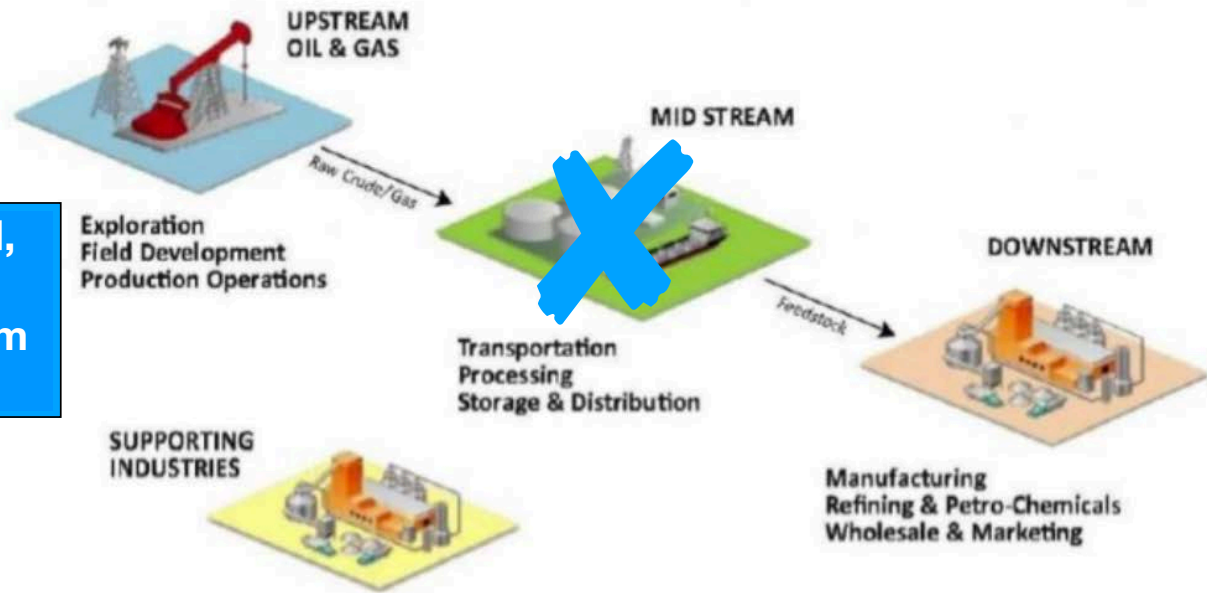


Image Source: AVATA

'CLOSED METHANE SYSTEM'
& the Elimination
of Fugitive Methane Emissions

- Integrated gas production, pipeline gathering & manufacturing.
- All new wells, new pipeline, no compressor stations.
- No gas of unknown origin.



CCUS - Application & Implications

HOW PRODUCTS ARE MADE

Hydrogen is synthesized from methane in natural gas and combined with nitrogen from the air to make ammonia. Ammonia and Carbon Dioxide are used to produce Urea. Exhaust Treatment is a mixture of Urea & ultra clean water.

PRODUCTS

(Preliminary Calculation = 51% reduction in CO2)

#1. AMMONIA

Ammonia in a gas or liquid form used in industry, medical, agriculture and combustion exhaust treatment.

'Blue Ammonia & Blue Hydrogen & Blue Nitrogen'
Low-Carbon when process CO2 is captured & permanently sequestered.

(Preliminary Calculation = 23% reduction in CO2)

#2. Low-Carbon UREA/DEF

Automotive Grade Urea is used as diesel exhaust treatment
DEF - DIESEL EXHAUST FLUID

HOW PRODUCTS ARE SHIPPED

Preliminarily 51% by rail = apx. 10 cars per day
and 49% by truck = apx. 22 trucks per day

PLANT SITE

Greenfield, 220 acre site within privately managed habitat.

KEYSTATE PRODUCTS

Low-Carbon Products:

- Blue Hydrogen - Blue Ammonia for Industrial, Medical & Energy Uses
- Blue Nitrogen - Fertilizer

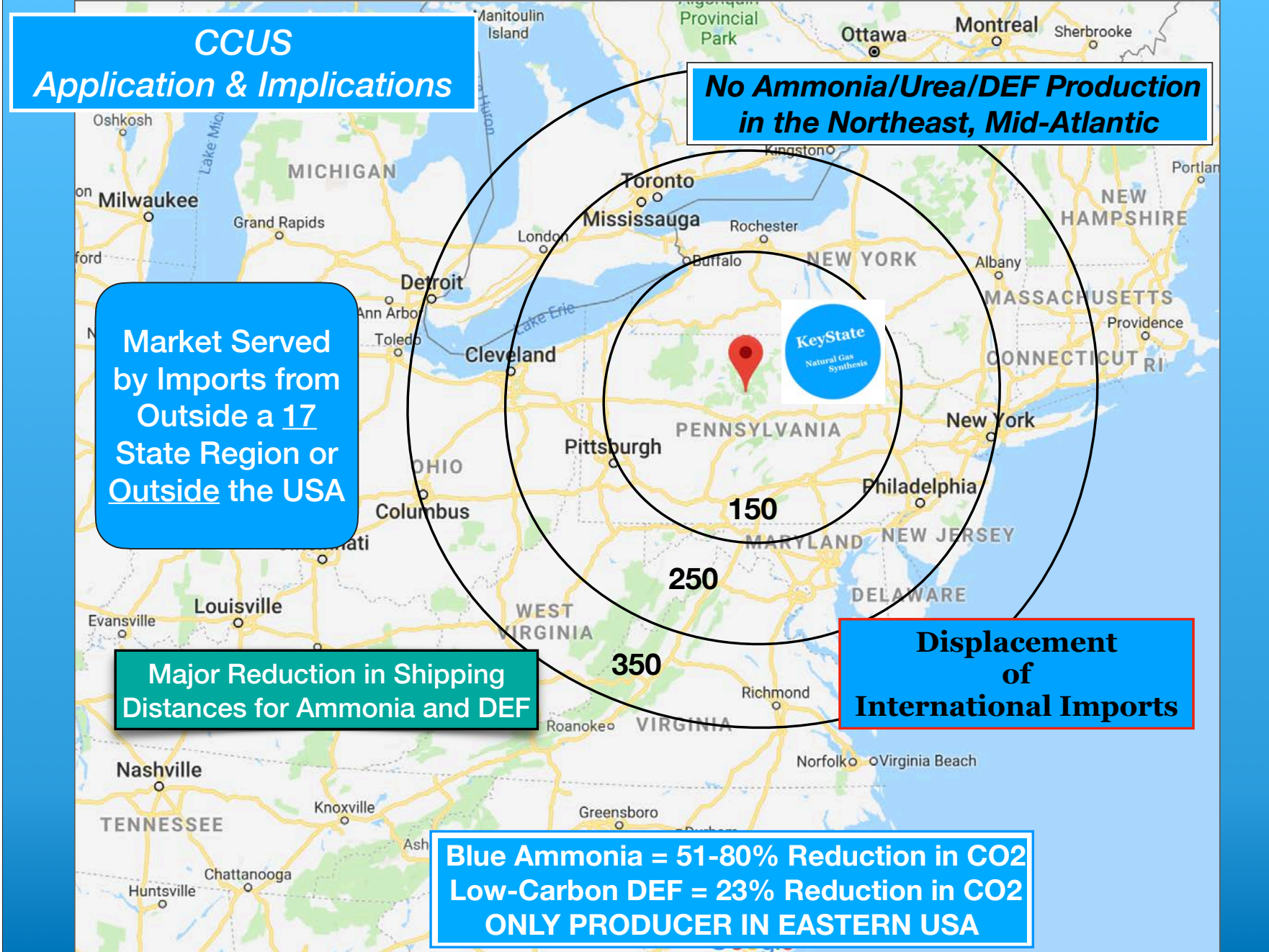
Emissions Reduction Products:

- Diesel Exhaust Treatment (DEF)
- Power Plant Exhaust Treatment



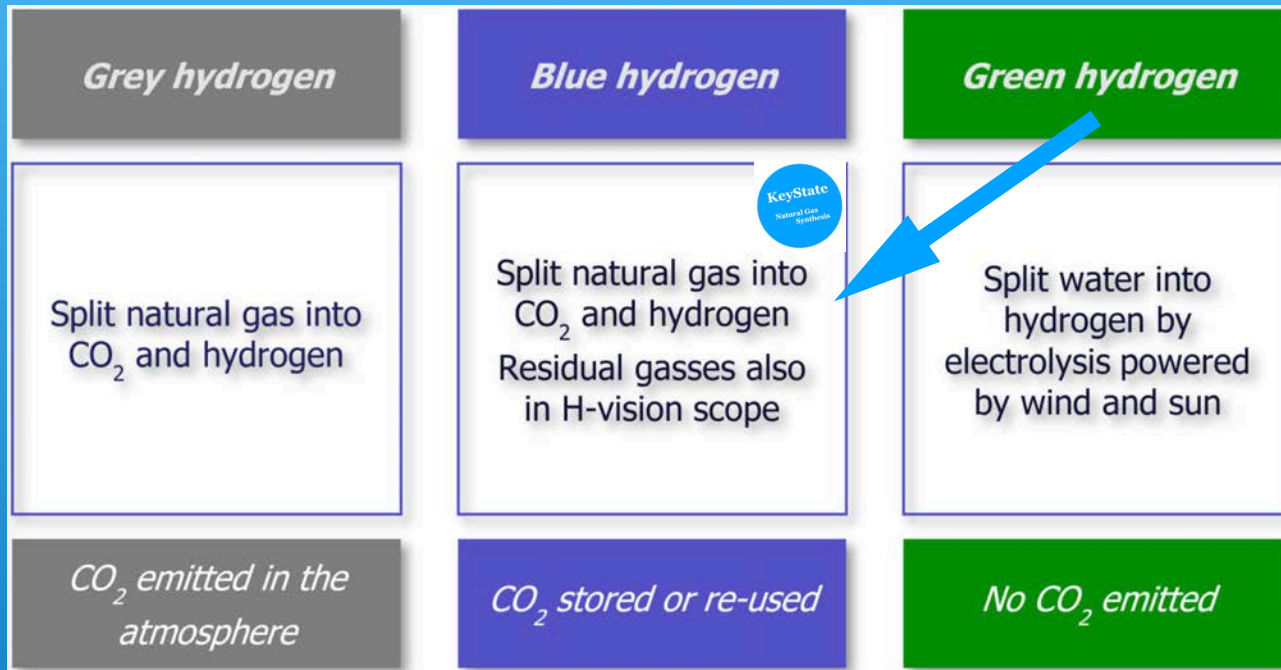
KeyState

Pennsylvania's
Next Energy
Revolution



Hydrogen/Ammonia Economy Breakthrough

Low-Carbon Hydrogen Produced from Natural Gas with Onsite CO₂ Capture & Storage



‘Using blue hydrogen for the power sector and industry, to replace natural gas, coal, and possibly also residual gases from the petrochemical industry, can rapidly achieve megaton-scale CO₂ emissions reduction.’ <https://blog.sintef.com/sintefenergy/elegancy-tno-h-vision-project/>



https://www.youtube.com/watch?time_continue=6&v=h3h_YihGKdc&feature=emb_logo



CCUS - Application & Implications

BLUE HYDROGEN & AMMONIA

Pennsylvania's Hydrogen Economy Breakthrough

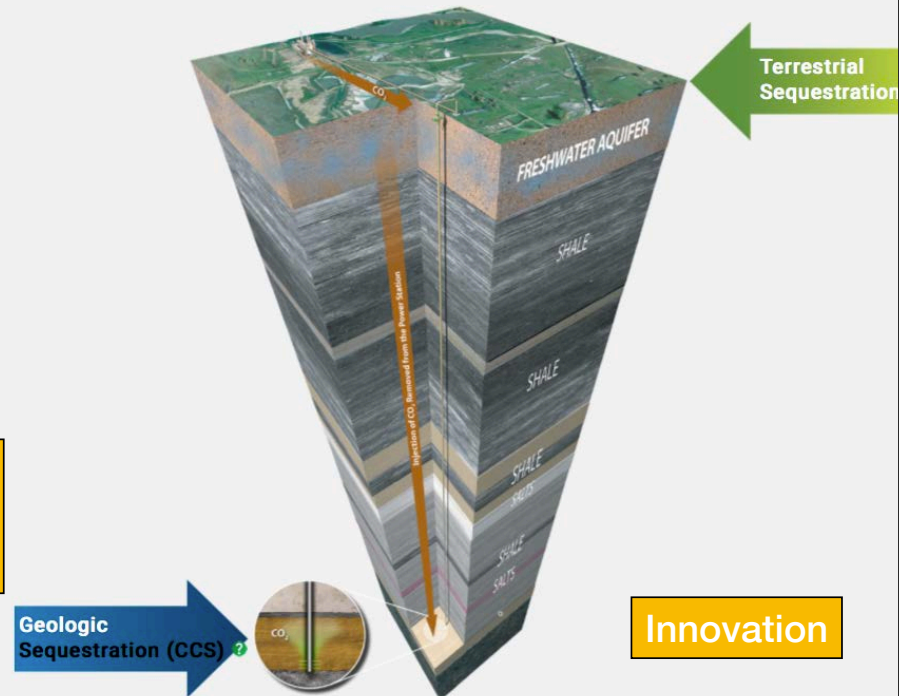
- Ammonia Made from Natural Gas
- = Effective Hydrogen Carrier
- = Low-Carbon Ammonia called, 'Blue Ammonia' when CO₂ is Captured & Stored
- = Low-Carbon Nitrogen Carrier for Fertilizer

- Onsite Geological Carbon Sequestration
- Integration of Capital & Operational Costs of Gas Production and Carbon Storage

KeyState Carbon Capture & Storage

What Is CO₂ Sequestration?

Sequestration means permanent storage. Carbon or CO₂ sequestration means putting carbon into storage for millions of years. There are two major types of CO₂ sequestration: **terrestrial** and **geologic**.



Blue Hydrogen & Blue Ammonia Made From Pennsylvania Natural Gas

FOR BACKGROUND INFORMATION ON CCUS: Pennsylvania's Carbon Capture Utilization and Storage Research
Kristin Carter, Assistant State Geologist PA DCNR, Bureau of Topographic & Geologic Survey

KeyState

Pennsylvania's
Next Energy
Revolution

GEOLOGIC CARBON SEQUESTRATION OPPORTUNITIES IN PENNSYLVANIA

CCUS - Application & Implications

Validating Pennsylvania's Geological Carbon Storage Potential

Innovation

KeyState
Natural Gas
Synthesis

- UNMINEABLE COAL AREAS
- SALINE FORMATIONS

Source: U.S. EPA Archive, Climate Change,
"Carbon Dioxide Capture and Sequestration: Overview."

Figure ES-10. U.S. Assessment of Geologic CO₂ Storage Potential

What is the impact of storing 100,000 tons of CO2 per year?

EPA Greenhouse Gas Equivalencies Calculator

Greenhouse gas emissions from



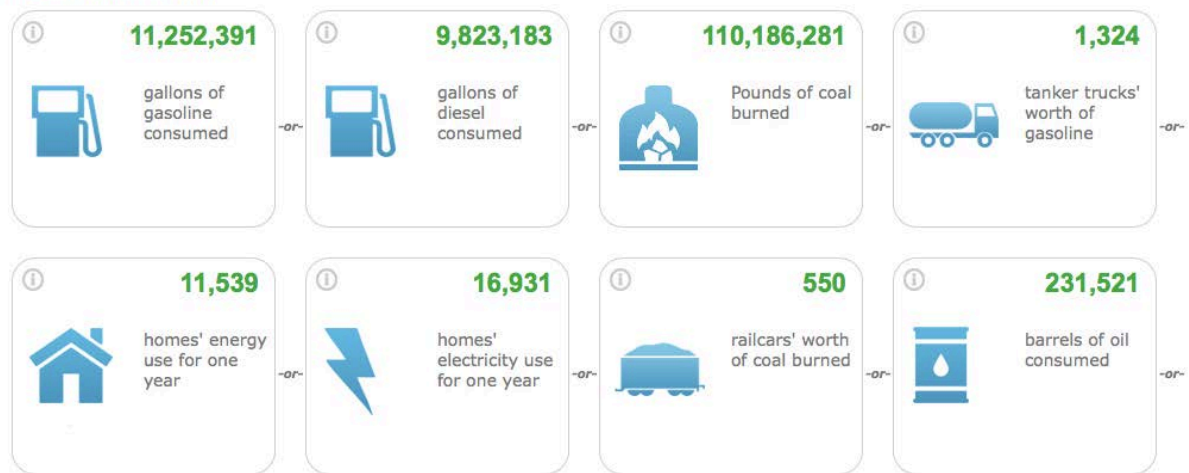
Carbon sequestered by



Greenhouse gas emissions avoided by



CO2 emissions from



<https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>

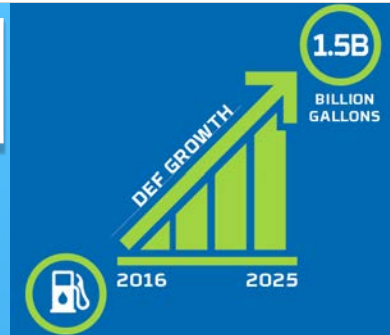
CCUS - Application & Implications

Emissions Reduction Products

What is Selective Catalytic Reduction?

Selective Catalytic Reduction (SCR) is an advanced active emissions control technology system that injects a liquid-reductant agent through a special catalyst into the exhaust stream of a diesel engine. The reductant source is usually automotive-grade urea, otherwise known as Diesel Exhaust Fluid (DEF). The DEF sets off a chemical reaction that converts nitrogen oxides into nitrogen, water and tiny amounts of carbon dioxide (CO₂), natural components of the air we breathe, which is then expelled through the vehicle tailpipe.

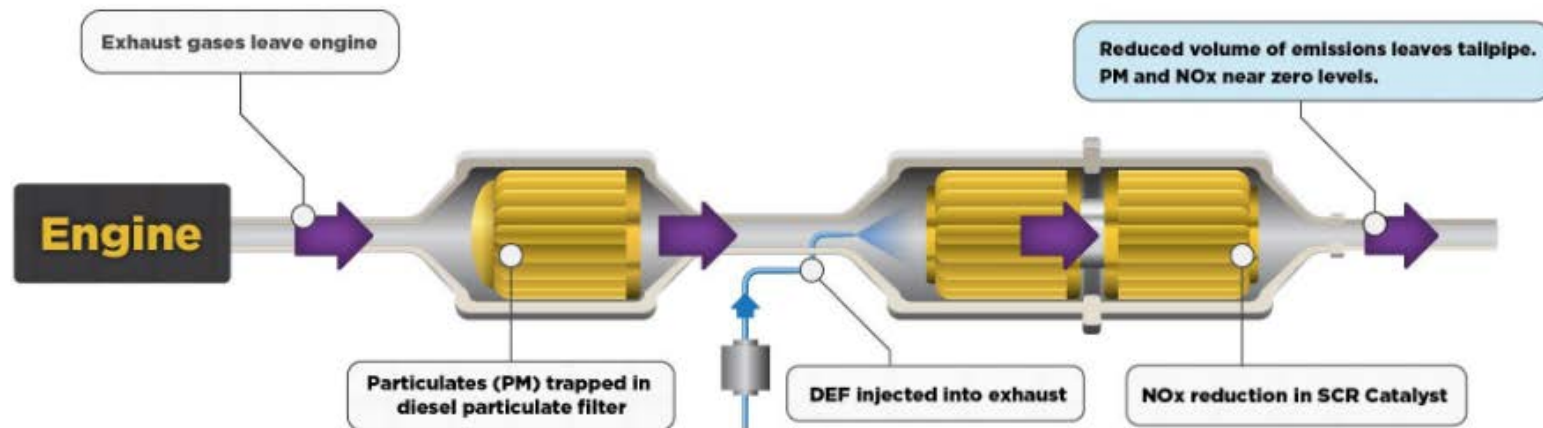
SCR technology is designed to permit nitrogen oxide (NO_x) reduction reactions to take place in an oxidizing atmosphere. It is called "selective" because it reduces levels of NO_x using ammonia as a reductant within a catalyst system. The chemical reaction is known as "reduction" where the DEF is the reducing agent that reacts with NO_x to convert the pollutants into nitrogen, water and tiny amounts of CO₂. The DEF can be rapidly broken down to produce the oxidizing ammonia in the exhaust stream. SCR technology alone can achieve NO_x reductions up to 90 percent.



**KeyState DEF Production
= Elimination of 90% of
NO_x/Smog Emissions for
8,000,000,000 Gallons of Diesel**

**Enough for every diesel bus,
truck, train, boat, generator
& heavy equipment
in Pa/NY/NJ +**

Diesel Emissions Control System



General Rule:

1 Gallon of DEF Used for Every 50 Gallons of Diesel

CCUS - Application & Implications

ENVIRONMENTAL SUMMARY

<p>ENVIRONMENT</p>	<ul style="list-style-type: none"> Former coal surface mining area. 220 acre plant site within KeyState managed private wildlife habitat. Major new Elk Habitat in collaboration with local and State experts. Overall, more than 1,000 acres of habitat enhancement through KeyState support. Onsite water treatment plant
<p>AIR QUALITY IMPACT</p>	<ul style="list-style-type: none"> KeyState will produce enough diesel exhaust treatment for 57% of the diesel used in the Northeast and Central Atlantic and 100% of all used in Pennsylvania. Diesel Exhaust Fluid eliminates 90% of smog forming NOx and particulate matter emissions from diesel trucks, busses, ships, commonly called, 'Short-Life' Green House Gases. KeyState will eliminate 90% of the NOx for up to 8,000,000,000 Gallons of Diesel Fuel per year!!
<p>PRELIMINARY DESIGN CAPACITIES</p> <p>CO2 EMISSIONS</p>	<ul style="list-style-type: none"> A Gas Synthesis plant is not a 'cracker plant' - different process, different science, different emissions profile Integral CO2 Capture Process <ul style="list-style-type: none"> - 174,000 tons of CO2 generated in the manufacturing process is captured and used in the production of Urea for diesel emissions treatment - 104,000 tons of CO2 is captured and permanently sequestered in onsite geological storage. Hydrogen/Ammonia production with CO2 capture and sequestration = 'Blue Hydrogen/Blue Ammonia' are low carbon replacements for conventional 'Grey Hydrogen/Grey Ammonia' - <u>51% reduction in CO2 per ton of ammonia.</u> Blue Hydrogen/Blue Ammonia for transportation fuel, fuel cells and industry Blue Ammonia allows heavy manufacturing to dramatically reduce carbon profile Blue Ammonia as low-carbon NOx reduction of flue gas in Coal, Gas fired power plants As cost effective technology advances, 100K additional tpy of CO2 can potentially be captured from exhaust gases <u>23% reduction in CO2 per ton of DEF/Diesel Exhaust Treatment</u> Balance of electrical power provided by adjacent renewable energy project
<p>METHANE EMISSIONS REMEDIATION</p>	<ul style="list-style-type: none"> INNOVATIVE 'CLOSED SYSTEM' - Onsite Methane Production + Onsite Methane Transport + Onsite Methane Use Natural gas is supplied to the KeyState plant from its own new wells and gathering system, and not from the pipeline gas grid with gas from unknown origins and unknown adherence to protective regulations. 5 new wells are drilled in year one and approximately one new gas well per year for 20 years Best practices elevated by ideal system to monitor, and remediate fugitive methane emissions
<p>RESEARCH to INNOVATION to COMMERCIALIZATION</p>	<ul style="list-style-type: none"> Major research partnership with academia, government and industry currently being negotiated. <ul style="list-style-type: none"> - Onsite CO2 capture, onsite usage and onsite sequestration. - Production, uses and impact of Blue Ammonia for industry, medical and agriculture - Enhance Gas Recovery - onsite CO2 - onsite gas wells - gas feedstock for onsite manufacturing - CO2 Cluster or Regional CO2 Storage Hub opportunity with nearby power and industry emitters. - Hydrogen storage in underground salt caverns

CCUS - Application & Implications

KEYSTATE 'FIRSTS'

FIRST to Demonstrate a Low-Carbon Future for Pennsylvania's Natural Gas

- FIRST commercial CCUS Project in Pennsylvania and the East.
- FIRST to integrate carbon storage and shale gas production.
- FIRST to demonstrate the carbon storage potential of Pennsylvania's Marcellus Region
- FIRST Blue Hydrogen/Blue Ammonia/Blue Nitrogen production in the Eastern USA.
- FIRST in the East to demonstrate the link between CCUS and the new Hydrogen economy
- FIRST to demonstrate a low-carbon-low-price product directly DISPLACING a higher-carbon-higher-priced product.
- FIRST to demonstrate onsite gas production, onsite manufacturing, and onsite carbon storage
- FIRST validation of 'several hundred years' of carbon storage' geology in Pennsylvania.
- FIRST to show Pennsylvania's potential as Hydrogen *SuperPower* for the next 30 years.
- FIRST to demonstrate that both major GHG emissions reduction objectives and natural gas production with CCS can work together resulting in massive longterm job creation and economic development for chronically poor, former coal mining and rust-belt areas.
- First to demonstrate 'clean' natural gas production via a 'Closed Methane System' of gas production, transport & manufacturing to monitor and eliminate methane emissions.

KeyState

Pennsylvania's
Next Energy
Revolution

KEYSTATE DEVELOPMENT TIMELINE	2020	2021	2021	2021	2022	2022/2024
	4th qt	1st qt	2rd qt	4th qt	4th qt	to 4th qt
DEVELOPMENT PHASE I	COMPLETE					
DEVELOPMENT PHASE II Pre-FEED Phase			COMMENCE	COMPLETE		
DEVELOPMENT PHASE III FEED Phase				COMMENCE	COMPLETE	
CONSTRUCTION PHASE					COMMENCE	COMPLETE
COMMERCIAL OPERATIONS						COMMENCE

Perry Babb

KeyState
Natural Gas Synthesis

President & Acting CEO
PBabb@KeyState.net
(814)574-9121
www.KeyState.net

