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ENERGY RESILIENCY AND SECURITY IN A GREEN ECONOMY

The Era of the Ammonia Economy

Presented by Adam Victor, President
TransGas Development Systems

Rome Italy, 14.IX.2023

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COAL ECONOMY

18th Century

Led to the
Industrial
Revolution

Most Resilient Fuel

- Long-term coal piles store massive amount of energy with no risk of interruption
- Difficult to ignite



OIL ECONOMY

19th Century

Gave us
transportation
modes we use
today

Basis for
petrochemical
industry

Estimated economic benefits
period adding 2,000 jobs in
Appalachia & West Virginia

Relatively Resilient

- Can be stored on site
– but subject to
attack
- Can be transported
by rail, truck, pipeline
and ship



NATURAL GAS ECONOMY

20th Century

Basis for hundreds of thousands of megaWatts of new electric generation

Allowed households to transform to solid fuel burning stoves for cooking and heating

- Freed up a new significant portion of the workforce

Chemical Feedstock for common chemicals

Somewhat Resilient

- Pipelines and LNG are susceptible to interruption



HYDROGEN ECONOMY

22nd Century

Very expensive
and energy
intensive

Explosive -
Hindenburg

Hydrogen
embrittlement makes
existing pipelines
unsuitable

Ideally used in Fuel
Cells and make
water vapor and
heat only

Least resilient due to
reliance on new weather
dependent sources of
green energy

- Dispersal of power
generation over broad
areas challenges the
ability to protect those
assets
- Required solar farms can
be over 100 square miles

AMMONIA ECONOMY

21st Century

Ammonia is the
“carrier” of Hydrogen

Bridge to
Hydrogen Economy

Technology allows existing
boilers to burn Ammonia

- Over 1000 Ammonia
Combustors are in service
in refineries worldwide

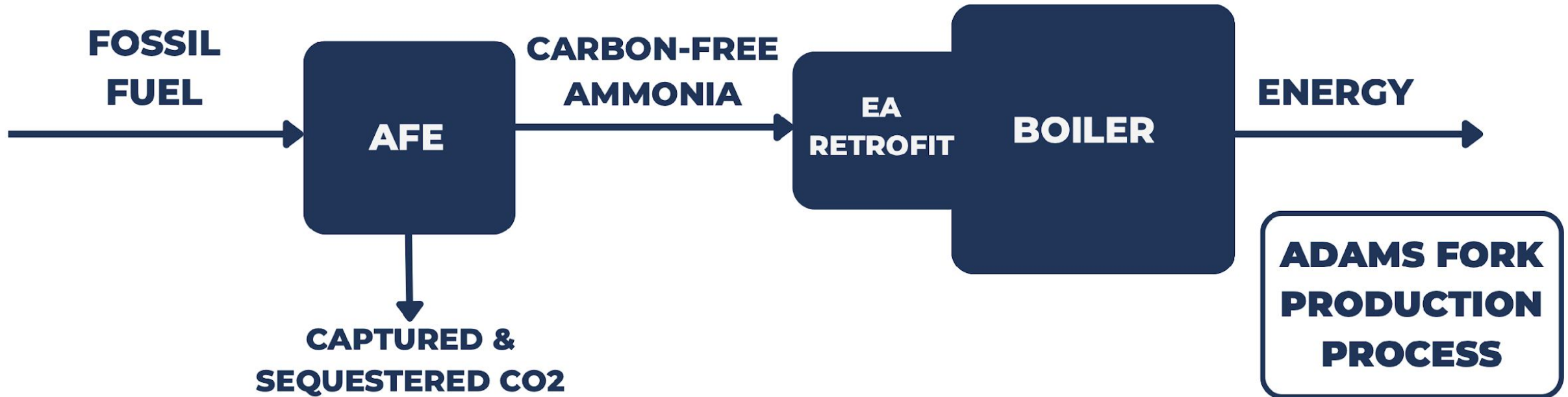
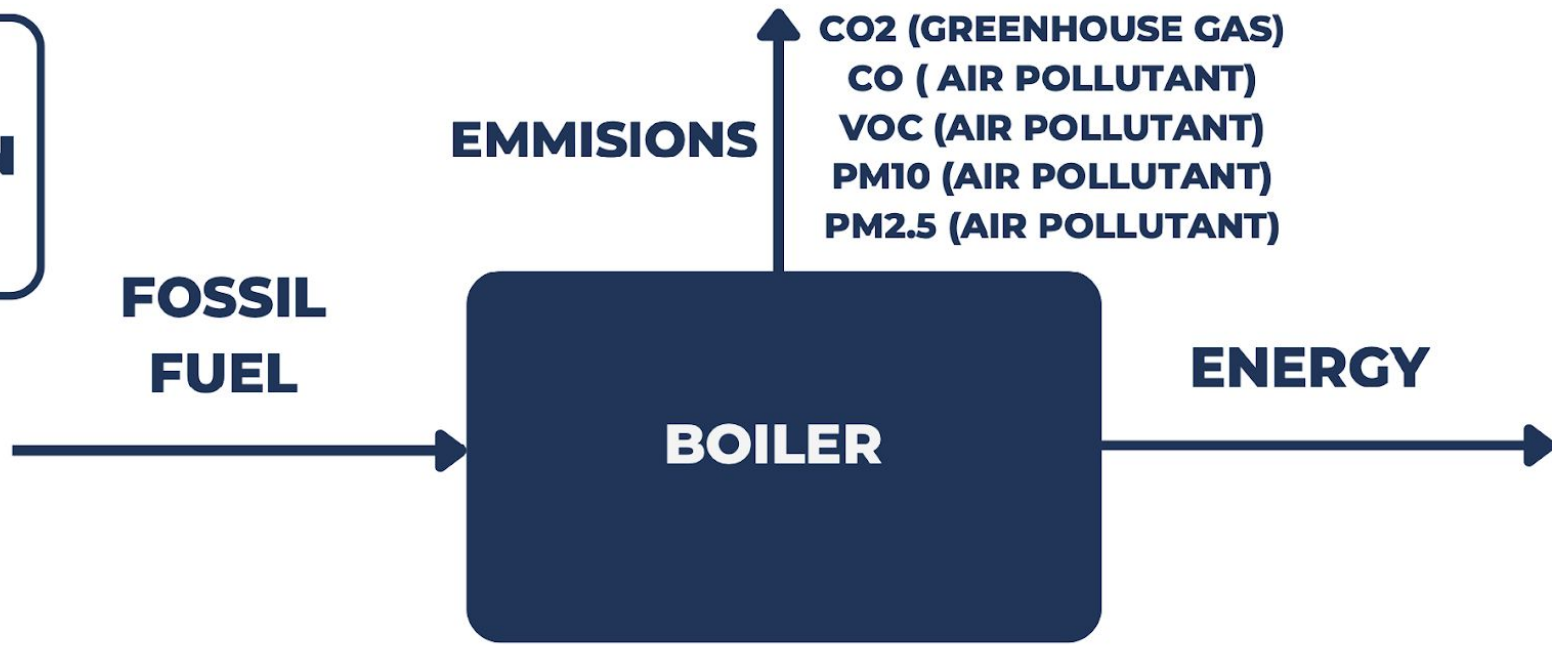
Ammonia, NH₃
has no Carbon

- Very Resilient
- Most widely transported
chemical in the world
 - Farmers worldwide deal
with Ammonia daily

Reciprocating engines
will be burning
Ammonia within 3 years

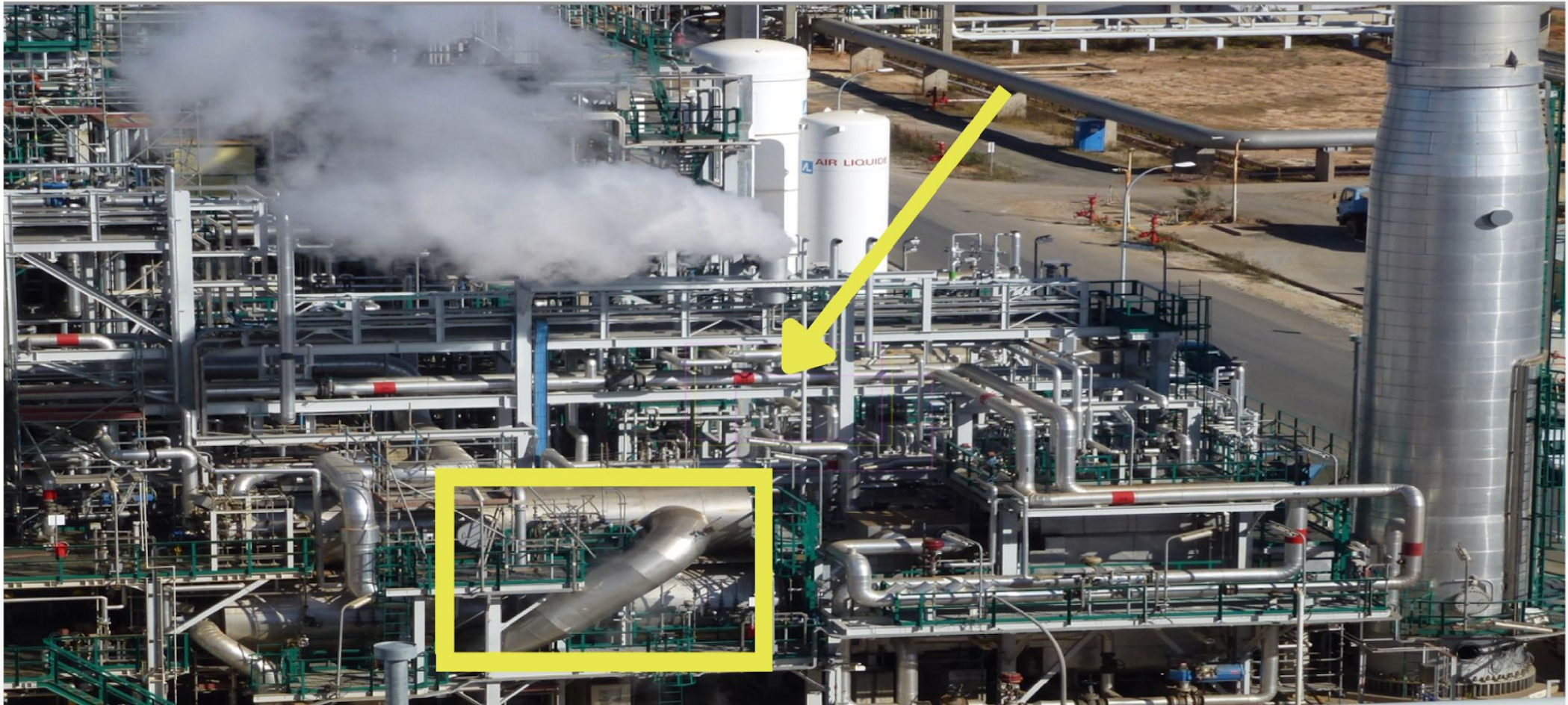


**CURRENT
PRODUCTION
PROCESS**



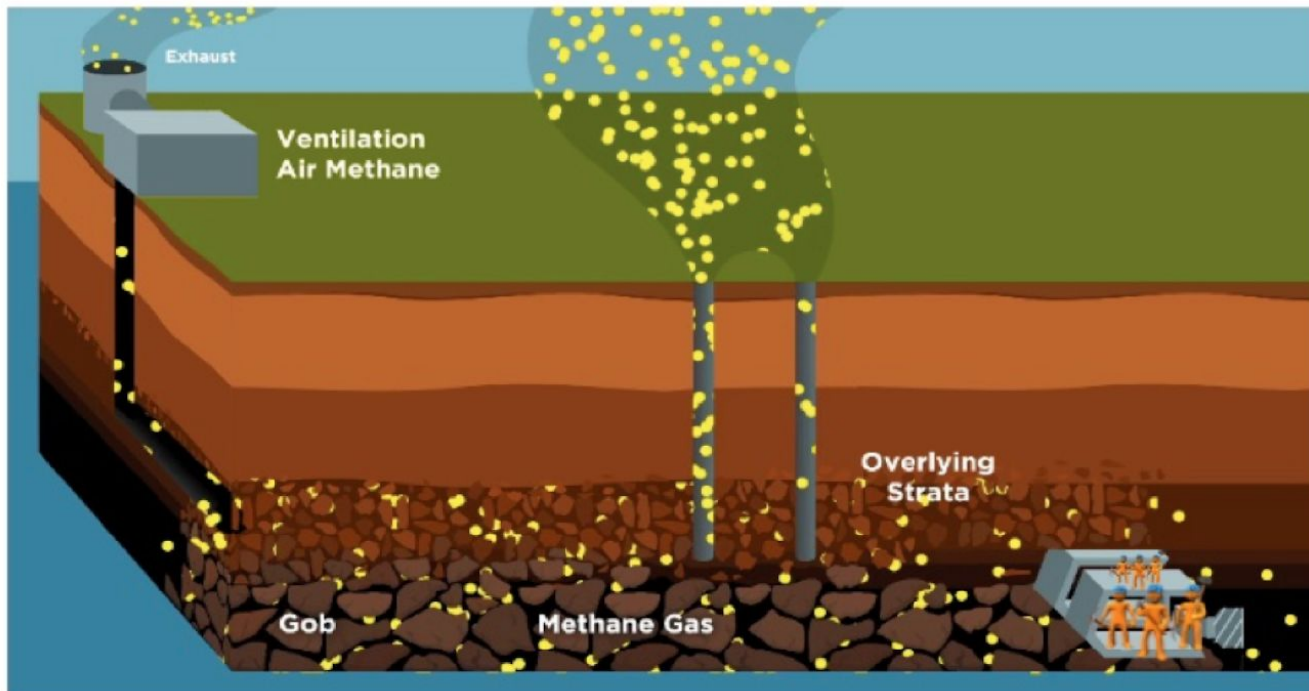
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EXISTING LOW NOX AMMONIA COMBUSTOR IN REFINERY



COAL MINE WASTE METHANE & LOWER GREENHOUSE GAS EMISSIONS

Mine Ventilation Process



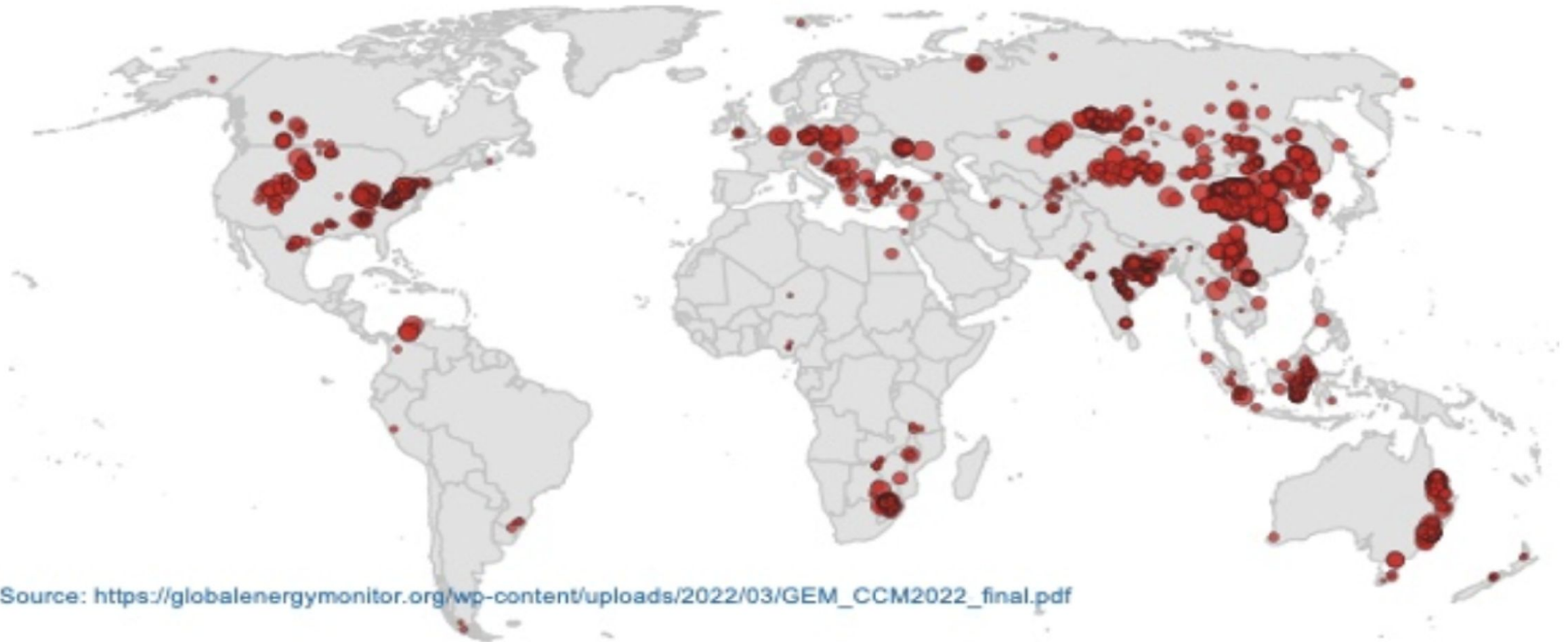
Safety: Historically, mine waste gas has been released into the atmosphere unmitigated, a result of legal requirements designed to keep underground mine workers safe – i.e., preventing combustible gases (primarily methane) from building up at the wall face where workers and equipment are present.

IEA: “Global coal demand is set to rise...coal mine operations released around 40.5 Mt of methane into the atmosphere in 2022, representing more than **10% of total methane emissions**”



WHERE IS COAL MINE METHANE

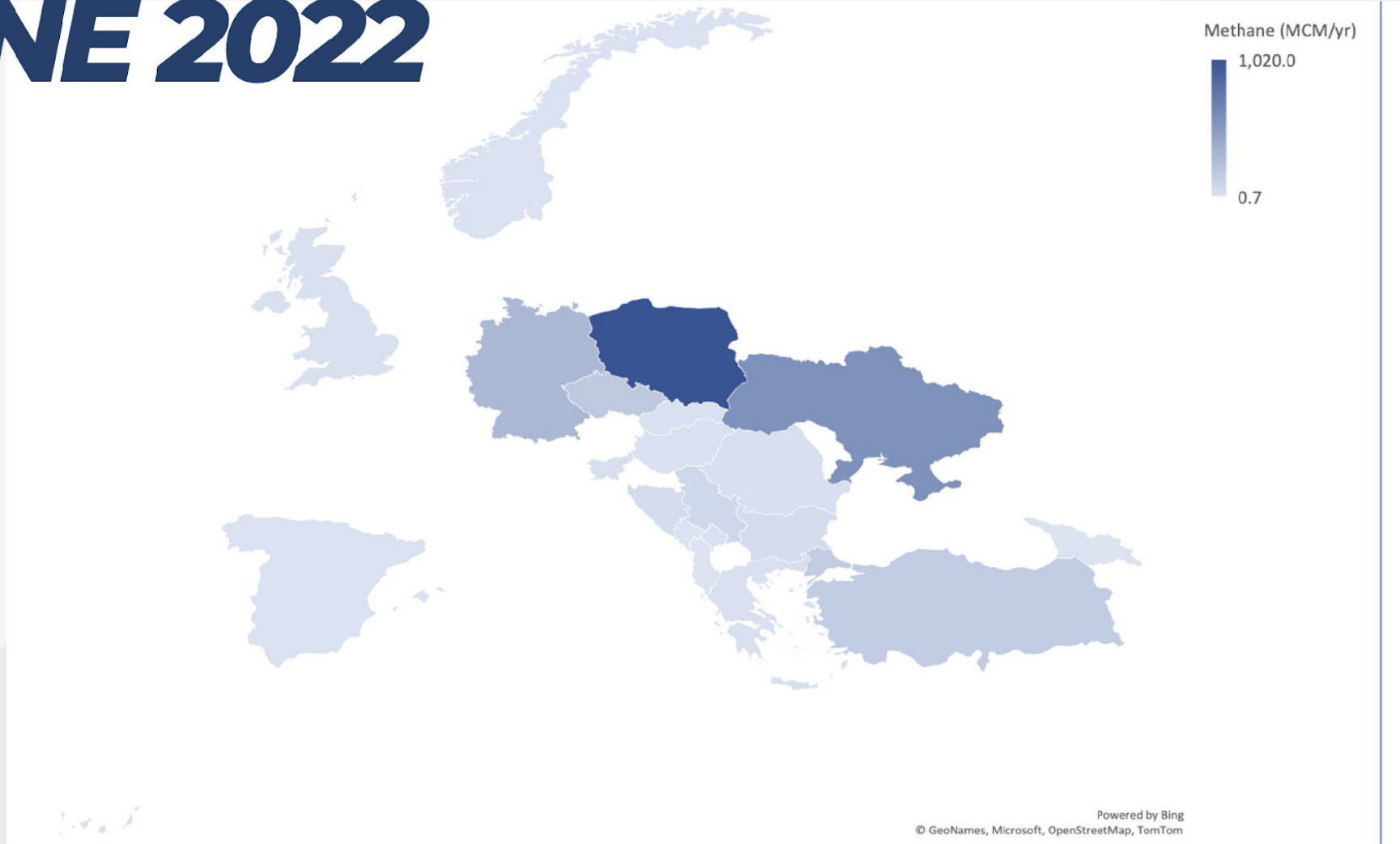
Figure 3: Global methane emissions at operating coal mines



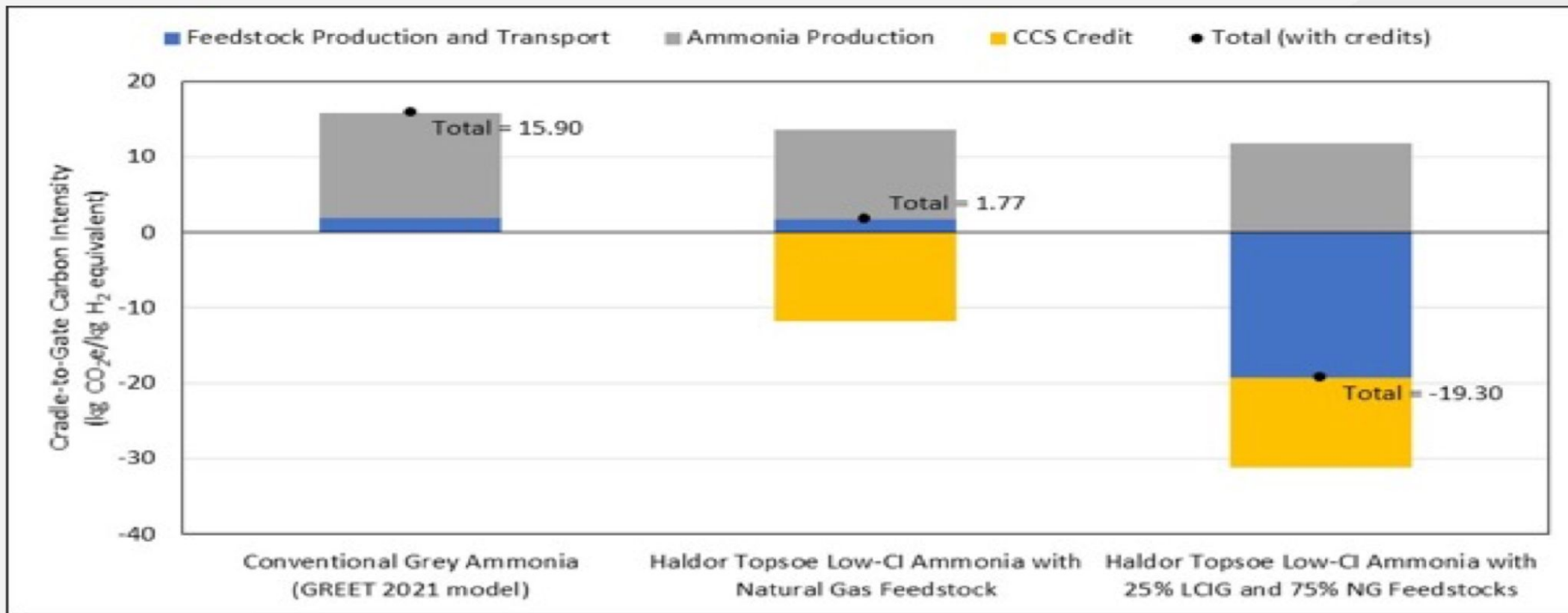
Source: https://globalenergymonitor.org/wp-content/uploads/2022/03/GEM_CCM2022_final.pdf

EUROPEAN COAL MINE METHANE 2022

Country	Methane (MCM/yr)
United States of America	4,352.9
Poland	1,020.0
Ukraine	578.0
Germany	301.5
Czech Republic	176.0
Turkey	157.8
Serbia	79.7
Bosnia and Herzegovina	45.5
Bulgaria	44.2
Romania	25.6
Slovenia	22.3
Greece	16.6
United Kingdom	14.9
Kosovo	9.7
Hungary	9.1
Slovakia	8.5
Spain	4.4
Norway	2.0
Montenegro	1.8
Georgia	1.1
Albania	0.7

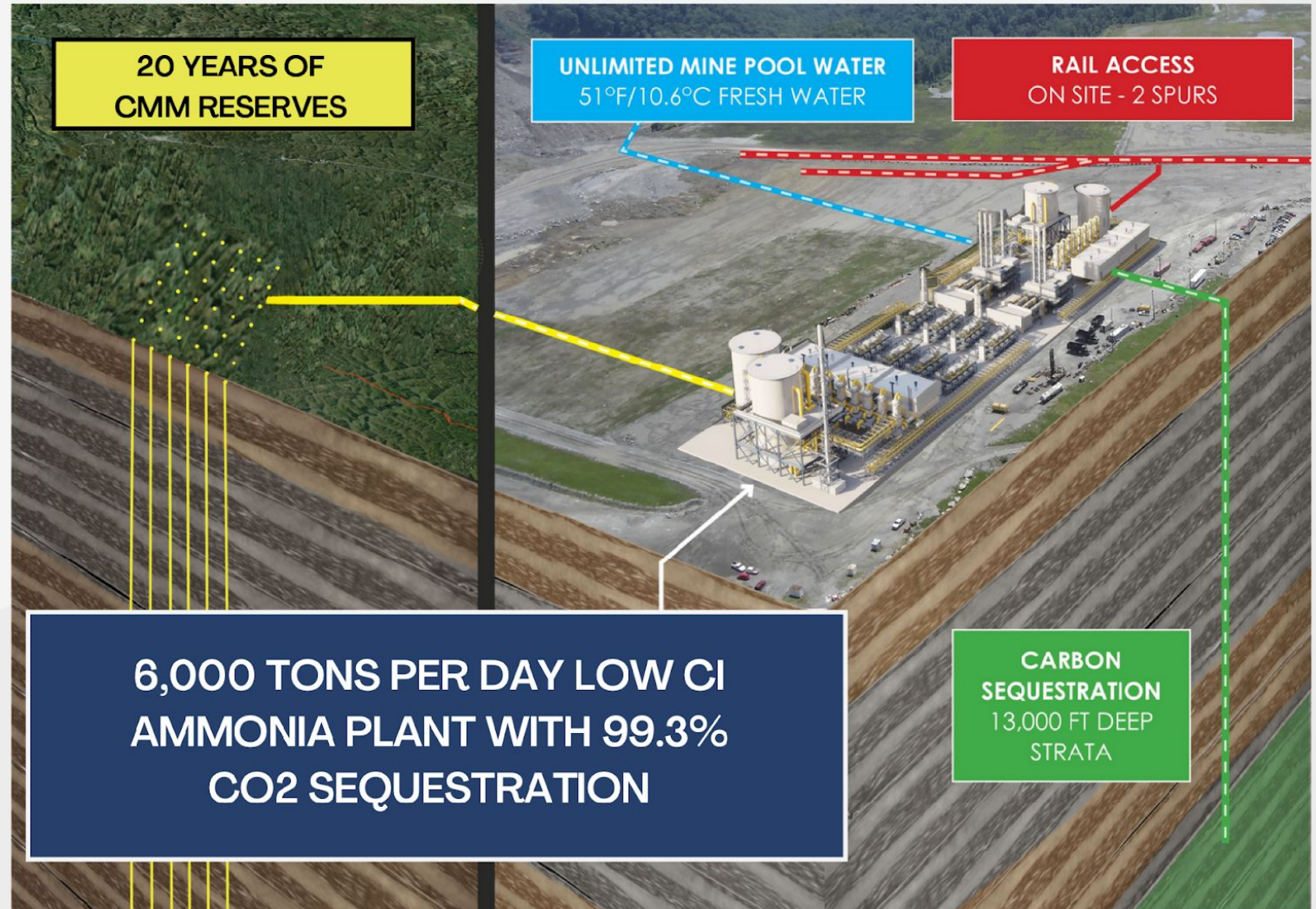


Source: Global Coal Mine Tracker, Global Energy Monitor, July 2022 release
Boston University Institute for Global Sustainability | visualizingenergy.org | CC BY 4.0



LOWER CARBON INTENSITY BY UTILIZING COAL MINE WASTE METHANE

COAL MINE WASTE METHANE BEING CONVERTED INTO NEGATIVE CARBON INTENSITY "BLUE AMMONIA"



ILLUSTRATIVE DIAGRAM



IMMEDIATE CONCERN: WINTER 2023-2024

- Switch from importing Propane to EU to importing Ethane canisters
- Both Ethane and Propane can be shipped in cannisters in cargo ships
- Will be cheaper, cleaner and more reliable





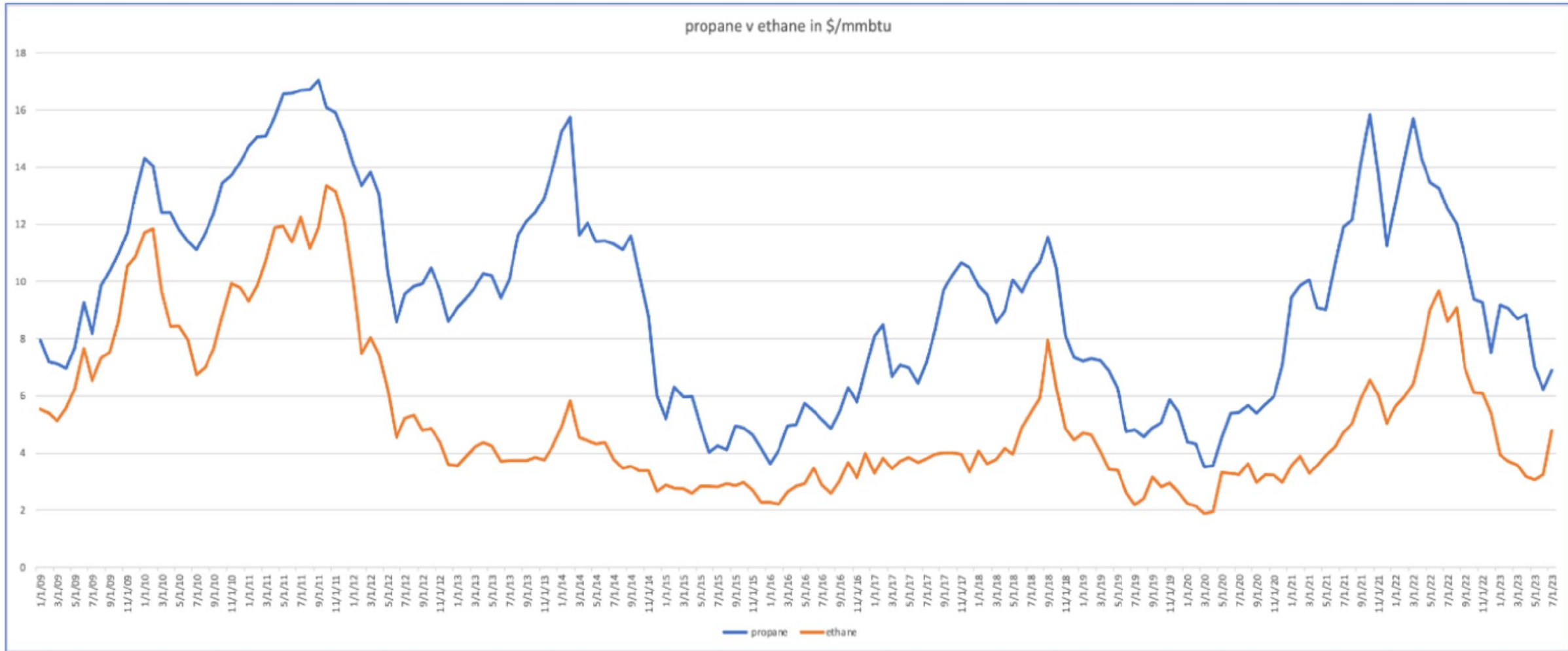
ETHANE VS PROPANE

- Ethane C_2H_6 has less Carbon than Propane C_3H_8
 - Ethane is more Climate friendly than Propane
- Ethane is widely available
 - Ethane US exports now exceed Propane US exports
- Ethane is cheaper than Propane
 - Ethane is priced off US natural gas
 - Propane is priced off World oil





ETHANE VS PROPANE PRICING





PARADIGMS FOR EUROPEAN ENERGY RESILIENCY

- Forget Propane. Immediately starting this winter use West Virginia Ethane (Commence winter 2023-2024)
- Start converting all Coal boilers to multifueled fueled - Coal, Blue Ammonia, CMM (direct gaseous use), Ethane and Methanol combustion (Commence winter 2024-2025)
- Harvest European Low Carbon Intensity Coal Mine Methane
 - Begin laying of Low Carbon Intensity CMM Pipelines to Coal plants (Winter 2024 - 2025)
 - Aggregate enough CMM for a small modular 300 tpd modular Methanol Plants
 - 7500 dekatherms per day (Winter 2025 - 2026)
 - Eventually aggregate enough CMM for a AFE type 6000 ATR Ammonia Plant
 - 200,000 dekatherms per day (Winter 2026 – 2027)
 - Operate coal plants on EU sourced CMM based Low Carbon Intensity Ammonia



THANK YOU

ADAM VICTOR
PRESIDENT



+1.917.816.3700



AdamVictor@TGDS.com

TransGas Development Systems'
ADAMS FORK ENERGY, LLC Blue Ammonia Project, Mingo County, West Virginia

