



Mobile Pipeline: Enabling Gas Distribution

(Originally Presented at World Gas Conference 2018 By Mark Babcock, Director of Business Development)

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Driving Energy Transformation



**DO YOU WANT
TANKS,
OR DO YOU NEED
HEXAGON?**

IF YOU

WANT TO DRIVE ENERGY TRANSFORMATION...

FOR ANY ENERGY APPLICATION,

**FROM COMPLEX SPACE PROGRAMS, TO DAILY
COMMUTER VEHICLES, TO ONSITE FACILITIES POWER...**

BY PARTNERING WITH

**THE WORLD'S MOST INNOVATIVE FUEL STORAGE AND
DELIVERY SOLUTIONS FOR HYDROGEN, CNG, AND
INDUSTRIAL GASES...**

...then Hexagon may be right for you. Because the future of energy depends on the most efficient solutions from the brightest engineering minds in the world.

Mobile Pipeline: Highlights



- Manufactured with Drive & Integrity in Lincoln, Nebraska
- Composite cylinders hold up to 3X the capacity of steel at the same vehicle weight, dramatically improving payload and range
- Growing success since it was introduced - Over 1,400 modules deployed globally on 6 continents
- TITAN® cylinders are the largest composite cylinders now available
- Safety is top priority for our development teams, which have delivered over 700,000 high pressure full composite cylinders over their 25 years

Mobile Pipeline: Any Gas Anywhere



492 MCF of Natural Gas
384 MCF of Hydrogen



Mobile Pipeline: Enabling Natural Gas Distribution



- Industry segments where Mobile Pipeline is effective:
 - Upstream opportunities
 - Collection of flare gas
 - Diesel displacement
 - Downstream opportunities
 - Energy Intensive Industries
 - Vehicular Fueling
 - Gas Islands
 - Renewable Natural Gas (Biomethane)
- Safety

Vehicle fueling: CNG & Hydrogen



- Mobile refueling units are used for compressed natural gas and hydrogen refueling.
- Hydrogen is transported at higher pressures (350-bar) than natural gas.
- It is becoming more common for hydrogen production to occur at a large, central facility and to be distributed by truck.

- Delivery of natural gas by Mobile Pipeline to vehicle fueling sites is economical.
- Savings are generated by avoidance of LDC transportation tariffs and lower per unit demand charges for electricity.
- Mobile fueling units are deployed faster than traditional CNG filling stations.



The Mobile Pipeline-Upstream



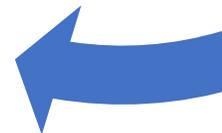
Pipeline injection site offloads module to 150 PSI



Empty module travels to Production site



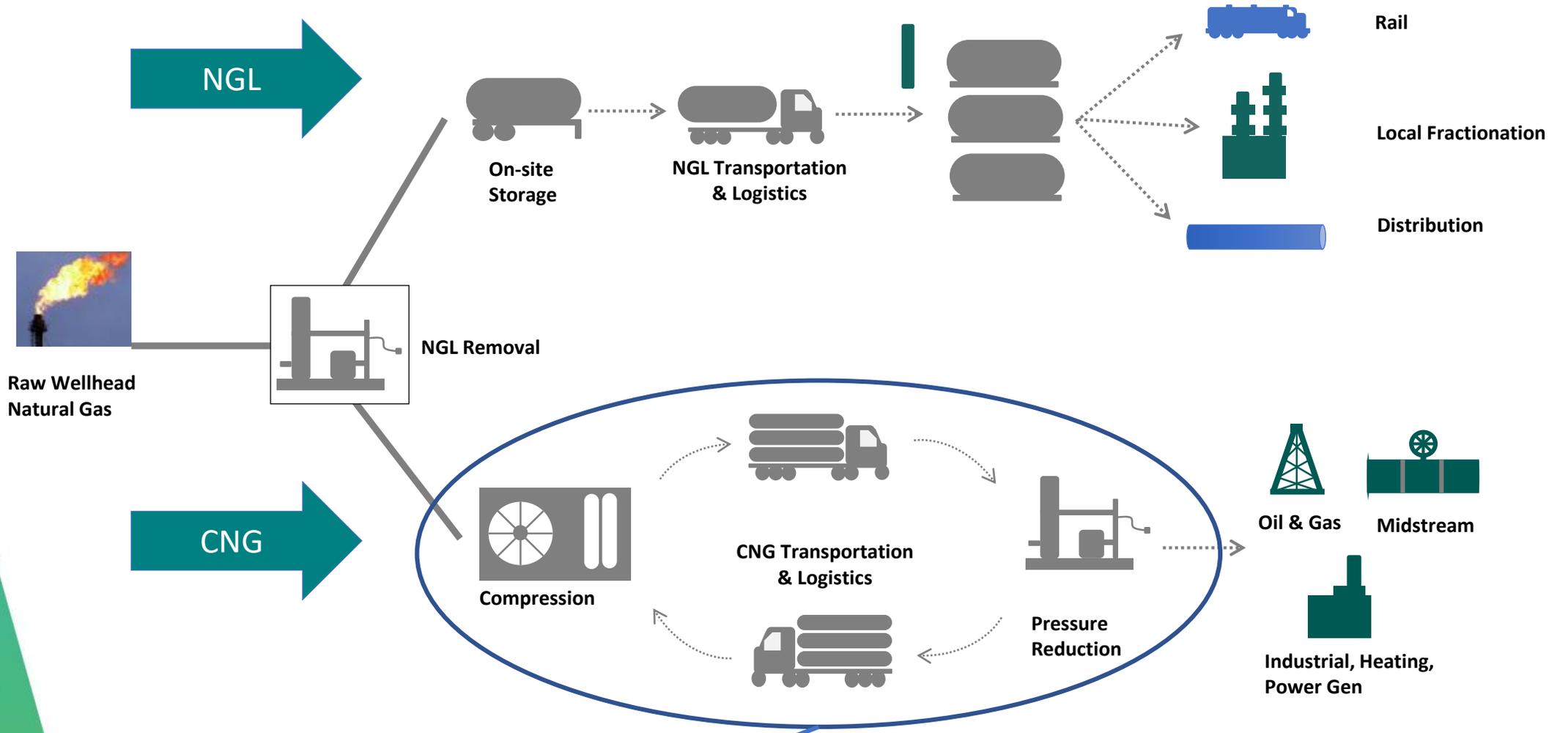
Module is filled to 3600 PSI at remote production site



Full module travels to injection station @ 3600 PSI



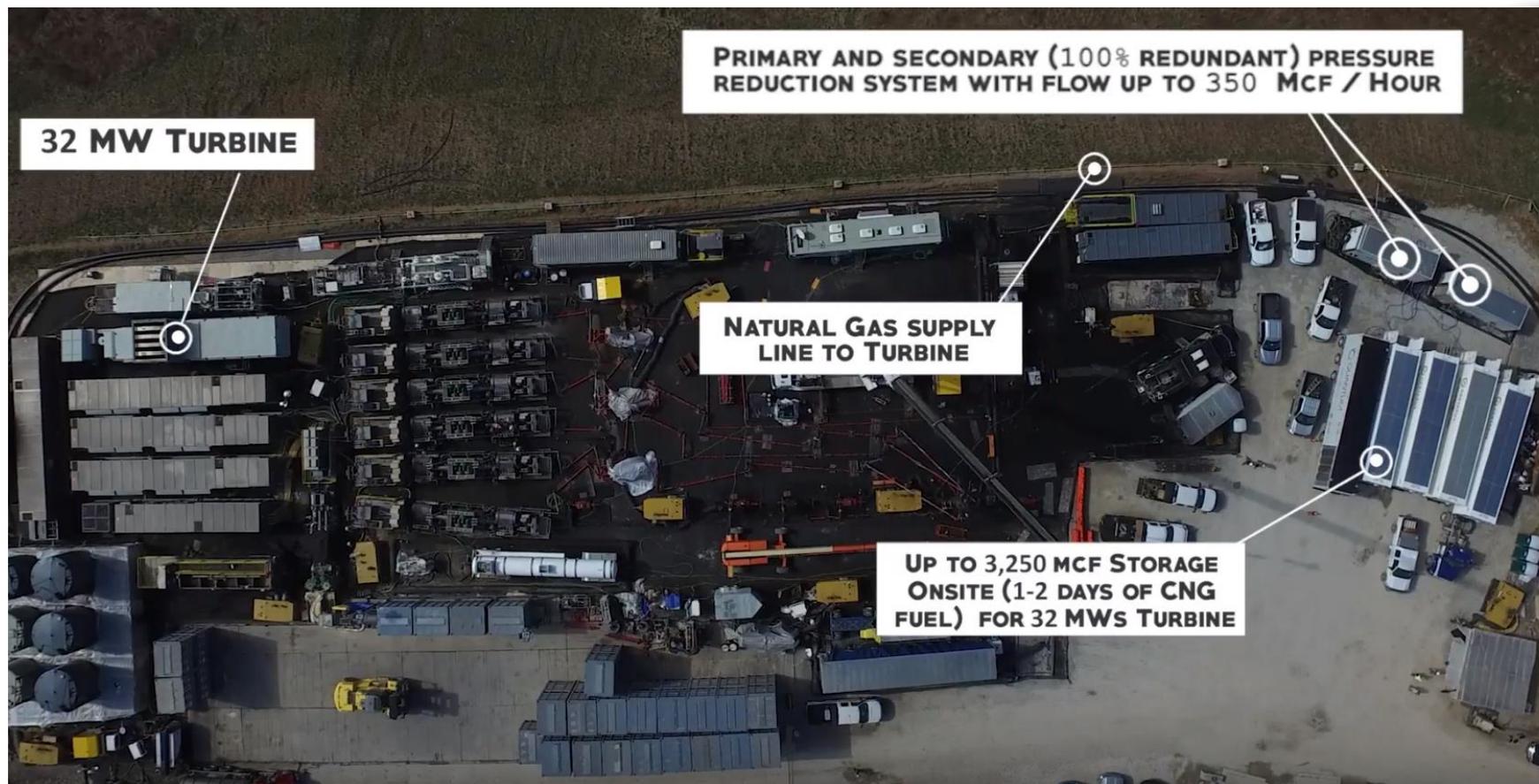
Value streams of flare gas capture



Uses of captured flare gas. Diagram provided by FERUS

This is the part of the value chain we are discussing

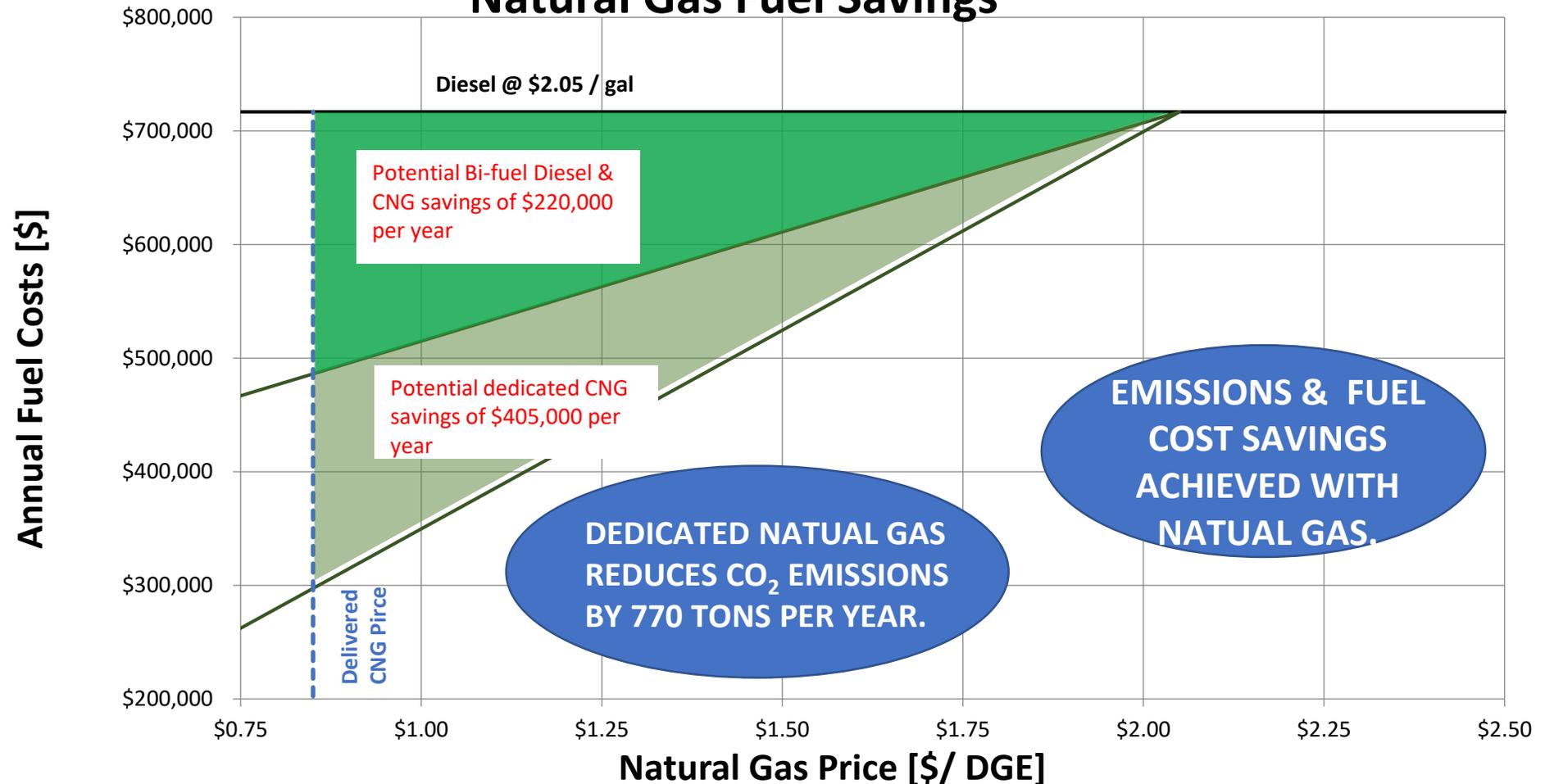
CNG for Diesel Displacement



Picture from Certarus video.

- Diesel typically used to power drilling and hydraulic fracturing equipment.
- Dual fuel substitution rate of 100-MMBtu/hr for hydraulic fracturing spread results in avoidance of ~ 720-gallons diesel/hr.
- Dedicated natural gas burning equipment results in higher natural gas burn rates. This increases the hourly fuel savings when equipment is running.

Texas Drill Rig- (349,000 gpy diesel) Natural Gas Fuel Savings



Upstream benefit summary



- A DGE of CNG can be delivered for as low as \$0.85. Using natural gas as an energy source for drilling and hydraulic fracturing equipment has opportunity to lower fuel costs.
- Well owners can use their own wellhead gas as energy for next project.
- Lower miles driven. While the number of trucks accessing a drilling site may will be higher using CNG, the total miles driven may be lower. CNG can be sourced much closer to the drill site compared with diesel.
- Reduced environmental footprint. A typical drilling rig may reduce CO2 emissions by 770-tons per year by switching to natural gas form Diesel.

The Mobile Pipeline-Downstream



- Energy Intensive Industries
 - Pulp & Paper
 - Food processing
 - Asphalt
 - Space heat needs at Hospitals, Universities, & Industrial facilities
- Gas Islands
- Renewable Natural Gas (Biomethane)
- Vehicle Fueling

Energy Intensive Industries



CNG decompression equipment and trailers at a large industrial site in the Southeastern United States. Picture provided by NeoGas.



CNG trailers at a ceramic plant in Vietnam.

- The majority of Energy Intensive Industries have access to natural gas.
- Any facility using more than 50,000 MMBtu/year and not using natural gas is candidate for Mobile Pipeline.
- Facilities are looking to displace higher cost fuels such as Residual Fuel Oil, Diesel, or Propane.
- Complimentary to pipeline natural gas.
- Number of loads required per day is a function of energy required.
- Upwards of 30% reduction in CO₂ emissions, 100% particulate matter, 95% or more SO_x, and 35% NO_x are achievable with natural gas conversions.
- Other non-tangible values include reduced environmental compliance costs, lower boiler maintenance, and extended maintenance intervals.

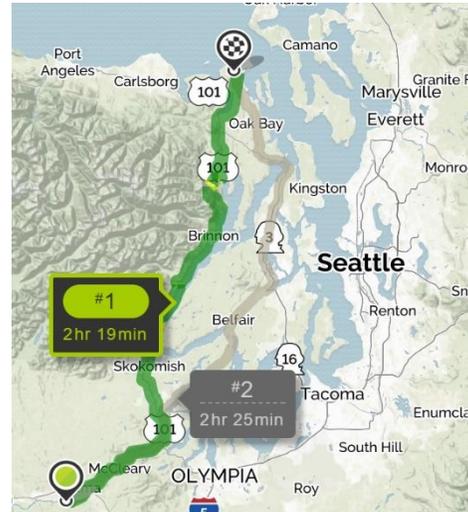
Case Study – Port Townsend Paper



Titan® XL40 in Washington used by XNG to serve Port Townsend Paper Co.



Port Townsend Paper Co, Port Townsend, WA



Satsop Industrial Park to Port Townsend, 104-miles.

Key Equipment Load Profile

Lime Kiln	400,000 Mmbtu/yr
Recovery Boiler	350,000 Mmbtu/yr
Package Boiler	100,000 Mmbtu/yr
Power Boiler	< 300,000 Mmbtu/yr

XNG supplies ~800,000 MMBtu/yr (nearly 1700 TITAN®XL deliveries per year)

Key statistics on the conversion

- Converted from RFO#6 to CNG in Sept 2016
- Estimated conversion cost: \$3.1MM
- Facility now complies with Max Achievable Control Technology (MACT) boiler rules.
- NG average Henry Hub price (\$3.02)
- **First year savings of \$1,200,000**, including fuel, maintenance, and regulatory compliance costs
- Long-term NG prices predicted to remain stable by the US EIA
- **Estimated reduction of 17,600 tons of CO₂ (27%) per year** through Mobile Pipeline®

Gas Islands

- Gas Islands are important to expanding Natural Gas access around the world.
- Example: Brazilian law requires extension of natural gas service to isolated communities.
- In Santa Catarina state of Brazil there are 14 identified gas islands requiring 150,000+ SM³/day of natural gas.
- Gas will be sourced as conventional natural gas or RNG.
- Utility service of natural gas will occur within the community. Mobile Pipeline functions as the transmission line to the gas island.



CNG decompression unit with redundant regulators and heaters. For gas islands, redundancy is critical to ensure uninterrupted gas service.

Renewable Natural Gas (Biomethane)

- RNG is produced in many remote/rural locations.
- Agricultural facilities, such as the Roeslein facility in Missouri produce RNG. No easy access to pipelines – Mobile pipeline allows the RNG produced to access gas market
- European production of RNG is occurring in multiple countries. Picture is from Northern England
- RNG has negative carbon intensity numbers in many occasions. These negative values are certified by the California Air Resource Board.
- Fragmented market with many producers and project developers.



Downstream summary



Pictures taken by author of CNG compression plant in Penjamo, Mexico.

- Downstream CNG compression projects are located along large gas transmission lines.
- Flow rates of 15,000 SCFM (25,500 M³/hr) are achievable.
- Multiple Mobile Pipeline units filling simultaneously with others in queue.
- Compression plants support downstream operations for Energy Intensive Industries, Gas Islands, and Vehicle Fueling.



Safety First

- Hexagon has more than 1,400 modules in Mobile Pipeline service globally.
- There are a number of accidents that have occurred with Hexagon manufactured Mobile Pipeline modules. To date, most accidents attributed to operator error. Modules performed as intended in these accident situations.
- Codes and Standards are adopting new testing technologies to ensure that composites remain safe throughout their life
- Significant factors of safety applied to both cylinder design and module design.



Left: Bonfire test on Hexagon cylinder to demonstrate that cylinder leaks before burst.

Right: Rail impact test to verify that cylinder support structure can withstand a multiple G-force impact.

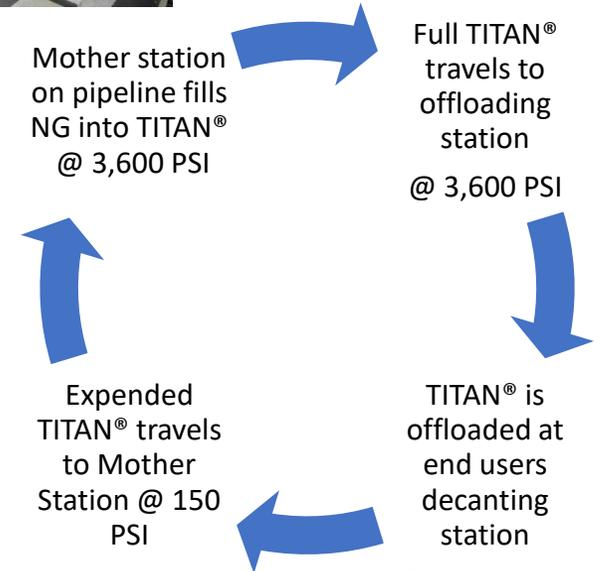


CNG & LNG are complementary

- CNG and LNG are both methods to distribute natural gas.
- Areas where distribution distances are less than 300-miles (480-KM) one way from source point lend themselves to CNG.
- Financial modeling has shown that the out the gate adder for CNG is less than LNG.
- Transportation costs for LNG are lower. More energy is transported on a LNG trailer than on a CNG trailer.
- CNG compression plants, due to their lower capital costs, tend to be located closer together. This enables CNG to be a cost effective method to deliver natural gas.

Mobile Pipeline Summary

- Mobile Pipeline is a safe, cost effective method to distribute natural gas.
- Mobile Pipeline is flexible. Uses are available all across the value chain.
- We can reach areas that don't have access to natural gas and hydrogen. Mobile pipeline gets us there.



THANK YOU FOR YOUR TIME
AND YOUR ATTENTION.