Helium: A Commercial Discussion: Helium Market Fundamentals, Processing and Marketing, IACX Otis Plant Case Study*

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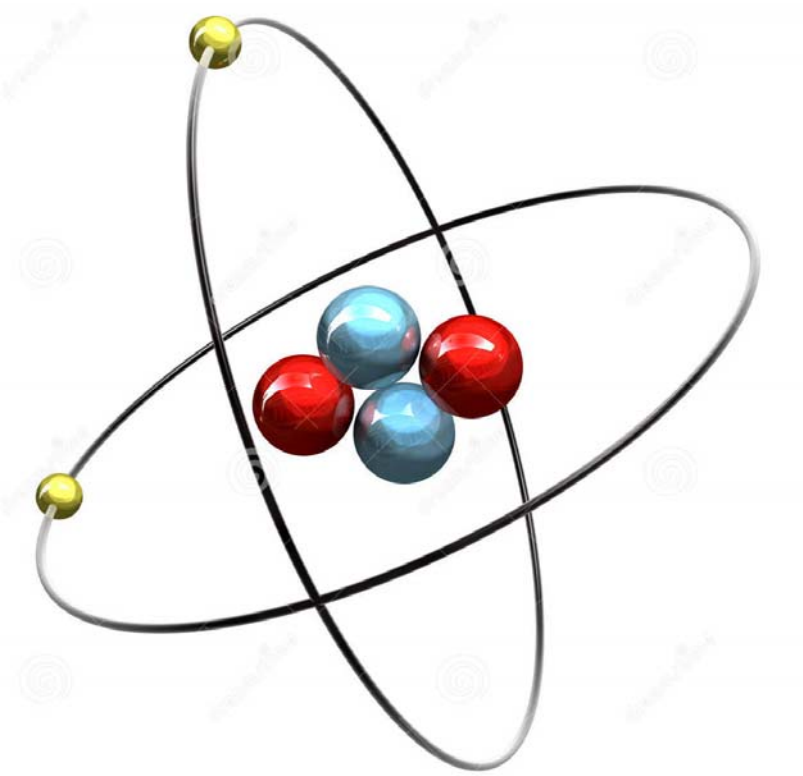
Abstract

IACX Energy operates a gas gathering and processing system in central Kansas (its 'Otis' system), which gathers gas from Barton, Rush, Ellsworth and Rice counties. The gas, which is, on average, 25% N2, 1.25% helium, is aggregated to a facility near Otis, KS, where nitrogen is removed, NGLs are extracted, and helium is purified before the residual methane is delivered to an intrastate pipeline system for sale. Before IACX took over operation of the gathering pipelines in 2008 and started up its Otis facility, gas from this system was shut in (the gas had previously been consumed as fuel in the Bushton gas processing complex; but that particular use for the gas evaporated in 2006). Once IACX's facility became operational, IACX not only began providing a market for the nitrogen-laden natural gas, it also began serving as a market for the helium contained in the gas. Between then and now, the price received by producers for the helium contained in their gas has steadily increased, significantly adding to the netback value of the gas. In some instances (depending on the specific helium concentration and wellhead volume), producers are realizing helium prices well in excess of $100/Mcf (1.25% helium at the wellhead and $100/Mcf translates to $1.25/Mcf of producers' realized value from helium alone). Helium prices, by and large, move independently of prices for hydrocarbons, and have served as a veritable hedge against natural gas and NGL prices in recent years.

Selected References

Newell, K.D., S. Bhattacharya, and M.S. Sears, 2009, Low-BTU Gas in the US Midcontinent: A challenge for geologists and engineers: Oil & Gas Journal, v. 107/36, p. 35-44, Web Accessed February 6, 2016, http://www.ogj.com/articles/print/volume-107/issue-34/exploration___development/low-btu-gas-in-the-us-midcontinent-a-challenge-for-geologists-and-engineers.html.

Yakutseni, V.P., 2014, World helium resources and the perspectives of helium industry development: Neftegazovaya Geologiya, Teoriya I Praktika, v. 9/1, p. 1-22, Web Accessed February 6, 2016, http://www.ngtp.ru/rub/9/11_2014_eng.pdf.



HELIUM: A COMMERCIAL DISCUSSION

Helium Market Fundamentals, Processing and Marketing
IACX Otis Plant Case Study

AAPG Mid-Con Section Meeting
October 5th, 2015
Tulsa, OK

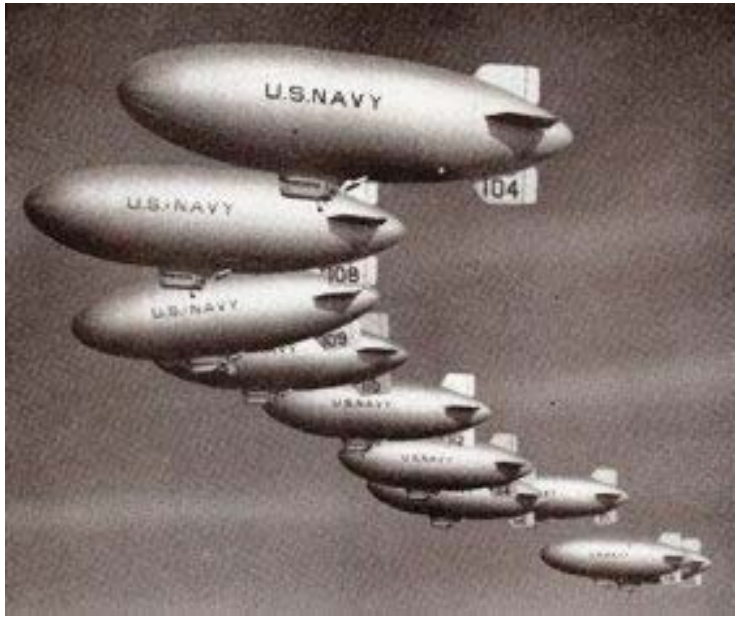
Helium Quick Facts

Primary Uses

- MRI machines → largest single use
- Semiconductor/fiber optic manufacturing
- Lift gas
- Breathing mixtures
- Purging/inerting
- Leak detection
- ***For many applications, there is no substitute***

Helium Properties

- Second lightest element
- Boiling point of -452°F
- High thermal conductivity
- Inert
- Small

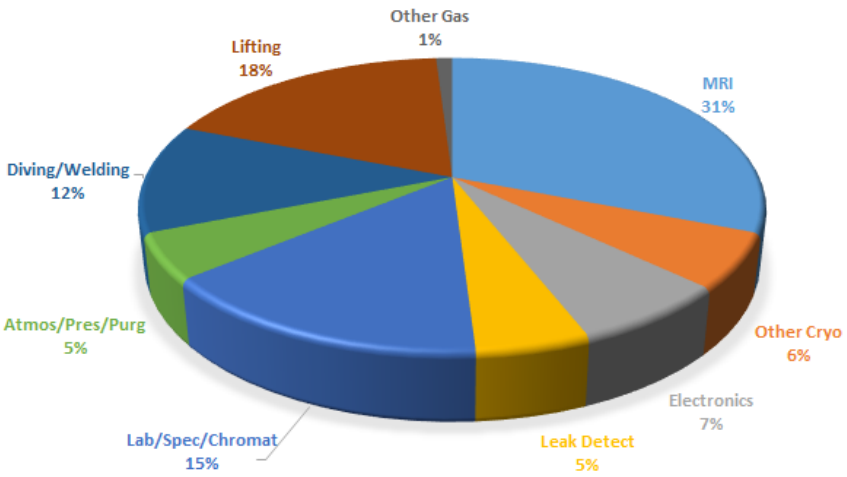


Helium Uses – Global & Domestic

2014 – Demand by Application

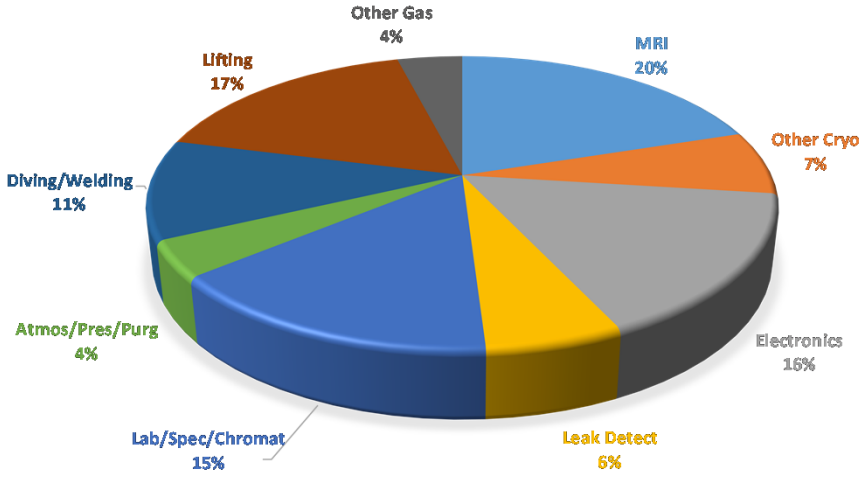
U.S. Helium Demand[1]

1.9 Bcf



Global Helium Demand[1]

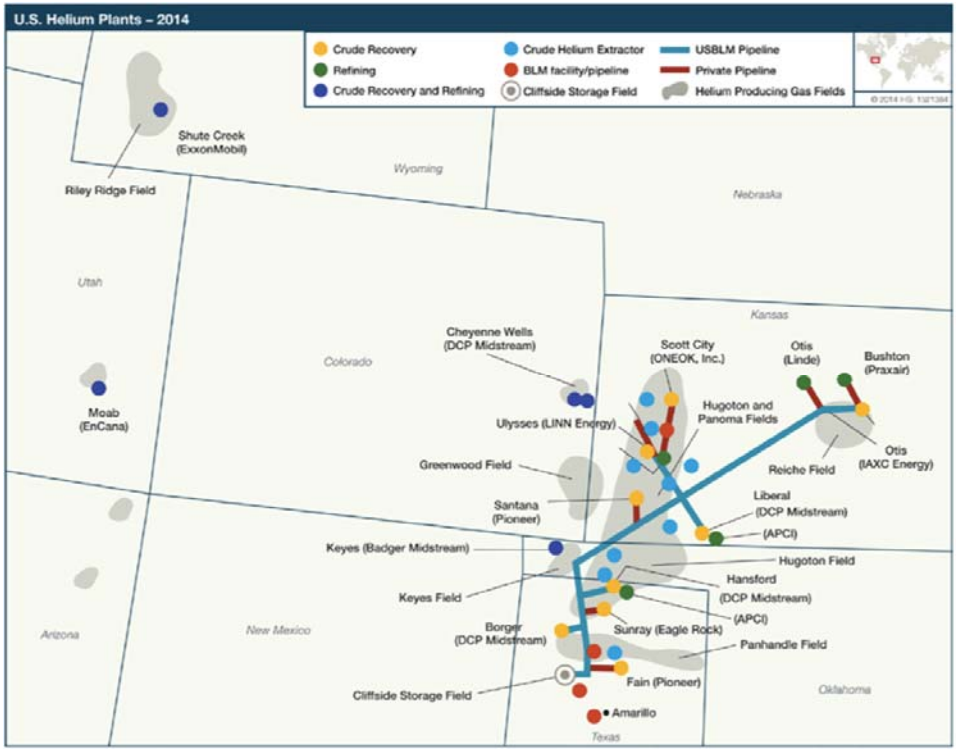
6.0 Bcf



(1) Sources: JR Campbell & Associates; USGS

Existing US Helium Infrastructure

Significance of BLM



Sources: BLM, IACX Energy, public company filings

Federal Helium Program

- Historically, helium produced in the US was, in essence, sold to, and stockpiled by, the federal government
- Helium produced as a byproduct of natural gas in the Hugoton stored in a reservoir north of Amarillo via a 400 mile pipeline running between Cliffside and Bushton
- Helium Privatization Act of 1996
- Currently six crude helium plants and six refineries along BLM pipeline
  - Refineries liquefy helium sold by the BLM, as well as native gas produced by Hugoton fields
- Pricing prior to 2015 determined solely based on formula established within HPA to recover govt's cost of capital for helium program
  - Not a true representation of market value
- Auction format has recently been implemented for a portion of federal helium sold each year
- Very little price transparency; minimal value ultimately passed through to producers
- Opacity of market and low realized value has unsurprisingly have hindered helium development

US Helium Production

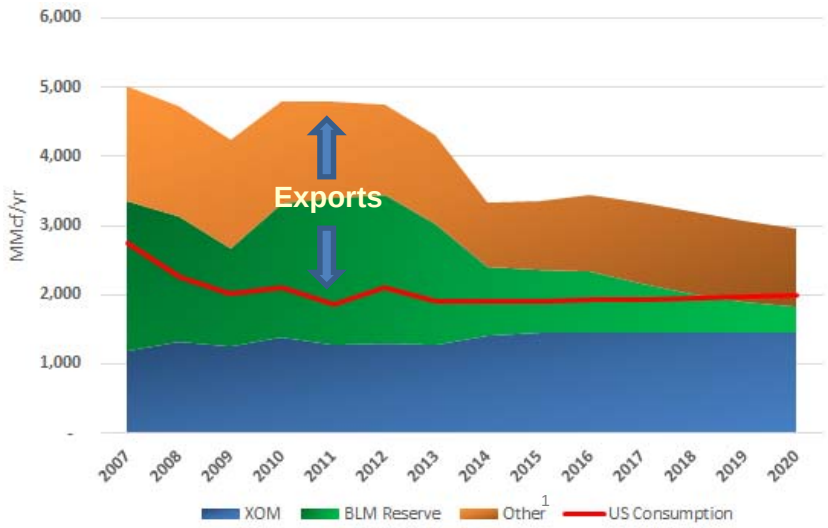
Historical and Projected

BLM is Declining

- In 2014, the U.S. Federal Helium Reserve provided roughly 1/6th (1 Bcf of a 6 Bcf market) of global helium supply and much of the global market's storage and supply flexibility. The Reserve is set to wind down by 2021.
  - ➢ Critical supply source; provides some measure of price transparency
- Annual BLM helium sales have declined from >2.0 Bcf in 2012 to approximately 900 MMcf in 2015
- Significant new supplies – domestically and abroad – will be needed to offset BLM declines.

- Aside from crude helium supplied by US BLM, helium has traditionally been supplied in the US from natural gas processing in the Mid-Continent, Rockies and Four Corners
- At > 1.4 Bcf annually, XOM Chute Creek facility will provide stable base of supply for years to come
- Native Hugoton production is, generally, tied to BLM pipeline system and subject to legacy incumbent infrastructure and contracts
  - ➢ Economic incentive isn't there to explore for helium within existing dedications, where producers receive very little, if any, value for helium
- Other US supply to come from Denbury/AP/MTG Riley Ridge (WY), Kinder Morgan/Air Products Doe Canyon; each ~200 MMcf/year

U.S. Supply/Demand Balance



Sources: BLM, JR Campbell & Assoc.
(1) Note: "Other" includes supply from Doe Canyon, Riley Ridge, IACX Energy

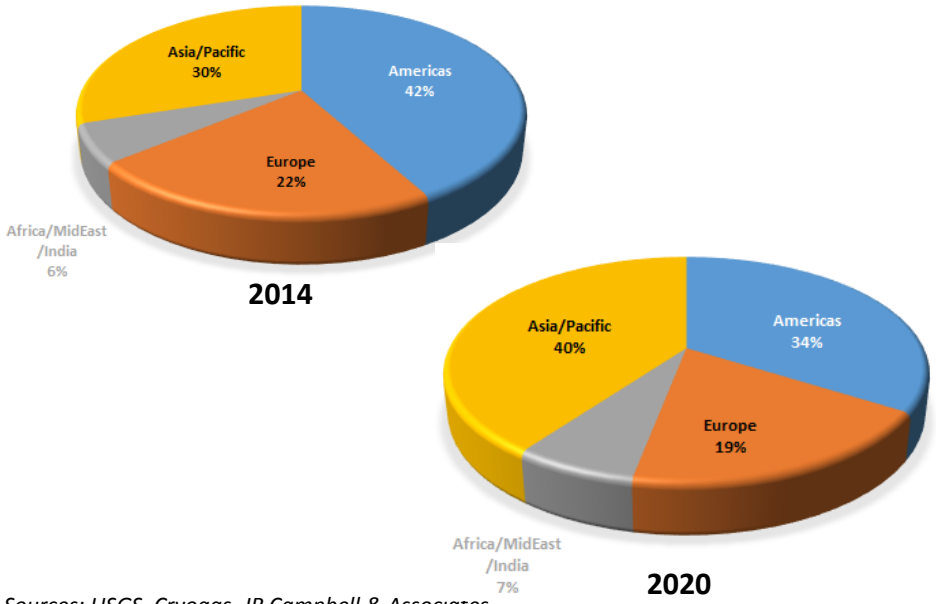
Global Helium Demand Estimates

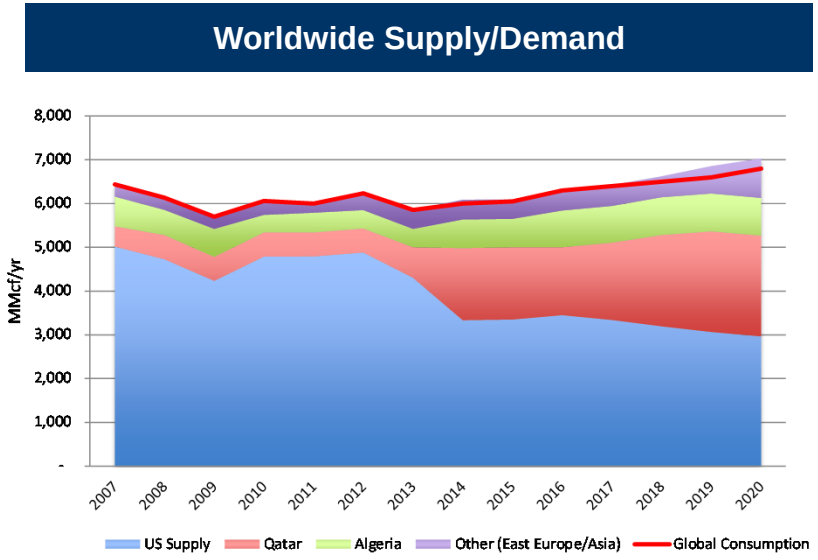
Shift to Asian Markets

Global Demand Increasing

- Between 2015 and 2020, annual worldwide demand is projected to increase from approximately 6.0 Bcf to just under 7.0 Bcf
- Both overall demand, and demand growth, expected to shift from the Americas and Europe to Asia
- Asian growth driven by increased access to healthcare (MRI), continued electronics demand (domestic demand and IT component exports), and general economic activity
- On the supply side, both Algeria, and, to a much larger degree, Qatar have filled the decline wedge left by US BLM, and have become critical to overall global supply stability

GLOBAL HELIUM DEMAND BY REGION

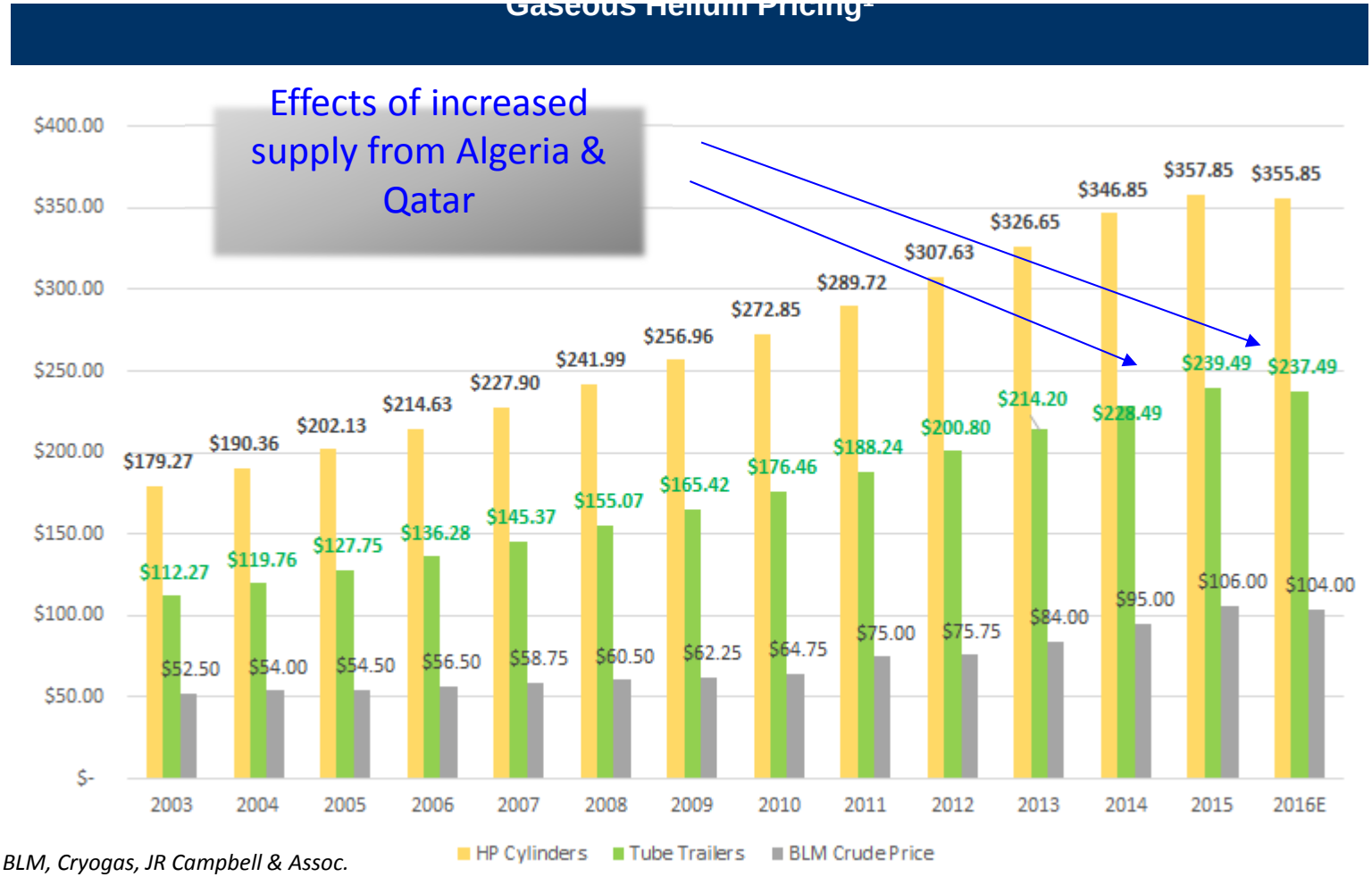




Sources: USGS, Cryogas, JR Campbell & Associates

Helium Pricing

Gaseous Helium

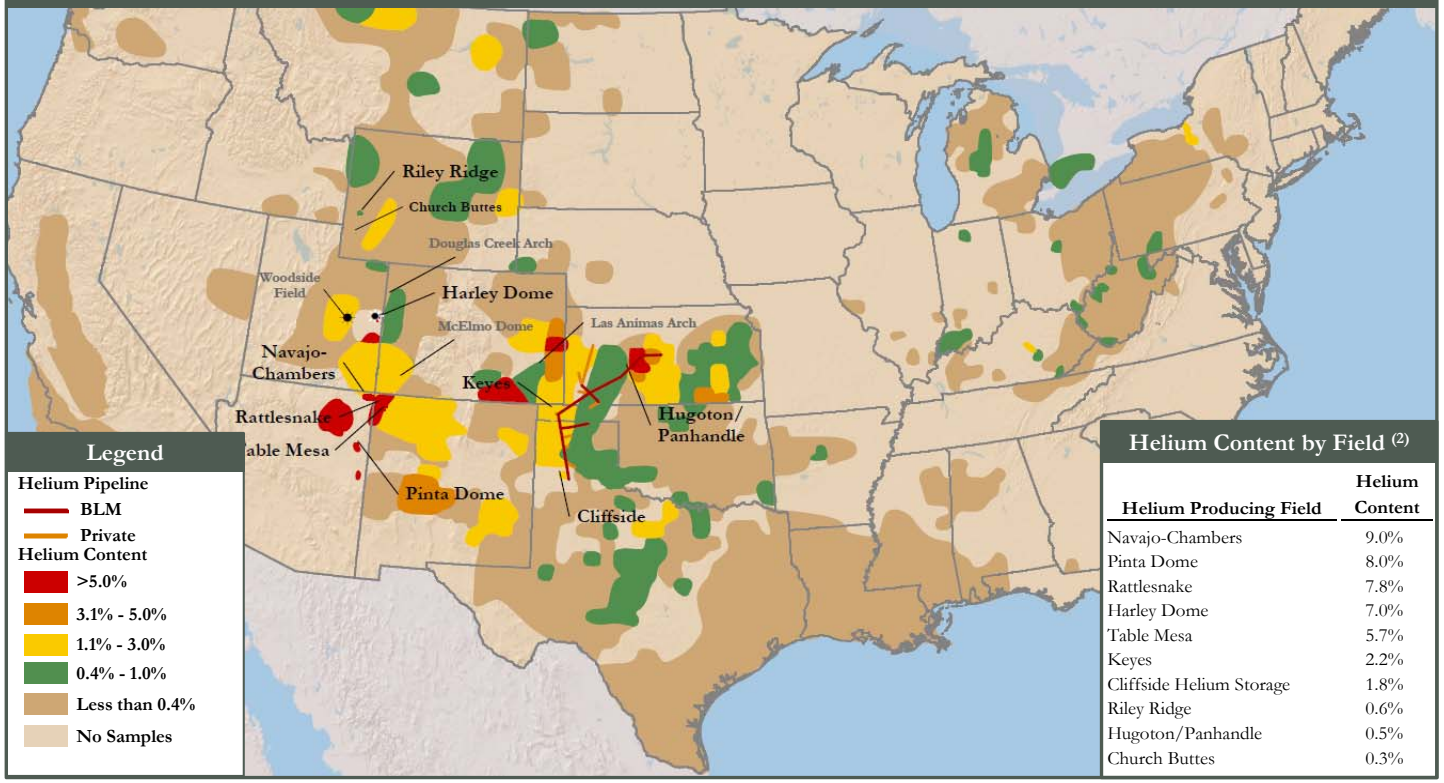


(1) Sources: BLM, Cryogas, JR Campbell & Assoc.

Helium Accumulations

Mid-Continent and Beyond

U.S. Helium Producing Basins & Helium Shows[1]



Helium Content by Field (2)

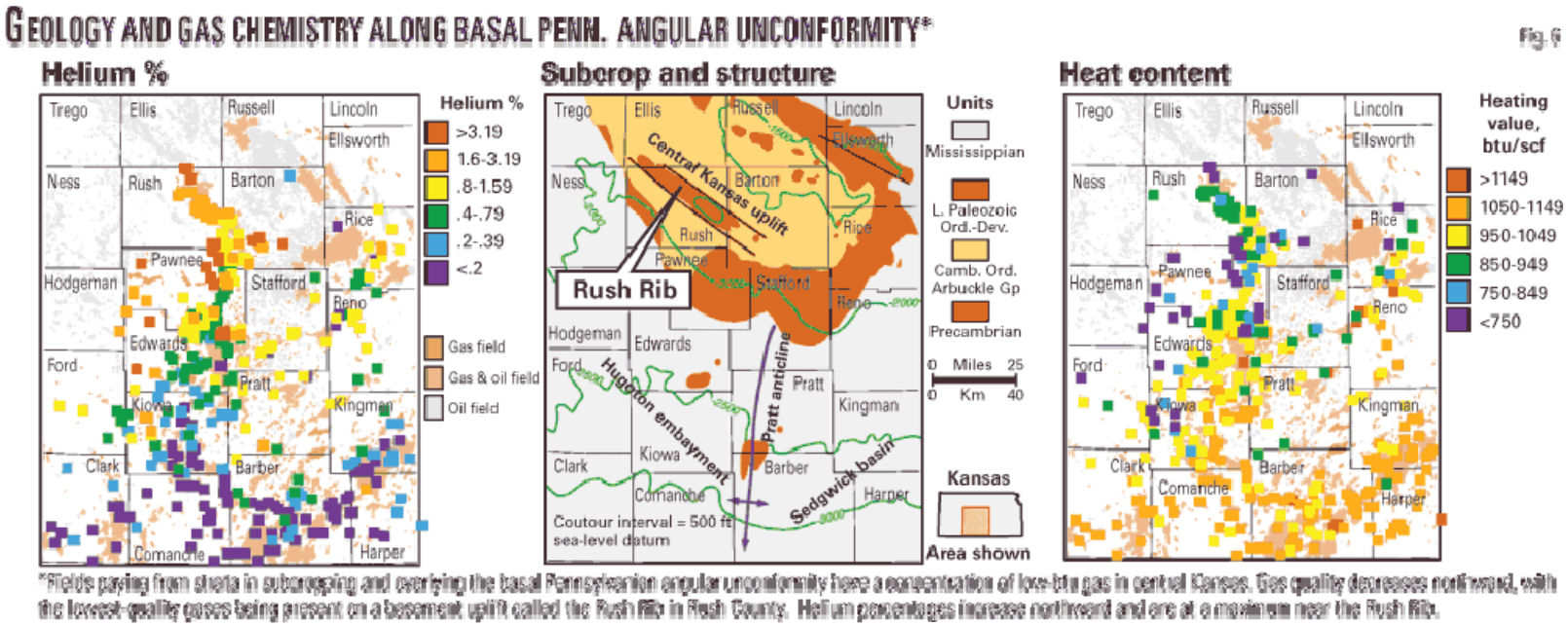
Helium Producing Field	Helium Content
Navajo-Chambers	9.0%
Pinta Dome	8.0%
Rattlesnake	7.8%
Harley Dome	7.0%
Table Mesa	5.7%
Keyes	2.2%
Cliffside Helium Storage	1.8%
Riley Ridge	0.6%
Hugoton/Panhandle	0.5%
Church Buttes	0.3%

(1) Sources: BLM, IACX
(2) Source: World Helium Resources and the Perspectives of Helium Industry Development, Yakutseni V.P., 2014

Kansas Helium

Nitrogen-Helium Correlation

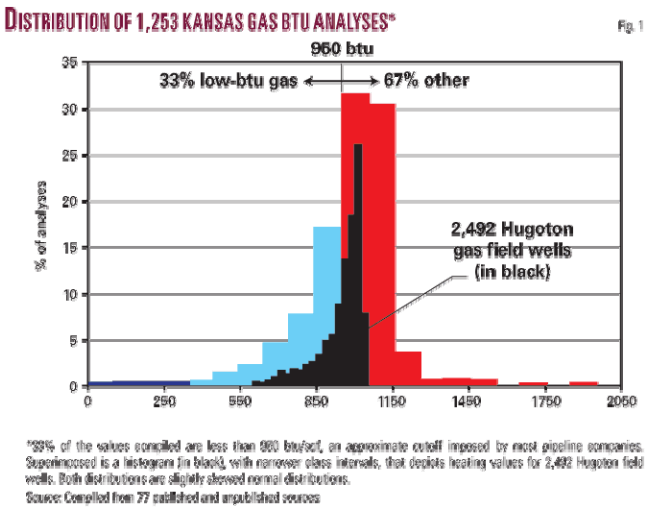
Helium is associated with other inert gases, usually nitrogen



Source: Oil & Gas Journal, "Low-Btu gas in the US Midcontinent", Newell, Bhattacharya, Sears (2009)

Mid-Continent Helium

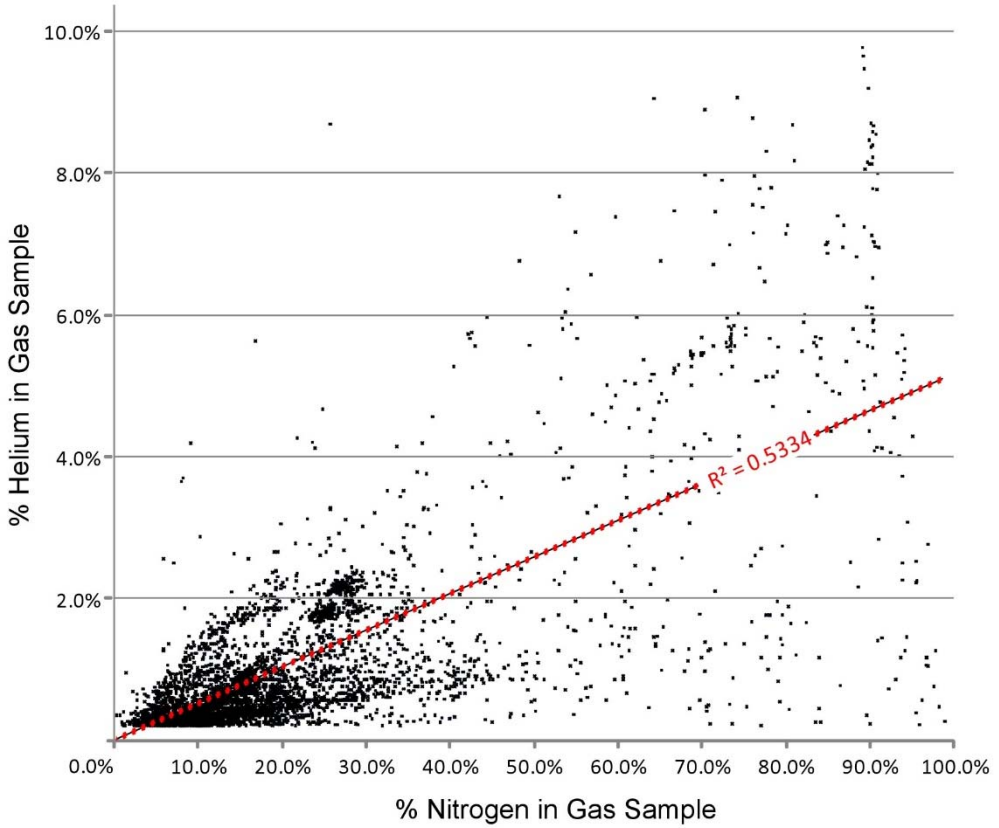
Nitrogen-Helium Correlation



- Almost all gas streams with commercial quantities of helium contain high levels of other inerts (unfortunately the inverse isn't the case)
- Most standard gas analyses do not test for helium

Sources: O&G Journal; IACX Energy

High-Helium Gas = High Total Inerts



Scatter plot analysis based on IACX study of more than 10,000 gas analyses, primarily from BLM database of North American gas analyses. Pulled samples showing incidents of helium content greater than 0.3%.

Helium Purification

Methodologies

PSA Plants

Liquefier

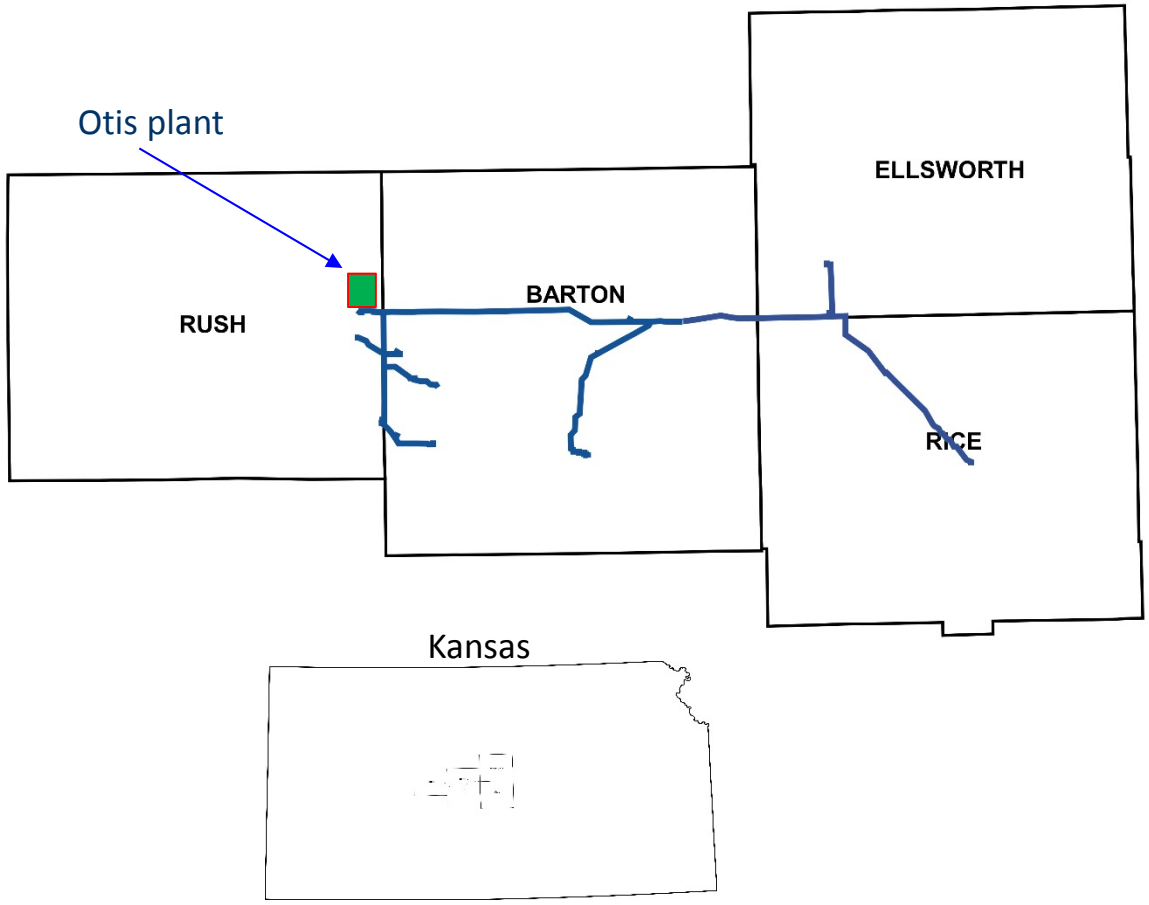
	PSA	Liquefaction
Volume	10-15 Mcfd+	100-150 Mcfd+
Pressure	Low	High
Purity	Crude to 99.999	Pure liquid
Comments	Flexible, turn down capability, good markets	Most efficient, inflexible process, deepest market

IACX Otis System

Central Kansas Infrastructure

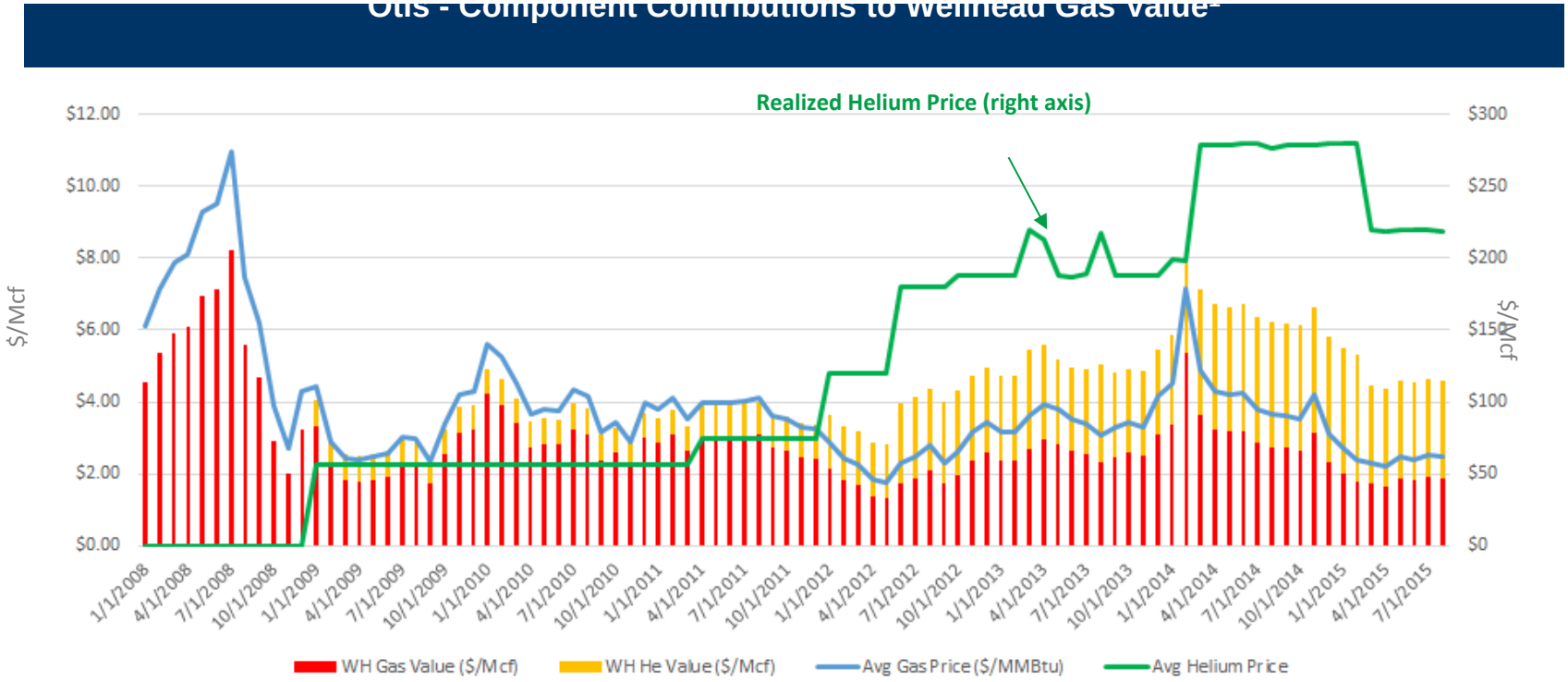
- Central Kansas Uplift
- Gas, on average, is ~1.25% helium, 750 Btu/Scf (25% N_2)
- IACX operates 200 miles of gathering and its Otis plant
  - N_2 rejection
  - Helium purification
  - Compression
  - Dehydration
  - NGL recovery
- Methane quality must be upgraded to meet pipeline spec of 950 Btu/Scf
- Without helium, economics wouldn't be there for producer or midstream company

Otis Gathering & Processing System



Otis Facility Case Study

Helium Adding Value to Low-Btu Gas



(1) Graph illustrates wellhead value of gas stream, before processing costs, pipeline losses, and fees. Avg gas composition at Otis is 1.25% He, 750 Btu/Scf

Netback Potential

Helium Adding Value to Low-Btu Gas

Helium Impact on Wellhead Gas Value[1]

Chart illustrates helium value on a netback basis at various potential wellhead helium concentrations and realized helium prices.

Wellhead Helium Content	Effective/Realized Helium Price ($/Mcf)						
	$50.00	$75.00	$100.00	$125.00	$150.00	$175.00	$200.00
2.0%	$1.00	$1.50	$2.00	$2.50	$3.00	$3.50	$4.00
3.0%	$1.50	$2.25	$3.00	$3.75	$4.50	$5.25	$6.00
4.0%	$2.00	$3.00	$4.00	$5.00	$6.00	$7.00	$8.00
5.0%	$2.50	$3.75	$5.00	$6.25	$7.50	$8.75	$10.00
6.0%	$3.00	$4.50	$6.00	$7.50	$9.00	$10.50	$12.00
7.0%	$3.50	$5.25	$7.00	$8.75	$10.50	$12.25	$14.00
8.0%	$4.00	$6.00	$8.00	$10.00	$12.00	$14.00	$16.00
9.0%	$4.50	$6.75	$9.00	$11.25	$13.50	$15.75	$18.00

(1) Note: chart does not take into account any capex, opex, processing fees, etc.