



# 2016 Minerals Yearbook

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## HELIUM [ADVANCE RELEASE]

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# HELIUM

By John E. Hamak<sup>1</sup>

Domestic consumption of Grade-A helium (99.995% or greater purity) in 2016 was 50.4 million cubic meters<sup>2</sup> (1.82 billion cubic feet). Exports by private producers totaled 62.3 million cubic meters (2.25 billion cubic feet), and imports of helium totaled 23.4 million cubic meters (844 million cubic feet). Total sales of U.S.-produced helium in 2016 were 89.3 million cubic meters (about 3.22 billion cubic feet), a slight decrease from that of 2015 (table 1). During 2016, domestic helium consumption increased by about 18% from the previous year, and helium exports decreased by 3% compared with those of 2015. Helium imports increased by 47% from those of 2015 and were equivalent to 26% of total sales of U.S.-produced helium. This increase was the second year of significant increases in imports (table 1).

## Legislation and Government Programs

On October 2, 2013, the U.S. Congress passed the Helium Stewardship Act of 2013 (HSA) (Public Law 113–40, 127 Stat. 534). With the passage of the HSA, Congress reauthorized the Federal helium program, but with significant changes. The HSA sought to mitigate helium shortages by allowing the sale of crude helium from the Federal Helium Reserve with the expectation of increasing taxpayer returns while stimulating investment in private helium sources through market-driven sales. The HSA provides for an orderly transition in four phases:

**Phase A, Allocation Transition**—This phase began upon passage of the HSA and ended on September 30, 2014. This phase continued the sales volumes and conditions contained in the Helium Privatization Act.

**Phase B, Auction Implementation**—This phase began on October 1, 2014, and terminates when the crude helium stored in the Federal Helium Reserve reaches 3 billion cubic feet. In July 2014, the U.S. Department of the Interior, Bureau of Land Management (BLM) conducted the first auction of helium for delivery during fiscal year (FY) 2015. As required by the HSA, 10% of the available helium for sale was offered through the auction. The auction was open to qualified bidders as defined in 50 U.S.C. 167d (b). Each year, the remaining helium is to be sold to refiners who have connections to the crude helium pipeline. The total quantity of helium sold in July 2014 was 25.7 million cubic meters (928 million cubic feet), of which 2.57 million cubic meters (92.8 million cubic feet) was sold at auction, and 23.2 million cubic meters (835 million cubic feet)

was sold at the average auction price to refiners and nonrefiners along the crude helium pipeline (CHPL). In this sale, 90% of the helium was allocated to refiners according to their operational capacity on the CHPL, and 10% was offered to nonrefiners with storage contracts on a non-allocated basis. The average price at auction was \$5.80 per cubic meter (\$161 per thousand cubic feet). The next auction was conducted in July 2015, for FY 2016 deliveries. At this sale, 8.32 million cubic meters (300 million cubic feet) was auctioned at an average price of \$3.75 per cubic meter (\$104 per thousand cubic feet) and 16.6 million cubic meters (600 million cubic feet) was sold at the allocated and nonallocated sale, respectively. At the 2016 sale, 11.1 million cubic meters (400 million cubic feet) was sold at auction for an average price of \$3.85 per cubic meter (\$107 per thousand cubic feet). At the sale in 2017, 13.9 million cubic meters (500 million cubic feet) was sold at an average price of \$3.86 per cubic meter (\$107 per thousand cubic feet). In each subsequent year, the percentage to be auctioned is to increase by at least 15% from that of the previous year until 100% is achieved.

**Phase C, Continued Access for Federal Users**—This phase begins when the remaining crude helium stored in the Federal Helium Reserve reaches 3 billion cubic feet. At that time, the BLM will continue to sell crude helium to Federal users. No sale or auction of helium to private entities would occur, but deliveries of helium sold to private entities in Phase B may continue. Current projections show that this phase is likely to begin on October 1, 2018, after the helium sold for FY 2019 delivery is transferred to private accounts.

**Phase D, Disposal of Assets**—During this phase, the Secretary of the Interior is required to dispose of assets by no later than September 30, 2021. These assets include all underground natural resources and the U.S. rights to those assets. Unlike the 1996 legislation, the BLM is no longer required to sell helium from the reserve in equal annual volumes. Under the HSA, sales can match the amount available for production from the reserve.

The HSA also contains four sections that require study and evaluation by the U.S. Geological Survey (USGS), the U.S. Department of Energy (DOE), and the BLM. The USGS is required to complete a helium gas resource assessment, and the DOE is required to support research into low British thermal unit (Btu) gas separation and helium conservation and determine the feasibility of separating helium-3 gas from crude helium or other sources. The BLM, in cooperation with Federal users of helium, is required to complete an assessment of consumption and demand for helium by Federal users and a 20-year strategic helium acquisition plan for Federal users.

The USGS was expected to complete the helium gas resource assessment by 2018. The DOE is sponsoring at least one low-Btu gas separation project. The BLM-sponsored assessment and 20-year strategic acquisition plan were completed in April 2015.

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<sup>2</sup>All metric helium volumes herein are at 101.325 kilopascals absolute (14.696 pounds per square inch absolute) and 15 °C (59 °F). Helium volumes reported in parentheses following metric units are measured in cubic feet at 14.7 pounds per square inch absolute and 70 °F—1,000 cubic feet (14.7 pounds per square inch absolute and 70 °F) equals 27.737 cubic meters (101.325 kilopascals absolute and 15 °C) and 1 cubic meter (101.325 kilopascals and 15 °C) equals 36.053 cubic feet (14.7 pounds per square inch absolute and 70 °F).

Highlights of the BLM report follow:

Federal helium demand is expected to remain relatively flat from 2016 through 2021. The demand projections for the next 20 years are also flat, but contributing agencies show less confidence in these projections.

After the helium program ends in 2021, Federal users must obtain helium from other sources. The acquisition strategy for Federal agencies comprised five parts: (1) promulgate regulations to begin a royalty-in-kind program from helium extracted on Federal lands; (2) establish an interagency working group that includes a Federal Strategic Sourcing Initiative to ensure all Federal agencies and intramural contract holders are fully supplied; (3) provide funding for conservation, recycling, and recapture efforts; (4) conduct an economic evaluation of options to continue a modified helium program beyond 2021; and (5) form an interagency working group to monitor above strategies and suggest changes as the helium market evolves.

Although future price projections were uncertain, the U.S. Department of the Interior expected that the 20-year strategy also would mitigate the effects on Federal agencies of higher prices for refined helium in the private market. This strategy also might deflect the immediate need for prioritization of helium uses. However, the BLM recommended formation of an interagency working group to continuously assess Federal agencies' helium needs, update helium demand and projections, and provide a process for prioritization of uses when necessary.

## Production

In 2016, 10 companies operated 19 privately owned domestic helium plants. Of the 19 operating plants, 6 extracted helium from natural gas to produce a crude helium product, 6 produced Grade-A helium, and 7 produced a near-pure helium product containing about 95% to 98% helium. The seven near-pure helium plants use a combination of pressure swing adsorption and membrane technology to extract helium. All crude helium plants and Grade-A helium facilities used cryogenic extraction processes. The six privately owned plants that produced Grade-A helium also produced liquefied helium. Plant operators and plant locations are listed in table 2.

Total sales of U.S.-produced helium in 2016 increased slightly compared with those of 2015. All natural gas processed for helium recovery came from gas fields in Arizona, Colorado, Kansas, Oklahoma, Texas, Utah, and Wyoming (figs. 1, 2). The BLM developed domestic production data for helium from records of its operations and State oil and gas agencies. This information represented 99% of the total helium sales and recovery data listed in table 3. An annual canvass of private U.S. operations was not conducted for 2016.

About 6% more helium was produced from the Government's helium reserve at the Cliffside Field in 2016 than in 2015. Most domestic helium production was from the Midcontinent and Rocky Mountain regions of the United States. The measured helium reserves from which helium is produced are in approximately 104 gas fields in 11 States. Most of these reserves are contained in the Hugoton Field in Kansas, Oklahoma, and Texas; the Panoma Field in Kansas; the Keyes Field in Oklahoma; the Panhandle West and Cliffside Fields in Texas; and the Riley Ridge area in Wyoming.

## Consumption

In 2016, private industry supplied 100% of domestic Grade-A helium for U.S. consumption. The major domestic end uses of helium were magnetic resonance imaging (30%); scientific, engineering, analytical, and specialty gas (20%); lifting gas (17%); and welding and controlled atmosphere, fiber optics, and semiconductors (9% each) (fig. 4). Other uses included diving, leak detection; leak detection; and pressurizing, purging, and other gas and liquid (Campbell and Garvey, 2016).

In 2016, U.S. domestic Grade-A helium consumption increased by 18% to 50.4 million cubic meters (1.82 billion cubic feet) compared with consumption in 2015. During 2016, U.S. helium exports decreased slightly to 62.3 million cubic meters (2.25 billion cubic feet) compared with those of 2015 (table 1).

In-kind crude helium sales regulations (43 CFR part 3195) require that helium refiners that sell helium to Federal agencies and their contractors buy an equivalent amount of crude helium from the BLM. In 2016, in-kind crude helium sales were about 4.0 million cubic meters (143 million cubic feet). The sales were made to eight companies through contracts with the BLM.

## Stocks

The volume of helium stored in the BLM helium conservation storage system, including the conservation pipeline network and the Cliffside Field, totaled 222 million cubic meters (8.00 billion cubic feet) on December 31, 2016. The storage system contained crude helium purchased by the Government under contract from 1962 to 1973 and privately owned helium extracted by industry from natural-gas-supplying fuel markets and stored under contract. This privately owned helium is returned to the owners, as needed, for purification to supply private demand. During 2016, 12.6 million cubic meters (455 million cubic feet) of privately owned helium was delivered to the BLM's helium conservation system, and 35.6 million cubic meters (1.28 billion cubic feet) was withdrawn, for a net decrease of 23.0 million cubic meters (829 million cubic feet) of helium in storage (table 4).

## Transportation

Private producers and (or) distributors shipped helium, predominantly as a liquid, in semitrailers that delivered the product to distribution centers, where a portion was gasified and compressed into trailers and small cylinders for delivery to end users. The remaining helium was sold as bulk liquid or repackaged in dewars of various sizes for delivery.

## Prices

The HSA requires the BLM to use market-based pricing for crude helium sales to private industry. In 2016, the conservation price was based on the annual auction results and an independent, confidential market survey of helium industry prices. The in-kind price was set at approximately 80% of the conservation price from the prior year. For FY 2016, the conservation price was \$3.75 per cubic meter (\$104 per thousand cubic feet), and the in-kind price was \$3.04 per cubic meter (\$84.40 per thousand cubic feet).

## Foreign Trade

In 2016, exports of Grade-A helium decreased to 62.3 million cubic meters (2.25 billion cubic feet), a 3% decrease compared with those of 2015, and accounted for about 70% of sales of U.S.-produced helium; private industry supplied all U.S. helium exports (table 1). Regionally, Asia, excluding China, received 32% of the helium exported from the United States; North America, Central America, and the Caribbean, combined, received 30%; Europe, 13%; China, 11%; South America, 10%; the Middle East and Africa, combined, 3%; and Australia and New Zealand, combined, 1%.

In 2016, imports of helium increased by 47% to 23.4 million cubic meters (844 million cubic feet) from 15.9 million cubic meters (573 million cubic feet) in 2015 (table 1). About 85% of imports came from Qatar, 9% from Canada, and 4% from Algeria.

For 2016, import tariffs on helium remained at 3.7% for normal trade relations (NTR) nations and 25% for non-NTR nations.

## World Review

Total world production was approximately 159 million cubic meters (5.73 billion cubic feet) in 2016. Excluding the United States, the world production capacity of helium was estimated to be about 110 million cubic meters (3.97 billion cubic feet) in 2016 (table 5). Helium was produced in Algeria, Australia, Poland, Qatar, and Russia. Worldwide, one new helium plant began operation in 2016, and an additional plant was slated to begin operating in 2018. Several more projects were in various planning stages.

## Outlook

From 2008 through 2012, total global sales of helium produced in the United States increased by about 3.5% per year. That trend reversed in 2013 with the addition of capacity in Qatar coupled with demand destruction owing to several years of prior-year shortages. U.S. domestic helium consumption increased substantially during 2016 but is expected to remain stable in 2017. As a result of the increased capacity of foreign plants and lower helium production in the United States, exports are expected to decrease during 2017 and imports are likely to continue increasing.

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TABLE 1  
SALES OF GRADE-A HELIUM  
IN THE UNITED STATES<sup>1</sup>

(Million cubic meters)

Year	Volume			Total sales of U.S.-produced helium
	Domestic consumption	Exports <sup>2</sup>	Imports <sup>2</sup>	
2012	50.9 <sup>r</sup>	82.9 <sup>r</sup>	0.8 <sup>r</sup>	133
2013	39.7 <sup>r</sup>	80.7 <sup>r</sup>	2.4	118
2014	43.2 <sup>r</sup>	66.3 <sup>r</sup>	7.5 <sup>r</sup>	102
2015	42.6 <sup>r</sup>	64.0 <sup>r</sup>	15.9 <sup>r</sup>	90.7 <sup>r</sup>
2016	50.4	62.3	23.4	89.3

<sup>r</sup>Revised.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals

<sup>2</sup>Source: U.S. Census Bureau.

TABLE 2  
OWNERSHIP AND LOCATION OF HELIUM EXTRACTION PLANTS IN THE UNITED STATES IN 2016

Owner or operator	Plant name	Status	Location	Product purity
Air Products and Chemicals, Inc.	Liberal	Operating	Seward County, KS	Grade-A helium. <sup>1</sup>
Do.	Panhandle	Standby	Hansford County, TX	Do. <sup>1</sup>
Do.	Doe Canyon	Operating	Dolores County, CO	Do. <sup>1</sup>
DCP Midstream, LLC	Ladder Creek	do.	Cheyenne Wells, CO	Near-pure helium. <sup>2</sup>
Do.	National	do.	Seward County, KS	Crude helium. <sup>3</sup>
Do.	Rock Creek	do.	Hutchinson County, TX	Do. <sup>3</sup>
Do.	Sher-Han	do.	Hansford County, TX	Do. <sup>3</sup>
Denbury Onshore, LLC	Riley Ridge	Standby	Sublette County, WY	Do. <sup>3</sup>
Eagle Rock Energy Partners, L.P.	Sunray	Operating	Moore County, TX	Do. <sup>3</sup>
ExxonMobil Gas & Power Marketing Co.	LaBarge	do.	Sweetwater County, WY	Grade-A helium.
IACX Energy LLC	Dineh-Bi-Keyah	do.	Apache County, AZ	Near-pure helium. <sup>2</sup>
Do.	Harley Dome	do.	Grand County, UT	Do. <sup>2</sup>
Do.	Hodgeman	do.	Hodgeman County, KS	Do. <sup>2</sup>
Do.	IACX Otis	do.	Rush County, KS	Do. <sup>2</sup>
Do.	Badger Wash	do.	Mesa County, CO	Do. <sup>2</sup>
Do.	Paden	do.	Okfuskee County, OK	Do. <sup>2</sup>
Do.	Woodside Dome	Under development	Emery County, UT	Do. <sup>2</sup>
Linde Global Helium, Inc.	Linde Otis	Operating	Rush County, KS	Grade-A helium. <sup>1</sup>
Linn Energy, LLC	Jayhawk	do.	Grant County, KS	Crude helium. <sup>3</sup>
Midstream Energy Services, LLC	Keyes	do.	Cimarron County, OK	Grade-A helium. <sup>1</sup>
Pioneer Natural Resources Co.	Fain	do.	Potter County, TX	Crude helium. <sup>3</sup>
Praxair, Inc.	Ulysses/Jayhawk	do.	Grant County, KS	Grade-A helium. <sup>1</sup>
Do.	Bushton	Standby	Ellsworth County, KS	Do. <sup>1</sup>

Do., do. Ditto.

<sup>1</sup>Including liquefaction, at least 99.99% helium.

<sup>2</sup>Generally contains between 95 and 98% helium.

<sup>3</sup>Generally contains between 60 and 80% helium.

TABLE 3  
HELIUM RECOVERY IN THE UNITED STATES<sup>1</sup>

(Million cubic meters)

	2012	2013	2014	2015	2016
<b>Crude helium:</b>					
Bureau of Land Management (BLM) sold (in-kind and open market)	60.6	61.8	53.2	28.5	32.0
<b>Private industry:</b>					
Private helium accepted and stored by BLM	10.2	11.7	10.6	10.3	12.6
Helium withdrawn from storage	-70.3	-60.8	-37.7	-29.9	-35.6
Total net helium put into storage	-60.1	-49.1	-27.1	-19.6	-23.0
<b>Grade-A helium:</b>					
Private industry sold	133.0	118.0	102.0	90.7	89.3
Total helium stored	-60.1	-49.1	-27.1	-19.6	-23.0
Helium recovery from natural gas	72.9	68.9	74.9	71.1	66.3

<sup>1</sup>Negative numbers denote a net withdrawal from BLM's underground storage facility, a partially depleted natural gas reservoir at the Cliffside Field near Amarillo, TX.

TABLE 4  
SUMMARY OF BUREAU OF LAND MANAGEMENT (BLM) HELIUM CONSERVATION STORAGE SYSTEM OPERATIONS<sup>1,2</sup>

(Million cubic meters)

	2012	2013	2014	2015	2016
<b>Helium in conservation storage system on January 1:</b>					
Stored under BLM conservation program <sup>3</sup>	368.5	306.1	242.9	188.4	159.5
Stored for private producers under contract	34.4	37.4	51.1	77.7	86.5
Total <sup>3</sup>	402.9	343.5	294.0	266.1	246.0
<b>Input to system:</b>					
Net deliveries from BLM plants	--	--	--	--	--
Stored for private producers under contract	10.2	11.7	10.6	10.3	12.6
Total <sup>3</sup>	10.2	11.7	10.6	10.3	12.6
Redelivery of helium stored for private producers under contract	-70.3	-60.8	-37.7	-29.9	-35.6
Systemwide measurement and plant losses and gains	0.6	-0.4	-0.8	-0.5	-1.1
Net addition to system <sup>3</sup>	-59.5	-49.1	-27.1	-19.6	-23.0
<b>Helium in conservation storage system on December 31:</b>					
Stored under BLM conservation program <sup>3</sup>	306.1	242.9	188.4	159.5	126.3
Stored for private producers under contract	37.4	51.1	77.7	86.5	95.5
Total <sup>3</sup>	343.5	294.0	266.1	246.0	221.8

-- Zero.

<sup>1</sup>Crude helium is injected into or withdrawn from BLM's underground storage facility, a partially depleted natural gas reservoir at the Cliffside Field near Amarillo, TX.

<sup>2</sup>Negative numbers denote a net withdrawal from BLM's underground storage facility.

<sup>3</sup>Net additions to system do not include in-kind crude sales or transfers. Totals, however, do include crude sales and transfers.

TABLE 5  
WORLD GRADE-A HELIUM  
ANNUAL PRODUCTION CAPACITY  
AS OF DECEMBER 31, 2016

(Million cubic meters)

	Capacity
United States <sup>1</sup>	160
Rest of world <sup>c</sup>	110
Total <sup>c</sup>	270

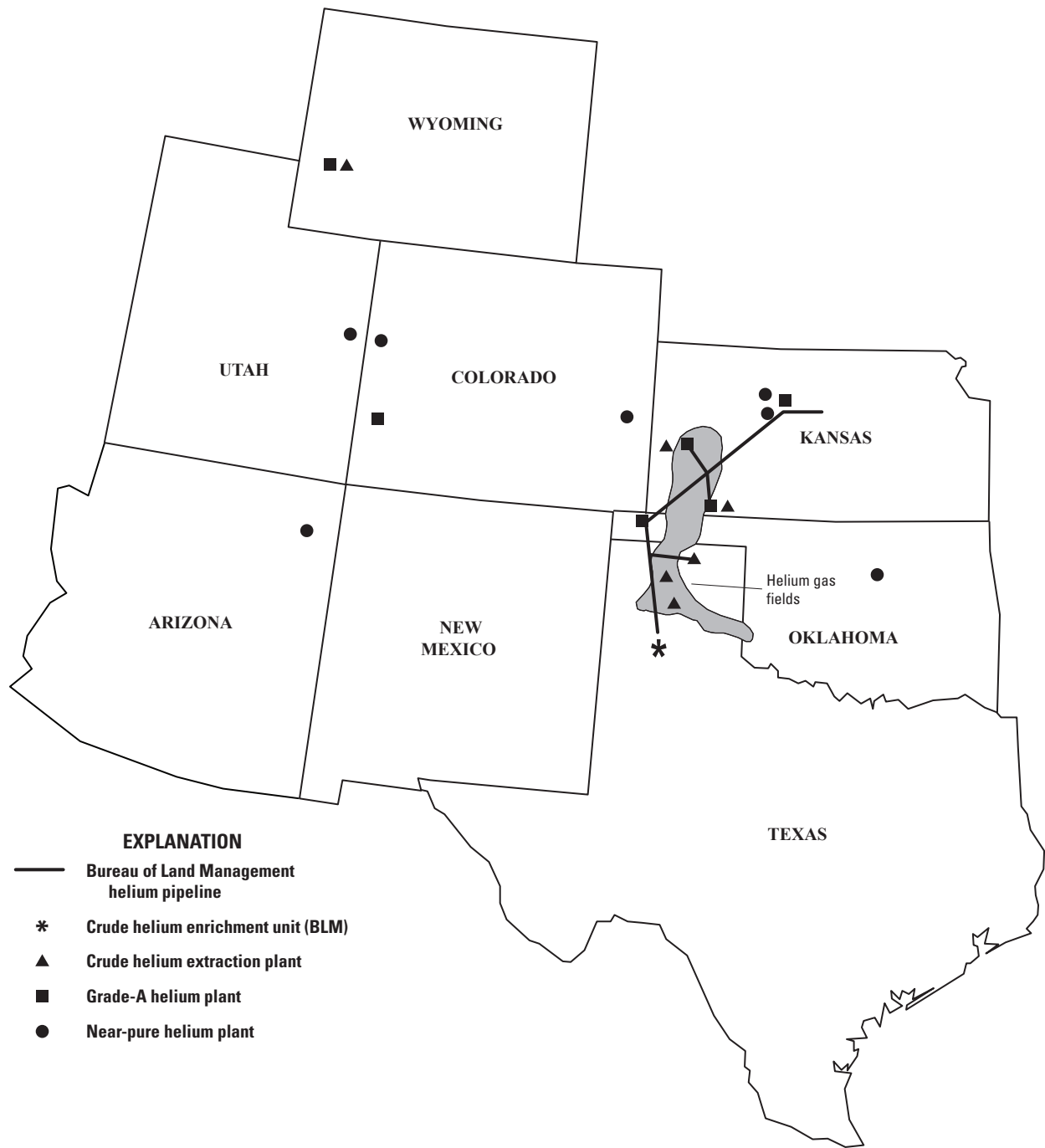
<sup>c</sup>Estimated.

<sup>1</sup>Includes plants on standby as well as operating plants.



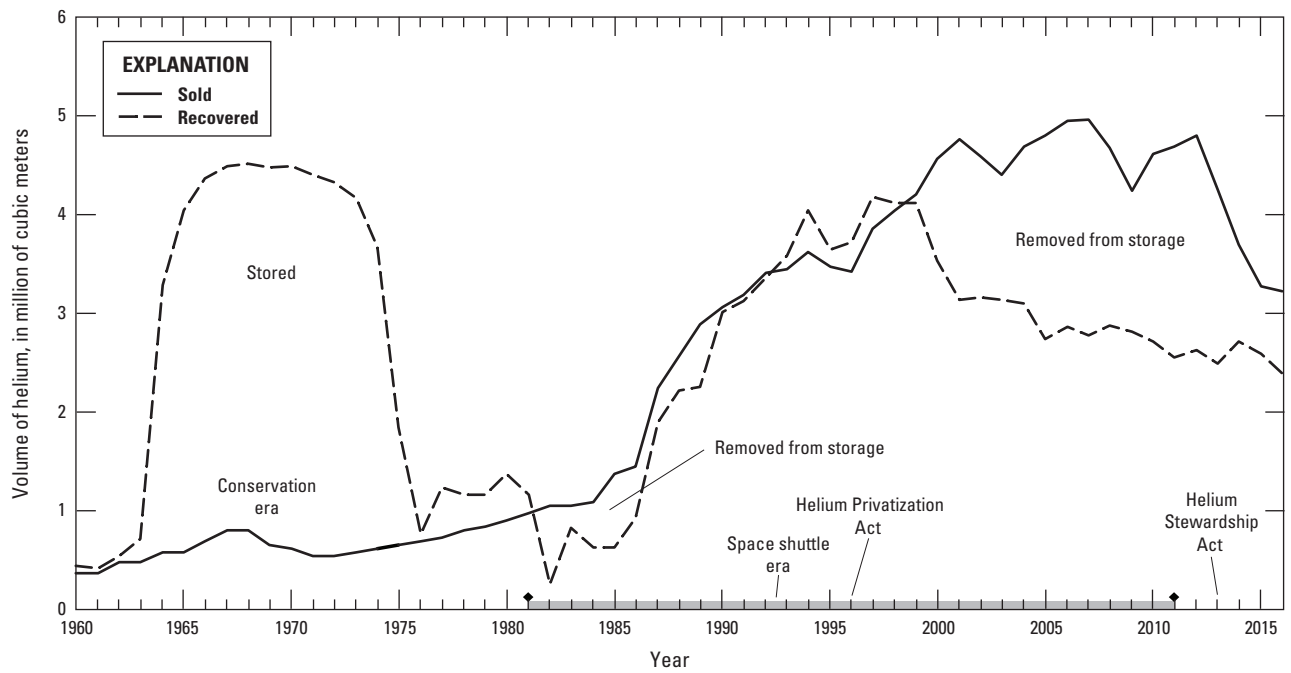


**Figure 1.** Major helium-bearing natural gas fields in the United States.

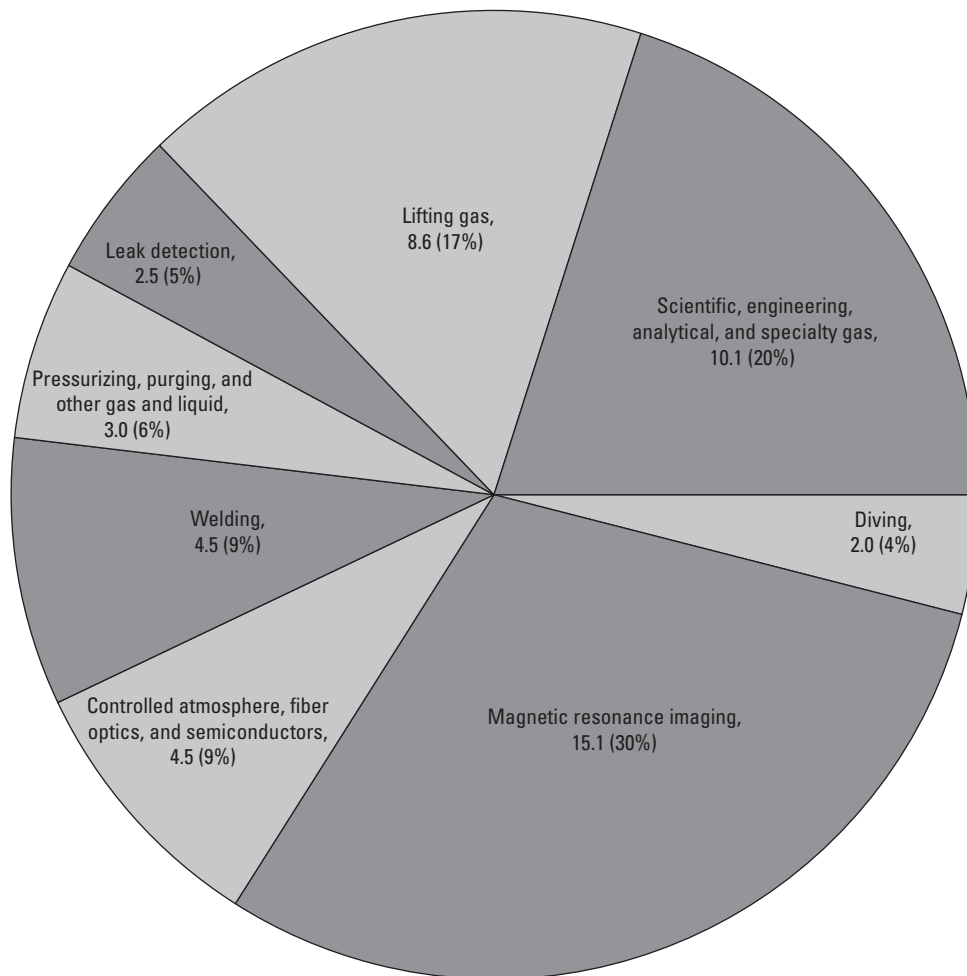


**Figure 2.** Helium extraction and refining plants in the United States.





**Figure 3.** Helium recovery in the United States, 1960–2016.



**Figure 4.** Estimated helium consumption in the United States in 2016, by end use, reported in million cubic meters. Total helium used in the United States in 2016 was 50.4 million cubic meters.