



2021 Minerals Yearbook

HELIUM [ADVANCE RELEASE]

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HELIUM

By Robert C. Goodin and John E. Hamak¹

Domestic consumption of Grade-A helium (99.99% or greater purity) and gaseous helium (98% or greater purity) in 2021 was 52.0 million cubic meters² (1.87 billion cubic feet). Exports by private producers were reported by the U.S. Census Bureau to be 33.1 million cubic meters (1.19 billion cubic feet). Imports of helium were reported to be 9.2 million cubic meters (332 million cubic feet). Total sales of U.S.-produced helium were 75.9 million cubic meters (2.74 billion cubic feet), a decrease of 7% from those in 2020 (table 1).

Government Actions and Legislation

On October 2, 2013, the U.S. Congress passed the Helium Stewardship Act of 2013 (HSA) (U.S. Congress, 2013). With the passage of the HSA, Congress established a timeline for the privatization of the helium marketplace. The Federal helium program would continue for a period of time but with significant changes to its operation. The HSA sought to mitigate helium shortages by enabling 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 sales. The HSA provided a transition in four phases.

Phase A, Allocation Transition.—This phase began upon passage of the HSA and ended on September 30, 2014. This was a continuation of the directive in the Helium Privatization Act of 1996 for the sale of much of the National Helium Reserve located at the Cliffside Field in Amarillo, TX, and prescribed sales volumes and conditions (U.S. Congress, 2013).

Phase B, Auction Implementation.—This phase was initiated on October 1, 2014, and was prescribed to end when crude helium stored in the Federal Helium Reserve was reduced to a level of 3 billion cubic feet (83.2 million cubic meters). In July 2014, the Bureau of Land Management (BLM) conducted the first auction of helium for delivery during fiscal year (FY) 2015 (October 1, 2014, through September 30, 2015). The auction was open to all qualified bidders as defined in 50 U.S.C. 167d(b). The last auction and sale were conducted in July 2018 for deliveries in FY 2019. At the July 2018 sale, 5.8 million cubic meters (210 million cubic feet) was offered at auction at the allocated sale, and 2.5 million cubic meters (90 million cubic feet) was sold at the nonallocated sale. This was the last auction

and sale conducted under phase B as the volume of conservation helium in storage dropped to approximately 3 billion cubic feet.

Phase C, Continued Access for Federal Users.—This phase began on January 1, 2019, as the remaining crude helium stored in the Federal Helium Reserve reached 3 billion cubic feet. The BLM continued to provide crude helium for sale to Federal users. In 2019, there were no more sales or auctions of helium to private entities, but deliveries to private entities of helium sold during phase B continued. Deliveries and sales of helium from the Cliffside Field were prescribed to continue until phase D is completed.

Phase D, Disposal of Assets.—During this phase, the Secretary of the Interior was required to dispose of assets in the Federal helium program no later than September 30, 2021. These assets include all underground natural resources and the United States' rights to those assets. Unlike the requirements of the Helium Privatization Act of 1996 (U.S. Congress, 1996), the BLM will no longer be 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. This phase was delayed indefinitely owing to disruptions related to the global coronavirus disease 2019 (COVID-19) pandemic.

On November 9, 2021, a proposed, revised U.S. Geological Survey (USGS) critical minerals list was published in the Federal Register (86 FR 62199). Helium was removed from this version of the critical minerals list because it did not meet the quantitative threshold: it did not have a single point of failure, the United States was the world's leading producer of helium, and the United States was a net exporter of helium (U.S. Geological Survey, 2021).

Production

In 2021, 11 companies operated 19 privately owned domestic helium plants. Of the 19 operating plants, 5 extracted helium from natural gas to produce a crude helium product, 8 produced Grade-A helium, and 6 produced gaseous helium. The six gaseous helium plants used a combination of pressure swing adsorption, membrane technology, and nitrogen rejection utilization to extract helium. All crude helium plants and Grade-A helium facilities used cryogenic extraction processes. The eight privately owned plants that produced Grade-A helium also produced liquefied helium. Two Grade-A helium plants and one crude helium plant were on standby status (table 2).

Total sales of U.S.-produced helium in 2021 decreased by 7% compared with those in 2020 (table 1). All natural gas processed for helium recovery came from gasfields in Arizona, Colorado, Kansas, New Mexico, Oklahoma, Texas, Utah, and Wyoming (figs. 1, 2). Domestic production data for helium were developed by the BLM from records of its own operations and from an annual voluntary canvass of private U.S. operations. All companies provided production information; those data, in

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²All metric helium volumes herein are at 101.325 kilopascals absolute (14.696 pounds per square inch absolute) and 15 degrees Celsius (°C) [59 degrees Fahrenheit (°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).

conjunction with information from BLM operations, represented 100% of the total helium sales and recovery data listed in table 3. Helium production from the Government's helium reserve at Cliffside Field in 2021 was 27% less than that in 2020 (table 3).

Most domestic helium production was from the Midcontinent and Rocky Mountain regions. The measured U.S. helium reserves were from fewer than 50 gasfields in 8 States. Most of these reserves are contained in the Cliffside and Panhandle West Fields in Texas; the Hugoton Field in Kansas, Oklahoma, and Texas; the Keyes Field in Oklahoma; the Panoma Field in Kansas; and the Riley Ridge area in Wyoming. The USGS estimated that the recoverable helium within known geologic natural gas formations in the United States was about 8.49 billion cubic meters (306 billion cubic feet) (Brennan and others, 2021).

Consumption

In 2021, U.S. domestic helium consumption slightly decreased to 52.0 million cubic meters (1.87 billion cubic feet) compared with consumption in 2020 (table 1). The major domestic end uses of helium were analytical, engineering, lab, scientific, and specialty gases (21%); controlled atmospheres, fiber optics, and semiconductors (18%); magnetic resonance imaging (17%); lifting gases (16%); and pressurizing, purging, and other gas and liquid (11%). Other uses, in descending order of use, included welding, leak detection, and diving (fig. 3) (Garvey, 2021a).

In-kind crude helium sales regulations (43 CFR part 3195) required helium refiners that sold helium to Federal agencies and their contractors to buy an equivalent amount of crude helium from the BLM. In 2021, in-kind crude helium sales were 4.4 million cubic meters (159 million cubic feet) (table 3). The sales were made to nine 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 approximately 121.7 million cubic meters (4.39 billion cubic feet) on December 31, 2021 (table 4). The storage system contained crude helium purchased under contract by the Government from 1962 through 1973, in addition to privately owned helium extracted by industry and stored under contract (fig. 4). The privately owned helium was returned to the owners as needed for purification to supply for private sale. During 2021, 7.1 million cubic meters (256 million cubic feet) of privately owned helium was delivered to the BLM's helium conservation system, and 14.2 million cubic meters (512 million cubic feet) was withdrawn, for a net decrease of 7.0 million cubic meters (252 million cubic feet) of helium in storage (table 3). Systemwide measurements showed that there was 7.0 million cubic meters (252 million cubic feet) lost from the BLM's helium conservation system in 2021 (table 4).

Prices

The HSA required the BLM to use market-based pricing for its crude helium sales to private industry. For FY 2021, the conservation price was no longer posted. The BLM last posted

conservation prices for FY 2018. The in-kind price to Federal Government users in FY 2021 was \$3.57 per cubic meter (\$99 per thousand cubic feet), a slight increase from that in FY 2020 (Bureau of Land Management, 2021).

Transportation

Private producers and (or) distributors shipped helium, predominantly as a liquid in semitrailers, delivered to distribution centers, where some of it was gasified and compressed into trailers and cylinders for delivery to end users. The remaining liquid helium was sold as bulk liquid or repackaged in dewars, specialized vacuum tanks used for storing cryogens, of various sizes.

Foreign Trade

In 2021, exports by private producers were reported by the U.S. Census Bureau to be 33.1 million cubic meters (1.19 billion cubic feet), a decrease of 6% from those in 2020 (tables 1, 5). The associated value of helium exports was \$333 million, a 22% decrease compared with that in 2020. The average unit value of exports in 2021 was \$10.08 per cubic meter [\$279.70 per thousand cubic feet (million cubic feet)], a 17% decrease from that in 2020. Regionally, Asia and the Pacific received 35% of the helium exported from the United States; North America, Central America, and the Caribbean combined, 30%; Europe, 24%; South America, 8%; the Middle East and Africa combined, 2%; and Australia and New Zealand combined, 1% (table 5). Private industry supplied all U.S. helium exports. For 2021, import tariffs on helium remained at 3.7% for normal trade relations (NTR) nations and 25% for non-NTR nations.

In 2021, imports for consumption of helium were 9.2 million cubic meters (332 million cubic feet), a 37% increase from those in 2020 (tables 1, 6). The associated value of helium imports was \$68.7 million, a 58% increase compared with that in 2020. The average unit value of imports in 2021 was \$7.43 per cubic meter (\$206.00 per million cubic feet), a 15% increase from that in 2020. Qatar supplied 39% of the United States imports for consumption, and Canada supplied 36% of imports for consumption (table 6). Global port congestion caused rising shipping costs and trade delays (Anderson, 2022).

World Review

In addition to the United States, helium was produced in Algeria, Australia, Canada, Poland, Qatar, Russia, and South Africa. Total world helium production was an estimated 161 million cubic meters (5.80 billion cubic feet) in 2021 (table 8). World production capacity of helium was estimated to be 336 million cubic meters (12.1 billion cubic feet) in 2021 (table 7).

Worldwide, several helium projects started up or were in the planning stage in 2021. In Amur, Russia, a helium-processing plant was commissioned by PJSC Gazprom (Russia) with a capacity of 60 million cubic meters per year (2.16 billion cubic feet per year). The first of three trains with capacities of 20 million cubic meters per year (721 billion cubic feet per year) started production in fall 2021. Qatargas Operating Co. Ltd.'s (Qatar) third helium plant (Qatar 3) started production in early

2021. This plant had a production capacity of 11 million cubic meters per year (400 million cubic feet per year) (Anderson, 2022). In April, North American Helium Inc. (Canada) started production from a helium purification facility in Saskatchewan Province, Canada (Speer, 2021) with a capacity of 1.40 million cubic meters per year (50 million cubic feet per year). Irkutsk Oil Co. (Russia) planned to start up 7.5 million cubic meters per year (270 million cubic feet per year) of liquid helium capacity in Irkutsk, Russia, in 2023. Saudi Arabian Oil Co. (Saudi Arabia) planned to start up 6.9 million cubic meters per year (250 million cubic feet per year) of liquid helium capacity in 2023. Qatargas Operating Co. Ltd. (Qatar) planned to start up a fourth helium plant (Qatar 4) by 2025. This helium plant was expected to have a liquid helium capacity of 27.7 million cubic meters per year (1.00 billion cubic feet per year). Two companies continued exploring for helium in the Lake Rukwa area of Tanzania (Garvey, 2021b).

There were multiple unplanned helium operation outages in 2021. The Helison Production plant in Skikda, Algeria, temporarily shut down in June because of issues with the liquefied natural gas facility that supplied feedgas to the helium plant. The Keyes Helium plant in Oklahoma temporarily shut down in June owing to a broken turbine. The BLM shut down its Crude Helium Enrichment Unit for 4 months starting in July to address safety issues (Kornbluth, 2021). At Gazprom's gas processing plant in Amur, Russia, a fire took place in October after decompression of plant equipment (Parkinson, 2021a).

Outlook

U.S. domestic helium consumption is expected to remain stable during 2022. Multiple companies were exploring for helium deposits throughout North America, some of which were nonhydrocarbon sourced (Parkinson, 2021b). The BLM is expected to dispose of assets in the Federal helium program in 2022. The BLM and the General Services Administration are working together to determine how to transition all Federal helium assets to private ownership (Cockerill, 2022).

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TABLE 1
SALES OF GRADE-A AND GASEOUS HELIUM IN THE UNITED STATES
(Million cubic meters)

Year	Volume			Total sales of U.S.-produced helium
	Domestic consumption ¹	Exports ²	Imports ²	
2017	44.8 ^r	74.2 ^r	18.5	100.6
2018	45.0 ^{r, e, 3}	83.6 ^r	7.5	89.9
2019	45.0 ^{r, e, 3}	57.8	6.8	86.2
2020	53.0 ^r	35.2 ^r	6.7	81.5
2021	52.0	33.1	9.2	75.9

^eEstimated. ^rRevised.

¹Defined as total sales of U.S.-produced helium plus imports minus exports; may not add to totals shown.

²Source: U.S. Census Bureau.

³Consumption is estimated because of unusually high exports reported by the U.S. Census Bureau.

TABLE 2
OWNERSHIP AND LOCATION OF HELIUM EXTRACTION PLANTS IN THE UNITED STATES IN 2021

Owner or operator	Plant name	Status	County, State	Product purity ¹
Air Products Corporation, Inc.	AP/MTG	Standby	Sublette, WY	Grade-A helium.
Do.	Doe Canyon	Operating	Dolores, CO	Do.
Do.	Liberal	do.	Seward, KS	Do.
Do.	Panhandle	Standby	Hansford, TX	Do.
DCP Midstream, LLC	National	Operating	Seward, KS	Crude helium.
Do.	Rock Creek	do.	Hutchinson, TX	Do.
Do.	Sher-Han	do.	Hansford, TX	Do.
DenburyOnshore, LLC	Riley Ridge	Standby	Sublette, WY	Do.
Energy Transfer	Sunray	Operating	Moore, TX	Do.
ExxonMobil Gas Marketing Co.	LaBarge	do.	Sweetwater, WY	Grade-A helium.
IACX Energy	Dineh-Bi-Keyah	do.	Apache, AZ	Gaseous helium.
Do.	Harley Dome	do.	Grand, UT	Do.
Do.	Hodgeman	do.	Hodgeman, KS	Do.
Do.	IACX Otis	do.	Rush, KS	Do.
Do.	Paden	do.	Okfuskee, OK	Do.
Do.	Roswell	do.	Chaves, NM	Do.
Linde Global Helium, Inc.	Ulysses	do.	Grant, KS	Grade-A helium.
Messer, LLC	Messer Otis	do.	Rush, KS	Do.
Midstream Energy Services, LLC	Keyes	do.	Cimarron, OK	Do.
Paradox Resources	Lisbon	do.	San Juan, UT	Do.
Scout Energy	Jayhawk	do.	Grant, KS	Crude helium.
Tumbleweed Resources	Ladder Creek	do.	Cheyenne, CO	Grade-A helium.
Do., do. Ditto.				

¹Grade-A helium, including liquefaction, is at least 99.99% helium. Gaseous helium is generally greater than 98% helium. Crude helium generally contains between 60% and 80% helium.

TABLE 3
HELIUM RECOVERY IN THE UNITED STATES¹

(Million cubic meters)

	2017	2018	2019	2020	2021
Bureau of Land Management (BLM) crude helium sold (in-kind and open market)	28.6	13.4	5.0 ²	5.9 ²	4.4 ²
Crude helium accepted and stored by BLM	4.5	3.1	3.2	5.1	7.1
Crude helium withdrawn from storage	-32.7	-31.2	-25.0	-14.7	-14.2
Total net crude helium put into storage ³	-28.1	-28.2	-21.8	-9.6	-7.0
Private industry gaseous or Grade-A helium sold	100.6	89.9	86.2	81.5	75.9
Total helium recovered from natural gas ³	72.4	61.7	64.4	71.9	68.9

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

²Open market sales have ended; represents only in-kind sales.

³Numbers may not add to totals shown owing to rounding and conversions.

TABLE 4
SUMMARY OF BUREAU OF LAND MANAGEMENT (BLM) HELIUM CONSERVATION STORAGE SYSTEM OPERATIONS^{1,2}

(Million cubic meters)

	2017	2018	2019	2020	2021
Helium in conservation storage system on January 1:					
Stored under BLM conservation program	126.3	97.9	83.1	77.5	68.9
Stored for private producers under contract	95.5	98.6	82.0	65.2	61.7
Total ³	221.8	196.5	165.1	142.7	130.6
Additions to system:					
Stored for private producers under contract	4.5	3.1	3.2	5.1	7.1
Redelivery of helium stored for private producers under contract	-32.7	-31.2	-25.0	-14.7	-14.2
Systemwide measurement and plant losses or gains	2.8	-3.3	-0.6	-2.6	-7.0
Total ⁴	-25.4	-31.4	-22.4	-12.2	-7.2
Helium in conservation storage system on December 31:					
Stored under BLM conservation program ⁴	97.9	83.1	77.5	68.9	60.7
Stored for private producers under contract	98.6	82.0	65.2	61.7	61.0
Total ³	196.5	165.1	142.7	130.6	121.7

¹Crude 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.

²Negative numbers denote a net withdrawal from BLM's underground storage facility.

³Numbers may not add to totals shown due to rounding and conversions.

⁴Net additions to system do not include in-kind crude sales or transfers. Totals, however, do include crude sales and transfers.

TABLE 5
U.S. EXPORTS OF HELIUM, BY REGION AND DESTINATION¹

(Million cubic meters, thousand dollars, and dollars per cubic meter)

Destination	2020			2021		
	Quantity	Value ²	Unit value	Quantity	Value ²	Unit value
Africa and the Middle East:						
United Arab Emirates	1	6,270	12.48	(3)	1,630	13.84
Other	1	8,880	16.84	(3)	2,840	6.84
Total	1	15,100	14.71	1	4,470	8.39
Asia:						
China ⁴	3	24,800	8.45	1	14,000	11.24
Japan	3	67,300	20.26	3	51,500	17.24
Korea, Republic of	6	95,400	14.84	4	60,800	14.15
Taiwan	4	56,600	14.39	3	42,200	14.69
Other	(3)	148	3.29	(3)	489	11.37
Total	17	244,000	14.66	11	169,000	14.76
Europe:						
Belgium	4	55,000	15.51	4	46,700	12.17
Germany	1	3,860	5.49	1	9,180	7.25
Netherlands	1	6,510	8.19	1	373	(3)
United Kingdom	1	6,010	10.52	1	10,700	8.12
Other	(3)	3,560	10.02	1	9,830	13.65
Total	6	74,900	12.55	8	76,800	9.61
North America:						
Canada	3	28,300	10.41	4	29,600	8.31
Costa Rica	(3)	361	1.17	1	427	0.43
Mexico	3	29,500	9.66	3	25,200	7.52
Other	(3)	3,590	2.02	2	3,870	1.58
Total	8	61,700	7.86	10	59,100	5.89
Oceania, Australia	(3)	610	2.45	(3)	459	1.50
South America:						
Brazil	2	20,000	10.53	1	15,300	10.71
Other	2	9,850	6.45	1	8,440	6.28
Total	3	29,900	8.71	3	23,700	8.56
Grand total	35.2 ^r	426,000	12.12	33.1	333,000	10.08

¹Revised.

²Table includes data available through June 12, 2023. Data are rounded to no more than three significant digits, except "Unit value"; may not add to totals shown.

³Free alongside ship value of material at U.S. port of export. Based on transaction price; includes all charges incurred in placing material alongside ship.

⁴Less than ½ unit.

^rIncludes Hong Kong.

Source: U.S. Census Bureau.

TABLE 6
U.S. IMPORTS OF HELIUM, BY COUNTRY OR LOCALITY¹

(Million cubic meters, thousand dollars, and dollars per cubic meter)

Country or locality	2020			2021		
	Quantity	Value ²	Unit value	Quantity	Value ²	Unit value
Algeria	1	11,200	7.56	1	4,620	7.06
Canada	1	5,940	5.32	3	21,000	6.39
Germany	(3)	146	5.41	1	5,890	7.40
Qatar	3	21,900	6.57	4	32,100	8.80
Russia	(3)	2,170	4.81	1	4,080	5.97
Other	(3)	2,180	6.52	(3)	985	5.66
Total	7	43,600	6.46	9	68,700	7.43

¹Table includes data available through June 12, 2023. Data are rounded to no more than three significant digits, except "Unit value"; may not add to totals shown.

²Cost, insurance, and freight value of material at U.S. port of entry. Based on purchase price; includes all charges (except U.S. import duties) in bringing material from foreign country to alongside carrier.

³Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 7
ESTIMATED WORLD ANNUAL GRADE-A AND GASEOUS
HELIUM PRODUCTION CAPACITY, DECEMBER 31, 2021¹

(Million cubic meters)

Country or locality	Capacity
Algeria	50
Australia	6
Canada	6
Poland	3
Qatar	72
Russia	19
South Africa	1
United States	179
Total	336

¹Includes capacity at operating plants and at plants on standby basis. Data may not add to total shown.

TABLE 8
HELIUM: WORLD PRODUCTION, BY COUNTRY OR LOCALITY¹

(Million cubic meters)

Country or locality	2017	2018	2019	2020	2021
Algeria ^c	14	14	14	14	10
Australia ^c	4	4	4	4	4
Canada ^c	1	1	1	1	1
Poland	3	3	3	3	3
Qatar ^c	45	45	45	51	61
Russia ^c	3	3	5	5	5
South Africa ^c	--	--	--	(2)	1
United States	101	90	86	82	76
Total	171	160	158	160	161

^cEstimated. -- Zero.

¹Table includes data available through July 13, 2023. All data are reported unless otherwise noted; totals may include estimated data. Totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Less than ½ unit.

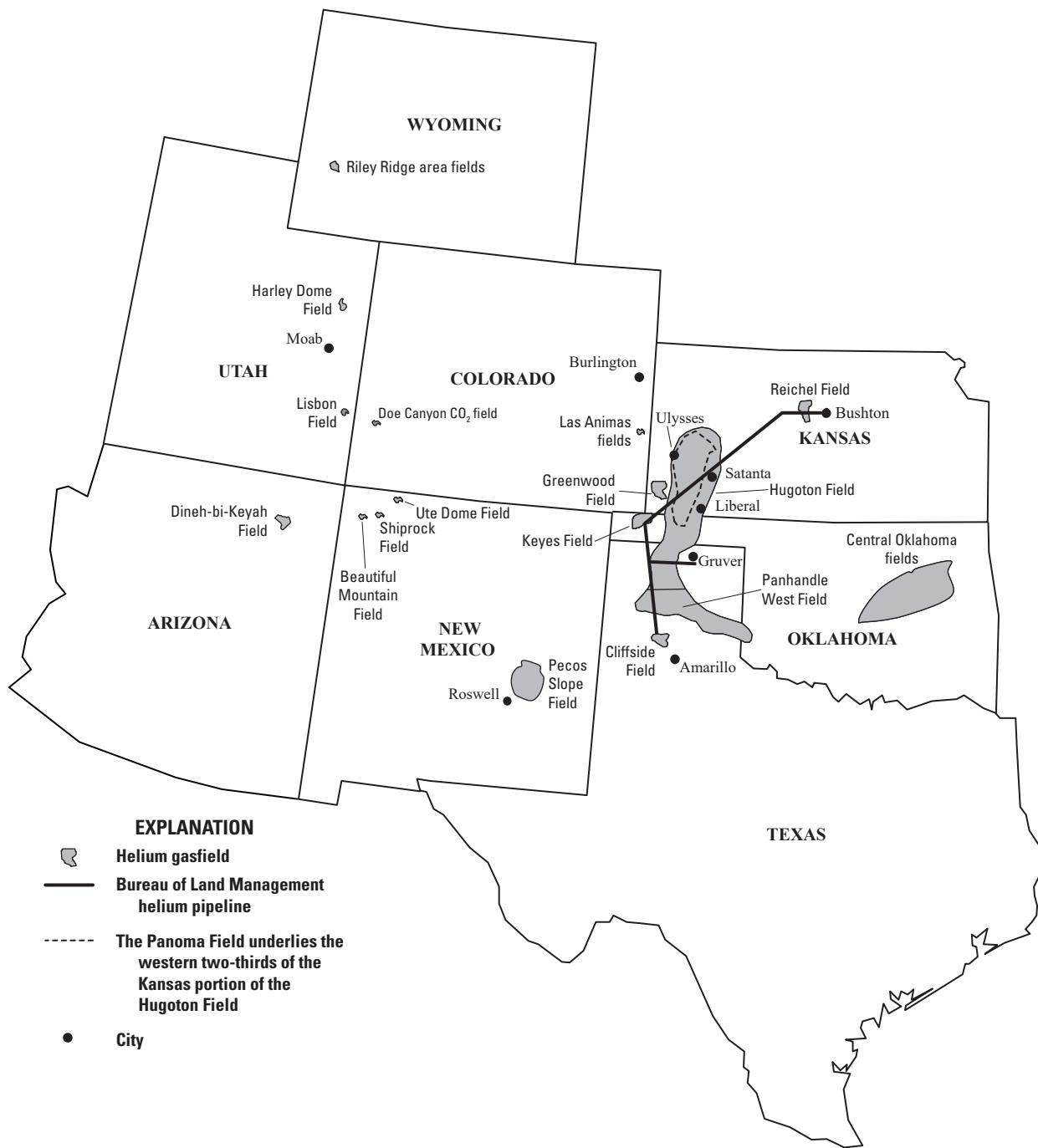


Figure 1. Major helium-bearing gasfields in the United States in 2021.

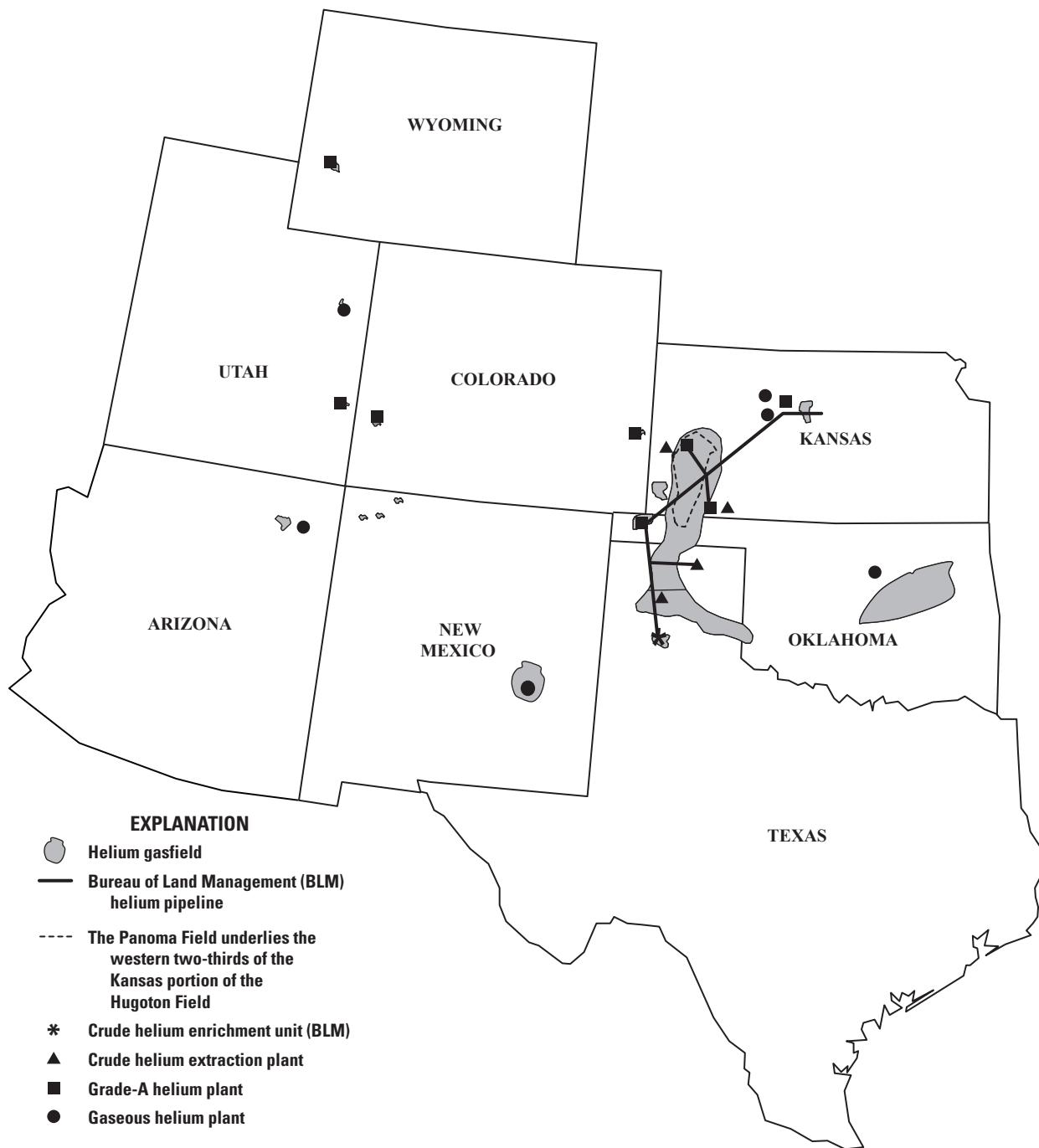


Figure 2. Active helium extraction and refining plants in the United States in 2021.

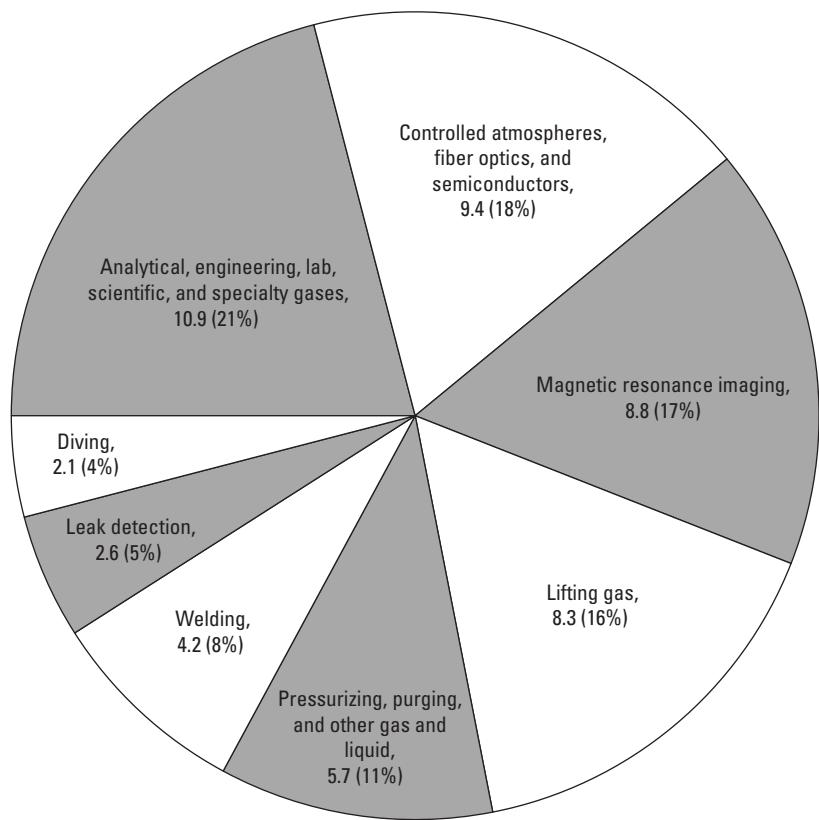


Figure 3. Helium consumption in the United States in 2021, by end use, reported in million cubic meters (Garvey, 2021a).

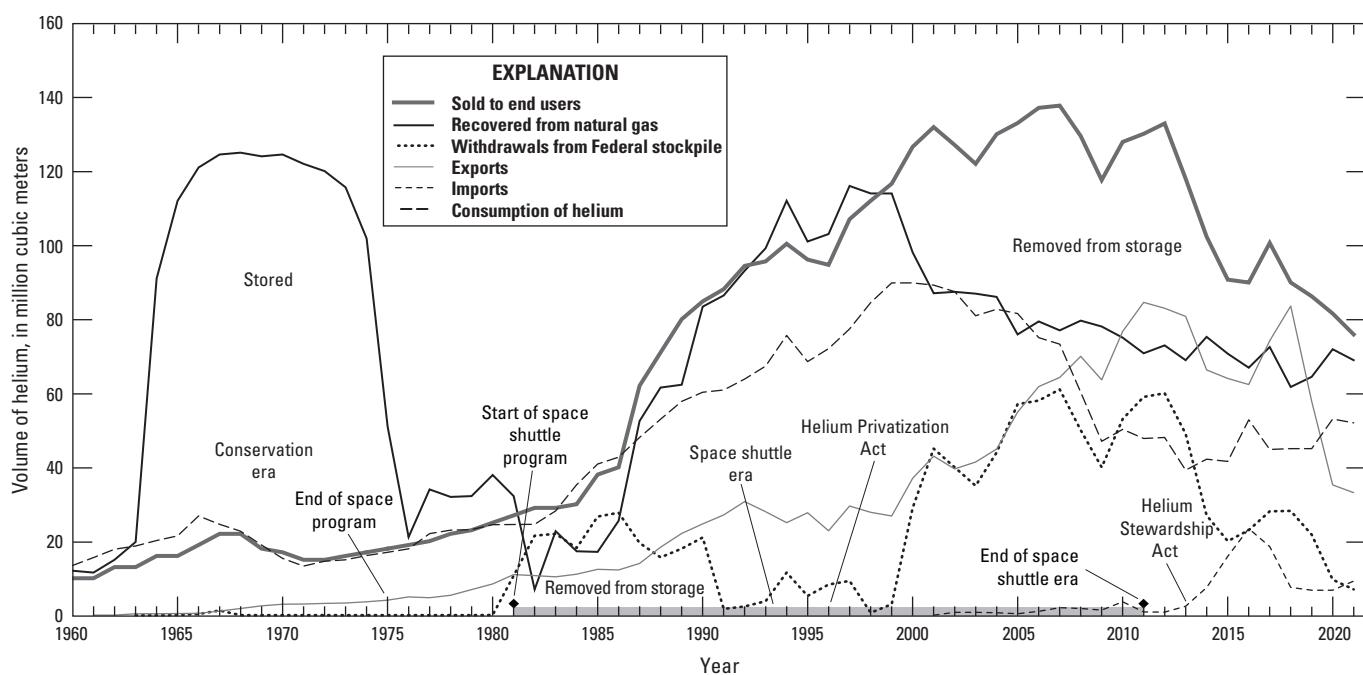


Figure 4. Helium recovery in the United States, 1960 through 2021.