Uranium Resources in the State of Texas - A Comprehensive Review

Prepared for:

Texas Commission on Environmental Quality

Prepared by:

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Overview

- Introduction
- Geologic Overview
- Recovery Methods
- U Recovered to Date
- U Remaining & Current Activity
- Economic Considerations
- Regulations
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- References

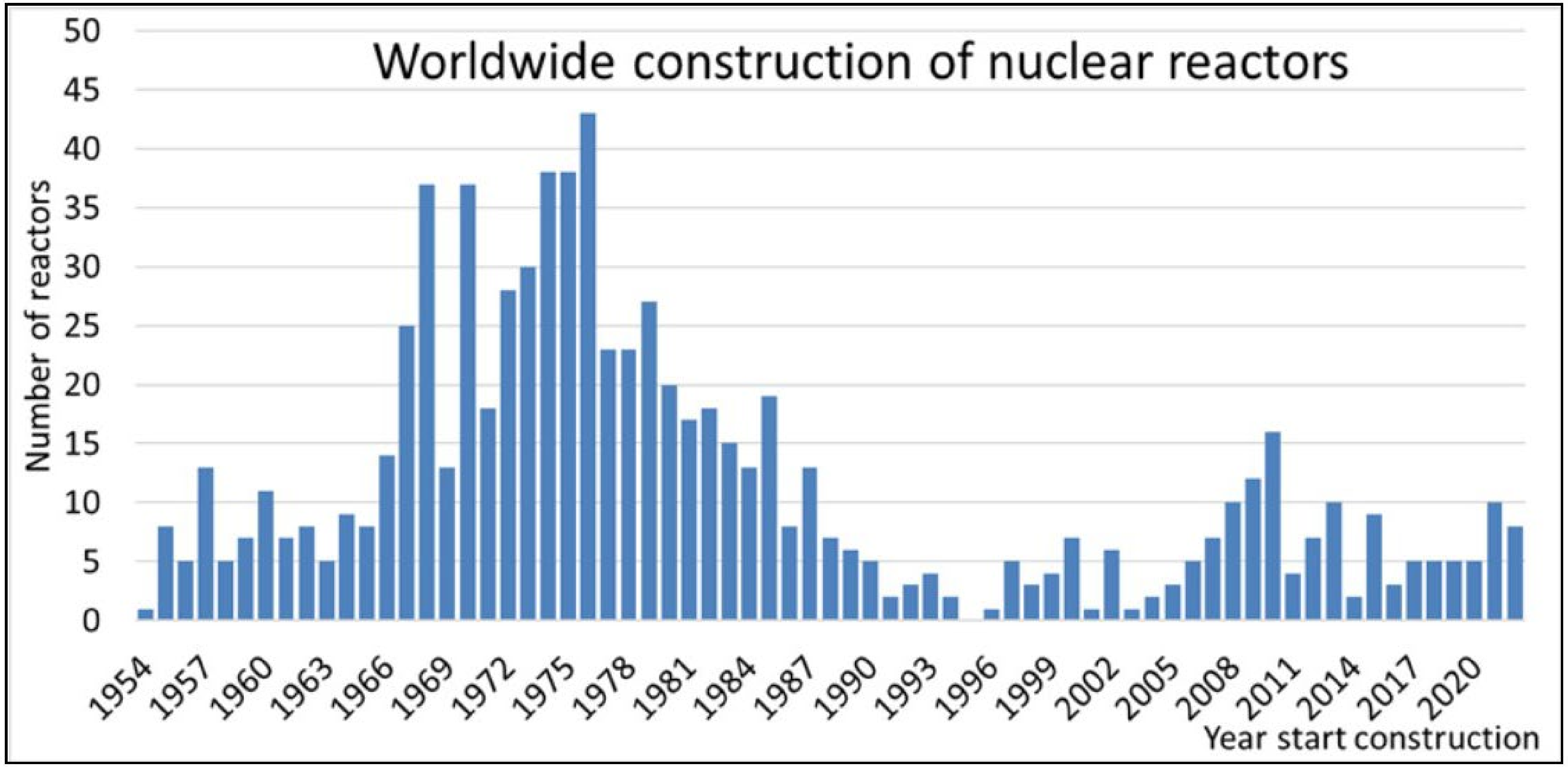
Introduction-At a glance

Contents within this report summary are a compilation of published data from agencies and previously published papers.

Time frame of report was from earliest recovered uranium discovery to fall 2024.

Introduction-In the beginning

- All time high of uranium mining was in the 1960-1970s due to favorable market price.
- 1st energy creating nuclear reactor project in 1951 Argonne National Lab-1960 commercial reactor
- 1970s domestic uranium supply
- Price drop in uranium in 1980s



Introduction-The Question

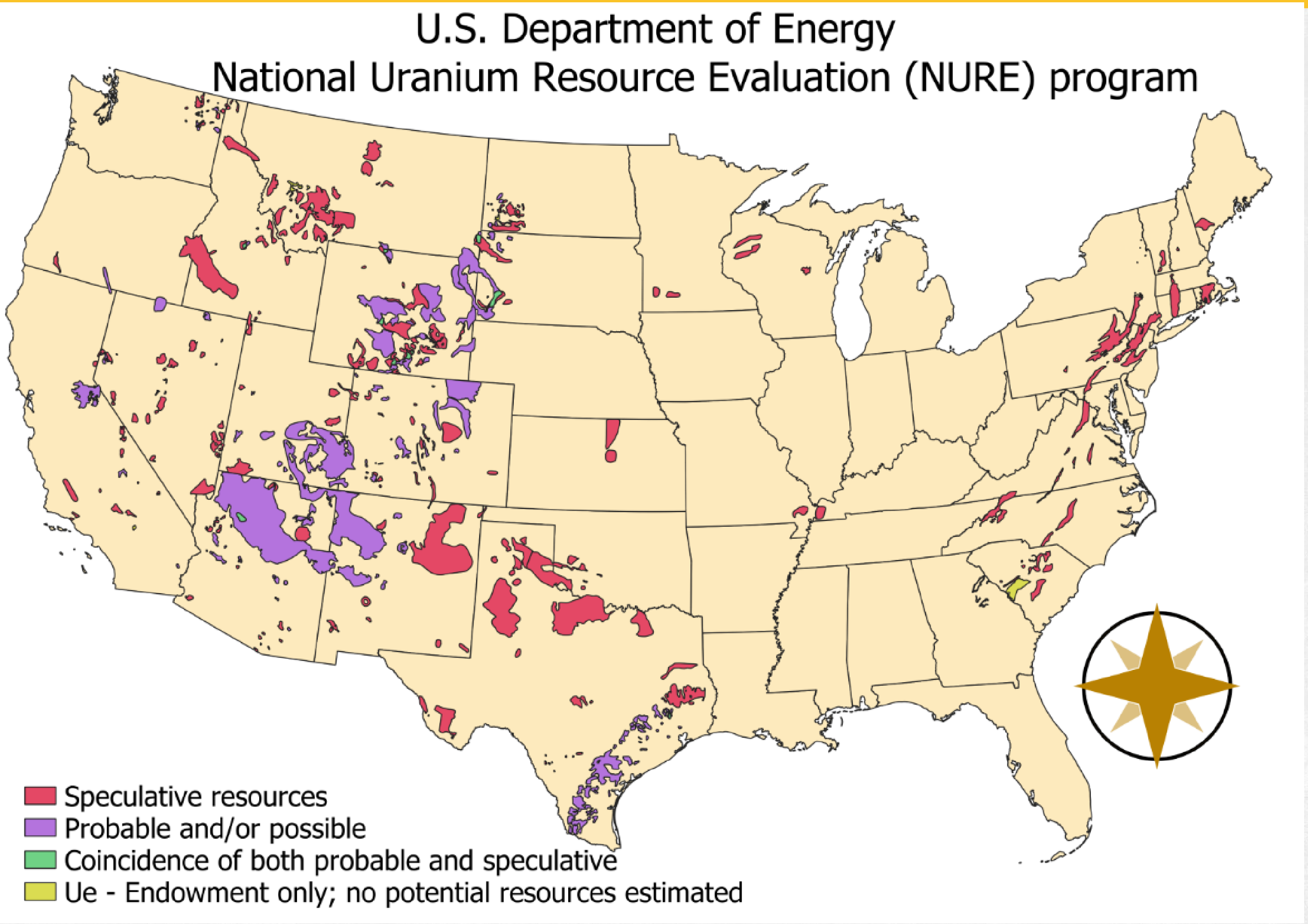
What brought the renewed interest in uranium mining in Texas?

- Restriction of global supply
- Energy independence
- New generation of smaller, more efficient modular nuclear reactors (SMRs)

Geologic Overview

Geologic Overview - National

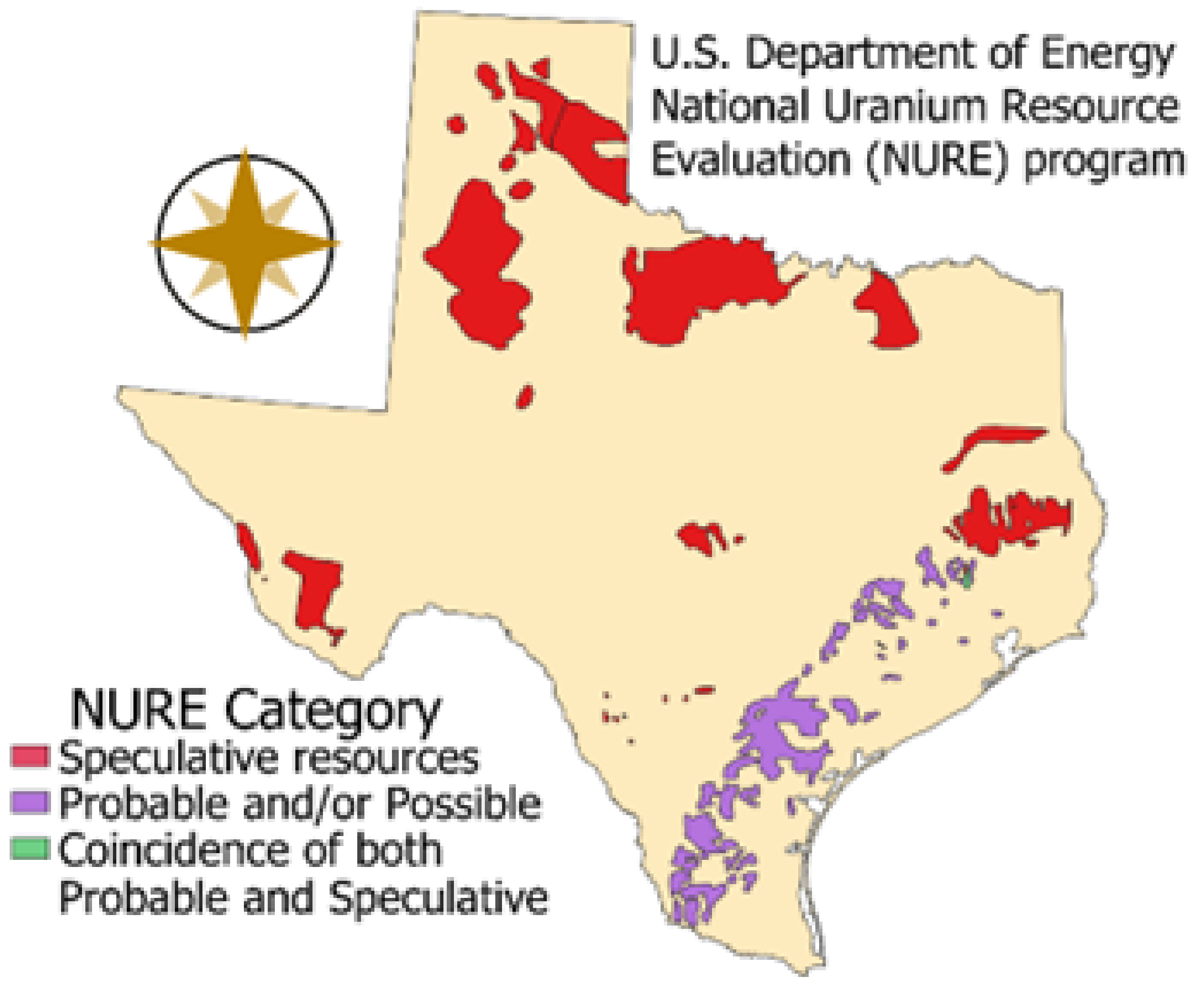
- NURE est. 1973 -1984
- Possible- geologic settings that elsewhere are productive. Undiscovered or partly defined deposits
- Speculative- yet to be explored but share characteristics of productive locations
- Probable- higher level of certainty



National Uranium Resource Evaluation (NURE) areas, as provided by the US Department of Energy (EIA, 2020a).

Geologic Overview-State

- NURE resources spread over 18 counties
- All mining of uranium has been done in South Texas known as the Texas uranium belt
- Texas Uranium Belt

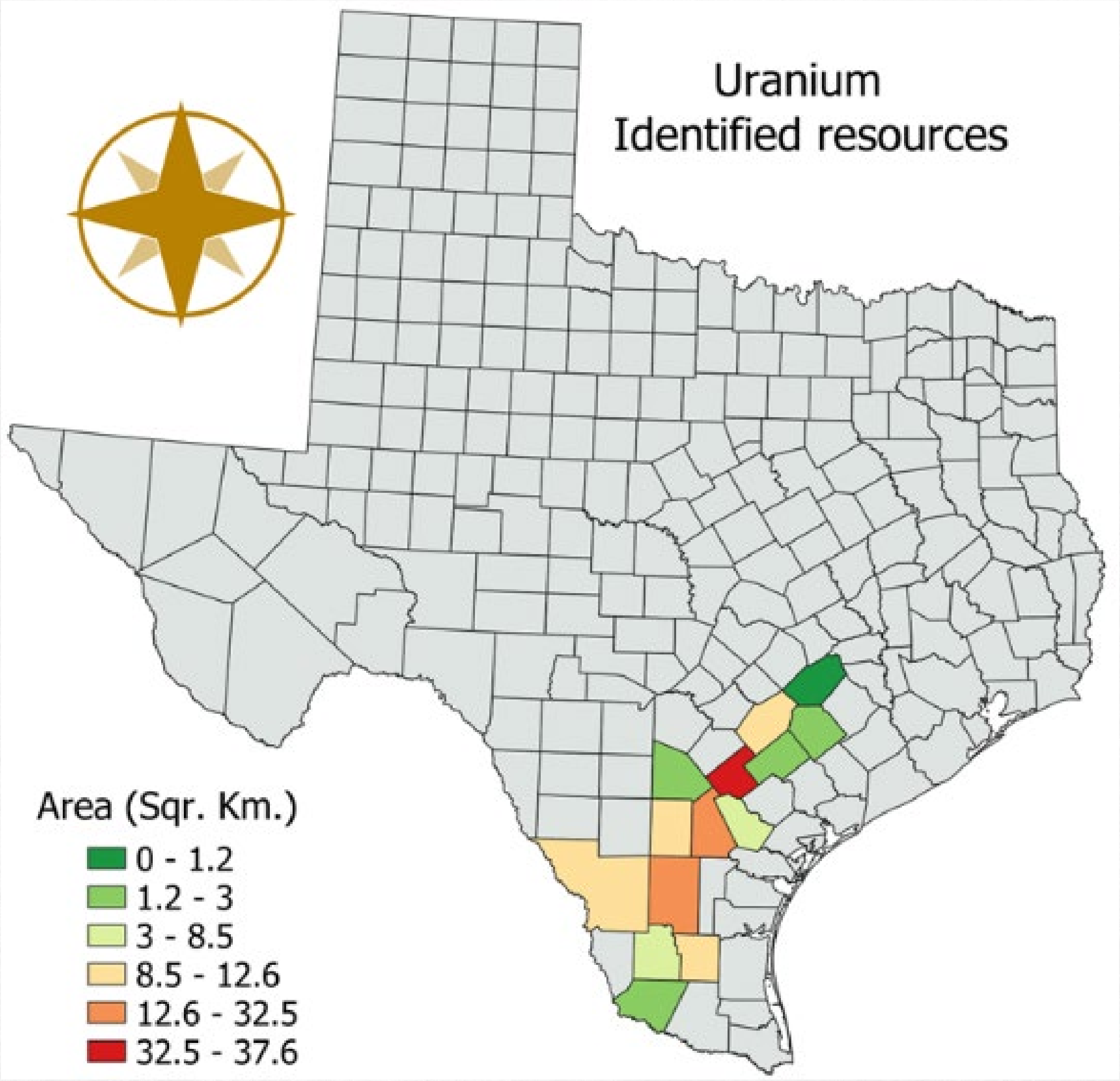


National Uranium Resource Evaluation (NURE) areas for Texas, as provided by the US Department of Energy (EIA 2020a).

Geologic Overview- Counties

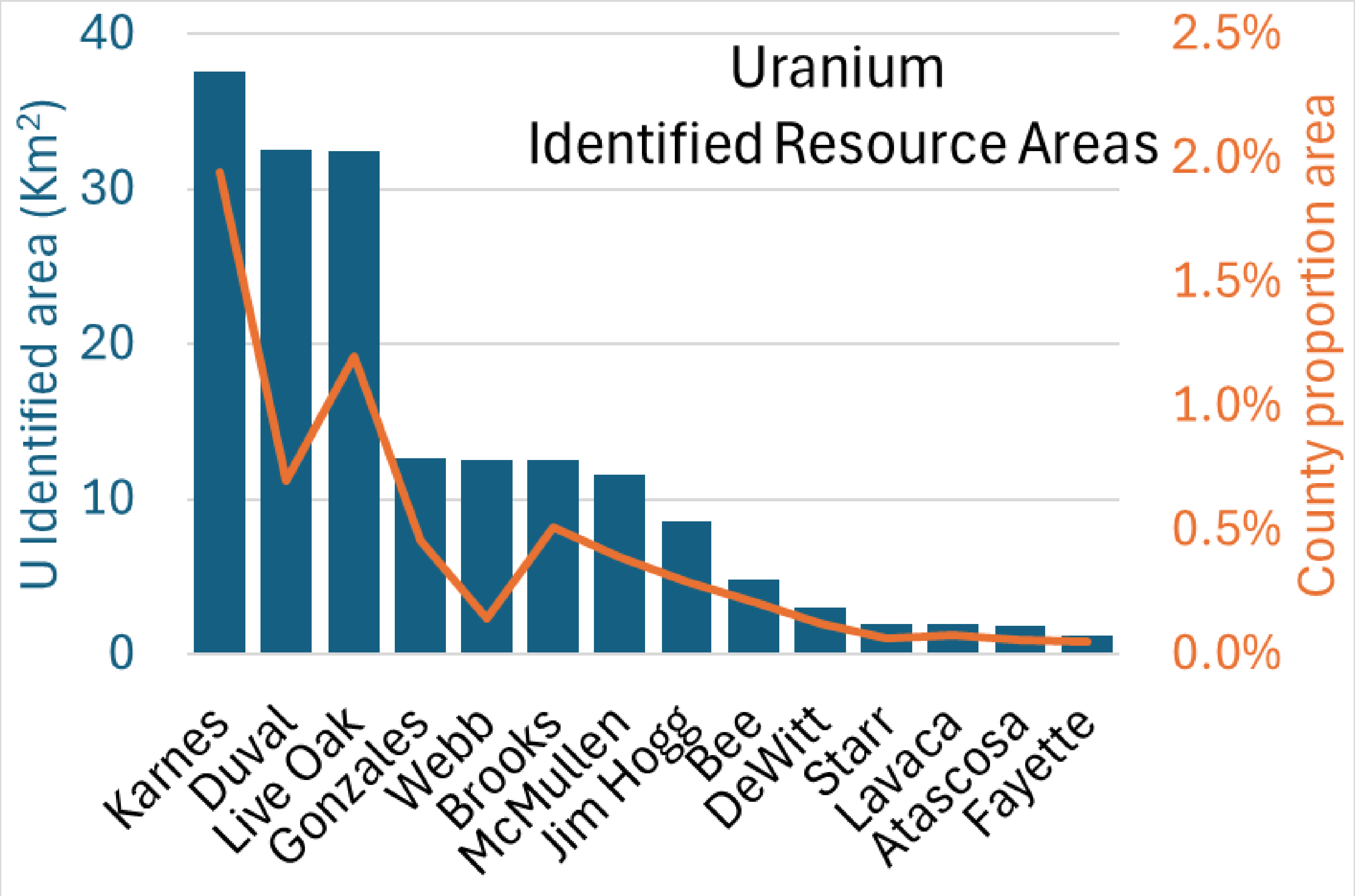
- US Energy Information Administration Uranium Identified Resource Areas by county

- Uranium Identified Resources in Texas is distributed across 14 counties in the southern part of the state



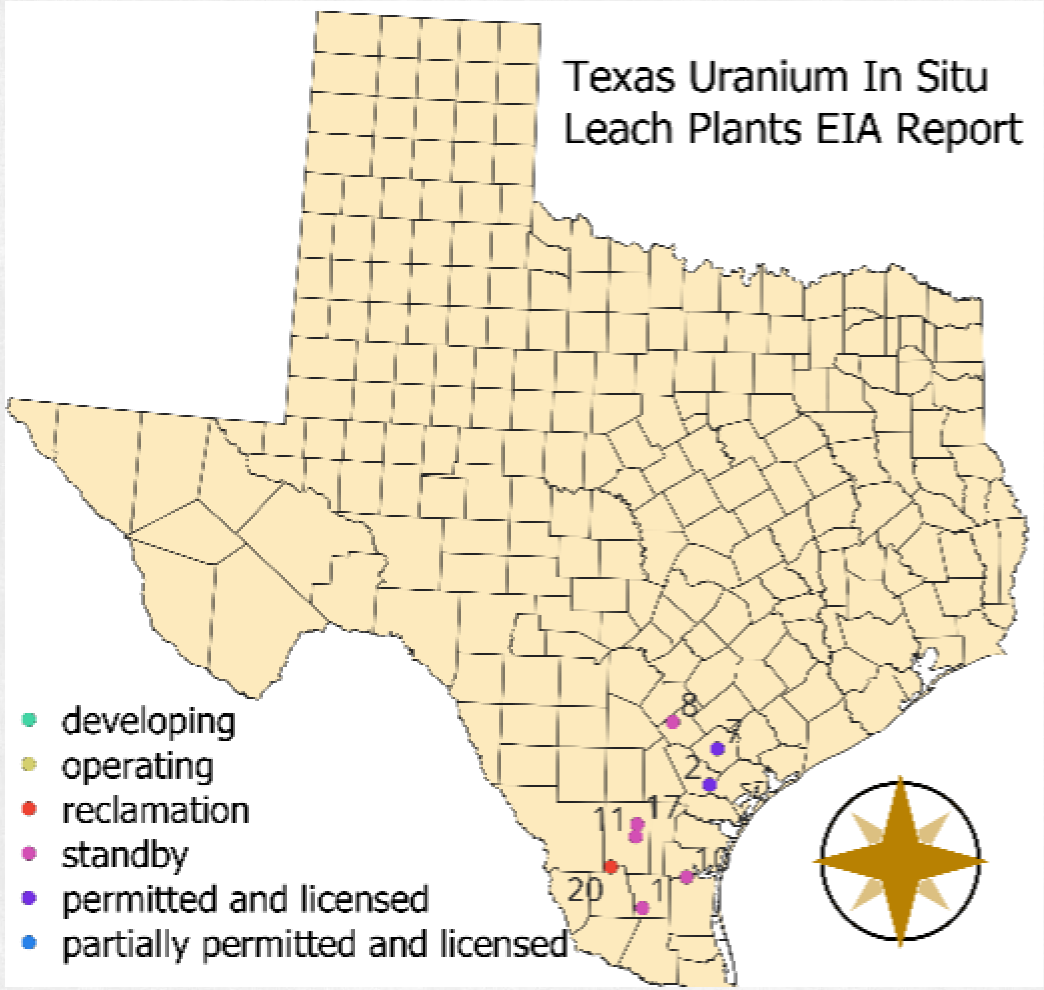
US Energy Information Administration Uranium Identified Resource Areas by counties in Texas with ranges of surface area in the identified uranium area category

Geologic Overview – Texas Counties

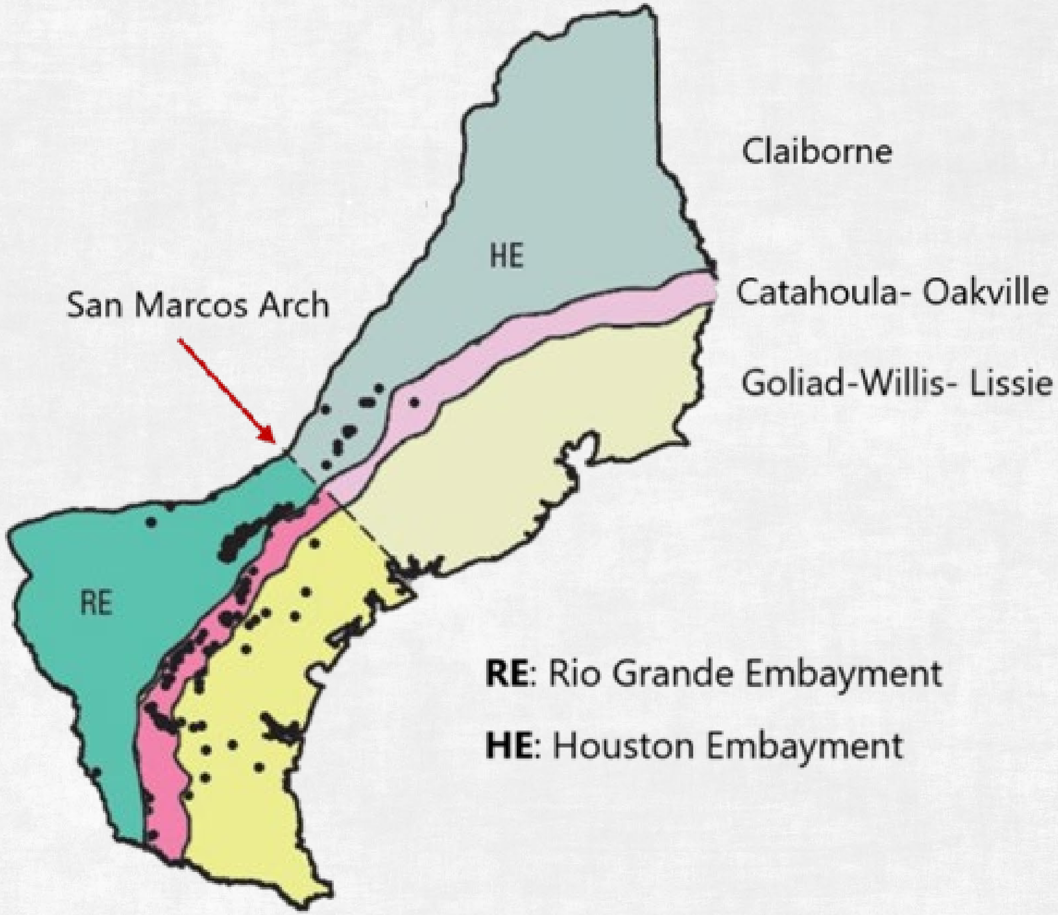


- US Energy Information Administration Uranium Identified Resource Areas
- Bar chart indicating the surface area for the identified uranium area category (EIA,2020b)

Geologic Overview- State and Geological Region



Location of uranium in situ recovery plants, classified according to their operational status in Texas.

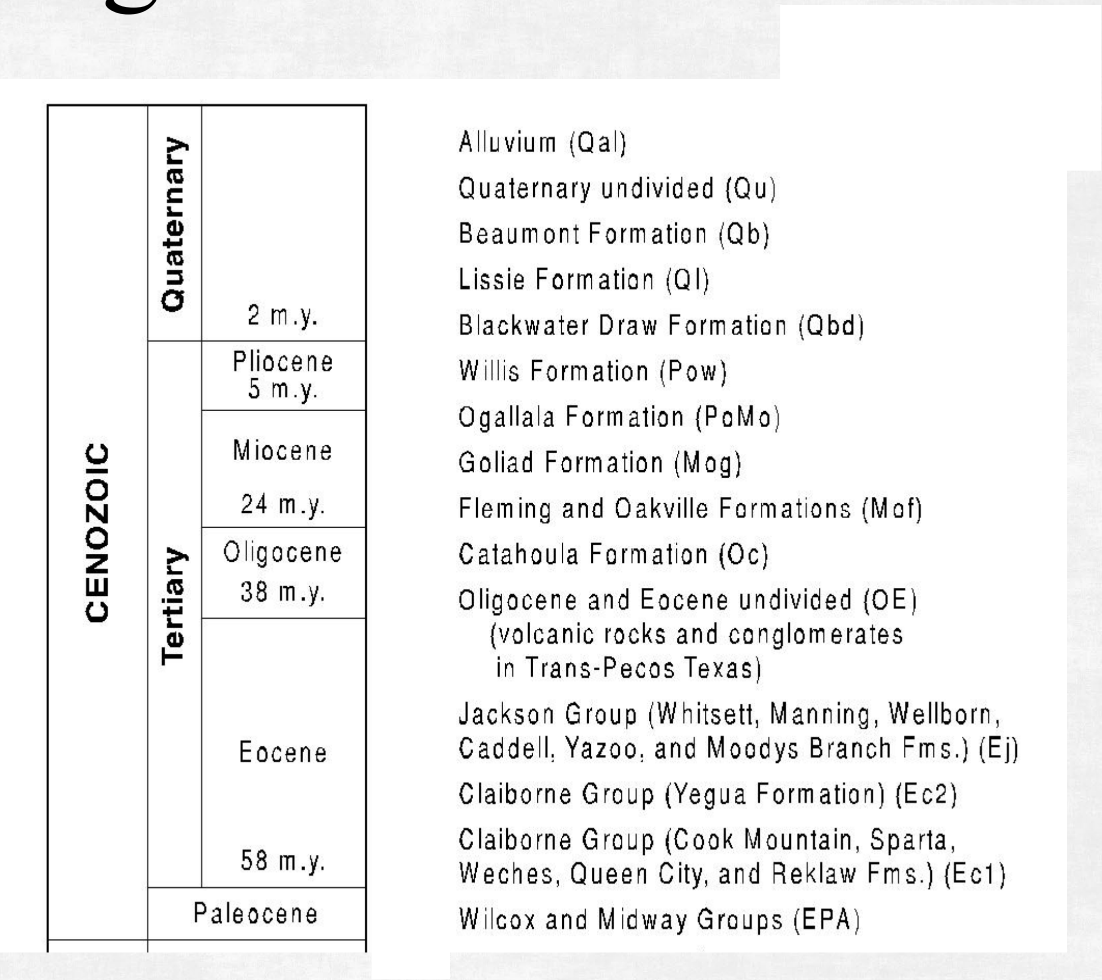


Map indicating geological regions for the Coastal Plains region in Texas.

Geologic Overview- Geological formations

Four major units were identified to host economic uranium deposits in the South Texas region

- The Jackson is the oldest of the documented uranium deposit-bearing units in the Tordilla Hill area in Karnes County
- Catahoula is a major host for uranium deposits in South Texas
- The Oakville formation's composition is notably marked by reworked volcanic debris, chert, and Cretaceous rocks and fossils sourced from the Edwards Plateau
- The Goliad is a coarse, clastic fluvial unit deposited by moderately low-gradient, intermittently torrential streams across the broad, flat coastal plain. The Goliad is also a major aquifer and a host for several known major uranium orebodies



Geologic Timescale

Recovery Methods (Past and Present)

- Open Pit Mining aka Surface Mining
- In Situ Recovery/Leeching aka ISR
- Underground, Shaft, Mining

Recovery Methods-Open Pit Mining

- AKA Surface Mining
- Best when target minerals are close to surface.
- Excavation and relocation of large quantities of earth.
- 86 open pit mines from 1950-1990
- Costly due to large equipment and waste rock
- Destruction of land, groundwater impacts from mining.

A simple layered open pit mine.

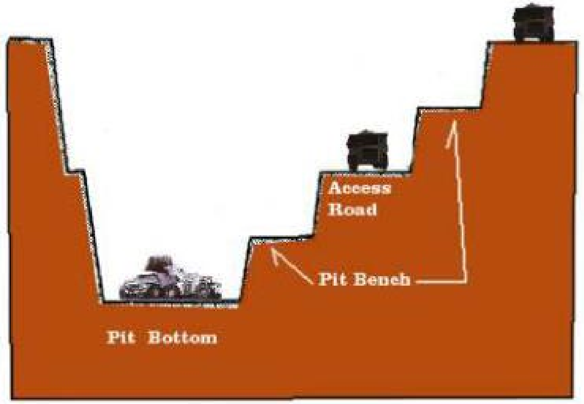
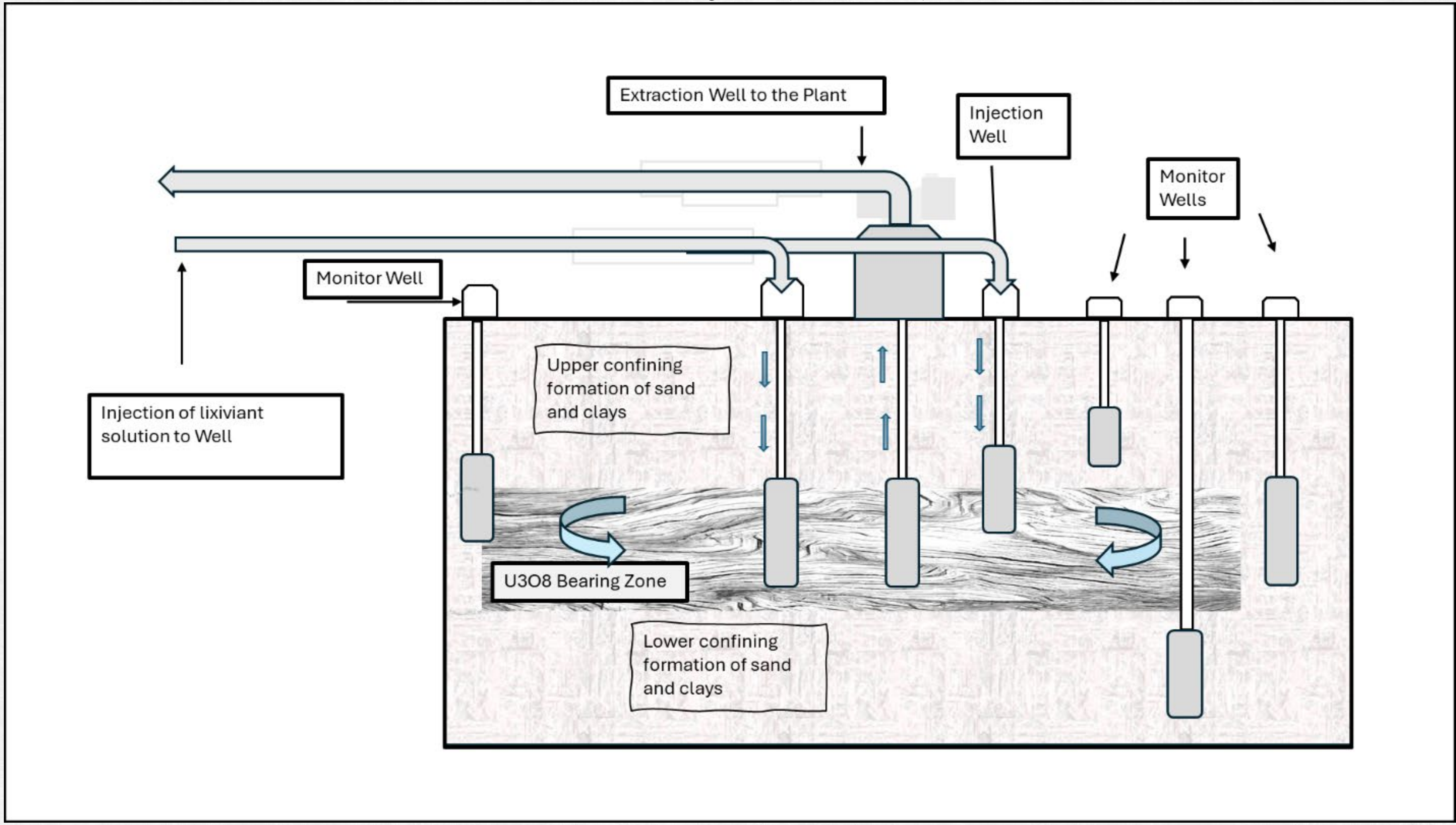


Fig. 1

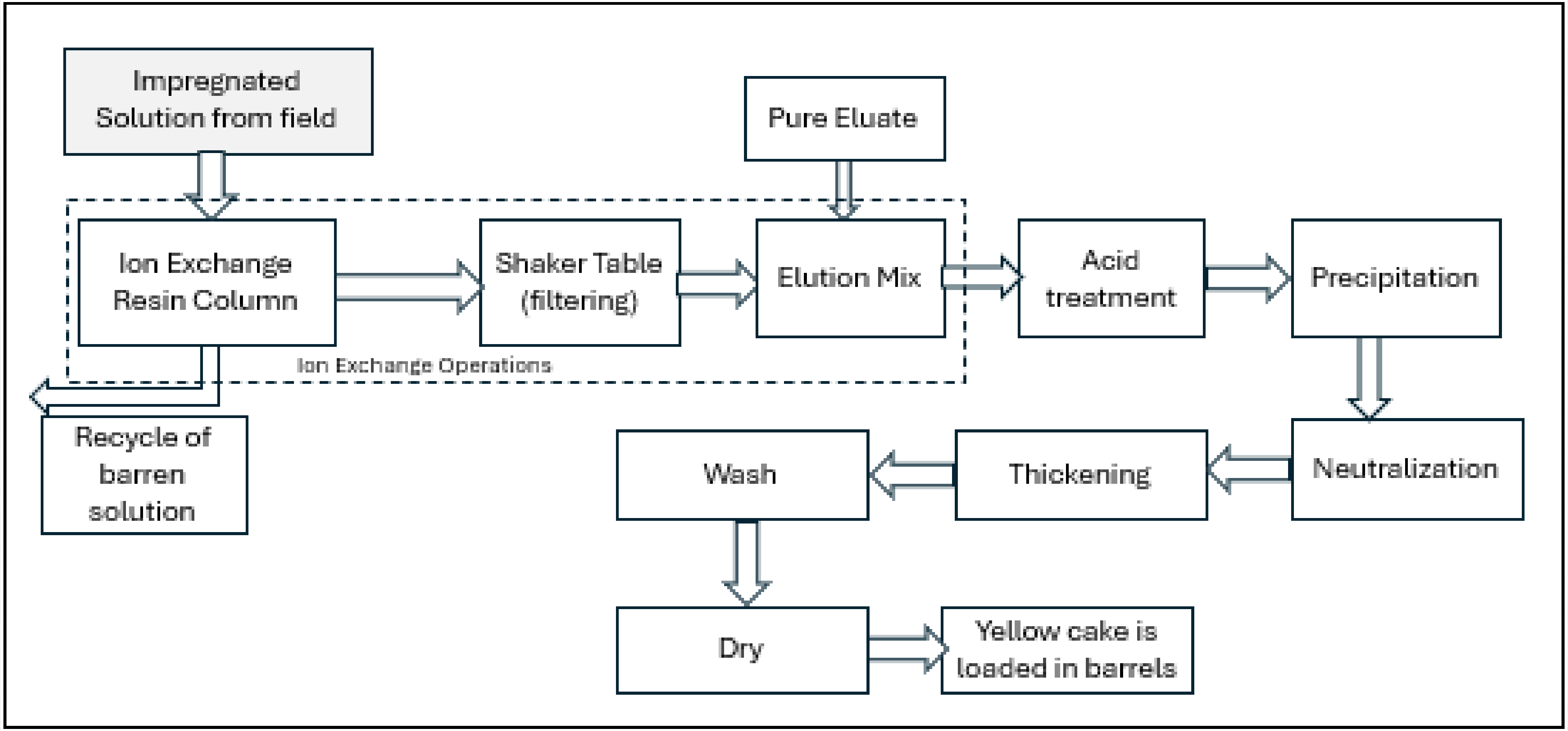
Recovery Methods - In Situ Recovery (ISR)

- Acid or alkaline Lixiviant solution injected
- Oxidant (O_2 or H_2O_2) mobilizes uranium
- Complexing agent (Carbonate or sulfates) combine with oxidized uranium
- Impregnated solution recovered then sent from the extraction well to CPP



Cutaway of the ISR process

Recovery Methods- ISR to Central Processing Plant



Block flow diagram from post wellfield retrieval.

Recovery Methods-Underground Mining- Shaft Mining

- Once attempted at La Palanga site in 1958 by Union Carbide Corporation
- Unconsolidated ground and hydrogen sulfide pockets found unfavorable

Uranium Recovered Date

Uranium Recovered to Date-By Formation

- Approx 80 M lbs U3O8 1955-2013
- Via 92 mines and 1 tailing facility
- Although some reports say 67.4 M lbs or 73.6 M lbs have been recovered

precise quantitative figures are uncertain due to the information derived from DOE database, which only sometimes tracks production from a specific mine.

Formation	Total Estimated (lbs. U_3O_8)	Produced (lbs.)	Remainder (lbs. U_3O_8)	Reference
Goliad	>10,000,000	5,000,000	5,500,000	i
		10,380,000	30,400,000	ii
		11,442,094	33,464,600	iii
Jackson	40,171,000	31,961,000	8,210,000	i
		20,800,000	3,160,000	ii
		22,937,815	3,490,614	iii
Oakville	27,250,000	18,260,000	11,100,000	i
		33,600,000	10,560,000	ii
		37,026,575	11,629,994	iii
Catahoula	24,175,000	12,175,000	9,000,000	i
		8,780,000	9,920,000	ii
		9,672,382	10,936,813	iii

Uranium Recovered to Date-By Formation

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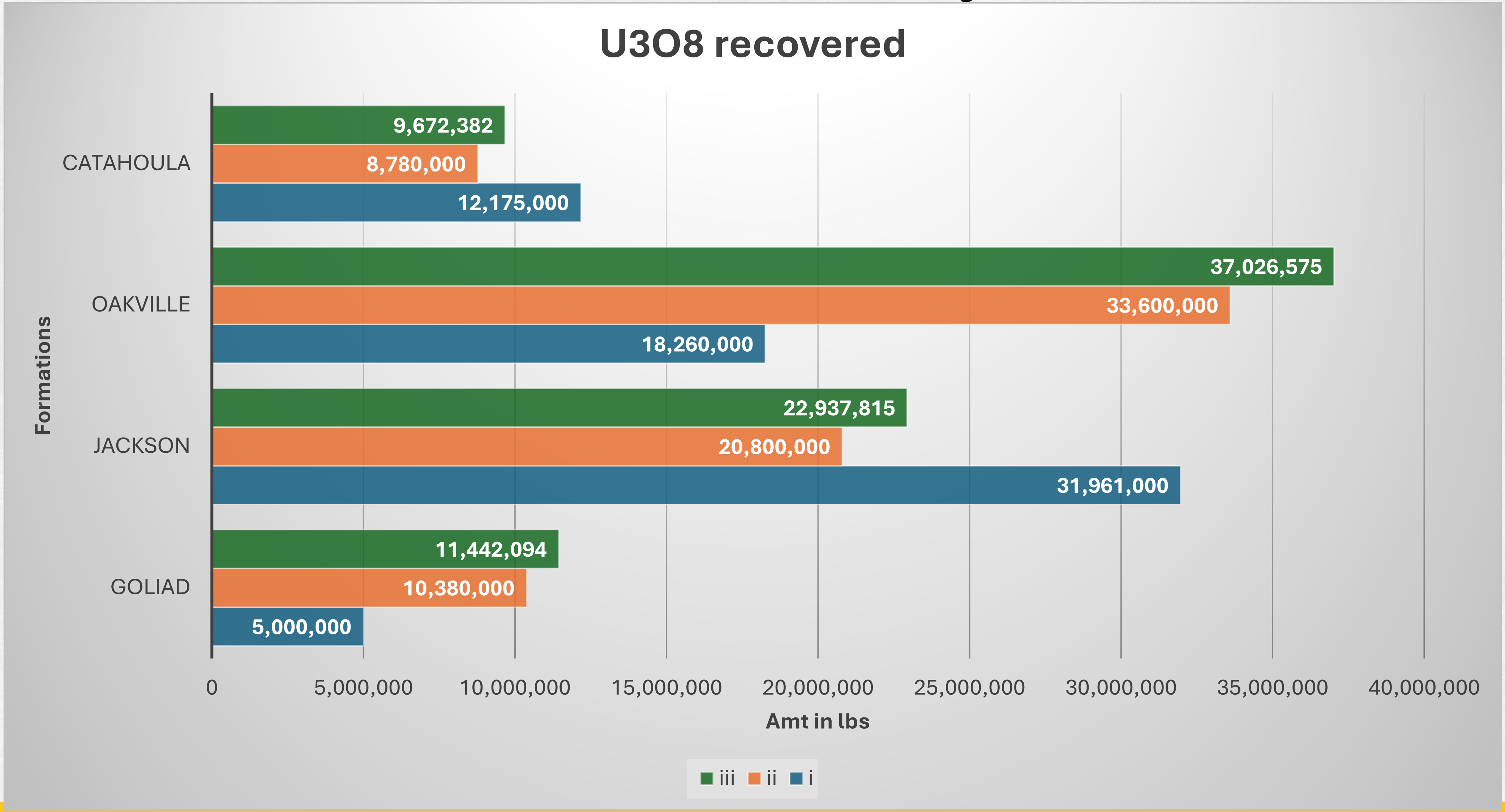
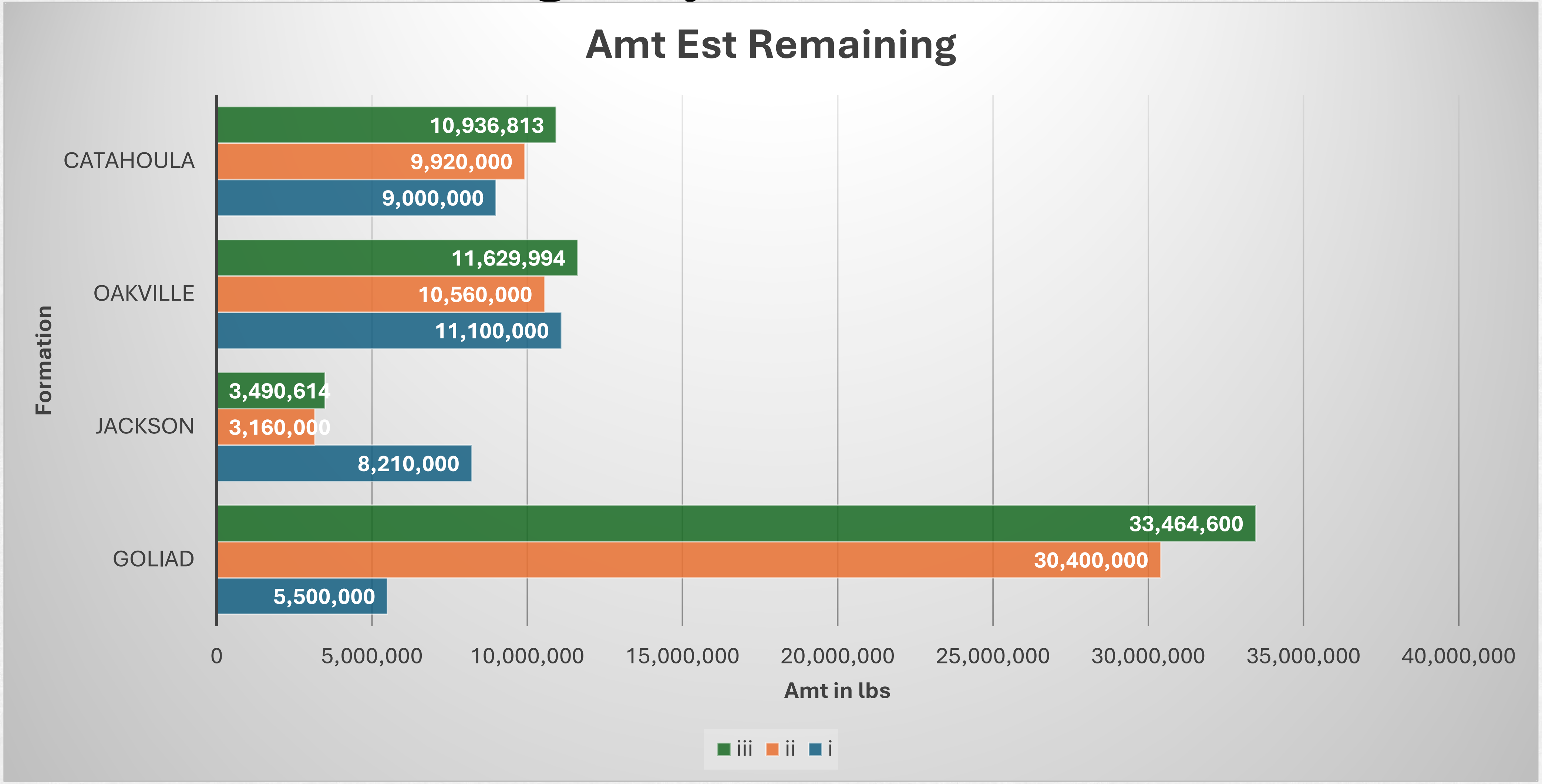


Uranium Remaining -By Formation



Uranium Recovered to Date-Method & Formation

Methods of extraction by geological formation

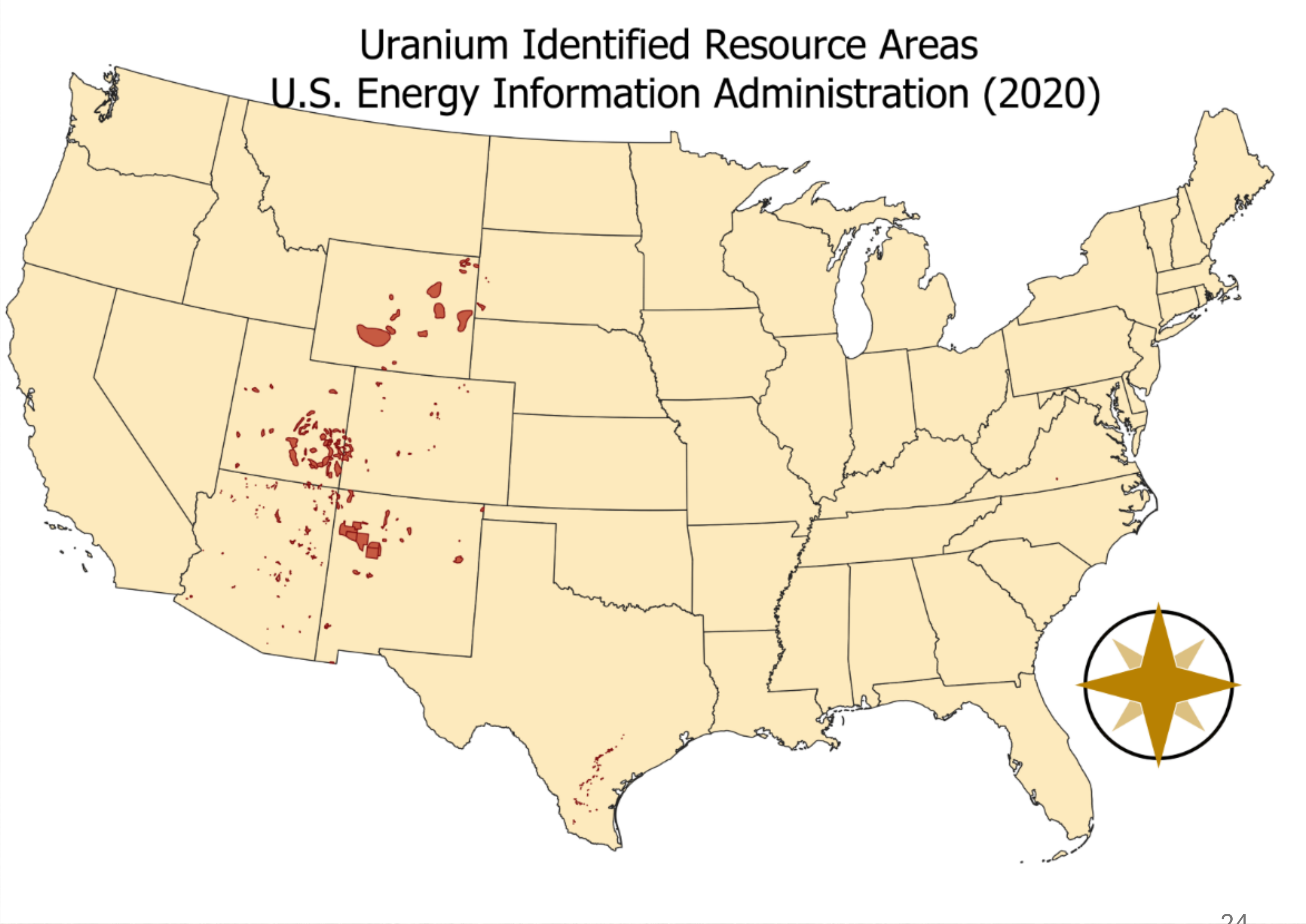
Operation type	Goliad	Jackson	Oakville	Catahoula	Total
Open pit	0	65	13	8	86
ISR	15	3	20	16	54
Unknown	1	8	3	17	29
Total	16	76	36	41	169

Operation types used per formation host unit. Data extracted from Hall et al, 2017

Remaining Uranium & Current Activity

Uranium Remaining

- Re-examination reports of NURE findings done by USGS in 2012
- Actual amounts of remaining uranium may vary based on non-reporting or limitations on land access



US Energy Information Administration Uranium Identified Resource Areas for the United States

Uranium Remaining-State

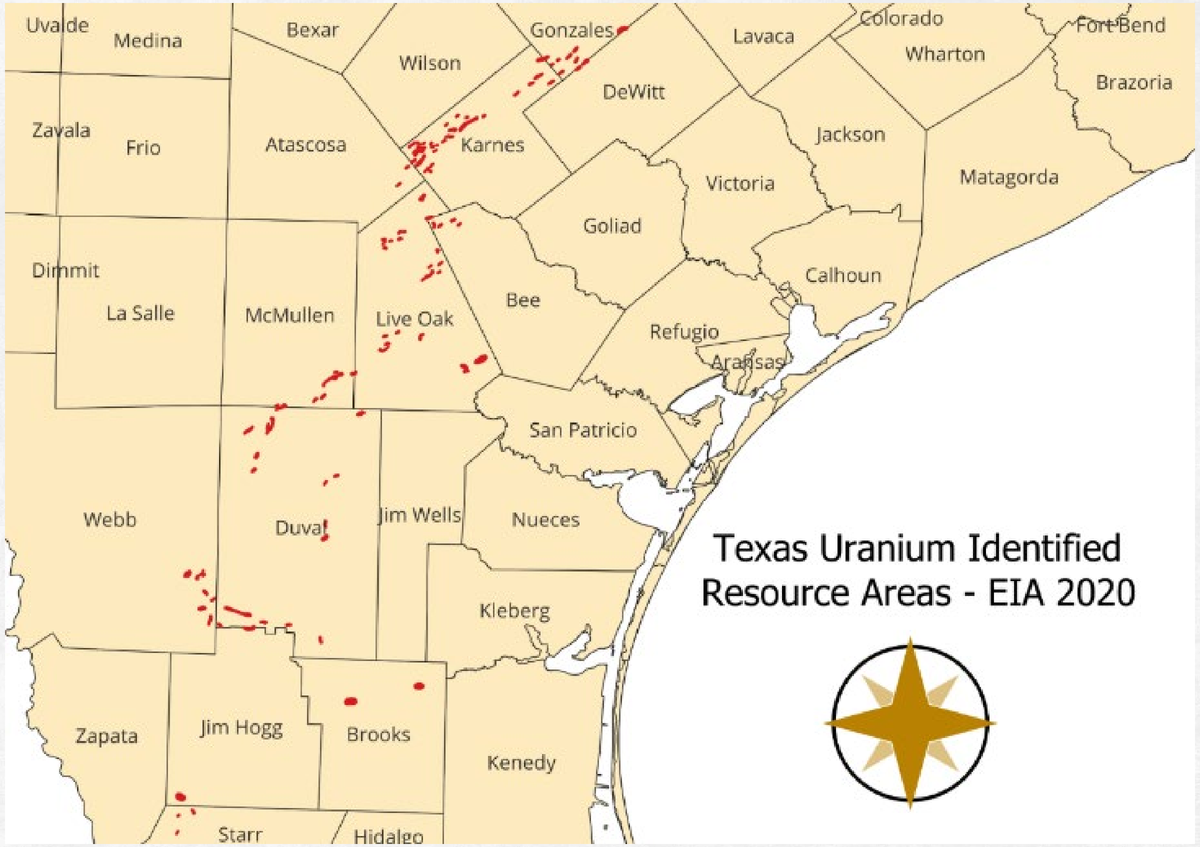
- Based on some recent reporting, the Southern High Plains of northwest Texas and Texas Coastal Plains show significant resources
- Potential around 30 M to 1.4 B lbs at depths up to 4500 ft. (economical and non)
- Depths of 500 ft ideally economical
- 399 M lbs with productive and economical consideration

Texas with EIA identified resources

Uranium Remaining –Texas Coastal Plains

- Estimated 60 - 108 M lbs. of U_3O_8 identified and 170 M lbs of undiscovered resources remain per Mihalaskys 2018

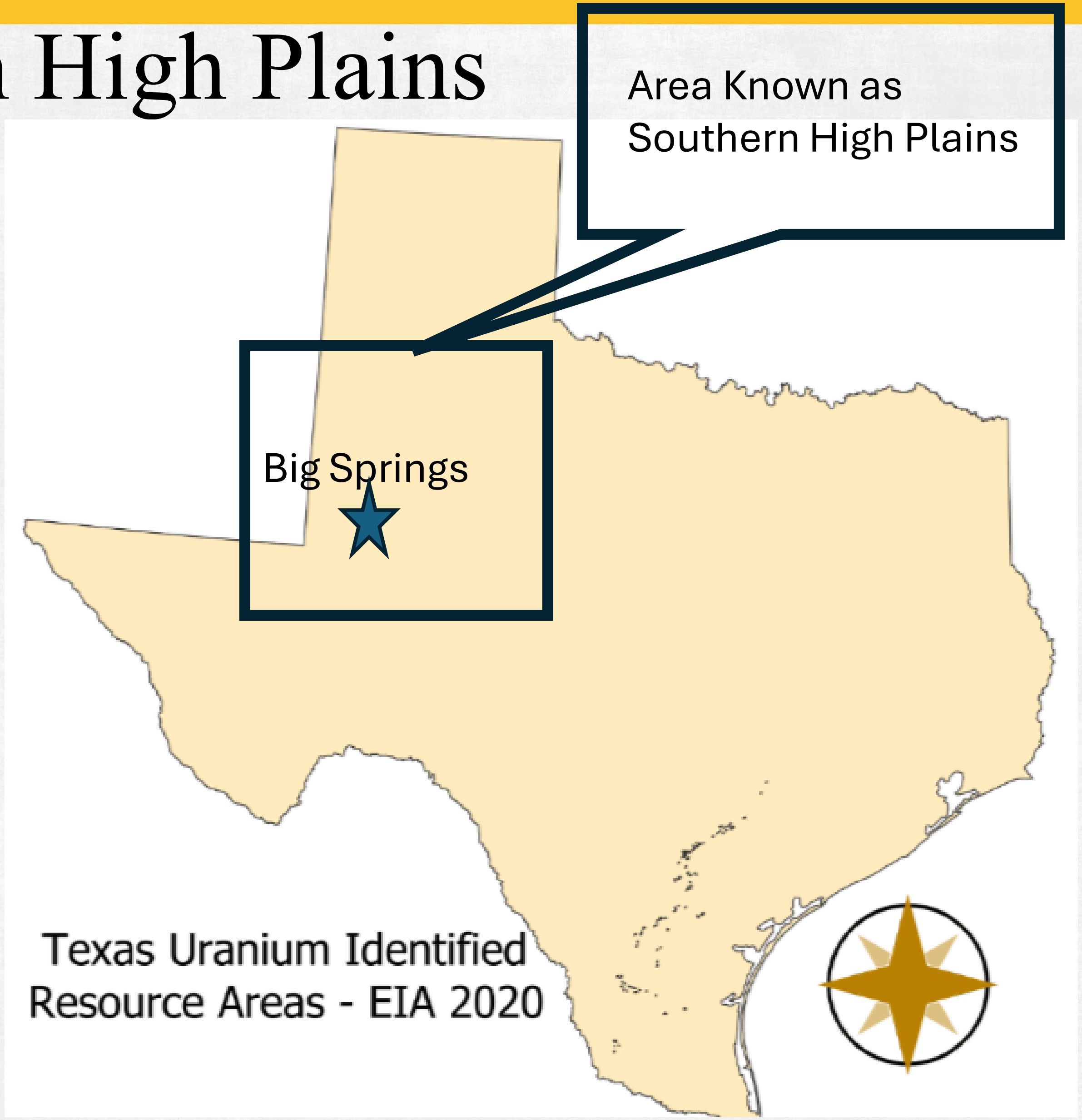
- In 2022 assessment, South Texas had potential 220 M lbs of recoverable uranium. Can supply 8 years of civilian powered reactors



US Energy Information Administration Uranium Identified Resource Areas for South Texas counties

Uranium Remaining-Southern High Plains

- Mid-1970s discovery near Big Springs: Buzzard Draw deposit, and the Sulfur Springs Draw deposit
- Kerr-McGee Corp determined one deposit 2.1 M tons of 0.037% U_3O_8 and the other 0.93 M tons of 0.047% U_3O_8
- Never in production due to price drop and land access



US Energy Information Administration Uranium Identified Resource Areas for Texas

Current Activity

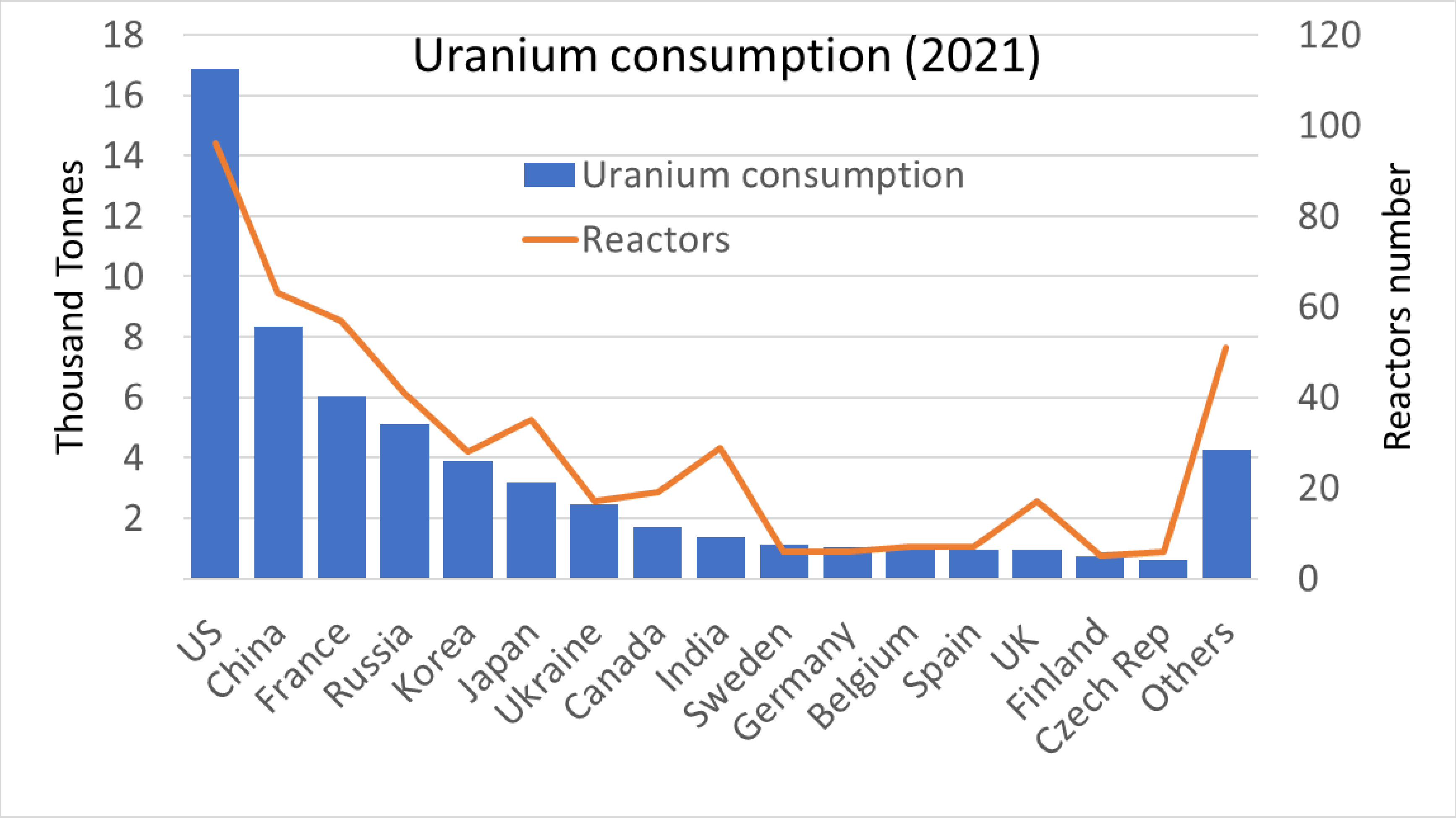
- ISR only method of extraction used in Texas
- Alta Mesa and Rosita are currently producing
- 9 ISR and/ or processing facilities (3 standby, 2 actively producing , 2 licensed & not constructed , 1 decommissioning, and 1 undergoing license termination
- 1 application for addition of new ISR site under review

Economic Considerations

Economic Considerations-US Consumption

- US consumes the most uranium globally, more than 28% of supply

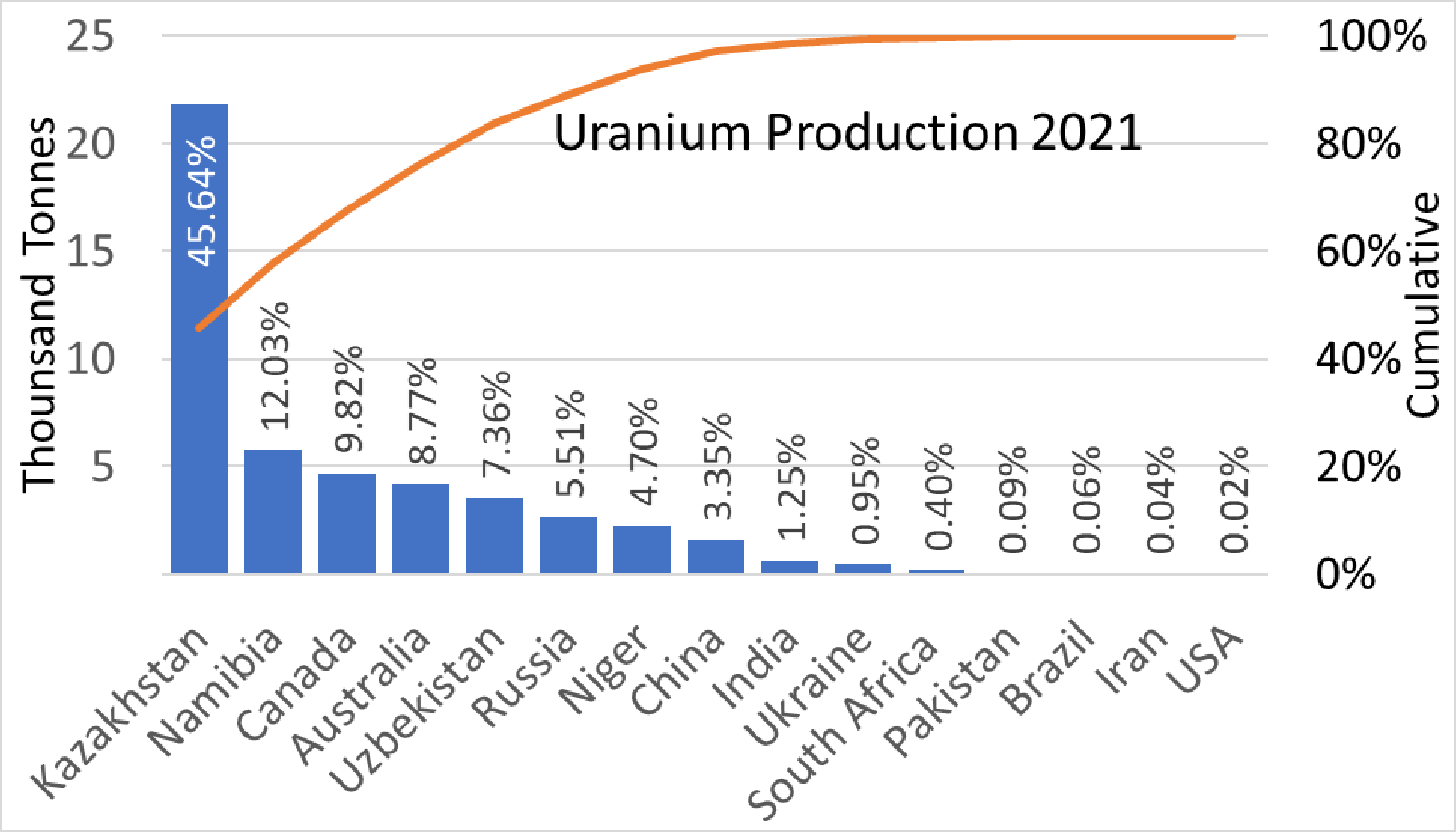
- US has 1/5 of all reactors (in use or in construction)



World uranium consumption per country including number of reactors in operation and in construction as reported by the Nuclear Energy Agency and the International Atomic Energy Agency (NEA, 2022; BGR, 2023).

Economic Considerations-Production

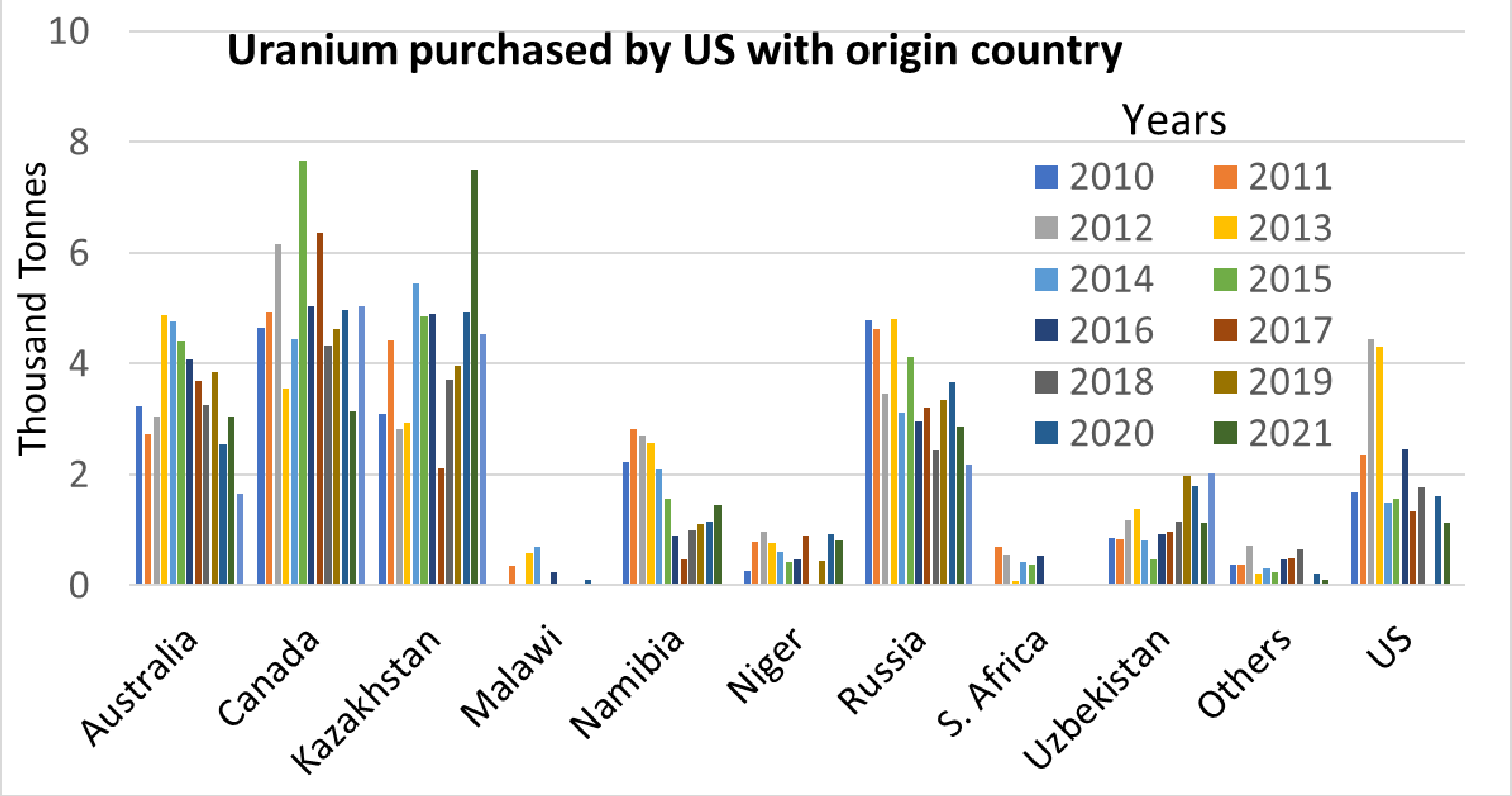
- US Uranium consumption is the highest in the world,
- However, Uranium production is lower when compared with other countries.



World uranium mining production as reported by the World Nuclear Association (OECD-NEA & IAEA, Uranium 2022).

Economic Considerations-Imports

- The US relies heavily on uranium imports
- Price and negotiated contracts determine volume per country
- Several Uranium major world suppliers have been affected by current geopolitical instability.



Uranium purchased by owners and operators of U.S. civilian nuclear power reactors by origin country. Metric (EIA, 2023; EIA, 2019; EIA, 2015).

Economic Considerations-Uranium Price

- Due to abundant supply prices dropped below $60 during the 2010's.

- This impacted domestic production of uranium, which decreased significantly.

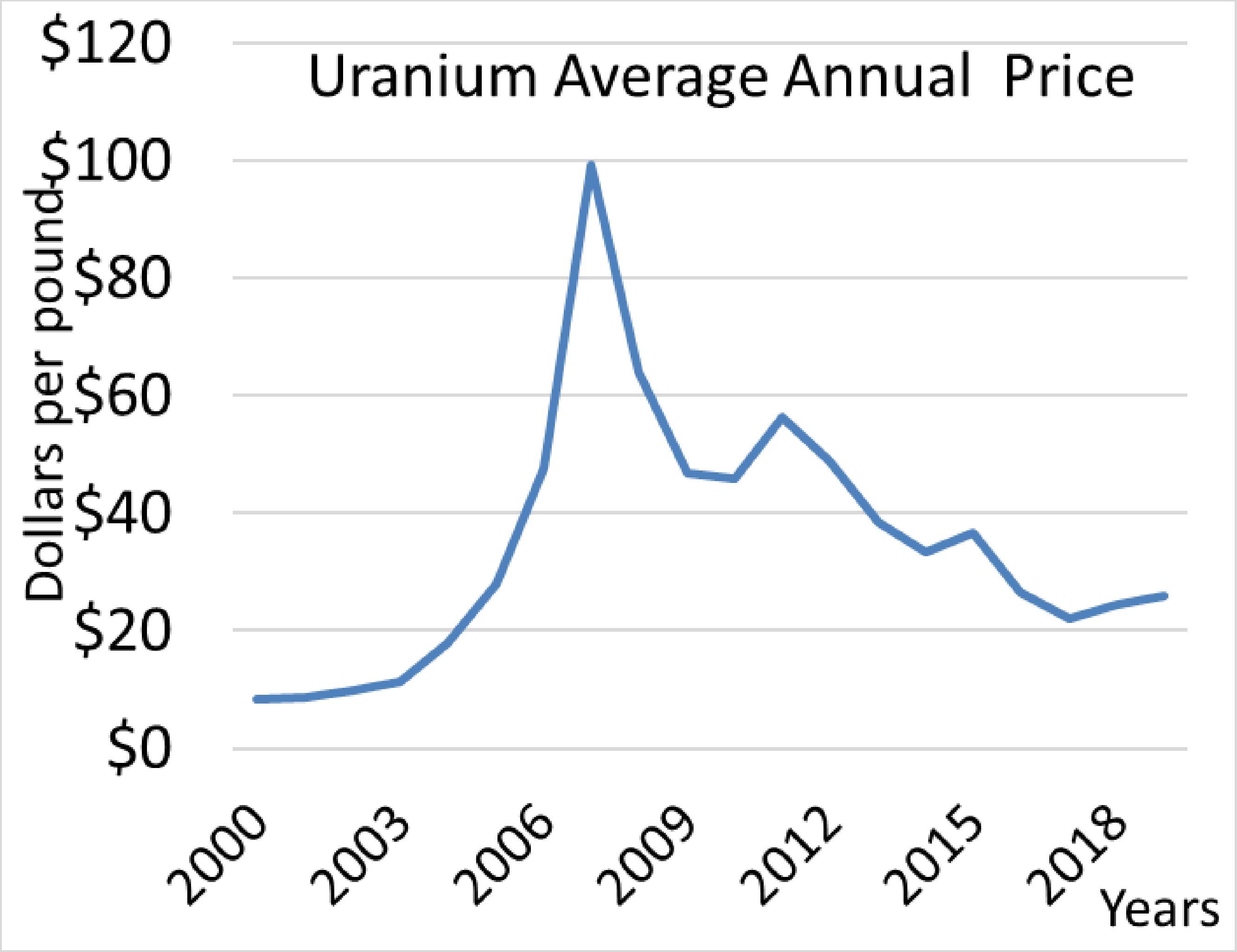


Figure: Prices of uranium (a) world average annual price (St. Louis Fed., 2023a) (

Economic Considerations-Uranium Price

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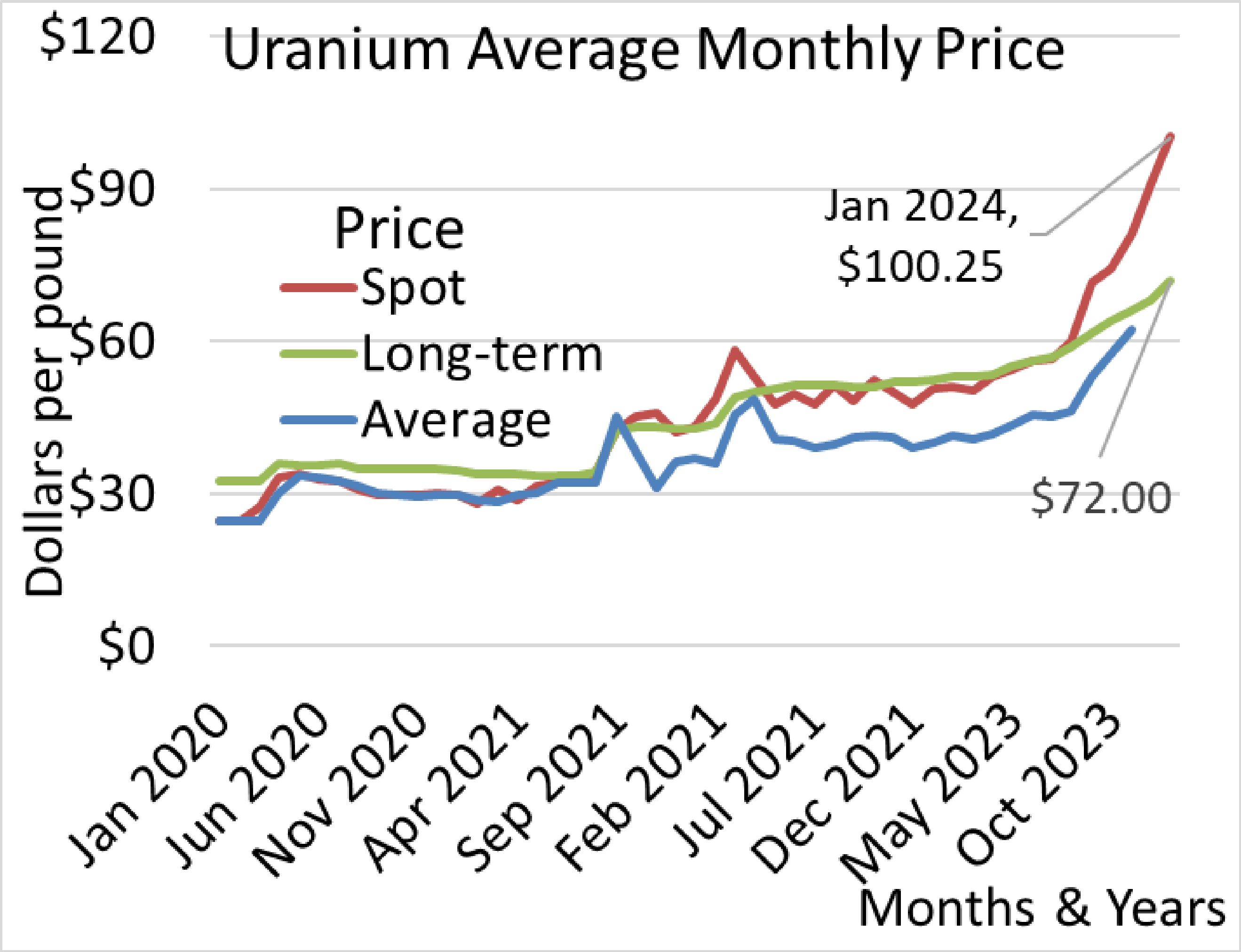
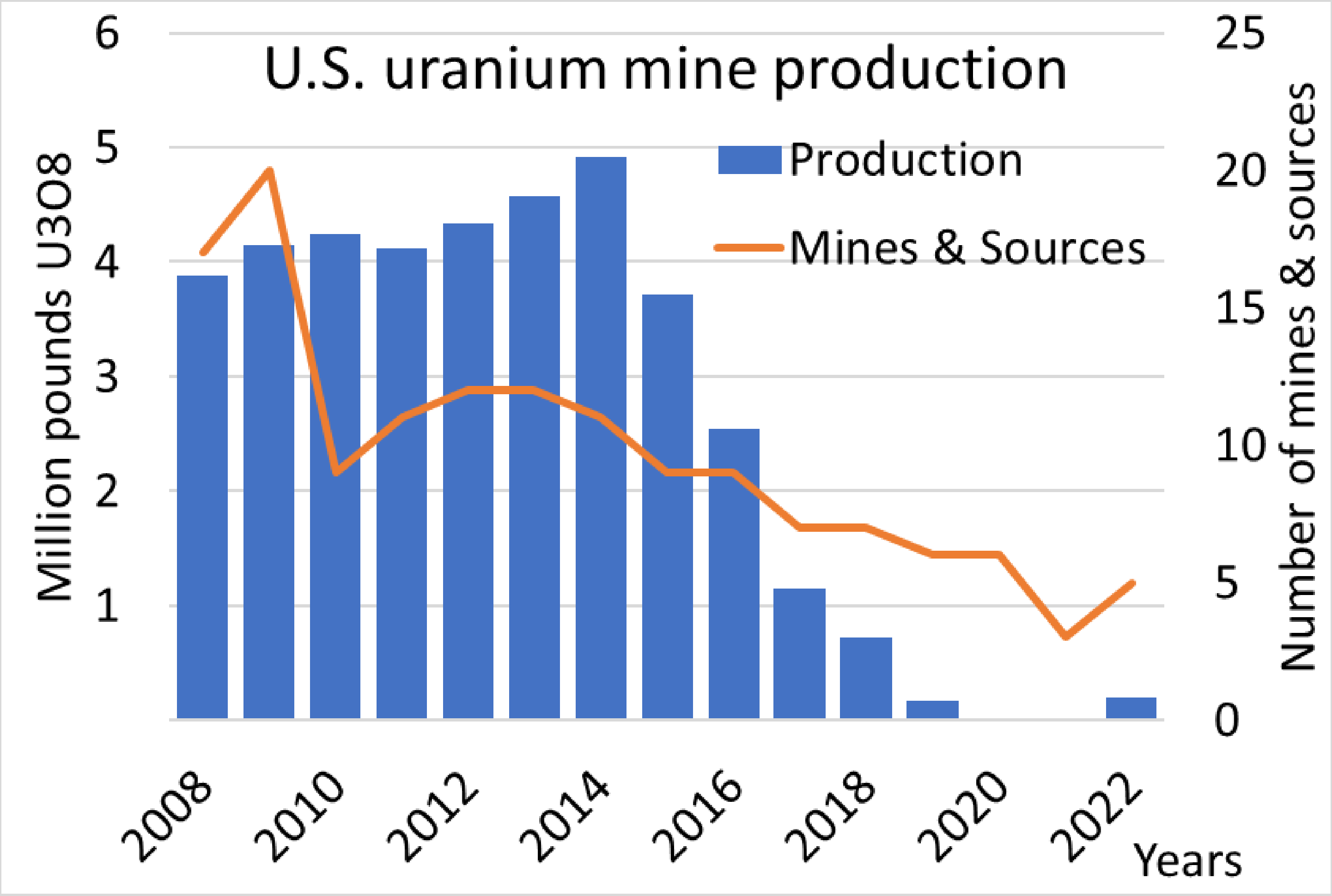
- Increase on Uranium demand and restricted supply in recent years.
- Price has significantly increased.
- Forecast indicates that price could remain higher during the following years.



Prices of uranium world average monthly prices (St. Louis Fed., 2023b; Cameco, 2024).

Economic Considerations-Mine Production

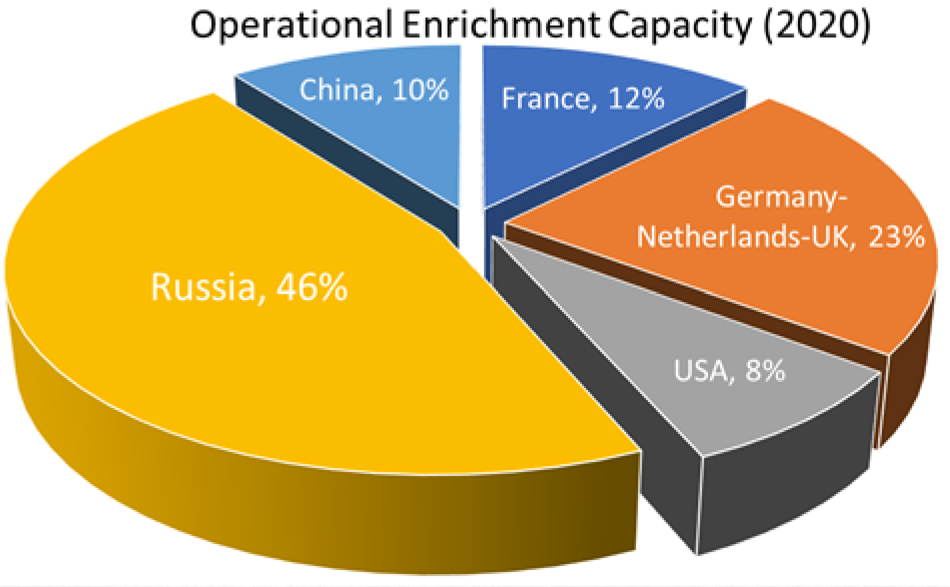
- The impact of price reduction in the 2010's was observed in reduction of production and operational mines.
- Recent statistics indicate a significant reactivation on domestic Uranium production.



United States mine production including U_3O_8 production and the number of mines (EIA, 2022).

Economic Considerations-Enrichment

- Vulnerabilities in uranium enrichment can are noticed as nuclear power generation grows globally
- Russia hosts almost half of the world’s uranium enrichment facilities
- USA has one facility but owned by the British-German-Dutch company Urenco



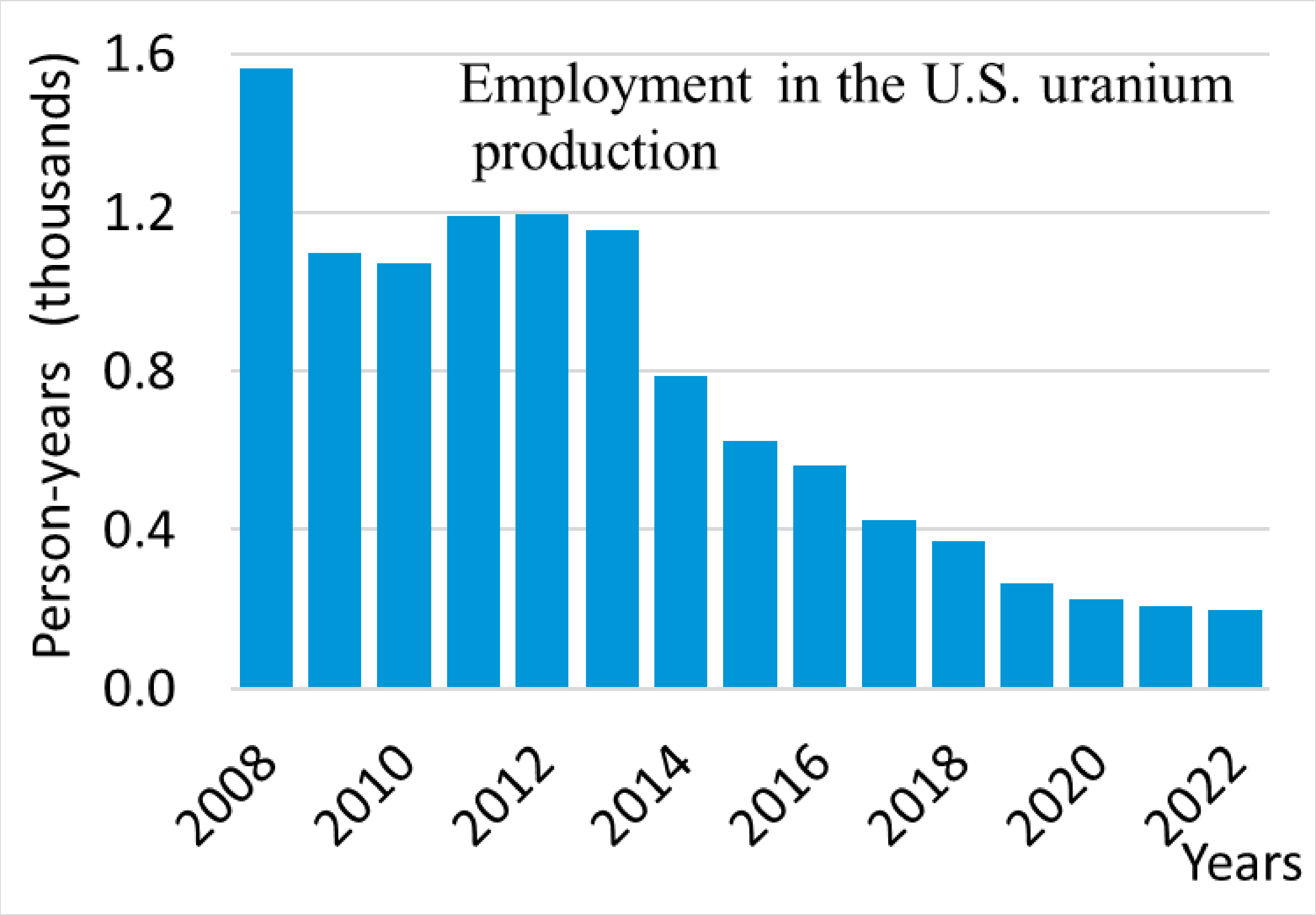
- France - Areva, Georges Besse I & II
- GER - Urenco: Gronau, Germany; Almelo, Netherlands; Capenhurst, UK.
- USA - Urenco, New Mexico
- Russia - Tenex: Angarsk, Novouralsk, Zelenogorsk, Seversk
- China - CNNC, Hanzhun & Lanzhou

World enrichment capacity operational as 2020 (WNA, 2022) (a) by country and (b) enrichment locations by company per country.

Economic Considerations-Employment

- Currently the number of qualified workers for this sector has been on the decline especially in the recovery of the product.

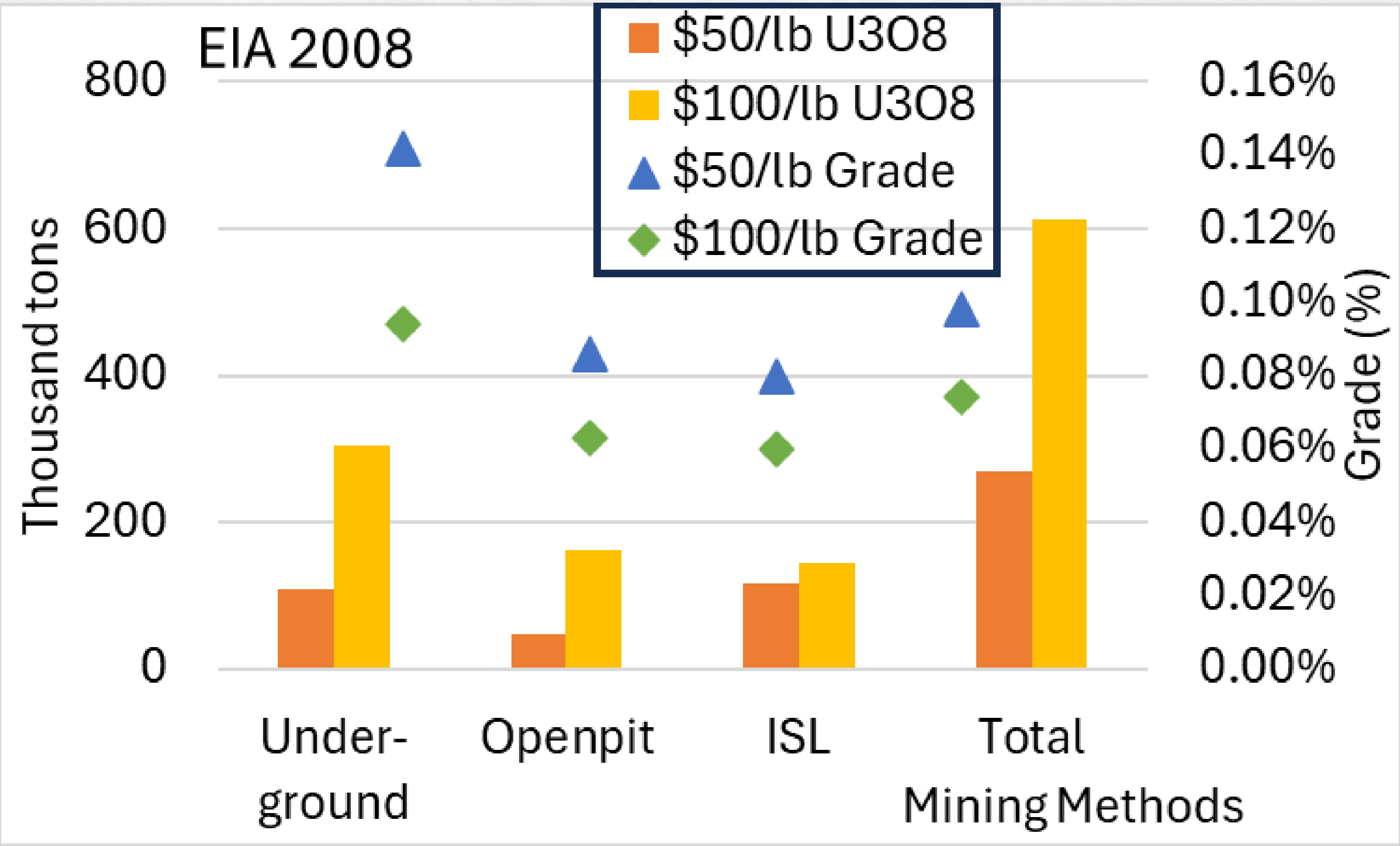
- This can be tied to the market price of the product and reduction on domestic production.



Employment in the U.S. uranium production (EIA, 2023a).

Economic Considerations-Reserve

- Results from previous reports indicate prevailing prices below favorable forward cost levels for the US.
- As uranium prices increase, higher reserve become available.

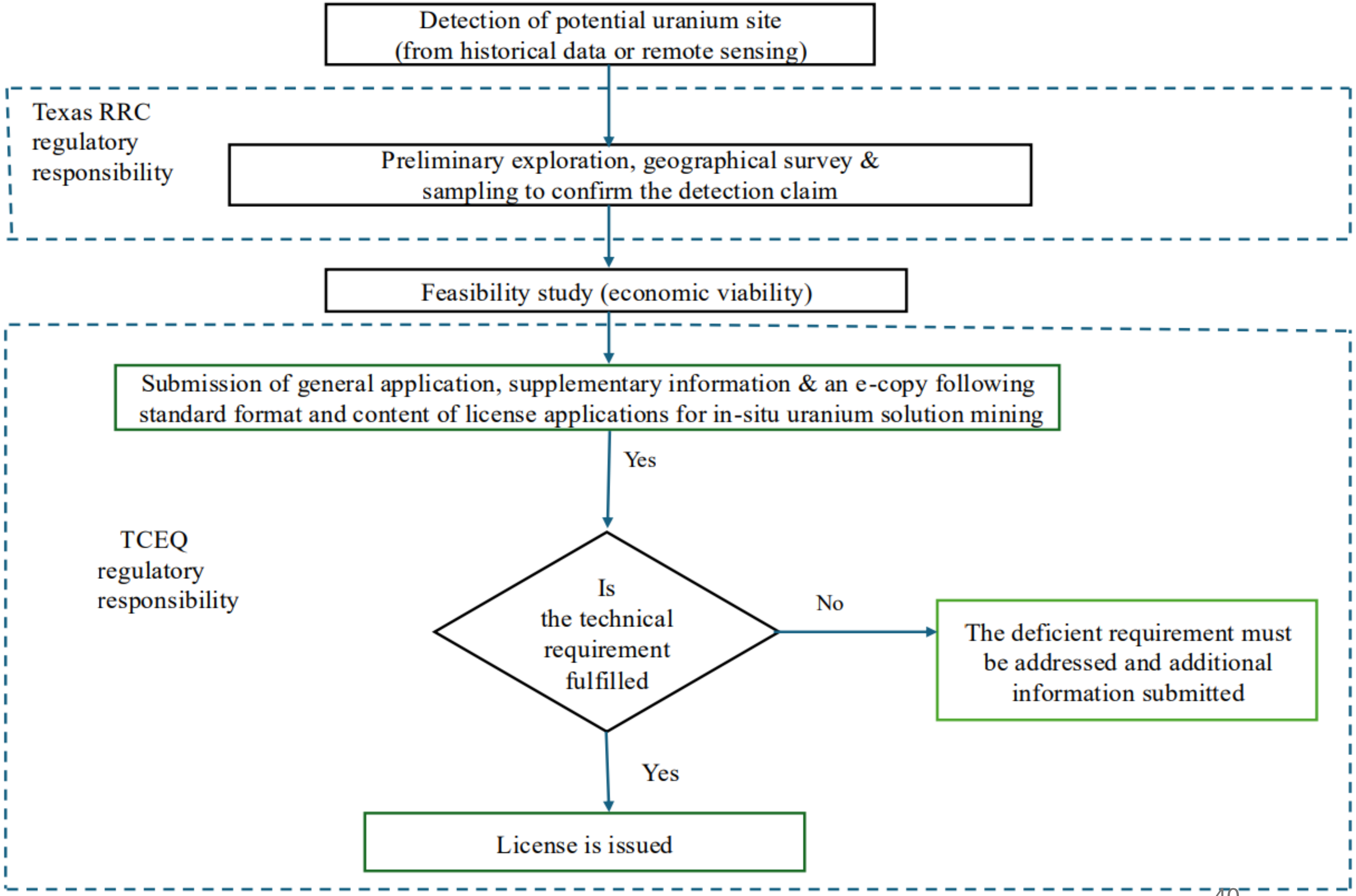


Uranium reserve estimates in the United States for 2008 as reported by the Energy Information Administration classified by mining method (EIA, 2010).

Regulations

Regulations-Current Process

- Texas and Wyoming most efficient permitting process
- Both are Agreement States



General licensing process.

Regulations-Regulatory Suggestions

- Consulted enCore Energy and Uranium Energy Corp
- Clarification of language on statutory regulatory changes , ie public hearing process
- Modification of renewal periods (10 years) of Mine Area Permits, Radioactive Material Licenses, and the Class 1 Disposal Well Permits even if no changes in addition to the quarterly and annual compliance data to TCEQ
- Extend or eliminate the renewal periods due to regular reporting already being done.
- Empower TCEQ with authority and increase funding to counter high turnover

Regulations-Incentive ideas

TAX INCENTIVES - PROVIDING TAX CREDITS OR DEDUCTIONS FOR URANIUM EXPLORATION AND PRODUCTION

RESEARCH & DEVELOPMENT FUNDING - INVESTMENT IN ADVANCED URANIUM MINING TECHNOLOGIES

FOCUS ON EFFICIENCY AND ENVIRONMENTAL IMPACT REDUCTION

INFRASTRUCTURE INVESTMENT - DEVELOPMENT OF ROADS, UTILITIES, AND OTHER ESSENTIAL INFRASTRUCTURE

PUBLIC-PRIVATE PARTNERSHIPS - COLLABORATION BETWEEN GOVERNMENT AND PRIVATE SECTOR TO SHARE RISKS & COSTS

EDUCATIONAL & WORKFORCE DEVELOPMENT - TRAINING PROGRAMS TO BUILD A SKILLED URANIUM MINING WORKFORCE

Let us Recap

Summary

- Uranium mining thrived in Texas from the 1950s -1970s, driven by resource availability and market demand.
- Significant untapped uranium resources exist in Texas, beyond known dormant sites.
- Drive for further energy independence created a favorable environment for reactivating US uranium mines, including those in Texas.
- Some Texas facilities have already resumed production, bolstering US energy security.
- Nuclear energy is crucial for meeting the surging electricity demand from economic growth, data centers, AI, and electric vehicles.
- Advanced nuclear technologies, such as small modular reactors (SMRs), are rapidly developing.
- Texas is poised to play a critical role in supplying uranium for the future of nuclear energy in the U.S

References-to name a few

- U.S. Energy Information Administration
- Department of Energy
- enCore Energy
- International Atomic Energy Agency
- US Nuclear Regulatory Commission
- World Nuclear Association

- Full remainder can be viewed on uranium-resources-in-the-state-of-texas.pdf

Acknowledgements-

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