SUSTAINABLE DEVELOPMENT OF URANIUM PRODUCTION: STATUS, PROSPECTS, CHALLENGES
(an inside outlook)

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Global Uranium Supply Demand Projections


- Primary uranium production must be increased from current 59 to 90kt U in 2035, i.e. by 1.5 times.
- Production from existing mines will decrease by 50% in 2035, while new mines may partially replace exhausted capacities.
- U output from stand by projects must reach 30 ktU/y by 2035.

UxC Uranium Market Outlook, Q1 2018. Mid case supply-demand scenario

- Uranium production ramp up by 24% or to 73kt U in 2035
- Uranium production from existing and new mines will decline by 28% by 2035
- Output from stand by projects must reach 27 ktU/y by 2035.
- Demand may exceed supply in 2018

Starting from 2025 uranium demand may exceed supply
How to supply future uranium demand?

Are uranium resources and mining capacities sufficient to meet future requirements?

30,000 tU in 2035 from new mines

- New discoveries - exploration
- Stand by deposits development
- Secondary sources and stockpiles
Production was substantially ahead of reactor requirements until 1990. About 1mtU have been stockpiled.

Since 1990, requirements have exceeded production by approximately 0.6 mtU. The difference was covered by inventories and other secondary sources.

Current variance between cumulative production and demand is 414 ktU - potential stockpiles.
After 2014 drop, in 2016 uranium production restored to a level of 62 ktU – a maximum since 1983, and dropped back to 59 ktU in 2017
- Sustainable U production grow in Kazakhstan - six-fold over 10 years
- Kazakhstan produced 40% and Canada 22% of 2017 global uranium

- Kazatomprom keeps leadership with 21% share, followed by Orano, Cameco with 16% and Rosatom (Uranium One + ARMZ) with 14% share
- Uranium One was the forth largest producer in 2017 with 9% share

* Source: UxC Q4 2017 Uranium Market Outlook, public reports, author private expertise
In Situ Leach (or In Situ Recovery) is the main uranium mining method since 2009. Its share in the global production has increased from 20% in 2005 to 50% in 2016 and 2017 (30 ktU). Kazakhstan ISL mining contributed 40%, while five other ISL producing counties 10% of world total.

ISL mining capacities will decline after 2028 from 33 ktU to 27 ktU in 2030.

Low cost (< $20/lb) ISL production will sharply decline in 6 times during 2022 - 2029 due to mines closure, while higher cost ($20-30/lb) ISL production may partly replace capacities until 2028

Companies may face economic and technical challenges in new ISR projects development

* - Uranium Production Cost Study, UxC Consulting, September 2017
Operating Uranium Mines Production Capacity and Full Cost

Operating ISL uranium mines:
- 26 of 43 operating mines (60%)

Operating ISL mines in Kazakhstan:
- 17 of 19 mines (95%) with full cost below current spot price
- 27% of total existing production capacity and 29% of total U resources
- Five Uranium One mines in Kazakhstan are in TOP 10 global low cost mines

Planned Mines:
- Seven small new ISL mines including only one mine in Kazakhstan

Today is the era of Kazakhstan and ISL mining
Only low cost producers or companies with favorable contracts survive

Source: U production cost study, UxC 2017
Companies Revise Uranium Mining Plans

Factors Affecting Uranium Production and Mines Development

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<th>Resources</th>
<th>Technical risks</th>
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<th>Financial risks</th>
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Production plans revise. Major events

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<th>Asia</th>
<th>North America</th>
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<tr>
<td>Production cut &amp; halt</td>
<td>Kazakhstan all mines: -10% drop in 2017 - 20% below contracts in 2018-2020</td>
<td>Canada: McArthur - minus 7ktU in 2018; USA: multiple ISL mines</td>
<td>Ranger</td>
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<td>Postponed development</td>
<td>Ukraine – Novokonstatinovka</td>
<td>Canada: Millennium, Midwest, Roughrider</td>
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<td>Care and maintenance</td>
<td>Russia – Elkon, Gornoye</td>
<td>Canada: Rabbit Lake USA: White Mesa</td>
<td>Honeymoon, Jabluka, Ranger Deep</td>
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Actual production is often behind mining capacities and original forecasts. Companies adjust mining plans, put projects on hold, under care and maintenance. Main reasons:

- Current uranium supply demand imbalance and uranium oversupply.
- Depressed uranium market and low prices - historical minimum during last decade;
- Technical constraints, political, social and environmental factors.

Uranium production may drop by another 10% in 2018 and cause temporary undersupply. Over 12 ktU will be unavailable to the market during the 2016-2018 period*

During 2009 to 2015 the total global uranium resources increased by 21%, but low cost resources in <80$/kgU category decreased by 48% and its share decreased from 59% to 27%.

- 65% of global resources in <130$/kg category belong to operating and under construction mines
- Leaders in uranium resources: Australia (23%), Kazakhstan (12% leader in low cost resources), Canada and Russia (both 9%)

Total resource base is sufficient to ensure long-term needs of nuclear power industry. The great share of resources is poorly explored and belongs to high cost categories.

Source: URANIUM 2016: resources, production, demand. NEA/IAEA, OECD 2016
The History of Uranium Discoveries in Kazakhstan by Volkovgeology

- Total initial resources 1,326 ktU (3,448 Mlbs), including 1,238 ktU (3,219 Mlbs) of sandstone type roll front type for ISL mining.
- Almost all deposits in Kazakhstan for ISL mining were discovered between 1970 and 1990.
- During 2000’s, detailed exploration occurred to convert resources to higher level of confidence.
Kazakhstan Uranium Resources and Production Capacities*

- Kazakhstan U resources amounted to 1,073 ktU as of 01.01.2015, including 760 ktU (71%) of low cost sandstone type, amenable for ISL.
- 95% of ISL resources belong to low cost category and to operating and under construction mines.
- Maximal annual Uranium production capacity of 25 ktU may be maintained until 2020.
- Uranium production capacities may decrease after 2020: by 40% in 2030 and by 70% in 2035 due to resources mining depletion.
- Limited potential for new ISL mines development.

Current and Potential ISL Mining Countries

[Map showing countries with active and potential ISL production, including Tanzania, Namibia, Argentina, Australia, China, Mongolia, Kazakhstan, USA, Brazil, India, Paraguay, Turkey, and Uzbekistan.]
Conclusion remarks

1. Starting from 2023 global uranium demand may exceed supply.
2. The global resource base is sufficient to ensure the long-term production, but its great share belongs to high cost categories.
3. In 2016 global uranium production reached a historical maximum since 1983 but dropped by 10% in 2017.
4. In 2018 uranium production may drop by another 10% and cause undersupply.
5. Low uranium prices don’t boost production. Major uranium companies revise plans due to unfavorable market.
6. Uranium companies face economic and technical challenges in operating and new mines development.
7. Companies with low cost production and favorable long term contracts may survive in current challenging market.
8. Kazakhstan increased uranium production more than six times during the last decade and keeps the world leadership since 2009 with about 40% from the world total output in 2017. After 2020 uranium production may decline due to resources mining depletion and mine closure.
9. Uranium exploration must be focused on low cost resources discovery.
Thank You!

Akdala

South Inkai

Karatau

Akbastau

Zarechnoye

Kharasan