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Les enjeux de la filière uranifère au Québec

6211-08-012

The Uranium Market: Global Trends

Presentation to the Bureau des audiences
publiques sur l'environnement

Quebec City, September 18, 2014



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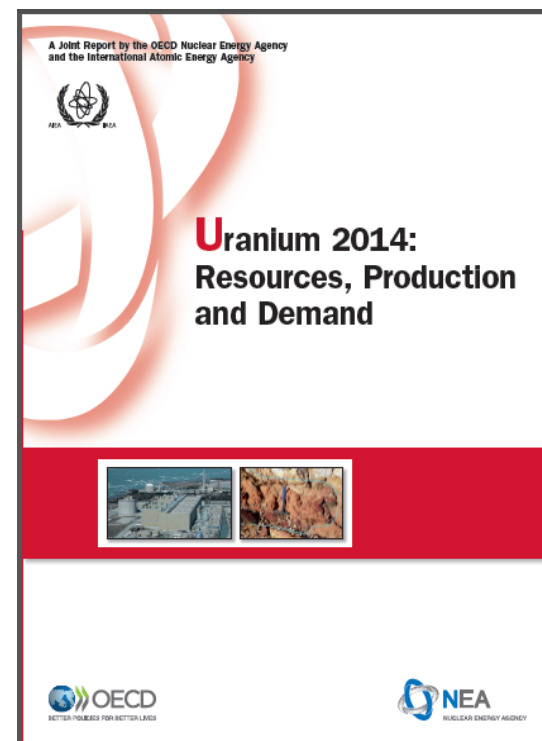
Outline of Presentation

- World Uranium Demand
- World Uranium Production
- The Uranium Market
- World Uranium Resources
- Economics of Uranium Deposits
- Conclusions



Update: 2014 “Red Book”

- On September 9, 2014, the International Atomic Energy Agency (IAEA) and the OECD Nuclear Energy Agency (OECD-NEA) released *Uranium 2014: Resources, Production and Demand*.
- The “Red Book” is the authoritative reference on world uranium.
- The Red Book is free to download:
www.oecd-nea.org/ndd/pubs/2014/7209-uranium-2014.pdf



Current World Uranium Requirements

- 65 000 tonnes of uranium (tU) per year now required to fuel world's current fleet of nuclear power plants:
 - About 60 000 tonnes now produced annually by mining – 16% of which comes from Canada;
 - Additional uranium is provided by secondary supplies – government stockpiles, reprocessing;
 - Between 1993 and 2013, additional secondary supply equivalent to 9 200 tU per year provided by U.S.- Russia agreement to dismantle nuclear weapons.
- To meet current uranium demand, new mines will be needed, given reduced availability of secondary supplies and to replace mines which close when their resources become depleted.

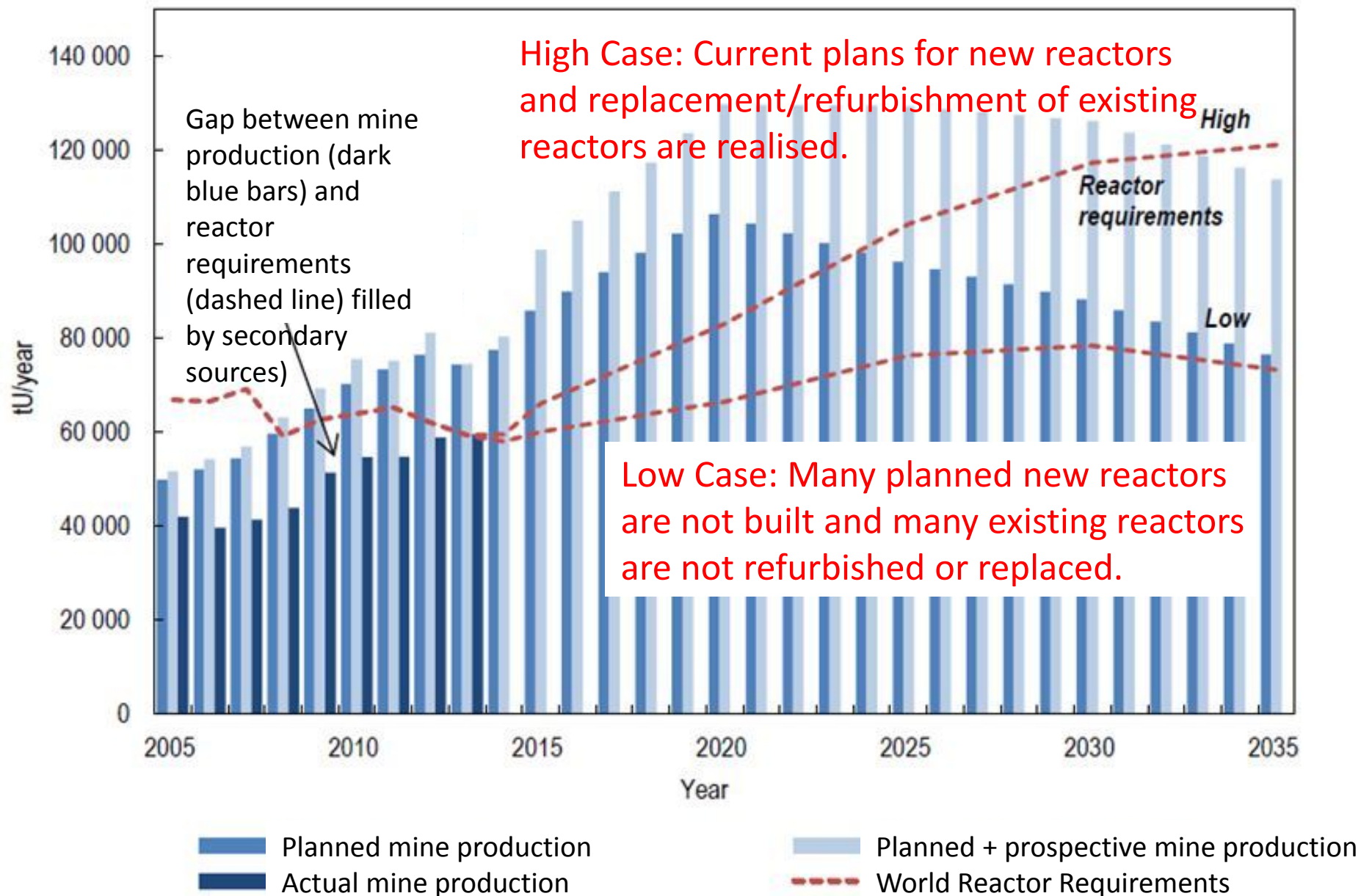


Future Uranium Requirements

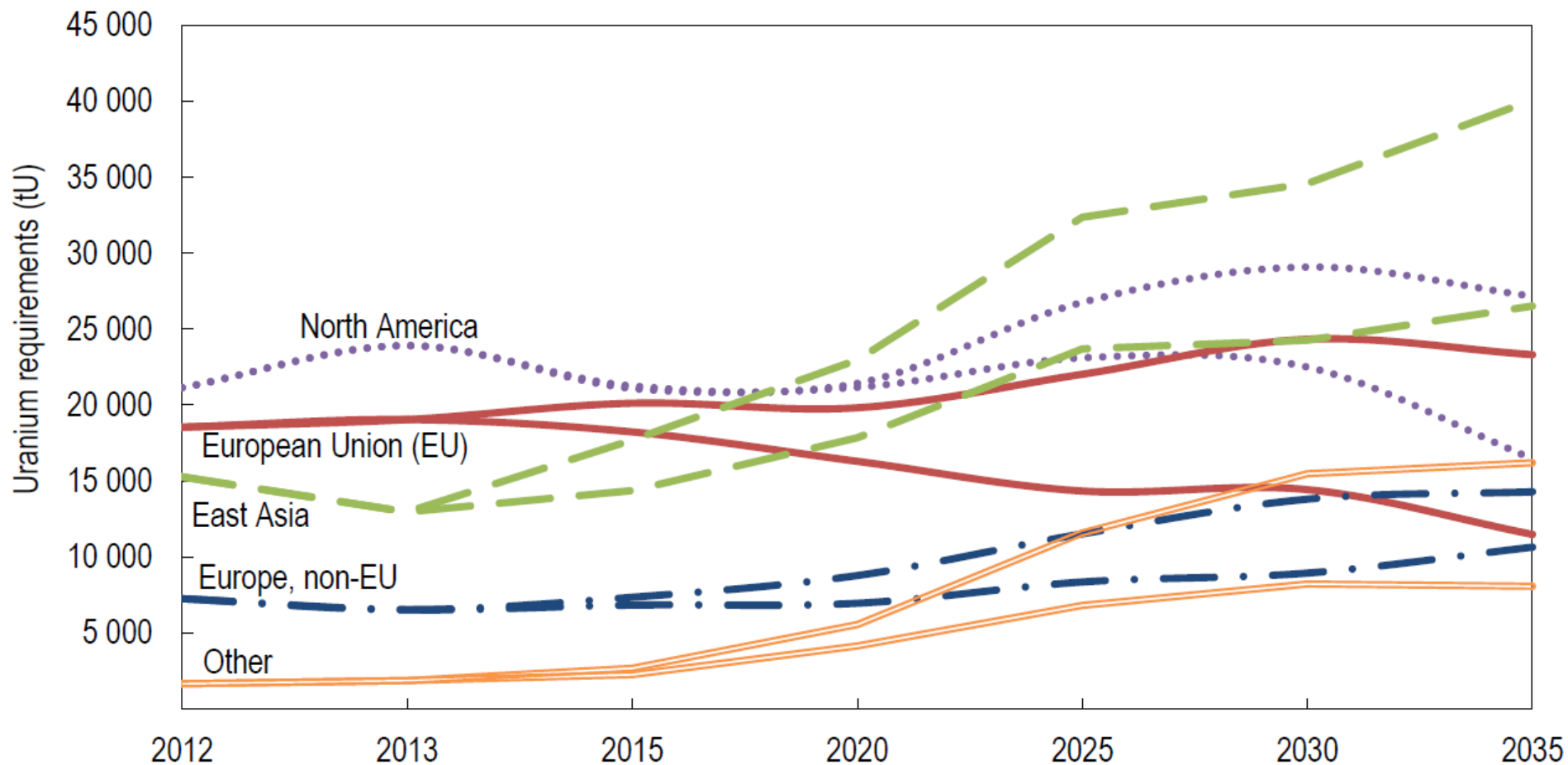
- If nuclear power just maintains its current 12% share of world's electricity production, annual uranium requirements in 2035 would be more than 100 000 tU per year;
- However, the IAEA/OECD-NEA indicates that nuclear power production could grow by up to 80% by 2035;
- New mines needed to supply increased demand;
- Uranium prices expected to rise as demand increases;
- With increased prices, more uranium deposits will become economic.



Future Uranium Demand (IAEA/OECD-NEA, 2014)

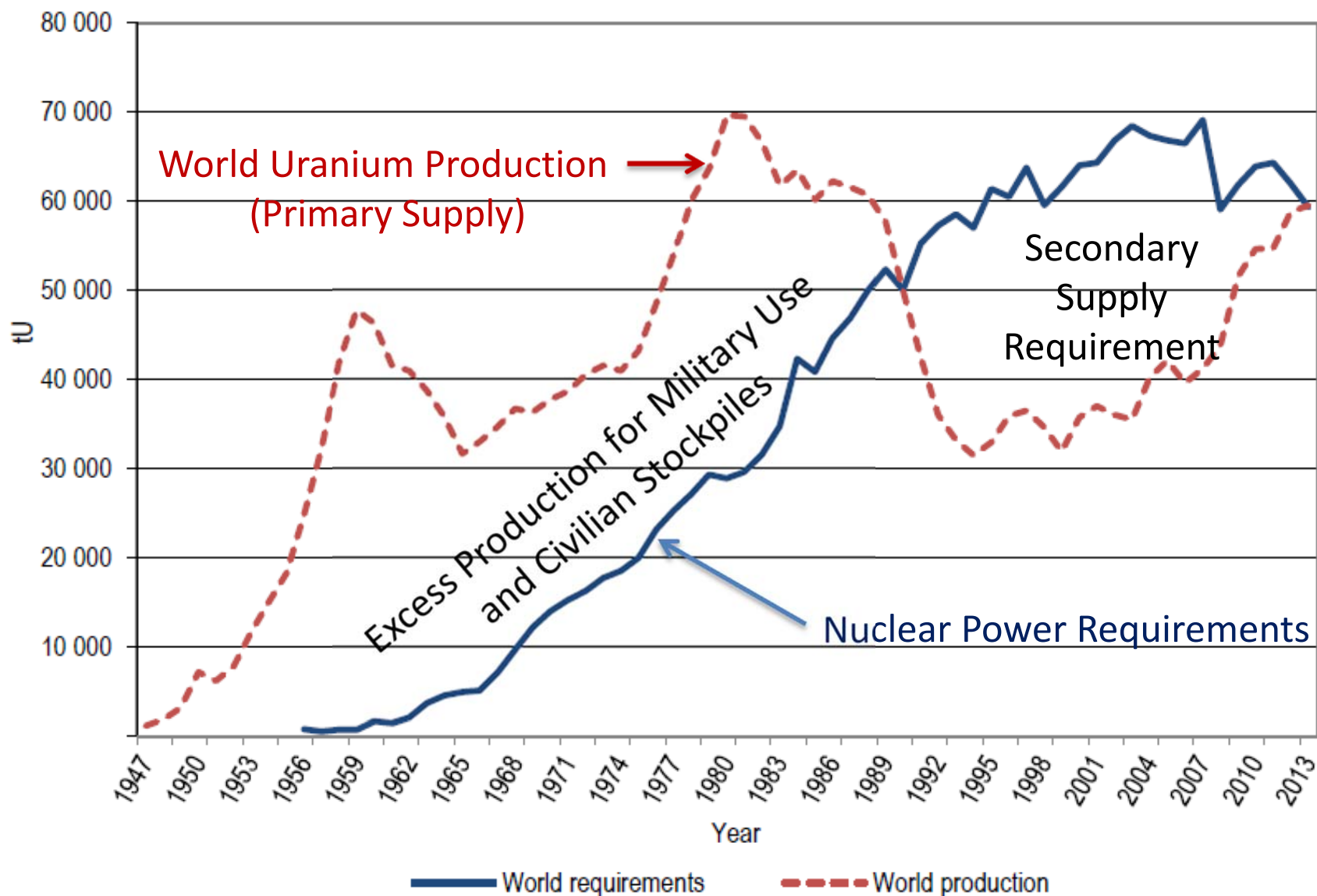


Low and High Projections of Regional Uranium requirements to 2035 (IAEA/OECD-NEA, 2014)



Historic World Uranium Production and Demand

(IAEA/OECD-NEA, 2014)



Secondary Supplies: Military Stockpiles

- Between 1993 and 2013, a secondary supply of highly enriched uranium, equivalent to ~175,000 tU of mined uranium, was provided by U.S.-Russia agreement to dismantle Russian nuclear weapons for use in nuclear power plants.
 - Agreement was not extended.
- US Department of Energy is releasing its excess military uranium inventory (~50,000 tU).
- Military stockpiles are limited and can only provide a portion of future uranium requirements.



Secondary Supplies: Reprocessing Spent Nuclear Fuel

- A few countries reprocess spent nuclear fuel.
- Recovered plutonium is used to manufacture mixed-oxide fuel which is used in some reactors.
- Recovered uranium is mostly stored as reprocessed uranium fuel to be used when breeder reactors become available.
- The cost of reprocessing greatly exceeds the cost of purchasing new uranium and there are significant technical challenges.
- Reprocessing currently replaces 2,000 tU of uranium production per year



Secondary Supplies: Enrichment of Uranium Tails

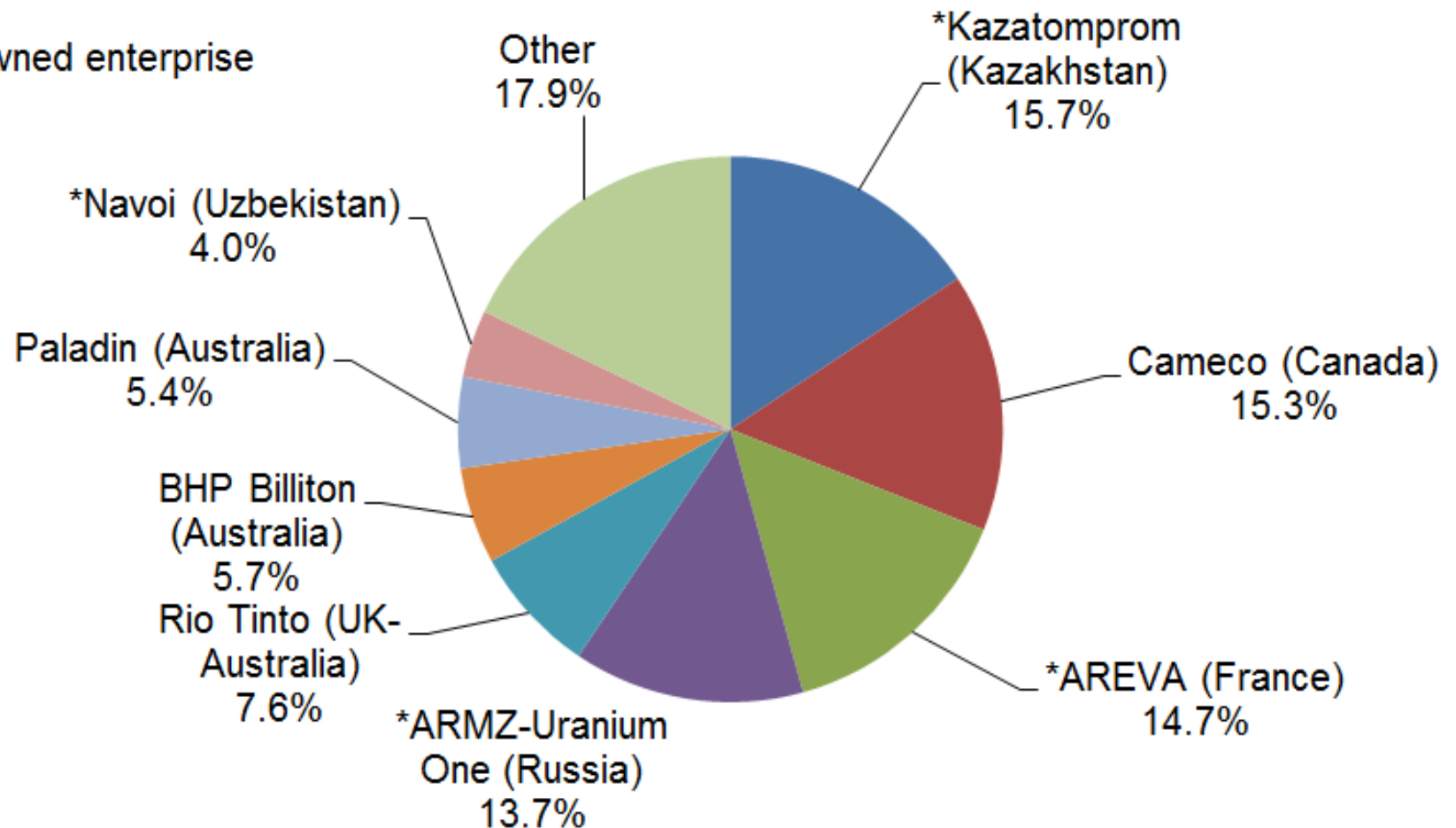
- Natural uranium contains 0.7% uranium-235, the isotope that is required for fission.
- Uranium is enriched to 3-5% uranium-235 for use in light water reactors.
- Uranium tails from the enrichment process can still contain up to 0.3% uranium-235.
- Uranium tails can be reprocessed to produce enriched fuel but this is currently not economic.



Uranium Mining Companies: Nationality and Share of World Production

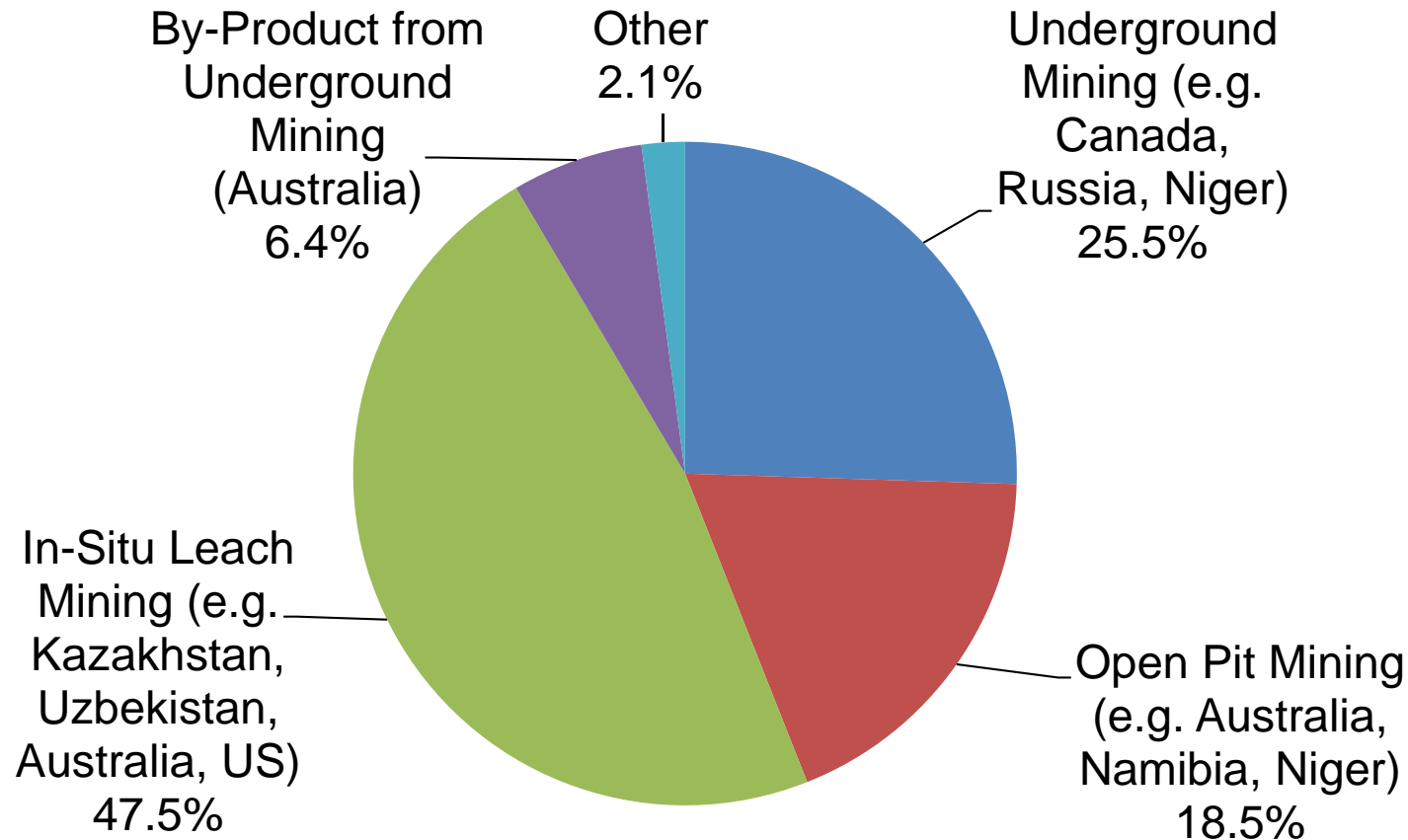
Total 2013 Production: 59,637 tU (World Nuclear Association).

* State-owned enterprise



2013 World Uranium Production by Production Method

(IAEA/OECD-NEA, 2014)



Ore Grades, Resources and Production at the World's Largest Conventional Uranium Mines (IAEA/OECD-NEA 2014)

Mine	Location	Type	% Grade	Resources (including reserves) (tU)	2013 Production (tU)
1 - McArthur River	Canada	underground	11.5	170 000	7744
2 - Cigar Lake	Canada	underground	14.0	120 000	0 (March 2014 start-up)
3 - Olympic Dam	Australia	Underground copper-gold mine	0.02	1 109 200	3399
4 - SOMAIR	Niger	open pit	0.14	67 200	2730
5 - Ranger	Australia	open pit	0.06	58 200	2510
6 - Priargunsky	Russia	underground	0.16	98 000	2133
7 - Langer Heinrich	Namibia	open pit	0.05	60 900	2098
8 - Rossing	Namibia	open pit	0.03	51 600	2031
9 - Rabbit Lake	Canada	underground	0.61	14 700	1587
10 - COMINAK	Niger	underground	0.35	20 800	1508



Uranium Market: Buyers

- Buyers primarily public and private utility companies.
- Require continued and secure supply of uranium and prefer entering into long-term contracts for supplying uranium.
- Uranium not sold on a commodity exchange like other metals.
 - Purchases are negotiated with the producers.



Uranium Prices

- Mining industry: Price of uranium concentrates (yellowcake) in US\$ per pound of U_3O_8 .
- IAEA/OECD-NEA: Price in US\$ per kilogram of uranium metal (kgU).
- $US\$1/lb U_3O_8 = US\$2.6/kgU$.



Uranium Prices

- Uranium Spot Price:
 - Price for uranium to be delivered in the short term (usually less than one year)
 - Less than 15% of total uranium market.
 - Current Spot Price (September 15, 2014):
 - US\$34/lb U_3O_8 = US\$88.4/kgU



Uranium Prices

- Long-Term Contract Price:
 - Uranium price for new contracts negotiated between the buyer and seller to supply uranium over period of several years.
 - More than 85% of total uranium market.
 - Contracts may have a floor and ceiling price based on the Spot Price.
 - Current Long-term Price (September 15, 2014):
 - US\$44/lb U_3O_8 = US\$114.4/kgU



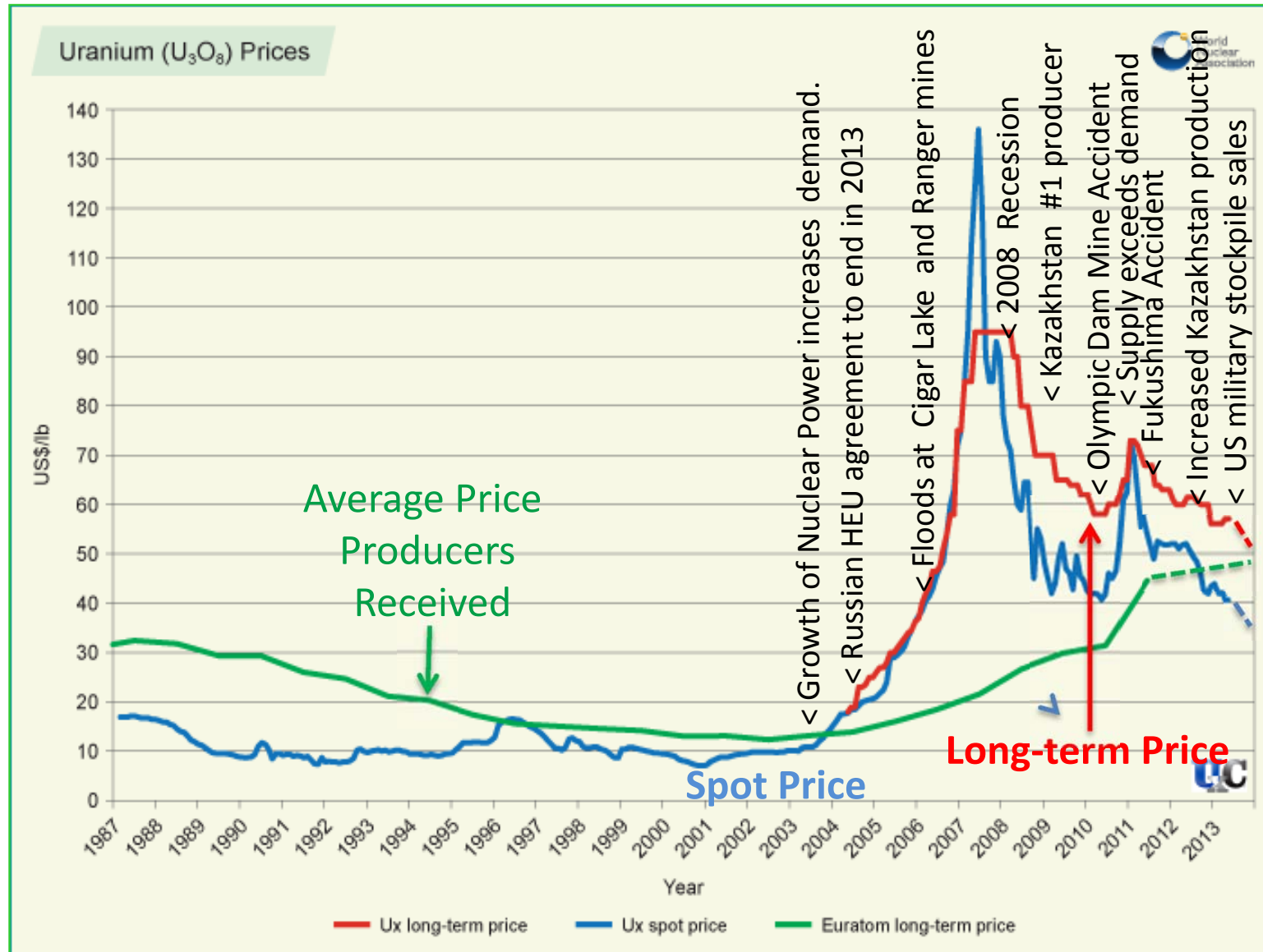
Uranium Prices

- Average price that producers receive:
 - More than 85% of production is sold through long-term contracts.
 - Many of these contracts were signed when prices were much higher than today.
 - The price received from long-term contracts as well as the price received from spot market sales is used to calculate an overall average price received.
 - Examples: Euratom Supply Agency long-term price, Cameco average realized price.



Uranium Prices: 1987 – 2013

(World Nuclear Association, 2014)



Resource Estimates

- List the tonnage and average grade of deposit which has potential to be economically mined at specified price.
- An assumed future commodity price and preliminary rough estimate of the mining costs per tonne of ore are used to determine a cut-off grade.
- Standards exist for ensuring resource estimates are conducted by qualified persons:
 - Canada – National Instrument 43-101
 - Australia – Joint Ore Reserves Committee (JORC) Code



Resource Estimates

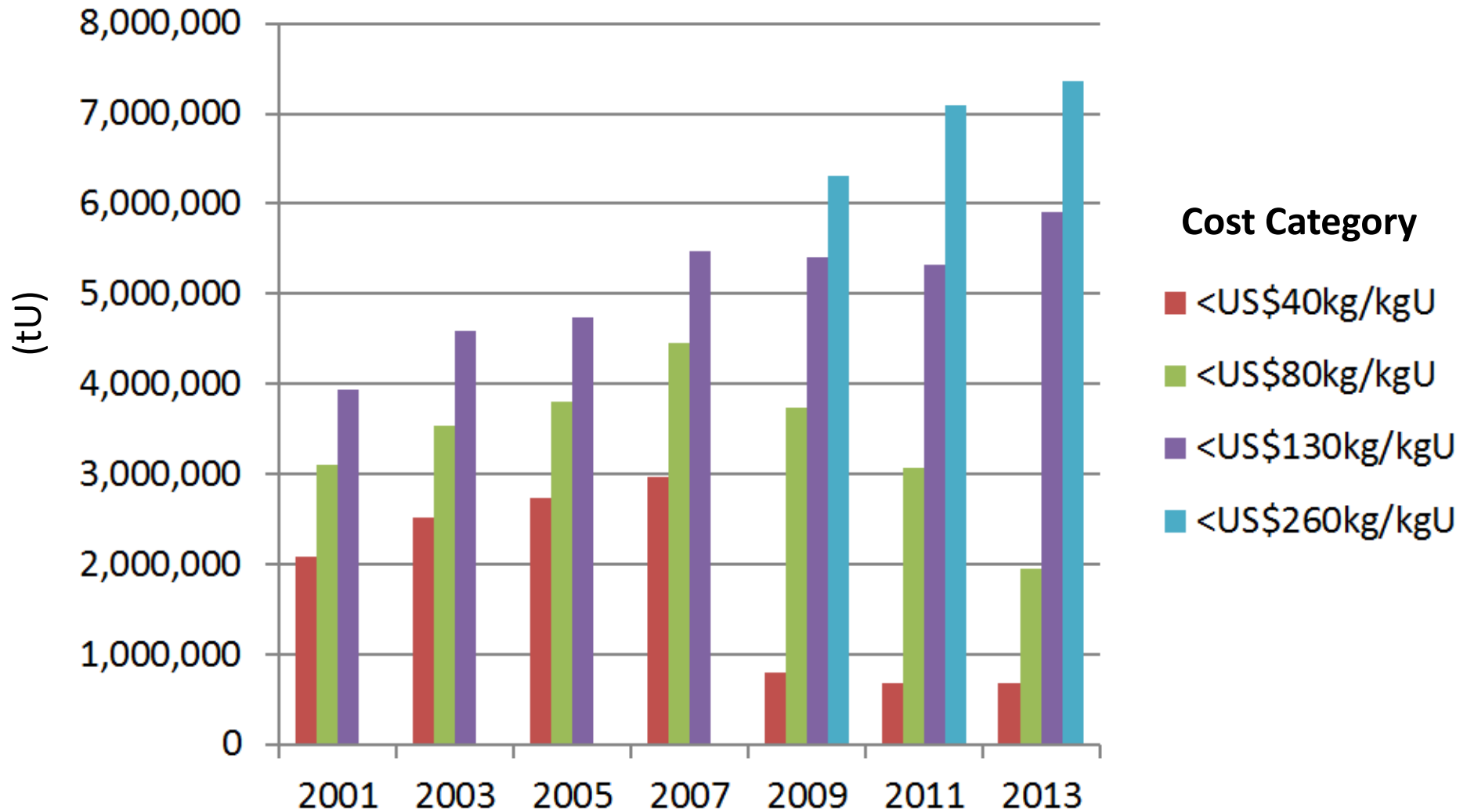
- Three resource categories:
 - Measured – tonnage and grade of ore are well defined by adequate sampling;
 - Indicated – tonnage and grade of ore are estimated from partial sampling and geological interpretation;
 - Inferred – tonnage and grade of ore are estimated based on geological interpretation with limited sampling.

- IAEA/OECD-NEA Identified Resources:
Measured + Indicated + Inferred

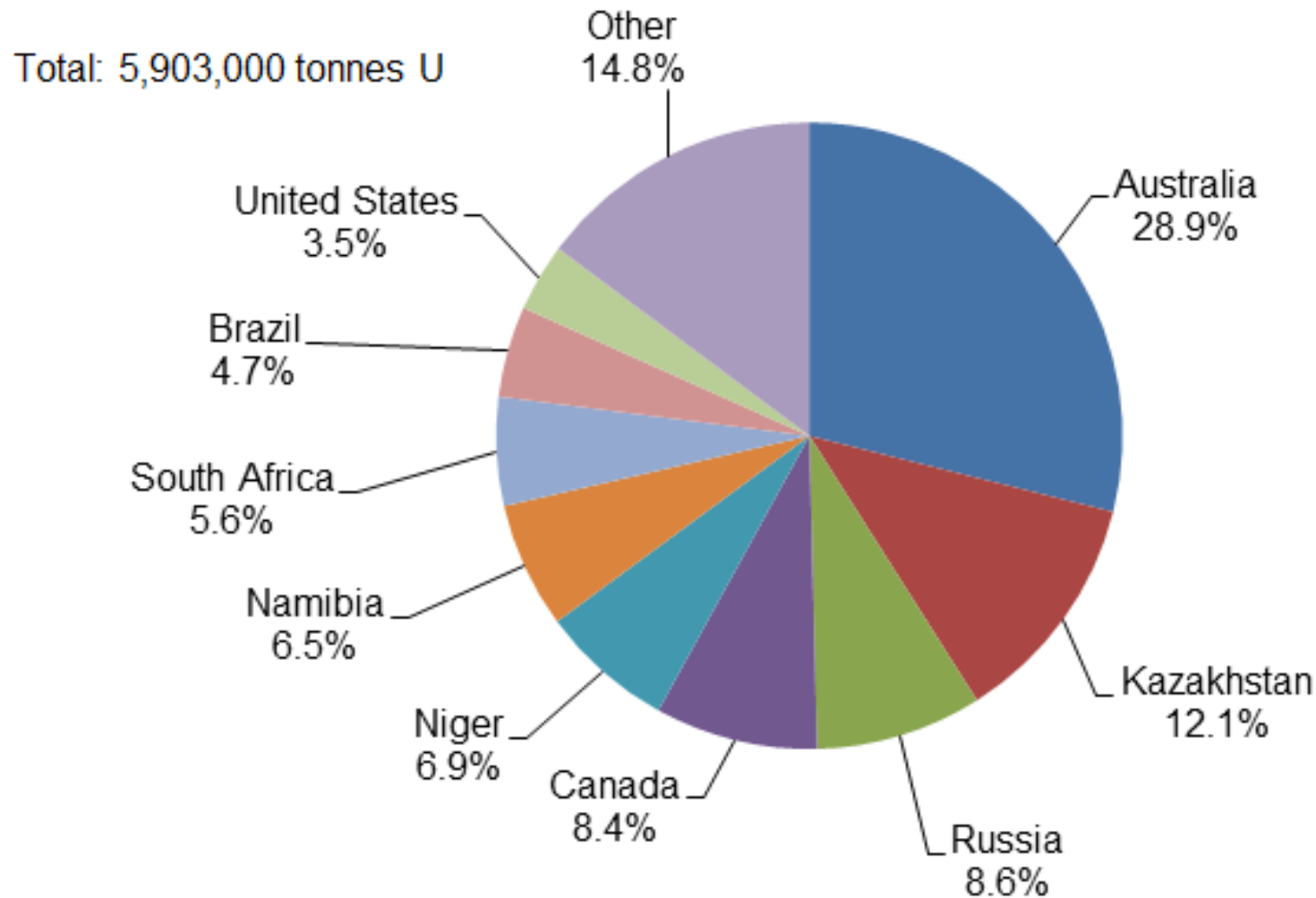


Identified Resources: 2001-2013

(IAEA/OECD-NEA)



World Identified Uranium Resources <US\$130kgU January 1, 2013 (IAEA/OECD-NEA)



Mineral Reserves

- Mineral Reserve: portion of an ore body demonstrated to be economically mineable.
- Resources are upgraded to Proven Reserves or Probable Reserves by conducting further work.
- Usually requires an advanced exploration stage to increase knowledge of ore body.
- Advanced exploration may also be used to find adjacent ore bodies.
- Establishing a Mineral Reserve requires a preliminary economic feasibility study which includes a potential mining plan.



Economics of Mineral Deposits

- For a mine to be economic, the mineable ore must have a market value that exceeds the costs of mine development, operation and closure (decommissioning, site remediation and long-term monitoring).
- The proposed mining method (open pit or underground) and processing method (milling or leaching) must be first determined.
- An economic feasibility study and an environmental assessment is conducted before deciding to develop a mine.



Conclusions:

- Additional uranium mines will be needed in the future to supply nuclear power demands.
- The identified uranium resources are sufficient to support substantial growth of nuclear power.
- Increased demand will lead to an increase in uranium prices, improving the economics of many uranium deposits.

