



Uranium: 101 Information Session

Nunavut Mining Symposium
April 2014

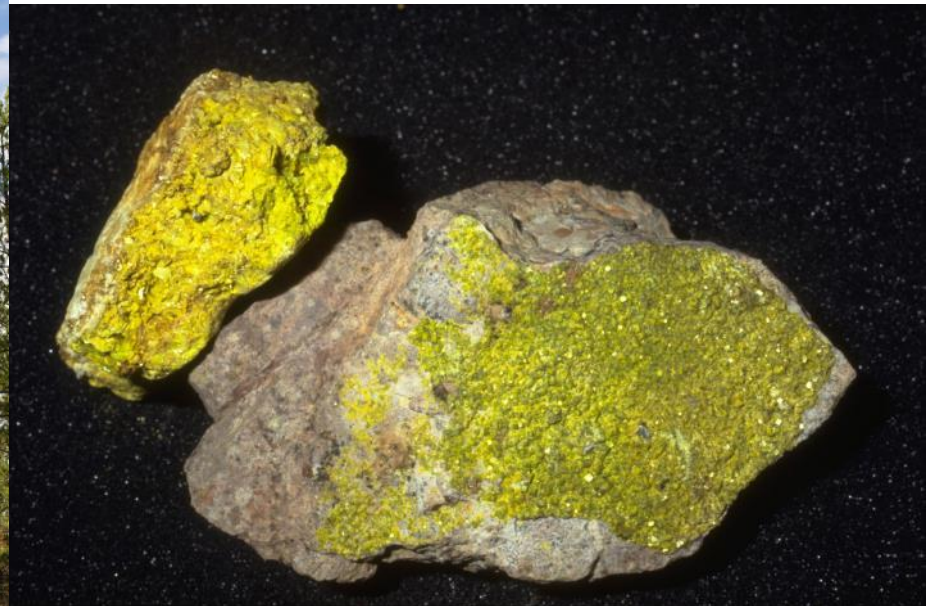


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Uranium



“Uranium is a metal, common and abundant in nature, found in most rocks, soil, rivers, oceans, food and the human body.”

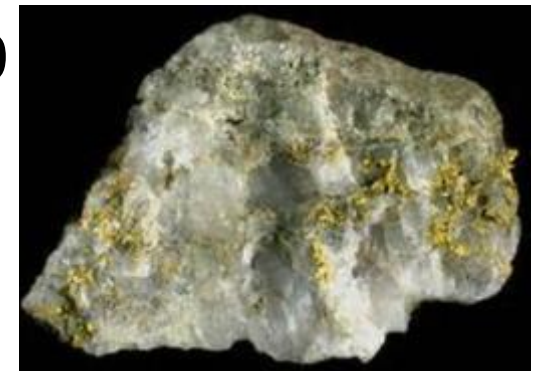
Uranium Overview

▶ Gold mine

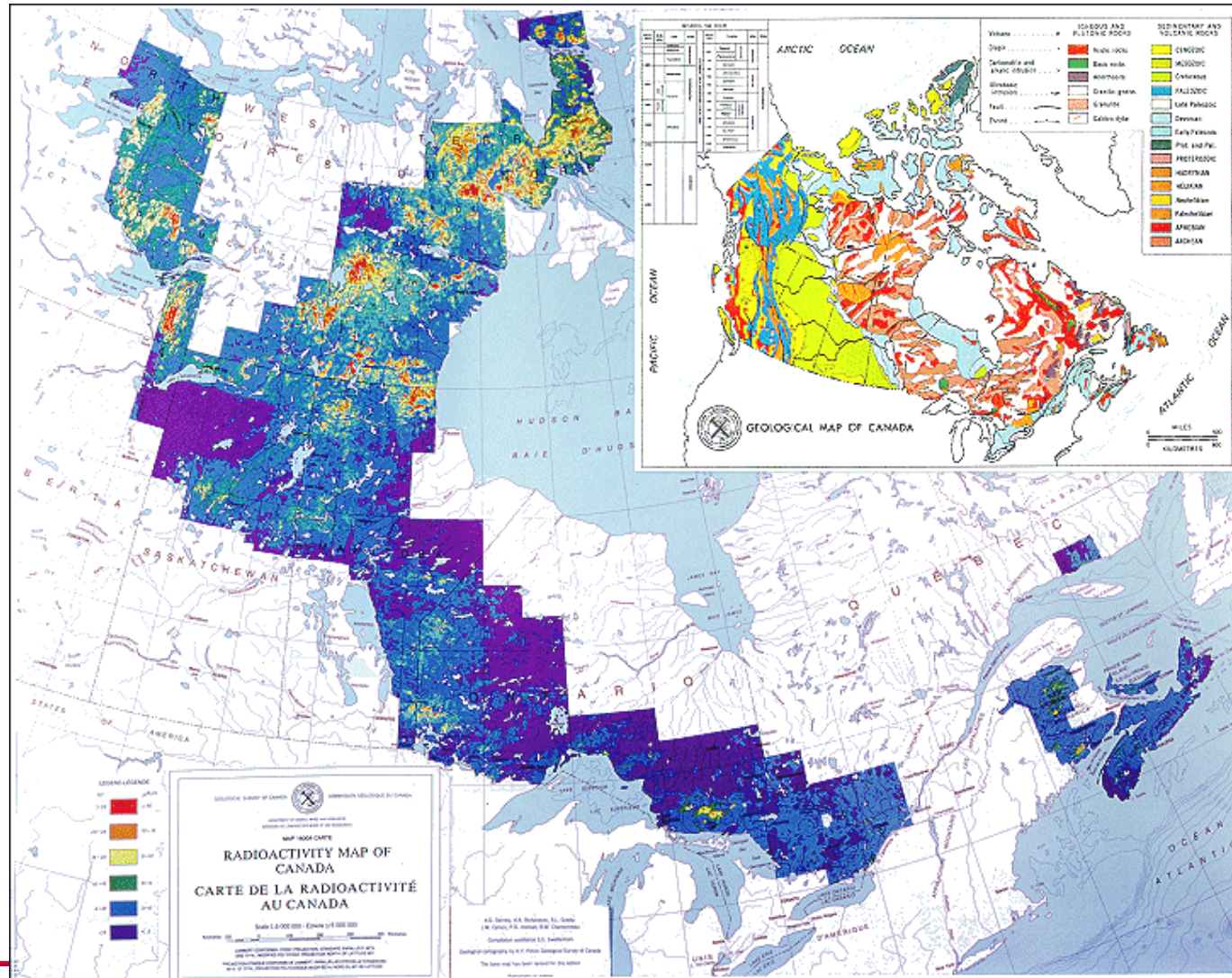
- ◆ Background level: trace
- ◆ Average mining grade: 1 - 2 ppm

▶ Uranium Mine

- ◆ Background level: 2 – 4 ppm
- ◆ Average grade worldwide: 5000 ppm
- ◆ Saskatchewan High Grade: 200,000 ppm



Uranium Overview



Uranium – a Unique Market

What makes the Uranium Market Unique?

▶ Uranium (U_3O_8) is a commodity

- ◆ “any unprocessed or partially processed good” (Source: Dictionary.com)
- ◆ Similar to gold, silver, copper, and other commodities
- ◆ Conventional mining is often used
 - Open Pit, Underground mining is common in all minerals
- ◆ After processing and packaging, virtually homogeneous
 - Origin of product becomes less important technically
 - Quality difference is minimal at this stage

Summary: Uranium is a commodity - this does not make it unique, in fact it makes it similar to other minerals

Uranium – a Unique Market

Uranium - uses

- ▶ **Uranium has only two commercial uses**
 - ◆ **Nuclear Power**
 - ◆ **Nuclear Medicine**
- ▶ **Nuclear Power is by far the most significant consumer**
 - ◆ **Percentage of electricity generated from Nuclear ranges from zero in many countries to 75% in France**

The limited use of uranium makes it somewhat unique among commodities

- ◆ ***Most commodities have widespread usage and therefore broad markets – uranium has neither***

Uranium – a Unique Market

Uranium market players

▶ Limited number of customers

- ◆ Demand comes from the Nuclear Power industry
- ◆ Approximately 400 operating nuclear reactors
 - But many utilities own a number of reactors
 - Therefore, less than 100 different customers

▶ Typical customer profile is unusual

- ◆ Electricity generation is generally a natural monopoly
- ◆ Most customers are state-owned utilities

Customers know suppliers have a limited market

Uranium – a Unique Market

Uranium market players

▶ Limited number of suppliers

- ◆ Over 80% of uranium production in recent years is from less than 10 companies
- ◆ Many companies exploring for uranium
 - But may not have the capability to bring new deposits into production
- ◆ Significant regulatory expertise required
- ◆ Very long lead time to bring new mines into production

Suppliers know customers have limited sources of supply

Uranium – a Unique Market

Additional market factors

▶ Security of supply

- ◆ Key factor for utility decisions on sourcing
- ◆ Geographic diversity
- ◆ Supplier diversity

▶ Oversupply corrections are slow

- ◆ Mines can be expensive to shut-down

Balance between supply and demand is dependent upon the balance between all of these factors at any given time

Uranium – a Unique Market

Uranium 2012 world production

Canada

- 4% since 2006

9,100

Kazakhstan

20,900 +400% since 2006

Niger

+ 39% since 2006

4,800

Namibia

+ 77% since 2006

4,300

Australia

+ 11% since 2006

7,900

Top 6 countries

85 % of overall

1. Kazakhstan 35%
2. Canada 15%
3. Australia 13%
4. Niger 8%
5. Namibia 7%
6. Russia 6%



59,000 t or 153 million lbs
+8% annual growth

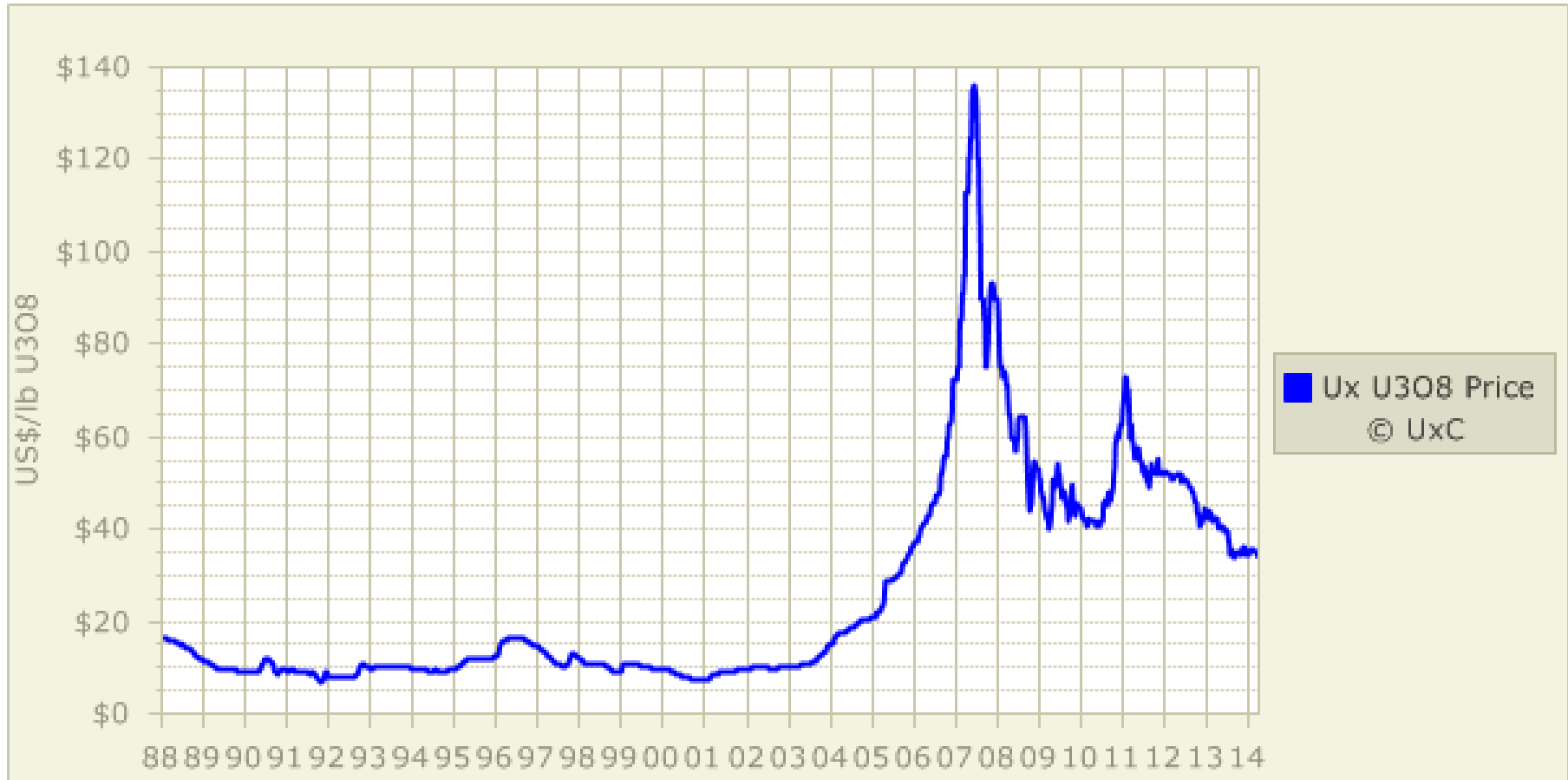


production 2012 (tU)

Source: AREVA estimates from companies reports and WNA

Market Conditions – Uranium prices

25 year



Source: Ux Consulting Company, LLC – please see <http://www.uxc.com/> for more information

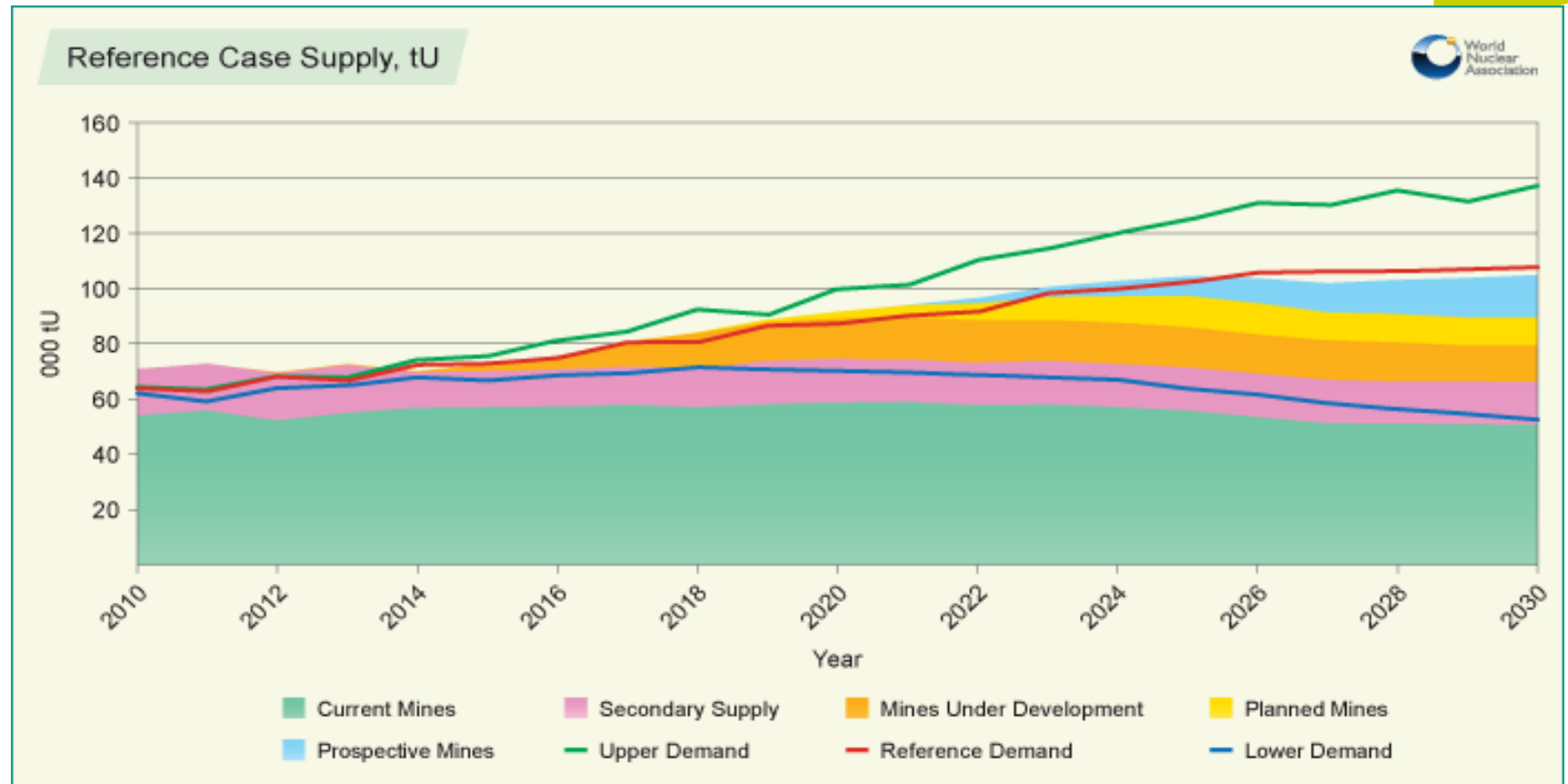
Market Conditions – Uranium prices

Five year



Source: Ux Consulting Company, LLC – please see <http://www.uxc.com/> for more information

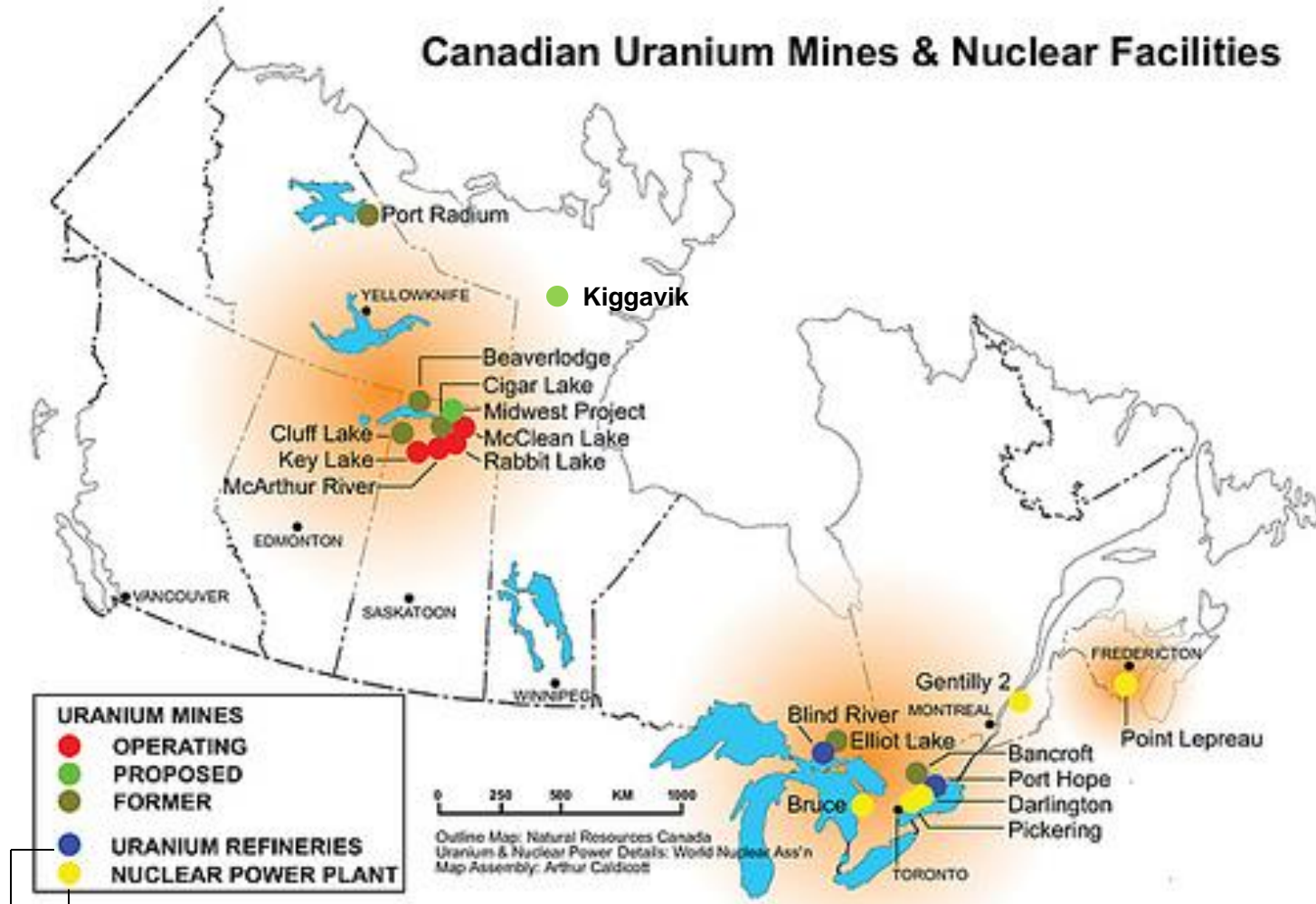
Market Conditions – long-term optimism



► **All developing, planned and prospective mines must reach production within scheduled timeframes to meet expected demand**

◆ History has proven this to be difficult to accomplish

Canadian Nuclear Industry



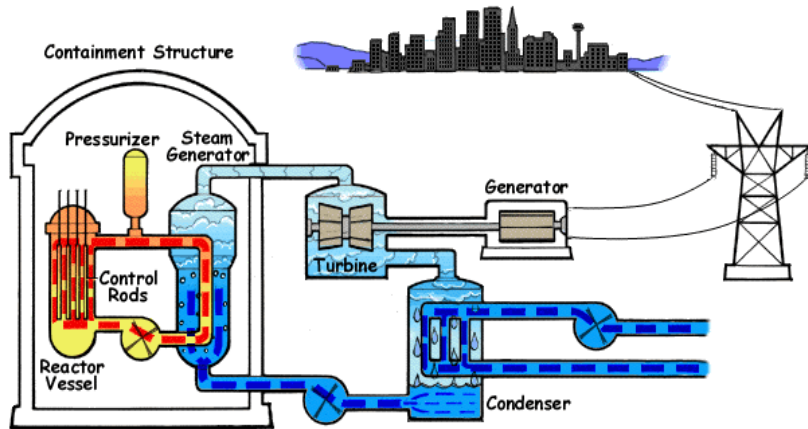
Mining Uranium



Processing Uranium



Powering Reactors



Schematic of nuclear power reactor

Several additional steps are required to turn U_3O_8 into fuel for a nuclear power plant

- Refining
- Conversion
- Enrichment
- Fuel Fabrication



Photo: OPG

“ Ontario Power Generation’s Pickering Nuclear site is capable of supplying most of Toronto’s electricity needs.

Energy Equivalents

Power Production Equivalents

1 uranium fuel pellet =



1 ton of coal



17,000 cubic feet
of natural gas



5,000 pounds of wood

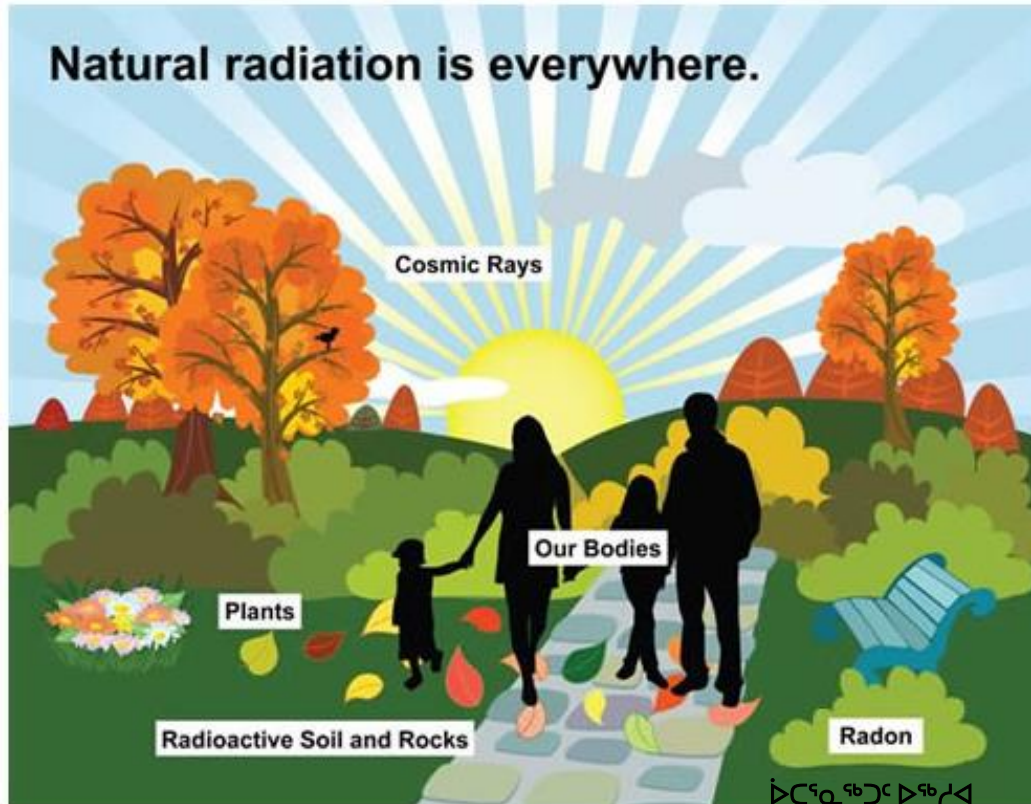


149 gallons of oil



Source: Nuclear Energy Institute

Radiation



► Natural Background Radiation Sources

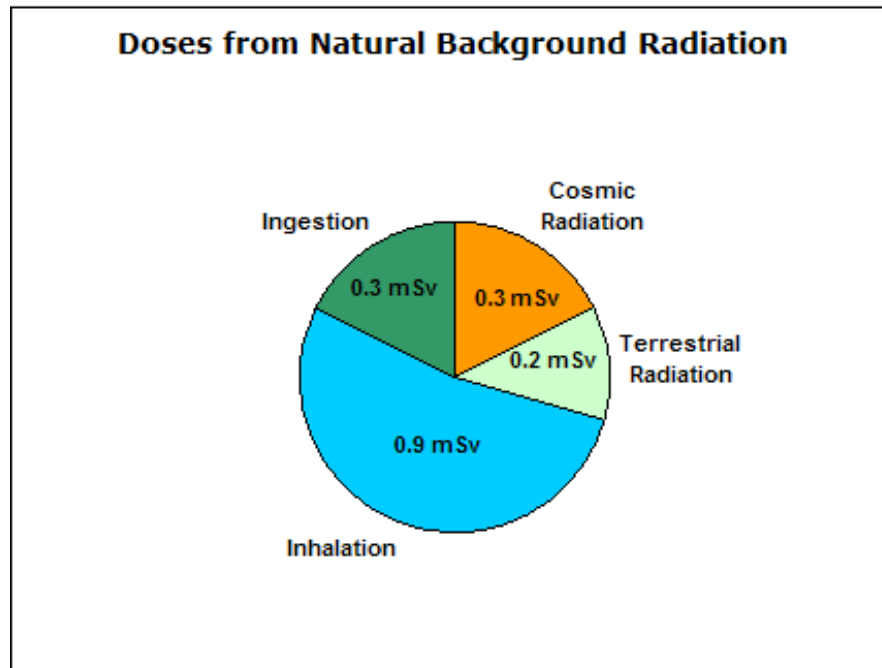
- ◆ Cosmic radiation
- ◆ Terrestrial radiation
- ◆ Intakes through
 - Inhalation
 - Ingestion

According to the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), there are four major sources of natural radiation: cosmic radiation, terrestrial radiation, and intakes of naturally-occurring radionuclides through inhalation and ingestion.

Radiation – Commodity Specific Hazard

► Effective dose from natural radiation:

- ◆ Worldwide average effective dose from natural radiation is approximately 2.4 mSv/year
- ◆ In Canada the average effective dose is 1.8 mSv



Source: CNSC Fact Sheet – Natural Background Radiation, January 2013

History of Doses: Radon Uranium Discovery

- ▶ In 1931, at Great Bear Lake, prospector Gilbert Labine discovered the first uranium deposit.
- ▶ Port Radium, in the Northwest Territories, was the location of the first uranium mine site.



History of Doses

Port Radium



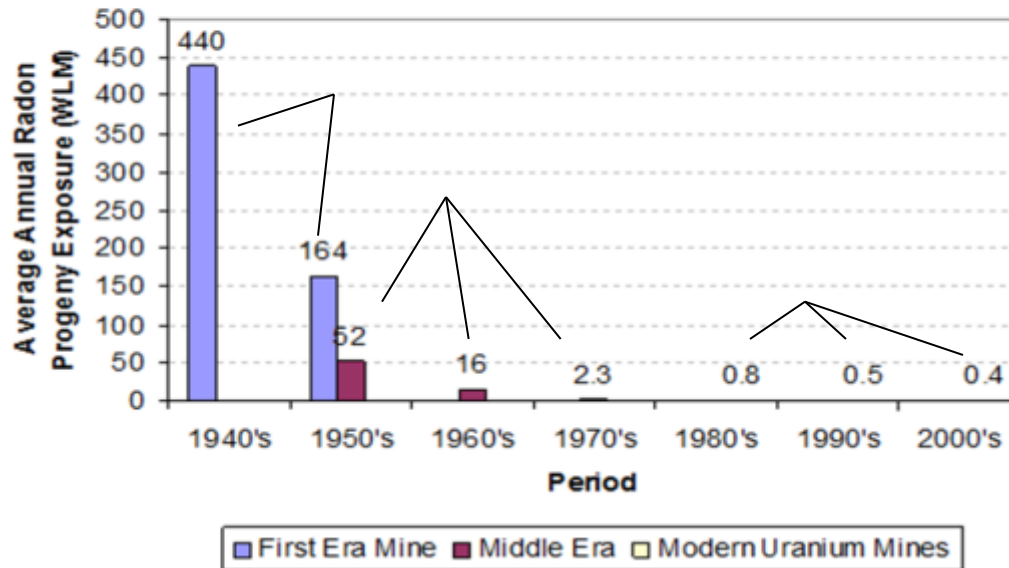
Beaverlodge



McClellan Lake



Uranium Miner Average Radon Progeny Exposures



Radiation: Industry Oversight

INTERNATIONAL OVERSIGHT

UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
ICRP	International Commission on Radiological Protection
IAEA	International Atomic Energy Agency
WHO	World Health Organization



INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION



United Nations Scientific Committee
on the Effects of Atomic Radiation



IAEA
International Atomic Energy Agency



**World Health
Organization**

Radiation: Commodity Specific Hazard

► Easily measured



Radiation: Commodity Specific Hazards

- ▶ **Low specific radioactivity**
- ▶ **Not flammable**
- ▶ **Very low solubility**
- ▶ **Stable form of uranium**
- ▶ **Generally handled as other heavy metals**



Un-calcined Yellowcake



Calcined Yellowcake

History of Doses: Radon Modern Era Mines in Canada



McClean Lake



► Modern Knowledge and Practices

- ◆ Knowledge gained through studies of past miners
- ◆ Licensed, regulated and monitored by the Federal, Territorial & Provincial Governments
- ◆ Dose Limits
- ◆ Improved Mining Techniques
 - Containment
 - Ventilation



Managing Radiation

▶ In Canada Uranium Mines and Mills are regulated by the Canadian Nuclear Safety Commission (CNSC)

- ✓ Regulates and licenses all existing and proposed uranium mining and milling operations in Canada
- ✓ Manages licensing, certification and compliance in accordance with the requirements of the Nuclear Safety and Control Act and its Regulations
- ✓ Focus on health, safety, security and the environment
- ✓ Ensures Canada implements its international obligations on the safe use of nuclear materials

More Resources

- ▶ **Nuclear Energy at a Glance (Nuclear Energy Institute):**
 - ◆ <http://safetyfirst.nei.org/wordpress/wp-content/uploads/2011/08/splash.swf>
- ▶ **How It Works (Canadian Nuclear Association):**
 - ◆ http://www.cna.ca/how_works/
- ▶ **Nuclear Fuel Cycle (World Nuclear Association):**
 - ◆ <http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Introduction/Nuclear-Fuel-Cycle-Overview/>
- ▶ **Uranium 101 (Cameco):**
 - ◆ http://www.cameco.com/uranium_101/

Uranium 101: Information Session

