# URANIUM MARKET

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Our mission is to become a reliable and respected uranium producer.

## Highlights

Almost all uranium is sold on long-term contracts directly between miners and the utilities; these contracts are confidential and have a very limited relationship with the oft-quoted ‘spot price’.

As contracts continue to roll off, higher cost producers will need to ‘reposition’. Global stockpiles might be able to sustain demand in the short term, however, this is not a sustainable strategy.

Nuclear generating capacity is expected to increase by 38% in the next decade.

Current and growing future demand for nuclear power means existing mines must remain open and new mines need to come on stream.

Photo credit: pdac.ca/convention and envisiondigitalphoto.com

# AS LONG-TERM CONTRACT PRICES INEVITABLY CORRECT, VIMY'S MULGA ROCK PROJECT WILL BECOME A STRATEGICALLY IMPORTANT URANIUM MINE.

## URANIUM MARKET

The nuclear industry is a somewhat closed club and as a result, many investment analysts often overlook the subtle nuances within the uranium market. For example, an emphasis by some commentators on the 'spot' uranium price belies a fuller understanding of the more important, but less visible, 'long-term contract' market. Moreover, the uranium market is not like typical metal markets in that there is no clearing house like the London Metal Exchange. Almost all uranium is sold on long-term contracts directly between the miners and the utilities; these contracts are confidential and have a very limited relationship with the oft-quoted 'spot price'. However, the spot price is the only visible measure of the uranium price and so has a huge influence on not only market sentiment, but has also created unrealistically low expectations on the part of utilities regarding fair long-term contract prices.

Owing to the mostly conflicting, and therefore mostly incorrect, publicly available data, Vimy has embarked on its own detailed view on the current and future state of the long-term contract market. Various development scenarios are considered for the growth of nuclear power over the period and these scenarios are then converted into an associated UOC demand estimate.

The present uranium market pricing mechanism, both in proposed new contracts and the current spot price, would be inadequate to sustain production of current global uranium demand in a normal metals market. However, most uranium miners are shielded by a portfolio of long-term contracts written at a time of historically high uranium prices. But over the next few years, many of these contracts come to an end and so the industry is entering a period of re-adjustment as the disconnect between utilities and the uranium miners begins to play out.

This situation was demonstrated through the significant announcement by Cameco Corporation (TSX:CCO) on 8 November 2017 about the suspension of operations at the McArthur River Mine in Saskatchewan for ten months from January 2018 (CCO 69.8% ownership). This single mine produced 18Mlbs $U_3O_8$ in 2016 and contributes 11% of global primary uranium supply. It is also one of the lowest cost producers on Vimy's uranium cost curve (Figure 13.1). Yet, as Cameco admits, the favourable contracts are running out and it is necessary to reposition the company to sustain cash flows.

Furthermore, on 4 December 2017 Kazatomprom announced a 20% reduction in annual production over the next three years, and approximately 10Mlbs $U_3O_8$ in 2018 alone. When combined, these are significant reductions amounting to 18% of global uranium production.

As contracts continue to roll off, the higher cost producers will also need to 'reposition' and while global stockpiles might be able to sustain demand in the short term, this is not a sustainable strategy. Current and growing future demand for nuclear power means existing mines must remain open, and new mines need to come on stream.

As long-term contract prices inevitably correct to sustain and grow primary supply uranium production, Vimy's Mulga Rock Project will become a significant and strategically important uranium mine.

## NUCLEAR FUEL CYCLE

All uranium mines produce a uranium oxide concentrate referred to as UOC, but with slightly differing chemical composition depending on the uranium process used (i.e. $UO_4$, $UO_3$, $U_3O_8$). In any event, all UOC is normalised to $U_3O_8$ for reporting purposes and this section will refer only to $U_3O_8$ or UOC interchangeably.

To prepare uranium for use in a nuclear reactor, it undergoes mining and milling, conversion, enrichment and fuel fabrication for use in the reactor. These steps make up the 'front end' of the nuclear fuel cycle.

Figure 13.2 shows the 'nuclear fuel cycle' and a full description is available on the World Nuclear Association website.

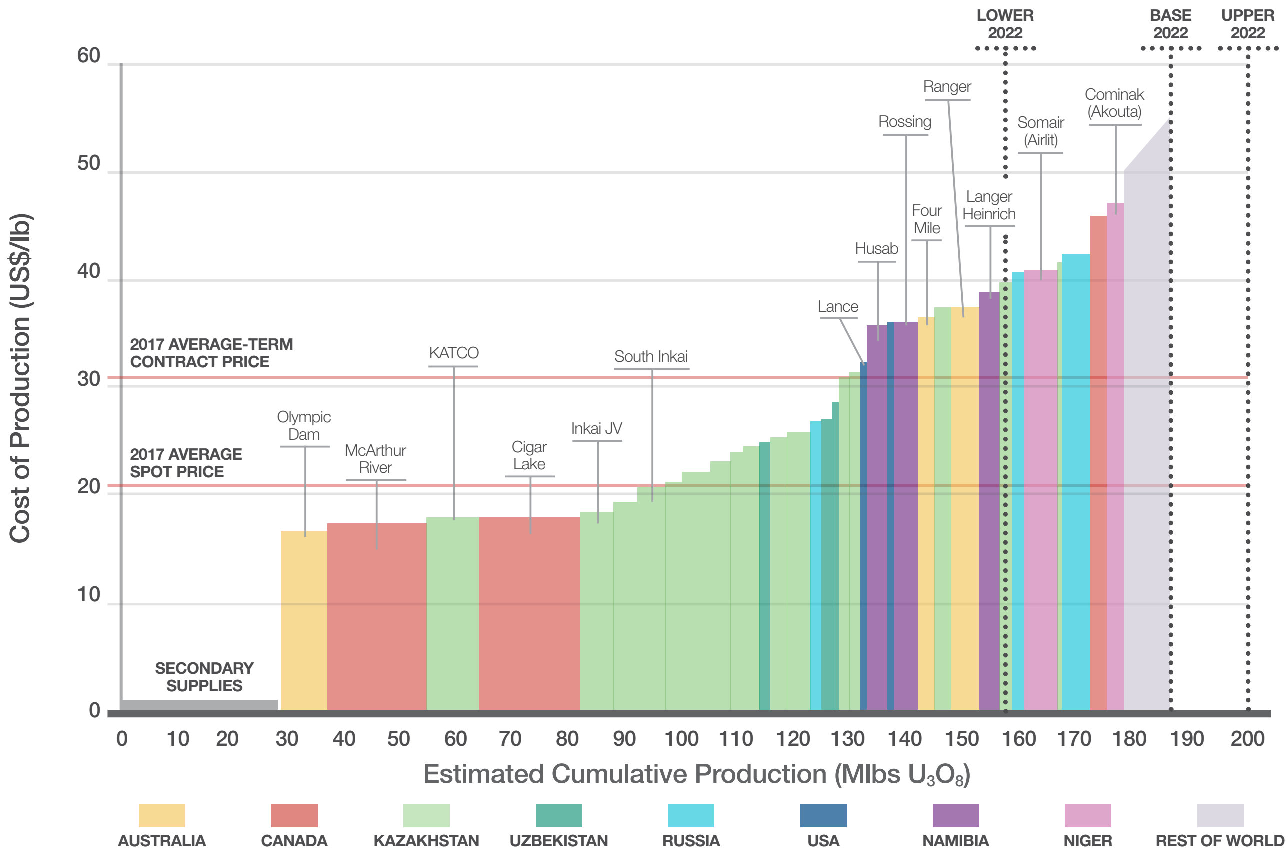


Figure 13.1: Estimated 2017 ‘All-In Sustaining Cost’ of Global Uranium Production - showing Vimy’s Demand Cases (Lower, Base, Upper)

Source: Company Data + Analysts’ Views + Vimy Calculations, US Energy Information Administration | 2016 U Marketing Annual Report

Uranium sold by Australian mining companies can only be used as fuel in nuclear reactors. Reactors typically burn circa 27t of uranium fuel for each GW of electricity produced. This requires circa 200 tonnes, or 440,000lb of UOC to go into the front end of the fuel cycle.

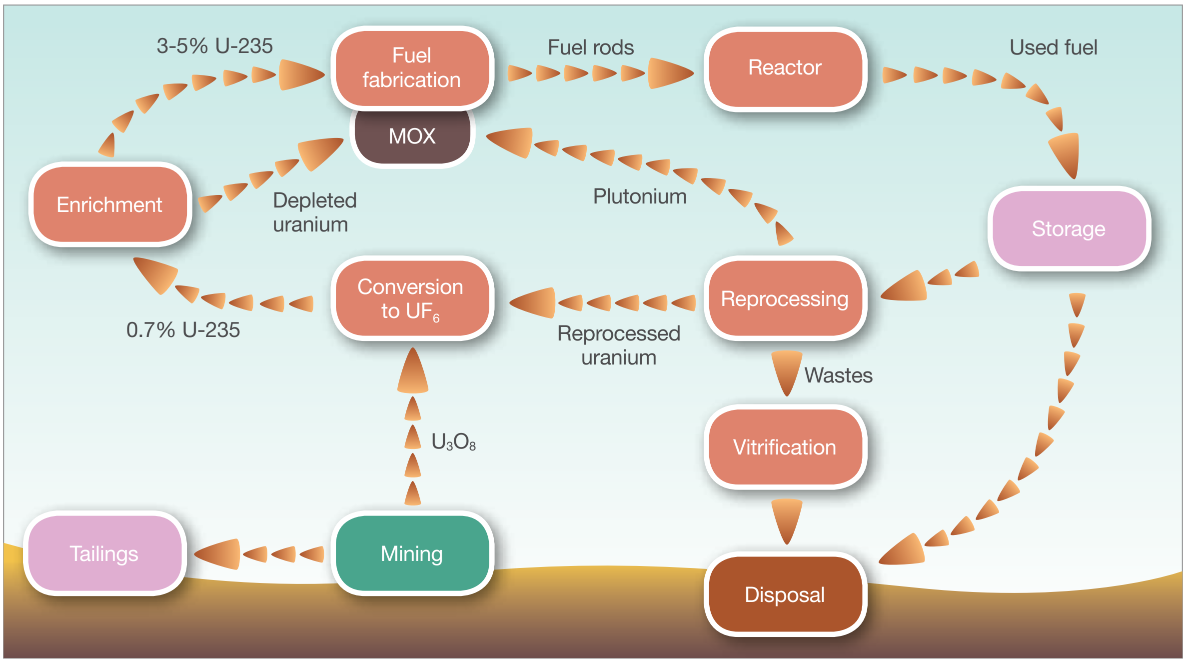


Figure 13.2: The Nuclear Fuel Cycle

Courtesy of World Nuclear Association

## NUCLEAR CAPACITY DEVELOPMENTS

Vimy has developed three scenarios (Base, Upper and Lower) for the development and growth of nuclear capacity. The Company considered the two main variables to total nuclear capacity: new reactors coming on line, and existing reactors being retired.

These are predictable factors as any new reactor coming into operation will have been through a long lead-in and once in the construction phase is subject only to possible construction delays. Reactor life is also relatively long-term and predictable, although life extensions/early retirement decisions can be made with only a few years' notice.

Refurbishments and extensions, particularly in the OECD nations with aging nuclear fleets, will certainly play a bigger role moving forward.

In completing our demand model, Vimy considered five key issues:

- The restart of Japan's nuclear reactors
  - Japan restarts 55% of its pre-Fukushima reactor fleet (26 GWe)
  - Japan will source all of its uranium requirements from existing stocks
- China's nuclear build program
  - Inland program commences from 2020
  - Chinese build capacity increases
- France's continued support of nuclear energy
  - provides 75% of France's electricity
  - Germany's experience pushes France's timing of their reduction of nuclear to 2035
- American plans to sustain its existing nuclear fleet
  - Nuclear provides 20% of electricity and 60% of its non-emitting electricity generation
  - USA comprises 26% of uranium demand; (40% from Kazakhstan, 40% from Canada)
- The adoption of nuclear energy by new players particularly in the Middle East and non-OECD countries
  - Non-OECD 'superpowers' Russia, China, and India are ramping up nuclear
  - Middle Eastern countries building and/or considering nuclear power.

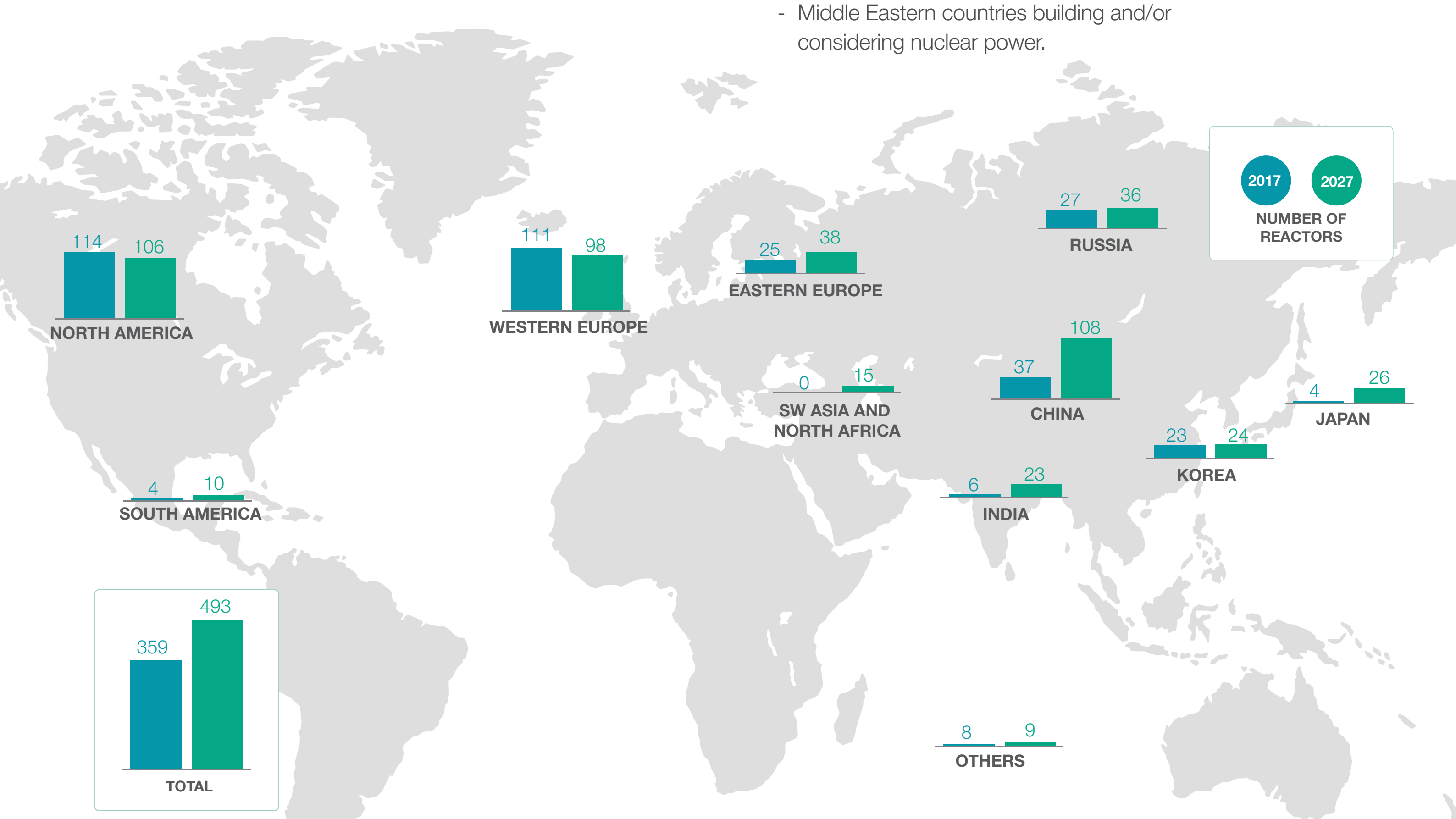


Figure 13.3: Regional Breakdown of Nuclear Reactor Growth for Base Case

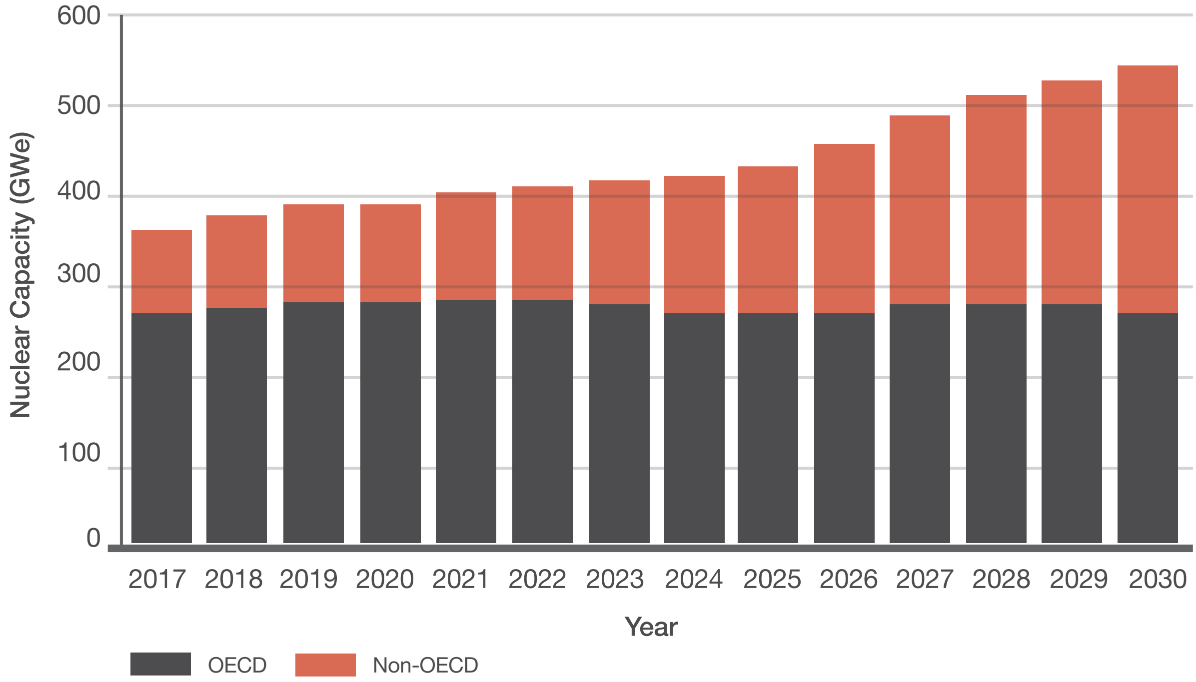


Figure 13.4: Base Case Growth (GWe) in Nuclear Capacity OECD vs Non-OECD

## DEVELOPMENT SCENARIOS

The three nuclear capacity development scenarios were then converted into three scenarios for expected demand of UOC.

The Base Case uses information from the current build programs and planned developments against expected retirements based on announced closure plans and current licencing practices. The Lower and Upper Cases then assess other variables which will cause variation from the Base. This modelling of nuclear capacity growth was done country by country and by individual reactors within each country.

The Base Case was fundamentally conservative as when a range of possibilities was assessed, the modelling used the outcome that had the lowest nuclear capacity (e.g. build times).

The Lower Case assumed all green-left political posturing would be put into effect (i.e. France, Korea), and modelled possible delays to Japanese restarts and global build start-ups.

The Upper Case assumed no politically-based closures and assumed new builds, refurbishments, and restarts being done exactly as scheduled rather than factoring in delays typical of the recent past, which was done for the Base Case.

Vimy's Base Case scenario shows 3.3% annual growth out to 2030 (compared to the World Nuclear Association's 1.7%) and is based on growth from China, India, Russia, Japanese restarts, and the Middle East. China, Russia, and Korea also have aggressive export plans to Eastern Europe and Southeast Asia.

Popular cultural pessimism about nuclear power's prospects is largely derived from the perspective of OECD economies where cheap gas and governments' financial support for renewables has undermined the economics of nuclear power as well as emboldening anti-nuclear sentiment. But growth in nuclear capacity is predominantly in the non-OECD countries that need rapidly increased electricity generating capacity without the corresponding pollution and where nuclear is in competition with coal. The difference in this outlook is starkly illustrated by comparing OECD countries with non-OECD countries as shown in Figure 13.4.

## NUCLEAR FUEL REQUIREMENTS

When assessing fuel requirements for the world nuclear fleet, Vimy considered these factors:

- Existing fleet, which uses approximately 200t of $U_3O_8$ annually per GWe;
- New builds, which have the same burn rate as the existing fleet, but require about two and a quarter years' worth of fuel in the core on initial fuelling; and
- Japanese start-ups, which do not require initial fuelling and will draw on existing stocks for the assessment period.

The timing and extent of the Japanese restarts is an inexact science. There are 4.2GWe in five reactors currently authorised to operate, and another 2.3GWe in two reactors expected to commence operations early in 2018. A further 19.9GWe have applied for restarts and are undergoing assessment; other reactors will subsequently apply over time.

As a working assumption, the Japanese restart is averaged over the next five years adding 4.4GWe each year and increasing the global fuel burn by around 10Mlbs per year by the end of 2022. However, when modelling the impact of Japanese restarts on aggregate fuel demand, Vimy assumed that Japanese restarts will only use existing stock holdings for refuelling the idled reactors and that there will be no increase in demand caused by the need to build precautionary stocks or to hold product as part of new working inventory.

Adding together overall demand for nuclear fuel as a result of the expected Japanese restart program with expected developments everywhere else results in a demand profile that commences at around 165Mlbs per annum, but grows quickly over the next decade by an average of 7Mlbs per year to reach 235Mlbs per annum by 2027.

## SUPPLY

There are two forms of supply of uranium for use as fuel in nuclear reactors - primary supplies which are stocks of uranium that are mined and sent for immediate use as fuel in nuclear reactors, and secondary supplies which are all other sources of uranium that have been mined in earlier years and held in various parts of the fuel cycle which find their way back to being used as nuclear fuel. These secondary supplies include:

- Civilian, government and military stockpiles;
- Reprocessing spent fuel (plutonium);
- Underfeeding; and
- Enriching already depleted uranium.

Primary supply of uranium is dominated by a handful of key players; Kazatomprom, Cameco and Areva control around two-thirds of the world's primary supply. All of these companies announced production cuts for 2018 which will remove about 40Mlbs of production compared to 2016 levels.

Although Cameco announced a 'temporary' ten-month suspension of mining at McArthur River, if contract prices remain low, that suspension is expected to be extended until prices have adequately and sustainably recovered. The same holds true for Areva and Kazatomprom in that the announced cuts are unlikely to be reversed until pricing fundamentals improve. Furthermore, the uranium price required to provide an economic incentive to add future production required to meet increasing demand must be substantially higher than current prices and, in Vimy's view, higher than the price required to justify a reversal of the above-mentioned cuts. Accordingly, it can be deduced that a return to full production of those assets would not cause the same oversupply situation to recur for Vimy's base demand case.

Vimy's model assumes that the production cuts are expected to last for three years before being reviewed as the market recovers and achieves equilibrium.

Secondary supplies are expected to remain relatively stable at just below 30Mlbs per annum until 2020 and then fall as a result of the expected decrease in US Department of Energy uranium stockpile transfers. Although third party forecasts suggest this will be offset by additional supplies generated by the enrichment of depleted uranium using laser technology from 2024 onwards, Vimy does not expect this to be implemented until well after 2030.

## MARKET BALANCE AND PRICE

The announced production cuts are expected to be sufficient to generate a significant market deficit with supply falling 25Mlbs and demand increasing by about 5Mlbs, turning an estimated 12Mlb surplus for 2017 into an 18Mlbs deficit in 2018. That market deficit is then expected to grow as new nuclear capacity starts up in Finland (Olkiluoto 3), South Korea (Shin Kori 4 and Shin Hanul 1-2) and the UAE (Barakah 1-4) and further Japanese restarts lead to a burn requirement that outpaces new production ramp-ups and existing miners continuing to maintain their discipline.

It is assumed that by the end of 2020, with the main producers having maintained supply-side discipline, prices will have recovered sufficiently to warrant a reversal of supply-side cuts which would be unwound over the following two to three years. However, under Base Case assumptions, nuclear capacity growth will have been sufficient to keep the market in a technical deficit, with the shortfall being met by stockpile management and drawdown. With nuclear capacity expected to show strong growth, particularly in China from the early 2020s onwards, the outlook is for growing shortages.

Vimy's view is that once long-term contract prices have reached a level around US$60/lb, the dominant supply-side participants are likely to be satisfied that prices have recovered sufficiently and that reversing the cuts will not precipitate a price collapse.

The recent relationship, post the 2007 uranium bubble, between the spot price and long-term contract price has shown an average premium for long-term prices of around 25%; this differential indicates that a spot price of around US$48/lb would be consistent with the long-term contract price of US$60/lb.

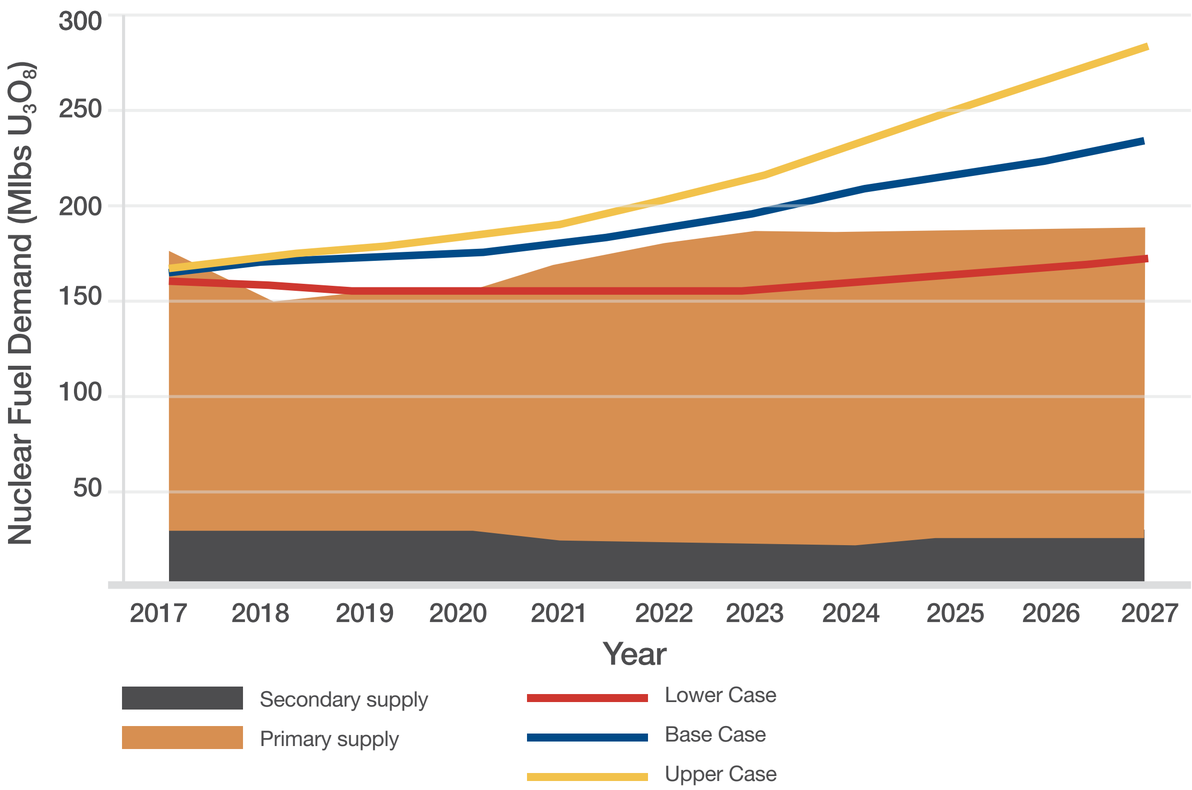


Figure 13.5: Market balance under differing scenarios

Should demand ultimately prove to be closer to Vimy's Upper Case, then a long-term price of US$60/lb is unlikely to incentivise sufficient new production to replenish depletion of existing production and to meet increasing new demand. Accordingly, at a US$60/lb long-term contract price, it is foreseeable that further deficits will occur, leading to a further escalation in prices beyond Vimy's price assumption.