TradeTech
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The Nuclear Review

October 2021 | Number **638**

Adaptation & Innovation in the Uranium Market—*An Interview with Cameco's Grant Isaac*

Building China's Nuclear Future

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Grant Isaac, Senior Vice President & Chief Financial Officer, Cameco Corp.

For three decades, Cameco Corporation (TSX: CCO | NYSE: CCJ) has been safely and reliably producing uranium and nuclear fuel products to generate electricity at the world's nuclear power plants. As one of the largest global nuclear fuel providers, Cameco tier-one operations have the licensed capacity to produce more than 53 million pounds (100% basis) of uranium concentrates annually. In addition, the Saskatchewan-based company is a supplier of uranium refining, conversion, and fuel manufacturing services. In this article, "The Nuclear Review" features a conversation with Grant Isaac, senior vice president and chief financial officer for Cameco, who discusses the company's uranium assets, tier-one production, and marketing strategies.

TNR: ***What milestone events have defined Cameco's established history in the uranium-rich Athabasca Basin in Saskatchewan?***

Isaac: Cameco has a long history in Saskatchewan's Athabasca Basin with two of our tier-one mining assets residing in the prolific basin. In the 1990s, we developed our McArthur River Mine bringing into production the largest high-grade uranium mine in the world, leveraged with the existing Key Lake Mill, which is the world's largest.

In 2015, commercial production from the Cigar Lake Mine was declared. Similar to the McArthur River Mine, the Cigar Lake Mine production also leveraged Orano's McLean Lake Mill. Initially determined to be impossible to mine, the development of both high-grade assets demanded we be innovative by developing and applying new yet deliverable approaches to underground mining. Success overcoming each challenge with innovative mining solutions always requires the full engagement of our regulators. This engagement and commitment to protecting employees, communities, and the environment translated into 10-year licenses at our Saskatchewan operations. These milestones were not easily achieved, they were hard earned by our outstanding teams.

TNR: ***What does Cameco see as adaptive and innovative trends in the uranium market today?***

Isaac: Our thanks to TradeTech for the opportunity to participate in the "Spotlight on Innovation" series. As usual, you are leading the industry by focusing on key issues like innovation. Indeed, you are practicing it yourself. The development of the Production Cost Indicator (PCI) represents the most significant innovation in price reporting we have seen. Recognizing that investments in required productive capacity are not keeping pace with demand, you identified that the problem is a classic signaling failure in the market.

The long-term uranium price had become unmoored from the realities of project delivery and production economics. An oversupplied spot market had pulled the term price down to be the forward price of surplus spot material. Clearly, you saw the negative consequences for our industry. Low prices have prevented investment in the productive capacity that is indisputably required in the future resulting in a structural gap (**Figure 1**).

Why is this so important? As the global climate crisis has driven the challenge of achieving net-carbon zero targets, a global energy crisis has now taken hold. Nuclear power has an unparalleled opportunity to expand delivery of carbon-free, secure, reliable,

and affordable energy. We would argue that the future of nuclear power has never been more promising. Key to this future is a stable nuclear fuel cycle. However, persistent price signaling failures have created a worrisome structural gap between productive capacity and demand. Investments that need to occur now, to be available to meet the future demand, are not being made due to insufficient price signals. A global supply chain crisis adds a more immediate risk. It would be tragic if improper price signaling today meant that nuclear power's tremendous opportunity was constrained because of doubts about the stability and reliability of the nuclear fuel cycle.

Building on the PCI innovation, you are now tackling the hard realities of project delivery and production in the uranium segment and providing the roadmap for long-term supply stability. You are posing the tough questions such as: what is a tier-one producer, what is a tier-one asset, what is the role of ESG (environmental, social, and governance) factors and innovation in uranium supply. You are shining a light on both the tremendous opportunities and, more importantly, the significant challenges that the uranium supply side faces in meeting the demand of the future. We are pleased to provide our views on these crucial questions.

TNR: ***What are the key points that customers and investors should know about Cameco today?***

Isaac: Customers and investors know that our strategy—based on experience with every market transition—creates the combination of operational flexibility, market alignment, and financial strength required for full-cycle value capture and security of supply.

Cameco is a leading commercial tier-one producer with proven tier-one uranium and fuel service assets achieving outstanding ESG performance. We are continually innovating to improve the efficiency and reliability of our supply. Customers and investors alike can count on us to do what we say we will do, to deliver on our commitments and, ultimately, to provide them the long-term value they are both expecting with the comfort of knowing that we will responsibly manage risk.

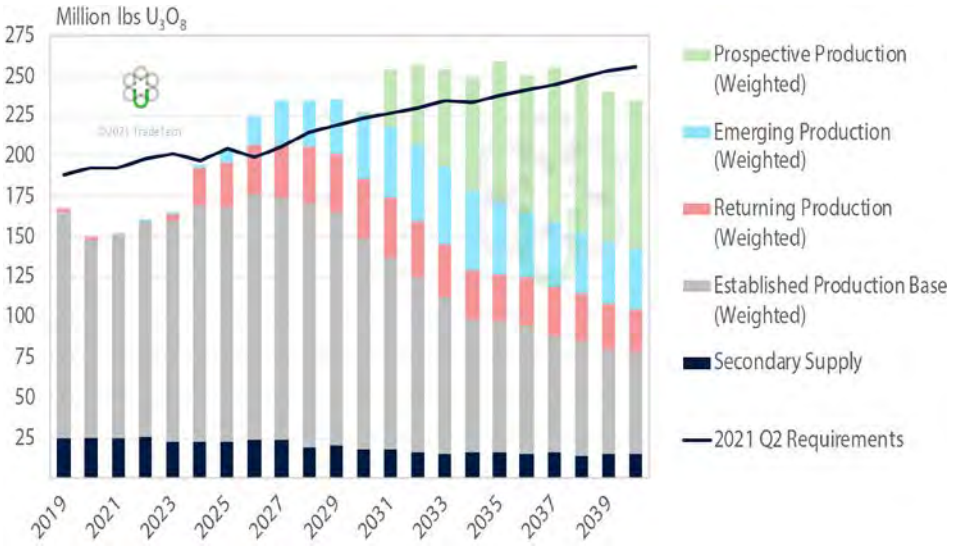

Figure 1 **Uranium Supply & Demand through 2040, TradeTech Forward Availability Model 1**
Source: TradeTech

TNR: ***It is common to hear terms such as "Tier-One Uranium Producer" to describe actual or potential uranium producers. What attributes—geological, engineering, regulatory, socioeconomic, environmental, managerial, and market-related—distinguish Cameco as a "Tier-One Producer"?***

Isaac: A tier-one producer is proven, it is not simply promised and promoted. To answer this question, let's remember that the uranium market structure is principally based on term contracts covering the annual run-rate requirements of nuclear power plants with a small spot market to serve discretionary demand. The market has suffered through a decade where uncommitted primary production without a contract home has swamped the spot market. Consequently, the term price, which is supposed to reflect the full costs of productive capacity, collapsed to be nothing more than the forward price of surplus spot material.

A tier-one producer understands the structure of the uranium market and the negative impacts of uncommitted primary production. It understands that having a great resource base is a necessary but far from a sufficient condition for value capture and supply stability. Along with a great resource base, a tier-one producer is a proven and reliable operator with a record of honouring annual term supply commitments. A producer with extensive licensing, permitting, and operating experience. A tier-one producer is vertically integrated with tier-one assets in key segments of the nuclear fuel cycle, with verifiable performance across ESG metrics. A tier-one producer retains the financial capacity to self manage risk and position for opportunity. Crucially,

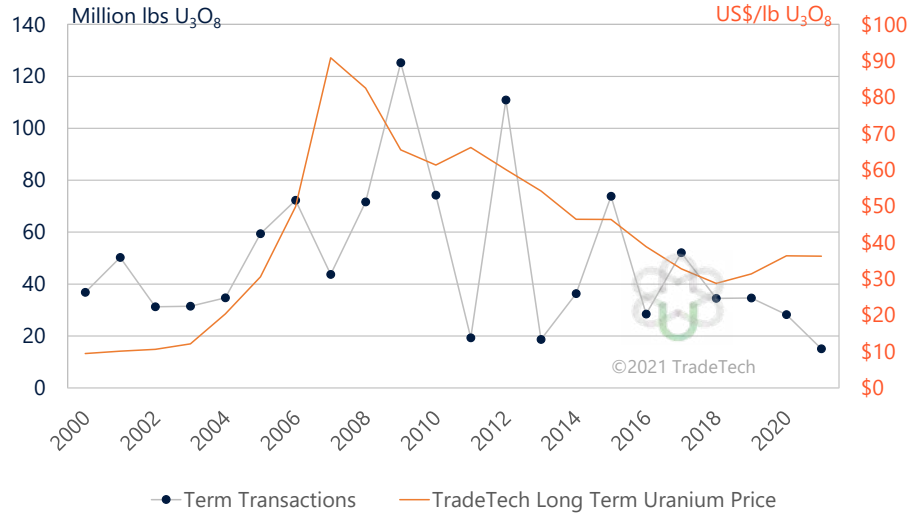

Figure 2 **Term Contract Volumes vs TradeTech's monthly Long-Term U_3O_8 Price, 2000 – 2021**
Source: TradeTech

a tier-one producer has a market alignment contract strategy, carefully planning production decisions to match cyclical term contract market opportunities from end users.
A tier-one producer recognizes the uranium market structure and does not build and operate productive capacity exposed to the discretionary spot market; time and time again this strategy of uncommitted primary production has represented nothing more than a threat to sustainable supply as significant value transfers from the supply-side of the market (whether private or state investors) to the demand side of the market (well-informed fuel buyers capturing the value of an oversupplied spot market).

A tier-one producer has proven, reliable, long-term supply and value creation. Confusing promises and promotion with proof risks creating a false sense of security in the long-term stability of the nuclear fuel cycle.

TNR: ***You state that a tier-one producer recognizes the uranium market structure and does not build and operate productive capacity exposed to the discretionary spot market. Can you explain what this means?***

Isaac: Since spot is not the market, true contracting value is only captured and measured full cycle. As noted previously, the uranium market structure is one where the vast majority of run-rate fuel requirements are procured under term contracts with only a small, discretionary spot market. This market structure serves the reality that nuclear power is largely baseload electricity and the fuel supply is a relatively small proportion of overall operating costs compared to other sources of baseload like natural gas and coal.

The current energy crisis and spiking energy prices are clear evidence of this reality. The uranium price signaling failure was caused by persistent and poorly timed primary production with no contract home being dumped into the under-sized spot market. The long-term price broke from being a reference to production economics and settled out to be the forward price of surplus spot material. There is no indication that the uranium market structure is breaking from a term-contract market and to a fully spot market. In fact, replacement-rate contracting cycles (where annual contracted volumes equal or exceed annual uranium consumption) restores the dominance of the term market over the spot market.

It is strategically foolish to position productive capacity to be exposed to the discretionary demand of the spot market, which has neither the size nor the transaction frequency to absorb uncommitted primary production without being rapidly value destructive for both investors and for the industry. Clearly, it is strategically wise to position for contracting in the cyclical term market (**Figure 2**).

The industrial structure of the nuclear fuel cycle, often overlooked, is also critical to understand. About half of the current and potential future uranium supply could be categorized as tier zero; supply that historically has not responded to price signals and should not be expected to in the future. It just comes to the market. And, during low levels of term contracting, it comes to the spot market. Tier-zero suppliers have ranged from diversified mining companies with uranium as a by-product to state-owned enterprises with production volume strategies or, more damaging to price signals, strategies to serve state nuclear power ambitions with low-cost fuel.

The great news for Cameco is that the tier-zero supply is not sufficient to meet all of the demand. Commercial, price-sensitive supply is definitely required. But it is strategically foolish to assume that the tier-zero supply will adjust to the commercial supply. Instead, it is critical for commercial suppliers to have a clear market alignment strategy and to make full-cycle contracting decisions locating productive capacity in the available commercial space, capturing

maximum value while not contributing to value destructive spot oversupply.

At Cameco, our contracting decisions account for the market structure, the industrial structure and the distinct cyclicality at the front end of the nuclear business. We capture maximum value for our investors, provide maximum supply reliability for our customers, and fuel clean, carbon-free baseload electricity over the full cycle.

TNR: ***When we look at Cameco's average realized price we see that it outperforms the market over the cycle. Can you talk about the drivers behind your performance, contracting decisions, and achieving investor support?***

This question is really about the alignment of industry and investor interests in the supply of nuclear fuel. A stable fuel cycle needs investors willing to support the return and expansion of commercial uranium production. There is a lot to unpack so let's examine this in detail.

For investors, the role of nuclear power in a net-carbon zero world amplified by a current energy crisis creates tremendous investment opportunity. Over the next decade, current productive capacity equals only about 70 percent of the run-rate requirements. Thirty percent of the requirements need new production. The imbalance only grows over a 15- and 20-year outlook. As 100 percent of the future demand chases the 70 percent of productive capacity currently available, a term-contracting cycle will occur. During the contracting cycle, the term price will anchor to the production economics. More likely, during a contracting cycle, the price may shoot well above the production economic level for a brief period of time. Incumbent producers with actual supply capture the value from these price levels, which are reflected in multi-year term contracts . However, in the past, this price overshoot has also incentivized investment in excess productive capacity based upon the belief that prices will remain at these levels permanently. Given the time frames between mine investments and actual production, this productive capacity misses the contracting opportunity and shows up after the demand has been captured by incumbent producers. This homeless capacity is now exposed to the spot market and becomes rapidly value destructive for investors and destabilizing for the fuel cycle as these producers cannot survive the spot exposure.

> ***"A tier-one producer has proven, reliable, long-term supply and value creation. Confusing promises and promotion with proof risks creating a false sense of security in the long-term stability of the nuclear fuel cycle."***

The distinct cyclicality of term contracting means that investors are rewarded by the cash flow generated from a commercial producer's contract portfolio that is leveraged to higher prices and protected from lower prices. Long-term investors understand the term contracting cycle and understand that uranium assets must be managed with a market alignment strategy and contracted for full-cycle cash flow generation. These investors understand that spot is not the market and that building commercial productive capacity without a contract home results in price-destructive spot exposure undermining the value of the assets. These investors underpin the stability of commercial nuclear fuel supply.

Obviously, not all investors are long-term. Some recognize that the supply and demand imbalance will, once again, drive rapid price improvement which, of course, supports the share price of producers and, disproportionately, the share price of potential producers. The goal is simply to participate in this capital gain with no conviction to stay invested full cycle. Without full-cycle conviction, these investors are often unconcerned what happens to the contract portfolio of a commercial supplier in a price-off cycle as they don't intend to participate in it.

A proper functioning capital market fundamentally requires both type of investors (and all those in between). However, commercial producers, advanced exploration companies and, indeed, other investors must be careful to ignore inaccurate and misleading statements from short-term investment pundits on crucial matters such as what constitutes appropriate uranium fuel cycle contracting. Perhaps these statements may simply reflect a genuine lack of knowledge about the role of the discretionary spot market in the overall market structure.

Perhaps more likely, these statements may be purposely aimed to target and take advantage of new investor interest— such as the new interest from clean energy investors or from social platform investment communities— to encourage these investors to follow into particular investments only to be

abandoned as the investment pundit exits the space when a return goal is achieved.

An extreme example is a recent call for a US$200 per pound uranium price in a market that breaks 100 percent to a spot market. Certainly, supply and demand shocks can cause very high uranium prices. But confusing a potential shock event with supply and demand fundamentals is profoundly naïve. It ignores the realities of the nuclear fuel cycle's market structure, industrial structure, and distinct cyclicality. It ignores global geology. It completely lacks a robust, transparent, and verifiable empirical analysis capable of withstanding the scrutiny of real market experts. It completely lacks a credible (or even a non-credible) third-party analysis supporting it.

This empirically empty belief made by investment pundits who try to create the impression they are experts (or are associated with experts) is then used to encourage investment in advanced exploration projects promoted for spot exposure. This advice has been proven terrible for both investors and commercial producers since spot exposed productive capacity is price destructive. Yes, if timed perfectly, the spot exposure may enjoy briefly high prices on small volumes, but it is the spot exposure itself that sets in motion the price-off cycle and the ensuing value destruction. This advice represents a doubling down on the disastrous spot sales strategies that caused the price signaling failure in the first place. It can only be understood as ill-informed hyper-promotion that should be wisely ignored.

For Cameco, the facts matter and the facts are clear. Responsible contracting decisions recognize the market structure, the industrial structure, and the cyclical nature of the nuclear fuel cycle in order to capture maximum value for investors while providing maximum supply reliability for customers over the full cycle. Real value is created by building a contract portfolio that supports the operation of productive assets, is leveraged to greater returns as prices increase, and provides downside protection during periods of lower prices. Therefore, to create long-term value, we manage our contract portfolio by layering in volumes over time and in accordance with market conditions as they cyclically evolve. This approach has proven beneficial, as our average realized price has exceeded the uranium spot price for many years through the recent market downturn.

> *"Responsible contracting decisions recognize the market structure, the industrial structure, and the cyclical nature of the nuclear fuel cycle in order to capture maximum value for investors while providing maximum supply reliability for customers over the full cycle."*

Given our current market view, our preference is for market-related pricing mechanisms leveraged to rising prices. There are a number of additional contract factors we also must consider—duration, volume, product form, region, and customer—to ensure we have a diversified portfolio. In this environment, contracts may contain hybrid pricing mechanisms, a mix of base-escalated and market-related prices, that reflect current and expected market conditions.

As the market improves, we will continue to layer in volumes capturing greater upside using market-related pricing mechanisms. We don't just ride the spot market curve, we lock in multi-year value at higher prices to support cash flow over the cycle, always with a view to our preference for a contract portfolio with a 60/40 split of market-related and fixed-price (escalated to time of delivery) contracts.

We have seen in the past, when the uranium market price improves, the investor focus obviously shifts from our currently committed contract volumes that have provided down-side protection and to a focus on our yet uncommitted contract volumes that have remained strategically leveraged to higher prices and that provide maximum cash flow from tier-one production (**Figure 3**). Investors with a clear understanding that spot is not the market gravitate to producers whose contracting strategies align with full-cycle value creation. These strategies have proven to achieve maximum value creation and long-term fuel supply stability.

TNR: ***Recently, we've seen the financial funds return to the uranium market. How does the introduction of these entities affect the market structure and influence supply and demand fundamentals?***

Isaac: Further stressing the supply-demand imbalance is the return of financial funds to the physical uranium space, including the Sprott Physical Uranium Trust, the Yellow Cake Investment Fund, the Uranium Royalty Corp., and Kazatomprom's recent announcement of the ANU Energy Fund.

We have seen financials position in physical uranium previously. However, there are some very important differences that seem to signal that the

managers of these particular physical funds understand the uranium market structure and have set strategies accordingly. First, there appears to be a focus on spot purchasing of pounds of uranium already "in the can" versus forward purchasing that simply incentivizes undisciplined suppliers to continue to produce material without a home. Second, the ability to raise fresh capital on a daily (or regular) basis directly imputes the view of investors on what the production economic price of uranium should be. That is, if investors collectively view the current uranium price as low, the funds will have access to capital that can quickly be converted into spot purchases of the perceived low-priced uranium. Third, the sequestered nature of the purchased material, ranging from a non-redeemable trust to funds with lock-up periods, prevents the initial spot purchasing demand surge from quickly becoming a supply surge of spot selling as we have seen in the past.

Financial funds with a clear focus on how the uranium market actually works, and the investors supporting them, are already playing an important role in further sequestering uranium and restoring the term price to reflect production economics.

TNR: ***TradeTech advocates that interpretations of a "Tier One" project can mean very different things to different people; whether they be a member of the general public, an investor, a promoter, a geologist, or an end-user nuclear utility. How might different peoples' perception of asset quality affect the timely development and availability of primary uranium concentrates to the future uranium marketplace?***

Isaac: A tier-one asset is demonstrated, it is not simply discovered and declared.
A uranium mining asset is tier-one only when a discovered resource has been properly permitted, when stakeholder support has been achieved, when the development project is delivered, when production is successfully commissioned, when actual performance can verify the production costs and the ESG achievement, and when the uranium is properly marketed and delivered into a contract home. Only then an asset is tier-one in terms of value capture and sustainable supply.

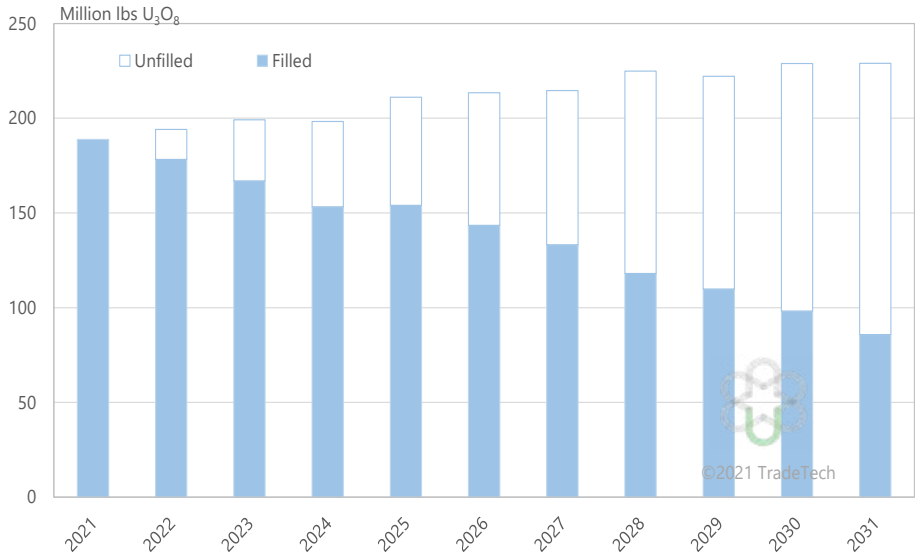

Figure 3 **Uncovered Uranium Requirements, 2021 – 2035**
Source: TradeTech

In many cases the declaration of a tier-one asset is made prematurely. Too often a false equivalency is drawn between various asset evaluations ranging, for example, from a preliminary economic analysis, to a prefeasibility study, to a definitive feasibility study (DFS), and to a technical report. To be clear, these are not equivalent. The first three represent an incomplete portrait of an asset when all of the material technical, regulatory, stakeholder, project, operating, and market challenges remain ahead.
In some cases, the declaration of a tier-one asset is made a decade or more before first production can be realistically hoped for and before any production is sold into a contract home. The declaration is made before technical evaluations are complete, and before regulatory submissions, let alone regulatory decisions, are made. Before stakeholder support is obtained. Before the project schedule and budget have been tested in the harsh reality of real project delivery. The declaration is made on a study that is but a moment in time and incapable of capturing dynamic change to all of these factors, for example, project inflation, increasing regulatory requirements, or increasing stakeholder scrutiny. Only a technical report on an operating material asset represents a demonstration of performance after all of these factors have been addressed.

Because of these factors, uranium assets that leverage brownfield infrastructure tend to produce more certain supply and value capture—for customers and investors alike—than greenfield. They benefit from existing physical and human capital infrastructure. They benefit from licensing and permitting experience, as well as established stakeholder relationships. They benefit from customer confidence in the

predictability, certainty, and financial capacity to deliver on annual product commitments. They benefit from layering into existing contract portfolios while removing the uncertainty and potential market distortion of uncommitted primary production.

To go a step further, pureplay uranium assets tend to produce additional value capture because unlike co-product or by-product uranium streams, production from pureplay uranium assets does not vary with the price signals from unrelated commodity markets like copper and gold, again, driving customer confidence in the predictability and certainty of annual product delivery.

More recently, the industrial structure of uranium supply in the nuclear fuel cycle has come under pressure from both countries and from financial markets grappling with where the uranium is coming from and who is supplying it.

For countries, the geopolitical focus on the supply of critical minerals, including uranium, means that origins increasingly matter and so too does the governance of the entity supplying the minerals, whether a commercial enterprise or a state-owned enterprise (SOE). The critical mineral arguments seem to range from the risk that an SOE makes non-commercial supply decisions that can disrupt the proper functioning of commercial markets to the risk that an SOE makes decisions that are part of a broader national geopolitical objective that may not be aligned with objectives of the importing country. Various policy measures—trade policy (e.g. tariffs or quotas) and industrial policy (e.g. strategic nuclear fuel reserve)—have been contemplated in key nuclear power markets to deal with a real or perceived vulnerability of the clean energy infrastructure.

For financial markets, the focus on green or sustainability-linked financing means increasing scrutiny on the origin of fuel products and their production in accordance with a comprehensive set of ESG metrics that have often not been a priority in some jurisdictions and by some entities supplying uranium.

Clearly a tier-one asset is demonstrated across a significant range of technical, stakeholder, commercial, geopolitical, and ESG factors, and is not simply discovered and declared. Confusing discoveries and declarations with demonstrable and dependable supply can risk the long-term stability of the nuclear fuel cycle by prematurely locating assets in the global supply stack and improperly locating them on the global cost curve (**Figure 4**).

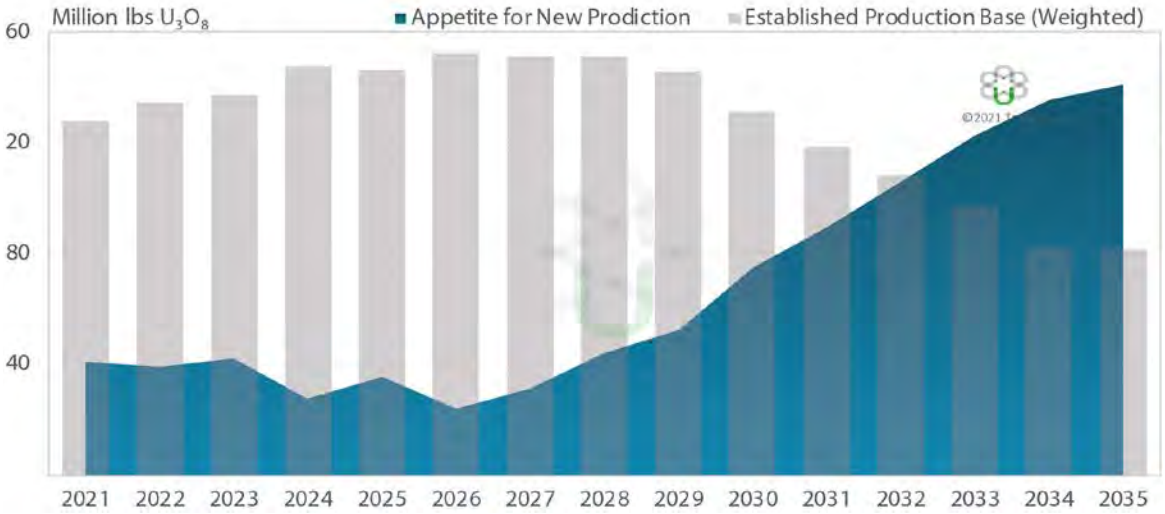

Figure 4 **Appetite for New Uranium Production**
Source: TradeTech

TNR: ***Managing all matters concerning Environmental, Social, and Governance (ESG) is critical to maintaining buyer and shareholder support in today's industry. Over the last decade or so, how has Cameco managed the ESG risks and opportunities that have the potential to significantly impact its business?***

Isaac: One of the most exciting developments is the focus on ESG factors, which contribute to a durable demand improvement for clean nuclear power by driving electron accountability. It also shines a light on a true competitive advantage for Cameco.

Let's start with electron accountability. The "E" of ESG has been focused on the adoption of net-zero carbon targets by countries and companies turning attention to a profound triple challenge. The challenge to lift one-third of the population out of energy poverty by growing reliable and clean baseload electricity. The challenge to replace 85 percent of the current global electricity grids that run on thermal power with a clean alternative. The challenge of then growing the global grids further by electrifying industries, such as private and commercial

transportation, home, and industrial heating, which are largely powered with thermal energy today—all while achieving net-carbon zero. Hard targets mean that countries and companies cannot simply dodge responsibility for the how the electrons are produced. There is now accountability.

The challenge of achieving net-zero carbon targets has recently been joined by widespread energy reliability and affordability crises. The energy crises have drawn welcome attention to the reality that energy policy must balance the three objectives: a clean emissions profile; a reliable and secure baseload profile; and an affordable levelized cost profile. Too much focus on one at the expense of the other two has left some jurisdictions struggling with power shortages and spiking prices. Nuclear power is extraordinarily well positioned to address electron accountability with its clean emissions profile, while simultaneously achieving a reliable and secure baseload profile and a low-cost profile. It is no wonder we are witnessing a growing and durable support for nuclear power.

ESG metrics are familiar territory for us. Serving the interests of our stakeholders has always been at the heart of what we do. We do this not only because it adds significant business value but also because it is simply the right thing to do. Our relationships with our workforce, Indigenous Peoples, and local communities are fundamental to our success as a reliable, long-term supplier. The protection of our workforce and the public is our top priority in our assessment of risk and planning for safe operations and product transport. To deliver on our vision to energize a clean-air world we invest in programs to attract and retain a diverse, skilled workforce dedicated to continuous improvement and committed to our values.

We have a long history of working collaboratively with Indigenous Peoples and local communities wherever we operate, exemplified by the long-term relationships and numerous mutually beneficial agreements we have with Indigenous Peoples in Canada and Australia. We believe that Indigenous Peoples and local communities should benefit from resource development on or near their communities or traditional lands through employment, training, business opportunities, community investment, and environmental stewardship. We tailor our engagement approach across our operating areas to reflect the needs of the local communities.

> ***"Confusing discoveries and declarations with demonstrable and dependable supply can risk the long-term stability of the nuclear fuel cycle by prematurely locating assets in the global supply stack and improperly locating them on the global cost curve."***

Protection of the environment is one of our highest corporate priorities during all stages of our activities from exploration through development, operations, decommissioning, and reclamation. Environmental stewardship is embedded in how we operate. We strive to be increasingly efficient in our use of resources and we work to minimize our impacts on land, water, and air consistent with the ambition of the Paris Climate Agreement to limit global temperature rise.

Across our operations, we comply with strict regulations and have systems in place to monitor and mitigate our impacts. In addition to our own rigorous environmental monitoring, we collaborate with communities around our operations to give confidence to local communities that traditionally harvested foods remain safe to eat, and water remains safe to drink. In 2020, the Mining Association of Canada awarded Cameco one of its prestigious Towards Sustainable Mining® Excellence Awards, in recognition of the Community Based Environmental Monitoring Program and its innovative focus on bridging traditional and scientific knowledge.

We believe that sound governance is the foundation for strong corporate performance. We are dedicated to our core value of integrity and apply high standards of ethical behavior and transparency to our business activities. We have a suite of policies, programs, and practices to manage and protect our systems, information, and assets.

We're very proud of our over 30-year commitment to protect, engage, and support development of our people and their communities and to protect the environment. The only thing new is the moniker—ESG.

TNR: ***How will Cameco's investment in innovation foster a more flexible asset base and, given the company's market outlook, why is this necessary?***

Isaac: Our investments in innovation are designed to achieve three inter-related objectives. First, since a tier-one producer has a market alignment contract strategy, innovation is required to optimize production flexibility to match term contract opportunities as efficiently as possible. Typically this means creatively transforming

traditional fixed costs into variable costs; costs that vary with the level of production desired.

A classic example is ventilation in our high-grade mines. Innovations in ventilation-on-demand allows us to target ventilation to active mining and development areas rather than the full mine workings. Fixed ventilation costs become activity-based variable costs. Second, a more efficient operation has lower costs for energy consumption, lower input costs such as chemical reagents and lower indirect costs such as flight and camp management costs. Current inflationary pressures simply amplify the critical need to invest in innovations that gain efficiencies. Third, a more efficient operation has lower energy consumption improving our environmental performance and, hence, improving our overall ESG performance.

TNR: ***Innovation is not simply restricted to technology and changes in the way that uranium is physically recovered; it can apply to a company's operating structure, team management, business strategy, and shareholder engagement. What innovations have Cameco implemented at the corporate level to remain competitive and resilient amid challenging market conditions?***

Isaac: An innovative tier-one producer with tier-one assets fundamentally recognizes that its business strategy is executed by an outstanding team. To support our team our top priority remains safety.

While we speak a lot about return on investment, return on capital, etc. there is no return more important than the safe return home of our team after every shift. Epitomizing this commitment was our curtailment of production at the Cigar Lake Mine, as well as at our Fuel Services facilities during the early days of the COVID-19 global pandemic (**Figure 5**). To protect our employees, their families, and their communities, prior to effective testing and before vaccines were developed and distributed, we curtailed production in order to implement the industrial protocols required to ensure proper screening and provide safe travel, camp, and workplace conditions for our employees. This was the right thing to do. It was costly but safety was the priority.

Figure 5 **Cameco's Fuel Manufacturing Facility, Ontario, Canada**
(A state-of-the art robotic arm assembles natural uranium fuel bundles)
Source: Cameco Corporation

During this time of production interruption we did not miss a single delivery commitment. Additionally, corporate culture innovation is focused on critical areas like mental health, diversity, and inclusion, as well as gender-based pay equity.

Addressing these foundational areas makes us resilient and competitive, which is clearly required in the dynamic nuclear fuel market. Looking ahead, improving our digital culture, in terms of the identification and adoption of processes and tools that streamline our operating structure and enhance our team engagement, is a priority.

TNR: ***Advanced exploration companies are proposing large-scale projects with relatively shorter production lifetimes in the less infrastructure-rich southwest portion of the Athabasca Basin. What hurdles—including engineering, tails management, permitting, ascertaining a social license to operate and marketing—might one encounter with such operations?***

Isaac: As a tier-one producer that has built and operates mines in the Athabasca Basin, our experience suggests it is a high-risk journey to develop a greenfield uranium mine and mill with the required supporting infrastructure. Before placing greenfield projects in the global supply stack and cost curve a careful risk assessment must be undertaken. If not, the long-term stability of the nuclear fuel cycle can be jeopardized, as productive capacity is not brought on in the time frame outlined by aggressive assumptions.

The mining industry is rife with examples of technical and project delivery realities that prove proposed timelines and cost estimates of development of assets were aggressive

due to an improper risk assessment. In the case of uranium mining in the southwest of the Athabasca Basin, these realities are exacerbated by the required development of significant supporting infrastructure. Achieving the necessary regulatory approvals typically takes more time and attaches further requirements than anticipated, which impacts the schedule and cost estimates. The more novelty proposed, naturally, the more time required to develop a proper regulatory framework and assess a project against that framework.

Attaining support from impact communities to proceed with a project is critical. More than a voice these communities have traditional connections and clear rights to be involved in the projects that must be respectfully considered in order to achieve support. And, this support is not guaranteed for the life of the project or the life of the operation. It must be maintained by continually delivering on the commitments made. If cost and schedule estimates prove unrealistc, investor expectations are not met, and financing challenges can emerge, which creates second-order impacts on cost and schedule.

These hurdles are common to all mining projects. Uranium mining projects have the additional hurdle related to properly timing the delivery of production to match the timing of a term contracting cycle. Certain long-term supply requires certain long-term contracts. Building productive capacity in order to sell as uncommitted primary production into the spot market fails to achieve the value promised. This puts the sustainability of the producing entity at risk and, hence, the long-term stability of the nuclear fuel cycle that counts on that source of supply.

In a market structure dominated by long-term supply commitments, leveraging brownfield infrastructure to expand productive capacity or developing greenfield capacity that can be streamed into an existing contract portfolio has proven to be the best approach to mitigating the risk of project delivery and market cycle hurdles.

TNR: ***How is the deposit geology at the Cigar Lake Mine best described? From a technical perspective, what advantages and challenges does the geology present?***

Isaac: The Cigar Lake deposit has similarities to the McArthur River deposit in its geological setting, including the location at the unconformity between the permeable sandstone which contains large volumes of water at significant pressure and basement rock. The Cigar Lake deposit is flat lying atop the basement rock. The very high-grade ore means that it can produce 18 million pounds (100% basis) per year by only mining a few hundred tonnes of ore per day. (**Figure 6**).

The main challenge to mining at Cigar Lake was to develop and implement a mining method where all required mining infrastructure is located in the competent basement rock below the orebody. The extraction and processing of the ore must also be done from below the orebody. The highly innovate jet boring system—mining with high pressure water—has been developed, successfully deployed, and subsequently optimized to effectively meet the challenge of mining Cigar Lake. Not only was this an innovative feat, it also represents the time required to obtain regulatory approval for mining uranium with an innovative approach; it took over six years to obtain the full approval to mine with this technique.

Innovations in uranium mining methods are always subject to a time-consuming precautionary principle. Even the ones that, in fact, are not a significant departure from proven underground mining techniques.

Additionally, the presence of water in the sandstone requires innovative

Figure 6 **Cigar Lake Uranium Mine, Norther Saskatchewan, Canada**
Source: Cameco Corporation

use of freezing technology that both immobilizes the water and provides ground support, as well as pumping capacity on standby, in the event that water penetrates the mine workings.

TNR: ***What innovative technologies have Cameco developed to overcome geological and mining-related challenges at the Cigar Lake Mine?***

Isaac: The geology of the Athabasca Basin that gives rise to very high-grade deposits creates a number of mining challenges. As a result of these challenging conditions, we are unable to utilize more traditional mining methods. Instead, mines like Cigar Lake have become hotbeds of innovation.

As mentioned, the permeable sandstone that overlays the deposit and basement rocks contains large volumes of water under significant pressure. From surface, we freeze the ore zone and surrounding ground in the area to be mined to prevent water from entering the mine, to help stabilize weak rock formations, and meet our production schedule. This system freezes the deposit and underlying basement rock in two to four years, depending on water content and geological conditions.

We have identified greater variation of the freeze rates of different geological formations encountered in the mine, based on information obtained through surface freeze drilling. To manage our risks and to meet our production schedule, the area being mined must meet specific ground freezing requirements before we begin jet boring. Bulk freezing reduces but does not eliminate the risk of water inflows.

Artificial ground freezing is accomplished by drilling a systematic grid of boreholes through the orebody from surface. A network of supply and return pipes on surface convey a calcium chloride brine to and from each hole. The warm brine returning from each hole is chilled to a temperature of approximately -30°C at the surface freeze plant and recirculated.

Once frozen, to mine the orebody we use the jet boring mining method. This non-entry mining method has been innovatively developed and adapted specifically for this deposit. This method involves:

- drilling a pilot hole into the frozen orebody, inserting a high-pressure water jet, and cutting a cavity out of the frozen ore; collecting the ore and water mixture (slurry) from the cavity and pumping it to storage (sump storage), allowing it to settle;
- using a clamshell, transporting the ore from sump storage to an underground grinding and processing circuit;
- once mining is complete, filling each cavity in the orebody with concrete; and
- starting the process again with the next cavity.

Mining is carried out from headings in the basement rock below the deposit, so employees are not exposed to the ore. This mining approach is highly effective at managing worker exposure to radiation levels. Combined with ground freezing and the cuttings collection and hydraulic conveyance system, jet boring reduces radiation exposure to acceptable levels that are well below regulatory limits.

> *"A tier-one producer is vertically integrated with tier-one assets in key segments of the nuclear fuel cycle, with verifiable performance across ESG metrics, while retaining the financial capacity to self manage risk and position for opportunity."*

TNR: ***Since first commissioning in 1999, how has the evolution of resources and reserve geology at the McArthur River Mine driven changes in the way the deposit is mined?***

Isaac: The mineral reserves are contained within seven zones at McArthur River. As each zone can have different properties, mine designs and mining methods are selected based on the ability to mitigate hydrological, radiological, and geotechnical risk. Access to the ore, stability of the rock, and the impact on the freeze wall are key determinates. We have three approved mining methods; however, over time we have moved to using only two methods: raisebore and blasthole stope mining.

TNR: ***How is the implementation of digital and automation technologies at the McArthur River Mine set to support its restart?***

Isaac: We expect that digitization and automation will help us be more flexible with our production. This will allow Cameco to align production with market opportunities. We have used the time while the operations are not running, as this is the optimal time, to examine every procedure and pull apart every process. When the McArthur River Mine and the Key Lake Mill return to operation, we expect they will be more flexible from a production point of view, will run more efficiently in terms of input costs and, consequently, will require lower energy consumption than previously (**Figure 7**).

TNR: ***Over the last 18 months, several (Re)Emerging uranium companies have published***

Figure 7 **Key Lake Uranium Mill, Saskatchewan, Canada**
Source: Cameco Corporation

consecutively lower uranium production costs in successive feasibility studies. As an experienced uranium producer, how does Cameco's interpretation of cost disclosures promoted by newcomers to the industry align (or diverge) from the realities of operating a successful mine over its full life cycle?

Isaac: As mentioned previously, a tier-one asset is demonstrated not simply discovered and declared. There is no comparability between a feasibility study and a technical report that is based upon actual mining experience. A feasibility study represents a mere snapshot of a project before any real work has begun. Just as we don't crown the champions in various sports leagues based upon their team roster before a single game is played, it is entirely premature and unwise to confuse even a DFS with demonstrated and dependable supply that can address the future shortfall in productive capacity.

To understand our views on these studies requires a discussion of their main purpose. The growing recognition of nuclear's role in net-zero and energy security is very exciting. This is driving a welcome renewed interest in the nuclear fuel cycle, and is shining a light on the lack of investment particularly focused on the uranium supply segment. In turn, advanced exploration companies—often with only a single asset to promote—need to distinguish their projects as they appeal to investors.

What better way to do so than promoting studies that promise ever more radical reductions in capital and operating costs with the potential to generate enormous profits even if the output is simply sold into the spot market.

This is how the advanced exploration segment works in every commodity. The typical goal is not to actually develop new supply but to sell the project to a producer willing and able to take on the development risk.

The threat to the stability of the nuclear fuel cycle emerges because, unlike other commodities, in a small industry such as uranium the attempts to distinguish various projects to investors and potential acquirers spills over to create the impression that the supply-side will front run the demand-side of the industry. You can see time and again that various trade and industry fuel market reports often take these feasibility studies as given and they are prematurely incorporated into the global supply stack and improperly located on the global cost curve conferring an inappropriate certainty and predictability to the future supply. Confusing these discoveries and declarations with demonstrable and dependable supply is a risk to the long-term stability of the nuclear fuel cycle.

The history of greenfield development in the uranium segment is clear; feasibility study costs, whether capital or operating costs, tend to be very light.

Once a project leaves the comfortable feasibility stage and steps over the edge into the valley of development the harsh reality of real project delivery sets in; schedules are delayed and cost targets are missed and the promised value is eroded. Technical parameters are proven to be inappropriate. Regulatory timelines are proven to have been aggressive. Stakeholder support proves to be time-intensive to earn and easy to lose. Project costs of materials and labor escalate as the class of engineering estimate tightens. Current global supply chain challenges exacerbate the project inflation risk.

Delivering a commissioned project is just the beginning, it is the preseason, and now the regular season competition begins with actual operation and ongoing mine development. Confusing declarations with dependable supply threatens the stability of the nuclear fuel cycle.

Obviously, this project and operation reality is great news for Cameco. As a proven and reliable tier-one producer with long-lived tier-one assets

and a brownfield leverage growth strategy, when it is recognized that other projects were over-promoted, prematurely included in the supply stack, and improperly located on the cost curve, the value capture for Cameco's supply portfolio will be tremendous. We have seen this before and we have the strategic patience, including the financial strength, to position for this value capture.

TNR: ***Select developers in the Athabasca Basin are exploring innovations such as freeze-wall in-situ recovery (ISR) and surface access borehole resource extraction (SABRE) to improve the economic efficiencies of their proposed operations. As proponents of novel engineering in the Basin, what challenges might companies looking to implement these new technologies encounter?***

Isaac: We fully agree that continuous innovation must be a priority to improve operational flexibility, cost efficiency, and ESG performance. We make a point of staying up to speed on all proposed innovations in the uranium mining space. But, as we do, we also carefully distinguish between innovation and invention. The former potentially produces material improvements on existing practices and techniques while the latter potentially produces novel practices and techniques not previously regulated, permitted, or utilized. This distinction is important because as mentioned previously our experience suggests that innovation applied to brownfield mining methods tends to have a more robust value profile in the uranium industry than mining method inventions applied to greenfield development.

To assess various mining methods, we supplement our experience as the only company mining in the Athabasca Basin with our global operating experiences including, for example, ISR mining in the USA and Kazakhstan. Among the many assessment criteria, there are two quite different ones that illustrate just how thorough our assessments must be. Consider first the criteria of assessing a mining method according to the technology readiness level (TRL) framework. A well-understood concept in the pipeline from research and development through project management to market readiness, the TRL framework is a highly effective tool for us in helping to understand whether a mining method is a scientific concept (TRL 1) or is proven and ready for permitting and application (TRL 9). Even at TRL 6, a mining method is still technically a laboratory experiment in a simulated, controlled environment. Only at TRL 7 is a method ready for testing in an actual operating environment.

> ***"We make a point of staying up to speed on all proposed innovations in the uranium mining space. Our experience suggests that innovation applied to brownfield mining methods tends to have a more robust value profile in the uranium industry than mining method inventions applied to greenfield development."***

Running parallel to the TRL framework assessment, we would highlight the second criteria of regulatory oversight. The more novel the method, the less likely a regulatory framework exists. Developing a regulatory framework requires impact data over a time series that assess cumulative impacts across the human health and environmental effects spectrum. This is often combined with public consultation periods. Each level of technology readiness needs to correspond to an appropriate regulatory structure informed by appropriate time series data. Perhaps more streamlined when still a laboratory experiment, the challenge becomes when regulations need to be developed for TRL 7, testing in an actual operating environment. As innovation realists, in considering new mining methods we combine these two assessments with many other criteria to create a mining method risk profile that needs to be compared to existing, proven, licensed methods that have, by definition, a lower risk profile. The lower the risk, the greater the economic certainty and value capture.

While it is likely that new mining methods, perhaps including SABRE and ISR, will be used in the Athabasca Basin someday, our current assessment suggests that there are no novel methods in a position to address the future shortfall in productive capacity over the coming contracting cycle for requirements out to 2030 or 2035. Again, we have seen this before and our strategic patience and financial strength allows us to position for the value capture that occurs when new productive capacity fails to arrive as promoted and incumbent supply, like ours, captures the demand.

TNR: ***Earlier this year, a Canada-based explorer paused on-site work at its flagship property in the southern Athabasca Basin to continue consultations with local communities. What is Cameco doing to foster indigenous peoples' relationships in the Basin, and how do Cameco's project goals align with native title holders' willingness to support Cameco's social license to operate in the Basin?***

Isaac: Since Cameco was formed in 1988, we have worked in close collaboration with northern Saskatchewan communities, the majority of which are Indigenous. We regularly work with more than 17 Indigenous communities around our Cigar Lake Mine, McArthur River Mine, Key Lake Mill, and Rabbit Lake Mine and Mill. All of these operations are located on traditional territory and have formal collaboration agreements in place with these local Indigenous communities.

Our community and Indigenous relations activities in this area are supported by our three Indigenous community liaisons in the Athabasca Basin. In northern Saskatchewan, we use a five-pillar approach to guide and define our activities, which include: workforce development; business development; community investment; environmental stewardship; and community engagement.

We employ Indigenous workers across our business areas in a variety of skilled positions, from operators and supervisors to technicians and corporate professionals.

In northern Saskatchewan, we have had a long-standing commitment to maximize the employment of Residents of Saskatchewan's North (RSN), the vast majority of whom are Indigenous. At the end of 2020, RSNs comprised roughly half of the workforce at our operations in northern Saskatchewan. Last year, RSN workers (including contractors) earned C$44 million (US$35.7 million)working for Cameco.

"Nuclear power is extraordinarily well positioned to address electron accountability with its clean emissions profile, while simultaneously achieving a reliable and secure baseload profile and a low-cost profile. It is no wonder we are witnessing a growing and durable support for nuclear power."

We have established a northern Indigenous apprenticeship program for instrumentation technologists, recognizing that as our operations become more digital, there is a need to prepare more Indigenous people for hiring into technical positions.

To incorporate Indigenous perspectives and to reflect the communities where we operate, our diversity policy requires at least one director to have Indigenous heritage and be a native of Saskatchewan.

Since 2001, Cameco has been gold-certified under the Progressive Aboriginal Relations program of the Canadian Council for Aboriginal Business and was recertified in 2020.

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