OCEAN WALL

ASP isotopes

ASP Isotopes – Enriching Our Future One Industry at a Time

July 2024

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COMPANY PROFILE

ASP Isotopes (ASPI) is a leader in isotope enrichment technology for the medical, green energy and industrial sectors. Of particular interest is the Company's ability to produce specialised isotopes where Russia has historically dominated the supply chain.

Ticker: ASPI
Exchange: NASDAQ
Sector: Chemicals
Founded: 2021
Stock Price: US$3.08
Market Cap: US$159m
Av. Daily Volume: 934k
Performance Since IPO: +10%
Performance YTD: +77%

Data as of 10/07/2024

ASP ISOTOPES – AT A GLANCE

ASPI's advanced technology platform leverages 20 years of R&D history to enrich isotopes in varying levels of atomic mass. Its innovative technology is designed to manufacture a diverse range of isotopes to meet the growing demand in the Nuclear Medicine, Nuclear Energy, and Quantum Computing industries. In addition, we believe ASPI has the ability to benefit from an increasingly bifurcated geopolitical environment, given Russia is responsible for 85% of stable isotope production globally.

WHAT ARE ISOTOPES?

A family of people often consists of related but not identical individuals. Elements have families as well, known as isotopes. Isotopes are members of a family of an element that all have the same number of protons but different numbers of neutrons.

Two isotopes of the same element often have identical chemical properties but differ in mass and therefore in physical properties. There are stable isotopes, which do not emit radiation, and there are unstable isotopes, which undergo radioactive decay and emit radiation. The latter are called radioisotopes.

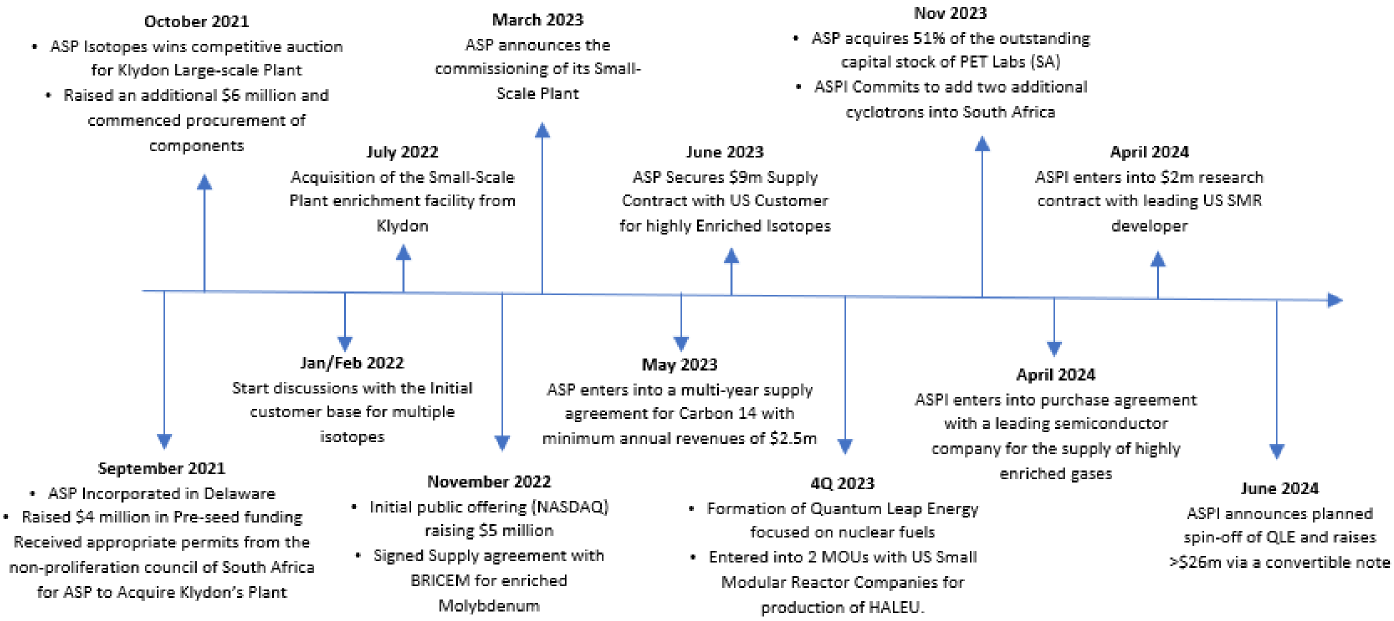
The number of protons in a nucleus determines the element's atomic number on the periodic table. For example, carbon has 6 protons and its atomic number is 6. Carbon occurs naturally in three isotopes: carbon 12, which has 6 neutrons (plus 6 protons to equal 12), carbon 13, which has 7 neutrons, and carbon 14, which has 8 neutrons. Most elements in the periodic table have multiple isotopes.

The addition of even one neutron can dramatically change an isotope's properties. Carbon-12 is stable, meaning it never undergoes radioactive decay. Carbon-14 is unstable and undergoes radioactive decay with a half-life of about 5,730 years (meaning that after 5,730 years half of the material will have decayed to the stable isotope nitrogen-14). This decay means the amount of carbon-14 in an object serves as a clock, showing the object's age in a process called "carbon dating."

Isotopes have unique properties, and these properties make them useful in diagnostics and treatment applications. They are important in nuclear medicine, oil and gas exploration, basic research, and national security.[1]

ASPI, via their proprietary Aerodynamic Separation Process ("ASP") technology, aims to enrich natural isotopes into higher concentration products, which could be used in several industries.

COMPANY TIMELINE [2]



Paul Mann, Founder and CEO of ASPI, discovered the former company (Klydon) in 2020 when it was in financial distress. ASPI obtained the relevant permits required to own and operate their plants in South Africa and then acquired the assets during a competitive auction from business rescue (bankruptcy). The auction was held in October 2021 where ASPI was the only buyer with the required permits (nuclear). At that time, Paul estimated the book value of the assets to be worth $15-20m and paid $750k for them. ASPI have subsequently spent ~$15m developing the assets. In November 2022, ASPI listed on NASDAQ, raising $5m in its initial public offering. Since incorporation, ASPI has raised approximately $30 million of equity capital.

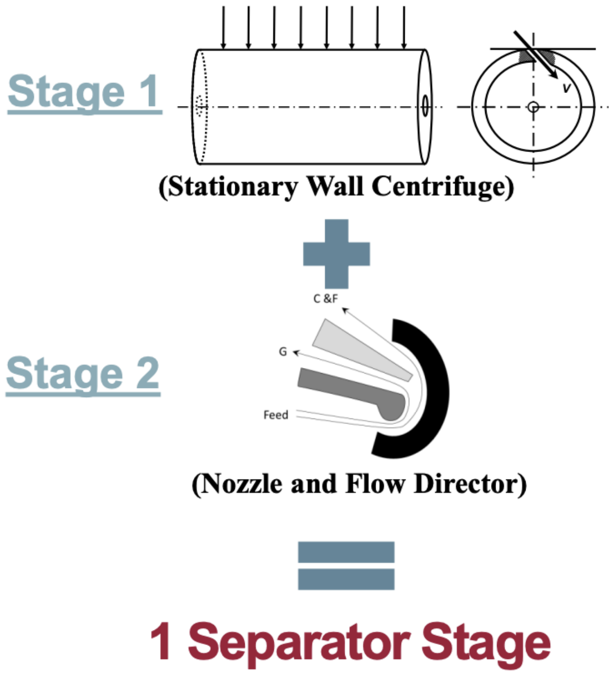
There are currently three assets owned by ASPI (two are operating), with a fourth under construction, all are located in South Africa. These plants are small in footprint and modular in design allowing for rapid capacity expansion. A single unit costs between $5-30m depending on the size, and can be built in just 9-12 months, providing both accessibility and scale. The technology used in these plants is referred to as "Aerodynamic Separation Process" (ASP), which varies from the method of enrichment that would be used for uranium (more on this later).

ASP has its origins in the South African Government Uranium Enrichment Program of the 1980s and has been developed over the last 18-years by ASP scientists, since leaving the program.

The ASP device separates gas species and isotopes using an aerodynamic technique similar to a stationary wall centrifuge. The isotope material in raw gas form enters the stationary tube at high speed, the gas then follows a flow pattern that results in two gas vortexes occurring around the geometrical axis of the separator.

[1] https://www.energy.gov/science/doe-explainsisotopes
[2] https://aspisotopes.com/

The isotope material becomes separated as a result of the spin speed of the isotope material reaching several hundred meters per second. A component of each tube then feeds isotope material to the respective ends of the separator where they are collected.



Source: ASP Isotopes

Benefits of a Stationary Wall Centrifuge:

- No moving parts vs a conventional centrifuge
- No unique materials are required
- Cost-efficient at small scale
- High Separation Efficiency
- Enrichment of lighter isotopes
- Enrichment at high temperatures

During 2024, ASPI expects to produce carbon-14 from the smaller of their two isotope enrichment facilities (production expected to start in H2’24). Carbon-14 has applications in the pharmaceutical and agrochemical industries. In January, ASPI announced that it and its partner (a Canadian company, CCN Nuclear), had started to process the feedstock. The estimated global market size for carbon-14 is likely ~$10 million per annum. Historically, Russia was the sole supplier of carbon-14, but there has been little availability since the start of 2022 and customers are looking for alternative suppliers. ASPI’s isotope enrichment facility is able to produce over 400 grams per year and the company has signed a multi-year take-or-pay contract with its Canadian partner for a minimum of $2.5m per year. ASPI has said that it believes that the gross margin on this product is similar to a pharmaceutical (i.e., very high).

At ASPI’s second isotope enrichment plant, silicon-28 (applications for quantum computing), as well as molybdenum-98/100 (applications for nuclear medicine) will be produced during 2024.

Silicon-28, which will enable quantum computing, artificial intelligence, and next generation semiconductors, may potentially represent a very large commercial opportunity longer term. However, the nearer term revenue opportunity is likely to be single-digit millions of dollars. We believe that Rosatom is currently the only other company able to enrich these isotopes. ASPI believes that the gross margin on these isotopes is lower than that achieved on carbon-14 but it is still high (>60%).

While ASPI is currently focused on the production of the isotopes mentioned above, there are various other isotopes that are of interest including zinc-67/68, ytterbium-176, nickel-64, xenon-129/136 (all applications for nuclear medicine), as well as chlorine-37 and lithium-6 (applications for nuclear energy), and germanium-70/72/74 (applications for quantum computing). Each isotope has varying market opportunities, some present multi-billion-dollar addressable markets, while others are in the tens of millions.

Interestingly, plants present interoperable characteristics as well, meaning that an enrichment facility can be reconditioned to produce a different isotope in just 3-6 months and minimal cost, allowing ASPI to adapt to varying market conditions and opportunities. Operational flexibility mitigates Supply/Demand risk.

For future plants, ASPI expects to operate a model on a joint venture structure whereby ASPI will provide technology and expertise, and their partners provide investment capital in return for supply security at advantageous prices. This capital light model is designed to allow ASPI to roll out plant units at scale, without significant shareholder dilution. This is part of the strategy for 2024, with the goal of ASPI starting to generate free-cash flow, expanding product lines, and ultimately starting the construction of additional plants for other isotopes. ASPI plans to open the first isotope enrichment facility outside of South Africa during 2025.

PET LABS

In October 2023, ASPI entered into a joint venture by acquiring 51% of PET Labs, a radioisotope company in the nuclear medicine sector. Nuclear medicine uses radiation to provide diagnostic information about the functioning of a person's specific organs, or to treat them. Diagnostic procedures using radioisotopes are now routine.

Radiotherapy can be used to treat some medical conditions, especially cancer, using radiation to weaken or destroy particular targeted cells.[3] Over 40 million nuclear medicine procedures are performed each year, and the global radio pharmacy market size is likely >$100bn per annum. We believe that radiotherapeutic developments are likely to have higher efficacy than more widely used cancer treatments.

Currently, PET Labs produce fluorine-18, which is used for medical imaging. This process is conducted by using a cyclotron, a particle accelerator, at a facility in Pretoria. This single unit generates approximately $500k in annual EBITDA, which in our opinion is likely to increase year over year by 2027. We believe that additional cyclotrons – which cost around $1.5-2m per unit – and the modular nature of the business, will allow ASPI to capitalise on the burgeoning global demand for both the radio diagnostic and radiotherapeutics.

There are many advantages to using accelerators:

- Easier to supervise and improved safety
- Lower maintenance an decommissioning costs
- The amount of radioactive waste produced is lower than that produced in reactors
- There's no risk of nuclear proliferation

Given radioisotopes undergo radioactive decay, having a cyclotron in close proximity to hospitals is essential to get patients the treatment they need in a timely manner. As such, ASPI intends to invest >$10m into South African radioisotope production capabilities during the next five years, and over time, aim to roll out the PET Labs playbook in many other frontier economies.

[3] https://world-nuclear.org/information-library/non-power-nuclear-applications/radioisotopes-research/radioisotopes-in-medicine.aspx

This process is starting in South Africa where two more cyclotrons are being delivered, with one estimated to start operations in May 2024 and the other expected to come online in September 2025. By 2025, PET Labs expect to be producing many advanced radioisotopes including fluourine-18, galium-68 and zirconium-89.

CURRENT CONTRACTS

ASPI currently has three contracts executed for 2024, which we believe will likely generate between $12-30m of revenue, with contracts varying from annually recurring to one-off payments. Revenue guidance has not yet been provided but given the capacity of these plants there is the opportunity to flex up contracts for certain isotopes if demand is there (e.g. Molybdenum-100). For reference, the production capacity of the initial plants was >4x oversold without a dollar spent on external marketing.

	Contract 1	Contract 2	Contract 3	Contract 4	Customer 5
Customer	BRICEM	RC-14	Undisclosed	Undisclosed	Undisclosed
Customer Location	China	Canada	United States	United States	Undisclosed
Product	Molybdenum-100	Carbon-14	Enriched Isotope	Nuclear Fuel Research	Silicon-28
Deal Value (2024)	$2.5-27m	$2.5-3.8m	$9m	$2m	Undisclosed
Deal Type	Annually Recurring	Annually Recurring	One-Off	One-Off	Undisclosed
Deal Date	Nov-22	Jun-23	May-23	Apr-24	Jun-24

ASPI has stated that it is expecting to start the construction of its fifth plant in Iceland during 2024 to capitalise on lower electricity costs. These plants will be manufactured in South Africa where technological and engineering expertise of historic plant builds can be leveraged, and then shipped to Iceland in modular components meaning on-site build times can be expedited.

ASPI PRODUCT MATRIX

Isotope	Application	Annual Market Size (m$)	Current Market Price ($/g)	Estimated Year of Commercialisation	Known Competitors	Production Method
Carbon-14	Medical Tracing	10	$24,000	2024	N/A	Aerodynamic Separation (ASP)
Molybdenum-100	Medical Diagnostics	4,610	$500 - $2,000	2024	N/A	Aerodynamic Separation (ASP)
Silicon-28	Quantum Computing	30	$500 - $600	2024	Rosatom / Silex	Aerodynamic Separation (ASP)

Zinc-68	Medical Diagnostics	1,150	$250 - $2,000	2025	N/A	Aerodynamic Separation (ASP)
Technetium-99	Medical Diagnostics	N/A	N/A	2025	N/A	Accelerator Production - Cyclotron
Gallium-68	Medical Diagnostics	127	N/A	2025	N/A	Accelerator Production - Cyclotron
Ytterbium-176	Oncology Treatment	15	$25,000 - $35,000	2024-25	Rosatom / Shine	Quantum Enrichment
Nickel-64	Oncology Treatment	32	$40,000 - $80,000	2025	N/A	Quantum Enrichment
Uranium-235 (HALEU)	Nuclear Fuel	40	$18 - $22.5	2026-27	Centrus Energy	Quantum Enrichment

**ASPI also has the ability to produce many additional isotopes including various radioisotopes for which prices vary significantly based on factors such as patients' weight, distance to radiopharmacy, time of procedure and hundreds of other factors. ASPI is well positioned to tailor production of enriched products to future demand / high-value contracts going forward.*

THE OPPORTUNITY IN URANIUM - HALEU

NEXT-GENERATION NUCLEAR POWER

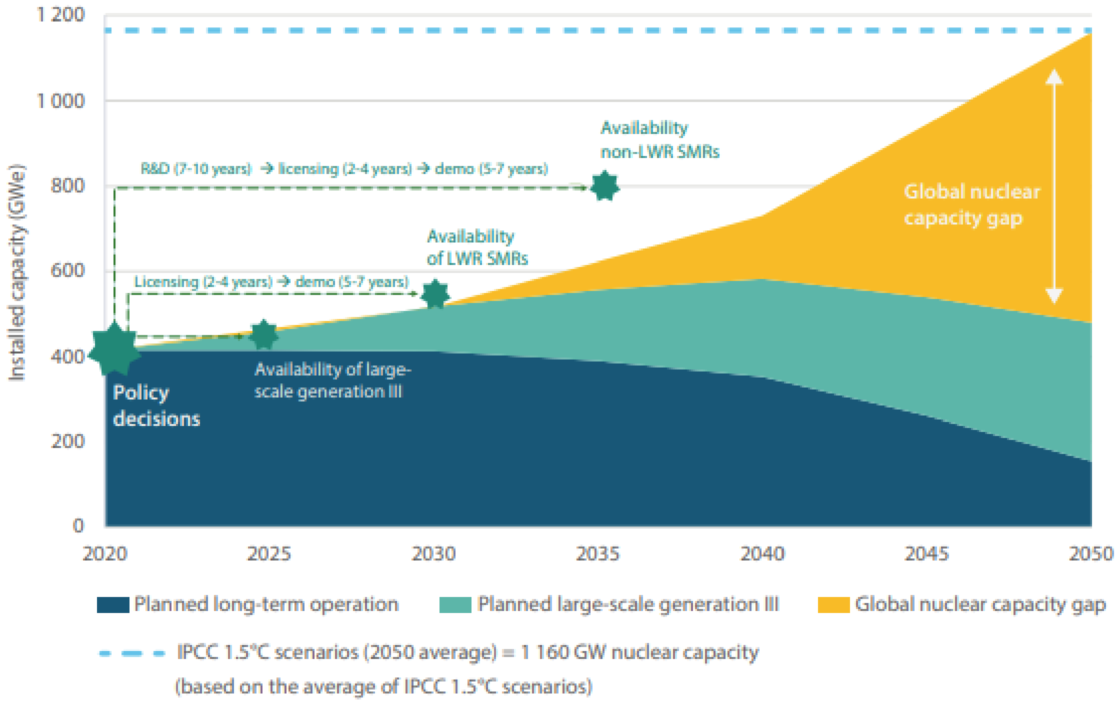
There is near global consensus that nuclear power presents one of the most effective solutions to the climate crisis, with 28 countries pledging to triple nuclear capacity by 2050 at last years' COP28. Today, nuclear power already accounts for 10% of global electricity production, and 25% of low-carbon power.[4]

There are, undoubtably, issues around scaling the construction of traditional nuclear power plants, which presents one of the key obstacles global economies must overcome if they are to meet their nuclear ambitions. We continue to see – particularly Western economies – struggling to bring new-build nuclear projects in on budget, or on schedule. In fact, at a cost of £31-34bn (£10m per MW) the UK's Hinkley Point C will cost five times more than it costs to build a new nuclear power plant in South Korea, for example.[5]

Small Modular Reactors (SMRs) and Advanced Modular Reactors (AMRs) are an emerging solution to the current scalability issues around nuclear reactor construction and therefore financing. SMRs are advanced nuclear reactors that have a power capacity of up to 300 MW(e) per unit, which is about one-third of the generating capacity of traditional nuclear power reactors.

The NEA estimates that, by 2050, SMRs could reach 375 GW of installed capacity in an ambitious case, nearly matching the current global installed capacity of 392 GW.[6] The IAEA reports that there are more than 80 SMR designs and concepts globally, with four SMRs in advanced stages of construction in Argentina, China and Russia, and several existing and newcomer nuclear energy countries are conducting SMR research and development.[7]

[4] https://world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.aspx#:~:text=Nuclear%20energy%20now%20provides%20about,of%20the%20total%20in%202020).
[5] https://www.ft.com/content/1157591c-d514-4520-aa17-158349203abd
[6] https://www.oecd-nea.org/upload/docs/application/pdf/2023-02/7650_smr_dashboard.pdf
[7] https://www.iaea.org/topics/small-modular-reactors



Source: NEA *(note this does not include the recent pledge to triple nuclear capacity at COP28)*

In the US specifically, the NRC expects it will receive 25 licensing applications in the next five years for SMRs and AMRs. Timelines for deployment vary based on technology and regulatory readiness, with some designs expected to be demonstrated and commercialised before 2030 and others to follow later in the 2030s.

Nonetheless, the expectation is that SMRs will play a pivotal role in reaching net zero, with more reactors coming onstream through the 2040s and 2050s that will help us sustain our climate objectives.

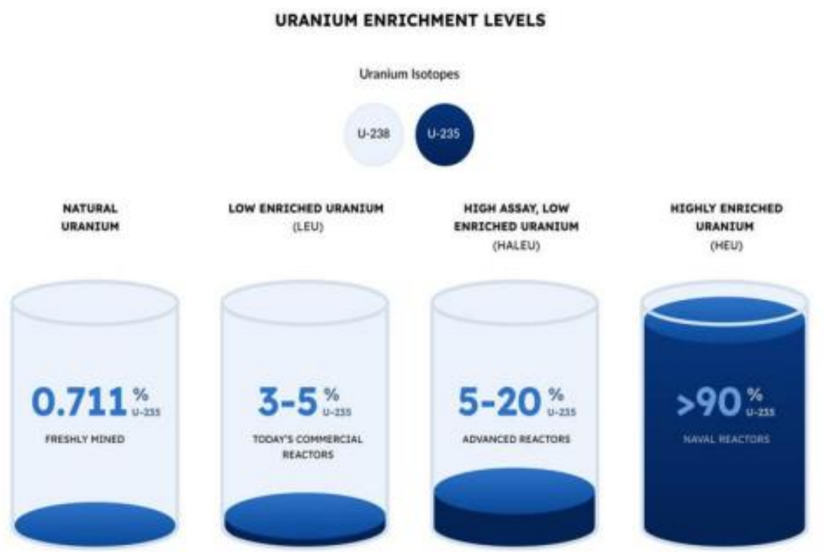
The benefits of SMRs are:

- Safety: Facility protection systems, including barriers that can withstand design basis aircraft crash scenarios and other specific threats, are part of the engineering process being applied to new SMR designs.
- Modularity: the ability to be able to put major components of the reactor together in a factory, requiring limited onsite preparation.
- Cost: Reduced capital investment due to the lower plant capital cost, mainly associated with modularity.
- Location: SMRs can provide power for applications where large plants are not needed or sites lack the infrastructure to support a large unit, creating far better site flexibility.
- Efficiency: SMRs can be coupled with other renewable energies or fossil fuels to leverage resources and produce higher efficiencies and multiple energy end-products while increasing grid stability and security.
- Economic: deployment of a 100 MW SMR could create 7,000 jobs and generate more than $1 billion in sales.[8]

[8] https://www.energy.gov/ne/benefits-small-modular-reactors-smrs#:~:text=SMR%20designs%20have%20the%20distinct,applied%20to%20new%20SMR%20design.

HALEU – MARKET SIZE AND DEMAND

Where traditional nuclear reactors require low-enriched uranium, or LEU, which is uranium enriched to 3-5% U-235 (the fissile isotope in uranium), many SMR and AMR designs require an enrichment level approximately five times this amount, or up to 19.75% U-235 (close to 70% of SMRs studied by the NEA require HALEU). For context, weapons grade uranium requires an enrichment level of around 90% U-235. When uranium is enriched to between 5-19.75% U-235, it is known as high-assay low-enriched uranium, or HALEU.



Source: Centrus Energy

HALEU has numerous advantages over traditional LEU, in that it allows smaller reactor fuel assemblies, and thus smaller reactor designs, produces less waste, exhibits true interoperability between reactors, and inherent safety features. As a fuel source, it is incredibly energy dense, and just 750 grams of HALEU can meet an average American's electricity needs for life.[9]

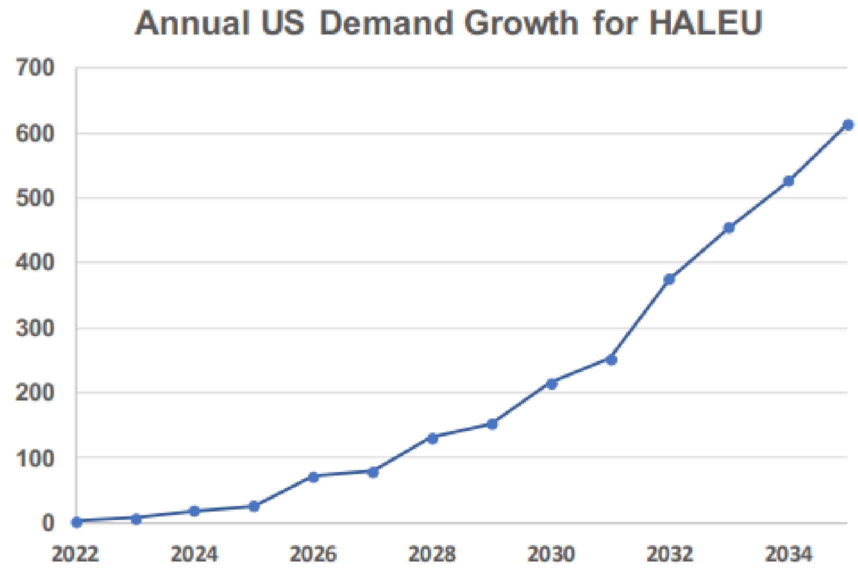
The problem is that the only commercial volumes of this fuel are produced in Russia - which is unsurprising given their dominance in isotope enrichment - and the many countries who oppose Putin's illegal invasion of Ukraine no longer see Russia as a viable counterparty with which to do business.

The scarcity of HALEU is becoming a major problem for many SMR developers, for example, Bill Gates' TerraPower delayed the start-up of its Natrium Reactor by two years from 2028 to 2030 due to the lack of availability of HALEU and many other SMR developers are finding themselves in a similar position.[10]

While commercialisation of these reactors is not likely until the end of the decade, there is a market for HALEU that exists today. For example, in 2020, the DOE selected two companies for awards under the Advanced Reactor Demonstration Program (ARDP). Both reactor designs require HALEU and can be operational in about seven years. Today, it is estimated that the companies selected for the demonstration pathway will require HALEU for their reactors beginning in 2024 to support fuel fabrication ahead of reactor startups. In addition, one of them will require HALEU in the 2024-2025 timeframe and other companies will also require HALEU in the near future.

[9] https://investors.centrusenergy.com/static-files/058b474a-c135-4600-a84b-e9908864a7af
[10] https://world-nuclear-news.org/Articles/HALEU-fuel-availability-delays-Natrium-reactor-pro

The Nuclear Energy Institute (NEI), estimates that by 2035, US domestic demand for HALEU could reach >600 MT.[11] A 2021 report compiled by the Idaho National Laboratory found that total cumulative HALEU requirements by 2050 could be as high as 7,175 MT. HALEU is needed in small amounts for reactor demonstrations starting in 2027 then increases as more reactors are deployed, reaching ~520 MT per year in 2050, split two thirds for reloads and one third for start-up cores for new reactors.[12]



Source: NEI

To put these numbers into perspective, Centrus Energy in the US, has capacity to produce approximately 1 MT per year from their 16 advanced centrifuges, ramping up to 6 MT yer year contingent on an estimated $1bn of investment and three and a half years after securing the necessary funding and/or offtake commitments.[13] As such, the NEI have stated that the US will need to acquire HALEU from international suppliers in the near term to support the larger goal of deploying advanced reactors in the US in a timely manner.

The promise of SMRs, coupled with an uncertain market for reactor fuel, has given birth to various government initiatives designed to accelerate the commercialisation of these projects. In the US, for example, the government has made a multi-million-dollar commitment to help commercialise HALEU-fueled advanced reactors, as well as a $700m funding plan as part of the Inflation Reduction Act for the DOE's HALEU Availability Program.[14] In January 2024, the DOE announced that the US is seeking bids from contractors to help establish a domestic supply of HALEU, and in February 2024 committed $2.72bn to boost enrichment of domestic Uranium for LEU & HALEU, as part of the $118bn Emergency National Security Supplemental Bill.[15]

In January 2024, the UK government announced it will invest £300 million to launch a HALEU programme, making the UK the first country in Europe to launch such a nuclear fuel strategy. A HALEU production hub is planned for the North West of England, with UK Energy Secretary, Claire Coutinho, highlighting *"We stood up to Putin on oil and gas and financial markets; we won't let him hold us to ransom on nuclear fuel."*[16]

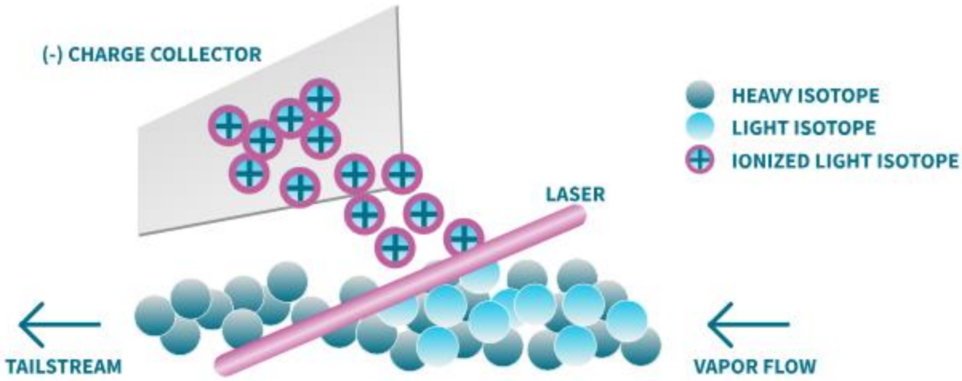
The market for next-generation SMRs is evolving, but the scarcity of fuel represents one of the, if not the major bottleneck in commercialising these projects on schedule and on budget.

[11] https://www.nei.org/CorporateSite/media/filefolder/resources/letters-filings-comments/NEI-Letter-for-Secretary-Granholm_HALEU-2021.pdf
[12] https://fuelcycleoptions.inl.gov/SiteAssets/HALEU%20Requirements%20for%20Net-zero.pdf
[13] https://www.energy.gov/ne/articles/centrus-produces-nations-first-amounts-haleu
[14] https://www.energy.gov/ne/articles/inflation-reduction-act-keeps-momentum-building-nuclear-power
[15] https://www.world-nuclear-news.org/Articles/US-seeks-proposals-for-domestic-HALEU-production
[16] https://www.world-nuclear-news.org/Articles/UK-to-launch-HALEU-production-programme

QUANTUM LEAP ENERGY (QLE)

Through its newly formed wholly owned subsidiary, Quantum Leap Energy LLC (QLE), ASPI expects to enter the nuclear fuel market by 2027 and expects to enrich uranium to 19.75%. The laser-based enrichment method promises affordability, lower production costs, and efficient construction, positioning HALEU and nuclear power as a cost-effective alternative to traditional, carbon-intensive electricity production.

The QLE method for uranium enrichment is referred to as "Quantum Enrichment", which achieves the separation of two isotopes by taking advantage of the slight differences in the transition energy between two isotopes. This method is described as a "quantum mechanics" method. Using lasers to produce a large number of photons, atoms can be selectively photonised and then electrically separated. The isotopic selectivity of enrichment is very high and can likely produce the desired enrichment in a single step.



Source: ASPI Corporate Presentation

To date, the QLE enrichment method has proven the ability to produce highly enriched uranium at a lab scale, although not since the 1980s. However, since this process was done, lasers have improved dramatically, becoming much cheaper and more efficient ASPI is currently constructing an enrichment facility to enrich ytterbium-176 and nickel-64 using Quantum Enrichment which could be production ready as early as H2'24 and has the potential to produce the highest gross margins across the company's product line.

Commercialising the production of these isotopes would be an essential milestone in the production timeline for HALEU, as the chemical characteristics are similar those of U-235. The main difference being the temperature at which U-235 vaporises is approximately 4x higher than that of ytterbium-176, otherwise, the enrichment processes have significant overlap. The similarities between ytterbium, nickel and uranium will mean that the construction of this facility will significantly reduce the time required to construct a HALEU facility.

The company expects this plant to be completed towards the end of 2024 or early 2025, and they have received considerable interest from customers for both isotopes (Russia is the only commercial enricher of both). Management has said that regulatory barriers and licensing is likely the most significant challenge in constructing a uranium enrichment facility using Quantum Enrichment and the Company is currently in advanced discussions with three countries to obtain these licenses.

The efficacy of the QLE technology gained further credibility during 2023, when ASPI announced that it had entered into two Memorandum's of Understandings (MoUs) with two US-based SMR companies to supply HALEU. The Company has also entered discussions with four additional customers to supply HALEU, focused on enriching uranium for the production of advanced nuclear fuels. Both the MoUs and the additional customer discussions are also focused on formalising a collaboration to develop a HALEU production facility. These discussions include providing financial support for the development of a production facility and the future supply of metric tons (MT) of HALEU. ASPI has received interest from potential customers totalling over $30bn of HALEU demand at recent market prices by 2037.

QLE estimates that the capital cost of constructing a Quantum Enrichment plant for uranium enrichment is less than $100m, approximately 85% cheaper than that of a traditional gas centrifuge enrichment facility. We estimate that this cost could come down even further as they replicate plant manufacturing processes.

Quantum Enrichment plants are modular, so their construction time is likely faster and more flexible than competing technologies. In addition, the enrichment facilities are smaller than traditional gas centrifuges which means they can place them near fuel fabrication facilities for enhanced security of production and transportation. The Company expects operating costs to be comparable to or cheaper than costs for other methods of uranium enrichment.

In terms of construction time, the Company expects a uranium enrichment facility could be built in approximately 18-24 months (from receiving necessary licenses) and production volumes would gradually ramp up to the final capacity of 20 MT per year per unit.

Furthermore, many SMR projects were modelled and financed under the assumption that the cost of HALEU would be approximately $7,000/kg, at which price, many reactor projects had double digit IRRs. The cost of producing HALEU today is much higher, closer to $30,000/kg. As such, these projects would produce negative IRRs making them uneconomical.

The main cost associated with producing HALEU today is the ore (feed), which accounts for approximately 54% of the overall cost of production. Enrichment makes up 35% of costs, while conversion accounts for 11%.

ASPI is looking to solve this issue. Initially, ASPI expects to use LEU or natural uranium (ore) as a feedstock, which will maximise the production volume of HALEU whilst still providing satisfactory gross margins. Because of the high selectivity associated with Quantum Enrichment, the Company believes it may be able to enrich depleted tails (waste from other enrichers). The company expects to transition to this lower cost feedstock after a few years. Not only will this provide a solution to a growing environmental problem (71,000 tonnes of waste is added to global reserves per annum) but this gradual change in feedstock should result in substantially higher gross margins and allow the Company to price HALEU at a lower price than any competitor and open up emerging markets customers who require a cheap, reliable source of energy.

Commercialising the production of HALEU from depleted tails would complete the circular economy for nuclear, and would be a game changer for the industry, CO_2 emissions targets and how ESG, energy transition, climate, and green funds, look at the whole uranium sector and nuclear value chain.

Subject to licensure, ASPI believes it can produce commercial quantities of HALEU by 2027 that would satisfy the anticipated demand from all advanced reactors currently in development, at a lower price than competitors.

COMPETITOR ANALYSIS

The competitive landscape for uranium enrichment is inherently limited, due to huge barriers to entry and regulation. Uranium enrichment is highly controlled and regulated by the IAEA and licensing of new facilities is an extremely costly and timely process. Most enrichers are either government owned or state sponsored. Globally, there are five major producers of LEU, but we believe only Russia has produced commercial quantities of HALEU.

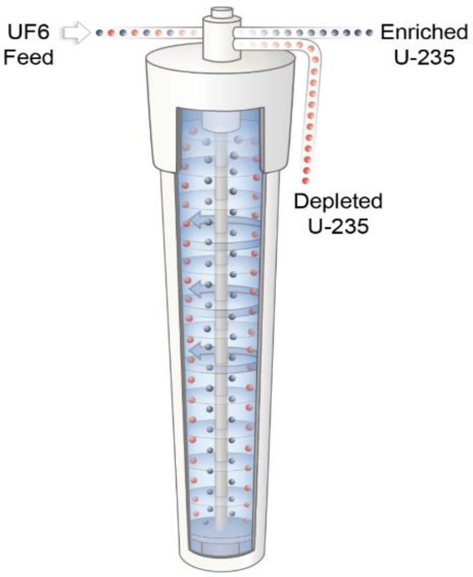
We believe that there are two main competitors for ASPI: Centrus Energy (NYSE: LEU), and Silex Systems (ASX: SLX).

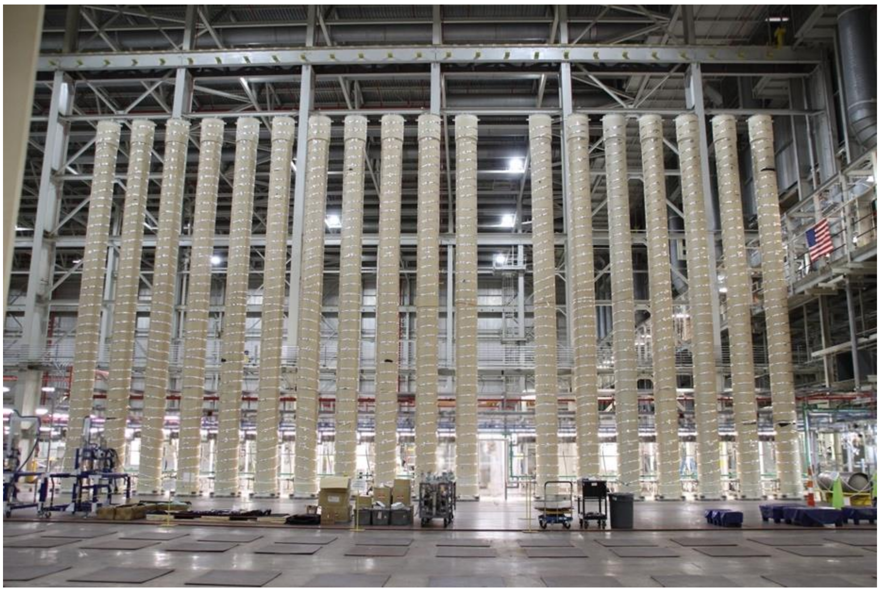
CENTRUS ENERGY

Centrus Energy is a US$651m market cap, NYSE listed uranium enrichment company, generating over $320m of revenues in 2023 from uranium sales (85% of which was from sales of LEU). Centrus does not actually produce any LEU and has no SWU capacity to produce LEU. Instead, Centrus relies on Russia's TENEX for SWU (enrichment) capacity, and then sells this product at a mark up to US utilities.

Centrus started to produce their first volumes of HALEU in 2023 using centrifuge enrichment. Centrifuges are 40 ft cylindrical tubes that have rotors inside that spin incredibly fast, the centrifugal force created by the spinning rotor concentrates the heavier U-238 isotopes at the outer wall of the rotor and the lighter U-235 isotopes toward the rotor center.

Since the desired enrichment level cannot be achieved in one centrifuge, several machines must be connected in a series in what is called a "cascade".[17] A centrifuge enrichment plant is made up of multiple cascades as you can see on in the image on the right below.





Source: Centrus Energy

For context, the capacity of Centrus' 16-centrifuge cascade that began operations in October 2023 will be modest – about 900kg (0.9 MT) of HALEU per year. According to Centrus, a full-scale HALEU cascade, consisting of 120 centrifuge machines, with a combined capacity to produce approximately 6 MT of HALEU per year, could be brought online within about 42 months of securing the necessary funding according. Centrus could add an additional HALEU cascade every six months after that.

However, there are inherent technological issues with trying to enrich uranium to 19.75% using centrifuges. This is because you cannot enrich U-235 without producing U-234 using a centrifuge. U-234, as it undergoes radioactive decay, emits alpha and thorium-230, which stick to the walls of a centrifuge. South Africans found that their enrichment process was half as effective when trying to enrich U-235 to more than 10% using a centrifuge, as it was below 10%, due to U-234 causing malfunctions.

ASPI anticipates being able to produce multiple metric ton (MT) quantities annually at a cost of a few tens of millions of dollars (estimated build time for a new plant >12 months assuming licenses and permits are in place), potentially making ASPI's enrichment method substantially cheaper and more scalable.

[17] https://world-nuclear.org/information-library/nuclear-fuel-cycle/conversion-enrichment-and-fabrication/uranium-enrichment.aspx

	Quantum Enrichment Plant	Gas Centrifuge
Capital Cost per plant	<$100 million	>$800 million
Energy use (kWh) per SWU	<40	50-240
Construction time	2-3 years	2-3 years
Levelized cost per SWU*	<$50	$140

SILEX SYSTEMS

Silex Systems is a US$790m market cap, ASX listed technology company focused on the commercialisation of their SILEX laser enrichment technology. The technology was invented by Dr Michael Goldsworthy (current CEO) and Dr Horst Struve (retired) in the 1990s at Lucas Heights, Sydney. The ASPI Laser team have decades of experience in constructing laser systems and actually constructed and sold the lasers to Silex Systems.

ASPI believe that Quantum Enrichment is superior to SILEX enrichment because the higher selectivity means that Quantum Enrichment allows for the production of HALEU in a single step and doesn't require cascading laser systems.

However, given the strategic nature of uranium enrichment, little information has been publicly disclosed regarding the SILEX technology. The technology is classified by Australian and US Governments with no patent disclosures permitted. Silex currently have a baseline commercialisation estimate for 2030+.

	Gaseous Diffusion	Centrifugation	Atomic Vapor Laser Isotope Separation (AVLIS)	Silex Systems	Quantum Leap Energy
Cost	High capital cost	Capital 1/10 of Diffusion	Low Capital, small size	Low Capital, small size	**Low Capital, small size**
Speed	High pressure	High speed	U metal 3000K	Adiabatic expansion nozzles (10 – 20K)	**U metal 3000K**
Technology Notes	High technology	Rotor design & material	Selective Photoionization	Laser excitation transmission by skimmer	**Enhanced resonant multiphoton ionization**
Selectivity	Selectivity α ≥ 1.003	Selectivity α ≥ 1.15	Selectivity α ≥ 10-50	Selectivity α ≥ 2 - 20	**Selectivity α ≥ 50**
SWU	2500 kWh/SWU	50 kWh/SWU	40 kWh/SWU	Estimate < 50 kWh/SWU	**40 kWh/SWU**
Stages Required	500 Stages to reactor grade	50 Stages	1-2 Stages	1-2 Stages	**Single stage**

Source: ASP Istopes

From a valuation perspective the market cap and EV of ASPI is a fraction of those of Silex and Centrus, whilst having what could be the leading technology solution. ASPI will also require much less capital to roll out its technology across its three divisions which in the long run should provide a much better ROIC.

CENTRUS ENERGY – CONSENSUS FORECASTS

Source: Bloomberg	2023	2024	2025	2026	2027
Revenue ($m)	320.20	351.67	366.00	381.00	354.00
Gross Margin	35.01%	30.15%	30.05%	29.40%	-
Operating Profit	52.40	48.60	51.20	51.70	-
EBITDA	59.50	57.33	63.60	66.70	66.80
Net Income	84.40	46.45	45.35	48.00	47.50
EPS adjusted	$5.44	$2.69	$2.71	$2.98	$2.95
P/E	-	15.17	15.02	13.67	-
EV/EBITDA	-	9.33	8.41	8.02	-
EV/Revenue	-	1.52	1.46	1.40	-
Net Debt (Cash)	-101.5	-	-	-	-
EV	-	534.89	534.88	534.93	-

SILEX SYSTEMS – CONSENSUS FORECASTS

Source: Bloomberg	2023	2024	2025	2026	2027
Revenue ($m)	6.2	2.86	2.86	2.53	3.5
GM	-	-	-	-	-
Operating Profit	-0.482	-5.694	-5.889	-6.474	-11.798
EBITDA	-11.395	-5.596	-5.791	-6.377	-11.60
Net Income	-11.686	-7.151	-7.464	-7.223	-2.960
EPS adjusted	-.055	-.005	-.006	-.004	.003
P/E	nm	nm	nm	nm	nm
EV/EBITDA	nm	nm	nm	nm	nm
EV/Revenue	-	273	273	308	-
Net Debt (Cash)	-	-1.4	-	-	-
EV	-	782.8	-	-	-
Mkt Cap	-	784.2	-	-	-

ASPI FINANCIALS

KEY DATA

Stock Price	$3.08
Market Capitalisation (USD $m)	$159
Shares Outstanding (as of 30/06/2024)	52.1m
FD Shares Outstanding	56.3m
Cash & Cash Equivalents (pro-forma at 31/04/2024)	$23.9m
Long Term Debt	$0
Insider Ownership	35%

ASPI – CONSENSUS FORECASTS

Source: Bloomberg	**2023**	**2024**	**2025**	**2026**	**2027**
Revenue ($m)	1.400	11.650	15.737	22.315	29.517
Operating Profit	0.630	5.825	7.868	14.505	19.186
Net Debt (Cash)	-	-10	-	-	-
EV	-	131	-	-	-
Mkt Cap	-	141	-	-	-

RISKS

GEOPOLITICAL

From the perspective of ASPI, operating in South Africa presents certain political risks that need to be carefully considered. The country has a complex political landscape characterized by historical inequalities, socio-economic challenges, and ongoing political tensions.

Key risks include…

- Policy Uncertainty: South Africa's political environment is marked by frequent policy changes and debates, which can impact businesses operating in various sectors. ASPI may face challenges in forecasting regulatory changes and adapting its strategies accordingly.
- Political Instability: South Africa has experienced periods of political unrest and protests, often driven by issues such as corruption, unemployment, and inequality. Such instability can disrupt business operations, threaten safety, and lead to economic uncertainties.
- Corruption and Governance: Corruption remains a significant concern in South Africa, affecting government institutions and business practices. ASPI must navigate the risks associated with bribery, extortion, and opaque decision-making processes when conducting operations and engaging with local stakeholders.
- Labour Relations: South Africa has a history of labour strikes and disputes, which can disrupt production, affect supply chains, and impact profitability. ASPI needs to carefully manage its relationships with labour unions and ensure compliance with labour laws to mitigate these risks.

- Economic Challenges: South Africa faces economic challenges such as high unemployment rates, inequality, and sluggish growth. These factors can affect consumer demand, market dynamics, and investment opportunities for ASPI.

TECHNOLOGICAL

There are inherent technological risks associated with the ASPI and QLE technology given the nascence of both the science and its applications.

As previously mentioned, the QLE enrichment method has not been applied to uranium since the 1980s, and while management is optimistic that the Quantum Enrichment process, coupled with vastly improved technology, will provide a basis for commercialisation, this is in no way guaranteed and as such production timelines could extended.

REGULATORY

Given the nature of the products that ASPI and QLE aim to produce, there are regulatory and permitting barriers that need to be overcome. This is particularly relevant for the HALEU business given the safety risks associated with radioactive material.

While conversations are advancing with various governments, entering new markets, particularly in the nuclear sector, can be a highly bureaucratic and time-consuming process which might negatively impact production timelines. Other potential licensing risks could include supply chain components such as transport or import or export licenses for key equipment such as lasers.

PERSONNEL

Given the technical nature of ASPI and QLE operations, there are many specialist personnel including but not limited to engineers, scientists, mathematicians, and physicians. Worth highlighting is that the Company currently has a 100% retention rate for its employees but should key personnel stop working for the Company for whatever reason, this too could negatively impact production timelines and commercial viability of various products.

FINANCING

While ASPI and QLE intend to operate a model on a joint venture structure whereby partners provide investment capital in return for technology, expertise, and supply security, there will be financing requirements as the Company continues to grow. As such, generic financing risks will apply but might be exacerbated given the nature of the Company's operations.

RAISE HISTORY

Date	Type	Shares (m)	Price ($)	Value ($m)	Shares in Issue (m)
Jun-24	QLE Convertible	-	-	$5.4	-
Feb-24	QLE Convertible	-	-	$20	-
Sep-23	Equity Offering	9.95	$0.95	$9.1	48.7
Mar-23	Equity Offering	3.16	$1.58	$4.99	37.4
Sep-22	IPO	1.5	$4.00	$6.00	34.36
Feb-22	Pre-IPO	3	$2.00	$6.00	N/A
Sep-21	Pre-IPO	16	$0.25	$4.00	N/A

SHAREHOLDERS

	Position	% Out
AK Jensen (Tees River)	6,516,874	12.59
Paul Mann	5,805,643	11.22
Sergey Vasnetsov	3,838,607	7.42
TIANNE HOLDINGS PTY LTD	2,353,772	4.55
CARLEIN INVESTMENTS	2,097,424	4.05
Blackrock	1,534,302	2.96
Vanguard	1,021,019	1.97
ELISTA LLC	1,000,000	1.93
Ainscow Robert	961,373	1.86

MANAGEMENT TEAM

ASPI has a highly qualified management team comprising of scientific, commercial, and financial executives with proven track records.

Paul Mann, Chairman of the Board, Chief Executive Officer
Paul Mann co-founded ASP Isotopes in September 2021 and serves as the Chairman of the Board of Directors and Chief Executive Officer. Paul has more than 20 years of experience on Wall Street investing in healthcare and chemicals companies. Having worked at worked at Soros Fund Management, Highbridge Capital Management and Morgan Stanley. Paul started his career as a research scientist at Procter and Gamble, and has an MA (Cantab) and a Master of Engineering from Cambridge University, UK where he studied Natural Sciences and Chemical Engineering, and he is a CFA charter holder.

Dr. Hendrik Strydom, PHD, Chief Technology Officer
Dr. Strydom has over thirty years of experience in isotope enrichment. He co-developed the isotope separation technology, known as “Aerodynamic Separation Process” (ASP), which is the technology backbone of ASP Isotopes. Hendrik’s work on the separation of isotopes started when he was employed as a scientist at the South African Atomic Energy Corporation (AEC), where he specialized in the laser separation of heavy isotopes. Hendrik left AEC in 1993 to co-found Klydon, an isotope enrichment company based in South Africa. Dr. Strydom holds a PhD (Physics) from the University of Natal.

Heather Kiessling, Chief Financial Officer
Prior to joining ASP Isotopes, Heather served as Managing Director at Danforth Advisors LLC, a life science consulting firm. Prior to joining Danforth Advisors, Heather held finance leadership roles at Cytonome/ST, LLC and AutoImmune Inc. and started her career as an auditor at Price Waterhouse. Heather is a CPA and holds a BA from University of California, San Diego, and an MBA from University of Michigan Graduate School of Business.

Robert Ainscow, Chief Operating Officer
Robert Ainscow co-founded ASP Isotopes in September 2021 and serves as the Chief Financial Officer. He has more than 20 years’ experience in finance, having worked at Morgan Stanley, Bear Stearns and Investec Bank. He started his career in the legal and regulatory department with responsibility for M&A and capital markets oversight. He later transitioned into the capital markets business units and became a Senior Transactor, structuring a broad range of bespoke transactions and funding programs for balance sheet assets and on behalf of clients. Mr Ainscow holds a BA (Law & Modern Languages) from Bristol UWE in the UK.

Professor Michael Gorley, Ph.D, Board of Directors
Professor Gorley is Chief Technologist at the UK Atomic Energy Authority and a visiting Professor at the University of Bristol. He is a well-known expert in fusion technology and fusion materials. In 2014, Mike was awarded a Ph.D. (DPhil) in Materials Science from Oxford University, with a thesis on ODS steels (specialized alloys for high-performance applications). Soon after joining the UK Atomic Energy Authority in 2016, Mike directed the establishment of the Materials Technology group and supporting materials testing laboratories and led the EUROfusion Engineering Data and Design Integration group. For the past three years, Mike has served as a Strategic leader and program area manager for fusion technology at the UK Atomic Energy Authority.

Gerdus Kemp, MD, PhD, CEO of PET Labs
Dr Kemp served as Medical Director at Klydon and Molybdos. He holds a PhD in Inorganic Chemistry from the University of Johannesburg and is currently a lecturer in Radiography at the University of Pretoria.

Xandra Van Heerden, PhD
Dr van Heerden transitioned to industry as part of the R&D department at a major bio-engineering firm, leading a team in developing wound care devices and skin substitutes. She later became General Manager of a sister company, overseeing multiple bio-medical projects in product research, design, and training. Her extensive experience includes project management, engineering management, and commercialization of R&D processes.

AUTHORS

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ASP isotopes


necsa
VISITOR CENTRE
The Necsa Mandate
We're in your World
Necsa Business Subsidiaries


HURCO

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