From isotopes to advanced nuclear fuels: Paul Mann and Dr. Ryno Pretorius on The Next Big Thing

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Key Takeaways

- ASP Isotopes (ASPI) operates across nuclear medicine, electronic gases, liquefied natural gas, and nuclear fuels. These four verticals are exposed to some of the most critical material supply gaps of the coming decade.
- The ASP technology traces back to South Africa's secret nuclear weapons programme and has been continuously refined since 1993, offering a proven, lower-cost alternative to conventional centrifuge enrichment.
- Modern reactor designs are engineered to be inherently safe. The physics of the system prevents meltdown without any need for human intervention.
- Russia controls more than 40% of global enrichment capacity. The US has banned Russian enriched uranium imports, but a Western alternative is still being built - making this a matter of energy security, not just economics.
- QLE has secured a 10-year, over $3 billion HALEU supply agreement with TerraPower and is advancing facilities across the US, South Africa, and the UK.

Nuclear energy is having a moment. Governments are committing to triple global capacity. Tech giants are signing 20-year power deals, and the race is on to build the fuel supply chains that will make it all possible. But isotope enrichment, the process at the heart of that supply chain, is dangerously concentrated, technically demanding, and poorly understood outside specialist circles.

Two companies are working to change that. ASP Isotopes (ASPI) is building enrichment infrastructure across nuclear medicine, semiconductors, and nuclear fuels. Its nuclear fuel subsidiary, Quantum Leap Energy (QLE), is focused specifically on producing the advanced fuels that next-generation reactors will need.

That is why we invited Paul Mann, founder and CEO of ASP Isotopes, and Dr. Ryno Pretorius, CEO of Quantum Leap Energy, onto The Next Big Thing. Paul came to this space from Wall Street, where his experience of supply chain fragility in the isotope sector ultimately led him to acquire and rebuild the

underlying technology. Ryno came from the engineering side, with a PhD in fluorination chemistry and years of hands-on experience scaling first-of-a-kind industrial processes.

This blog post summarises some of the key messages from the conversation. To get the full episode, follow the link here.

What is ASP Isotopes?

Paul Mann founded ASPI after years managing money on Wall Street, where some of his most profitable short positions were companies whose operations were constrained by isotope supply chain problems. He began getting interested in critical materials around 2017, when he started to see clear cracks emerging in supply chains that had been stable for decades. About five years ago, he and his co-founder acquired technology assets in South Africa out of a business rescue process - essentially a form of bankruptcy - and have since raised around $400 million to build out the business. ASPI now operates across four verticals. In nuclear medicine, its PET[1] Labs subsidiary is the leading supplier of nuclear medicine isotopes in South Africa and also operates radio pharmacies in the United States. In electronic gases, ASPI has built a plant to enrich silicon-28, the ultra-pure isotope required for next-generation semiconductors and quantum computing hardware; it has shipped its first samples and expects commercial products before the end of the year. The company is also bringing online a helium and liquefied natural gas facility, as helium is a material with no real substitute, used in semiconductor manufacturing and rocket launches, and supply from its traditional sources in Qatar and Russia has been shrinking. The fourth vertical is nuclear fuels, which is handled through QLE.

What is the ASP technology and where does it come from?

The aerodynamic separation process (ASP) is the technology at the heart of both ASPI and QLE. Its origins are extraordinary. In the 1970s and 1980s, South Africa secretly developed nuclear weapons, producing somewhere between six and seven warheads entirely without centrifuges. The approach they used was a vortex tube or aerodynamic separation process, which achieved weapons-grade uranium enrichment at a fraction of the cost of conventional centrifuge technology. When South Africa signed the Treaty of Pelindaba in 1993, making Africa a nuclear-weapons-free continent, all the hardware, licensing, and knowledge from the programme was preserved in place. The scientists who came out of it continued to develop and refine the technology. Ryno Pretorius, who has a PhD in fluorination chemistry funded by the South African government specifically to keep this expertise alive, is part of a small group of engineers who bridge the gap between the original post-retirement scientists and a new generation entering the field. His journey to QLE took him through South Africa's Nuclear Energy Corporation, a period scaling hard tech startups in California (where he learned magnesium production, which is a key step in converting uranium hexafluoride into metal form), and ultimately a phone call to Paul Mann the day he got his green card. QLE now uses two enrichment technologies: the ASP process and a laser-based enrichment approach, giving it complementary tools for different isotopes and applications.

Why are new reactor designs inherently safer?

One of the most important parts of the conversation was Ryno's explanation of why modern reactor designs are fundamentally different from those associated with historic accidents. The Chernobyl reactor, he noted, was a knowingly flawed design even at the time: a graphite-moderated, water-cooled system where attempts to cool the reactor actually increased the nuclear reaction, rather than slowing it. New reactor designs work on the opposite principle: the more they heat up, the more the moderation naturally changes, and the reaction slows itself down. Reactors like the X-energy gas-cooled design and the TerraPower Natrium reactor are what engineers call 'inherently safe'. Engineers say they cannot melt down because the physics of their design prevents it, without any need for human intervention. Paul added that most modern reactors are largely autonomous, controlled by computers rather than operators. The highest standard of engineering safety is designing out the hazard entirely, rather than relying on someone to press the right button at the right moment. That is what this new generation of reactors achieves.

What is HALEU and why does it matter?

Most of today's nuclear reactors run on low-enriched uranium (LEU), enriched to below 5% uranium-235. The next generation of reactors, including small modular reactors and advanced designs from companies like TerraPower and X-energy, require high-assay low-enriched uranium, or HALEU, enriched to between 10% and 20%. HALEU enables longer fuel cycles, greater efficiency, and opens the door to extending the operational life of existing reactors that are currently destined for decommissioning. The challenge is that almost no Western enrichment capacity for HALEU currently exists. Russia has historically dominated global uranium enrichment, accounting for more than 40% of capacity. The US has already banned imports of Russian enriched uranium, but the domestic supply chain to replace it is still being built. US government estimates put the HALEU market at somewhere between 50 and 600 tonnes per year by 2035, and the current global nuclear fleet does not even have enough supply for its existing LEU requirements. QLE is one of the few companies building dedicated HALEU enrichment capacity, with facilities planned across the US, South Africa, and the UK.

What partnerships has QLE secured, and how does the commercial model work

The commercial logic for long-term nuclear fuel supply agreements mirrors what is driving the broader energy deals being signed by Microsoft, Meta, and others: reliable, stable baseload power is a competitive necessity for data centres, and the fuel supply chain that makes that possible needs to be locked in. QLE has secured a 10-year supply agreement with TerraPower, Bill Gates' nuclear venture, worth over $3 billion. TerraPower is also supporting QLE financially through the development and commercialisation of the technology, as well as providing a committed offtake agreement that allows QLE to build out capacity with confidence. QLE is also in discussions with a major US utility (which has requested anonymity to protect commercially sensitive information) and is actively advancing plans with Fermi America for a potential HALEU enrichment and conversion facility at the Amarillo, Texas site. The Amarillo site already has decades of geological, environmental, and operational data available, which significantly accelerates the development timeline. The company is also engaged with European nuclear technology companies about future fuel deliveries. Ryno's description of the commercial dynamic was direct: the industry faces

a chicken-and-egg problem where customers want supply agreements before they commit, but suppliers need committed offtake before they can justify the capital investment to build. Ryno said QLE is going all in regardless, because the demand signal is clear enough.

What is the regulatory and policy backdrop?

Ryno was recently in Washington DC, and his read of the policy environment was notably optimistic. Nuclear legislation is advancing rapidly, and he described it as moving on a near-weekly cycle. The two biggest obstacles to nuclear deployment, he argued, are the regulatory framework and the fuel cycle, and both are being addressed simultaneously. On the regulatory side, the Trump administration has targeted Nuclear Regulatory Commission (NRC) approval timelines of 18 months, compared to the 10 to 15 years that were normal under previous administrations. The pilot plant programme, supported by the Department of Energy and the Idaho National Laboratory, has already seen four reactors reach criticality, with a fifth done entirely by private funding. Oklo's isotope reactor going online in Lockhart, Texas, built in under a year, is the clearest signal yet that the pace of progress has genuinely changed. On the fuel cycle side, Ryno pointed to growing momentum around spent fuel recycling, alternative fuel sources including thorium and plutonium, and the development of domestic uranium mining capacity. The US has significant in-ground uranium resources that have been held back by regulatory and environmental constraints, and those constraints are now being revisited.

What is the geopolitical dimension of the nuclear fuel supply chain?

The geopolitical dimension of the nuclear fuel supply chain is something Paul and Ryno addressed directly. The world has committed to tripling nuclear capacity over the next 25 years or so, and 38 countries are at least discussing the target. But the supply chain to get there is deeply exposed. Kazakhstan is currently the world's largest producer of uranium yellow cake, a legacy of the Soviet era, and Ryno noted plainly that China is likely to buy as much of it as it can. That means the West needs to build its own supply from Africa, South America, Canada, and North America. The US itself has significant uranium resources, including some locations where uranium concentration in groundwater is high enough that it can be extracted without conventional mining. The enrichment side of the picture is even more concentrated: Russia's dominant share of global enrichment capacity means that even France, which has historically drawn uranium from African suppliers, could find itself dependent on Russian enriched product as those African supply routes are disrupted. Paul summarised the challenge clearly: the world does not just need more uranium in the ground. It needs the full supply chain: mining, conversion, enrichment, and deconversion, to be rebuilt at scale in the West. That is the opportunity ASPI and QLE are positioning themselves to fill.

Final thought

This conversation was a reminder that the nuclear energy story is not just about reactors. It is about the entire supply chain behind them, and right now that supply chain has serious gaps. Ryno was refreshingly blunt about why progress has been slow. We have spent decades applying the best minds of our generation to building better algorithms for keeping people glued to their phones. Hard tech is hard, and it takes real capital and real will to do it. But it can be done. The Manhattan Project was hard, going to the moon

was hard, and we did both. He was equally candid about nuclear's image problem. Forty years of Homer Simpson falling asleep at a control panel, dropping plutonium rods into the sewer, has been a PR disaster for an industry that did not deserve it. The new generation of reactors bear no resemblance to Chernobyl. They are designed so that the physics itself prevents a meltdown, without anyone needing to press a button. Texas alone faces a shortfall of over 400 gigawatts just for data centres. The demand is real, the technology exists, and the regulatory environment is finally moving in the right direction. What the industry needs now is for the right people to point their energy at the right problems.

[1] Positron emission tomography

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