Tuesday 1st December, 2020

INITIATING RESEARCH COVERAGE

PPK Group Limited (ASX: PPK)

- Potentially game-changing technology

Spec Buy

12 Month Target	N/A
Price	$6.00
Implied Return	N/A

Company data

ASX code	PPK
ASX price	$6.00
Shares on issue*	88.79m
Fully diluted shares*	89.81m
Market cap. (undiluted)	$515.99m
Cash on hand*	~$17.70m
12-month price range	$1.70-6.90
ASX turnover (shares – Nov 20)	3.73m

**Post placement announced on 27 November 2020.*

Board

Robin Levison	Executive Chairman
Glenn Molloy	Executive Director
Dale McNamara	Executive Director
Graeme Webb	Non-Executive Director
Anthony McDonald	Non-Executive Director

Major Shareholders*

Glenn Molloy	16.64%
Graeme Webb	11.45%
Australian Innovation Centre Pty Ltd	10.13%
Dale McNamara	5.43%
Robin Levison	5.21%
Top 20 Shareholders	68.51%

**As of 31 October 2020*

12-month share price, Source: ASX

Introduction: We initiate coverage on PPK Group Limited (ASX: PPK), a mining services and technology commercialisation group based in Brisbane, Australia. Historically, the company have focussed on the design and manufacturing of underground coal mining equipment in Australia. More recently, the decision was made by management to reposition PPK as a technology commercialisation business, headlined by a landmark agreement (November 2018) to acquire a 50% stake in BNNT Technology Limited (BNNTTL), a 50:50 joint-venture with Deakin University to commercialise their proven and patented Boron Nitride Nanotube (BNNT) technology. Over the last 15 years, Deakin University have been developing a manufacturing process to produce BNNTs at scale, allowing for use in a range of potentially lucrative applications. In 2018, this technology was exclusively licensed to BNNTTL for 20 years. Building on this agreement, PPK have strategically taken positions in Li-S Energy (58%), Craig International Ballistics (45%), 3D Dental Technology (45%), and more recently BNNT Precious Metals (45%) and Strategic Alloys (45%), all of which provide vertical integration opportunities utilising BNNT technology.

Value Proposition

- **Potentially game-changing technology with a broad range of applications –** BNNTs are an advanced nanomaterial with unique properties, making it one of the strongest fibres ever created. BNNT's are 100 times stronger than steel and 50 times stronger than carbon fibre, despite being lighter. They are super flexible and can be bent thousands of times without failure. They are more thermally conducive then copper, they can sustain temperatures of up to 1000°C without degradation and provide neutron radiation shielding capabilities. Due to its superior characteristics, BNNTs have the potential to be used in a very wide array of applications, including the production of ceramic dental composites, biomedical cellular scaffolding, lithium sulphur batteries, aerospace technology and radiation shielding applications, among others. All of which, have the potential to supersede existing solutions available on the market.
- **World-leading manufacturing process** – Since first being discovered in 1995, commercial applications of BNNTs have been severely hampered by complications in developing an efficient and commercially scalable manufacturing process. As a result, global production volumes have remained low (only 36kg in 2018) and price levels high at ~ US$900,000/kg. However, the patented manufacturing process developed by Deakin University is world-leading and proven to consistently produce the highest purity (99%) BNNTs among the 7 commercial samples available globally, as validated by an independent study conducted by the University of New South Wales in September 2020. PPK also recently reported that it has doubled its production capacity per module to 30kg p.a. and will replicate this (at a capital cost of A$700,000 per module) as it further scales up its manufacturing process to meet global BNNT demand for specific products such as lithium sulphur batteries, ceramic dental composites, aluminium alloys and body armour.
- **New joint-venture with Amaero International Limited and Deakin University –** PPK announced (9th November) that it has entered into a joint venture research agreement with Deakin University and Amaero Alloys Pty Ltd, a subsidiary of Amaero International Limited (ASX: 3DA), to develop super strength aluminium alloys incorporating BNNTs, which acts as a nano-reinforcement in certain metals, significantly improving their mechanical properties. Multiple applications exist for super strength aluminium alloys, particularly in the aerospace and defence sectors. Amaero, is a specialist in metal additive manufacturing (3D printing) for the defence, aerospace and tooling sectors.
- **Strong management team –** PPK has an experienced and diverse management team with a proven track record in creating significant value for investors. Robin Levison, Dale McNamara and Anthony McDonald were all part of the executive team that grew previously ASX-listed Industria from a $3m minnow in 2005 to circa $700m at the time of acquisition by General Electric in 2012.

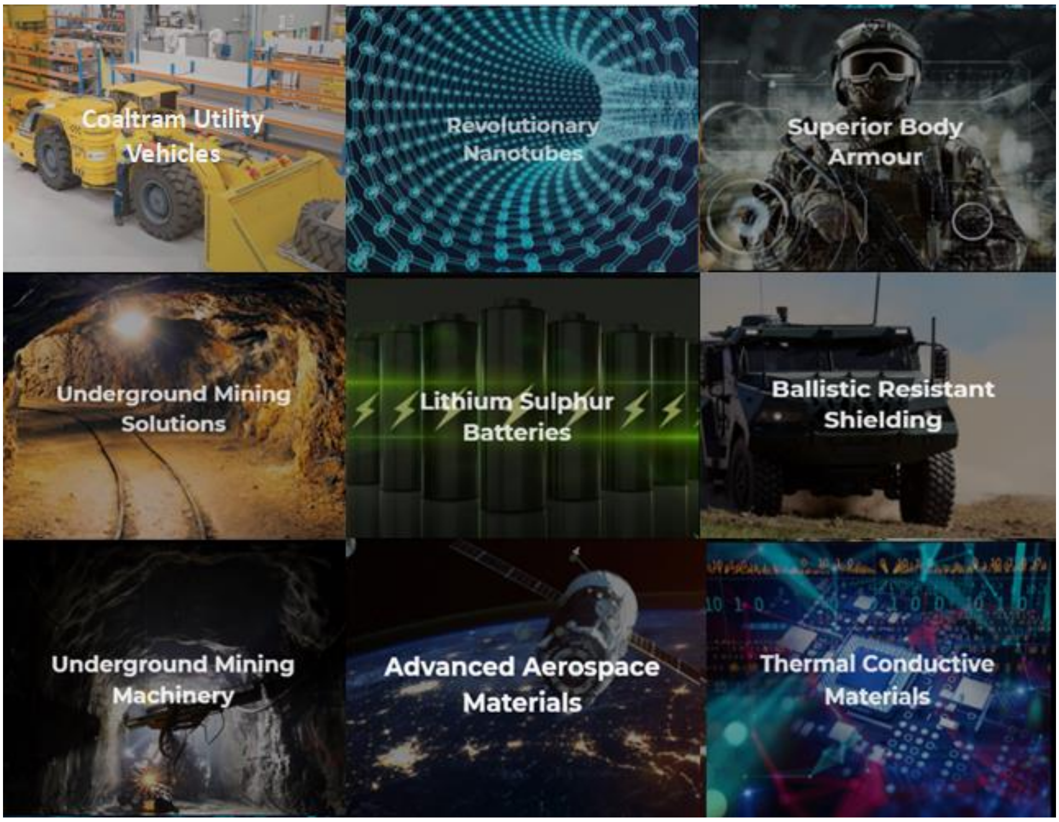
Investment View: We initiate coverage of PPK with a Speculative Buy recommendation. We have valued PPK's mining services business at $0.58 per share using DCF modelling and 12% WACC, and note that the company is currently reviewing options to divest this business unit. Our investment thesis, accordingly, focuses on the value in BNNTTL; the 50% owned manufacturing entity that produces BNNT, together with the upstream commercialisation entities (both existing and future). We recognise that BNNTTL's manufacturing process is able to produce the world's highest purity BNNTs at less than 50% of the cost of production of other producers. We anticipate material value inflexion points to occur as the company continues its progression towards commercial sales of BNNT to both industry buyers and to its upstream commercialisation entities focusing initially on lithium sulphur batteries, dental composites, armour and aluminium alloys. We expect the company to validate the scalability of their manufacturing process for use in several applications by CY22 and expect sales to commence from this point onwards. While there is currently no existing high-volume market for BNNTs making it difficult to establish a point of reference, we believe the evolution of the graphene market provides a strong pointer towards the potential trajectory of the BNNT market. Like BNNTs, graphene is a relatively new technology with similar potential applications and issues in manufacturing. On the back of some recent progress (production costs falling by 25-33%) the value of the global graphine market surged from US$8.1m in 2016 to US$78.7m in 2019 (CAGR of 113%) and is forecasted to grow to over $1.08b by 2027. We believe this is a strong indicator of a potential pathway for the BNNT market if further progress in developing a commercially scalable manufacturing process is made, in particular, validation of use in specific product applications. Among the global BNNT producers, PPK looks best placed to achieve this.

PPK Group Limited (ASX: PPK)

Potentially game-changing technology

Company Overview

PPK Group (ASX: PPK) are a mining services and technology commercialisation group based in Brisbane, Australia. Since being established in 1979, the company has predominantly focused on the provision of manufacturing equipment to service the underground coal mining sector in Australia. However, over the last 24 months the company has repositioned itself as a technological commercialisation business in both new technology and mining sectors. This shift in strategy was underpinned by a landmark agreement with the Australian Innovation Centre Pty Ltd (AIC) in November 2018. As part of the agreement, PPK acquired full ownership of AICIC, who held a 50% stake in BNNT Technology Limited (BNNTTL), a 50:50 joint-venture with Deakin University to commercialise their patented Boron Nitride Nanotube (BNNT) Manufacturing Technology. Over the last 15 years, Deakin University's Institute of Frontier Materials (IFM) have been developing the world's leading manufacturing process to produce BNNTs at scale. In 2018, IFM licensed this technology to BNNTTL for an exclusive period of 20 years. Going forward, PPK's key focus comprises of commercialising the company's BNNT technology, throughout its various applications. The company have taken positions in 5 upstream commercialization entities; LI-S Energy Limited (lithium sulphur battery technology), 3D Dental Technology Limited (dental composites) and Craig International Ballistics and Ballistic Glass Pty Ltd (armour and glass), Strategic Alloys Pty Ltd (aluminium alloys) and BNNT Precious Metals Limited (gold and silver), which focus solely on commercialisation pathways of the company's BNNT technology, while the company's other business unit PPK Mining Equipment Pty Ltd, operates the company's legacy mining services business.



PPK's existing mining-related businesses (left column) and the new BNNT-related opportunities, Source: PPK

PPK Group Limited (ASX: PPK)

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Baron Nitride Nanotubes (BNNT)

Summary

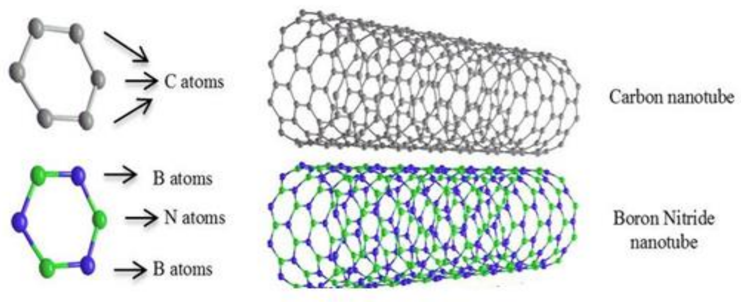
Boron Nitride Nanotubes (BNNT) are a structure of Boron Nitride, a thermally and chemically resistant refractory compound. BNNTs are 100 times stronger than steel and 50 times stronger than industrial-grade carbon fibre, despite sharing the same weight characteristics. They are extremely flexible and can be bent thousands of times without failure. BNNTs are more thermally conducive than copper; they can sustain temperatures above 1,000oC without degradation and offer neutron radiation protection. BNNTs have a range of exceptional properties that make them suitable for a variety of applications, including high temperature composites, electrically insulating thermal management materials and aerospace.

History

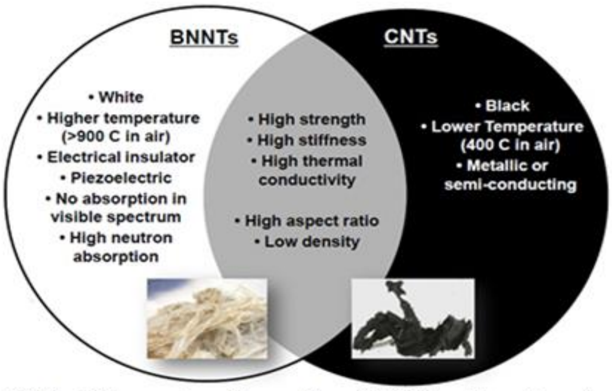
The first theoretical predictions of the existence of BNNT were discovered in 1994 by Dr Marvin Cohen of the Department of Energy's Lawrence Berkley National Laboratory, while confirmation of the experimental synthesis was achieved in 1995 by Dr Alex Zettle (Berkley), using the arc discharge/arc-jet plasma method. Several other synthesis methods have been tested over the last 25 years; however, the vast majority have encountered significant issues in producing commercial quantities, particularly, yield, purity and the existence of defects.

Structure and Properties

Structurally, BNNTs has a similar tubular nanostructure to carbon nanotubes (CNTs), except that boron and nitrogen atoms (as opposed in carbon atoms) are arranged in a hexagonal network. Because of the similarities in structure, both BNNTs and CNTs share some similar intrinsic characteristics. Both possess strong mechanical properties, with superb stiffness and bending flexibility with a Young's Modulus reading's above 1TPa, and each possess piezoelectric behaviour; the generation of electricity when subject to bending, distortion, heat and pressure, a key element of materials used for electricity generation. Both also possess high levels of thermal resistance, although BNNTs are materially superior in this area, with the ability to remain stable at levels between 800-1,000 °C, compared to CNTs at 300-400°C. Despite having similar structural characteristics, BNNTs and CNTs significantly differ significantly in their chemical and physical properties. Where CNTs can be metallic or semiconducting, depending on their rolling direction and radius, BNNTs are an electrical insulator with a wide-bandgap of ~5.7 eV, meaning they are not dependant on their chirality and morphology. This together with its strong chemical properties make BNNT's a strong neutron and ultraviolet absorber, providing a shield against radiation. BNNTs also offer radio-frequency (RF) signal transparency, a characteristic not share by CNTs. There are also visual differences between the two. CNTs are black in colour and encompass a smooth surface, whereas BNNTs are white/translucence and more corrugated in nature.



Structure of BNNTs vs CNTs. Source: Comparison of small scale effect theories for buckling analysis of nanobeams, Kadir Mercan & Omer Civalek

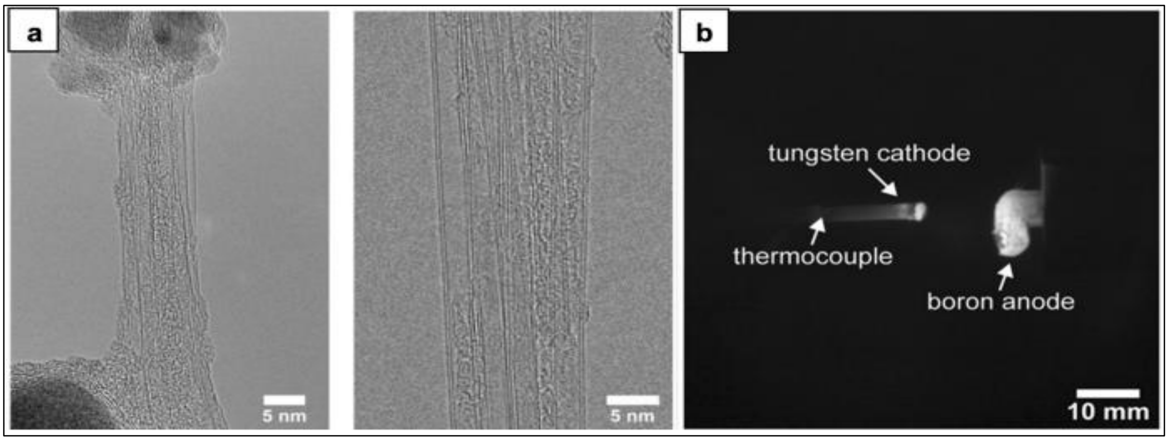


BNNT vs CNT comparison, Source: Boron Nitride Nanotubes: Properties, Synthesis and Applications, Richard Dolbec, Sigma Aldrich

Synthesis Methods

Several synthesis methods have been documented for the production of BNNTs. The majority of these methods are the same as those previously used in CNT fabrication. The essential factor rendering efficient BNNT synthesis process is the rate of conversion from boron and nitrogen sources into BN radicals. Each technique has been scientifically developed using different and distinct parameters, including the type of boron precursor, catalyst, temperature, mode of heat and duration, all of which are determinants of the ultimate length and size of BNNT's produced. We have provided a summary of documented synthesis methods below. It is important to note, that each synthesis method in itself, has been performed and documented in many different variations. For the purpose and practicalities of this of this report, we have provided only a succinct summary of each method.

1. **Arc Discharge –** BNNTs were first discovered using the arch discharge method in 1995. This method involves inserting a BN rod into a hollow tungsten electrode to utilise as an anode and a cooled copper electrode as a cathode. Arc plasma generated between the cathode and anode vaporised the anode component. The BNNT's synthesised using this method were dark gray in colour and had a diameter of 1-3nm, a length of 200nm and one end wrapping a dense particle, probably tungsten or tungsten compound with boron and nitrogen. Later applications of the arc discharge method have used hafnium dibide (HfB_2) electrodes, and conductive boron substances such as TB6 to produce BNNTs. The main disadvantage of the arch discharge method is that it is difficult to produce BNNT at scale as the reaction zone at the arc core is confined to a small volume.



(a) Single and double-walled BNNT synthesised by arc discharge method; and (b) IR image of the cathode and anode electrodes in the chamber. Source: Y.-W. Yeh et al., Stable synthesis of few-layered boron nitride nanotubes by anodic arc discharge. Sci. Rep. 7(1), 3075 (2017)

2. **Substitution Reaction –** Due to the structural similarities of CNTs and BNNTs, BNNTs can also be obtained from CNTs via a process called substitution reaction. The first substitution reaction reported used CNTs as templates to react with boron oxide (B_2O_3) in N2 gas at 1500°C. While heating, the CNTs were first oxidized (combined with oxygen), and then B and N atoms positioned themselves in vacancies. BNNTs produced using this method were grey in colour. This method was further modified by adding molybdenum trioxide (M_0O_3) and vanadium oxide (V_2O_5) into boron trioxide (B_2O_3), resulting in well aligned BNNTs in rope form and metal particles found in both the nanotube tips and walls, possibly due to the temperate used. In addition to CNT templates, BNNTs have also been successfully produced using anodic aluminium oxide and mesoporous silica templates. The key disadvantages of the substitution reaction method are the existence of impurities and bad crystallinity in the BNNTs produced.

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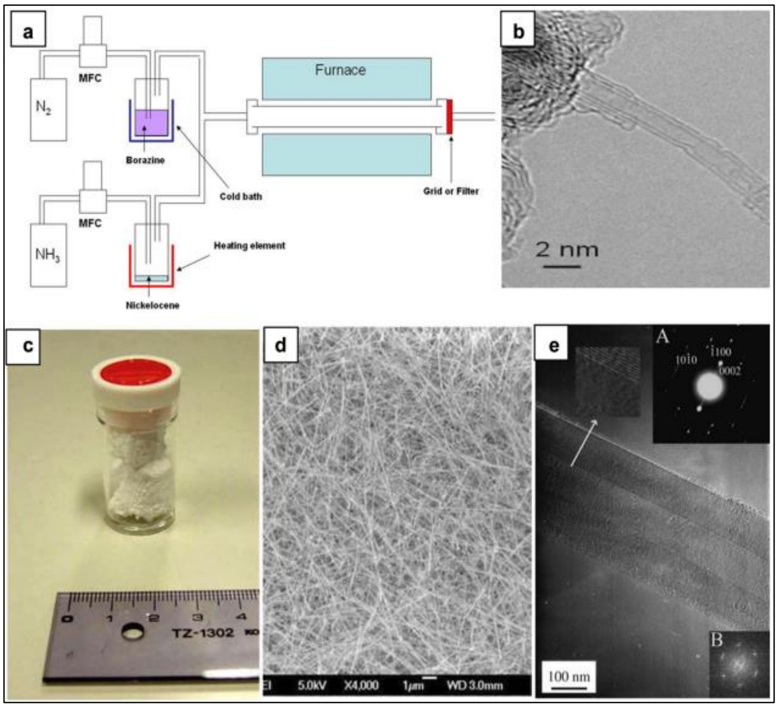
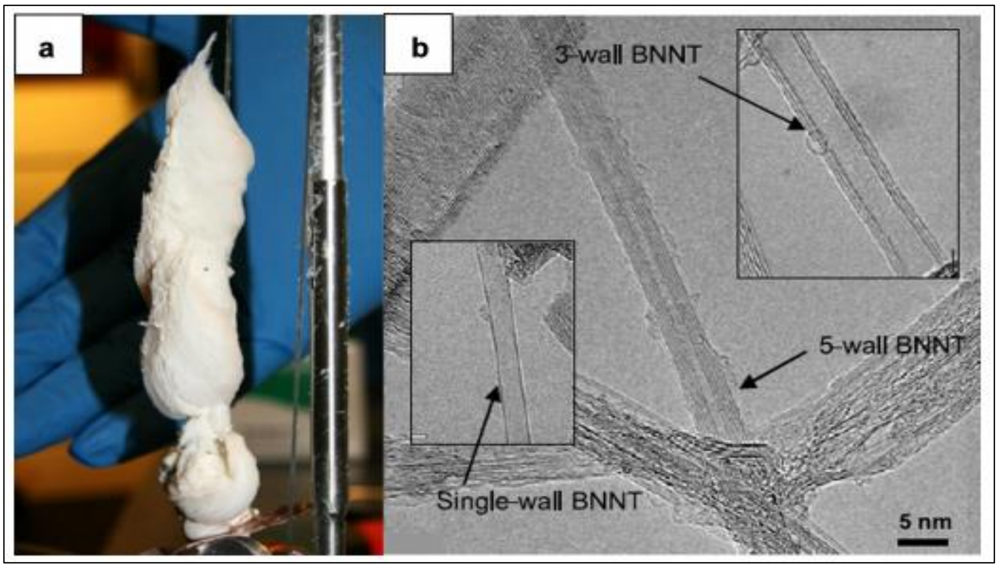
3. **Chemical Vapour Deposition** – Chemical Vapour Deposition has been one of the more common methods used to produce CNTs, and more recently, it has also been used to produce BNNTs. This technique is popular because it generates high yield products and requires simple experimental procedures. Compared to other methods, this technique allows for better control of key parameters including growth mechanism, experimental setup, precursors, catalysts and temperature, ensuring a higher quality and quantity of nanomaterials. This process involves combining a starting material with a metal catalyst such as Cobalt (Co), Nickel (Ni), NiB or Ni2N at temperatures usually between 1,000-1,200 °C. BNNTs produced using this technique usually have a multi-walled structure and tube length up to 5 µm and irregular caps.



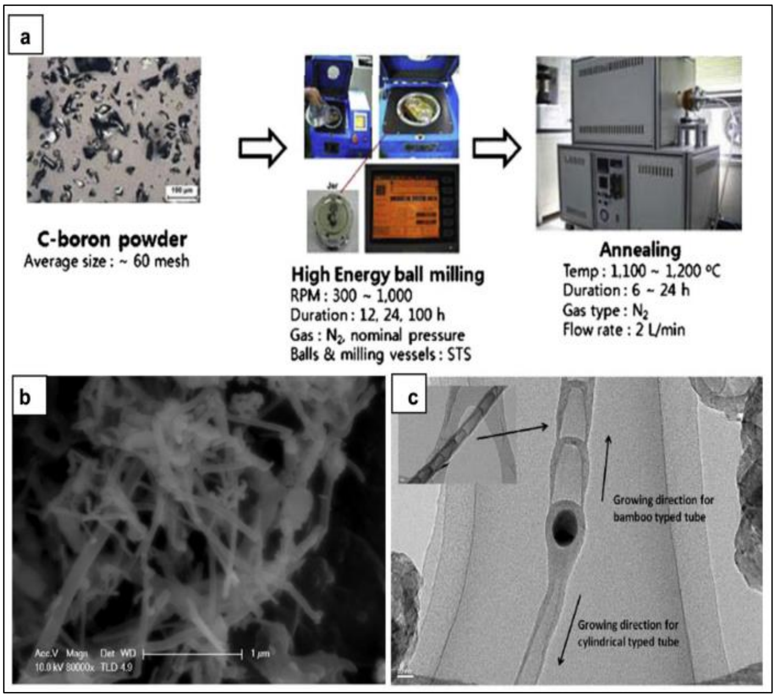
(a)Schematic of the catalytic chemical vapor deposition (CCVD) and (b) TEM image of the double-walled BNNT produced by CCVD method. (c) 200 mg of BNNTs synthesized by boron oxide chemical vapor deposition (BOCVD) at 1500 °C over 1 h. Images of (d) SEM and (e) TEM of as-grown BNNTs by BOCVD, inset A and B in (e) are corresponding SAED and FFT patterns. Source: M.J. Kim et al., Double-walled boron nitride nanotubes grown by floating catalyst chemical vapor deposition. Nano Lett. 8(10), 3298–3302 (2008) & C. Zhi et al., Effective precursor for high yield synthesis of pure BN nanotubes. Solid State Commun. 135(1), 67–70 (2005)

4. **Laser Ablation –** The laser ablation method involves a target made of boron or boron nitride undergoes a phase transformation from solid to liquid at a high temperature that exceeds the boron melting point (2000 °C) due to laser heating. As a result, the direct reaction between surrounding nitrogen atmosphere and boron target can be enhanced efficiently, resulting in the efficient growth of BNNTs. The laser ablation method has the advantage of producing high-quality nanotubes with a high aspect ratio and crystallinity.



(a) 200 mg of BNNTs synthesized by the laser ablation method in a one production process. (b) TEM image of one-, three- and five-walled BNNTs. Source: M.W. Smith et al., Very long single-and few-walled boron nitride nanotubes via the pressurized vapor/condenser method. Nanotechnology 20(50), 505604 (2009)

5. **Ball Milling –** The ball-milling technique is one that has shown the potential to synthesize BNNT at an industrial scale with low cost. This method involves producing a direct reaction between boron and nitrogen in ambient conditions by introducing defective or amorphous structure in boron starting powders. This is achieved by applying a sufficient amount of mechanical energy, controlled by several parameters including milling time and intensity. The amount of BNNTs produced using this technique depends on the producers ability to extend milling time (to hundreds of hours) and anneal (heat and slowly cool) the treated boron powder.



(a) Experimental procedure of ball-milling method. (b) SEM and (c) TEM image of BNNTs produced by the ball-milling method. Cylindrical- and bamboo-like shape of BNNTs is shown in TEM image. Source: J. Kim et al., Synthesis and growth of boron nitride nanotubes by a ball milling–annealing process. Acta Mater. 59(7), 2807–2813 (2011)

The Problem

As discussed earlier, the many exceptional properties of BNNT make it a potentially transformational technology with wide-ranging applications. However, since first being discovered in 1995, the development of a commercially scalable production route has proven to be a significant hurdle to overcome due to the extreme conditions required and the low yields and poor quality achieved at scale using existing methods. Consequently, the cost of producing BNNTs has remained at very high levels (we estimate US$300,000-500,000/kg) with only minimal amounts produced each year – e.g. 2018 global production was only 36kg. This has severely hampered its practicality for commercial use. To put this into perspective, the current market rate for a kilogram of BNNT is approximately US$900,000.

PPK's Solution

BNNT Technology Limited (BNNTTL) patented manufacturing process is the world's leading technique for the scalable production of BNNTs. Developed over 15 years of research at Deakin's Institute for Frontier Material's (IFM), the manufacturing technology was licensed to BNNTTL in 2018. The technique involves a unique semi-automated modular process derived from the patented ball milling and annealing technology. This technique utilises custom built equipment specifically designed to operate within extremely stringent parameters. BNNTTL's IP includes the patented technology, equipment design and detailed scientific knowledge, including precise values for the many critical operating parameters. A recent independent study conducted by University of New South Wales analysed 7 commercially available samples from the 5 different known global suppliers of BNNT. Results from the study found that that BNNT's produced by BNNTTS patented technology had the highest purity (99%) among all the commercially available products globally. The analysis placed BNNTTL as the only company in the "High" category of purity and showed that the BNNTs produced were 30-120nm in diameter and >2um in length. The current module design utilises a two-furnace configuration, however in a recent production update (11 November 2020), the company reported that it had purchased an additional two furnaces to double current production output. Each production module will be able to produce 15kg per annum per shift and each module is capable of 2 shifts per day, therefore increasing annual production output to 30kg per module. As the company scales up, the 4-furnace configuration module can be replicated for a total capital cost of less than A$700,000 per module.

Applications

Due to its superior mechanical and unique physiochemical properties, BNNT technology has a very broad and growing range of potential applications. We have summarised some core areas below:

1. **Biomedical –** Preliminary research indicates that BNNT is non-cytotoxic, meaning that it may be suitable for use in nano-textured cellular scaffolding for nerve and bone tissue regeneration, nanoscale drug vectors and electroporation-based oncology therapies.

2. **Ceramic Composites –** The extreme thermal resistance of BNNT indicates that it would be suitable for use in the production of lightweight ceramic composites, which are utilised in a wide array of industries from dentistry through to aerospace and defence.

3. **Electrically Insulating –** Thermally conductive and electrically insulating components make BNNT a strong potential material in the production of electrical insulators, with applications ranging from lightweight wiring, enhanced cooling of electric components and high performance batteries.

4. **Fire Retardant Cabling –** BNNT may be used in the production of high strength lightweight conducting cabling for applications for use in an expanded range of temperate and extreme operational environments.

5. **Piezoelectric** – Strong mechanical characteristics combined with the outstanding piezoelectric and electrostrictive properties of BNNT's allow for the creation of nontoxic lightweight piezoelectric systems with better response and mechanical properties than current piezoelectric polymers. This will be key for use in enhanced sensors and robotics including applications in unmanned aerial vehicles, energy harvesting solutions and satellites.

6. **Polymer Composites –** Although still in its infancy, BNNT has shown ability to composite well with a wide array of polymers. Potential applications for BNNT polymer composites include batteries, thin coatings, and armoury and aerospace.

7. **Radiation Shielding –** BNNTs can be the basis for neutron shielding composites for use in radiation shielding applications due to the presence of boron with its unique high efficiency for absorbing thermal neutrons. BNNT can also be used for ultra violet (UV) shielding applications.

- Metal Polymer & Ceramic Components
- Transparent material for Defence, Automotive & Aviation
- Thermal conductive & electrical Insulating semiconductors
- Sensors
- Long-lasting batteries
- Efficient solar panel arrays
- Supercapacitors
- Hydrogen storage
- Desalination.
- Water purification
- Fire retardant clothing & materials
- Cancer and cellular regeneration therapies.
- 3D Printers
- Bullet proof clothing & glass
- Temperature-tolerant vibrational dampeners.
- Composites for unmanned aerial vehicles.
- Tough coatings
- Bright LEDs
- Radiation shielding
- Neutron detection
- Rugged aerospace components
- Biomedical scaffolding for nerve & bone tissue regeneration
- Targeted drug delivery
- Cancer treatments.
- Computer component shielding heat, electricity & radiation
- Screen protection glass
- Polyurethane-modified Bucky paper composites
- Reinforced aluminium
- Nanoelectronics where heat dissipation is critical.
- Nano transducers
- Nano Bio sensors.
- Fillers in metal/ceramic composites high temperatures.
- Optoelectronic devices,
- Lithography applications
- Antifouling surfaces.
- Aerospace components
- Applications in Dentistry.
- Fire retardant cabling
- Satellite structure & shielding
- Light weight armour
- High temperature components
- Spintronics or spin-based electronics
- Orthopedic implant applications

Specific BNNT applications under research globally, Source: PPK

Group Structure

1. **BNNT Technology Limited (BNNTTL) –** BNNTTL is a 50:50 joint-venture with Deakin University. BNNTTL focus on the development, manufacture and commercialisation of BNNTs. As explained earlier, BNNT's have very unique and exceptional properties, that if manufactured on a commercial scale, provide the opportunity to be used in a very wide array of potential applications. PPK has 3 main strategies for BNNTTL:
   - **a.** Produce BNNT to pure grade and in commercial quantities – As reported by PPK on 10 June 2020, the company has achieved 99% purity levels using a single furnace, a milestone attained in only 12 months and the highest level recorded globally. The world-leading BNNT production process used by BNNTTL was further validated by a recent study conducted by the University of New South Wales, which conducted an independent analysis of 7 commercially available BNNT samples from 5 different suppliers around the world. As per the announcement released on 10 September 2020, results from the study found that BNNTs produced by BNNTTL had the highest purity among the samples, and were the only ones placed in the "high" category of purity. The BNNT's produced by BNNTTL were 30-120nm in diameter and >2um in length. The company have advanced their design manufacturing innovation and acquired additional equipment to move towards a semi-automated multi-furnace configuration. BNNTTL currently utilise a 2-furnace configuration module and are in the process of increasing this to a 4-furnace configuration module, capable of 2 shifts per day, and to produce 30kg of BNNTs per annum. A module which can be replicated as the company scales up its manufacturing. The company's ultimate goal is to develop a continuous 24-hour production process.
   - **b.** Supply BNNTs to product manufacturing partners – Once the company has validated its ability to manufacture high-purity BNNTs in commercial quantities, a key strategy for the company is to develop supply partnerships with specialised product manufacturers that can blend or infuse BNNT into their products.
   - **c.** Upstream opportunities – Another more lucrative strategy for the company, is to partner with application or industry leaders to blend or infuse BNNT into their products to create or enhance new products, and in doing so, PPK retains a financial interest in the new entity and multiple opportunities to generate future revenues.

PPK currently hold positions in 5 upstream application projects in progress with Deakin University, all of which have an 18 to 36-month time horizon. They include:

i. **LI-S Energy Limited (58% interest) –** In January 2020, PPK, Deakin and BNNTLT executed a 2-year R&D agreement to focus on the development of Lithium Sulphur battery technology. Lithium sulphur batteries have a multitude of advantages over alternative batteries, however there are a number of technical hurdles that make it difficult to produce on a commercial scale. Li-S researchers at Deakin University believe that by incorporating BNNTs into the design of the Lithium Sulphur batteries, they will be able to overcome these technical hurdles, allowing the many advantages if Lithium Sulphur battery chemistry to be realised on a commercial scale. Specifically, the project aims to develop BNNT as a nano-insulator in lithium sulphur batteries to significantly increase the energy density capability, lower recharge times, increase discharge/charge cycles while addressing existing stability and safety issues relating to use of lithium ion batteries in general. Deakin University's lithium sulphur batter project was established over 6 years ago, however strong progress has been made since the BNNT was introduced over recent months. The Li-S battery laboratory was completed in October 2020, 4 months behind schedule due to COVID-19 however R&D has been ongoing. Li-S Energy is an unlisted public company and undertook a $3.25m capital raising in July this year. The raise was based on a valuation of $35m and was oversubscribed. Concurrent to the capital raising, Li-S Energy was presented with the opportunity to acquire an interest in Zeta Energy LLC (Zeta Energy), a Delaware limited liability company currently also a pre-IPO stage. Zeta Energy is developing battery technology at Rice University in Houston, Texas. Its battery uses a hybrid anode created from grapheme and carbon nanotubes. They are in the prototype development stage aiming to build a low volume pilot facility and is targeting commercial sales within 2 years. Li-S agreed to issue 2% of its share capital (pre-Li-S Energy's capital raise) to Zeta Energy and received 2% of a non-voting limited liability interest in Zeta Energy (in a pre-IPO capital raise). Li-S Energy made a further cash investment of $500K bringing its total investment in Zeta Energy to 2.4%. Prior to its capital raise, Zeta Energy was valued at US$70m, thereby valuing Li-S Energy's stake at circa US$1.173m.

ii. **3D Dental Technologies Limited (45% interest) –** On the 9th of July 2020, PPK, Deakin and Dr David Dunn, executed an 18-month R&D agreement to investigate the ability to infuse BNNT into nanocomposites with frequently used dental materials including zirconia, lithium disilicate, alumina and ceramic composite resins, to fabricate BNNT into the molecular matrix to manufacture advanced dental applications commonly used in prosthetic and implant dentistry (e.g. inlays, onlays, veneers, crowns, bridges). Researchers at Deakin University believe that incorporating BNNT into these applications will result in a lower risk of implant failure, smaller configurations, and superior fracture resistance, compared to existing alternatives. The project has been scoped and research and development agreements have been finalised. The company has applied for a funding grant while an International (PCT) Patent Application has been filed. Dr Dunn is a noted aesthetic dentist with over 25 years of clinical and diagnostic experience in cosmetic dentistry and dental implants. The market opportunity to potentially manufacture superior dental materials is significant, with the size of the implant and prosthetics market reaching US$4.6b in 2019.

iii. **Craig International Ballistics & Ballistic Glass Pty Ltd (45% interest)** – Craig International Ballistics & Ballistic Glass Pty Ltd (CIBBG) is a leading supplier of body armour to the Australian Defence Force (ADF) and Police Forces. The company has won a number of key government and defence contracts for the supply of aircraft armour panels, armoured vehicles, structural armour and covert and tactical body armour. In December 2019, PPK acquired a 45% stake in Craig International Ballistics Pty Ltd (CIB), an unlisted company that is a leading manufacturer of soft and hard ballistic (body armour) products primarily for the security and defence sectors, and on 11 March 2020, the company incorporated Ballistic Glass Pty Ltd to develop a manufacturing process for incorporating BNNT into transparent materials to enhance the resistance and weight characteristics of ballistic body armour and bullet resistant glass. The company is working with two industry specialists seeking alternative solutions from different directions with the results that they may have two or more new products available to the market. PPK has a 40% interest while CIB has a 20% interest in Ballistic Glass Pty Ltd.

iv. **Strategic Alloys Pty Ltd (45% interest) –** On the 9th of November 2020, PPK announced that it had entered into a joint venture research agreement (JVRA) with Deakin University and Amaero Alloys Pty Ltd, a subsidiary of Amaero International to develop a super strength aluminium alloy. As part of the agreement, the parties have incorporated Strategic Alloys Pty Ltd to undertake this advanced materials project, which will be owned 45% by PPK, 45% by Amaero Alloys Pty Ltd and 10% by Deakin University. The new super strength aluminium alloy will incorporate BNNTs into its formulation, which acts as a nano-reinforcement in certain metals, significantly improving mechanical properties. Super strength aluminium alloys have multiple applications in a wide array of industries, particularly in the aerospace and defence sectors. The research will be undertaken at Amaero's manufacturing plant and R&D Laboratories at Notting Hill, Victoria, in addition to Deakin University in Geelong, and is due to commence in November 2020, with initial market validation expected in early 2021.

v. **BNNT Precious Metals Limited (45% interest) –** On 22 October 2020, PPK executed an 18 month research & development agreement to investigate the use of BNNT in the molecular matrix of gold and silver, to improve their strength, hardness and durability for use in electronic, jewelry, dentistry, medicine and other industries. Gold and silver have a range of benefits and uses, however due to their soft composition they need to be alloyed with other metals which compromise their effectiveness, properties, and value. BNNT introduces a nano-reinforcement to pure metals to give them superior strength, hardness and durability without alloy additives.

2. **PPK Mining Equipment –** PPK Mining Equipment Pty Ltd (PPKME) is PPK's legacy mining services business. The company designs, manufactures and services a range of COALTRAM flameproof and explosion proof diesel Load Haul Dump (LHD) utility vehicles. They are produced at its manufacturing and service centre in New South Wales which operates to world-class, large scale, lean manufacturing standards that meet the most stringent global export specifications. Its COALTRAM utility vehicles, which are manufactured in a range of size variations, are widely deployed at mines throughout Australia by clients including BHP, Centennial Coal and Glencore. PPKME have also made material progress towards the electrification of a range of battery underground vehicles. The company operate a service and support centre at Port Kembla, Wollongong.

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FY20 Results - Overview

On the 27th of August 2020, PPK reported their annual results for FY20. Total revenue from ordinary activities came in at $41.1m, unchanged from FY19, all of which was derived from the company's mining segment. Revenue from customer contracts was $39.8m, an increase of 2.4%. This was made up of the rendering of services of $24.6m (61.8% of total) and goods sales of $15.23m (38.2%). The company had a strong first half year with revenues of $22.05m, with the back half of the year ($19.05m) impacted by COVID-19. The company also reported other income of $9.45m which was mainly due to the write back of $9.04m to income of a contingent consideration made in the 2019 financial year. The largest expense items were mining services expenses of $8.58m (65.3% of total) and corporate expenses (23.3%). EBITDA for the period came in at $8.8m, up 300% from FY19 ($2.2m). The company booked an NPAT of $8.31m for the period, an increase of 362% on FY19 ($1.8m), although ignoring the write back of the contingent consideration, the company would have booked a loss for the year of -$0.77m. The company announced a fully franked final dividend of 1 cent, bringing the total dividend for the year to 2 cents. Operating cash receipts from customers totaled $48.35m, up 15.4% from FY19 ($41.91m) while net operating cash flows came in at $3.32, an increase of 295% on FY19 (-$1.70m). In October 2019, PPK raised $8.5m at $4.25 per share to finance BNNT related projects. In December 2019, the company completed an acquisition of 45% of Craig International Ballistics Pty Ltd (CIB) for a total consideration of $5m, payable via the issuance of 500,000 shares (at $4.50/share) and a cash payment of $2.75m. In June 2020, the company accounted three new BNNT application ventures, Li-S Energy, 3D Dental Technology and Ballistic Glass. As of 30 June 2020, PKK maintained a current asset position of $24.66m, net working capital of $16.92m and cash balance of $5.34m.

Recent Capital Raising

On the 27th of November 2020, PPK Group announced that it had raised $15.4m via a single-tranche share placement to institutional and sophisticated investors. Under the terms of the placement, the company issued 2.8m shares at an issue price of $5.50 per share. Funds raised will be utilized as working capital to further develop and pursue the commercialization of BNNT, funding new investment opportunities and assist in the separation of the mining business. In addition, two Directors, Mr Robin Levison and Mr Dale McNamara have also sold a total of 1,845,000 PPK shares (Levison 345,000, McNamara 1,500,000) at $5.50 per share, with the sales proceeds providing the opportunity to participate directly and alongside PPK into a new or merged mining venture when PPK separates or demerges its mining business as previously announced. Both the placement and the sell-down were completed at a 9.8% discount to the last close price ($6.10) and 10.4% discount to the 15-day VWAP ($6.14). Following the completion of the capital raise, the company will maintain a cash balance of ~$17.7m.

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Strategy & Developments

Over the last 24 months, PPK management have set upon a strategic path to reposition the company away from its legacy mining services business and towards becoming a technology commercialisation business. To achieve this objective, the company have put in place the following steps, which to date have been partially executed:

- **Commercialise BNNT technology –** In November 2018, PPK into a Heads of Agreement with the Australian Innovation Centre Pty Ltd (AIC) for the 100% acquisition of the AIC Investment Corporation (AICIC) for $6.65m (predominantly via script). This acquisition (completed in March 2019) gave PKK a 50% holding in BNNT Technology Limited, a 50:50 joint venture with Deakin University to commercialise their patented BNNT manufacturing technology.
- **Vertical Integration –** Following its acquisition of AICIC, PPK been actively investigated strategies to vertically integrate its BNNT production process into lucrative end markets. Whilst BNNT technology has a very high number of potential applications, the company is initially focussing on the highly lucrative markets of lithium sulphur battery technology, dental composites, ballistic armour and glass, and aluminium alloys.
- **Establish Partnerships –** PPK is also focusing on building a secondary business to partner with specialised product manufacturers to enable further investigation into the potential to integrate BNNT into other conventional materials.
- **Reviewing options for mining services business –** In order to maximise shareholder value, the PPK are investigating options to potentially separate the mining services business from the company's BNNT related activities. This may be via way of a separate ASX listing, co-ventures, mergers and whole or partial disposal.

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Investment Thesis

- **World leading BNNT manufacturing process –** The patented manufacturing process developed by Deakin University over the last 15 years is world leading, producing the highest purity of BNNTs among all commercial samples available globally. Further, the company have indicated an ability to produce BNNTs at less than half the cost of other manufacturers and is confident in the scalability of its technology.

- **Unlimited potential –** As explained previously, BNNT is a game changing technology with a multitude of lucrative potential applications. As a result, the market opportunity available to any manufacturer that can demonstrate a capability to produce BNNTs in commercial quantities is enormous.

- **Broad range of applications** – Due to the nature of BNNT technology, the company can test the use BNNTs across a broad number of potential applications, thus increasing the chances of success.

- **Strong management team –** PPK have an experienced and diverse executive management team with a strong track recording of creating significant value for investors. Robin Levison, Dale McNamara and Anthony McDonald were all part of the executive team that grew previously ASX-listed Industria from a $3m minnow in 2005 to a company it sold for circa A$700m to General Electric in 2012.

- **Acquisition target** – If the company can validate its manufacturing process for use in a specific application (e.g. lithium sulphur batteries or dental composites), then the significant enhancements to these products through the incorporation of BNNTs will likely make the company an acquisition target for larger international industry players.

Risks

- **High risk –** PPK is the typical high-risk high reward investment proposition. While the technology is exciting, it is still early days for large scale commercial use, thus posing a material risk for investors.

- **Still work to do –** Since discovery in 1995, the progression of BNNTs from lab to market has been severely hampered by an inability to develop a commercially scalable production process. While Deakin University has made great strides in this area in recent decades, further technology validation is required before it can be applied to specific commercial uses.

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Board and Management

Name & Position	Description
Robin Levison **Executive Chairman**	Appointed as a Director and Executive Chairman on 22 October 2013. Mr Levison is also Chairman of ASX listed Founders First Limited (ASX:FFL), is the recently retired Chairman of Retirement Village operator Eureka Group Holdings Limited (ASX: EGH) and from 2005 -2013 was Managing Director and CEO of ASX 200 listed mining services company Industrea Limited (ASX:IDL) which was acquired by US based General Electric (GE). He then served as Global Director of M&A with GE Mining.
Glenn Molloy **Executive Director**	Member of the PPK Group Limited Board since listing on 21 December 1994. Mr Molloy founded the former entity Plaspak Pty Ltd in 1979 and has acted as a director of the consolidated entity since that time. He has extensive experience on public company boards, and in advising publicly listed and private entities on commercial aspects of mergers, acquisitions and divestment activities. Mr Molloy was appointed to the role of Executive Director in September 2009 following the retirement and resignation of David Hoff as Managing Director.
Graeme Webb **Non-Executive Director**	Mr Webb is Chairman of EDG Capital Limited and has over 40 years of experience in building, construction and property development undertaking over $600 million of projects during his career to date. In addition, Mr Webb has a broad range of business experience having acted as a director and/or chairman of a number of private and public companies engaged in a range of industries including plastics packaging, merchant banking, aluminium fabrication, glazing and glass toughening.
Dale McNamara **Executive Director**	Appointed as a Director on 29 April 2015. Mr McNamara has more than 30 years' experience in operational and management roles in the coal mining industry in Australia and China. He founded Wadam Industries, a subsidiary of ASX 200 listed mining services company Industrea Limited and served as its Managing Director from 1993. He was then appointed as Deputy Chief Executive Officer of Industrea in 2009. Following the takeover of Industrea in November 2012 Mr McNamara assumed the position of Global Director, Mining with GE Mining.
Anthony McDonald **Non-Executive Director**	Member of the PPK Group Limited Board since listing on 21 December 1994. Mr McDonald has extensive experience as a lawyer and a director of listed public companies including previously ASX 200 listed mining services company Industrea Limited which was acquired by General Electric (GE). He has been involved in the natural resources sector in Australia and internationally for many years. Mr McDonald is also a non-executive director of ASX listed Santana Minerals Limited.
Andrew J. Cooke **Group Company Secretary**	Appointed as Group Company Secretary on 9 May 2012. Andrew has extensive experience in law, corporate finance and is the Company Secretary of a number of ASX listed companies. He is responsible for corporate administration together with stock exchange and regulatory compliance.

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Valuation Potential

As a starting point, we have valued PPK's mining services business (PPKME) using a Discounted Cash Flow (DCF) Model and a WACC of 12% over a period of 5 years. Based on this, we have derived a valuation of $0.58 per share for PPKME and note that management is currently reviewing options to divest this business unit.

Considering the significant discrepancy between the company's current share price and the valuation we have attributed to the mining services business, it is easy to see that the vast majority of value attributed to the company by the market is related to its BNNT technology business. However, placing a value on PPK and its technology business is a very difficult proposition. Due to the historical difficulties associated with manufacturing, there is currently no established market for BNNT, making it difficult to establish a point of reference. An obvious comparison is the carbon nanotube market which is expected to grow to around US$10b by 2023; although there are still distinct differences that exist between the two, including manufacturing difficulty and chemical properties. Perhaps the best point of reference is the global graphene market. The evolution of graphene shares many distinct similarities to that of BNNTs. It is still in its infancy, being first discovered in 2004 and it maintains many outstanding qualities similar to those of BNNTs. Graphene is extremely strong and stiff, it is ultra-lightweight, and is an amazing conductor of electricity and heat. As a result, graphene also shares a wide range of potential applications including the production of composites and coatings, electronics, energy harvesting and storage solutions. Further, the commercial adoption of graphene has similarly been plagued by difficulties in developing a commercially scalable manufacturing process. Consequently, despite gradually increasing in recent years, production volumes still remain relatively low. While these challenges remain, progress has been made in recent years with the average cost of producing a sheet of graphene and powdered/liquid graphene falling by a third and quarter respectively over the last 2 years. Despite still being in its very early stages, the potential benefits of graphene have seen the size of the global graphene market increase exponentially in recent years, growing from only US$8.1m in 2016 to US$78.7m in 2019 (CAGR of 113%), while looking forward, it is forecasted to grow by a CAGR of 38.7% to US$1.08B by 2027. In our view, the growth of the graphene market over the last 5 years provides a strong pointer towards the potential trajectory of BNNT market. With the world's leading manufacturing process for BNNTs, producing the highest purities at half of the cost of other producers, PPK is best placed to benefit from any imminent surge in the BNNT market, particularly if they can validate specific product applications, which they are on track to achieve over the next 24 months. In our view, even if the company is only successful in developing a manufacturing process for only one specific commercial application of BNNT, this would still be sufficient to see a significant appreciation in the value of the company, and also likely making it an acquisition target for larger global industry players.

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PKK Mining Equipment Business Unit

Valuation Ratios (A$m)

Year ending June	2020A	2021E	2022E	2023E	2024E
NPAT	8.3	2.5	3.2	4.0	4.9
EPS_{adj} (¢)	**0.09**	**0.03**	**0.04**	**0.04**	**0.05**
EPS growth	**270.9%**	**70.4%**	**27.7%**	**24.6%**	**22.3%**
P/E ratio	**63.9 x**	**216.2 x**	**169.3 x**	**135.9 x**	**111.1 x**
Enterprise Value (m)	510	498	499	497	493
EV/Sales (x)	12.41 x	11.02 x	10.04 x	9.09 x	8.19 x
EV / EBIT (x)	57.7 x	181.2 x	145.1 x	117.8 x	96.5 x
EV / EBITDA (x)	57.7 x	181.2 x	145.1 x	117.8 x	96.5 x
DPS ($)	0.02	0.02	0.02	0.02	0.02
Dividend Yield	**0.3%**	**0.3%**	**0.3%**	**0.3%**	**0.3%**
Payout Ratio	0.0%	72.1%	56.4%	45.3%	37.0%
Franking	N/A	N/A	N/A	N/A	N/A
FCFPS (¢)	0.13	0.05	0.04	0.07	0.05
P/FCFPS	46.67	127.90	141.06	90.59	124.20

Cashflow (A$m)

Year ending June	2020A	2021E	2022E	2023E	2024E
Receipts	48.35	45.21	49.73	54.71	60.18
Payment to suppliers	(44.75)	(45.87)	(48.17)	(50.57)	(53.10)
Interest	(0.29)	0.00	0.00	0.00	0.00
Interest received	0.01	0.01	0.01	0.01	0.01
Grant	0.00	0.00	0.00	0.00	0.00
Income Tax	0.00	0.00	0.00	0.00	0.00
Operating cashflow	**3.31**	**(0.66)**	**1.57**	**4.14**	**7.08**
Investing cashflows					
Payments for PPE	(0.72)	(0.72)	(0.72)	(0.72)	(0.72)
Intangibles	(1.47)	(1.47)	(1.47)	(1.47)	(1.47)
Financing activities					
Share issue	11.75	15.40	0.00	0.00	0.00
Borrowings	5.15	0.00	0.00	0.00	0.00
Repayments	(7.26)	0.00	0.00	0.00	0.00
Principle lease payments	(1.56)	0.00	0.00	0.00	0.00
Other	(1.42)	(0.77)	0.00	0.00	0.00
Net cashflow	**4.33**	**11.57**	**(0.83)**	**1.73**	**4.68**
Cash at beginning year	1.05	5.38	16.95	16.12	17.85
Cash at 30/06	**5.38**	**16.95**	**16.12**	**17.85**	**22.53**

Revenue Split (A$m)

Year ending June	2020A	2021E	2022E	2023E	2023E
Sales Revenue	41.10	45.21	49.73	54.71	60.18
Other	9.45	0.84	0.84	0.84	0.84
Group Revenue	**50.55**	**46.05**	**50.57**	**55.54**	**61.01**

Profit and loss (A$m)

Year ending June	2020A	2021E	2022E	2023E	2024E
Operating revenue	41.1	45.2	49.7	54.7	60.2
EBITDA	8.8	2.7	3.4	4.2	5.1
D&A	2.4	1.1	1.2	1.3	1.4
EBIT	**6.5**	**1.7**	**2.2**	**2.9**	**3.7**
Net interest income	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)
NPBT	8.5	2.5	3.2	4.0	4.9
Tax Expense (benefit)	(0.2)	0.0	0.0	0.0	0.0
NPAT	**8.3**	**2.5**	**3.2**	**4.0**	**4.9**
Significant Items	0.0	0.0	0.0	0.0	1.0
NPAT	**8.3**	**2.5**	**3.2**	**4.0**	**4.9**
EBITDA Margin	21.5%	6.1%	6.9%	7.7%	8.5%
EBIT Margin	15.8%	3.7%	4.5%	5.3%	6.1%
NPAT Margin	20.2%	5.5%	6.4%	7.2%	8.1%

Balance sheet (A$m)

Year ending June	2020A	2021E	2022E	2023E	2024E
Bank Balance	5.3	16.9	16.1	17.9	22.5
Receivables	6.3	8.6	9.4	10.4	11.4
Inventories	10.6	10.6	10.6	10.6	10.6
Other	0.74	0.90	0.99	1.09	1.20
Current assets	**24.7**	**37.0**	**37.1**	**39.9**	**45.7**
Net PPE	5.2	5.9	6.5	7.1	7.8
Intangibles	3.04	1.61	1.61	1.61	1.61
Investments	27.63	27.63	27.63	27.63	27.63
Other					
Non-current assets	**39.58**	**35.12**	**35.70**	**36.35**	**37.06**
Total assets	**64.24**	**72.11**	**72.82**	**76.24**	**82.77**
Payables	4.33	7.23	7.96	8.75	9.63
Borrowings	0.15	0.00	0.00	1.28	0.00
Other liabilities	0.00	0.00	0.00	0.00	0.00
Provisions	1.88	3.41	3.75	4.12	4.54
Contingent	1.68	0.00	0.00	0.00	0.00
Total liabilities	**10.05**	**10.64**	**11.71**	**14.16**	**14.17**
NET ASSETS	**54.19**	**61.47**	**61.11**	**62.08**	**68.60**

Balance Sheet Ratios

Year ending June	2019A	2020E	2021E	2022E	2022E
Net Debt	(5)	(17)	(16)	(17)	(23)
NTA	54.19	61.47	61.11	62.08	68.60
Price / NTA (x)	0.111 x	0.098 x	0.098 x	0.097 x	0.087 x
Return on assets	12.9%	3.5%	4.4%	5.2%	5.9%
Return on equity	15.3%	4.0%	5.2%	6.4%	7.0%

Valuation

Year ending June			
Discounted Cash Flow Method		WACC	12.00%
Discount Period	5 years	**Price Target**	**$0.58**

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Disclosure of Interests

Lodge directors, consultants and advisers currently hold less than 1% of issued shares in PPK Group Limited (ASX: PPK) and may buy or sell the shares from time to time. Lodge has earned and will continue to earn broking commissions by acting for individual clients that are buying or selling their shares in the company.

Explanation of Lodge Partners recommendation system:

Recommendations are assessments of each Lodge Partners Analyst's view of potential total returns over a 1-year period.

Expected total Return is measured as (capital gain (or loss) + dividend)/purchase price

We have divided our recommendations into three main categories:

Buy: Expected Total Return in excess of 15% over a 1 year period.

Hold: Expected Total Return between 0% and 15% over a 1 year period.

Sell: Expected Total Return less than 0% over a 1 year period.

Analyst Verification

I verify that I, Shannon Zeneli, have prepared this research report accurately and that any financial forecasts and recommendations that are expressed are solely my own personal opinions. In addition, I certify that no part of my compensation is or will be directly or indirectly tied to the specific recommendation or financial forecasts expressed in this report.

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