

SPANGEL Mining Flash Note

Non-Independent Research

Talga Resources

TLG AU

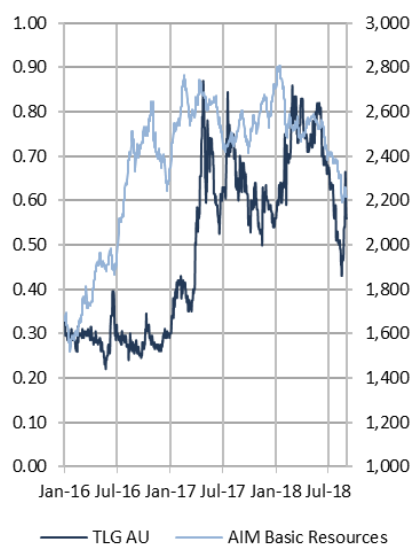
BUY

27 November 2018

Stock Data

Ticker	TLG AU
Share Price:	A\$0.44
Market Cap:	A\$94.7m

Price Chart



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Integrated advanced materials unlocking the future of graphene

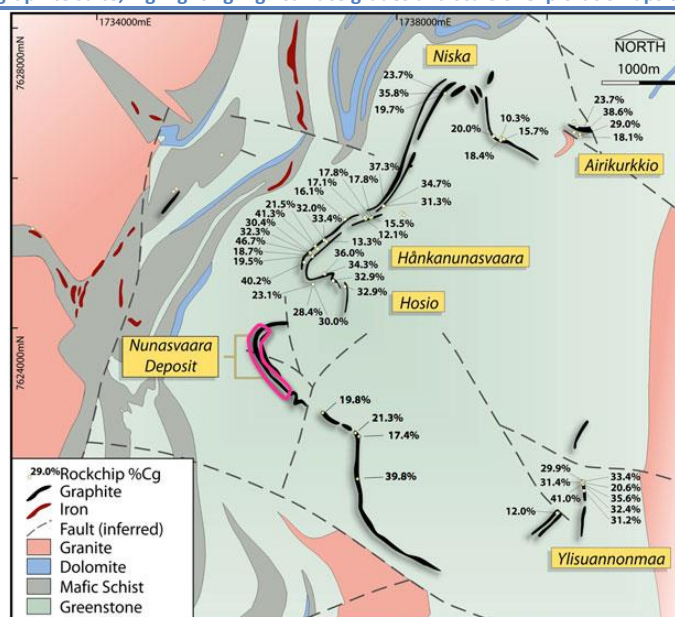
Vertically integrated advanced materials company, Talga Resources, principally focus on enabling stronger, lighter and more functional graphite and graphene products for the global coatings, polymer composites, construction and energy storage markets. Developing the world's highest grade JORC graphite deposit in Sweden, the company utilise their proprietary ore electrochemical exfoliation process to manufacture bulk value-add Talga graphene products.

Talga Resources are diversifying across the battery metal suite with exposure to prospective cobalt assets in Sweden.

Graphite the most overlooked battery metal

- Talga Resources flagship project develops one of the world's highest-grade JORC-compliant graphite resource; the Nunasvaara deposit of 12.3Mt @ 25.5% TGC ("total graphitic carbon"), based on a 17% TGC cut-off.
- The Nunasvaara resource includes a higher-grade domain of 2.0Mt @ 32.6% TGC, based on a 30% Cg lower cut-off. Mineralisation is present from surface to 220m depth and remain open along strike and at depth. Nunasvaara is encompassed within the 400km² exploration permit combined within the Vittangi project.
- Work to date includes geophysics, trenching, core drilling and trial mining of 5,000 tonnes ore completed in 2016. Permitting for full scale development is underway.
- Tests of Nunasvaara graphite as the anode material in Lithium-ion batteries have shown higher than average performance, including 20% more capacity and ultra-fast charge capability (from 0-100% charge in 3 minutes).
- Nunasvaara has been declared a mineral deposit of national interest by the SGS (Geological survey of Sweden), providing benefits against competing land uses.

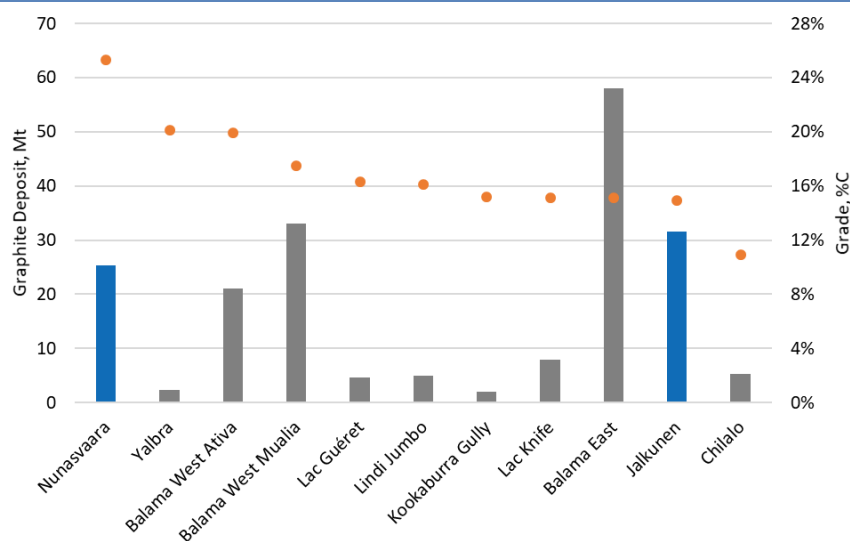
Vittangi project graphite suite, highlighting high surface grades and scale of exploration upside



Source: Talga Resources

- The operation has significant exploration upside, with the Nunasvaara graphite unit extending over 15km strike, of which less than 8% has been drilled to date. Surface rock sampling indicates expansion of graphitic mineralisation, averaging 26.2% TGC and with grades encountered up to 46.7% TGC. The figure above highlights the major potential for expansion of the future resource base.

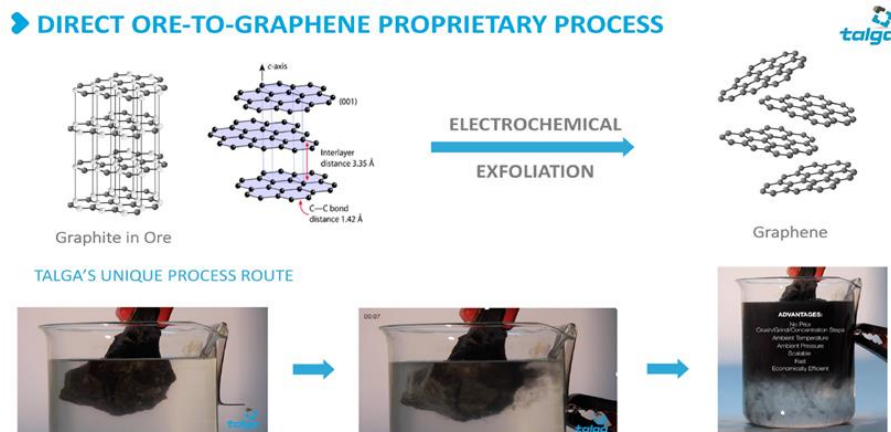
Global leader in graphite resource grade (orange dots) with Talga in blue



Source: SP Angel, company websites

- Breakthrough processing pathway development for Nunasvaara graphite demonstrated a simplified and effective method to extract graphene in bulk quantities during the same single-step process applied for graphite liberation.





Talga's unique graphite to graphene pathway



Source: Talga Resources

- Trial mining during 2016 extracted 5,000t graphite ore to demonstrate a scale-up of the process test work focusing on electro-chemical exfoliation rather than crushing/grinding. The Advanced Materials GmbH process test facility in Rudolstadt, Germany, expands on the November 2014 scoping study to develop industrial quantities of graphene nanoplatelets alongside Li-ion battery anode graphite (D90<10 microns).
- Talga advanced materials are proactively developing industry potential of Talphite® product with agreements across the principal sectors with a strategy to pursue revenue opportunities and partnerships, and the objective of releasing a project pre-feasibility study in Q1 2019.
- Talga's approach focuses on 'fit for purpose' products for application across markets with large volume capacity whose graphene usages either already exist (enhanced with Talga material) or new purposes with short pathways to commercialisation. Four prime industrial sectors are: coatings; polymer composites, construction and energy storage.

Talga graphene target sectors

 <p>ENHANCED COATINGS</p> <p>Protective, High Performance, Functional & Nano Coatings</p> <p>Eco-friendly Cr(VI)-free based pre-treatment coatings for multi metals</p> <p>Pre-fabrication and post fabrication primers & anti-corrosion coatings</p> <p>Marine anti-fouling systems</p> <p>Low friction coatings</p>	 <p>COMPOSITES & RESINS</p> <p>High Strength, Low weight & Conductive CFRC & two pack Resins chemistry</p> <p>High strength carbon fibre reinforced plastic systems</p> <p>Conductive plastics and polymers composites</p> <p>Lightening strike protection and EM shielding</p> <p>Thermal Interface Materials, Conducting adhesive & Inks</p>	 <p>ENERGY STORAGE</p> <p>Batteries, Conductive Inks & Fuel Cells</p> <p>Next generation higher performance lithium-ion battery anodes</p> <p>Conductive additives</p> <p>Flexible, printable batteries for 'IoT' and 'Wearable' devices</p> <p>PEM-FC-BPP coatings & membrane</p>	 <p>CONSTRUCTION</p> <p>High strength, thermal & electrically conductive building materials</p> <p>Combined graphite and graphene mixtures for high strength building materials</p> <p>Thermally conductive screeds for de-icing systems</p> <p>Electrical conductive flooring, wall panel systems combined with heating or cooling systems</p>
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Source: Talga Resources

What is the “wonder material” – Graphene?

- A rapidly emerging product derived from graphite is graphene. Rewarded with a Nobel Prize in Physics for pioneering work, researchers Prof. Andre Geim and Prof. Kostya Novoselov playfully isolated graphene during their “Friday night experiments” in 2004.
- The two-dimensional atomic layer of graphite displays properties favourable for innovative technology markets. Graphene is more robust than diamond, measuring the strongest discovered material equivalent to 40x gemstone strength. The material is also flexible, thin (1mm = 3 million sheets of graphene), lightweight, transparent and an excellent conductor of electricity and heat.
- McKinsey Global Institute identified 12 potentially economically disruptive technologies, where advances will transform life, business and the global economy. Properties of graphite and graphene are expected to support at least 8 of these segments (indicated by Talga Resources symbol), giving robust outlook for consumption.
- Graphene’s superlative properties encourage broad use with applications in energy, electronics, high-strength bulk materials, carbon fibres, coatings, sensors and membranes for purifying water and many more (*source*: Talga Resources). However, the majority of potential products are currently in early development phases and due to high production costs and/or lack of scalability, have not yet been commercialised outside sporting goods and specialist composites.
- In 2017, 58% of the world’s graphene patent applications were from China, according to a Ministry of Industry and Information Technology report. Growth across the future material markets is expected to accelerate as China lifts investments in clean technologies to reduce pollution, driving increasing demand for electrification (batteries) and lighter, stronger, multi-functional materials, providing a boon for the upstream graphene industry.
- Graphene as a commercial product is typically marketed as either bulk powder, dispersion in solution or small areas of continuous thin film, with variable extraction methods such as chemical vapour deposition (CVD), mechanical or electrochemical exfoliation and epitaxial growth. While no universal standards exist for graphene materials, some organisations such as ISO have begun publishing standards terms and definitions. Generally classification can be defined by the number of sheets in the particle:

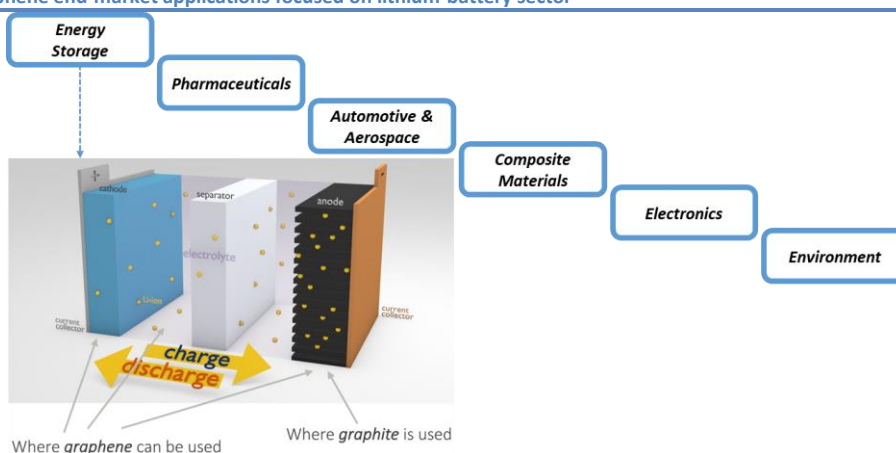
Graphene definition and approximate offer price (2016)

	# sheets	Offer price (US\$/kg)
- Graphene (monolayer)	1	~\$750
- Few layer graphene (FLG)	2 - 5	~\$100 - \$250
- Multilayer graphene (MLG)	2 - 10	~\$40 - \$60
- Exfoliated graphite "graphene nanoplatelets" (GNP)	> 10	~\$30 - \$50

Source: Carbon Journal, fullrex

- While nanomaterials broker Fullerex foresee the principal industrial segment as composites, consuming almost half bulk graphene market by 2024, the rapidly advancing electric economy is the major driver for the advanced material.
- The addition of graphene in anode components can be utilised to double theoretical capacity to 740-780Ah/kg, compared to traditional natural or synthetic graphite. Combined to create a composite to overcome fundamental instabilities, graphene-phosphate based anodes can reach capacity of 1,400Ah/kg.
- Gradually falling graphene costs, declining by approximately 8% per year to \$165/kg by 2020 (*source: Goldman Sachs*), is leading to adoption by primary consumers of Lithium iron Phosphate (LFP) technology such as BYD and Guoxuan High-Tech. As a conductive additive, graphene LFP cathode demand could reach 164,400 tonnes by 2025 (*source: Goldman Sachs*).

Graphene end-market applications focused on lithium-battery sector



Source: Johnson Matthey

- Further to LFP technologies, other next generation battery manufacturers are investigating preferential incorporation of graphene instead of graphite, including Samsung with their 'graphene coated silicon'. Cumulatively, the addressable market for graphene batteries by 2025 is forecast to rise to Rmb6.3bn (US\$0.9bn) (*source: Goldman Sachs*).
- The end-use market is receiving significant R&D funding, with the 'Graphene Flagship' initiative delivering Europe's biggest-ever research enterprise of €1 billion in a joint, coordinated research consortium. The group consists of over 150 academic and industrial research parties across 23 nations taking graphene from the realms of academic laboratories to market. In addition, the UK government are also funding £246 million into the 'Faraday Challenge' initiative targeting superior battery technologies and promoting local supply chains.

Exfoliated graphene manufacture to yield industrial quantities

- The atomically thin layer of carbon atoms, graphene, exhibit remarkable material properties. The combination of high electrical conductivity, chemical and thermal stability, and excellent stretchability provides considerable advantages for the use of graphene in a broad number of end-use markets.
- Isolated graphene was found to exhibit a high charge carrier mobility ($2 \times 10^5 \text{ cm}^2/\text{Vs}$), high thermal conductivity ($\sim 5000 \text{ W/mK}$), exceptional Young's modulus ($\sim 1.0 \text{ TPa}$) and large theoretical specific surface area ($2630 \text{ m}^2/\text{g}$). Moreover, a single graphene layer absorbs only 2.3% of incident light and therefore has a transparency of 97.7%, according to an article exploring exfoliation process methods "*Exfoliation of graphene via wet chemical routes*".
- The microchemical cleavages within graphite can be utilised to extract pristine graphene, however previous methods fail to yield industrially significant high-quality production.

- The method of electrochemical exfoliation is an excellent approach to producing high-quality graphene, according to the above article (available <https://www.sciencedirect.com/science/article/abs/pii/S0379677915300229>). The utilisation of a conductive liquid electrolyte and direct electrical current to drive structural expansion within graphite to split off the graphene layers offers a number of advantages, including;
 - (1) low cost of operation (executable at ambient temperature and pressure) and high control over the synthesis process (functionalization and/or exfoliation can be tuned by varying the electrolysis parameters)
 - (2) scalable mass production potential and relatively fast synthesis rates
 - (3) liberation of graphene flakes without physical and chemical damage enables higher performance products with lower oxidation and higher conductivity

Talga graphene advantages

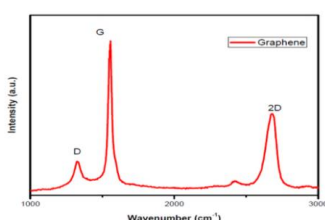


Source: Talga Resources

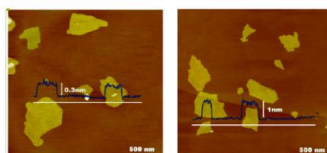
- The highly homogeneous nature of the raw graphite ore enables consistent manufacture of high-quality 1-5-layer graphene. First sale was completed in July 2014 to German group Microdrop Technologies, and more recently BASF and Haydale, with the company focusing on testing and engineering towards full scale production in Sweden.
- Phase 2 circuit stages have been completed since September 2016, expanding capacity and providing real world data. The production process begins by 'unzipping' layers of graphite at an atomic level from Talga's raw ore slabs in custom designed electrochemical exfoliation cells, followed by proprietary recovery, concentration and functionalisation stages. Currently ~76% input graphitic carbon reports to high-purity graphene products, verified by multiple industry measures including Raman spectroscopy and atomic-force microscopy.

Talga graphene process delivers high quality, conductive product

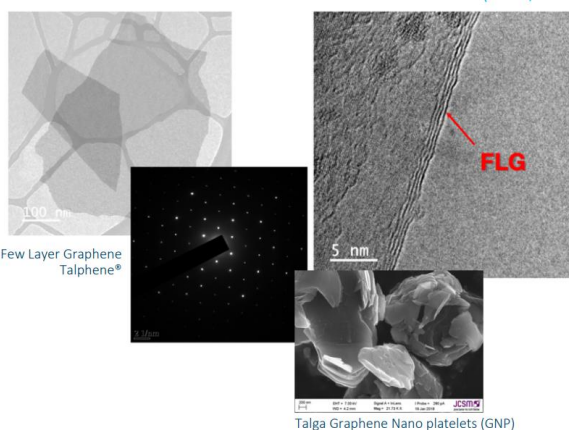
RAMAN SPECTROSCOPY



ATOMIC FORCE MICROSCOPY



TRANSMISSION AND SCANNING ELECTRON MICROSCOPY (TEM / SEM)



Source: Talga Resources

- Talga completed commissioning of Phase 3 construction of modules to increase parallel output as planned in 2018. Phase 3 provides further important process and design data for the upcoming feasibility studies, project and product planning and permitting applications towards full-scale development in Sweden.
- Motivation for enhancing the Talga exfoliation method is to drive production costs below existing carbon materials, such as carbon nanotubes and synthetic carbon, to provide a strong incentive to adopt this new material. Pricing today for graphene powders ranges between US\$50-200/kg, with Goldman Sachs estimating that graphene would be competitive at a cost of US\$25/kg.

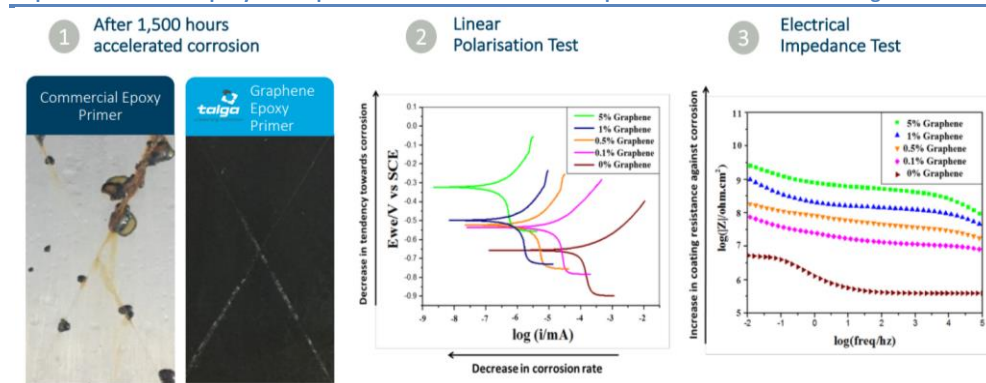
Commercial developments focus on expanding industry partners

- Throughout 2018, Talga have been advancing product development programmes, with materials and products delivered to Chemetall Group (subsidiary of BASF), Bosch, Heidelberg Cement AG, Haydale and Zinergy UK Ltd., amongst other undergoing partner programs.
- The company are proactively accelerating industry partnerships, expanding the pipeline of market opportunities as product development and supply programs are underway with over 125 companies.
- The growth is viewed as very positive as the company promote their assets with new patents lodged and trademarking of Talga produced graphite (Talphite®), graphene (Talphen®) and anode material (Talnodel®).

Coatings

- Proprietary chemical functionalisation tailor's graphene into higher performance surface treatments and coatings focusing on enhancing tensile strength, abrasion resistance and corrosion rates.
- Test work emphasises that the addition of low loadings of graphene can provide major increases in anti-corrosion performance and mechanical properties.

Talphen® enhanced epoxy-based primer with increased corrosion protection at increased loadings



Source: Talga Resources

- Further mechanical improvements indicate enhancements to abrasion resistance by 82%, tensile strength by 160% and elongation by 95%.
- The primary focus appears to be increasing volumes of engagements with the world's largest coatings companies in marine and industrial markets to offer eco-friendly Cr(VI)-free based pre-treatment coatings for multi metals.
- The company have also commenced on innovate electrically conductive film and ink programmes with numerous companies.

Composites & Resins

- The integration of graphene into composite materials can enhance the conductivity and strength of bulk materials, which are also resistant to heat and pressure.
- *Graphene-info* note applications for graphene-composite seem endless, as “one graphene-polymer proves to be light, flexible and an excellent electrical conductor, while another dioxide-graphene composite was found to be of interesting photocatalytic efficiencies, with many other possible couplings of materials to someday make all kinds of composites”.
- The potential of graphene composites includes medical implants and engineering materials for aerospace and renewables.
- Talga have commenced a test programme at the leading R&D institute TWI (The Welding Institute) in Cambridge, covering multiple graphene product developments including de-icing and lightning strike protection for aircraft.

Energy storage

- Talga Resources continue to strengthen its battery technology division with the appointment of senior scientist Dr Fengming Liu, joining Talga staff who are ex-Dyson and Toyota, boosting capabilities of its in-house expertise of leading battery development including graphene, solid state battery and silicon anode specialism.
- Test work at the global independent battery prototyping facility at the Warwick Manufacturing Group, part of the University of Warwick’s Energy Innovation Centre, present significant performance benefits over reference leading commercial anode products (“CAP”).

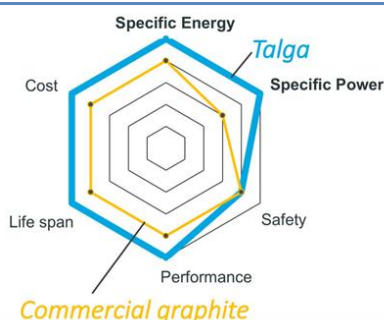
Full-scale pouch cells (A5) targeting 4Ah capacity containing Talnode® and NMC cathode



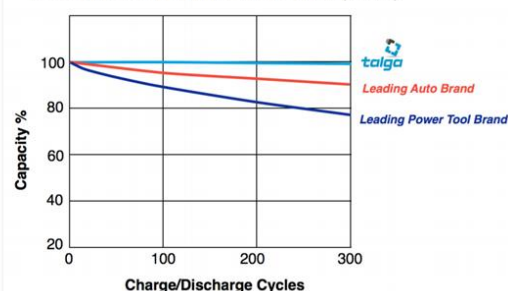
Source: Talga Resources

- Independent results highlight Talga’s outperforming pouch cells, while ongoing work aims to validate result across multiple battery test facilities in Europe and leading independent battery development institute in Asia.

Talga battery cell characteristics and cycle life results against leading commercial cells



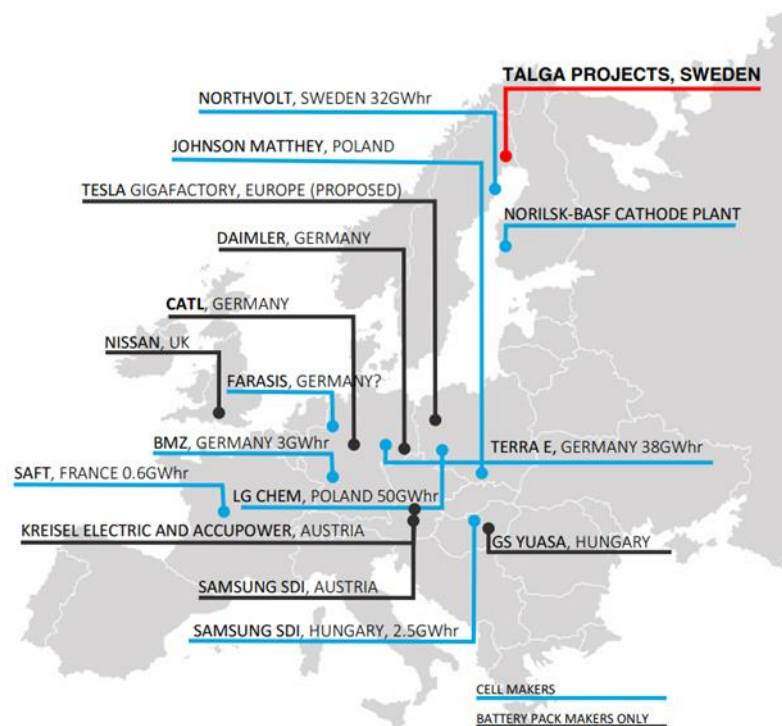
BATTERY LIFE CHARACTERISTICS (@25°C)



Source: Talga Resources

- Talga successfully scaled up Talnode product from half coin cells to commercial-size pouch cells with meaningful performance benefits over reference anode graphite:
 1. 20% higher capacity (total energy)
 2. 20% higher power (fast charge/discharge)
 3. No capacity fade after 300 cycles (>99% energy retention), indicating normal life of greater than 4,000 cycles
 4. 94% first cycle efficiency
- Subsequent test results show Talga's anode product has been engineered to have excess capacity to conventional cell anodes, enabling ultra-fast charge rates in excess of >300mAh/g at 20C. In general terms, this allows full charge (0% - 100%) of lithium-ion batteries in 3 minutes without losing capacity, significantly improving the usability over current iterations of battery technology.
- Talga's graphite anode solution represents a substantial leap forward in the practical characteristics of lithium-ion batteries, enhancing the impact on electromobility and mass adoption rates. We also recognise production costs enhancements from Talga's unique graphite deposit, as the material eliminates comparatively expensive industry standard spheronisation, micronisation and coating associated with flake production.

Gigafactory growth across Europe is significant

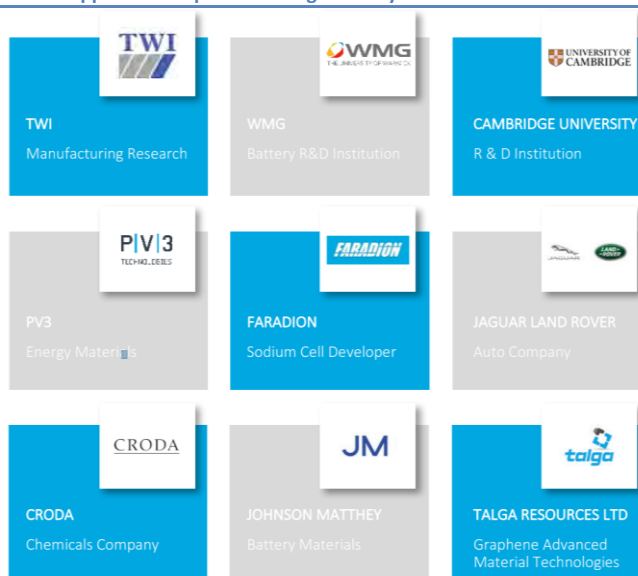


Source: Talga Resources

- Roughly 80% of the world's existing and planned battery production capacity is in Asia, according to Bloomberg data. China alone has 69%, with the US at 15% and the EU at under 4%. The EU are targeting billions of euros funding for electric battery plants in order to remain relevant in the global race for electrification.
- The scale of growth across the battery supply chain, especially across Europe, is significant. A wave of scheduled capacity is expected to swell across the EU by 2020 with at least 80GWh 'Gigafactory' facilities under development.
- The EU's Horizon 2020 research fund has set aside €200m for battery projects, €800m is available to finance building demonstration facilities and the European Fund for Strategic Investment is available from the European Investment Bank to co-fund the billions of euros capital requirement to develop capacity.

- By 2035, all vehicles sold in Europe will be electric, according to the latest forecast by Dutch bank ING. The report findings indicate a huge increase in the adoption of electric vehicles potentially overtaking many country's own regulations which promise to cut the sale of petrol and diesel cars.
- ING's report estimates price parity with ICE's as economies of scale allow the cost of EV components to fall will create a 'rational choice' for consumers through to 2024.
- To address the scarcity of raw materials, the EU is actively mapping European mineral potential, supplementing with plans to improve recovery from recycling. The bloc hosts significant cobalt, lithium, graphite and nickel deposits across France, Finland, Portugal, Spain and the Czech Republic.
- Energy vice-president at the European Commission, Maros Sefcovic, acknowledges participation of 260 companies across the supply chain, creating substantial demand for the strategic raw material battery supply offered by Talga Resources.

Collaboration partners to support development of Talga battery materials



Source: Talga Resources

- Talga have signed binding collaboration agreements to support the ongoing development and integration of battery technologies, including Jaguar-Land Rover, Johnson Matthey, Croda, Faradion, PV3, Cambridge University and Warwick Manufacturing Group.
- Developing expertise also targets additional breakthroughs in performance of Talphite anode material, with the company investigating graphene for silicon and other new generation Li-ion battery anodes under their 'Safevolt' program.
- The disruptive market has scope for growth, with Goldman Sachs estimating a Rmb6.3bn (US\$0.9bn) addressable market by 2025 for graphene in batteries.

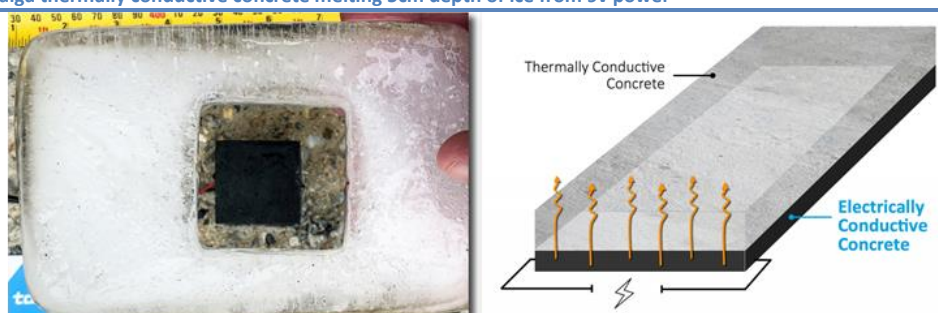
Construction

- Impregnating cement with graphene has the potential to generate greener building materials with enhanced strength, impermeability, resistance to surface abrasion, and electrically and thermally conductive.
- The technology represents an opportunity to disrupt an industry valued over US\$450bn/annum (source: World cement & concrete additives market). Speciality concretes form a subset of this, and while no formal volume that may be attributed to the new products, we recognise the market opportunity is significant.
- Breakthroughs from the company's graphite-graphene research and development lab offer substantial improvements in existing and emerging applications, particularly as concrete is the world's largest construction material by volume; exceeding 5 billion

tonnes/year (*source: Cement Market Forecast*). A MoU with the world's second largest concrete manufacturer, Heidelberg Cement, focussing on thermally conductive concrete gives significant indication on the technological potential of Talga graphene-impregnated concrete.

- Recent study from the University of Exeter (*ultrahigh performance nanoengineered graphene-concrete composites for multifunctional applications*) suggests the nanotechnology enhances concrete strength by 146% with four-times more water resistance than existing iterations.
- Greenhouse gas emissions associated with concrete and cement-making remains stubbornly high, accounting for ~8% global emissions in 2015, according to reporting by PBL Netherlands Environmental Assessment Agency. The minor addition of graphene minimises the volumes of concrete required, limiting the chemical process involved in the break-up of limestone and associated carbon dioxide release. The study suggests an estimated 50% reduction of cement consumed would result in a 446kg/t reduction in carbon emissions.

Talga thermally conductive concrete melting 5cm depth of ice from 9v power



Specimen	Conductivity (Siemen/cm)	Resistivity (Ohm.cm)
Talga Concrete	20	0.05
Standard Mortar	0.000001	1000000

Source: Talga Resources

- Initial tests at Talga's German process test facility and Betotech (Heidelberg Cement Q&C) laboratory with the addition of pristine graphene targeted high electrical percolation at low material concentrations and with potentially lower cost factors.
- Sample measurements undertaken by Professor Ian Kinloch's group at the University of Manchester recorded significant reduction in electrical resistivity from ~1,000,000 ohm-cm for the reference mortar to 0.05 ohm-cm.
- Current iterations significantly improve on historical performance of attempts relying on the addition of high loadings of magnetite (iron), steel fibres, synthetic and natural carbons. In addition to the large relative quantities, active materials tend to cause negative effects on cost, strength, corrosion and abrasion resistance, maintenance costs and weight.
- Electrically conductive 'graphene concrete' has broad applications across underfloor heating, anti-static flooring, EMI shielding (radio frequency interference), and 'solid state heater' offering rapid and environmentally-friendly ice and snow clearing of key transport routes.

Idealised concept of inductive charging technologies for electric vehicles



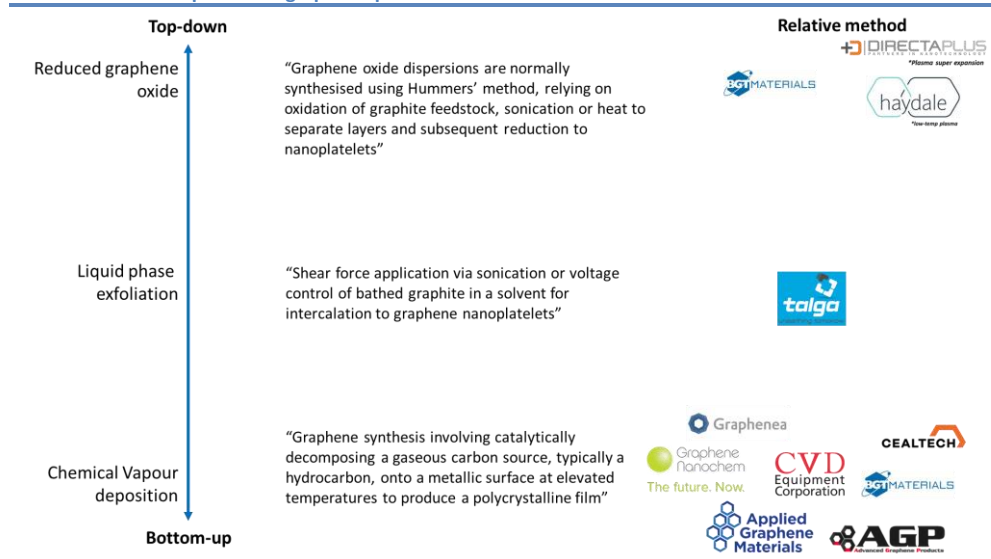
Source: Talga Resources

- Future capability also investigates electrically conductive concrete for a cost-effective role in enabling inductive (wireless) charging technologies for electric vehicles under dynamic (driving) as well as stationary (parking) conditions.
- Wireless charging roads are receiving major global interest to support usability and mass adoption of electric vehicles, and are becoming closer to reality in the UK under a new £40m government proposal.
- The Department for Transport foresee electromagnetic induction charging could be positioned at service stations and car parks as well as during mobility in dedicated charging lanes. Chargemaster add *“wireless charging will make driving an electric vehicle as similar as possible to driving a petrol or diesel car but without frequent trips to the petrol station”*.
- A partnership between Renault, Qualcomm Technologies and Vedecom are developing dynamic electric vehicle charging (DEVC) at a €9m project 100m test track capable of charging up to 20kw at practical motorway speeds.
- Successful implementation of dynamic charging is expected to significantly boost the global requirement for inductive concrete, while electric vehicle developments will also support the desire for Talga graphite and graphene product suite.

Talga advance graphene products against a number of innovative manufacturers

- Innovative manufacturing methods are competing against Talga electrochemical exfoliation technology and vertically integrated carbon supply, with the aim of providing the market cost competitive products against existing leading carbon materials.
- Nanomaterial fabrication target either bottom-up techniques relying on synthetic graphene sources or top-down focus on downstream reprocessing of graphite; each offering distinct advantages, disadvantages, scales and costs.

Non-exhaustive comparison of graphene production methods



Source: SP Angel

- Expanding application of graphene across growing markets means that Talga has entered its pioneering processing methods in direct competition to incumbents. The high-quality graphite ore feedstock from the Vittangi project lends itself to ambient temperature electrochemical exfoliation, with the process yielding a high proportion of graphene at industrially scalable volumes and low costs, while a higher proportion of global manufacture focus on higher energy synthesis from purchased pre-purified carbon sources.

Advanced Graphene Products – Owns a unique but low volume production method of large High-Strength Metallurgical Graphene (HSMG) based on the growth of graphene on a liquid metal substrate, originating from the Institute of Materials Engineering at the Lodz University of Technology in Poland. The graphene layer can be applied as a coverage to any surface, with standard substrates including PMMA (polymethyl methacrylate), quartz and silicon wafers. The process improves on the CVD (Chemical Vapour Deposition) process to minimise the overlapping effect resulting in common defects.

Graphenea – Chemical Vapour Deposition offers graphene monolayers by combining carrier gas molecules hosting disassociated carbon atoms with the substrate to create a material film on the surface. While the method produces coatings with high purity, impervious, fine grained characteristics, the gaseous by-products are typically very toxic and require extreme temperatures. As documented by Graphenea, deposition methods onto substrates create an issue upon separation or exfoliation of graphene from the substrate without damaging the graphene. Current solutions focus on a copper substrate, which then requires dissolving in toxic acids to remove the graphene. Another major hurdle focuses on creating a completely uniform layer due to the kinetic transport dynamics of the gases, resulting in inconsistencies in the final graphene sheet.

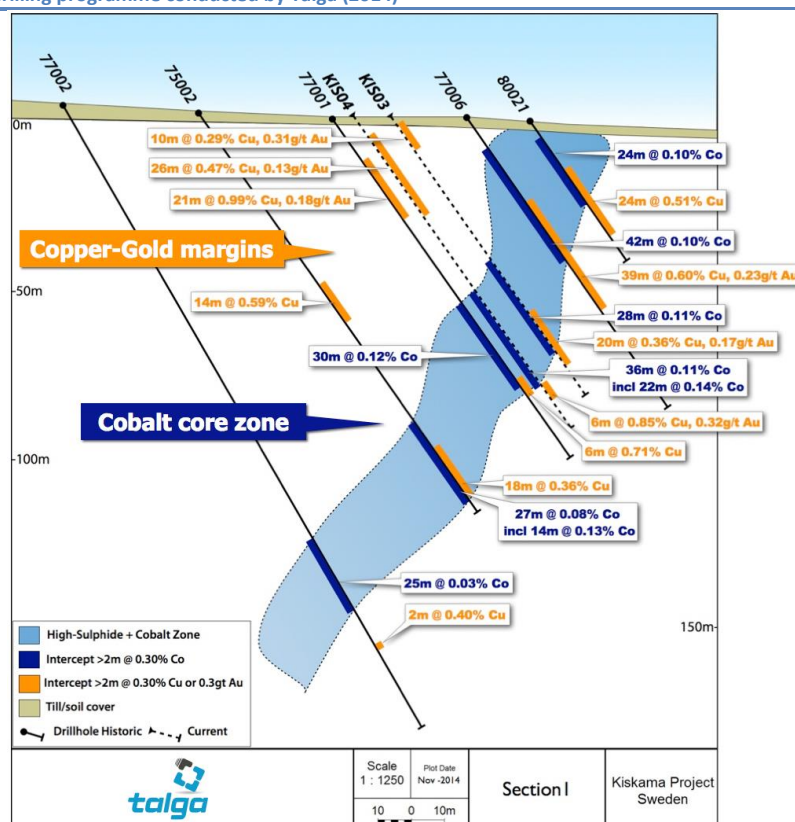
Applied Graphene Materials – Relying on a unique multiple dispersion technique, the lack of graphite feedstock or any oxidation procedures generates graphene with limited graphitic impurities, graphene oxide or transition metals.

Directa Plus – After launching 'The Graphene Factory' in 2014, the company have been expanding capacity to 30tpa pristine graphene nanoplatelets using patented technology. Using 'super plasma expansion' high purity graphite feedstock is exposed to temperatures of 10,000°C where it becomes possible to separate into a collection of graphene platelets. While costs associated with drawing the process to extreme temperatures are high, the process relies on no chemical toxicity preserving the characteristics of the graphene.

Kiskama project enhanced Talga exposure to battery metals

- As part of the purchased Teck Sweden package in 2012, Talga Resources inherited battery metals exposure through a wholly owned suite of highly prospective cobalt minerals assets, focusing on the Kiskama project. The company announced the incorporation of 100%-owned Swedish subsidiary – Talga Battery Metals AB – to support the advance of the project.
- Acquisition targeted Kiskama, Sweden's largest cobalt deposit, with current Talga exploration efforts enhancing 101 historic drill holes for 13,836m which test only 1km strike of a 7km cobalt-copper-gold zone.
- Encouraging drill intercepts highlight; 36m @ 0.11% Co, 0.27% Cu & 0.13g/t Au, 33.1m @ 0.10% Co & 0.56% Cu and 28.1m @ 0.11% Co & 0.51% Cu.

Kiskama drilling programme conducted by Talga (2014)



Source: Talga Resources

- First pass metallurgical results in 2017 demonstrated positive recoveries including up to 91% Cobalt, 86% Copper and 77% Gold.
- The company have recently (Oct 2018) obtained all necessary permitting to commence a diamond drilling as part of a maiden JORC-compliant resource. Talga recently began IP (induced polarisation) and MLEM (moving loop electromagnetic) geophysics to further define zones of mineralisation.
- The suite of cobalt licences also incorporates Lautakoski, Ahmavuoma and East Aitik projects which host vital mineralisation, including 'wildcat' drill core sampling intercepting 91.8m @ 0.18% Cu and 147ppm Co at Lautakoski and 52m @ 0.24% Co, 0.59% Cu, 0.17g/t Au including 21m @ 0.38% Co, 1.12% Cu, 0.42g/t Au from Ahmavuoma
- SP Angel recognise the projects are supported by close proximity to established infrastructure, including transport links to smelters, and low-cost sustainable hydropower, as well as being situated in the same mining district as Europe's largest copper-gold mine with Aitik milling 36mtpa.

Conclusion

While complications in achieving commercial breakthroughs in production of graphene have hampered the hype surrounding the 'wonder material', extensive test results from Talga Resources highlight the impressive progress for the advanced materials manufacturer. Preliminary developments in high performance battery materials improve on industry leading reference anodes including 20% more capacity and ultra-fast charge capability (0-100% in 3 minutes). In-house capability and commitment to R&D is enabling the company to enter the higher value chain, as Talga advance testing at leading independent facilities across Europe and Asia, looking to advance additive silicon and next-generation solid silicon electrodes. We look forward to further understanding the potential of Talga battery products, as the company scale commercial sample/prototype batches throughout 2019.

Innovative end-use cases for graphene products are rapidly expanding, with Talga boosting industry partnerships above 125 companies across target coatings, composite and resins, energy storage and construction. Competitive global manufacture appears to be advancing to match growth, however the energy cost and environmental impacts will impact the long-term viability. The ambient temperature, relative speed and scale of batch processing and environmentally benign nature of electrochemical exfoliation are all significantly positive for Talga's unique graphene pathway.

Battery market development and studies are currently underway to potentially incorporate battery anode production into the current Vittangi project pre-feasibility studies, now due in Q1 2019. We look forward to understanding the development strategy for the world's highest grade JORC graphite resource, with subsequent upside potential in the suite of drilled cobalt deposits.

**SP Angel act as broker to Talga Resources*

** SP Angel analysts have visited the leading battery R&D institution WMG partnering with Talga.*

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