

Graphite market report and forecast for Nouveau Monde Graphite October 2018

Prepared by Benchmark Mineral Intelligence

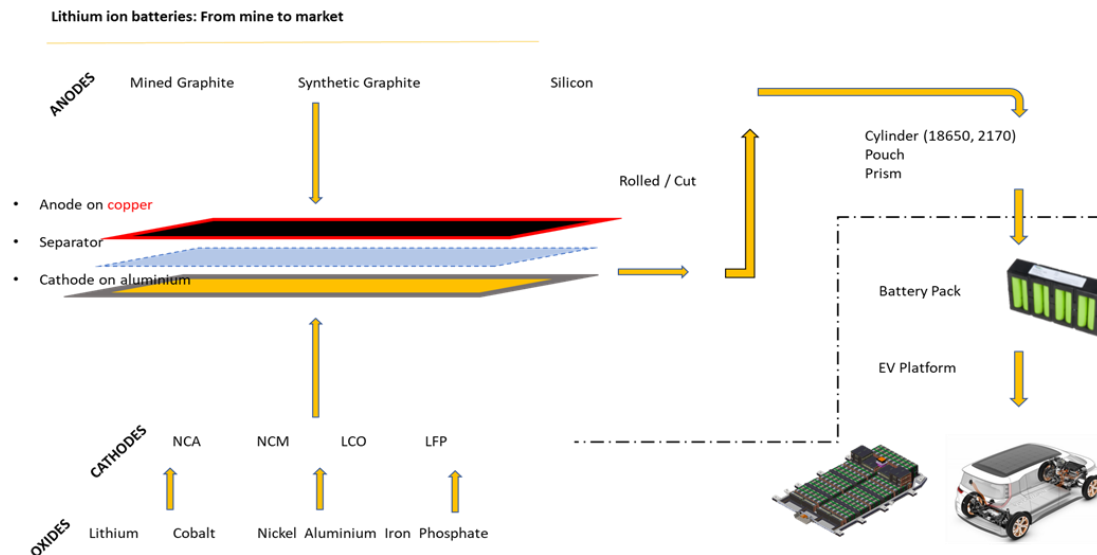
Introduction

- Nouveau Monde Graphite is developing the Matawinie Graphite production area in Quebec, Canada, for which it is preparing 43-101 report in order to support further financing.
- This report has been prepared for Nouveau Monde Graphite in order to assist with its financing efforts and presents Benchmarks independent forecasts for graphite demand, supply and pricing.
- The report will cover the following:
 1. Introduction and Forecast Assumptions
 2. Long Term Supply Forecasts for Natural Flake and Synthetic Graphite to 2040
 3. Natural Flake Graphite Price Forecasts
 4. Premium Graphite Markets Outlook and Prices

1. Introduction and Forecast Assumptions

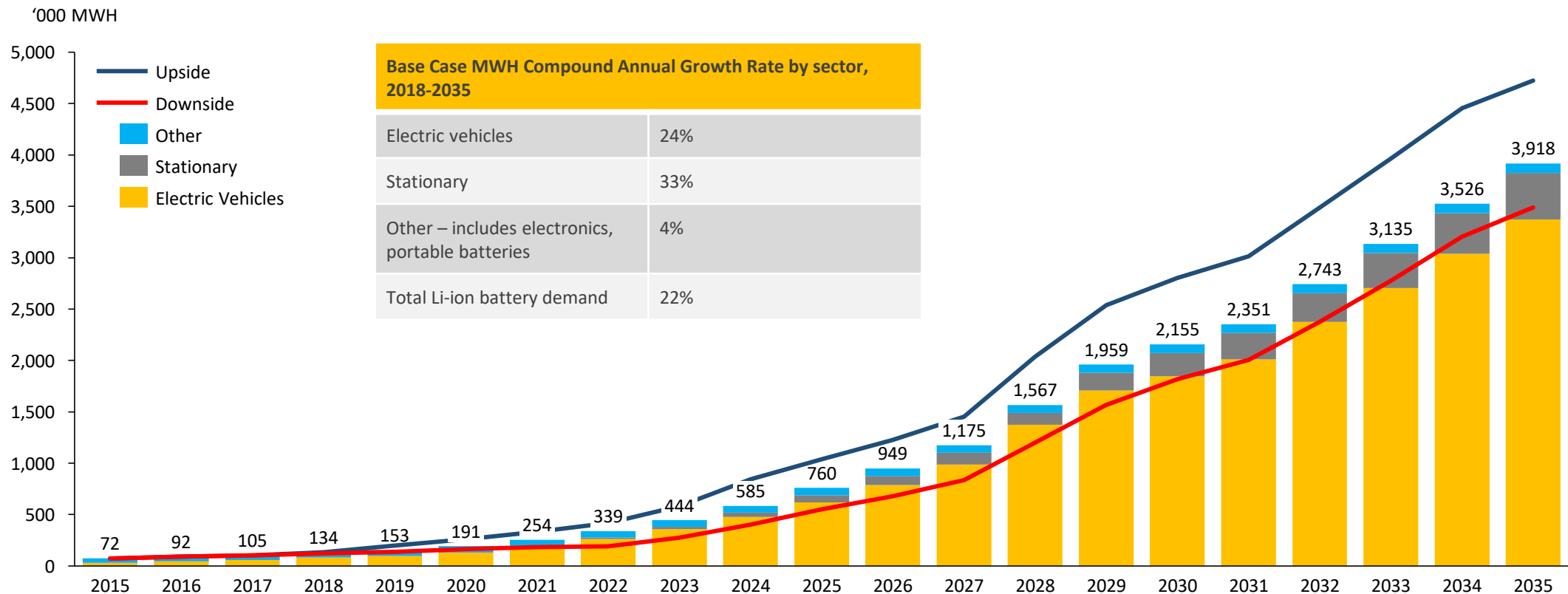
1. Introduction and Forecast Assumptions

- This section will look at the current and future supply chain for graphite, with a focus on the burgeoning li-ion battery market. We will also highlight the current announcements and investments being made in the supply chain, including government policy, investment in battery manufacturing plants and announced investments from the automotive sector.
- We will also show our demand forecast methodology, flowing from government policy to EV penetration to battery demand and graphite consumption in Li-ion batteries and the outlook of other end-use markets.
- Graphite plays a critical role in the lithium-ion battery supply chain, as the main input for the anode material. At present roughly half of anode material is sourced from natural graphite, the other 50% comes from synthetic graphite, demand from this sector in 2018 is estimated at 161,000 tonnes.
- In terms of total graphite demand, our current base case shows graphite consumption increasing from 723,000 tonnes in 2018 to 1.9m tonnes in 2025, excluding inventory build, and shows a structural supply gap opening in natural flake graphite markets.



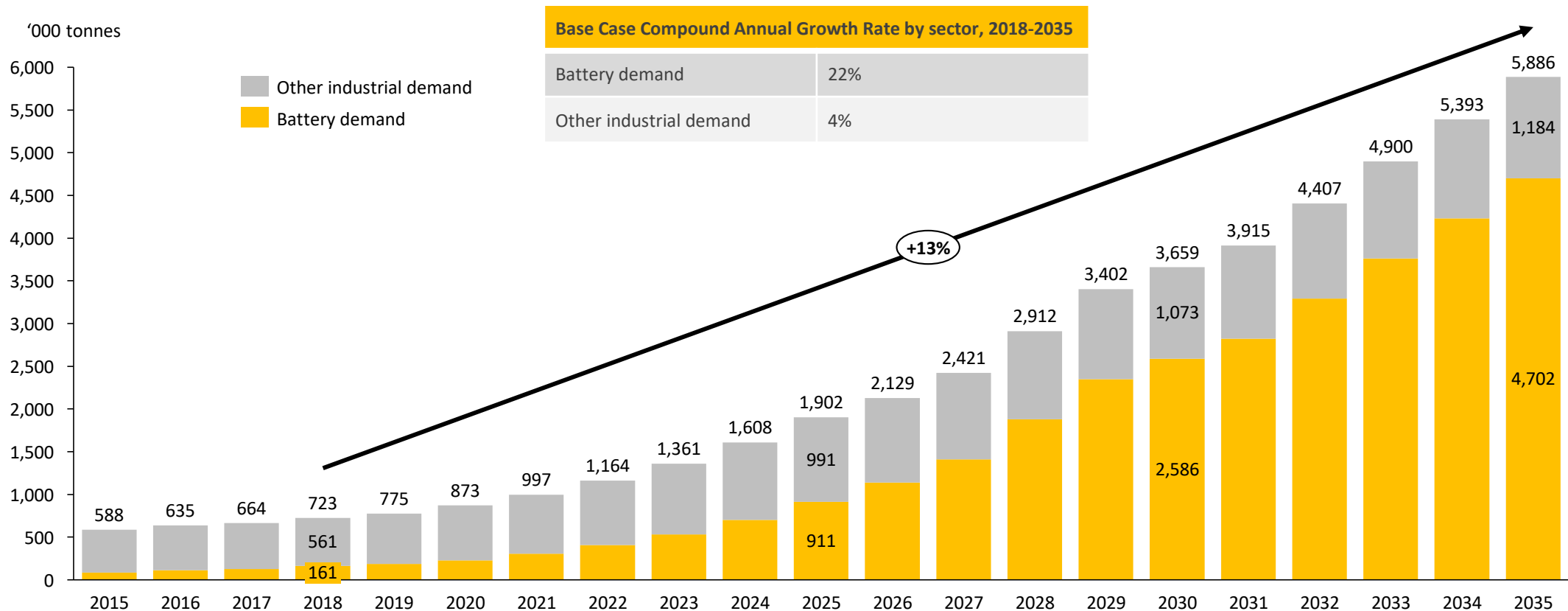
1. Introduction and Forecast Assumptions

- The chart below outlines the key drivers of demand for lithium-ion batteries over the forecast period. As can be seen the major growth area is for EVs, followed by stationary (grid) applications. In our base case scenario we expect that demand will be approximately 134,000 MWH in 2018, reaching 760,000 MWH by 2025 and 4M MWH by 2035.



1. Introduction and Forecast Assumptions

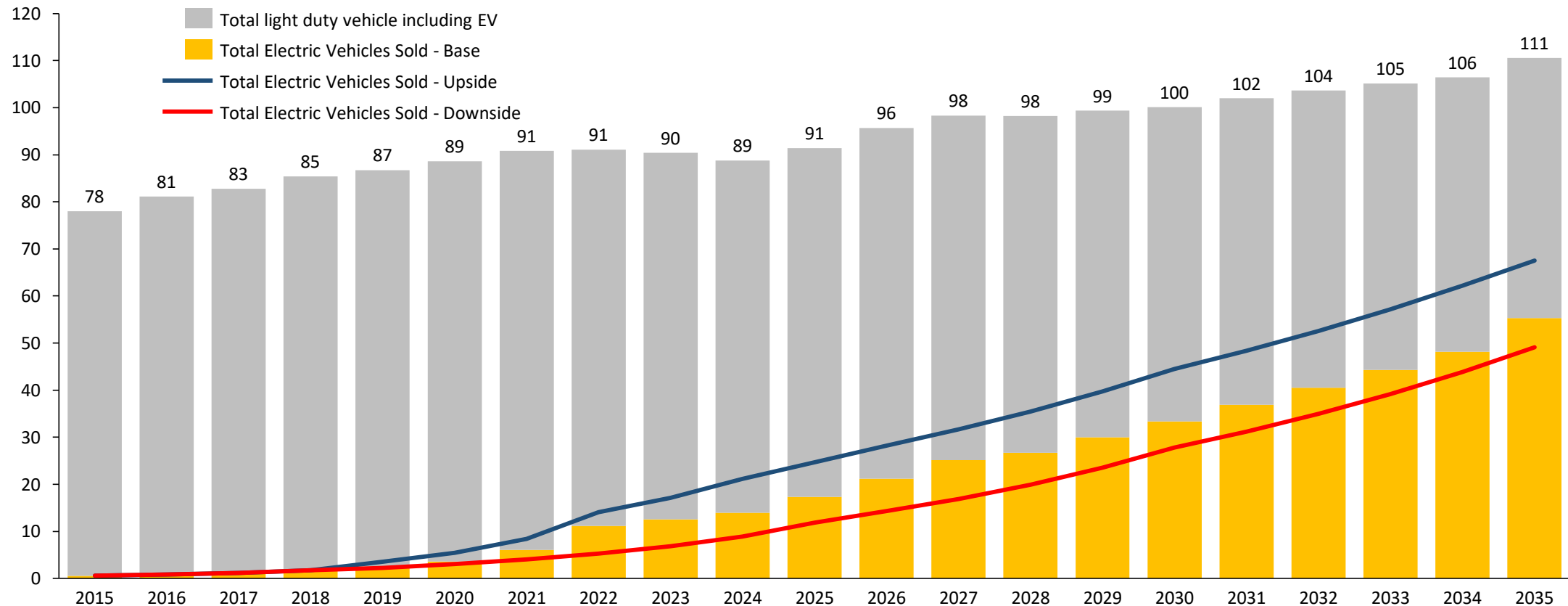
- The chart below outlines the development of demand for graphite over the forecast period to 2035, broken down by broad end-use sector. As can be seen battery demand broadly reaches parity with other industrial demand by 2025-2026 given the level of growth forecast for both sectors. By the end of the forecast period we expect that graphite demand will reach 5.9 million tonnes, growing at a CAGR of 13% over the forecast period.



1. Introduction and Forecast Assumptions

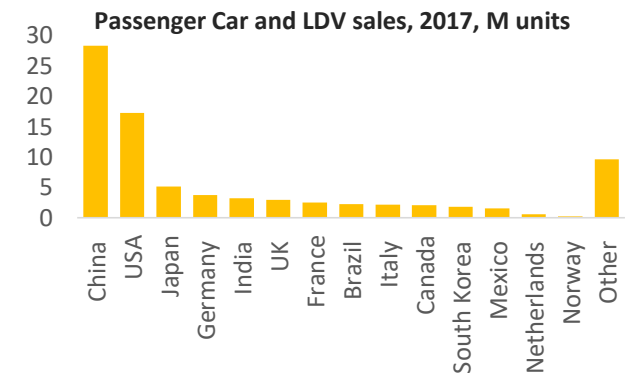
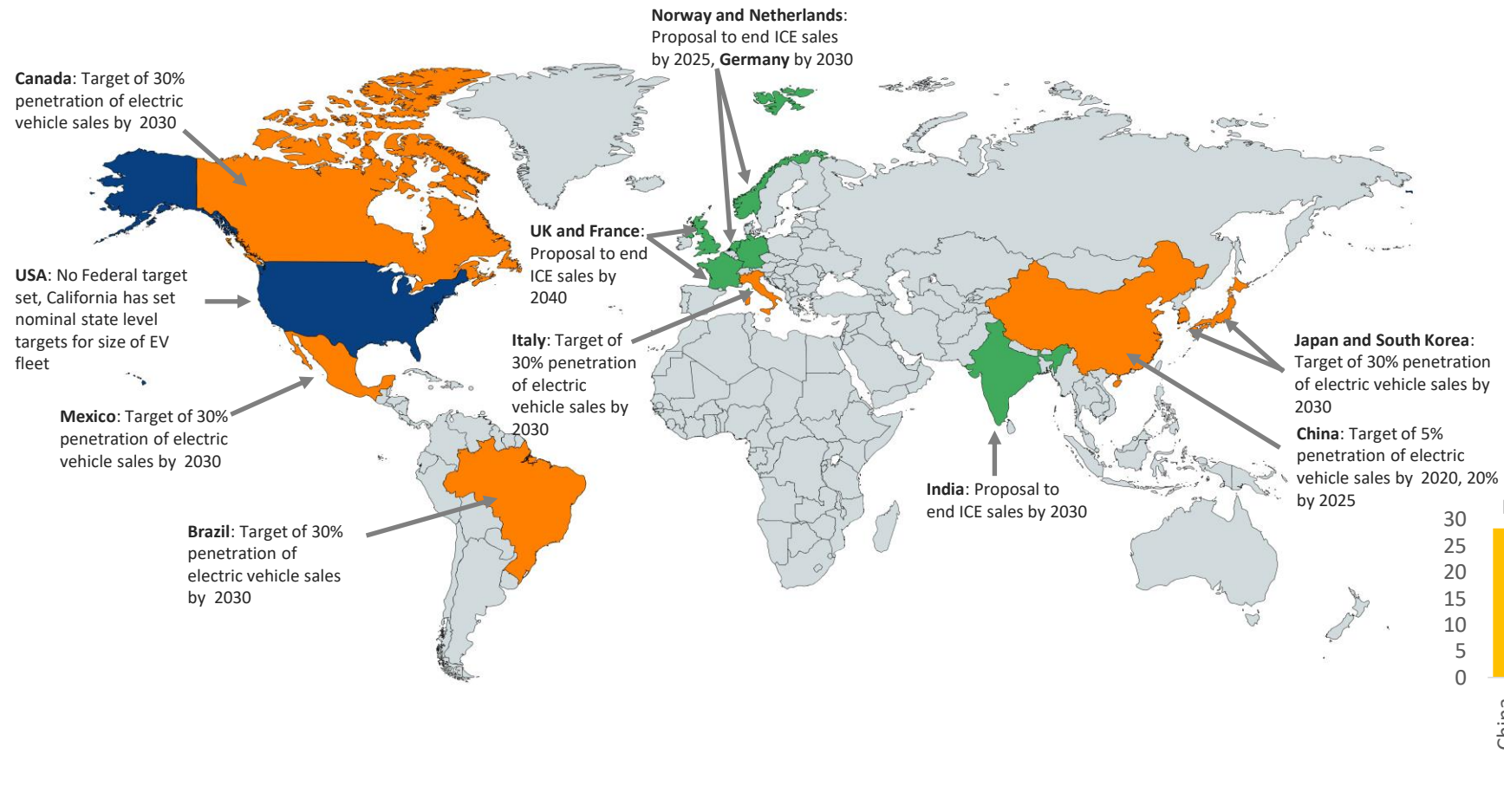
- There are a number of factors underpinning the expected growth in EV penetration, notably government transport emission policies, and Original Equipment Manufacturer (OEM) strategy. We examine these in more detail on the following slides, and supply alternate EV penetration scenarios to examine how this will impact on overall battery demand.

Million units sold



1. Introduction and Forecast Assumptions

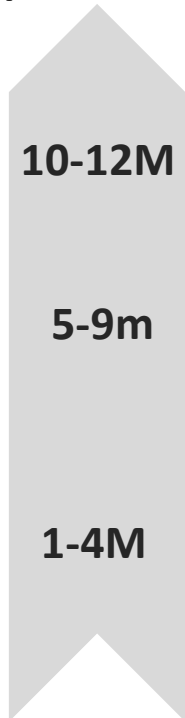
Global policy statements by governments supporting EV adoption



1. Introduction and Forecast Assumptions

Major passenger car and light duty vehicle OEM EV strategy announcements

Total annual vehicle production



Launching 12 EV models by 2022



GM planning to introduce at least 20 EVs by 2023



Ford is planning to invest \$11Bn in EVs by 2022, and will have 40 hybrid and full EV models



Daimler will bring 10 pure EVs to the market by 2022

Chinese OEMs expected to comply with 20% EV penetration rate ruling by 2025



VW group plans to invest more than \$24bn in zero-emission vehicles by 2030. Will develop 80 EV models by 2025, wants to offer an electric version of each of its 300 models by 2030



Toyota has set a sales target of around 1m EVs and fuel-cell vehicles (FCVs) by 2030, investment \$13 billion to develop and make batteries

Aiming to develop 8 EV models by 2025, with 30 planned by 2030



Has set a target of two thirds of vehicle sales EV by 2030

BMW plans to deliver 12 pure EVs by 2025



PSA aims to develop at least 40 electric vehicles by 2025



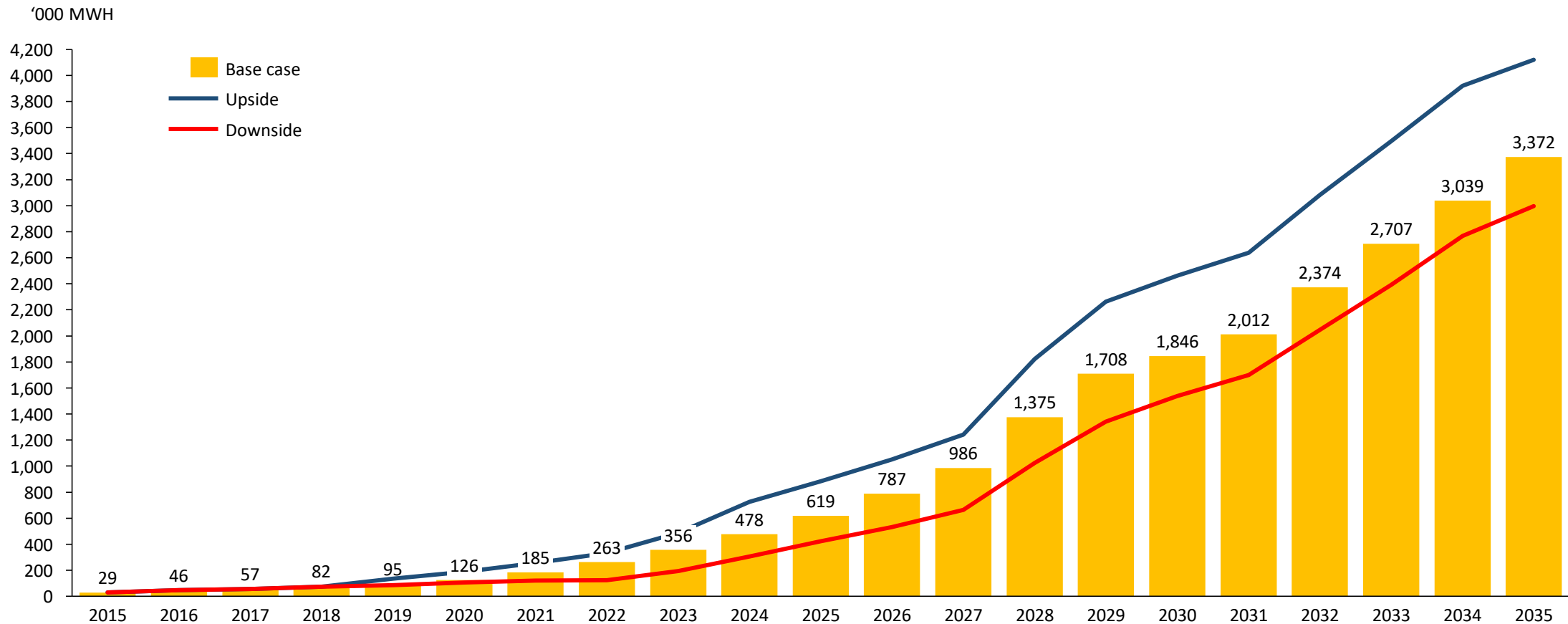
2022

2025
EV strategy timeline

2030

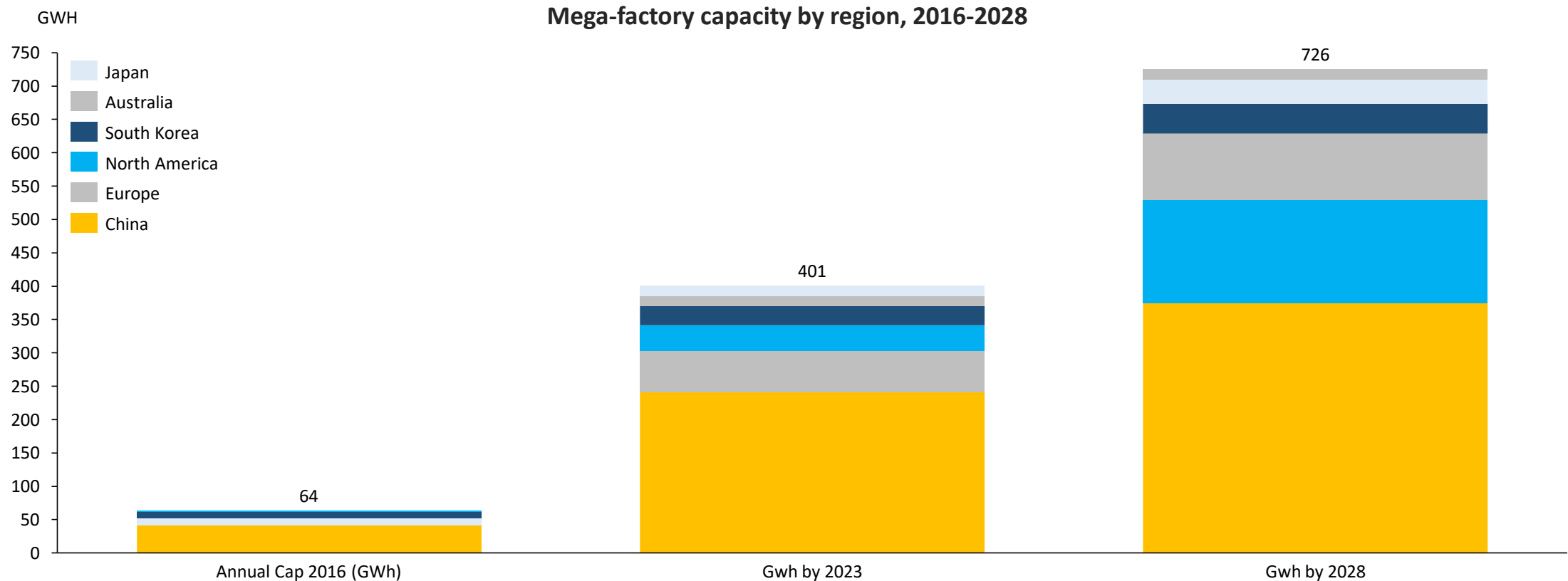
1. Introduction and Forecast Assumptions

For our base case scenario, in 2018 we expect battery demand, expressed in Mega Watt Hours, will be in the region of 82,000 MWH. By 2025, we expect this to grow to 405,000 MWH, by 2030 to 1.9M MWH.



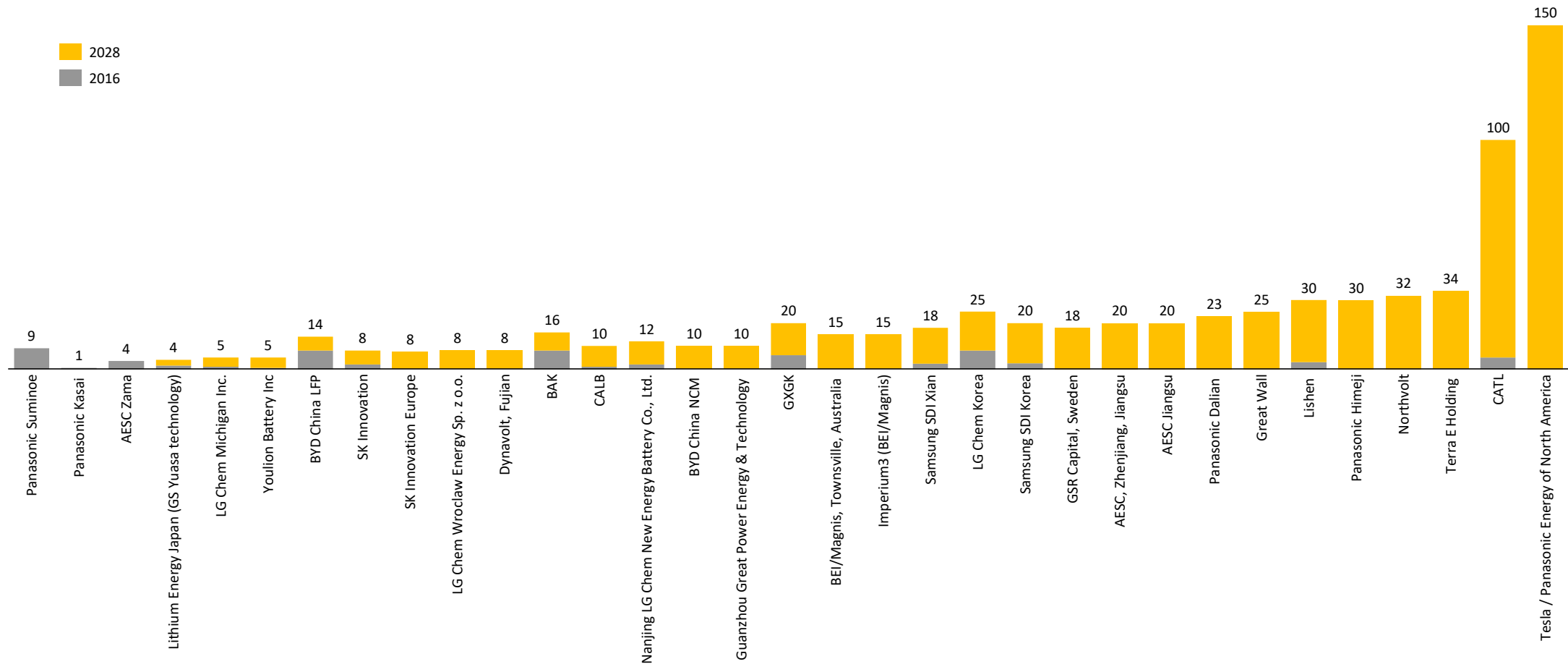
1. Introduction and Forecast Assumptions

- In order to meet higher battery demand new Giga-factory capacity will need to be added. In this slide we summarise by country where new mega-factory supply is likely to be added, as we can see the majority of capacity will be added in China and North America.
- As can be seen, based on current mega-factory capacity expansion announcements and our outlook for battery demand we are projecting a shortage by 2028 of 649 GWH. We do expect that further capacity projects will be announced in order to fill this gap, especially given the level of pledged investment from automotive manufacturers.



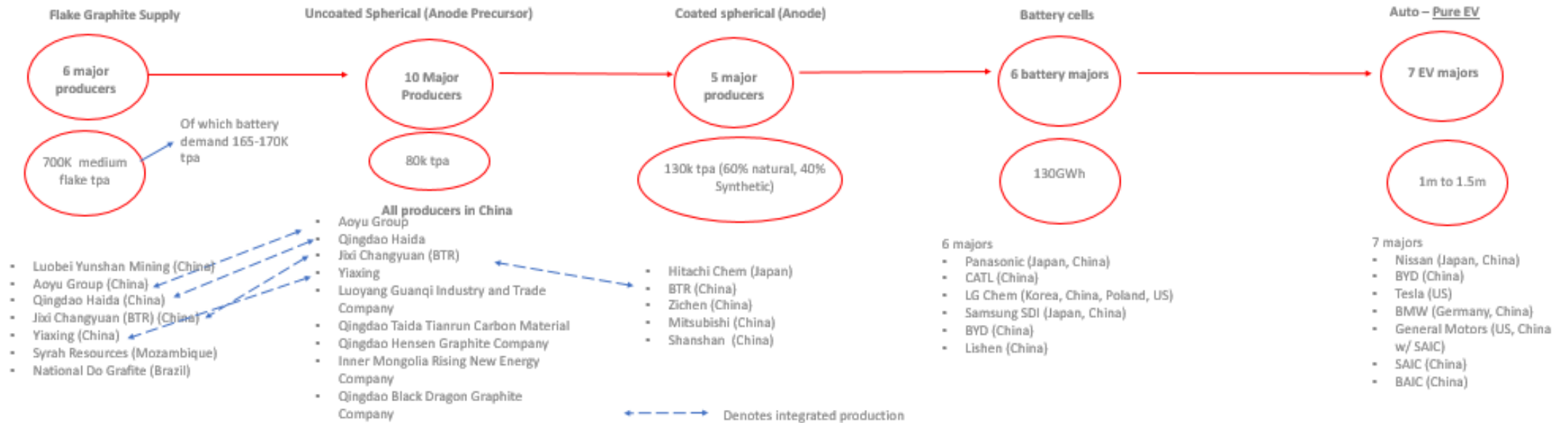
1. Introduction and Forecast Assumptions

Mega-factory capacity by company, 2016-2028
Gigawatt Hours



1. Introduction and Forecast Assumptions

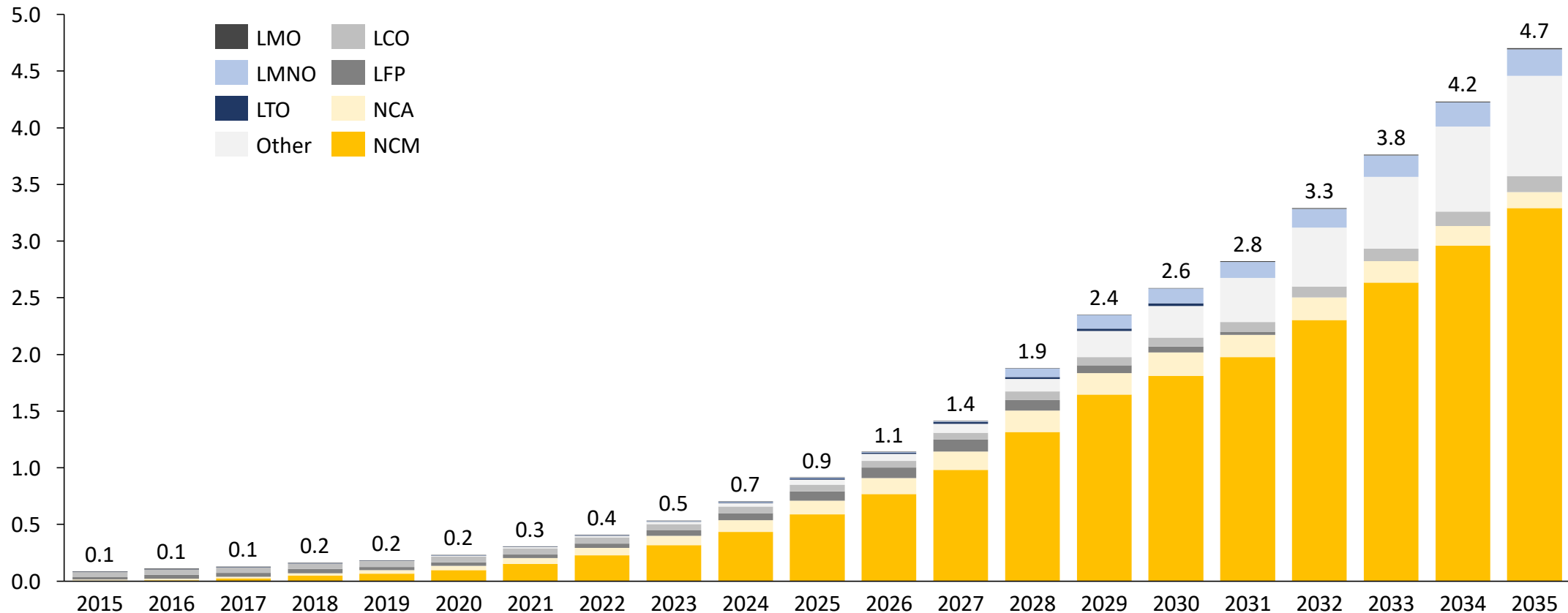
Graphite Supply Chain Margin Flow Diagram in 2018



1. Introduction and Forecast Assumptions

The chart below outlines our forecast for graphite material for use as an input to anodes in the lithium-ion battery supply chain, we expect that graphite by battery type will remain stable throughout the forecast period

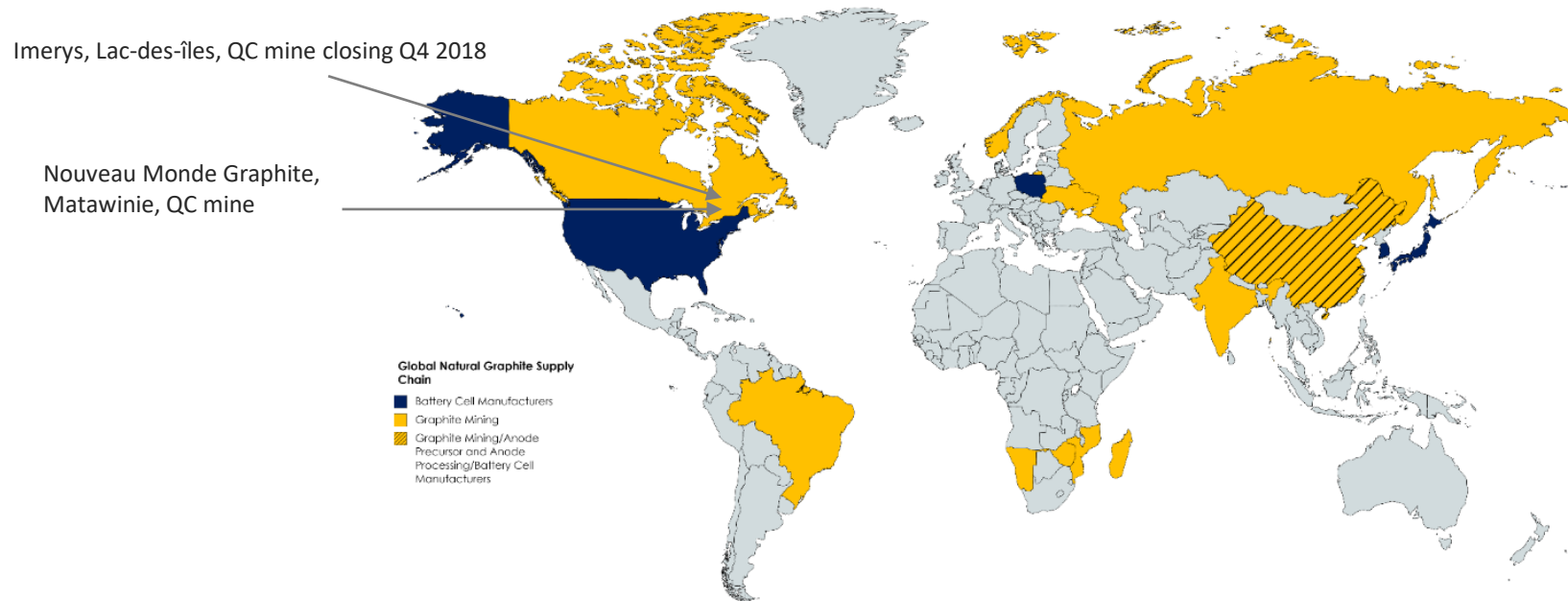
Million tonnes



2. Long Term Supply Forecasts for Natural Flake and Synthetic Graphite to 2040

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- This analysis will examine the outlook for supply, identifying key capacity changes among existing market players and new entrants. We will review existing capacity and provide an outlook for both likely mine expansion projects, as well closures over the forecast period, also provided in an Excel database format.
- Graphite is mined in several countries around the world, the main sources of flake graphite for batteries are Brazil, Mozambique and China. Nearly all of this material is currently processed to uncoated spherical (anode precursor) and coated spherical (anode) in China. Battery cell manufacture also takes place in China, as well as Japan, Korea, Poland and the US.
- At present roughly 60% of total graphite supply comes from synthetic production, based in China, India, Europe and the US, we expect this share to fall over time owing to the relatively high cost of production, and an expansion in natural graphite capacity

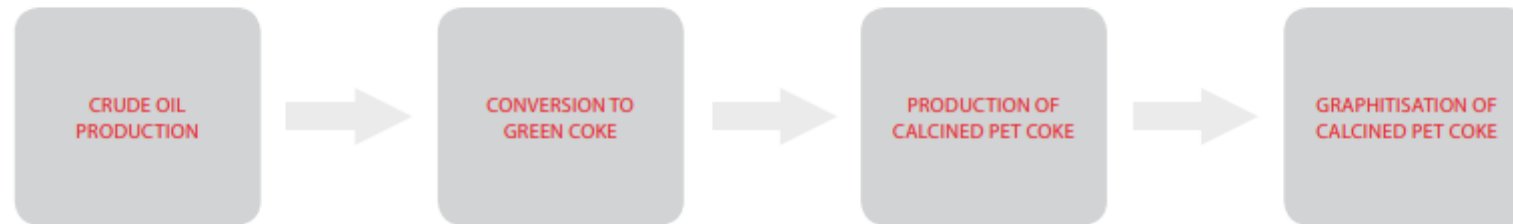


2. Long Term Supply Forecasts for Natural Flake and Synthetic Graphite to 2040

Overview and outlook for synthetic graphite

- Synthetic graphite is produced using high temperature treatment of amorphous carbon materials, notably petroleum coke, also known as needle or green coke, a by-product of crude oil production. The production process is described in the flow diagram below.

SYNTHETIC GRAPHITE SUMMARY FLOW SHEET



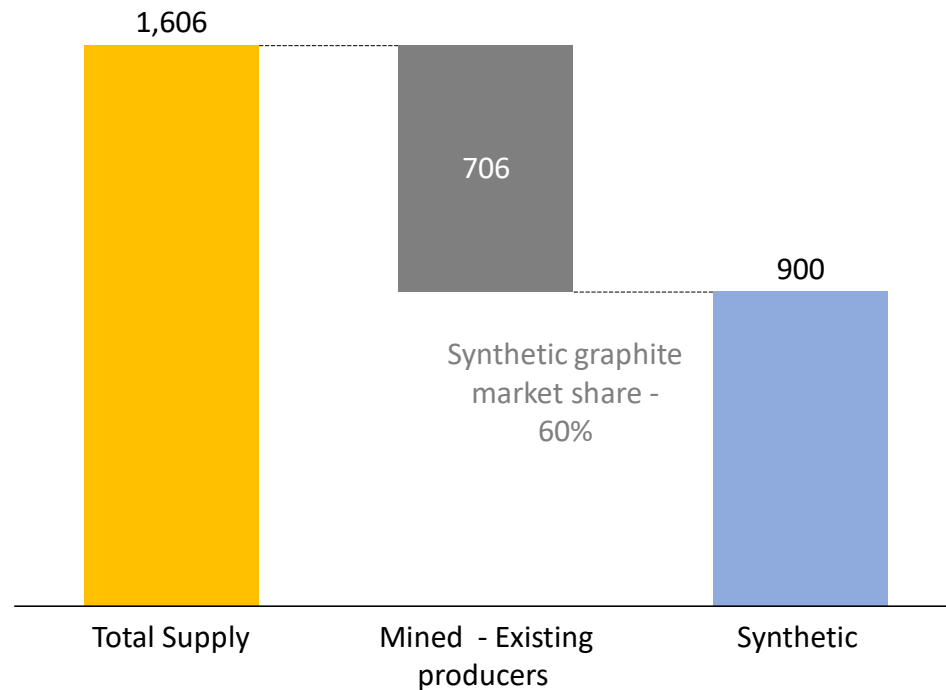
Total energy required to produce 1 ton of synthetic graphite (approx. 95.5% carbon) is 7,500 kWh/MT

- Synthetic graphite production has the advantage of producing consistently high quality graphite (90%+ C) suitable for battery applications, however owing to the energy intensity of production it is a very high cost source of supply. In addition the principal feedstock, needle coke, has increased in price dramatically in recent years, from a long-term average of roughly \$800 per tonne to \$8,000 per tonne. Further, given that needle coke is a by-product of crude oil production supply is subject to movements in oil output, affecting both price and availability.
- At present synthetic graphite is manufactured in China, India, Europe and the US. In China the main producers are Fangda Carbon New Material Technology Co Ltd, Jilin Carbon Co Ltd, Sunstone Development Co Ltd, Hongte Group and Jinzhou Petrochemical Co Ltd. Outside of China the main producers are SGL, Graftech, Imerys and Showa Denko.
- Given the higher cost of production of synthetic graphite and the relative availability of cheaper natural flake graphite, we do not expect that new synthetic graphite capacity will be added in the coming years. That, coupled with the expansion of natural graphite supply will see the market share for synthetic graphite contract markedly in the forecast period

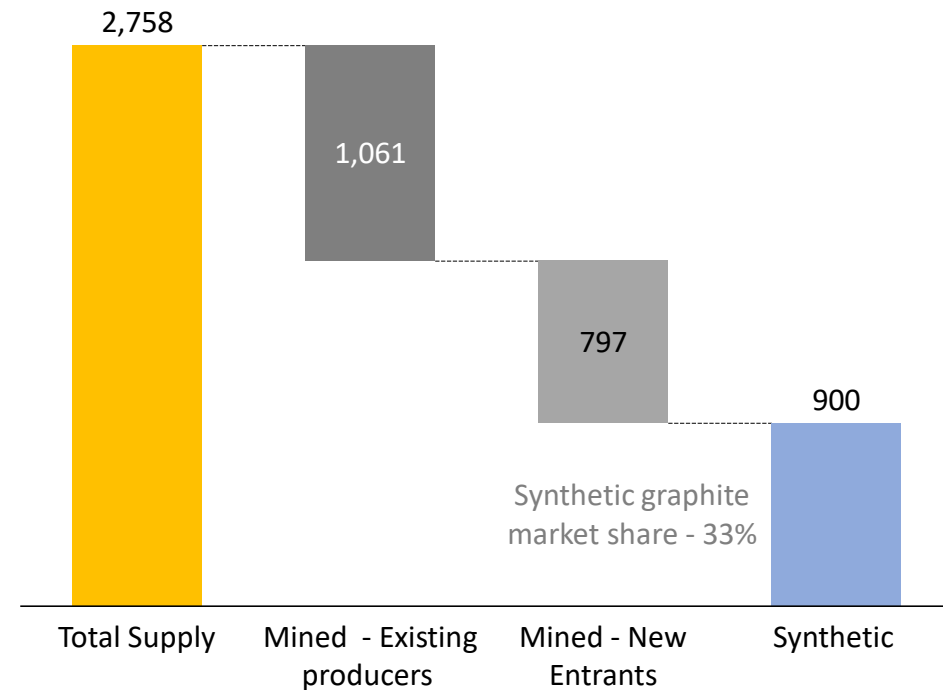
2. Long Term Supply Forecasts for Natural Flake and Synthetic Graphite to 2040

- The charts below illustrate our forecasts for the breakdown of graphite supply for all end-uses in both 2018 and 2025. As can be seen, we expect that significant new capacity will come online from both incumbent natural graphite miners and new entrants
- In the following slides we detail how we expect this to happen, beginning with brownfield capacity expansions at existing operations and then looking at mining projects.

Natural Flake and Synthetic graphite supply-balance 2018
(‘000 tonnes)



Natural Flake and Synthetic graphite supply-balance 2025
(‘000 tonnes)



2. Long Term Supply Forecasts for Natural Flake and Synthetic Graphite to 2040

Natural flake capacity expansions, 2018-2040

- At any time there are a number of brownfield and greenfield graphite capacity projects announced and undergoing development, however there are a number that will either never come to fruition and some that proceed at a faster or slower pace than projected.
- The factors that determine how likely a project is to come online are often related, below we group individual issues by type and show linkages between them:

Resource geography factors

Political risk – resources located in territories with an unstable political situation are less likely to secure financing or necessary human resources to proceed

Resource costs – Capex factors such as land values and opex factors such as labour, transport and energy costs will largely be determined by resource geography

Access to key markets – transportation costs and lead times often feature heavily in a projects ability to be competitive

Resource geology factors

Resource size – Resource size will determine the likely capex for the project as well as the mine life and capacity

Resource quality – the distribution of flake sizes and quality, and suitability for processing to battery grades are crucial for securing buyers and premium pricing

Resource costs – the resource type and quality will largely determine the capex and operating mining costs for the project and likelihood of securing financing

Financial factors

Access to financing – securing financing is a crucial stage in project development, and linked to several factors as shown

Price forecasts – consensus price forecasts determine a projects forecast revenue and are therefore vital in securing financing

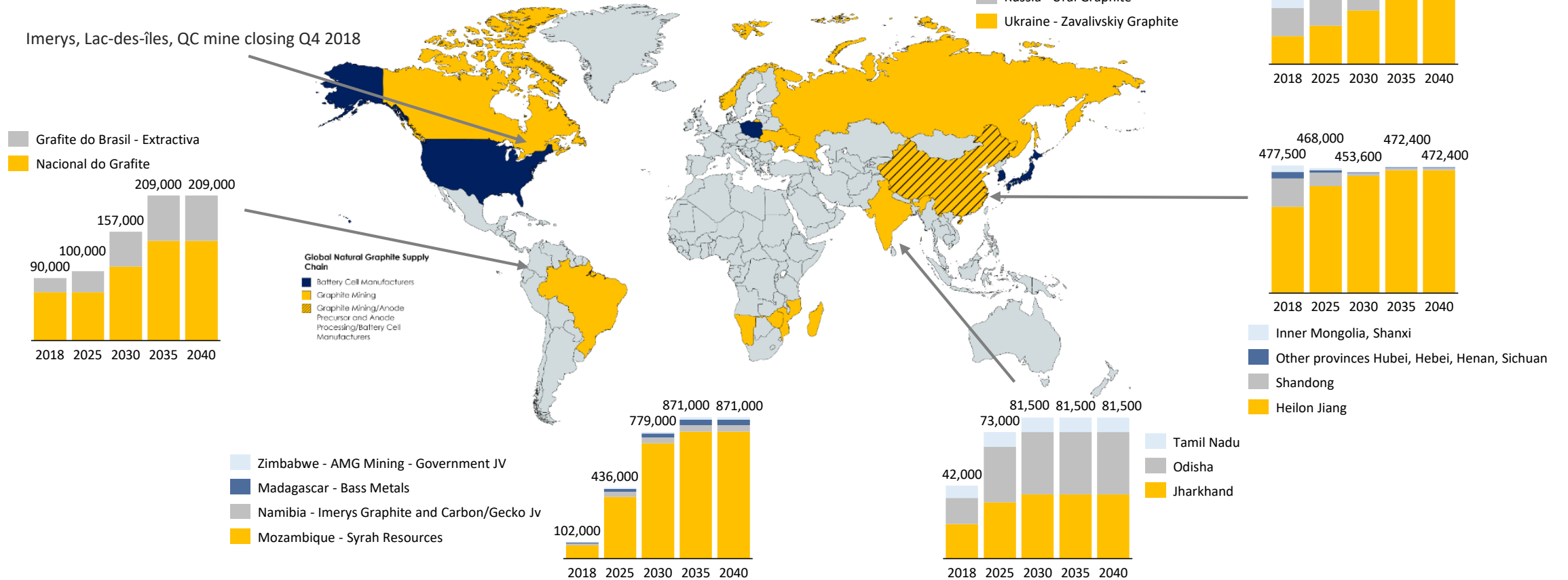
Off-take agreements and strategic partnerships – the likelihood a project coming online is massively boosted by securing off-take agreements and/or involvement of an end-user

2. Long Term Supply Forecasts for Natural Flake and Synthetic Graphite to 2040

Brownfield natural flake capacity expansions, 2018-2040

- In this slide we outline expected capacity expansions at existing graphite producers over the forecast period. Over the period to 2040 we expect that there will be nearly 900,000 tonnes of brownfield capacity expansions by existing producers, notably in China, the Ukraine and Mozambique

Imerys, Lac-des-îles, QC mine closing Q4 2018

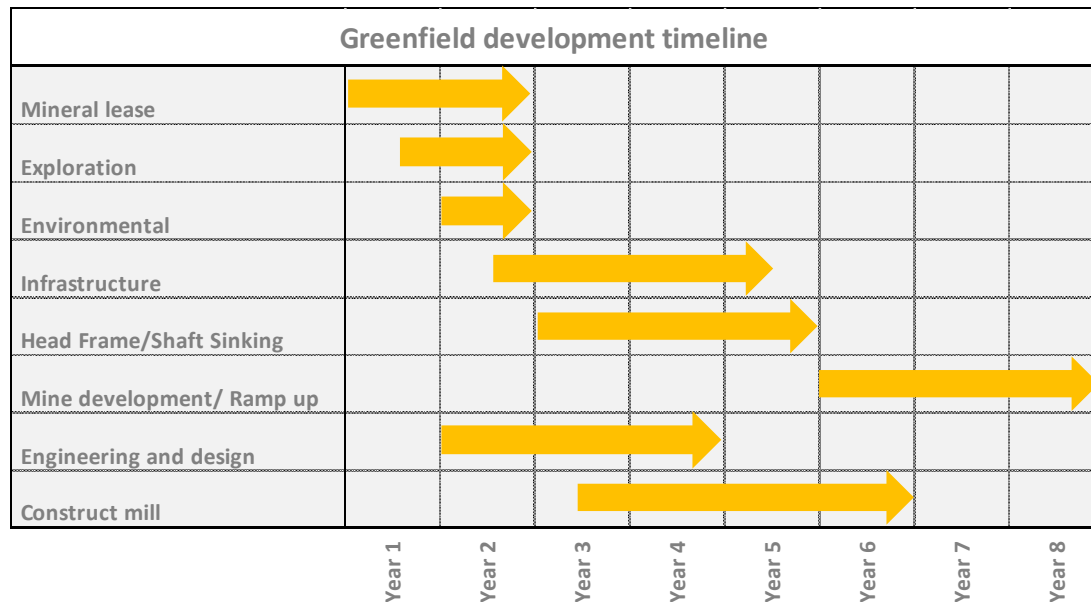


2. Long Term Supply Forecasts for Natural Flake and Synthetic Graphite to 2040

Greenfield natural flake capacity expansions, 2018-2040

- In the flow chart below we outline the main development stages for the development of a greenfield graphite mining project.
- At present we are tracking numerous projects that we classify as ‘Highly probable’, ‘Probable’ and ‘Possible’ based on their current stage of development and likely progress to production. In the following slide we outline the current stage of development for a number of major greenfield projects

Route to development for a greenfield mining project



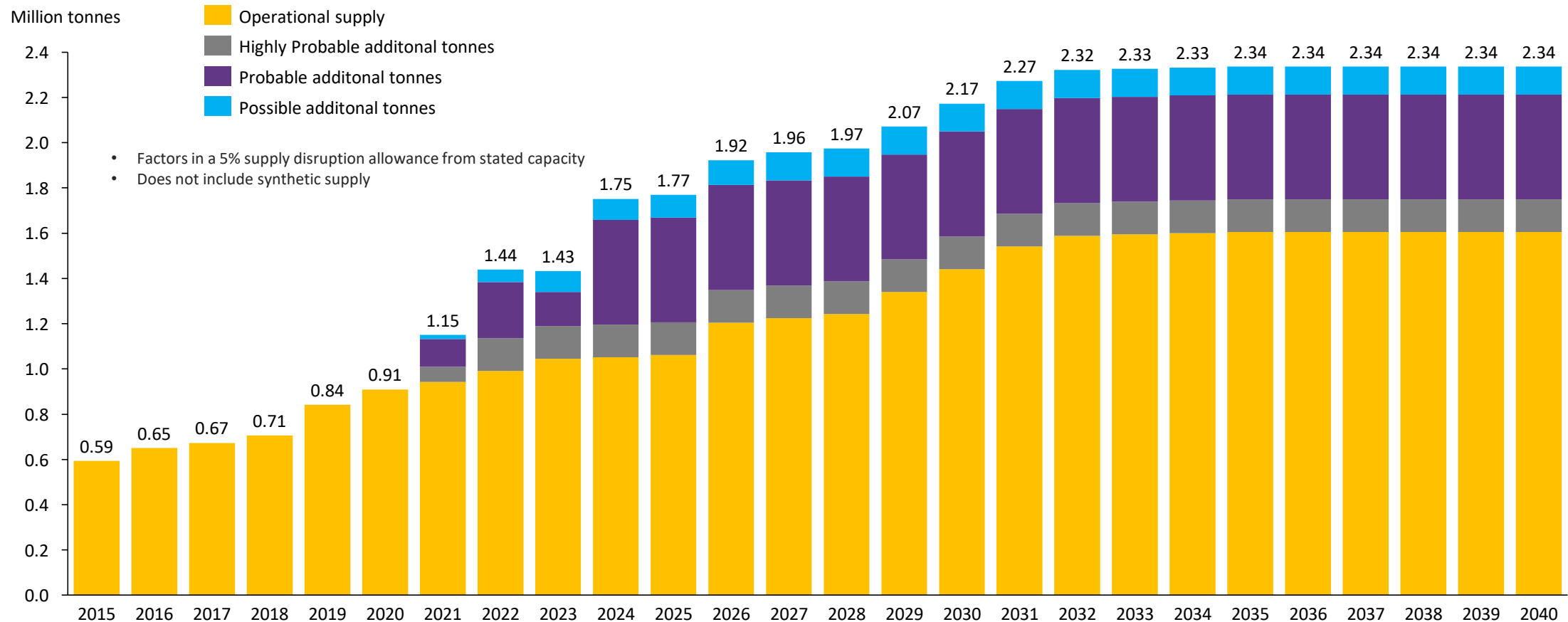
Typical project development milestones

- **Scoping:** initial financing to undertake preliminary exploration of a deposit
- **Resource estimation:** scoping results used to raise further finance for sufficient drilling to publish NI 43-101 and/or JORC compliant resource estimates¹
- **Pre-feasibility study:** preliminary engineering plans and economic viability to determine whether to proceed to a full feasibility study
- **Feasibility study:** presentation of plans for extraction and processing and full assessment of a project’s geological profile and economic viability
- **Financing:** subsequent to feasibility study financing is secured for project construction
- **Construction:** final development of project to completion

1. NI 43-101 is the mineral project disclosure standard for companies listed on Canadian Stock Exchanges, JORC is the equivalent for Australian-listed companies

2. Long Term Supply Forecasts for Natural Flake and Synthetic Graphite to 2040

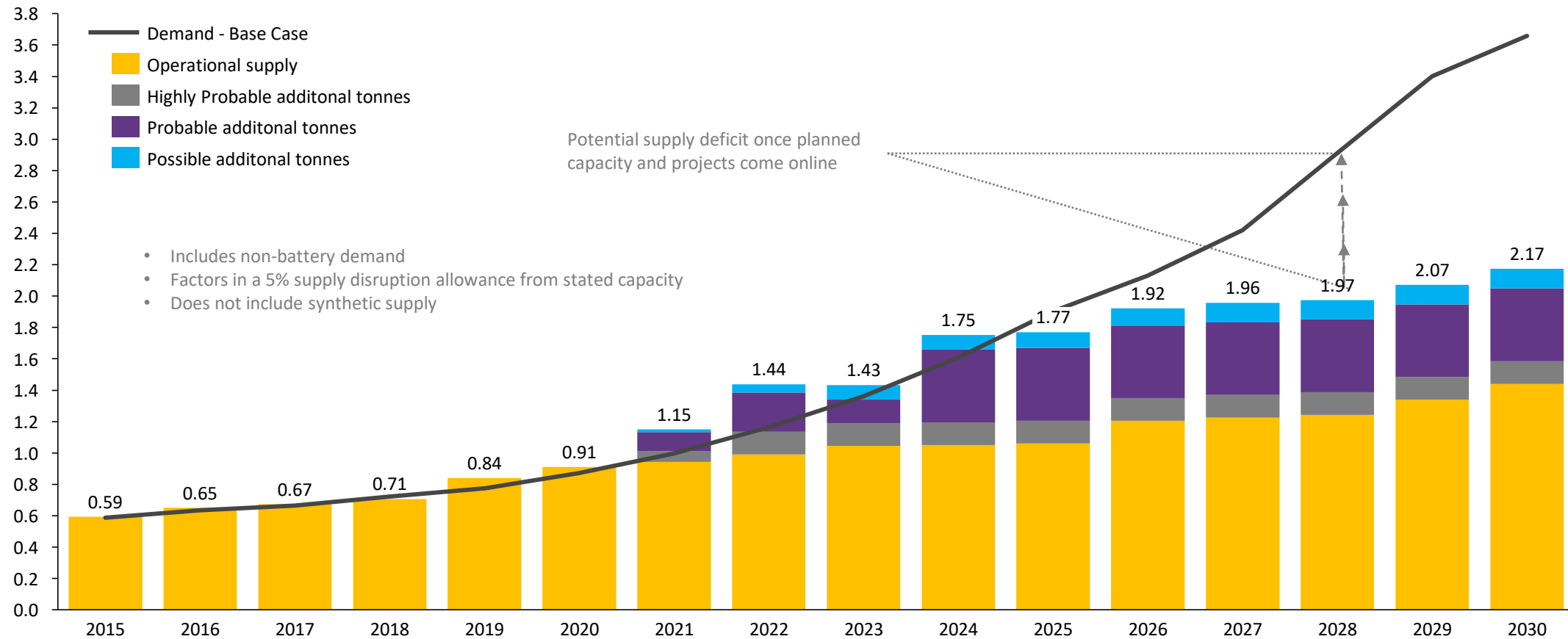
- In the chart below we outline our forecast for the development of natural flake capacity over time. As can be seen there is a significant pipeline of new capacity coming online for graphite over the next decade. There will need to be further greenfield and brownfield capacity expansions in the period beyond 2028 in order to meet rising demand, even in our downside demand scenario



2. Long Term Supply Forecasts for Natural Flake and Synthetic Graphite to 2040

There is a significant pipeline of new capacity coming online for graphite over the next decade. There will need to be further greenfield and brownfield capacity expansions in the period beyond 2028 in order to meet rising demand, even in our downside demand scenario

Million tonnes



3. Natural Flake Graphite Price Forecasts

3. Natural Flake Graphite Price Forecasts

- In this section we provide a price forecast for each grade that Matawinie project will produce, on a delivered North America basis and also a weighted basket price forecast including all grades.
- The Matawinie project has high carbon contents, 97-98%, with the following flake size distribution for natural flake graphite:

Natural flake graphite (97-98% C) flake size	Product weighting
+100 mesh	17%
+50 mesh	31%
+80 mesh	12%
-100 mesh	40%

- In order to arrive at a final forecast for each grade that Matawinie project will produce, on a delivered North America basis we look first at the drivers of graphite pricing, including price differences between grades, and we use the benchmark China Fob reference price as the basis for the forecast. We then add a location premium for a delivered North America price for the grades Matawinie will produce.

3. Natural Flake Graphite Price Forecasts

Introduction to natural flake graphite pricing

There are two key determinants of achieved prices for flake graphite:

- Flake size – larger flake sizes dictate a premium over smaller flake sizes
- Carbon content – higher carbon content is at a premium to lower grades

Flake Graphite Pricing, 2015-2018

USD per tonne, China FOB

2,500

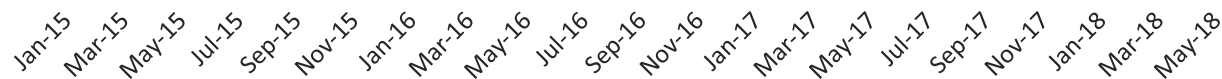
2,000

1,500

1,000

500

0



— +50 mesh 96-97% C — -100 mesh 96-97% C — -100 mesh 90-93% C

+50 mesh flake sizes achieved an average premium of approximately \$750 per tonne in 2017 over -100 mesh grades of equivalent C content. The premium has been rising, and has been over \$900 per tonne since August 2017

The higher carbon content in -100 mesh 96-97% C material over 90-93% C graphite of the same mesh size commanded a premium of roughly \$200 per tonne in 2017

3. Natural Flake Graphite Price Forecasts

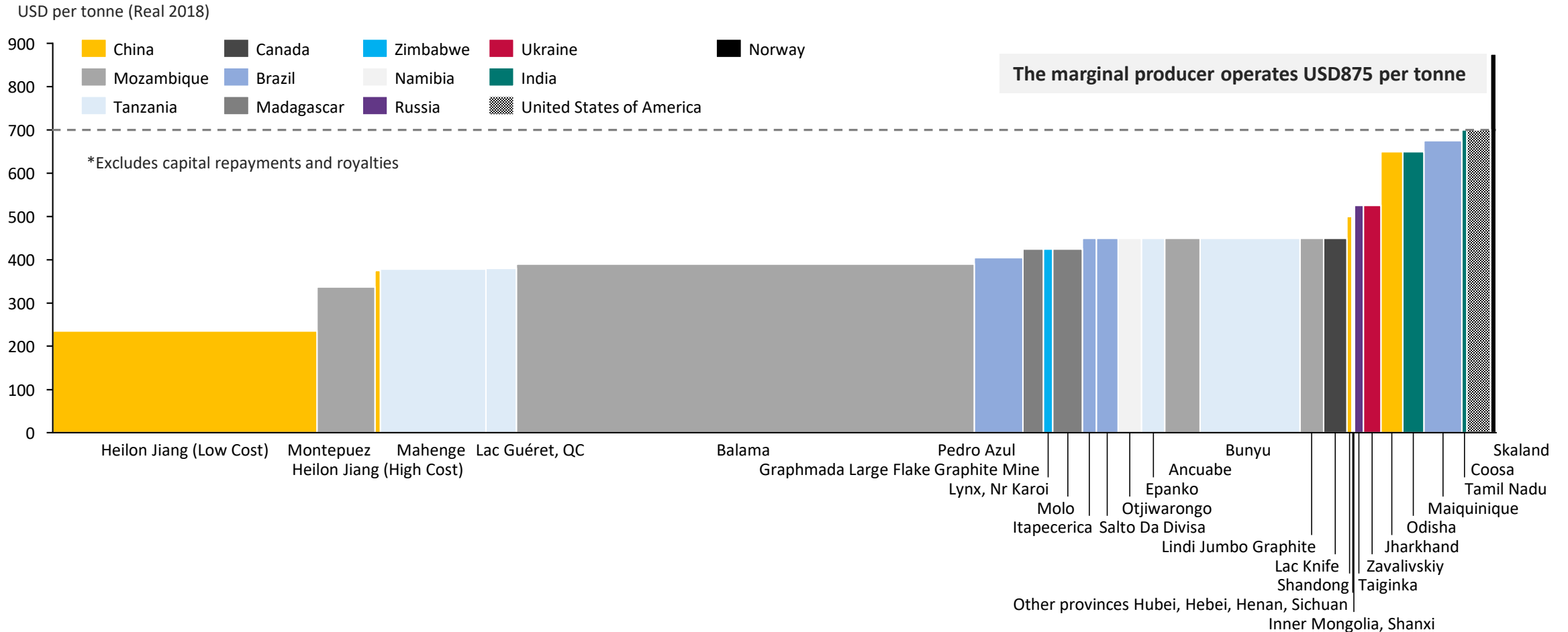
Benchmark Graphite price forecast methodology

- Our medium and long-term price forecast methodology for lithium considers the following factors:
- **Balance of supply and demand** – Based on our analysis of the development of demand over time, and our understanding of the pipeline of new greenfield and brownfield capacity, we are able to make an assessment of the extent of over and under supply in the market over time, and how this is likely to impact prices
- **Production costs for the marginal cost producer** – Long run pricing in commodity markets is often determined by the level at which the highest cost producer needed to supply the market can continue to operate; for graphite this would be at a cash cost level of around USD900 per tonne. For the forecast we expect this will be less of a factor, due to the ongoing need to incentivise new projects prices will be well above this level
- **Incentive pricing for new greenfield and brownfield capacity investment** – There will be an ongoing requirement for new greenfield capacity over the course of the forecast period. We have conducted an Initial Rate of Return (IRR) analysis for a ‘Typical’ greenfield natural flake graphite project, which suggests that at a price level of USD2,000 per tonne for a basket of graphite grades the IRR would be 27%. This is approximately the level that junior miners are using for their assessment of project economics, and reflects the fact that as the lower cost new supply comes online there will be a need for the development of higher capex projects over time.

IRR assumptions for a ‘Typical’ greenfield graphite project		IRR at different graphite long run pricing	
Output at full capacity (tonnes per annum)	40,000	Graphite long run pricing long run price assumption	Indicative IRR
Mine Life (years)	30	USD1,500 per tonne	22%
Capital Expenditure (USD Million)	200	USD2,000 per tonne	27%
Operating Cost (USD per tonne)	450	USD1,000 per tonne	15%

3. Natural Flake Graphite Price Forecasts

Graphite industry cash cost* curve 2035

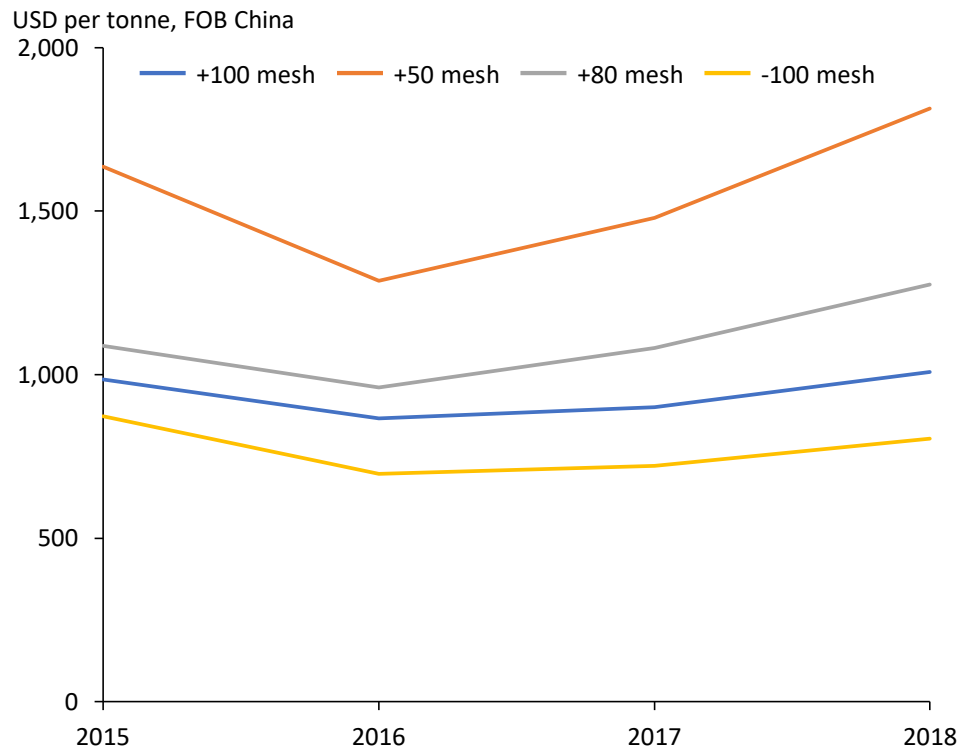


3. Natural Flake Graphite Price Forecasts

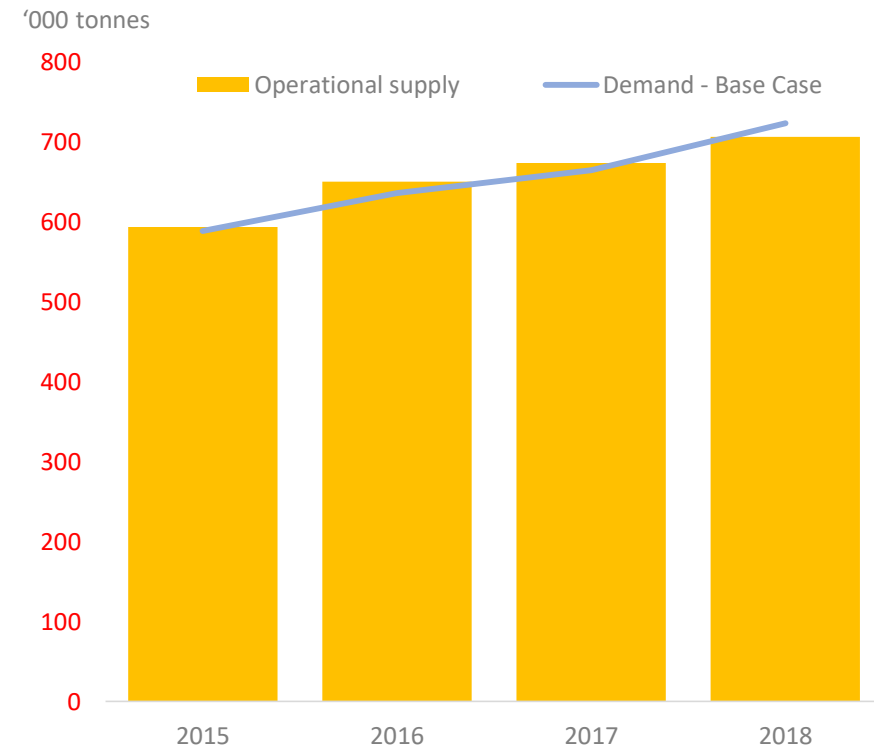
Natural flake graphite historical pricing 2015-2018

- In the charts below we illustrate the price history for high carbon graphite grades since 2015, and the industry supply and demand balance over the same period.
- There has been a marked increase in graphite pricing over the last two years, especially for higher flake sizes, as a response to a tightening in the market over the same period, and this trend has accelerated in 2018 as the market has moved into a supply deficit despite brownfield expansions from existing producers.

High carbon (96-97% C) natural flake graphite pricing history, 2015-2018



Graphite supply and demand balance, 2015-2018



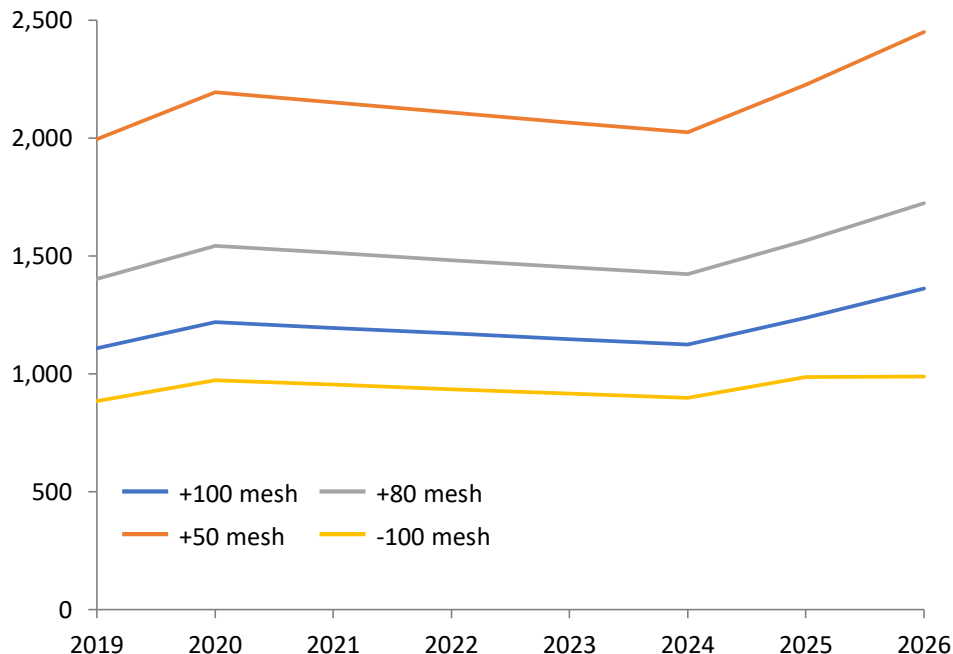
3. Natural Flake Graphite Price Forecasts

Natural flake graphite price forecast 2019-2026

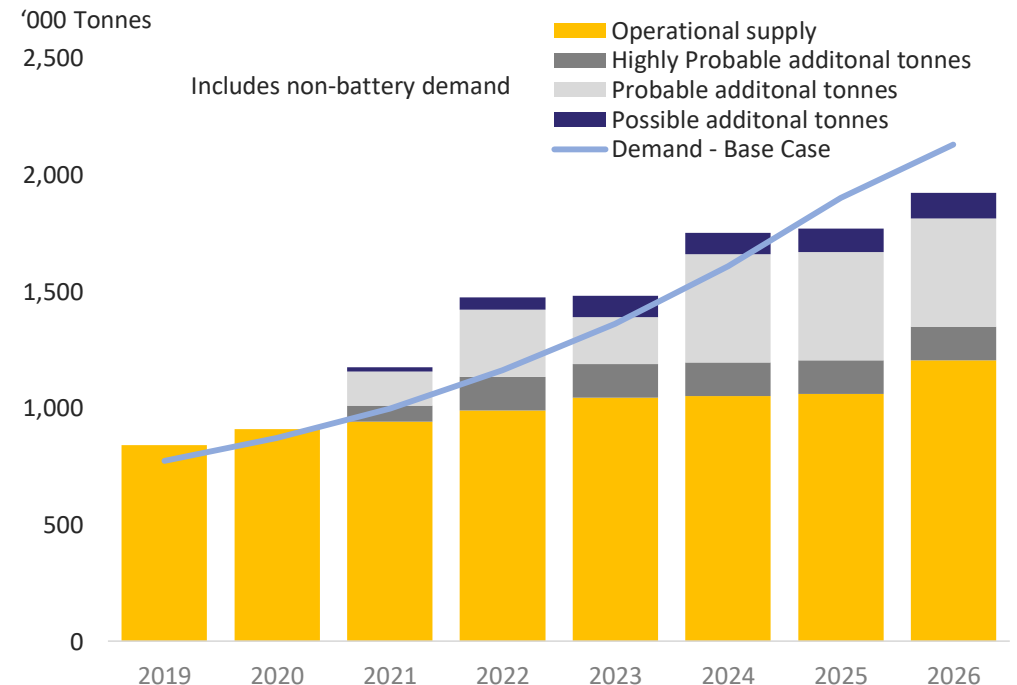
- In the ‘medium term’ to 2026 we will see continued brownfield expansions, and from 2021 new capacity coming online from green field projects. In the middle of this period it is likely that the market will move into slight oversupply for a number of years as new capacity ramps up faster than demand growth. The market quickly moves back into deficit towards the end of the period however, as the pipeline of new capacity projects is exhausted and demand continues to grow.
- As a result there will need to be incentivise new projects to come online from 2025 onwards, which would mean they begin development in 2019 or 2020, therefore we do not anticipate a significant price reduction in this period

High carbon (96-97% C) natural flake graphite price forecast, 2019-2026

USD per tonne, Real 2018, FOB China



Graphite supply and demand forecasts, 2019-2026

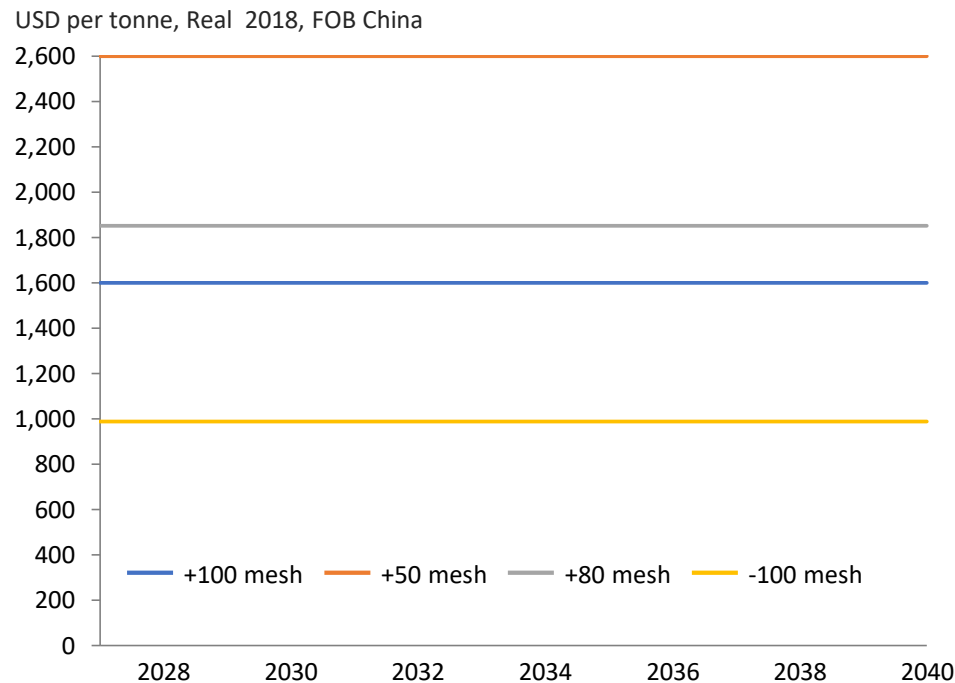


3. Natural Flake Graphite Price Forecasts

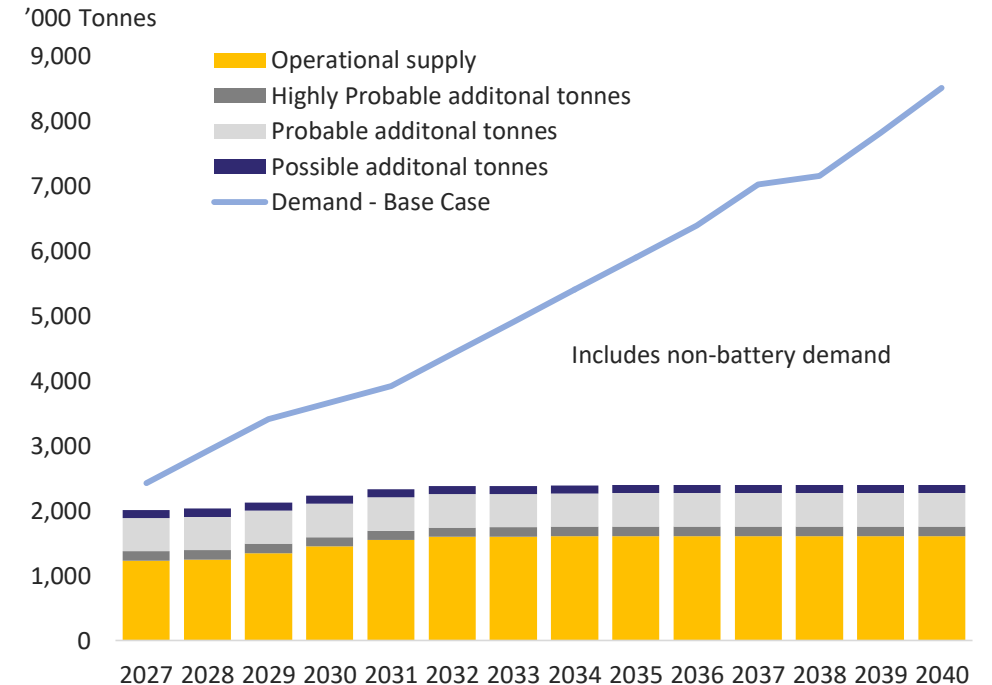
Natural flake graphite price forecast 2027-2040

- From 2027 until the end of the forecast period at 2040 the market remains in deficit and will continue to need new supply coming online in order to meet demand. Prices will therefore need to be high enough to incentivise demand.
- As we stated the main determinant of long term prices for graphite over the forecast period will be the need to incentivise new supply to make up this deficit. Based on our IRR calculations and our consideration of the typical cost of capital for greenfield mining projects of this type, we estimate that the average price for high carbon grades (96-97% C) will be USD2,000 based on the range of pricing in the chart on the left below.

High carbon (96-97% C) natural flake graphite price forecast, 2027-2040



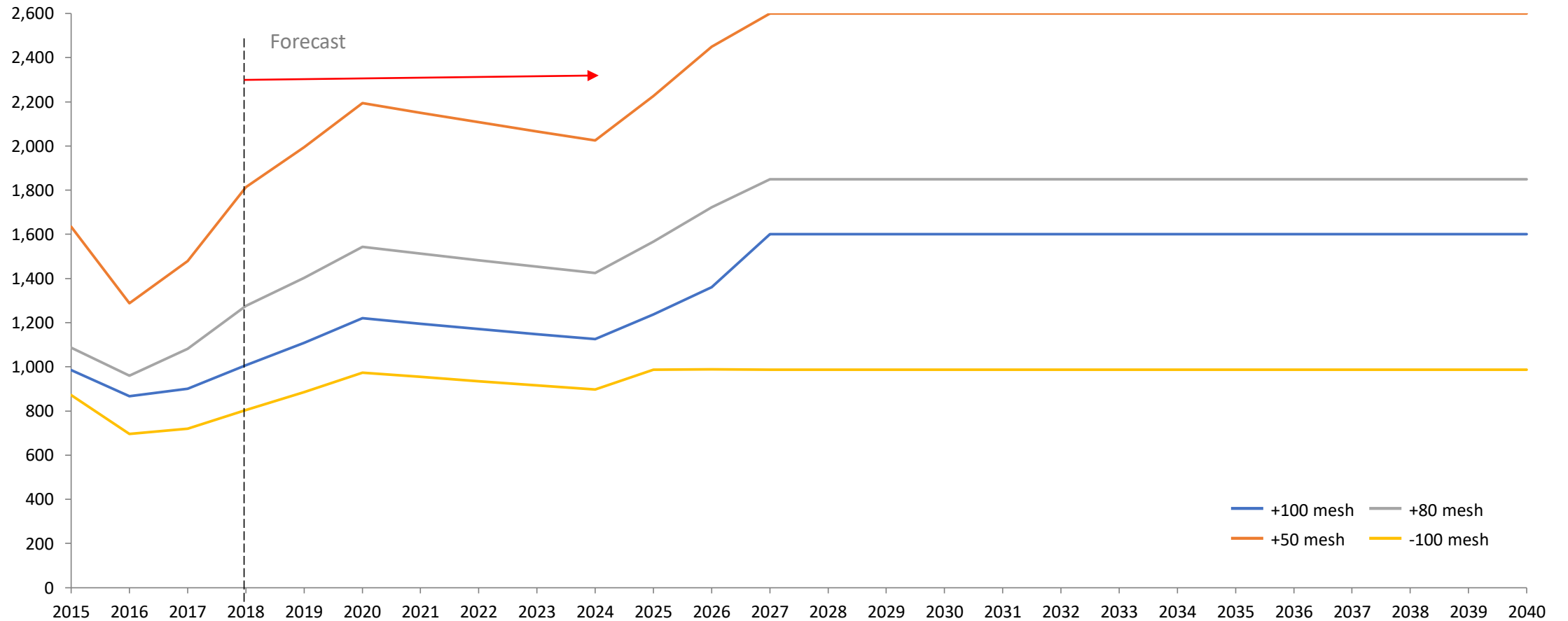
Graphite supply and demand forecasts, 2027-2040



3. Natural Flake Graphite Price Forecasts

High carbon (96-97% C) natural flake price history and forecast, 2015-2040

USD per tonne, Real 2018, FOB China



3. Natural Flake Graphite Price Forecasts

- In order to arrive at a price forecasts for the Matawinie project on a delivered North America basis we add a location premium to the benchmark China Fob prices on the previous slides, as a well as adjustments for grades based on the expected output of the operation.
- The premium varies by grade, and there is some variance over time. For the purposes of this forecast we will use the following premiums by grade:

Natural flake graphite (96-97% C) flake size	Location premium, USD per tonne
+150 mesh	100
+50 mesh	150
+80 mesh	120
-100 mesh	110

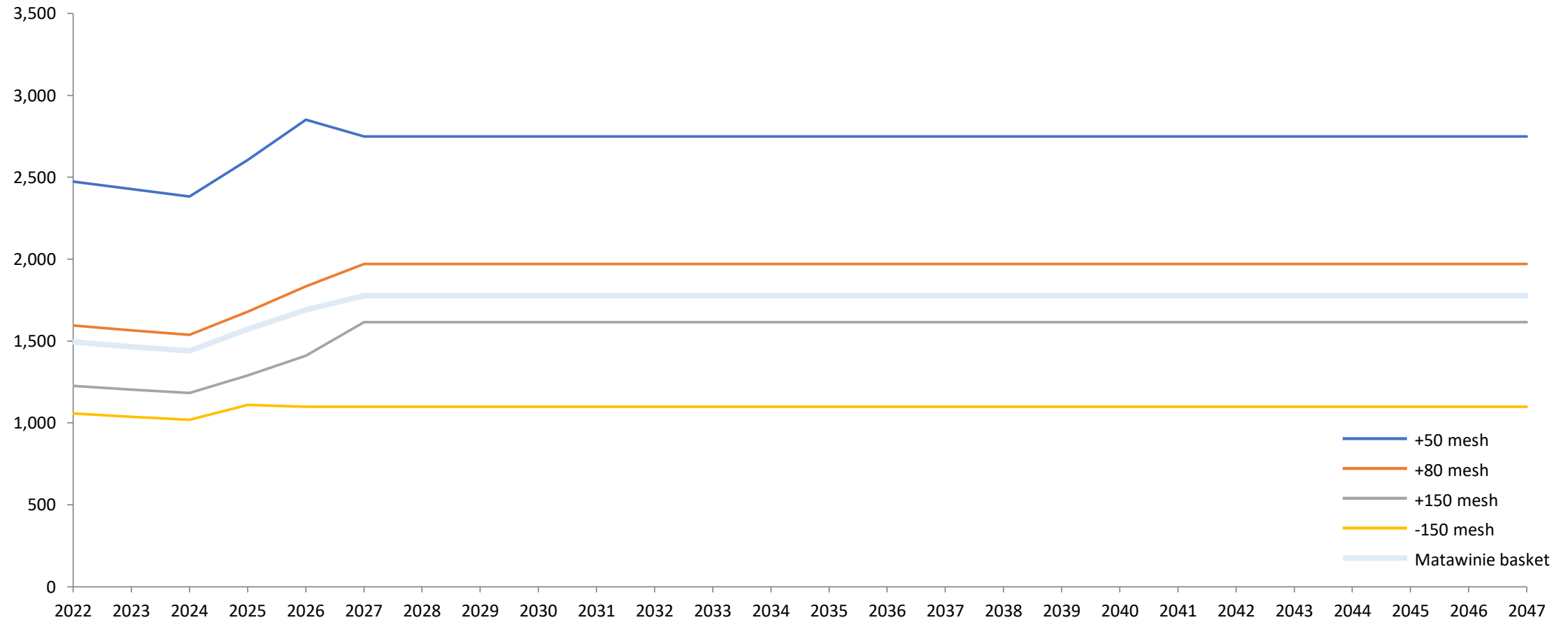
- We also provide a weighted average of the price forecast based on Matawinie’s planned product mix.

Natural flake graphite (96-97% C) flake size	Product weighting
+150 mesh	27.7%
+50 mesh	14.8%
+80 mesh	33.4%
-100 mesh	24.1%

3. Natural Flake Graphite Price Forecasts

High carbon (96-97% C) natural flake price history and forecast, 2022-2047

USD per tonne, Real 2018, North America CFR



4. Premium Graphite Markets Outlook and Prices

4. Premium Graphite Markets Outlook and Prices

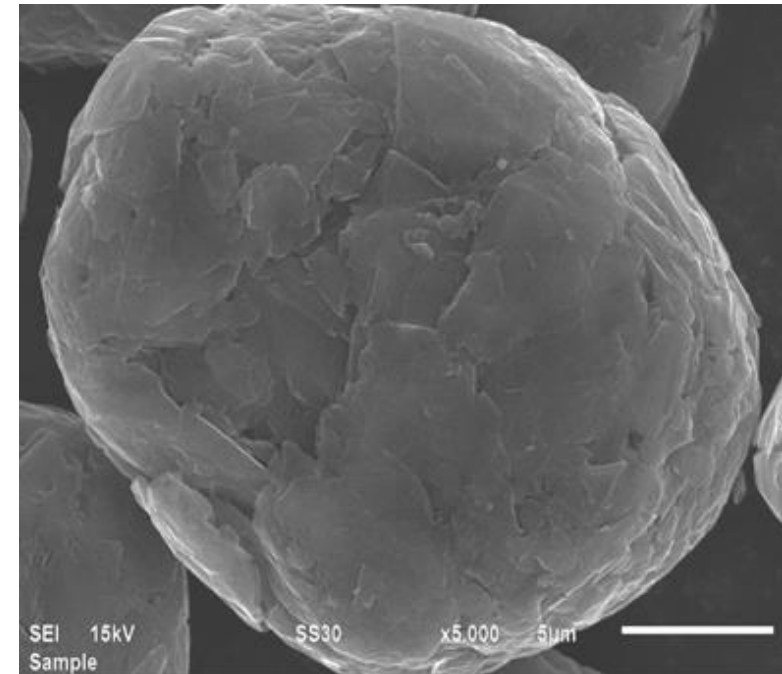
- Nouveau Monde is currently developing second transformation processes in order to serve higher value-added markets. In this section we will provide an overview and market size breakdown for the following processed, premium graphite products, including:
- Spherical uncoated and coated graphite for anodes
- Expandable graphite
- Purified micronized graphite

4. Premium Graphite Markets Outlook and Prices

Coated and uncoated spherical graphite overview

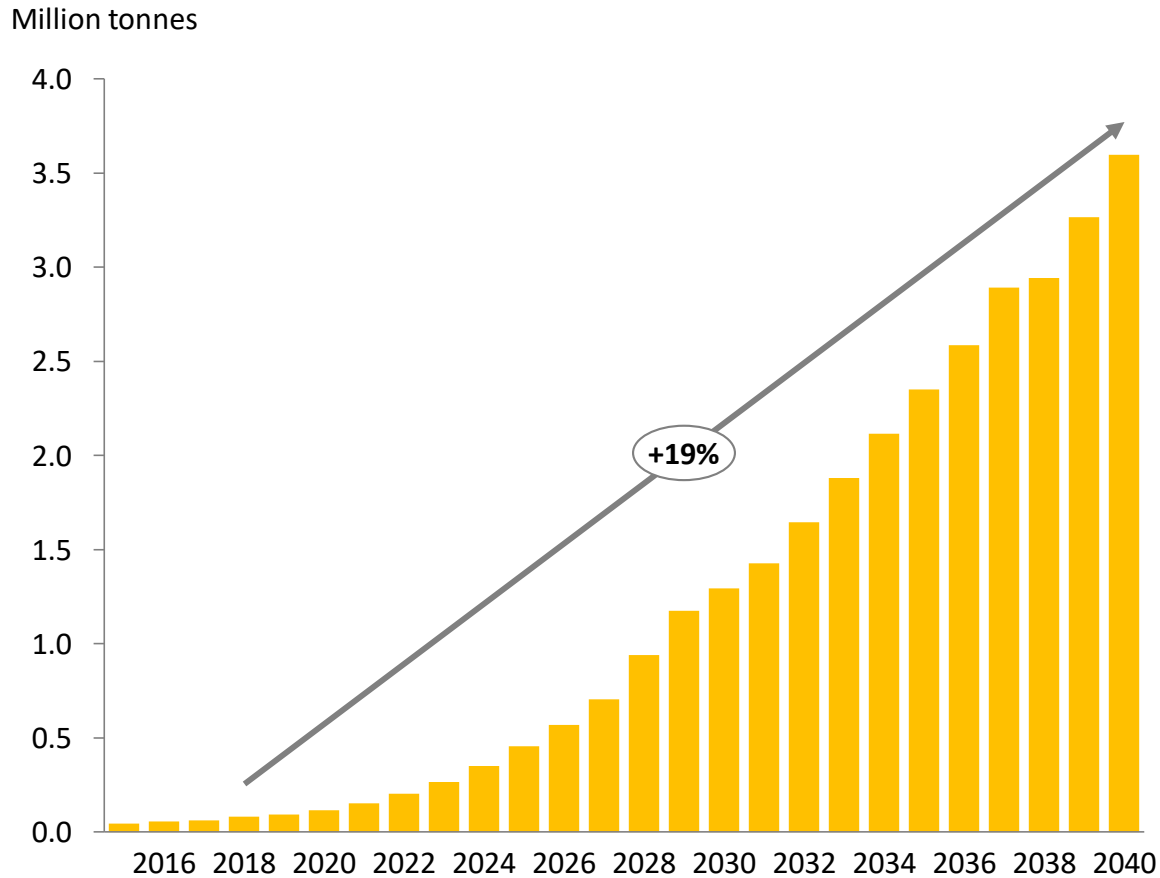
- Spherical graphite is formed by processing flake graphite through consecutive milling steps. This is an energy-intensive process, with a yield of 30 to 50%. In the case of Natural Graphite, the shaping must be preceded by purification, most commonly through chemical leaching.
- The current price for uncoated spherical (anode precursor) material is in the region of USD3,500 per tonne, while coated spherical (anode) currently sells for USD9,000 per tonne.
- Spherical shapes usually measure between 10 to 40 micron and generally have a carbon content of 99.95% C or above. This process increases the surface area and conductivity making it ideal for use as the anode material for battery technologies.
- As such demand growth is linked to the development of the battery market. On the following slide we detail our expectations for both coated and uncoated demand over the forecast period

Coated spherical graphite

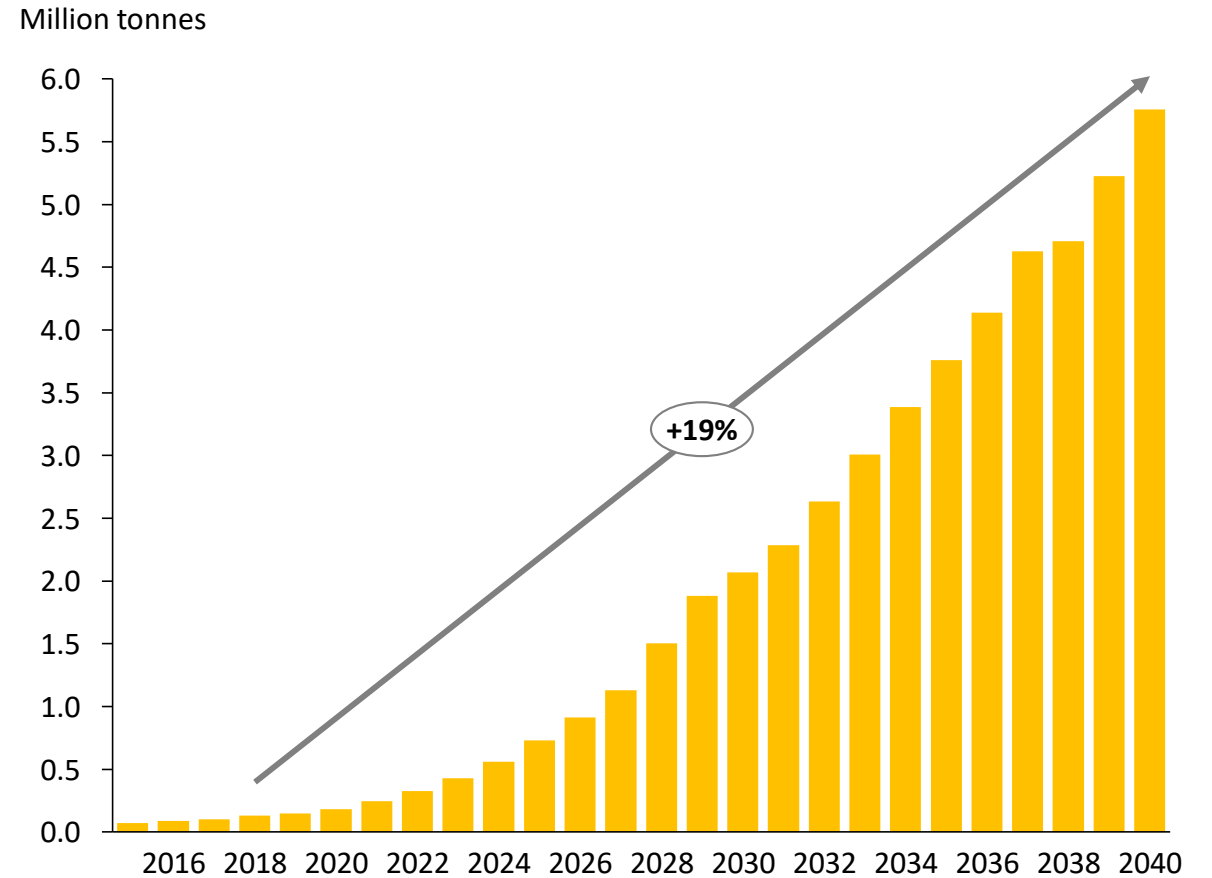


4. Premium Graphite Markets Outlook and Prices

Uncoated spherical graphite (anode precursor) demand forecast, 2015-2040



Coated spherical graphite (anode) demand forecast, 2015-2040



4. Premium Graphite Markets Outlook and Prices

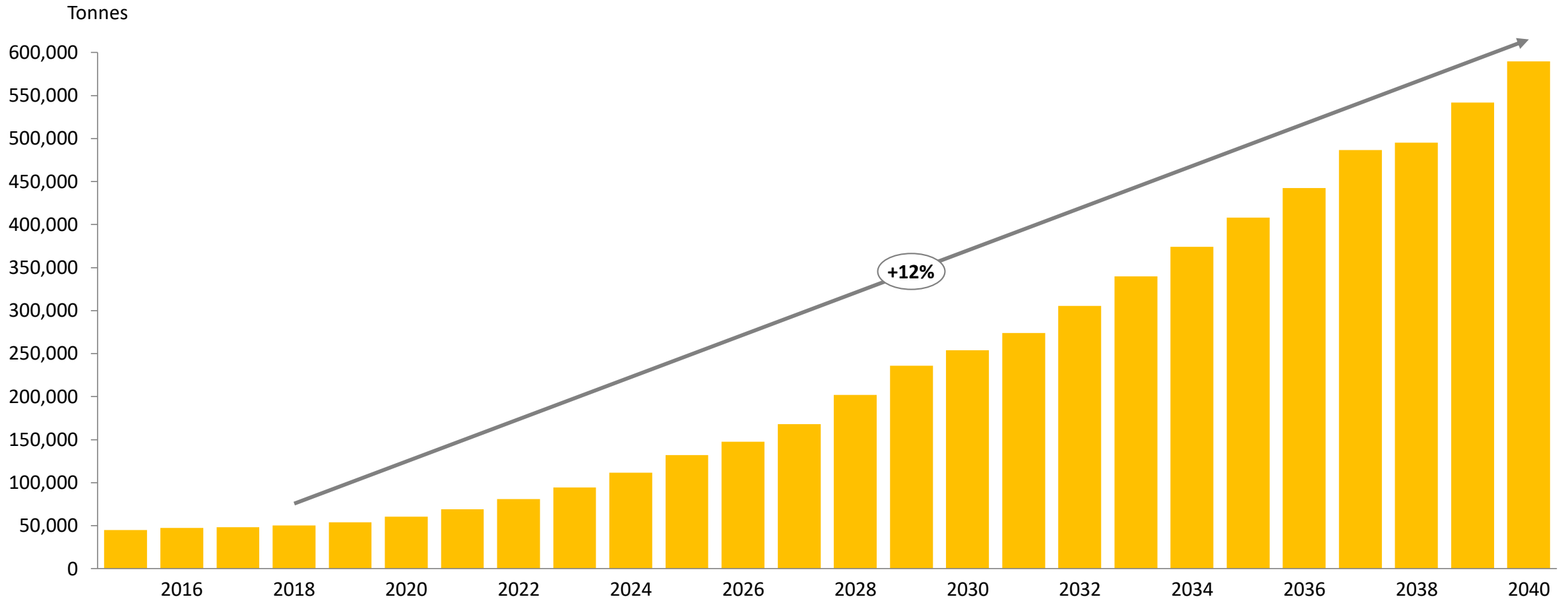
Purified micronized graphite overview

- Purified micronized graphite is subjected to the same chemical leaching process to achieve the required grades as is crushed and ground to achieve a size of less than 30 microns, with a carbon content of 99.9% C.
- It is used as a feedstock for spherical material and is suitable for a range of applications including traditional alkaline batteries, polymers, lubricants, powder metallurgy. As such we expect that demand for purified micronized graphite will grow at a similar pace to total graphite demand over the life of the forecast, at a compound annual growth rate (CAGR) of 12%, with the majority of this growth being driven by battery demand growth.
- Prices for Purified micronized graphite are reported at USD3,000 per tonne



4. Premium Graphite Markets Outlook and Prices

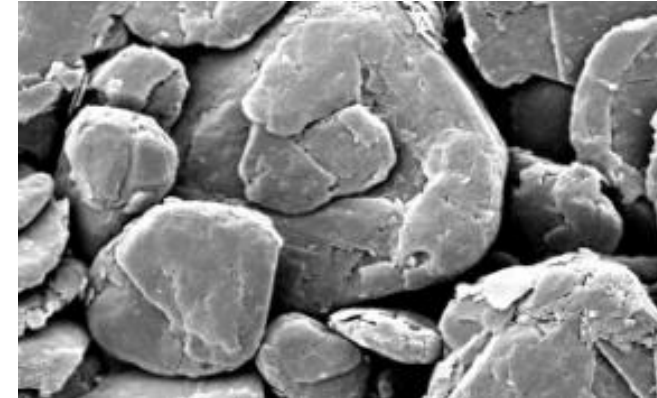
Purified micronized graphite demand forecast, 2015-2040



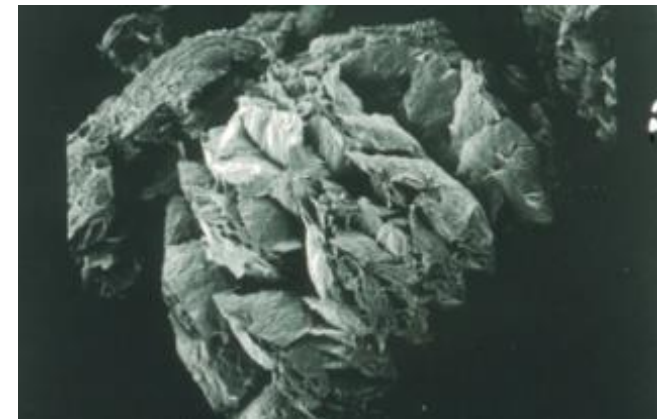
4. Premium Graphite Markets Outlook and Prices

- Expandable graphite is produced by a process in which an intercalant material is inserted in between the graphene layers of flake graphite. Typically the feedstock for expandable graphite is flake graphite with particle size distribution of +80 mesh.
- A number of chemical compounds can be used to intercalate graphite materials. The most common process is the insertion of sulphate compounds to create ‘graphite bi-sulphate’
- This material is manufactured by treating highly crystalline natural flake graphite with a mixture of sulphuric acid and other oxidizing agents which aid the sulphate intercalation. The final carbon content of this material is very high at up to 99.9% C
- The resultant product is a highly intumescent form of graphite that useful in applications that include fire retardants, high performance gaskets, conductive fillers, electromagnetic pulse and radiation shielding, foundry products.
- Benchmark estimates that the market for expandable graphite at present stands at roughly 60,000 tonnes per annum, the bulk of which is for use in fire retardants.
- The markets for expanded graphite, in particular for fire retardants, are forecast to exceed industrial and GDP growth in the coming years as fire safety regulations are expected to become more stringent in all major economies. We anticipate a 6% CAGR for expandable graphite demand over the life of the forecast.
- At present the market price for expanded graphite is in the region of USD2,700-USD3,200 per tonne depending on the purity of material

Flake Graphite
(unexpanded)



Expanded Graphite



4. Premium Graphite Markets Outlook and Prices

