

# What to look for when making a graphite investment

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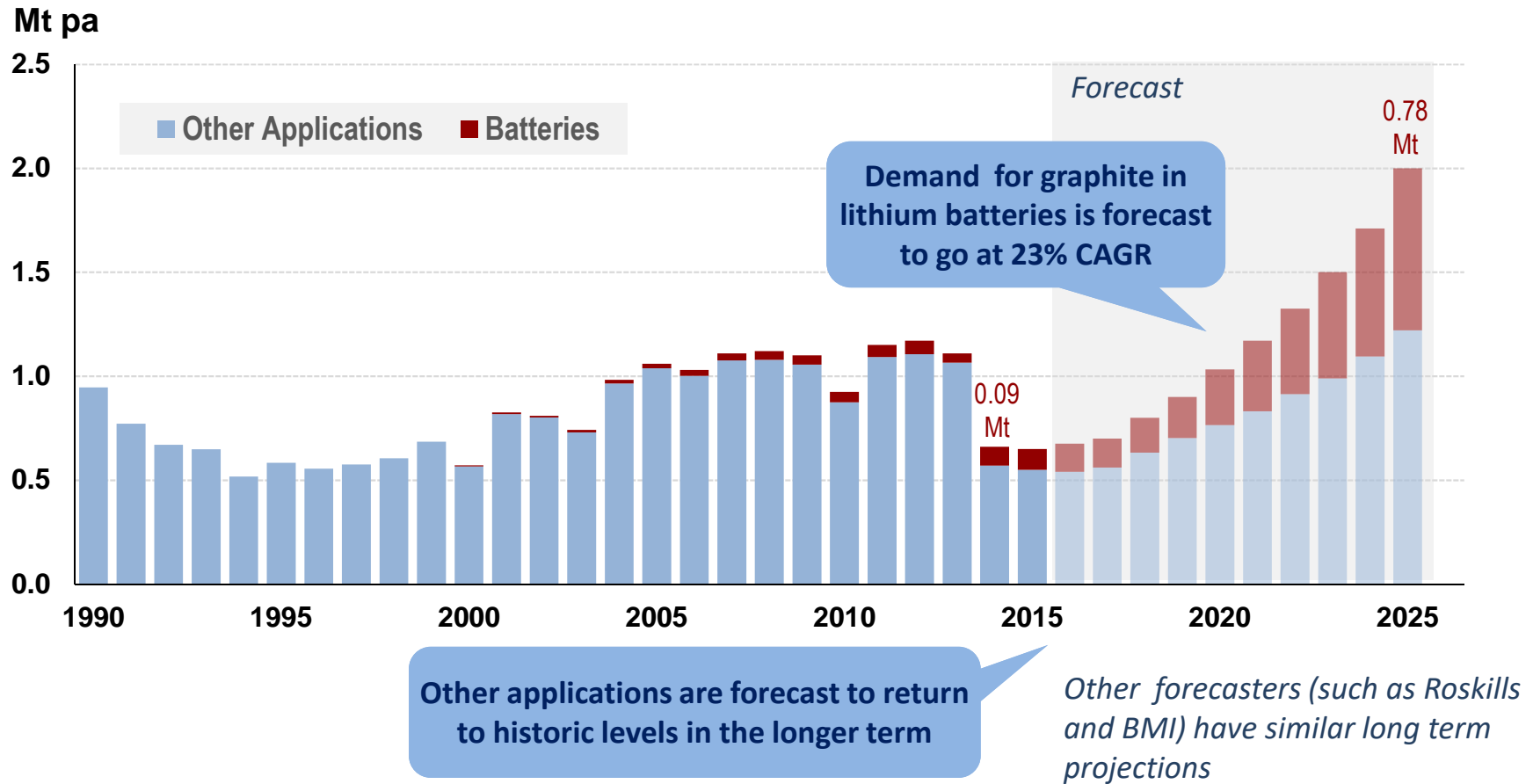
29<sup>th</sup> November 2016 London

# Overview

1. Supply and demand for natural graphite is set to grow rapidly of the next decade, however ...
2. Several large graphite deposits have been found in the last decade ... so not every project will be developed
3. Key Success Factors for a good graphite project ... have identified 9 factors
4. Summary / Conclusions

# **1. SUPPLY AND DEMAND FOR NATURAL GRAPHITE**

# Growth in demand is driven by a reversion in existing markets and rapid growth for Li batteries

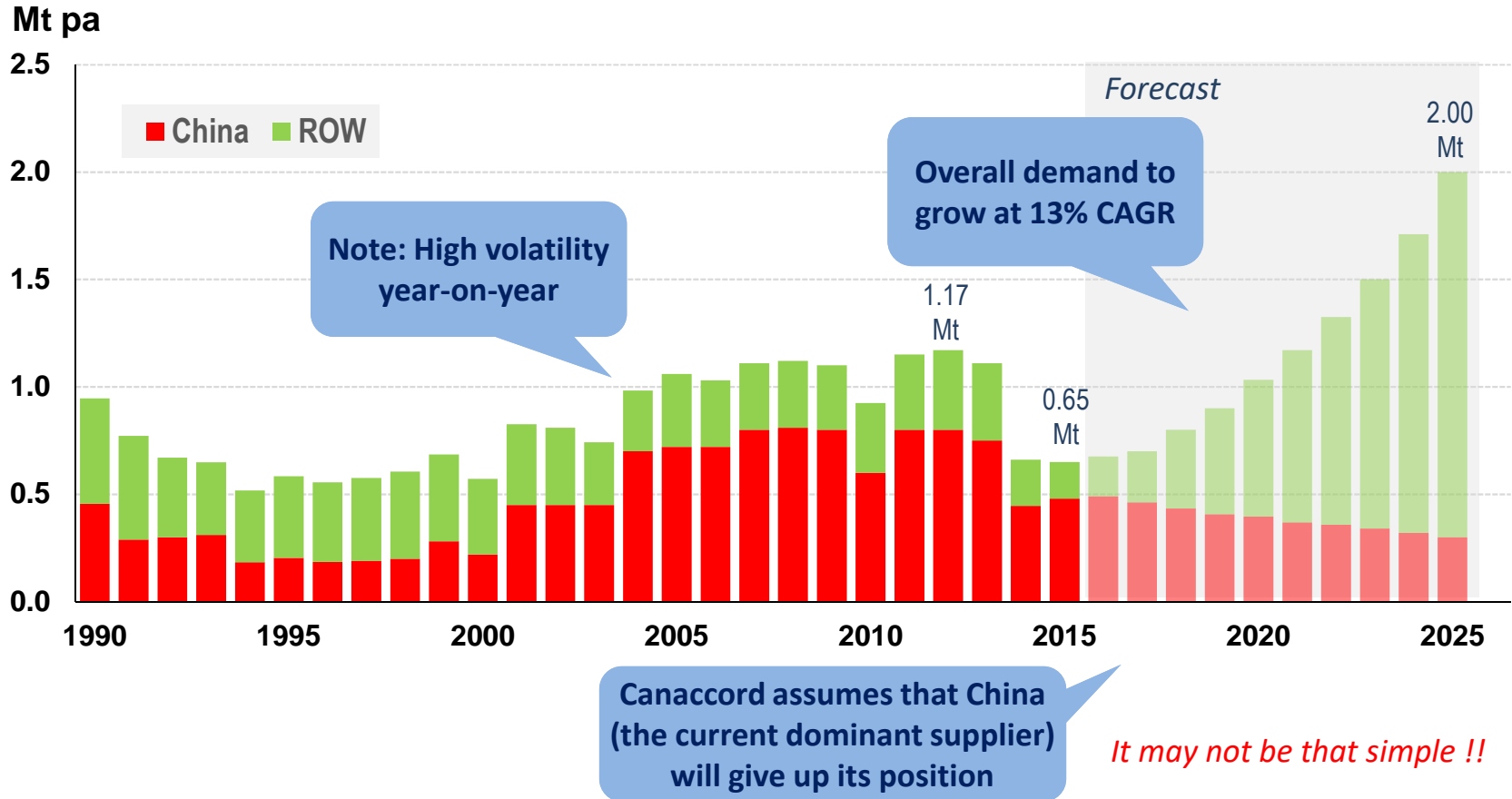


Note: Includes flake and amorphous production.  
Excludes supply of synthetic graphite

Sources: Historical data from Roskill  
Forecast from Canaccord Nov 2016

# Opportunities for new entrants

## Natural Graphite Mine Production World: 1990-2025

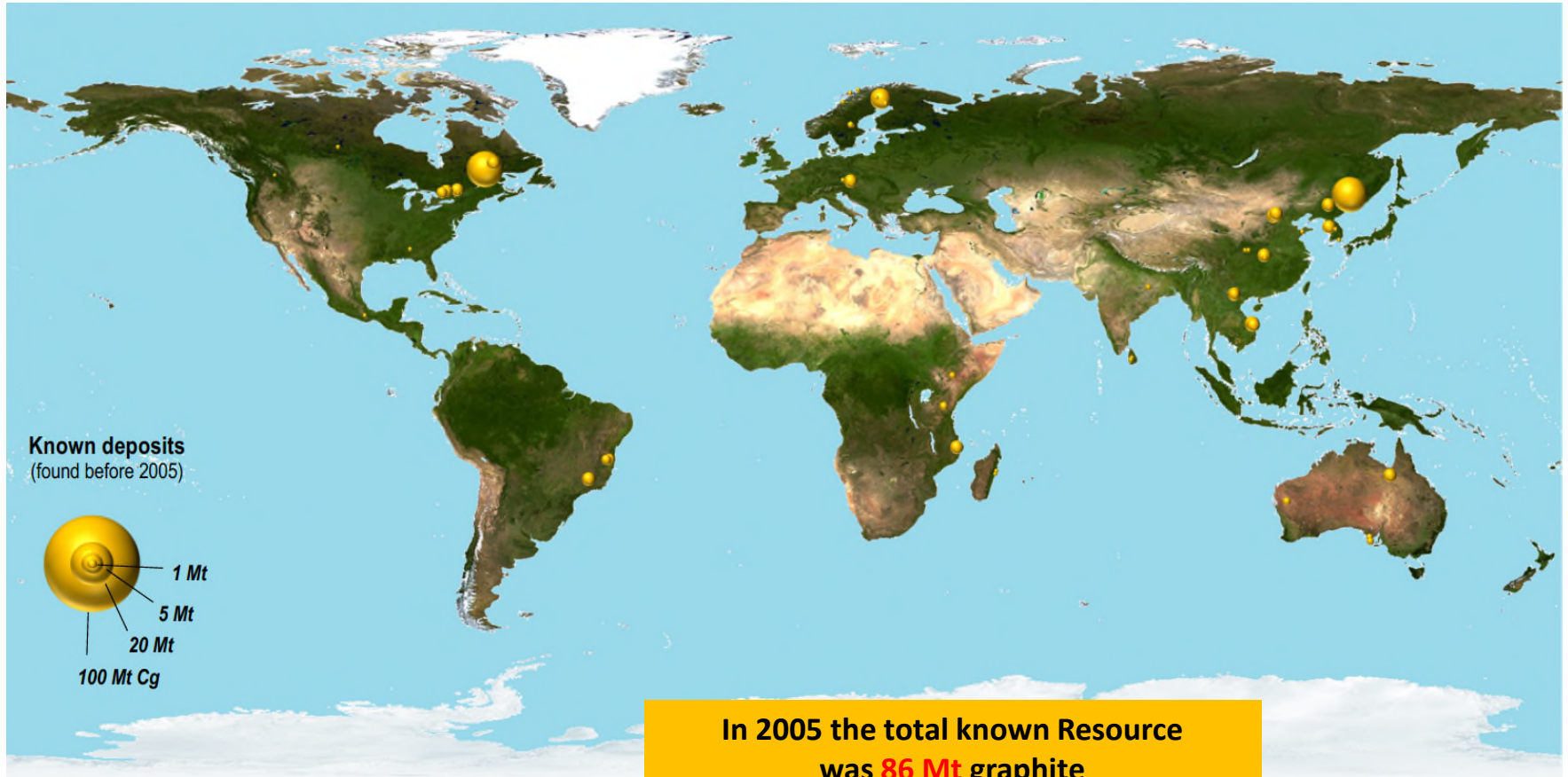


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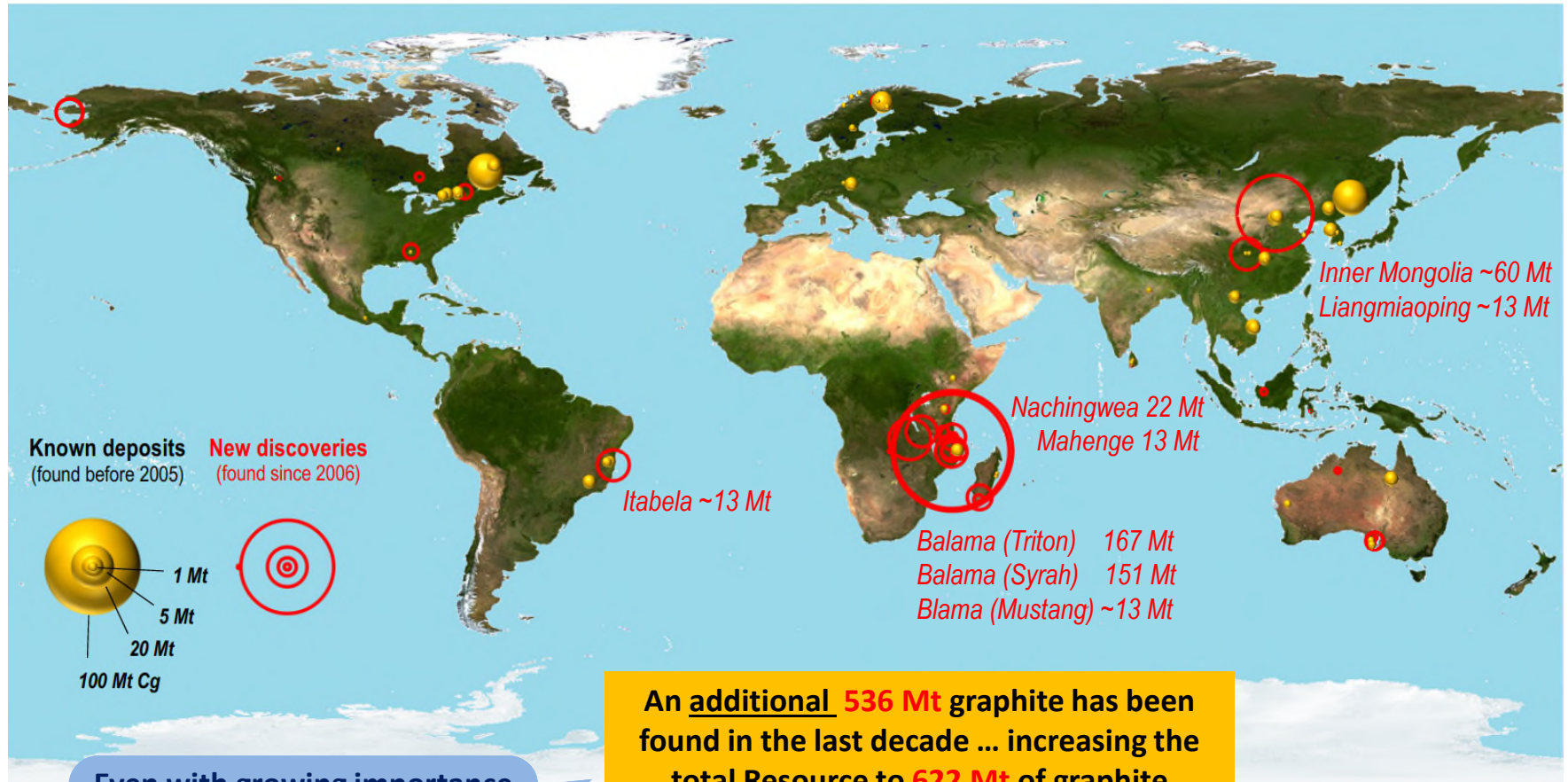
## **2. RECENT DISCOVERIES HAVE LED TO A MAJOR INCREASE IN RESOURCES**

# Graphite deposits (as known in 2005)



Source: MinEx Consulting © Nov 2016

# Total graphite Resources have increased 6-fold in the last decade



Source: MinEx Consulting © Nov 2016



# ... resulting in more than enough projects to supply future growth in demand

Stage	Number of Projects	Number of Companies	Capacity (Mt pa)	Resource (Mt Cg)
Operating Mines (including China)	176 (inc ~150 in China)	124 (inc ~100 in China)	1.10 Mtpa (inc ~0.8 Mt in China)	51 Mt (inc ~30 Mt in China)
Under Construction #	3	3	0.60	161 Mt
Feasibility #	5	5	0.24	30 Mt
Pre-Feas & Scoping #	22	20	>1.10	~240 Mt
Advanced Exploration #	42	34	??	~140 Mt (and growing)
Grassroots Exploration #	~180	~120	??	NA
<b>TOTAL #</b>	<b>~280 #</b>	<b>~210 #</b>	<b>3.04</b> (including China)	<b>~622 Mt</b> (including China)

Forecast demand  
in 2025 is **2.0 Mtpa**

# Note: Excludes China, due too lack of available public data

Source: MinEx Consulting © Nov 2016

# Question ...

Given that most graphite projects are unlikely to be developed in the next decade, how do I choose the “pick of the litter” ?



*... or at least avoid being sold a “pup” !*

# **3. KEY SUCCESS FACTORS FOR A GOOD GRAPHITE PROJECT**

# Key Success Factors

- ✓ ✓ ✓ High quality / high purity
- ✓ ✓ ✓ Consistent product
  - ✓ ✓ Low costs – both capex and opex
  - ✓ ✓ Close relationship with the customer / tester
  - ✓ ✓ Value-add by producing spherical graphite
    - ✓ Location – close to customer / diversity of supply
    - ✓ Patience – it will take several years to get your product accepted
    - ✓ “Green” credentials
    - ✓ Unique product – expandable graphite, coarse flake

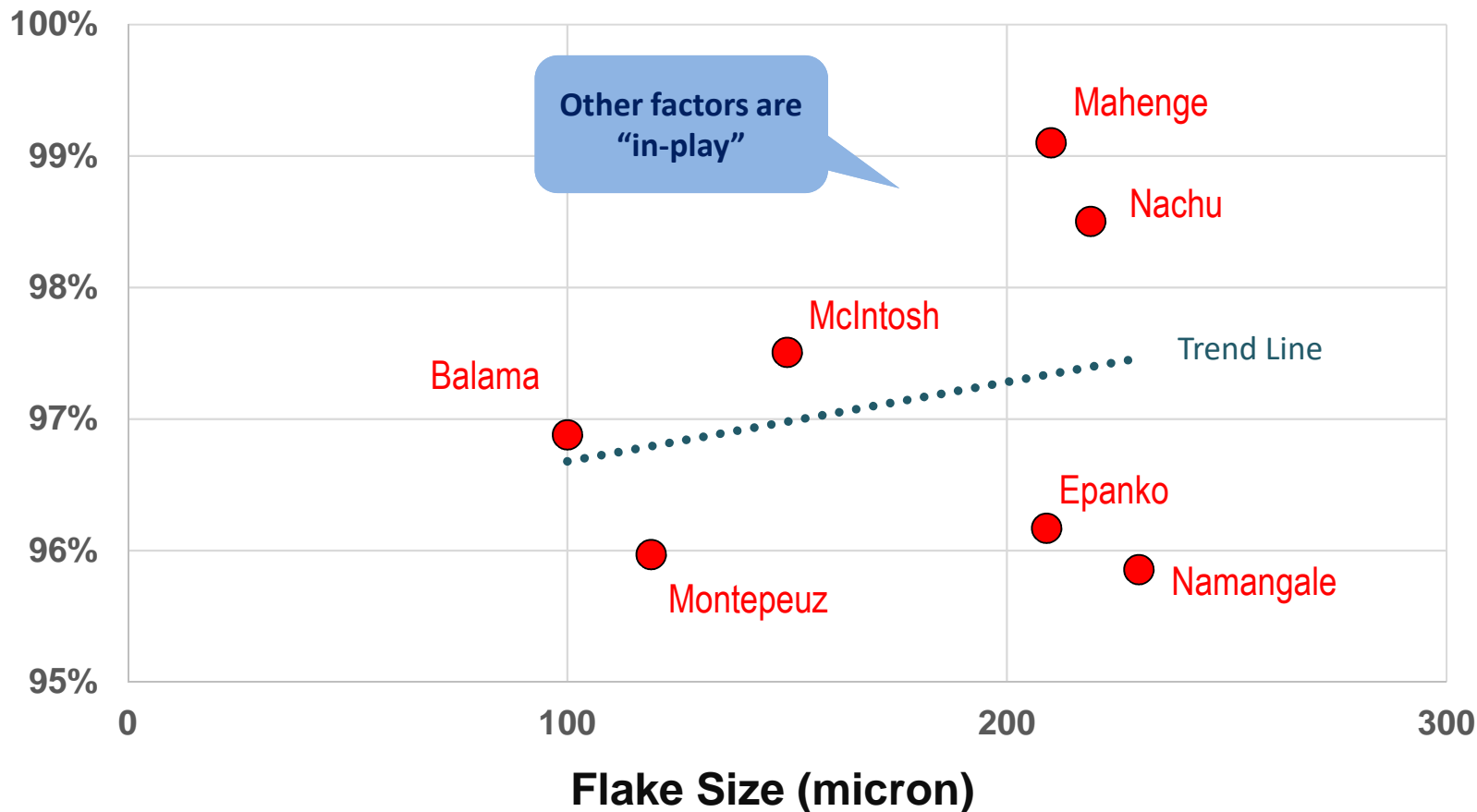
*Having a large high grade resource will help with costs, product consistency and developing relationships over the long term*

## ✓ ✓ ✓ High Quality / High Purity

- Unlike gold or LME-metals, you can't treat graphite as a "simple commodity". The product needs to fit the special needs of your customer. Each customer/application is different.
  - First step is understand the customer's needs
  - Provide plenty of samples for the customer to evaluate
    - Need to choose a reliable/reputable tester
  - Carbon content is important (<85% TCG sells at a deep discount, >99% TCG commands a big premium)
  - Flake size is a "proxy" for quality

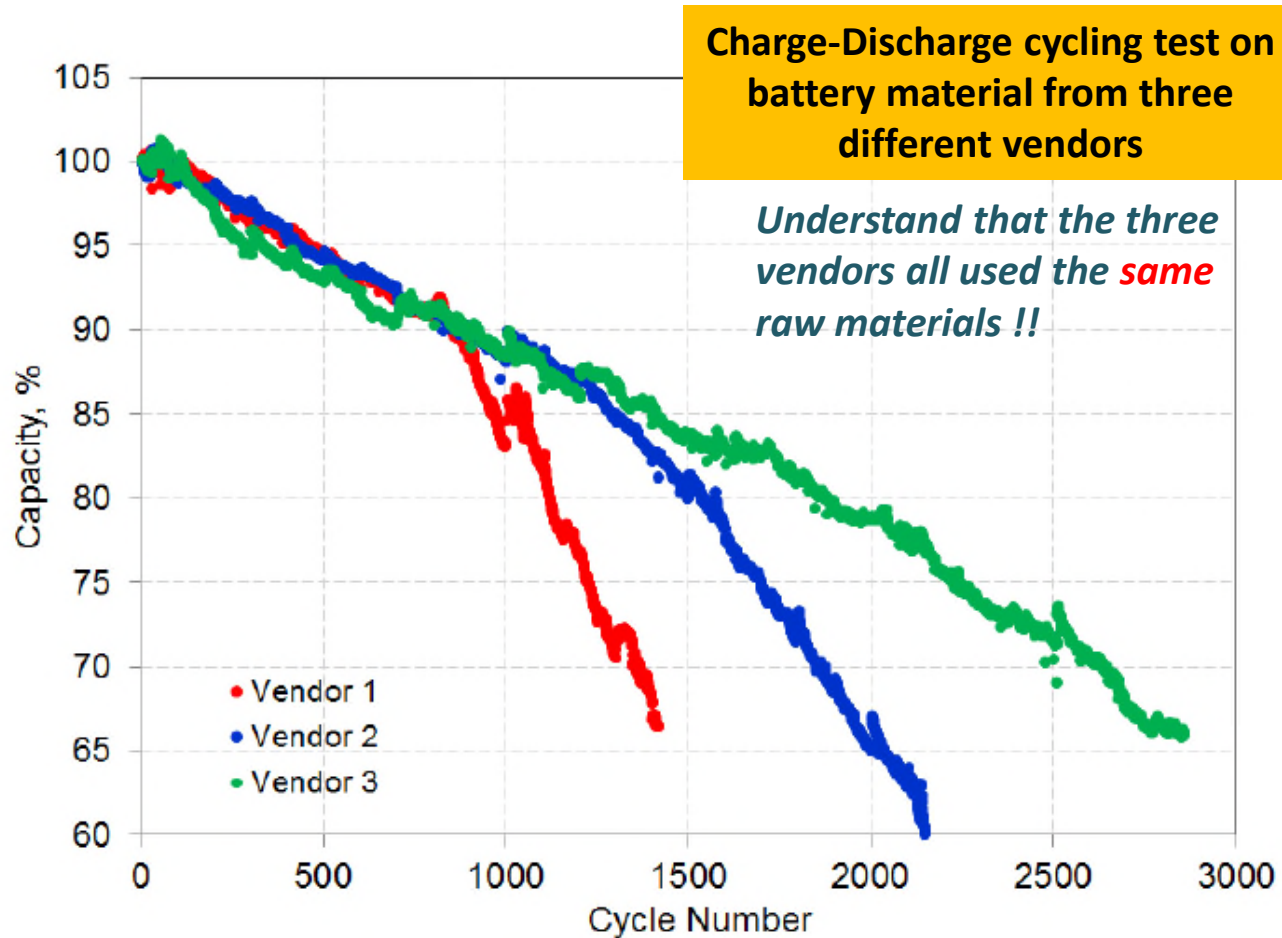
# Loose correlation between flake size and the purity of graphite concentrate

## Concentrate Purity (% TCG)



Source: Canaccord Nov 2016

# Consistent Product



Source: Boston Power 2016

# ☑ ☑ Value-Add

Stage	% TCG	Tonnes of Material	Recovery Factor (%)	Unit Price (US\$/tonne)
Raw Ore	5%	66.67	-	
Mechanical Processing	50%	6.60	99%	
Flotation	95%	3.48	99%	\$700-1,000
Milling	95%	3.30	95%	\$800-1,200
Spheroidisation	95%	1.10	33%	\$3-4,000
Purification	99.5%	0.95	90%	\$4-6,000
Surface Treatment	94.5%	1.00	100%	\$7-10,000

**Downstream processing produces more valuable products**

*However, it is critical that the product meet the required specifications. Need to keep a close check on recovery rates, so as to avoid wasting product and losing money*

Source: MinEx Consulting © Nov 2016



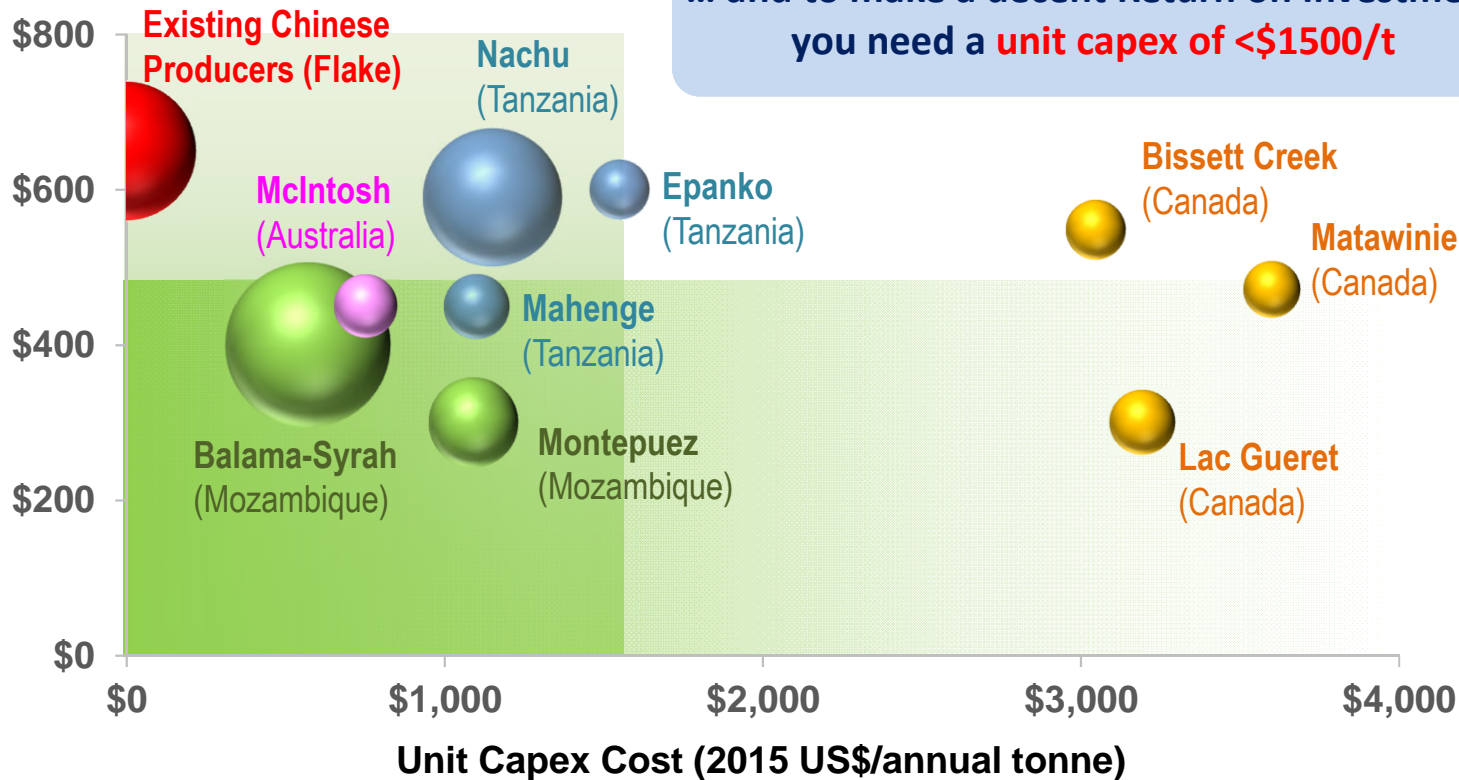
# ✓ ✓ Low Capital and Operating Costs

Opex Cost  
(2015 US\$/tonne FOB)

To survive a price-war the project needs to have an **opex cost < \$500/t FOB**

*Need high-grades, economies of scale and good access to infrastructure and grid power*

... and to make a decent Return on Investment you need a **unit capex of < \$1500/t**



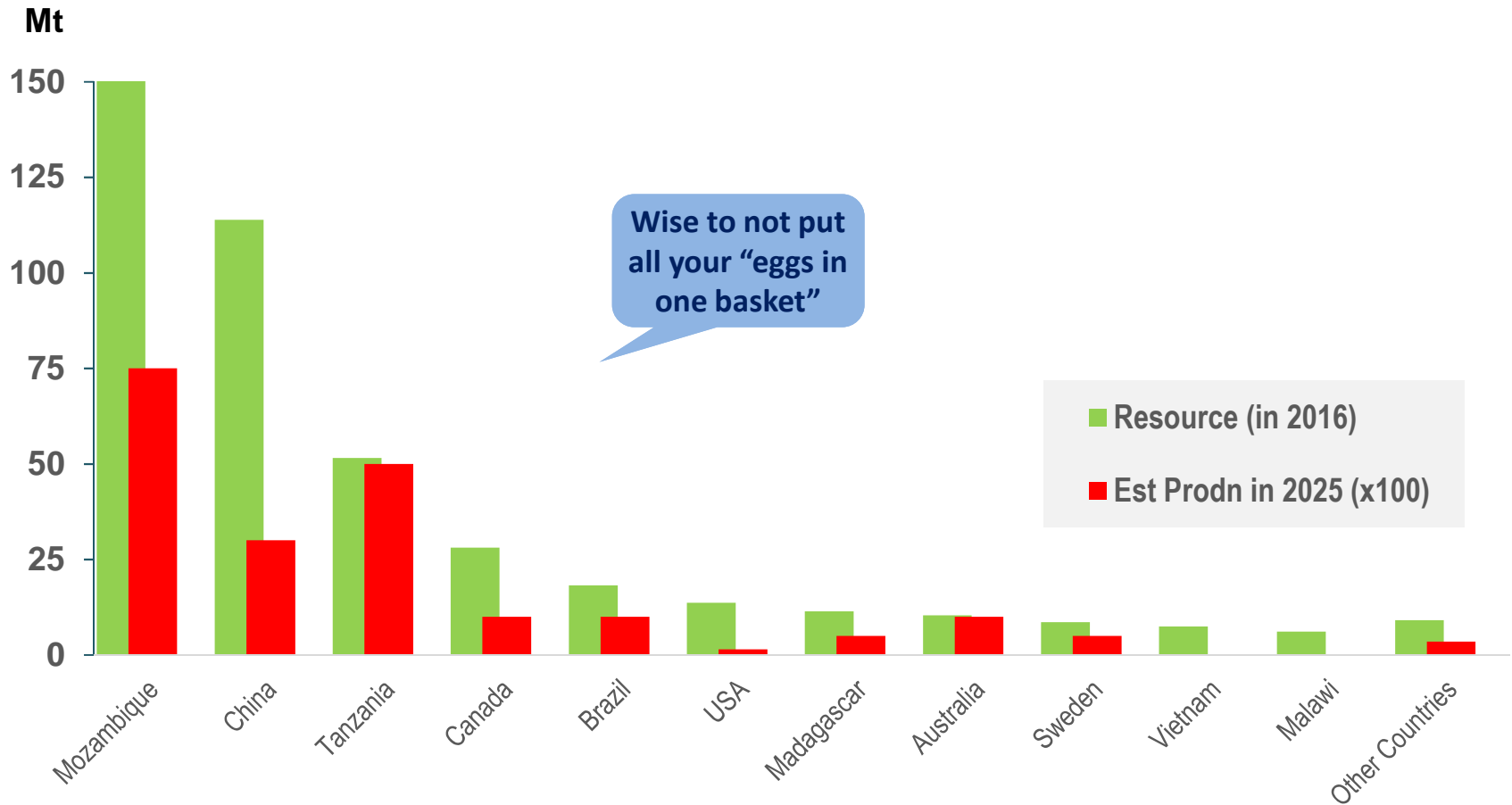
Caution: Capex and opex costs are for floatation product-stage only  
No allowance made for differences in value-add / product quality

Source: MinEx Consulting © Nov 2016  
based on Company reports



# Customers are keen to diversify supplies

## Top 10 countries by Resource



Source: MinEx Consulting © Nov 2016

# 4. SUMMARY / CONCLUSIONS

# Summary / Conclusions

## 1. Supply & Demand for natural graphite

- *Due to Lithium Battery market, demand for natural graphite is set to double to 2.0 Mt pa by 2025*
- *Chinese production (currently the dominant supplier) is set to fall from ~0.8 Mt pa to 0.3 Mt pa by 2025*

Great opportunity for new entrants

## 2. Recent discoveries have led to huge increase in available resources

- *Over the last decade giant discoveries in Africa have led to a 6-fold increase in available resources (up from 86 Mt in 2005 to ~622 Mt in 2016)*

Not all projects will get developed

# Summary / Conclusions [2/3]

## Key success factors for a good project

- ✓ ✓ ✓ High quality / high purity .... *> 95% TCG, >200 micron flake*
- ✓ ✓ ✓ Consistent product ... *has to have reproducible properties*
- ✓ ✓ Low costs .... *capex <\$1500/ t and opex <\$500/t FOB*
- ✓ ✓ Close relationship with the customer ... *and the tester*
- ✓ ✓ Value-add by producing spherical graphite ... *focus on improving the yield and producing on-spec product*
- ✓ Location ... *ideally close to customer*
- ✓ Patience ... *it will take several years to build the market*
- ✓ “Green” credentials ... *avoid use of acids / waste materials*
- ✓ Have a unique product ... *ultra high purity, expandable graphite, coarse flakes etc*

# Summary / Conclusions [3/3]

*Having a large high grade resource will help with containing costs, improving product consistency and developing strong relationships with customers over the long term*

Aim for >100 kt pa open pit operation with good infrastructure and low strip ratio and >20 years reserve life and >10% TCG and >40% recovery on spheroidisation ...

... this should deliver a capex cost <\$1500/annual tonne and opex <\$500/t FOB



“Pick of the litter”

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