Board Meeting, April 4th – Executive summary

The market: regardless of the assumed market development scenario, high-energy-density cathode material provides a large market opportunity for Client

The value chain: the value chain is rapidly evolving and requires flexibility and adaptability – automotive OEMs represent an attractive target group besides cell manufacturers

The battery technology landscape: Client has developed a strong initial high-energy-density cathode material – given the threat of competition and potential breakthrough technologies, continuous development of portfolio required

The market entry strategy

Next steps: detailed implementation plan to be set up and regular review of strategy along defined signposts to be established

SOURCE: Source

We modelled 3 market evolution scenarios as a basis to develop the market entry strategies

	High-energy-density cathode material market (2030)[1] kt	Profit GBP billion	Drivers: EV uptake	Resource prices and availability	Battery technology development
Scenario 1: xEV flop ▪ Battery technology remains stagnant ▪ As a result, EV adoption in the mass market is slow and global resource prices stabilize	584	1.9	Low case	Stabilization of prices	Stagnant
Scenario 2: xEV evolution ▪ Battery technology continues to evolve steadily but there is no major breakthrough ▪ Regulators and OEMs push EVs into the market and demand gradually increases ▪ Growing pressure on raw materials caps EV mass market adoption	1,334	3.3	Base case	Volatile prices	Progression
Scenario 3: xEV revolution ▪ There is a major breakthrough in battery technology ▪ As a result, xEV uptake increases dramatically ▪ Cathode manufacturers with next generation technologies reap the benefits, the others disappear	1,782	3.4	High case	Steady increase of prices	New tech

Options

1. Based on Client Clean Air, McKinsey Auto 2030 modelling (see appendix). High energy density cathode defined as enhanced NCA, NMC811, NMC9XX

High energy density market in 2030 is derived a bottom up market model1

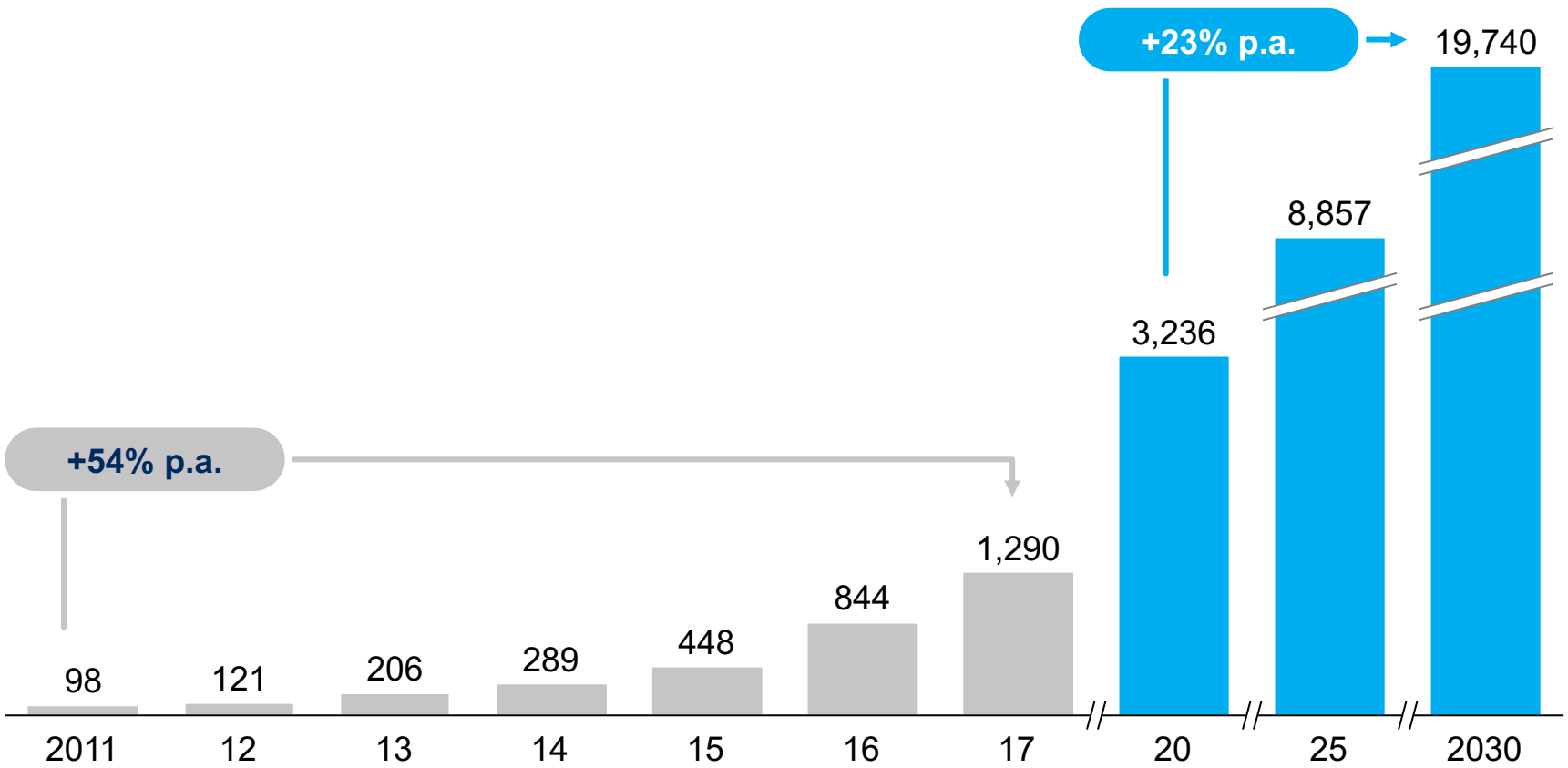
	EV volumes [2] # Million	Battery demand[2] GWh	Cathode material market[2] kt	High-energy-density cathode material market kt	GBP billion
Scenario 1: xEV flop	24.4	1,078	1,710	584	1.9
Scenario 2: xEV evolution	28.3	1,716	2,550	1,334	3.3
Scenario 3: xEV revolution	41.3	2,913	2,682	1,782	3.4

1 Details on market model in appendix; Based on Client Clean Air, McKinsey Auto 2030 modelling (see appendix). High energy density cathode defined as enhanced NCA, NMC811, NMC9XX
2. Total demand from EV and HV. Based on Client Clean Air, McKinsey Auto 2030 modelling (see appendix)

xEVs have grown by 54% p.a. between 2011 and 2017 – growth is expected to continue at 23% p.a. through to 2030

Number of xEVs worldwide

Actuals and base case (evolution) xEV uptake predictions[1], # in thousands



Key insights

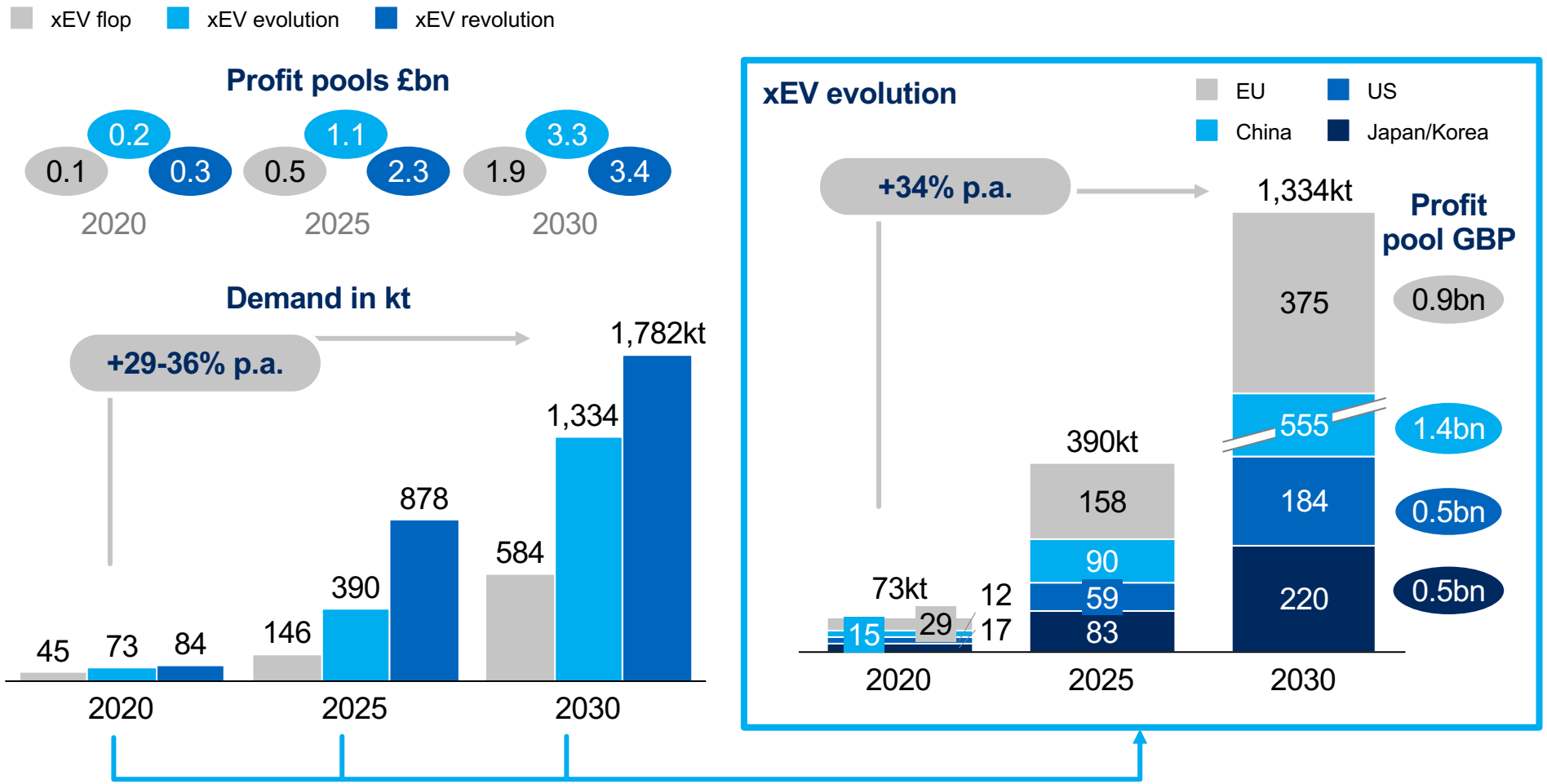
- xEVs have grown rapidly at 54% p.a. between 2011 and 2017
- Future xEV demand is driven **consumer pull** (cost economics) and **regulatory targets**
- xEVs are predicted to continue growing rapidly at 23% p.a. through to 2030
- xEV demand will total 19.7m xEVs worldwide in 2030
- **"xEV Evolution" case consistent with Clean Air business forecasts[2]**

1 Actuals 2011-17 and predictions from 2018-2030; PHEV and BEV only, does not include HEV or mild-HEV
2. xEV revolution (high case) a downside analysis of what this means for the Clean Air business estimates negative impact on the business of £42 million sales ex. PM and £6 million in operating profit in 2025

SOURCE: IHS (Nov 2017), Client Clean Air, McKinsey Auto 2030 modelling

Global profit pool for high-energy density cathode material will be between 1.9 to 3.4 bn GBP in 2030

High-energy-density cathode material market[1] Bar graph kt / ⬭ profit pool GBP bn



Key insights

- Significant uncertainty around market development, with global profit pools between 1.9 to 3.4bn by 2030 – China and Europe most important
- High energy density cathode materials likely found on larger, premium vehicle classes (e.g. Mercedes E-Class, Land Rover Range Rover, VW Touareg, Lexus GS)
- **Regardless of market assumptions large market opportunity for Client**

1 High-energy-density cathodes defined as materials including NMC811, NMC9xx, improved NCA

SOURCE: Client Clean Air, McKinsey Auto 2030 modelling

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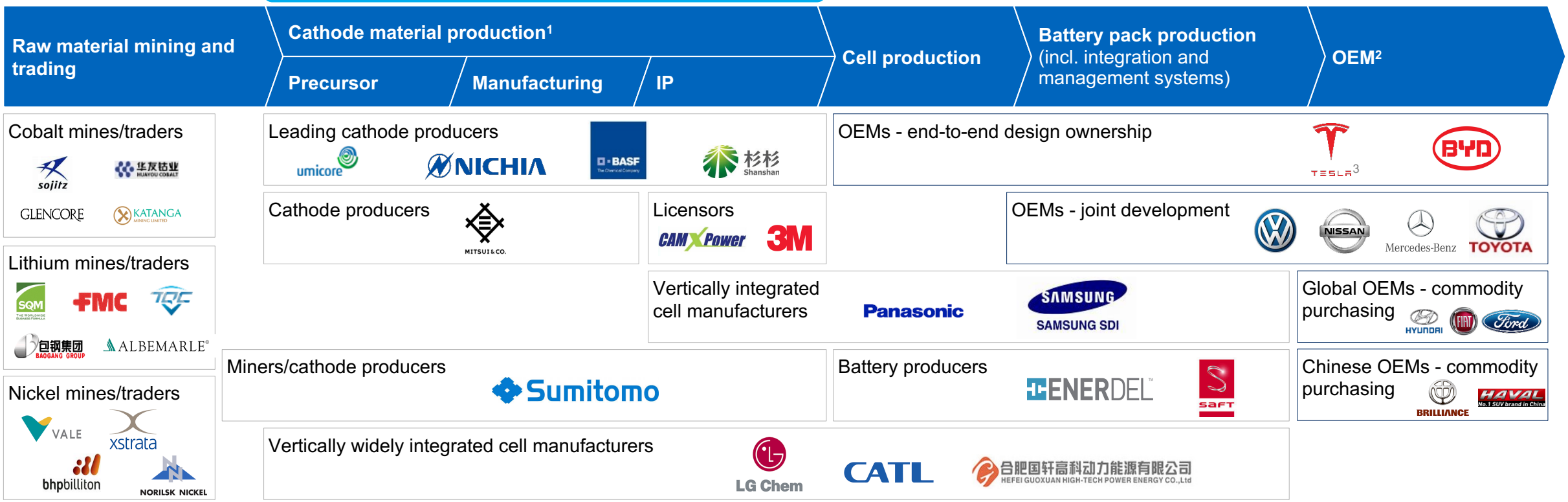
Due to the early nature of the industry, no stable industry value chain model has yet been established

Mostly multiple supplier relationships with cathode material producers and cell makers – exclusive partnerships not typical

Battery manufacturers and cathode materials producers usually not fully integrated along value chain

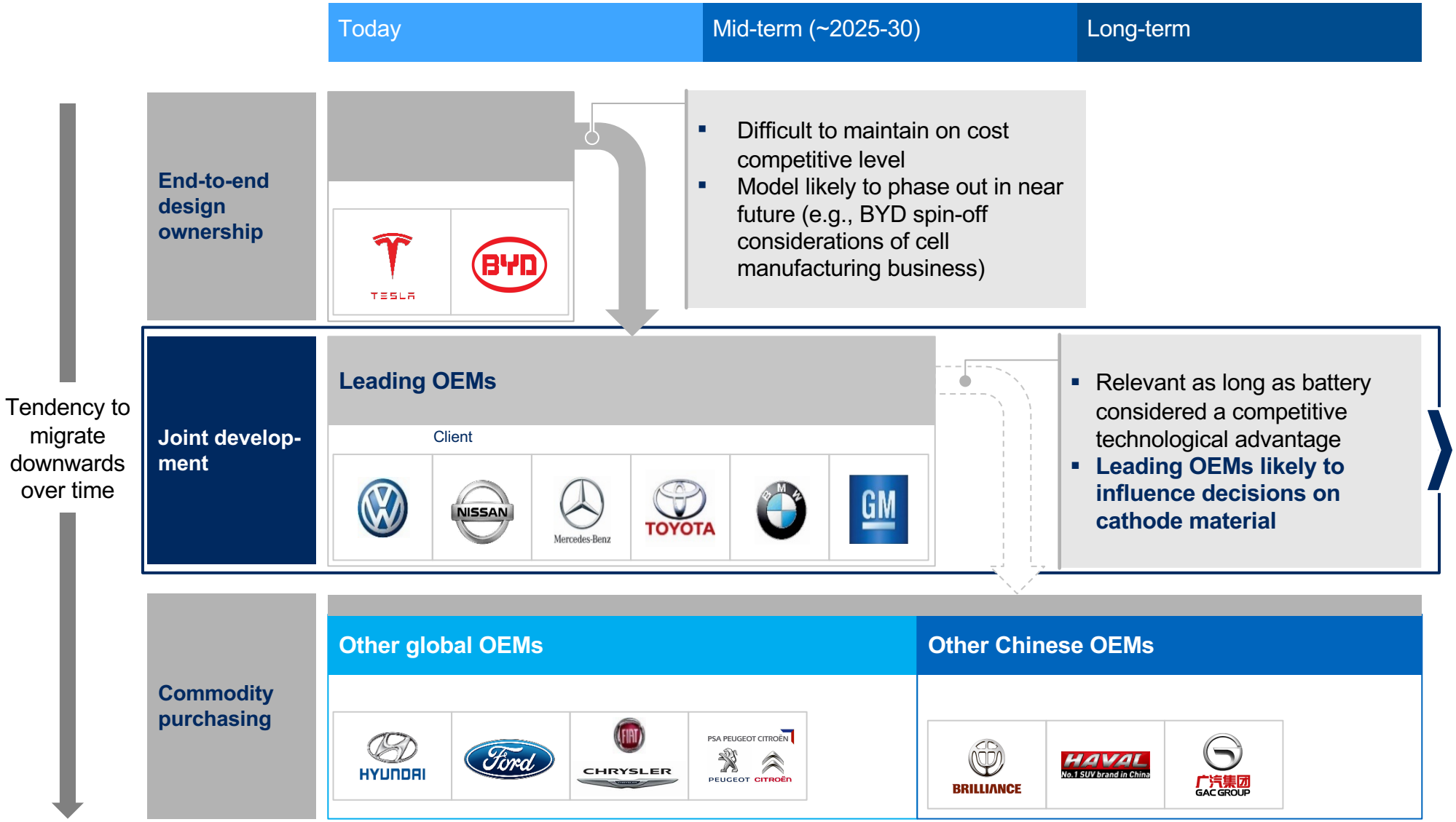
Different value chain strategy models followed by OEMs – most OEMs have built up strong relationship with 1-3 major battery suppliers



1 Simplified version of the value chain; multiple entry points for cathode material manufacturing exist e.g. dissolving of metals (Li, Ni, Co), processing of sulphates, or processing of finished precursor 2 Assuming "own-and-operate" model of batteries 3 Panasonic produces cells and packs for Tesla in Gigafactory

SOURCE: Market research; expert interviews

A group of OEMs will seek to cover key control points as long as battery technology remains a source of competitive advantage



Implications for Client

Most favourable model for Client – likely less margin pressure (similar to catalyst business model)

Client to target "Leading OEMs" that are likely to influence decisions on cathode materials and to **establish as a technological partner** for the long-term

SOURCE: Expert interviews

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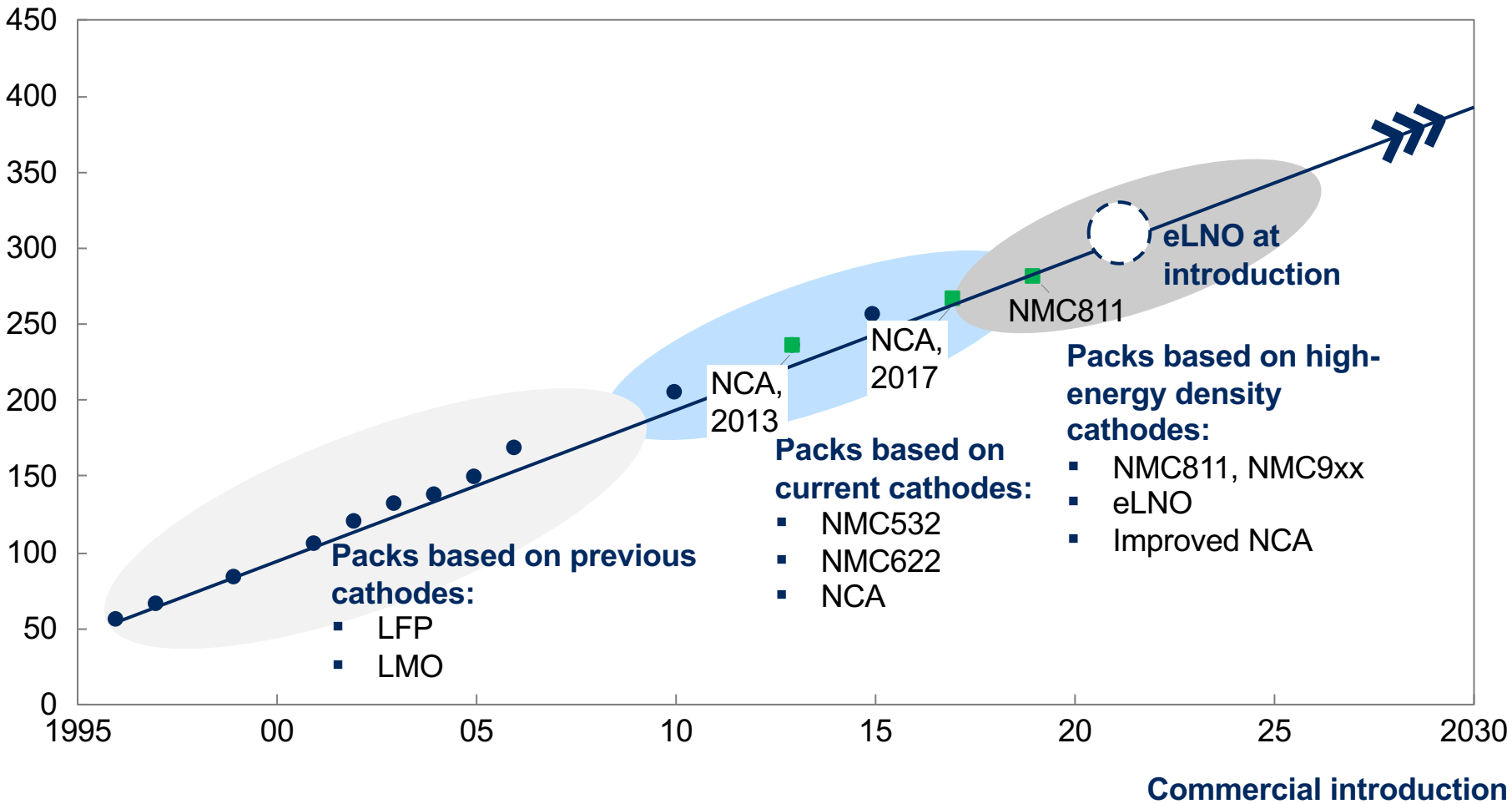
eLNO with a strong value proposition; need for continuous R&D investment to maintain competitiveness

Energy density
Pack level, Wh/kg



Key insights

- eLNO is a **first entry** into high-energy-density cathode market
- Initial analysis shows eLNO **is 2-5 years "ahead"** of NCA on energy density
- However, energy densities at pack level have increased roughly by 10 Wh/kg per year
- Client requires **continuous development** into energy-density technologies to **remain competitive** beyond first generation of eLNO

SOURCE: Blue dots - Bernstein estimates and analysis assuming 3 year go to market timeline;
Green squares – Credit Suisse Analysis on Tesla car batteries with different cathode materials

eLNO derives its competitive advantage from 4 sources

Precursor

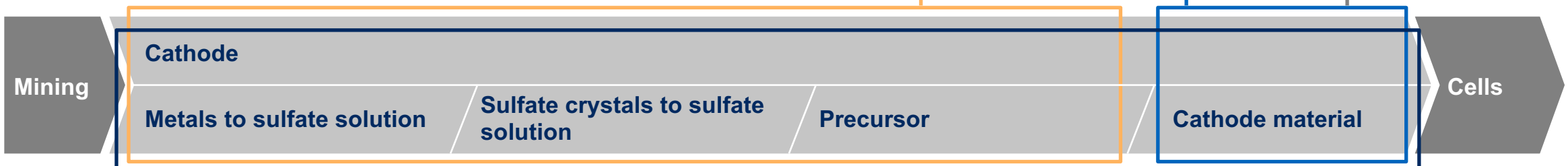
- Process of making the precursor enables
  - High particle density
  - Elemental composition control
  - Homogeneity of particle size
  - Morphology of particles
  - Crystal structure
  - Impurity control
- All of the above directly **impacts the capacity and cyclability** of the final cathode material manufactured
- Producing this in-house would allow customisation of final product to customer demands
- Future IP could be developed in this area

Coating

- Coating **increases the cyclability and safety** of high nickel cathodes when used with current electrolyte technology
- Uncoated eLNO is unlikely to fulfil cyclability and safety standards of customers in commercial batteries without a separate strategy, e.g. blending

Composition

Background IP licensed from CAMX



Manufacturing Process

- Tight process control is crucial to **maximise capacity and cyclability** of nickel rich materials
- The process of coating is especially sensitive to strict process control. Deviations can negate much of the benefits of coating

SOURCE: Source

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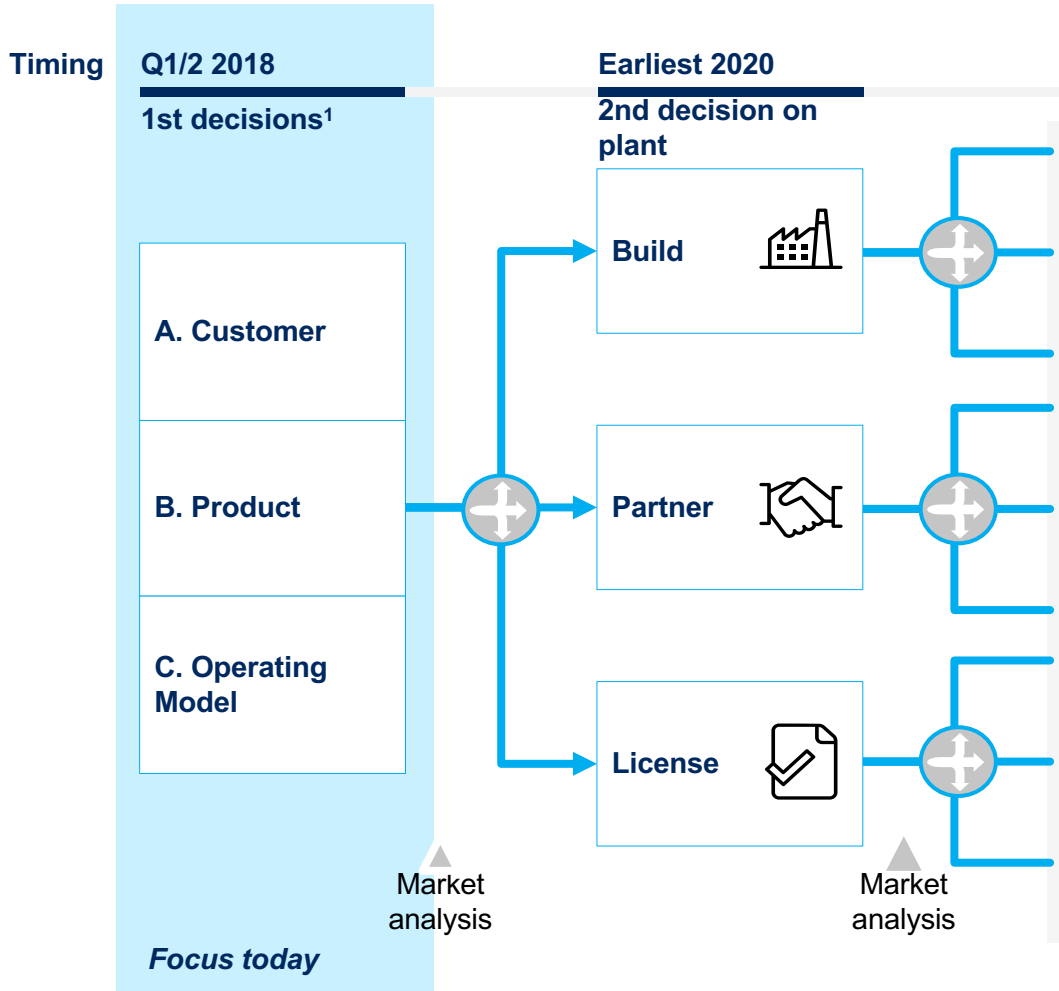
The strategic investment into a flexible manufacturing plant today gives Client maximum optionality in currently uncertain market



Sample end states in 2030	Size potential in "xEV evolution" scenario: Value pool[2]	Size potential in "xEV evolution" scenario: Capex[4]
Leading manufacturer of cathode electrodes for OEMs globally	~£660m+[3]	~£2.4bn
Partnership with major cell manufacturer to manufacture cathode material from metals	~£330m	~£1.2bn
Leading manufacturer of cathode active materials for European OEMs Successful licensor in Asia	~£260m	~£0.8bn
Large scale licensor of eLNO Technical development relationship with cell manufacturers to continue R&D in 1st plant	~£110m	~£250m

1 1st decision must also include decision on application centres and demo plant from extending down the value chain to produce slurry formulations and cathode electrodes (10kt), continued R&D cost estimated at £4m/year from 2018-2030

2 Assuming Client captures 20% of the high energy density market

3 Value pool based on cathode powder market, additional value expected

4 Capex for manufacturing is £200m for 1st plant (10 kt), all further capacity expansion at a capex of £8.8m/kt; Capex for licensing is £200m for 1st plant

We are proposing a set of key decisions for Client's market entry strategy of eLNO today

	Key decisions	
A Customer	▪ **Target leading OEMs who will likely influence cathode material selection**	▪ Close partnerships with leading **automotive OEMs that:** – Have substantial **high-energy-density cathode demand** – Will **influence the decision** on cathode material – **Specify** our product to cell manufacturers ("pull through")
	▪ **Cultivate cell manufacturer relationships in parallel to working with OEMs**	▪ Work with **cell manufacturers** to **establish relationships** and find opportunities to accelerate 22/23 time-frame sales
B Product	▪ **Manufacture cathode active material from metals (includes precursor manuf.)**	▪ **Buy in metals** to manufacture precursor ▪ Mid-term option to **develop downstream** into electrode formation ▪ **No immediate synergies and value add** by investing into non-cathode battery components
C Operating model	▪ **Invest in 10kt first plant** *Preparation of decision for July 2018*	▪ **Show commitment** through own investments ▪ **Prove performance** of our product in OEM and cell manufacturer applications ▪ **Ensure ability to manufacture at scale** cost competitively
	▪ **Build demo plant and set up application centres close to customers**	▪ **Sufficient demo capacity** for customer sampling and qualification needed ▪ **Application centres crucial** in order to customize product to pass customer validation

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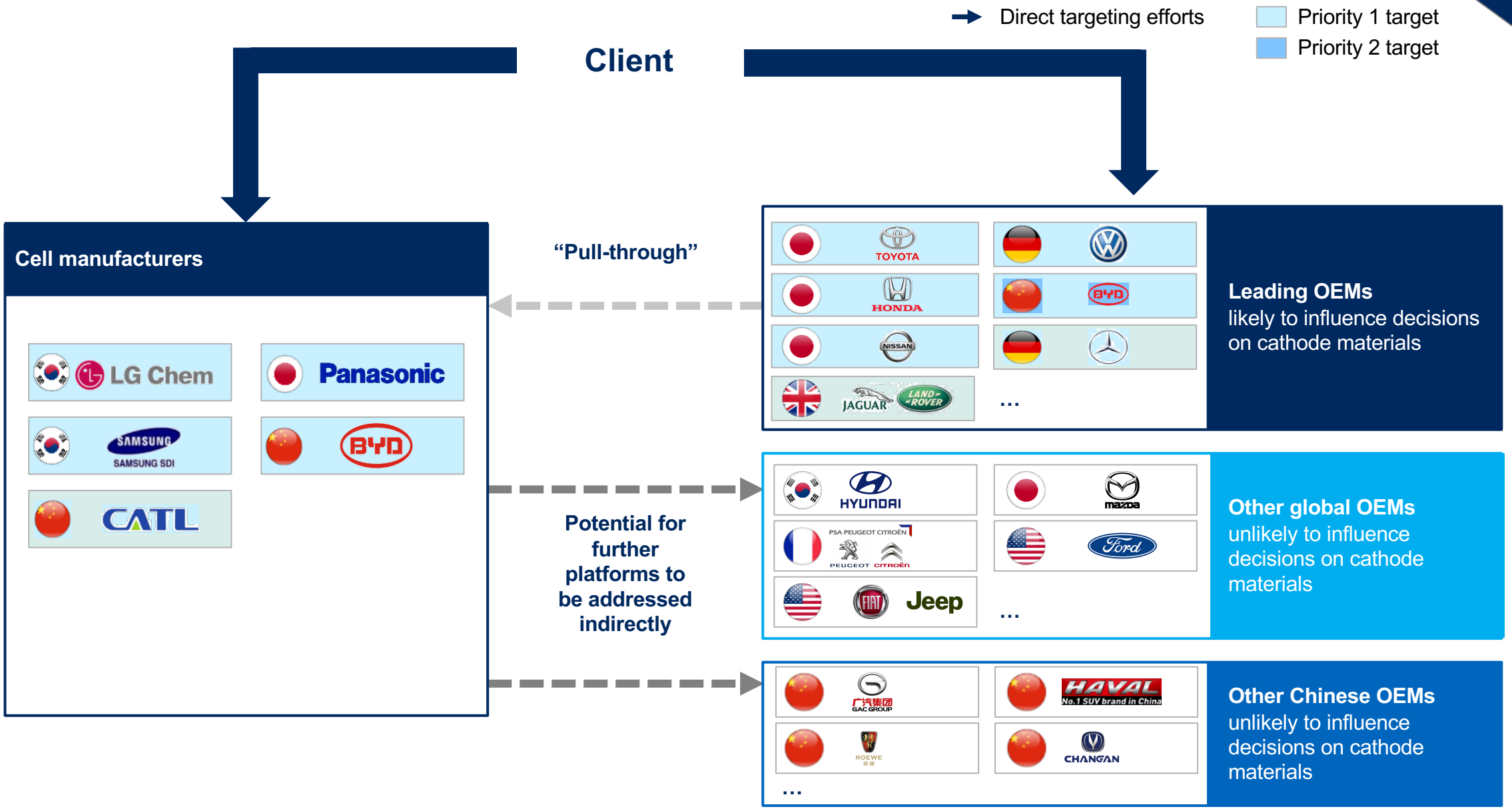
Client will directly target both leading OEMs and top cell manufacturers



Top OEMs account for a significant share of expected high-energy-density cathode demand

BEV ONLY
EUROPE, CHINA, JAPAN/KOREA
High
Low

OEM	2022 BEV share, %	2022 BEV models, #[1]	2022 Estimated high-energy-density cathode demand, kt	2025 BEV share, %	2025 BEV models, #[1]	2025 Estimated high-energy-density cathode demand, kt	Quality of Client relationship
Nissan, Infiniti [2]	10%	12	14	17%	17	38	
Volkswagen, Škoda, Seat [2]	7%	12	13	10%	16	34	
Mercedes-Benz, smart [2]	7%	12	9	16%	18	27	
Audi [2]	8%	7	8	12%	14	18	
Toyota [2]	3%	4	6	5%	6	13	
Honda [2]	5%	5	5	9%	5	13	
Jaguar, Land Rover [2]	5%	4	5	7%	7	10	
BMW, Mini [2]	3%	6	4	16%	13	20	
Porsche	11%	2	3	35%	7	10	
BYD	26%	10	1	36%	10	3[4]	

Key insights

- OEMs expected to influence cathode material decision largely **European and Japanese OEMs** (incl. their Chinese JVs)
- OEMs with strong manufacturing footprint in **China have lower share of high-energy-density cathodes** due to favouring low-nickel cathodes
- VW group has **central decision** making for testing new materials; group VW, Audi, Porsche, Skoda, Seat together

Note: Cathode demand is calculated using input from market model, incl. different energy density and cathode splits per year and per region

1 Incl. all models introduced between now and 2022/2025 2 Incl. output from their JVs in China 3 Only BMW North America 4 BYD figures believed to be higher based on Client local team intelligence but not changed in the model

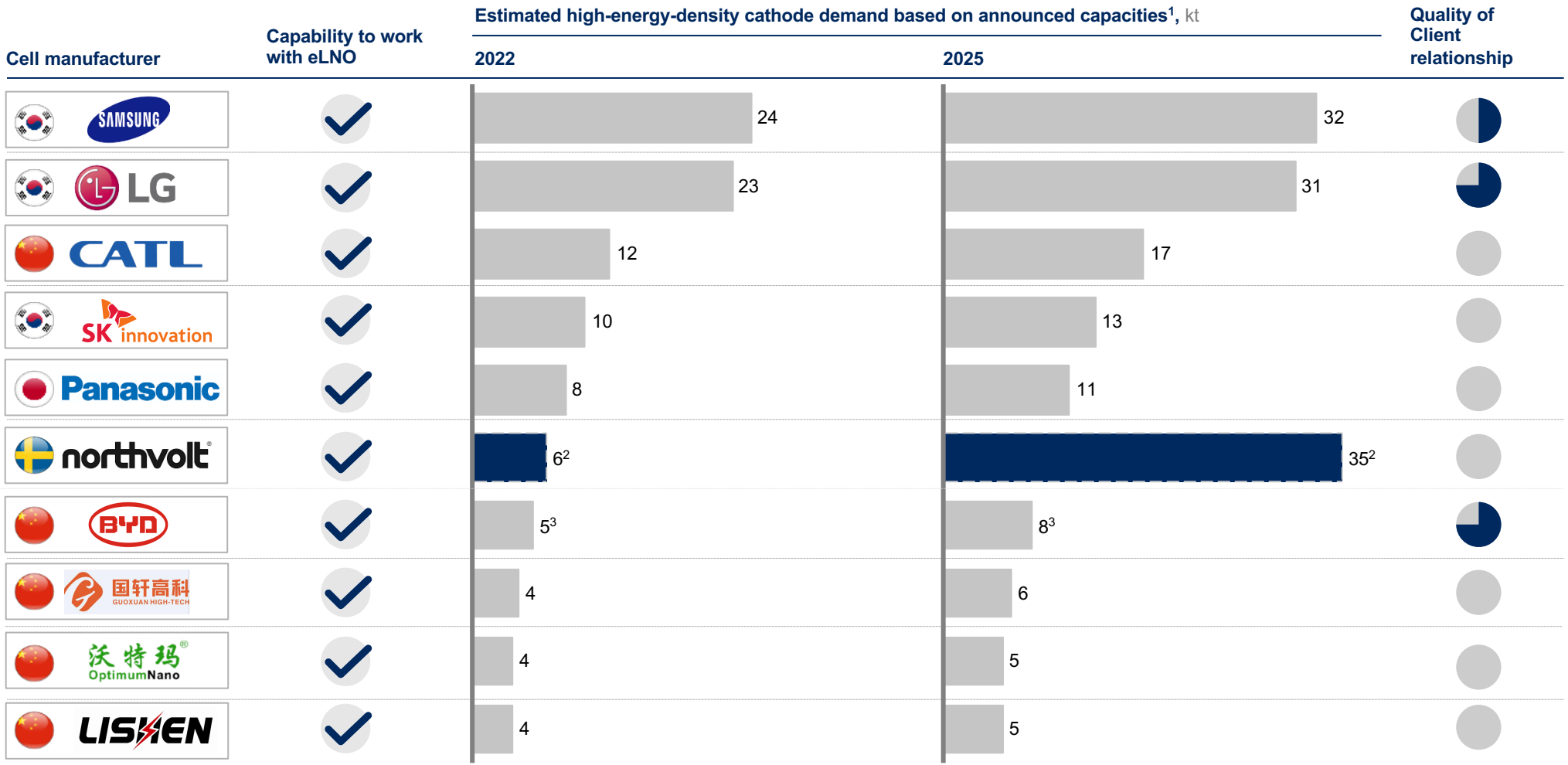
SOURCE: IHS; market models; expert interviews

A small set of cell manufacturers will dominate future cathode production

BEV ONLY

EUROPE, CHINA, JAPAN/KOREA

High
Low



1. Cathode demand is calculated using input from the market model built for Client, incl. different energy density and cathode splits per year and per region
2. Veracity of Northvolt's large capactiy announcements are to be viewed skeptically until actual market entry
3. BYD battery capacity differs to OEM BEV volumes based on announced capacity

SOURCE: IHS; market models; expert interviews

Key insights

- Most high-energy-density cathode demand expected from **Asia cell manufacturers** incl. current leaders (Samsung, LG Chem, CATL, SK Innovation, Panasonic)
- Asia cell manufacturers are expanding their **manufacturing footprint in Europe** (e.g., LG Chem, Samsung)
- Cell makers with strong manufacturing footprint in China have lower share of high-energy-density cathodes due to favouring low-nickel cathodes

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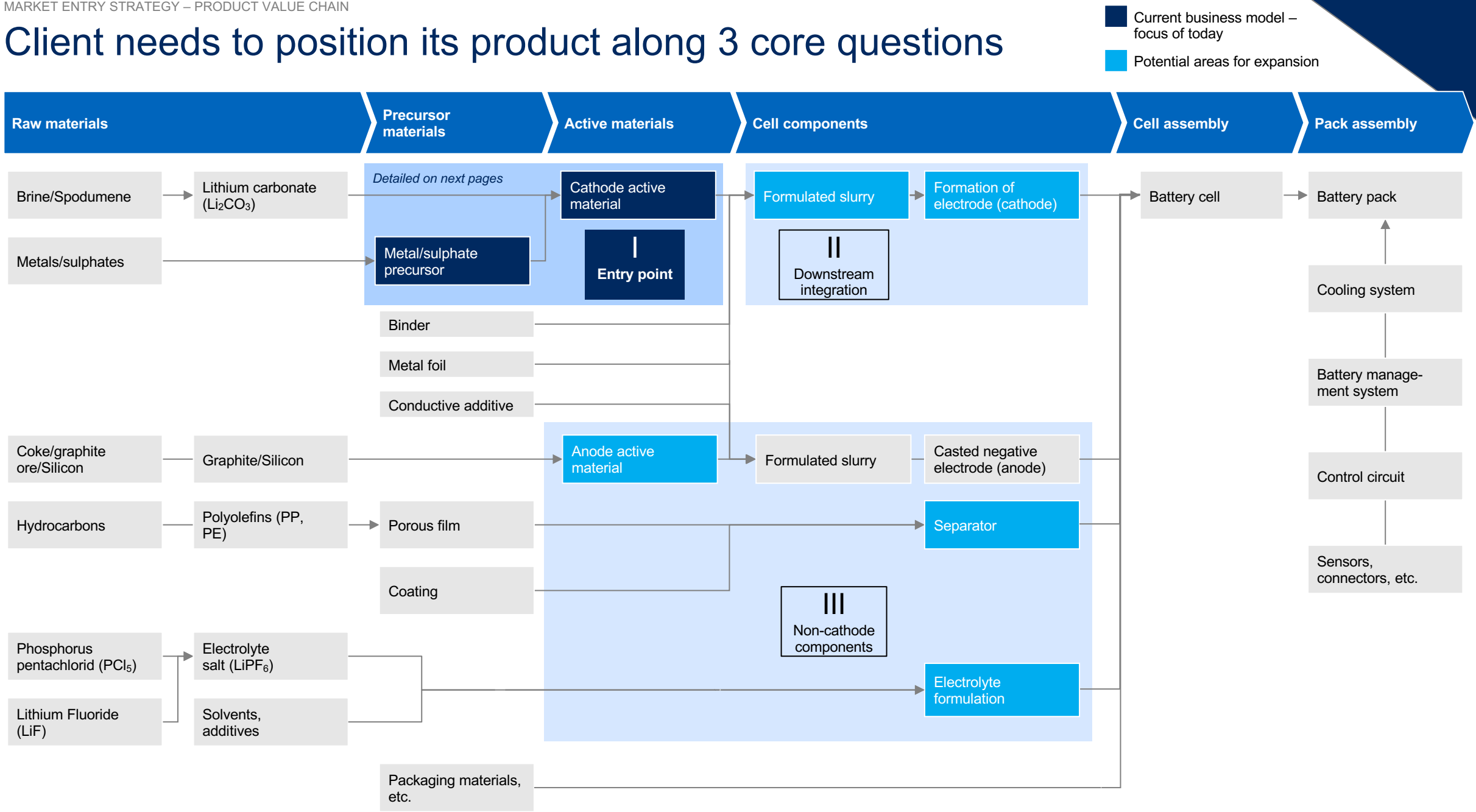
Client needs to position its product along 3 core questions



SOURCE: Expert interviews

To control major competitive differentiation of eLNO, Client should own the process from metals to cathode active material

Business model options

1 2 3

	1 Metals to Cathode material	2 Sulphate Crystals to Cathode material	3 Cathode material (Brunp precursor)
1st plant financials			
Operating Margin	8%	6%	5%
Required investment[1] GBP mn	~200	~192	~140
ROIC	9%	7%	8%
Rationale	▪ In-house production **allows customisation** to customer demands ▪ **Future IP** could be developed in this area ▪ **Metal supply** expected to be more **stable** as large quantity produced for a range of industries	▪ Producing in-house would **allow customisation** of final product to customer demands ▪ **Future IP** could be developed in this area ▪ **Sulphate supply stability** expected to be **poorer than metals**	▪ Buying precursor **allow neither customisation nor development of future IP** ▪ Quality **precursor produced by few suppliers** ▪ Currently **single-source supplier** (Brunp is owned 69% by CATL)
	RECOMMENDATION		

Key insights

- **Controlling performance and quality** of eLNO relies on in-house manufacture of precursor (from metals or sulphates)2
- **Security of supply and quality control** higher with metals over sulphate crystals
- **Added benefits** of starting from metals include:
  - Mitigation against potential restricting regulations on Cobalt sulphates
  - Flexibility on customer metal sourcing
  - **Increased optionality** of future business models (manufacturing, tolling, or licensing)

1 Based on exchange rate of 1.25 used in CMD, Client business modelled numbers. Numbers are +/-30%
2. Enables control over morphology, elemental composition and impurity control)

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Decisions on the operating model expand along 3 dimensions

Recommendation

		Options				Rationale	For decision today
I	**Operating model for market entry**	**Manufacturing**	Licensing	Tolling		▪ Manufacturing 10kt offers the only option to enter the market now	✓
II	**First plant location** *(incl. related decisions on demo plant and application centres)*	**Europe**	China	South Korea	Other locations	▪ Europe recommended location ▪ Demo capacity to serve 5 customers needed ▪ Application centres in both Europe (UK) and Japan required to serve target customers effectively	✓
III	**Operating model for scale-up** *(to achieve 20% of high-energy-density cathode market)*	Large scale manufacturing	Licensing process	Other operating models or combination		▪ *Outlook – decision on expansion needed earliest 2020* ▪ *Decision Framework needed - what actions are required in next 2 yrs to be ready to take decision in 2020*	

1 Client should enter the cathode market with eLNO now, building our own 10kta commercial scale manufacturing plant

Recommendation

What is the market entry operating model?[1]

Licensing and Tolling are not options

- Client IP not sufficiently developed to allow licensing
- Constrained by current CAMX licenses
- Relevant CAMX patents expire in 2022
- No potential tolling partners exist

Client owned Manufacturing

- Provides Client with an asset to prove technology, travel learning curve, and create IP
- Provides optionality for future growth through scaled manufacturing, partnerships, or licensing

How big is the first commercial scale plant?[1]

10kta

- Meets minimum capacity to qualify for battery cell manufacturers (8kta)
- Proves technology at production scale but with flexibility to adapt asset for alternative materials or adopt alternative business model
- Though financial economics (ROIC) below target Client levels, asset needed to prove the technology

30kta

- Higher technology risk at 30kta
- Even with 30kta, unproven process means achieving full economies of scale in first application unlikely
- Higher risk of stranded or inflexible assets

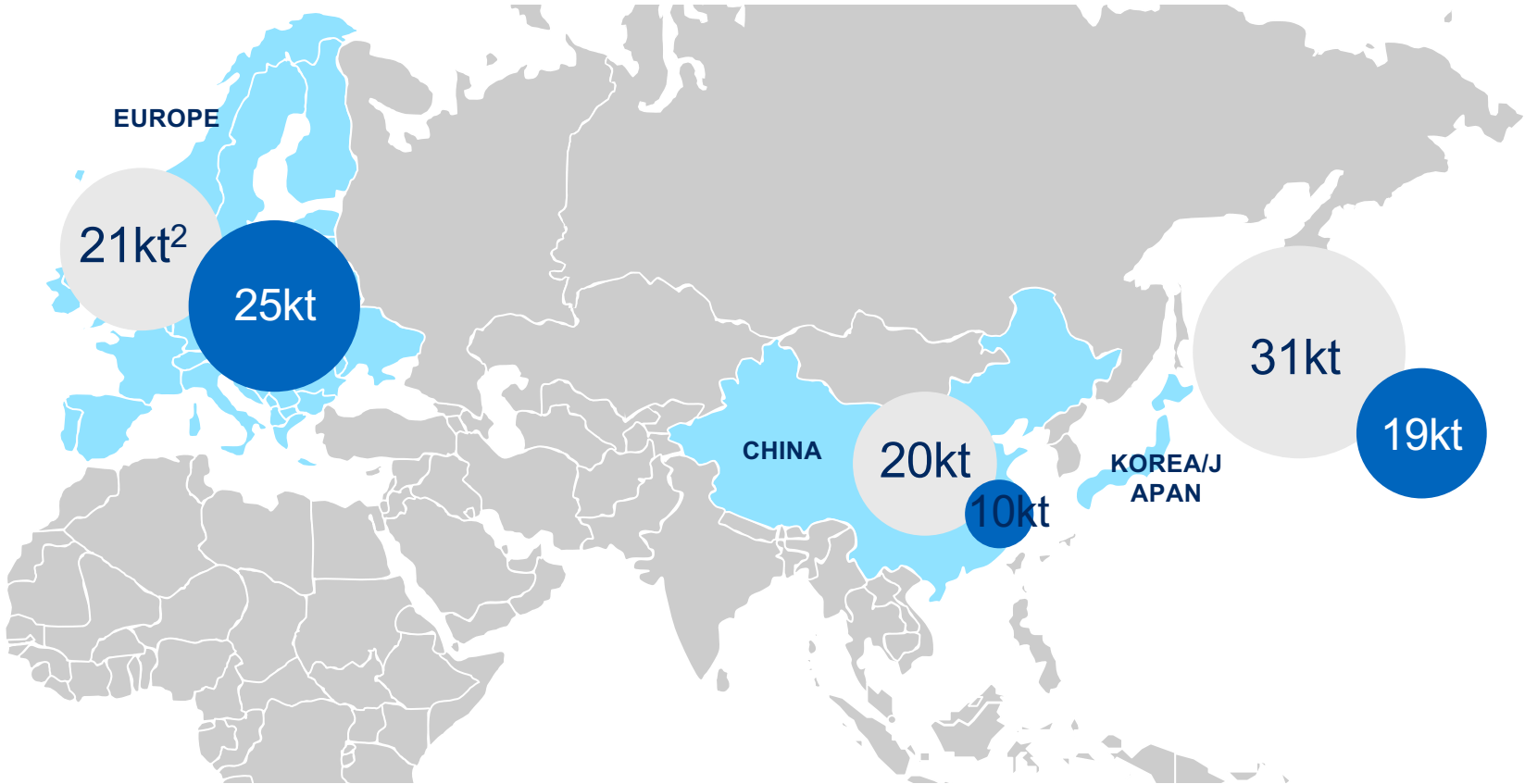
Key insights

- Only viable option to enter the market is by **building own manufacturing asset**
- Asset must be designed to **prove eLNO technology from metals to cathode material**:
  - at the minimum volume levels required by customers
  - in a robust yet flexible way, providing options for future development
  - with appropriate level of risk
- **30kta build considered** but not recommended:
  - Increases technology risk without achieving sufficient economy of scale benefits
  - Has downside risk of inflexible assets and reduced optionality to license or toll

1 Pros/Cons of each options captured in back-up

2 In 2022, significant demand for high-energy density cathodes from target OEMs and cell manufacturers will come from EU

Estimated demand for high-energy-density cathode material from prioritised targets, kt, 20221



Key insights

- Largest demand from **selected OEMs** in 2022 in Europe
- Demand from **selected cell manufacturers** in all regions, which would allow Client to access additional platforms through them
- By 2025, majority of **cell manufacturer demand in Europe** as well[3]

1 Remaining demand from non-targeted OEMs is 21kt in Europe (total 48kt), 22kt in China (total 32kt), and 12kt in Japan/Korea (total 31kt); remaining demand from non-targeted cell manufacturers is 8kt in Europe (total 45kt incl. 10kt under capacities), 19kt in China (total 36kt incl. 4kt overcapacities), and 8kt in Japan/Korea (total 34kt inc. 5kt overcapacities); regional demand based on BEVs produced, incl. production from OEMs headquartered outside respective regions

2 Does not include Northvolt announced capacity

SOURCE: IHS; Client market model

2 There are 3 location options for the first plant – current recommendation: Europe

Best
Mid
Worse
Knock out
Recommendation

		Europe	China	South Korea
Speed with which Client can build first plant		Mid	Best	Knock out
Established Client ecosystem		Best	Best	Knock out
Target priority OEM volume in region in 2022, kt		25	10	19[3]
Target priority cell manufacturer volume in region in 2022, kt		21[2]	20	31[2]
Investment required GBP million		200	~175[1]	n/a
Trade barriers	Corporate tax rate	19%	25%	22%
	Tariffs (Export of eLNO)	Best	Mid	Best
	Regulatory environment	Best	Mid	Mid
People capability and know-how		Best	Mid	Best
Risk Assessment	Incentive landscape	Best	Mid	Best
	IP risk	Best	Worse	Best

Key insights

- Speed-to-market and missing Client business ecosystem removes South Korea from consideration
- Regional volume from target customers in 2022 not key deciding factor – significant and near equivalent regional demand with ability to transport materials[3]
- China 6 months faster, but delay concerns exist based on recent experience and changing regulatory requirements
- Assuming near equivalent timelines, Europe is more attractive:
  - Closer to development and engineering teams in UK
  - Higher IP protection
  - More stable incentive landscape
  - Strong trade relationships, including with S. Korea
  - Greater expertise within Client to build/operate in Europe
- Site selection within Europe is underway, currently working with E&Y for detailed site assessment

1 Based on same standard / source of equipment, Chinese build ~12.5% cheaper 2. Based on announcement capacities for target customers 3. Assume volume indicated under S.Korea (19 kt OEM / 31kt Cell makers) is addressable from both Chinese and EU facilities; higher cell demand in Asia but limited restrictions on movement of materials in region and good trade agreement between Europe and S.Korea

2 At 500tpa demo plant capacity, there is an expected bottleneck on short-term customer sampling bandwidth

	Pilot Plant	Demo Plant[1]	Production Plant
Average capacity	10 tpa Sept18 (Wet ~Jan 2019)	500 tpa mid 2019 (wet early 2020)	10 kta mid/late 2021
Sample size	A sample: ~1 t/platform	B sample: ~200 t/platform	C sample: ~300 t/platform (Production)
Sampling bandwidth	Pilot plant covers samples for target customers	Bottleneck for sampling between 2019 and 2021	Can support an 8kt platform win as well as C sample qualification
Max customer	8-10	2	4+X

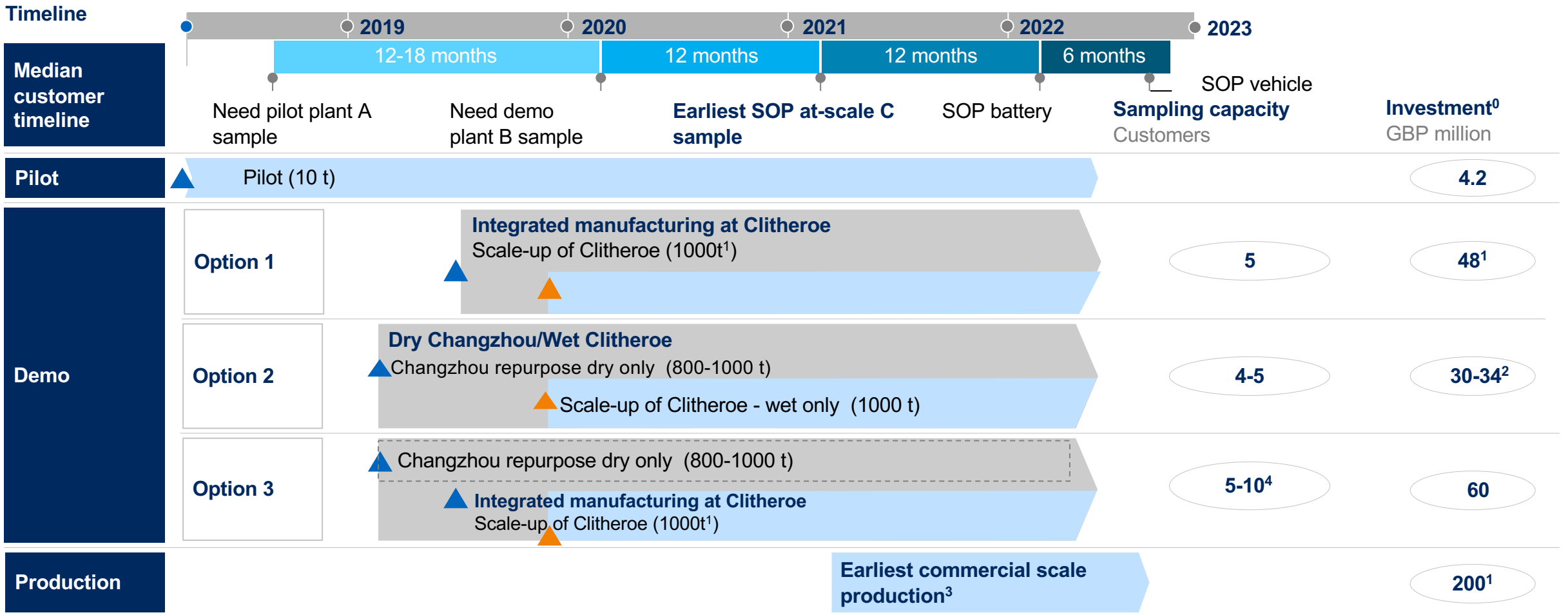
1 Based on discussions to date Clitheroe plant – further expansion possible throught scale up of Clitheroe, repurpose of Changzhou asset in China

SOURCE: Based on major cell manufacturer sampling volumes and timeline intelligence (see back up)

2 3 options available to increase demonstration capacity to minimum 1000tpa, enabling sampling of 5-10 customers

ALL DATES ESTIMATES

Dry SOP
Wet[6] SOP



0. All investments are +/-30%
1 Scaling up Clitheroe to 1000t (500t was £25m dry, £8m wet; +500t = +£15m)
2. Repurpose Changzhou dry is £10-12M, Wet capacity build Clitheroe 1000t level £22m (potential to reduce by £1-3m)
3. Based on mid-2022 production run, earliest need would be Q1 2021, this is not the Client plant SOP timeline 4. Additional customers would require use of purchased precursor as wet capacity limited to 1000t

2 We recommend to build an integrated demonstration plant in Clitheroe and repurpose Changzhou

Attractiveness
- Best
- Mid
- Worse
- Recommendation

Influence of option on	1 Integrated Clitheroe plant	2 Repurpose Changzhou LFP plant	3 Integrated Clitheroe & repurpose Changzhou
Time to market	▪ **6 months slower** to SOP[2]	▪ **6 months faster** on dry[2, 3]	▪ **5 months faster** on dry[2, 3] ▪ **Greater capacity:** up to 10 customers
Technical scale-up	▪ **De-risks** scale up best ▪ Best position for faster next generation **product development cycles** (proximity to pilot & process development teams)	▪ **Higher risk** (unproven tech transfer across continents)	▪ **De-risks** scale up best ▪ Best position for future **product development** ▪ Development of **future product potential in China**
Long term	▪ **Full scalability** of learnings to future investments ▪ Easier to service **EMEA** ▪ More efficient **supply chain**	▪ **Chinese footprint maintained** ▪ Easier to service **Asia**	▪ **Full scalability learnings** ▪ **China** footprint maintained ▪ **Flexibility** to service **multi-regions**
Investment costs	**£48m**[4] ▪ Plus pot. Changzhou **write-off**[1]	**£30-34m** ▪ No Changzhou **write-off**[1]	**£60m** ▪ No Changzhou **write-off**[1]
			RECOMMENDATION

Rationale

- **Integrated Clitheroe plant** is the best option to de-risk eLNO and build an innovation engine – key success criteria for eLNO success
- **Changzhou repurpose** maintains Chinese footprint, accelerates time to market and creates a viable option for the former LFP plant
- Option 3 to **combine innovation engine with China** ambition

1 Worst case is estimated at (£20M) incl. all closure costs, potential to sell asset 2 Wet plant beneficial operation the same in all cases and lags dry plant for all cases.
3. A faster 'dry' build would need to be initially fed with 3rd party precursor. Retrofit timeline for RHKs subject to further technical engagement with the vendor; potentially substantial lead time impact for services and replacement parts due to uplift in demand from industry; 4 All estimates ±30% 5. Dry capacity in Changzhou will required precursor from 3rd party; financial impact with 17% import duty on Chinese precursor if eLNO product through demo long term however options exist to product other NMC materials

2 To serve target customers in different regions, we recommend building 2 regional applications centers immediately

QC Quality control
AT Application testing
PD Local product development
PS Process scale-up capabilities
Immediate Priority

	Recommended setup		Time to build[1]	Required investment	Number people	Target customers served
1	**Europe, UK** (Chilton/Sonning) (Hub)	QC PD AT PS Chilton already in place	9-12	12	22 *(10 Chilton, 12 Sonning)*	▪ **Volkswagen** ▪ Daimler ▪ JLR
2	**Japan[2]** (Hub)	QC AT	9-12	10	15	▪ **Nissan** ▪ **Toyota** ▪ **Honda** ▪ **BYD** ▪ **LG Chem** ▪ **Samsung** ▪ **Panasonic** ▪ CATL
	China/ Korea[3]	QC	6-9	2-5	tbd	
	China/ Korea[3]	QC	6-9	2-5	tbd	
				£26-32 mn		

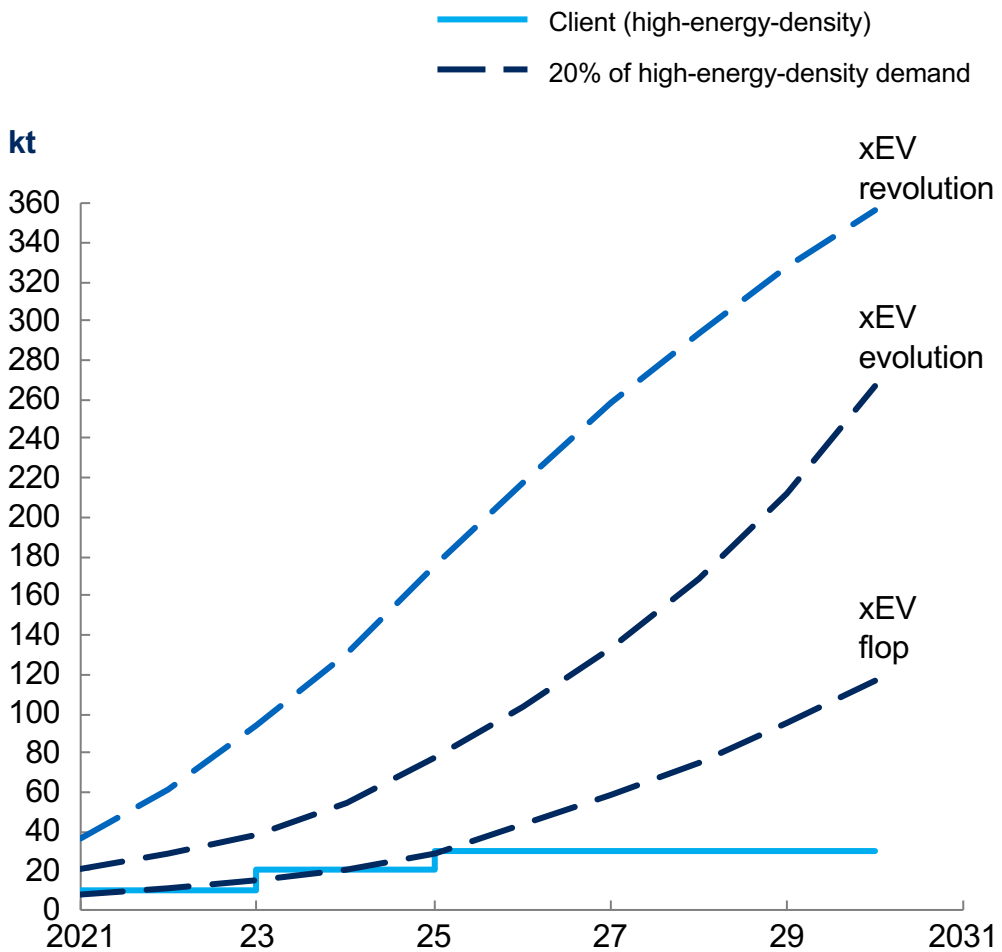
Key insights

- Application centres crucial for product customization, **necessary to pass customer validation**
- Quality control module located near target customers as minimum requirement for sampling process (in region)
- Modular setup allows for **lean capital investment**
- Recommend establishing **UK** and **Japan** centres immediately, capital request in April for UK.

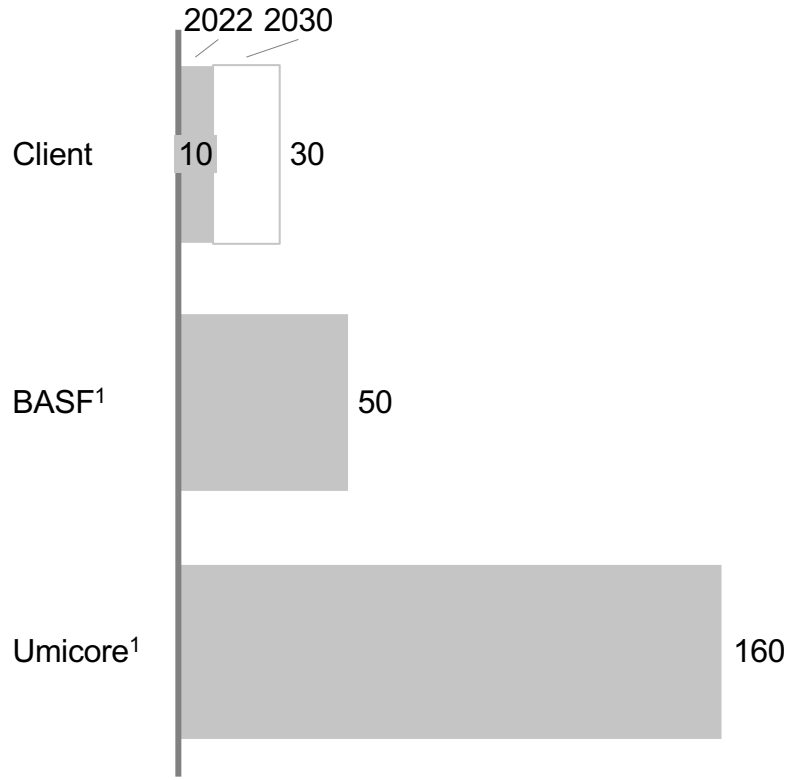
1 Based on existing Client asset. additional 6-12 months for a new site
2 Kitec considered but more likely to locate closer to OEMs west of Toyko
3 £2mn assumes QC excl. material characterization and setup in existing building. Potential to use existing site in China (Changzhou, Zhangjingang or Shanghai (CN)) no asset in Korea; Higher costs associated with new location 3

3 Client's current ramp up plan is behind its peers and well below capturing 20% of the high energy density cathode market

20% of demand and Client supply until 2030



Client and competitor cathode supply, kt



Key insights

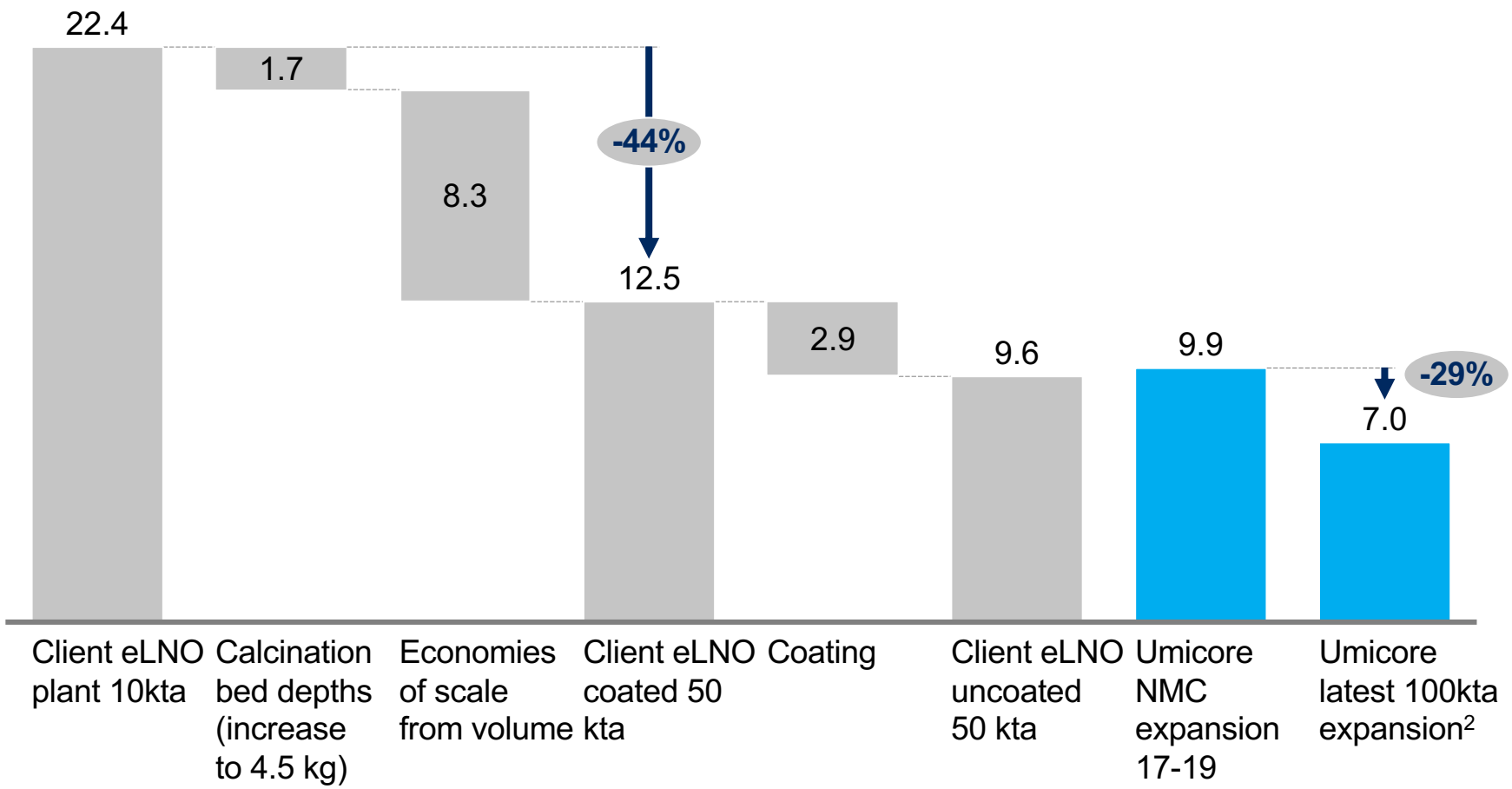
- To capture 20% of the high energy density cathode demand Client needs to ramp up to more than 3x the current scale planned in 2026
- The 30kta currently planned by Client leave it far behind its peers, Umicore with total cathode production of 160,000ta and BASF with total cathode production 50,000ta
- High-energy-density proportion of capacity undisclosed for both BASF and Umicore

1 High energy density (NMC811, 9xx and enhanced NCA) proportion of capacity undisclosed for both BASF and Umicore

Economies of scale could reduce Client's investment cost for each kiloton by 44%

Client
Umicore

Breakdown of proposed capital investment compared to benchmark, USD mn/kt



Key insights

- Cost competitiveness in the industry relies heavily on **economies of scale**
- Through major increase of plant capacity (50 kta) Client can **reduce its capital intensity by 44%**
- Outlook: next sets of decisions for Client will focus around **how to scale the business up effectively**

1 RHK: Roller Harth Kiln, a calcination furnace
2. Unclear from Umicore announcement what is included in expansion (full extent of cost included)

Board Meeting, April 4th – Executive summary

The market: regardless of the assumed market development scenario, high-energy-density cathode material provides a large market opportunity for Client

The value chain: the value chain is rapidly evolving and requires flexibility and adaptability – automotive OEMs represent an attractive target group besides cell manufacturers

The battery technology landscape: Client has developed a strong initial high-energy-density cathode material – given the threat of competition and potential breakthrough technologies, continuous development of portfolio required

The market entry strategy

Next steps: detailed implementation plan to be set up and regular review of strategy along defined signposts to be established

Major sign posts to be reviewed on regular basis to assess implications on major strategic decisions

Next major decision, framework detailed next

Reference points for detailed sign post assessment

	Sign post	Measure	2018	2019	2020	2021	2022	2023	2024	…
External	**Capital announcements** into high-energy-density cathode material	Manufacturing capacity for high-energy-density cathodes in kt[1]	29	48	69	98	133	176	257	
	xEV sales by region	xEVs sold in mn units[2]	3.4	4.6	5.8	7.0	8.1	9.5	12.4	
	Raw materials price development	Co ($/kg) Ni ($/kg)	82 12	82 12	82 12	82 12	82 12	82 12	82 12	
	Market intelligence on **technological advance-ments/breakthroughs**	Battery technology	Market development of NMC811, NMC9xx, eLNO, improved NCA							
							Market readiness of solid state, high-voltage mid-Ni, Mn-rich NMC, LMNO etc.			
Internal	**Product:** Validation of competitiveness of major product characteristics	Milestones 22/23 platforms	R&D panels + A sampling		B sampling		C sampling			
		25/26 platforms	Pre-sampling			R&D panels + A sampling		B sampling	C sampling	
	Process: Technical and economic viability of process improvements	Milestones	Sanction at +/-10% of capex	Demo plant at target cost and through-put[3]		First plant at target cost and through-put[3]		Achieving technical improvements leading to further cost reductions		
	Commercial success: Sampling progress, closed purchase orders	Milestones	Qualification sampling progress (map to "product" above) for targeted customers (OEM and BM) for each programme SOP, realised through POs							
					Decision on 2nd plant (est.)	Start of production first plant	Decision on scale-up going forward (est.)			

1 Global cathode demand for xEVs as a proxy for installed cathode manufacturing capacity 2 BEV, PHEV, HEV 3 Target = showing theoretically competitive process and cost structure when scaled further, also taking into account benchmarking against high-energy-density cathode expansions of competitors

Building the 2nd plant and further scale-up can be prepared even before 2020

Sample end states 2030	Signposts 2020[1]	
A. Leading manufacturer of cathode electrodes for OEMs globally	▪ **Client successfully advances through qualification process** and is on track to fill initial plant, with sufficient volume in pipeline for second plant ▪ **Priority OEMs** specify cathode material to their cell mnf ▪ **Chinese OEMs** adapt high-energy-density batteries quicker than base case ▪ Proof that **Client electrodes** can deliver superior performance and cost for customers compared to "only powder" and interest from OEMs to purchase electrodes / invest in joint development ▪ Client (or customers) can **secure sufficient raw materials** through long-term contracts or vertical integration	A B C D E
B. Partnership with major cell manufacturer manufacturing cathode material from metals	▪ **Client successfully advances with cell manufacturers** and is on track to fill initial plant, with sufficient volume in pipeline for second plant ▪ **OEMs** move to outsource batteries, are not influencing cathode decision actively and **cell manufacturers** become key player along value chain ▪ **No successful proof** for superior performance of "Client electrodes"	A C I J
C. Leading manufacturer of cathode powder for European OEMs Successful licensor in Asia	As with A, except: ▪ **Chinese OEMs** don't seek control of battery value chain or Chinese high-energy-density cathode market gets highly competitive ▪ **No successful proof** for superior performance of "Client electrodes"	A B C F H
D. Large scale licensor of eLNO Technical development relationship with cell manufacturers	▪ **xEV market remains tumultuous** and hence risky, with OEMs failing to achieve a clear growth path on xEV sales ▪ **Cathode manufacturing** becomes an oversaturated market, e.g., due to overcapacity, subsidized expansion of Chinese players or commoditization ▪ **Raw material supply** remains problematic, with customers and Client not able to secure reliable long-term supply	G

How to prepare pre 2020

- **A** Evaluate willingness for **significant capital investment** for scale-up (500+mGBP per plant)
- **B** **Pre-load pipeline** of future platforms; **consider additional OEMs** as target customers
- **C** Explore opportunities to **secure raw materials** at large-scale and for recycling
- **D** **Prove advantages of electrodes** at lab scale (in partnership with e.g., P&G)
- **E** Identify **potential sites** for manufacturing in China
- **F** Identify potential partners for manufacturing in China
- **G** **Build licencing packages**
- **H** **Prepare licencing packages**
- **I** Build strong relationship with **cell manufacturers** towards partnership
- **J** Identify and develop **potential sites** for co-location to cell manufacturer

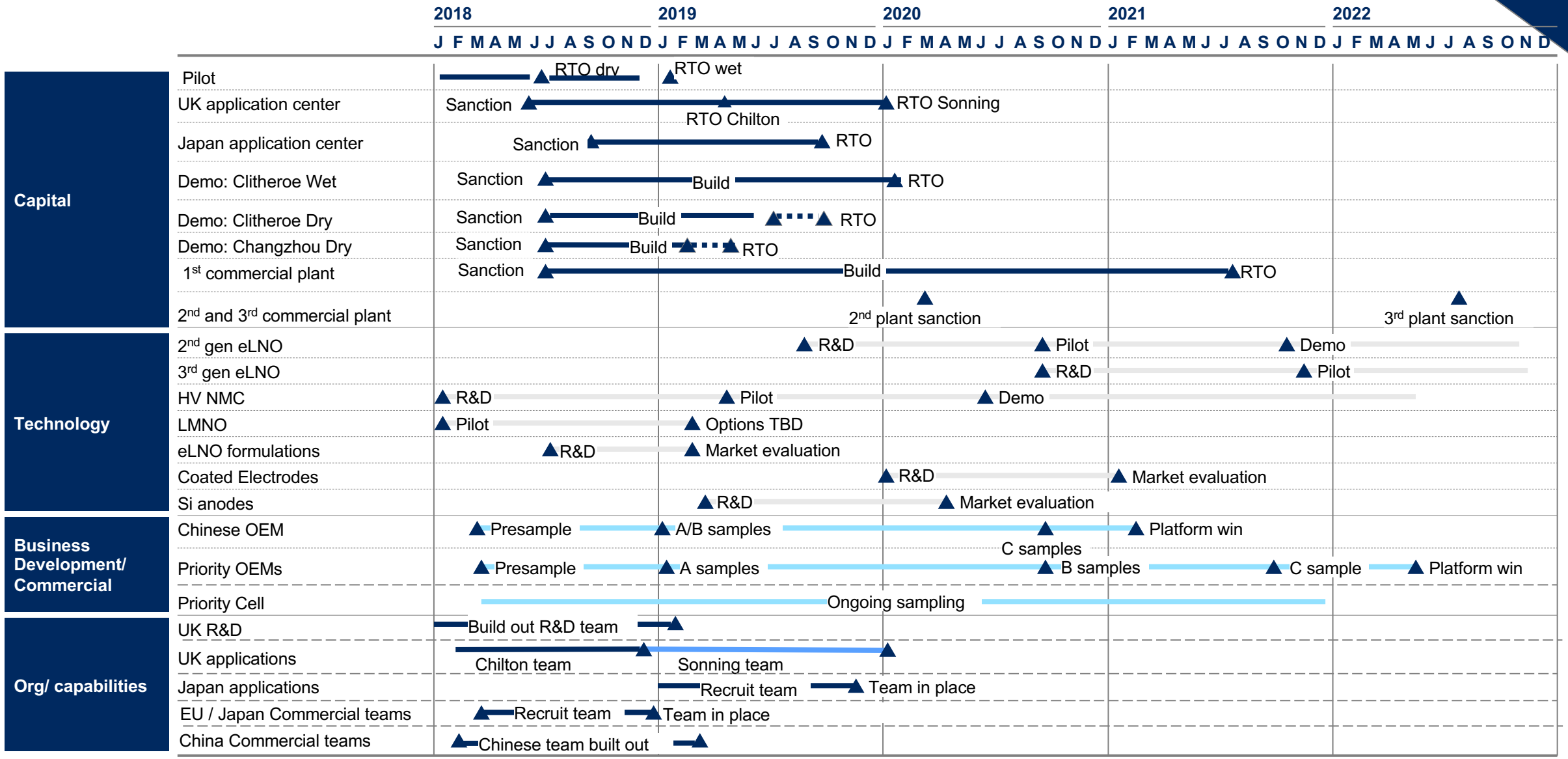
1 Assumes in all cases eLNO retains a competitive advantage -Based on customer aceptance of eLNO and other suppliers' announcements
2 Assumes all states require ongoing investment in R&D and application centres,

High-level implementation plan

Jul 18 | Dec 18

	Immediate next steps	Activities until end of 2018	Long-term activities
Targeting and geography	▪ Set up commercial team and prepare customer development plans ▪ Continue and intensify relationship with prioritized OEMs/ cell manufacturers	▪ Initiate official PPAP qualification with A samples for first potential customers	▪ Ensure continuously filled sampling pipeline
Operating model	▪ Finalise plan (particularly wet build) and set up pilot plant ▪ Finalise investment plan for commercial-scale plant, demo plant(s), and application centres	▪ Finalise detailed implementation plan and start setup of demo plant(s), and application centres ▪ Develop and integrate raw materials strategy	▪ Finalise detailed implementation plan and start setup of commercial-scale plant
Value chain	▪ Continue R&D process around precursor production	▪ Finalize stable process to manufacture high-quality precursor ▪ Continue ongoing discussions around cathode formulation and formation with PPG	▪ Develop detailed view including financials on downstream integration and non-cathode components
Overarching	▪ Further break-down of high-level implementation plan, incl. responsibilities, exact timings and deliverables per action item	▪ Define target setting process incl. incentivization mechanisms ▪ Set up reporting and review logic towards division and group executive reviews	▪ Review battery materials strategy on an ongoing basis based on internal and external sign posts

We are developing an execution and implementation outline[1]



1 Detailed implementation plan and program management office to be established in coming weeks

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The market entry strategy

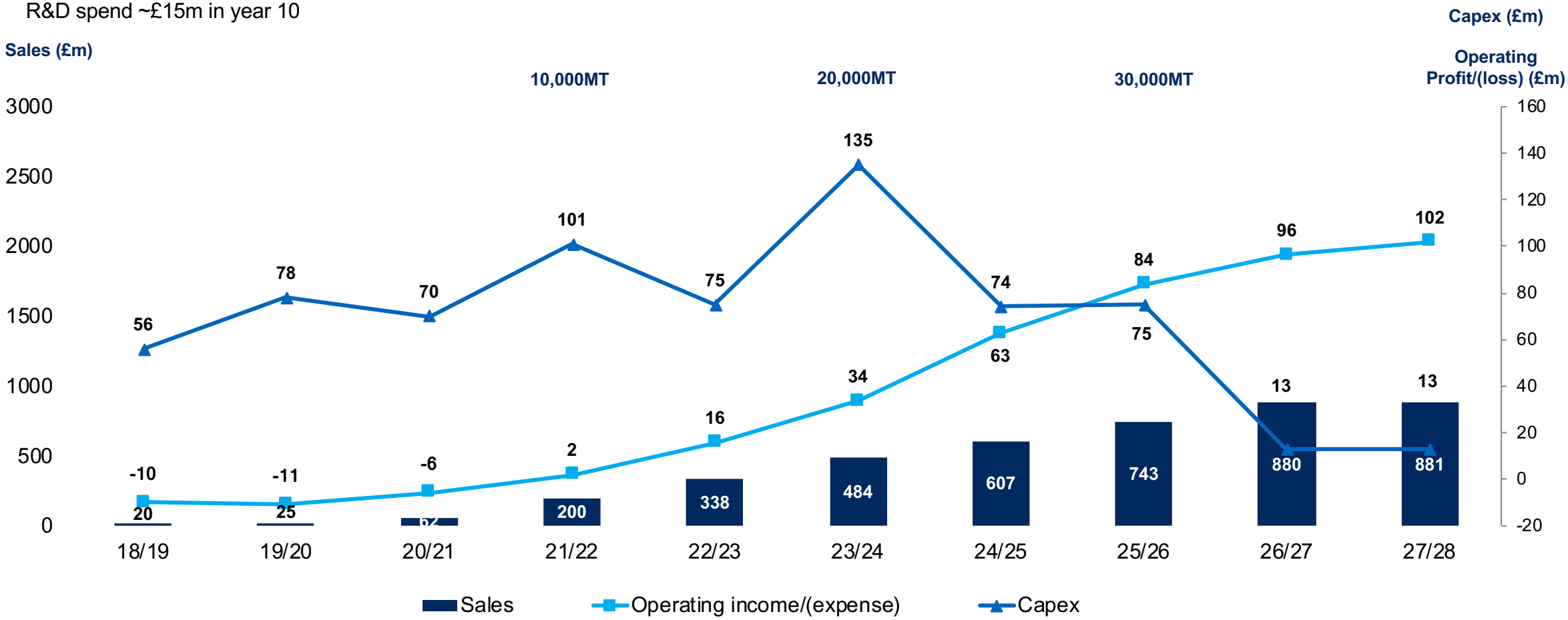
Battery Materials Business: Summary and Financials

The eLNO market-entry strategy addresses key learnings from our LFP business experience

	eLNO market entry strategy	LFP business
I	**Diverse customer base** ▪ Customer segmentation roadmap includes premium OEMs across geographies and leading global cell manufacturers ▪ We will subsequently limit single-source customer volumes to less than [25%]	**High customer concentration** ▪ Two large volume customers, long tail of small volume customers
II	**Strong Cathode Technology and Product Portfolio** ▪ Cathode materials include: LFP, NMC, eLNO, LMNO ▪ Multiple products within the eLNO family (e.g., precursors, base materials, coating, formulations, casting)	**Limited product portfolio** ▪ Two LFP cathode materials
III	**Flexible and robust manufacturing assets** ▪ Provides ability to manufacture different cathode materials and types, through different operating conditions ▪ Supports development and production of the next generation of cathode materials	**Purpose-built assets** ▪ Candiac and Changzhou manufacturing assets were purpose-built for LFP cathode materials ▪ Specifically cathode materials designed for high energy density and high power density
IV	**Robust business model** ▪ Long term investment case based on metrics without financial incentives ▪ Strong in-region commercial teams – build relationship with key policy influencers, – better understand and anticipate changes, particularly in China	**Business model reliant on subsidies** ▪ China xEV market is underpinned by subsidies, and as these subsidies for LFP changed significantly in December 2016 the market for LFP also changed which reduced the market potential for Client LFP materials in China

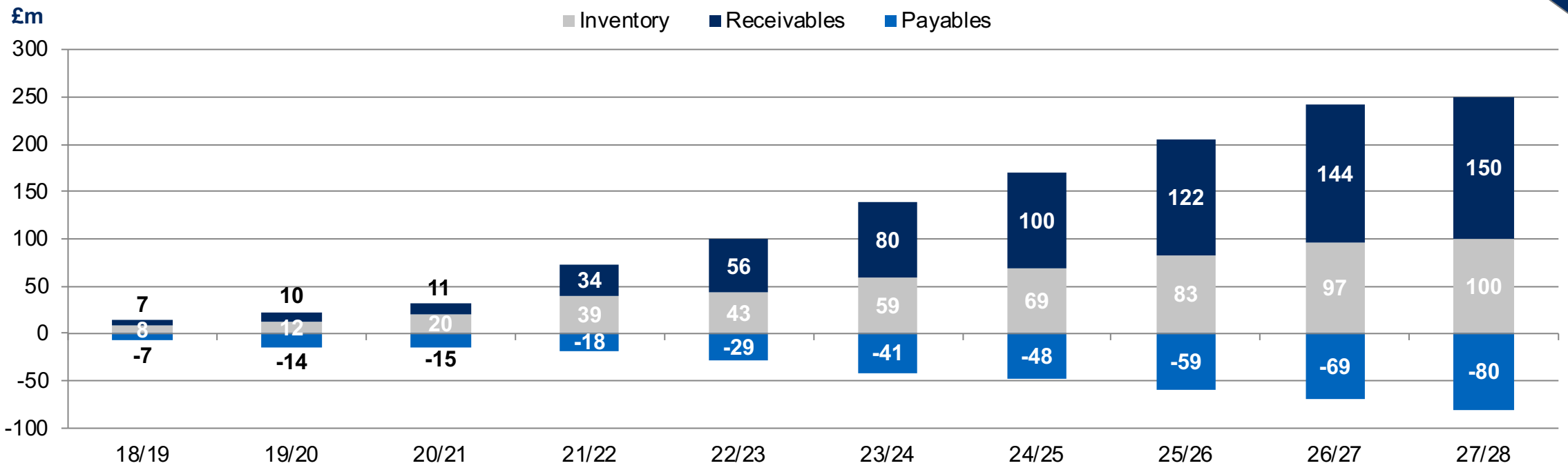
Battery Materials 10 Year Plan

- Consolidated financials comprised of investment in LFP, eLNO and R&D
- R&D spend ~£15m in year 10



RoS (%)	(50%)	(43%)	(9%)	1%	5%	7%	10%	11%	11%	12%
RoA (%)	(7%)	(4%)	(2%)	1%	3%	5%	9%	10%	12%	12%

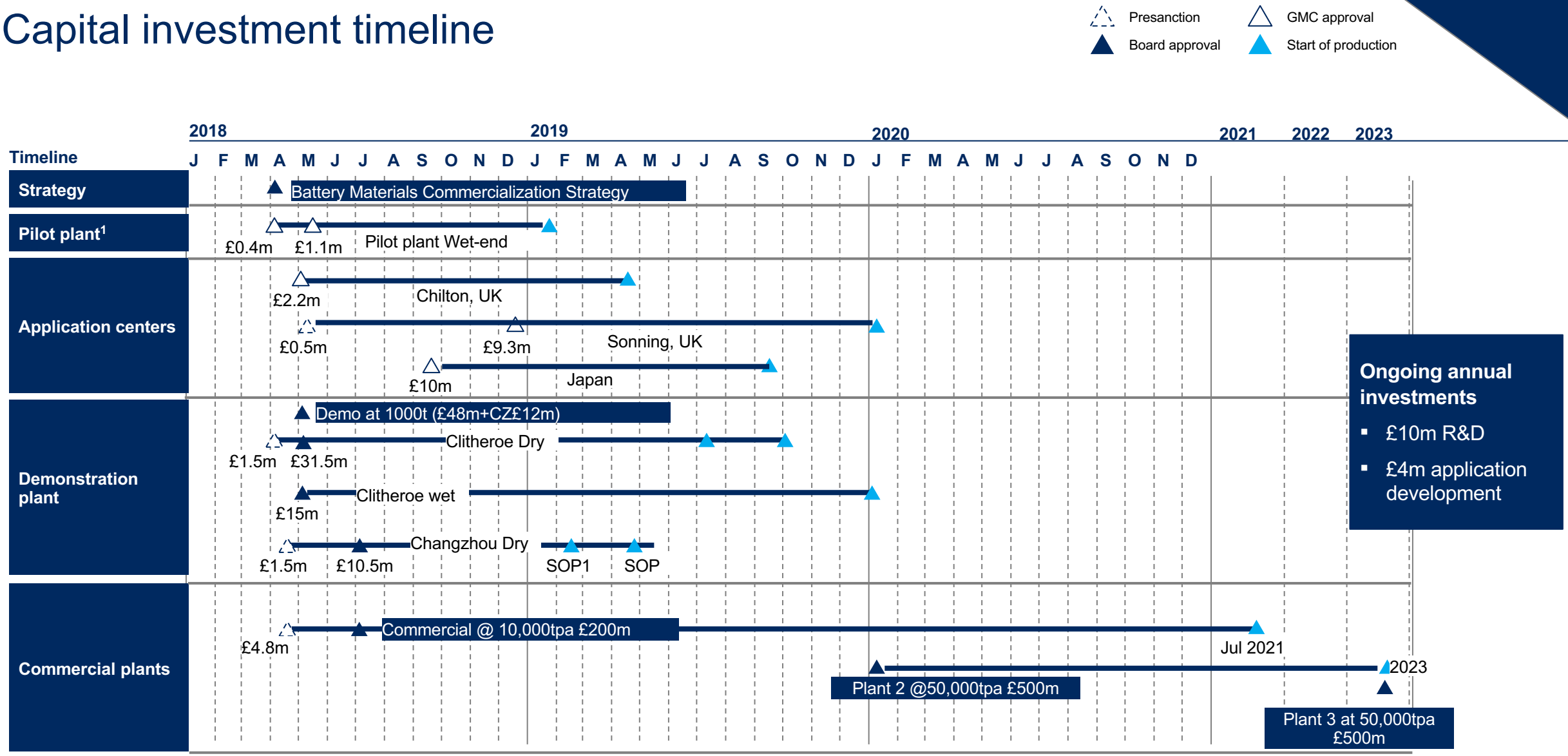
Battery Materials 10 Year Plan – Working Capital Requirements



	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27	27/28
Total WC	£5m	£8m	£16m	£55m	£71m	£98m	£121m	£146m	£172m	£170m
WC Days	83	121	96	99	76	74	73	72	71	70

- Assumptions – 60 Days Receivables, 30 Days Raw Materials, 7 Days WIP, 30 Days Finished Goods, 45 Days Payables
- For initial eLNO investment of ~£200m – working capital required will be ~£70m (~35% of investment)
- Challenge to move into group target (50-60 days) at steady state depends on <30 days inventories, and <60 day customer payment terms

Capital investment timeline

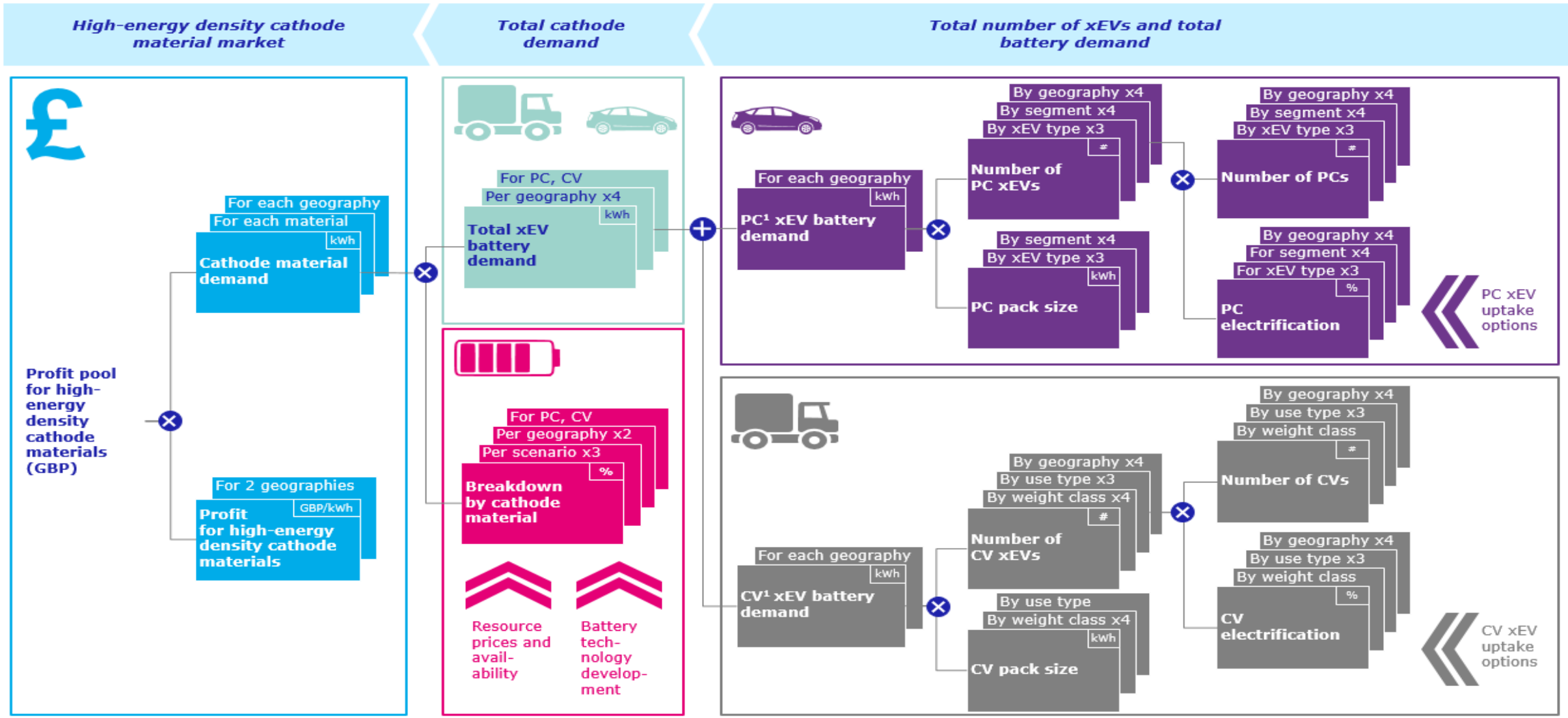


1 £0.4m +/- 10% April 2018, £1.1m +/- 10% May 2018 2 Chilton £2.2m +/- 10%, Sonning £0.5m pre-sanction, full sanction +/-10% Dec 2018 3 Operating date may slip by 3months as impact of switching from 500mtpa to 1000 Mtpa is assessed in detail 4 £1.5m pre-sanction April 2018, £ 66m RHK +/-10% May 2018, £24.9m +/-10% July 2018
5 £4.8m presanction April 2018, £30m RHKs ~ £5m land July 2018 with FEED study 40% complete so some areas +/-10%, some +/-30%; £100m org Nov 2018 £60m wet March 2019
6 Excluding R&D, application development and second/third commercial plant

Battery Materials Market Entry Strategy

BACKUP

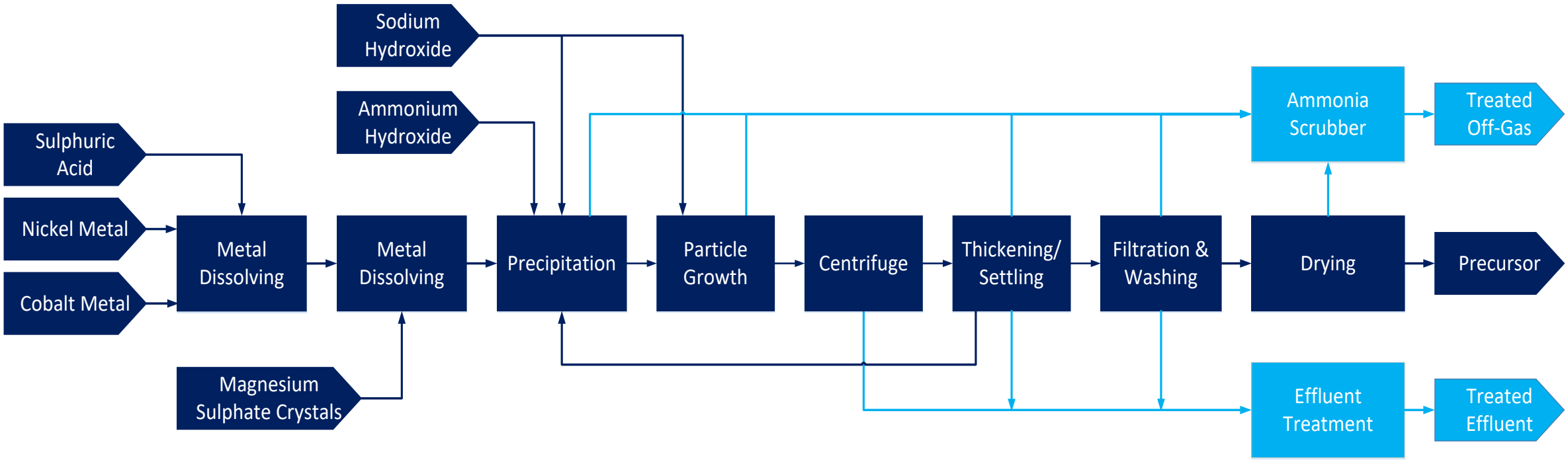
The market model structure to obtain profits for high energy density cathode materials has 5 elements



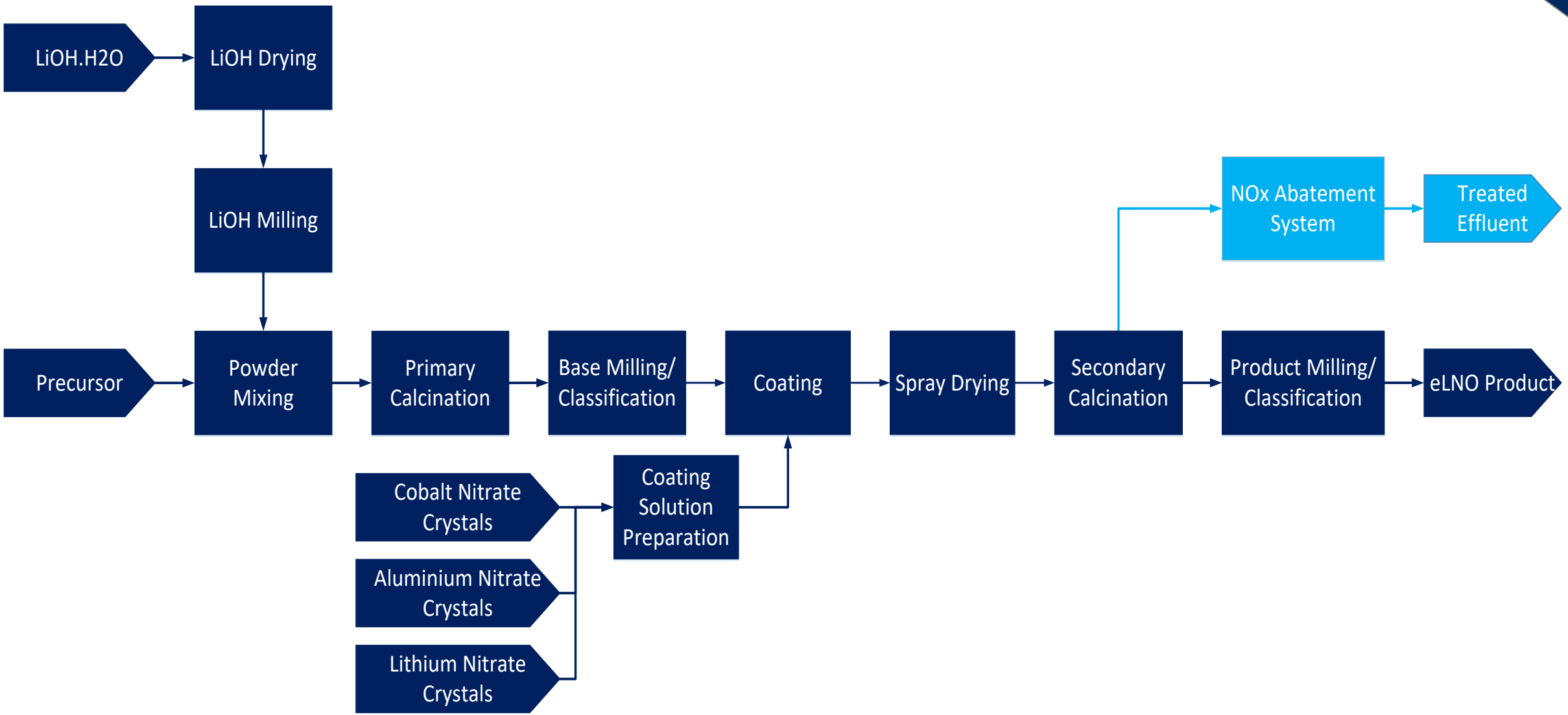
1 PC: Passenger Car, CV: Commercial Vehicle

See technology section

Precursor (wet) process flow



Cathode Active Material (dry) process flow



1 Client should enter the cathode market with eLNO as soon as possible by building a 10kt manufacturing plant

Recommendation

With what operating model should Client enter the market in the short term?

Manufacturing

- ⊕ Capital available
- ⊕ Proof of concept of eLNO at scale
- ⊕ Control own process and opportunity to learn
- ⊖ Requires investment

Licensing

- ⊖ Client IP currently not development far enough to allow licensing
- ⊖ Constrained by current CAMX licenses with relevant patents expiring in 2022

NOT FEASIBLE

Tolling

- ⊖ Potential tolling partners not interested (no spare capacity)

NOT FEASIBLE

With what plant size should Client enter at scale production and why?

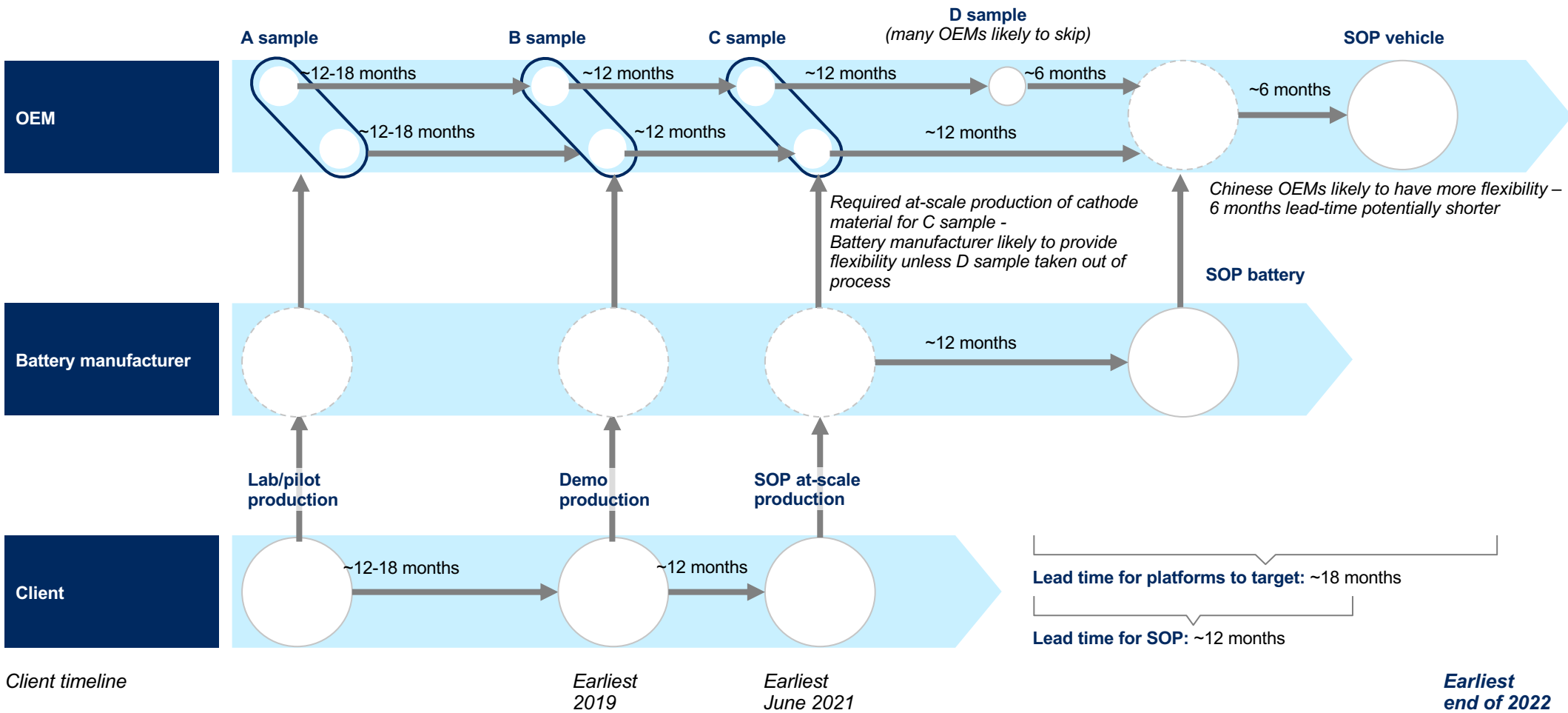
10kt

- ⊕ Fulfill minimum capacity to qualify for battery cell manufacturers (8kt)
- ⊕ High equipment specification allows further process development to reduce risk in further scale up
- ⊕ Quicker route to full utilization
- ⊖ Does not realize economies of scale

30kt

- ⊕ More cost-effective capex structure
- ⊕ Reduces perceived scaling risk for future partners
- ⊕ Strong commitment signal
- ⊖ Risk due to unproven equipment and longer ramp up
- ⊖ Reduced learning potential as flexible equipment too costly
- ⊖ Very large capex commitment for Client without previous learnings from intermediate plant

2 Given typical development and procurement timelines, we can qualify for platforms with SOP in 2023



- Battery manufacturers align qualification process with process of OEM
- Chinese OEMs with likely more flexibility/speed in process, i.e. slightly shorter period from SOP battery to SOP vehicle
- At-scale production required for C sample – battery manufacturers likely to provide some flexibility if D sample still part of process
- Demo production required for B sample
- Pre-samples/ A samples possible on lab/pilot level- however, limited capacity for production of samples

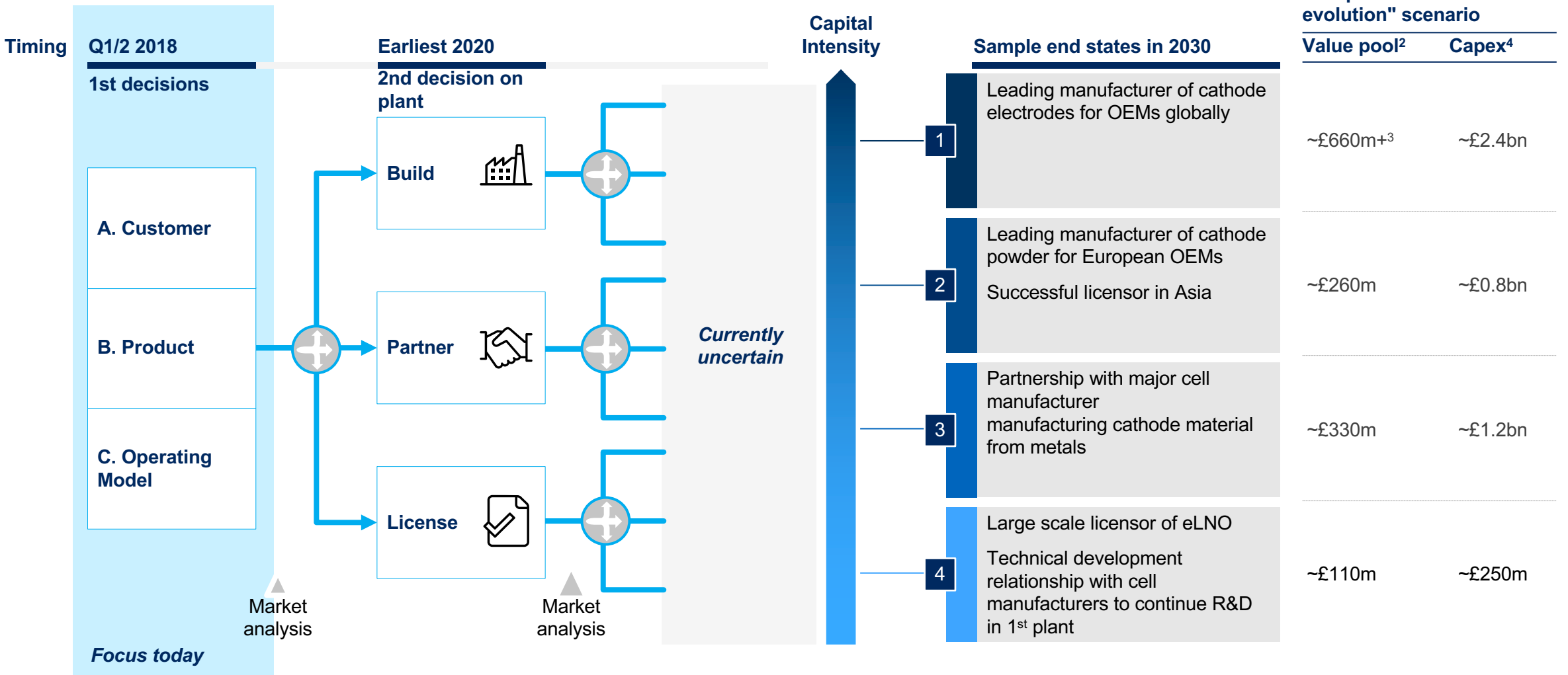
1 A: Basic performance (<10 Mt required)
B: Basic performance + Safety, life performance (short-term, ~200 Mt required)
C: Full-scale functionality, safety, life performance (long-term, ~300 Mt required)
D: Processability, manufacturing capability – many OEMs are not requiring D samples anymore (~50 Mt required)

3 The anticipated cost structure at 100 kt is significantly more attractive than at 10 kt

	10kt plant	100kt plant
Capex, USD mn	224	~1,250–1,500[2]
Operating margin[1], %	8%	~12-13%
ROIC, %	10%	~18-23%
Assumptions	▪ Manufacturing **precursor and cathode active material** in-house starting from base metals ▪ Assuming **2×5kt lines**	▪ Manufacturing **precursor and cathode active material** in-house starting from base metals ▪ Assuming **3×33kt lines** in aggressive case and **10×10kt lines** in conservative case ▪ Based on **theoretical scaling factors**

1 Assuming selling price of $35.75/kg and today's resource prices
2 100kt capex values only include economies of scale from volume but do not include assumptions on calcination bed depth increases to 4.5 kg

Overview of end states and their respective value pools and capex requirements



1 1st decision must also include decision on application centers and decision on the demo plant from extending down the value chain to produce slurry formulations and cathode electrodes (10kt), continued R&D cost estimated at £4m/year from 2018-2030

2 Assuming Client captures 20% of the high energy density market

3 Value pool based on cathode powder market, additional value expected

4 Capex for manufacturing is £200m for 1st plant (10 kt), all further capacity expansion at a capex of £8.8m/kt; Capex for licensing is £200m for 1st plant

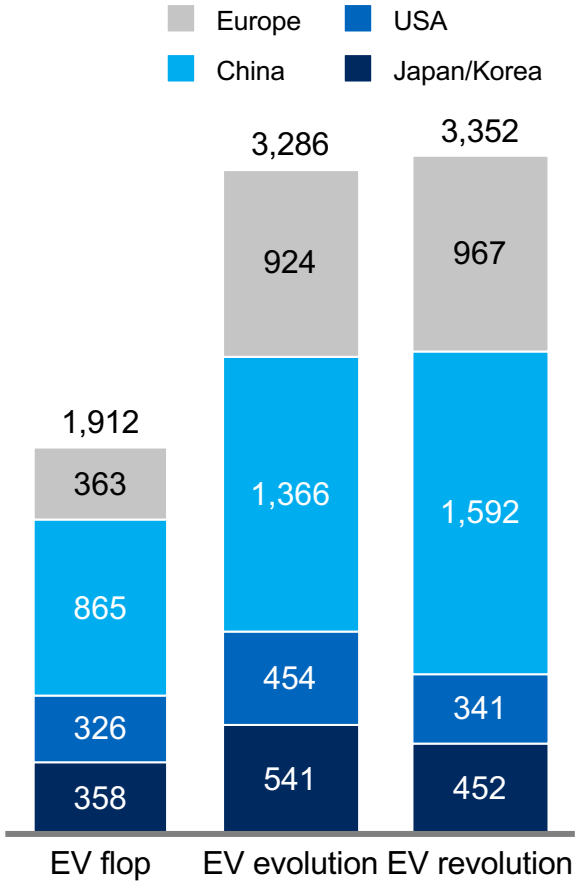
Value pools for high-energy-density cathode material were derived from vehicle sales, xEV share and battery technology development

		EV flop			EV evolution			EV revolution		
		2020	2025	2030	2020	2025	2030	2020	2025	2030
Vehicle sales	Mio #	82	86	90	82	86	90	82	86	90
xEV share	%	6%	15%	27%	7%	18%	31%	9%	24%	45%
xEV sales	Mio #	5	12	24	6	15	28	8	21	40
Average Pack size	kWh/vehicle	21	20	41	37	41	56	37	49	67
xEV battery demand	MWh	101	253	987	216	631	1.557	282	1.015	2.698
Share of high-energy-density cathodes (China)	%	2%	10%	25%	7%	16%	37%	7%	46%	43%
Share of high-energy-density cathodes (RoW)	%	34%	59%	69%	39%	74%	90%	39%	64%	44%
HED cathode material demand	kt	45	146	584	73	390	1.334	84	878	1.782
EBIT margin	GBP/kg	3,3	3,3	3,3	3,3	2,9	2,5	3,3	2,7	1,9
Value pool	GBPm	146	477	1.912	238	1.148	3.286	276	2.336	3.352

Assumptions to derive Client opportunity by sample end state

Value pool high-energy-density cathode material

GBP million



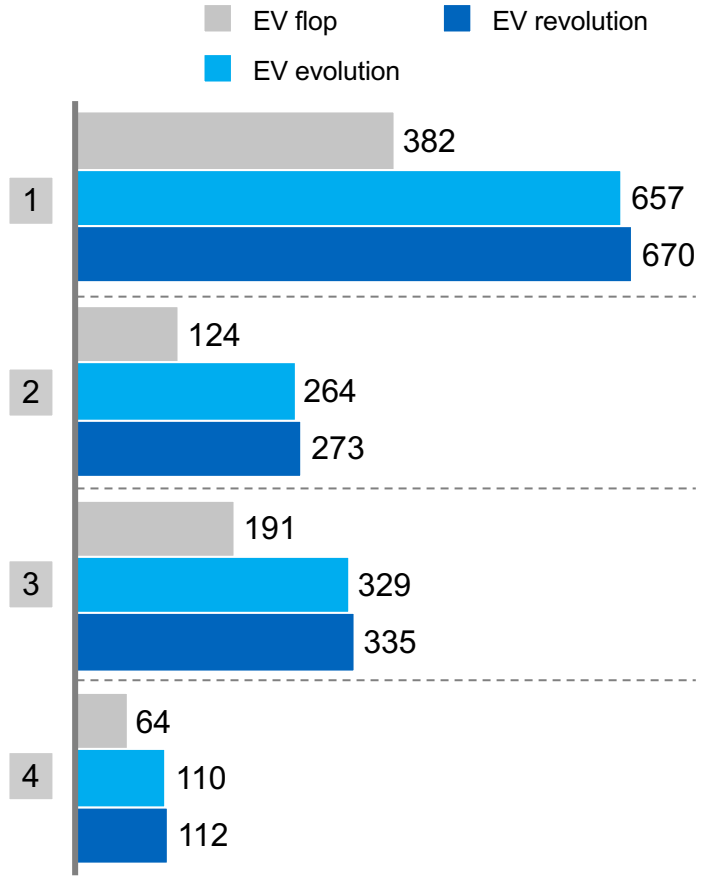
Sample end states

Key assumptions

	Market share	Geography	Value capture
1	20%	Global	Manufacturing (100%)
2	20%	EU	Manufacturing (100%)
	20%	China, US, Japan/Korea	Licensing (25% of which 2/3 profit)
3	20%	Global	Partnership (50%)
4	20%	Global	Licensing (25% of which 2/3 profit)

Value pool in sample end states

GBP million



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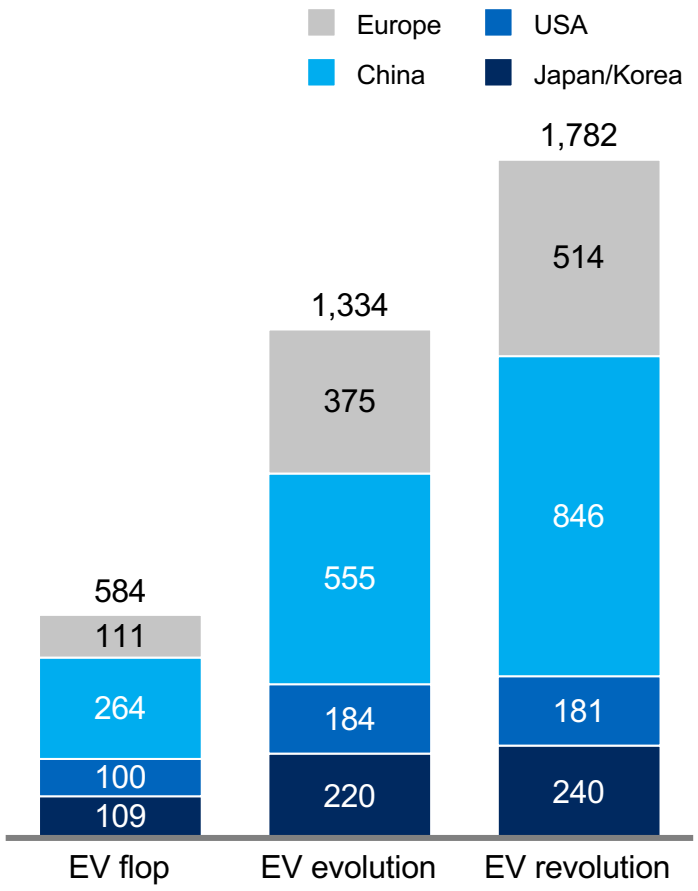
Assumptions to derive required capex by sample end state

Value pool high-energy-density cathode material

kt



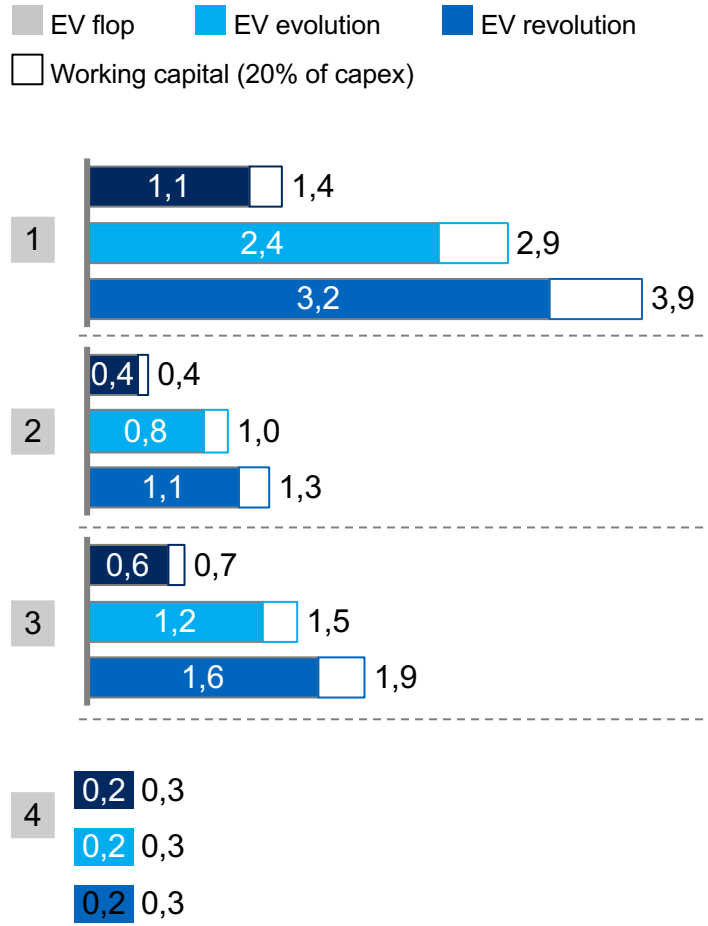
Key investment assumptions per sample end state

Capex first plant £mn	200.0
Volume of first plant t	10,000
Capex cost for scale-up, £mn per kt capacity	8.8
R&D cost/ year for licensing	4
Timespan for R&D 2018-2030	12
Working capital % of capex	20

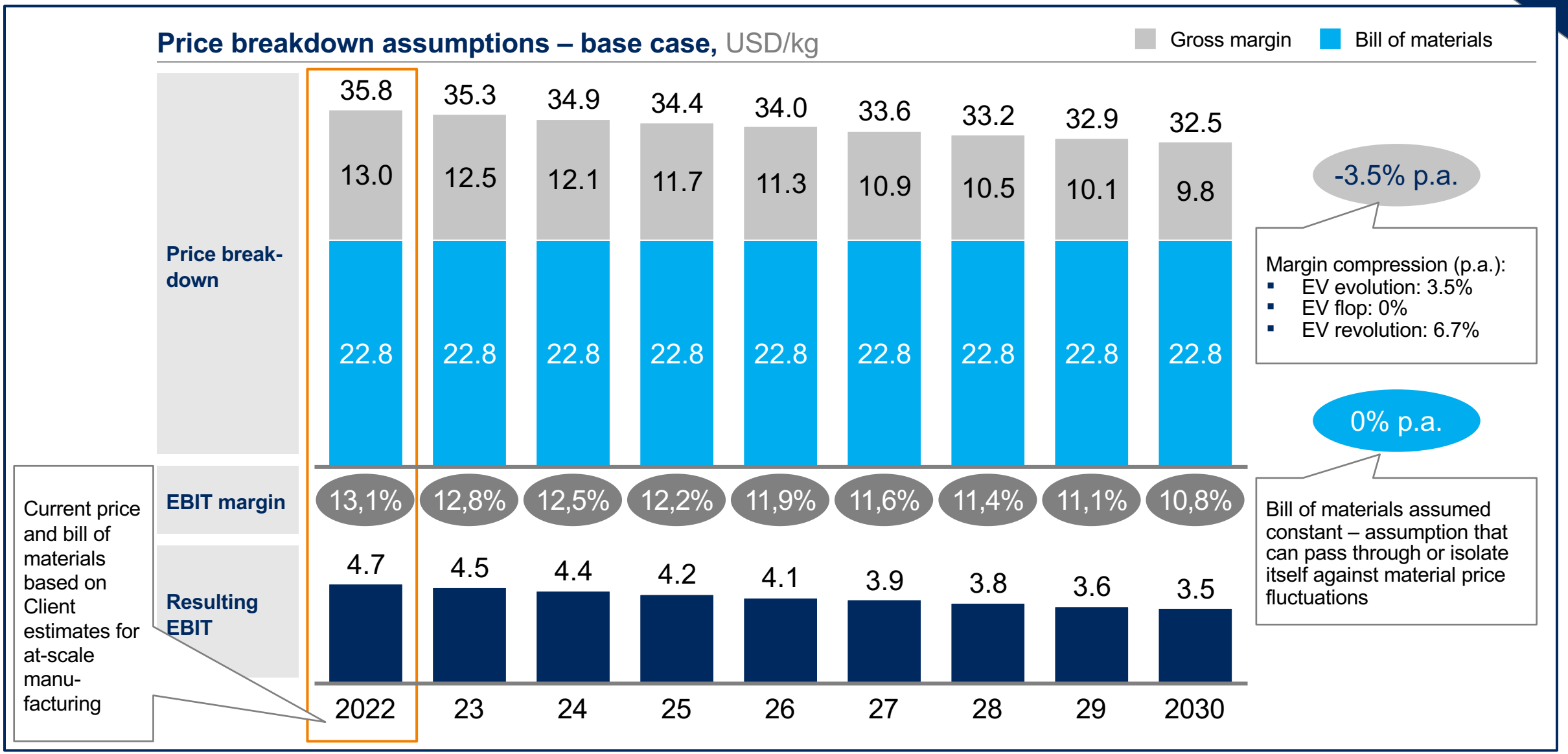
1	200 for first plant plus plants at economies of scale thereafter
2	200 for first plant plus plants at economies of scale thereafter in Europe plus R&D spend to support licensees over 12 years
3	Half the capex investment compared to manufacturing only option
4	200 for first plant plus R&D spend for £4m/year over 12 years

Required capex in sample end states

GBP billion



Assumptions for profitability of high-energy-density cathode material



Building the 2nd plant and further scale-up can be prepared even before 2020 (1/2)

Sample end states in 2030	Signposts by 2020 that Client should follow this path[1]	How to prepare pre-2020
Leading manufac-turer of cathode electrodes for OEMs globally	▪ **Client retains a competitive edge:** Based on customer acceptance of eLNO and other suppliers' announcements, eLNO retains a competitive advantage ▪ **Client successfully advances through qualification process** and is on track to fill initial plant, with sufficient volume in pipeline for second plant ▪ **Priority OEMs** specify cathode material to their cell manufacturers ▪ **Chinese OEMs** adapt high-energy-density batteries quicker than considered in the base case, building internal capabilities and specifying cathode material ▪ Proof that **Client electrodes** can deliver superior performance and cost for customers compared to "only powder" and interest from OEMs to purchase electrodes / invest in joint development ▪ Client itself or direct customers can **secure sufficient raw materials** through long-term contracts or vertical integration	▪ Evaluate willingness for **significant capital investment** for scale-up (500+m GBP per plant) ▪ **Pre-load pipeline** of future platforms; **consider additional OEMs** as target customers ▪ Explore opportunities to **secure raw materials** at large-scale and for recycling ▪ **Prove advantages of electrodes** at lab scale (in partnership with e.g., P&G) ▪ Identify **potential sites** for manufacturing in China ▪ Continue to **invest in R&D and application centers**
Leading manufac-turer of cathode powder for European OEMs **Successful licensor in Asia**	As above, except: ▪ **Chinese OEMs** don't seek control of battery value chain or Chinese high-energy-density cathode market gets highly competitive ▪ **No successful proof** for superior performance of "Client electrodes"	▪ Evaluate willingness for **significant capital investment** for scale-up (500+m GBP per plant) ▪ **Pre-load pipeline** of future platforms; **consider additional OEMs** as target customers ▪ Explore opportunities to **secure raw materials** at large-scale and for recycling ▪ Identify **potential partners** for manufacturing in China ▪ Prepare **licensing package** ▪ Continue to **invest in R&D and application centers**

1 Selection of most significant signposts for each sample endstate

Building the 2nd plant and further scale-up can be prepared even before 2020 (2/2)

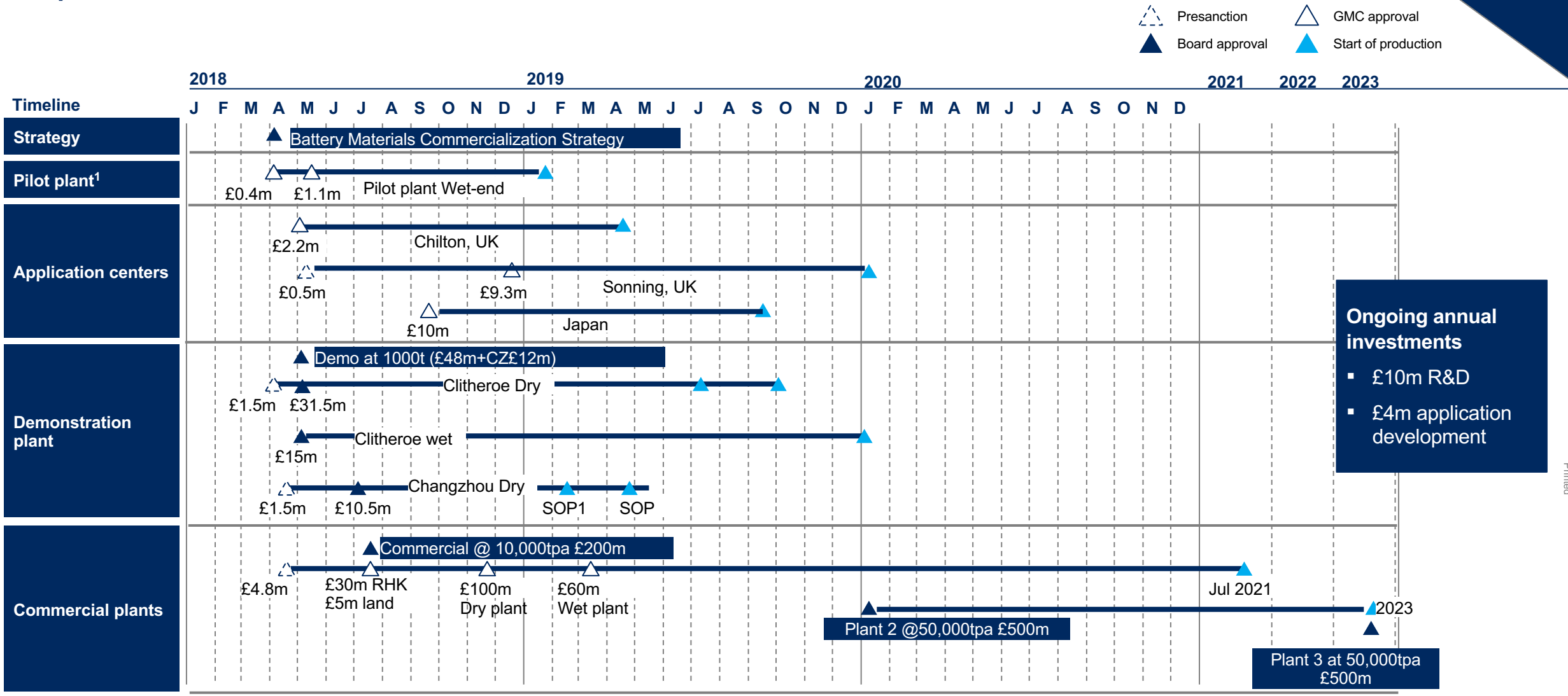
Sample end states in 2030	Signposts by 2020 that Client should follow this path[1]	How to prepare pre-2020
Partnership with major cell manufacturer manufacturing cathode material from metals	▪ **Client retains a competitive edge:** Based on customer acceptance of eLNO and other suppliers' announcements, eLNO retains a competitive advantage ▪ **Client successfully advances with cell manufacturers** and is on track to fill initial plant, with sufficient volume in pipeline for second plant ▪ **OEMs** move to outsource batteries, are not influencing cathode decision actively and **cell manufacturers** become the dominant player along the value chain ▪ **No successful proof** for superior performance of "Client electrodes"	▪ Evaluate willingness for **significant capital investment** for scale-up (500+m GBP per plant) ▪ Build strong relationship with **cell manufacturers** towards partnership ▪ Explore opportunities to **secure raw materials** at large-scale and for recycling ▪ Identify and develop **potential sites** for co-location to cell manufacturer ▪ Continue to **invest in R&D and application centers**
Large scale licensor of eLNO **Technical development relationship with cell manufacturers to continue R&D in 1st plant**	▪ **eLNO retains a competitive edge:** Based on customer acceptance of eLNO and other suppliers' announcements, eLNO retains a competitive advantage ▪ **xEV market remains tumultuous** and hence risky, with OEMs failing to achieve a clear growth path on xEV sales ▪ **Cathode manufacturing** becomes an oversaturated market, e.g., due to overcapacity, subsidized expansion of Chinese players or commoditization ▪ **Raw material supply** remains problematic, with customers and Client not able to secure reliable long-term supply	▪ Build **licensing package** ▪ Continue to **invest in R&D and application centers**

1 Selection of most significant signposts for each sample endstate

We have incorporated key learnings from LFP into the market entry strategy to de-risk our approach

LFP context	Learning	Action
▪ LFP business had a very **limited product portfolio** of two LFP cathode materials	▪ Develop a **portfolio of different types and grades of cathode materials with freedom to operate** to create a diversified and unencumbered product offering	▪ We have developed a **robust portfolio of cathode materials – LFP, NMC, eLNO, LMNO** – and multiple products within the eLNO family of high energy cathode materials (e.g., precursors, base materials, coating, formulations, casting)
▪ LFP business had a **high customer concentration with primarily two large volume customers** and a long tail of small volume customers	▪ Maintain a **diverse customer base and segmentation** across application types and geographies and limit revenue exposure to any single customer to less than [25%] of the overall business revenue	▪ We have developed **a broad customer segmentation roadmap including premium OEMs across geographies and leading global cell manufacturers** and will subsequently limit single-source customer volumes to less than [25%]
▪ Candiac and Changzhou manufacturing assets were **purpose-built for LFP cathode materials**, and specifically cathode materials designed for high energy density and high power density	▪ Design manufacturing assets for **robustness to enable to production of multiple types and grades of cathode materials** to maintain flexibility of manufacturing for next generation cathode materials	▪ We have designed **a robust manufacturing asset that provides flexibility over a range of operating conditions** to facilitate the manufacture of different cathode materials and types, and support the development and production of the next generation of cathode materials
▪ **China xEV market is underpinned by subsidies**, and as these subsidies for LFP changed significantly in December 2016 the market for LFP also changed which reduced the market potential for Client LFP materials in China	▪ Actively participate in **government relations** to anticipate the impact and timing of incentives and subsidies on revenue, and implement a robust business model that is sustainable despite the existence of subsidies and incentives	▪ We will strengthen **in-region commercial focus particularly in China** with a focus on improving data collection on government policy, and make future investment decisions following a stress-test of subsidies and incentives with a long-term view that the investment must meet financial metrics in an environment ex. financial incentives

Capital investment timeline



1 £0.4m +/- 10% April 2018, £1.1m +/- 10% May 2018 2 Chilton £2.2m +/- 10%, Sonning £0.5m pre-sanction, full sanction +/-10% Dec 2018 3 Operating date may slip by 3months as impact of switching from 500mtpa to 1000 Mtpa is assessed in detail 4 £1.5m pre-sanction April 2018, £ 66m RHK +/-10% May 2018, £24.9m +/-10% July 2018
5 £4.8m presanction April 2018, £30m RHKs ~ £5m land July 2018 with FEED study 40% complete so some areas +/-10%, some +/-30%; £100m org Nov 2018 £60m wet March 2019
6 Excluding R&D, application development and second/third commercial plant