Indigenization of battery manufacturing in India

Presentation for ACEF 2023 Deep Dive Workshop

Somesh Kumar, Partner & Leader (Power & Utilities - GPS)

Not for circulation

Snapshot of grid scale battery storage investment pipeline (i.e, under bidding, permitting and under construction projects) and policy ecosystem in India

USD ~7.3 billion

Total investment in pipeline

Rajasthan and Gujarat are top two states accounting for more than 60% of investment where project locations are reported.

208 GWh

BESS capacity for optimum generation mix by 2030 planned by CEA

The energy storage capacity required for 2029-30 is likely to be 60.63 GW (18.98 GW PSP and 41.65 GW BESS) with storage of 336.4 GWh (128.15 GWh from PSP and 208.25 GWh from BESS).

~4.1 GWh

Total capacity in pipeline

Standalone BESS projects account for ~75% share and remaining are hybrid collocated with RE sources.

USD cents ~11 - 12/kWh

Levelized cost of service determined in recent auctions

Determined @ 2 cycles per day for 3-4 hours of discharge; Govt. is targeting USD cents 5-6 / kWh for mass adoption.

Policy description	Key highlights (status quo)
Guidelines for Procurement and Utilization of BESS as part of GT&D assets	Fixed cost recovery (INR / MW / month) for project developers helps de-risk uncertainties in capacity utilisation (no. of charge-discharge cycles)
Energy Storage Purchase Obligations	Total prescribed obligations will progressively increase from 1% in 2023-24 to 4% by 2029-30
Viability gap funding for BESS projects	Announced in FY-24 budget for supporting ~4000 MWh capacity addition; Guidelines for VGF application under development
Goods and Services Tax (GST)	Lithium-ion batteries currently attract 18% GST
Basic customs duty (BCD)	Li-ion batteries currently attract 10% BCD on imports
Production linked incentives (PLI)	*PLI scheme dedicated for manufacturing of stationary grid storage batteries is under development*

Source: EY analysis

Snapshot of battery manufacturing investment pipeline and policy ecosystem in India

USD ~16 billion

Total investment in pipeline

Gujarat, Karnataka, Tamil Nadu and Telangana are top two states accounting for more than 90% of pipeline.

~5 GWh

Manufacturing capacity of stationary grid storage batteries for allocating PLI

Under planning

~97 GWh

Total capacity in pipeline for manufacturing

Much of this capacity is likely catering to mobility applications (electric vehicles); ~65% for cell and pack assembly followed by 24% for pack assembly and 9% for cell component manufacturing

~30 GWh

Eligible for production linked incentives (PLI) of USD 2.2 billion from government

Most of these incentives is likely to benefit EV battery supply chain and linked to achieving domestic value addition (60% in five years). Another 20 GWh is likely to be allocated soon within this budget.

Structuring PLI for grid storage battery manufacturing	EY Point of View
Battery chemistry / technology (Li-ion, Na-ion, Redox flow, Metal air etc.)	Agnostic to enable cost optimisation and long duration storage capabilities
Cycle life	>10,000 @ 5 C - C/100
Energy density	Not important
Cost of cell production	<50 USD per kWh for mass adoption
Active materials for electrode assembly	Earth abundant (beyond lithium, vanadium)
Safety (thermal runaway)	Inorganic / solid state / non-oxidizable electrolytes will reduce cost of thermal management

Source: EY analysis

The value chain of lithium-ion battery manufacturing ecosystem

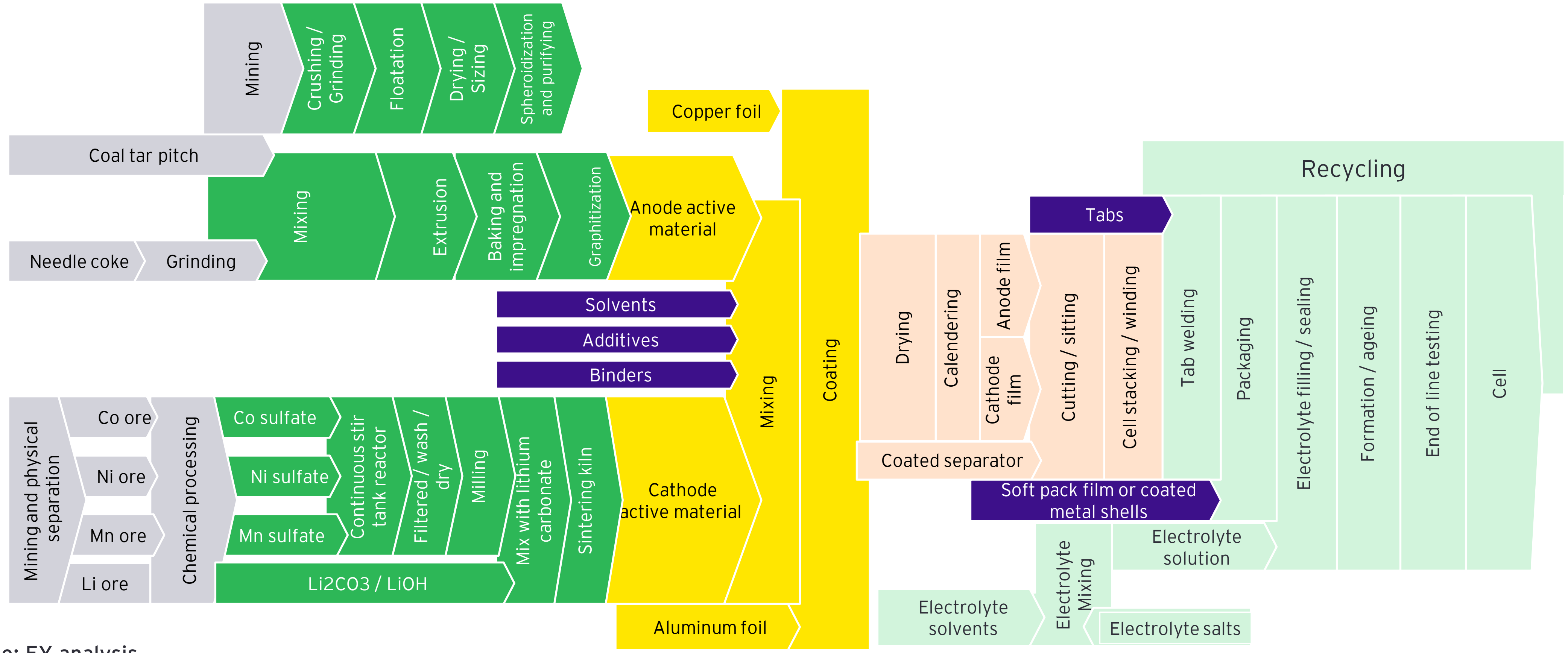
Mining
Extraction of raw materials, such as Li, Co, Ni, Mn and graphite

Chemical processing
Conversion of raw materials into intermediate compounds

Active material production
Manufacturing of electrode materials, such as NMC, LFP, etc.

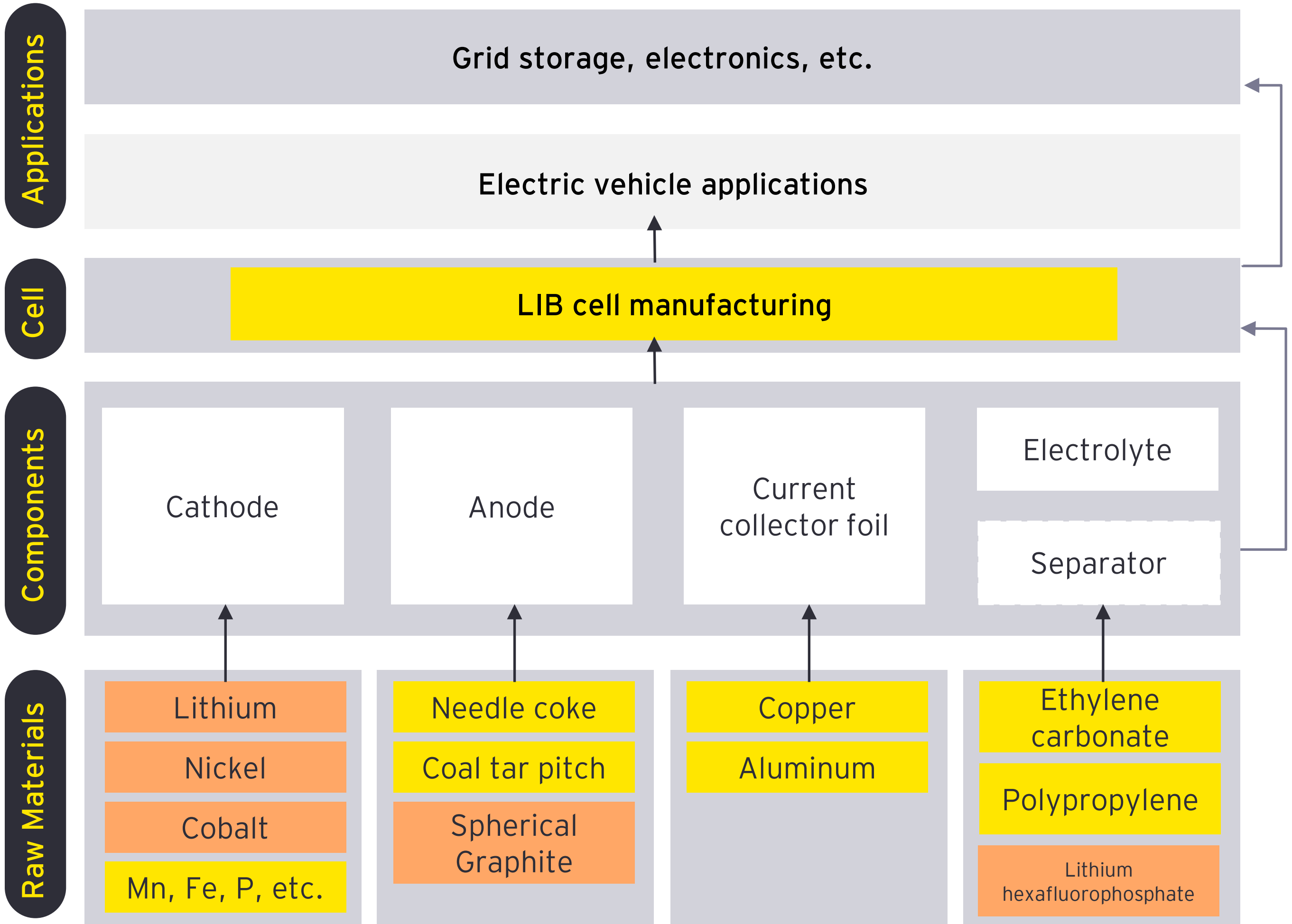
Cell production
Integration of electrodes, electrolytes, and separators into a sealed unit

Recycling
Reclamation of valuable materials from used batteries



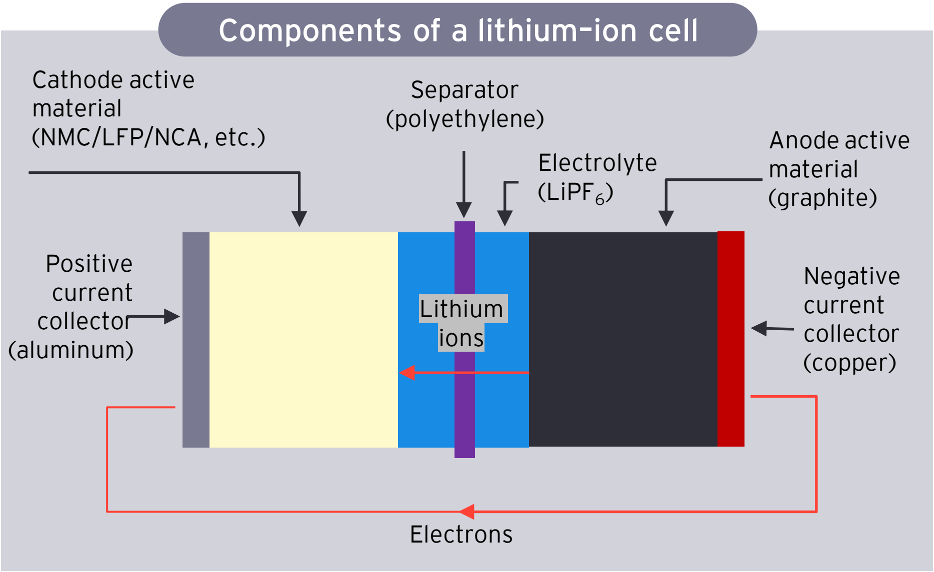
Source: EY analysis

Key components and materials for manufacturing lithium-ion batteries (LIBs)



Supply chain bottlenecks

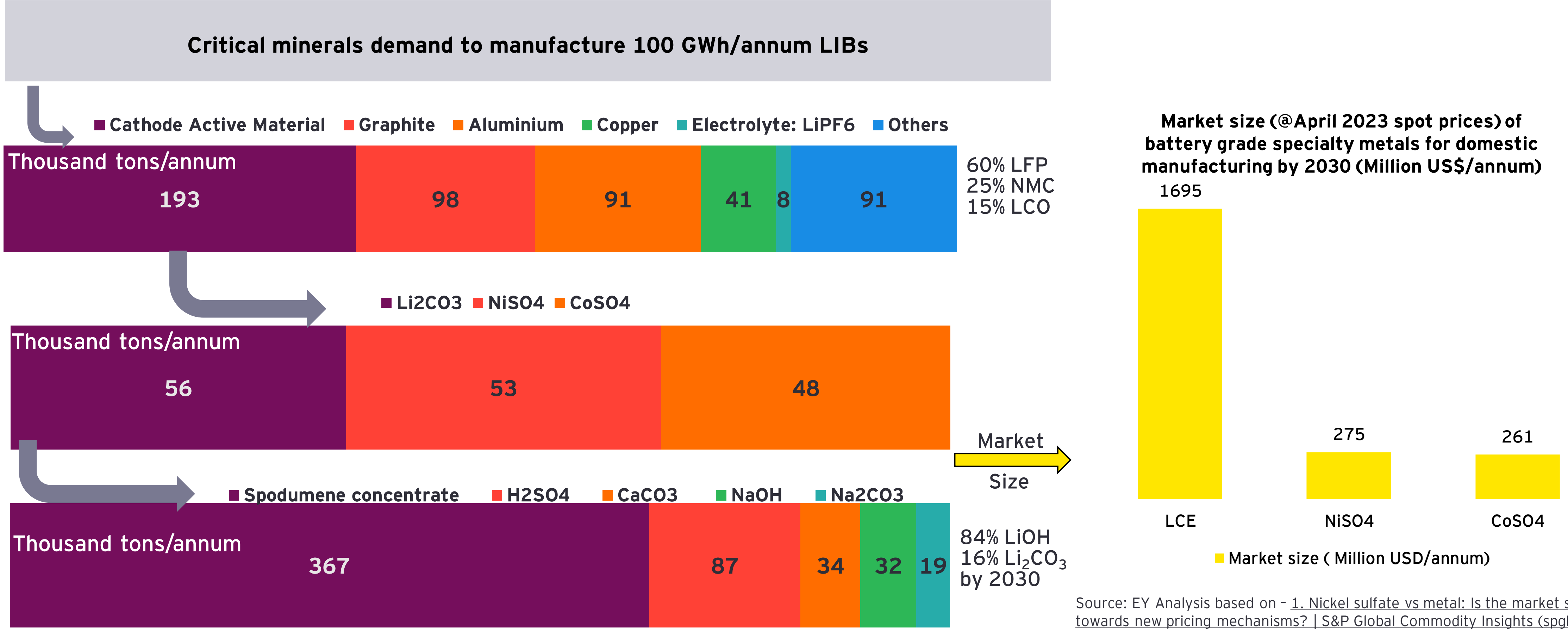
Sizeable domestic supply chain exists



Source: EY analysis

Demand outlook for critical materials required to manufacture 100 GWh/annum LIBs by 2030

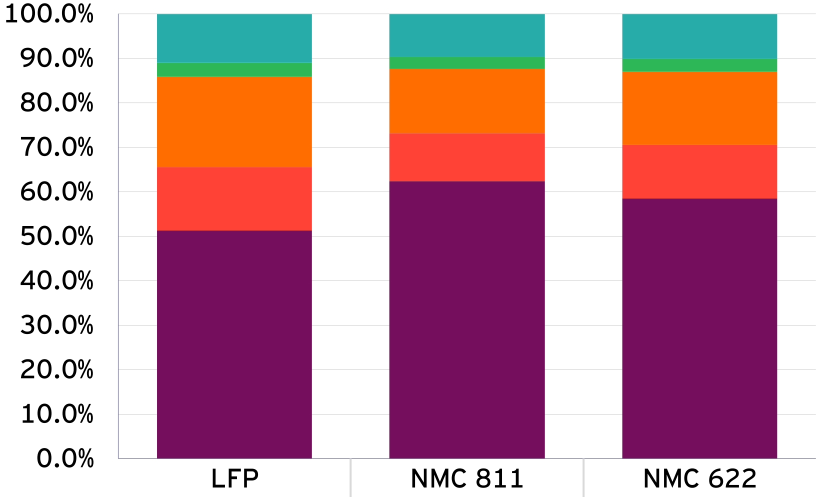
- India's LIB cell manufacturing industry will need ~193 thousand tons/annum of cathode active material, ~98 thousand tons /annum of anode active material, 91 thousand tons /annum of aluminum and 41 thousand tons of copper and 8 thousand tons/annum of LiPF6 electrolyte material to produce ~100 GWh / annum of batteries by 2030.



Source: EY Analysis based on - 1. Nickel sulfate vs metal: Is the market shifting towards new pricing mechanisms? | S&P Global Commodity Insights (spglobal.com)
2. Green Metals Battery Metals Watch The end of the beginning (goldmansachs.com)

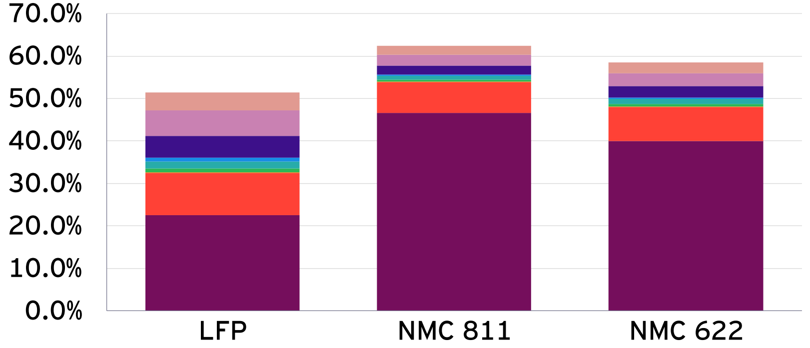
Cost breakdown of manufacturing LIBs indicates active materials synthesized from critical mineral commodities and their chemical precursors can contribute up to ~55% of overall cost

Cost breakdown as % share of LIB pack cost



	LFP	NMC 811	NMC 622
Total cost of profits and warranty	10.9%	9.7%	10.1%
Total cost of BMS	3.3%	2.6%	2.8%
Total cost of manufacturing	20.2%	14.6%	16.5%
Total cost of purchased items	14.3%	10.7%	12.0%
Total cost of materials	51.4%	62.4%	58.6%

Material cost break down as % share of LIB pack cost



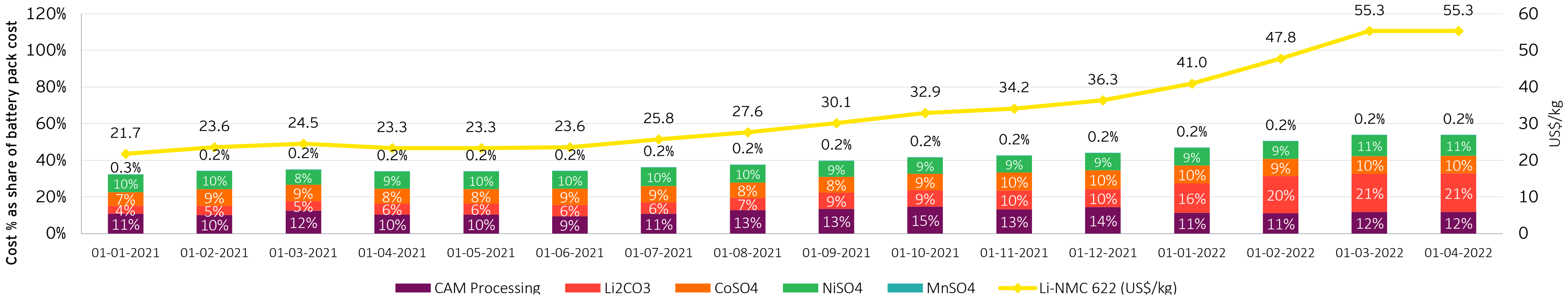
	LFP	NMC 811	NMC 622
Additives	0.0%	0.0%	0.0%
Electrolyte	4.2%	2.2%	2.6%
Separators	6.1%	2.5%	3.1%
Negative current collector	5.1%	2.1%	2.6%
Positive current collector	0.8%	0.3%	0.4%
Solvents	1.7%	0.9%	1.1%
Binders	0.8%	0.5%	0.6%
Carbon additive	0.3%	0.2%	0.2%
Negative active material	9.8%	7.1%	7.9%
Positive active material	22.6%	46.7%	40.1%

Sources: EY analysis based on BatPaCV5.0 by UChicago Argonne, LLC

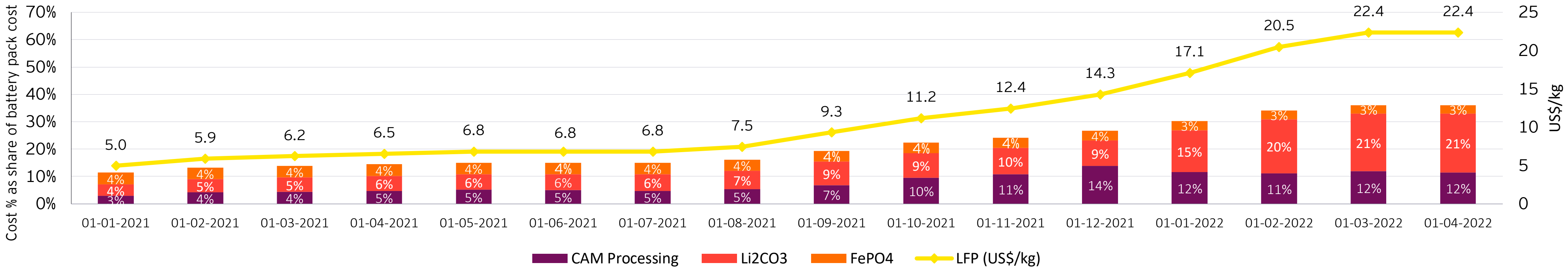
Note: Cost breakdown is estimated by over riding default value for positive active material cost in BatPaCV5.0 @ current market prices, (i.e. LFP cathode powder – US$ 11.37/kg; NMC811 cathode powder – US$ 44.46/kg; NMC622 cathode powder – US$ 30.61/kg, April 2023 prices). Ternary Precursor and Material prices | New Energy | SMM - China Metal Market

Synthesizing active cathode materials and their chemical precursors can add up to ~40% value addition in LIB pack manufacturing

Cost breakdown of cathode active material as a % share of NMC-622 LIB pack cost



Cost breakdown of cathode active material as a % share of LFP LIB pack cost



Source: EY Analysis based on market (spot) prices for active materials and their critical mineral constituents (battery grade chemical precursors) from the period of Jan 2021 – April 2022.
Note: The prices considered for Li-NMC 622 powder is taken from "https://source.benchmarkminerals.com/article/cathode-prices-fall-for-first-time-since-may-on-weaker-demand", prices for Li2CO3, Cobalt and Nickel is taken from internal EY data. For FePO4 a constant price of US$ 2/kg and for MnSO4 a constant price of US$ 1.5/kg is considered for the period of Jan 2021 – April 2022.

2030 Action plan for building resilience in critical battery mineral supply chains

Strategic intervention	Action Plan
Domestic exploration, mining and refining of critical mineral resources	‣ National stockpiling of refined mineral precursors used in LIB electrodes ‣ Incentives for critical battery mineral exploration, mining and extraction through appropriate royalty and tax regimes ‣ PLI for setting up critical mineral processing / refining units, especially for Li_2CO_3 / LiOH, $NiSO_4$, $CoSO_4$ and Spherical graphite ‣ Production linked incentives for extraction of critical minerals through recycling LIBs
Overseas exploration and mining of critical mineral resources	‣ Strengthen Indian missions in critical mineral bearing foreign countries to facilitate due diligence of greenfield / brownfield mining assets, acquisition and investment by Indian companies ‣ Strengthen KABIL to plan and undertake joint exploration, mining activities in critical mineral bearing foreign countries
Establish supply chain linkages with friendly foreign countries	‣ "G20 Critical Minerals Security Partnership" (G20-CMSP) should focus on building resilient supply chain of critical battery minerals, including stockpiles in different member countries as per comparative advantages in extraction and processing ‣ Critical Battery Minerals Supply Chain should be prioritized as a key pillar of Indo-Pacific economic framework and a key factor in diplomatic outreach with mineral bearing foreign countries

R&D to develop recycling, extraction technologies and find earth abundant alternatives to critical battery minerals	‣ Formulate national R&D grand challenge for:
	  ‣ developing high performance LIB electrodes made from earth abundant alternatives
	  ‣ direct lithium extraction technologies from seawater that can selectively separate lithium from sea water using physical or chemical processes

Our Offices

Ahmedabad
22nd Floor, B Wing, Privilon
Ambli BRT Road, Behind Iskcon
Temple, Off SG Highway
Ahmedabad - 380 059
Tel: + 91 79 6608 3800

Bengaluru
12th & 13th floor
"UB City", Canberra Block
No.24 Vittal Mallya Road
Bengaluru - 560 001
Tel: + 91 80 6727 5000

Ground Floor, 'A' wing
Divyasree Chambers
11, Langford Gardens
Bengaluru - 560 025
Tel: + 91 80 6727 5000

Chandigarh
Elante offices, Unit No. B-613 & 614
6th Floor, Plot No- 178-178A
Industrial & Business Park, Phase-I
Chandigarh - 160 002
Tel: + 91 172 6717800

Chennai
Tidel Park, 6th & 7th Floor
A Block, No.4, Rajiv Gandhi Salai
Taramani, Chennai - 600 113
Tel: + 91 44 6654 8100

Delhi NCR
67, Institutional Area
Sector 44, Gurugram
Haryana - 122 003
Tel: +91 124 443 4000

3rd & 6th Floor, Worldmark-1
IGI Airport Hospitality District
Aerocity, New Delhi - 110 037
Tel: + 91 11 4731 8000

4th & 5th Floor, Plot No 2B
Tower 2, Sector 126
Gautam Budh Nagar, U.P.
Noida - 201 304
Tel: + 91 120 671 7000

Hyderabad
THE SKYVIEW 10
18th Floor, "SOUTH LOBBY"
Survey No 83/1, Raidurgam
Hyderabad - 500 032
Tel: + 91 40 6736 2000

Jamshedpur
1st Floor, Shantiniketan Building
Holding No. 1, SB Shop Area
Bistupur, Jamshedpur – 831 001
Tel: + 91 657 663 1000

Kochi
9th Floor, ABAD Nucleus
NH-49, Maradu PO
Kochi - 682 304
Tel: + 91 484 433 4000

Kolkata
22 Camac Street
3rd Floor, Block 'C'
Kolkata - 700 016
Tel: + 91 33 6615 3400

Mumbai
14th Floor, The Ruby
29 Senapati Bapat Marg
Dadar (W), Mumbai - 400 028
Tel: + 91 22 6192 0000

5th Floor, Block B-2
Nirlon Knowledge Park
Off. Western Express Highway
Goregaon (E)
Mumbai - 400 063
Tel: + 91 22 6192 0000

Pune
C-401, 4th floor
Panchshil Tech Park, Yerwada
(Near Don Bosco School)
Pune - 411 006
Tel: + 91 20 4912 6000

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