VENDIGITAL®

HOW TO SOURCE A LI-ION BATTERY

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Introduction

For EV manufacturers, one of the most crucial aspects of their strategy will be how they obtain their batteries, and how they ensure the quality of the batteries is up to the highest standard. For those that have decided to purchase complete Lithium-Ion Batteries (LIBs) rather than producing them in house, identifying the best supplier will give them the edge on their competitors, both financially and in terms of their business viability.

This guide has been created to share some procurement best practices specific to the sourcing of LIBs, with the aim of helping EV manufacturers identify the right supplier partner, as well as achieve the optimal technical and commercial outcomes.

Understand **your need**

Before embarking on a shopping spree, it is crucial to clarify the business requirements internally. This is to streamline the dialogues with supply market and avoid subsequent re-work or delay due to internal misalignment. Two main topics to focus on are Vehicle Functional Attributes and Target Volume Requirements.

01 What are the fundamental design principles of the vehicle? How does that shape the battery requirements?

Design Dimension	Useful Questions	So-What
Vehicle Type	Is the vehicle going to be Hybrid (HEV), Plug-in Hybrid (PHEV), or Battery Electric Vehicle (BEV)?	These are the three main types of electric vehicles. HEV uses batteries to support acceleration, while PHEV and BEV use them as a primary or sole source of energy and power. The required energy to power ratio increases as the vehicle type transits to BEV, or fully electric.
Range & Power	What's the required range of the vehicle? What level of battery power is required?	The longer the range within one charge, the higher capacity is required; the higher the speed requirement, the higher power is required. For BEV, the common capacity is 30-80kWh, with a 100kW power, while for PHEV, the common range is 5-20kWh, with 40-60kW power. HEV still relies on ICE for propulsion therefore battery capacity and power matter less.
Condition	Does the vehicle expect to operate in urban or rural areas? What's the operating temperature range? Does the vehicle expect to be recharged frequently?	Urban and rural journeys often differ in distance and braking frequency. The normal operating temperatures for Li-ion batteries are -20C to 60C, but extreme high or low temperatures tend to accelerate battery degradation, impacting both the capacity and power. Vehicles may be recharged frequently or have a long full charge every few days. LFP / NMC batteries are agnostic to recharging pattern.
Cost	What's the budgeted battery cost? What's the strategic position on owning or leasing the batteries?	Batteries can be up to 45% of the full vehicle BoM (BEV). An accurate budgetary estimate helps kicking off the right dialogue with suppliers. It also adds to the agility of organisational strategy to understand early on if owning batteries is a key requirement (for IP or other purposes), since if not, operational leasing is becoming a more and more popular option.
Life & Sustainability	Does your organisation have specific sustainability goals, both within and beyond first life?	Within the battery first life, sustainability metrics such as carbon footprint can be tracked with a fit-for-purpose Battery Management System and analysed by specialised software solutions. Beyond first life, batteries can be recycled for raw materials, reused, or traded with a professional vendor, each involving a specific segment of market.

02 What is the target volume ramp-up?

Volume Level	Customisation level	So-What
Low	Low	If the product required is off-the-shelf but with a low volume with no clear ramp-up, a distributor may be preferred to get more favourable commercial and logistical terms
	High	For initial, low volume of a highly customised design, a prototype partner with strong R&D capabilities may be preferred
High	Low	Securing suppliers with the right capacity and manufacturing efficiency is crucial for a known high volume of off-the-shelf products
	High	Both capacity and R&D capabilities are crucial in a supplier partner in this scenario
Evolving	Evolving	If the volume forecast is evolving but hard to commit to, and the customisation requirement is uncertain, it may be required to develop multiple supplier conversations in parallel and prepare for a multi-phase partnership from low to high volume. It is also possible to select a partner who would grow with your organisation to meet evolving capacity requirement.

Understand the **market** and **strategic match**

Once the internal requirements are aligned, they can be used to research the supply market and identify the type of suppliers, as well as supplier relationship, with the best strategic match. A few useful questions include:

01 What is the availability of the required technologies in the market? What are the common types of chemistry and how do we know which one is the most suitable?

Among a full list of available or developing battery chemistry, there are two leading types of Li-ion batteries in the market – Lithium Iron Phosphate (LFP) and Lithium Nickel Manganese Cobalt Oxide (NMC), both referring to the material in the Cathode.

Dimension	NMC	LFP	So-What
Cost over lifetime	Lower unit cost but shorter lifespan	Higher unit cost but longer lifespan	LFP is less expensive over a longer lifespan
Safety	Lower temperature threshold for thermal runaway	Good thermal stability and safety	LFP is slightly safer than NMC especially regarding thermal resistance
Energy Density	Higher energy density		For the same capacity, NMC battery will be smaller than LFP
Degradation		Slower (dependent on use)	LFP battery lasts longer with a slower degradation curve
Recycle		Less toxic material	LFP is easier to recycle with less toxic materials
Stress-test use cases	Extreme cold temperature	When battery is of a low charge	NMC performs better with colder temperatures while LFP is better when the state of charge is lower

02 Who are the top battery suppliers? What is the capacity/cost outlook? How do we expect the landscape to evolve?

Globally, there are three leading supplier, CATL, LG Energy Solution, and Panasonic, followed by some promising start-ups, such as SVOLT, Automotive Cells Company (ACC), Northvolt, and Britishvolt, while some OEMs are developing in-house cell production capabilities, such as Tesla and BYD.

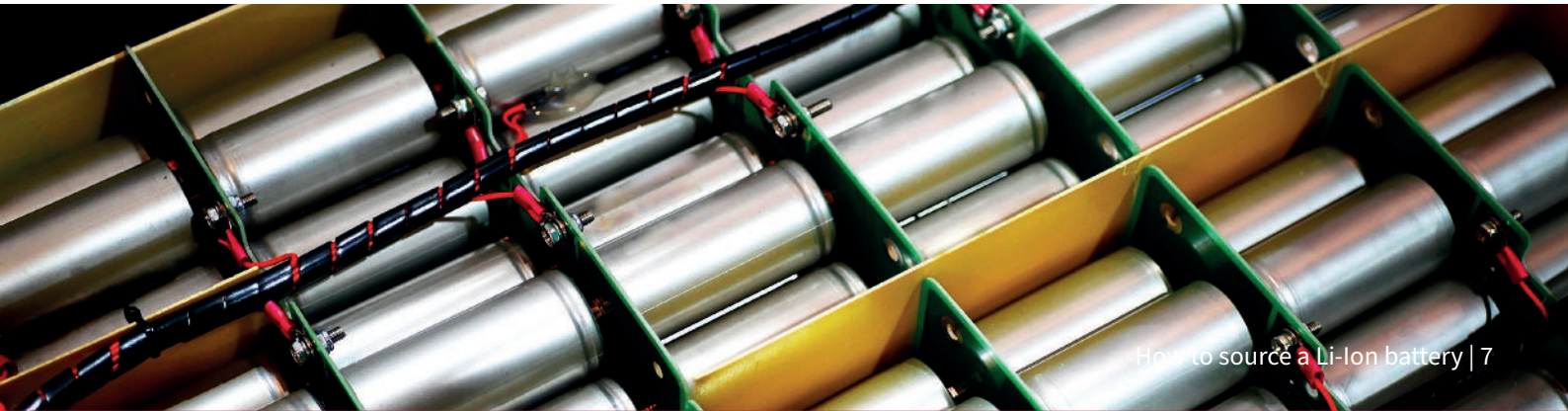
It is worth looking into both the current production capacity of battery, as well as the upstream trends, risks, and other macro factors. For example, the demand for key battery materials, lithium, nickel, cobalt etc. is expected to rise sharply in the next decade to meet the global demand – the prices of these materials have already risen by 100% or more in 2021 and the trend is continuing. If anticipated demand is strong and growing, it's crucial to understand how potential supplier partners manage their own supply chain risk, such as whether there's any partnership with raw material providers, any risk mitigation plan against potential supply chain challenges etc.

Region	Current Installed Capacity	Positive Factors	5-year Prospect
Greater China	166GWh (72% of total)	Government support Low manufacturing cost Access to raw materials (cobalt, lithium)	Remain a leader in battery production and battery raw material capacity but with reduced market share
Europe	126GWh (13% of total)	Existing plan of LG Energy Solution in Poland Additional plants of Tesla and CATL in Germany	Growing by more than 50% with a high utilisation rate
North America	63GWh	Increase in government subsidies Infrastructure bill (charging) Reserves of raw materials in Canada (cobalt, lithium, and nickel)	Market share growing by more than 800%
Japan/ Korea	72GWh	Home to four of the biggest cell manufacturers	Growing but at a lower rate due to preference for hybrids
South Asia	Minimal	India – new production linked incentive scheme for advanced chemistry cell manufacturing	Growing but at a lower rate

Assess **technical compatibility**

To understand the technical compatibility of a product to your requirements, the following technical matrix could be used as a reference point.

ID	Technical Requirement	Potential Questions
1	Chemistry	What materials are used e.g. cathode and anode? Is there any other chemistry application contained in the battery?
2	Size and Capacity	What's the power (kW)? What's the capacity (kWh)? What's the energy density (kWh/L)? What's the specific energy (kWh/kg)? What's the voltage range? What are the physical dimension and weight?
4	Charge Rate / Discharge Rate	How long does it take to charge the battery (what is the C Rate)?
5	Self-Discharge Rate	What is the self-discharge rate per month (calendar degradation)?
6	Charge and Discharge Temperatures	What are the optimal temperature ranges for charging and discharging?
7	Impedance	Are you capable of screening cells and/or cell impedance matching?
8	Cycle Life	How many charge cycles is the battery expected to achieve?
10	Disposal requirements	What are the disposal recommendations of the battery? What's the toxic content of the materials and are they easy to separate?
11	Terminal form factor	Are the batteries cylindrical, prismatic, pouch, or other?



Evaluate possible **commercial models**

Depending on the business requirements, potential commercial models are:

Owned model

It's an attractive option for consumers if anticipated usage of the vehicle is high, since the purchase costs are spread thin across a high mileage. It also gives the opportunity to drive value from second life options. However, it represents a significant, upfront investment.

As-a-service model

If a consumer's anticipated usage is light, it may be more economical to lease the batteries, where the leasing costs vary per usage. It also avoids the upfront cash outlay. However, there are very few offerings of such services – Renault offers battery leasing for cars, while for commercial vehicles the offering is still in embryo forms.

Model	Pros	Cons
Owned	Purchase cost can be spread thin if the usage is intense over a long period Opportunities to drive value from second life options	High upfront investment and significant asset to balance sheet
As-a-service	Leasing cost can be low based on a light usage profile No need for high upfront investment or significant asset in balance sheet	Leasing offerings are still few but growing

Other common commercial discussion points are listed in "Common challenges"

Common **challenges**

01

High and rising material cost

Costs of batteries are rising, and the trend is continuing. It is driven by rising raw material costs, increase in demand, constraints in global capacity and supply chain disruptions, to name a few. In the commercial discussion, please address these key cost drivers accordingly.

For example, for raw materials, try establishing an indexation arrangement where the raw material prices fluctuate with a credible, public index by an agreed, fixed margin.

To meet ramped up demand, try securing an advance agreement on future volume. It may require advance ordering and partial and full prepayment.

To lessen the impact of potential supply chain disruptions, try reviewing the logistics route of your supply and consider diversifying supply among multiple suppliers if possible.

02

Uncertain maintenance costs out of warranty

Depending on the offered warranty period from OEM, you may need to cover some of the maintenance costs before battery replacement. It is then critical to be able to simulate the maintenance profile and costs for this gap period. Data may be collected from telematics of charging infrastructure, or under the guidance of OEM. In the meanwhile, battery usage could be optimised such as by managing charging and discharging pattern, i.e., frequent short charging or long full charge every few days etc.

03

Recycling and second life

As large quantities of EV batteries are being placed in the market, reuse market of the same is also forecast to grow rapidly. As of 2022, the total addressable reuse market is 90GWh, with CAGR of 21.7% until 2030.

At the end of battery first life, either a second application (reuse) or recycling for raw material can generate further value. The current reuse market is organised regionally, but not mature enough to support a robust pricing model based on state of health of batteries, but rather driven by demand and supply and other application-specific requirements, such as the form factor. As to recycling, it is subject to both the weight of materials in a battery and the ease of extraction. Current LIB capacity is c.a. 828k tonne, with a forecast CAGR of 13.3% until 2030.

Cheat sheet: how do your requirements impact the battery costs?

Parameters		Purchase cost	Lifecycle cost
Vehicle type	HEV	Low	Low
	PHEV	Med	Med
	EV	High	High
Range & power	Low	Low	Low
	High	High	High
Capacity	Low	Low	Low
	High	High	High
Usage	Light	Same	Low
	Intensive	Same	High
Temperature range	Ambient	Same	Low
	Extreme temperatures	Same	High
Charging / discharge rates (C-rate)	Low	Same	Low
	High	Same	High
Volume	Low	High	High
	Vol	Low	Low
Chemistry	LFP	High	Low
	NMC	Low	High

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Authors

Dominic Tribe
Partner – Automotive, Vendigital
E: dom.tribe@vendigital.com

Beibei Sun
Managing Consultant, Vendigital
E: beibei.sun@vendigital.com

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At Vendigital, we deliver data-led accelerated cost transformation. We achieve this by combining multi-disciplinary consulting expertise and our proprietary digital platform – through our Insights360 methodology – to generate and embed client-specific operational insights.

An award-winning UK top-20 management consultancy, we work across procurement and supply chain; operating strategy; cost and value engineering; and portfolio management to deliver tangible, quantifiable cost benefits for clients.

Core to our approach is our deep industry and operational expertise, and in-house data science capability – importantly, this is underpinned by our extensive business transformation and implementation experience.

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vendigital-ltd

vendigital.com

@VendigitalLtd

+44 (0)20 3871 2769

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+44 (0)20 3871 2769 vendigital.com vendigital-ltd @VendigitalLtd