STRATEGY ENGINEERS

Study

# Electrified opportunities with traction batteries

How automotive suppliers can grow a profitable battery business

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## Management summary

Electrification brings radical change to the automotive industry – change that not only affects OEMs and end customers, but the entire supply chain involved. In an electrified powertrain, the traction battery is the single most valuable part. It also largely defines vehicle range, which is of high importance in customers buying decisions. OEMs and suppliers are busy finding their positioning along the emerging battery supply chain to claim their stake in its value. This study examines opportunities for suppliers of automotive battery systems and battery components to grow profitable businesses for the electrified automotive future.

In the first step, we analyse original equipment manufacturers' (OEMs) demand for automotive battery systems by combining views on make-or-buy and technology strategy. Integrating data for battery market price development as well as bottom-up data for light-duty vehicle production, we forecast a global market potential of € 113 bn for battery electric vehicle (BEV) batteries in 2030 – equal to an average battery value of € 5,200 per car.

To engage in this market, suppliers can select one out of four different supplier plays from component to system level. We expect most OEMs to source battery cells as complete sub-system or even higher integrated as complete battery system. Only for Global Volume OEMs, we see the potential to enter the cell business on component level. In addition to the cells, we consider housing, electrics / electronics and thermal as the other sub-systems of a battery pack. Large OEMs consider these other sub-systems an opportunity to sustain employment – which is much needed since BEVs are less labour intensive in assembly. In turn, they will aim to keep value creation in-house by sourcing from component suppliers. In contrast, we forecast niche as well as new OEMs to opt for sourcing on higher integration levels.

In the second step, we analyse actual supplier offerings from a financial perspective by assessing the battery system's value structure and viable integration paths from component to system level. For a BEV battery pack, the cells are the most valuable sub-system accounting for 74% of system value. Today, global cell supplies are shared between few Asian companies. We do not see economic incentives for these cell suppliers to expand to system level for three reasons: (1) Cells yield the highest margin potential within the battery, (2) cell production requires deep technological and process knowhow, and (3) cell types can be standardised. For suppliers specialised in other battery sub systems, we do not see a chance to integrate to system level without close partnering with a battery cell supplier. Again, the reason being the exceptional value and margin potential the cells are holding. If battery cells and the related system business are excluded, the remaining market is still holding € 35 bn in 2030. Within this market, chances are high for suppliers to benefit from electrification through component-based innovation or meaningful integration of sub-systems.

Its value structure and supply situation make battery systems a challenging environment for suppliers looking for system opportunities: Cells dominate the battery system both in terms of value, margin, and performance. In parallel, most OEMs seek to capture value creation on system integration level. As a result, suppliers should focus on providing innovation on component level for battery housing, electrics / electronics, and thermal design. For those who want to grow profitable businesses with batteries, we recommend ten first steps at the end of this study.

## Introduction

The automotive supply chain faces a drastic change with the upcoming electrification of powertrains. Throughout the past 30 years, suppliers seized the opportunity to spread their product and service portfolio, thereby increasing their share of value creation inside the automotive supply chain. With the traditional internal combustion engine slowly being replaced by electric powertrains, OEMs rethink their role in the supply chain and might capture the chance to gather electrification know-how in-house rather than opting for buy-in from suppliers.

On these grounds, suppliers need to decide now on where to position themselves to get most of the automotive supply chain of tomorrow. With the traction battery being one of the most critical but value promising parts of the electrified automotive propulsion system, we examine in this study which role Tier-1 suppliers of BEV batteries should take along the battery supply chain. We will therefore answer the following questions:

» How is the battery demand forecast until 2030?

» Where could suppliers position themselves inside the battery system?

» What integration depth do OEMs ask for in their suppliers?

» What are possible expansion paths for suppliers?

## An outlook on the automotive battery market

We've come a long way from Alessandro Volta constructing the first electrochemical cell around the year 1800 to today's batteries that power devices of all sizes and kinds. While we are used to primary and secondary batteries inside everyday appliances for a long time, their application inside cars – replacing conventional fuels – is still new to the market. This is about to change. We believe, that until 2030 electrified vehicles (xEVs) will experience an upturn that will drive growth for traction batteries. In the following chapter, we explain our understanding of the traction battery and its respective sub-systems. Afterwards, we will change perspective and look at the Strategy Engineers market forecast for automotive traction battery systems.

### Comprehending traction batteries and their sub-systems

As a joint evaluation base, we cluster automotive traction battery systems into five sub-systems along the assembly sequence (see also Figure 1): Battery cells, the battery module, thermal functions, E/E and the battery housing. Additional to the five sub-systems, we will also take **integration and assembly** into consideration to get a holistic picture of the value creating factors of a battery.

» **Battery cells** represent the heart of the battery system and are either designed as cylindric, prismatic or pouch cell. For automotive application, they have to meet different requirements such as energy density, safety characteristics or fast charging ability next to factors like dimension, weight or cost.

» The next sub-system we consider is the **battery module**. For ease of assembly and maintenance, common automotive traction batteries are usually designed in a modular structure. In our definition, the module contains structural elements as well as cell contacting, wiring and sensors.

» To guarantee full operational performance and availability at all operating and environmental conditions, an efficient **thermal management** is crucial. It performs cooling and heating tasks that depend on both the kind of vehicle and the type of cells chosen. The battery thermal system is linked to the vehicle thermal system including interior heating, ventilation and air conditioning.

» **Electrics and Electronics** (E/E) are the fourth sub-system. Typical xEV architectures are designed for voltages between 48 and 800 V. E/E includes the high and low voltage wiring harness, connectors and sensors as well as the control unit of the battery management system (BMS). The latter is responsible for charging and discharging of the battery and keeps track of battery health. For example, the BMS keeps track of critical incidents (e.g. shocks, high temperatures, overvoltage) and supports on- and off-board diagnosis.

» The **battery housing** is the fifth sub-system we consider. It represents the internal and external structures of the battery pack and protects it from mechanical impact and external hazards. Depending on the vehicle design, the battery housing also functions as an integral part of the vehicle body providing stiffness.

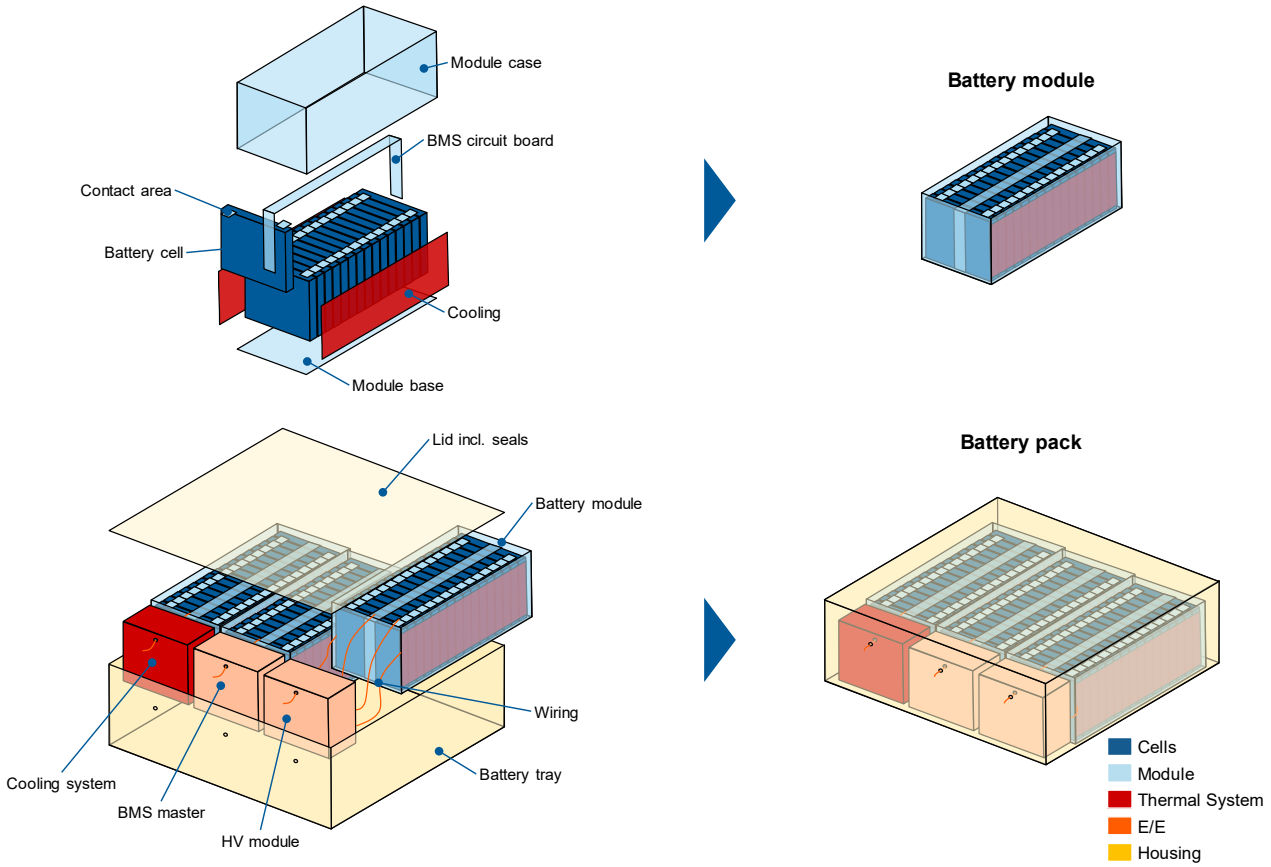


Figure 1: Structure of a battery module and a battery pack and assignment to sub-systems (illustrative)

## Knowing what to expect - battery market forecast

The Strategy Engineers vehicle market outlook (Figure 2) considers the expected vehicle production until 2030. We use it to outline the development of different propulsion systems and thereof derive the future market potential of batteries.

xEVs are forecast to outnumber conventional vehicles until 2025

Until 2025, the production of electric vehicles (xEVs, consisting of xHEVs, FCEVs and BEVs) is forecast to have outnumbered those of conventionally propelled vehicles according to our forecast. We see a steady increase of xEVs from 11.4 mn vehicles as of today to 75.9 mn vehicles being produced in 2030. In the same period, the production of conventional vehicles is more than halving from 86.9 mn in 2019 to 40.9 mn in 2030.

Europe and China push global xEV production volumes

The growth of xEVs is mainly driven by the European and the Chinese market where the total vehicle production is forecasted to grow with an increasing share of xEV. In Europe, we expect that all light vehicles produced in 2030 will be electrified. In China, we expect this share to be 80%. The North American market on the other hand is forecast to show an electrification rate of only 60% in 2030, accompanied by a stagnating total production volume growth.

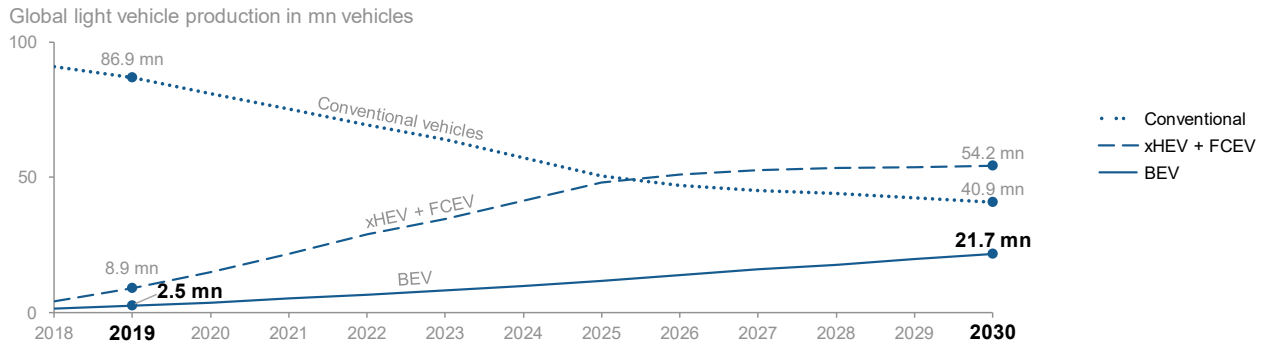


Figure 2: Strategy Engineers global light vehicle production forecast

It is important to recognise the conditions and limitations of such market forecasts. The Strategy Engineers forecast is more ambitious than other forecasts since it assumes that customer acceptance of electrified vehicles will grow and that more and more governments and cities around the world will ban conventional combustion vehicles. Because most market forecasts model the number of electric vehicles needed to avoid penalties, and therefore assume that OEMs rather invest in R&D than in non-compliance, they neglect that customers might eventually like EVs. Even though we are also sceptical about product attractiveness in near-term due to lacking charging infrastructure, concerns about well-to-wheel sustainability or high sales prices, we hypothesize that in the years to come, EVs with practical use and promising drive experience will be available to affordable prices. This in turn would raise the question as to whether the automotive supply chain would be ready to cover higher-than-expected demand for the new energy vehicles they have been so tentative to develop.

Anyways, suppliers should be prepared to deal with any of the given market scenarios, be it driven by the need to comply with legislation or by end customer demand. Because at the end of the day, the question is not if electrification will come but rather when and for which application.

## Supplier strategies to electrify drive

To assess the future strategic positioning of traction battery suppliers, we examine possible options from three sides that need to be considered collectively. First, suppliers need to take informed decisions on choosing the right integration depth for their product. Second, they need to know their potential customers and their current and expected demand to adjust their portfolio bandwidth if necessary. Third, they need to understand both value and margin opportunities of their focus components to grab the chance to expand their portfolio if possible or needed.

### Chosing the right integration level

According to their integration depth in the traction battery assembly sequence from component to system level (compare Figure 3), we segment suppliers in four different plays from component to system level. This sets the base to evaluate strategic options we see for suppliers when positioning themselves in the future supply chain.

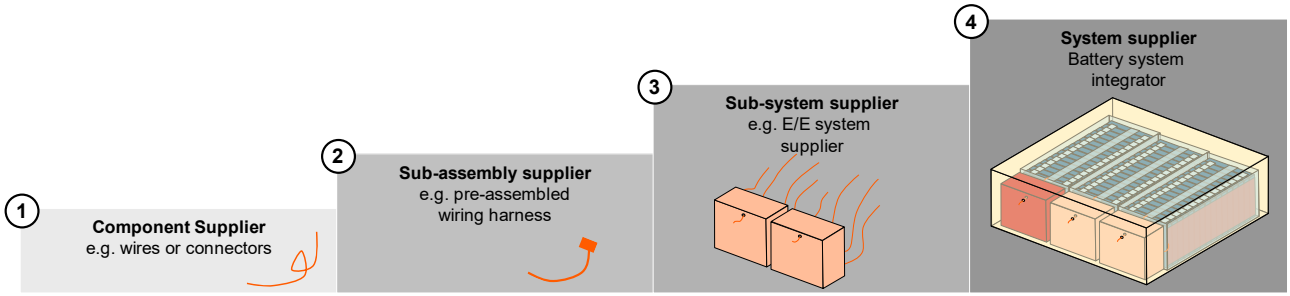


Figure 3: Battery technology supplier roles

- On the lowest integration level, a supplier following the **component** play will provide single parts to OEMs. For the E/E sub-system of an automotive battery, this could be wires or connectors.
- The second level, which we call the **sub-assembly** level, includes suppliers that offer pre-assembled components to vehicle manufacturers, such as for example a wiring harness for the E/E sub-system.
- In case the supplier already performs multiple assembly steps before delivering their product, we speak of a **sub-system** supplier. These would deliver their customers specific sub-systems according to their requirements, e.g. a thermal subsystem or an E/E sub-system.
- The fourth and last level is considered **system** level where suppliers offer complete battery systems that can be integrated into a given vehicle. These would be developed in close alignment with both the OEMs and potential third-party suppliers to ensure thorough compatibility with the vehicle and its specifications.

In summary, a higher integration level promises a higher share of value creation for the supplier but also causes additional effort. The supplier would not only need more in-house expertise and a higher tooling and production invest but also has to set up a closer collaboration with the respective OEM or potential third-party suppliers.

A higher integration level provides the chance to increase value creation for suppliers

## Understanding sourcing strategies of OEMs

The current and expected future sourcing behaviours of OEMs determine the business opportunities for Tier-1 BEV battery suppliers. Building on the assessment of OEM make-or-buy strategies, we cluster passenger cars OEMs into seven segments (see Figure 4) to analyse the demand side of the battery market.

Due to their specific system value shares, we consider the battery cells separate from all other sub-systems. From expert interviews, we derive the trend that large OEMs are likely to refer to suppliers on component level through all sub-systems while in contrast, newcomers, niche OEMs and followers are expected to address their battery supply on higher integration levels.

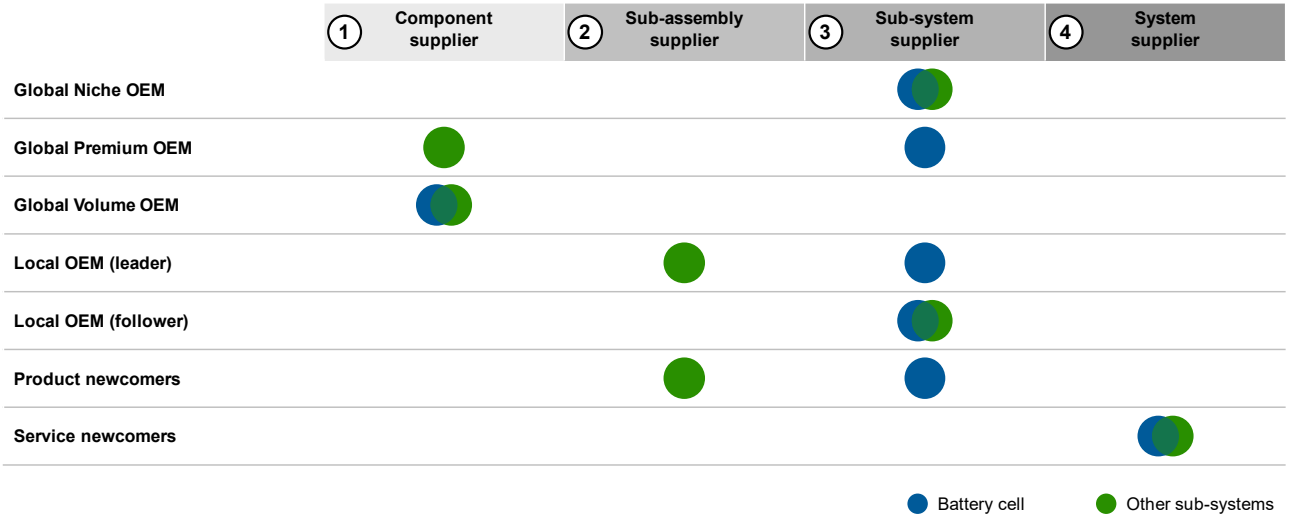


Figure 4: Specific sourcing behaviours of different OEM segments

Global Premium and Volume OEMs demand suppliers on component level to secure jobs and keep their know-how inhouse

We expect the two largest segments **Global Premium** (e.g. Porsche) and **Volume OEMs** (e.g. Toyota) to focus on component suppliers for all sub-systems except the battery cells for two reasons: (1) They intend to develop and keep BEV capabilities internal to increase inhouse expertise and value creation. (2) They look at large labour forces whom they need to employ. Since Global Volume OEMs have the resources to keep the valuable part of the battery business in-house, we expect them to cover the cell assembly as well. This way, they are also sourcing cells on component level. Global Premium OEMs though are rather sourcing the cell as assembled sub-system to integrate it into their battery pack.

Even though **Local OEMs (leader)** like Geely or PSA face the same employment issues as the Global Premium and Volume OEMs, they do not have the possibility to develop internal expertise due to engineering resources and required investments. Suppliers on sub-assembly level can get their share of value creation in this segment and support their customers in sustaining their leading role. For the battery cell, we expect local OEMs to source the whole cell itself on sub-system level.

**Product newcomers** like NIO often require specially tailored batteries for their design and package innovations. However, they do not have a internal organisation or established supplier structure which is why they need to rely on experienced partners for joint development. Since their business relies on daring and disrupting innovations (e.g. integrated body design or quickly exchangeable batteries), they will not

outsource the entire battery business – we rather expect them to ask for sub-assembly suppliers for most sub-systems while sourcing the battery cell as complete sub-system and performing the assembling and integration steps themselves.

**Global Niche** and **Local OEMs (follower)** like Jaguar or FIAT have in common that they cannot rely on rich engineering resources. For this reason, they need reliable sub-system providers for all sub-systems. Tier-1 battery suppliers can seize the opportunity to build strong and valuable partnerships with OEMs in these segments – with the opportunity to become the preferred system supplier in the long-term.

**Service newcomers** like Uber lack both an experienced organisation and product know-how. Since they do not focus on the engineering part, we expect them to be the only segment to source the battery pack as an integrated system. Therefore, they need to establish a close partnership with their system supplier.

In summary, battery cells are sourced as complete sub-system by most OEMs – only Global Volume OEMs have a chance to dig deeper into cell manufacturing. For the other sub-systems, we observe that traditional, high-volume OEMs show a trend to initially increase their inhouse value creation, while niche and newcomer players on the electric vehicle market are dependent on system or at least sub-system level suppliers with respective experience and resources.

The battery cell will mostly be sourced as complete sub-system

## Creating value with automotive batteries

In today's BEVs, a traction battery accounts for average cost of € 8,190 per vehicle, assuming a 65 kWh battery pack. We believe that this cost will decrease by 3.9% annually over the next years to € 5,200 per vehicle in 2030 assuming constant 65 kWh. Starting from this assumption and the Strategy Engineers vehicle market outlook introduced in the previous chapter, we derive the global traction battery system demand. Despite the decreasing cost per vehicle, we expect the global BEV battery demand to grow by 17% per year to € 113 bn until 2030. Approximately 60% of this is forecasted to be covered by demand from Global Premium and Volume OEMs on low supplier integration levels. Compared to the market of xHEV and Fuel Cell batteries, this market is expected to be more than four times larger.

60% of the global battery market is covered by suppliers for Global Premium and Volume OEMs

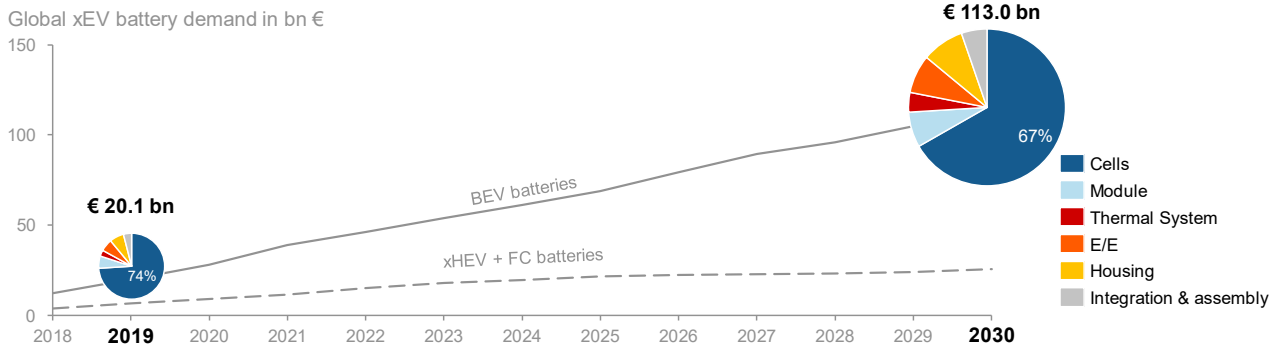


Figure 5: Global xEV battery demand and value share

Next to the predicted battery demand, suppliers need to consider the value and margin share of batteries, to maximise their margin potential. Inside a battery system, the battery cells account for approximately three fourth of the value (compare Figure 5). Due to cost digression on cell level though, this share is forecast to shrink from

74% to 67% over the next years until 2030. Nevertheless, the battery cell stays the highest value sub-system of the battery by far.

Battery cells account for 82% of a battery system's EBIT margin potential

Combining value share and typical margin potential assessed from analysing more than 60 suppliers, we analysed the EBIT margin contribution of a complete battery system as shown in Figure 6. In total, an EBIT margin potential of 10.7% is assessed for 2030 with tendency to decrease further. In this point of view, the battery cells are the dominating sub-system of the battery and account for 76% of the total in 2030. E/E sub-system follows with an EBIT margin contribution of ~9%, the housing with ~6%, the module and the thermal system as well as integration and assembly.

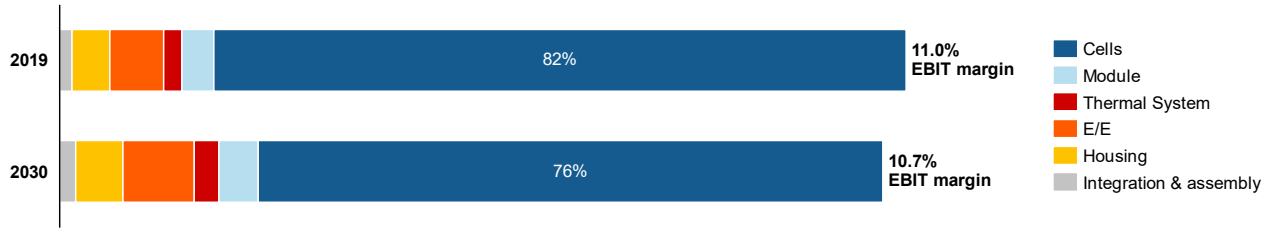


Figure 6: EBIT margin potential and contribution of the sub-systems for 2019 and 2030

In summary, when revising their portfolio, suppliers need to decide which integration level to offer. The supplier panel that we analysed indicates that positioning on component level and offering a highly focussed portfolio allows highest profitability options. Since assembly services are less profitable than pure manufacturing tasks, component suppliers typically have higher profitability opportunities. Additionally, companies with a higher focus on their product portfolio can build unique capabilities and expert know-how which gives them the chance to outperform competitors with a broader spectrum. System suppliers for a complete battery pack would need to offer better electrical, thermal and mechanical integration than OEMs or pack specialists which seems daunting. Even if they could, it would be impossible to achieve good EBIT margins without owning the cells.

## Accessing the supply chain

For suppliers, it is crucial to find early access to the battery supply chain of the future and understand their business opportunities. We see four different possible paths to expand their portfolio for this as depicted in Figure 7.

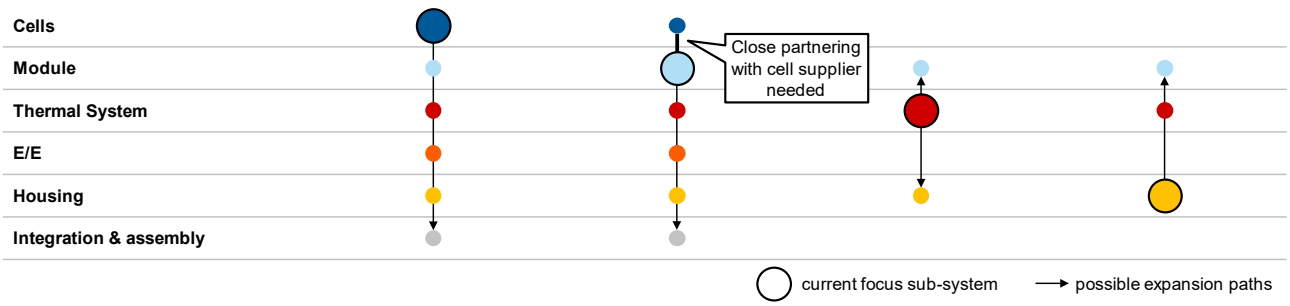


Figure 7: Integration paths inside battery systems from suppliers

Cell suppliers have a chance to expand to system level because they have control over the most valuable part of the whole system. But since the cell itself is already

System level is only attainable for cell or module suppliers

the most promising when it comes to margin potential, this path does not seem economically meaningful since it could shrink total EBIT margin and add unnecessary complexity to the business. Moreover, typical competences for cell production are very different from the rest of the battery.

Module suppliers on the other hand have a realistic chance to expand their business to system level when establishing a close partnership with cell suppliers – even though economic efficiency is challenging as discussed above. Since sub-system suppliers for Thermal Systems or Housing are specialised in metals or plastics, they can opt to expand to other structural parts of the battery.

We nevertheless see innovation potential for sub-system suppliers beyond the cell business, e.g. when it comes to new technologies for the thermal system or electrics and electronics. Besides, E/E also holds a promising EBIT margin potential that is comparable to that of battery cells. Because they do have a lower value share inside the battery that does not affect the whole battery margin as much as the battery cell does. When a supplier would focus on all sub-systems except the battery cell, he could achieve a possible EBIT margin of 7.7% compared to 11.0% of the whole system. The accessible battery market decreases by 70% from € 113.0 bn to € 34.5 bn when battery cells are out of scope.

If suppliers of electrical or thermal sub-systems would deepen their integration level to become a battery system supplier, they would have to buy battery cells from the specialists and therefore face massive challenges including:

- Only controlling a minor share of the product while depending on battery cell specialists for most of the product value (the cell)
- High likelihood of the third-party cell supplier to interfere when it comes to the module design
- Unfavourable impact on price and delivery commitments through limitation in scaling
- Full system liability towards the OEM

If suppliers miss the chance to enter the supply chain now, they might have to face high entrance barriers in the future – and might then only get the chance to replace the first-generation competitors by either beating their pricing or by coming up with great innovations on the product.

## A supplier's agenda to grow a profitable business

Time is running out for suppliers: Those who want to participate in the expected market take-off from 2022 onwards need to prepare now. We define the following ten steps to be taken by suppliers. There is a mere three years left to kickstart a profitable battery business.

First, suppliers need to define their future product offering and portfolio:

1. **Integration level**
   Choose the right integration level for you from component to sub-assembly and sub-system level
2. **OEM customer segment**
   Select which customer segment you want to address and understand their specific needs
3. **Make-or-buy decision**
   Decide about make-or-buy of components and think about how to broaden the product portfolio
4. **Margin and revenue potential**
   Consider margin and revenue potential depending on the chosen product portfolio and integration level
5. **Partnerships**
   Add missing parts and competences through partnering with organic or inorganic options

Second, suppliers need to understand how to master the challenges of the upcoming electrification business inside and outside their company:

6. **Capabilities and know-how**
   Assess existing capabilities and know-how inside your company and decide where and how it needs to be extended
7. **Project organisation**
   Define the right project organisation and lay out the long-term organisation development, e.g. from a project centre to a new division
8. **Simultaneity of businesses**
   Master the simultaneity of running current and entering new business at the same time. Address differentness of both businesses in e.g. organisation, decision making or required competences
9. **Business case**
   Calculate and evaluate tailored business cases for decision making, modelling specific ramp-up and implementation scenarios
10. **Customer collaboration**
    Develop and evaluate collaboration models with selected OEM customers to facilitate go-to-market

## Nomenclature

| | |
|---|---|
| BEV | battery electric vehicle |
| BMS | battery management system |
| EBIT | earnings before interest and taxes |
| E/E | electrics and electronics |
| EV | electric vehicle |
| FCEV | fuel cell electric vehicle |
| HV | high voltage |
| kWh | kilo watt hour |
| (M)HEV | (mild) hybrid electric vehicle |
| OEM | original equipment manufacturer |
| PHEV | plug-in hybrid electric vehicle |
| R&D | research and development |
| xEV | all electric vehicle architectures |
| xHEV | all hybrid electric vehicle architectures |

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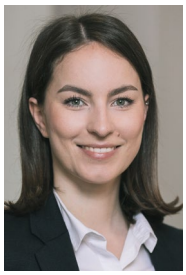


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