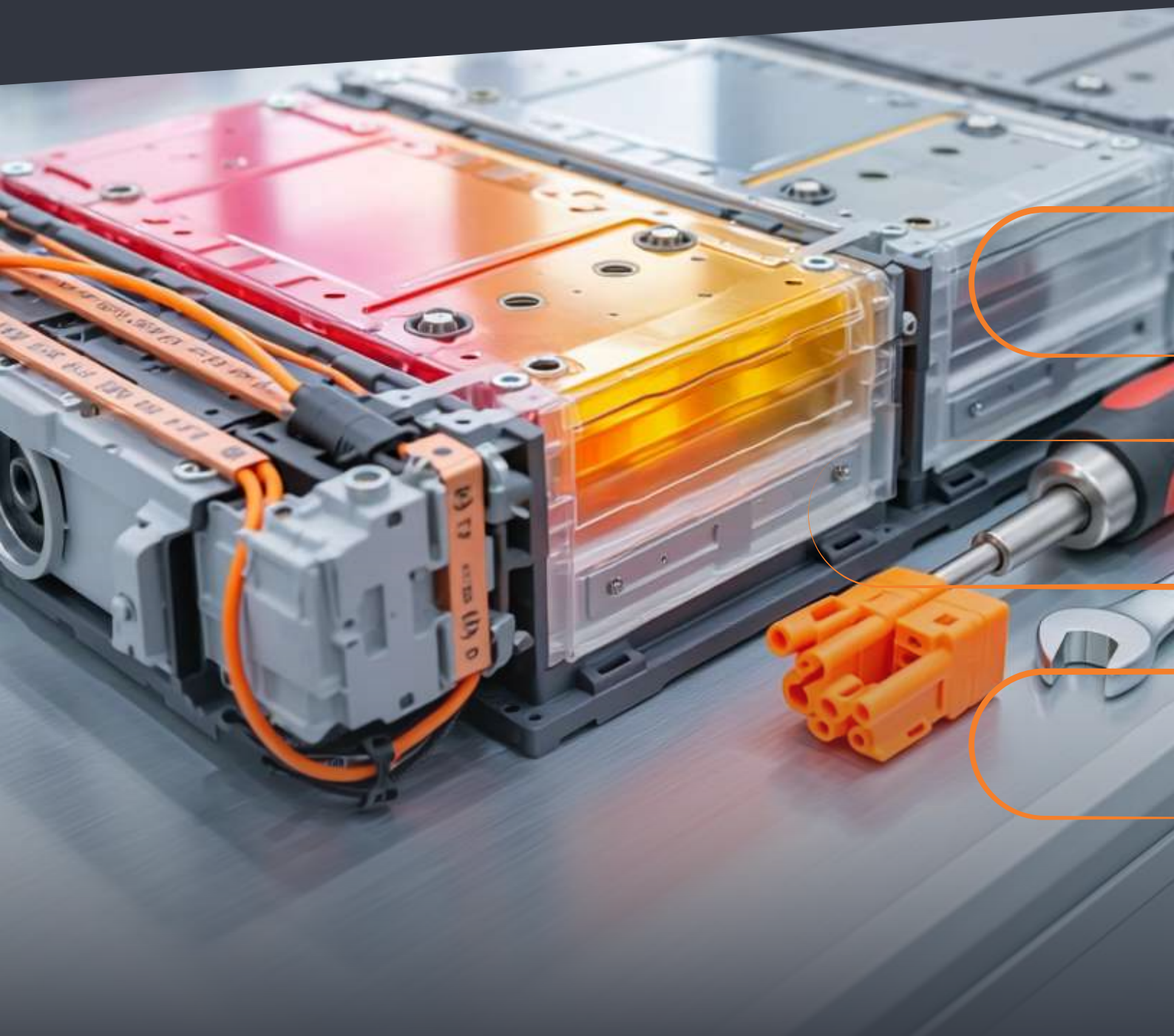
EFESO
MANAGEMENT CONSULTANTS

Building Scalable EV Battery Cell Factories

A Strategic Approach to Scalable, Risk-Aware Battery Manufacturing



The *Gigafactory Paradox*: Growth Meets Uncertainty

The rapid growth of the EV battery market creates enormous opportunities - but also introduces significant investment risks.

The European battery market is projected to grow exponentially in the coming years, with cell manufacturing representing one of the largest value-creation segments in the EV ecosystem (approx. 30% of total value chain revenues by 2030).

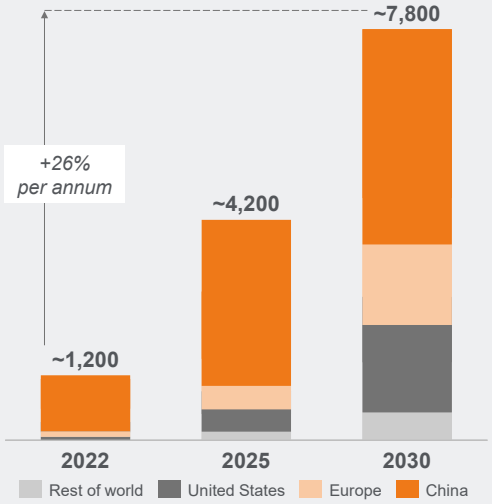
At first glance, the strategic conclusion seems obvious: build big, build fast, build gigafactories. Yet reality has shown something different.

The past years have demonstrated that large-scale gigafactory investments (>50 GWh) are exposed to significant political, financial, and operational volatility. Rapid demand shifts, financing constraints, technology changes, and ramp-up complexity have turned several large investments into high-risk ventures.

The challenge is no longer only technological.
It is strategic.

How can investors and manufacturers capture market growth without exposing themselves to oversized, inflexible investments?

"Global Li-ion cell demand growth & value distribution" chart



Sources: Fraunhofer ISI, 2024

Why Bigger is not *Always Better*

Large gigafactories promise scale - but in volatile markets they also increase financial, operational, and strategic risk.

Gigafactories are often seen as the fastest way to capture market growth. However, very large investments also concentrate risk.

High upfront CapEx, long realization timelines, ramp-up complexity and uncertain demand create fragile investment structures. If market conditions change, oversized factories can quickly become structural liabilities.

Recent developments in the European battery sector highlight three main risk areas:

Financial

- Financing constraints and rising capital costs
- Long payback periods
- High exposure to demand volatility and utilization risk

Operational

- Ramp-up complexity and operational delays
- Workforce availability challenges
- Supply chain dependency for critical materials and equipment

Strategic

- Structural overcapacity risks
- Technology inflexibility according to cell chemistry
- Reduced ability to adapt footprint and capacity to market shifts

In volatile markets, scale without flexibility can destroy value. Growth remains essential.

The challenge is to scale in a controlled and resilient way.

Start Small. *Scale Smart*

A modular factory strategy allows manufacturers to scale production while maintaining flexibility in an uncertain market.

The key question is therefore not whether to invest in cell production - but how to do so without exposing investors to excessive risk.

EFESO's strategic approach is based on one simple principle: build modular, scalable cell factories that grow with demand - not ahead of it.

Instead of starting with 50 GWh capacity, we propose beginning with a robust, optimized 5 GWh production unit, designed from day one for seamless expansion.

This approach offers:

- Lower initial investment exposure
- Faster realization time
- Easier financing access
- Reduced operational risk
- Technology adaptability
- Controlled scaling (e.g., 5 + 5 + 5 GWh modules)

> *"Scalability is not an afterthought. It is embedded into the architecture."*

Designing the Right Cell Factory: *Strategic Foundations*

Key strategic decisions made early in factory planning determine the scalability, cost structure, and long-term success of the facility.

Before defining layout or machinery, the right strategic questions must be answered:

- Which cell design (prismatic, cylindrical, pouch)?
- Which chemistry (LFP, NMC, future technologies)?
- What installed starting capacity?
- What is the long-term expansion potential?
- What footprint is required?
- What CapEx structure is sustainable?
- What value stream shape supports future growth?

Battery production is highly dependent on design and chemistry decisions.

Each choice impacts machinery, layout, utilities, CapEx, and scalability potential. This is why strategic alignment must precede technical planning.

Product	Industrial	Strategic
Chemistry	Capacity	Location
Design	Value Stream	CapEx
		Expansion

The U-Shape Production Concept: *Built for Growth*

A modular U-shaped production layout enables efficient operations while allowing seamless future expansion.

A central differentiator of the EFESO concept is the U-shaped production layout, integrating eleven core production steps:

1. Mixing
2. Coating & drying
3. Calendering
4. Slitting
5. Vacuum drying
6. Winding
7. Packaging
8. Electrolyte filling
9. Formation
10. Aging
11. End-of-line testing

Arranged within approximately 30,000 m², this layout ensures:

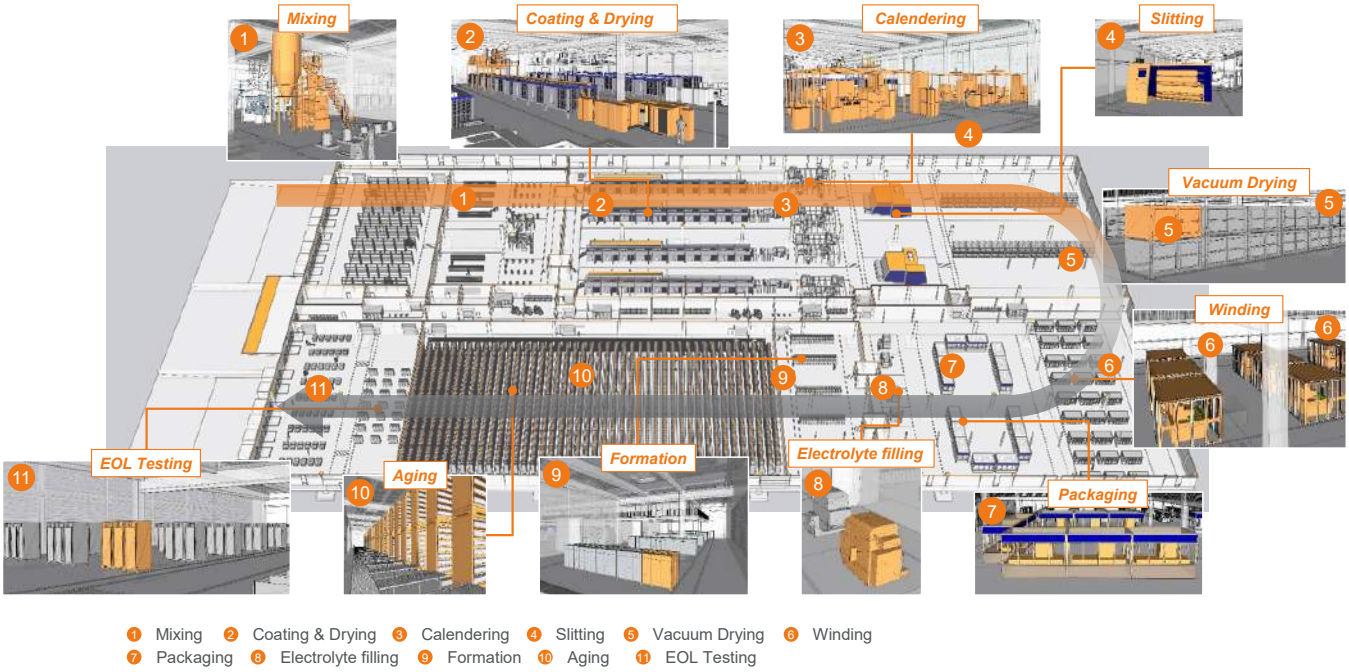
Short internal transport distances	Efficient material flow	Optimal space utilization	Clear production zoning

But most importantly: it allows **lateral scalability without internal reconfiguration.**

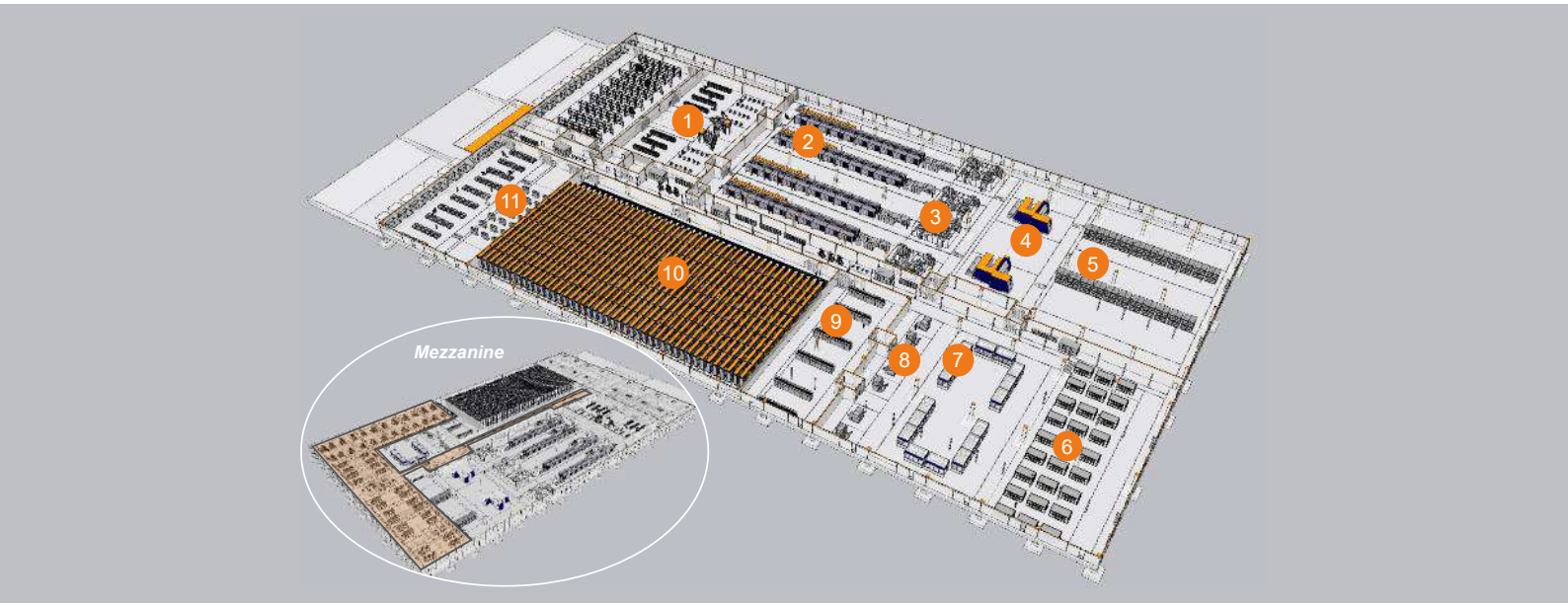
- Each production module can be extended outward.
- Additional mixing lines can be placed adjacently.
- Coating lines can be replicated next to existing ones.
- The building envelope expands - the core production logic remains intact.
- This eliminates one of the biggest scaling risks: reconfiguring heavy, complex production systems.

> *Scalability is physical, not theoretical.*

11 production steps visualization



U-shape layout visualization with key facts



1 Mixing
2 Coating & Drying
3 Calendering
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11 EOL Testing

The 5 GWh *Reference Factory*

A 5 GWh reference factory demonstrates how scalable battery production can balance investment efficiency and operational performance.

To demonstrate feasibility, EFESO developed a fully dimensioned reference case

Key figures:

- 5 GWh annual capacity
- ~1,900 cells/ h output
- ~30,000sqm production building
- ~140,000sqm total plot footprint
- ~500 employees
- CapEx ≈ €300 million
- Realization time ≈ 2.5 years
- Fully automated aging warehouse

This reference is not a “one-size-fits-all” solution. It is a proof of concept demonstrating:

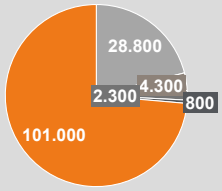
- Technical feasibility
- Investment structure transparency
- Operational scalability
- Sustainability integration

5 GWh is not small. **It is strategically right-sized.**

Project key figures & cost breakdown

Areas [m²]

- Production area
- Logistic area
- Administrative area
- Technical area
- Outdoor area



~ ∑ 30.000 m²

Output rate

~1900 cells/h

Employees

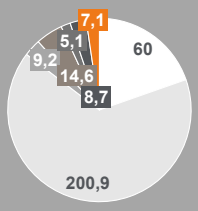
500

Realization time

2,5 years

Costs in m€

- Construction costs
- Systems and machines
- IT Infrastructure
- Utilities
- Logistics Equipment
- Planning, Enginering & PM
- Miscellaneous



~ ∑ 300 m€

Capacity

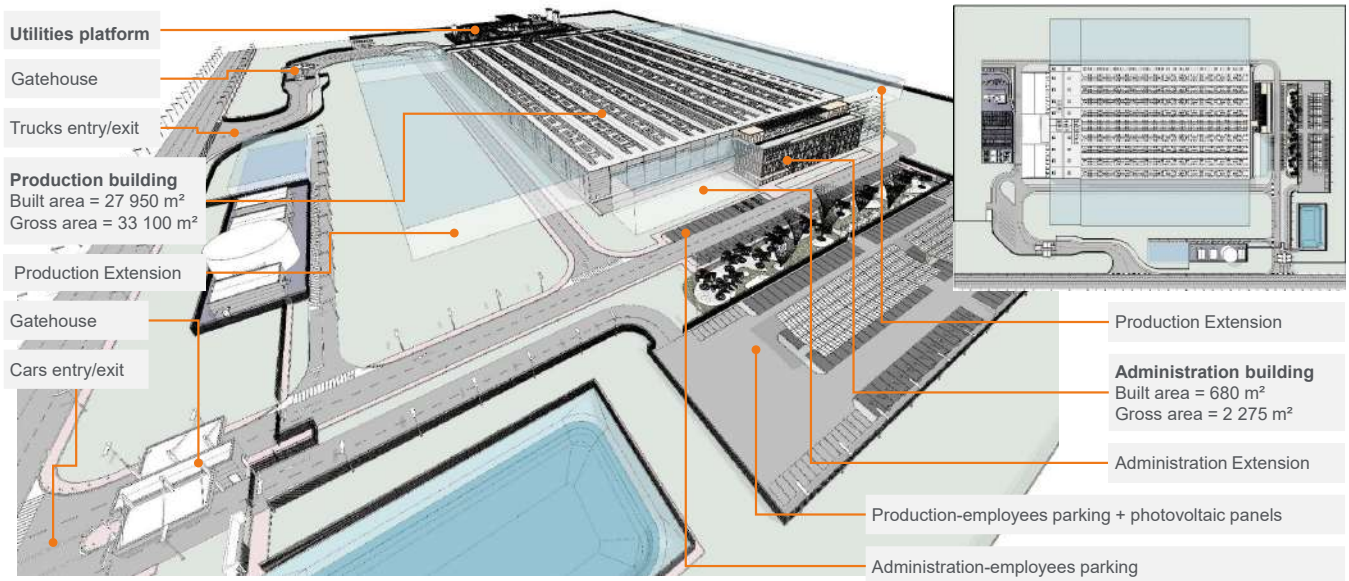
5 GWh/year

Sustainability

CO_2

-100%
reduced CO_2 emissions

Site extension visualization



From Vision to SOP: EFESO as *One-Stop Partner*

EFESO supports clients across the entire factory lifecycle - from strategic concept development to industrial ramp-up.

Building a battery cell factory is not only a construction project. It is a strategic transformation journey.

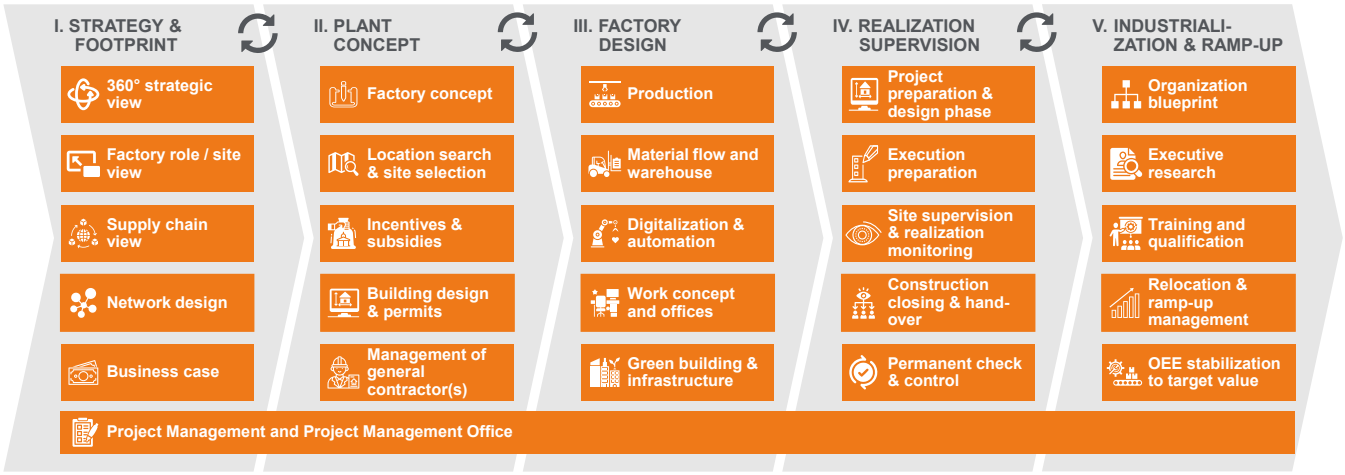
EFESO supports clients across all phases:

- Strategy & footprint definition
- Business case development
- Location search & incentives
- Factory concept design
- Production & material flow engineering
- Building design & permits
- Digitalization & automation planning
- Green building & sustainability integration
- Realization supervision
- Industrialization & ramp-up
- OEE stabilization

This integrated approach ensures:

- Alignment between strategy and execution
- Controlled CapEx
- Shorter time-to-SOP
- Stable ramp-up

EFESO one-stop-shop capability overview



*We support our customers holistically or in every phase in which our customer currently finds himself OEE = Overall Equipment Effectiveness *Topics are cross-phase and are only assigned for rough indication*

Conclusion: Scalable Investment as *Strategic Insurance*

In volatile markets, scalable investment strategies reduce risk while preserving long-term growth potential.

The EV battery market will continue to grow, but volatility will remain.

The objective is not to eliminate uncertainty. It is to design investments that can withstand it.

A scalable, modular 5 GWh starting factory:

- Reduces financial exposure
- Maintains technological flexibility
- Enables controlled growth
- Protects investor value

The battery market will reward scale - but only when it is built on flexibility.

In a volatile market, flexibility is not optional. It is strategic insurance.

Contact our experts

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EFESO

MANAGEMENT CONSULTANTS

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