



Bridging the Global Cost Gap in Battery Cell Production

From Locational Factors to Factory Planning and Policy Design

Maximilian Lechner^[a], Felix Nanz^[a], Felix Diller^[a], and Rüdiger Daub^[a,b]

^[a] Technical University of Munich, Germany; TUM School of Engineering and Design, Department of Mechanical Engineering, Institute for Machine Tools and Industrial Management (iwb), Boltzmannstr.15, 85748 Garching, Germany – ✉ maximilian.lechner@iwb.tum.de
^[b] Fraunhofer Institute for Casting, Composite and Processing Technology (IGCV), Am Technologiezentrum 10, 86159 Augsburg, Germany

Motivation

Lithium-ion battery cell production is currently concentrated in Asia, resulting in cost advantages that challenge emerging European and North American gigafactories. Despite large-scale policy support, many projects struggle to reach economic viability.

Goal:

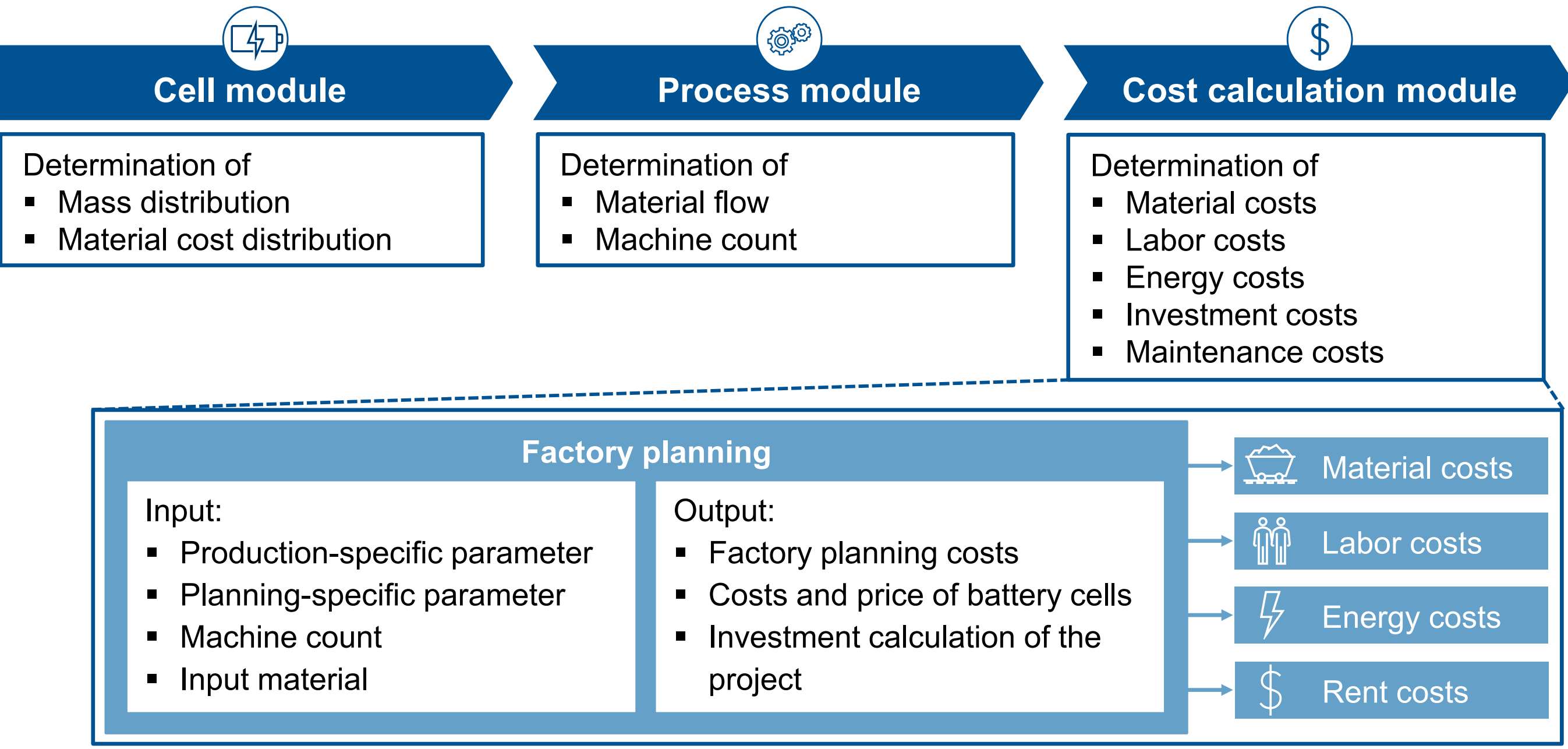
- Extend an existing battery production cost model
- Separate location effects from structural cost drivers
- Evaluate factory planning, ramp-up, and policy measures
- Identify realistic levers to improve competitiveness

Methodology

A techno-economic cost model [1] is applied and extended to capture the full lifecycle of a battery cell production, including early project phases that are often neglected in cost analyses. Fig. 1 provides an overview of the base model and its extension.

Model characteristics:

- Full, marginal, and leveled cost calculation
- Explicit modeling of factory planning and ramp-up phase
- Integration of policy instruments



Legend: Base cost model (Lechner et al. 2024) Factory planning extension

Fig. 1. Overview of the cost model structure comprising the base model from Lechner et al. (2024) [1] and the extended factory planning model

Results & Discussion

Case study scenario:

- Cell format: Cylindrical 4680
- Chemistry: NMC811 | Graphite
- Production capacity: 15 GWh per year

Scenario variations:

- I. Production location (GER, SWE, HUN, USA, CAN, CN)
- II. Ramp-up duration
- III. Subsidy forms

I. Production Location

A comparison of global production locations shows that differences in site-specific costs are smaller than commonly assumed (cf. Fig. 2).

Key findings and interpretation:

- Location-based cost gap: ~ 6 \$ kWh⁻¹
- Material costs (>80%) dominate at all locations.
- Labor, energy, and building costs affect rankings.
- Location alone cannot explain the observed market prices of Chinese cells [2].
- Structural and operational advantages must be decisive.

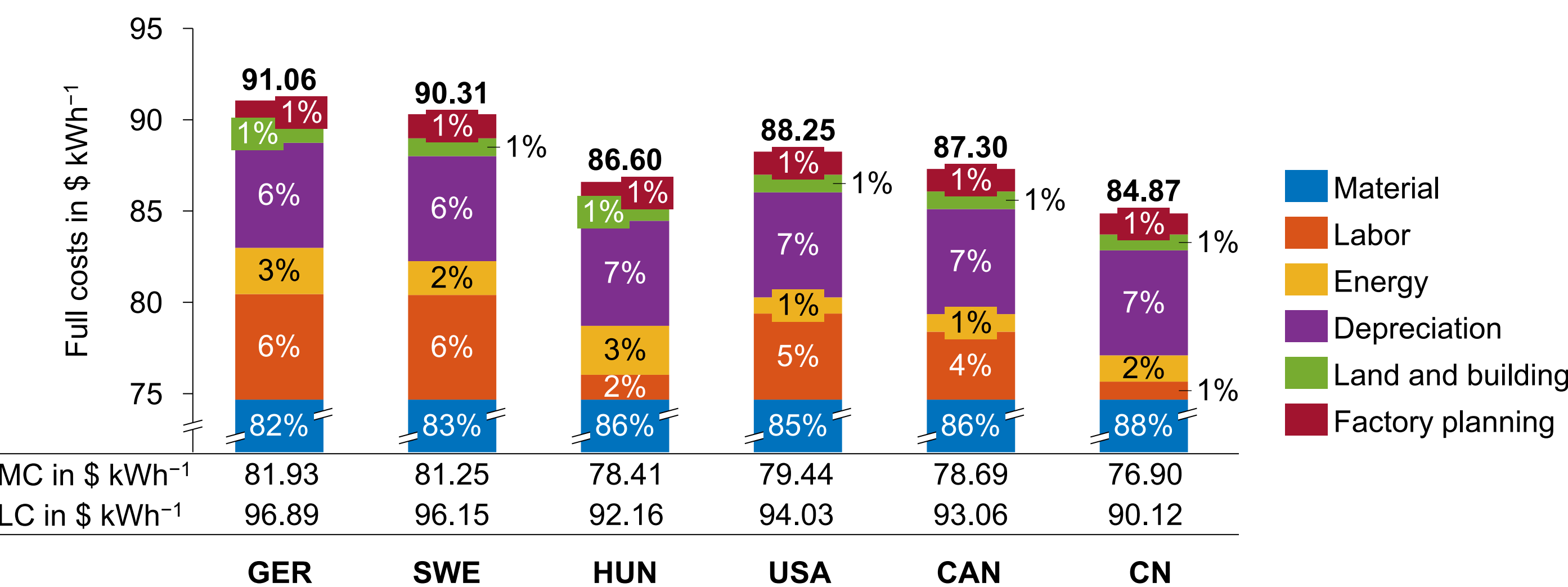


Fig. 2. Full, marginal (MC), and leveled costs (LC) for six global production locations

Reported market prices of Chinese battery cells [2] are significantly below the modeled baseline costs. A reverse cost derivation (cf. Fig. 3) identifies the underlying drivers of this advantage.

Main cost levers:

- Lower investment costs for production equipment [3]
- Significantly reduced scrap rates [2]
- Shorter factory planning timelines
- Lower material prices through vertical integration [4]

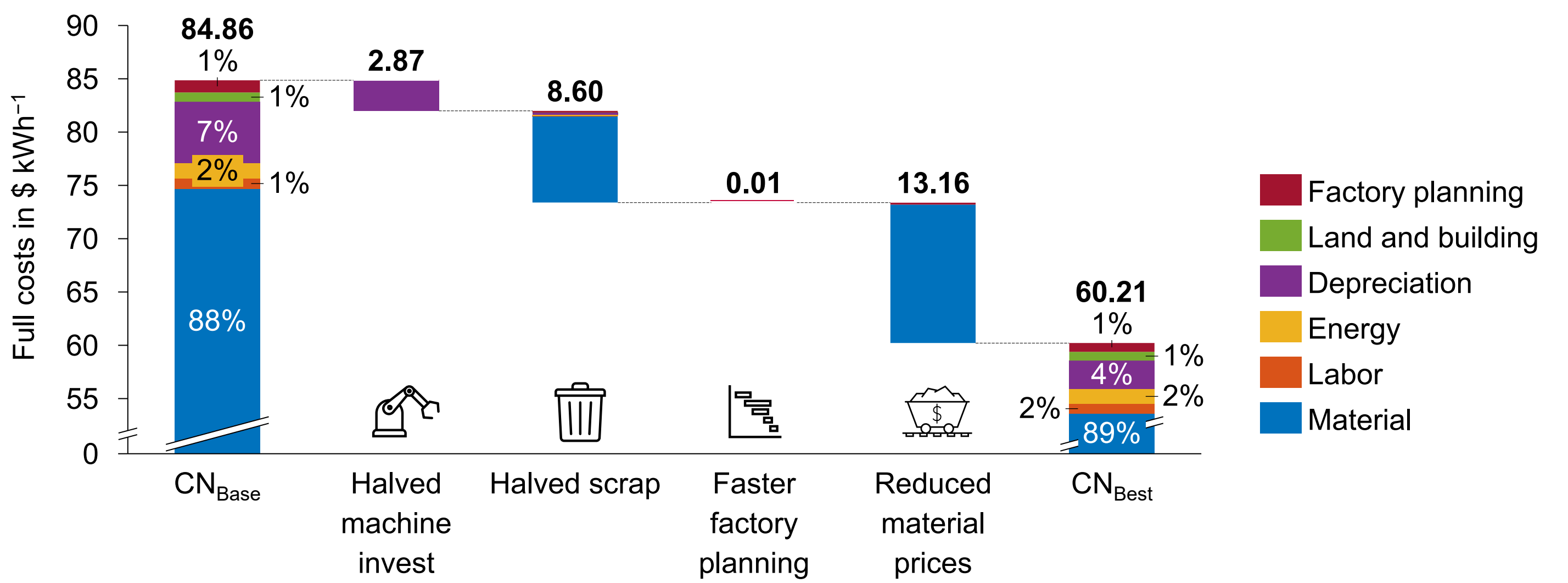


Fig. 3. Contribution of individual cost levers to the reduction of Chinese battery cell production costs

II. Production Ramp-Up

The ramp-up phase represents one of the most critical economic risks for new gigafactories. Fig. 4 depicts the cumulative ramp-up costs for different ramp-up durations of the exemplary gigafactory.

Observed effects:

- Strong cost increase during the last third of the ramp-up phase
- Ramp-up costs of ~ \$1 million per week and per GWh capacity
- Efficient production scaling is imperative to prevent ramp-up delays.

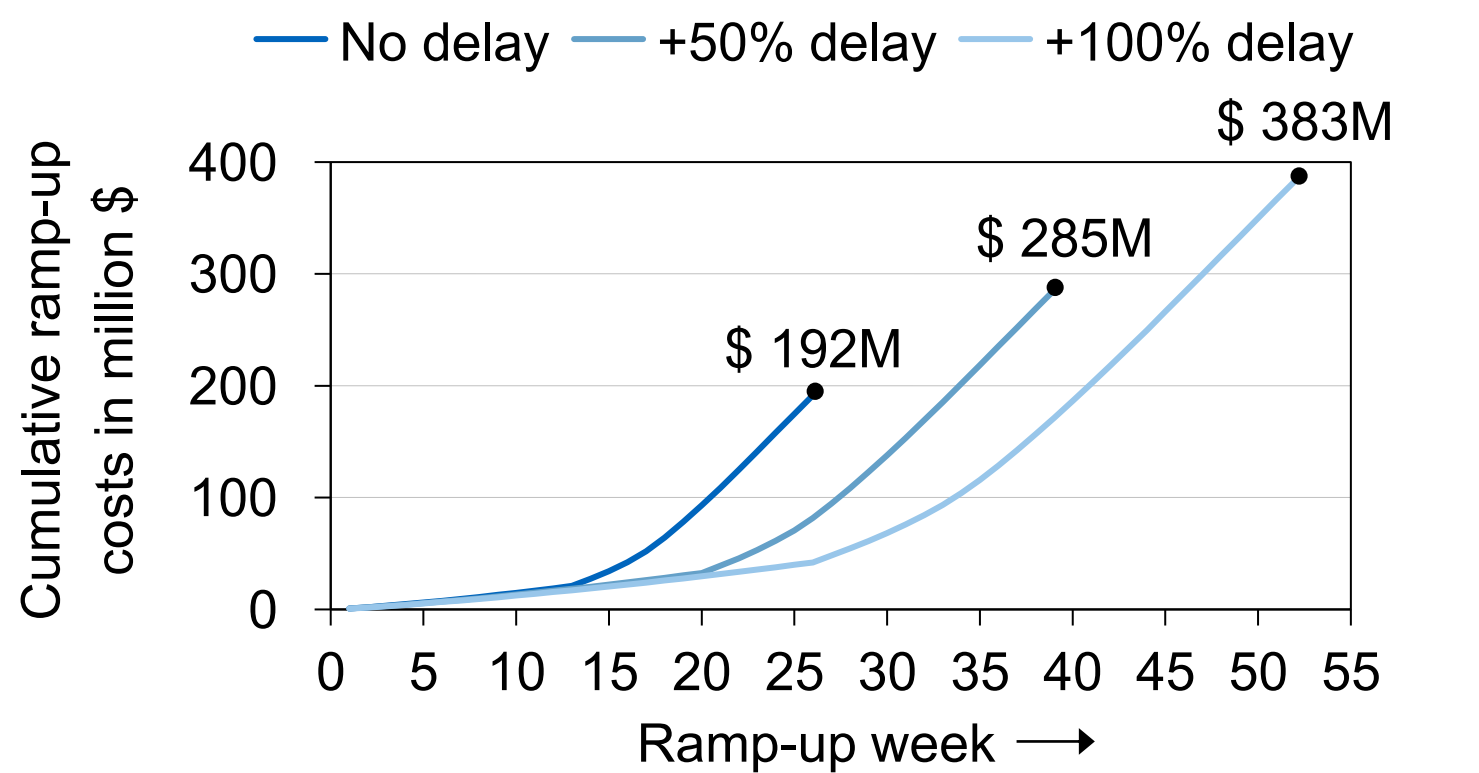


Fig. 4. Cumulative ramp-up costs for different ramp-up durations of a 15 GWh battery cell factory

III. Political Support Measures

Different political measures (cf. Fig. 5) vary strongly in their economic effectiveness.

Evaluation results:

- Continuous per-kWh subsidies are the most effective for price competitiveness.
- One-time investment grants: limited long-term impact
- Combined subsidy schemes perform best.

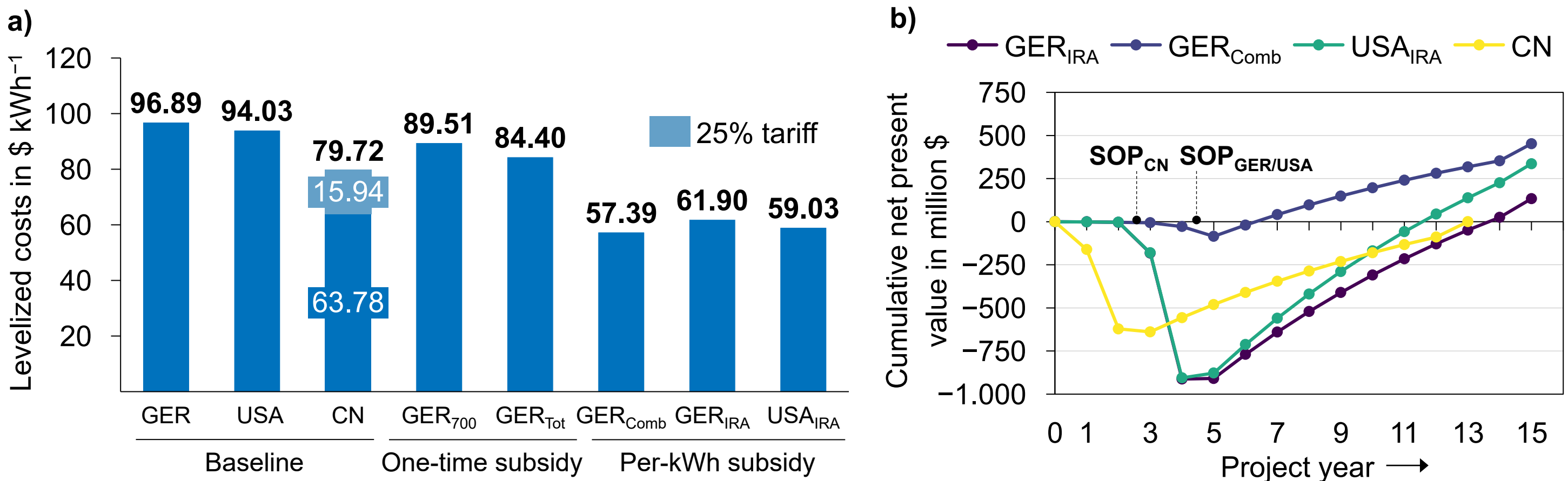


Fig. 5. a) Impact of different subsidy forms on leveled costs and b) cumulative net present value
Explanations: GER₇₀₀: One-time payment of \$700M; GER₁₀₀: One-time payment to cover all investment costs; GER_{comb}: Combined subsidy with one-time payment to cover all investment costs, including per-kWh payment of 27.01 \$ kWh⁻¹; USA_{IRA}/GER_{IRA}: Per-kWh payment of 35 \$ kWh⁻¹; SOP_{CN}: Start of production in China; SOP_{GER/USA}: Start of production in Germany and USA

Conclusion

This study shows that the global cost gap in lithium-ion battery cell production is primarily driven by material prices, equipment costs, and production performance rather than by location-specific factors. **To reach competitive price levels with China, the EU would need to invest \$20 billion per year at a forecasted annual output of 700 GWh in 2026.**

Implications for industry and policy:

- Prioritize fast and stable ramp-up
- Strengthen innovations and learning curves
- Design continuous per-kWh support mechanisms

Acknowledgements

The authors would like to thank the German Federal Ministry of Education and Research (BMBF) for the funding within the project TUBE (grant number: 03XP0425). A great thanks also goes to the experts who took the time to provide valuable industry-relevant parameters.



[1] Lechner, M.; Kollenda, A.; Bendzuck, K.; Burmeister, J. K.; Mahin, K.; Keilhofer, J. et al. (2024): Cost modeling for the GWh-scale production of modern lithium-ion battery cells. In: Commun Eng 3 (1), S. 1–11. DOI: 10.1038/s44172-024-00306-0.
[2] Kampker, A.; Heimes, H. H.; Bernhart, W.; Chan, I.; Frieges, M.; Born, H. et al. (2025): Battery Monitor 2024/2025: The Value Chain between Economy and Ecology. Aachen.
[3] Kampker, A.; Heimes, H. H.; Dorn, B.; Offermanns, C.; Frieges, M.; Wennemar, S. et al. (2023): Battery Monitor 2023. Aachen.
[4] Bhandari, N.; Cai, A.; Yuzawa, K.; Zhang, J.; Joshi, V.; Fang, F. et al. (2022): Batteries: The Greenflation Challenge. Goldman Sachs. New York.