Battery Swapping Technology in the Electrification of Trucks

Master Thesis

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Current status of truck electrification

Growing Fast But Not Fast Enough Yet

Supplying Energy to Electric Trucks

Direct battery charging (MCS)

Hydrogen fuel cells

battery swapping

Research Questions

- Current status and possible role
- Available technologies of battery swapping for trucks
- Technology readiness levels
- Costs of the trucks and swapping infrastructure
- Implications of battery swapping to the electricity grid
- Comparison with other electric and hydrogen fuel cell alternatives

Research methodology

- A systematic literature review
- Semi-structured interviews (Academia, Policy makers, Industry and Users)

What do country experiences say about battery swapping?

Country/Region	Current Status
China	Global leader, moved from pilot phase to commercial deployment, Hundreds of active stations, Plan to open 1000 of them by 2025, With government support
Europe	Prioritise MCS; limited to research and pilot projects AFIR → request to develop a technical standard by the end of 2027
Australia	Operating swap stations (small-scale, limited network)
USA	Still conceptual, no truck-focused pilots

Discussion & Future Outlook

Advantages: 3–6 minute downtime, BaaS (reduce upfront purchase price, battery management), reduce grid stress

Challenges: High investment costs for swap stations, the need for standardisation across manufacturers, and questions about battery ownership and lifecycle management.

Conclusion

- There is **no single "silver bullet" technology**
- Different charging options serve **different use cases**
- **Combination of solutions (**fossil-fuel trucks :diesel and natural gas**);** Competition: technological progress
- Success will depend on **supportive policies, and cooperation among stakeholders**
- **Battery swapping can play a particularly important role** by reducing downtime, lowering upfront truck costs, and easing the burden on the electricity grid
- Helping to accelerate the transition toward **zero-emission heavy-duty transport**.

Thank you!