

Electrification of Mobile Machinery in Agriculture and Construction

Impact of Electrification beyond 2030

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Kai Krüger, Michael Wittler

Viabile solution for reducing CO₂ emissions at reasonable add-on cost

The electrification of Mobile Machinery in agriculture and construction is a feasible yet ambitious undertaking, driven by a variety of factors aimed at achieving a more sustainable industry beyond 2030. The study analyzes four use cases within construction and agriculture, revealing that electrification introduces a range between 0.05% to 12% of cost increase in the final product depending on use case. However, sector-specific challenges such as small-scale and specialized production, long product lifetimes, and the qualification of extensive dealership and service networks need to be overcome. While other alternatives such as hydrogen and renewable fuels were not explored in this study, the focus on all-electric machines presents a viable solution for reducing CO₂ emissions at reasonable add-on cost beyond 2030.

Trends & Drivers

Trends towards Carbon-Neutral Powertrains

The Mobile Machinery industry is witnessing clear trends towards carbon-neutral powertrains, aligning with developments in passenger and commercial vehicles. Anticipated CO₂ emission regulations around 2030 further underscore the industry's move toward sustainable solutions. Regulatory support, coupled with a market pull from construction companies and farmers, is driving the adoption of battery electric solutions.

Uncertainties in E-Fuels and Market Pull

The study takes an isolated perspective and draws a scenario, where only electric powertrains would be feasible in the future. This shall constitute a possible scenario, accounting for uncertainties around e-fuels, where accountability and availability are posing potential challenges. Additionally, market pull from construction companies, especially in inner-city construction, and farmers, particularly those engaged in high-value crops or livestock farming, further contribute to the demand for electric machinery solutions.

Technology Development

Significant improvements in battery technology are expected, leading to lower-cost solutions and increased energy density as key enabling factors. Besides having the maximum battery capacity installed to the vehicle, the study also explores alternative solutions such as battery swapping and plugged electric options. For some machinery, these are the only viable solutions for electrification, showcasing the dynamic landscape of technology development required within the mobile machinery industry.

Construction Use-Cases

The construction industry has been analyzed in terms of building and highway construction. Building construction is typically stationary and has good access to infrastructure, while highway construction is a mobile use-case with less access to energy infrastructure.

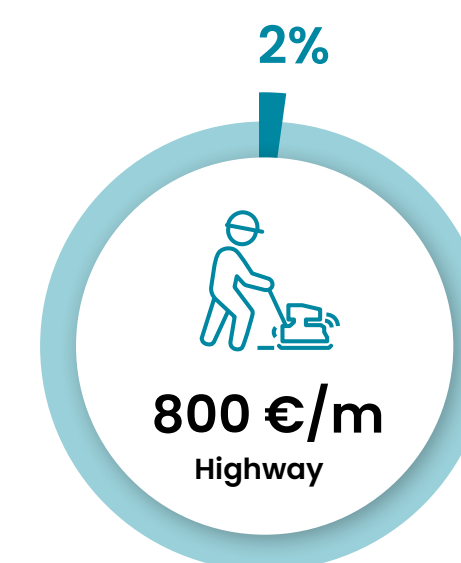


Building Construction

In the building construction use case, the replacement of the conventional powertrain with a battery-electric solution is feasible without major changes to the operator experience. Prerequisites include adequate grid availability, with potential limits arising in specific cases such as selected mobile cranes requiring off-grid energy sources and facing challenges with road admission.

+ 0.05%

higher cost per square meter floor space with electric machinery



Highway Construction

For highway construction, the electrification concept requires opportunity charging during breaks and plug-in solutions for slow-moving or stationary applications. Prerequisites include stringent preplanning of construction processes and an effective business model for managing a more complex energy provision infrastructure. Special cases, like the new construction of elevated bridges, may pose unique challenges for the infrastructure.

+ 2%

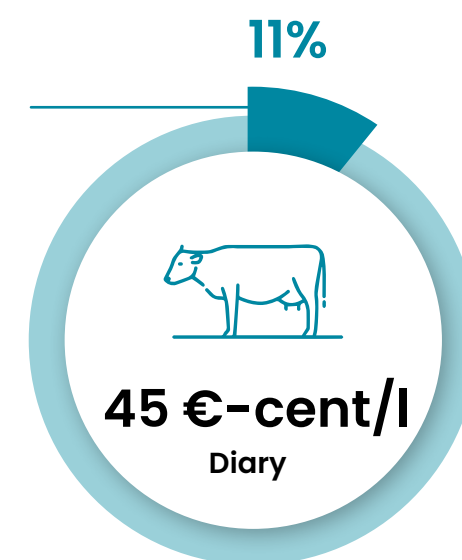
higher cost per meter highway with electric machinery



Agriculture Use-Cases

The analysis focused on dairy farming and corn silage production in the agriculture industry. Dairy farming involves on-site tasks with access to local infrastructure. Corn silage production involves heavy-duty tasks, such as harvesting, with limited access to energy infrastructure.

Machine-related cost

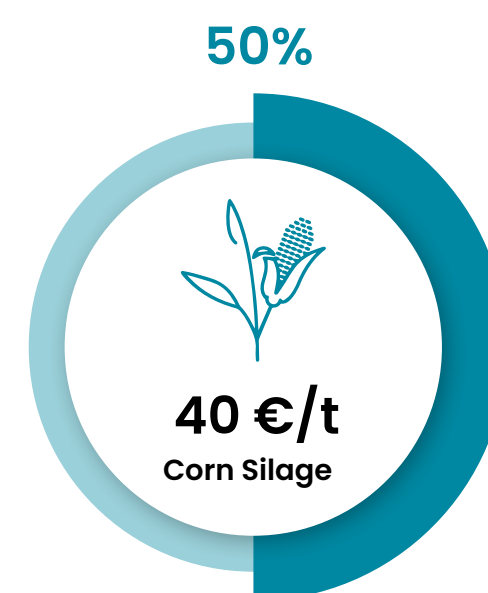


Dairy Farming

The electrification concept for dairy farming includes the replacement of the powertrain with a battery-electric solution, as overnight charging for full-day operation is feasible. Prerequisites involve local availability of electric energy, either through a solar farm or adequate grid availability. Challenges may arise in cases where neither option can be economically attractive.

+ 4%

higher cost per liter milk with electric machinery



Corn Silage Production

Corn silage production requires battery swapping solutions, requiring mature technology and intensive planning of energy-related logistics. Additional challenges include soil compaction from heavier machinery and the need for frequent battery swapping events for large harvesting machinery.

+ 12%

higher cost per ton of corn silage with electric machinery



The all-electric scenario for mobile machinery presents challenges to the industry, but also offers attractive opportunities

Strength

- ▶ Zero CO₂ emissions¹⁾
- ▶ Enabling of new features and functionalities
- ▶ Energy and machine specific operating efficiency
- ▶ Enhanced customer experience through reduced noise and vibration

Opportunities

- ▶ Become a market leader as an ecosystem provider and setting the standard
- ▶ Enable new business models: X-as-a-service
- ▶ Adding value with an expanded product portfolio
- ▶ Develop an appropriate battery strategy
- ▶ Offsetting the decline in sales of conventional machines

Risks/Weaknesses

- ▶ Operator education for electric machinery
- ▶ Cost disadvantage depending on the use case
- ▶ Infrastructural issues (system boundaries)
- ▶ Breakthrough of other technologies
- ▶ High initial investment

Threats/Challenges

- ▶ Lack of R&D capabilities and competencies
- ▶ Thinking in an ecosystem - new interfaces
- ▶ Transformation of production facilities
- ▶ After-sales service concepts
- ▶ Market displacement caused by a too small company size leading to consolidation

1. By regulation electric vehicles are accounted as zero CO₂ vehicles for the operators, on a global level the CO₂ emissions are depending CO₂ footprint of the related electricity production

IMPLICATIONS

The industry can navigate towards a sustainable future

Business Opportunities

Accelerated battery technology development, dedicated electric machinery vehicle concepts, and new charging infrastructure solutions present attractive business opportunities. Manufacturers must adapt their product strategies, focusing on battery system strategy, new competencies in product development, and strategic technology partnerships, especially for smaller companies.

Sector-Specific Challenges

The NRMM industry faces sector-specific challenges, including small-scale and specialized production, long product lifetimes, and the qualification of extensive dealership and service networks. Operational efficiency is directly linked to energy supply solutions, with practical considerations for agricultural use-cases posing additional challenges.

Moving Towards an Ecosystem Provider

To successfully implement electric machinery offerings, manufacturers should consider expanding their product offerings to supplementary systems, embracing Battery-as-a-Service models, and transitioning from equipment manufacturers to ecosystem providers. The sector-specific challenges make electrification more difficult, necessitating strategic adaptations in product development, business models, and partnerships.

In conclusion, the electrification of NRMM in agriculture and construction holds significant promise but requires a nuanced understanding of sector-specific challenges and a proactive approach to technology development and business strategies. As the industry navigates towards a sustainable future, careful consideration of trends, use cases, and implications will be critical for success.

We welcome
your comments,
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Please feel
free to get in
contact:



ALEXANDER NASE
Managing Director

alexander.nase@fev.com



DR. MICHAEL WITTLER
Director

michael.wittler@fev.com



KAI KRÜGER
Principal

kai.krueger@fev.com

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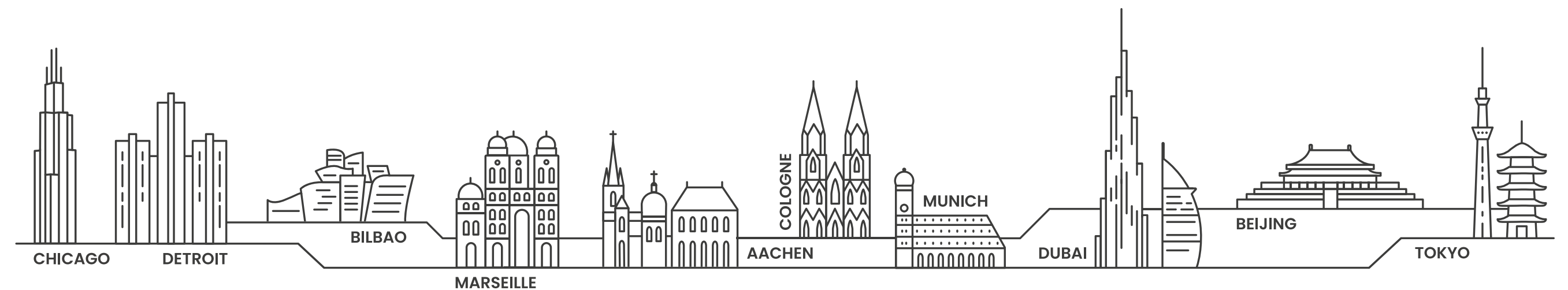
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Michael Wittler
Kai Krüger



Name XYZ
Name VADWA



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