

VEHICLE ELECTRIFICATION

and transformation of the industry

THE CHALLENGE

PASSENGER CAR MARKET

In 2020, the passenger car market was heavily influenced by the COVID-19 crisis. However, battery electric vehicles gained further market shares, especially in Europe. We expect a fast recovery of the sales volume to pre-COVID-19 scenarios, with an annual growth rate of 1.9%. This growth is dominated by the Chinese and Rest-of-World (RoW) markets while US and European market are assumed with constant volume.

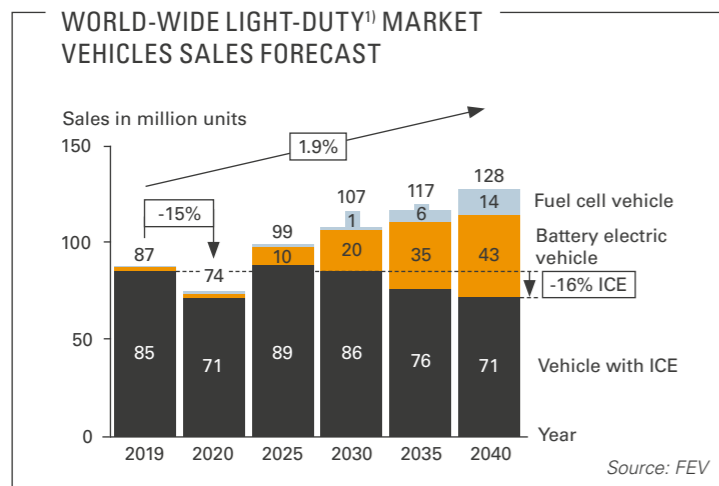
The market growth is dominated by electric powertrain types, such as battery electric and fuel cell powertrains. The sales volume of vehicles with an ICE should decrease by 16% by 2040 compared to 2019. These remaining powertrains with an internal combustion engine (ICE) become electrified as well. We expect mild and full hybrids to be widespread.

The shift of powertrain types is driven by the CO₂ emission reduction targets in the key market regions. In Europe, the ambition is set the highest of all the markets. By 2050, the transport sector (vehicles on the road) should decrease CO₂ emissions by 90% compared to 1990 level. This means that no new vehicle should have any CO₂ tailpipe emissions by 2040 at the latest, which can only be achieved by battery electric or hydrogen fueled vehicles. Additionally, fuels from renewables (e.g. e-fuels) could also be CO₂ neutral, however their role in the regulations is currently under negotiation.

In the USA the CO₂ targets were relaxed under Trump. The Biden administration already announced that it will revoke the relaxation and set more ambitious targets again. California and some supporting states are pushing for even more radical regulations, for example a ban of combustion engines.

In China the strategy appears more balanced and the target of becoming CO₂ neutral was shifted to 2060. The draft of the so-called Roadmap 2.0 gives a push to the new energy vehicles (NEV) and low fuel consumption vehicles. In essence, the strategy supports the market introduction of battery electric, fuel cell and hybrid powertrain vehicles.

In 2040, we expect that 57 million electric vehicles (battery or fuel cell) are sold globally. The largest markets are Europe and China with approx. 15 million units each.



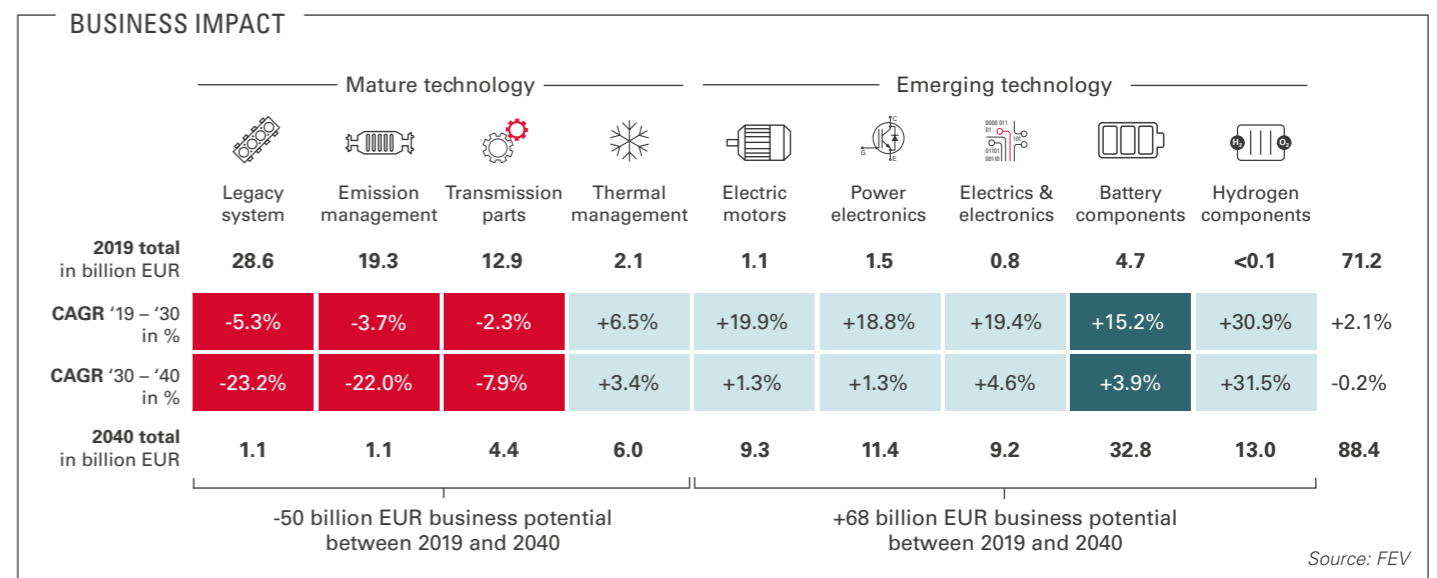
¹⁾ Including passenger cars and light commercial vehicles up to 3.5t gross vehicle weight

BUSINESS IMPACT

The shift of powertrain types has a dramatic effect on the business potential within the manufacturing value chain. Mature technologies, i.e. the legacy system (base combustion engine components), emission management components and transmissions, suffers most by the transformation. Between 2019 and 2040, we calculated a business potential reduction of 50 billion EUR. Although the combustion engine efficiency is further improved it cannot compensate for the sales volume reduction. R&D and investment budgets are limited and shifted to electrified powertrain types, hence we expect a strong reduction of combustion engine based powertrain variants. In consequence we also expect an extended usage of the existing production equipment. Only thermal management system components show an increased business potential within the mature technology category. Those components are needed for electric vehicles, too, and are getting more complex within these applications.

The emerging technologies are related to powertrain electrification. Battery systems, electric motors and fuel cell components will create a rapid growth of the business potential. Between 2019 and 2040 we calculated an increase of 68 billion EUR. However, the growth is not directly translated into manufacturing value creation. There is an overlay by the shift from manufacturing intensive components towards higher material intensity. Hence, the manufacturing value creation share is reduced and shifted to the upstream supply chain, e.g. battery material processing.

In total, we expect 24% business potential growth between 2019 and 2040. However, this results from the period until 2030 only. Thereafter, the reduction of the business potential by the shift to electric powertrains cannot anymore be compensated by the increase of combustion engine technology and hybrid powertrains. The transformation towards electric vehicles is accelerated.



THE IMPLICATIONS



-20 BILLION EUR

LESS YEARLY VALUE CREATION IN EUROPE WITHIN CONVENTIONAL POWERTRAIN TECHNOLOGIES UNTIL 2040



-160 THOUSAND JOBS

WITHIN PASSENGER CAR POWERTRAIN PRODUCTION IN EUROPE OVER 580 THOUSAND JOBS LESS FOR CONVENTIONAL TECHNOLOGY



57 MILLION EVs

BATTERY & FUEL CELL ELECTRIC VEHICLES GLOBALLY EXPECTED TO BE SOLD EVERY YEAR IN 2040



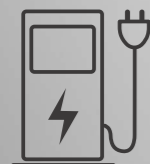
12 BILLION EUR INVESTMENT

CONSTANT AVERAGE ANNUAL INVESTMENTS IN EUROPE INTO MACHINES AND PRODUCTION EQUIPMENT REQUIRED



50 EUR / kWh

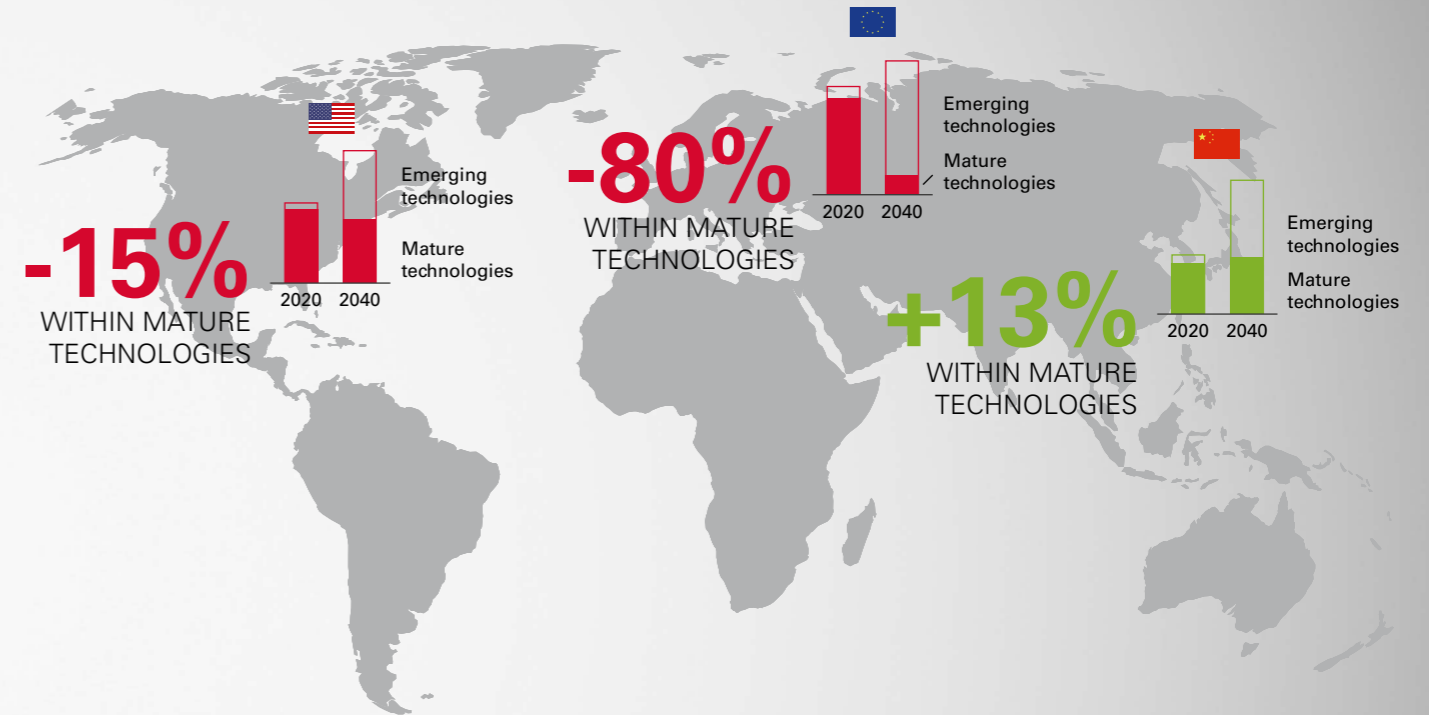
LONG-TERM AVERAGE BATTERY PACK COST EXPECTED TO BE REACHED UNTIL 2040



INFRASTRUCTURE & SERVICE

OFFER FURTHER BUSINESS AND VALUE CREATION POTENTIALS FOR THE AUTOMOTIVE MACHINERY & COMPONENTS SUPPLY INDUSTRY

BUSINESS POTENTIAL ANALYSIS



KEY RESULTS

The transformation of the automotive industry by the shift towards electric vehicles has a strong impact on the supply chain. For battery systems, electric motors or electronic components, different manufacturing processes are required compared to combustion engine components. These processes are also less labor-intensive. As a result, we calculated that 160,000 jobs less are required in Europe by 2040 within the production of automotive powertrain systems. The loss of 580,000 jobs within the mature technologies (combustion engines,

transmission) cannot be compensated by the 420,000 new jobs within the emerging technologies.

However, we expect additional jobs should be created in the upstream supply chain processes, for example processing materials for battery cells. Furthermore, the charging and hydrogen infrastructure build-up and operation should generate new jobs as well. Finally, independently of the transformation, new business areas are generated from connected vehicles and digital services.

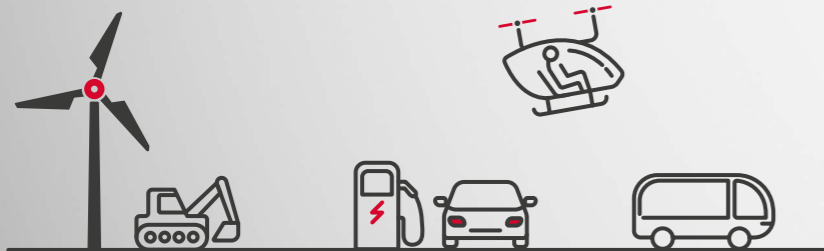
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ANY QUESTIONS?

We welcome your comments, questions and suggestions. Please feel free to get in contact:



Alexander Nase
Managing Director

Mobile +49 (160) 94110987
alexander.nase@fev.com



Dr. Michael Wittler
Principal

Mobile +49 (175) 9338913
wittler@fev.com



Kai Krüger
Manager

Mobile +49 (170) 7846439
kai.krueger@fev.com



**WE WORK WITH
6300 EXPERTS
IN THE FEV GROUP**



FEV Consulting GmbH
Neuenhofstraße 181
52733 Aachen

How to reach us online:
fev-consulting.com



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Aachen Office

(Global Headquarter)
FEV Consulting GmbH
Neuenhofstr. 181
52078 Aachen
Germany

Beijing Office

(FEV Powertrain Technology Co., Ltd.)
No.168 HuaDa street,
Yanjiao High-tech development zone,
Sanhe city, Hebei province,065201

Bilbao Office

(FEV Iberia Sl.)
Calle del Cardenal Gardoqui 1,
48008 Bilbao
Spain

Cologne Office

FEV Consulting GmbH
Niehler Str. 104
50733 Köln
Germany

Detroit Office

(FEV Consulting Inc.)
4554 Glenmeade Lane
Auburn Hills, MI 48326-1766
USA

Dubai Office

FEV Asia GmbH (Branch)
P.O.Box No. 112687,
Dubai Airport Free Zone,
Dubai, U A E.

Munich Office

FEV Consulting GmbH
Ingolstädter Str. 22
80807 Munich
Germany

Tokyo Office

FEV Japan Co. Ltd.
Kjimachi,
Chiyoda City,
Tokyo 102-0083
Japan

How to reach us online:

fev-consulting.com



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