VDI|VDE|IT

Accompanying Research
BATTERY CELL PRODUCTION

Sustainability of battery (cell) production in Europe

How sustainable are batteries and electric mobility really?

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ACCOMPANYING RESEARCH – MISSION AND ACTIVITIES

Mission:

The accompanying research team supports the **built-up of the European battery production industry** on behalf of the **German Ministry for Economic Affairs and Energy** and strives to **maximize the impact of the battery IPCEIs**.

Team:

More than 30 experts from VDI/VDE Innovation + Technik GmbH, TÜV Rheinland Consulting and Technical University Berlin

What the accompanying research team offers to support the ecosystem:

Knowledge transfer

- Information
- Publications
- Discussions
- Events

Community building

- Networks
- Social media
- Data analytics
- Match making

Stakeholder dialogue

- Interviews
- Working Groups
- Workshops

CONTENT

Key messages (of main drivers / enablers of a sustainable battery cell production)

With regard to…

- ➢ **Climate protection**
- ➢ **Industrial policy**
- ➢ **Circular economy**
- ➢ **Raw materials governance**
- ➢ **Economic efficiency**
- ➢ **Employment**

➢ **Conclusions / to sum up**

KEY MESSAGES

The timely establishment of a truly sustainable German / European battery cell production (BCP) …

- is a decisive success factor / **enabler for** achieving the **EU climate targets**
- should be based on **cooperation & political governance**
- will be accelerated through **public funding** of battery cell production
- is supported by the **circular economy**
- requires an ecologically & socially oriented **raw materials governance**
- will (still) accelerate the **cost advantage of e-cars** over combustion engines
- is target-oriented / **desirable from an macroeconomic perspective**

ACHIEVING THE EU CLIMATE TARGETS

→ How can a German / European BCP contribute to this?

The climate policy context:

- **Climate policy regulations** and instruments increasingly **set clear targets for decarbonising the transport sector:**
  - To meet the 1.5 °C target, emissions from the transport sector would have to fall to 0 as early as 2042-45
  - To meet the EU climate target for 2030, reduction of CO_2 emissions from new passenger cars by an average of 37.5% per km vs. 2021 level
  - Translated into climate target for the German transport sector by 2030: -40-42% vs. 1990

ACHIEVING THE EU CLIMATE TARGETS

→ Why are these climate protection targets relevant for German / European battery cell production?

- **Production of BEV currently still emits more GHG than comparable ICEV**
  - Production - especially of the battery – is very **energy-intensive**
  - In this respect, production on the basis of **renewable energies** and high **energy efficiency** is essential
  - Progress in the field of RE and e-efficiency clear & **ambitious EU targets** in this respect
  - **Europe** as a location already offers **advantages** in terms of **production-related GHG emissions** and also for the GHG balance over the entire life cycle of EVs, and will further expand these advantages in the coming years

ACHIEVING THE EU CLIMATE TARGETS

→ The operation of BEV is more climate-friendly than those of comparable FCEV or ICEV

- Regarding **energy demand** (well-to-wheel) of various drive technologies per travel distance, **ICEV show highest GHG emissions** (although being in the middle in terms of energy demand) & **BEV lowest GHG emissions & energy demand**

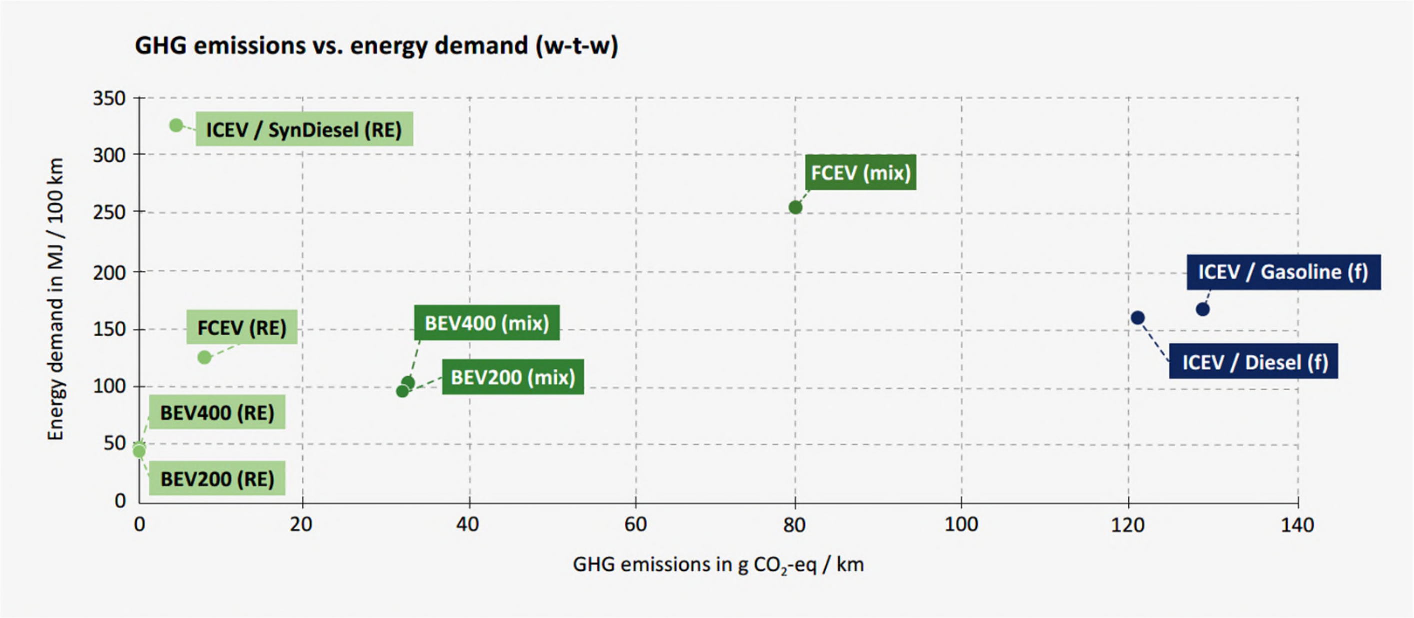


Figure 3: Well-to-wheel analysis: GHG emissions and energy demand of different propulsion technologies or energy sources (f=fossil; mix=EU electricity mix; RE=renewable energy). According to JEC Well-To-Wheels report v5.

COOPERATION & POLITICAL GOVERNANCE

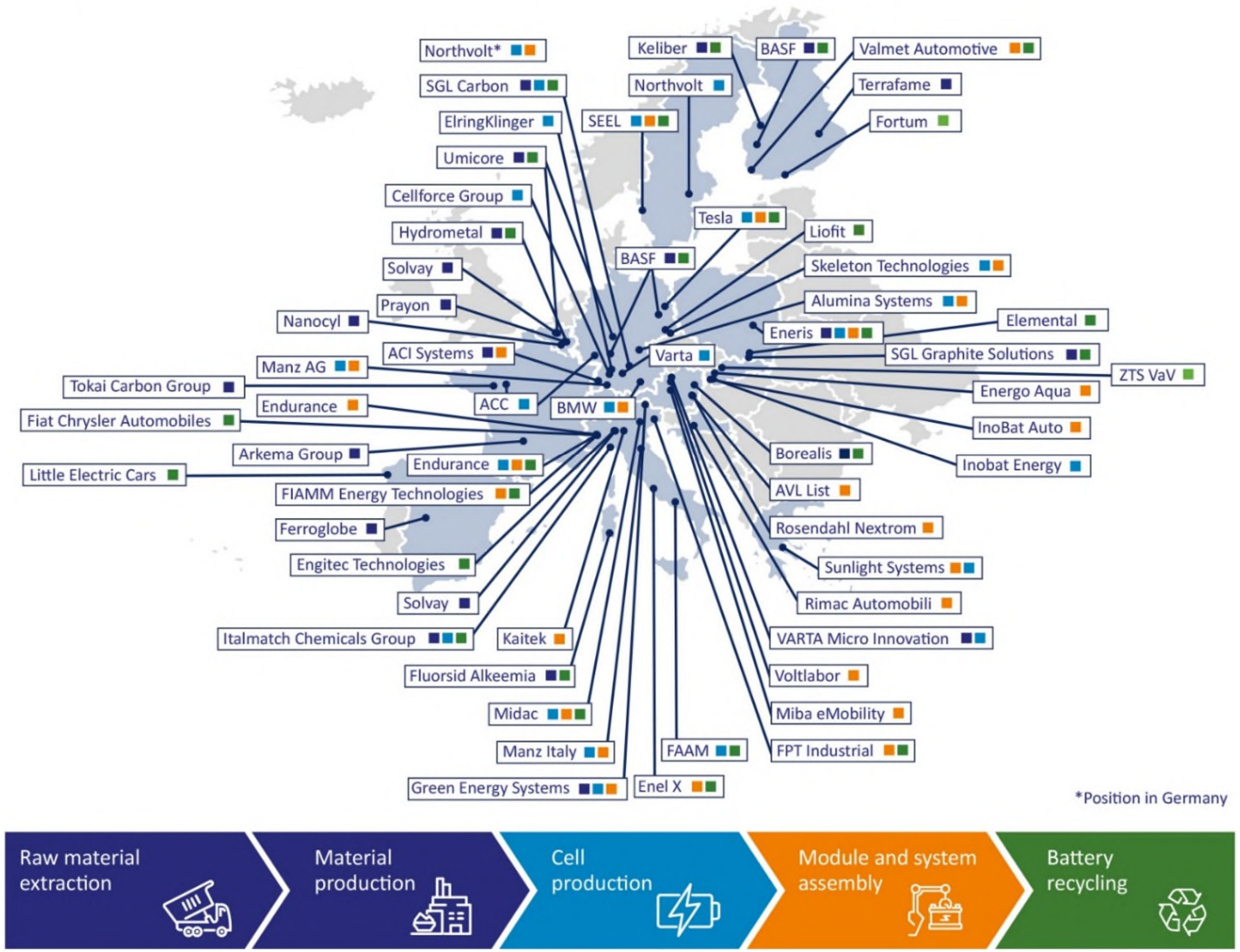
→ Cooperations increase efficiency, enable joint learning and ensure sustainability along the entire (battery) value chain

- **Examples (1):**
  - **Recycling cooperation between BASF, Fortum & Nornickel (in Finland):** Fortum to take over recycling of spent batteries, Nornickel the refining and BASF the production of precursor material for the cathode production
  - **Cooperation between Umicore, Northvolt and BMW:** from material production to cell manufacturing and product integration to recycling. Aim: establish a sustainable value chain with closed cycles
  - **JV Automotive Cell Company (ACC) between PSA & Saft:** joint R&D centres, battery production on GW scale to be supplied to PSA and other manufacturers

COOPERATION & POLITICAL GOVERNANCE

➢ **Examples (2): Battery IPCEIs**

Participants and locations of the projects funded by IPCEI on Batteries and IPCEI EuBatIn



Source: Own representation

PUBLIC FUNDING OF BATTERY CELL PRODUCTION

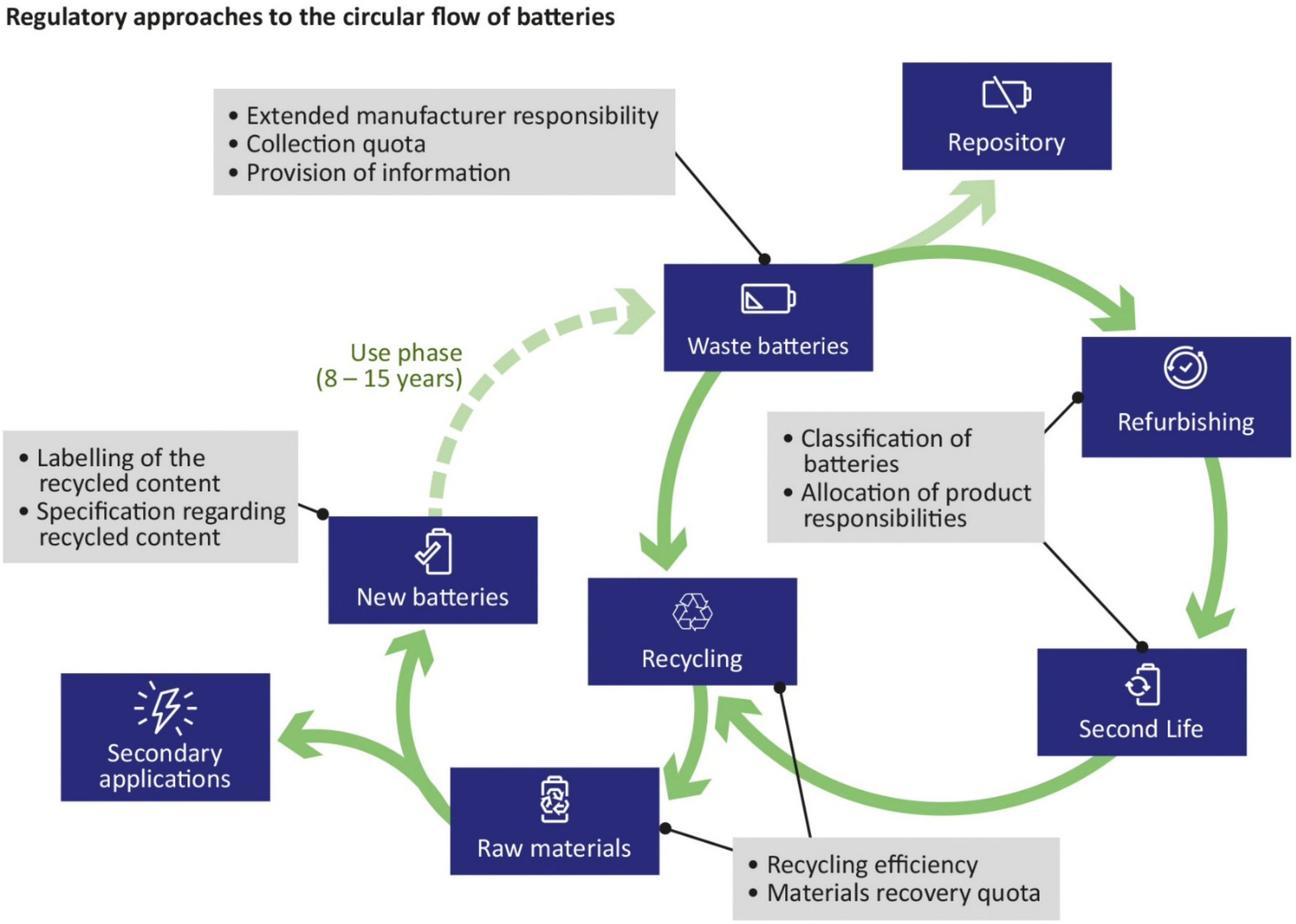
- Important role of public innovation and industrial policy, especially due to **"(capital) market failure"** & high barriers to market entry
- **Targeted promotion of innovations** in the EU battery value chain will make it easier to catch up with Asian competitors
- Facilitated by joint European efforts, e.g. through **battery IPCEIs**
  - Advantages: **Covering the entire VAC; broad networking of actors; knowledge and technology transfer**
- Promotion of electro mobility / BCP **no abandonment of the principle of technology openness** => cf. promotion of H2 economy

SUPPORT BY THE CIRCULAR ECONOMY

→ **Political requirements lay essential foundations for the establishment of a battery circular economy**

- **Especially within the framework of the proposal for an EU Battery Regulation**
  - Will not only regulate the **handling of spent batteries**, but also the **production** and **use phase**
  - **Circular economy** as a **central active principle** therein
  - Creation of **planning security**
  - Enabling of **new business areas / models** with regard to battery circular economy

SUPPORT BY THE CIRCULAR ECONOMY



Possible paths for the recycling of spent batteries. The boxes highlighted in dark grey show the regulatory approaches to strengthening a battery circular economy. Own representation.

SUPPORT BY THE CIRCULAR ECONOMY

(1) Via recycling

- **reduces the need for raw material imports** & leads to more raw material independence
- However, **competitive prices** for secondary raw materials **are necessary** for economic recycling
  => volatile!
- Increase in registrations of e-cars => increase in number of spent batteries
  => **increasing utilisation of recycling facilities**
- Enables automation of disassembly of battery packs => **increases efficiency & profitability of recycling** => enables recycling of other raw materials such as lithium, graphite or manganese
- Automation of recycling still hampered by diversity of packs & components
  => **Design for recycling / reuse**

SUPPORT BY THE CIRCULAR ECONOMY

(2) Through processing and reuse of spent batteries => more efficient use of raw materials :

- Batteries in electric cars reach the end of the 1st use phase after approx. 8-15 years (= < 80% initial capacity).
- **Use of the remaining capacity in other applications** e.g. in stationary energy storage systems (BESS)
- Thus longer use of the raw materials contained in the battery => **improvement of the battery's CO_2 balance**
- However, **reuse must also be/become economically sustainable**
  - Reduction to a few / most efficient process steps & automation
  - Specifications & standards for the standardisation of battery packs
  - Access to BMS data => Reduction of effort for condition checks

ECOLOGICALLY & SOCIALLY ORIENTED RAW MATERIALS GOVERNANCE

→ Since: Sustainability requirements for actors in the supply chain of battery raw materials are increasing

→ Therefore: Development of new technologies in the area of raw material extraction, preparation and processing in order to meet sustainability requirements

- Example **lithium**: extraction of Li hydroxide directly from residual brine (previously a waste product, less water consumption)
- Example **nickel**: extraction by bio-leaching (use of micro-organisms for energy-efficient dissolution of the metal => reduction of CO_2 footprint by up to 60%)
- Example **recycling**: large recycling plants provide new sources of raw materials and meet the requirements of future regulations (currently 95% of battery materials can already be recovered (through hydrometallurgical processes))

ECOLOGICALLY & SOCIALLY ORIENTED RAW MATERIALS GOVERNANCE

→ Since: Innovations in product tracking & sustainable handling of raw materials create transparent & responsible supply chains.

- **e.g. through a "digital twin" in the form of a battery passport.**
  - Verifiable and forgery-proof storage of information on material provenance, battery performance, CO_2 footprint, etc.)
  - Allows users of batteries (consumers, workshops, resellers, 2^{nd}-life users, recyclers, etc.) to assess the sustainability and condition of the battery more easily and to make business decisions
  - In the proposal of the EU battery regulation, mandatory for batteries > 2 kWh (from 2026 onwards)
  - GBA project for the development of a battery passport to be operational from approx. 2023 onwards

ECOLOGICALLY & SOCIALLY ORIENTED RAW MATERIALS GOVERNANCE

→ Because: The extraction of raw materials largely takes place in countries with low environmental and social standards and is often associated with ecological, social and economic challenges

→ Therefore: Due diligence by companies is an important instrument for creating legal certainty and strengthening compliance with human rights

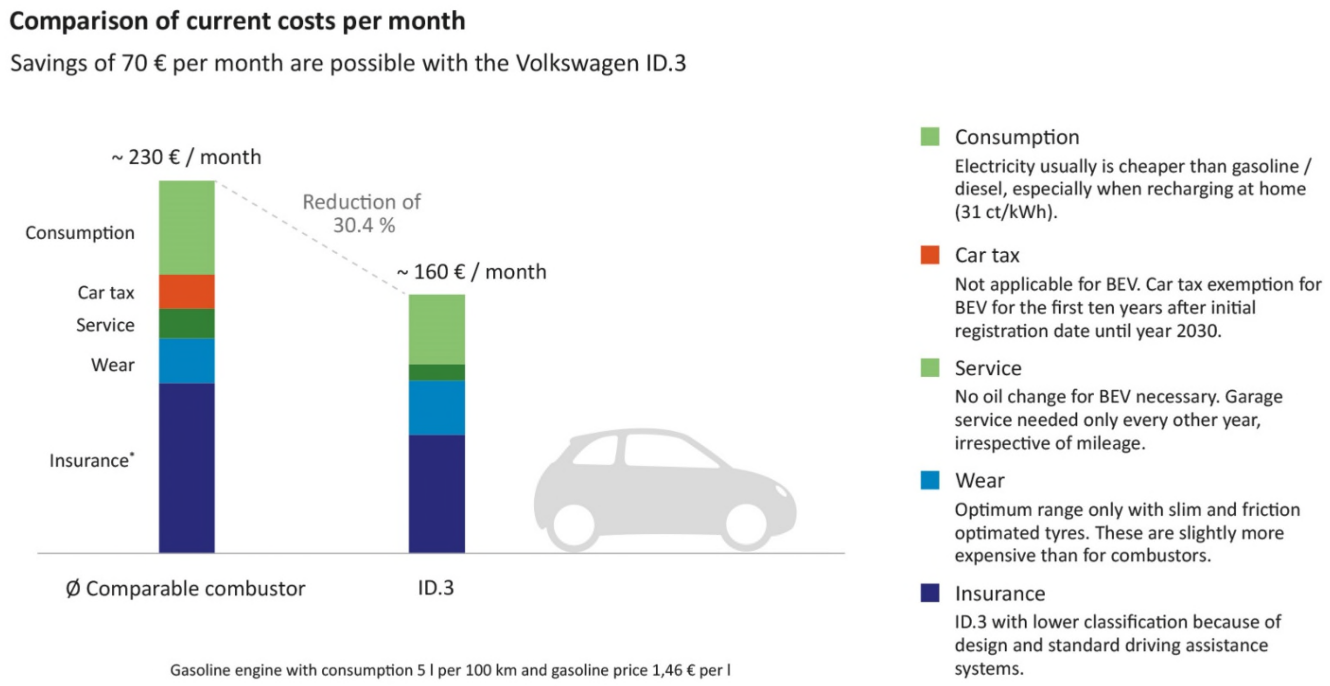
- Example Germany: New Due Diligence Act passed (comes into force in 2023): Obligation for large / medium-sized companies to monitor their supply chains with regard to human rights violations & environmental risks
- Example EU: proposal of battery regulation: Provides for mandatory due diligence on raw materials for industrial and automotive batteries (based on OECD guidelines, among others)

ACCELERATION OF COST ADVANTAGE OF E-CARS OVER COMBUSTION ENGINES

- Even though: **E-cars are usually still more expensive** to buy than combustion cars (due to even higher production costs, especially with regard to battery production)
- But: **Cost parity could be achieved as early as 2022/24** => mainly due to accelerated market ramp-up of e-cars and resulting learning and economies of scale
- Already now, **purchase premiums partly provide for lower acquisition costs of e-cars compared to combustion engines** => e.g. Germany: incl. 9,000 EUR environmental bonus VW ID3 cheaper than comparable Golf with petrol or diesel engine

ACCELERATION OF COST ADVANTAGE OF E-CARS OVER COMBUSTION ENGINES

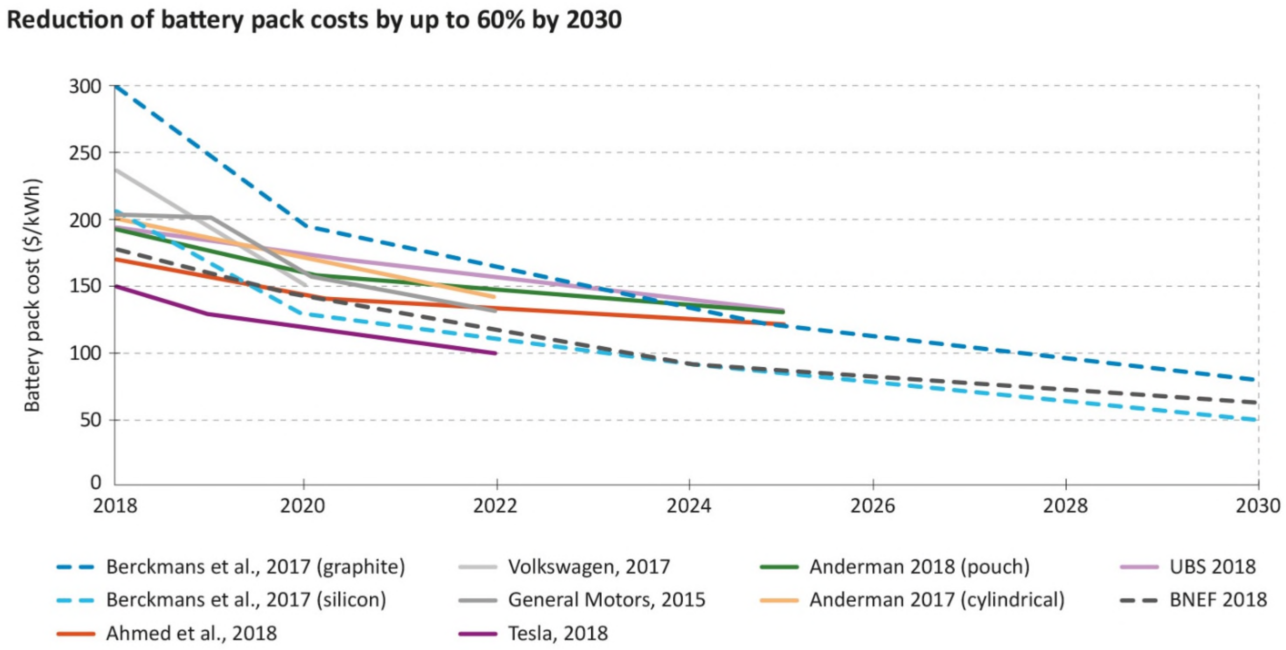
- In a " proper " comparison of total cost of ownership (TCO) (i.e. including costs for insurance, vehicle taxes, maintenance/repairs, depreciation, fuel/electricity costs, etc.), e-cars are already cheaper than many internal combustion vehicles



Comparison of running costs between e-car and vehicle with combustion engine, according to Volkswagen, 2020c.

ACCELERATION OF COST ADVANTAGE OF E-CARS OVER COMBUSTION ENGINES

- Because: battery (pack) costs will drop by up to 60% by 2030 compared to 2020 levels (from 137 USD/kWh to 56-58 USD/kWh

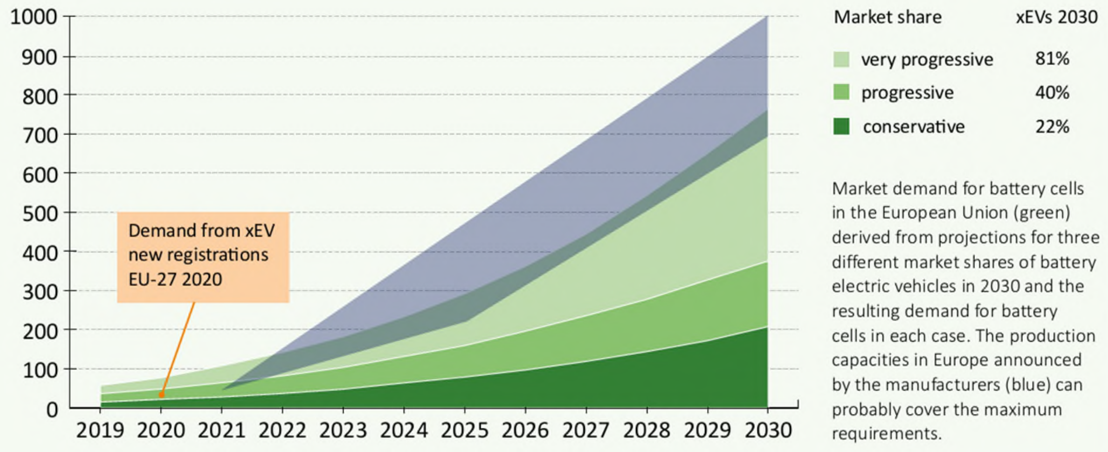


Predicted cost developments of battery pack costs until 2030 (according to Lutsey/Nicholas 2019)

ACCELERATION OF COST ADVANTAGE OF E-CARS OVER COMBUSTION ENGINES

- The battery currently accounts for around 40% of the value added of an electric car
- **Battery cell production in Europe has considerable potential for value creation**
- **Proximity to the production sites is an advantage** due to logistical and economic risks related to long distances
- Annual production capacity in Europe expected to reach 697 - 959 GWh in 2030 & share of production in Germany will be 25 - 32%
- **Will lead to strong economies of scale and reduction in production complexity ➔** with corresponding effect on battery costs & manufacturing costs of EVs

Figure 2: Battery cell demand and production capacity in Europe
Gigawatt hours per year



Source: Market analysis Q2 2021 of the Accompanying Research – Battery Cell Production

MACROECONOMIC PERSPECTIVE

Initially / first:

→ Mainly due to technical advances in manufacturing (use of digital technologies, automation, driverless logistics, etc.), **increase in shared mobility, and above all lower number of components in EVs compared to ICEs initially decrease in employment**

- **Examples:**
  - VW: technical progress alone will reduce the number of employees needed by 12% until 2029
  - Ifo Institute: Up to 47% low-emission vehicles needed in EU by 2030 to comply with EU fleet limits => corresponding decrease in ICE production => loss of up to 198,000 jobs

MACROECONOMIC PERSPECTIVE

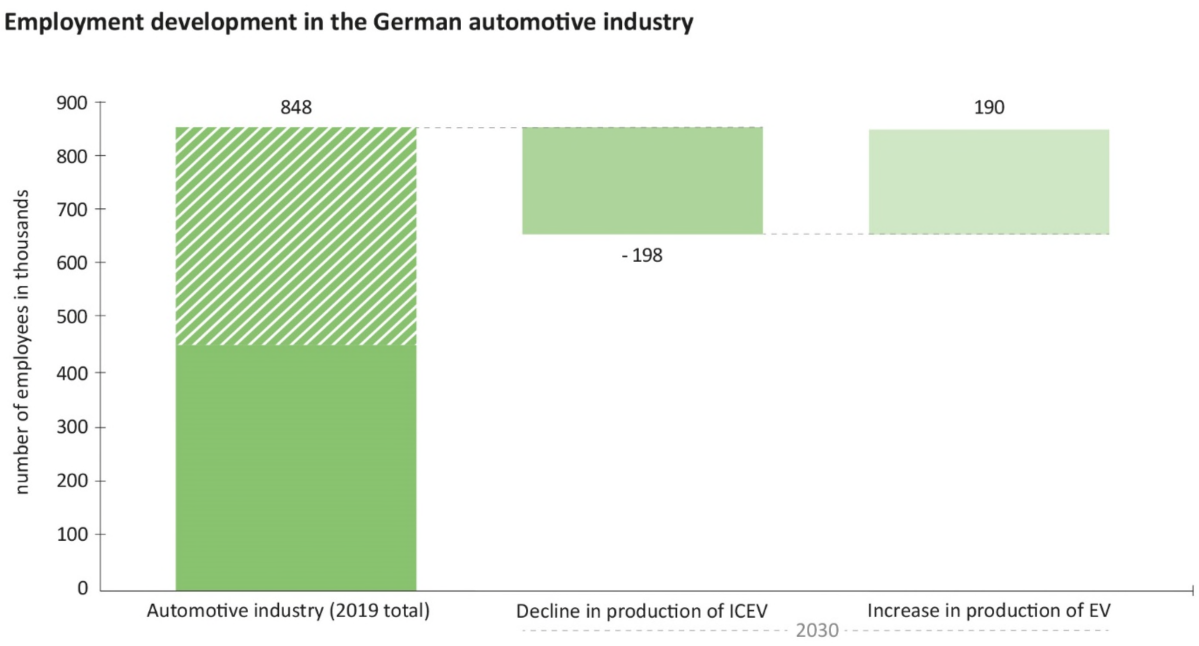
But then:

→ Due to the market ramp-up of electric mobility / e-cars and, above all, the development of considerable production capacities for EVs/CEs in Germany/EU, the **decline in employment will be largely compensated for**

- **Example:**
  - BCG: Through increased growth in European BEV (incl. battery) production, up to 190,000 (new) jobs

MACROECONOMIC PERSPECTIVE

- BCG: production of BEVs basically requires only slightly less workforce than that of a comparable ICEV (-1% fewer working hours)
- If OEMs would produce all powertrain & power electronics components (incl. battery cells) themselves, labour hours per vehicle would even increase by 7%



Balance of employment in the German automotive industry starting from about 848 thousand employees in 2019, of which about 422 thousand are directly related to the production of vehicles with combustion engines (shaded area). Decrease by 2030 based on ifo Institute estimate due to increase in EV share to 47%. Increase based on the Boston Consulting Group‘s findings. Own representation according to Falk et al., 2021 and Niese et al., 2021.

CONCLUSION / TO SUM UP

→ Batteries are a decisive key technology for a sustainable transformation of mobility and energy supply

→ Battery technology still has clear potential for optimisation regarding its sustainability

- **Climate protection:** still a huge GHG reduction potential (mainly during EV production)
- **Industrial policy:** Need for cooperation & smart funding
- **Circular economy:** Need for efficient raw material usage, 2nd life, innovative recycling processes & economies of scale

CONCLUSION / TO SUM UP

- **Raw material governance:** Need for compliance with environmental & social standards in raw material extraction & processing => transparency in the supply chain through tracking of compliance with standards (e.g. battery passport)
- **Economic efficiency:** cost parity between EV & ICEV soon to be reached & still huge potential for further cost reduction of EV
- **Employment:** Decline in traditional jobs in automotive industry to be largely compensated by establishment of EU EV / battery industry => huge need for qualified personnel & training opportunities

CONCLUSION / TO SUM UP

→ If those challenges can be overcome, battery production will create a strong, future-oriented industrial sector in Germany and Europe

→ First steps have already been taken - many more will follow

Download our study:

https://vdivde-it.de/sites/default/files/document/Study_Sustainability-battery-cell-production-Europe.pdf

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Thank You!

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