FEV CONSULTING

AACHEN, AUGUST 2020

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BENCHMARK KIA SOUL EV 2020

ELECTRIC POWERTRAIN

BENCHMARKING

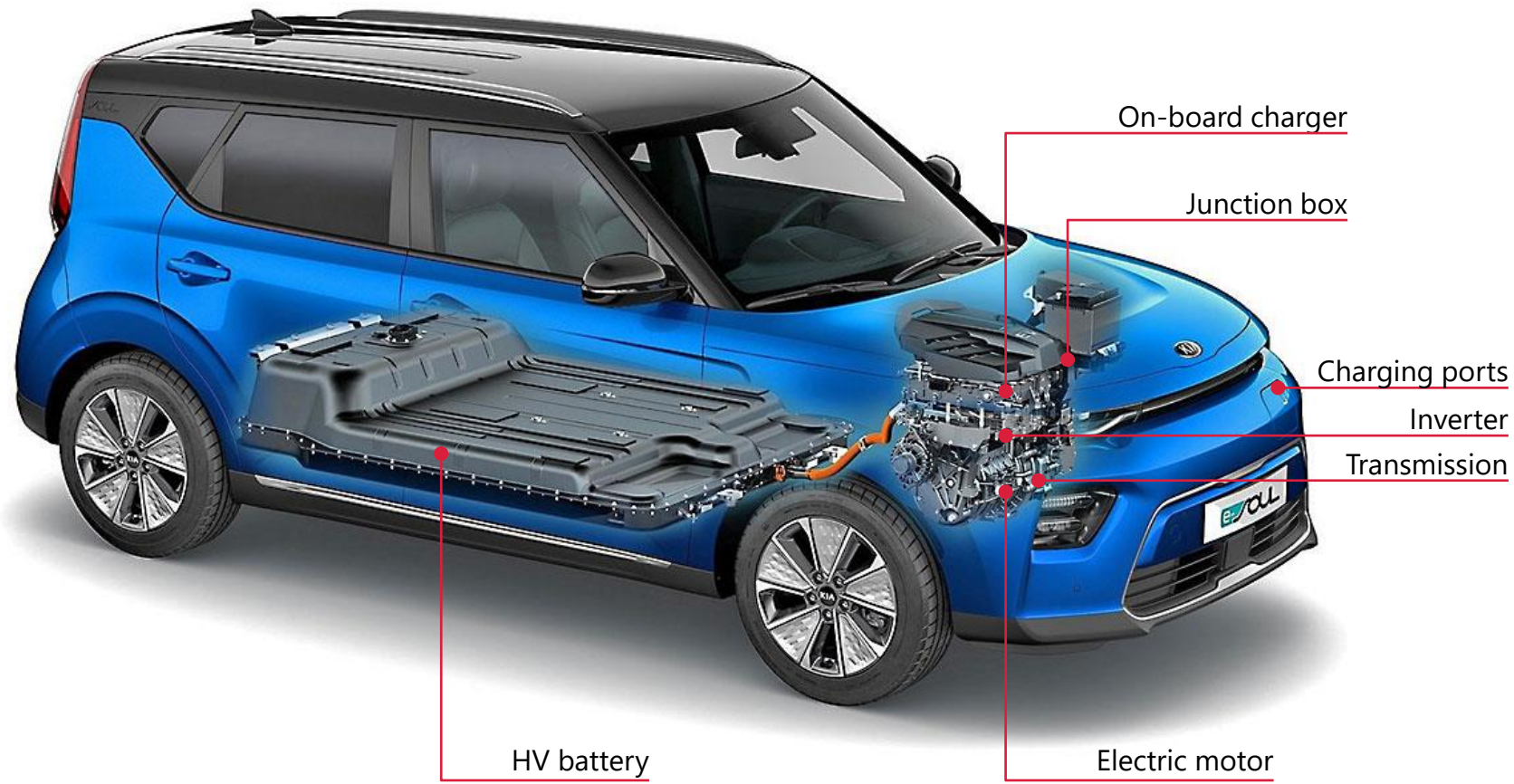
INTRODUCTION

KIA SOUL EV MY 2020

- Crossover SUV battery electric vehicle
  - Variant: e-Soul 204, model year 2020
  - Curb weight: 1,757 – 1,833 kg
  - Base price level: from Euro 37,790 incl. tax (Germany)
- Performance data:
  - Top speed: 167 km/h
  - Acceleration 0-100 km/h: 7.9 s
  - Range city (WLTP): 648 km
  - Range weighted: 452 km
- Key powertrain components:
  - 64 kWh underfloor HV battery, SKI pouch cells, liquid cooled, also used at KIA Niro and Hyundai Kona
  - PMSM front drive EDU with 150 kW peak power and 396 Nm torque

FEV benchmarking experts analyzed in detail the Kia Soul EV MY2020 electric powertrain components by teardown study and cost analysis

MAIN ELECTRIC POWERTRAIN COMPONENTS



Source: kia.com

E-POWERTRAIN

- HV Battery:
  - Energy: 64 kWh
  - Nominal capacity: 180 Ah
  - Cells: SKI pouch cells; 3P98S
  - Liquid cooled (water/glycol)
  - Decentral BMS configuration
- EDU (Electric drive unit):
  - Type: PMSM machine
  - Power: 150 kW @ 3,800-8,000 min^{-1}
  - Torque: 396 Nm @ 0-3,600 min^{-1}
  - Front-wheel drive
  - 1-speed reduction gearbox
- Power Electronics:
  - Inverter with integrated DC/DC converter to 12V
  - Inverter output directly connected to electric motor
  - AC charging up to 7.2 kW at 1 phase
  - DC charging up to 100 kW

The benchmark report of the KIA Soul EV 64 kWh battery pack contains a detailed teardown documentation, technical specifications and cost analysis

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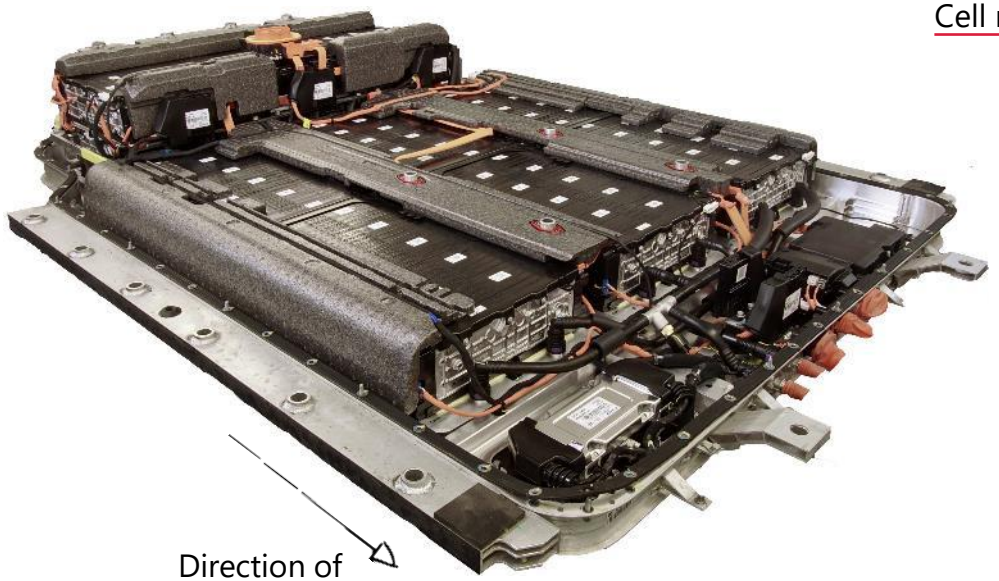
OVERVIEW HV BATTERY PACK



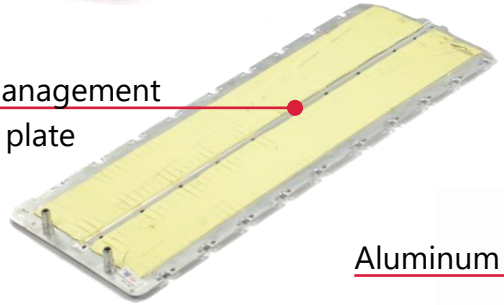
Direction of travel

Cell module

Deep drawn sheet metal cover

Thermal management

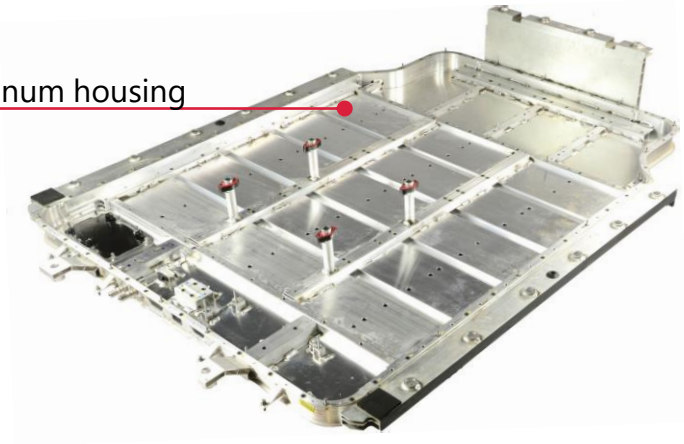
- Cooling plate



BMS / BDU unit

- 1 BMS master
- 5 BMS slaves

Aluminum housing



HV Battery:

- Energy: 64 kWh
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Receive interesting technical insights of the Kia Soul EV electric drive unit including detailed teardown documentation and cost analysis

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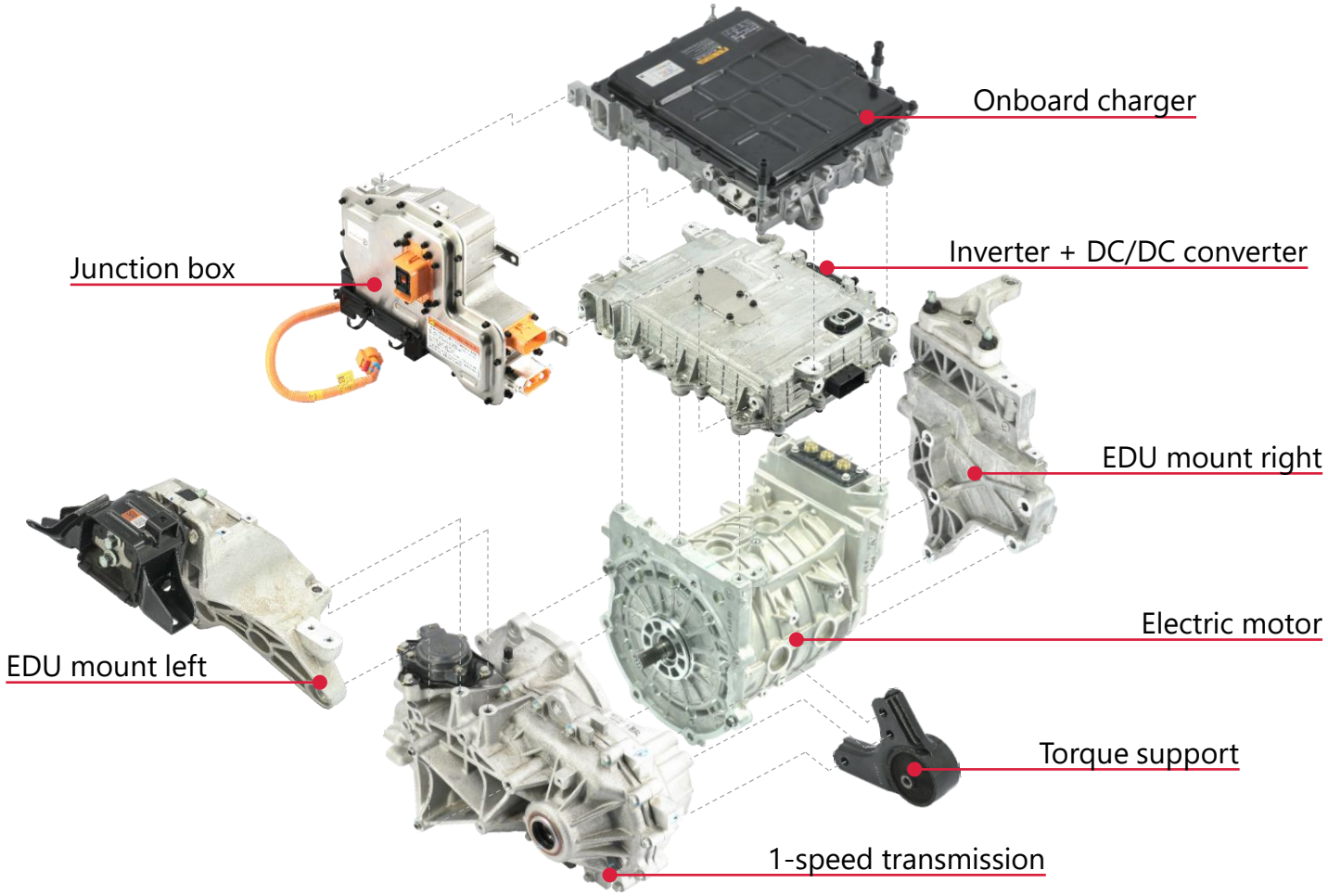
OVERVIEW ELECTRIC DRIVE UNIT



POWER ELECTRONICS

- Inverter & DC/DC
  - Integrated DC/DC converter to 12V
  - Output directly connected to electric motor
- Onboard charger
  - Connector type: Type 2 + CCS
  - AC charging up to 7.2 kW at 1 phase
- Junction box
  - DC charging up to 100 kW

E-MOTOR & TRANSMISSION

- Electric motor
  - Type: PMSM machine
  - Peak power: 150 kW @ 3,800-8,000 min^{-1}
  - Torque: 396 Nm @ 0-3,600 min^{-1}
- Transmission
  - Front-wheel drive
  - 1-speed reduction gearbox
  - Ratio: 7.981

Single benchmark modules of the Kia Soul EV e-powertrain teardown and cost analysis study can be chosen

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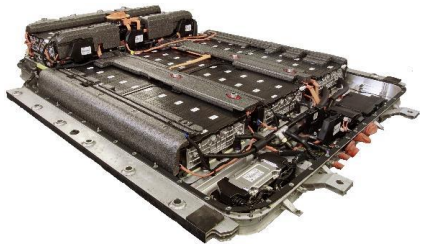
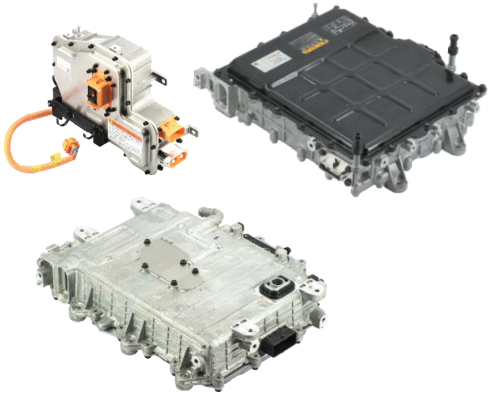
BENCHMARKING MODULES	HV BATTERY	EM & TRANSMISSION	POWER ELECTRONICS
TEARDOWN & DESIGN STUDY ▪ Detailed component teardown ▪ Photo documentation ▪ Bill of material with available specifications like mass, key dimensions, material[1)], available supplier info ▪ Comprehensive teardown report incl. technical details like system architecture, cooling concept etc.	Module 1.1 	Module 2.1 	Module 3.1 
COST ANALYSIS ▪ FEV Should Cost Analysis based on defined boundary conditions ▪ Detailed calculation of main components, rough calculation and cost estimation of minor and standards parts ▪ Cost analysis report with costed BOM and cost break down	Module 1.2	Module 2.2	Module 3.2

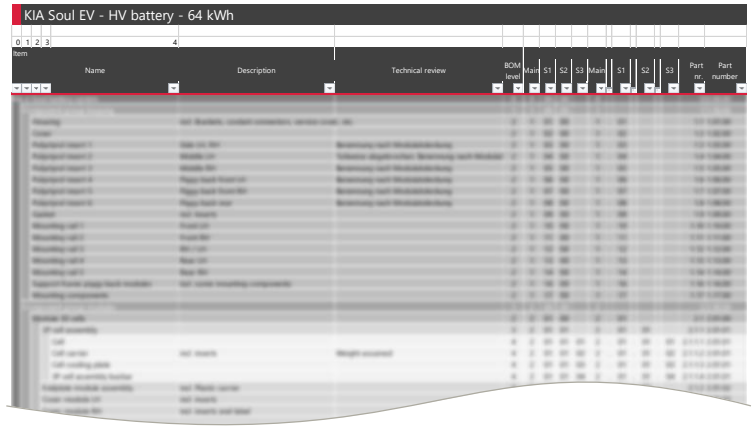
1) Based on visual check and expert evaluation
All prices given are exclusive of VAT and any other local taxes

FEV provides detailed technical documentation and cost analysis results within comprehensive benchmarking reports

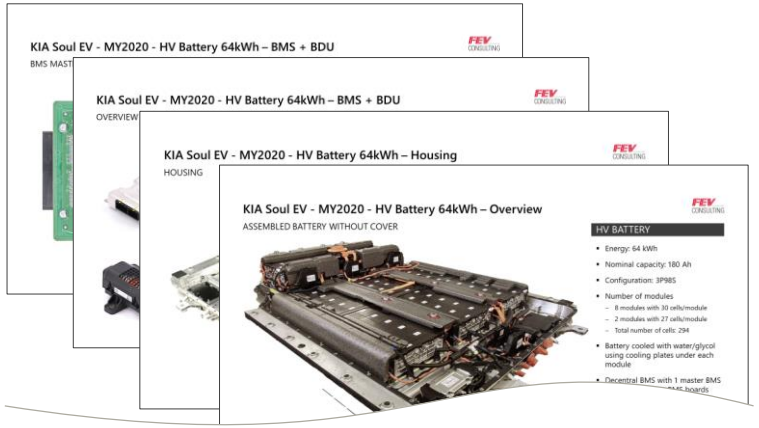
CONTENT

PHOTOS

BILL OF MATERIAL



REPORT



Photos

System overview, sub-assemblies and single components in high resolution

BOM

Includes main items with naming / description, major sizes, material[1] and weight

Report

Includes system overview, techn. description, component details and cost analysis results & break down

1) Based on visual check and expert evaluation

CONTACT DETAILS

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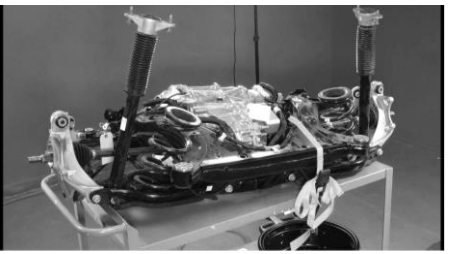
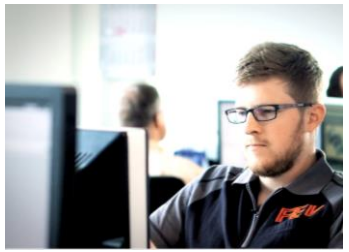
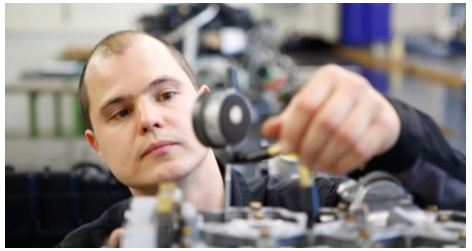
“We not only show you how it looks, we explain why!”

FEV Group is a global leading engineering and consulting service provider which turns technical and business innovation into reality



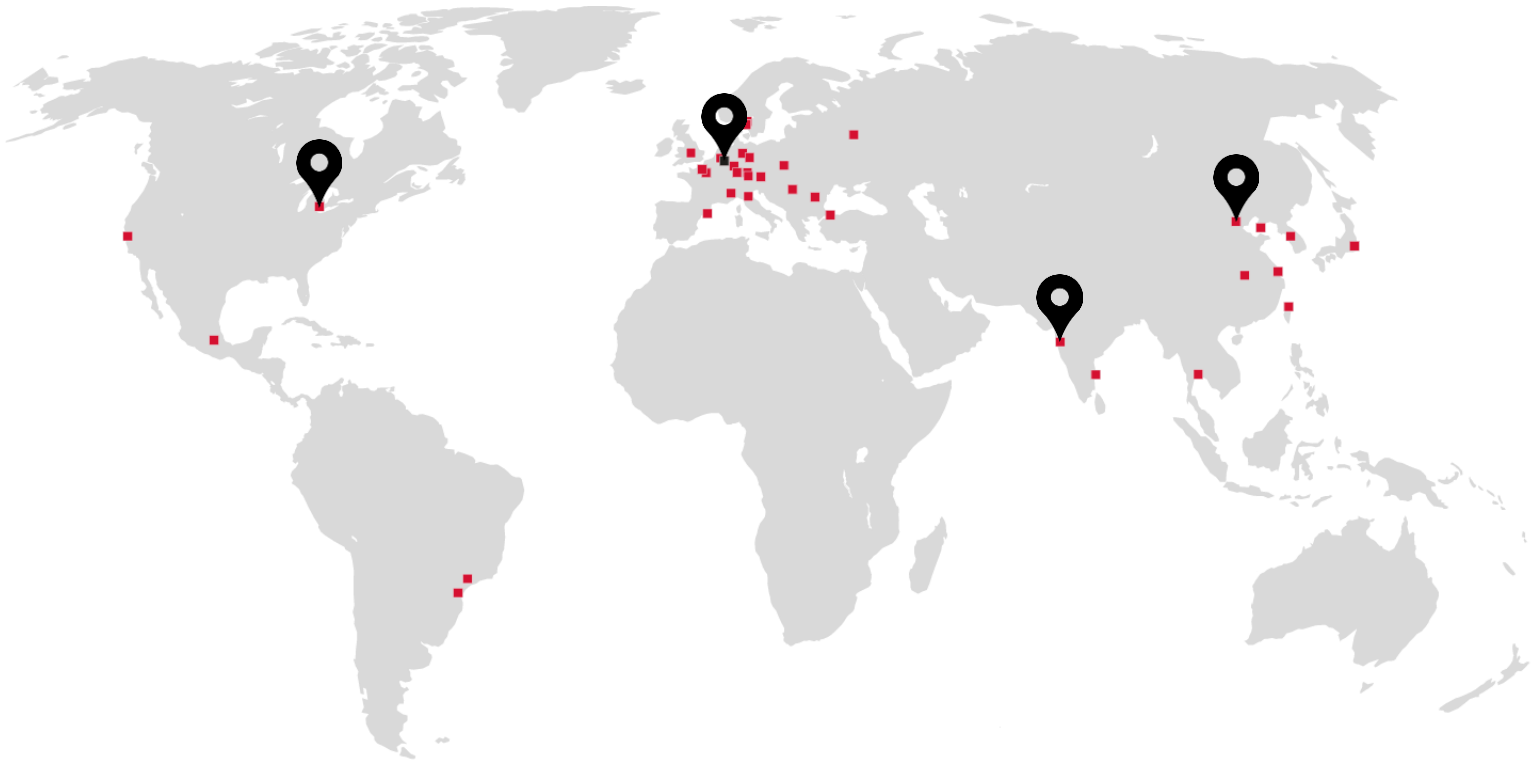



- Independent / Family owned since 1978
- Driving OEM and Tier 1/2 engineering programs to develop future mobility solutions and innovative products
- Unique combination of deep technical knowhow with consulting and cost engineering skills
- Highly involved in key industry sectors as automotive, commercial vehicle, agriculture & construction equipment and other highly engineered products

850 mn Euro revenue expected in 2020

6700+ employees globally

FEV offers engineering and consulting services worldwide with a global network of subsidiaries, technical and benchmark centers



■ Headquarter ■ Subsidiary FEV Benchmark Centers

4 main benchmark centers

12+ technology centers

42+ subsidiaries on four continents

300+ test benches for various vehicle and powertrain architectures

FEV offers a unique benchmarking service combining deep technical knowhow, comprehensive test facilities and cost engineering skills

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BENCHMARKING

Do you want to …

… have an insight view into latest technologies?

… understand functions and design of products in detail?

… receive measured performance data & comparisons?

… know about the cost structure of competitor products?

- Technical Benchmarking
- Teardown Analysis
- Cost Benchmarking
- Benchmark Academy
- Benchmark Database

»Automotive »Commercial Vehicles »Agriculture & Construction Machinery »Other Highly Engineered Products

Key Benefits

- Early analysis of new technologies
- Technical data & scatter bands
- Vehicle & power-train experts
- Conventional, hybrid & electric
- ADAS, AD & HMI
- Global footprint
- Wide range of test facilities
- Cost engineering
- Innovative methods & tools

FEV comprehensive benchmarking services include technical benchmarking, teardown studies, cost analysis and a benchmark academy

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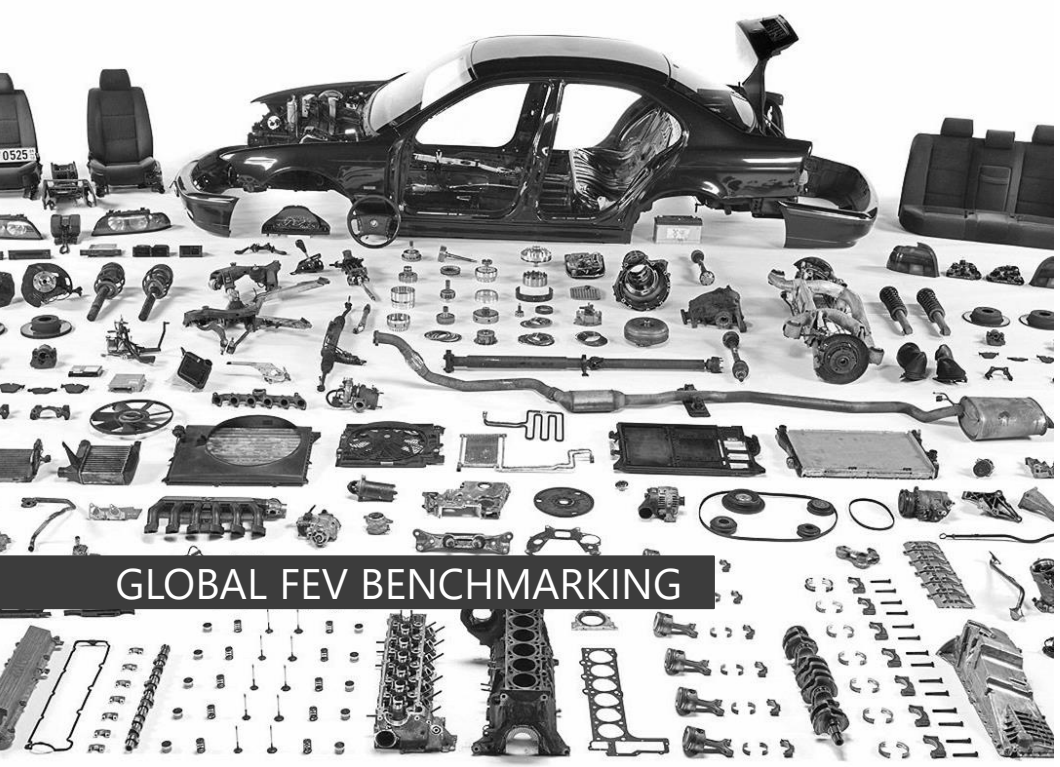
BENCHMARKING



Technical Benchmarking

- Operating Strategy & Performance
- Efficiency & Emissions
- Vehicle Dynamics
- Noise, Vibration & Harshness
- Durability & Friction
- ADAS, Autonomous Driving, HMI

Teardown Analysis

- Hardware Research & Procurement
- Vehicles, Systems & Components
- Professional Pictures & Videos
- Bill of Material with Key Data
- Technical Component Analysis
- 3D Scanning, X-Ray & Virtual Reality

Cost Benchmarking

- Material & Manufacturing Analysis
- Should Cost Analysis
- Functional Cost Analysis
- Cost Breakdown & Comparison
- Design to Cost Ideas
- Cost Reduction Workshops

Benchmark Academy

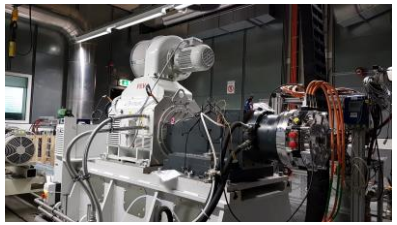
- Driving & Technology Events
- Teardown Workshops
- Hardware Exhibitions
- Technical & Costing Expert Advisory
- Brainstorming & Idea Generation
- Benchmark Community & Network

Benchmark Database, Scatter Bands and Online Platform

FEV offers a wide range of advanced test facilities and brings the required knowhow to run highly specialized tests





ON-ROAD TESTING:
- Standardized duty cycles
- Portable emission measurement syst.

TEST TRACK:
- Multipurpose proving grounds
- 5G network
- City simulation

TEST BENCHES:
- Climate AWD chassis dyno
- Combustion engine & turbocharger
- Transmission
- Noise, vibration & harshness
- Electric motor & electric drive unit
- HV battery
- Power electronics

TEARDOWN WORKSHOPS:
- Professional photo & video equipment
- 3D scanning and virtual reality






1) ADAS: Advanced Driver Assistance Systems
2) PEMS: Portable Emission Measurement System
3) NVH: Noise Vibration and Harshness

FEV has performed numerous benchmarking studies on conventional, hybrid & electric vehicles and powertrains

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SELECTED AVAILABLE BENCHMARK STUDIES

Internal Combustion Engine

- Mazda 3 Skyactiv-X
- Infiniti QX50 with VCR
- Mercedes E350 M264 48V BSG
- VW UP GTI EA211
- BMW Mini Cooper S B48 TÜ1
- VW Golf 1.5 TSI EA211
- Audi G-tron CNG
- VW Polo TGI CNG
- Renault Grand Scenic dCi 48V
- BMW 730d B57

Plus a wide range of turbochargers:

- IHI, WG, Audi EA888 Gen3B
- Garrett, VTG, VW 1.5l TSI EA211
- BWTS, WG, JLR 2.0l high power 2018
- BWTS, WG, VW Polo 1.0 TGI 2019
- BorgWarner, DS, GM Silverado 2.7l 2019
- Garrett, TS, BMW B48 2.0l 2019

Transmission

- Porsche Panamera ZF 8DT80
- VW Tiguan R DQ381
- VW DQ 400e
- Audi DL382
- BMW 760li ZF 8HP90
- BMW X5 40e ZF 8HP electric
- Land Rover Evoque ZF 9HP
- Aisin 8F45
- Getrag 7DCT 300
- Getrag 6DCT 205
- Dodge Promaster MTA M40
- Ford 10R80
- Ford 8F35

Hybrid & Electric Powertrain

- Hyundai Nexo Fuel Cell
- Audi e-tron
- Tesla Model 3
- Tesla Model S
- Renault Zoe
- Mercedes E300de OM654 PHEV
- BMW 225xe PHEV
- Daimler 48V Battery Pack
- Kia Soul EV
- BYD T4 LCV
- Porsche Taycan
- VW ID.3
- Peugeot e208

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