



Modular Hybrid Powertrain

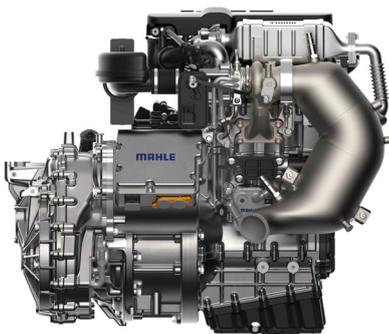


Powetrain Modularity in Multiple Applications

Electrification and hybrid technologies are now widely accepted as the preferred approach to achieving future vehicle emissions targets. In Europe, for example, OEMs must comply with a fleet average CO₂ emissions target of <60 g/km by 2030.



So, there is an urgent need for the rapid adoption of appropriate, scalable solutions across a broad spectrum of vehicle segments to meet these objectives. In response, MAHLE has developed the Modular Hybrid Powertrain concept using a dual-mode (series and parallel) configuration to provide the best features of both series and parallel architectures.



- Dual mode plug-in hybrid (PHEV) powertrain
- Dedicated Hybrid Internal Combustion Engine (DHE)
- Scalable across multiple vehicle applications
- Improved emissions & reduced after treatment complexity
- Seamless torque delivery provided by the traction motor
- Low, weighted drive cycle CO₂ (< 2030 proposed target)

The new MAHLE Modular Hybrid Powertrain (MMHP) provides a realistic, scalable solution for a high efficiency, series and parallel hybrid powertrain for a wide range of vehicle applications.

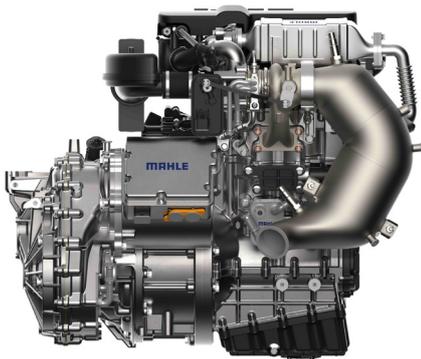
The MMHP incorporates a turbocharged gasoline IC engine, traction motor, generator, inverters and bespoke transmission (with 1,2 or 4 speeds) in a compact, fully integrated package.



Reduced complexity for lower costs
Low, weighted drive cycle CO₂

Benefits

- IC engine, traction motor, generator & transmission arranged in compact, fully integrated package
 - › Vehicle operates in different modes according to battery charge & driving speed
- Traction motor connected directly to wheels
 - › Engine de-coupled by transmission & so runs at limited speed / load range ensuring low fuel consumption and CO₂ emissions
- Engine, motor and HV battery all scaled easily to different outputs
- MHP offers several advantages:
 - › Scalability
 - › Fuel efficiency
 - › Low emissions
 - › Reduced weight



MAHLE downsizing engine

Dedicated Hybrid IC Engine (DHE)

- Parallel twin cylinder, with contra-rotating balancer shaft
- 2 valves per cylinder, SOHC, fixed valve event timing
- Port fuel injection with MAHLE Jet Ignition (MJ[®])
- Turbocharger with MAHLE electronic wastegate actuator
- Miller-cycle operation with high geometric compression ratio
- Limited speed/load range operation for fuel efficiency
- Minimum BSFC = 207 g/kWhr (target < 200g)
- Compact, light weight & low cost engine
- Low technology requirement



Hybrid electric drive & 2 speed transmission

Hybrid Electric Drive & Transmission

- Direct drive HV MAHLE traction motor with optimised cooling
- HV MAHLE generator mounted on transmission input shaft
- MAHLE Inverters integrated into motor and generator housing
- Simplified transmission - no torque interruption
- Traction motor provides full vehicle dynamic performance
- No clutch as neutral selection decouples DHE from driveline



Dedicated hybrid engine