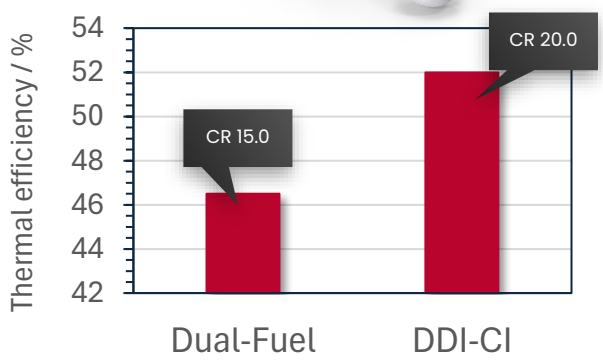
Advanced Methanol Dual-Fuel System Development

FEV SIGNATURE SOLUTIONS

Speed up your methanol development plans!

FEV offers

- Engineering of new powertrains or conversion of your current engine
- Combustion system definition based on FEV's assessment studies
- Gas exchange and combustion simulation with specific methanol combustion models based on in-house experimental data
- State-of-the-art methanol test benches ready for pre-mixed and diffusive combustion
- Risk assessment via FEV's safety matrix and implementation and validation of safety measures for methanol engines



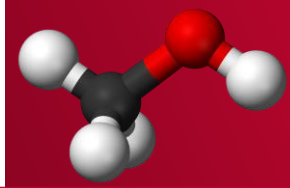
DDI-CI = Dual Direct Injection Compression Ignition

Why FEV

- **Proven expertise:** 45+ years of engineering excellence, trusted by global OEMs and Tier-X suppliers to deliver innovative, production-ready solutions with deep domain expertise
- **Complete lifecycle support**: From concept to series maturity, including design, simulation, prototyping, testing, industrialization, and implementation
- **Customer-centric solutions:** Transparent and customizable, enabling you to extend, integrate, and scale your own development

Selected reference projects

ADVANCED METHANOL DUAL-FUEL SYSTEM DEVELOPMENT



Large European OEM

Methanol combustion engine development program

- Full development program for conversion of diesel engine to methanol dual fuel
- Ongoing project

FEV responsibility

- Performance & Emissions via 1D and 3D simulations
- Design of all upgraded and new components, including all safety requirements, drawings, etc.
- Full CAE scope of development
- Engine integration and automation system
- SCE combustion development, MCE calibration & validation
- Engine manuals, type approval testing, etc.

OEM

Methanol combustion engine comprehensive concept study

- Large bore high speed engine (5 l cylinder displacement class)
- Derived from existing diesel engine

FEV responsibility

- Market study and competitor analysis
- Performance & emissions concept including ECU requirements
- Design and safety concept
- Product cost implications
- Development roadmap

OEM

Methanol combustion system development on medium-speed SCE

- Medium-speed large bore engine
- Derived from existing diesel engine
- Completion in 2025

FEV responsibility

- Design, validation and procurement of SCE hardware
- Consulting for hardware definition
- Definition of test program and test execution

FEV internal

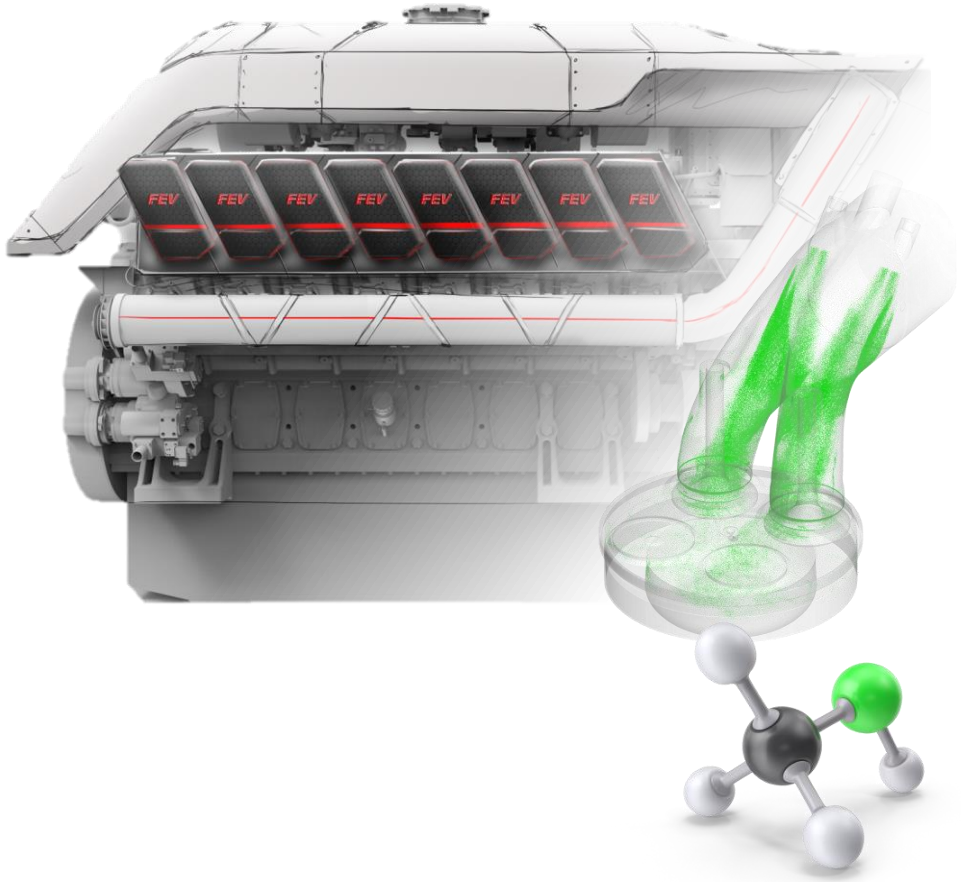
Methanol combustion research on heavy-duty and high-speed SCE

- HD and HS SCE investigations
- HD: Heavy duty commercial vehicle engine (2.13 l cylinder displacement), ideal to test different combustion systems on the same base engine
- HS: Large bore high speed engine (5 l cylinder displacement class) derived from existing diesel engine

FEV responsibility

- Different combustion system configurations tested
  - PFI (and DI SI for HD SCE)
  - DDI CI / HPDI with lateral pilot injector

We offer the complete range of services



Combustion system definition	30+ years research experience with methanol **Dedicated alternative fuel specialists** Experience with a wide range of methanol combustion systems
Gas exchange and combustion simulation	0-D chemical kinetic based simulation **1-D performance simulation** 3-D simulation for mixing & combustion
Single cylinder engines	Dedicated methanol hardware (piston/head) **PFI, DI SI, and diffusive dual-fuel investigated in detail** Test data from previous investigations available
Methanol test benches	**FEV testbenches are methanol-ready** Full transient and automated operation possibility 24/7 operation possible Cold condition testing possible
Demonstrator vehicle	**Control software development** Functional safety concepts Experience with demonstrators for different alternative fuels

Get in touch with us for further information

www.fev.com/en/signature-solutions