



**FH Joanneum
6. April 2016**

DIE NEUE OTTOMOTORENFAMILIE VON BMW.

WOLFGANG MATTES, BMW GROUP.

**BMW
GROUP**



DIE NEUE OTTOMOTORENFAMILIE VON BMW.

INHALT.

- ▷ **Baukasten**
- ▷ **Ottomotorenfamilie**
- ▷ **i8 Motorisierung**
- ▷ **Efficient Dynamics
und Elektrifizierung**
- ▷ **Ausblick**



HERAUSFORDERUNGEN.

Uneingeschränktes
Bedürfnis nach individueller
Mobilität

Weltweit weitere
Verschärfung der
Emissionsgrenzwerte

Weltweit zunehmende
Anspannung bezüglich
CO₂ Ausstoß

Zunehmende
Urbanisierung

Zunehmend volatiles
wirtschaftliches
Umfeld

Neue und weltweit
unterschiedliche
Testzyklen

Zunehmend härterer
Wettbewerb in allen
Fahrzeugsegmenten

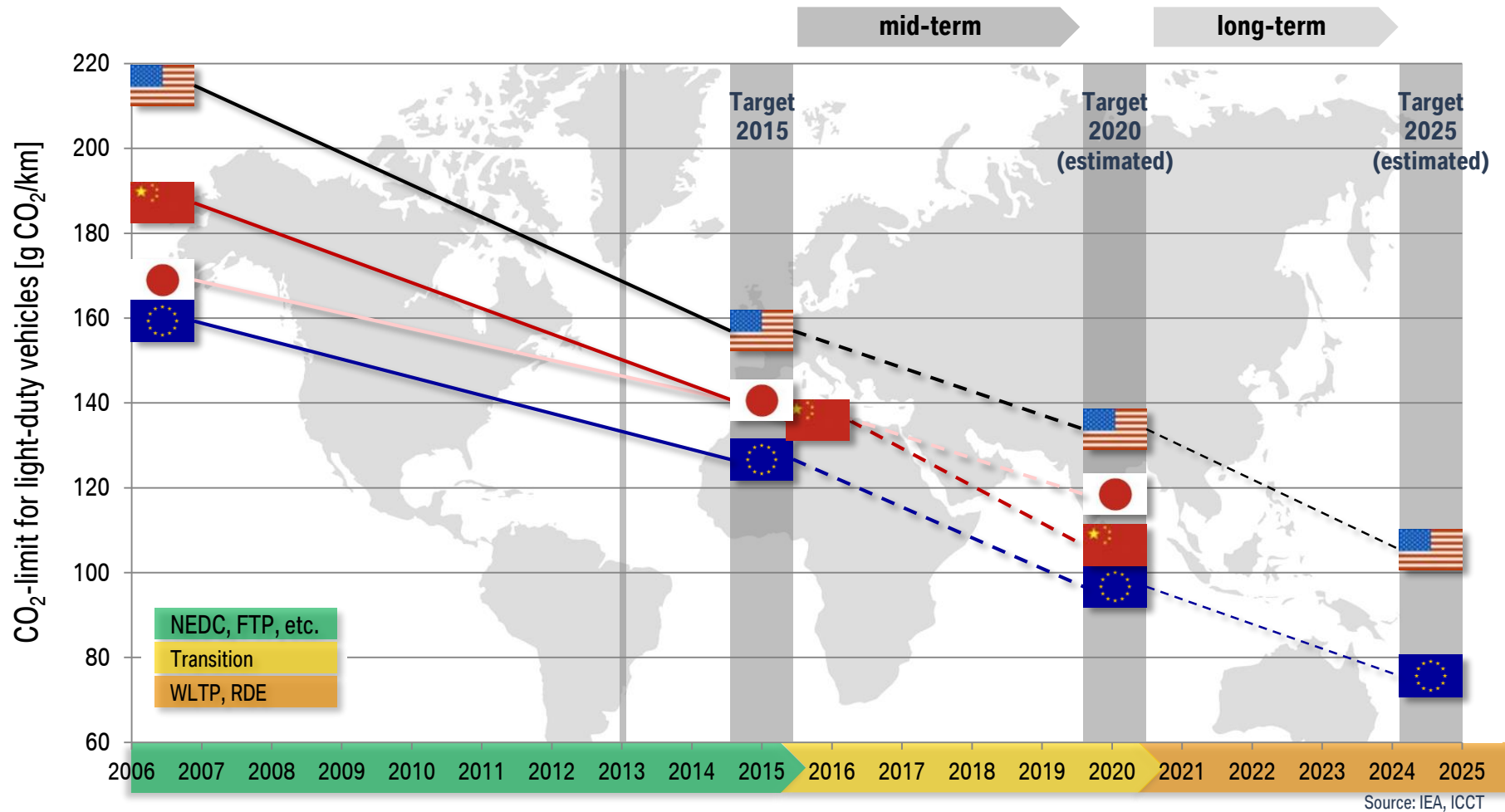


Ausgeprägte
Diversifizierung von
Fahrzeugvarianten

Weltweit
unterschiedliche
Kraftstoffqualitäten

Weltweit unterschiedliche
Energieträger
(Benzin, Diesel, Erdgas,
Wasserstoff, Alkohol)

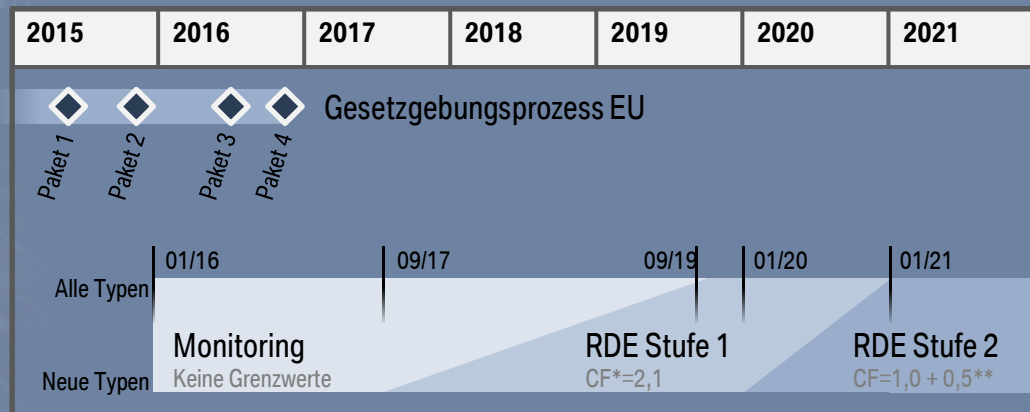
WELTWEITE GESETZLICHE CO₂-/VERBRAUCHS- UND EMISSIONS-ANFORDERUNGEN.



REAL DRIVING EMISSIONS (RDE) ZUM NACHWEIS DER EMISSIONSGRENZ-WERTE IM NORMALEN FAHRBETRIEB AUF DER STRASSE.

Herausforderungen:

- Enorme Varianz der Randbedingungen → Messungen sind nicht reproduzier- und vergleichbar.
- Geringe Zeit zwischen Definition Gesetz und Inkrafttreten.



Paket 1: Prinzipielle Verankerung RDE

Paket 2: Testrandbedingungen und Regulierung NO_x

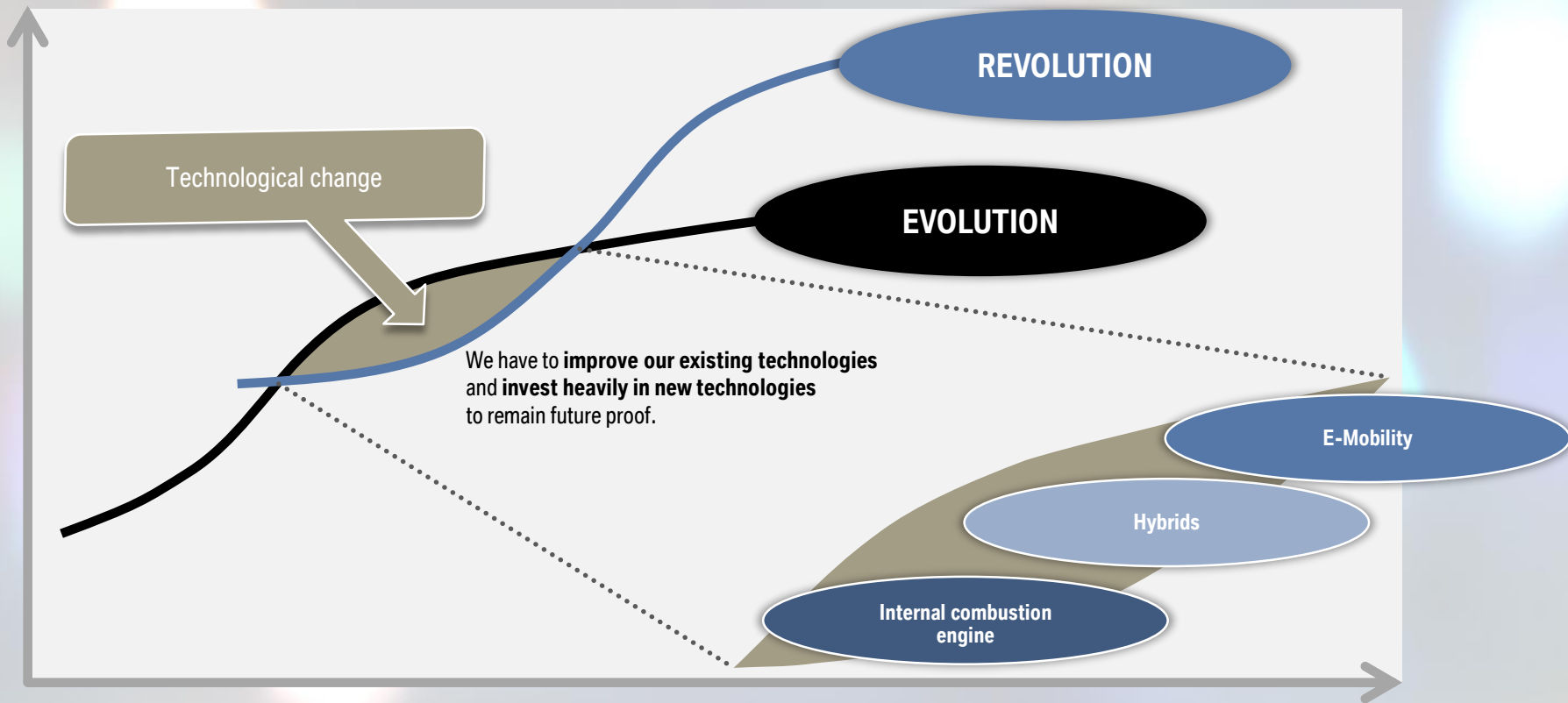
Paket 3: Regulierung Kaltstart und PHEV, sowie Transferfunktion

Paket 4: In-Use-Conformity

*) CF: Conformity Factor; Grenzwert RDE = EU6c Grenzwert * CF

**) Aufschlag aufgrund Messunsicherheit der mobilen Messtechnik

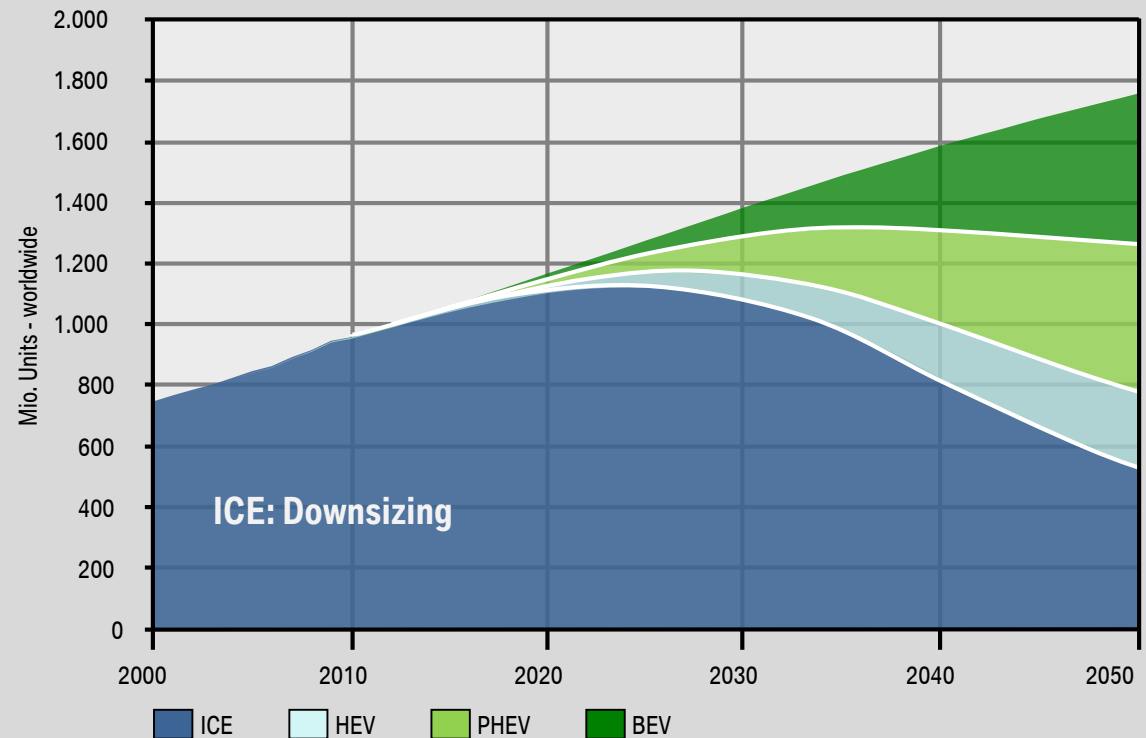
EINFÜHRUNG NEUER TECHNOLOGIEN.



VOLUME SHARE DEVELOPMENT OF DIFFERENT POWERTRAIN CONCEPTS.

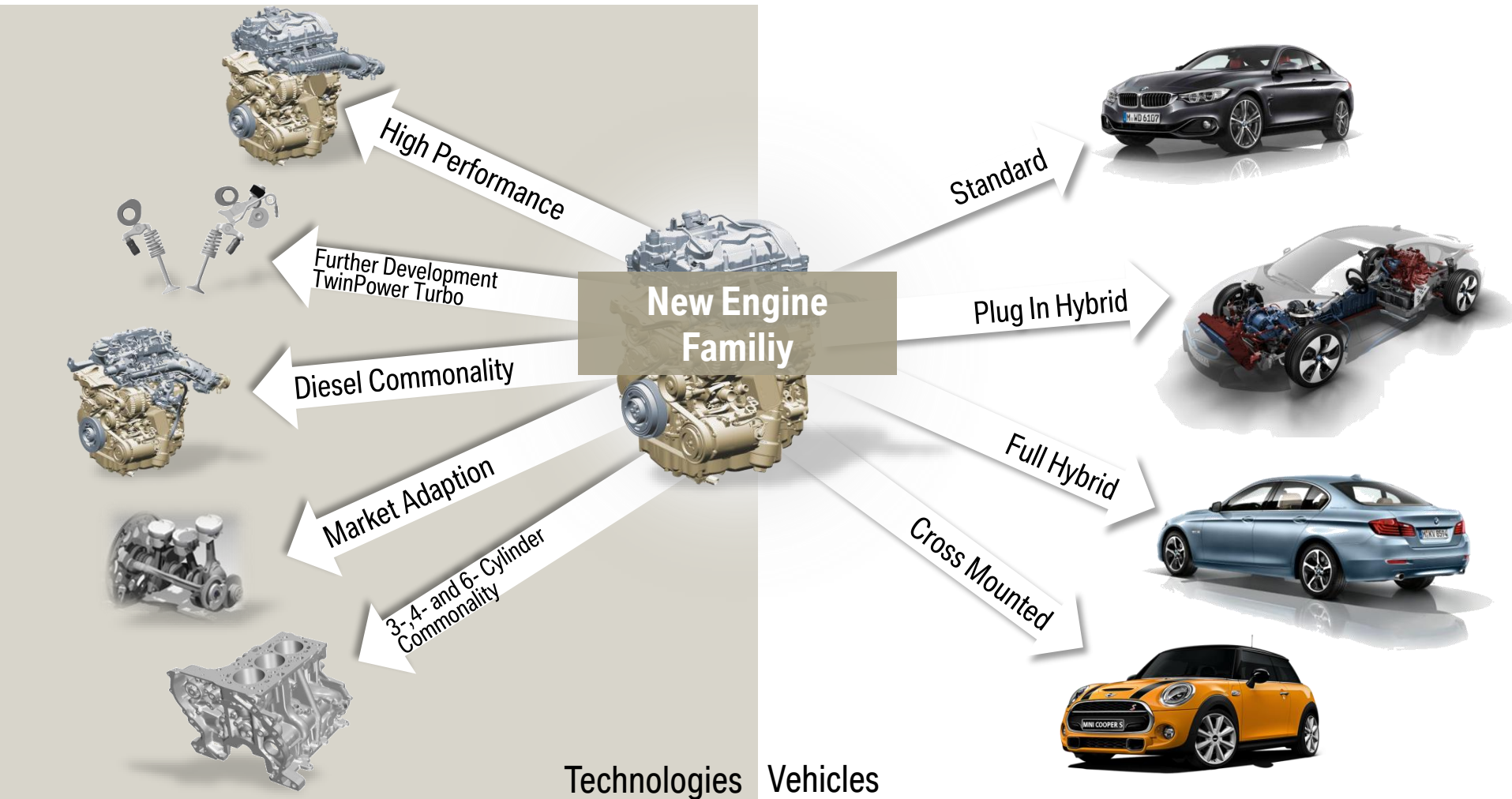
PROGNOSIS

- **Continuous growth of electric concepts.**
- Trend towards **Downsizing** of ICEs.
- Further **increase of concepts including combustion engines** until 2030+.

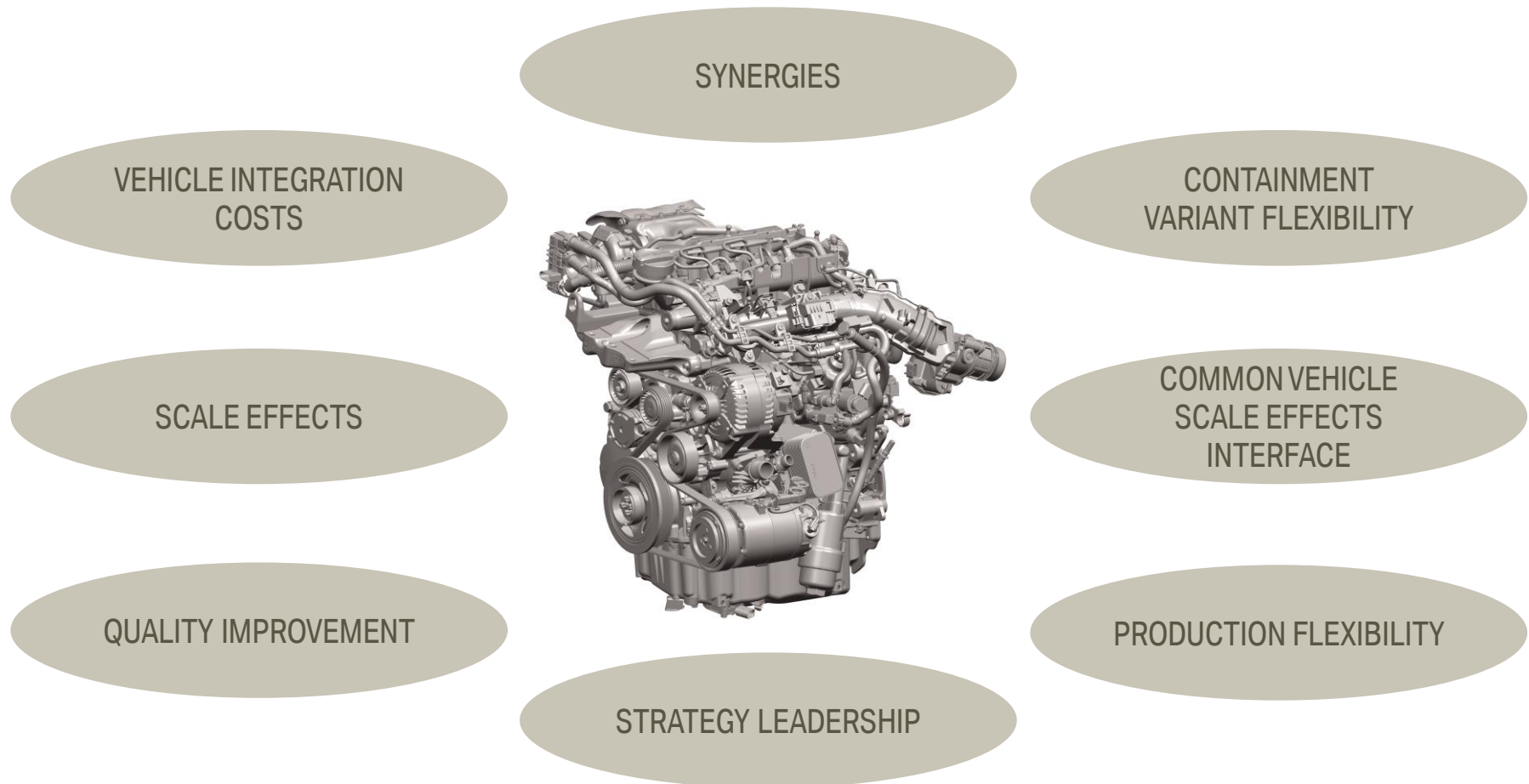


Sources: United Nations, Global Insight, Credit Suisse, BMW-Calculations.

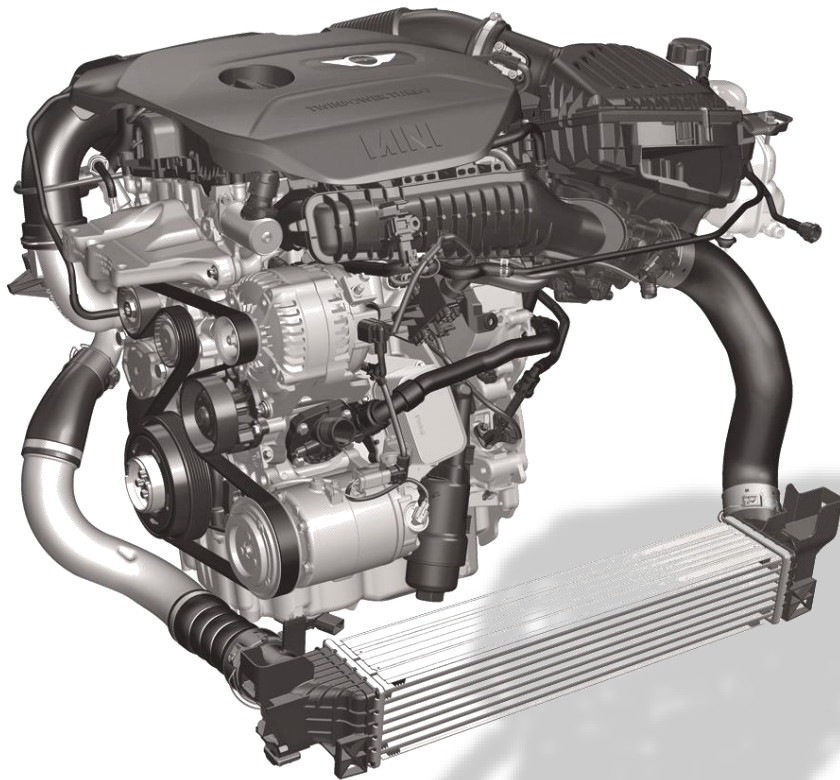
THE NEW BMW EFFICIENT DYNAMICS ENGINE FAMILY. OBJECTIVES.



NEW EFFICIENT DYNAMICS ENGINE FAMILY. TARGETS.

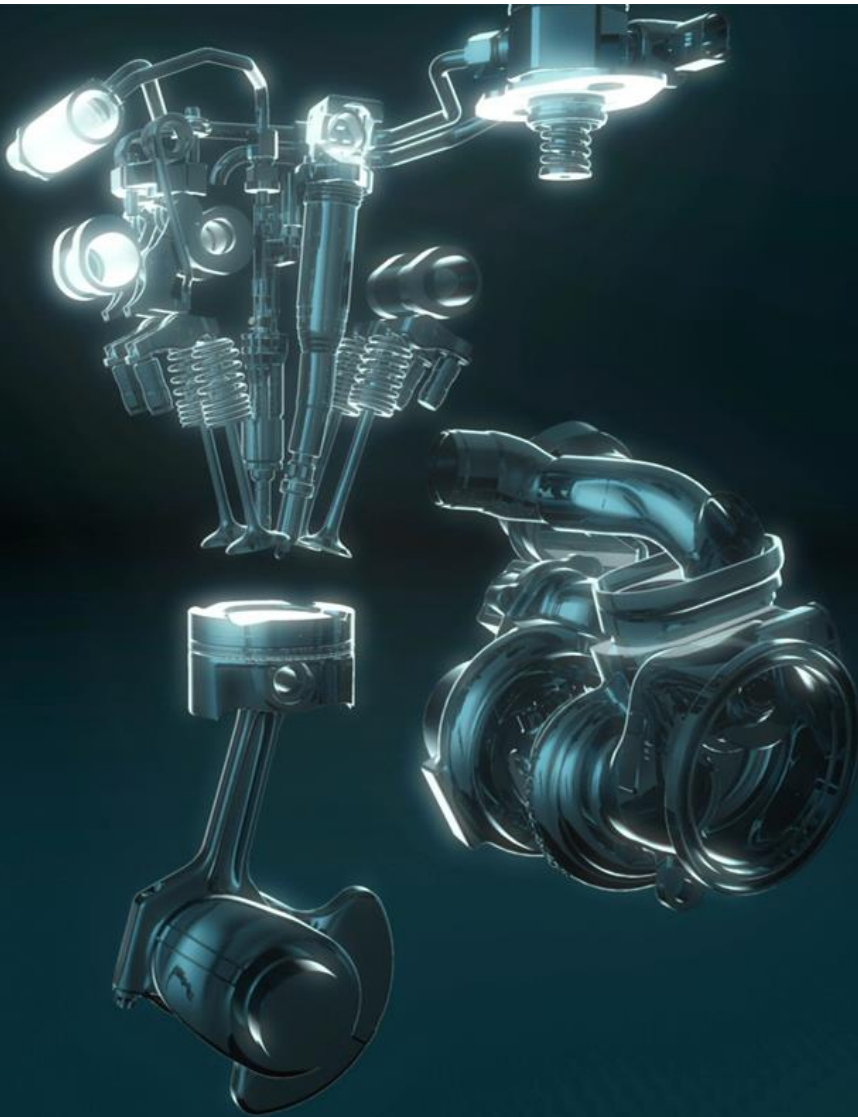


THE NEW BMW EFFICIENT DYNAMICS ENGINE FAMILY. OBJECTIVES.



- Specific power output up to 115 kW/dm³.
- High low-end torque at speeds just above idle speed.
- Low fuel consumption during customer operation and in certification drive cycles.
- Compliance with the strictest exhaust emission limits worldwide.
- Maximal production flexibility (gasoline/ diesel, 3-/ 4-/ 6-cylinder) across a number of production facilities.
- Simple and rapid construction of derivatives.
- Uniform vehicle interfaces for all variants.

BMW EFFICIENT DYNAMICS. DIE NEUE BMW MOTORENFAMILIE.



New engine family with TwinPower Turbo Technology

- 3 Cylinder Engine
- 4 Cylinder Engine
- 6 Cylinder Engine

Combustion Chamber:

- Optimal size 500 ccm
- Central injector
- Minimized friction

Different aspects for Gasoline/Diesel:

- Cylinder head elements
- Combustion process

Approximate range of torque and power per cylinder:

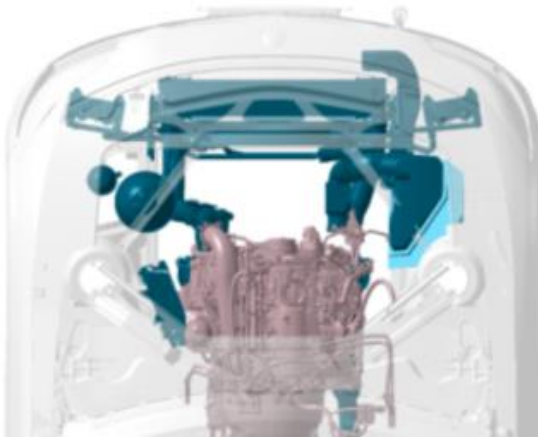
- Gasoline: 60-100 Nm, 30-60 kW
- Diesel: 75-100 Nm, 20-40 kW

DIE NEUE BMW MOTORENFAMILIE. GEMEINSAME SCHNITTSTELLEN DER MOTOREN IM FAHRZEUG.

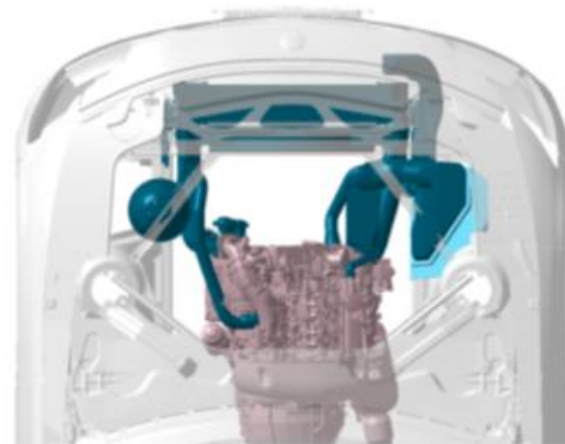
→ EINBAULAGE UND EINBAUWINKEL IDENTISCH

→ FAHRZEUGSCHNITTSTELLEN IDENTISCH

3-ZYLINDER-BENZINMOTOR



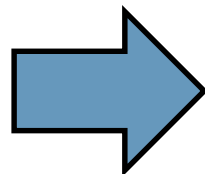
3-ZYLINDER-DIESELMOTOR



NEUE MOTORENFAMILIE. VARIANTENMANAGEMENT.

Varianten-Management:

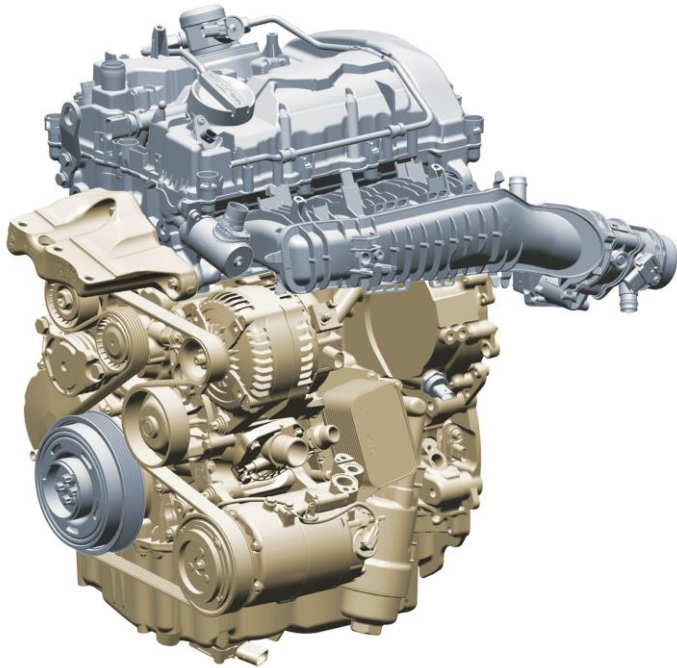
- 3-/4-/6-Zylinder
- quer / längs
- Leistungsstufen (uL, mL, oL, TOP)
- FWD / RWD / AWD
- Verbrenner / PHEV
- ECE / US (Emissionsstufen)
- Heissland, Nordland, Ländervarianten, ...
- race track
- Schlechtkraftstoff
- ...



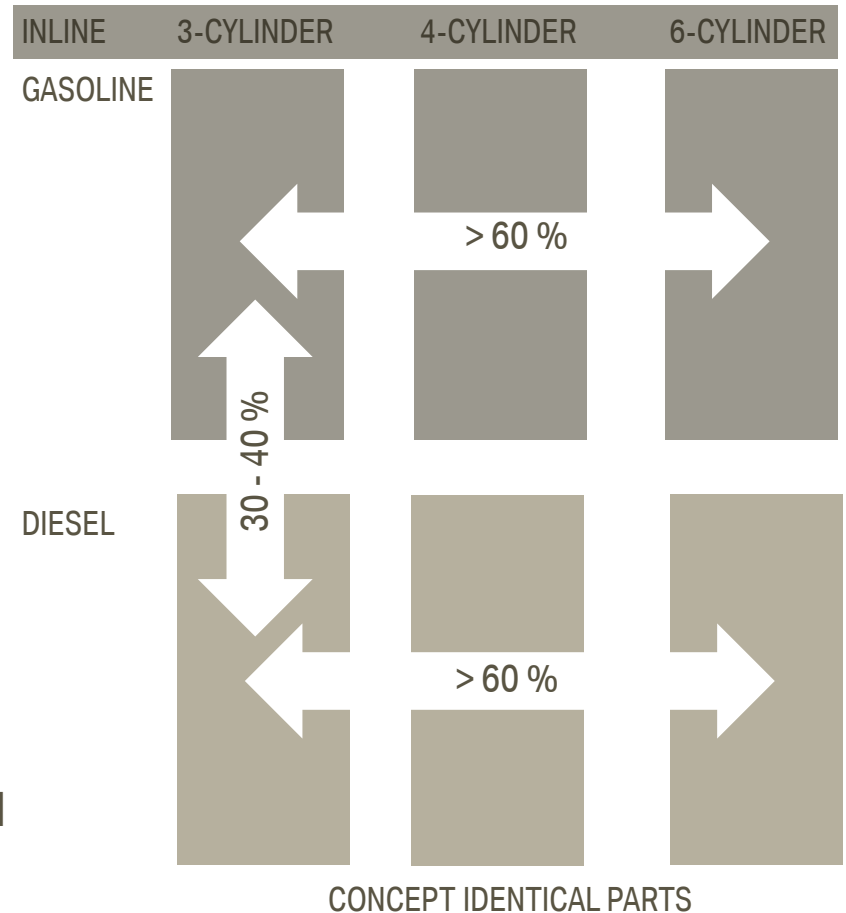
modularer Baukasten



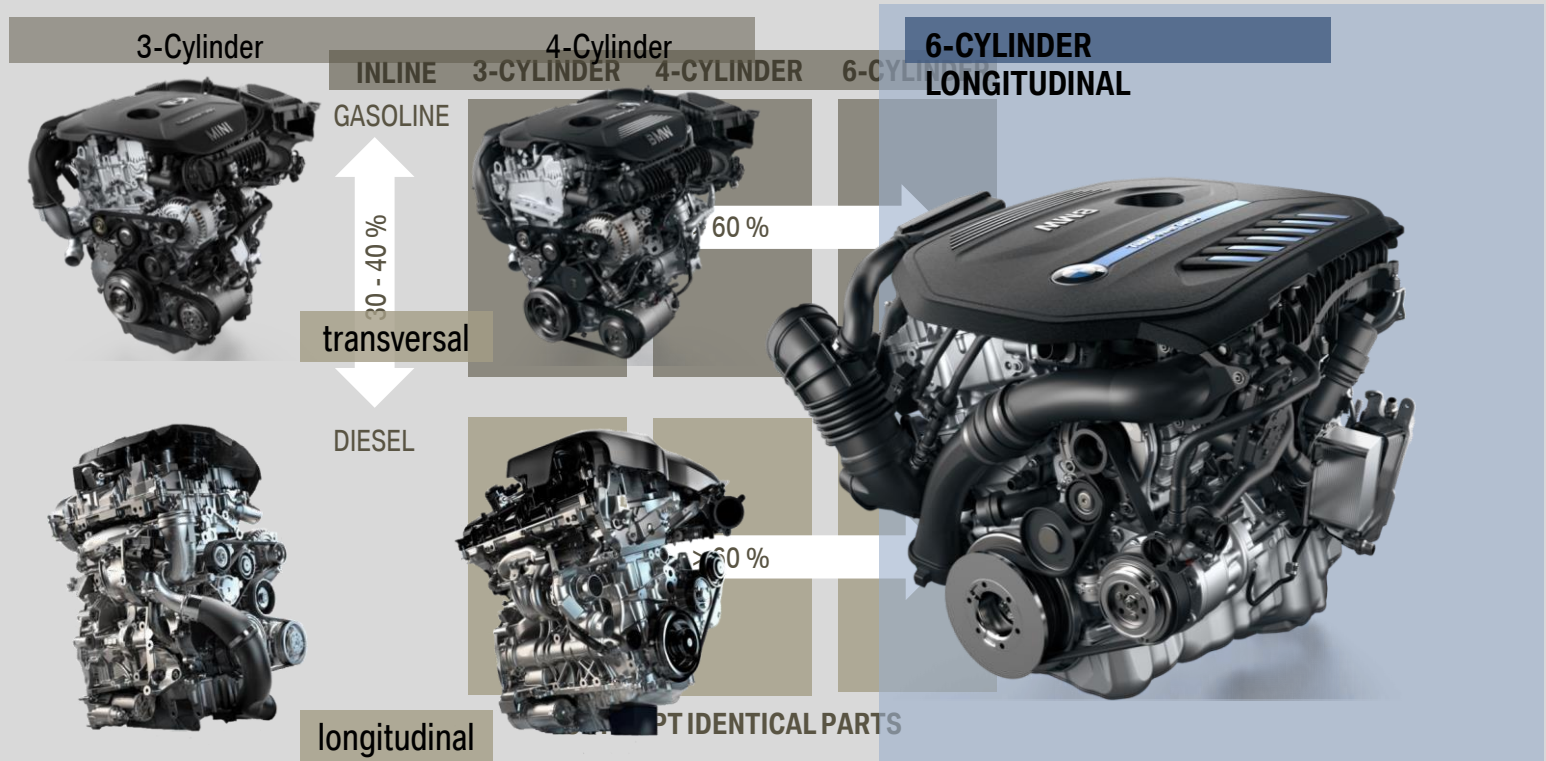
THE NEW BMW EFFICIENT DYNAMICS ENGINE FAMILY. HIGH PORTION OF COMMON PARTS.



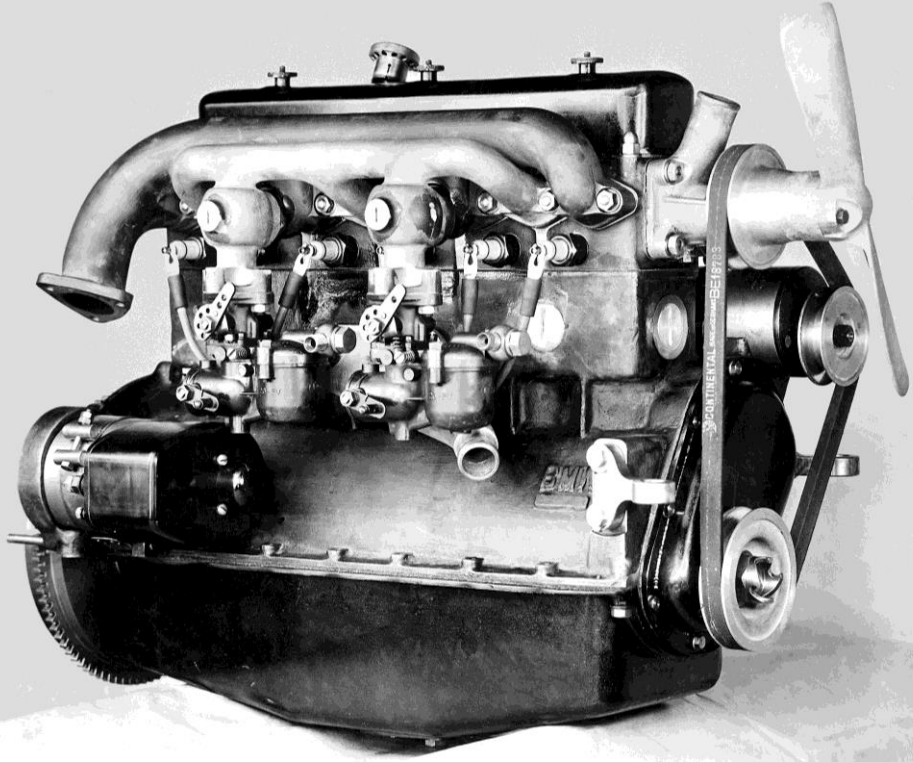
-  Different parts gasoline - diesel
-  Common and synergy parts gasoline - diesel



The new BMW Efficient Dynamics Engine Family.



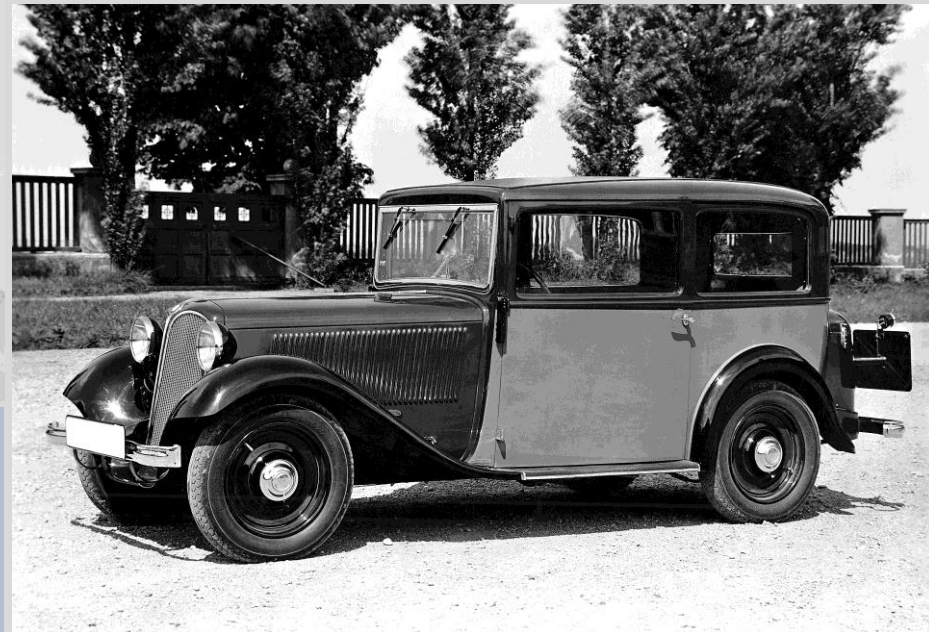
BMW 6-CYLINDER TRADITION.



BMW B303 1933

Power: 22kW

Weight: 850 kg



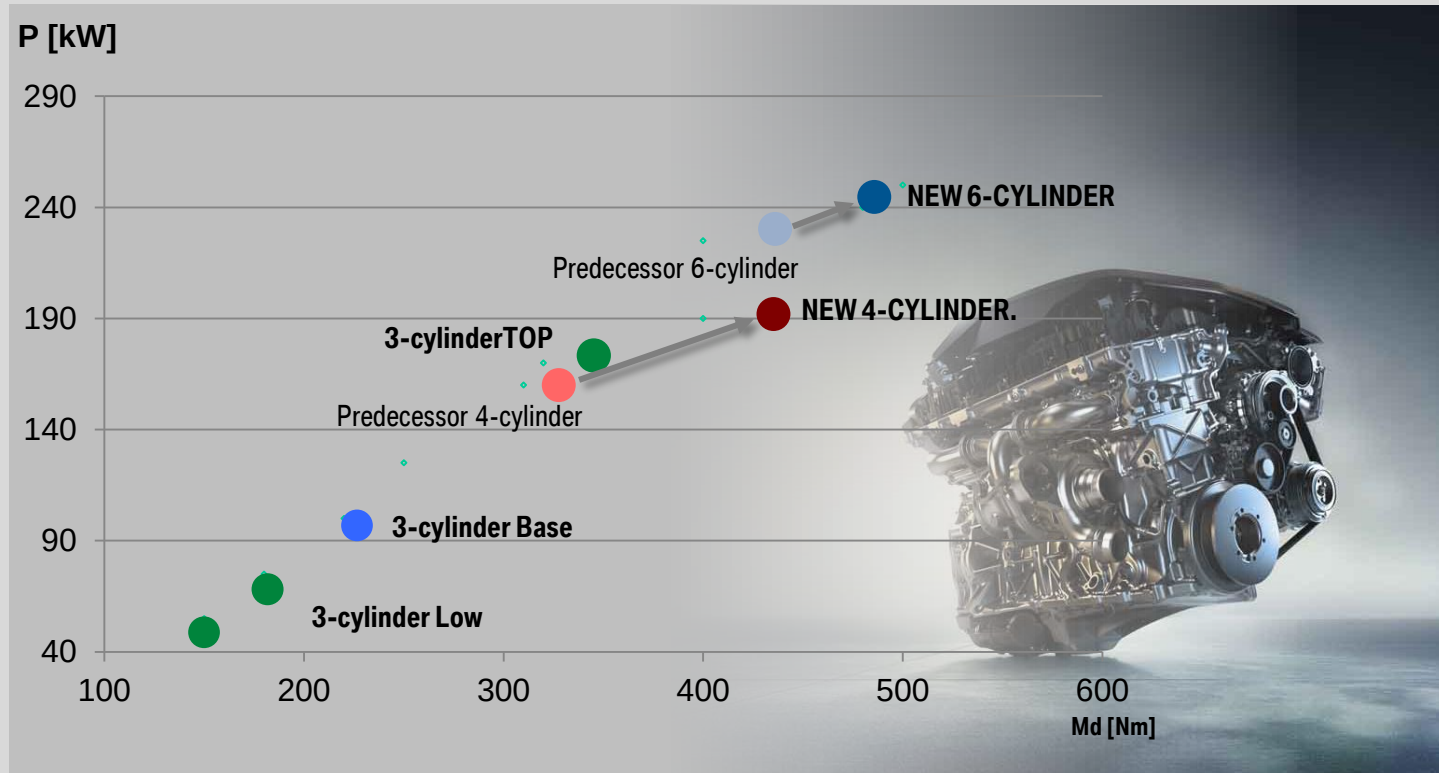
FIRST BMW SIX -CYLINDER 1933

Engine displacement :1,2L

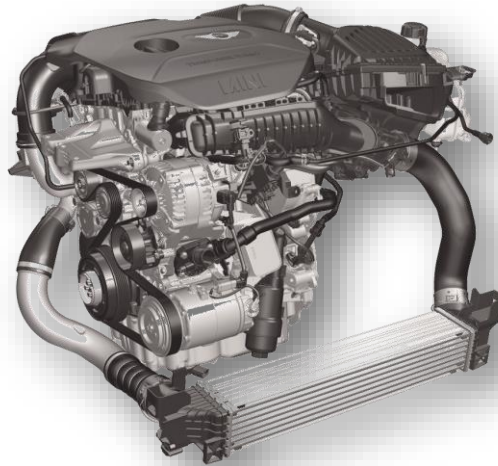
Power: 22 kW

The new BMW Efficient Dynamics Engine Family.

Map power & torque.



THE NEW BMW EFFICIENT DYNAMICS ENGINE FAMILY. 3- AND 4-CYLINDER TWIN POWER TURBO GASOLINE ENGINE.



Cylinder	3			4
Displacement [l]	1.2	1.5		2.0
Power @ speed	75 4250	100 4500	170 5800	141 4700
Torque @ speed	180 1400	220 1250	320 3700	280 1250
CO ₂ [g/km]	108*	105*	49**	133*
Emission Level	EU6	EU6	EU6	EU6

* Mini ** BMW i8

BMW EFFICIENT DYNAMICS. BMW TWIN POWER TURBO GASOLINE.

TWIN POWER

TURBO

VARIABILITY

DIRECT INJECTION

TURBOCHARGING

GASOLINE



VALVETRONIC

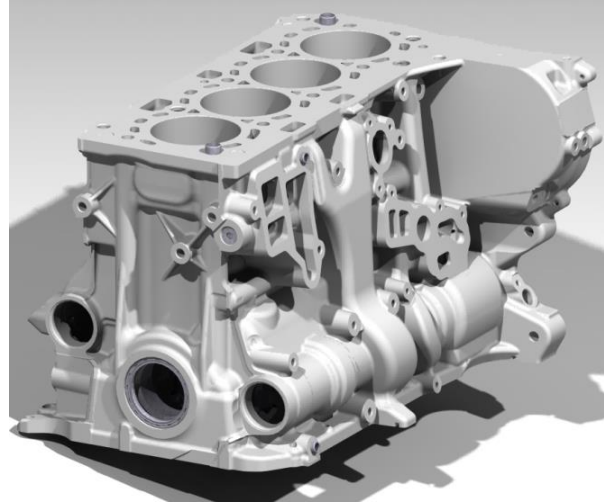
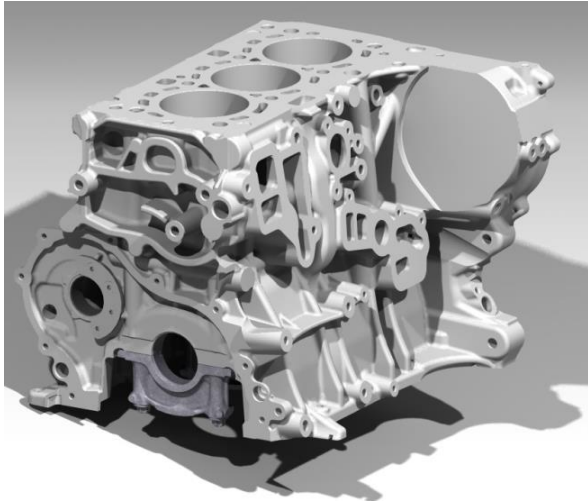


HIGH PRECISION INJECTION



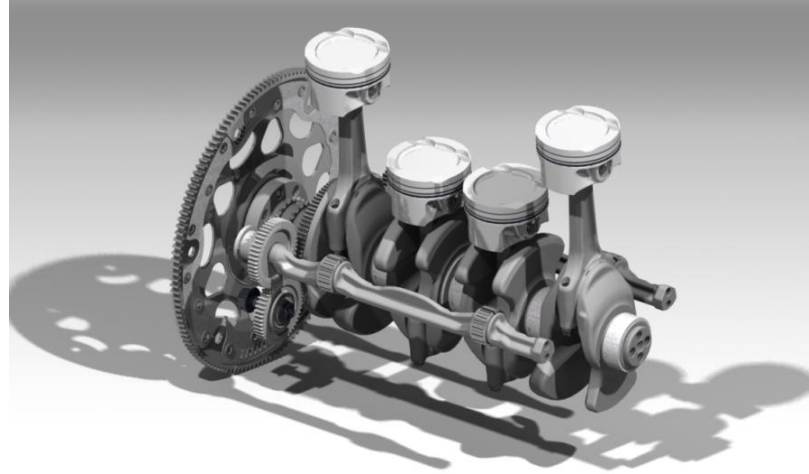
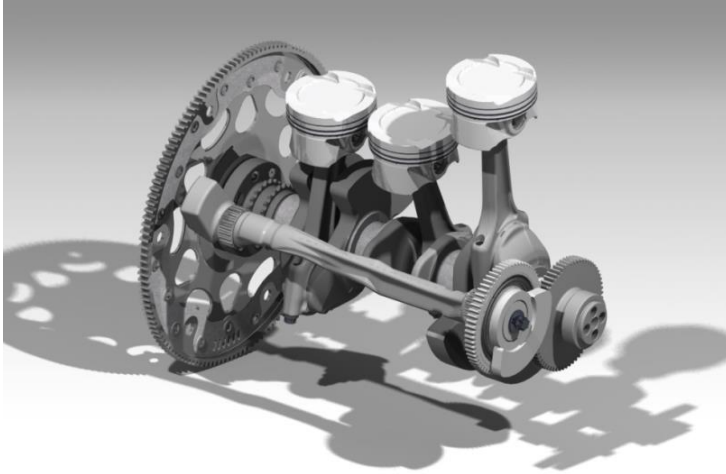
SINGLE TURBO
TWIN-SCROLL TURBO
TWIN TURBO

THE NEW BMW EFFICIENT DYNAMICS ENGINE FAMILY. CRANKCASE CONSTRUCTION.



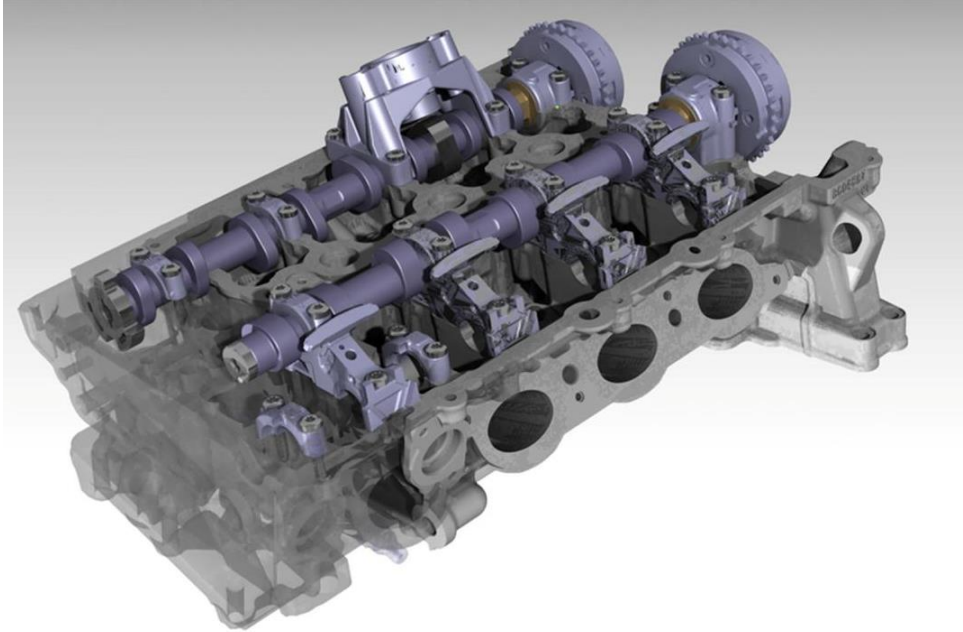
- Deep skirt crankcase design.
- Standardized interfaces on all crankcases of the 3-cyl. / 4-cyl. gasoline / diesel engines.
- Chain cover located on the flywheel end.
- AlSi7Cu3 with subsequent T6 heat treatment.
- Cylinder liner coating by means of wire arc spraying.
- Integrated balance shaft.

THE NEW BMW EFFICIENT DYNAMICS ENGINE FAMILY. CRANKSHAFT DRIVE.



- Crankshafts made of forged C38+N.
- Inductively hardened bearing points.
- Dual-substance aluminum main bearings.
- Three-layer polymer coated connection rod bearing.
- Casted aluminum pistons.
- Forged balance shafts mounted on ball bearings.

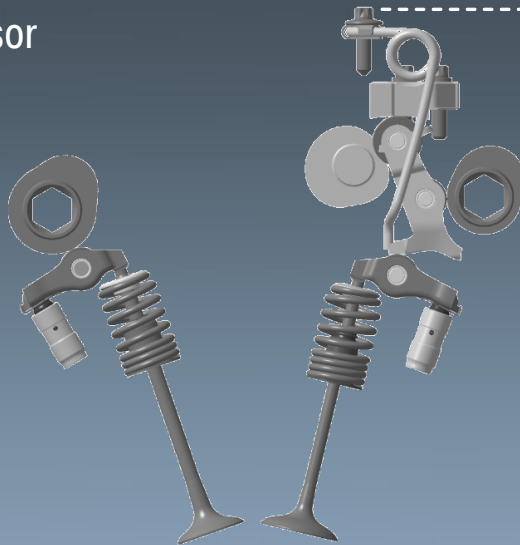
THE NEW BMW EFFICIENT DYNAMICS ENGINE FAMILY. CYLINDERHEAD.



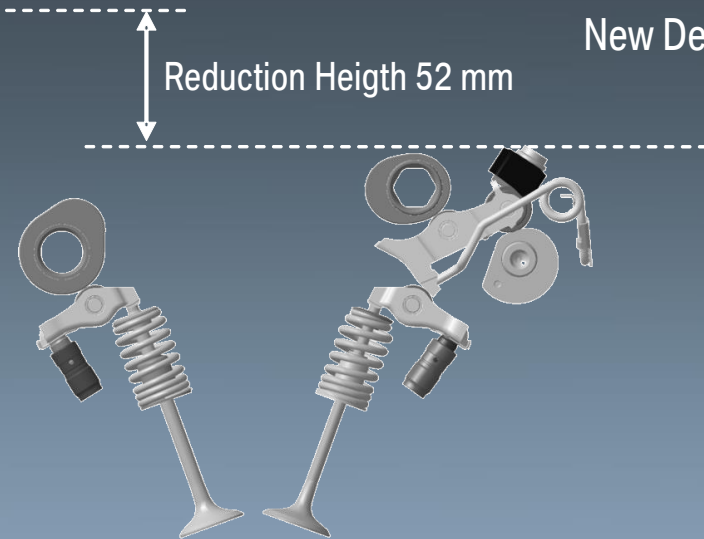
- Construction in the same way for transverse and longitudinal application.
- 3-cyl. up to 100kW with lost foam cast cylinder head.
- 4-cyl. and 170kW 3-cyl. gravity die casted with $AlSi7MgCu0.5$.
- Identical chain drive position for 3-cylinder and 4-cylinder engines.

VALVETRONIC.

Predecessor



New Design

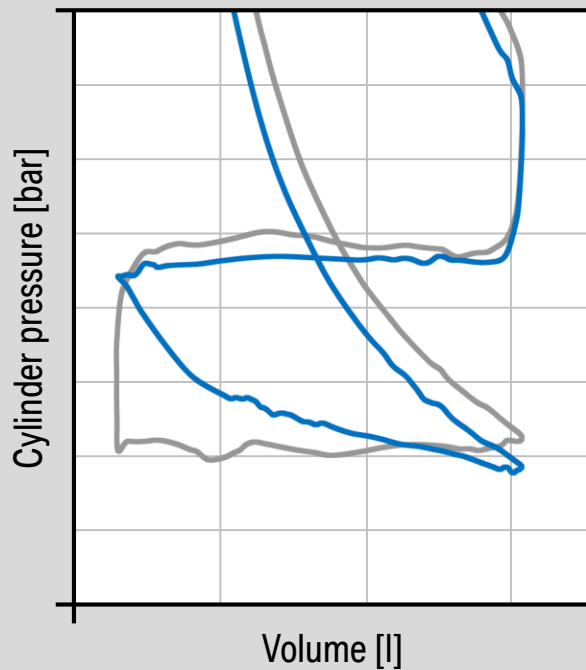


Reduction Height 52 mm

- Enhanced 4th generation of BMW VALVETRONIC.
- Significant reduction in the installation height by transposing the intake camshaft with the eccentric shaft.
- Familiar industry modules are used for standard components as hydraulic valve play compensation and roller cam followers.
- Hydraulic phase shifters at intake and exhaust shaft.

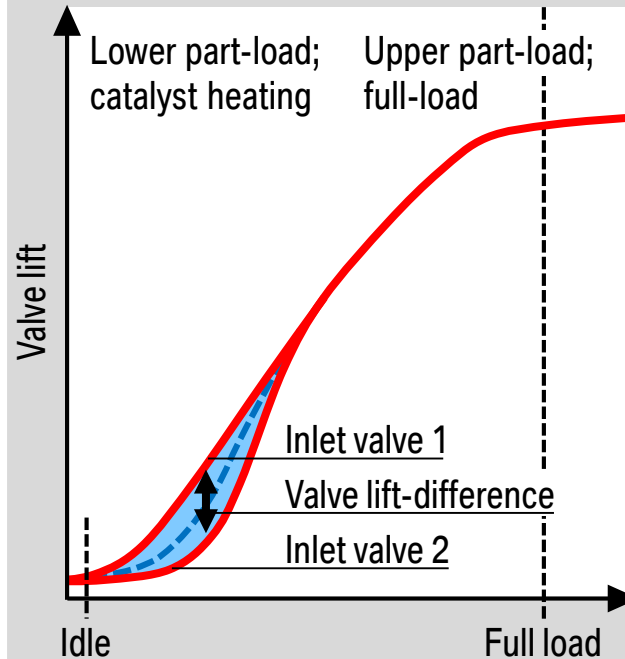
BMW TWIN POWER TURBO OTTOMOTOREN. FUNKTIONSPRINZIP VALVETRONIC.

Gas exchange



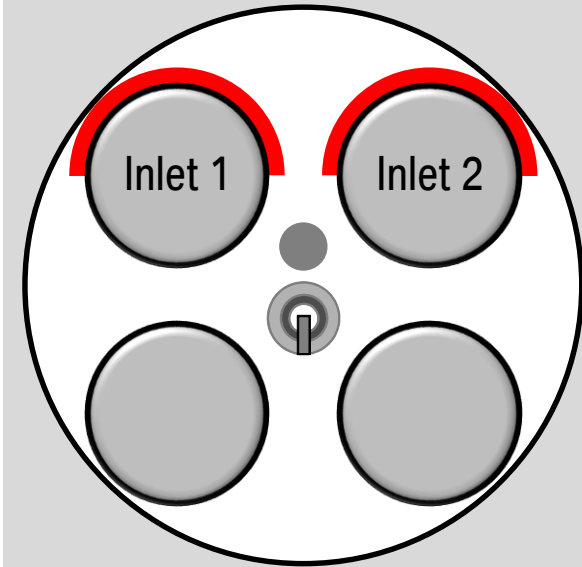
Fully variable valve lift and timing to reduce pumping losses and residual gas concentration.

Phasing



Increasing the mass flow through inlet valve 1 for swirl generation.

Masking



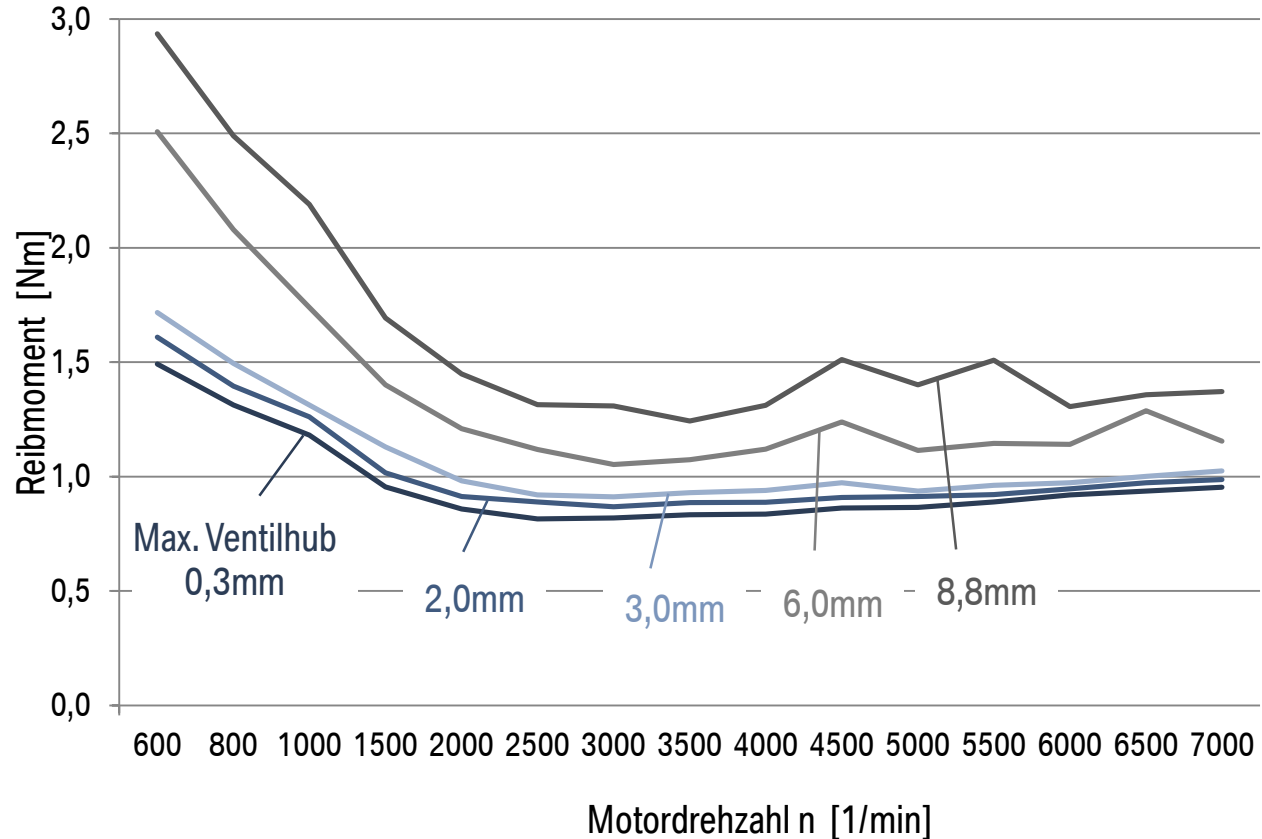
Orientation of inlet mass flow for optimal swirl and tumble.

BMW EFFICIENT DYNAMICS. REIBUNGSREDUZIERUNG - VALVETRONIC.

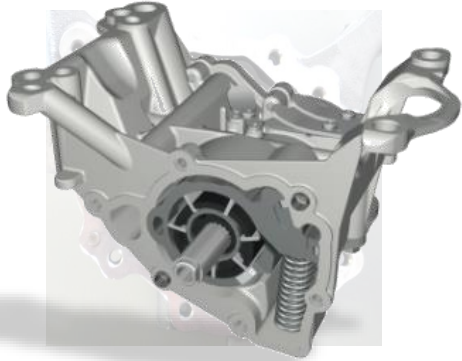


VALVETRONIC

MIT DIESER TECHNOLOGIE WERDEN ZUM EINEN DIE DROSSELVERLUSTE BEIM LADUNGSWECHSEL ERHEBLICH REDUZIERT, ZUM ANDEREN ABER AUCH EINE DEUTLICHE REIBUNGSMINDERUNG BEI TEILLAST ERZIELT.

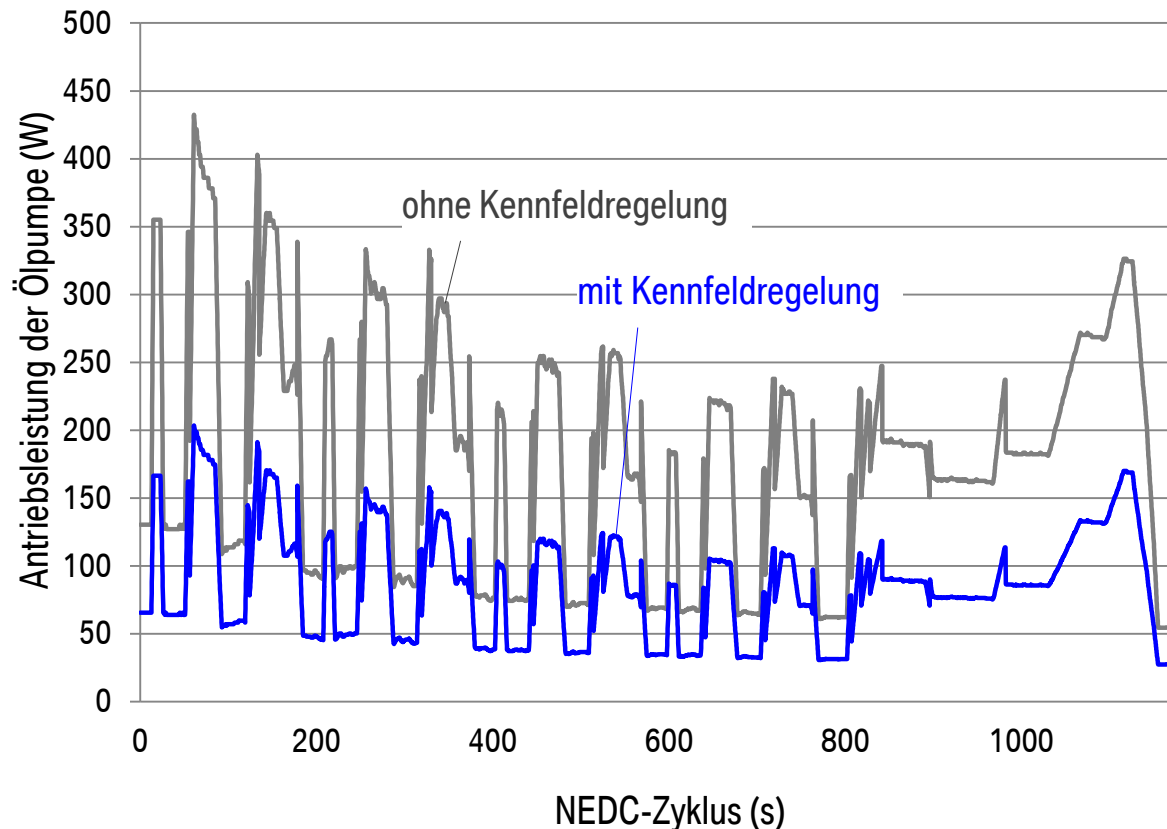


BMW EFFICIENT DYNAMICS. REIBUNGSREDUZIERUNG - KFR ÖLPUMPE.

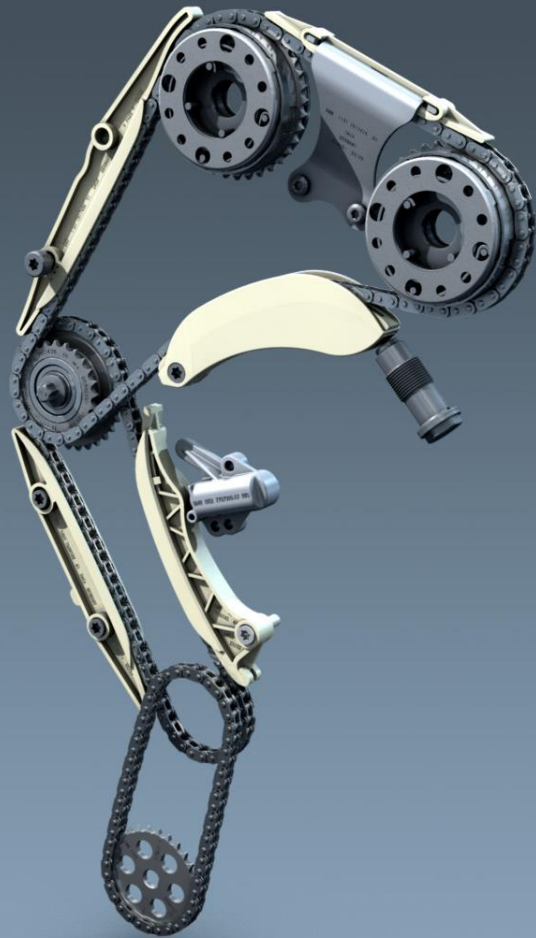


ÖLDRUCK KENNFELD-GEREGELT

DIESE TECHNOLOGIE ERMÖGLICHT DIE OPTIMALE ANPASSUNG DES ÖLDRUCKS AN DIE TATSÄCHLICHEN MOTORANFORDERUNGEN UND FÜHRT ZU EINER VERBRAUCHSREDUZIERUNG BIS ZU 1,8%

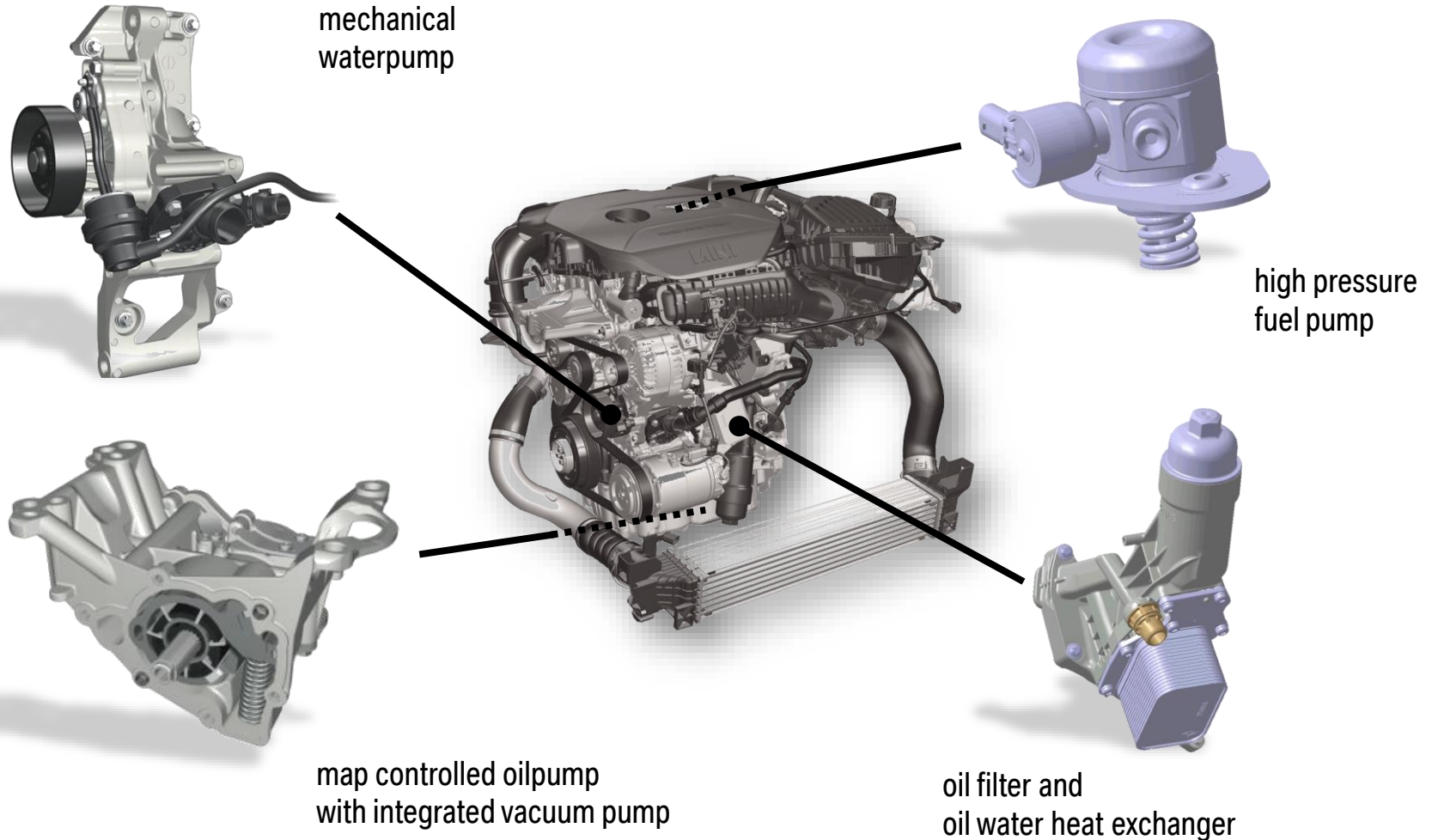


CHAIN DRIVE.



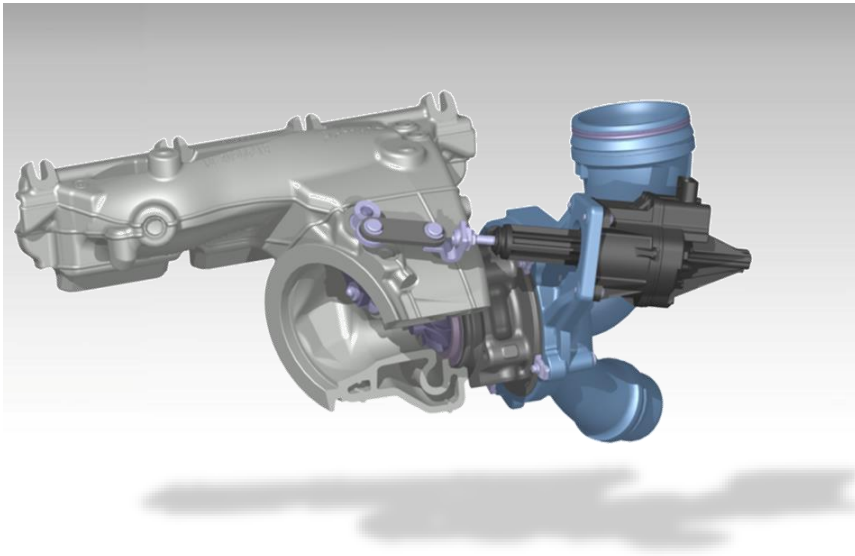
- Chain Drive at the power output side.
- Same layout for diesel and gasoline engines.
- Common component for 3-cyl. and 4-cyl. engines.
- Common component for transversal and longitudinal application.
- Low engine friction due to straight guide rails and minimal linkage at the tensioning rails.

THE NEW BMW EFFICIENT DYNAMICS ENGINE FAMILY. AUXILIARY COMPONENTS.



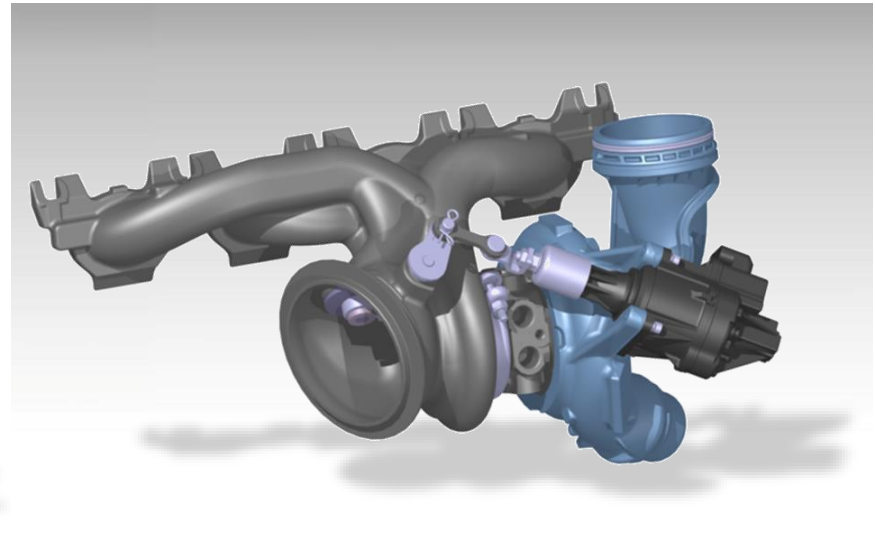
THE NEW BMW EFFICIENT DYNAMICS ENGINE FAMILY. CHARGING SYSTEM.

3-cylinder , 75 kW / 100 kW



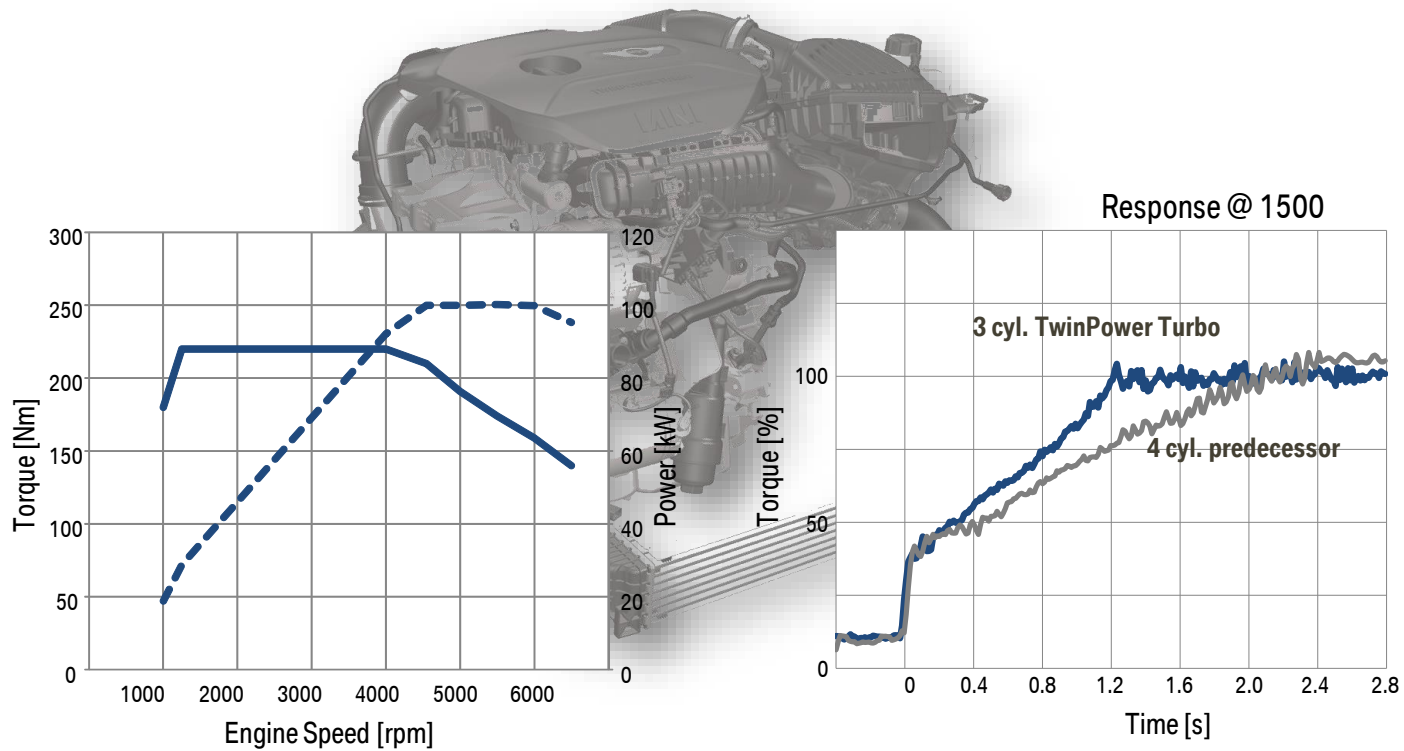
- Worldwide first water-cooled full-aluminum exhaust turbocharger.
- flanged onto the cylinder head by means of a clamping/sliding bar.
- Electric actuated wastegate.

4-cylinder

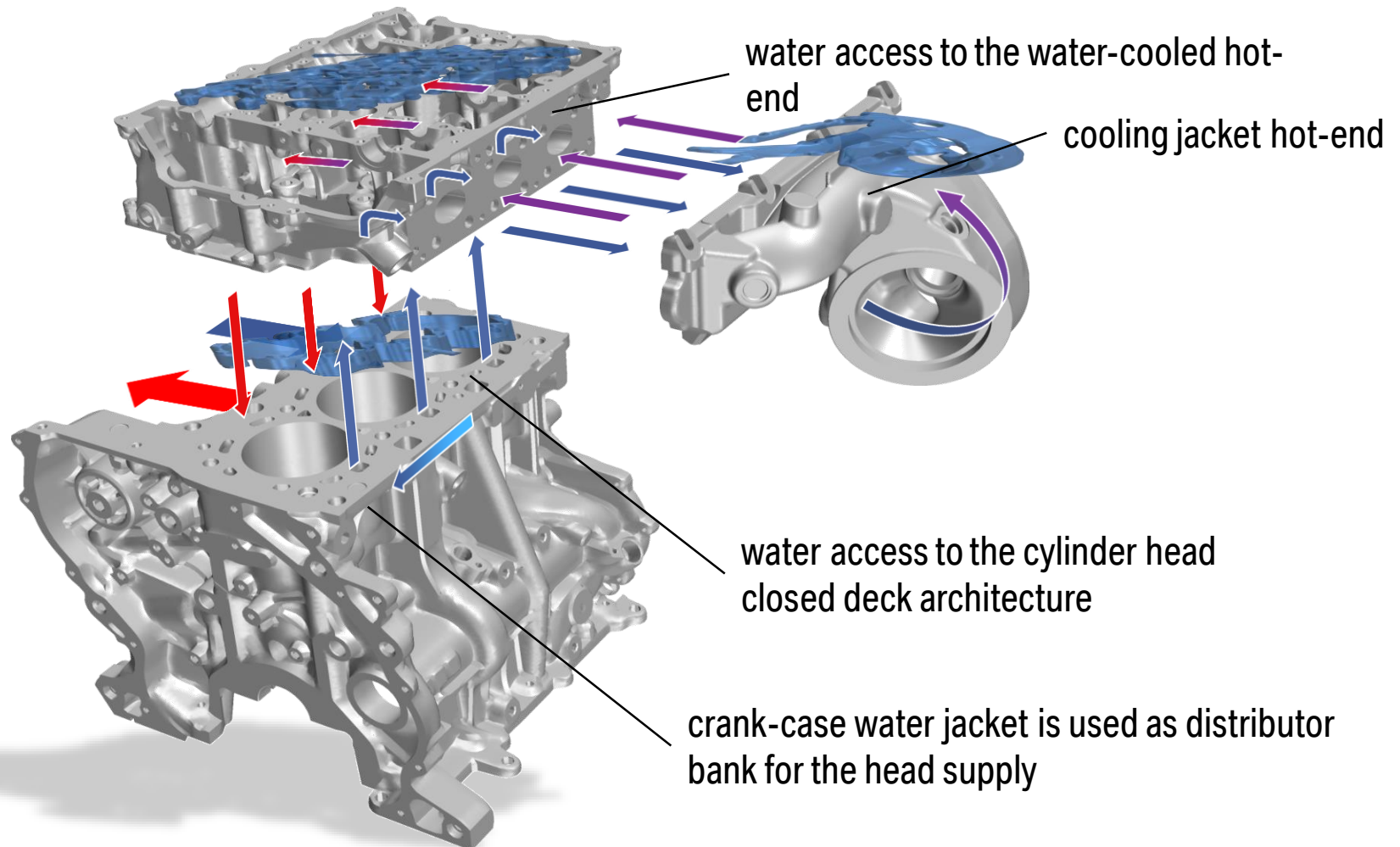


- Twin Scroll Turbine with integrated exhaust manifold.
- flanged onto the cylinder head by means of a clamping/sliding bar.
- Electric actuated wastegate.

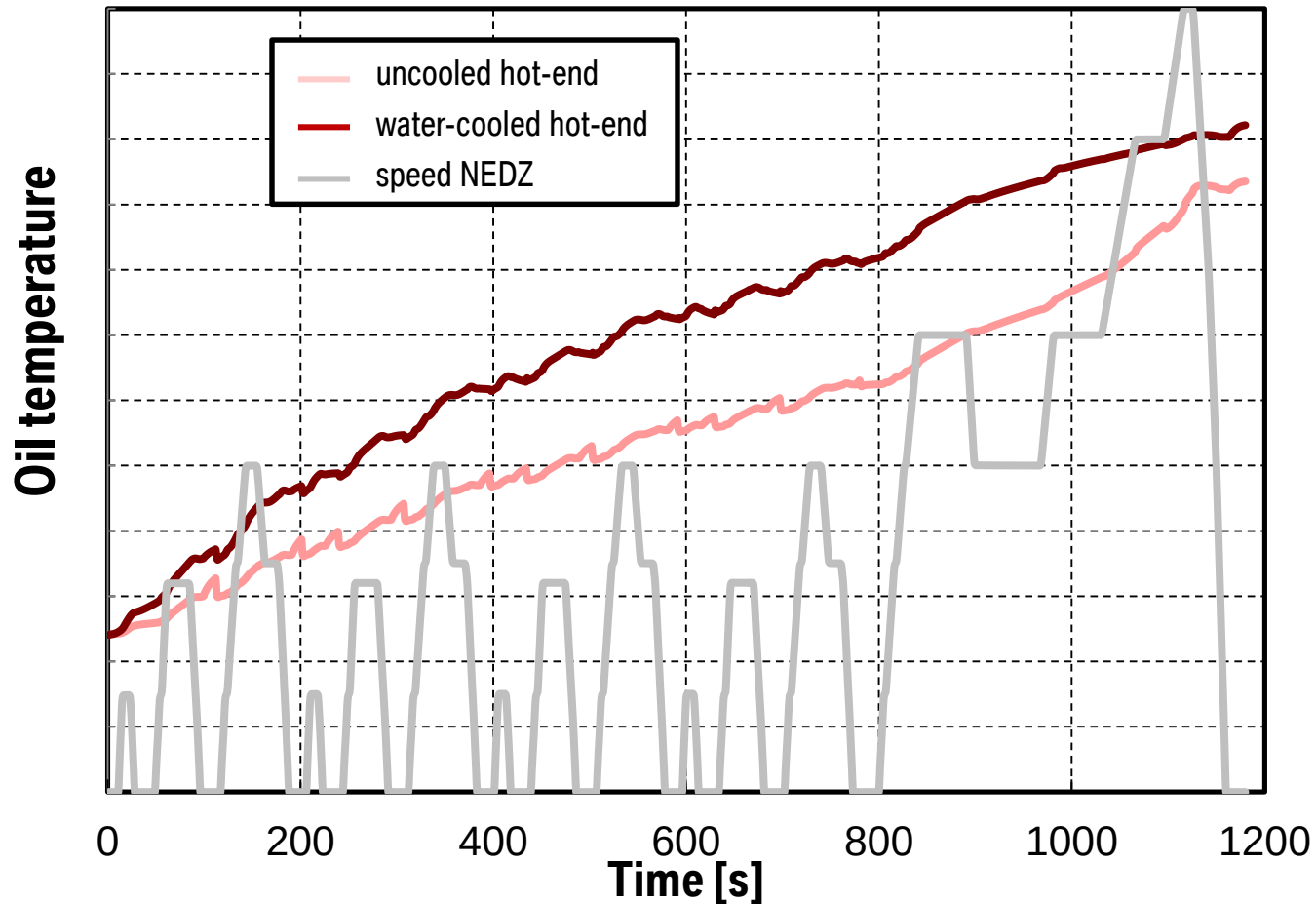
THE NEW BMW 3-CYLINDER GASOLINE ENGINE. FULL LOAD.



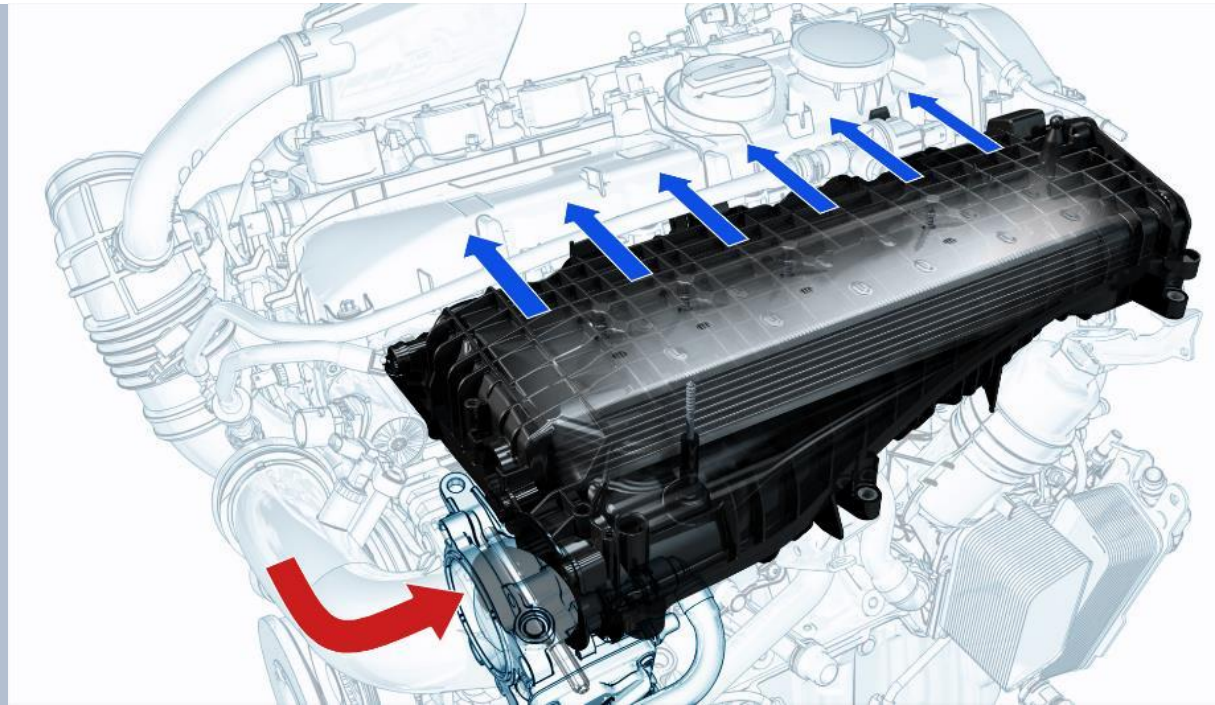
THE NEW BMW EFFICIENT DYNAMICS ENGINE FAMILY. 3-CYLINDER WATER COOLED CHARGING SYSTEM.



THE NEW BMW EFFICIENT DYNAMICS ENGINE FAMILY. WARMING UP OIL CIRCUIT.



INTAKE MANIFOLD WITH INTEGRATED AIRCOOLER.



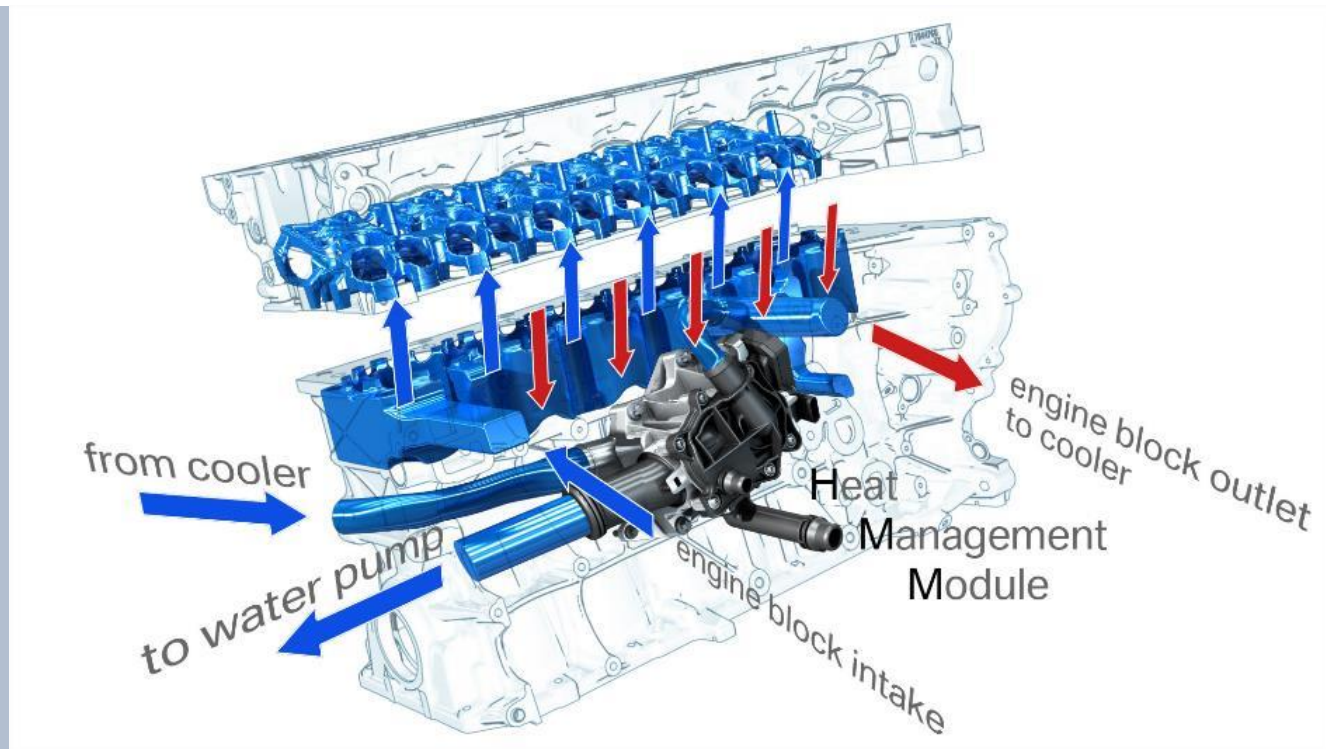
- Throttle valve as common part for all longitudinal engines
- Integrated Aircooler (mounted from the rear side of the manifold)
- No internal seal necessary

BELT DRIVE.



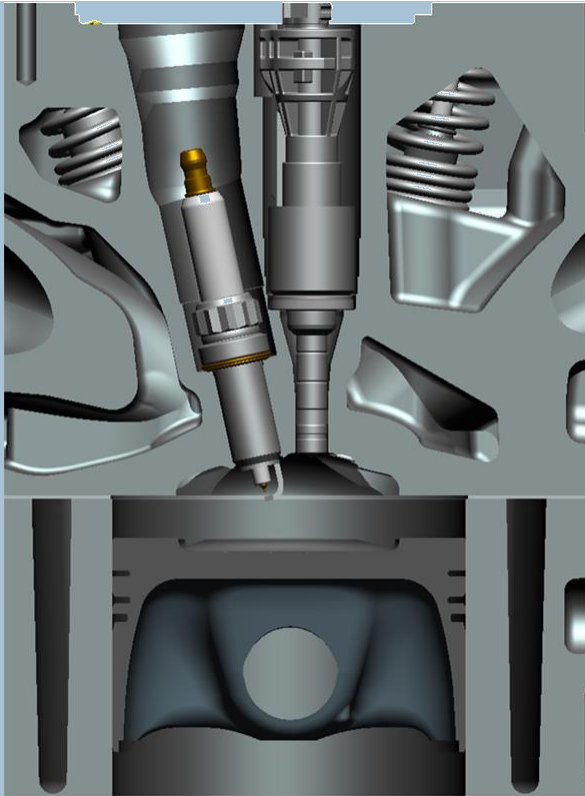
- Identical Layout and parts for all longitudinal engines
- Configured for lower initial tension

HEAT MANAGEMENT FOR LONGITUDINAL ENGINES.



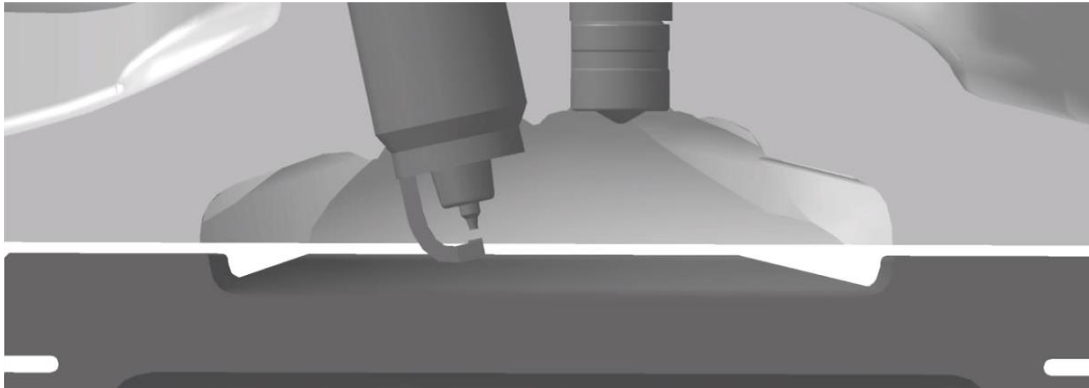
- Electrical actuated ball valve
- Mounted on engine outlet
- Shorter reaction times

BMW TWIN POWER TURBO OTTOMOTOREN. BRENNRAUM.



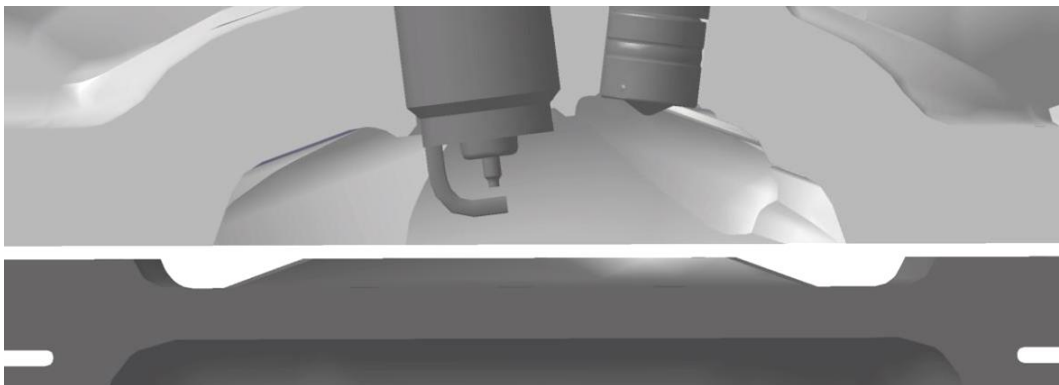
- Central injector position.
- Spark plug and injector transversely positioned.
- Spark plug on exhaust side.
- Friction optimized piston shaft coating.
- CFD optimized charge motion.

THE NEW BMW EFFICIENT DYNAMICS ENGINE FAMILY. COMBUSTION CHAMBER.



Previous engine

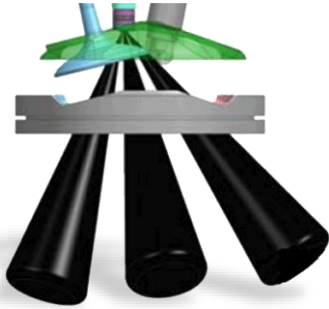
- compression ratio 10.0
- spark position 6.0 mm
- small piston bowl
- bore 84mm



New engine

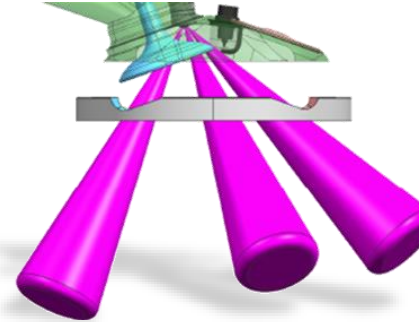
- compression ratio 11.0
- spark position 4.7 mm
- wide piston bowl
- bore 82 mm

THE NEW BMW EFFICIENT DYNAMICS ENGINE FAMILY. INJECTION TECHNOLOGY.



Predecessor Engine

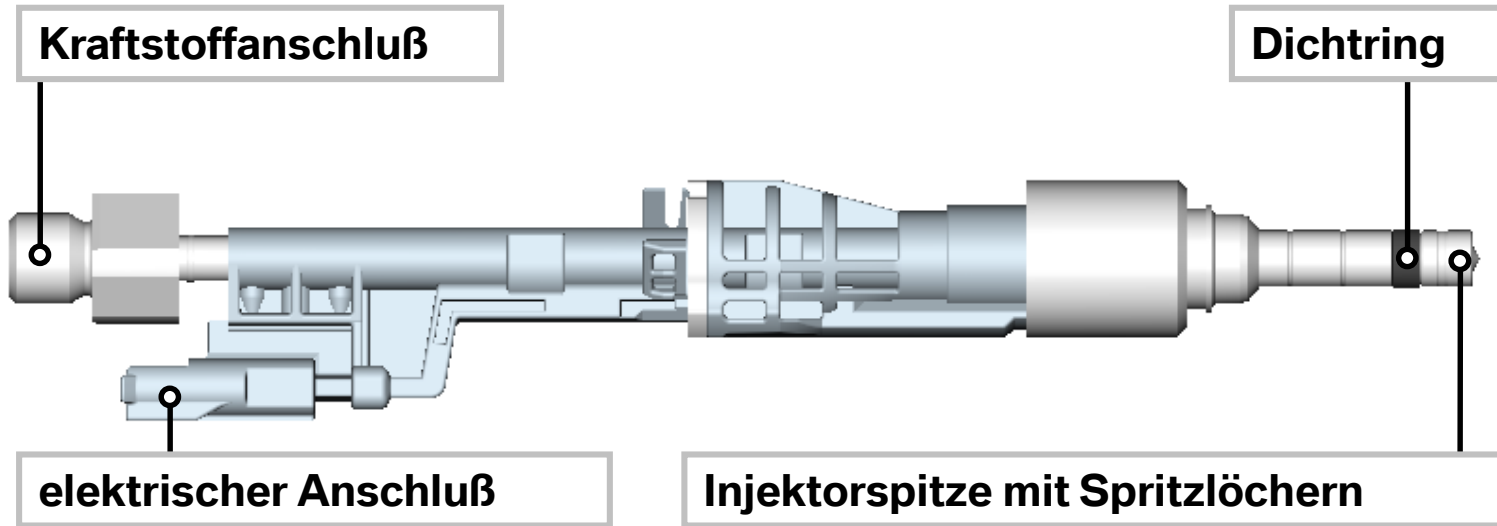
- Eroded fuel holes.



New Engine

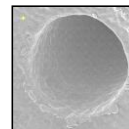
- Static flow reduced vs. predecessor.
- Wide spray and wide piston bowl.
- Laser-drilled fuel holes with individual hole layout.

BMW TWIN POWER TURBO OTTOMOTOREN. MEHRLOCHINJEKTOR IN ZENTRALER EINBAULAGE.

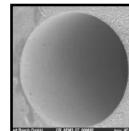


lasergebohrte Spritzlöcher

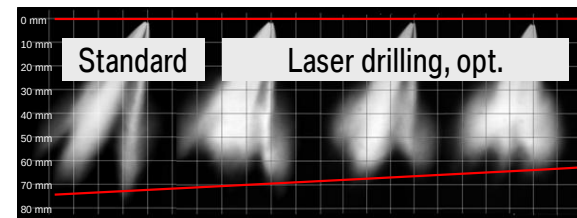
- verbesserte Zerstäubung
- erhöhter Lufteintrag ins Spray
- reduzierte Eindringtiefe



Standard
EDM

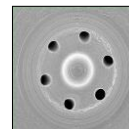


Laser
drilling

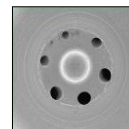


lochindividuelles Spray

- individuelles Design für jedes Spritzloch
- verbesserte Gemischhomogenisierung
- reduzierte Wandbenetzung



Standard
EDM

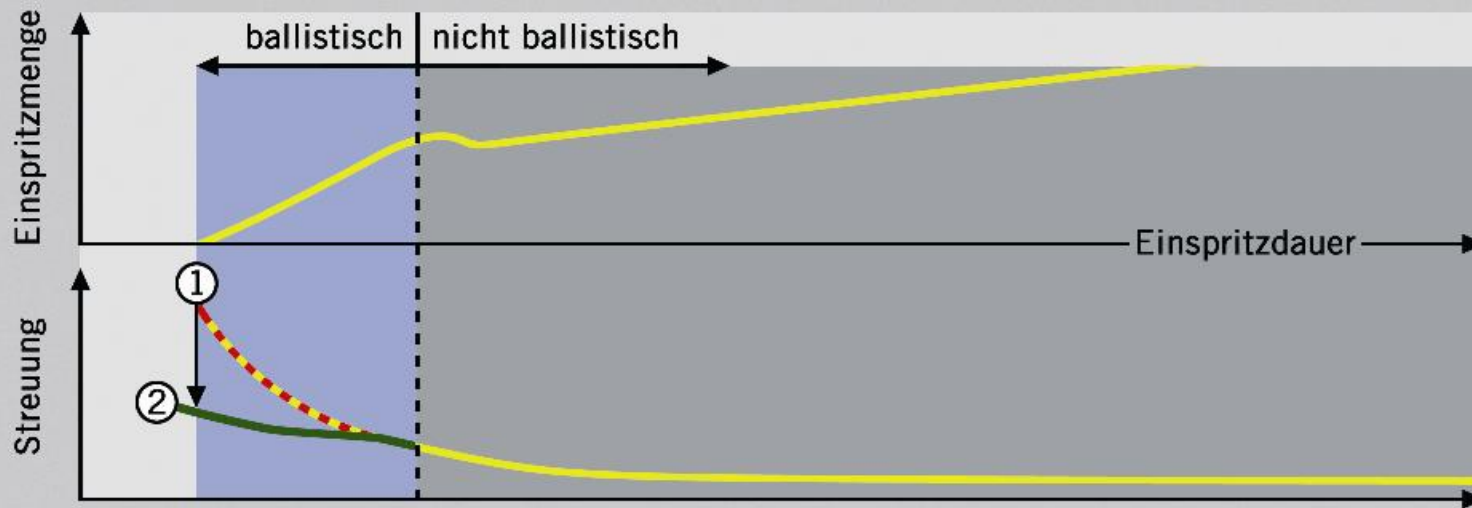


Laser
drilling

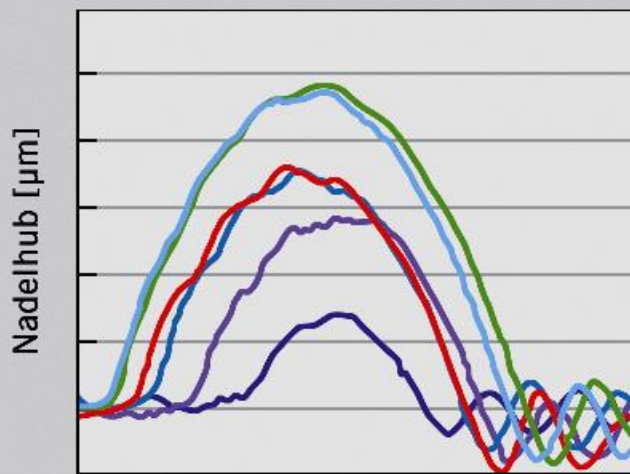


BMW TWIN POWER TURBO OTTOMOTOREN. KLEINSTMENGENFUNKTIONALITÄT.

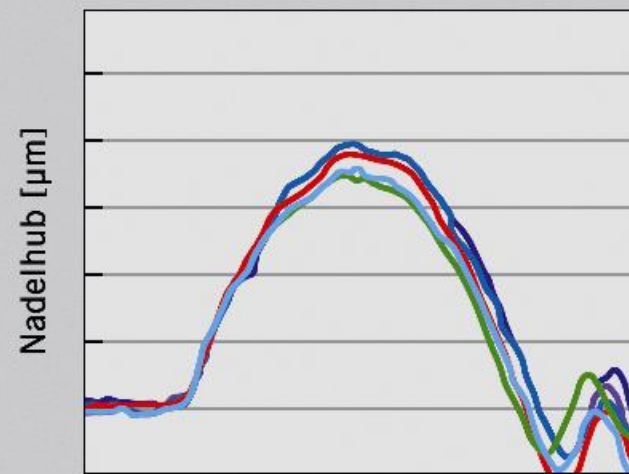
Controlled Valve Operation (CVO).



① Gesteuerter Nadelhub



② Geregelter Nadelhub

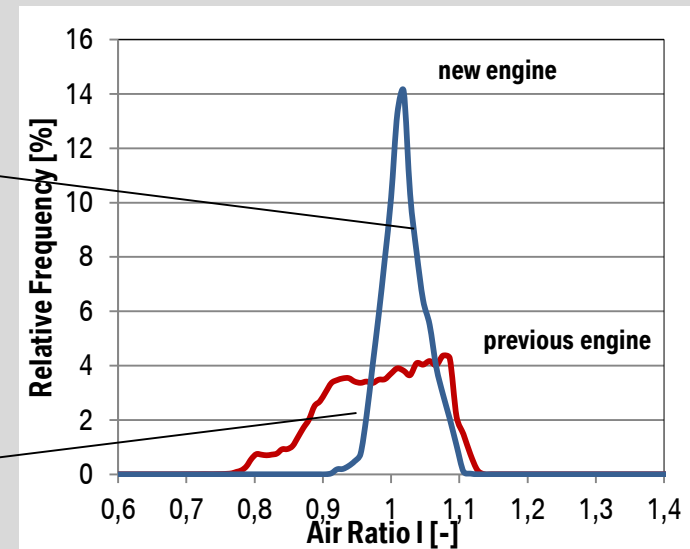
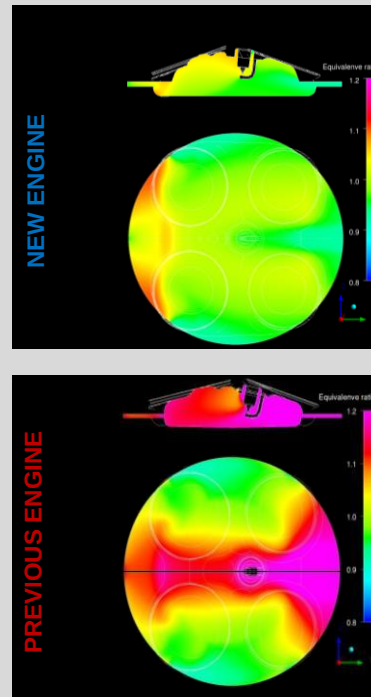


Quelle: Bosch

EMISSIONS: COMBUSTION SYSTEM OPTIMIZATION FOR REDUCED HC-EMISSIONS.

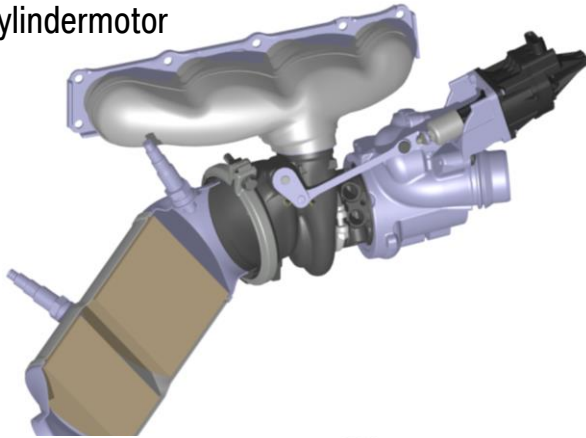
KEY FEATURES FOR ENHANCED MIXTURE HOMOGENIZATION

- Improved atomization through injector design.
- Optimized fuel distribution by improved spray design.
- Large stroke/bore ratio for high level of charge motion for enhanced mixture distribution.
- Turbulence generation towards TDC for robust ignition and high burning velocities.

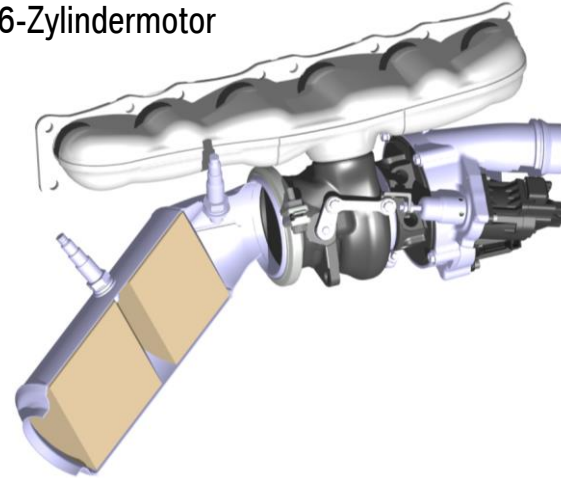


BMW TWIN POWER TURBO OTTOMOTOREN. OPTIMIERUNGSMABNAHMEN AM HOTEND.

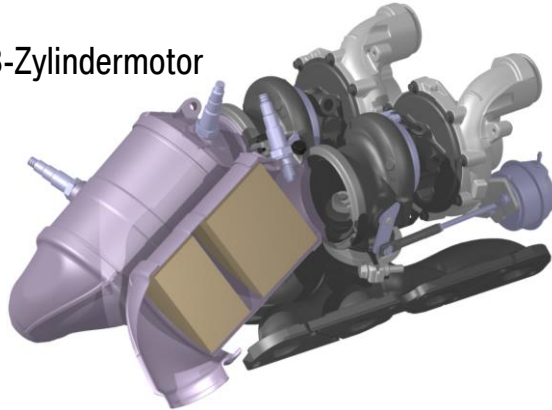
4-Zylindermotor



6-Zylindermotor

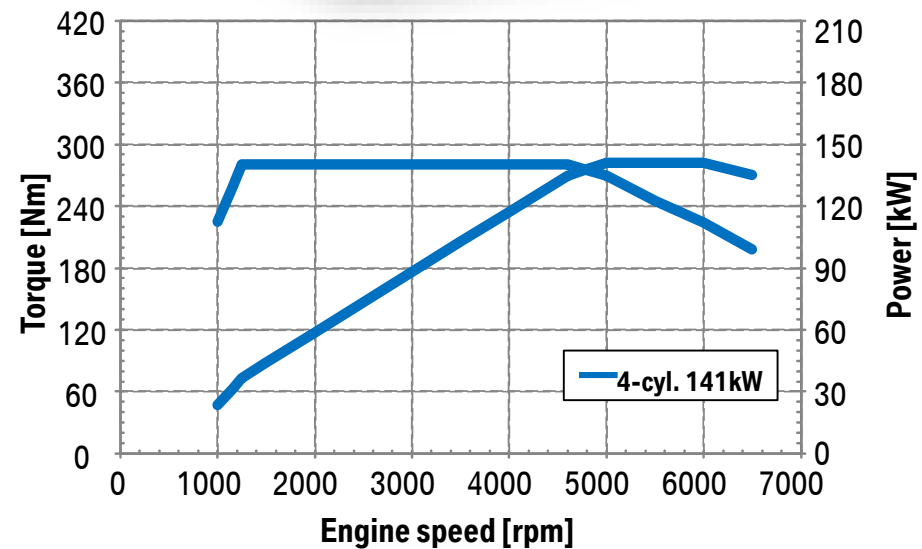
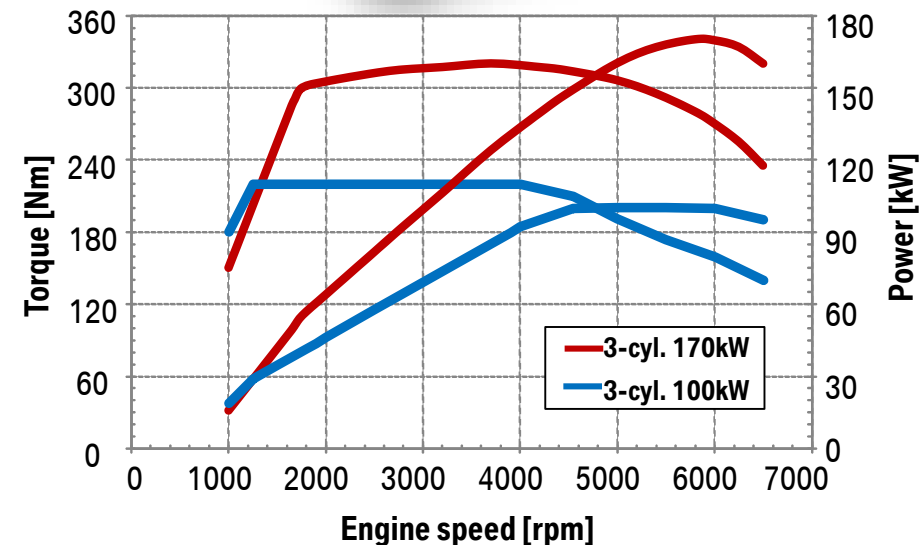


8-Zylindermotor

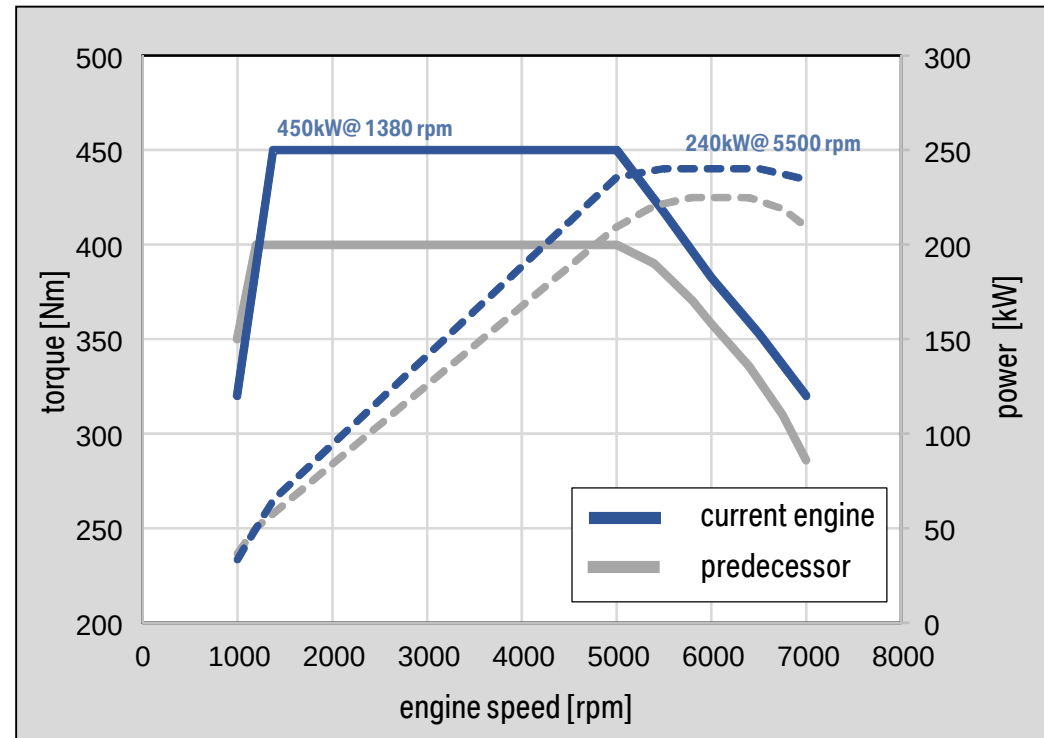
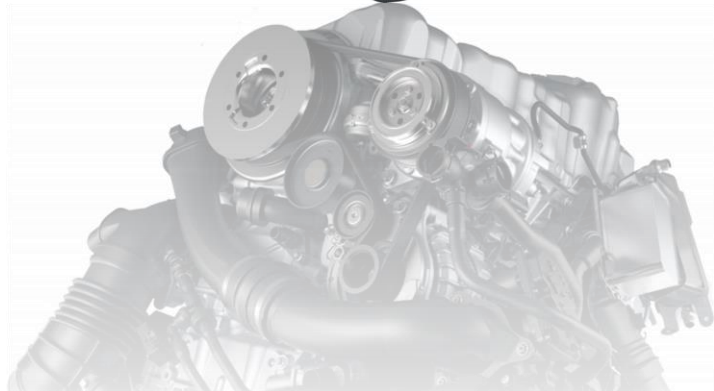


- optimierte Wastegate - Kanäle
- weit öffnendes Wastegate
- optimierte Katalysator - Anströmung
- turbinennahe Katalysator - Position

THE NEW BMW EFFICIENT DYNAMICS ENGINE FAMILY. FULL LOAD.

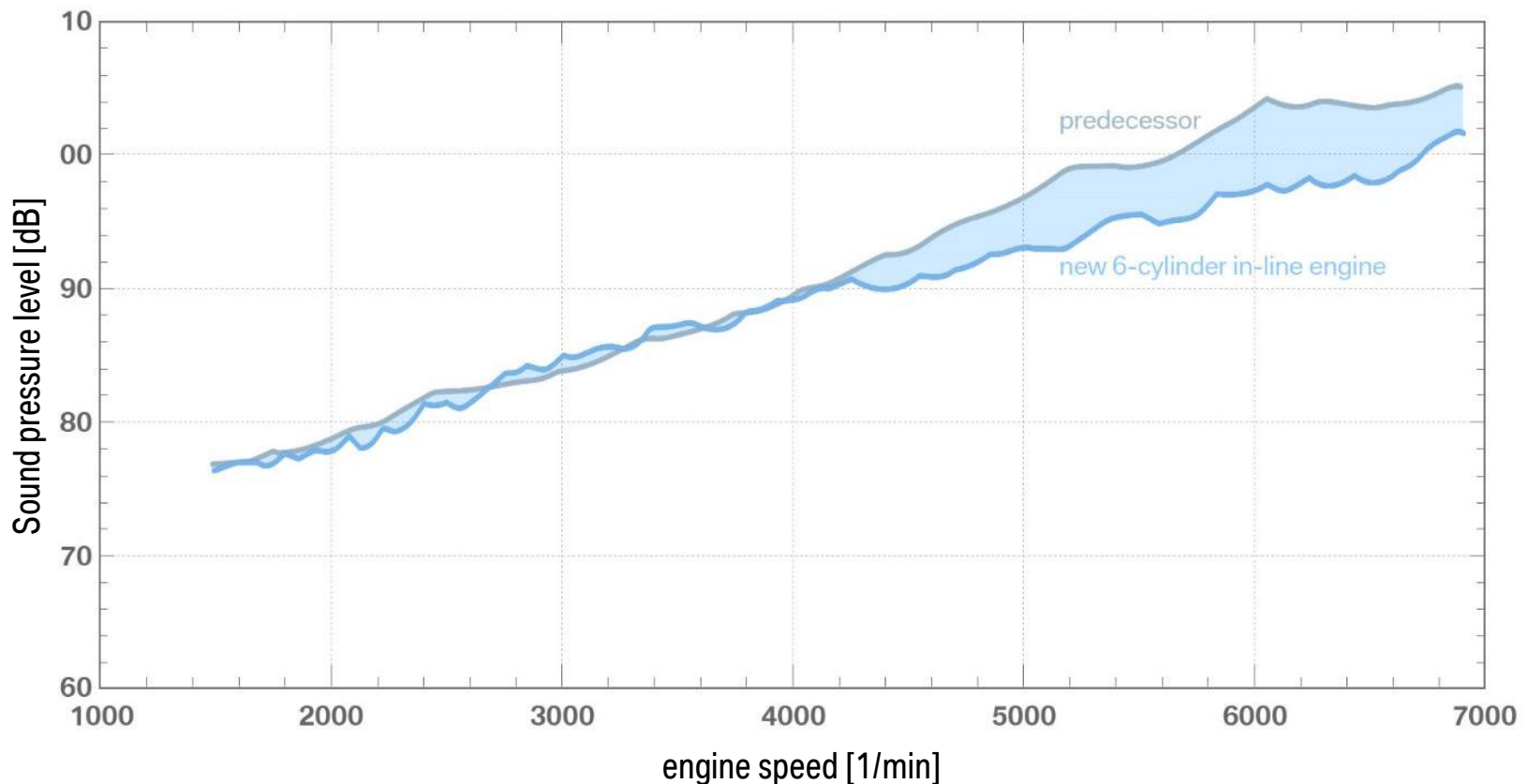


THE NEW BMW INLINE 6 CYLINDER ENGINE. FULL LOAD CURVE.



ACOUSTIC. IMPROVEMENT OF OVERALL SOUND IN COMPARISON TO PREDECESSOR

Airborne noise at left engine side



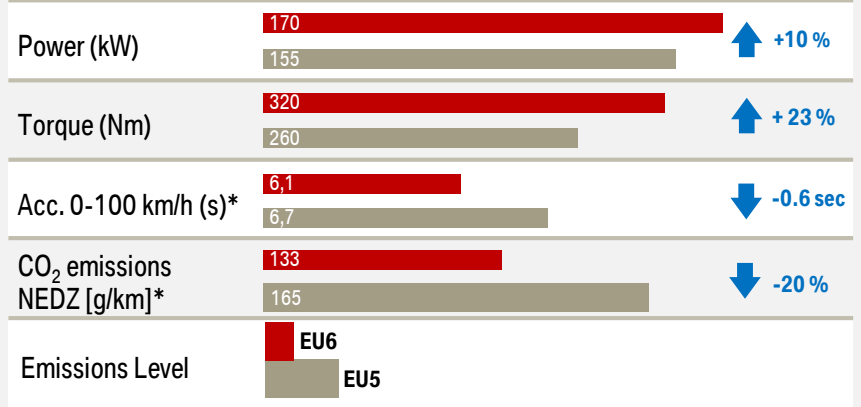
THE NEW BMW EFFICIENT DYNAMICS ENGINE FAMILY. CONSUMPTION AND DRIVING PERFORMANCE MINI.



Power (kW)	100	90	↑ +11 %
Torque (Nm)	220	160	↑ +38 %
Acceleration 0-100 km/h (s)	7,9	9,1	↓ -1,2 sec
CO ₂ emissions NEDZ [g/km]	105	127	↓ -17 %
Emissions Level	EU6		

 MINI Cooper Model Year 2014
 Predecessor MINI Cooper

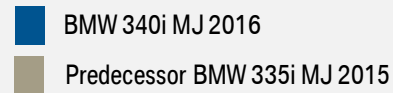
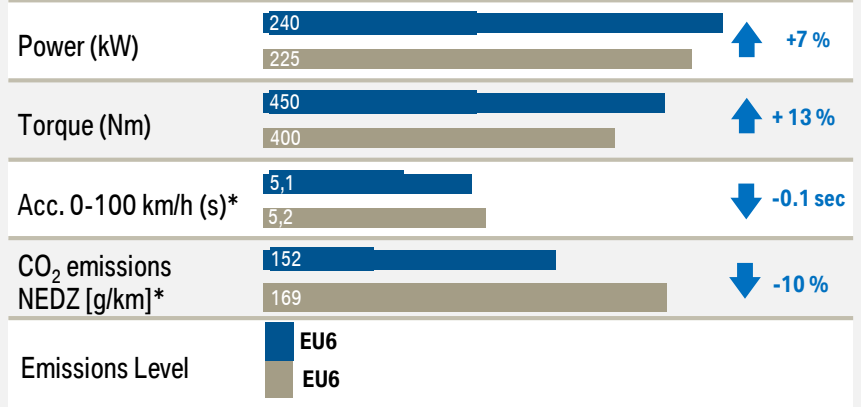
THE NEW BMW EFFICIENT DYNAMICS ENGINE FAMILY. CONSUMPTION AND DRIVING PERFORMANCE MINI.



- MINI John Cooper Works 2015
- Predecessor MINI John Cooper Works

* with automatic transmission

THE NEW BMW EFFICIENT DYNAMICS ENGINE FAMILY. CONSUMPTION AND DRIVING PERFORMANCE BMW.



* with automatic transmission

THE POWERTRAIN OF THE BMW i8. BMW i-SUSTAINABILITY DRIVES THE LIFECYCLE.

New vehicle concepts



New materials
and recycling



Production concept
of the future



New electric
drivetrain



Integrated approach of BMW i – BORN ELECTRIC.



New processes



Employees



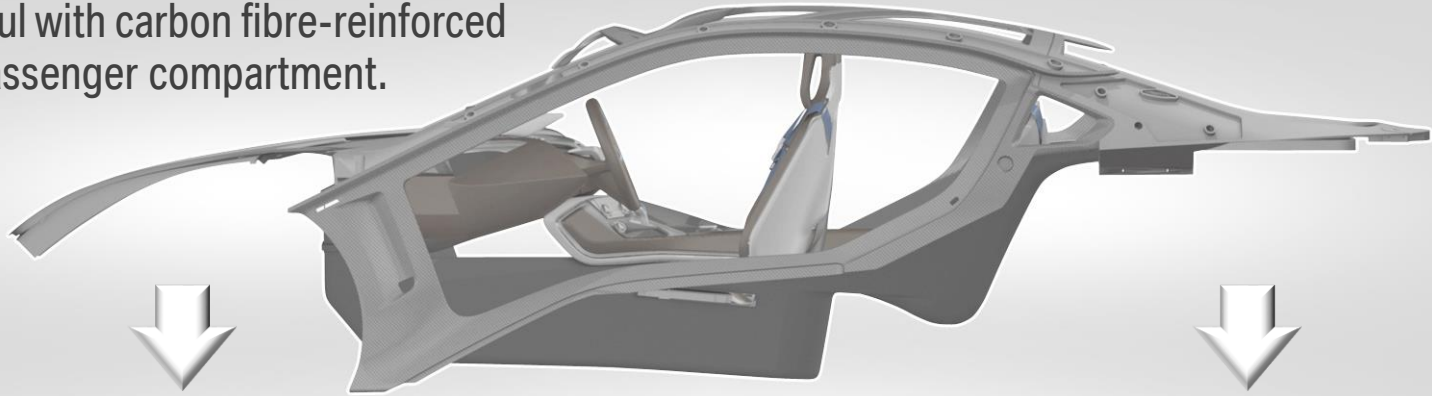
Pioneering design



New customer focus

THE POWERTRAIN OF THE BMW i8. LIFE DRIVE - ARCHITECTURE.

Life-modul with carbon fibre-reinforced plastic passenger compartment.



Body surfaces

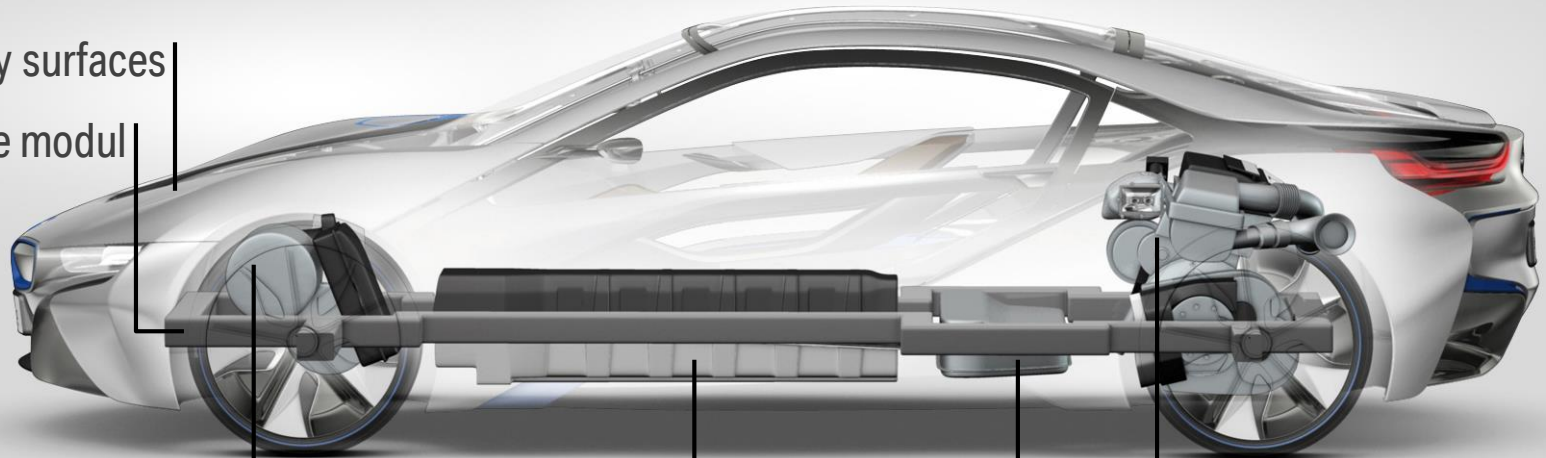
Drive modul

Electric motor with
power electronics

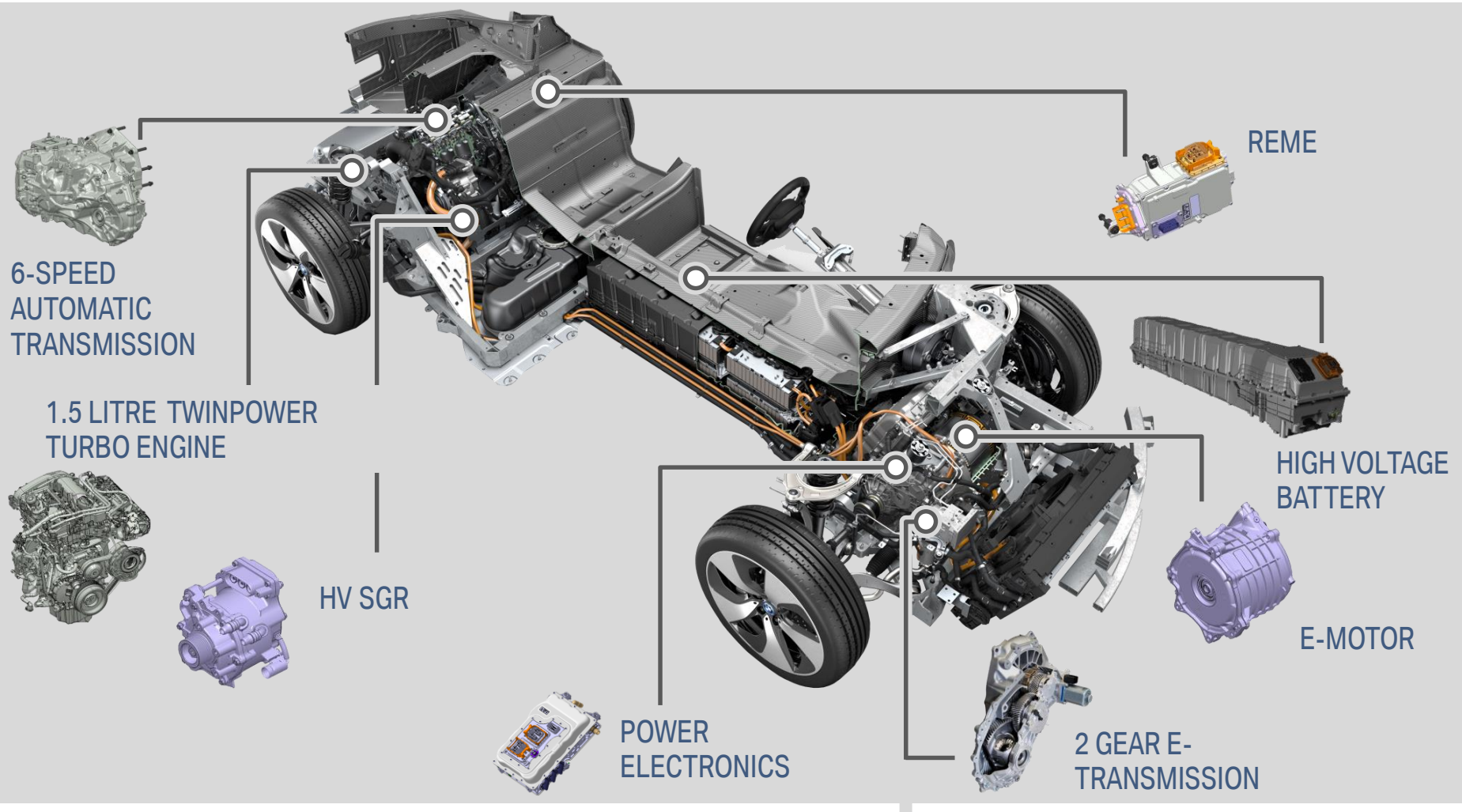
Lithium-ion battery

Fuel tank

Internal combustion
engine with transmission

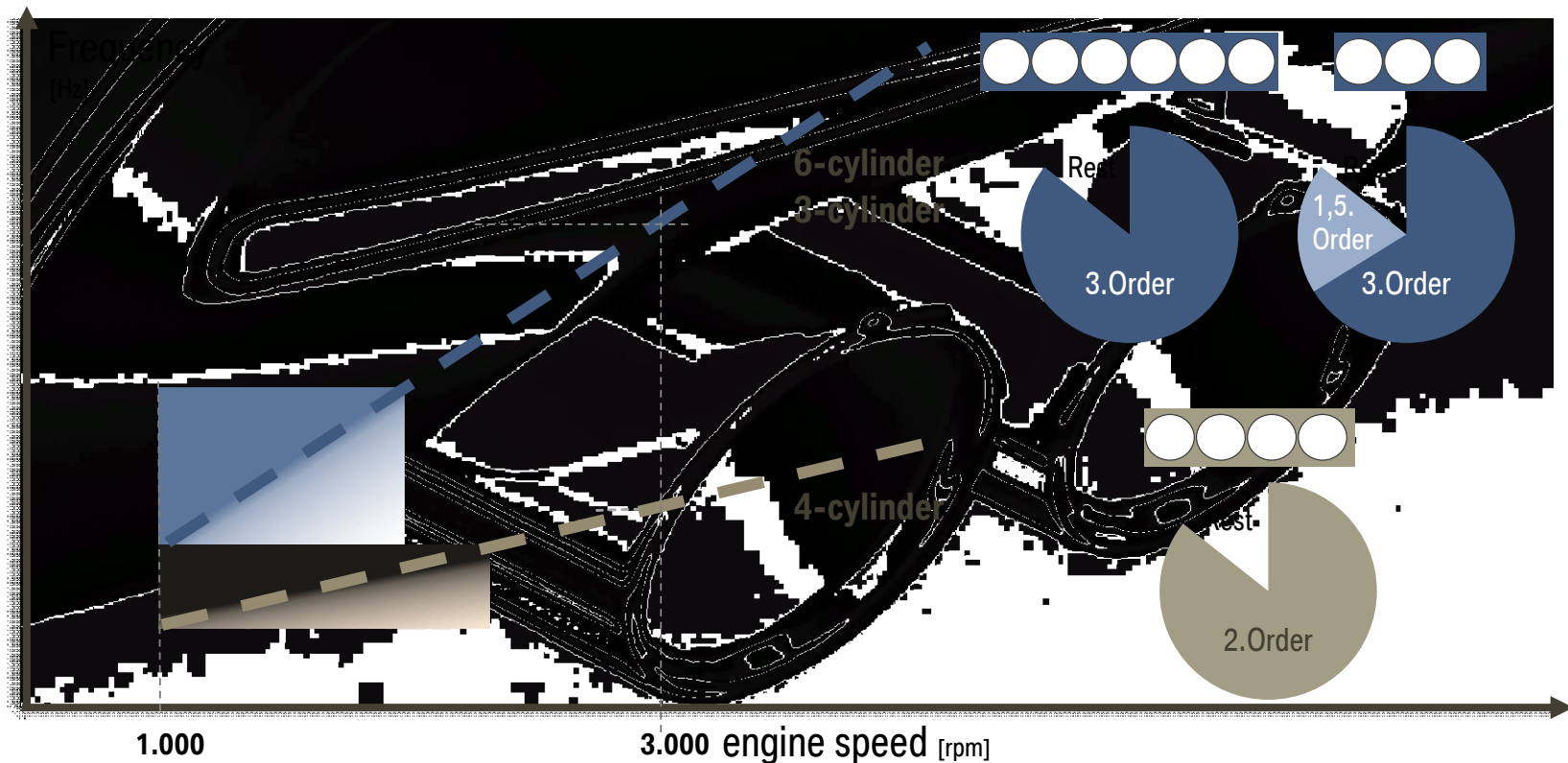


THE POWERTRAIN OF THE BMW i8. POWERTRAIN SYSTEM OVERVIEW.



3-CYLINDER SOUND CHARACTER. DOMINANT FREQUENCY OF EXHAUST SYSTEM.

- 3-cylinder with potential to support typical 6-cylinder timbres.
- Support for sporty character.

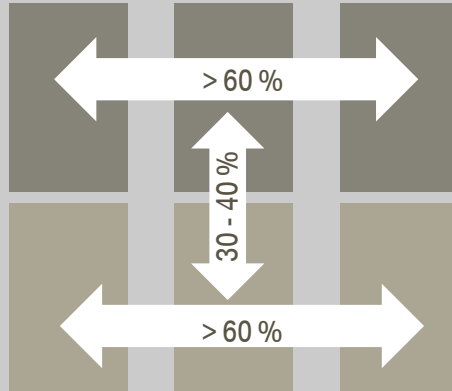


NEW PETROL / DIESEL ENGINE FAMILY.

INLINE 3-CYLINDER 4-CYLINDER 6-CYLINDER

GASOLINE

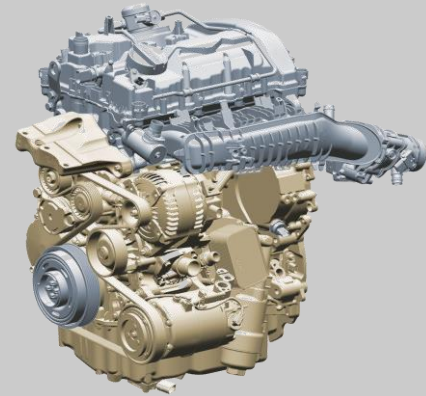
DIESEL



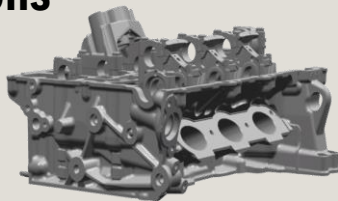
CONCEPT IDENTICAL PARTS

Different parts
gasoline – diesel

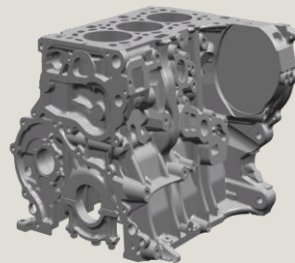
Common and
synergy
parts gasoline - diesel



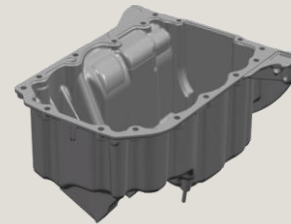
i8-variations



- gravity cast cylinder head
- Nimonic outlet valves



- closed deck design
- deep-skirt architecture
- different main bearing machining

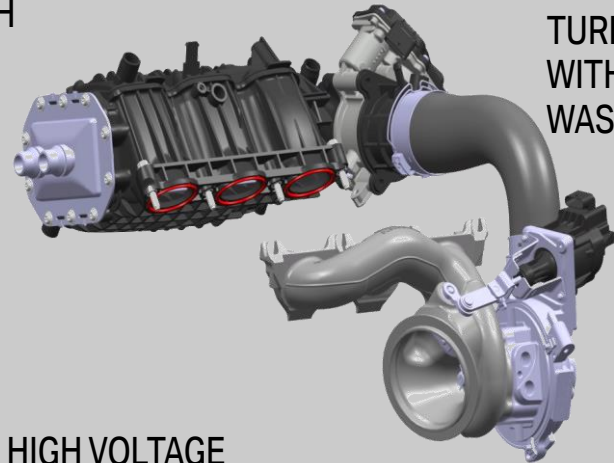


- different machining

NEW PARTS.



AIR INTAKE WITH
INTEGRATED
WATERCOOLED
INTERCOOLER

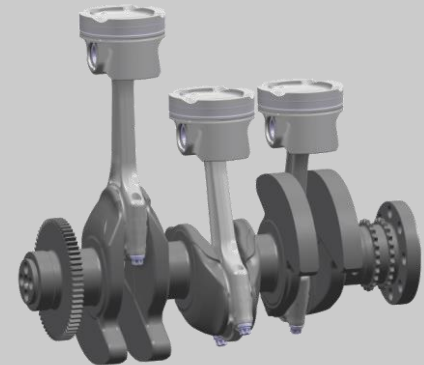


TURBOCHARGER
WITH ELECTRIC
WASTEGATE

HIGH VOLTAGE
STARTER-ALTERNATOR

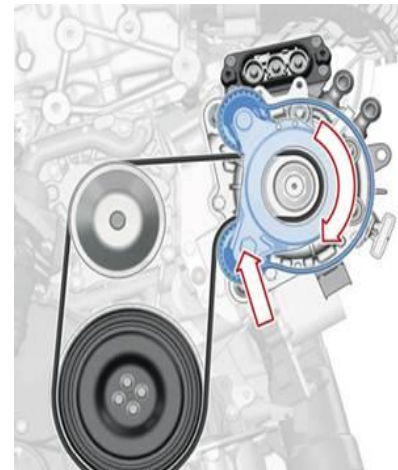
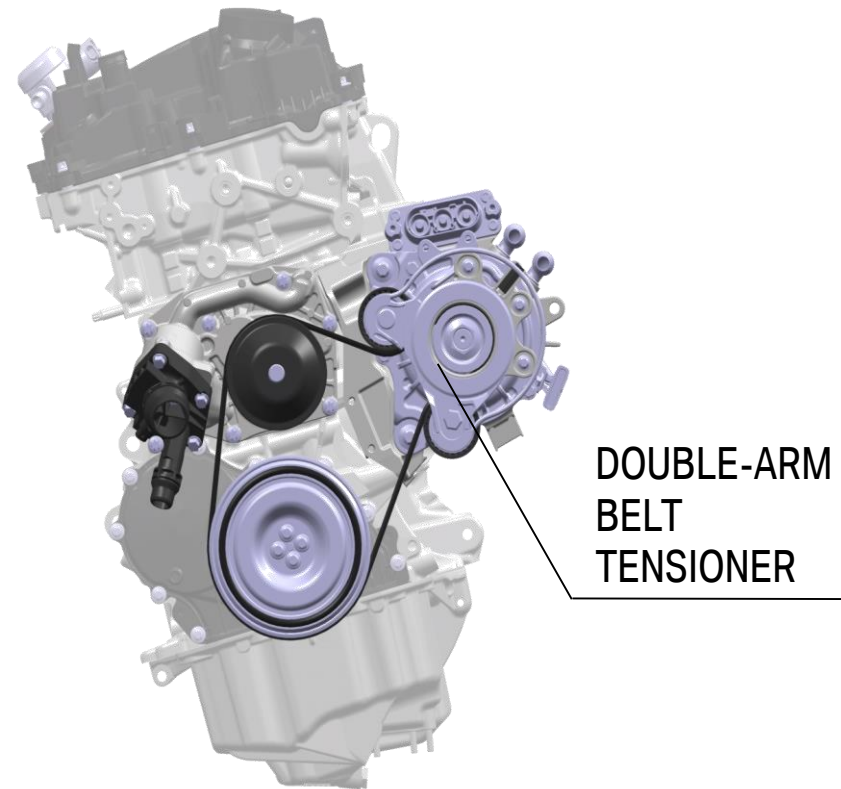


BELT DRIVE

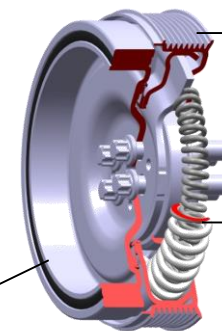


CRANKDRIVE

BELT DRIVE.



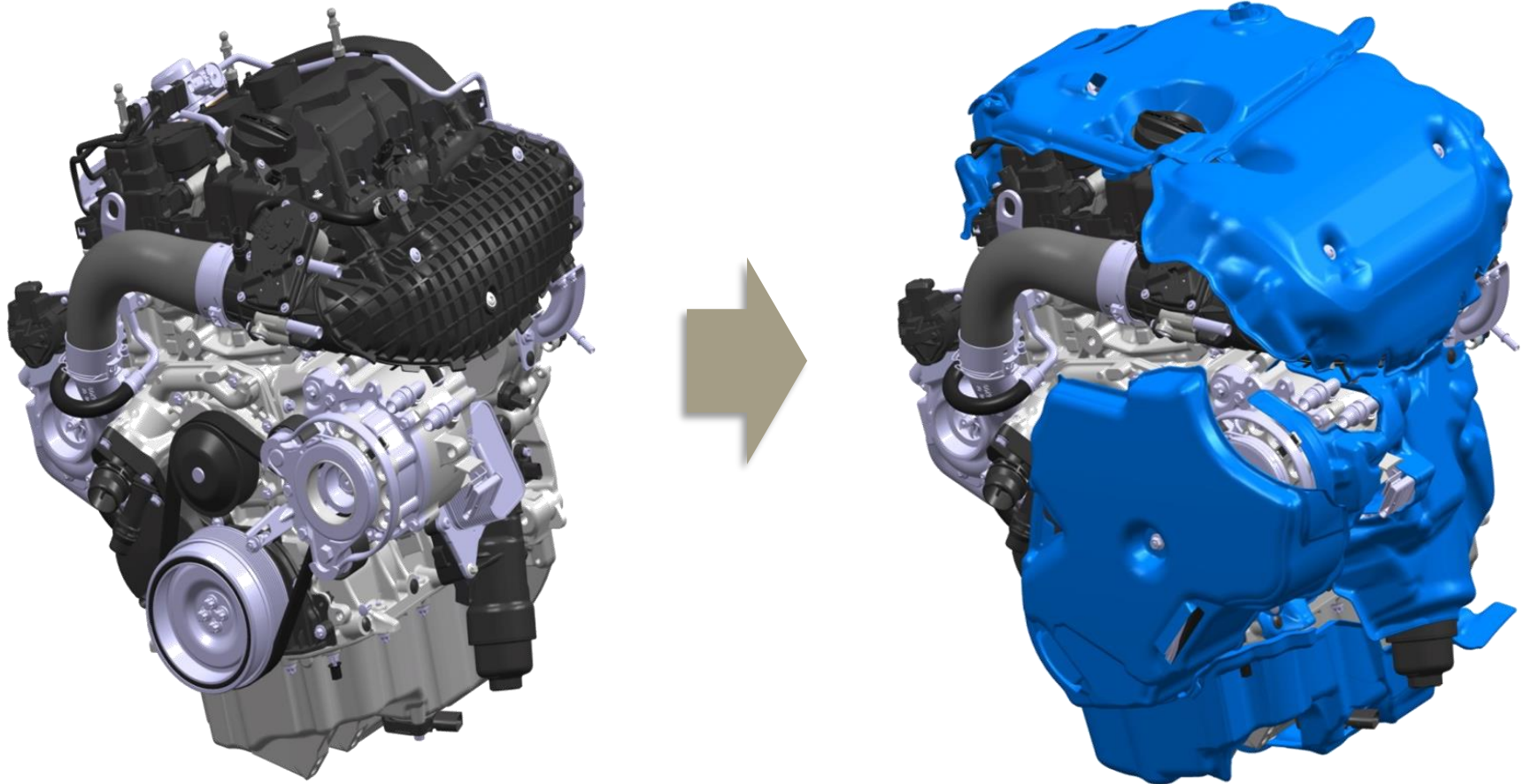
TORSIONAL DAMPER



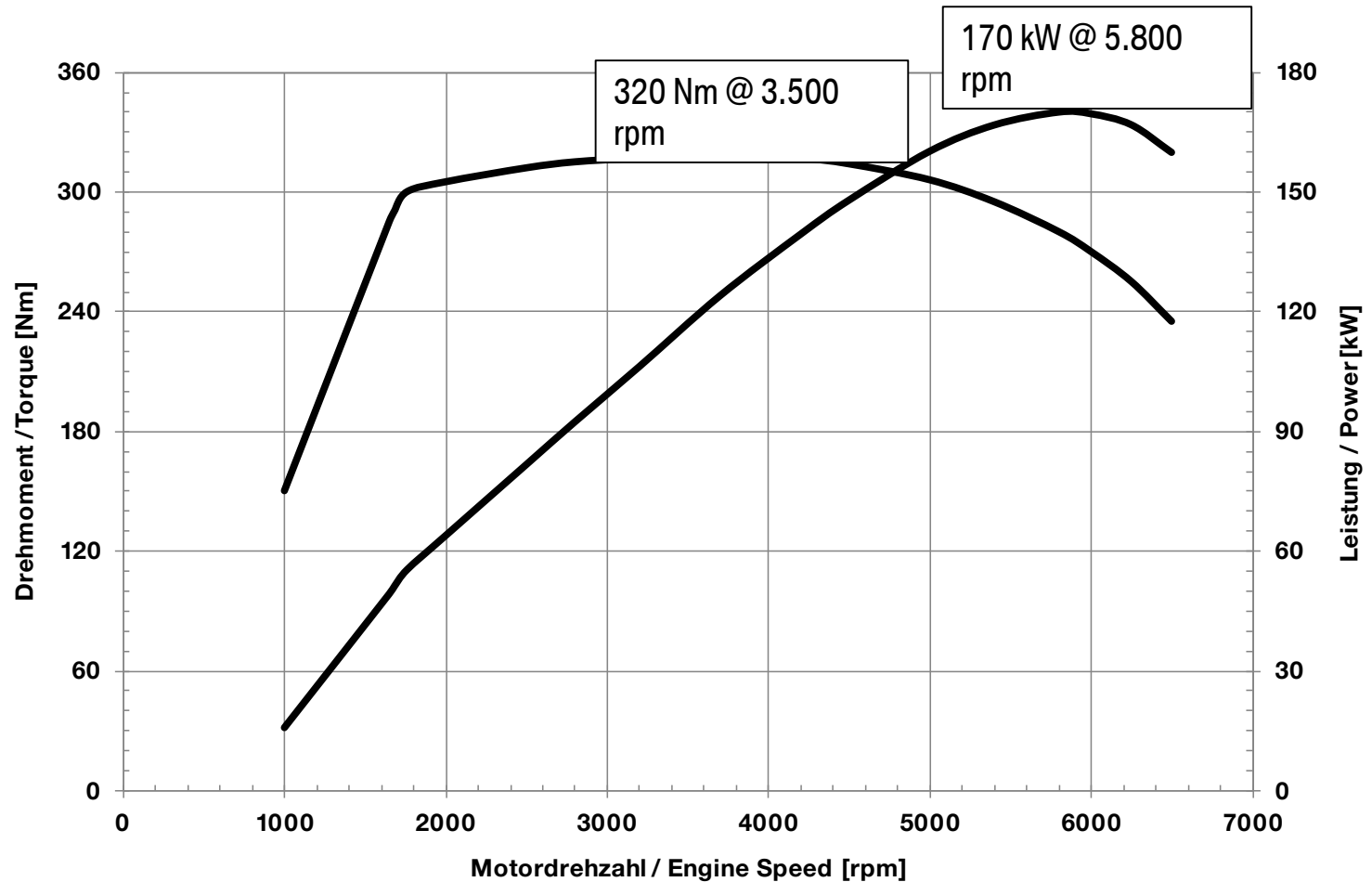
DECOUPLED BELT PULLEY

BOW SPRING

THERMIC AND ACOUSTIC CAPSULES.



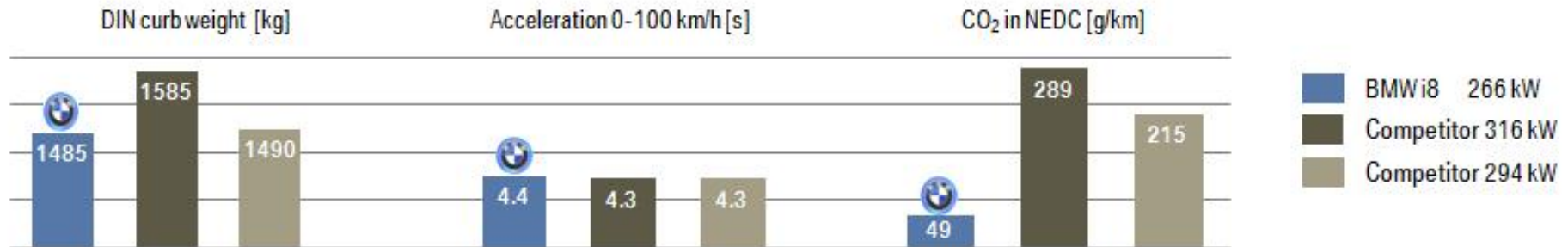
POWER AND TORQUE CURVE.



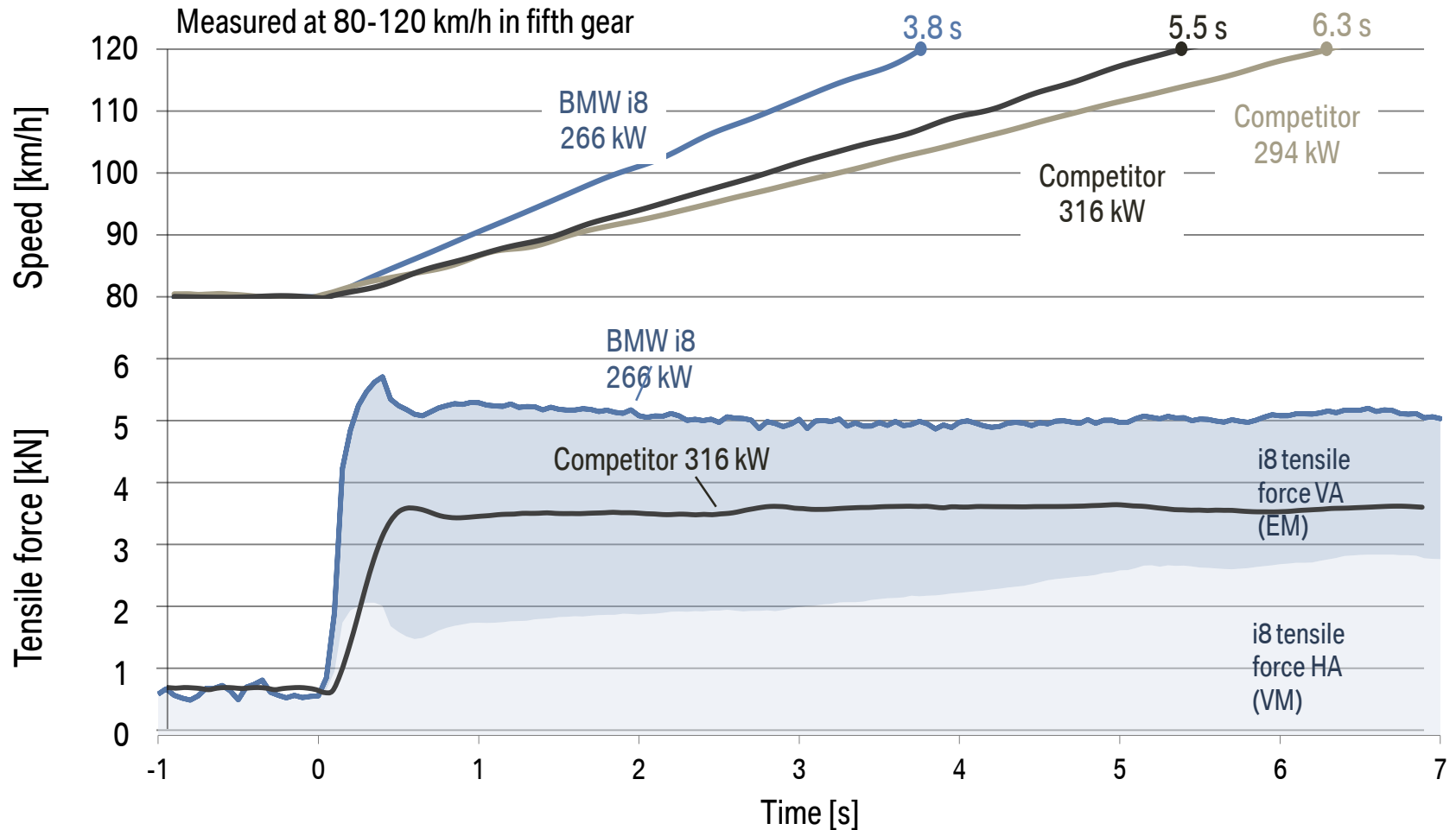
THE BMW i8 ARCHITECTURE COMBINES THE DRIVING CHARACTERISTICS OF A SPORTS CAR WITH THE FUEL CONSUMPTION OF A SMALL CAR.



Electric range NEDC:	37 km
Drag coefficient c_x :	0.26
Acceleration 0-4s:	57 m
Max. initial acceleration:	8.5 m/s^2



THE COMBINATION OF E-DRIVE AND COMBUSTION ENGINE ENSURES SUPERIOR RESPONSE BEHAVIOR AND AGILITY.



ELEKTRIFIZIERUNG BEI BMW.

2002	2004	2006	2008	2010	2012	2014	2015
							
BMW X5 Hybrid 270 kW / 1000 Nm SuperCaps	BMW X3 Hybrid 200 kW / 600 Nm SuperCaps	BMW X6 ActiveHybrid 357 kW / 780 Nm E-Reichweite 2 km NiMH	MINI E 150 kW / 220 Nm E-Reichweite 160 km 35 kWh Li-ion	BMW 1er Active E 125 kW / 249 Nm E-Reichweite 160 km 32 kWh Li-ion	BMW i8 266 kW / 570 Nm E-Reichweite 35km 5 kWh Li-ion	BMW X5 eDrive 40e 230 kW / 450 Nm E-Reichweite 31 km 7 kWh Li-ion	
							
			BMW 7er ActiveHybrid 342 kW / 700 Nm Li-ion	BMW 5er / 3er ActiveHybrid 250 kW / 450 Nm E-Reichweite 4 km LFP	BMW i3 125 kW / 250 Nm E-Reichweite 160 km 18 kWh Li-ion	BMW 3er eDrive 183 kW / >400 Nm E-Reichweite 36 km 6 kWh Li-ion	
							
					BMW 5er eDrive 200 kW / 380 Nm E-Reichweite 58 km 12 kWh Li-ion	BMW Concept Active Tourer eDrive >140 kW / >250 Nm E-Reichweite 35 km	

ZUNEHMENDE ELEKTRIFIZIERUNG. FRAGEN.

**Macht es noch Sinn den
Verbrennungsmotor weiterzuentwickeln?**

**Gibt es noch Weiterentwicklungspotenzial
beim klassischen Verbrennungsmotor?**

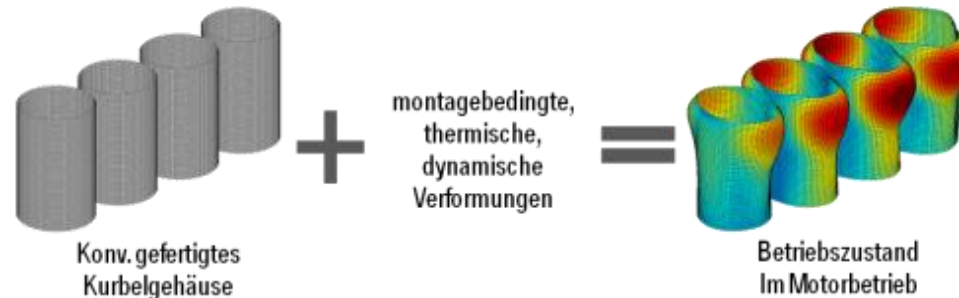
BMW EFFICIENT DYNAMICS. REIBUNGSREDUZIERUNG - FORMHONEN.



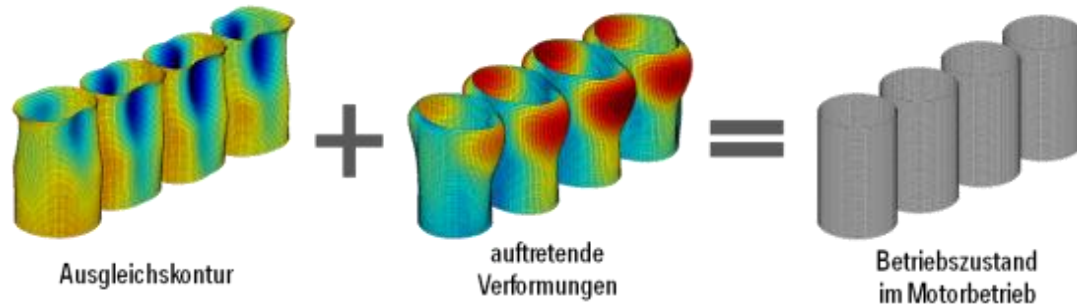
FORMHONEN

MIT DIESER NEUEN TECHNOLOGIE KÖNNEN DIE VERFORMUNGEN DIE IM MOTORBETRIEB AUFTRETEN AUSGEGLICHEN WERDEN UND DIE KOLBENRINGE MIT GERINGERER VORSPANNUNG BETRIEBEN WERDEN, WAS ZU EINER REIBUNGSREDUZIERUNG FÜHRT.

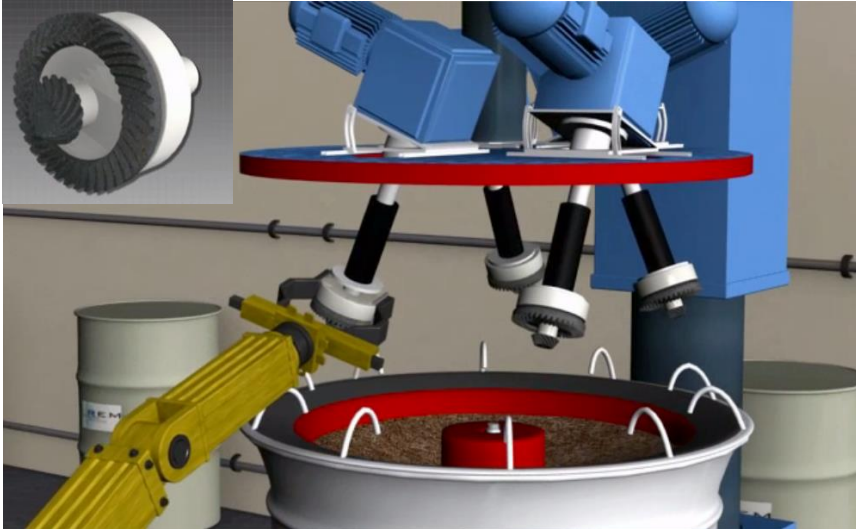
Serie



Formhonen



CHEMISCHES BESCHLEUNIGTES GLEITSCHLEIFEN (ISF). PROZESSTECHNIK.



- Flüssiger Compound wird in Gleitschleifanlage dosiert



- Compound erzeugt dunkelgraue Oxidschicht auf Bauteilen, Oberflächenpassivierung, Prozess stoppt



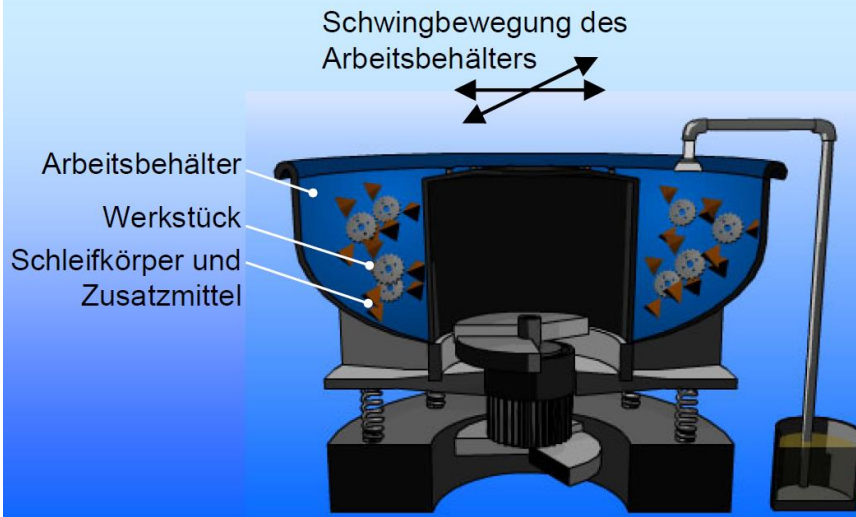
- Abtragung der Oxidschicht zusammen mit den Rauheitsspitzen durch keramische Schleifkörper



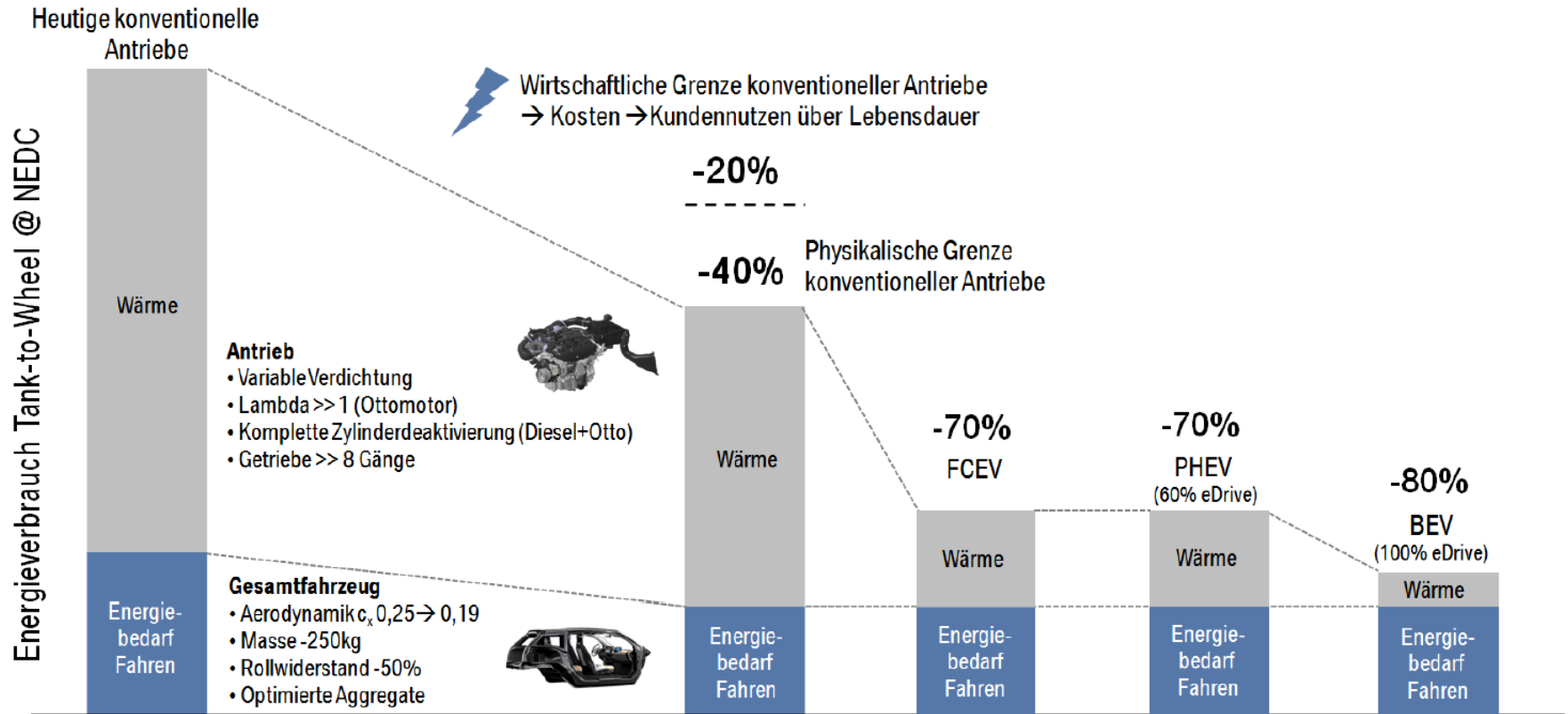
- Oxidschicht bildet sich kontinuierlich neu und wird immer wieder abgetragen, während das Material in den Werkstücktälern und -riefen erhalten bleibt



...weiterer Abtrag...



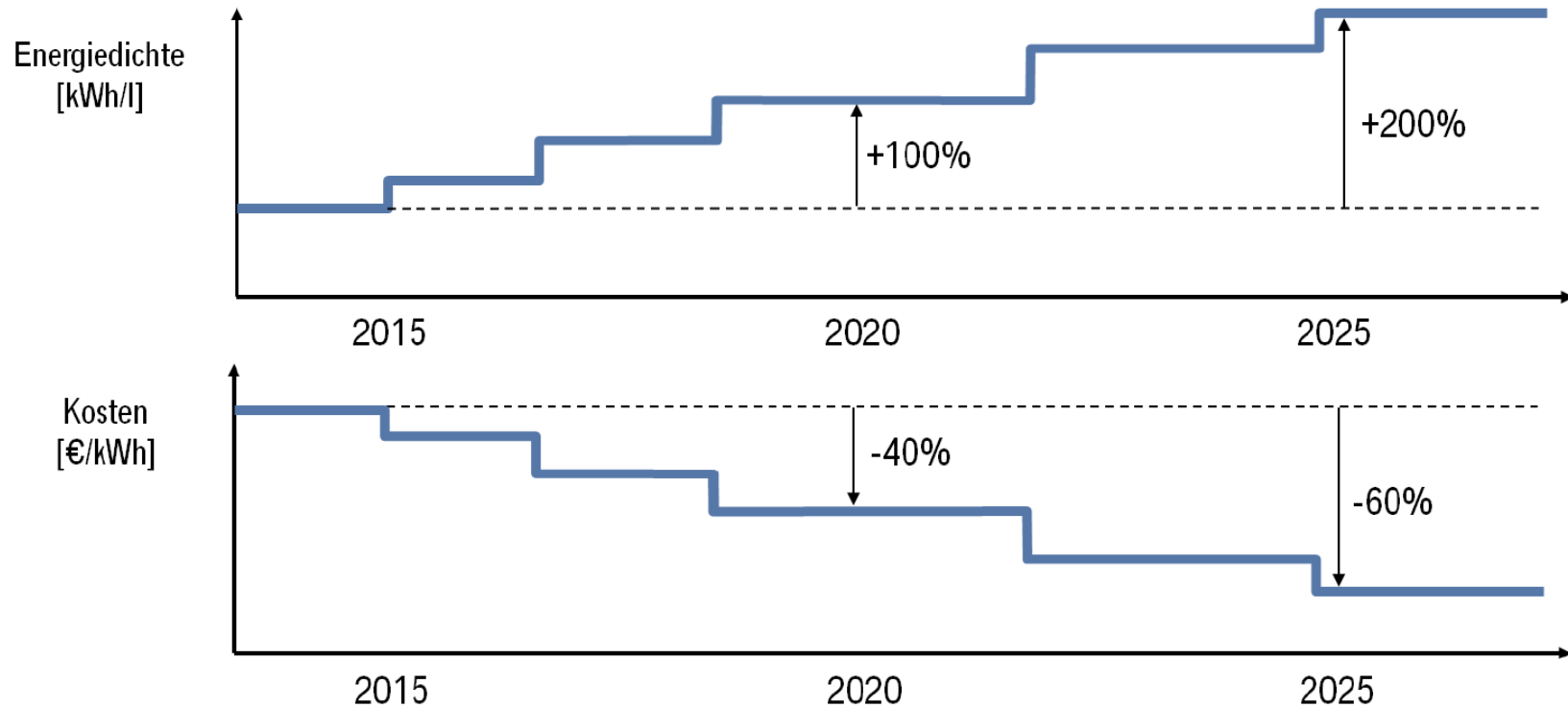
GRENZEN DER VERBRAUCHSREDUZIERUNG.



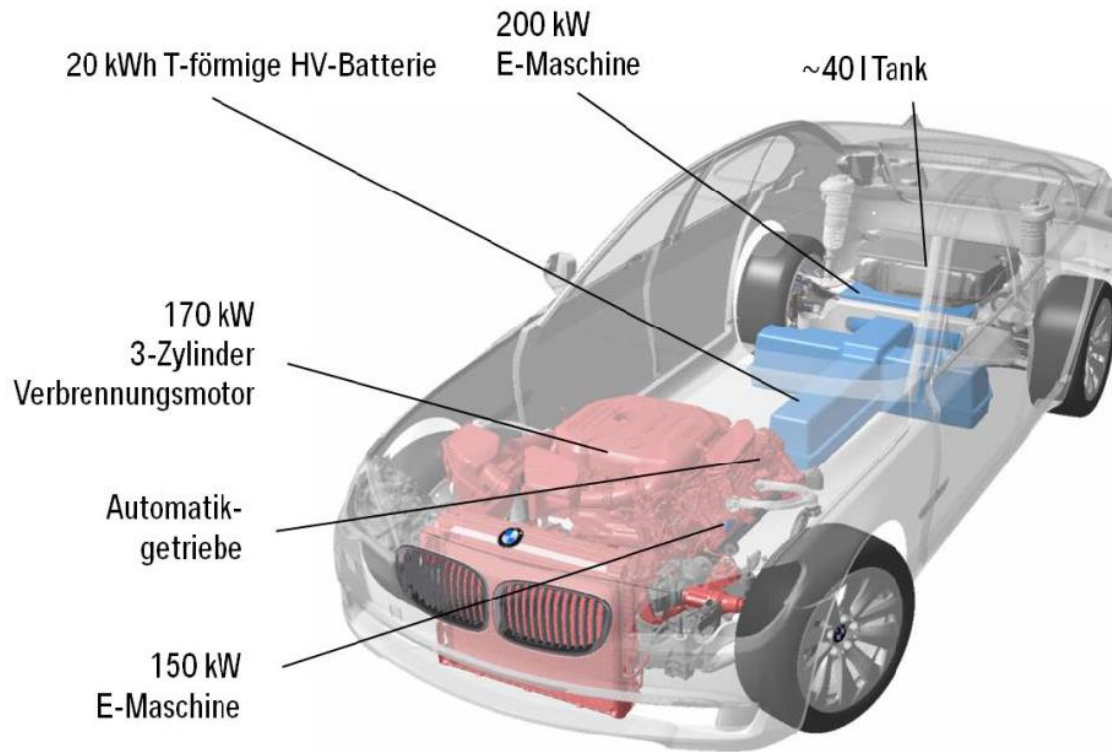
Physikalische Grenzen der konventionellen Verbrauchsreduzierung.

BATTERIEENTWICKLUNG.

???



BMW POWER E-DRIVE CONCEPT.



Versuchsfahrzeug 2014



0 - 100 km/h	4,3 s
120 - 200 km/h	7,5 s
Höchstgeschwindigkeit	210 km/h
E-Reichweite (@ Kunde)	80 km
Gesamtreichweite	~600 km
Max. Initialbeschleunigung	8,5 m/s ²

Abbildung 10: BMW Power eDrive Concept: Versuchsfahrzeug 2014.

POWER EDRIVE TECHNOLOGY: POSITIVE RESPONSE.

BMW Demonstrator im Fahrbericht

Watschn' für die Birkenstock-Latschen

**auto
motor
und sport**



BMWS HYBRID-ZUKUNFT FAHRT ZU ZWEI DRITTELN ELEKTRISCH

In der Karosserie dieses „Demonstrators“ steckt die Hybrid-Zukunft von BMW: Zwei Elektromotoren und ein Range-Extender leisten zusammen 640 PS. Eine Mitfahrt.

**Auto
Bild**

MOTOR TALK

BMW's Tesla-Killer

In diesem BMW Prototyp stecken zwei E-Motoren und der Benziner aus dem i8.

THANK YOU FOR YOUR ATTENTION.

