

# Efficient Dynamics Innovation Days. Energy and Environmental Test Centre.



**BMW Group**

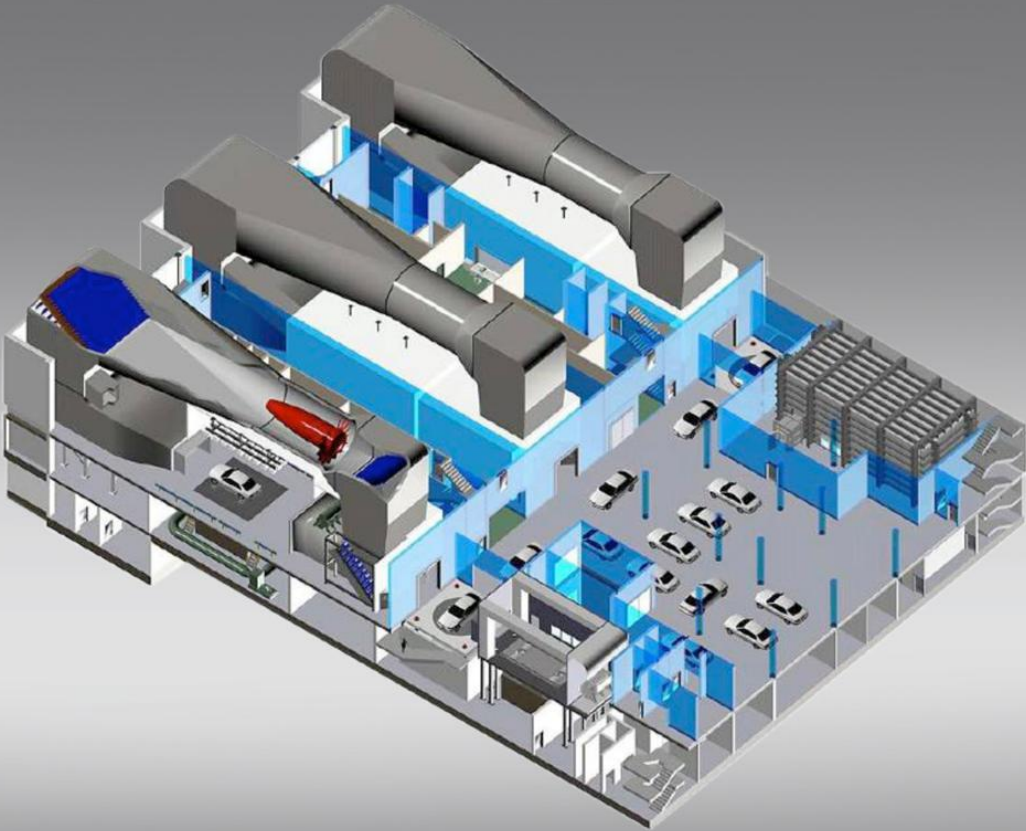


# Energy and Environmental Test Centre (ETC).

## Workshop: Altitude test chamber.

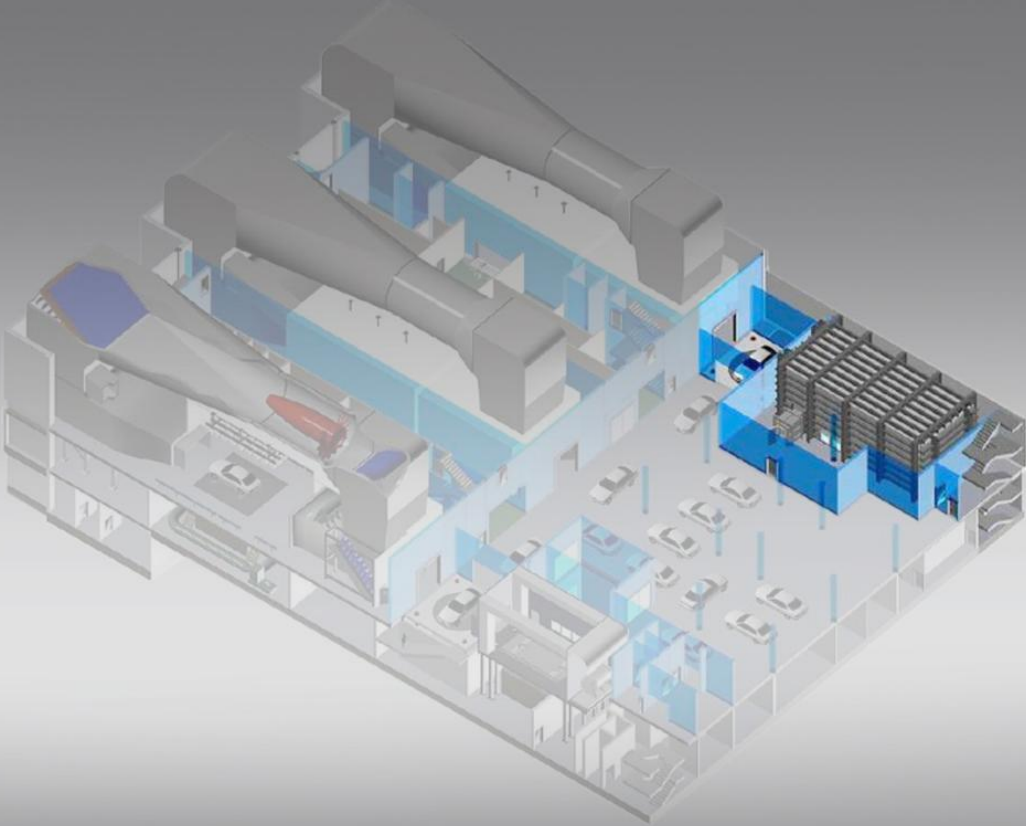


# Energy and Environmental Test Centre (ETC). Altitude test chamber.

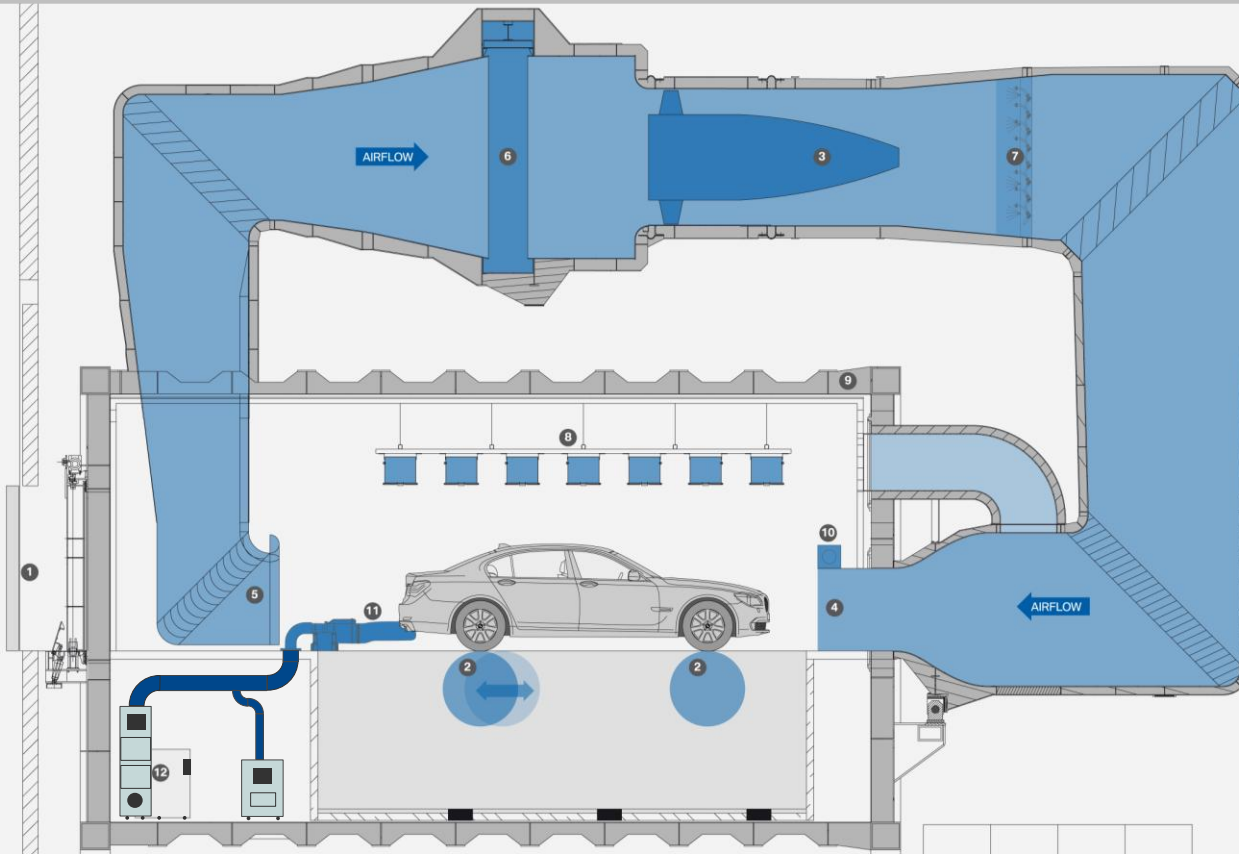


# Energy and Environmental Test Centre (ETC).

Altitude test chamber.



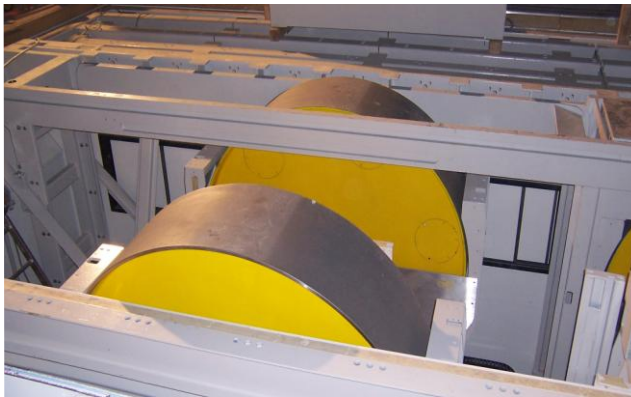
# Energy and Environmental Test Centre (ETC). Altitude test chamber.



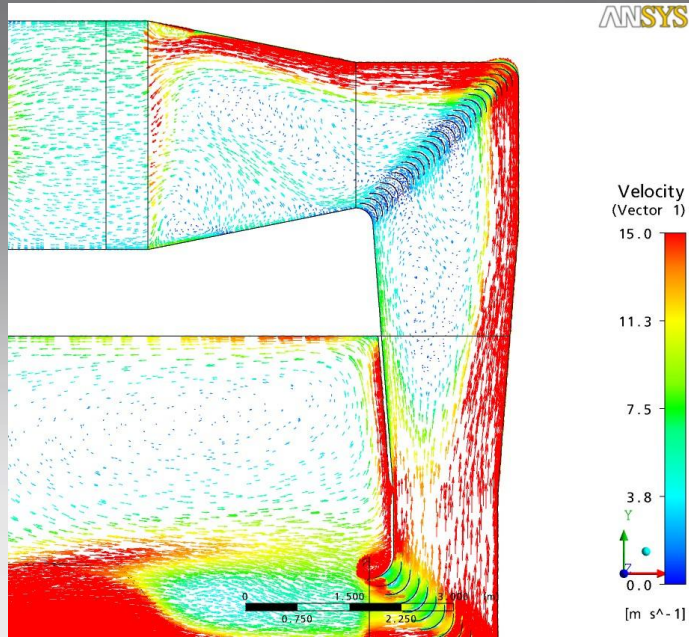
## Altitude test chamber Höhenprüfstand

- 1 Access for vehicle / Einbringung Fahrzeug
- 2 Roller dynamometer / Rollenantrieb
- 3 Fan / Gebläse
- 4 Nozzle / Düse
- 5 Collector / Kollektor
- 6 Heat exchanger / Wärmetauscher
- 7 Humidity regulation / Feuchteregulierung
- 8 Solar simulation / Sonnensimulation
- 9 Pressure cell / Druckhülle
- 10 Idle city flaps / Idle City Klappen
- 11 Exhaust extraction / Abgasabsaugung
- 12 CVS Emission analysis / CVS Abgasanalyse

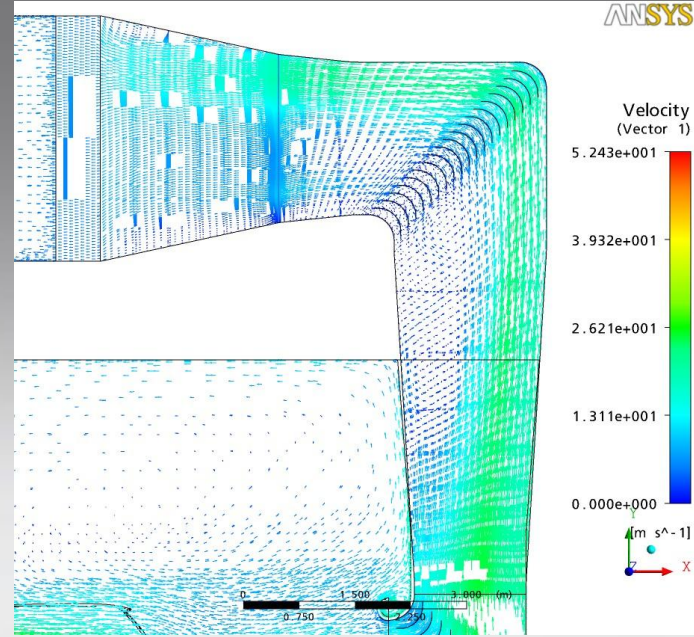
# Energy and Environmental Test Centre (ETC). Altitude test chamber: Construction.



# Energy and Environmental Test Centre (ETC). Altitude test chamber: Flow simulation.



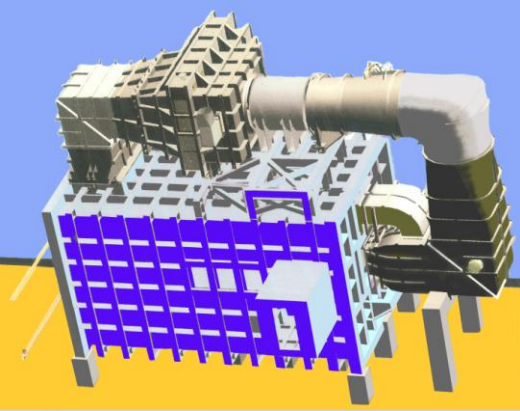
Poor: flow separation



Good: uniform flow distribution

# Energy and Environmental Test Centre (ETC).

## Altitude test chamber: Specifications.



Thermally isolated pressure chamber (constructed using 60 tonnes of steel)

Plenum: 12 m x 6 m

Temperature range: -30 to +45°C

Relative humidity controllable in the range 5-80%, from +5°C

Altitude range: -200 m to +4200 m

Four-wheel dynamometer with max. power: 750 kW

Max. wind speed: 250 km/h

Nozzle: 2 sq.m.

Fan diameter: 2240 mm

Max. rpm: 1350 rpm | max. power: 900 kW

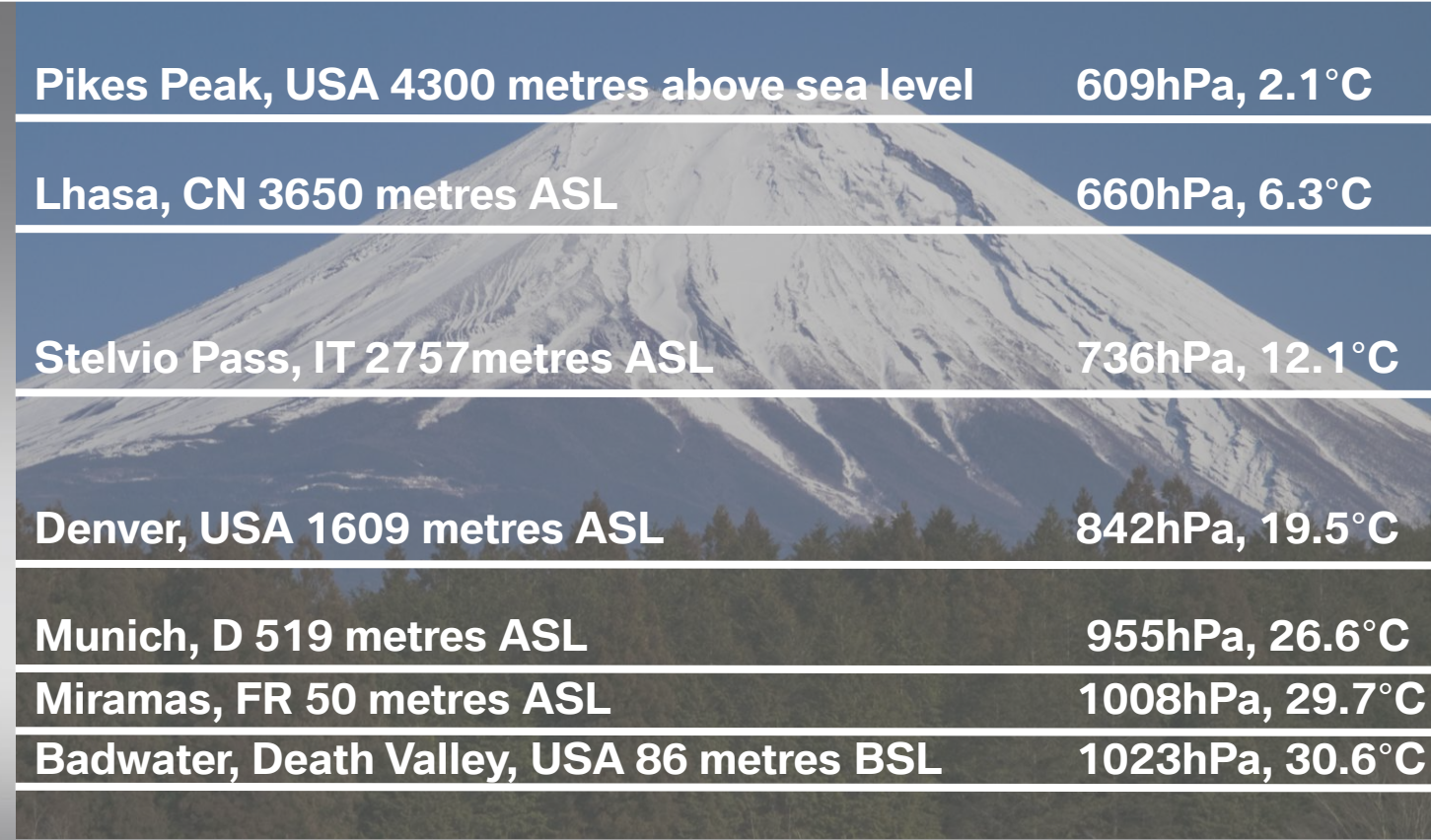
Solarium 400 to 1200 W/m<sup>2</sup>

Emission and fuel consumption measurement at speeds up to 200 km/h



# Energy and Environmental Test Centre (ETC).

## Comparative altitudes.



<b>Pikes Peak, USA 4300 metres above sea level</b>	<b>609hPa, 2.1°C</b>
<b>Lhasa, CN 3650 metres ASL</b>	<b>660hPa, 6.3°C</b>
<b>Stelvio Pass, IT 2757metres ASL</b>	<b>736hPa, 12.1°C</b>
<b>Denver, USA 1609 metres ASL</b>	<b>842hPa, 19.5°C</b>
<b>Munich, D 519 metres ASL</b>	<b>955hPa, 26.6°C</b>
<b>Miramas, FR 50 metres ASL</b>	<b>1008hPa, 29.7°C</b>
<b>Badwater, Death Valley, USA 86 metres BSL</b>	<b>1023hPa, 30.6°C</b>

# Energy and Environmental Test Centre (ETC).

## What altitude means.



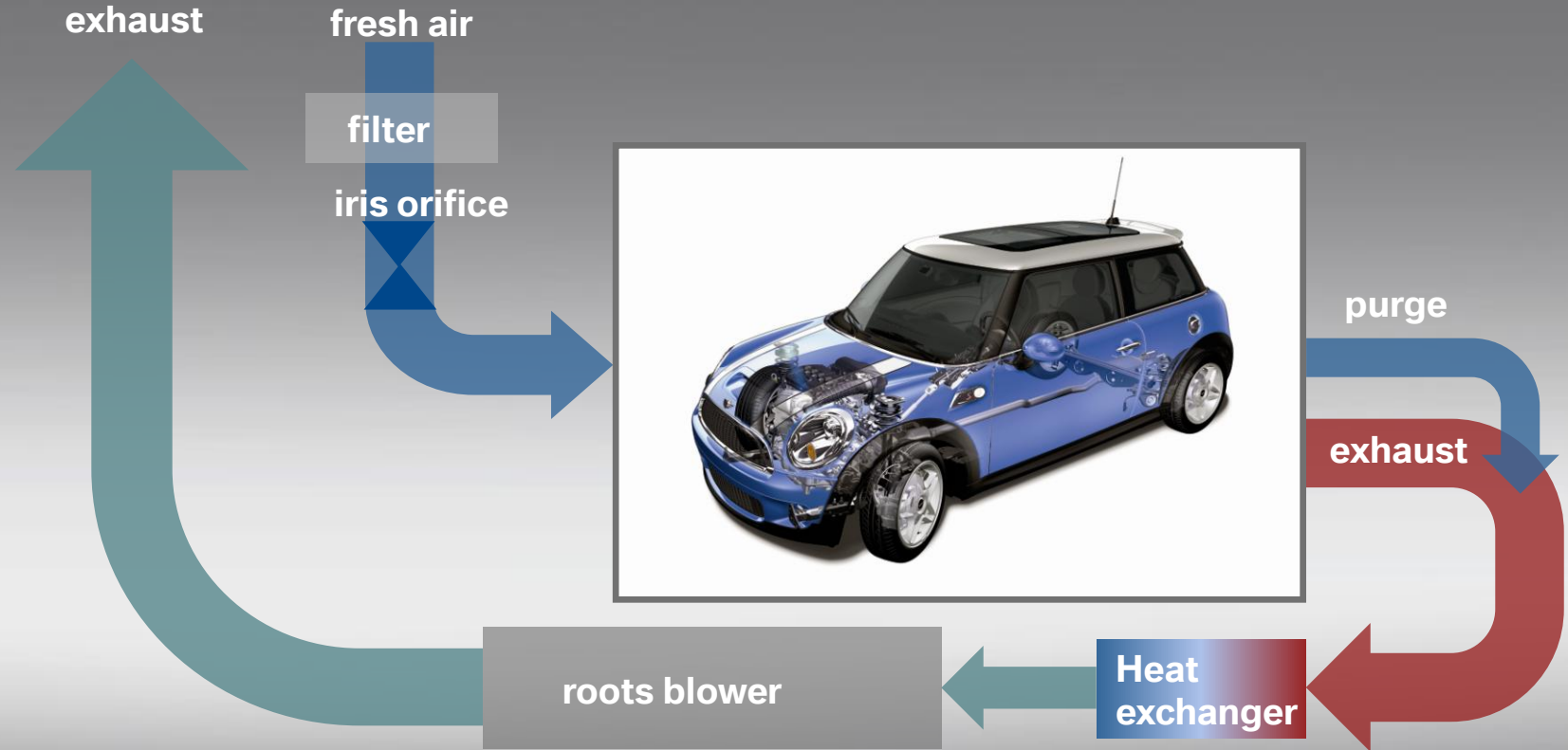
Altitude: 414 m



Altitude: 2240 m

# Energy and Environmental Test Centre (ETC).

Altitude test chamber: Airflow schematic.



# Energy and Environmental Test Centre (ETC). Range of tests.



**Emission and fuel consumption measurement** development and homologation

**Engine calibration** turbocharger / exhaust aftertreatment systems

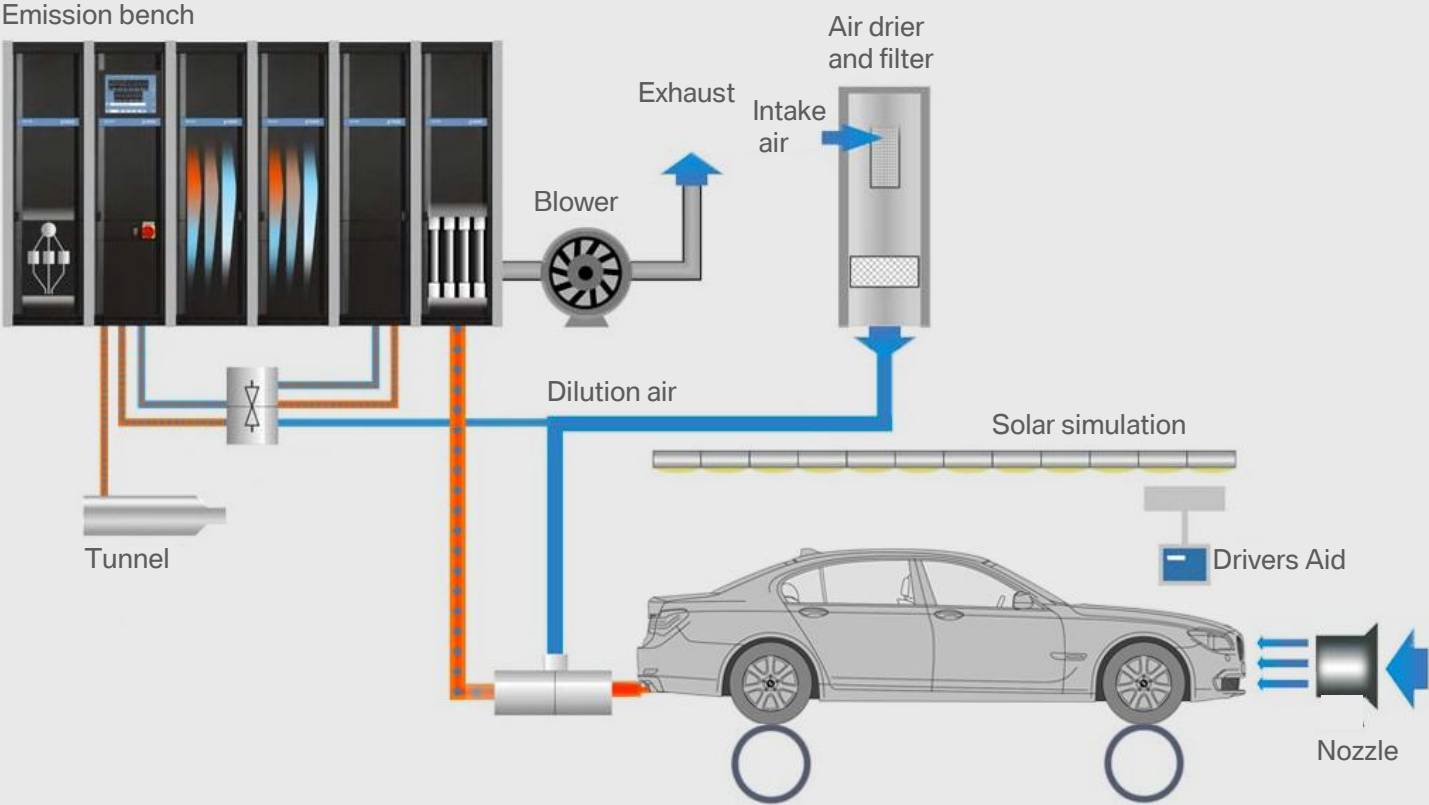
**Fuel supply system** temperature and pressure

**On-board diagnosis** engine and transmission

**Simulation up-hill driving** evaluation complete vehicle

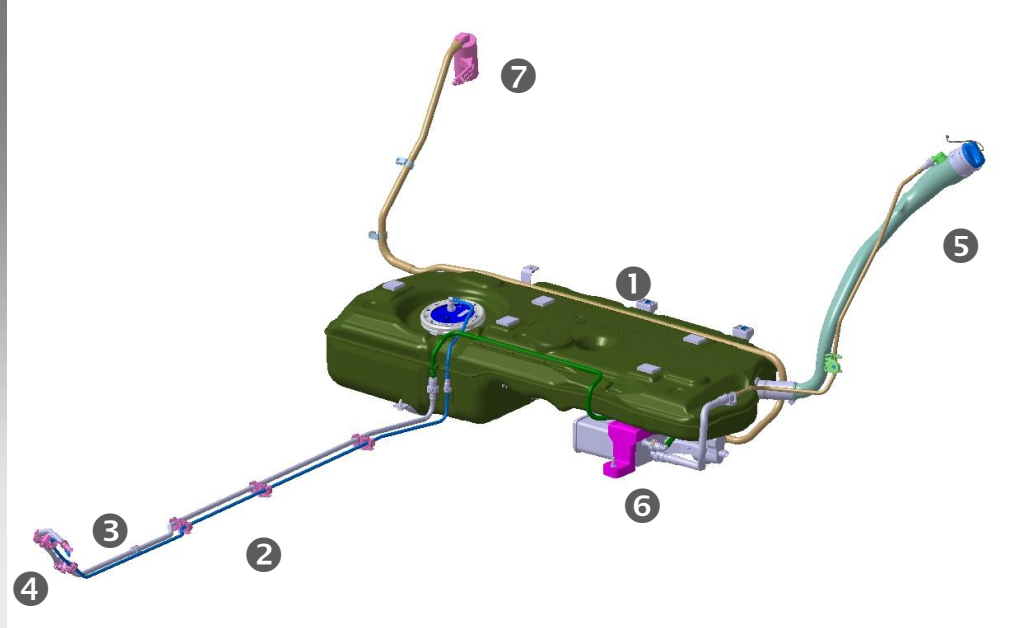
**Power measurements** cars and motorcycles

# Energy and Environmental Test Centre (ETC). Altitude test chamber: Emission measurement .



# Energy and Environmental Test Centre (ETC).

## Fuel supply calibration.



① Tank with fuel pump

② Fuel line

③ Fuel vapour line

④ Fuel injection

⑤ Filler neck

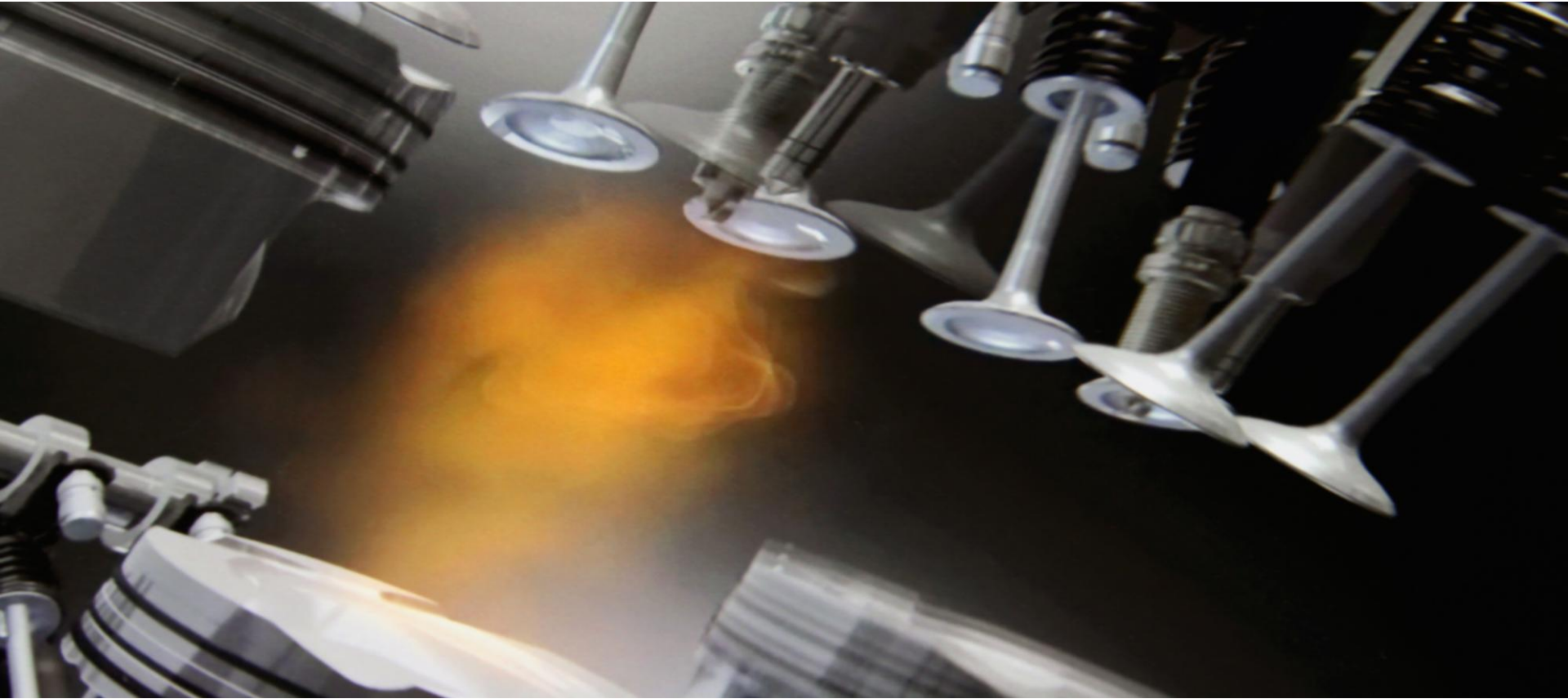
⑥ Charcoal canister

⑦ Dust filter

0m: water boils at 100°C

3000m: water boils at 90°C

**Energy and Environmental Test Centre (ETC).**  
**Workshop: A new generation of drivetrains.**

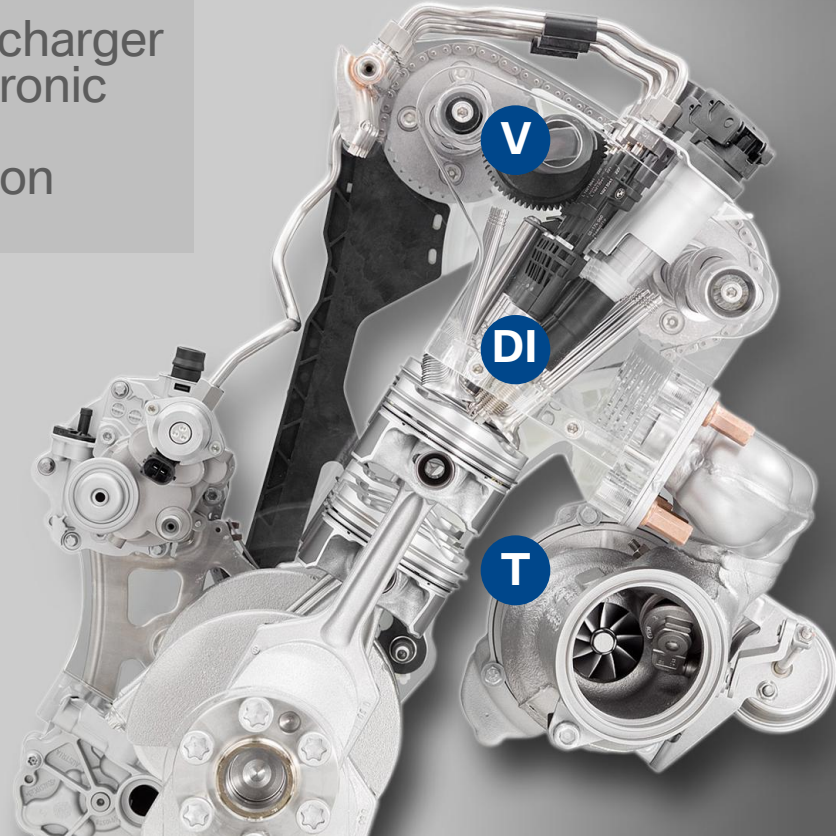


# Energy and Environmental Test Centre (ETC).

A new generation of powertrains. The new TVDI SI engine.



**T** Turbocharger  
**V** Valvetronic  
**D** Direct  
**I** Injection





# Energy and Environmental Test Centre (ETC).

The new TVDI SI engine.

The evolution of VALVETRONIC.

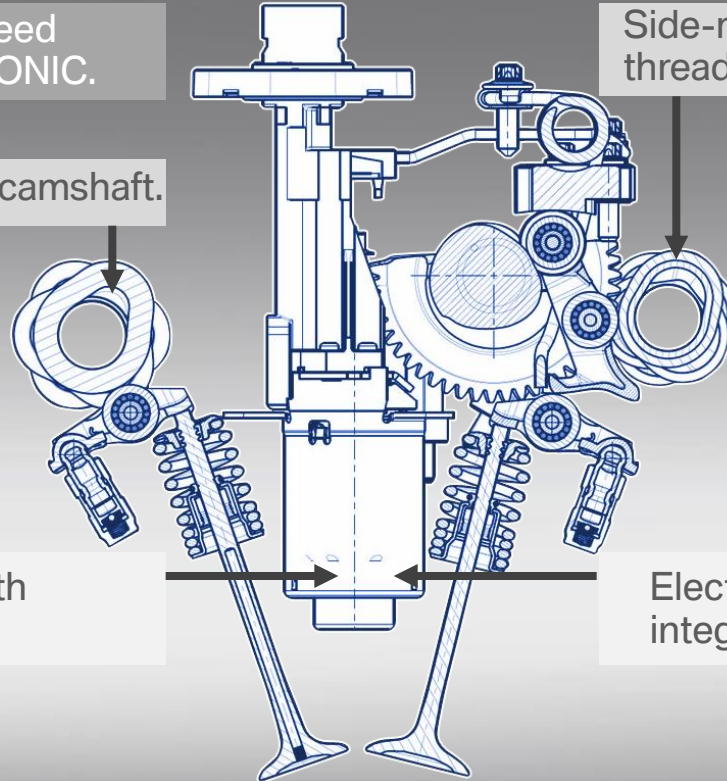
Significantly increased speed and dynamic of VALVETRONIC.

Pressure-formed built-up camshaft.

Side-mounted fuel rail with threaded connection to injector.

Electric actuator motor with integral position sensor.

Electric actuator motor integrated into cylinder head.



# Energy and Environmental Test Centre (ETC).

The new TVDI SI engine.

The evolution of VALVETRONIC.

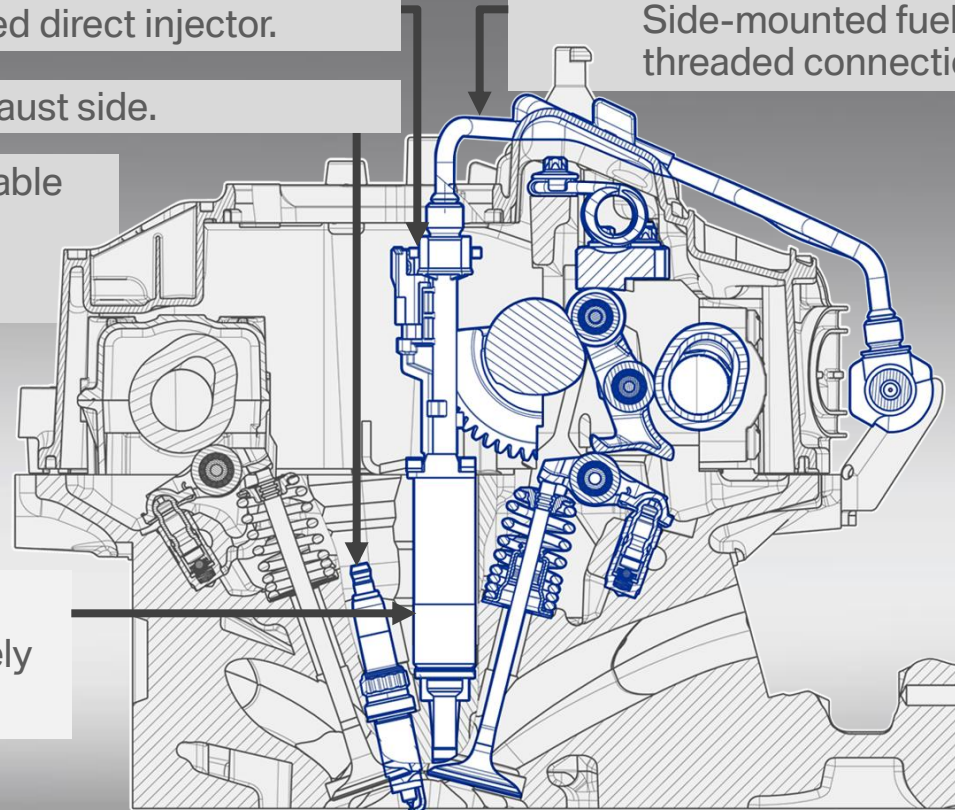
Centrally positioned direct injector.

Spark plug on exhaust side.

Fuel pressure variable  
between 50 and  
200 bar.

Spark plug and  
injector transversely  
positioned.

Side-mounted fuel rail with  
threaded connection to injector.



# Energy and Environmental Test Centre (ETC).

The new TVDI SI engine.

Twin Scroll Turbocharger – “Two in one”.

Exhaust path

Cyl. 2 and 3

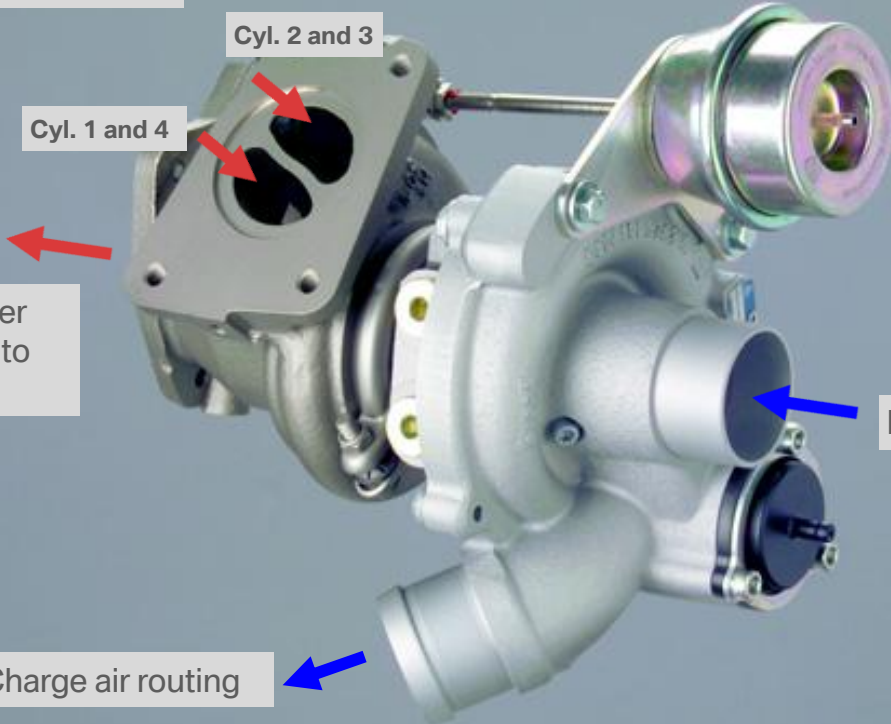
Cyl. 1 and 4

Catalytic converter  
positioned close to  
engine

Intake air routing

Charge air routing

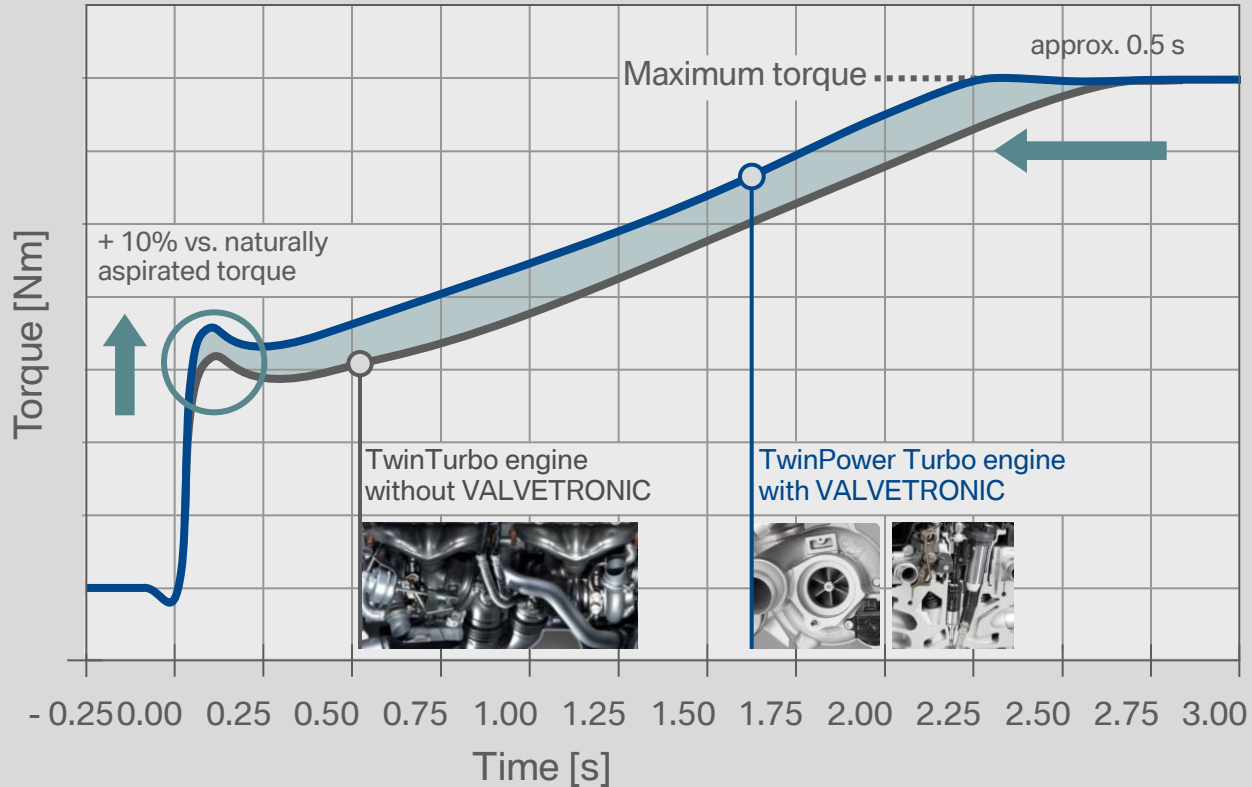
Air path



# Energy and Environmental Test Centre (ETC).

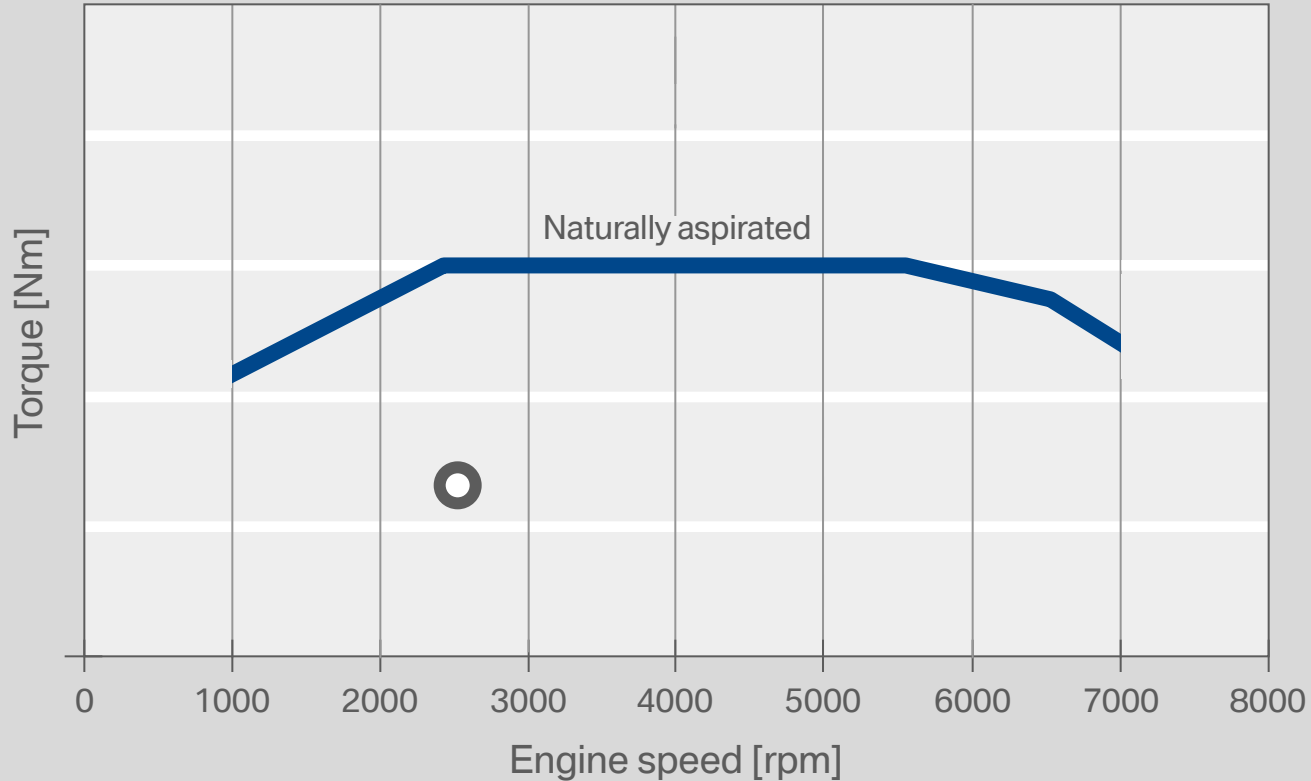
The new TVDI SI engine.

With even better response.



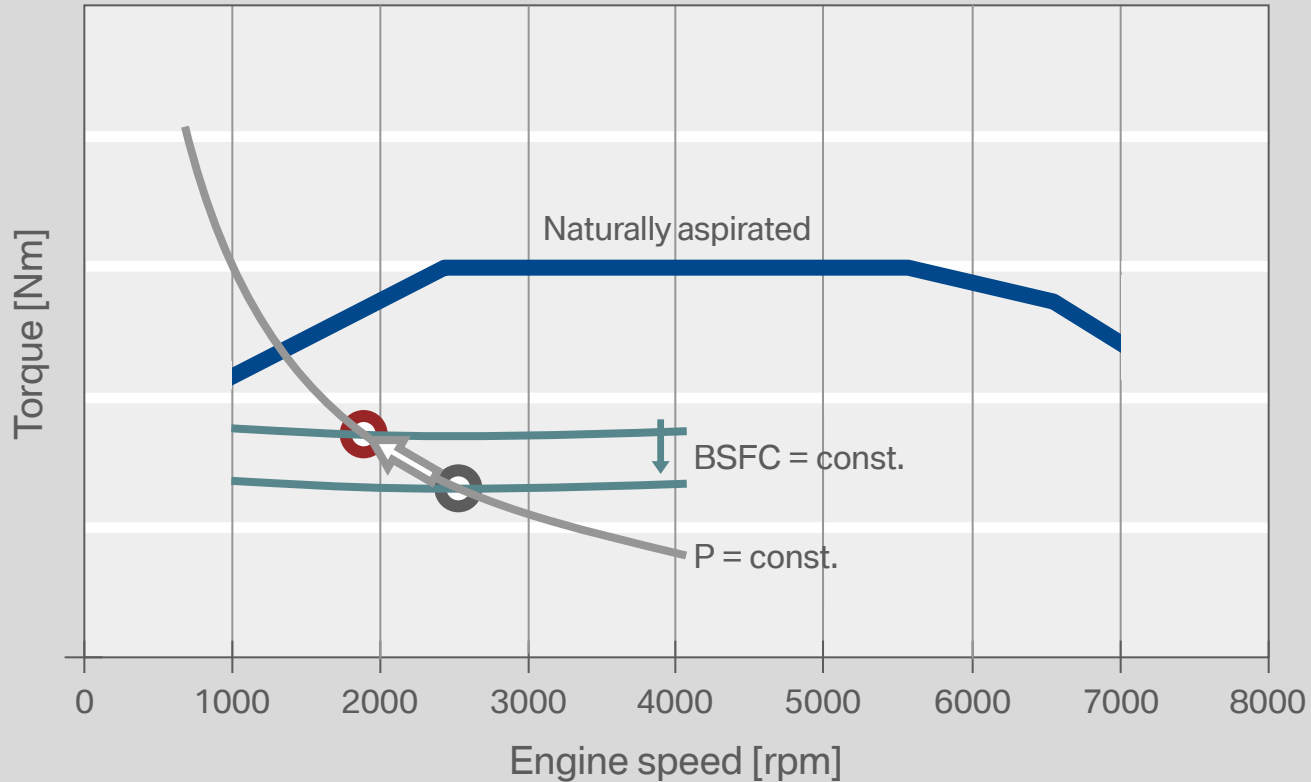
# Energy and Environmental Test Centre (ETC).

A new generation of powertrains. The new powertrain philosophy – a combination of reduced consumption and increased dynamics.



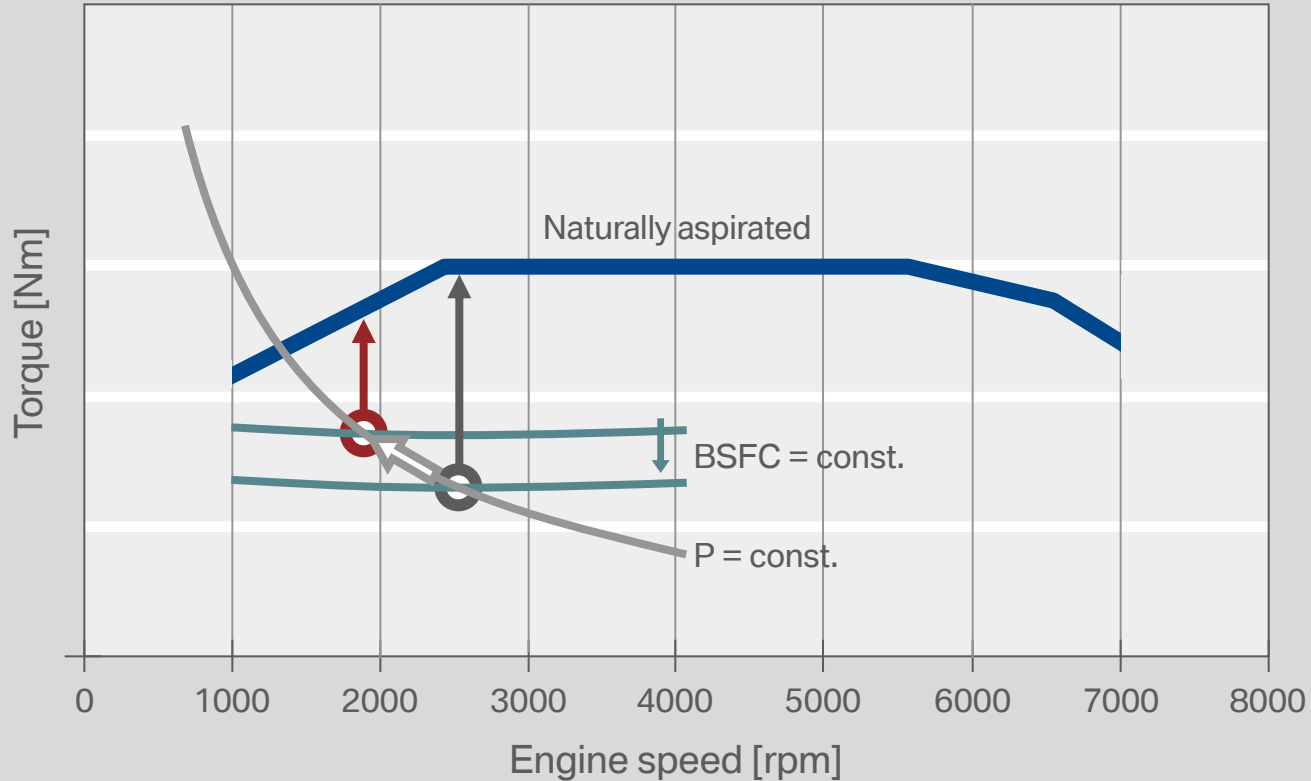
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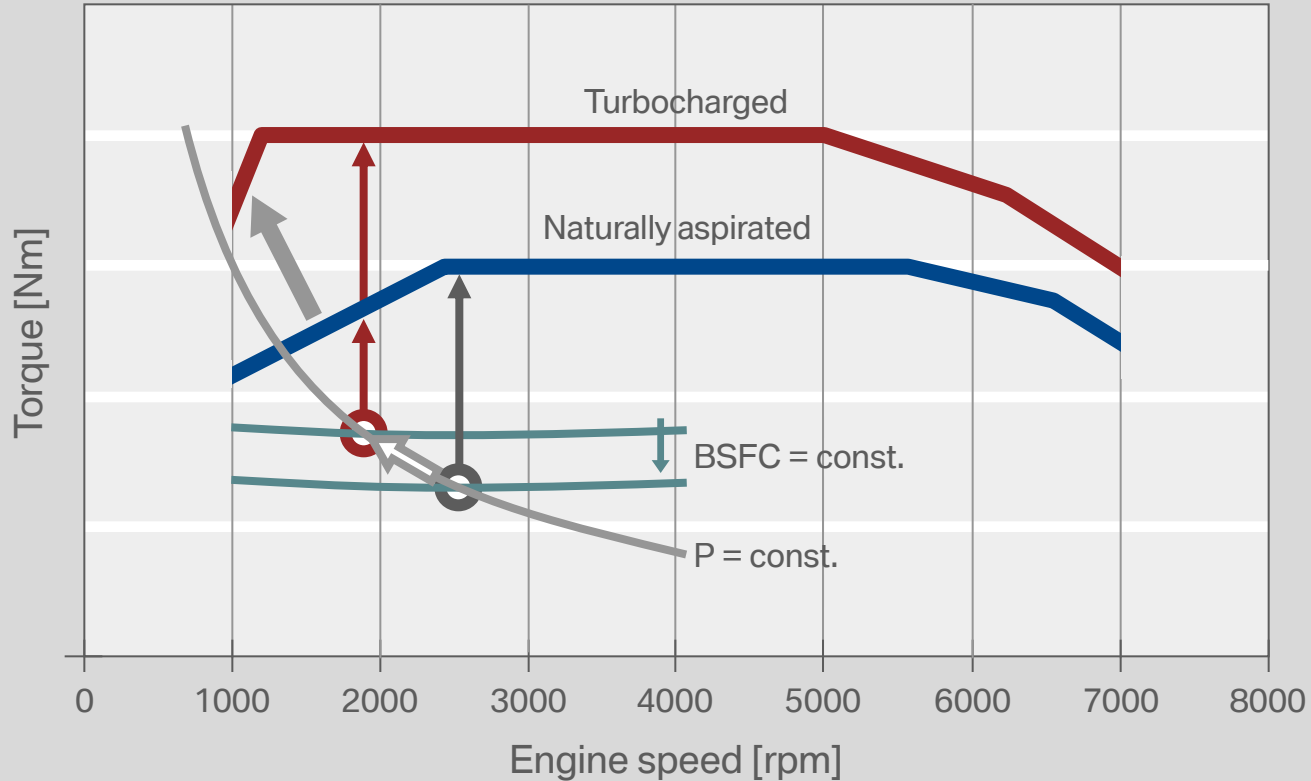
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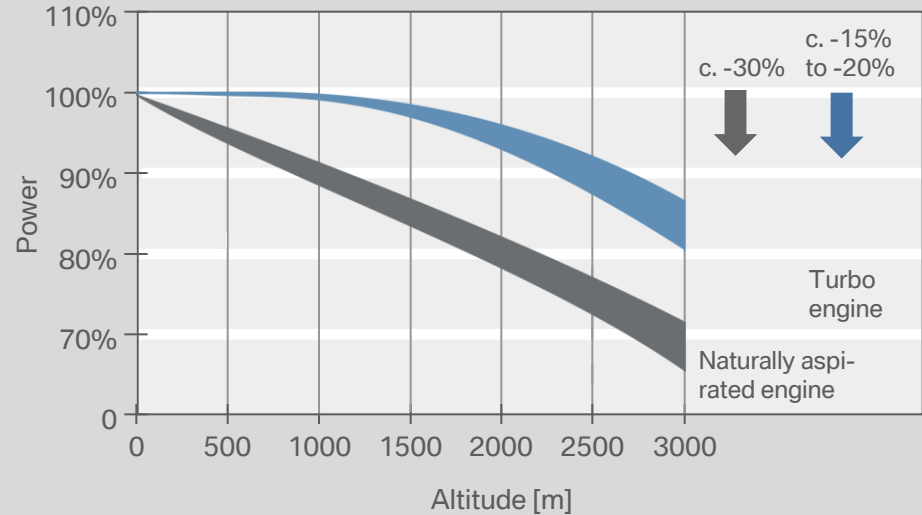
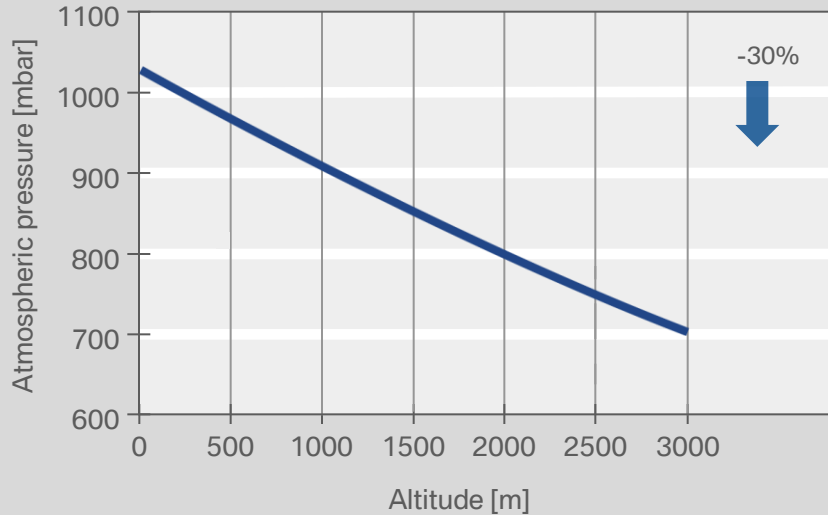
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# Energy and Environmental Test Centre (ETC).

Altitude-related performance – naturally aspirated engine is left gasping for breath.



# Energy and Environmental Test Centre (ETC).

From engine test bench to altitude test chamber –  
an efficient and dynamic symbiosis.

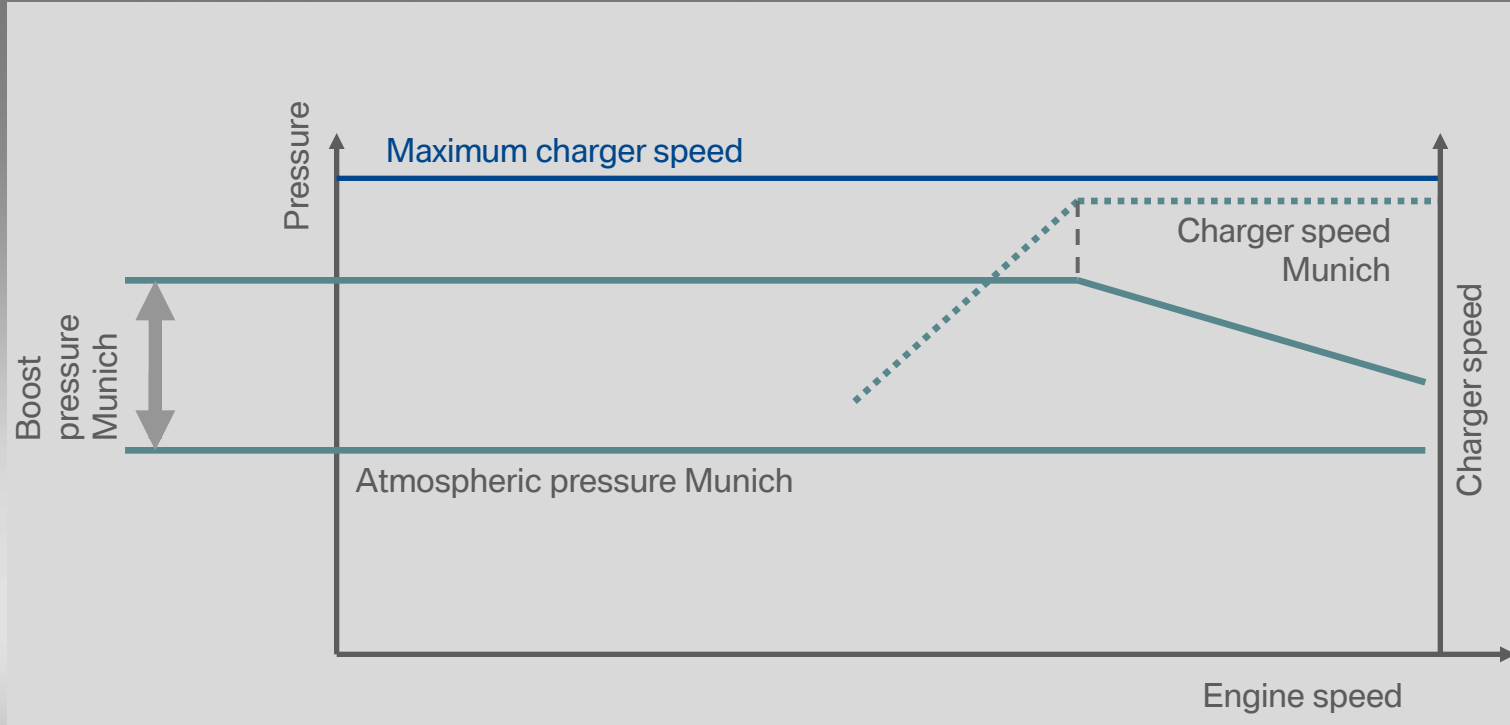


- Basic application.
- Performance development.
- Dynamic behaviour of engine and powertrain.

- Validation of vehicle integration.
- Validation of cooling system in the vehicle under real airflow conditions, cycles and driving resistance.
- Confirmation of robustness of the combustion process under different environmental conditions.

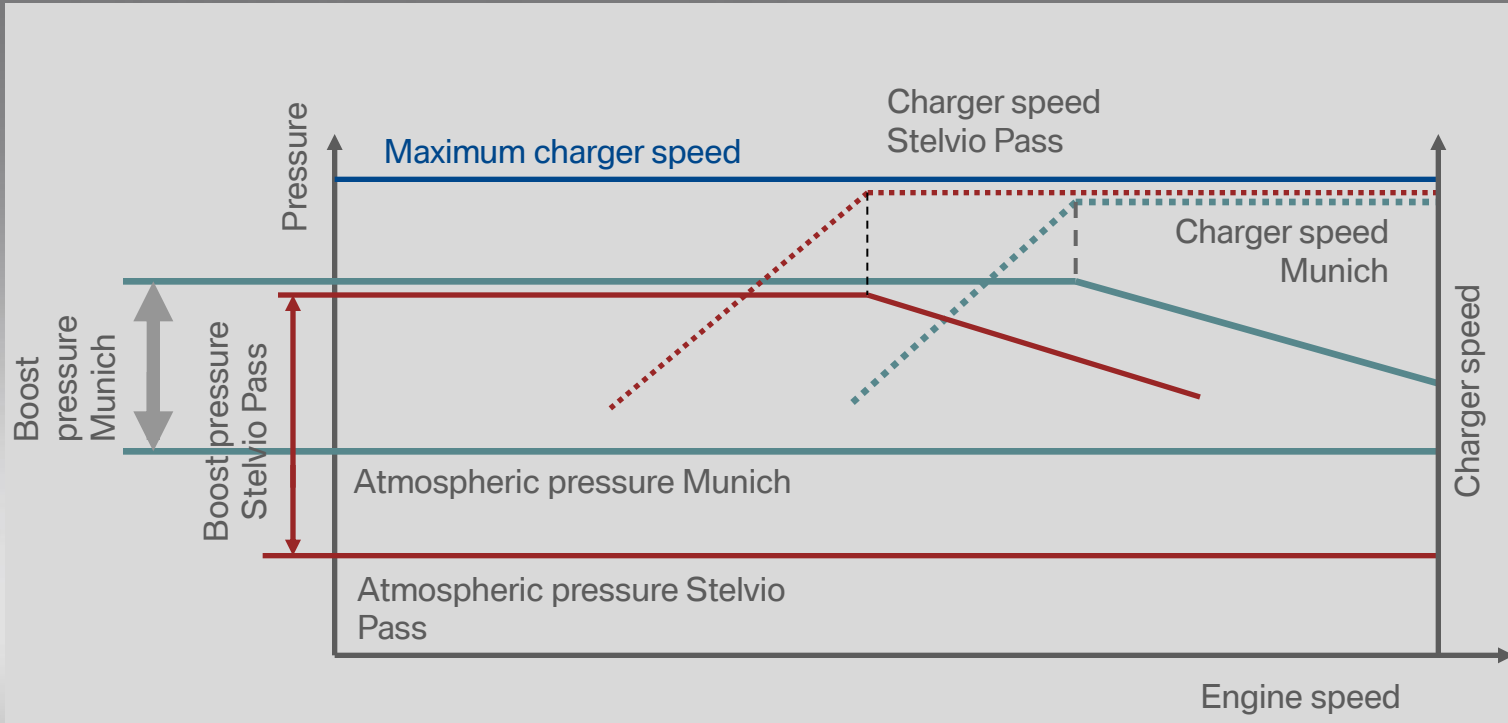
# Energy and Environmental Test Centre (ETC).

Limiting turbocharger speed – all the way to the limit.



# Energy and Environmental Test Centre (ETC).

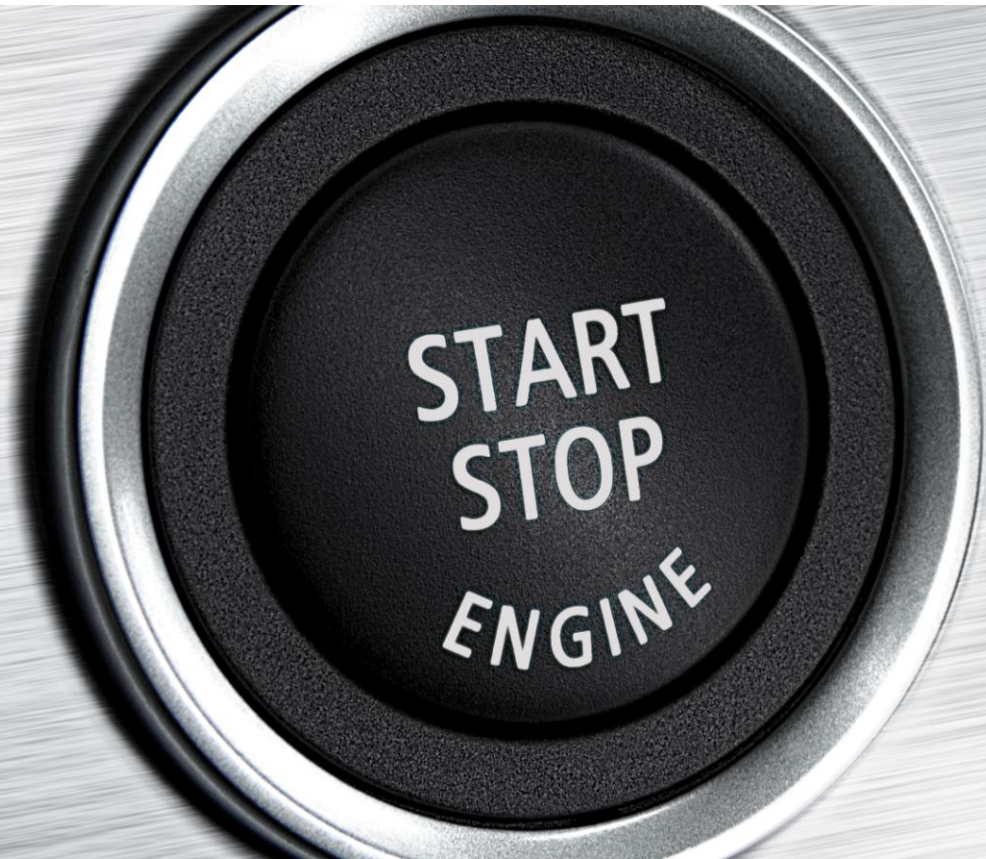
Limiting turbocharger speed – all the way to the limit.



## **Energy and Environmental Test Centre (ETC).**

Adjusting the amount of fuel during start-up –

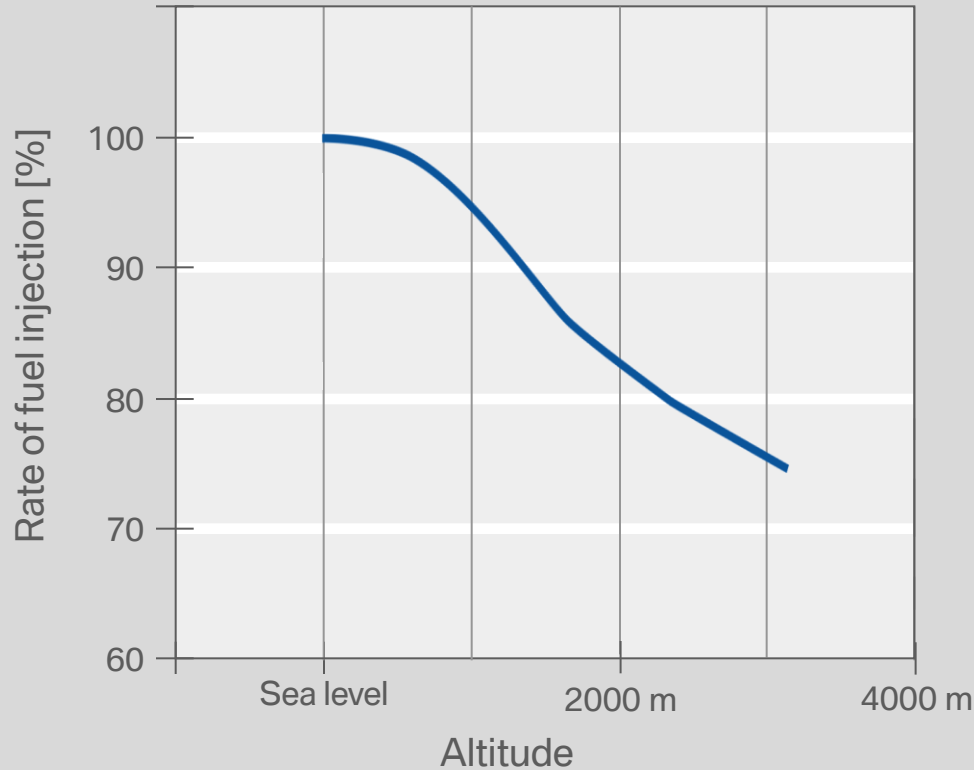
“top-notch” EfficientDynamics with engine Start/Stop as well.



# Energy and Environmental Test Centre (ETC).

Adjusting the amount of fuel during start-up –

“top-notch” EfficientDynamics with engine Start/Stop as well.



**Energy and Environmental Testing Centre (ETC).**  
Thank you for your attention.

