Bosch powertrain technologies

Powertrain Technologies for more fuel efficiency

Gasoline Systems
CO₂ emission/FE target worldwide 全球CO₂排放或燃油经济性目标

LT = Light Truck 轻型货车, LCV = Light Commercial Vehicle 轻型商用车, PC = Passenger Car 乘用车

Source: ICCT 02/2014*
**Bosch powertrain technologies**

**CO₂ Emission of Top 20 Chinese passenger cars**

中国排名前20位的乘用车CO₂排放

### Fuel consumption vs. Curb weight

- **Top 20 Chinese passenger cars**
  - Minibus 小客车
  - Sub Compact Class 超紧凑型车
  - Compact Class 紧凑型车

- **CN fleet target 2015**
  - 中国2015年车队目标值

- **GO EU reference in year 2000**
  - CC 4 cyl. 2,0l PFI MT6 100 kW
  - SC 4 Zyl. 1,6l PFI MT5 65 kW

- **National Target**
  - 全国目标值

- **Proposed CN fleet target 2020**
  - 提出的中国2020年对目标值

**China TOP20 vehicles in SC and CC Segment already implemented FE-Technologies**

中国超紧凑型和紧凑型细分市场的前20位的车辆已经采用燃油经济性技术

**Gasoline Systems**

Fuel consumption NEDC

Single normal vehicle FC limit CN

(New type/All type: 2016.1.1/2017.1.1)
Gasoline PFI powertrains offer CO₂-reduction potential of up to 20%
To fulfill 2020 targets a mixture of PFI, DI and vehicle measures is needed

Gasoline Systems

Fuel consumption NEDC

Single normal vehicle FC limit CN

(New type/All type: 2016.1.1/2017.1.1)
Bosch powertrain technologies

Future fuel efficiency technologies 未来的燃油效率技术

Subcompact 超紧凑型

Compact 紧凑型

PFI Powertrains offer further CO₂-reduction potential of up to 9% 点喷动力总成具有进一步减少CO2达9%的潜力

Gasoline Systems

1) Fuel consumption [liter per 100km] in NEDC

Bosch solution available
Bosch powertrain technologies

Advanced gasoline port fuel injection (A-PFI) 高级汽油点喷

Features 特性

- Combination of new PFI technologies in an integrated system approach 新的点喷技术集成
- Twin-Injection: 2 Injectors per Cylinder 双喷：每缸两个喷头
- PFI Scavenging: using VVT & T/C 采用可变气门正时和涡轮增压
- Pressure Increase: DECOS (variable fuel supply) 增压：DECOS（按需供油）
- Open Valve Injection under WOT (full load) optimized by Twin Injectors 开阀喷射（满负荷）由双喷头优化

Customer benefits / USP 用户利益

- up to 9% CO2-Reduction (incl. Twin-Injection, OVI, DECOS, Downsizing & T/C) 减少CO2高达9%（包括双喷头，开阀喷射，按需供油，减少排量以及涡轮增压）
- Up to 40% Low end torque increase (Fun2Drive) 可增加40%低端扭矩（Fun2Drive）
- Enlarge performance range (Engine Power) 增加性能范围（发动机动力）
- > 20% Emissions-Reduction (Test Cycle) 排放减少 >20%（测试工况）
- Further benefits by combination w/ air charge systems (e.g. metering range) and exhaust gas recirculation (swirl concepts) 更多的利益可通过充气系统（如计量范围）和废气再循环（旋流概念）来实现

Gasoline Systems

<table>
<thead>
<tr>
<th>PFI...Port Fuel Injection</th>
<th>VVT...Variable Valve Timing</th>
<th>DECOS...Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>controlled fuel supply</td>
<td>OVI...Open Valve Injection</td>
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Bosch powertrain technologies

Future fuel efficiency technologies 未来的燃油效率技术

Subcompact 超紧凑型

Compact 紧凑型

Gasoline Direct Injection Powertrains offer further CO₂-reduction potential of up to 15% 汽油直喷动力总成具有进一步减少CO₂达15%的潜力

1) Fuel consumption [liter per 100km] in NEDC

Gasoline Systems

He= high efficiency 高效 | DI = direct injection 直喷 | APFI = advanced port fuel injection 高级点喷 | AMT = automated manual transmission 手自一体变速器 | AT = automatic transmission 自动变速器 | DCT = double clutch transmission 双离合变速器 | T/C = turbocharger 涡轮增压 | DZ = downsizing 减少排量 | BRS = Boost recuperation system 增压回收系统 | sHEV = strong hybrid 强混合动力 | TR = transmission 变速器

Bosch solution available
**Features 特性**

- High-pressure injection directly into the combustion chamber
  直接高压喷射到燃烧腔
- Injection pressure up to 200 bar, higher pressures under evaluation
  喷射压强高达200 bar，更高的压强还在评估中
- “Scavenging” for better cooling / charging
  “排气”为了更好的降温或充气

**Customer benefits / USP 用户利益**

- Fuel savings up to 15% (by downsizing turbo-charger or $\lambda > 1$) vs. PFI N/A
  省油高达15% (采用减少排量，涡轮增压或$\lambda > 1$) vs 点喷，自然气
- With Turbo: low end torque increase up to 50% vs. PFI
  采用涡轮：低端扭矩增加达50% vs. 点喷
- Quick response on kick-down (prevention of typical turbo-delay) with DI T/C and scavenging
  直喷涡轮增压和排气快速响应（防止典型的涡轮延迟）
- Emission: all legislation levels (EUVI, SULEV, LEVIII)
  排放: 所有立法层面
- Worldwide applicable for all specified fuels
  所有指定的燃料全球适用
Future fuel efficiency technologies
未来的燃油效率技术

Subcompact 超紧凑型

Compact 紧凑型

Diesel powertrains offer CO₂-reduction potential of up to 30% 柴油动力总成具有减少CO₂达30%的潜力

Gasoline Systems

1) Fuel consumption [liter per 100km] in NEDC

Bosch solution available
Features 特性
- Available for passenger cars (PC) & light commercial vehicles 适用于乘用车和轻型商用车
- Adaption for heavy commercial & off-highway engines possible 可能用于重型商用和非道路发动机
- High injection pressures of up to 2,500 bar, higher pressures under evaluation for future applications 高压喷射达2,500 bar，未来的高压喷射还在研究中
- Fewer emissions and noise than conventional diesel systems 比传统的柴油系统更少的排放和噪音

Arguments pro Diesel 论据偏向于柴油
Economical: 经济:
- Up to 30% better fuel economy than a comparable gasoline* engine depending on vehicle type and size 根据车辆类型及大小，比同等的汽油发动机高达30％的燃油经济性
- Accordingly, up to 20% lower CO₂ emission and up to 35 % higher mileage 从而，减少CO₂高达20%和高达35%的里程

Clean: 清洁:
- Minimal particulate matter and NOₓ emission 最少的颗粒物和NOx排放

Fun: 有趣:
- Up to 40% higher torque than a comparable gasoline engine depending on the vehicle size & type 根据车辆类型及大小，比同等的汽油发动机高达40％的扭矩
- High torque, even at lower engine speeds, for comfortable acceleration and good towing capacity 甚至在较低的发动机转速下具有高扭矩，且有舒适的加速和良好的牵引性能

* Based on the comparison of more than 1,200 diesel/gasoline pairs, data provided by ADAC
Future fuel efficiency technologies 未来的燃油效率技术

Subcompact 超紧凑型

Compact 紧凑型

48V Boost Recuperation Systems offer CO₂-reduction potential of up to 14% 48V的增压回收系统具有减少CO2达14%的潜力

Gasoline Systems 1) Fuel consumption [liter per 100km] in NEDC

Bosch solution available

HE= high efficiency 高效 | DI = direct injection 直喷 | APFI = advanced port fuel injection 高级点喷 | HEV = hybrid electric vehicle 混合动力车

HE= = high efficiency 高效 | DI = direct injection 直喷 | APFI = advanced port fuel injection 高级点喷 | AMT = automated manual transmission 手自一体变速器 | AT = automatic transmission 自动变速器 | DCT = double clutch transmission 双离合变速器 | T/C = turbocharger 涡轮增压 | DZ = downsizing 减少排量 | BRS = Boost recuperation system 增压回收系统 | sHEV = strong hybrid 强混合动力 | TR = transmission 变速器
Boost recuperation system (BRS) 增压回收系统

Features 特性

- Electrical machine delivering up to 10 kW 电机供应高达10kW
- Energy supply from brake energy recuperation 从制动能量回收提供能量
- Electrical boost function 电激励功能

Customer benefits 用户利益

- Up to 14% fuel-efficiency improvement in NEDC (without coasting, with gearshift optimization, basis: start-stop) 在NEDC工况下提高燃油效率高达14%（没有滑行，采用换挡优化，基本：怠速起停）
- Very short & comfortable ICE restart feasible, enabling start-stop and coasting 短且舒适的内燃机再启动特性，可以怠速起停和滑行
- Reduced starting time, noise and vibration 减少启动时间，噪音和振动
- Cost-efficient entry system for electrification 性价比高的电子化系统
- Fun to drive (e-boost) 开起来有趣（e-boost）

Reduced Starting Noise 减少启动噪音

Noise level 100 cm to front of vehicle (hood open) in dB(A)

- Blue line: SSM
- Red line: BRS

Gasoline Systems

SSM: start-stop starter motor, ICE: internal-combustion engine

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Future fuel efficiency technologies 未来的燃油效率技术

Subcompact 超紧凑型

<table>
<thead>
<tr>
<th>Bosch solution available</th>
<th>TR</th>
<th>PFI</th>
<th>DI</th>
<th>BRS</th>
</tr>
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<tbody>
<tr>
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<td>Compact 紧凑型</td>
<td>HE- AMT</td>
<td>AT DCT</td>
<td>DI T/C eDZ</td>
<td>BRS 48V</td>
</tr>
<tr>
<td>Future Potential</td>
<td>3-6%</td>
<td>9-11%</td>
<td>10-14%</td>
<td></td>
</tr>
</tbody>
</table>

Hybrids & EVs offer CO₂-reduction potential of up to 100% 混合动力和电动车具有减少CO₂达100%的潜力

Gasoline Systems 1) Fuel consumption [liter per 100km] in NEDC 2) +credits Bosch solution available
Plug-in hybrids (PHEV) 插电式混合动力

**Features 特性**

- Combination of efficient ICE* & electric driving (comfort) 高效内燃机和电动驱动相结合
- CO2 reduction and driving enjoyment 减少CO2排放及增加驾驶舒适度
- Attractive due to legislation and consumer expectations 由于立法和消费者的期望，具有吸引力
- Electrical energy supply from charge spot (230/400 V) 电能供应来自充电点（230/400 V）
- Optimal layout in terms of cost/ benefit and customer acceptance: 50 km el. range and 120 km/h max. el. Speed 成本/效益和客户接受方面的优化布局：50 km的电驱动驾驶行程及120 km/h最高电驱动驾驶速度
- Future: market penetration from upper vehicle segment 未来：从高端一些的细分市场渗入

**Customer benefits 用户利益**

- 50–90% fuel-efficiency improvement in NEDC (e-range) 在NEDC工况下燃油效率提高50–90%
- Electric driving ranges sufficient to allow access to low-emission zones 电驱动驾驶行程下足够可以进入低排放区
- Green image (electric drive) + driving enjoyment (e-boost) 绿色形象（电力驱动）和驾驶乐趣（e-boost）

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**High-voltage battery** 高电压电池
**Lithium-ion battery** 锂离子电池
4 - 12 kWh

**Power electronics module** 电力电子模块
**DC link voltage** 直流电压 250 - 450V
**DC/DC converter** 1.5 - 3 kW

**Electric motor** 电动机
**traction drive** 牵引驱动
30 - 80 kW
Future fuel efficiency technologies 未来的燃油效率技术

Future powertrain technologies 未来动力总成技术

Gasoline Systems 未来汽油系统

1) Fuel consumption [liter per 100km] in NEDC 2) *credits

Bosch solution available

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Subcompact 超紧凑型

Compact 紧凑型

Future potential offers further CO₂-reduction potential 未来动力总成技术具有进一步减少CO₂的潜力
To fulfill 2020 targets various technology paths are possible

Gasoline Systems

Fuel consumption MEAP

L/100km

kg

11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0

800
1200
1400
1600
1800
2000
2200
2400

Top 20 Chinese passenger cars

Minibus 小客车
Sub Compact Class 超紧凑型车
Compact Class 紧凑型车

CN fleet target 2015
提出的中国2015年车队目标值
= proposed vehicle limit 20161)

G0 EU reference in year
2000: CC
4 cyl. 2,0l
PFI MT6
100 kW

SC
4 Zyl. 1.6l
PFI MT5
65 kW

G4 EU
Best in market
2012: CC
4 cyl. 1.4l
DI T/C MT6
90 kW

SC
3 cyl. 1.2l
PFI MT5
60 kW

To fulfill 2020 targets various technology paths are possible

Gasoline Systems

Fuel consumption MEAP

L/100km

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summary

- China TOP20 sales vehicles already implemented FE-Technologies but still have to reduce the fuel consumption by 20–40% 中国销量排前20位的车辆已经采用了节油技术，但是仍然需要减少油耗20–40%

- There is still optimization potential for PFI engines especially with hybridization 对点喷发动机还具有优化潜力，特别对于混合动力

- For small vehicle classes PFI engine technology with vehicle measures are sufficient to achieve 2020 target 对于小车细分市场，点喷发动机技术与车辆技术结合足够达到2020目标值

- In Compact Class DI, Diesel or PFI + Electrification is needed. Diesel and Hybrids enables even Large/SUV vehicles to reach 2020 targets 柴油和混合动力驱使大型车及SUV达到2020年目标

- Gasoline Direct Injection with best cost/benefit ratio to achieve 2020 targets in Compact Class but increase engineering effort 对于紧凑型，汽油直喷具有最佳的性价比以达到2020目标，但会增加工程投入

Gasoline Systems