



WELCOME

***FORD POWER DRIVE :
NICE TO GENEVA***

#fordpowerdrive

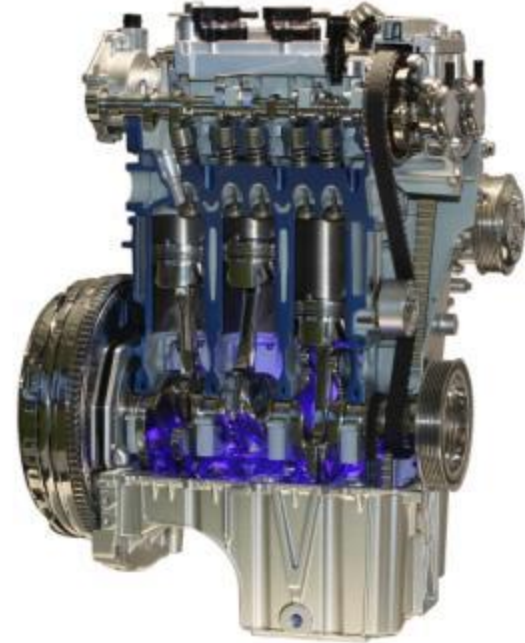


Why are we here?

The Ford Focus



The 1.0-litre EcoBoost Engine



An amazing new engine in a great, technologically advanced family car

Fuel efficiency without compromise on power

Driving is believing – and fun!



The Route



3. LAUSANNE

Hotel Alpha-Palmiers



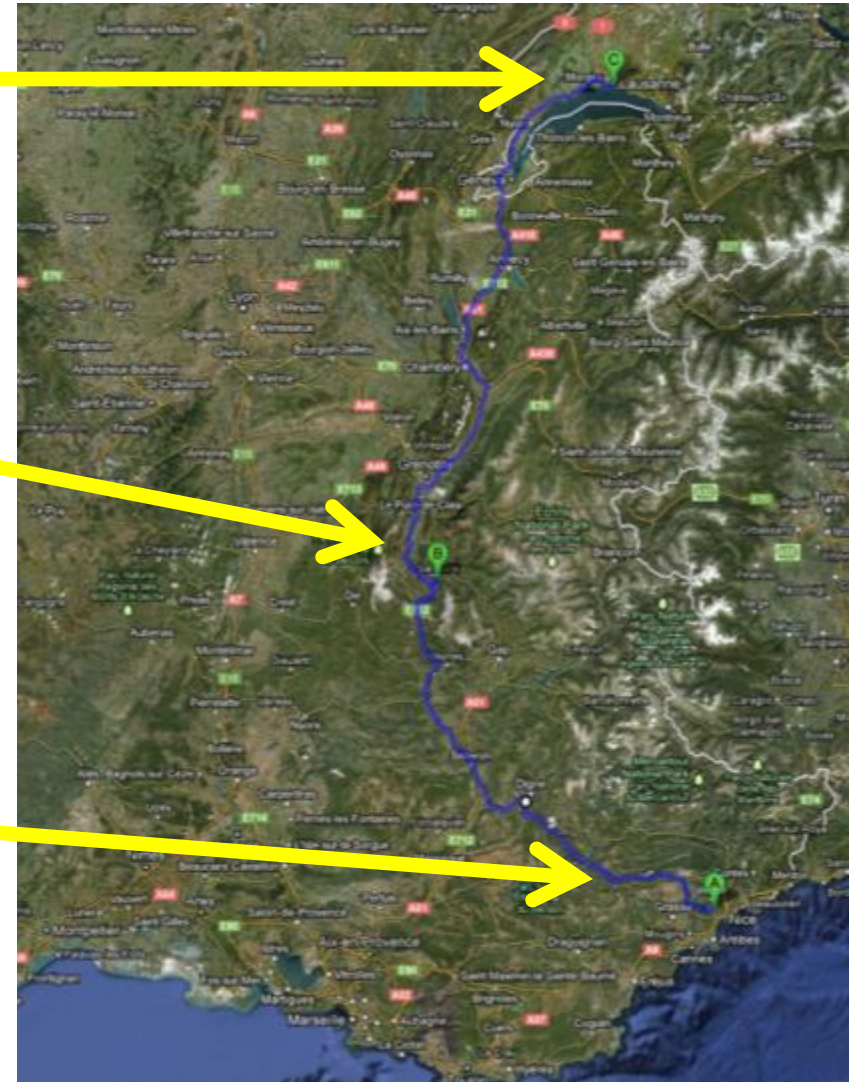
2. LUNCH

La Maison de Bonthoux



1. START

Hotel Le Mas de Pierre





New 1.0 litre Ecoboost Powertrain

Andrew D.J. Fraser
Manager, Gasoline PT Development

March 4th 2012

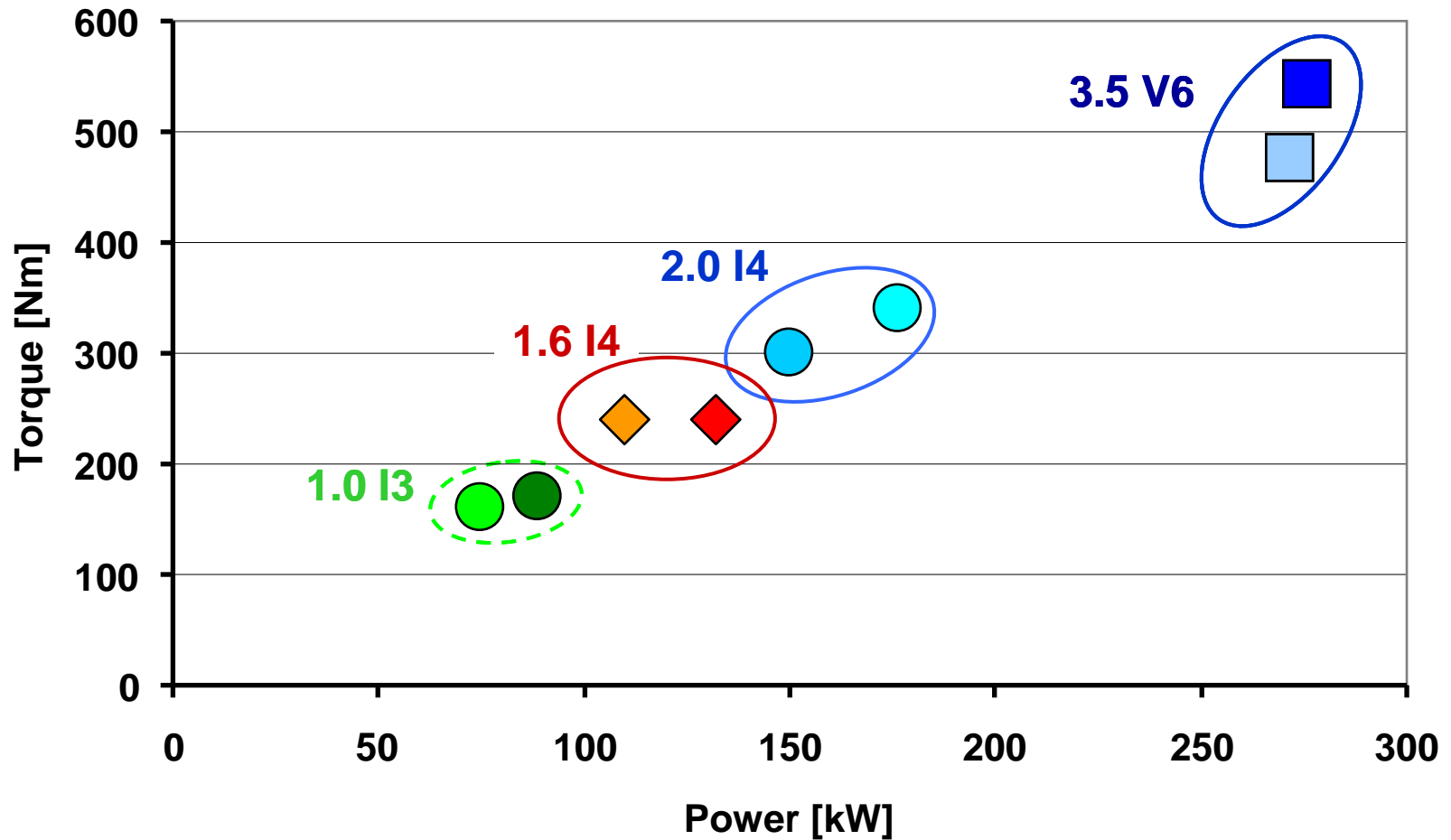


Introduction

- Ecoboost is a new generation of Ford petrol engines, which deliver outstanding fuel economy, together with great fun to drive and refinement in line with the Ford brand DNA.
- Ecoboost offers customers a genuine alternative between conventional naturally aspirated petrol engines, and very efficient, but increasingly complex and expensive Diesels.
- The new 1.0l engine is the fourth in the Ecoboost series, which started with the 3.5 V6, launched in North America in 2009, continued with the 2.0 and 1.6 in 2010, and extends further with the 1.0 launch in 2012.



Ecoboost Engine Families



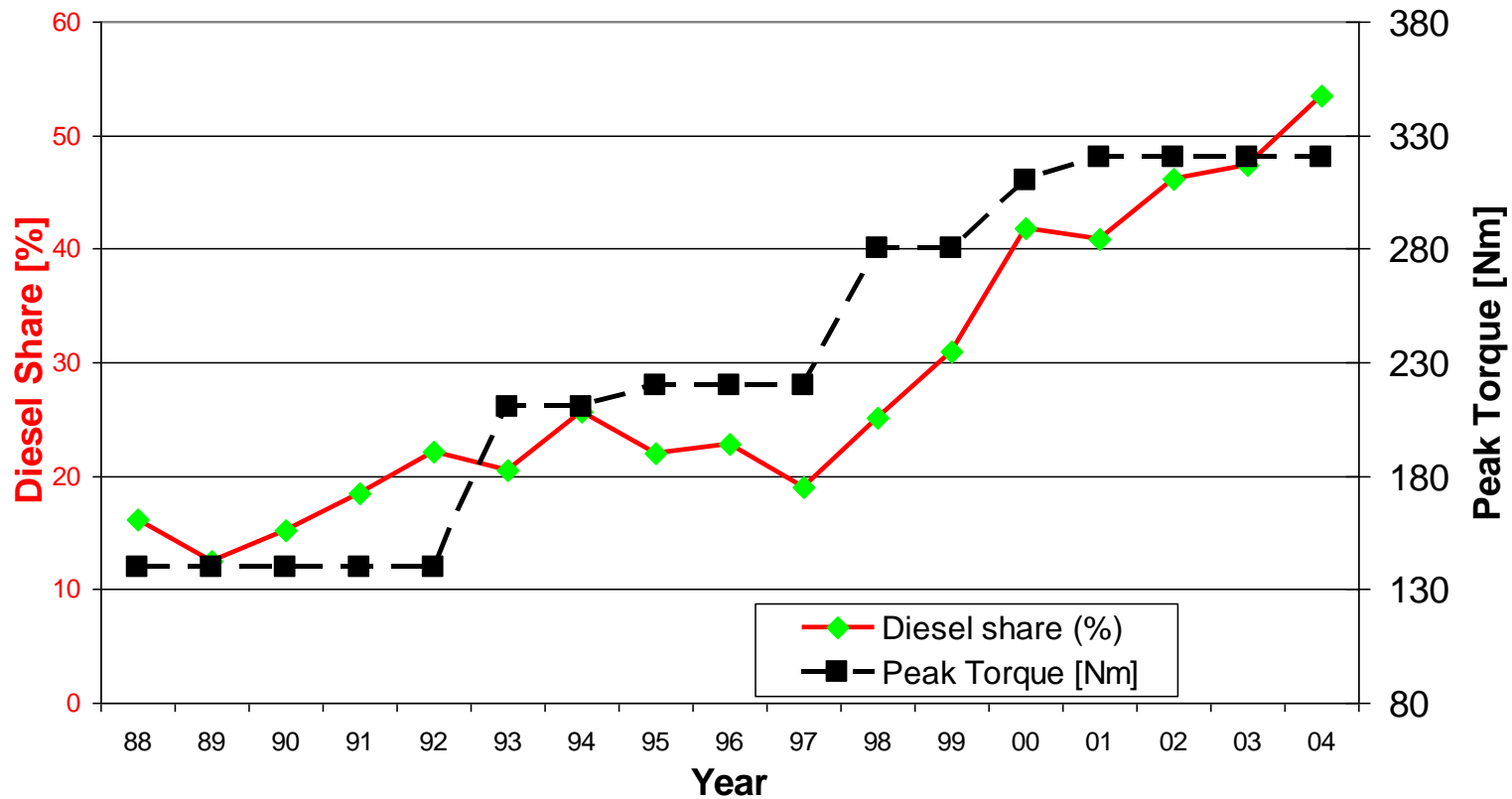
Ecoboost Family Philosophy

- All Ecoboost engines feature significant downsizing vs. naturally aspirated derivatives, as a means to enhance fuel economy. Downsizing offers numerous advantages:
 - Lower mass: better performance, reduced real world consumption, improved dynamics, smaller tyres, less energy consumed by PAS.
 - Less cylinders: lower cost, keeps technology accessible for consumer
 - Reduced friction: fewer cylinders, bearings, less lubrication
 - Significantly better warmup for both good fuel economy and rapid cabin heating.
- Key engineering challenge is to maintain, or enhance, performance and refinement, while delivering the fuel economy advantages of downsizing, as customers have shown that they are reluctant to compromise.



European Diesel share vs. performance.

- Diesel sales growth driven by performance gains, not FE advantage.

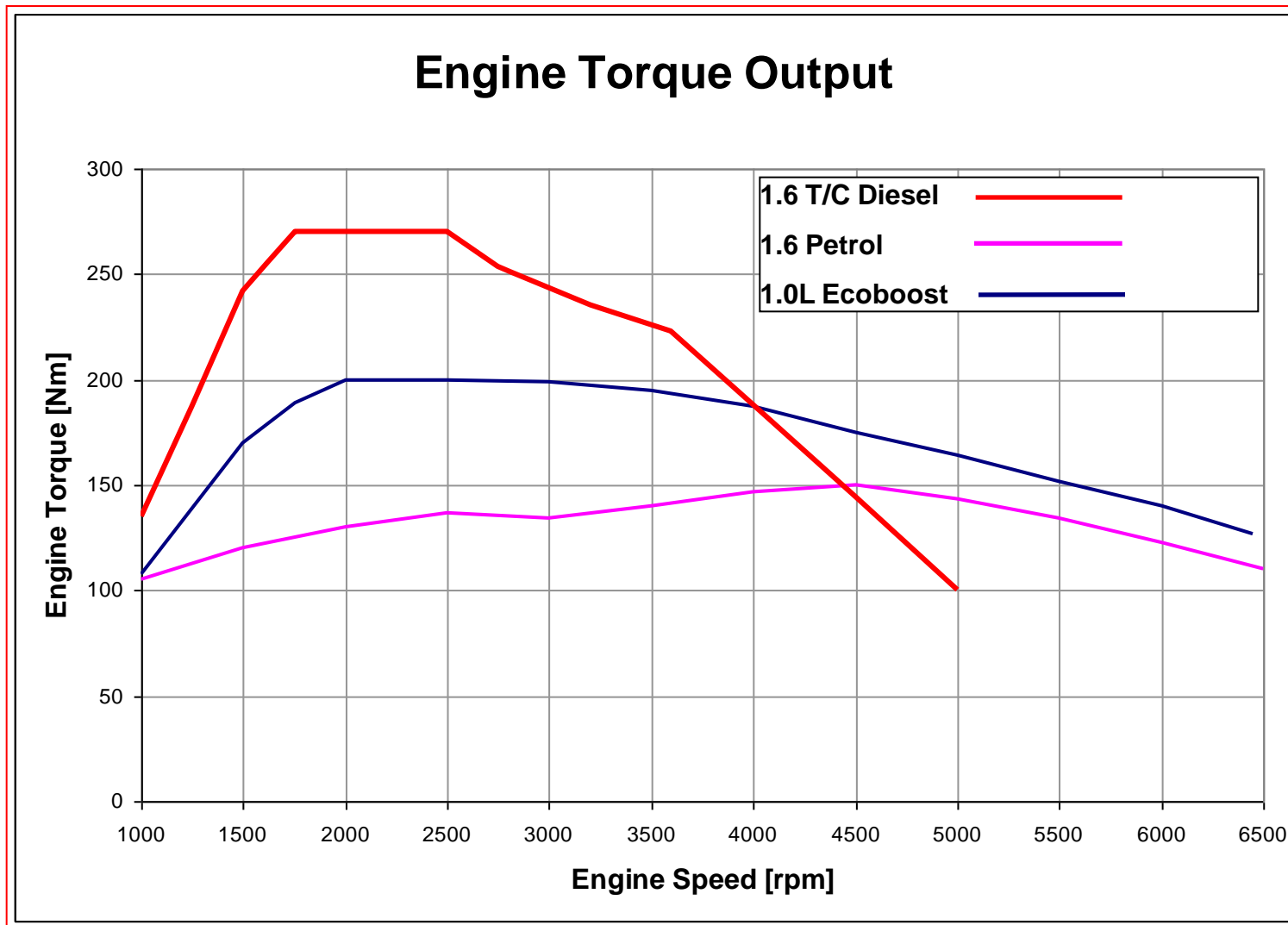


Customer Performance Expectations

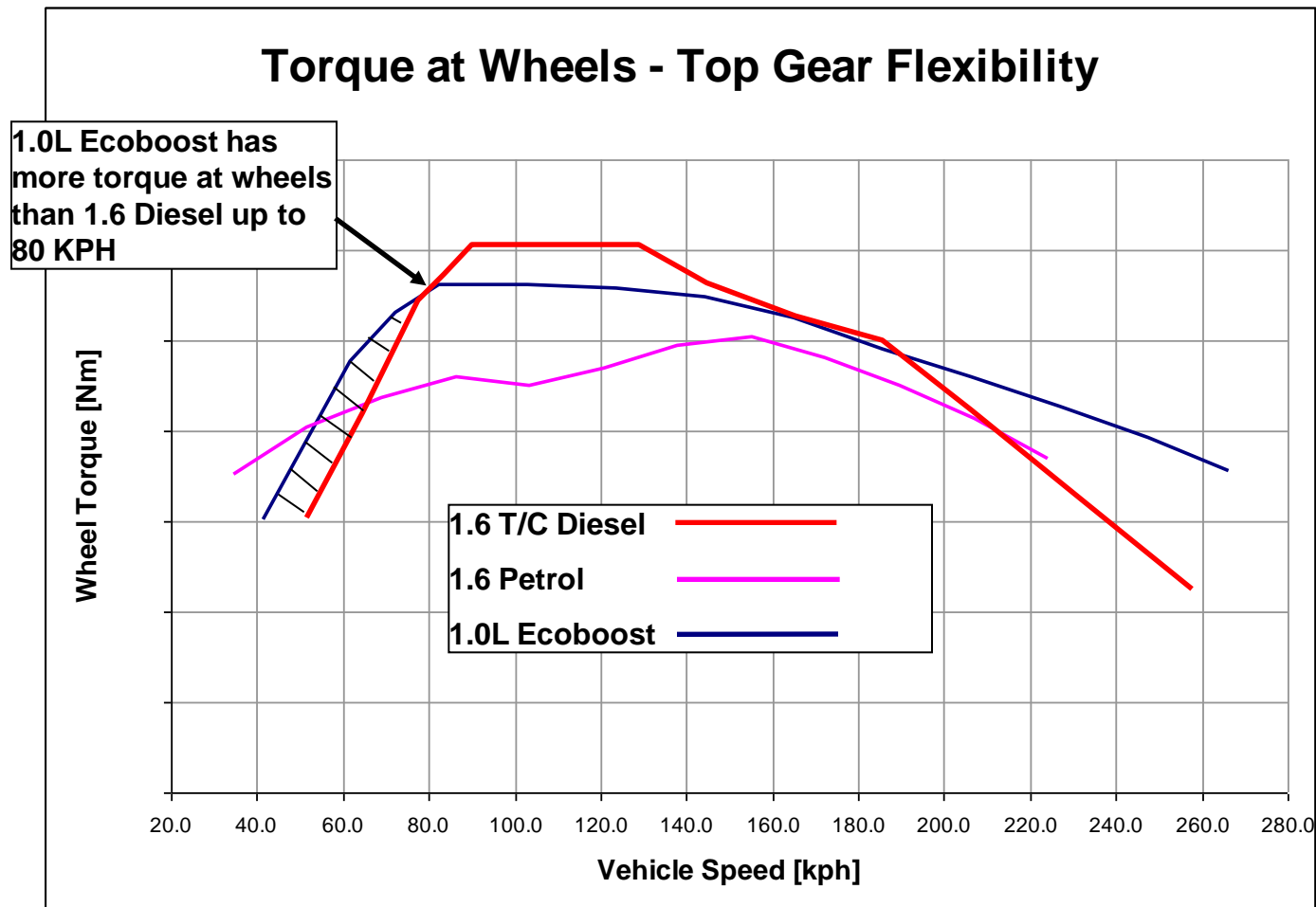
- Traditional petrol engine customers enjoy smooth, free-revving nature and peak power figure high in RPM range.
- Diesel customers like high peak torque from low RPM, and relaxed cruising.
- Ecoboost engines offer both of these attributes, and careful matching to the vehicle by means of gearing, means that Ecoboost engines appeal to wide variety of customers, driving style and environments.



Engine Torque Comparison



1.0L Ecoboost Performance 6th Gear

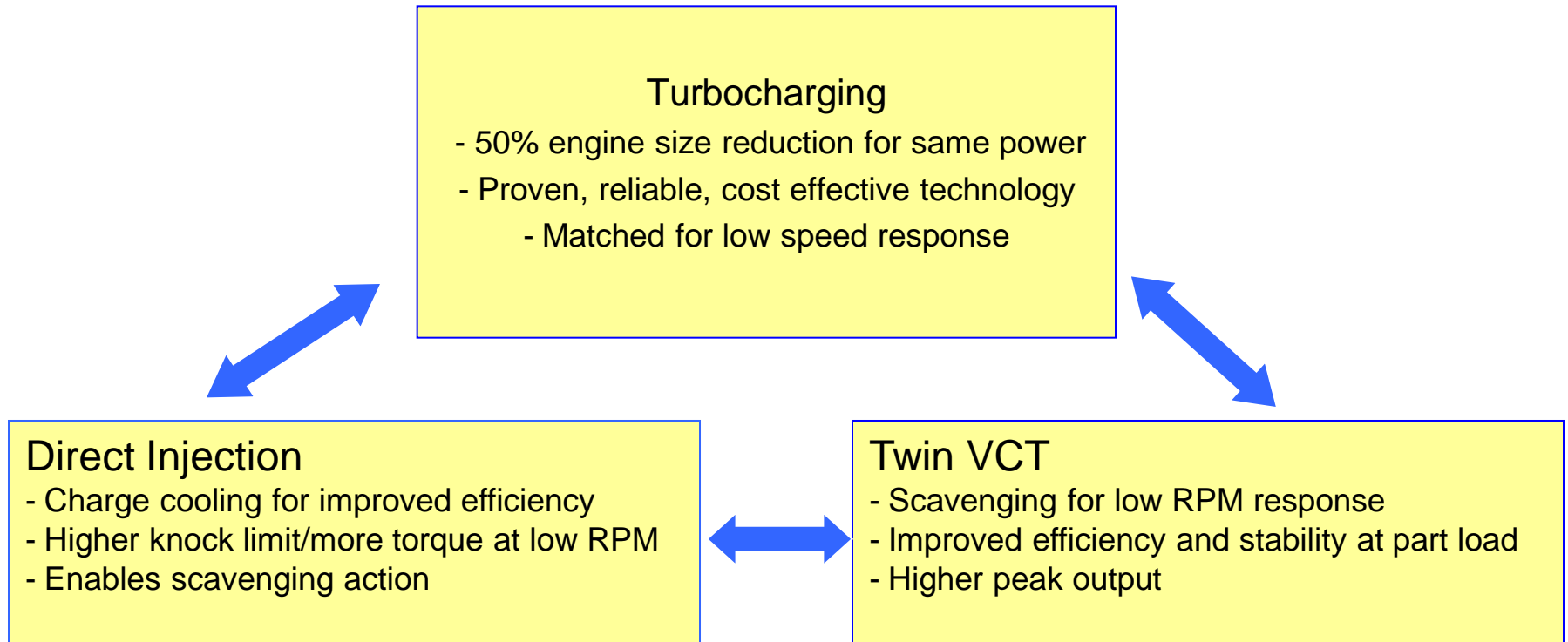


Ecoboost Technology

- Ecoboost engines feature three key enabling technologies:
- Turbocharging – allows much greater torque & power from smaller engine
- Direct injection – improves combustion efficiency
- Variable camshaft timing – increases bottom end torque, mid range efficiency and peak power capability.



Ecoboost: Three Key Elements Working as a System



Ecoboost Technology - Turbocharging

- Ecoboost focus is on responsiveness and low speed torque rather than very high peak power figures.
- Torque at 1500 RPM, and time for torque to increase to maximum output are key metrics.
- Achieved by utilising very small, low inertia turbochargers, capable of running at very high speeds, up to 248,000 RPM on 1.0L
- Low inertia turbos greatly reduce “lag” in response when throttle is opened from low RPM, a traditional problem with turbocharged engines



Ecoboost Technology – Direct Injection

- Fuel is injected directly into combustion chamber via high pressure solenoid injectors, with 6 holes giving precise fuel targeting and mixing.
- High injection pressures (up to 150 Bar) give excellent atomisation and mixing.
- Multiple injections per stroke are used at some operating points to optimise fuel economy, emissions and stability
- Evaporation of fuel in cylinder cools mixture before combustion, reducing tendency to “knock”.
- Allows higher Compression Ratio than normal for turbo engines, improving part-load fuel efficiency.
- Eliminates transfer of fuel mixture from inlet to exhaust during valve overlap, improving fuel consumption and reducing exhaust emissions.



Ecoboost Technology – Variable Cam Timing

- Variable cam timing on both intake and exhaust allows great flexibility to optimise engine efficiency under all conditions, e.g.
 - Moderate overlap at full load to improve breathing and output with reduced boost level
 - Low overlap at idle for stability
 - Late exhaust valve opening at part load for fuel efficiency
- Greatest benefit is for low speed torque and responsiveness, where valve overlap can be increased to allow *scavenging* effect.

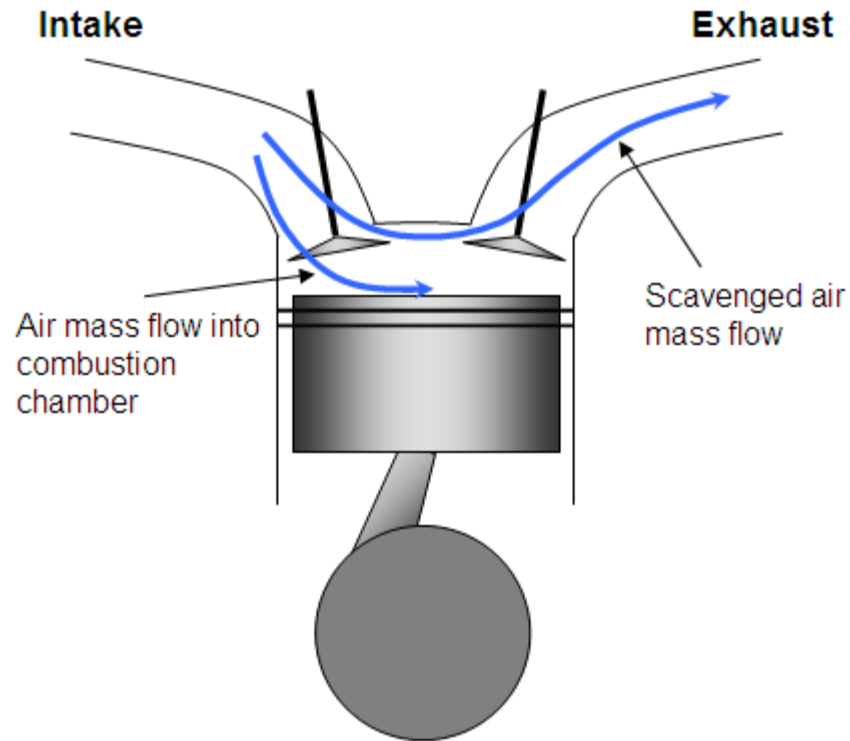


Scavenging Effect

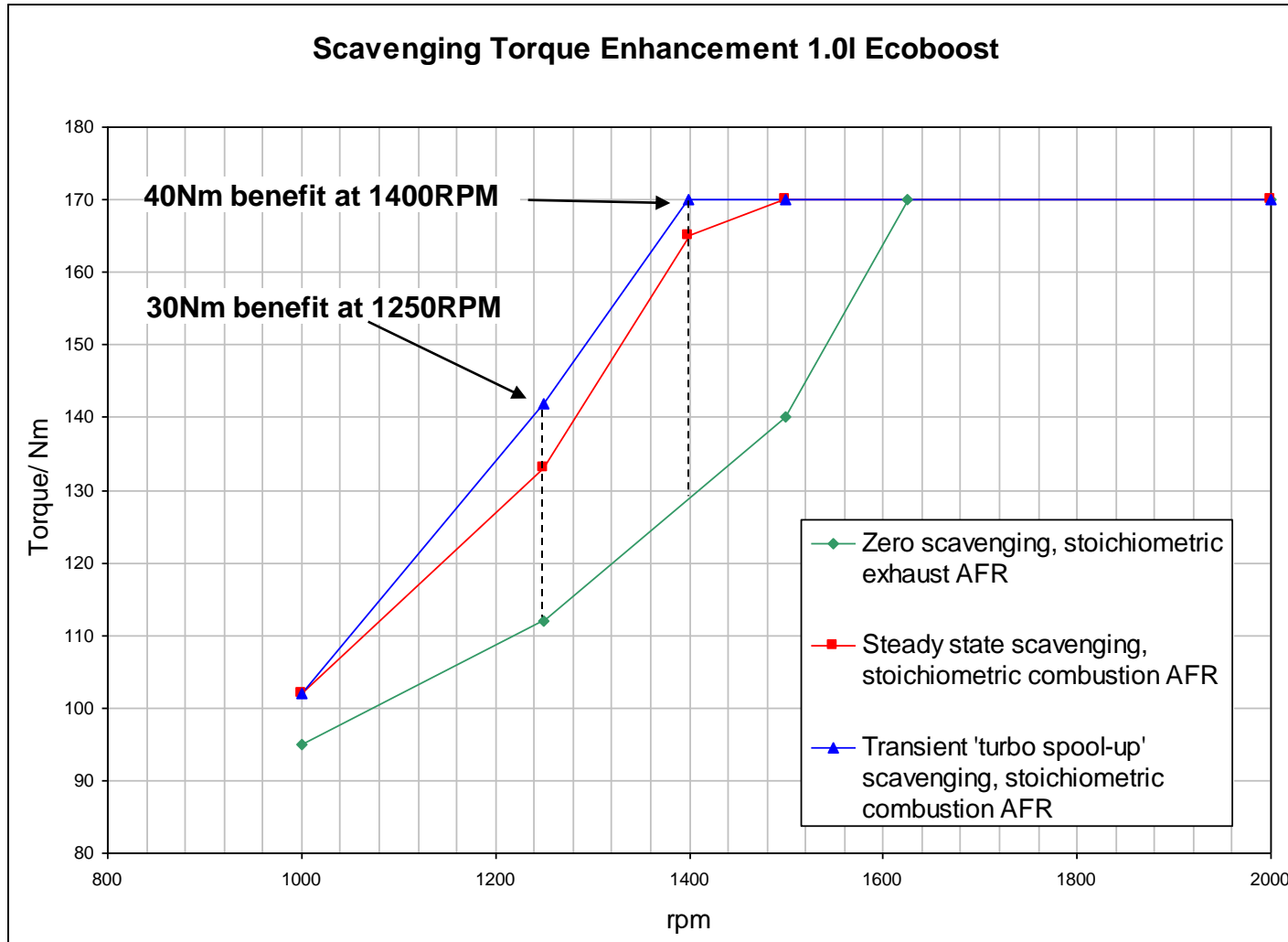
At low speed & high load, during the valve overlap period, it is possible for the intake manifold pressure to exceed the instantaneous exhaust back pressure due to turbo-charging.

- Under these circumstances, “scavenged” air will flow directly from the intake into the exhaust.
- Scavenging flushes residual gases from cylinder, increasing mass of following charge, and cooling gas to reduce tendency to knock. It also increases turbo mass flow, helping spool-up turbo.

Intake Manifold Pressure > Exhaust Back Pressure (due to boost)



Ecoboost – Low RPM Torque Benefit



1.0L 3-Cyl Ecoboost Technology Highlights

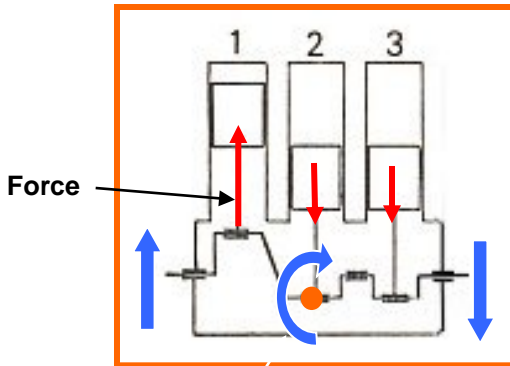
- Extremely compact block design, enabled by use of cast iron ilo aluminium, small bore, long stroke geometry (71.9mm x 82.0mm), and 6mm siamesed bore design. Total block length 286.2mm.
- Aluminium cylinder head with integrated exhaust manifold (IEM). 4V layout with central injector & compact spark plug. 10.0:1 CR
- Rapid warmup due to small iron block, IEM, and split cooling system with horizontally split head and controlled block/head circuits.
- ECU controlled variable displacement oil pump and low loss lubrication system
- New Continental turbocharger with vacuum actuated wastegate, allowing opening when off boost to reduce backpressure.
- Ultra-low friction design, with offset crank, coated pistons & tappets, low tension rings, low friction crank seals.
- Cam drive via unique belt-in-oil design, giving full life belt, with advantages of quietness & lightness vs. chain.



1.0L Ecoboost Balancing Strategy

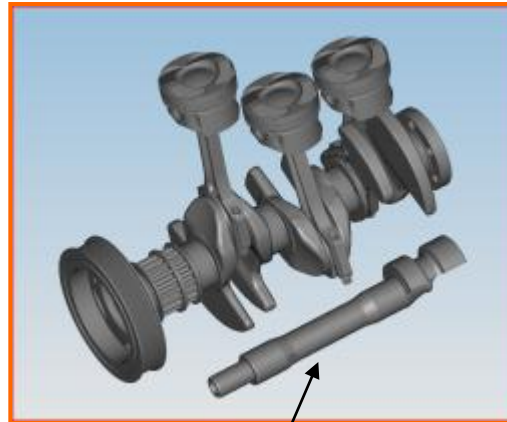
In-line 3 cylinder engines naturally develop a 1st order (engine speed) couple resulting in a combined pitch and yaw motion

Vehicles are often sensitive to this 1st order forcing and this is manifested as a booming noise and vibration in the vehicle

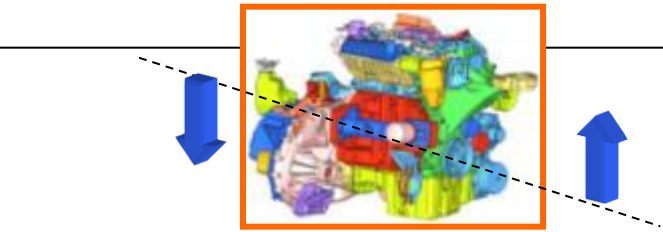


Resultant engine motion about centre of gravity

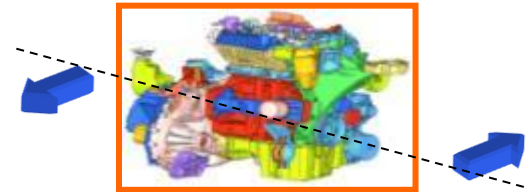
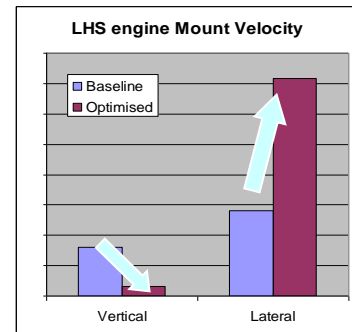
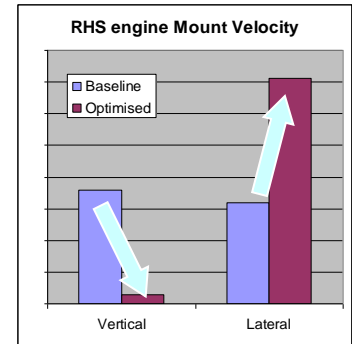
Balance shafts are conventional technology to counteract out-of-balance forces in a I3 engine. However, they increase engine weight and degrade friction thus fuel economy and CO2 performance



1st order balance shaft

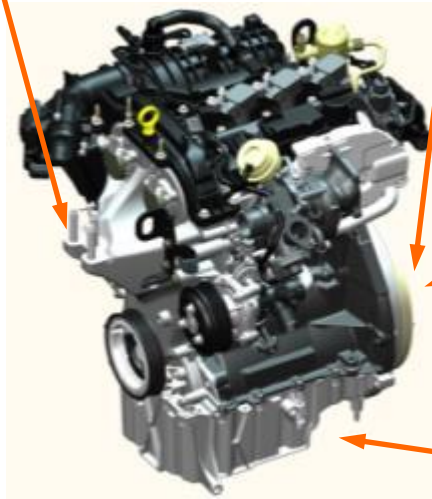


Instead of employing energy-draining balance shafts, Ford strategy on the 1.0 engine is to intentionally “unbalance” the flywheel and crank pulley in conjunction with P/T mount optimisation to offset the primary engine shaking forces into a less sensitive direction.

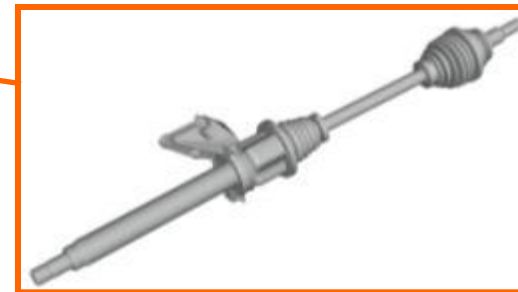


1.0L Ecoboost Noise and Vibration Refinement

Engine mount system refined to decouple shaking forces and provide best balance between idle and pullaway vibration performance



DMF (125PS) and clutch damper tuning, flywheel inertia optimisation (100PS) to minimise torsional excitation – better vibration characteristics and rattle avoidance



Modified driveline to achieve optimum balance between vibration transfer path and ride/handling attribute

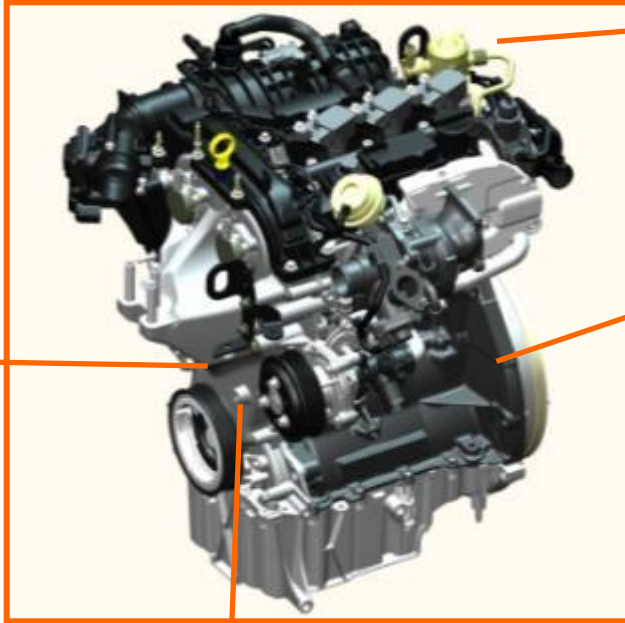


1.0L EcoBoost Noise & Vibration Refinement



Belt-in-oil primary drive system provides low noise content and controls any whine character

Engine acoustic foam cover to reduce top end noise



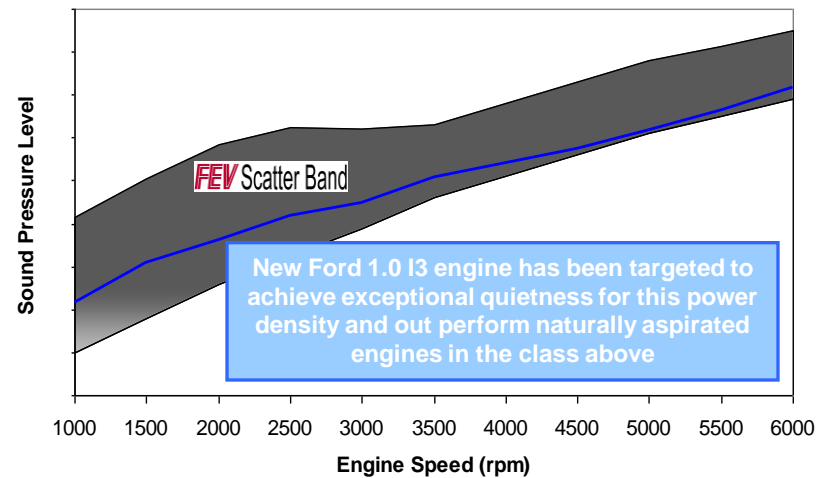
Integrated engine mount bracket and front cover for best stiffness and weight

Fuel injector isolators and fuel pump soft-landing strategy to control high frequency noise content

Engine structure optimised for best radiated noise, stiffness and weight



Ford 1.0L 120PS EcoBoost Full Load Radiated Noise Performance



1.0L Ecoboost

- Outstanding performance, flexibility & responsiveness for 1.0 l engine
- Benchmark fuel economy
- Class leading refinement



What You Need

- **TO BE SAFE**

- This is not a race, but hopefully an experience we will all enjoy...and all arrive in one piece

- **TO NOT SPEED**

- Any speeding tickets will need to be paid for by the driver of the vehicle

- **TO ASK QUESTIONS**

- We have badges for the toll roads and maps etc but if we forget anything feel free to ask

- **TO ENJOY YOURSELF**

Good scenery, good food, good driving and good company

If you need it the hashtag for the drive is #fordpowerdrive



In Geneva



- **Ford B-MAX**– Ford’s ingenious new car with best in class technologies, powertrains and all new ‘easy-access’ door system



- **Ford Kuga** –Rugged SUV provides more load space and new technologies including hands-free tailgate lift



- **Fiesta ST** – Global production reveal of Ford’s small car performance vehicle
- **PLUS:** Focus BEV, and the Transit Tourneo

