| PRESS INFORMATION

ECOBOOST: THE TECHNOLOGY, DURABILITY AND AVAILABILITY

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FORD'S NEW ECOBOOST TECHNOLOGY AT A GLANCE

DETROIT, January 2009 – The first in a wave of new Ford EcoBoost™ engines makes its debut in the Lincoln MKS, MKT and Ford Flex later this year as part of Ford Motor Company's global initiative to provide powertrains that deliver the fuel efficiency and power customers demand.

The twin-turbocharged 3.5-liter V-6 EcoBoost engine delivers the performance found in a normally aspirated V-8 while maintaining the fuel economy found in a normally aspirated V-6 engine.

A look at the highlights of the EcoBoost story:

- **Power and fuel economy:** The twin-turbocharged 3.5-liter Duratec V-6 EcoBoost engine produces 355 horsepower at 5,700 rpm and 350 ft.-lb. of torque at 3,500 rpm. A 10-15 percent fuel-economy benefit is expected versus normally aspirated 4.6-liter V-8 engines in the same competitive class.

  "The beauty of EcoBoost is that it enables us to downsize for fuel efficiency, yet boost for power," said Derrick Kuzak, Ford's group vice president of Global Product Development. "We're able to decrease the size of the available engine – such as installing a V-6 versus a V-8 – yet boost the power using turbocharging to deliver similar power and torque of that larger engine."

- **Engine:** Base engine architecture comes from the proven Duratec 3.5-liter V-6. To handle the increased torque that EcoBoost delivers, some upgrades were made to some of the components, such as the cylinder block, crankshaft, connecting rods pistons and exhaust valves to ensure the EcoBoost V-6 engine is as robust as possible.

  "The Duratec 3.5 family is a good example of Ford's forward planning in terms of powertrain technologies," said Brett Hinds, EcoBoost design manager. "The engine architecture itself was well protected for high-boost applications, so it didn't require an

extensive durability program. It was in good shape to start with."

- **Turbochargers:** Two Honeywell GT15 turbochargers with water-cooled bearings and operate in parallel, spinning at approximately 170,000 rpm up to 12 PSI. They are rated for a 150,000-mile, 10-year life.

  "We've tested the turbochargers at a much-higher duty cycle than a customer would ever experience," said Keith Plagens, turbo systems engineer. "Our whole goal from the beginning was to make the operation of the turbochargers seamless, so the customer wouldn't even know they were there."

- **Direct fuel injection:** A cam-driven high-pressure fuel pump feeds the fuel injectors at pressures ranging from 200 to 2,175 PSI (pounds per square inch) depending on customer driving. A typical port fuel injection system operates at pressures of around 60 PSI. Six sprayers in each injector target fuel into the cylinder, resulting in a cleaner and more-efficient fuel burn and better cold-start emissions.

"By injecting the fuel directly into the combustion chamber and under high pressure, the fuel is sent exactly where we want it to be for a given combustion cycle," said Joseph Basmaji, direct injection fuel system technical specialist. "This aids burning of fuel more efficiently and effectively."

# # #

ECOBOOST TECHNOLOGY: DIRECT INJECTION IS COOL

- Direct fuel injection is one of the key enabling technologies of Ford's EcoBoost strategy to deliver advancements in fuel economy of up to 20 percent without sacrificing the performance customers want. Paired with turbocharging, direct injection gives the new 3.5-liter EcoBoost engine in the Lincoln MKS the power and torque of a 4.6-liter V-8 with the fuel economy of a V-6

- Direct injection uses high-pressure fuel injectors to spray a fine mist of fuel directly into each cylinder. This precisely controlled fuel delivery improves the engine's transient response, contributes to improved fuel economy and enables improved emissions, particularly at cold start. The EcoBoost engine reduces CO2 emissions by 15 percent

- Like the spray from an atomizer bottle one might use to keep cool in the summer, the fine mist generated by each solenoid-controlled injector's six tiny outlet holes helps to create a well-mixed air-fuel mixture. It also cools the incoming air, helping to reduce the potential for engine knock

DETROIT, January 2009 – Direct injection is one of the cool technologies that makes Ford's new EcoBoost engine possible.

The all-new engine delivers better fuel economy and reduced emissions as well as improved performance and engine refinement gives it a cool all its own. With an estimated, class-leading 355 horsepower, the 2010 Lincoln MKS with EcoBoost is expected to deliver best-in-class highway fuel economy of 25 mpg.

With its premium EcoBoost engine, the new Lincoln will deliver more power and better highway efficiency than the 2009 Lexus GS460 (24 mpg) or 2009 Infiniti M45 (21 mpg).

“Direct injection is a significant player in Ford’s strategy to replace larger engines with smaller EcoBoost engines, improving fuel economy by up to 20 percent without sacrificing performance,” says Brett Hinds, EcoBoost design manager. “We’re going to be deploying direct injection to bring a wave of EcoBoost engines into Ford Motor Company products. It starts with the Lincoln MKS and by 2013 more than 90 percent of our North American lineup will offer EcoBoost technology.”

Direct injection even uses its cool to chill engine intake air, which improves fuel economy and reduces the potential for engine knock.

“Cool air is good for an engine because it minimizes the engine knocking phenomenon,” explains Corey Weaver, EcoBoost project leader. “Anything you can use to cool the air is good. Injecting the fuel into the cylinder, you cool it on the spot, where you’re going to burn it. Fuel vaporization during the intake stroke cools the air, improving the volumetric efficiency, the breathing of the engine and the knocking tendency.”

EcoBoost Direct Injection

The EcoBoost direct injection system precisely delivers a fine mist of fuel directly into each cylinder for optimal performance, economy and emissions. Unlike port-fuel-injection (PFI) engines that spray fuel in the intake system, the direct injection system puts the fuel exactly where it needs to be for combustion.

A high-pressure injector is positioned to the side of each cylinder, aiming the fuel directly into the cylinder adjacent to a high-intensity spark plug and alongside the intake and exhaust valves. Fuel is sprayed into the cylinders at pressures of up to 2,150 pounds per square inch (PSI), which is about 35 times more intense than PFI injection.

Fuel from the vehicle tank is pumped at normal pressure to the engine compartment, where a special, cam-driven, high-pressure fuel pump increases the fuel pressure. Depending on the demands of the driver, the system operates between 200 and 2,150 PSI.

“Think of the direct injection system like the mist from an atomizer bottle that you spray to keep yourself cool,” explains Craig Stephens, EcoBoost powertrain control system manager. “Our system creates a fine spray that atomizes the fuel, making it easy to ignite and burn completely.”

Each bank of cylinders in the V-6 EcoBoost engine has a high-pressure fuel rail that feeds the individual injectors and a fuel rail pressure sensor on each rail that helps the vehicle powertrain control module precisely control the fuel pressure.

The Bosch high-pressure fuel injectors use internal solenoids to switch on and off the flow of fuel extremely precisely. Fuel flows through six tiny outlets – like pinholes – in each injector, and each spray is positioned to provide benefits in fuel economy and emissions.

Electronic control system varies the timing and intensity of the fuel delivery according to engine operating conditions.

“This new EcoBoost direct injection system gives us great flexibility, particularly for cold-start performance and emissions,” said Todd Rumpsa, EcoBoost calibration supervisor. “We can achieve multiple injections per combustion event, tuning where those injections should best take place to deliver the strongest start possible with the lowest emissions.”

# # #

PUMP IT UP: ECOBOOST TWIN TURBOS PACK POWER TO GIVE V-6 ENGINES V-8 PERFORMANCE FEEL

- Twin turbochargers harness exhaust gas to pump V-8 power out of the smaller-displacement EcoBoost™ V-6 engine. This technology – in conjunction with direct fuel injection – allows EcoBoost to punch above its size in terms of power and responsiveness

- EcoBoost engine has been engineered with such refinement that the driver never notices the turbocharger operation. Sophisticated electronic controls balance boost and torque levels to give the driver the feeling of continuous torque delivery, without turbo "whines" and "whooshes" that characterized some previous-generation turbo engines

- The EcoBoost turbo system runs at very high temperature, up to 950 degrees Celsius (1,740 degrees Fahrenheit). An air-to-air intercooler is used to cool the compressed intake air before it enters the combustion chamber, and water cooling protects the internal turbo bearings in the high-temperature operating environment

DETROIT, January 2009 – The "boost" of Ford's new EcoBoost engine technology comes from two small devices the size of an orange but with appeal that's far larger for fans of fuel-efficient performance.

They are turbochargers, which harness exhaust gas to pump more power out of a smaller-displacement engine. The new 3.5-liter EcoBoost V-6 engine uses twin turbochargers – in conjunction with direct fuel injection – to punch above its size in terms of power and responsiveness. It produces the horsepower and torque of a 4.6-liter, normally aspirated V-8 while delivering the fuel efficiency of a normally aspirated V-6 engine.

As an example, the 2010 EcoBoost Flex boasts segment-leading fuel economy among full-size performance crossovers with 22 mpg highway and 18 mpg combined, demonstrating Ford's commitment to deliver top fuel economy in each new vehicle.

Twin Honeywell GT15 turbos are fitted to each EcoBoost V-6, one for each bank of the vee. Exhaust gas flowing through the turbocharger spins a turbine wheel at very high speed – approximately 170,000 rpm – which drives a compressor turbine on the clean air side of the turbo. This fan effect densely packs intake air into the engine – compressed air up to 12 PSI that results in increased performance.

With its twin turbos, the EcoBoost V-6 swallows about 25 percent more air than its normally aspirated cousin, the 3.5-liter Duratec V-6.

"A turbo is basically a large air pump," explains Craig Stephens, EcoBoost powertrain control system manager. "Increasing the mass of air in the engine increases its power output, and that's why it's called 'boost.' "

Two small is better than one large

The new EcoBoost engine strategically uses two small turbochargers rather than one larger one. This is to fight turbo lag, the tendency for previous generation turbocharged engines to have hesitation at low engine revs while the turbocharger spooled up to its operating speed.

The EcoBoost V-6 is the first application of twin turbos in a Ford.

EcoBoost's smaller turbines are quick to respond to throttle inputs, spooling up instantly. Mated with direct fuel injection, turbo lag in the EcoBoost V-6 is imperceptible and torque output is impressive, peaking earlier in the rev range than a comparable, normally aspirated V-8.

"EcoBoost gives the driver a very linear torque response," explained Corey Weaver, EcoBoost project leader. "You get peak torque across a very wide engine speed range – usable performance that's available to you when you pull away from a stoplight or pass someone on a secondary road," he added. "You don't need to wind the engine out to get performance out of it. It's there all the time."

Yet, the EcoBoost engine has been engineered with such refinement that the driver never notices the turbocharger operation.

Sophisticated electronic controls, including active turbocharger wastegate control, work in conjunction with throttle control to balance boost and torque levels very precisely. The system controls wastegate pressure release and throttle position finely to give the driver the feeling of continuous torque delivery, without turbo "whines" and "whooshes" that characterized some previous-generation turbo engines.

The small size of the EcoBoost twin turbos allows them to be mated to compact, stainless steel exhaust manifolds, which reduce heat loss and facilitate close-coupled catalysts for emissions quality.

The turbo system runs at very high temperature, up to 950 degrees Celsius (1,740 degrees Fahrenheit). An air-to-air intercooler is used to cool the compressed intake air before it enters the combustion chamber. This allows it to be even more densely packed for optimal performance.

Engineered for reliable performance

The EcoBoost turbocharger system is engineered for long-term reliability, incorporating water cooling to protect the internal turbo bearings in the high-temperature operating environment. The water cooling system prevents the phenomenon known as oil coking, in which oil in previous-generation turbo bearings would bake and solidify, causing premature bearing failures.

The EcoBoost engine's turbo water cooling even works after the engine is switched off. The water cooling system is engineered to allow a process called reverse siphoning to take place. When the engine is switched off, the water pump ceases operation. The coolant in the extremely hot turbo boils and fresh coolant floods in behind it. This process continues until temperatures reduce, providing sustained, key-off protection for the turbo bearings.

Ford engineers have tested EcoBoost robustly in both engine dynamometer test labs and in real world environments ranging from high-temperature conditions to cold conditions down to minus 40 degrees Fahrenheit. Drivability, cold starts, high-altitude running and trailer towing were validated, and the Ford EcoBoost V-6 performed effortlessly in the place a V-8 engine would once have been.

"The EcoBoost engine has been designed and tested for use without any special operating precautions," said Michael Shelby, EcoBoost engine development leader. "You don't need to sit and idle before switching the engine off. You don't need to observe special oil-change intervals, and you don't need special oil."

The new 3.5-liter EcoBoost V-6 is offered initially as a premium engine for the 2010 Lincoln MKS and the 2010 Ford Flex, but the turbocharged Ford EcoBoost strategy is spooling up for more fuel-efficient, performance-rich engine products. By 2013, more than 90 percent of Ford's North American vehicle lineup will offer EcoBoost technology.

# # #

ACHIEVING V-8 POWER WITH V-6 FUEL EFFICIENCY MEANS MORE PRESSURE UNDER AN ECOBOOST VEHICLE'S HOOD

- There's more pressure under the hood of an EcoBoost™ engine-equipped vehicle, thanks to its unique technology that combines turbocharging and direct fuel injection. Compared with a typical engine system, the operating pressures of EcoBoost's fuel and air induction systems are significantly higher

- The new 3.5-liter EcoBoost V-6 operates at fuel pressures about 35 times higher than the typical port-fuel injected (PFI) gasoline engine. Precisely controlled, EcoBoost fuel pressure ranges from 200 to 2,150 pounds per square inch (PSI), compared with about 60 for the typical PFI engine

- Turbocharging boosts the pressure of intake air feeding the EcoBoost engine to deliver V-8 style performance from a V-6. EcoBoost operates with a boost level of 8-12 PSI

DETROIT, January 2009 – It's a high-pressure role to achieve the power of a V-8 with the fuel economy of a V-6, but the new Ford EcoBoost engine debuting in the Lincoln MKS, MKT and Ford Flex knows how to handle pressure.

That's because there's more fuel and air pressure under the hood of an EcoBoost engine-equipped vehicle. Different technology is the reason.

Turbocharging and direct fuel injection – the dynamic duo in Ford's strategy to deliver affordable fuel efficiency improvements for millions – put different demands on the underhood environment than the typical car. Operating pressures of EcoBoost's fuel and air induction systems are significantly higher.

The new EcoBoost engine has been engineered to harness those pressures. The benefits in terms of performance and fuel efficiency are considerable.

"Combining direct injection and turbocharging to create EcoBoost brings specific advantages," said Michael Shelby, EcoBoost engine development leader. "With EcoBoost, we use smaller-displacement engines in place of larger engines. Turbocharging delivers the performance and direct injection enables fuel efficiency while mitigating turbo lag and minimizing emissions."

The EcoBoost system is part of Ford Motor Company's commitment to deliver the best fuel economy in each new vehicle, with at least three more additions for the 2010 model year. The 2010 EcoBoost Flex, for example, boasts segment-leading fuel economy among full-size performance crossover vehicles, with 22 mpg highway and 18 mpg combined. The 2010 EcoBoost MKT also leads its segment in fuel economy, exceeding the V-8-powered Audi Q7 by 4 mpg highway. With its premium EcoBoost engine, the new Lincoln MKS will deliver more power and better highway efficiency (25 mpg) than the 2009 Lexus GS460 (24 mpg) or 2009 Infiniti M45 (21 mpg).

What's so different about an EcoBoost engine?

Fuel Pressure – A typical PFI gasoline engine delivers fuel into the intake manifold – and indirectly into each cylinder – at a pressure of about 60 PSI. EcoBoost delivers fuel directly into each cylinder at a much higher pressure, up to 2,150 PSI – that's 35 times the pressure.

Fuel to an EcoBoost engine starts its journey from the fuel tank at a similar pressure to that of a typical PFI engine. But that's where the similarity ends.
A high-pressure, cam-driven pump on the engine is used to pressurize the fuel in a rail structure on each side of the EcoBoost V-6. The pressurized fuel in each rail supplies fuel to the injectors themselves.

The solenoid-controlled injectors create a fine, high-pressure spray pattern through six holes directly into the cylinder. The pressure and duration of each injection is precisely controlled by the vehicle's powertrain control module.

This fine, high-pressure mist is designed for optimal combustion efficiency, especially in the dense, turbocharged air.

Even at idle, the fuel pressure at the injectors is more than three times that of a PFI engine. The operating pressure range is between 200 and 2,175 PSI.

"The EcoBoost engine is constantly controlling the rail pressure to a target level based on what the customer is demanding from the engine," explained Todd Rumpsa, EcoBoost calibration supervisor. "As the driver increases demands on the engine, higher rail pressures maintain optimized combustion performance by delivering the best atomization of fuel and the precise injection duration."

Air Pressure – A typical, normally aspirated PFI engine draws unpressurized air into the intake manifold. The EcoBoost V-6 uses twin turbochargers to boost the pressure of the intake air and the increased mass of air entering the engine increases power output. EcoBoost pressurizes the intake air 8-12 PSI.

The turbocharger uses exhaust gas to spin compressor blades at high speed – approximately 170,000 rpm. An intercooler helps to cool the intake air, making the charge air more dense and increasing the performance potential.

"Turbocharging is very efficient because it uses the energy of the engine's exhaust gas, which would otherwise be wasted, to boost the pressure of the intake air," explained Shelby.

Oil Pressure – Although the EcoBoost engine does not differ significantly from a PFI engine in terms of engine oil pressure, the Ford EcoBoost V-6 still makes clever use of its oil pressure to deliver its enhanced performance and fuel efficiency.

That's because the EcoBoost engine delivers a short spray of oil to the underside of each piston on each stroke. "Squirt jets" deliver a 25-PSI dose of oil to the piston. This achieves a cooling effect that aids combustion efficiency.

The squirts have an important side benefit, too. On cold startup, the squirts help to warm the oil to optimal operating temperature more quickly, which improves the fuel economy.

"EcoBoost engine technology is about managing the pressures to extract the maximum in terms of performance and fuel economy," Rumpsa says. "We know we've done our job when customers don't even notice what's happening in the engine compartment. They just need to concentrate on enjoying the responsive V-8 power and torque and the excellent V-6 fuel economy."

# # #

RED-HOT TORTURE: NEW ECOBOOST ENGINE'S TURBOCHARGERS GLOW IN DURABILITY TESTING

- The reliability of the new Ford EcoBoost™ V-6 engine is a hot topic at Ford. That's because EcoBoost's twin turbos glowed orange-hot while enduring – and passing – extremely rigorous durability testing in Ford engine dynamometer lab. Ford engineers ran EcoBoost at maximum boost continuously for hundreds of hours under far more severe conditions than customers are expected to dish out

- Designed for long-life reliability, EcoBoost's turbochargers feature water-cooled bearing jackets. This architecture is designed to prevent oil "coking" that could occur in previous-generation turbochargers. The new design means that EcoBoost drivers don't need to observe special operating precautions, such as idling the engine before switching it off

- The new 3.5-liter EcoBoost engine features normal gasoline engine service intervals of 7,500 miles and uses the same 5W20 engine lubricating oil as Ford specifies for other gasoline engines

DETROIT, January 2009 – It's difficult to get the twin turbochargers in the new Ford EcoBoost V-6 engine too hot under the collar. Not that Ford engineers didn't try.

Working to ensure the long-life reliability of the dual-turbo, direct-injected engine, Ford put the new engine through a barrage of torture testing.

One of the key areas of testing focused on the two turbos – key weapons in the EcoBoost strategy to deliver the performance of a V-8 with the fuel economy of a V-6. Would their reliability match the rest of the robust engine architecture, based on Ford's proven 3.5-liter V-6 engine?

"The answer is yes," says Michael Shelby, EcoBoost engine development leader. "We put the EcoBoost V-6 through the same extensive durability signoff testing as any Ford gasoline engines, and we went beyond it to validate the EcoBoost water-cooled turbocharger design and air-to-air intercooling strategy."

The EcoBoost system is part of Ford Motor Company's commitment to deliver the best fuel economy in each new vehicle, with at least three more additions for the 2010 model year. The 2010 EcoBoost Flex, for example, boasts segment-leading fuel economy among full-size performance crossover vehicles, with 22 mpg highway and 18 mpg combined. The 2010 EcoBoost MKT also leads its segment in fuel economy, exceeding the V-8-powered Audi Q7 by 4 mpg highway. With its premium EcoBoost engine, the new Lincoln MKS will deliver more power and better highway efficiency (25 mpg) than the 2009 Lexus GS460 (24 mpg) or 2009 Infiniti M45 (21 mpg).

Engine Dynamometer 'Torture Chamber'

Going beyond the normal test protocol meant ramping up the boost to the maximum in special Ford engine dynamometers. These dedicated test cells allow engineers to operate the engine exactly as it would operate in a vehicle.

"The idea is to run the engine through a very difficult testing regimen at its maximum-rated operating performance," Shelby explained. "That's when things get hot."

Once the EcoBoost engine was installed in the dynamometer, operators increased rpm to full boost operation.

This meant the turbos were running flat out at incredibly high temperatures. "That's beyond red hot," Shelby says. "They're orange hot."

Reliable to the Extreme

Turbochargers operate at high speed – up to 170,000 rpm – and under intense temperatures of up to 950 degrees Celsius (1,740 degrees Fahrenheit). Some previous-generation turbos were reputed to suffer from oil coking, in which they would bake their lubricating oil.

Because oil coking can lead to premature turbocharger bearing failures, Ford's advanced engine engineers specified the use of new, water-cooled turbochargers to combat this problem.

"During normal turbo operation, the turbo receives most of its bearing cooling through oil," said Keith Plagens, turbo system engineer. "After shut down, the problems with turbos in the past were you would get coking in the center bearing. Oil would collect in the bearings, the heat soaks in and the oil would start to coke on the side and foul the bearing. Water cooling – used in the EcoBoost engine – eliminates that worry."

The new EcoBoost V-6 uses two Honeywell GT15 water-cooled turbos.

"The EcoBoost engine uses passive thermal siphoning for water cooling," Plagens explains. "During normal engine operation, the engine's water pump cycles coolant through the center bearing. After engine shutdown renders the water pump inactive, the coolant flow reverses. Coolant heats up and flows away from the turbocharger water jacket, pulling fresh, cool coolant in behind. This highly effective coolant process is completely silent to the driver, continuing to protect the turbocharger."

Going for a Spin - Flat Out

To validate their water-cooled turbo design choice, Ford engineers put EcoBoost through a special turbocharger test.

The test ran EcoBoost at maximum boost flat out for a 10-minute period. Then the engine and all cooling were abruptly shut down and the turbo was left to "bake" after this high-speed operation. If that sounds severe, imagine repeating this cycle 1,500 times without an oil change. That's what EcoBoost's turbos endured.

After 1,500 cycles, the turbos were cut open for detailed technical examination. The turbos passed the severe test with flying colors.

"We've attained things here the customer would never be able to do in their vehicle," Plagens said. "Ten minutes of peak power (355 hp, 350 foot-pounds of torque) is something that's probably only achievable in a vehicle for fractions of a minute, 10 seconds maybe in the extreme. We run it for 10 minutes many, many times over, and that's far, far more harsh and severe than a vehicle test would be."

EcoBoost also endured Ford's standard engine durability test signoff. Back in the dynamometer lab, the 3.5-liter EcoBoost V-6 went back up to full revs – and maximum turbo boost – for a real endurance test. This time the duration was a bit longer – 362 hours at full throttle. That's like running the 24 Hours of Daytona for more than 15 days straight.

Other tests subjected EcoBoost to a grueling range of operating temperatures.

"We run all of our durability testing at the maximum temperature," Plagens said. "For the turbos, the test is 150 hours long. Every 10 minutes the test alternates between peak power at max exhaust temperature and completely cold motoring. The goal is to verify that the turbochargers can withstand extreme thermal cycling without affecting their performance. It's pretty brutal and extreme but it's important to prove out durability."

Making the Grade

As the first Ford EcoBoost engine makes its production debut, it has earned its stripes in Ford's engine boot camp. It uses that same grade of 5W20 engine oil specified by Ford for gasoline engines, and oil changes are scheduled at the same 7,500-mile intervals, too.

"Ford customers can be sure that their new EcoBoost engine requires no special treatment for its reliable operation," Shelby said. "EcoBoost owners can pull in their driveways and switch off just like any other engine, and there's no special oil or shorter oil-change intervals. That means the owner can concentrate on enjoying the great performance and fuel economy."

# # #

INTRODUCTION OF 3.5-LITER ECOBOOST V-6 ENGINE ADDS EVEN MORE VERSATILITY TO DISTINCTIVE FORD FLEX

- The 2010 Ford Flex will offer an available 3.5-liter EcoBoost V-6, the first gasoline direct-injection twin-turbocharged engine produced in North America

- EcoBoost is a key Ford Motor Company initiative to deliver significant advancements in fuel economy – up to 20 percent – without sacrificing the performance customers want. The 3.5-liter EcoBoost engine delivers an impressive 355 horsepower and a responsive 350 lb.-ft. of torque across a broad rpm range, simultaneously giving Ford Flex the power of a normally aspirated 4.6-liter V-8 while enjoying V-6 fuel efficiency

- The 3.5-liter EcoBoost V-6 is the first in a wave of EcoBoost engines coming from Ford as part of a strategy to bring major fuel-efficiency improvements to millions. By 2013, more than 90 percent of Ford's North American lineup will be available with EcoBoost

DETROIT, January 2009 – Ford Flex turns heads with its distinctive design – and in 2009, the unique full-size crossover becomes even more noteworthy, thanks to an available twin-turbocharged 3.5-liter EcoBoost V-6 engine.

This all-new engine gives Flex V-8 power and performance feel with the fuel economy of a V-6. The twin-turbocharged 3.5-liter EcoBoost V-6 produces an estimated 355 horsepower at 5,700 rpm and 350 foot-pounds of torque at 3,500 rpm. In addition to the power upgrade, the 2010 EcoBoost Flex boasts segment-leading fuel economy among full-size performance crossover vehicles with 22 mpg highway and 18 mpg combined.

The 2010 Flex has unsurpassed fuel economy in the full-size crossover segment with 24 mpg highway and 19 mpg combined, one of a number of new Ford products delivering the best or among the best fuel economy.

"We are committed to delivering fuel economy leadership in every new vehicle," said Derrick Kuzak, Ford's group president of Global Product Development. "We do this with affordable technology that can be applied to the widest number of vehicles. EcoBoost is an important component of that goal.

"The beauty of EcoBoost is that it enables us to downsize for fuel efficiency, yet boost for power. We're able to decrease the size of the available engine – such as installing a V-6 versus a V-8 – yet boost the power using turbocharging to deliver similar power and torque of that larger engine."

The twin-turbocharged 3.5-liter EcoBoost V-6 engine requires all-wheel drive and will be available on well-equipped SEL and Limited models of the 2010 Flex, packaged with several high-demand customer features.

"People who drive the Flex want to make a statement, and the new twin-turbocharged 3.5-liter EcoBoost V-6 is very much in keeping with that attitude," said Ron Heiser, chief engineer of the Ford Flex. "We're proud and excited to add Ford's most advanced engine, which is the first V-6 direct-injection twin turbocharged engine produced in North America, to the Flex line."

The addition of the EcoBoost engine builds on what already is a strong package for Flex.

"We know that there are customers who are looking for the power and performance of a traditional V-8 but are not willing to sacrifice this for fuel economy," said Kate Pearce, Flex marketing manager. "No one else in this segment offers this level of performance and versatility, and when you wrap it up in Flex's unique package, we believe that it will offer a compelling buy in the crossover segment."

The EcoBoost program is part of Ford's ongoing and wide-ranging initiative to deliver fuel-efficient powertrain systems with power and performance found in larger-displacement engines.

"EcoBoost engines offer more power and better fuel economy," said Brett Hinds, EcoBoost design manager. "It's all part of Ford's strategy to bring adaptable powertrain technology to all kinds of vehicles and all kinds of lifestyles. This technology is affordable and applicable to all gasoline engines."

Hinds said the 3.5-liter EcoBoost V-6 will handle any tasks Ford Flex drivers ask of it. "The drivability of EcoBoost engines is superior and it just generates a lot more confidence in your Flex – it goes where you want it to go," he said. "You're rewarding yourself as a driver."

The twin-turbocharged 3.5-liter EcoBoost V-6 also will arrive in the Lincoln MKS and MKT in 2009. Although these are three very different vehicles that serve different needs for customers, the EcoBoost engine can handle the roles seamlessly and effectively. The 2010 EcoBoost V-6 MKT, for example, provides segment-leading fuel economy, exceeding the V-8-powered Audi Q7 by 4 mpg on the highway.

"A key element in our EcoBoost strategy is the efficiency we gain by employing a common control unit across a wide variety of vehicle applications," said Craig Stephens, EcoBoost powertrain control system manager. "All the driver should notice is the seamless power delivery and terrific fuel economy."

The key to the EcoBoost system is the harmony between the twin turbochargers and the direct injection fuel system. The turbochargers recover energy from the exhaust that otherwise would've been wasted and put it back in the engine to gain efficiency. Simply, the turbocharging system puts more air into the engine for more power. A compressor increases or "boosts" the pressure of the air entering the engine. An intercooler reduces the air temperature before it enters the engine.

The twin parallel turbochargers, which are water cooled and operate simultaneously, combine with a direct-injection fuel system to produce power when the driver pushes down on the gas pedal. The high-pressure fuel pump operates up to 2,175 psi – more than 35

times the norm seen in a conventional V-6 engine. The high-pressure pump is a cam-driven mechanical pump with a single piston and an electronic valve that controls how much fuel is routed into the fuel rails to the injectors.

As demands on the twin-turbocharged 3.5-liter EcoBoost V-6 engine are increased, the control system responds to maintain optimal combustion, timing and injection duration.

On each stroke, six individual jets spray fuel directly into the combustion chamber, mixing with the incoming air. "By bringing the fuel injector right into the combustion chamber, there's no delay from the time you inject the fuel to when it's used by the engine," Hinds said.

The fuel injectors are located on the side of the combustion chamber. When the fuel is injected into the cylinder, it evaporates and cools the air that's been inducted into the cylinder. "Another benefit of our direct injection method is that it cools the air right where you're going to burn it," Hinds said. "This action both improves the breathing of the engine and minimizes knocking."

The direct injection of fuel into the cylinder also helps provide a well-mixed air-fuel charge, increasing engine efficiency. Direct injection provides several benefits in terms of fuel burn and lower emissions.

"Because the fuel is directly introduced into the combustion chamber, you don't get fuel wetting the combustion wall like with port fuel injection, you don't saturate the ports and you don't get droplets that might recombine and add to saturation," Hinds said. "By injecting fuel directly into the combustion chamber and under high pressure, the fuel can be directed to exactly where we want it to be for a given combustion cycle."

The spray pattern for the fuel was optimized after extensive modeling work, with the angle of how the fuel is sprayed key to the process.

"The better combustion process is a big advantage of direct injection," Hinds said. "In a port fuel system, at key off it's possible to have fuel on the walls of the intake port, which

migrates to the top of the valve and puddles. So when you key on, you get that emissions spike. Direct injection is much cleaner from that standpoint."

Turbo lag virtually eliminated

The simultaneous turbocharger operation paired with the direct-injection system help to virtually eliminate turbo lag, one of the main reasons turbocharger technology was not previously more widely used.

The dual-turbocharger setup has several advantages over previous turbocharging systems, including:

- The turbochargers are smaller, resulting in more-compact exhaust manifolds, which don't generate as much heat
- Turbochargers are packaged adjacent to the cylinder block and have improved mounting providing NVH (noise, vibration, harshness) improvements
- The dual turbochargers spool up quicker, allowing the 3.5-liter EcoBoost V-6 engine to reach peak torque faster. The turbochargers spin at approximately 170,000 rpm. By comparison, the redline for the engine is approximately 6,500 rpm

"Our two turbochargers both operate identically over the speed range of the engine – one is responsible for the left bank of the engine and the other is responsible for the right bank," Hinds said. "Both spin immediately and produce boost, even at low engine speeds."

The turbochargers are designed for a life cycle of 150,000 miles or 10 years.

"Our testing is far, far more harsh than could be achieved in the real world," Hinds said. "In an extreme situation, a customer might be able to hit peak power for about 10 seconds – probably not even that much. We test at peak power for hundreds of hours to ensure we can reach our durability and reliability goals."

The turbochargers are only about the size of an orange, but help provide a big performance advantage to customers. Hinds describes the torque response in terms of linear acceleration – power whenever you need it.

"You get peak torque across a very wide engine speed range," he said. "It's available when you pull away from a stoplight or pass someone on a secondary road at a comparatively low speed. You don't need to wind up the engine to get performance out of it. It's there all the time."

Turbocharger "whoosh" is mitigated by electronically controlled anti-surge valves, which proactively relieve the boost in the intake, which can range up to 12 PSI. Precise software calibrations manage the pressures in the intake manifold.

"We control the boost to make sure that customers don't recognize when the boost is building," Hinds said. "As the turbochargers spool up, the electronic control system takes over. Our active wastegate control along with the throttle controls the boost and torque levels very precisely and the customer perceives a continuous delivery of torque."

Extensive durability tests on the twin-turbocharged 3.5-liter EcoBoost V-6 engine ensure it will excel in all conditions. Start-up tests, with a wide variety of fuels, were made in conditions ranging from minus 40 to 110 degrees Fahrenheit. Altitude testing up to 12,000 feet in Colorado also was performed.

"The direct-injection fuel system allows us some real opportunities in terms of optimizing cold start for both emissions and robustness," Hinds said. "We have multiple injections for each combustion event, and we can essentially tune where those injections should take place to deliver the strongest start possible with the lowest emissions."

Mated to the 3.5-liter EcoBoost V-6 engine is the 6-speed 6F-55 SelectShift automatic transmission, which is dedicated to the twin-turbocharger engine.

The 6F-55 transmission was developed from the successful 6F-50 transmission to specifically respond to the increased torque demands of the EcoBoost V-6 engine. Upgrades were made to the transmission's friction material in response to the higher shift energies, and a new torque converter has been optimized for performance and fuel economy.

Additionally, the 6F-55 transmission operates more efficiently. The transmission team was able to reduce the fluid level in the transmission, which in turn reduced weight and drag torque on the system. Upgrades to the transmission's thermal valve mean the system warms up quicker, reducing gear-spin losses.

"We've upgraded the gear sets to handle the increased torque," said Joe Baum, powertrain team leader. "We've also adjusted the final drive ratio and matched the gear ratios to provide the optimum performance and fuel economy.

"Our final drive ratio is 2.73. With a lower final drive ratio, the engine spins lower at highway speeds, which helps save fuel. And with all the torque, the Ford Flex still delivers good low-speed launch performance."

One harmonious system

Careful powertrain system management ensures the engine, turbochargers and transmission work together harmoniously.

"The Flex is a hit with our customers, bringing new customers to Ford," Heiser said. "Adding the 3.5-liter EcoBoost V-6 is just more great news."

# # #

ECOBOOST DEBUT: FUEL-EFFICIENT NEW V-6 ENGINE GIVES FLAGSHIP LINCOLN MKS THE POWER OF A V-8

- The 3.5-liter EcoBoost™ V-6 engine, the first V-6 direct-injection twin-turbocharged engine produced in North America, makes its debut in the 2010 Lincoln MKS. EcoBoost is one of Ford Motor Company's key initiatives to deliver significant advancements in fuel economy of up to 20 percent without sacrificing the performance feel customers want

- With the fuel economy of a V-6, the 3.5-liter EcoBoost engine delivers an impressive 355 horsepower and a responsive 350 lb.-ft. of torque across a broad rpm range. That gives the Lincoln MKS the power of a normally aspirated 4.6-liter V-8

- The new 3.5-liter engine is the first in a wave of EcoBoost engines coming from Ford as part of a strategy to bring affordable fuel efficiency improvements to millions. By 2013, more than 90 percent of Ford's North American lineup will be available with EcoBoost technology

DETROIT, January 2009 – Launched last summer, the Lincoln MKS upholds the luxury and comfort standards unique to Lincoln. Now, with the addition of all-new EcoBoost engines, the Lincoln MKS also will deliver a compelling combination of V-8 power and V-6 fuel economy.

The Lincoln MKS is among the first Ford Motor Company vehicle to introduce a premium twin-turbocharged 3.5-liter EcoBoost V-6 engine for the 2010 model year and is expected to deliver best-in-class highway fuel economy of 25 mpg. By 2013, more than 90 percent of Ford Motor Company's North American lineup will be available with EcoBoost technology.

"We are committed to delivering fuel economy leadership in every new vehicle," said Derrick Kuzak, Ford's group vice president of Global Product Development. "We do this

with affordable technology that can be applied to the widest number of vehicles. EcoBoost is an important component of that goal.

"The beauty of EcoBoost is that it enables us to downsize for fuel efficiency, yet boost for power. We're able to decrease the size of the available engine – such as installing a V-6 versus a V-8 – yet boost the power using turbocharging to deliver similar power and torque of that larger engine."

The 3.5-liter EcoBoost V-6 is expected to attain fuel economy numbers of 16 mpg city and 25 mpg highway based on preliminary testing of the all-wheel-drive 2010 Lincoln MKS while producing an estimated 355 horsepower at 5,700 rpm and 350 lbs.-ft. of torque at 3,500 rpm.

With its premium EcoBoost engine, the new Lincoln MKS will deliver more power and better highway fuel efficiency than the 2009 Lexus GS460 (24 mpg) or 2009 Infiniti M45 (21 mpg).

"We're delighted with how well the Lincoln MKS has been received. Customers have really responded to the vehicle's balanced combination of luxury, comfort and performance," said Pete Reyes, chief nameplate engineer. "Adding the 3.5-liter EcoBoost V-6 is another great enhancement to our luxury sedan. We now can deliver V-8 power without sacrificing fuel economy."

The Lincoln MKS will be among the first vehicles to receive the 3.5-liter EcoBoost V-6 starting in the summer of 2009, enhancing what's already a strong package. Standard on the Lincoln MKS EcoBoost series will be 19-inch wheels, steering-wheel paddle shifters to the six-speed SelectShift® automatic transmission, all-wheel drive and an expanded technology package that includes Intelligent Access with Push Button Start, ambient lighting, adaptive HID headlamps with Auto Highbeam, rain-sensing wipers and rear-window power sunshade.

"The Lincoln MKS EcoBoost series provides customers the best combination in style, technology and power," said Pei-Wen Hsu, Lincoln MKS Marketing manager. "An EcoBoost appearance package also will be available, offering customers a more aggressive and sporty look that further differentiates the Lincoln MKS from other competitors."

The EcoBoost program is part of Ford's ongoing and wide-ranging initiative to deliver innovative fuel-efficient powertrain systems with horsepower and torque performance found in larger-displacement engines.

"Our EcoBoost engines offer more power and better fuel economy," said Brett Hinds, EcoBoost design manager. "It's all part of Ford's strategy to bring adaptable powertrain technology to all kinds of vehicles and all kinds of lifestyles. This technology is affordable and applicable to all gasoline engines."

The turbochargers recover energy from the exhaust that otherwise would be wasted and put it back in the engine to gain efficiency. Simply, the turbocharging system puts more air into the engine for more power. A compressor increases or "boosts" the pressure of the air entering the engine. An intercooler reduces the air temperature before it enters the engine.

The twin parallel turbochargers, which are water-cooled and operate simultaneously, combine with a direct-injection fuel system to produce power when the driver pushes down on the accelerator pedal. The high-pressure fuel pump operates up to 2,175 psi – more than 35 times the norm seen in a conventional V-6 engine. The high-pressure pump is a cam-driven mechanical pump with a single piston and an electronic valve that controls how much fuel is routed into the fuel rails to the injectors.

As demands on the twin-turbocharged 3.5-liter EcoBoost V-6 engine are increased, the control system responds to maintain optimal combustion, timing and injection duration.

On each stroke, six individual jets spray fuel directly into the combustion chamber, mixing with the incoming air. Hinds: "By bringing the fuel injector right into the combustion chamber, there's no delay from the time you inject the fuel to when it's used by the engine."

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The Lincoln MKS team also was careful to give customers an exhaust note from the 3.5-liter EcoBoost V-6 that was pleasing but not overpowering. A precision-tuned induction sound tube directed into the cabin complements the feeling of power.

"It has the powerful sound Lincoln MKS customers will respond to," Hinds said.

With the addition of the twin-turbocharged 3.5-liter EcoBoost V-6, the overall package for the Lincoln MKS is one customers will respond to as well.

"With its elegant styling, wide suite of convenience technology and incomparable ride, the Lincoln MKS is an outstanding luxury sedan," Reyes said. "We're pleased and proud to add the 3.5-liter EcoBoost V-6 to an already-great car."

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About Ford Motor Company
Ford Motor Company, a global automotive industry leader based in Dearborn, Mich., manufactures or distributes automobiles across six continents. With about 224,000 employees and about 90 plants worldwide, the company's core and affiliated automotive brands include Ford, Lincoln, Mercury, Volvo and Mazda. The company provides financial services through Ford Motor Credit Company. For more information regarding Ford's products, please visit www.ford.com

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Press Information and pictures on www.fordpress.be

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