

# ENVIRONMENTAL PERFORMANCE

## NISSAN FUELS DRIVING PASSION WHILE MEETING TOMORROW'S CHALLENGES

A STRATEGIC SHIFT IS OCCURING. Today's drivers are demanding more from their cars, trucks, and SUVs, no doubt because of high gas prices and a growing desire to move toward a more sustainable future. At the same time, performance often remains a priority. Competing goals? Not really. A shift in perspective like this simply kicks creativity in gear. Nissan's answer is an array of innovative and advanced products like the Altima Hybrid, which offers an ideal mix of gasoline and electric power to combine driving pleasure with greater environmental performance. Forward-looking fuels and technologies are showcased in vehicles like the advanced X-Trail hydrogen FCV, and in Nissan's plug-in hybrid and electric vehicle development work. Advanced diesels also have a role in Nissan's move toward high fuel efficiency and CO2 reduction.

Renewable fuels such as E85 ethanol are on the agenda at Nissan. The Titan and Armada are two models capable of running on any combination of this renewable fuel or gasoline in the same tank. Those looking for spirited driving and high fuel efficiency in a small car have another choice in the Nissan Versa. And those interested in near-zero emission motoring with conventional gasoline get their wish with Nissan's Sentra and Altima PZEV models available in certain markets.

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# DRIVING GREATER EFFICIENCIES

## THE IMPERATIVE: HIGHER MPG AND LOWER EMISSIONS

At every level, Nissan is a company motivated by innovation. This passion for original thinking dates back over 70 years when Nissan manufactured the first mass-produced Japanese automobile, the economical 1937 Datsun Type 15. From that foundation, Nissan's innovative approach to engineering and design continues to set the highest standards for environmentally compatible cars and trucks that deliver real driving excitement.

### MEETING TODAY'S EVOLVING NEEDS

In a rapidly changing world, Nissan recognizes there are many paths to ensuring sustainable mobility for future generations. While some promising solutions are still years – if not decades – away, important near-term transportation challenges are addressed now by Nissan's extensive car and truck portfolio.

Nissan's current product lineup is diverse and thoughtful, offering green alternatives without compromise. The next generation of efficient compact cars is represented by the clever Nissan Versa. Great fuel economy is central to the design of the affordable Sentra. In certain markets, when equipped with the 175 horsepower, 2.5-liter four-cylinder engine, the Nissan Altima achieves Partial Zero Emission Vehicle (PZEV) status. PZEVs emit 90 percent

fewer tailpipe pollutants than an average car and also offer near-zero evaporative emissions from the fuel system. The new Altima Hybrid qualifies as an Advanced Technology Partial Zero Emission Vehicle (AT-PZEV) and offers the ability to run on its gasoline engine, electric drive, or a combination of both under specific driving conditions for exceptional economy.

### NEW FUELS AND TECHNOLOGIES

Clean, efficient, and powerful gasoline engines headline Nissan's powertrain lineup, but are far from the only alternatives shaping tomorrow's transportation needs. The nation's current fueling infrastructure enables regional use of partially renewable fuels like E85 ethanol or blends of biodiesel and cleaner ultra low sulfur diesel (ULSD). Nissan is geared to capitalize on these advancements and is also exploring promising fuels and technologies of the future like hydrogen fuel cell powered vehicles.

Innovative advances in engine technology increase economy, reduce emissions, and produce greater power than traditional designs. Prime examples are Nissan's Variable Valve Event and Lift (VVEL) and Continuous Valve Timing Control (C-VTC), which work together to optimize gasoline engine performance. VVEL can reduce carbon dioxide emissions by up to 10 percent

while improving fuel efficiency. In certain operating conditions, VVEL can act as its own throttle to control the amount of air entering the engine, rather than utilizing a conventional throttle valve to control intake air. The result is that valve events and lifts are continuously controlled to deliver more efficient airflow to the cylinders, allowing for a more responsive engine with better performance, increased fuel economy, and lower emissions. In addition to CO2 reductions, optimized valve timing at startup allows exhaust gas temperature to rise quickly so a catalytic converter can work more effectively.

### CLEAN DIESEL COMING

With the recent availability of cleaner-burning ULSD, the potential for efficient diesel passenger cars to finally hit their stride in the U.S. market is a promising one that could have a real impact on lessening oil dependency. Because diesel engines on average are 30 percent more fuel efficient than comparable gasoline engines, the potential fuel savings are substantial. Diesel powertrains also offer the ability to further reduce petroleum usage by operating on blends of partially renewable biodiesel fuel.

Nissan will offer a clean diesel version of the flagship Maxima sedan in 2010. The car will be powered by an all-new Alliance diesel engine



Versa Hatchback -- up to 33 mpg (2008 EPA est.)



Fuel efficient VVEL technology



Clean diesel coming to Maxima

that Nissan is co-developing with partner Renault. The state-of-the-art Alliance diesel builds on the considerable expertise of Nissan and Renault in the European market. In addition to offering exceptional fuel efficiency and fun-to-drive performance characteristics, this Nissan clean diesel will meet stringent U.S. Environmental Protection Agency (EPA) Tier II Bin 5 emission requirements.

Carlos Ghosn, president and CEO of Nissan Motor Co., Ltd., sums up the company's strategy this way: "Nissan is fully engaged in reducing emissions and improving fuel economy and efficiency. Launching a clean diesel engine in the U.S. will offer customers the benefits of fuel economy, CO2 reduction, and a satisfying fun-to-drive performance that is a hallmark of the Nissan brand. You can expect to see more diesel engines in our product lineup in Europe, Japan, North America, and China by fiscal year 2010."

# ADVANCED VEHICLES AND FUELS



Altima Hybrid uses gas and electric power



Titan and Armada FFVs can run on E85 ethanol

## AT NISSAN, HYBRID POWER AND E85 ETHANOL ANSWER THE CALL

Changing the way you move through the world starts today. Nissan is addressing transportation challenges with a variety of technologies working toward the common goal of sustainable mobility.

### HYBRID POWER, PERFORMANCE INCLUDED

The most advanced Altima ever, the Altima Hybrid offers a winning combination of outstanding performance, economy, and low emissions. A true full hybrid, the Altima Hybrid is capable of driving at low speeds on electric drive alone. At higher speeds and when quick acceleration is needed, the highly efficient 2.5-liter, four-cylinder gasoline engine joins in to deliver performance on par with larger V6 powerplants.

The hybrid system's gasoline engine produces 158 horsepower and 162 lbs-ft of torque, with additional power provided by a 40 horsepower AC motor-generator. The combination delivers a net power rating of 198 horsepower. Altima's hybrid powertrain is made all the more efficient with an electronically controlled Xtronic™ transmission. Energy is provided by a 244.8-volt nickel metal hydride battery pack. A regenerative braking system makes use of the

motor-generator during deceleration to generate electricity that's directed back to the batteries.

Satisfying performance doesn't come at the expense of fuel efficiency. The 2008 Altima Hybrid delivers up to 35 mpg in the city and 33 mpg on the highway (2008 EPA estimates), providing a driving range of nearly 700 miles. Based on Nissan's most popular model line, this mainstream application offers all the functionality and extremely low emissions of the popular gasoline Altima while adding even better fuel economy. The Nissan Altima Hybrid is assembled at the Nissan North America Manufacturing plant in Smyrna, Tennessee.

Designated by the EPA as an Advanced Technology Partial Zero Emission Vehicle (AT-PZEV), the Altima Hybrid ranks among the cleanest vehicles in the world. Nissan pioneered PZEV technology in 2000 with the Sentra CA, becoming the first automaker to introduce a production gasoline vehicle with near-zero emissions meeting California's stringent PZEV certification. When driving in poor air quality conditions, tailpipe emissions from a PZEV car may actually be cleaner than the ambient air surrounding it.

### DISPLACING GASOLINE USE

The quickest path to reducing petroleum dependency is to increase fuel efficiency across a broad range of existing models. Nissan is committed to delivering the most fuel-efficient vehicles possible without sacrificing performance or capability. As you can imagine, this is no simple challenge. Nissan approaches this with innovative thinking, creative design, and the application of advanced technologies wherever they make sense and are cost-effective for Nissan customers. On a parallel course, oil dependency can also be dramatically reduced with a shift to alternative fuels capable of powering our vehicles cleanly, efficiently, and in ways that fit our lifestyles.

Flexible-fuel vehicles (FFVs) like the Nissan Titan full-size pickup and Armada SUV allow drivers to operate on E85 ethanol, gasoline, or any combination of the two fuels. Ethanol is of growing interest because it's a sustainable, largely domestically-produced fuel derived from a variety of plant sources. E85 is a mix of 85 percent ethanol and 15 percent gasoline. While driving, the transition from gasoline to E85 and back is seamless, with sensors in the fuel system recognizing the fuel mix in real

time and adjusting engine controls accordingly.

E85 brings many advantages. It has the highest oxygen content of any fuel currently available, thus it burns cleaner than gasoline and also produces fewer greenhouse gas emissions, including carbon dioxide. Ethanol tends to cost less than gasoline and its higher octane offers the capability for higher performance. However, this alternative fuel has less energy content than gasoline so a car will drive fewer miles per gallon on E85 than on gasoline.

Increasing E85 production and use is a logical approach to the challenge of energy diversity and one of many reasons for Nissan's interest in this fuel. Full-size, V8 powered flexible-fuel vehicles like the Titan and Armada stand to displace the highest quantity of gasoline when operated on E85 and are thus an early priority in Nissan's alternative fuel program.



Super Motor (left), Hypermini (above)

# FOCUS ON ELECTRIC DRIVE

## THE COMMON LINK TO ELECTRIC, FUEL CELL, AND PLUG-IN HYBRID VEHICLES

Bring up “electric drive” and battery powered electric vehicles often come to mind. That image has morphed in recent years as electric drive has been discussed with increasing frequency in the world of gasoline-electric hybrids. The truth is that electric drive is also a fundamental building block for plug-in hybrids and hydrogen fuel cell vehicles, and even an integral part of more advanced conventional drivetrain systems as well.

### GREATER EFFICIENCIES

The reason for this is simple: Electric drive is inherently efficient at transforming energy into propulsion power, significantly more so than gasoline or diesel internal combustion engines. It's also quite adaptable. Electric motors can be used readily for front drive, rear drive, and all-wheel drive applications, in various combinations. A single motor can drive either front wheels or rear, or even separate in-wheel motors can be used.

Greater design flexibility and enhanced performance are also provided with electric drive. Controllers, batteries, and electric motors can be integrated into new vehicle designs in novel ways, allowing Nissan designers to create vehicles with new and innovative profiles that aren't built around today's traditional front engine layout. Nissan has explored new and in-

teresting directions in electric car design, one of the most recent the very untraditional PIVO, an electric car that incorporates “by-wire” technology to enable its centrally-mounted, forward-facing cabin to rotate in any direction and do away with the need to reverse.

There are other advantages. Greater passenger comfort can be engineered in since electric drive used in rear- and four-wheel drive applications does away with the rear driveshaft. This allows a flat rear floor and extra legroom. When used in tandem with conventional front-drive, internal combustion engine models, Nissan's unique e.4WD system not only provides high-performance 4WD capabilities and better legroom, but also improved fuel efficiency because of its compact design, lightweight construction, and minimal engine-transmission loss.

One of the greatest advantages of electric drive is that its use is not limited to a single type of vehicle or drive technology. That's why Nissan has incorporated electric drive into its conventional products in the form of e.4WD, in battery electric vehicle concepts and demonstrators, and even in the advanced X-Trail hydrogen fuel cell vehicle. Efficiencies should be applied wherever they make sense, and electric drive is clearly a pathway to efficiency and environmental performance.

### LONG HISTORY WITH ELECTRIC DRIVE

Nissan is no newcomer to electric vehicles. In fact, electric vehicle development has been part of Nissan's history since the 1940s. In recent times, this development led to the test marketing of battery electric vehicles in California. Here, Nissan's Altra EV, an advanced electric-powered vehicle based on the R'nessa minivan sold in Japan, offered comfortable five-passenger seating and a better than 100 mile driving range. It charged its batteries with a sophisticated magnetic inductive charging paddle. It also stood apart from the crowd with its early use of powerful lithium-ion batteries, the same battery technology being explored today for advanced electric drive vehicles including plug-in hybrids.

Other electric vehicles have carried the Nissan emblem. One of the more high-profile is the Hypermini, a small electric commuter car that was test marketed in Japan and also underwent field trials for a time in the U.S.

### ADVANCED TECHNOLOGY CENTER

Electric vehicle development has continued over the years with new concepts introduced as a matter of course. In fact, electric drive is so important to Nissan's future that the company has opened a new facility in Japan to spearhead in-

novations in environmental and safety technologies. The Nissan Advanced Technology Center (NATC) in Kanagawa prefecture, Japan, aims to accelerate Nissan's research and advanced engineering breakthrough technologies for next-generation products, including those involving advanced electric drive.

“Future technologies being developed are aimed at environmental sustainability and towards creating a safer mobile society,” says Mitsuhiro Yamashita, Nissan Motor Company's executive vice president. At NATC, Nissan engineers will pursue a range of green technologies to address the challenges of CO2 reduction including electric vehicles, hybrids, and plug-in hybrids.

Separately, Nissan has joined with NEC Corporation, and its subsidiary NEC TOKIN Corporation, to focus on developing lithium-ion battery technology through a new company, Automotive Energy Supply Corporation (AESC). The goal at AESC is to focus on lithium-ion battery business for wide-scale automotive applications by 2009.

There's little doubt that the evolution toward cleaner powertrains will lead to greater importance for electric drive vehicles including hybrids, plug-in hybrids, electric vehicles, and hydrogen fuel cell vehicles. Nissan's activities include significant investments in the high-tech facilities and talented engineers and scientists that will make this happen.



Inductive charging circa-1998 Altra EV



# BUILDING A SUSTAINABLE FUTURE

## NISSAN GREEN PROGRAM 2010 IN MOTION

It's a rethinking of the entire automaking process. Nissan's long-term vision focuses attention on environmental initiatives company-wide and at every level. This holistic approach encompasses high level strategic planning, advanced technology research and development, design, engineering, and vehicle production. The goal: Fresh thinking and creative solutions that will provide cleaner transportation solutions without losing sight of the passion for driving that defines Nissan as an automaker.

### ACHIEVING ENVIRONMENTAL PROGRESS

Nissan recently announced its "Nissan Green Program 2010" (NGP 2010), a mid-term environmental action plan that addresses immediate concerns and creates a foundation toward long-term sustainability. NGP 2010 is designed to fulfill Nissan's environmental philosophy of "symbiosis of people, vehicles, and nature."

"Our most urgent R&D challenge today is to meet society's environmental expectations," explains Carlos Ghosn, president and CEO of Nissan Motor Company, Ltd. "That's why 40% of our budget for advanced engineering is devoted to Nissan Green Program 2010, our five-year environmental blueprint. For our industry, environmental sustainability represents the biggest engineering challenge. And no matter what you may hear, there is no silver bullet, no quick fix. In this race, the finish line is still nowhere in sight."

This underscores the importance of NGP 2010. The primary environmental issues addressed in the plan include reduc-

ing CO<sub>2</sub> and exhaust emissions, along with accelerating recycling efforts. To guarantee these goals are met, Nissan is making CO<sub>2</sub> reduction a key management performance indicator. By 2010, CO<sub>2</sub> emissions will be reduced at Nissan global manufacturing plants by 7% compared to those of 2005. Specific goals in NGP 2010 include launching a gasoline fueled "three liter car" by 2010 that will travel 100 km on just three liters of gas – that's 78.4 U.S. mpg. The program also includes expanded availability of Nissan E85 ethanol flexible-fuel vehicles, development of a Nissan-exclusive hybrid, accelerated development of a Nissan plug-in hybrid, and the launch of a Nissan electric vehicle by early in the next decade.

### BUILDING CLEANER CARS

NGP 2010 is just the first phase of a fundamental shift in the way Nissan does business. It's also one of many reasons why Nissan has been rated among the top 50 companies worldwide for corporate social responsibility by Global Reporters, a survey jointly conducted by SustainAbility Ltd., the U.N. Environment Program, and Standard & Poor's (S&P).

Lowering emissions and reducing fuel consumption while pursuing alternative energy are primary concerns. However, other creative solutions are making Nissan cars and trucks cleaner as well. The use of natural materials, like grape seed polyphenol in high-performance air filters that remove allergens from Nissan vehicle interiors, is one example. A newly-developed catalyst for gasoline-powered cars that requires only half the precious metals of today's catalysts is another. Major improvements in Nissan's recycling and vehicle recovery efforts also put less waste in our landfills.

Passionate driving that takes care of the environment. That's the Nissan mission.



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