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Climate Change

2010 HIGHLIGHTS...

- Offered four Ford vehicles that achieve 40 mpg or better
- Began producing the Transit Connect Electric, the first of five electrified vehicles
- Reduced CO_2 emissions from global operations by 5.6 percent on a per-vehicle basis since 2009
- Announced development of a solar energy system at the Michigan Assembly Plant

Ford is committed to doing our share to prevent or reduce the potential for environmental, economic and social harm due to climate change.

We have a comprehensive, science-based global strategy to reduce greenhouse gas (GHG) emissions from our products and processes while working cooperatively with the public and private sectors to advance climate change solutions. We are taking a holistic approach to the issue, recognizing that it affects all parts of our business and is interconnected to other important issues, from water availability and energy security to human rights.

We believe our commitment to addressing the climate change issue in a comprehensive and strategic way is one of the factors that has helped to transform our Company's current and future products and prospects.

Our Commitment

Our climate change strategy is based on doing our share to stabilize carbon dioxide (CO_2) concentrations in the atmosphere at 450 ppm, the level generally accepted to avoid the most serious effects of climate change. Our stabilization commitment includes:

- Each new or significantly refreshed vehicle will be best in class, or among the best in class, for fuel economy
- From our global portfolio of products, we will reduce GHG emissions enough to contribute to climate stabilization – even taking into account sales growth
- We will reduce our facility CO_2 emissions by 30 percent by 2025 on a per-vehicle basis.

During 2010, we expanded the climate stabilization analysis that we had undertaken previously for the U.S. and Europe to the other regions in which we operate. This analysis defines the emission reductions needed to meet our stabilization commitment. For an in-depth look at the science behind our commitment, please see Ford's Science-Based CO_2 Targets.

Our technology migration plan – embodied in our blueprint for sustainability – maps the road we're taking to achieve our product goals.

Our Progress

We are on track to meet our commitments. We are making progress by adding advanced technology to all our products and offering high-value, attractive models that are smaller, lighter and more fuel efficient, encouraging customers to shift purchase behavior. We also continue to invest in energy-efficiency improvements at our facilities worldwide and, during 2010, explored carbon emissions in our supply chain through multi-stakeholder projects.

Among recent and upcoming actions, we:

- Reduced fleet-average CO_2 emissions from our 2010 model year U.S. and European new vehicles by 10.5 percent and 8.1 percent, respectively, compared to the 2006 model year.[1]
- Reduced CO_2 emissions from our global operations by 5.6 percent on a per-vehicle basis, compared to 2009.
- Announced three more engines with our patented EcoBoost fuel-saving technology. By 2013, we expect to be producing approximately 1.5 million EcoBoost engines globally, about 200,000 more than originally expected.

Perspectives on Sustainability

Mark Fulton and Bruce Kahn

Global Head of Investment Research and Senior Investment Analyst for Climate Change, DB Climate Change Advisors

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Perspectives on Sustainability

Gerhard Schmidt

Chief Technical Officer, Vice President of Research and Advanced Engineering (Emeritus), Ford Motor Company

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- Offered four models in North America that provide 40 miles per gallon or better – compared to 2009, when our most fuel-efficient vehicle achieved 35 miles per gallon.
- Offered 18 models in Europe that achieve a CO_2 emission level of 130 grams per kilometer, and two that achieve less than 100 grams per kilometer.
- Announced the development of a solar energy system – one of the largest in Michigan – that will help power the production of fuel-efficient small cars, including the Focus Electric, at our Michigan Assembly Plant.

Our Policies

Ford cannot achieve climate stabilization alone. Reducing emissions by the amount required calls for an integrated approach – a partnership of all stakeholders, including the automotive industry, the fuel industry, government and consumers. It can only be achieved by significantly and continuously reducing GHG emissions over a period of decades in all sectors of the economy. In the transportation sector, this means improving vehicle fuel economy, developing lower-carbon fuels and providing price signals to encourage consumers to purchase more fuel-efficient vehicles.

If there is a mismatch between available fuels, vehicles and consumers, climate stabilization goals will not be met. Accordingly, we are committed to advocating for effective and appropriate climate change policy. We are promoting comprehensive market-based policy approaches that will provide a coherent framework for GHG emission reductions, so that companies like ours can move forward in transforming their businesses with a clear understanding of our obligations.

In This Section

In this section of our Sustainability Report we provide an overview of GHG emissions, including data on the contribution of light-duty vehicles, lifecycle CO_2 emissions from a typical vehicle and Ford's own climate "footprint." We also discuss the risks and opportunities the climate change issue poses for Ford, our climate change strategy – including our blueprint for sustainability – and how we are addressing climate change public policy issues. An electrification case study explores how we are bringing electrified vehicles to market.

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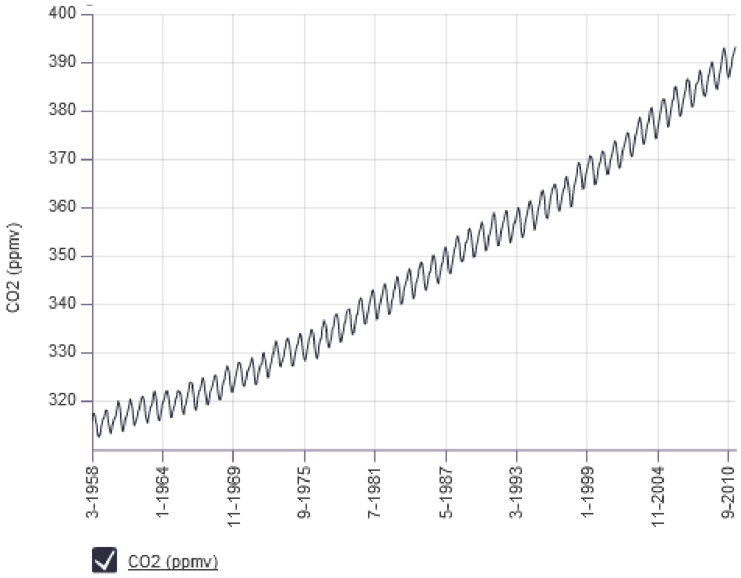
1. Please see Sue Cischke's letter for a discussion of our CO_2-reduction goal for North America and Europe.

Greenhouse Gas Emissions Overview

Climate change is the result of an increase in heat-trapping (greenhouse) gases in the atmosphere. Carbon dioxide (CO_2) is the major long-lived greenhouse gas (GHG). The burning of fossil fuels (to provide electricity, heat and transportation, and to support industry and agriculture), as well as deforestation, leads to emissions of CO_2 and increased levels of atmospheric CO_2. The atmospheric concentration of CO_2 has increased from a preindustrial level of 270–280 parts per million (ppm) to a level of approximately 390 ppm in 2010 (see Figure 1).

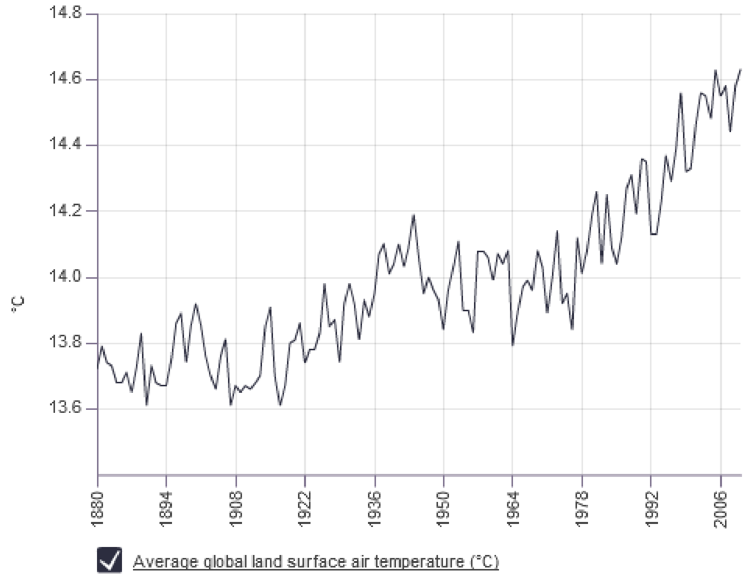
Global temperature records have been reported independently by scientists at the National Aeronautics and Space Administration (NASA) in the U.S., the National Oceanic and Atmospheric Administration in the U.S., the Climate Research Unit at the University of East Anglia in the U.K. and the Japanese Meteorological Agency. The records from these four independent groups are in good agreement and show a distinct warming trend over the past century. The past decade was the warmest decade in the instrumental temperature record. As shown in Figure 2, the warming trend is continuing, and 2010 was one of the warmest years on record. Independent measurements of rising sea level, increasing acidification of the oceans, loss of Arctic sea-ice, and the retreat of glaciers around the world are consistent with the impact of rising GHG concentrations and global temperature.

Figure 1: CO_2 concentration measured at the observatory in Mauna Loa, Hawaii



Data source: NOAA (2011)

Figure 2: Global temperature



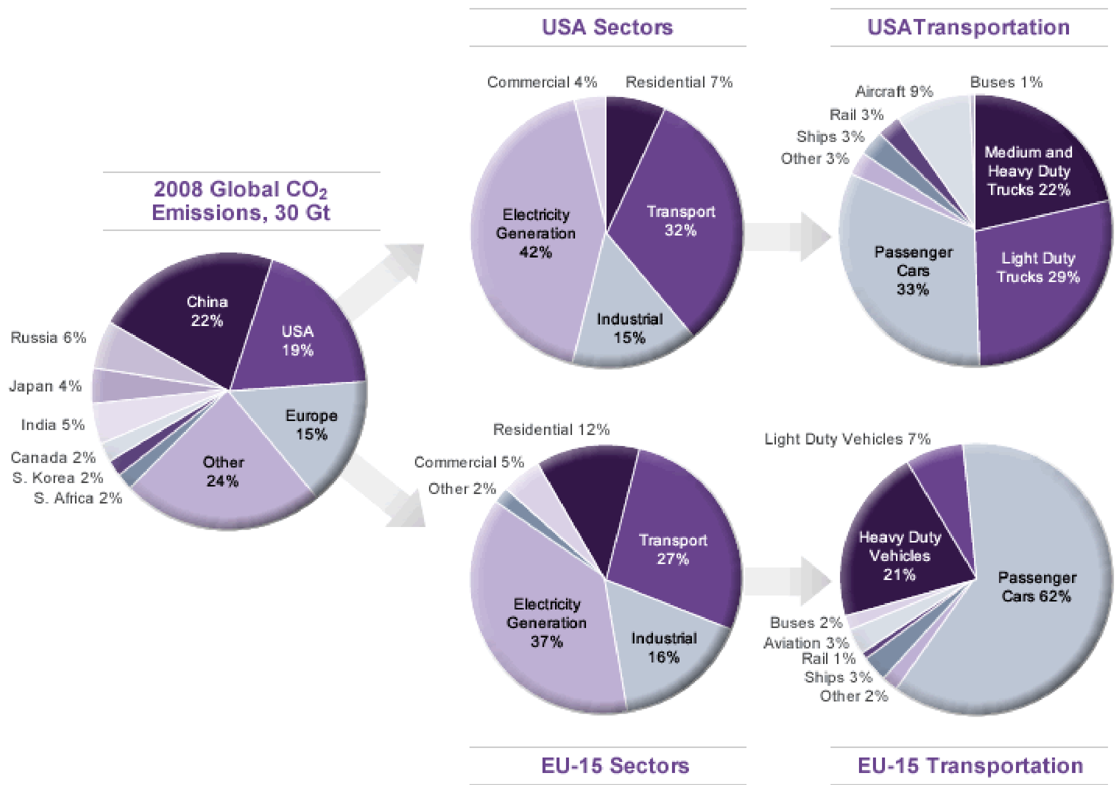
Data source: NASA (2011)

Global Emissions

Figure 3 (below) provides a breakdown of estimated 2008 fossil fuel CO_2 emissions by region. For the U.S. and Europe, the emissions are further broken down by sector and by mode in the transportation sector. The data were taken from reports published by the International Energy Agency, the European Environment Agency and the U.S. Environmental Protection Agency. Globally, emissions from cars and light-duty trucks comprise about 11 percent of all fossil fuel CO_2 emissions. In the U.S., cars and light-duty trucks account for approximately 20 percent of fossil fuel CO_2 emissions, or approximately 4 percent of global fossil fuel CO_2 emissions. In Europe, passenger cars and light-duty trucks account for approximately 19 percent of fossil fuel CO_2 emissions, or about 3 percent of global fossil fuel CO_2 emissions.

Until recently, the U.S. was the largest CO_2 emitter. In 2007, however, emissions from China surpassed those from the U.S. It is expected that the gap between emissions from China and the U.S. will continue to widen in the future, although per-capita emissions of CO_2 in the U.S. are expected to remain higher (currently by approximately a factor of four) than those in China.

Figure 3: Regional distribution of fossil fuel CO_2 emissions in 2008



The top pie charts show a breakdown of U.S. emissions into end-use sectors and a breakdown of emissions from the U.S. transportation sector into different transportation modes. The bottom pie charts show comparable data from the EU.

Lifecycle Vehicle Emissions

The GHG emissions associated with Ford's activities include emissions from our facilities, from the transportation of our products and people, from the vehicles we produce once they are in use by customers and from our suppliers. In this report, we provide data on CO_2 emissions from our facilities and our U.S. and European new products. Additional information on our GHG footprint is found in the Lifecycle Vehicle CO_2 Emissions section.

For conventional gasoline- or diesel-powered vehicles, most of the lifecycle CO_2 emissions are released when the vehicles are driven, rather than when they are manufactured, maintained or recycled at end of life. As vehicle fuel efficiency improves and lower-carbon fuels are made available, we expect that the relative contribution of CO_2 emissions from the fuel-consumption phase will decrease (see Lifecycle Vehicle CO_2 Emissions). For Plug-in Hybrid Electric Vehicles (PHEVs), Battery Electric Vehicles (BEVs) and hydrogen-powered Fuel Cell Vehicles (FCVs), most of the lifecycle CO_2 emissions are released during the production of the electricity or hydrogen that provides the energy for the vehicle. A systems perspective is required when considering the CO_2 emissions and energy use associated with light-duty vehicle technologies. Considering either the vehicle technology or the fuel technology in isolation is not sufficient. BEVs and FCVs are capable of achieving very low CO_2 emissions, but only when powered by low-CO_2 electricity or hydrogen. The use of energy-efficient vehicles such as BEVs or FCVs does not in itself lead to a reduction in CO_2 emissions; those vehicles need to be combined with low-CO_2 fuels to achieve low total CO_2 emissions.

The estimation of lifecycle CO_2 emissions associated with myriad possible future vehicle-fuel combinations is a complex task. Scientists at Ford are working to develop a detailed understanding of the lifecycle impacts of the different technologies. We anticipate this will be an ongoing effort and that we will discuss the results in future Sustainability Reports.

Snapshot of Greenhouse Gas Emissions from Ford Facilities and Ford-Produced Vehicles

Related Links

This Report:
- Delivering More Fuel-Efficient Vehicles
- Supply Chain Greenhouse Gas Emissions

During 2010, we updated our estimate of global GHG emissions from our facilities and Ford vehicles, using data from 2008, the most recently available. The estimate is shown in Figure 1, along with the estimates carried out in 2001 and 2006/7 for the years 1999 and 2005, respectively.

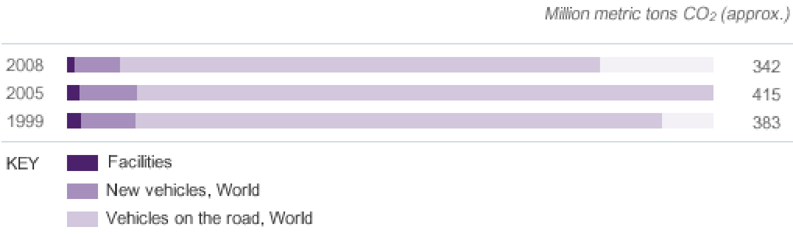
We estimate that our total CO_2 emissions are in the range of 350–400 million metric tonnes (Mmt) per year, varying over time with fluctuations in vehicle production and sales, on-road fleet size and vehicle miles traveled. The estimate includes emissions from our facilities, emissions from current year vehicles and emissions from all Ford vehicles on the road. Please note that while we can exercise a significant degree of ongoing control over our facility emissions, we have essentially no control over the emissions of vehicles once they are produced and on the road.

Our assessment of the emissions from Ford's facilities and Ford-made vehicles on the road decreased between 2005 and 2008 from approximately 400 to 350 million metric tonnes of CO_2, primarily due to better data availability for a key parameter.[1] Normalizing for the change in the key parameter, the emissions remained relatively stable at approximately 350 Mmt.

Outside the scope of this estimate, we are also in the process of understanding the GHG emissions from our key suppliers' facilities, as described in the Supply Chain section.

Figure 1. Estimate of CO_2 emissions from our facilities and Ford vehicles on the road in 2008, 2005 and 1999.

Chart | Table



Million metric tons CO_2 (approx.)

	1999	2005	2008
Facilities	9	8	5
New vehicles, World	35	37	29
Vehicles on the road, World	338	370	308
Total	383	415	342

New vehicles are those sold in the year of interest; vehicles on the road are those sold prior to the year of interest.

In detail, the updated 2010 snapshot of estimated CO_2[2] emissions shows that between 2005 and 2008:

- Emissions from our facilities improved by approximately 38 percent during this period. This reflects an approximately 16 percent improvement in the amount of CO_2 emitted per vehicle produced (i.e., our energy-efficiency index improved globally by about 16 percent from 2005 to 2008). It also reflects lower overall vehicle production. These estimates are fairly precise.[3] Facility GHG emissions, however, are a small percentage (about 2 percent) of the total.
- Emissions from current-year (2008[4]) vehicles on the road decreased by about 22 percent relative to the prior year, primarily reflecting a decline in vehicle sales. We have moderate confidence in the precision of the estimate for U.S. vehicles; the estimate for the rest of the world is less precise.[5] These emissions account for about 8 percent of the total.
- Emissions from all Ford vehicles on the road are estimated to be about 308 million metric tonnes of CO_2 per year, lower than in our previous analyses, primarily due to better data availability for a key parameter. This estimate, which accounts for about 90 percent of the total,

remains highly uncertain.[6]

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1. Our estimate for the CO_2 emissions for the greater-than-one-year-old on-road fleet decreased from 370 to 308 Mmt between 2005 and 2008. This decrease primarily reflects better data availability for a key value in the calculation (the global Light Duty Vehicle fraction of road transportation petroleum use, which we now assume to be 0.6 as opposed to 0.7 in our previous analyses). Using the old data value of 0.7 for the 2008 global CO_2 estimate would increase the 308 Mmt value to 359 Mmt. Such changes in our assessment reflect the difficulties in assessing precisely the emissions from the global fleet of Ford vehicles.
2. CO_2 emissions account for substantially all of the GHG emissions from our facilities and vehicles.
3. This is calculated consistent with the World Resources Institute/World Business Council for Sustainable Development Greenhouse Gas Protocol; it includes direct (Scope 1) and indirect (Scope 2) emissions.
4. 2008 is the most recent year for which complete data is available.
5. Calculated using Ford U.S. Corporate Average Fuel Economy and global market share figures. This estimate is subject to considerable uncertainty as it incorporates multiple assumptions about how consumers use their vehicles (e.g. miles traveled overall and urban-highway breakdown) and about fuel economy values in markets outside of the U.S.
6. This is calculated based on our market share and a sector-based approach to determine the fractional contribution of LDVs to global total CO_2 emissions. This estimate is subject to considerable uncertainty, as it is based on multiple assumptions, including that all automakers' fleets have the same fuel economy and vehicle life span.

Supply Chain

We are currently evaluating climate change risks and opportunities across our supply chain and expanding our approach to enhance supplier environmental performance beyond more established supplier environmental performance expectations, such as robust environmental management systems (ISO 14001 certification) and responsible materials management. (See the Greenhouse Gas Emissions section for details of our participation in initial efforts to assess greenhouse gas emissions in our supply chain.)

Within the Aligned Business Framework agreement with our strategic suppliers, environmental leadership is integral to overall business performance metrics. Climate-change-related activities are highlighted as potential leadership opportunities. In addition, our requirement that suppliers implement robust environmental management systems will better enable them to understand, measure and report their emissions. We will also seek out opportunities to partner with suppliers to improve the greenhouse gas emissions performance of our products and processes, and improve energy efficiency throughout the vehicle lifecycle, including in the supply chain.

Related Links

This Report:

- Supply Chain Greenhouse Gas Emissions

Beyond CO_2

We have a holistic view of climate change and have addressed non-carbon-dioxide (CO_2) long-term greenhouse gases such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), nitrous oxide (N_2O) and sulfur hexafluoride (SF_6). Through our Restricted Substance Management Standard we have prohibited SF_6 in tires in magnesium casting and PFCs in open systems. We are continuing our scientific research to determine the relative contribution of a wide range of long-lived greenhouse gases to radiative forcing of climate change.

In 2010, we worked with an international team of climate and atmospheric scientists under the auspices of the World Meteorological Organization to assess the global warming potentials of long-lived greenhouse gases. Given the impressive reductions in the emission of criteria pollutants (hydrocarbons, NOx, particulate matter and carbon monoxide) enabled by improvements in engine and exhaust after-treatment technology, we believe that the contribution to climate change by these short-lived pollutants from light-duty vehicles will be of relatively minor importance in the future.[1] We have presented a technical assessment arguing that time horizons of 20 years, or longer, are needed in assessments of the contribution of road transport to radiative forcing of climate change.[2]

While carbon dioxide is by far the most important greenhouse gas associated with the use of motor vehicles, small amounts of other greenhouse gases are also emitted, notably methane (CH_4), N_2O and hydrofluorocarbon-134a (HFC-134a). Methane is formed in the engine and emitted into the atmosphere. We have assessed the contribution to climate change made by methane emissions from vehicles as about 0.3 to 0.4 percent of that of the CO_2 emissions from vehicles. We have assessed the contribution to climate change from N_2O emissions from vehicle tailpipes (not including potential emissions associated with fuel production) as about 1 to 3 percent of that of the tailpipe CO_2 emissions from vehicles. Finally, we have estimated that the radiative forcing contribution of HFC-134a leakage from an air-conditioner-equipped vehicle is approximately 3 to 5 percent of that of the CO_2 emitted by the vehicle.[3] When expressed in terms of "CO_2 equivalents," the contribution of vehicle emissions to radiative forcing of climate change is dominated by emissions of CO_2.

CFCs, HFCs, HFOs and the Montreal Protocol

The Montreal Protocol on Substances that Deplete the Ozone Layer (1987) regulates the emissions of ozone-depleting substances such as chlorofluorocarbons (CFCs). Ford has been a leader in conducting research on CFC replacements. In 2010 we were awarded a U.S. Environmental Protection Agency Montreal Protocol Award in recognition of our work in this area. In the 1980s and early 1990s all vehicle manufacturers used CFC-12 (CF2Cl2) as the refrigerant in air conditioning (AC) units. By the mid-1990s vehicle manufacturers switched to hydrofluorocarbon-134a (also known as HFC-134a or CF3CFH2). Hydrofluorocarbons contain only hydrogen, fluorine and carbon. Hydrofluorocarbons do not contain chlorine and hence do not contribute to the well-established chlorine-based stratospheric ozone depletion chemistry. HFC-134a has a shorter atmospheric lifetime and smaller global warming potential than CFC-12 (see Table 1).

The lifecycle emissions of CFC-12 from AC-equipped vehicles in 1990 was approximately 400 g per vehicle per year.[4] We estimate that lifecycle emissions of HFC-134a from vehicles manufactured in 2010 are approximately 100 g per vehicle per year.[5] Looking to the future, based on published assessments,[6] we believe that HFC-134a emissions from a typical light-duty vehicle manufactured in 2017 will be approximately 50 g per vehicle per year.

Regulations in the EU require us to use compounds with global warming potentials of 150 or less in the AC units of all new vehicles starting in 2011 and all registered vehicles starting in 2017. HFC-134a has a global warming potential of 1,370,[7] and the automotive industry will not be able to use this compound in the future in new vehicles in the EU. Hydrofluoroolefins (HFOs) are a class of compounds that are safe for the ozone layer and have very small global warming potential (typically <10). Based upon engineering, environmental and safety assessments, Ford has chosen the compound known as HFO-1234yf (also known as HFC-1234yf or CF3CF=CH2) for use in our European vehicles subject to the above-mentioned legislation timing. Research at Ford[8] has established that HFO-1234yf has a global warming potential of 4.

To place the emissions of CFC-12, HFC-134a and HFO-1234yf into perspective, we can compare their contribution to radiative forcing of climate change with that of CO_2 emitted by the tailpipe of the vehicle. Figure 1 shows this comparison for a typical car in the U.S. from 1990, 2010 and 2016. The CO_2 equivalent (CO_2eq) contributions from refrigerants in Figure 1 were calculated assuming a CFC-12 AC system in 1990, an HFC-134a system in 2010 and either an HFC-134a or an HFO-1234yf system in 2016. The CO_2eq values for CFC-12, HFC-134a and HFO-1234yf were calculated using the emission estimates given above and the global warming potentials given in Table 1. The tailpipe CO_2 values were calculated using the U.S. National Highway Traffic Safety Administration requirement fuel economies of 27.5 mpg in 1990 and 2010 and 37.8 mpg in 2016

Related Links

External Websites:
- Montreal Protocol

and assuming the car is driven 10,000 miles per year.

As seen in Figure 1, the emissions of CFC-12 from an AC-equipped car in 1990 had a climate impact that was actually greater than that of the CO_2 emitted from the tailpipe of the car. Replacement of CFC-12 with HFC-134a, together with improvements in the AC system, has led to a dramatic (approximately 30-fold) decrease in the climate impact of refrigerant emissions per vehicle for an AC-equipped vehicle (compare the two left-hand columns in Figure 1). Looking to the future, we anticipate a further – approximately factor of two – decrease in the impact of HFC-134a emissions on a per-vehicle basis (see the third column in Figure 1). Replacing HFC-134a with HFO-1234yf leads to a further decrease in the climate impact, and the AC refrigerant impact ceases to be discernible in the right-hand column in the figure.

The U.S. Environmental Protection Agency has proposed that HFCs such as HFC-134a should be added to, and regulated as part of, the Montreal Protocol. We do not support the inclusion of HFCs within the Montreal Protocol based upon three well-established scientific facts:

First, HFCs do not contribute to the depletion of stratospheric ozone. HFCs should therefore not be included in the ***Montreal Protocol on Substances that Deplete the Ozone Layer***.

Second, as seen in Figure 1, replacing CFC-12 by HFC-134a has been a major step forward in environmental protection. Retaining the option to use HFC-134a in the future increases our ability to deliver cost-effective solutions for our customers.

Third, emissions of CO_2, CH_4 and N_2O, not HFCs, are the main driver of climate change. (HFCs are currently responsible for less than 1 percent of the radiative forcing by long-lived GHGs.13) Regulations focused on less than 1 percent of the problem are not very useful. We need to adopt a lifecycle perspective and focus on the most cost-effective options. More study, including an assessment of cost effectiveness, is required before enacting blanket restrictions on HFCs.

Figure 1: Annual in-use greenhouse gas (GHG) emissions from typical AC-equipped cars in the U.S. in 1990, 2010 and 2016 using either CFC-12 (in 1990, left-hand bar), HFC-134a (2010 and 2016, middle bars), or HFO-1234yf (right-hand bar) refrigerants.

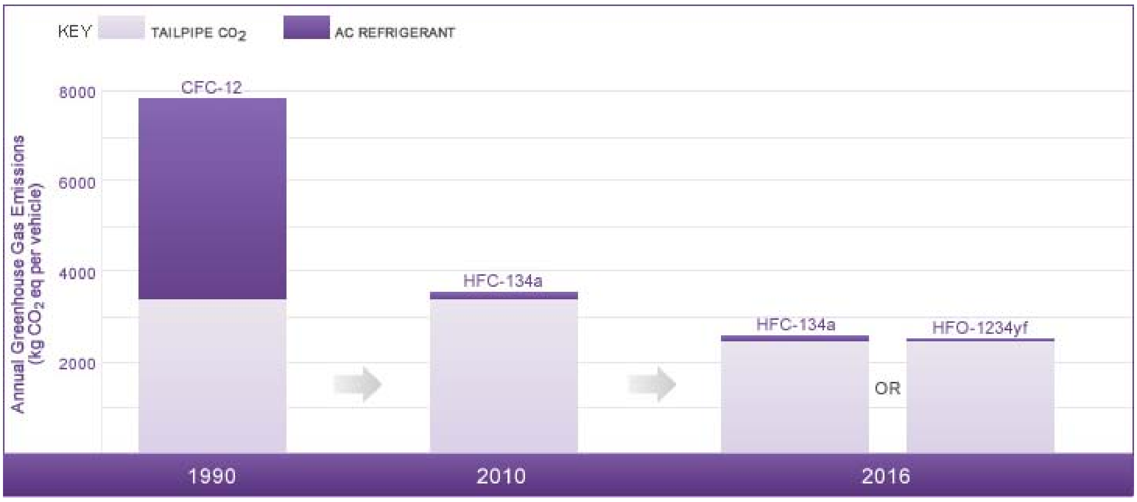

Table 1: Comparison of CFC-12, HFC-134a and HFO-1234yf

Compound	Chemical Formula	Safe for Ozone?	Atmospheric Lifetime[9]	Global Warming Potential[9]
CFC-12	CF_2Cl_2	No	100 years	10,900
HFC-134a	CF_3CFH_2	Yes	13.4 years	1,370
HFO-1234yf	$CF_3CF{=}CH_2$	Yes	11 days	4

1. T.J. Wallington, J.E. Anderson, S.A. Mueller, S. Winkler and J.M. Ginder, “Emissions Omissions,” ***Science*** 327, 268, (2010).
2. T.J. Wallington, J.E. Anderson, S.A. Mueller, S. Winkler, J.M. Ginder and O.J. Nielsen, “Time Horizons for Transport Climate Impact Assessments”, ***Environ. Sci. Technol.*** 45, 3169 (2011).
3. T.J. Wallington, J.L. Sullivan and M.D. Hurley, “Emissions of CO_2, CO, NOx, HC, PM, HFC-134a, N_2O and CH_4 from the Global Light Duty Vehicle Fleet,” ***Meteorol.*** Z. 17, 109 (2008).
4. IPCC/TEAP, ***Special Report: Safeguarding the Ozone Layer and the Climate System***, Cambridge University Press, 2005.
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6. S. Papasavva, D.J. Luecken, R.L. Waterland, K.N. Taddonio and S.O. Andersen, “Estimated 2017 Refrigerant Emissions of 2,3,3,3-tetrafluoropropene (HFC-1234yf) in the United States Resulting from Automobile Air Conditioning,” ***Environ. Sci. Technol.*** 43, 9252, 2009.

7. World Meteorological Organization, *Scientific Assessment of Ozone Depletion: 2010*, Geneva, 2010.
8. O.J. Nielsen, M.S. Javadi, M.P. Sulbaek Andersen, M.D. Hurley, T.J. Wallington and R. Singh, "Atmospheric Chemistry of CF3CF=CH2: Kinetics and Mechanisms of Gas-Phase Reactions with Cl Atoms, OH radicals, and O_3", *Chem. Phys. Lett.* 439, 18 (2007).
9. Data source: WMO/UNEP, Scientific Assessment of Ozone Depletion: 2010, Geneva, 2010.

Lifecycle Vehicle CO_2 Emissions

Lifecycle assessment tracks emissions generated and materials consumed for a product system over its entire lifecycle, from cradle to grave, including material production, product manufacture, product use, product maintenance and disposal at end of life. For vehicles, this includes the environmental burdens associated with making materials (e.g., steel, aluminum, brass, copper, plastics, etc.), fabricating them into parts, assembling the parts into a vehicle, operating the vehicle over its entire lifetime, producing fuel for the vehicle, maintaining the vehicle and finally disposing of the vehicle at the end of its life. Lifecycle assessment is an essential tool when thinking about the environmental impacts of complex systems.

In our report last year, we presented the results of a lifecycle analysis for a representative midsize car and SUV in the U.S. We have used our Product Sustainability Index method to report the lifecycle carbon dioxide (CO_2) emissions from the Ford Galaxy, S-MAX and Fiesta vehicles sold in Europe. Full reports on these vehicles are available online. At present, lifecycle CO_2 emissions from vehicles are dominated by CO_2 released during fuel consumption. Product disposal has a minor impact on airborne emissions and energy consumption relative to other phases of the product system. As vehicle fuel efficiency improves and lower-carbon fuels are made available, the relative contributions of CO_2 emissions from the fuel-consumption phase will likely decrease. We are working on lifecycle emission estimates for electrified vehicles (i.e., plug-in hybrids and Battery Electric Vehicles) and expect to describe the results in future reports.

Related Links

This Report:

- Quantifying Our Environmental Impacts

Climate Change Risks and Opportunities

Over the past decade, concerns about climate change, the price of fuel and energy security – along with the global recession – have dramatically changed the automotive business. This creates substantial risks for automakers but also opportunities for innovation that enable growth and expansion. Below we discuss the general trends driving change in our markets and take a closer look at several key markets. We also discuss the physical and supply chain risks to our business posed by climate change.

Our Markets

There is little doubt that the climate change issue has fundamentally reshaped automotive markets around the world. The policy landscape is becoming more complex and interconnected with other market forces. The Climate Change Policy and Partnerships section of this report discusses regulatory developments in detail, but in brief, all of our major markets are increasingly shaped by government actions to regulate fuel economy and carbon dioxide (CO_2) emissions, introduce low-carbon fuels and provide incentives to shift consumer and business behavior. Many governments are also actively involved in promoting research, development and purchase of new vehicle and battery technologies.

Concerns about fuel prices and price volatility continue to drive a long-term trend toward consumer interest in smaller and more fuel-efficient vehicles. In many markets, energy security concerns are also a driver of fuel economy regulation and alternative fuel development, as governments and consumers seek to rely as much as possible on domestic sources of transportation fuel and reduce imports of petroleum products.

Investors are showing greater concern about climate change as a material risk for many companies. A variety of voluntary public registries and information services (such as the Carbon Disclosure Project) are providing information on greenhouse gas emissions to investors, while in some countries companies are required to disclose information about their climate risks. Thus, providing climate-change-relevant information to investors and shaping our business strategy with climate change in mind are important elements of maintaining access to capital.

These market shifts are very significant to our Company. Everywhere we operate, the financial health of our Company depends on our ability to predict market shifts of all kinds and to be ready with the products and services our customers demand.

Our product globalization strategy is designed to help us respond to changing markets and regional preferences and the risks and opportunities presented by the climate change issue. We have created global platforms that offer superior fuel economy, safety, quality and customer features. We then tailor each global platform to national or regional preferences and requirements. Our pledge that all our vehicles will offer the best or among the best fuel economy in their segment, coupled with a technology migration plan that is based on the science of climate change, positions us to keep pace or get ahead of regulatory requirements. New technology is also cutting the time required to bring new vehicles to market, which helps us respond more effectively to the ever-increasing pace of change in our markets.

This approach has helped us take advantage of the market demand for more fuel-efficient vehicles and gain market share. However, the possibility that fuel prices could decline means there is also a risk that consumer preferences will shift back toward less fuel-efficient vehicles.

Please see the Economy section for further discussion of our changing markets and how we are responding to them, and the Our Strategy: Blueprint for Sustainability section for discussion of Ford's strategic response to the risks and opportunities posed by the climate change issue.

Regional Market Trends

North America

New regulations (discussed in the Climate Change Policy and Partnerships section) and concerns about fuel prices, energy security and the impacts of climate change are encouraging the sale of more fuel-efficient vehicles. Between 2005 and 2010, the car share of the U.S. market increased from 47.2 percent to 49.6 percent, while the truck share declined from 52.8 percent to 50.4 percent. Sales of small cars increased from 19 percent to 21.9 percent of all sales. Sales of hybrid electric vehicles declined in 2010 but began to rise again in early 2011 as the cost of fuel rose significantly.

Europe

Related Links

This Report:
- Climate Change Policy and Partnerships

In Europe, the long-term trend of high-priced fuel and increasing fuel efficiency has continued the market shift toward diesel-powered vehicles, which now make up more than half of all new vehicle sales. This trend is reinforced by sales incentives in some European countries designed to encourage new vehicle sales, with the aim of reducing carbon dioxide emissions from older, less-efficient vehicles. Some of these incentives are bound to upper limits of CO_2 emissions of 160 g/km and less, which has boosted sales of small cars. Other schemes are linked to regulatory emissions standards (e.g., Euro 4 and Euro 5). In addition, tough new CO_2 emission regulations have come into effect, which will continue to drive fuel-economy improvements in new automobiles. Automakers, including Ford, have begun to introduce and announce plans for hybrid electric, battery electric and plug-in hybrid electric vehicles for the European market.

Asia

The Chinese government is actively promoting vehicle electrification and supporting research in this area, based on its desire to support growth and development, balanced with the need for energy security and a cleaner environment. The Chinese government currently provides limited incentives to fleet purchasers of "new energy vehicles" (predominately plug-in electric) under local government control through a pilot program in 20 cities that applies to vehicles made by Chinese automakers. Both domestic and global automakers are considering the introduction of electric vehicles, and a range of micro, medium and full hybrids are currently available.

South America

In Brazil, our largest market in South America, the use of biofuels is widespread as a result of national policy and consumer preference. All gasoline in Brazil is blended with 20 to 25 percent ethanol, and pure ethanol is also widely used. Most new vehicles offered are flexible fuel. While fuel economy and CO_2 emissions are not currently regulated in Brazil, a voluntary fuel-economy labeling program is already in place, along with a star ranking program for light vehicles that favors low-emission, low-CO_2, ethanol, flexible-fuel and hybrid vehicles. Consumers tend to choose vehicles with small engines, and 85 percent of new vehicles purchased have flexible-fuel capabilities. Several hybrid vehicles are currently offered or are planned for introduction to Brazil.

Physical Risks

Global climate change raises the potential for shifting patterns of extreme weather and other risks to our facilities. For insurance purposes, we assess the risks each of our facilities faces (with input from third-party engineers) at least annually. This risk assessment is updated based on new data and takes into account the risk of exposure to hurricanes, tornadoes, other storms, flooding and earthquakes. As a result of this process, we believe we have a good understanding of the physical risks faced by our facilities and how those risks are changing over time.

Extreme weather has the potential to disrupt the production of natural gas, a fuel necessary for the manufacture of vehicles. Supply disruptions raise market rates and jeopardize the consistency of vehicle production. To minimize the risk of production interruptions, Ford has established firm delivery contracts with natural gas suppliers and installed propane tank farms at key manufacturing facilities as a source of backup fuel. Higher utility rates have prompted Ford to revisit and implement energy-efficiency actions that previously did not meet our internal rate of return.

Climate change also has the potential to affect the availability and quality of water. We are examining this issue as part of our water strategy.

Supply Chain Risks

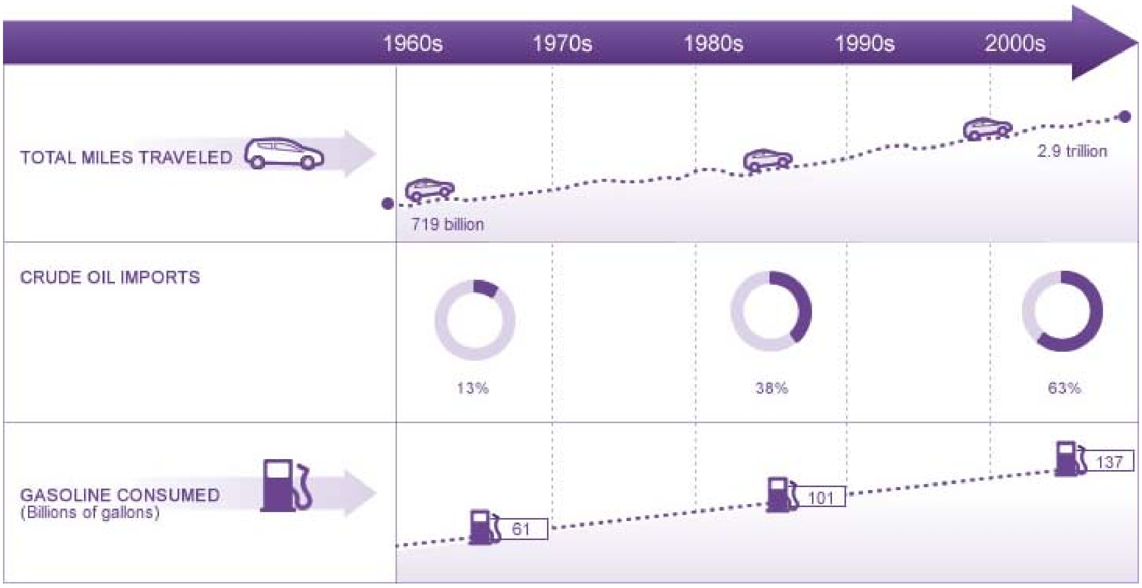
Our suppliers, which are located in more than 60 countries, are subject to market, regulatory and physical risks as a result of GHG regulation and the impacts of climate change. These risks could affect their competitiveness or ability to operate, creating the potential for disruptions to the flow of supplies to Ford. For example, suppliers may be subject to reporting requirements, fees or taxes, depending on where their operations are located. See the Supply Chain section for a discussion of actions we are taking to better understand the climate risks of our suppliers and promote a competitive supply chain.

U.S. Energy Security

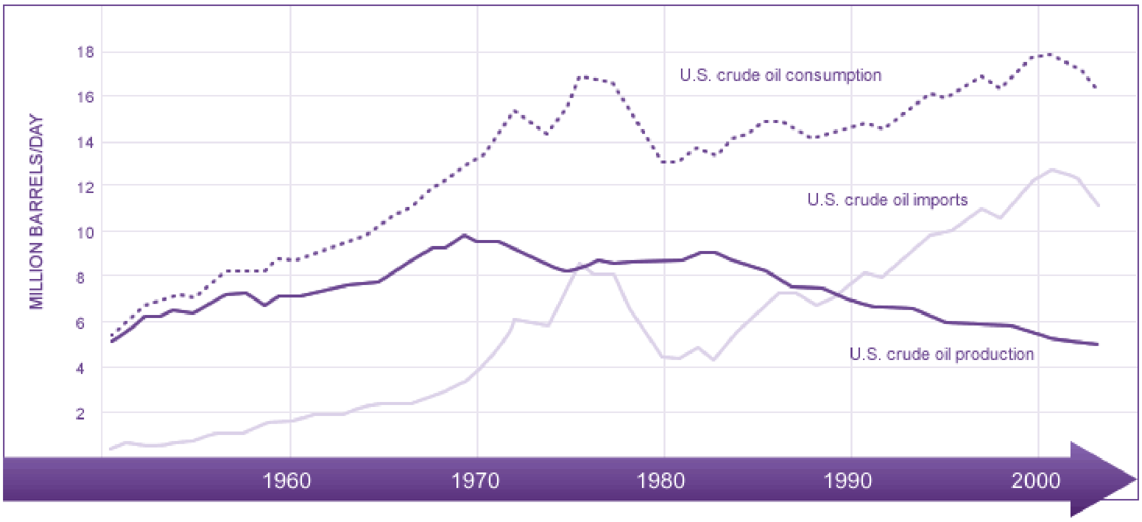
The following charts illustrate the primary issue underlying concerns about U.S. energy security – crude oil consumption is increasing, while domestic energy production is decreasing. Therefore, the U.S. is increasingly reliant on imported crude oil. The first chart shows the increase in the number of miles all U.S. drivers are traveling each year, the increasing percentage of crude oil imports and the increasing consumption of gasoline.

Since the 1970s, the fuel efficiency of new passenger cars more than doubled and fuel economy rates in trucks has increased by 53 percent. This increase is reflected in the chart below, which shows that miles traveled increased by a factor of four while gasoline consumption increased by a little over a factor of two.

The second chart shows the increase in U.S. demand for crude oil and the simultaneous decrease in U.S. crude oil production. Unlike the utility sector, which has a diverse energy portfolio, light-duty transportation is approximately 95 percent reliant on crude oil. This dominance of crude oil, coupled with the growing reliance on foreign countries for supply, is at the core of the U.S. energy security concerns. For example, during the first month after protests began in Libya, U.S. gasoline prices rose almost 15 percent, despite Libya supplying less than 2 percent of global oil and less than 0.5 percent of U.S. oil.



Crude Oil Consumption, Imports and U.S. Production



MATERIAL ISSUES
- Materiality Analysis
- Climate Change
  - Greenhouse Gas Emissions Overview
  - Climate Change Risks and Opportunities
  - Our Strategy: Blueprint for Sustainability
    - Climate Change Governance
    - Climate Change Strategic Principles
    - Ford's Science-Based CO_2 Targets
  - Ford's Sustainable Technologies and Alternative Fuels Plan
  - Progress and Performance
  - Climate Change Policy and Partnerships
  - Electrification: A Closer Look
- Water
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- Vehicle Safety and Driver-Assist Technologies
- Sustaining Ford
- Perspectives on Sustainability

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Our Strategy: Blueprint for Sustainability

To respond to the risks and opportunities posed by the climate change issue, our long-term strategy is to contribute to climate stabilization by:

- Continuously reducing the greenhouse gas (GHG) emissions and energy usage of our operations
- Developing the flexibility and capability to market lower-GHG-emission products, in line with evolving market conditions
- Working with industry partners, energy companies, consumer groups and policy makers to establish an effective and predictable market, policy and technological framework for reducing GHG emissions

Our product plans in all regions are aligned with our overall goal of contributing to climate stabilization. Our blueprint for sustainability, which spells out our technology and product strategy to meet this goal, is based on modeling of vehicle and fuel contributions to emission reductions and an analysis of market and regulatory trends (see figure below).

Product Sustainability Process

The blueprint's product strategy – called the Sustainable Technologies and Alternative Fuels Plan – details steps we are taking in the foreseeable future to develop and deploy vehicle and fuel technologies. The blueprint is supported by our sustainable mobility governance, which establishes structures and accountability for implementing the strategy.

We believe this strategy is already showing results by positioning our Company to take advantage of opportunities created by shifts in markets. We have implemented all of the near-term actions, and our commitment to outstanding fuel economy aligns well with consumer interest in fuel-sipping vehicles. During 2010, for example, our U.S. market share grew for the second year in a row, driven in part by the popularity of several of our vehicles that achieve best-in-class fuel economy.

For the longer term, we are preparing to provide regionally appropriate approaches based on global platforms to advanced vehicle technologies, including electric vehicles, biofuel vehicles and (as fuel and infrastructure become available) hydrogen fuel cell vehicles. In addition, we have conducted dialogues with stakeholders, exploring sustainable mobility projects to demonstrate mobility solutions that meet the needs of urban and rural communities by leveraging information technology to integrate private and public transportation options. Please see the Sustaining Ford section for more details.

Climate Change Governance

Because the climate change issue is so important to us at Ford, it is managed through governance systems at all levels of the Company. The Sustainability Committee of our Board of Directors regularly reviews Ford's actions related to climate change.

Substantive changes to our plans for addressing climate change – whether relating to our products, facilities or policies – are highlighted and agreed to at the highest levels of Ford's executive management through the Business Progress Review process. Related emerging issues are reviewed as needed in Special Attention Review meetings.

In addition, strategic product direction related to climate change goals is provided by a senior executive committee, made up of vice president and executive stakeholders, who guide the development of the vision, policy and business goals. (See Governance and Management Structures.)

Related executive planning teams are responsible for developing detailed and specific policy, product and technical analyses to meet objectives. These teams base their plans on scientific data and promote actions that will help achieve the Company's environmental ambitions, recognizing the need to use a holistic approach to effectively protect the environment. Metrics have been established and are reviewed regularly to ensure satisfactory progress. We have also developed strategic principles to guide our approach.

Climate Change Strategic Principles

Our approach to greenhouse gas (GHG) stabilization is aligned around the following key strategic principles:

1. Technical, economic and policy approaches to climate change need to recognize that all carbon dioxide (CO_2) molecules (or GHG equivalents) produced by human activities make the same contribution to the atmosphere's concentration of greenhouse gases. Once those molecules reach the atmosphere, they contribute to the greenhouse effect, regardless of the source. However, the cost of reducing those emissions varies significantly depending on their source, and we should attempt to achieve the most economically efficient solutions possible.

2. The transportation sector represents a closely interdependent system, characterized by the equation: "Vehicle + Fuel + Driver = GHG emissions." Each link in this chain depends on the others. For example, vehicle manufacturers can bring to market flexible-fuel vehicles, but successfully reducing GHG emissions with them will depend on fuel companies providing renewable biofuels, as well as consumer demand for the vehicles and fuels.

3. Future developments in technologies, ever-changing markets, consumer demand and political uncertainties require flexible solutions. The business strategies that Ford implements, and the public policies that we encourage, must have the flexibility to succeed in a range of potential scenarios.

4. Early affordable steps to reduce GHG emissions from our products and processes may delay the need for drastic and costly reductions later. Lack of agreement on long-term solutions cannot be used as an excuse to avoid near-term actions.

Toolbox

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Ford's Science-Based CO_2 Targets

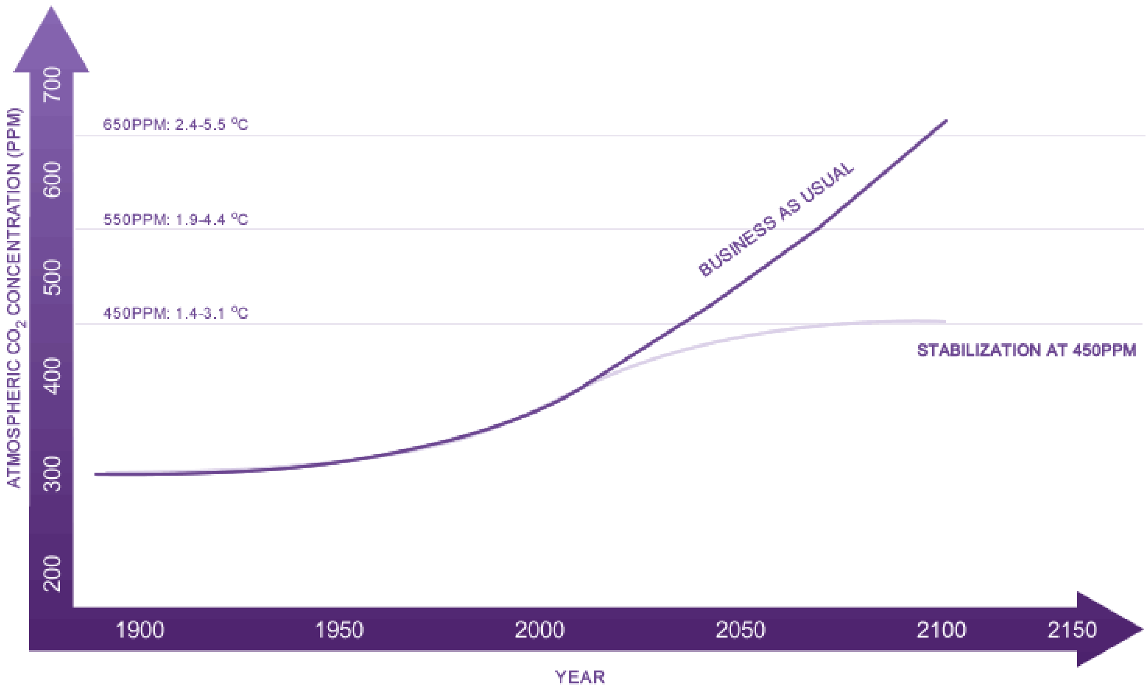
Throughout this report, we refer to Ford's climate goals as "science-based" – specifically, based on the science of climate stabilization. An advantage of this approach is that it gives us an objective, long-term goal focused on an environmental outcome – stabilization of carbon dioxide (CO_2) in the atmosphere. A disadvantage is that the goal can be difficult to explain and communicate. In this section, we delve into our science-based goal by discussing what stabilization means, how we use "glide paths" to align our product plans with emission reductions, and how our "black box" model works and how we use it in our planning.

The stabilization-based goal had its start in 2004, when Ford's internal Climate Change Task Force faced a dilemma. After an extensive study, it was clear to the cross-functional group of senior executives that several forces were converging to fundamentally change vehicle markets, especially in North America and Europe. Current and anticipated greenhouse gas and fuel economy regulation, rising fuel prices and growing consumer awareness of the climate change issue all pointed to a shift in sales toward cars rather than trucks and toward smaller and more fuel-efficient vehicles. We needed to rapidly reorient our product offerings.

But what should drive new product goals? As a practical matter, the Company needed to be able to meet new regulatory mandates. Beyond that imperative, we had taken to heart our responsibility to contribute to meeting the challenge of climate change. So, Task Force members decided to base product planning on the goal of climate stabilization, and they asked Ford's in-house scientists to devise a way to test scenarios for meeting that goal.

Our Stabilization Commitment

Ford researchers have played a leading role in scientific research to understand and quantify the contribution of vehicles to climate change. We have also worked with a variety of partners to understand current and projected manmade GHG emissions and the steps that can be taken to reduce them. Many scientists, businesses and governmental agencies have concluded that stabilizing the atmospheric concentration of CO_2 at approximately 450 parts per million (ppm) may help to forestall or substantially delay the most serious consequences of climate change (see chart below).



Ford has committed to doing our share to stabilize atmospheric CO_2 at 450 ppm. Using a science-based CO_2 model (see A Look Inside the "Black Box"), we have calculated the amount of light-duty vehicle (LDV) CO_2 emissions that are consistent with stabilizing the concentration of CO_2 in the atmosphere at this level. We then calculated the long-term, sustained reductions in the CO_2 emission rate (g/km) from new LDVs that would be needed to achieve 450 ppm atmospheric CO_2, based on projections of vehicle sales and scrappage. Plotting these emission levels over time yields the "CO_2 glide paths" that drive our technology plans.

We have calculated region-specific CO_2 glide paths for North America, Europe, Brazil and China. The glide paths take into account the effects of regional differences in vehicle size and fuel consumption, government regulations and biofuel availability. Although the initial (current) CO_2 emissions rate varies considerably by region, to provide the significant emission reductions needed, all regions need to move toward similar targets. For the light-duty vehicle sector to meet the 450 ppm CO_2 emissions limits, all automakers must reduce their LDV emissions by the same proportion as prescribed by the CO_2 glide paths. We have shared our thinking behind the development of these industry average targets with interested stakeholders and have received positive feedback. We believe that a science-based approach is the right way forward. Ford's sustainability plan is based on these science-based emissions targets. The reductions called for by the glide paths are more aggressive than our previously announced 30 percent reduction goal from 2006 to 2020.

We caution that while our product development plans are based upon delivering long-term reduction in CO_2 emissions from new vehicles similar to those shown for the industry-average glide paths, we anticipate that the year-over-year reductions will vary somewhat from the glide paths. In some years the reductions will be greater than those shown in the glide paths and in other years they will be less. That is because delivering on these targets will be dependent to some degree on market forces that we do not fully control (e.g., changes in energy prices and changes in the mix of vehicles demanded by the consumers in the markets in which we operate). Furthermore, our product strategy is based on multiple inputs, including regulatory requirements, competitive actions and technology plans.

We plan to annually review, and revise where necessary, the assumptions and input data in the CO_2 model. We anticipate that the model will evolve with better understanding over time, and we will report significant changes in future reports.

Climate change is a long-term challenge that demands long-term solutions. We believe a philosophy of continuous improvement implemented over the long term is the correct solution to this challenge. Following the CO_2 reductions called for in our glide path assessment is a significant challenge. It is a commitment that we do not undertake lightly. However, we believe that dramatic reductions in CO_2 emissions are required over the long term to forestall or substantially delay the most serious consequences of climate change, and we are committed to doing our part.

As illustrated in the table below, we have already made significant progress in improving the fuel economy, and hence reducing the CO_2 emissions, from our vehicles.

Nameplate Fuel Economy Improvement Summary

	2001 MY	2011 MY	% FE Improvement (Unadjusted Combined)
FOCUS			13.5[1]
ESCAPE			12.4[2]
EXPLORER			30.8[3]
F-150			12.4[4]

1. Wagon excluded.
2. Hybrids excluded.
3. Explorer Sport, Sport Trac and ethanol-fueled versions excluded.
4. Natural gas, alternative-fueled, bi-fueled and supercharged vehicles excluded.

In 2010, we applied the CO_2 glide path methodology to develop CO_2 targets for our commercial vehicles and facilities. We plan to review our glide path analysis, and update it as appropriate, to incorporate new developments in climate science, new forecasts for vehicle sales and future changes in the CO_2 intensity of fuels (e.g., increased use of biofuels, or oil from tar sands). Any significant changes to the glide path will be discussed in future Sustainability Reports.

To explore which vehicle and fuel technologies might be most cost-effective in the long-term stabilization of atmospheric CO_2 concentrations, we have worked with colleagues at Chalmers University in Gothenburg, Sweden. Specifically, they have assisted us in including a detailed description of light-duty vehicles in a model of global energy use for 2010 to 2100. Nine technology cost cases were considered. We found that variation in vehicle technology costs over reasonable ranges led to large differences in the vehicle technologies utilized to meet future CO_2 stabilization targets. We concluded that, given the large uncertainties in our current knowledge of future vehicle technology costs, it is too early to express any firm opinions about the future cost-effectiveness or optimality of different future fuel and vehicle powertrain technology combinations.[1] This conclusion is reflected in the portfolio of fuel and vehicle technologies that are included in our sustainability strategy. We are continuing to develop the global energy model with researchers at Chalmers. We believe the model will provide valuable insights into cost-effective mobility choices in a future carbon-constrained world.

A Look Inside the "Black Box": The Science Behind Our Scientific Approach

In 2005, Ford's scientists began development of a carbon dioxide (CO_2) model. To create it, they modified the Sustainable Mobility Project model (developed by the International Energy Agency) and combined it with global CO_2 emission-reduction pathways for varying levels of atmospheric CO_2 stabilization (as described by the Model for the Assessment of Greenhouse-Gas-Induced Climate Change, developed by the National Center for Atmospheric Research). The scientists then calculated the CO_2 emission reductions required of new light-duty vehicles up to the year 2050 for a range of CO_2 stabilization levels and different regions of the world, using a simplifying assumption that the rates of CO_2 emission reductions should be the same across all sectors.

At the lower CO_2 stabilization levels, the required emission reductions are extremely challenging and cannot be accomplished using vehicle technology alone. Joint investigations with BP provided insight into how the best new vehicle technologies and low-carbon alternative fuels can jointly and realistically fulfill the low-CO_2 emission requirements. Ford's CO_2 model and other modeling tools were combined to explore assumption sensitivities around vehicle technologies, baseline fuels and biofuels.

The CO_2 model is not intended to provide "the answer," but rather a range of possible vehicle and fuel solutions that contribute to a pathway to CO_2 reductions and, eventually, climate stabilization. Our blueprint for sustainability – and the technology and product actions it spells out – is based on options developed through this modeling exercise.

The model and its results have been a centerpiece of discussions with a variety of stakeholders. Below are some of the questions that have been raised through these discussions, and the answers to them.

How does the model account for emissions growth or reduction in developing countries?

We recognize that developing countries generally have relatively low per-capita energy use but high rates of emissions growth, reflecting growing economies. The CO_2 model uses a science-based approach that allows for growth in developing countries, to derive CO_2 reduction targets for light-duty vehicles consistent with a 450 parts per million (ppm) CO_2 stabilization pathway.

Since fuel use is the dominant cause of CO_2 emissions, how does the model account for projected changes in the carbon footprint of automotive fuels?

Ford has studied multiple scenarios in which the auto industry and the energy industry work together to reduce overall well-to-wheels CO_2 emissions from the light-duty transportation sector. These joint strategy scenarios (see figure below) allow us to develop a least-cost vehicle technology roadmap. For the carbon footprint of fuels, we rely on the well-to-tank CO_2 emissions for different alternative fuels estimated by different region-based models, including the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model for North America, and the EUCAR/JRC/CONCAWE analysis for Europe.

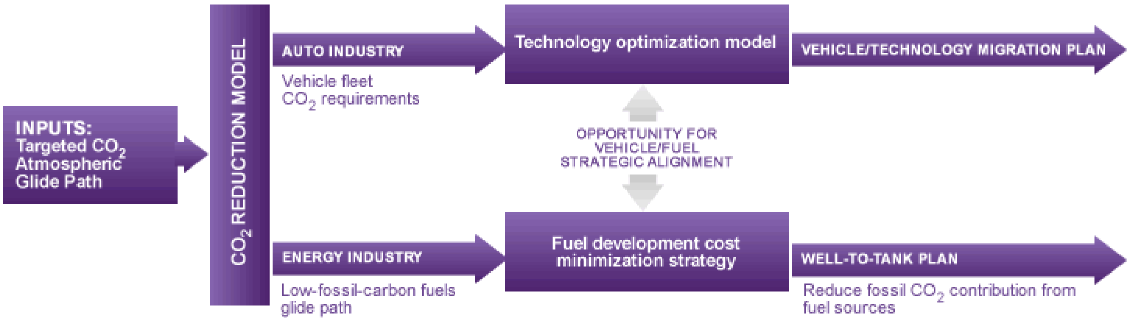
Are you continuing to test alternative scenarios?

In the long run, the roles of consumers, governments and fuel availability will be pivotal in dictating actual CO_2 emission reductions, and Ford continues to take them into consideration in fine-tuning a truly viable and sustainable CO_2 stabilization pathway.

How does the model consider the cost of technologies and alternative fuels?

In a separate study (and as discussed above), Ford and our partner Chalmers University have developed a global energy model that looks into minimal-cost scenarios across different sectors and explores assumption sensitivities around vehicle technologies, fuel technologies, connections between the different energy sectors, and biofuels. The model provides information on the combinations of options that will yield the necessary emissions reductions at an affordable cost to consumers. We have used this model to develop scenarios to assess the global lowest-cost vehicle and fuel technology solutions consistent with CO_2 stabilization.

Ford's Sustainability Framework and Technology Migration Development



1. M. Grahn, M.I. Williander, J.E. Anderson, S.A. Mueller, T.J. Wallington, “Fuel and Vehicle Technology Choices for Passenger Vehicles in Achieving Stringent CO_2 Targets: Connections between Transportation and Other Energy Sectors,” *Environ. Sci. Technol.* 43, 3365 (2009).

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Ford's Sustainable Technologies and Alternative Fuels Plan

IN THIS SECTION

Overview of Our Plan

To meet our science-based climate stabilization goal, we are implementing our plan to significantly improve the fuel economy of our global product portfolio and enable the use of alternative fuels.

READ MORE

A Portfolio Approach

Ford is taking a portfolio approach to developing sustainable technologies and alternative fuel options. Our goal is to provide consumers with a range of different options that improve fuel economy and overall sustainability while still meeting individual driving needs.

READ MORE

Improving Fuel Economy

This section outlines our plans for improving the fuel economy of traditional gasoline and diesel engines. These actions include implementing advanced engine and powertrain technologies, improving aerodynamics and reducing weight.

READ MORE

Migration to Alternative Fuels and Powertrains

Our plans for migrating to alternative fuels and powertrains include implementing vehicles that run on renewable biofuels, increasing advanced clean diesel technologies, increasing our hybrid vehicle applications and introducing battery electric vehicles and plug-in hybrids. We are also working to advance hydrogen fuel cell vehicle technologies.

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Ford's Green Partnerships with Federal and State Governments

Ford is working with federal and state governments to advance the development and commercialization of technologies that improve fuel efficiency and increase the use of alternative fuels and powertrains.

READ MORE

Overview of Our Plan

Our sustainable technologies and alternative fuels plan, mapped out in 2007, is our route to improving the fuel economy and cutting the CO_2 emissions of our products around the world. We have completed the near-term actions and are currently implementing the mid-term actions.

✓ indicates stage completed

2007	2011	2020 – 2030
NEAR TERM Begin migration to advanced technology	**MID TERM** Full implementation of known technology	**LONG TERM** Continue leverage of hybrid technologies and deployment of alternative energy sources
✓ Significant number of vehicles with EcoBoost engines	• EcoBoost engines available in nearly all vehicles	• Increased percentage of internal combustion engines using renewable fuels
✓ Electric power steering	• Electric power steering – high volume	• Volume expansion of hybrid technologies
✓ Dual-clutch and six-speed transmissions replace four- and five-speeds	• Six-speed transmissions – high volume	• Cotninued leverage of plug-in hybrid and battery electric vehicles
✓ Flexible-fuel vehicles	• Weight reduction of 250–750 lbs.	• Introduction of fuel cell vehicles
✓ Additional hybrid applications	• Engine displacement reduction facilitated by weight reductions	• Clean electric/hydrogen fuels
✓ Increased unibody applications	• Additional aerodynamics improvements	• Continued weight reduction through use of advanced materials
✓ Introduction of additional small vehicles	• Increased use of hybrids	
✓ Battery management systems	• Introduction of battery electric and plug-in hybrid vehicles	
✓ Aerodynamics improvements	• Vehicle capability to fully leverage available renewable fuels	
✓ Stop/start systems (micro hybrids)	• Diesel use as market demands	
✓ CNG/LPG prep engines available in select markets	• Increased application of stop/start	

A Portfolio Approach

In the very early years of our industry, automotive engineers experimented with a variety of methods for powering vehicles, including electricity and biofuels. The internal combustion engine using petroleum-based gasoline and diesel rose to the top fairly quickly, and has been the standard vehicle power source for the past 100 years. Reminiscent of those early years, we are now in a period of intense experimentation and adoption of new vehicle technologies and fuels. This time, however, there may be no single winner in the race for the vehicle of the future.

That is why Ford is taking a "portfolio approach" to developing sustainable technologies and alternative fuel options. Our goal is to provide diversity in fueling options, in order to meet customers' differing needs, while improving vehicle energy efficiency and long-term sustainability. We are thus providing customers with a range of affordable, fuel-efficient vehicles, advanced powertrains and alternative-fueled vehicle options.

We also believe that traditional gasoline- and diesel-powered vehicles with internal combustion engines will continue to be a major part of the mix for quite some time. So we are working to improve the fuel efficiency of the engines and transmissions of our current vehicles, along with every vehicle subsystem. For example, we are introducing fuel-saving technologies like our EcoBoost™ engines and efficient six-speed transmissions across a wide range of our traditional gasoline vehicle lineup.

Most importantly, we are developing global vehicle platforms that are compatible with a wide range of fuels and powertrain technologies. This allows us to offer a portfolio of options to our customers, target options to regions where they make the most sense and evolve our vehicles as technologies and markets develop. Global platforms that have "plug-and-play" compatibility with a wide range of technologies will also allow us to make the range of fuel and powertrain options available more affordably. For example, in the next three years we will be introducing an all-electric Ford Focus, a next-generation hybrid electric Ford C-MAX, and the C-MAX Energi plug-in hybrid – all built on our global C-platform.

Also, we currently produce 17 flexible-fuel vehicle models across our global markets that can run on either regular gasoline or E85 (a blend of 85 percent ethanol and 15 percent gasoline). Though biofuels are not available in every market, they are widely available in the U.S. and South America, and in some parts of Europe, so it makes sense for us to provide this option to customers who can take advantage of it. In addition, biofuel availability is expected to increase globally. In Europe, the EU's Renewable Energy Directive mandates that 10 percent of energy in the transportation sector must come from renewable fuels by 2020. In the U.S., the Renewable Fuel Standard requires annual increases in the volume of renewable fuels, reaching 36 billion gallons by 2022. Ford's flexible-fuel vehicles, which are provided at no or low additional cost, allow consumers to choose fuels based on availability and price.

We are also making engines that can be converted to run on compressed natural gas (CNG) and liquefied petroleum gas (LPG) available on select vehicle models. And, we are working with qualified vehicle modifiers to ensure that conversion to those fuels meets our quality, reliability and durability requirements. For example, we recently announced that the new Ford Transit Connect, which went on sale in the U.S. in early 2010, is available with a CNG/LPG conversion-ready engine package. Our F-Series trucks and E-Series vans are also available with a propane-ready engine. In Europe, we offer CNG and LPG conversions of various models in markets with a dedicated infrastructure, such as Italy, Germany and France.

CNG and LPG are particularly good options for fleet customers, such as taxi companies and delivery services, that use a central refueling system. In addition, CNG and LPG are widely available as vehicle fuels throughout South America and Europe. We are delivering CNG/LPG-ready engines to provide another lower-carbon option to those customers for whom this option makes sense.

As noted above, we are also developing a range of electrification technologies, including all-electric, hybrid electric and plug-in hybrid electric vehicles. Our vehicle electrification strategy is based on providing customers with a variety of vehicle choices to meet their driving needs. To read more about this strategy, please see Electrification: A Closer Look. All-electric and plug-in hybrid vehicles may initially make the most sense for urban drivers and fleet users who have daily commutes under 40 miles. However, as battery and recharging options continue to advance, we expect these vehicles to work for a wider range of our customers.

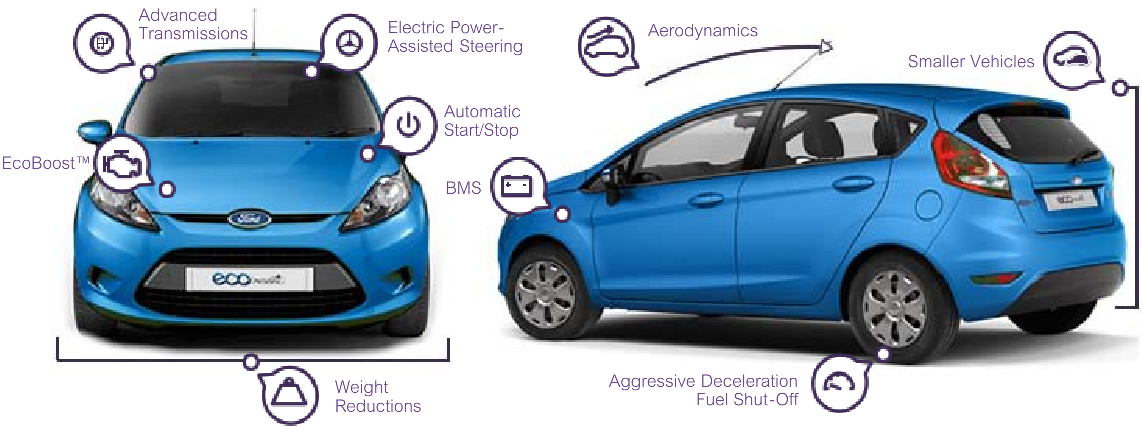
In the longer term, hydrogen may emerge as viable alternative fuel. Hydrogen has the potential to diversify our energy resources and lower lifecycle greenhouse gas emissions, if low-carbon hydrogen production becomes feasible. To prepare for this, we are developing technology to power vehicles with hydrogen fuel cells. In addition, we are working to pair hydrogen fuel cell technology with vehicle electrification technologies to maximize the sustainability benefits of both technologies.

Related Links

This Report:
- Electrification: A Closer Look

This section describes our current actions and future plans to develop a wide range of energy-efficient technologies, alternative fuels and advanced powertrain technologies that will give our customers near-, mid- and longer-term options for more sustainable vehicles.

Improving Fuel Economy



This section outlines our plans for improving the fuel economy of traditional gas and diesel engines. These actions include implementing advanced engine and transmission technologies, weight reductions and aerodynamic improvements, as well as increasing the efficiency of vehicle sub-systems.

For more information about each of our fuel efficiency technologies please click on the icons in the graphic above.

EcoBoost™

✓ indicates stage completed

2007	2011	2020 – 2030
NEAR TERM Begin migration to advanced technology	**MID TERM** Full implementation of known technology	**LONG TERM** Continue leverage of hybrid technologies and deployment of alternative energy sources
✓ Significant number of vehicles with EcoBoost engines	• EcoBoost engines available in nearly all vehicle nameplates	• Increase percentage of internal-combustion engines dependent on renewable fuels

The centerpiece of our near-term fuel-economy improvement efforts is the EcoBoost engine, which uses turbocharging and direct injection along with reduced displacement to deliver significant fuel-efficiency gains without sacrificing engine power or vehicle performance. EcoBoost engines help to improve vehicle fuel economy 10 to 20 percent and reduce carbon dioxide (CO_2) emissions up to 15 percent compared to larger-displacement engines.

EcoBoost offers better value than many other advanced fuel-efficiency technologies. Due to its affordability relative to competing powertrain options, and its compatibility with most of the gas-powered vehicles we produce, we are able to migrate EcoBoost's fuel-economy benefits throughout our product lineup more quickly and to a greater number of our customers. Our rapid deployment of EcoBoost in high volumes across a wide array of our vehicle nameplates is also helping us make a dramatic step forward in CO_2 emission reductions.

EcoBoost was first introduced in North America as a 3.5L V6 engine on the 2010 Lincoln MKS, Lincoln MKT, Ford Taurus SHO and Ford Flex. This engine provides similar performance to a normally aspirated V8 engine, but with the fuel economy of a V6. Thanks largely to EcoBoost technology, the V6 Ford Taurus SHO and Lincoln MKT deliver unsurpassed fuel economy in their respective segments.

EcoBoost has thus far proven to be a great success. For example, EcoBoost is influencing many consumers to consider and buy Ford vehicles who were not previously Ford customers. In other words, it is increasing Ford's "conquest rate" – i.e., the number of customers who are switching from other manufacturers to buy Ford vehicles. The Taurus SHO with EcoBoost now has the highest conquest rate in its segment, and the Flex EcoBoost has a more than 65 percent conquest rate after two years on sale. EcoBoost is proving especially attractive to 35- to 55-year-old males, an important demographic that has been less likely to purchase Ford vehicles in the past.

In addition to these commercial successes, the EcoBoost engine has received multiple awards, including the "Breakthrough" award from ***Popular Mechanics*** and a "10 Best Engines" award from ***Ward's***.

We continue to expand the application of EcoBoost technology to more engine types and vehicles. In 2010 and 2011, for example:

- We introduced the 3.5L V6 EcoBoost on the Ford F-150. The F-150 with EcoBoost is the most fuel-efficient pickup truck in its class, with a rating from the U.S. Environmental Protection Agency of 16 mpg city and 22 mpg highway.[1] The new F-150 also has best-in-class torque, payload and towing capacity.
- We also introduced a 2.0L EcoBoost engine, which is the first in the EcoBoost lineup to go truly global.
  - In the U.S., we will be introducing the 2.0L I-4 EcoBoost on the 2012 Ford Edge and the all-new 2012 Ford Explorer and 2012 Ford Focus. These are the first four-cylinder EcoBoost engines available in the U.S. The Edge and Explorer with the 2.0L I-4 EcoBoost are expected to deliver best-in-class fuel economy, with the performance feel of a traditional V6. The Explorer will feature fuel economy at least 20 percent better than the current model. We are also introducing the first high-performance vehicle with an EcoBoost engine – the Ford Focus ST, a special high-performance version of the Focus.
  - In Europe, we introduced the Ford S-MAX and Galaxy with a 2.0L EcoBoost option.
  - In China, we launched the 2.0L EcoBoost engine on the Ford Mondeo.
  - In 2011, we will introduce the 2.0L EcoBoost on the Mondeo followed by the Falcon in 2012 in Australia.
- We debuted a 1.6L I-4 EcoBoost on the 2011 Ford C-MAX in Europe. This engine is also now available in the all-new Ford Focus European version, and we plan to offer it in the 2013 Ford C-MAX, which will be available in the U.S.
- We revealed a 1.0L three-cylinder EcoBoost engine at the Paris Auto Show in 2010. This engine delivers the power of a 1.6L I-4 with better fuel economy. We plan to introduce it for use in Europe and other global markets.

These EcoBoost engines illustrate Ford's plans to use smaller-displacement, power-boosted engines to deliver improved fuel economy and performance throughout our vehicle lineup.

By 2013, Ford plans to offer EcoBoost engines on 85 to 90 percent of our North American and European nameplates and continue to migrate them to our other regions.

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1. The F-150's fuel efficiency is compared to other high-volume pickup trucks, not including low-volume special fuel-economy models.

Advanced Transmissions

✓ indicates stage completed

2007	2011	2020 – 2030
NEAR TERM Begin migration to advanced technology	MID TERM Full implementation of known technology	LONG TERM Continue leverage of hybrid technologies and deployment of alternative energy sources
✓ Dual-clutch and six-speed transmissions begin replacing four- and five-speeds	• Full implementation of six-speed transmissions	

To further improve the fuel economy of our vehicles, we are implementing a dual-clutch transmission system called PowerShift. PowerShift combines manual and automatic transmission technologies to deliver the fuel efficiency of a manual with the driving ease of an automatic. It uses six speeds instead of the four or five on most automatics, which further increases fuel efficiency. PowerShift technology increases fuel efficiency by up to 9 percent compared to traditional four-speed automatic transmissions, depending on the application.

A "wet clutch" version of this technology has already been implemented in Europe on the Ford Focus, C-MAX, Kuga, S-MAX, Galaxy and Mondeo, in combination with a 2.0L Duratorq® TDCi diesel. The wet clutch version is also the standard transmission for the new 2.0L EcoBoost™ engine on the Ford Mondeo, S-MAX and Galaxy.

A "dry clutch" version was introduced in North America in April 2010 on the all-new Ford Fiesta and subsequently on the new Ford Focus in November 2010. The dry clutch version gets even better gas mileage. Unlike wet clutch systems, the dry PowerShift transmission does not use an oil pump, making the system more efficient with the same weight as a traditional four-speed automatic transmission.

We are also introducing conventional six-speed transmissions to replace less-efficient four- and five-speed transmissions in a range of vehicles, including the new Super Duty® with 6.2L and 6.7L engines and all of the Ford Mustang, F-150 and new Explorer powertrain options. Six-speed transmissions improve fuel economy by up to 5 percent compared to typical four- and five-speed gearboxes; they also provide better acceleration, smoother shifting and a quieter driving experience. By the end of 2012, 98 percent of Ford's North American transmissions will be advanced six-speed gearboxes. And by 2013, we plan to offer advanced six-speed transmissions – both PowerShift and conventional six-speed technology – on 100 percent of our new, non-hybrid vehicles in Europe and North America and many new vehicles in other regions.

In the near term we are improving the performance of our PowerShift and conventional transmissions by further optimizing their operation with EcoBoost engines and reducing parasitic losses, such as mechanical friction and unnecessary hydraulic and fluid pumping, to achieve higher operating efficiency. In the longer term we will be researching advanced transmission concepts to support further engine downsizing and electrification.

Electric Power-Assisted Steering (EPAS)

✓ indicates stage completed

2007	2011	2020 – 2030
NEAR TERM Begin migration to advanced technology	MID TERM Full implementation of known technology	LONG TERM Continue leverage of hybrid technologies and deployment of alternative energy sources
✓ Electric power steering	• Full implementation of electric power steering	

We are phasing in electric power-assisted steering technology, which typically will reduce fuel consumption and decrease carbon dioxide emissions by up to 3.5 percent over traditional hydraulic systems, depending on the vehicle and powertrain application. On the 1.4L Duratorq® diesel Ford Fiesta, for example, which is available in Europe, EPAS provides a 3–4 percent improvement in fuel efficiency compared with a hydraulic-based power steering system. By combining EPAS with aerodynamic improvements, we improved the mileage of this vehicle by approximately 8 percent compared to the previous model year. In addition, EPAS supports other fuel-saving activities we plan to introduce. For example, "automatic start/stop" technology can be introduced without degrading steering assist to the driver. (For details on this technology, see Automatic Start/Stop.)

In 2010 and 2011, we added EPAS to the all-new Ford Explorer, Ford F-150, Ford Mustang and Lincoln MKZ hybrid in North America, as well as the new Ford C-MAX and Focus in North America and Europe. This adds to our existing lineup of vehicles with EPAS – the Ford Fusion, Flex, Taurus and Escape and the Lincoln MKS and MKT in North America, as well as the Ford Fiesta and Ka in Europe. Ultimately, we will introduce EPAS into all of our passenger cars and light-duty vehicles.

Automatic Start/Stop

✓ indicates stage completed

2007	2011	2020 – 2030
NEAR TERM Begin migration to advanced technology	MID TERM Full implementation of known technology	LONG TERM Continue leverage of hybrid technologies and deployment of alternative energy sources
✓ Start/stop systems (micro hybrids)	• Increased application of start/stop systems	

We have developed a "start/stop" technology that shuts down the engine when the vehicle is stopped and automatically restarts it before the accelerator pedal is pressed to resume driving. This technology maintains the same vehicle functionality as a vehicle without the technology, but it improves city driving fuel economy by up to 6 percent. The gain can be as high as 10 percent for some drivers, depending on vehicle size and usage. The technology can also reduce tailpipe emissions to zero while the vehicle is stationary, for example when waiting at a stoplight.

Start/stop technology includes sensors to monitor functions such as cabin temperature, power supply state and steering input, so that vehicle functioning remains exactly the same to the driver as when the engine remains on continuously. If the system senses that a vehicle function has been reduced and will negatively impact the driver's experience, the engine will restart automatically.

Start/stop technology is already being used in our hybrid vehicles and will eventually provide a cost-effective way to improve fuel efficiency on a large volume of non-hybrid vehicles. In the U.S., we are planning to introduce the technology into non-hybrid vehicles in 2012. When it debuts in the U.S. it will be available on automatic transmission vehicles, including those with fuel-efficient six-speed automatic transmissions. In Europe, automatic start/stop is already standard on the

Ford Ka and certain versions of the Mondeo, S-MAX and Galaxy. It is launching in 2011 on the Ford Focus, C-MAX and Grand C-MAX. By 2016, 90 percent of our vehicle nameplates globally will be available with start/stop technology.

Weight Reductions

✓ indicates stage completed

2007	2011	2020 – 2030
NEAR TERM Begin migration to advanced technology	MID TERM Full implementation of known technology	LONG TERM Continue leverage of hybrid technologies and deployment of alternative energy sources
✓ Increased unibody applications	• Weight reductions of 250–750 lbs	• Continue weight reductions using advanced materials

We are also working to improve fuel economy by decreasing the weight of our vehicles – in particular by increasing our use of unibody vehicle designs, lighter-weight components and lighter-weight materials.

Unibody vehicle designs reduce weight by eliminating the need for the body-on-frame design used in truck-based products. Unibody-based crossover vehicles provide many of the benefits of truck-based SUVs, such as roominess, all-wheel drive and higher stance, with significantly reduced total vehicle weight. The all-new 2011 Ford Explorer uses a lightweight unibody design, as do the current Ford Edge and Lincoln MKX crossovers.

EcoBoost™ engine technology allows us to use a smaller, lighter-weight engine system while delivering more power and better fuel economy. Similarly, the dual-clutch PowerShift system weighs up to 30 pounds less than the four-speed automatic transmission it is replacing.

The lighter-weight materials we are using include advanced high-strength steel, aluminum, magnesium, natural fibers and nano-based materials. These "lightweighting" efforts can reduce the weight of our vehicles by 250 to 750 pounds, without compromising vehicle size, safety, performance or customer-desired features. The following are examples of our use of lighter-weight materials:

- The 2010 Lincoln MKT crossover has an advanced lightweight magnesium and aluminum liftgate.
- We use an aluminum hood on the Ford F-150 and high-strength, lighter-weight steels in more than 50 percent of the F-150 cab.
- The 2011 Ford Explorer makes extensive use of high-strength steels. Nearly half of the vehicle's structure – including the A-pillars, rocker panels and front beams – are comprised of high-strength steels, such as boron.
- In the 2012 Ford Focus, more than 55 percent of the vehicle shell is made from high-strength steel and more than 26 percent of the vehicle's structure is formed from ultra-high-strength boron steels. The Focus combines these high-strength steels with innovative manufacturing methods to further reduce weight. For example, the vehicle's B-pillar reinforcement, a key structural part, is made from ultra-high-strength boron steel that has been produced using an innovative tailor-rolling process. The process allows the thickness of the steel sheet to be varied along its length, so the component has increased strength in the areas that are subjected to the greatest loads. The tailor-rolled B-pillar has eight different gauge thicknesses, to improve side-impact crash performance while saving more than three pounds per vehicle.
- We are also expanding our use of aluminum engine parts and all-aluminum engines. The 2011 Mustang, for example, has an aluminum engine. Combined with other fuel-efficiency improvements, this lighter-weight engine delivers class-leading fuel economy at 19 mpg city/30 mpg highway with a six-speed automatic transmission – a 25 percent improvement over the 2010 model.

Please see the Environment section for further information on materials-based weight reductions.

Battery Management Systems (BMS)

✓ indicates stage completed

2007	2011	2020 – 2030
NEAR TERM Begin migration to advanced technology	MID TERM Full implementation of known technology	LONG TERM Continue leverage of hybrid technologies and deployment of alternative energy sources
✓ Introduction of battery management systems		

Electrical systems are another area in which we are making progress. By reducing vehicle electrical loads and increasing the efficiency of the vehicle's electrical power generation systems, we can improve fuel efficiency. Our battery management systems, for example, control the power supply system (in particular the alternator) to maximize the overall efficiency of the electrical system and reduce its negative impacts on fuel economy. This is accomplished by maximizing electricity generation during the most fuel-efficient situations, such as vehicle deceleration. In less fuel-efficient situations, the alternator's electricity generation is minimized to conserve fuel. BMS has already been launched in Europe on the Ford Focus and Mondeo and in the U.S. beginning with the 2011 Ford Edge, Explorer and F-150, the 2011 Lincoln MKX, and the 2012 Ford Focus. We have also introduced more-efficient alternators, which improve fuel economy.

Agressive Deceleration Fuel Shut-Off

✓ indicates stage completed

2007	2011	2020 – 2030
NEAR TERM Begin migration to advanced technology	MID TERM Full implementation of known technology	LONG TERM Continue leverage of hybrid technologies and deployment of alternative energy sources
✓ Begin implementing ADFSO	• ADFSO at high volume	

We are deploying Aggressive Deceleration Fuel Shut-Off technology to improve fuel efficiency. ADFSO allows fuel supply to the engine to be shut off during vehicle deceleration and then automatically restarted when needed for acceleration or when the vehicle's speed approaches zero. This new system builds on the Deceleration Fuel Shut-Off technology available in our existing vehicles by extending the fuel shut-off feature to lower speeds and more types of common driving conditions, without compromising driving performance or non-carbon dioxide emission reductions.

This improved fuel shut-off will increase fuel economy by an average of 1 percent. An additional benefit of the ADFSO technology is increased deceleration rates, which should extend brake life and improve speed control on undulating roads.

Starting in 2008 this technology was implemented on the Ford Flex, F-150, Expedition and Escape and the Lincoln MKS and Navigator. We are continuing to implement it as we bring out new vehicles. For example, the 2011 Ford Edge, Ford Explorer and Lincoln MKX use ADFSO. The ADFSO technology will be a standard feature in all of our North American vehicles by 2015, and we will continue to expand implementation globally.

Aerodynamics

✓ indicates stage completed

2007	2011	2020 – 2030
NEAR TERM Begin migration to advanced technology	MID TERM Full implementation of known technology	LONG TERM Continue leverage of hybrid technologies and deployment of alternative energy sources
✓ Aerodynamic improvements	• Additional aerodynamic improvements	

We are optimizing vehicle aerodynamics to improve the fuel economy of our global product lineup. Using a systems engineering approach that integrates aerodynamics in an interdisciplinary and collaborative design and development processes with other fuel-economy technologies, we maximize the fuel efficiency of every vehicle we develop. During the development process, we use advanced computer simulations and optimization methods coupled with wind-tunnel testing to create vehicle designs that deliver up to 5 percent better fuel economy. In addition, we are developing simulation systems that allow us to replicate on-the-road driving conditions during the virtual design phase, to further improve the real-world benefits of aerodynamic improvements.

Using these approaches, we made significant improvements in aerodynamics in 2010. For example:

- In North America, we improved the fuel efficiency of Ford's midsize family sedans, including the 2010 Ford Fusion and Lincoln MKZ, by reducing aerodynamic drag by 5 percent. We accomplished this by further streamlining the exterior design and lowering the vehicles' ride height. These aerodynamic improvements were a key enabler for the Ford Fusion Hybrid's 41 mpg rating, which makes it the most fuel-efficient midsize sedan available in North America.[1]
- We have also reduced the aerodynamic drag of the 2010 Mustang by 4 percent for the V6 model and 7 percent for the V8 model. These aerodynamic improvements resulted in a 0.5

mpg and 1 mpg improvement in fuel economy at 70 mph cruising speeds, for the V6 and V8 models respectively.

- We improved the fuel economy of the 2011 Ford Edge and Lincoln MKX compared to the 2010 models in part through aerodynamic improvements, including underbody shielding, tire spoilers and optimized grille openings that reduce excess airflow to the engine compartment, thus reducing drag. The 2011 Edge and MKX have best-in-class fuel economy in their segments.
- In the 2011 Ford Explorer, we improved fuel economy by almost 1 mpg at highway speeds by coordinating the design of the front-mounted air dam and the rear roof-mounted spoiler.

For 2011, we are continuing to build on these improvements. For example, aerodynamic improvements helped the 2011 Ford Fiesta SFE achieve a U.S. Environmental Protection Agency-rated 40 mpg. Also in 2011, we introduced an “active grille shutter” technology that reduces aerodynamic drag by up to 6 percent, thereby increasing fuel economy and reducing carbon dioxide (CO_2) emissions. When fully closed, the reduction in drag means that the active grille shutter can reduce CO_2 emissions by 2 percent. This technology was implemented first on our European vehicles; in the U.S. the 2012 Ford Focus is the first vehicle to use it. Through that technology and other design improvements, we have significantly reduced the drag coefficient on the all-new 2012 Focus four-door to 0.297 from the current model’s 0.320. Optimized aerodynamics also helps reduce wind noise in the Focus.

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1. Midsize sedan segment based on the R.L. Polk segment definition.

Smaller Vehicles

✓ indicates stage completed

2007	2011	2020 – 2030
NEAR TERM	MID TERM	LONG TERM
Begin migration to advanced technology	Full implementation of known technology	Continue leverage of hybrid technologies and deployment of alternative energy sources
✓ Introduction of additional small vehicles	• Engine displacement reductions facilitated by weight savings	

Smaller vehicles provide consumers with another way to get better fuel economy. We are launching more small cars to provide more fuel-efficient options. For example:

- We are introducing subcompact vehicles commonly referred to as “B-cars.” These include the all-new Ford Fiesta, which was introduced in Europe in 2008, the Asia Pacific region in 2009 and the Americas in 2010.
- We are introducing a wide range of new vehicles in the U.S. and other markets based on our global “C-platform,” or compact sedan. At the 2011 North American Auto Show we showcased 10 new vehicles based on this C-platform, most of which will be available in the U.S. in the next few years. In 2011 we are introducing the next-generation global Ford Focus to North America. This vehicle includes the first in a series of powertrain technology developments that will give our C-car segment offerings a combination of power, performance and unsurpassed fuel economy. For example, the Focus will be equipped with a responsive, fuel-efficient, 2.0L I-4 engine with twin independent variable camshaft timing and direct injection, plus a dual-clutch PowerShift transmission. We will also offer a battery electric version called the Focus Electric. In addition, we are introducing the Ford C-MAX in the U.S., a multi-activity vehicle based on our C-platform. This vehicle will also ultimately include a hybrid and plug-in hybrid version.
- We brought the European Transit Connect small commercial van to North America. This vehicle fills an unmet need in the U.S. market by offering the large cargo space that small business owners need in a fuel-efficient, maneuverable, durable and flexible vehicle package.

We also loaded these smaller vehicles with features and options commonly found on larger or luxury vehicles to make them attractive, thus encouraging customers to choose more fuel-efficient cars and trucks.

All of these smaller vehicles illustrate Ford’s actions to provide consumers with a wider range of fuel-efficient options, as well as our efforts to leverage the best of our global products to offer new choices to customers in all of our regions worldwide.

Migration to Alternative Fuels and Powertrains

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Renewable Biofueled Vehicles


FCVs

At Ford, our plans for migrating to alternative fuels and powertrains include implementing vehicles that run on renewable biofuels, increasing advanced clean diesel technologies, increasing our hybrid vehicle applications and introducing battery electric vehicles and plug-in hybrids. We are also working to advance hydrogen-powered vehicle technologies.

For more information on our plans regarding each of these alternative fuels and powertrain technologies, please click on the Ford vehicles above.

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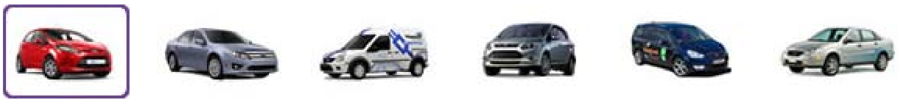

Advanced Clean Diesel | HEVs | BEVs | PHEVs | Renewable Biofueled Vehicles | FCVs

Advanced Clean Diesel

Ford Fiesta ECOnetic

Modern diesels are 30–40 percent more fuel efficient than gasoline vehicles. Ford offers a range of advanced diesels in Europe under the ECOnetic label. In the U.S., Ford introduced a new diesel engine on the 2011 F-Series Super Duty® truck that has 20 percent better fuel economy than the outgoing model.

2007 — 2011 — 2020 — 2030

NEAR TERM – Begin migration to advanced technology

MID TERM – Full implementation of known technology

LONG TERM – Continue deploying advanced powertrains and alternative fuels and energy sources

Advanced Clean Diesel

Modern diesels offer some significant advantages over traditional gasoline engines. They consume 30 to 40 percent less fuel, and on a well-to-wheels basis they emit 15 to 30 percent less carbon dioxide (CO_2).[1] In addition, direct-injection diesel engines provide exceptional power and torque, resulting in better driving performance and towing capabilities.

In Europe, diesel-powered vehicles account for more than 50 percent of new vehicle sales and make up approximately 30 percent of the total vehicle fleet on the road. Ford continues to improve its strong lineup of fuel-efficient and clean diesel vehicles in Europe. For example, we continue to introduce ECOnetic versions of Ford models that deliver improved fuel economy and emissions. The ECOnetic lineup currently includes versions of the Ford Fiesta, Focus, Mondeo and Transit. Several of the ECOnetic models use diesel engines, which meet the stringent Euro 5 emissions standards and emit less than 100 g/km of CO_2. For example, the Fiesta ECOnetic has fuel economy of 3.7 liters/100 km and emits just 98 g/km of CO_2. This vehicle is powered by a specially calibrated version of the 95-horsepower PowerShift 1.6L Duratorq TDCi, combined with a coated diesel particulate (soot) filter.

In the North American medium-duty truck market, diesel engines account for more than 50 percent of sales. In response to this demand, Ford introduced an all-new 2011 F-Series Super Duty® truck with a state-of-the-art diesel engine, new six-speed transmission and urea/selective catalytic reduction after-treatment system. The 6.7L Power Stroke® V8 diesel is cleaner and has 20 percent better fuel economy, 14 percent more power and 23 percent more torque relative to the outgoing model.

This new diesel engine also meets the U.S. Environmental Protection Agency's and the California Air Resources Board's strict 2010 heavy-duty truck emission regulations, which require 80 percent lower NOx emissions than the 2007 regulations. The new Super Duty uses a range of advanced technologies to meet the new regulations. For example, its 6.7L Power Stroke engine employs an innovative exhaust gas recirculation system with two independent cooling loops, which enable optimal combustion phasing for fuel economy while reducing NOx emissions from the engine into the after-treatment system. In addition, the after-treatment system has three key parts, including:

- a diesel oxidation catalyst that converts and oxidizes hydrocarbons into water and carbon dioxide;

- a selective catalytic reduction that uses an ammonia and water solution to convert the NOx in the exhaust stream into water and inert nitrogen; and
- a diesel particulate filter that traps any remaining soot and periodically burns it away when sensors detect that the trap is full.

The engine will also use a high-precision, common-rail fuel-injection system featuring piezo-electric injectors. This system uses a stack of more than 300 wafer-thin ceramic platelets to control the fuel injector nozzle, allowing it to operate faster than other electro-mechanical fuel injectors, decrease fuel consumption and reduce emissions.

The 2011 Super Duty is Ford's first vehicle in North America that is B20 compatible, meaning it can run on fuel composed of 20 percent biodiesel and 80 percent ultra-low-sulfur diesel. Biodiesel is a renewable fuel made from soybean oil and other fats. We went through extensive testing to ensure that this new truck would meet performance and durability requirements when fueled with B20, including running durability cycles on multiple blends of diesel and biodiesel fuels to ensure the robustness of the system. Previously, Ford Super Duty products in North America were approved to use B5 fuel, which is composed of 5 percent biodiesel and 95 percent petroleum diesel. In Europe, our vehicles are also compatible with B5, and we are working with European fuel standards organizations to establish fuel-quality standards for biodiesel blends greater than B5. The use of biodiesel helps to reduce dependence on foreign oil and reduces lifecycle CO_2 emissions. For more information on biofuels, please see the Renewable Biofueled Vehicles section.

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1. Figures based on J.L. Sullivan, R.E. Baker, B.A. Boyer, R.H. Hammerle, T.E. Kenney, L. Muniz, and T.J. Wallington, 2004, "CO_2 Emission Benefit of Diesel (versus Gasoline) Powered Vehicles," *Environmental Science and Technology*, 38: 3217-3223.

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Hybrid Electric Vehicles (HEVs)

Ford Fusion

HEVs are powered by a traditional internal combustion engine and battery power to deliver improved fuel economy. Ford is the largest domestic manufacturer of hybrid vehicles in the U.S. and has announced plans to introduce hybrids in Europe by 2013.

2007	2011	2020 — 2030
NEAR TERM Begin migration to advanced technology	MID TERM Full implementation of known technology	LONG TERM Continue deploying advanced powertrains and alternative fuels and energy sources

Hybrid Electric Vehicles (HEVs)

Ford is currently the largest domestic producer of hybrid vehicles, with more than 160,000 on the road as of March 2011. Ford introduced its first hybrid in 2004, the Ford Escape Hybrid, which was also the world's first hybrid SUV. We followed up with the Mercury Mariner Hybrid in 2005. In early 2009 we further expanded our hybrid vehicle lineup by introducing the Ford Fusion and Mercury Milan Hybrids. All of these vehicles are full parallel hybrids, meaning they can run exclusively on battery power, exclusively on gas power or on a combination of both to deliver the best overall fuel efficiency. We are currently increasing our hybrid volume, targeting a cost reduction of more than 30 percent in our 2012 next-generation hybrid systems and preparing for hybrid capability across our highest-volume global product platforms.

The Ford Fusion Hybrid has a U.S. Environmental Protection Agency fuel economy rating of 41/36 mpg city/highway, making it the most fuel-efficient midsize sedan in the U.S.[1] The Fusion Hybrid's fuel economy significantly exceeds that of its nearest midsize sedan competitor, and it can go more than 700 miles on a single tank of fuel. It includes an innovative new SmartGauge™ with EcoGuide instrument cluster that coaches hybrid drivers to maximize fuel efficiency.

In 2010, we launched the Lincoln MKZ Hybrid, which is the most fuel-efficient luxury sedan in America and is available at the same price as the gas model MKZ. In 2011, we announced the introduction of a hybrid version of the Ford C-MAX multi-activity vehicle. This will be one of three electrified vehicle options based on our C-platform. The others are the Focus Electric (a battery electric vehicle, or BEV), the C-MAX Energi (a plug-in hybrid, or PHEV) and the C-MAX Hybrid. The hybrid variant of the C-MAX will build on the fuel economy leadership of the Ford Fusion Hybrid, already the most fuel-efficient mid-sized sedan in America. This vehicle will use the Company's powersplit hybrid architecture, with improved fuel efficiency and a lighter, smaller lithium-ion battery system. The C-MAX Hybrid and C-MAX Energi, along with another still-to-be-announced HEV, will be introduced in North America by 2012 and in Europe by 2013.

Our next-generation hybrids will also have a suite of driver information systems to help drivers maximize fuel efficiency. They will feature an enhanced version of the MyFord Touch™ driver interface system that can be configured to show different levels of information, including fuel and battery power levels, as well as average and instant miles per gallon.

1. Midsize sedan segment based on the R.L. Polk segment definition.

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Battery Electric Vehicles (BEVs)

Transit Connect Electric

BEVs use no gasoline; they are powered by a high-voltage electric motor and battery pack. In 2010, Ford introduced its first BEV, the Transit Connect Electric. In 2011, Ford will introduce the Focus Electric with a planned range of 100 miles on a charge and half the recharge time of our competitors' BEVs.

2007	2011	2020 – 2030
NEAR TERM	MID TERM	LONG TERM
Begin migration to advanced technology	Full implementation of known technology	Continue deploying advanced powertrains and alternative fuels and energy sources

Battery Electric Vehicles (BEVs)

Ford has announced an expanded, comprehensive electric vehicle strategy aligned with growing public interest in advanced technologies that reduce the use of gasoline and diesel. Our approach to electrification tackles commercial issues such as battery cost, standards development and infrastructure deployment. In addition, strategic partnerships are an important part of this new approach. We are working with partners to develop appropriate battery cells, collaborate on government policy and define the infrastructure needed to speed the commercialization and acceptance of electric vehicles. To read more about our approach, please see Electrification: A Closer Look.

Battery electric vehicles do not have an internal combustion engine and do not use any on-board gasoline. Instead, they use a high-voltage electric motor, which gets its power from a high-voltage battery pack charged by plugging into a standard 110-volt or 220-volt outlet in the U.S., or a 230-volt outlet in Europe.

In 2010 we introduced a BEV version of the Ford Transit Connect light commercial van, for use by small business owners and fleet customers in the U.S. This vehicle is produced in partnership with Azure Dynamics, a world leader in the development and production of hybrid electric and battery electric commercial vehicles.

In late 2011 we will launch an all-electric passenger sedan, the Ford Focus Electric, based on the all-new Focus. This car has a target driving range of 100 miles on a single charge of its lithium-ion high-voltage battery. We are targeting 19 initial markets with this vehicle. We will be ready to expand to new markets and ramp up to higher volumes as the infrastructure develops and customer demand grows.

A full recharge of the Focus Electric is expected to take three to four hours at home with the 240-volt charge station – half the charging time required by competitors' battery electric vehicles. As fast-charge technology standards are developed, Ford's Focus Electric will be designed to take advantage of this capability.

The Focus Electric, as well as Ford's other electrified vehicles including HEVs and PHEVs, will use lithium-ion batteries. These batteries provide better performance, require less space and weigh less than the nickel metal hydride batteries used in current hybrid electric vehicles. The Focus

Electric's advanced lithium-ion battery system was engineered by Ford in cooperation with the supplier LG Chem. It uses an advanced, active liquid cooling and heating system to precondition and regulate the temperature, which helps to maximize battery life and fuel-free driving range.

The Focus Electric will include an enhanced version of MyFord Touch™ – Ford's new driver interface technology – that will give drivers information to help maximize driving range, plan the most eco-friendly route and manage the battery recharge process.

Drivers will also be able to manage their Focus Electric remotely using the Ford-developed MyFord Mobile app. This system enables customers to get instant vehicle status information, perform key functions remotely, monitor the car's state of charge and current range, get alerts when it requires charging, remotely program charge settings and download vehicle data for analysis from a smartphone or secure Ford website. For more information on the Focus Electric driver information systems and mobile controls, please see Living the Electric Lifestyle.

The Focus Electric will also work with Value Charging (powered by Microsoft®), a home energy management system that works exclusively with Ford electric vehicles to help customers reduce their electricity costs by taking advantage of off-peak or other reduced rates from their utility, without a complicated set-up process. For more information on this technology, please see Electrification: A Closer Look.

We are also introducing all-electric vehicles in Europe. We will launch the Ford Transit Connect Electric in Europe in 2011 followed by the Ford Focus Electric in 2012. In preparation for these launches, Ford is participating in BEV test trials in the UK and Germany with Transit Connect Electrics as well as early Focus Electrics, to test the technology's suitability in real-world situations.

Ford is actively working to help develop standards to ensure that plug-in and charge stations work for all BEVs and to ensure that the technology is reliable and durable for customers. In North America, the Society of Automotive Engineers, with Ford's participation, successfully aligned all major original equipment manufacturers on a standard charge connector and communication protocol, enabling all plug-in vehicles to use common charge points. This will be a key enabler for adoption in North America; the same connector is under consideration in Europe and China.

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Migration to Alternative Fuels and Powertrains

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Plug-in Hybrid Electric Vehicles (PHEVs)

Ford Escape

PHEVs are powered by a gas-powered engine and a high-capacity electric battery that can be charged from an electric outlet. Ford will introduce its first PHEV, the C-MAX Energi, in the U.S. in 2012 and in Europe in 2013.

2007	2011	2020 – 2030
NEAR TERM Begin migration to advanced technology	MID TERM Full implementation of known technology	LONG TERM Continue deploying advanced powertrains and alternative fuels and energy sources

Plug-in Hybrid Electric Vehicles (PHEVs)

PHEVs are similar to HEVs in that they are equipped with both an electric battery and a gas-powered engine. Unlike today's hybrids, however, PHEVs are equipped with a high-capacity battery that can be charged from a private household or public electric outlet. In addition, while regular HEVs maintain a roughly constant battery charge, plug-in hybrids discharge the battery while driving to provide additional fuel savings. PHEVs have the potential to reduce tailpipe emissions to near zero when running on battery power. However, the vehicle's overall lifecycle emissions depend on the electrical power source and the performance characteristics of the vehicle. PHEVs could be significantly less expensive for consumers to operate because they allow drivers to travel on grid-based electricity stored in batteries instead of more costly gasoline.

The success of PHEVs in the real world depends on cooperation between automakers, utilities, the government and drivers. Therefore, Ford is working with a range of partners – including technology partners, the utility industry and the U.S. Department of Energy (DOE) – to help make a smooth transition to electrified vehicles. In 2007, Ford began a collaborative project with Southern California Edison to advance the commercialization of PHEVs. In 2008, Ford expanded this program with the DOE and other partners to identify a sustainable pathway toward accelerated, successful mass production of these vehicles. The project now includes 11 additional partners: the Electric Power Research Institute, the New York State Energy Research and Development Authority, the New York Power Authority, American Electric Power, ConEdison of New York, DTE Energy, National Grid, Progress Energy, Southern Company-Alabama Power, Pepco Holdings and Hydro Quebec.

Ford was awarded $10 million by the DOE to support this program, which includes a three-year demonstration project with a vehicle fleet deployed by the DOE and the energy partners to collect real-world battery performance data and evaluate PHEV and grid performance in different geographical locations. The project aims to help the companies understand critical implementation issues, including the vehicle-utility interface, the impact of plug-ins on utility operations and emissions, and the value to users, utility companies and vehicle manufacturers.

In 2010, Ford completed the deployment of 20 vehicles with the DOE and its utility partners and continued to collect in-field vehicle performance data. To date, the fleet has logged more than 300,000 miles. The collected data is being analyzed by engineers in Ford's Sustainable Mobility Technology group in conjunction with the DOE, Idaho National Laboratories and Argonne National

Laboratories. The results of these analyses continue to drive future PHEV product offerings from Ford as well as aid utility companies in their expectations for when plug-in vehicles hit the market.

For more information on some of the key learnings generated by this collaboration thus far, please see Electrification: A Closer Look.

The demonstration vehicles used in this project (Ford Escape Plug-In Hybrids) have two distinct operational modes: charge depletion and charge sustaining. In charge-depletion mode, which is used when the high-voltage battery is above a predetermined state of charge, the vehicle draws the majority of the power required for operation from the battery. During normal driving, this usually translates into full-electric operation when the vehicle is traveling less than roughly 40 mph. When the power demand of the driver exceeds the power output capacity of the high-voltage battery, the gasoline engine automatically starts up to provide the difference. However, even when the engine is used to supplement power while in charge-depletion mode, the battery still provides the vast majority of the power required to propel the vehicle, giving the driver a sense that the engine is merely idling, even at highway speeds.

In charge-sustaining mode, which is used when the high-voltage battery is below a predetermined state of charge, the vehicle relies mainly on the engine to meet the driver's power demand. The high-voltage battery is charged during braking events and discharged during acceleration events to improve the overall fuel economy of the vehicle – similar to the operation of today's conventional hybrids.

Initial field data show significant improvements in fuel economy when these vehicles are operated in charge-depleting mode. The data also show that in city environments, a fully charged Escape Plug-in Hybrid is capable of an all-electric range in excess of 25 miles, when driven below 40 mph and if aggressive acceleration events are avoided.

We recently announced plans to introduce the Ford C-MAX Energi, our first production PHEV, which will be a variant of the Ford C-MAX multi-activity vehicle. The C-MAX Energi will be designed to deliver a more than 500-mile driving range with battery and engine power. It will launch in the U.S. in 2012 and in Europe in 2013.

The C-MAX Energi will include a wide range of technology to help drivers maximize fuel efficiency, driving range and charging efficiency. Like the Focus Electric, the C-MAX Energi will have an enhanced version of MyFord Touch™ – Ford's new driver interface technology – that will give drivers information to help maximize driving range, plan the most eco-friendly route and manage the battery recharge process. Drivers will also be able to manage their C-MAX Energi remotely using the Ford-developed MyFord Mobile app. The C-MAX Energi will also work with Value Charging by Microsoft®, a home energy management product that will help customers determine when and how to most efficiently and affordably recharge BEVs and PHEVs. For more information on these technologies, please see Living the Electric Lifestyle.

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FCVs

Renewable Biofueled Vehicles

Ford Galaxy

Biofuels offer a relatively affordable way to reduce carbon dioxide emissions. Ford is a market leader in biofueled vehicles with more than 5.5 million E85-capable vehicles and 17 E85 models globally.

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Renewable Biofueled Vehicles

Current Generation Biofuels

Ford has a long history of developing vehicles that run on renewable biofuels. Our founder, Henry Ford, was a strong proponent of biofuels, and we produced our first flexible-fuel vehicle approximately 100 years ago; the Ford Model T was capable of running on gasoline or ethanol.

Biofuels are an important component of our sustainability strategy for three reasons. First, biofuels can help to address economic, social and environmental sustainability, which includes helping us meet our carbon dioxide (CO_2) reduction targets. Second, the use of biofuels requires relatively modest and affordable modifications to existing vehicle and fueling technology, which makes them a viable near-term option. Third, biofuels offer synergies with our other strategies. For example, the high octane of ethanol is a potential enabler for the introduction of higher compression ratio engines and higher engine boost technologies that improve the efficiency and torque of our future downsized engines.

Given the current trends of increasing biofuel production, increasing investment in advanced biofuels, increasing vehicle efficiencies and the introduction of vehicles that do not use liquid fuels (such as electric and natural gas vehicles) we believe that the use of biofuels may increase from their current level of 2–3 percent globally to 10–30 percent of global liquid transportation fuel over the next few decades. Although Ford is a vehicle manufacturer and not a fuel provider, it is important for us to understand the physical and chemical properties of biofuels (such as their octane ratings), their sustainability attributes (such as lifecycle greenhouse gas (GHG) emissions, water use and energy consumption, etc.) and their performance in our vehicles. We are conducting research and development to ensure that our vehicles will be able to exploit the full benefits of biofuels. Our current work focuses on the two biofuels that are available at a commercial scale: ethanol and biodiesel.

The U.S. and Brazil are the world's largest producers of ethanol, which is made from the fermentation of sugars. In the U.S. the sugar is derived via the hydrolysis of corn starch, while in Brazil the sugar is obtained directly from sugar cane. Ethanol is typically used in blends with gasoline. Blends are identified using the volumetric content of ethanol, which is specified numerically after the letter "E" for ethanol. For example, E10 is 10 percent by volume ethanol and 90 percent petroleum gasoline, while E85 is up to 85 percent by volume ethanol. Most automotive fuel supplied in the U.S. is E10. The U.S. Environmental Protection Agency (EPA) has recently issued a waiver permitting E15 to be sold in the U.S. for use in 2001 or newer model year vehicles. Our position regarding E15 is discussed in a separate section below.

An important benefit of ethanol is its higher octane, which can improve the efficiency and torque of today's high-efficiency internal combustion gas engines. In 2010 we developed a fundamental molecular approach to calculating the octane boost provided by ethanol blended into gasoline that is more accurate than previous measurement approaches.[1] The octane number of a fuel is a critical fuel property that describes its resistance to "knock," which results from early or uncontrolled fuel ignition. To avoid "knocking," the compression ratios designed into engines are limited by the lowest expected octane number of available fuels. However, engines operate at higher thermal efficiency when they can be operated at higher compression ratios using appropriate higher-octane fuel. The increased availability of ethanol in the future provides an opportunity for fuel providers to deliver fuels with higher octane and automakers to provide higher compression ratio – and therefore more-efficient – engines. High-octane ethanol blends offer a win-win-win opportunity in which the increased availability of ethanol could enable increased engine efficiency, resulting in fuel savings for our customers, improved energy security and reduced CO_2 emissions. However, ethanol also may damage engines that are not designed to operate on higher concentrations of the fuel, which poses a concern for older vehicles. Our research into ethanol fuels and octane calculations will help us take the best advantage of higher-octane ethanol fuel blends in the future.

Biodiesel is a biofuel alternative to petroleum diesel made from the transesterification of vegetable oils obtained from oil seeds, including soy, canola, palm and rapeseed, or from animal fat. Biodiesel is distinct from "renewable diesel," which is made by hydrotreating vegetable oils or animal fats. In the U.S., most biodiesel is currently made from soybean oil. Biodiesel is typically used in blends with petroleum diesel, where the volumetric content of biodiesel is specified numerically after the letter "B" for biodiesel. In the U.S. and Europe all of our diesel vehicles can run on B5, a blend containing 5 percent biodiesel. We have worked with fuel standards organizations to allow the use of biodiesel blends of greater than B5 in our future products. For example, our 2011 F-Series Super Duty® trucks with a new 6.7L diesel engine are compatible with B20. In addition, the gasoline version of these vehicles will be compatible with gasoline, E85 or any ethanol-gasoline blend between E0 and E85.

Ford has taken a leadership position on biofuels. Since 1997, we have offered flexible-fuel vehicles (FFVs) capable of running on gasoline or E85 ethanol. In the U.S., we met our commitment to double our FFV production from 2006 to 2010. To date, we have introduced more than 5.5 million E85-capable vehicles globally, including more than 2.3 million in North America and nearly 2 million in Brazil. In the U.S., we have produced more than 1 million FFVs over the last three years alone. In Europe, Ford is a market leader and pioneer in ethanol-powered FFVs, with more than 70,000 vehicles delivered to customers since 2001. Ford FFV models are available in many European markets, with Sweden, Germany, Spain and France showing the strongest demand.

Ford currently offers 17 vehicle models in the U.S., Europe and South America that can run on E85. These include the Ford Crown Victoria, Expedition, Fusion, Escape, Econoline, Super Duty and F-150 and the Lincoln Town Car and Navigator in North America; the Ford Focus, Mondeo, S-MAX and Galaxy in Europe; and the Ford Fiesta, EcoSport, Focus, Ka and Courier in Brazil. In 2009 in Europe we launched a tri-fuel version of the Ford Mondeo, capable of running on gasoline, E85 or propane (LPG).

E15 in the United States

Over the last year, the EPA approved the use of E15 ethanol blends in 2001 and newer model year vehicles. While Ford supports the use of renewable fuels to meet the challenges of energy security and climate change and has committed to expand our lineup of vehicles capable of operating on E85, we do not support approving the use of E15 in older vehicles unless concerns with the use of E15 in the legacy fleet are addressed.

The entire legacy fleet of non-FFVs consists of vehicles designed to operate on E0 to E10 (or only E0 for very old vehicles). We are concerned that vehicles will not continue to meet customer expectations for quality, durability and performance, nor legal requirements relating to emissions and on-board diagnostics, if the vehicles are operated on a fuel they were not designed to use. The Alliance of Automobile Manufacturers and the Association of International Automobile Manufacturers are among many parties seeking review of the E15 waiver in the D.C. Circuit Court of Appeals. Ford is a member of the Alliance. Our ultimate goal is to ensure that we exceed customer expectations, and we will continue to work with our customers and dealerships to address any potential concerns.

One opportunity with the introduction of increased ethanol blends is to increase the octane rating of the new fuel. As discussed above, ethanol has an octane rating greater than today's gasoline, so when the fuels are mixed, the resulting fuel blend should have higher octane than the base gasoline. And as the octane rating of a fuel increases, it reduces the tendency for "engine knock." Many of today's advanced engines are programmed to improve the efficiency of the engine just short of the point where the consumer would experience engine knock. For such engines, an increase in the octane rating of the fuel could result in improved vehicle efficiency. Further improvement to engine efficiency (through increased compression ratio and downsizing) could be achieved if manufacturers knew how and when the minimum octane ratings of fuels would increase in the future. Given that vehicles' efficiency and performance depends on the fuel it uses, the two should be considered systematically. Coordinated efforts among the involved industries (oil, biofuel, auto) and regulatory agencies are needed to ensure that maximum benefit is gained from our future fuels and vehicles.

Future Biofuels

The biofuels currently available at a commercial scale (e.g., ethanol and biodiesel) have advantages relative to their petroleum-derived counterparts. They can be made from locally available raw materials, providing support for rural communities and reducing the need for foreign-supplied oil, while increasing national energy security. They also reduce lifetime (or well-to-wheels) CO_2 emissions compared to conventional petroleum-based fuels. However, important issues remain regarding biofuels' energy density, the best way to use these fuels to reduce GHG emissions, their ability to meet fuel needs without impacting food supplies and their potential impact on land-use decisions. (These issues are discussed in more detail later in the Biofuel Challenges section.)

Meanwhile, Ford is working to support and promote the next generation of biofuels, including cellulosic biofuels. These are primarily fuels made from plant cellulose – stalks, leaves and woody matter – instead of from sugars, starches or oil seeds. Cellulosic biofuels will have many advantages. They should minimize possible market competition between food and fuel. They would allow the more complete use of crops such as corn and soybeans by using additional parts of these crops, including stems and leaves, for fuel production. In addition, cellulosic biofuels can be made from "energy crops," such as switchgrass and wood, that require less fertilizer and less energy-intensive farming methods. This would further reduce the total CO_2 footprint of the resulting biofuels. We are also investigating the potential for algae-based biofuels to provide another feedstock for future biofuels. Given the challenges associated with developing and scaling up new production technologies, it is our assessment that next-generation biofuels will be available at scale in the marketplace in the next 10–15 years, if the necessary technical breakthroughs in production efficiencies are made.

The United States Renewable Fuel Standard and the Future of Biofuels

The Energy Independence and Security Act of 2007 expanded the Renewable Fuel Standard (RFS) by requiring a significant increase in the use of biofuels – to a total of 36 billion gallons per year by 2022. This law also requires that, beginning in 2010, a certain portion of biofuels must be "advanced" and/or cellulosic-based fuels. Ethanol blended into gasoline is expected to supply the majority of this biofuel mandate and could displace nearly 20 percent of U.S. gasoline demand by 2022.[2] The use of biodiesel in the U.S. is also likely to increase in the coming years. However, it will not likely increase to the same levels as ethanol, because the RFS mandates lower volumes of biomass-based diesel and because a relatively small percentage of light-duty passenger vehicles in the U.S. use diesel.

Using low-level ethanol blends such as E10 (which is the situation today), would achieve approximately 40 percent of the RFS-mandated biofuel use by 2022. Therefore, meeting the full RFS biofuel requirement will require much greater use of E85 in FFVs and/or the development of vehicles that can use "mid-level blends" of ethanol and gasoline (i.e., between E10 and E85). The expanded use of E85 in FFVs would require a corresponding increase in the E85 fueling infrastructure in the next 10 to 20 years. An approach using mid-level blends would require that all new vehicles be designed for higher ethanol capability, and the existing fueling infrastructure would need to be improved for higher ethanol compatibility. For any of these approaches to be successful, the new fuels will have to provide enough value to the consumer to compel them to buy ethanol-blend fuels. Regardless of the specific strategy used, coordinated efforts will be required between automakers, fuel suppliers, consumers and the government to meet the RFS mandate while ensuring the compatibility of vehicles and ethanol-blended fuel. Without alignment between vehicles, fuels and infrastructure, a mismatch will occur, and it will be difficult to meet the RFS mandate successfully.

Biofuel Infrastructure

To increase their benefits for reducing GHG emissions and improving energy security, biofuels must become more widely used. This requires the availability of both biofuels and vehicles capable of using biofuels. In the U.S., the E85 refueling infrastructure remains inadequate. Out of more than 160,000 refueling stations in the U.S., approximately 2,300 (or less than 2 percent) offer E85. For consumers to have a true transportation fuel choice, increased access to biofuels is necessary.

Biofuel Challenges

Much of the interest in biofuels results from their potential to lessen the environmental impacts of transportation fuels while contributing to energy independence. Biofuels are typically made from domestic and renewable resources, they provide an economic boost to rural communities, and they help to reduce greenhouse gas emissions because the plants from which they are made absorb CO_2 while they are growing. But are biofuels the best solution to our growing fuel-related environmental, economic and political problems? The issues are complex. We believe biofuels are an important part of the equation for addressing climate change and energy security. We recognize, however, that major advances need to be made in production processes, source materials and fuel types to achieve the full promise of biofuels.

Challenges relating to today's biofuels include the following:

Energy Density

The energy density of ethanol is approximately two-thirds that of gasoline.[3] This means there is approximately one-third less available energy in a gallon of ethanol than in a gallon of gasoline.

As a result, drivers using fuels containing higher amounts of ethanol will have to refuel more frequently. Ethanol does have improved qualities, such as higher octane, that can be leveraged to recover much of the lost energy content. Biodiesel has approximately the same energy density as conventional petroleum-based diesel.

Lifecycle Greenhouse Gas Emissions

The plants used to produce biofuel feedstocks capture as much carbon dioxide during their growth as they release when burned. However, current farming and production processes utilize fossil fuels in the production of ethanol and biodiesel, so the production of these biofuels results in a release of some fossil-fuel-based GHG emissions on a complete lifecycle basis. In addition, nitrous oxide (N_2O) emissions resulting from biofuel production need to be carefully considered for all types of biofuel feedstocks and farming techniques on a full lifecycle basis, including the appropriate allocation of emissions to co-products (such as animal feed) derived from biofuel production. Government and academic studies suggest that current E85 using ethanol from corn results in 20 to 30 percent fewer lifecycle GHG emissions than today's gasoline, on an energy-equivalent basis. In addition, GHG emissions related to petroleum can vary greatly depending on the source. Producing crude oil from tar sands, for example, results in a greater release of GHGs than producing crude oil from conventional sources. The use of renewable energy sources in the production of ethanol and biodiesel production can reduce their lifecycle GHG emissions further. We believe that developing cellulosic or biomass-based biofuels with next-generation processes will significantly decrease the GHG emissions associated with biofuels, perhaps by up to 90 percent.[4]

Competition with the Food Supply

Another concern about current corn- and soybean-based biofuels is that they compete in the marketplace with food supplies and are often cited as one of the factors that increase food prices. In the U.S., demand for corn used directly for human food (including high-fructose corn syrup) consumes less than 10 percent of the total corn supply. Approximately 42 percent of U.S. corn is used for animal feed. In 2009, about 32 percent of the corn harvest in the U.S. was used to produce ethanol. Ethanol production removes only the starch from the corn kernel – the remaining portion is a highly valued feed product (called distiller grains) and a good source of energy and protein for livestock and poultry. This mitigates the competition between ethanol production and food production. In addition, the growth of the energy crop market has encouraged improvements in farming productivity (e.g., bushels per acre) that may not have occurred otherwise, further reducing the impact of biofuels on corn availability. If next-generation biofuels can efficiently utilize biomass such as plant stalks, woodchips or grasses and be grown on marginal land with little irrigation, then competition with food crops should be minimized. In 2011, Ford researchers published a technical assessment of the contribution of biofuel production to the increase in food prices in 2008.[5] We agree with the majority of external studies that find that biofuel production has a small, or modest, impact on commodity food prices.

Land-Use Conversion for Biofuel Production

Recent studies have looked at the overall CO_2 and N_2O impacts of "direct" land-use changes associated with biofuels – i.e., converting natural ecosystems to farmland for the production of crops to make biofuels. Additional studies have considered an "indirect" land-use change scenario in which the use of farmland for biofuels in one region indirectly leads to the conversion of natural ecosystems to farmland in another region due to crop market feedbacks (either replacing the grain in the marketplace or due to increased prices). This is a complex and important issue. Converting natural lands to croplands can lead to the release of carbon stored in above- and below-ground biomass. Releasing this carbon in the form of CO_2 during land conversion to energy crop farming creates a carbon "debt," which may take a very long time to repay through the greenhouse gas benefits of the subsequent biofuel use. The use of degraded pastures or abandoned farmland, by contrast, rather than natural ecosystems, would incur minimal carbon debt, because there is limited CO_2 storage in these previously altered ecosystems.

At Ford, we are following the debates about biofuels closely. As we proceed, we need to consider how biofuels are derived and carefully review issues such as the potential net greenhouse gas benefits; political, economic, social and environmental concerns related to biofuel and petroleum use; and the management of land, food and water resources. We agree with the general consensus among scholars and industry experts that the current generation of biofuels have modest environmental benefits and are a first step toward cleaner transportation and energy independence. We are actively investigating the potential of next-generation biofuels that have greater environmental, energy security and economic benefits. We believe that improvements in the efficiency of farming technologies and biomass production processes, and the development of advanced biofuels, will significantly increase the benefits and long-term sustainability of biofuels. Even with these improvements, solving our climate change and energy security problems will require a multifaceted set of solutions, including new fuels, improvements in vehicle efficiency and changes in consumer driving patterns and practices.

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Hydrogen Fuel Cell Vehicles (FCVs)

Ford Focus

FCVs are powered by an electric motor fueled by hydrogen burned in a fuel cell system. They emit just water vapor, without other tailpipe pollutants. Ford began testing a fleet of Focus FCVs in 2004 and continues to research and develop technologies necessary to commercialize FCVs.

2007	2011	2020 2030
NEAR TERM Begin migration to advanced technology	MID TERM Full implementation of known technology	LONG TERM Continue deploying advanced powertrains and alternative fuels and energy sources
		Hydrogen Fuel Cell Vehicles (FCVs)

Hydrogen fuel cell vehicles are similar to battery electric vehicles (BEVs) in that they use a high-voltage electric motor to propel the vehicle. Unlike BEVs, however, FCVs are equipped with a hydrogen fuel tank and a fuel cell system that generates electric power to drive the electric motor. So FCVs use on-board hydrogen stored in the fuel tank, while BEVs are powered by electric energy stored in the high-voltage battery. As a result, FCVs provide many of the environmental benefits of a battery electric vehicle but have a longer driving range.

The fuel cell system runs the vehicle by converting hydrogen and oxygen into energy through an electro-chemical reaction. It emits just water vapor, without other tailpipe pollutants. Therefore, FCVs are considered to be zero-emission vehicles. FCVs can also be hybridized with a high-voltage battery, to improve vehicle performance and better optimize the cost and robustness of the fuel cell system. In fact, all of our efforts to improve high-voltage electronics, electric motors, regenerative braking and hybrid battery technology on BEVs, hybrid electric vehicles and plug-in hybrids can be applicable to FCVs, if and when these vehicles become commercially viable.

We believe that hydrogen-powered fuel cell vehicles may be an important long-term solution for improving energy security and diversifying our energy sources, as well as for reducing greenhouse gas emissions, if hydrogen fuel emerges as a viable low-carbon energy carrier. Therefore, Ford has committed to significant hydrogen fuel cell research and development.

Technology Demonstration

Ford has been working on fuel cell vehicle development and technology demonstration for more than a decade. We developed the first research prototype FCV in 1999. In 2004, we introduced a technology demonstration fleet of FCVs using the Ford Focus as a base vehicle. The Focus FCV uses a Ballard fuel cell technology, called HyWay1. It is one of the industry's first hybridized fuel cell vehicles, meaning it has a battery system as well as a fuel cell system.

From 2004 to 2009, Ford participated in a technology demonstration program partially funded by the U.S. Department of Energy (DOE), as well as other demonstration programs in Canada and Europe. A total of 30 Ford Focus FCVs have been in operation in these programs. These vehicles have been tested to demonstrate durability and reliability; for example, they were subjected to driving tests at sub-zero temperatures and high altitudes to prove vehicle performance under a range of customer-encountered driving environments. By 2009, these vehicles had accumulated more than a million driving miles without significant technical problems, thereby demonstrating the reliability of fuel cell powertrain systems in real-world driving conditions. The data collected from this fleet is critical for the further development of fuel cell technology. Based on the knowledge gained, we have completed the development and laboratory validation of our new fuel cell technology, called HyWay2/3. This new technology improves the robustness and "freeze start" capability of the fuel cell propulsion system.

Challenges of Commercialization

Even with the advances we have made in hydrogen technology over the past 10 years, we still have challenges to overcome before hydrogen FCVs can compete in the market with current vehicle technology. The cost and durability of the fuel cell system are the most significant challenges. For example, extensive DOE analysis has not yet revealed an automotive fuel cell technology that meets the DOE's targets for real-world commercialization, or that maintains proper performance throughout the targeted lifetime while staying within the targeted cost. There are also still significant challenges related to the cost and availability of hydrogen fuel and on-board hydrogen storage technology. To overcome these challenges and make fuel cell vehicle technology commercially viable, we believe further scientific breakthroughs and continued engineering refinements are required.

Research and Development

Given these significant challenges to commercialization, we believe that further investment in demonstrating hydrogen FCVs and integrating current FCV technology into existing vehicles are not high-value investments for Ford. Therefore, Ford has reprioritized its resources to concentrate on core fuel cell research that will help increase the commercialization potential of FCVs. For example, we are focusing on materials development and basic scientific research to solve cost and durability challenges.

Our materials research is focused on the membrane electrode assembly (MEA) and bipolar plates, which make up key cost and/or durability elements of the fuel cell stack. For example, we are working to develop a new fuel cell catalyst that will significantly reduce the use of precious metals, such as platinum, and we are exploring alternatives to expensive components, such as developing low-cost corrosion-resistant bipolar plates. Simultaneously, we are working to increase the power density of the individual fuel cell stack. This could potentially reduce the use of the expensive materials and components in the stack. MEA research is also crucial to our ability to optimize fuel cell stack operating conditions and reduce system complexity. We are working on the fuel cell stack research and development with our alliance partners: Daimler AG and the Automotive Fuel Cell Cooperation (AFCC), a Vancouver-based company owned by Ford, Daimler and Ballard.

We are also working to optimize the overall propulsion system architecture to take advantage of advances in fuel cell materials and lessons learned from our demonstration FCV fleet. By developing advanced computational modeling that will help us understand the mechanisms underlying ideal fuel cell functioning and anticipate failure modes under real-world usage, we are able to propose operating strategies and system architectures that minimize fuel cell propulsion system costs. These modeling tools support our fuel cell materials and system research.

On-board hydrogen storage is another critical challenge to the commercial viability of hydrogen FCVs. Current demonstration vehicles use compressed gaseous hydrogen storage. However, the high-pressure tanks required for this storage use expensive materials such as carbon fiber reinforcement. In addition, the current tanks are large and difficult to package in a vehicle without unacceptable losses in passenger or cargo space. Therefore, we are pursuing research on materials-based on-board hydrogen storage technology, including complex hydride and novel hydrogen sorbent technologies, which may ultimately achieve higher energy density and lower cost.

Hydrogen Refueling Infrastructure

Producing and distributing hydrogen fuel is another important hurdle on the road to implementing hydrogen-powered FCVs and hydrogen-powered internal combustion engines (H_2ICEs), which Ford led the automotive industry in developing commercially. The GHG reduction benefits of hydrogen fuel depend on what procedures and feedstocks are used to produce the hydrogen. Currently, the most state-of-the-art procedure is a distributed natural gas steam reforming process. However, when FCVs are run on hydrogen reformed from natural gas using this process, they do not provide significant environmental benefits on a well-to-wheels basis (due to GHG emissions from the natural gas reformation process). It would be necessary to employ carbon sequestration technologies in hydrogen production from fossil fuels or increase the use of renewable energy sources, to enable the hydrogen for hydrogen-fueled FCVs to provide significant environmental benefits.

Even if the challenges of producing hydrogen can be overcome, there is still no widespread hydrogen fueling system. Therefore, new infrastructure must be invested in, designed and executed throughout the country to make hydrogen-powered vehicles commercially attractive to Ford customers.

Working alone, Ford will not be able to overcome all of the challenges hydrogen vehicles face. That is why Ford is collaborating with a wide range of partners on the development of hydrogen vehicles, fuels and fueling systems. In addition to our work with the AFCC and Daimler described above, we are working with:

- The Freedom CAR and Fuel Partnership: a partnership between Ford, General Motors, Chrysler, five energy providers and the DOE to develop fuel cell technology, vehicles and hydrogen fuels that will provide freedom from imported oil and carbon-based fuel emissions; and
- The Clean Energy Partnership Berlin: a consortium of 13 corporate partners and the German government that is working to demonstrate the suitability of hydrogen as a fuel for everyday use.

Ford's Green Partnerships with Federal and State Governments

The 2007 Energy Independence and Security Act (EISA) continued the effort to transition interactions between automakers and the government on fuel economy standards from an adversarial relationship to a partnership. The EISA authorized tough standards for new vehicle fuel economy while creating the Section 136 Advanced Technology Vehicle Manufacturing Incentive Program. Section 136 authorized the U.S. Department of Energy (DOE) to make direct loans to eligible applicants for projects that re-equip, expand or establish manufacturing facilities in the U.S. to produce advanced technology vehicles or qualifying components, and also for engineering integration costs associated with such projects. This federal, $25 billion loan program sought to help automakers invest in the future and implement a new fuel economy mandate estimated by the National Highway Traffic Safety Administration to cost $114 billion.

In June 2009, Ford, Nissan and Tesla were the first companies selected to participate in the Section 136 program after each demonstrated that they had top "green" technologies and met a stringent financial viability test required by the loan program. All three manufacturers offered advanced technology that could "move the needle" on better fuel economy and reduce oil imports.

This government-industry partnership should not be confused with emergency taxpayer assistance provided as part of the Troubled Asset Relief Program (TARP). In contrast to TARP, these loans were awarded based on merit and the potential of the programs to deliver significant fuel economy improvements. Also, the borrowers had to be deemed financially viable, and the funds will be fully repaid with interest. Ford's loan was fully collateralized.

This DOE loan program is an example of how successful government-industry partnerships can work to achieve public policy goals. The DOE provided low-cost loans to help re-tool U.S. manufacturing facilities for the production of fuel-efficient, advanced-technology vehicles that will result in higher fuel economy and lower emissions, while saving consumers money at the pump and reducing our dependence on foreign oil. U.S. taxpayers will make money on these loans as they are repaid.

Ford is investing billions of dollars in advanced technology vehicles in the U.S. over the duration of the approved loan application, and the loans will help Ford achieve its ambitious goals for fuel-efficient vehicles and technologies. Ford expects to receive funding of up to $5.9 billion through these DOE loans. We will use this funding in part to redesign 11 Ford facilities in the U.S. that make more fuel-efficient vehicles, including the Michigan, Louisville, Chicago and Kansas City Assembly Plants.

An outstanding example of how Section 136 partnership funds are being used is the production of the Ford Focus at the Michigan Assembly Plant (MAP). MAP is being transformed from a large SUV factory into a modern, flexible small-car plant that will produce the global Ford Focus. The new Focus will be one of up to 10 unique models to be built from Ford's new C-car platform, which is expected to generate total sales in all regions of 2 million units annually by 2012. The Focus is also one of four Ford vehicles that achieves more than 40 mpg. We began production of the all-new Focus at MAP in 2011. In addition, we will produce three of our new electrified vehicle offerings at MAP. In 2011, we will begin producing the Focus Electric, and in 2012 we will begin producing our next-generation C-MAX Hybrid and the C-MAX Energi, our first commercially available plug-in hybrid. The C-MAX vehicles are also based on our new C-platform. For more information about MAP please see: Case Study: Michigan Assembly Plant.

The new Focus exceeds Section 136's Advanced Technology Vehicle requirements by combining key technologies to achieve class-leading fuel economy, including: an advanced combustion engine, six-speed transmission, deceleration fuel shut-off, electric power-assisted steering, improved aerodynamics and lightweight materials.

Ford is investing approximately $550 million to introduce the North American market to Ford's global C-platform, which underpins the Focus and C-MAX vehicles. This investment will support more than 4,000 high-tech manufacturing and engineering jobs, not to mention more than 10,000 supplier jobs and 175,000 dealership positions.

In 2010 – and also with the support of DOE's Section 136 loan funds – we invested $400 million in our Chicago Assembly Plant to ready it for production of the all-new 2011 Ford Explorer. The 2011 Explorer has best-in-class fuel economy for its segment and offers up to 30 percent better fuel economy than the previous Explorer model. It will offer our 2.0L I-4 EcoBoost™ engine, which delivers superior power and fuel economy. This redesign includes investment in advanced quality control and flexible manufacturing systems, and also resulted in Ford adding 1,200 new jobs at the plant. The plant will also continue production of the Ford Taurus and Lincoln MKS sedans. Our reinvestment in and redesign of the Chicago Assembly Plant to produce more fuel-efficient vehicles is especially symbolic, as this is Ford's oldest assembly plant still in operation in North America. It formerly produced the Ford Model T and Model A vehicles and produced military

Related Links

This Report:
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vehicles during World War II.

We are also investing $600 million to transform our Louisville Assembly Plant into a state-of-the-art facility, which will be our most-flexible high-volume plant in the world. When this plant reopens in 2011, it will produce our next-generation Ford Escape. This investment will result in 1,800 incremental jobs.

Finally, the DOE partnership is helping to fund our $400 million investment in our Kansas City Assembly Plant, to ready the plant for production of a new vehicle, yet to be announced. This plant previously built the Ford Escape, which will shift production to the Louisville Assembly Plant. The $400 million investment will pay for installing a new body shop, new tooling and other upgrades. The Kansas City plant will continue to produce the Ford F-150 on a separate production line.

Ford's sustainability commitments have received state government support as well. Working in close partnership with the state of Michigan, Ford received incentives and tax credits totaling $188 million to help in the continuous transformation of MAP. In addition to building the next-generation hybrid in Michigan, these incentives enabled Ford to bring advanced lithium-ion battery system design, development and assembly in-house.

Ford also received a $2 million grant from the state of Michigan to install a large, stationary battery-based energy storage facility with 750 kw capacity and 2 MWh of storage. This facility supports the state's "smart-grid" development initiatives as well as Ford's efforts to develop battery technology and secondary uses for vehicle batteries. As part of this facility, Ford is demonstrating the possibility for using vehicle batteries as stationary power storage devices after their useful life as vehicle power sources is over. Ford is participating in this project in partnership with DTE Energy, a Michigan-based energy provider. DTE Energy has installed a 500 kw solar photovoltaic (PV) electricity generation system at the demonstration facility, which will produce some of the energy to be stored in Ford's stationary battery storage facility. It is the largest PV array in Michigan. The solar PV system was funded by DTE Energy to support Ford's sustainability efforts and to help the state of Michigan meet its renewable energy production requirements. As part of this project, Ford developed 10 electric vehicle charging stations, which demonstrate advanced battery charging technologies and associated integration with renewable energy and other smart-grid advances.

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Progress and Performance

Vehicle + Fuel + Driver = GHG emissions

How is Ford doing in its quest to reduce greenhouse gas (GHG) emissions? Based on analyses of lifecycle vehicle carbon dioxide (CO_2) emissions, approximately 80 to 90 percent of GHGs are emitted while the vehicle is in use, rather than during its manufacture or disposal. The in-use emissions depend on three major factors:

1. The fuel economy of the vehicles, which in turn depends on many characteristics of the vehicles themselves (such as their weight, powertrain and aerodynamics).
2. The well-to-wheels greenhouse gas profile[1] of the fuels used in the vehicles.
3. How the vehicles are used and maintained by their drivers.

Our shorthand for this is "Vehicle + Fuel + Driver = GHG emissions." This section reviews our progress in reducing these emissions, as well as our progress reducing emissions from our facilities, our logistics and our supply chain.

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1. In other words, emissions resulting from making, distributing and using the fuel.

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Vehicle

Vehicle + Fuel + Driver = GHG emissions

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This Report:
- Our Strategy: Blueprint for Sustainability
- Product Sustainability Index

Vehicle Websites:
- Ford Fusion Hybrid
- Lincoln MKZ Hybrid
- Ford Fiesta
- Transit Connect

Our Approach

To meet our climate change commitments, we are focused in the near term on implementing the most cost-effective fuel-efficiency technologies across a large volume of our vehicles, as well as on introducing new products that offer improved fuel efficiency without compromising style or performance. We are concentrating on affordable and near-term sustainable technology solutions that can be used not for hundreds or thousands of cars – but for millions of cars, because that is how Ford can truly make a difference.

For example, we are introducing a wide variety of new engine and transmission technologies, as well as electrical system improvements, weight reductions and aerodynamic improvements that will deliver significant fuel-economy benefits for millions of drivers in the near term. Between 2008 and 2013, we will introduce 60 new or significantly upgraded engines, transmissions and transaxles globally to help us improve fuel economy and reduce carbon dioxide (CO_2) emissions across our global fleet.

We are continuing to implement the EcoBoost™ engine, a key technology in our fuel-efficiency strategy, which uses gasoline turbocharged direct-injection technology. EcoBoost delivers 10 to 20 percent better fuel economy, 15 percent fewer CO_2 emissions and superior driving performance compared to larger-displacement engines. Because EcoBoost is affordable and can be applied to existing gasoline engines, we can implement it across our vehicle fleet, bringing fuel-efficiency benefits to a wide range of our customers. We are on track to equip as much as 80 percent of our global lineup and 90 percent of our North American lineup with EcoBoost engines by 2013. That's about 1.5 million engines. For more information on the EcoBoost and our other near-, mid- and long-term fuel economy improvement technologies, please see our Sustainable Technologies and Alternative Fuels Plan.

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Results

In the U.S., we continue to improve the fuel economy of our new and refreshed vehicles. For example, the Ford Focus, Fusion and Mustang and Lincoln MKZ car vehicle lines, as well as the Ford F-series, Escape and Edge truck and crossover lines, all improved their fuel economy from the 2010 to the 2011 model years. As seen in the graphic below, Ford's 2011 model year U.S. vehicles rank better than the industry fuel economy average in six of 13 categories, worse in one and the same in six.

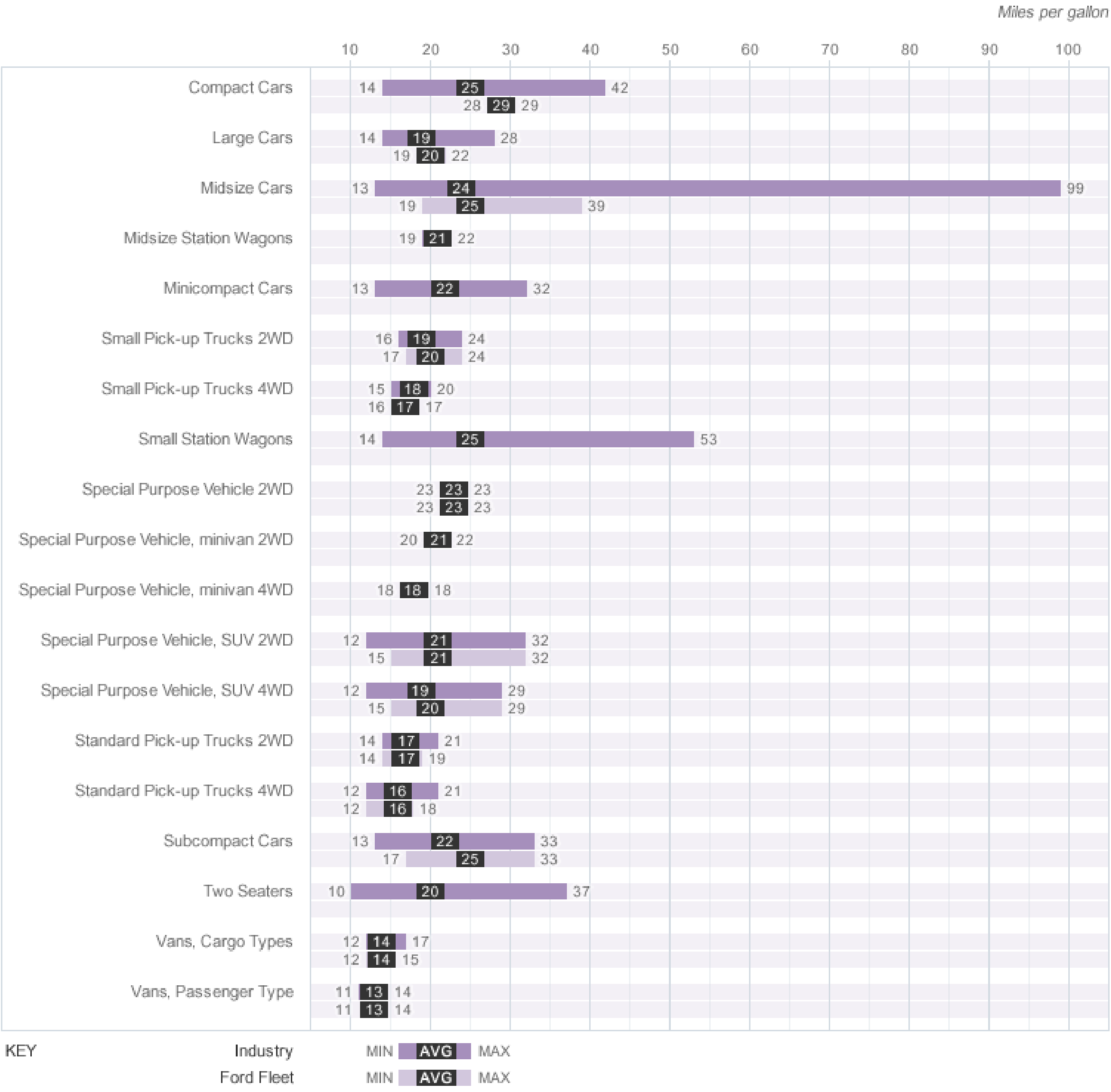
For the 2010 model year, our fleet CO_2 emissions increased slightly by about 1 percent relative to the 2009 model year, but improved 11 percent compared to the 2006 model year. Preliminary data for the 2011 model year project that the Corporate Average Fuel Economy (CAFE) values for the car and truck fleets will be about the same as the car and truck fleet averages for the 2010 model year. On an overall fleet basis, preliminary estimates indicate a 2011 CAFE improvement of 2.9 percent compared to 2010.

The reason the overall fleet average can improve while the individually calculated car and truck fleet averages remain about the same is that there have been changes to the vehicles included in the car and truck categories. New 2011 model year fleet changes include small, front-wheel-drive SUVs moving to the car fleet and medium-duty passenger vehicles being added to the light-duty truck fleet. For the car fleet, the movement of the front-wheel-drive Escape, Mariner, Edge and MKX to the car fleet largely offsets the car fleet improvements that would otherwise be seen due to the introduction of the Fiesta. For the light-duty truck fleet, the movement of the front-wheel-drive Escape, Mariner, Edge and MKX to the car fleet largely offsets the truck fleet improvements that would be seen due to increased fuel efficiency of the new F-150 and Explorer. So although our overall fleet fuel economy continues an improving trend, moving the more fuel-efficient crossover vehicles from the truck to the car category reduces the average fuel efficiency of both categories.

In Europe, we have reduced the average CO_2 emissions of 2010 model year vehicles by 8.1 percent compared to the 2006 model year.[1] We have achieved this through the introduction of a variety of innovations, such as advanced common rail diesel engines available across the European model range – including the ECOnetic range of low-CO_2 vehicles – and the use of lightweight materials.

Fuel Economy of U.S. Ford Vehicles by Segment

Chart Table



Miles per gallon

	Industry			Ford		
	Minimum	Average	Maximum	Minimum	Average	Maximum
Compact Cars	14	25	42	28	29	29
Large Cars	14	19	28	19	20	22
Midsize Cars	13	24	99	19	25	39
Midsize Station Wagons	19	21	22	-	-	-
Minicompact Cars	13	22	32	-	-	-
Small Pick-up Trucks 2WD	16	19	24	17	20	24
Small Pick-up Trucks 4WD	15	18	20	16	17	17
Small Station Wagons	14	25	53	-	-	-
Special Purpose Vehicle 2WD	23	23	23	23	23	23

Special Purpose Vehicle, minivan 2WD	20	21	22	-	-	-
Special Purpose Vehicle, minivan 4WD	18	18	18	-	-	-
Special Purpose Vehicle, SUV 2WD	12	21	32	15	21	32
Special Purpose Vehicle, SUV 4WD	12	19	29	15	20	29
Standard Pick-up Trucks 2WD	14	17	21	14	17	19
Standard Pick-up Trucks 4WD	12	16	21	12	16	18
Subcompact Cars	13	22	33	17	25	33
Two Seaters	10	20	37	-	-	-
Vans, Cargo Types	12	14	17	12	14	15
Vans, Passenger Type	11	13	14	11	13	14
Total	**10**	**21**	**99**	**11**	**21**	**39**

As of May 2011, many of our vehicles meet the commitment to be best in class or among the leaders in their segment for fuel economy. For example:[2]

- The 2011 Ford Edge has unsurpassed highway fuel economy among midsize crossover vehicles with V6 engines, with an EPA-estimated 19 mpg city and 27 mpg highway. The 2011 Edge also has unsurpassed horsepower in its segment.
- The 2011 Lincoln MKX has best-in-class fuel economy among luxury midsize crossover vehicles, with an EPA-estimated 19 mpg city and 26 mpg highway.
- The 2011 Ford Explorer has best-in-class fuel economy in the large utility segment, with an EPA-estimated 17 mpg city and 25 mpg highway, 25 percent better than the previous Explorer model. The Explorer with the 2.0L, I-4 EcoBoost™ engine, which will be available later in 2011, improves fuel economy by 30 percent over the previous model.
- The 2011 Ford F-150 delivers best-in-class fuel economy among full-size pickup trucks, with its 3.7L V6 4X2 option. The F-150 with a 3.5L V6 EcoBoost engine has unsurpassed fuel economy with 16 mpg city, 22 mpg highway; the 3.7L V6 has unsurpassed fuel economy with an EPA-rated 23 mpg highway; and the 5.0L V8 has unsurpassed fuel economy with an EPA-rated 21 mpg highway. The 2011 F-150 also has best-in-class torque and towing and maximum payload.[3]
- The Ford C-MAX with the 1.6L I-4 EcoBoost engine, which will be introduced in North America in the near future, is projected to have best-in-class fuel economy in the seven-passenger C-car segment.
- The 2012 Ford Focus SE with the SFE package is among the leaders in its segment for fuel economy, with an EPA-estimated 40 mpg highway, a 15 percent improvement over the previous model.
- In India, the 2010 Ford Figo with the 1.4L TDCi engine has best-in-class fuel economy for its segment at 20 km/L. Also, the Ford Endeavour 4X2 automatic with Duratorq® engine is among the leaders for fuel economy in the premium SUV segment, at 10.7 km/L.
- The 2011 Ford Fiesta SE with the SFE package, which was introduced in North America in 2010, delivers best-in-class fuel economy for its segment with an EPA-estimated 40 mpg on the highway, topping both the Honda Fit and the Toyota Yaris. The Fiesta uses the combination of a Ti-VCT 1.6L engine, PowerShift dual-clutch transmission and other fuel-economy technologies to accomplish this best-in-class performance.
- The 2011 Ford Mustang coupe with a new Ti-VCT 3.7L V6 engine and six-speed automatic transmission gets an EPA-estimated 31 mpg on the highway. This vehicle delivers superior performance – including 305 horsepower – and better fuel economy than any other V6-powered sports coupe in the world.
- The 2011 Mustang GT, featuring a new 5.0L V8, delivers up to 26 mpg on the highway – better than any competitor – as well as 412 total horsepower and 390 lb.-ft. of torque.
- The 2011 Ford Super Duty® truck with a 6.7L Power Stroke® V8 turbocharged diesel leads its class in fuel economy, towing and hauling. This engine also has significantly lower tailpipe emissions than previous models.[4]
- The 2011 Ford Escape Hybrid leads its segment with an EPA-estimated 34 mpg city.
- The 2011 Ford Ranger with an I-4 engine and manual transmission leads its segment with an EPA-rated 27 mpg highway.
- The 2011 Ford Fusion Hybrid has best-in-class fuel economy for midsize sedans, with an EPA-estimated 41 mpg city and 34 mpg highway.[5]
- The 2011 Ford Fiesta ECOnetic with 1.6L Duratorq TDCi diesel engine is one of the most fuel-efficient five-seat family cars in Europe, and it emits only 98 g/km of CO_2.
- The new Ford Mondeo ECOnetic features a specially calibrated 115 PS (85 kW) version of the 1.6L Duratorq TDCi engine equipped with a standard diesel particulate filter. Due to a combination of changes compared to the standard Mondeo, the second-generation Mondeo ECOnetic is delivering a combined fuel consumption of just 4.3 L/100km (65.6 mpg UK),[6] which translates into average CO_2 emissions of 114 g/km – an important tax break point in some European markets.
- The new Ford Focus ECOnetic, which will be launched in Europe in 2012, is expected to use less than 3.5 liters of fuel per 100 kilometers (equal to 80 mpg UK)[6] and have CO_2 emissions below 95 g/km – better than all compact cars currently on the market in Europe.

Some examples of our vehicles by region are below.

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North America

In North America, we continued to introduce new vehicles that use the technologies identified in our technology blueprint and offer outstanding fuel economy and reduce CO_2 emissions. For example, during 2010 and early 2011, we:

- Continued to introduce new vehicles with best-in-class fuel economy, including the 2011 Ford Edge, Explorer and F-150 and the Lincoln MKX, all of which have unsurpassed fuel economy in their respective segments.[7] Please see best-in-class list above for more vehicles with outstanding fuel economy.
- Introduced the Ford Fiesta, our global compact car, which uses the PowerShift dual-clutch transmission and other fuel-economy technologies to accomplish best-in-class fuel economy.[7]
- Began production of the Transit Connect Electric, the first of five electrified vehicles planned for North America by 2012. Ford is electrifying platforms – versus single vehicles – to offer customers the most choice. Three vehicles will be introduced based on the Ford Focus C-car platform: the Focus Electric, the C-MAX Energi plug-in hybrid and C-MAX Hybrid, followed by another next-generation hybrid sedan. (See the electrification case study for details.)
- Continued to expand the use of our EcoBoost engines, which significantly improve the fuel economy of gasoline engines. We will equip as much as 90 percent of our North American lineup with EcoBoost engines by 2013.

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Europe

Ford already offers one of the broadest low-CO_2 vehicle portfolios in Europe. In 2008, we began launching our ECOnetic line of vehicles. These ultra-low-CO_2 versions of select Ford diesel vehicles leverage several advanced fuel-saving technologies. The ECOnetic name was chosen because it links ecologically sensitive technology to our “energy in motion” design philosophy, which combines driving quality and emotional styling. Our ECOnetic cars use a combination of the latest common-rail diesel powertrains and other carefully selected features engineered to reduce CO_2 emissions to a minimum. These include: high-strength steels and other lightweight materials; electric power-assisted steering; an aerodynamics kit, including lowered ride height and aerodynamic details such as wheel covers and wheel deflectors; low-rolling-resistance tires; and our Auto Start/Stop and Active Grill Shutter.

With the new generations of the Ford Mondeo ECOnetic in 2011 and the new Ford Focus ECOnetic in 2012, we will extend the availability of best-in-class or among-best-in-class, extremely low-CO_2 vehicles, which now include the following:

- The Ford Fiesta 1.6L 95 PS TDCi, available since January 2009, with a fuel economy of 3.7l/100km (63.6 mpg (UK))[6], emitting only 98 g/km of CO_2.
- The new Ford Focus ECOnetic, which debuted at the Amsterdam Motorshow in April 2011 and will be launched in 2012, is expected to use less than 3.5 liters of fuel per 100km (equal to 80 mpg UK) and CO_2 emissions below 95 g/km – better than all compact cars currently on the market in Europe.
- The new Mondeo ECOnetic with a specially calibrated 115 PS (85 kW) version of the 1.6L Ford Duratorq TDCi engine equipped with a standard cDPF. Due to a combination of changes compared to the standard Mondeo, the second-generation Mondeo ECOnetic is delivering a combined fuel consumption of just 4.3 l/100km (65.6 mpg UK), which translates into average CO_2 emissions of 114 g/km – an important tax break point in some European markets.

The following table highlights the fuel economy and CO_2 improvements of the ECOnetic models introduced thus far.

Model	Fuel Economy[8] L/100km	CO_2 Emissions
2012 Ford Focus ECOnetic, with 1.6L Duratorq TDCi diesel engine	<3.5	<95 g/km
2011 Ford Mondeo ECOnetic, with 1.6L Duratorq TDCi diesel engine	4.3	114 kg/km
2011 Ford Fiesta ECOnetic, with 1.6L Duratorq TDCi diesel engine	3.7	98 kg/km

After the successful introduction of the new EcoBoost gasoline engine family in the U.S., Ford launched 2.0L and 1.6L EcoBoost engines in Europe in 2010. These turbocharged, direct-injection gasoline engines will deliver up to 20 percent better fuel economy and fewer CO_2 emissions compared to conventional gasoline engines.

In addition, our global electric vehicle plan is extending to Europe with five full electric or hybrid vehicles. Specifically, Ford will launch two zero-emission full battery electric vehicles, including the Transit Connect Electric light commercial vehicle in 2011 followed by the Ford Focus Electric in 2012. The Ford C-MAX Hybrid and C-MAX Energi plug-in hybrid will launch in 2013, together with another hybrid model.

Ford of Europe's innovative Product Sustainability Index (PSI) shows how the vision of sustainability can be made operational. By combining comprehensive sustainability criteria into the earliest stages of the product development process, Ford's PSI provides a groundbreaking design-for-sustainability tool. Designers can use it to assess the lifecycle CO_2 emissions of a vehicle, and consumers can use it to understand a vehicle's footprint.

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Asia Pacific and Africa

In our Asia Pacific and Africa region, we are focusing our near-term fuel-efficiency efforts on the systematic implementation of advanced diesel and EcoBoost engines, as well as advanced transmission technology. In China we currently offer the Ford Mondeo with an EcoBoost engine and PowerShift transmission. This product is best in its segment for fuel economy in the China market. We have also launched the Ford Fiesta with a Ti-VCT engine and six-speed automatic transmission across most of our Asia Pacific and Africa markets, making it among the leaders in its segment for fuel economy.

In India, we introduced the Ford Figo in March 2010, which has two engine options: a best-in-class, fuel-efficient 1.4L TDCi diesel and a very competitive 1.2L gasoline engine. The Figo introduction is highly significant to our success in India, as our studies show fuel economy to be the most important criteria in purchase consideration in that country.

In Australia, we will launch an EcoBoost version of the Ford Mondeo in 2011 and of the Ford Falcon in early 2012. Also in Australia, Ford's next-generation EcoLPi liquid-injection LPG system for the Falcon will go on sale in mid-2011, providing customers with the most advanced LPG technology on the market.

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South America

In South America, we are improving fuel economy by introducing some of the efficient engine and transmission technologies currently used in North America, and by using technologies specifically relevant to the widespread use of biofuels in Brazil. For example, we have implemented improved engine compression ratios – or the ratio in which the air and fuel mixture is compressed in the engine combustion chamber – on flexible-fuel vehicles in Brazil. This optimizes fuel efficiency in vehicles using biofuels, which have a higher octane rating than petroleum-based gasoline. We have also improved the gearing ratios, aerodynamics and rolling resistance of our South American models, further increasing fuel economy. We introduced a new, more-efficient "Sigma" engine on the 2010 South American Focus, which also will be extended to other vehicles. This engine will improve efficiency compared to current engines through reduced internal friction and improved electronic throttle controls. For the 2012 model year and beyond, we are planning to introduce even more fuel-efficient twin independent variable cam timing engines and direct-injection engines, Battery Management Systems, smart alternator systems, dual-clutch automatic transmissions and improved aerodynamics.

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1. These data do not include Volvo.
2. The vehicles listed here are best in class for fuel economy based on U.S. Environmental Protection Agency (EPA) segments, unless otherwise noted. Alternative segments are used where EPA segments do not provide a detailed breakdown of vehicle types. For example, the EPA only uses one category for SUVs, and it includes crossovers, compact SUVs and large SUVs.
3. F-150 fuel efficiency is compared to other high-volume pickup trucks, not including low-volume special fuel-economy models.
4. Based on a Ford drive-cycle test of comparably equipped 2011 Ford and 2010/11 competitive models. The class is Full-Size Pickups over 8,500 lbs. gross vehicle weight rating.
5. Midsize sedan segment based on the R.L. Polk segment definition.
6. This fuel economy number was calculated according to the European Fuel Economy Directive EU 93/116/EEC, which uses European drive cycles. They differ from fuel economy calculations developed in the U.S. or other regions of the world. The fuel economy figures in mpg are based on the UK imperial gallon, which is 1.2 times the U.S. gallon.
7. Based on adjusted city/highway fuel economy label values from the 2011 MY EPA Fuel Economy Guide.
8. These fuel economy numbers are calculated according to the European Fuel Economy Directive EU 93/116/EEC, which uses European drive cycles. They differ from fuel economy calculations developed in the U.S. or other regions of the world.

Fuel

Vehicle + Fuel + Driver = GHG emissions

To reduce the lifecycle greenhouse gas (GHG) emissions to the levels required for carbon dioxide (CO_2) stabilization requires the development of fuels with lower fossil carbon content.[1] Such fuels could then augment improvements in the fuel economy of our vehicles.

Electrification

Electrification addresses both energy security and climate change concerns, because electricity can be made from a wide variety of fuels, including domestic sources and renewable energy. Electrification also offers flexibility in tailoring lower-carbon solutions based on locally available fuels and technology options like carbon capture and storage.

Ford foresees a future that includes a variety of electrified vehicles, something we call "Power of Choice." We are electrifying existing, traditional vehicle lines rather than creating unique electrified vehicle models. This way, our customers can choose from a variety of vehicle powertrains, including hybrid electric vehicles, plug-in hybrids, and full battery electric vehicles. Our comprehensive electrification strategy touches all aspects of the electrification ownership experience, seeking to make it engaging, empowering and easy to live with. Ford is working with partners such as Best Buy, Microsoft and MapQuest to help transition customers easily to a new form of transportation.

In late 2010, Ford delivered the initial units of its first all-electric vehicle – the Transit Connect Electric. Full production of the Transit Connect Electric will ramp up in the U.S. in 2011. Also in 2011, the Ford Focus Electric, Ford's global, all-electric car, will be sold in 19 initial U.S. markets, then expand to Europe. In 2012, we will launch our next generation of hybrids, which will include the C-MAX Hybrid, the plug-in C-MAX Energi hybrid and another hybrid, all of which will use next-generation lithium-ion batteries. In Europe, we plan to deliver the same five full-electric or hybrid vehicles by 2013.

In early 2011, we announced an innovative charging station for the Focus Electric, developed jointly with Leviton, which allows the Ford Focus Electric to charge in just over three hours when using a 240V charge station installed in the customer's garage – half the time that it takes our competitors to charge up.

By 2020, we expect that 10 to 25 percent of Ford's global sales will be composed of electrified vehicles. This includes battery electric, hybrid and plug-in hybrid vehicles, with the majority coming from hybrid vehicles, and plug-in hybrids seeing the most significant share increase.

Expanding electrification holds tremendous promise, but a range of implementation challenges must be considered. These challenges relate to cost, battery technology, the development of charging infrastructure, the interface with utilities and how to ensure that potential emissions-reduction benefits are realized. Ford is working with municipalities and electric utility partners to address many of these challenges.

Please see the Electrification section for a full discussion of electrification issues and our approach to bringing electric vehicles to market.

Biofuels

Biofuel use is expanding globally, with bioethanol made from corn, beets or sugar cane substituting for gasoline, and biodiesel derived from plant oils substituting for diesel fuel. In the U.S. in 2007, federal legislation expanded the Renewable Fuel Standard (RFS), mandating a significant increase in the use of biofuels by 2022.

While current corn-based bioethanol production in the U.S. is estimated to provide a modest (~20 percent) reduction in vehicle GHG emissions on a well-to-wheels basis, next-generation biofuels such as lignocellulosic bioethanol could offer up to a 90 percent GHG reduction benefit.[2] Building a substantial fleet of flexible-fuel vehicles (FFVs) provides a bridge to the widespread use of lower-carbon biofuels in the future.

Ford has a long history of developing vehicles that run on renewable biofuels. We produced the first flexible-fuel vehicle approximately 100 years ago: a Model T capable of running on gasoline or ethanol. Ford offers 23 models in North America, South America, Europe and Asia that can run on ethanol blends greater than E10 (i.e., containing 10 percent ethanol and 90 percent gasoline). Ford has manufactured more than five million FFVs, including 3 million in the U.S. and nearly 2 million in Brazil.

Related Links

This Report:
- Electrification: A Closer Look

In Europe, Ford is a market leader and pioneer in bioethanol-powered FFVs, with more than 70,000 vehicles delivered to customers since 2001. Ford FFV models are now available in many European markets that offer a dedicated fuel infrastructure.

In certain Asian markets, Ford offers models that are capable of operating on E20.

In the U.S., we met our commitment to doubling the number of FFVs in our lineup by 2010, and we are continuing to produce substantial numbers of E85 flexible fuel vehicles.

Alternative fuels pose a classic chicken-and-egg problem – automakers can produce a range of products capable of running on fuels with varying carbon content, but the benefits are only realized if energy providers bring the fuels to market and consumers demand both the vehicle and the fuel. Since 2006, Ford has produced more than 1.5 million flexible fuel vehicles. Yet today, less than 2 percent of refueling stations in the U.S. offer E85. And the policy shift to increase ethanol blends rather than increase E85 availability creates questions about the potential growth and viability of E85. Furthermore, the development and production of FFVs increases engineering workload and vehicle cost. This investment into FFVs becomes increasingly difficult to justify, particularly if fuel availability is not developing.

The lack of progress on E85 has increased the focus on mid-level ethanol blends. The potential introduction of such blends creates an opportunity to increase the octane rating of the new fuel. Ethanol has an octane rating greater than today's gasoline, so that when the fuels are mixed, the resulting fuel blend should have higher octane than base gasoline. Many of today's advanced engines currently on the road are programmed to improve the efficiency of the engine just short of the point where the consumer would experience engine knock. For such engines, an increase in the octane rating of the fuel would result in improved vehicle efficiency. Further improvement to engine efficiency (through increased compression ratio and downsizing) could be achieved if manufacturers knew the octane rating of the fuel will be increased.

In the long term, we believe that next-generation biofuels made from a variety of feedstocks, including agricultural wastes (particularly lignocellulosic material) will be an important part of the GHG emission-reduction equation and will help address concerns about current-generation biofuels, including the potential competition between food and fuel crops and the conversion of natural lands to fuel production. These issues are explored in more detail in the Sustainable Technologies and Alternative Fuels Plan. To learn about Ford's perspective on biofuels public policy issues, please see Climate Change Policy and Partnerships.

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1. Of course, there is not only a need to reduce the fossil carbon content of the fuel itself, but to reduce any fossil-based CO_2 emitted during feed-stock excavation, fuel production and distribution.
2. *Ethanol: The Complete Lifecycle Picture*, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy, March 2007.

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Driver

Vehicle + Fuel + Driver = GHG emissions

Paradoxically, the "driver" portion of the GHG emissions equation holds the potential for substantial emission reductions at minimal cost, but it is often overlooked. Ultimately, drivers decide which vehicles and fuels they will purchase and how those vehicles will be driven. While our major focus is on the vehicles we make, we have also reached out to drivers around the world to promote the practice of "eco-driving." We do this by providing training, information and vehicle technology that helps drivers learn how to drive using the least fuel possible.

Information Technology

Ford's in-vehicle technology system – MyFord Touch™ – offers an array of real-time information on fuel-economy performance that can coach drivers to get more miles to the gallon and save on fuel costs. In addition, MyFord Touch's map-based navigation system offers an Eco-Route option that quickly calculates the most fuel-efficient route a driver can take to get from A to B. Ford testing shows that Eco-Route can help achieve fuel economy gains of up to 15 percent. This technology will be available across our full range of vehicles, from affordable small cars to high-end luxury vehicles. It debuted on the 2011 Ford Edge and Lincoln MKX crossovers, followed by the 2011 Ford Explorer and 2012 Ford Focus in North America. By 2015, approximately 80 percent of Ford's North American models will offer MyFord Touch, with similar percentages predicted for the world market. (MyFord Touch with SYNC® will be launched in Europe in 2012, initially on the Ford Focus.)

SmartGauge™ with EcoGuide is a dashboard display in the Ford Fusion and Lincoln MKZ Hybrids that gives drivers information to help them maximize fuel efficiency. The system provides information on current fuel economy, fuel economy history, odometer reading, engine coolant temperature, fuel level, battery charge status, electric vehicle mode, tachometer, engine output power, battery output power, power to wheels, engine pull-up threshold and accessory power consumption. Drivers can use the system to track their long-term fuel economy progress and illustrate it either with a traditional chart or using an innovative display of "growing leaves and vines." The more efficient a customer is, the more lush the leaves and vines, creating a visual reward for the driver's efforts. In addition, the real-time system feedback allows drivers to assess and modify their driving habits to achieve maximum fuel economy.

The EcoMode system that was first presented in the Ford Focus ECOnetic in Europe in 2009 has been made available in a wider range of vehicles. This system monitors the key parameters for optimal fuel consumption that drivers can affect by changing their driving behavior, including gear shifting, anticipation (i.e., driving as consistently and smoothly as possible) and motorway driving (i.e., driving with the most efficient speed on highways and country roads). In addition, the system considers the percentage of cold-engine short trips. Through this monitoring process, Ford EcoMode generates a driver profile with a scoring system for these driving parameters and offers information on how to improve fuel economy over time. This process can be translated into driver advice that can help make the best use of the vehicle's technology. The system will be implemented in more European Ford models in the future and in the North American 2012 Ford Focus.

Eco-Driving Information and Training

Ford has demonstrated that drivers who practice "eco-driving" can improve their fuel economy by an average of 24 percent. Eco-driving tips are available to the public on Ford's website, and online training is available through the Ford Driving Skills for Life (FDSFL) program. In addition, a web-based eco-driving program has been available to all U.S. salaried Ford employees since 2006.

Ford began work on the eco-driving concept in 2000, when we first offered an eco-driving program through our German dealerships, in partnership with the German Federation of Driving Instructor Associations and the German Road Safety Council. That program trains drivers in conservation-minded driving and vehicle maintenance habits. It uses specially trained and certified instructors to run programs for several target groups, including fleet drivers and customers. By the end of 2009, more than 16,000 German drivers had been "eco-trained" under real-world conditions.

In 2010 Ford's eco-driving training concept was recognized as a model for driver training with a "Good Practice Energy Efficiency" award from dena, the official German Energy Agency. The recognition was for the one-hour "compact course" version of the training. All of the Ford eco-driving program details, measurements and consumer surveys were analyzed and evaluated to ensure they meet dena's stringent criteria for good practice. Ford is the only automaker to receive

Related Links

Corporate.ford.com:
- Eco-Driving

Ford Websites:
- Driving Skills for Life

this recognition for its driver training programs, which benefits both the driver and the environment.

In Asia Pacific and Africa, Ford launched the FDSFL driver training program in 2008 with a "train-the-trainers" workshop in Bangkok, Thailand. At the workshop, Ford professionals from Germany trained two to three representatives from the Philippines, Vietnam, Thailand and Indonesia. The FDSFL program was customized to address the higher average age of beginner drivers in the region, as well as the unique driving environments within each market. It places equal emphasis on safe driving and eco-driving, as customers in the region are interested in both.

In 2009 and 2010, we held "train-the-trainers" workshops in Shanghai, China, and Chennai, India, and continued with the successful roll-out of the program to China, Taiwan, India and South Africa. Australia and Malaysia will launch FDSFL programs in 2011, bringing to 10 the number of Asia Pacific and Africa markets that offer the safe driver program. More than 33,000 licensed drivers have participated in FDSFL from its launch through 2010.

Ford is also helping drivers achieve efficient driving habits through Ford UK's "Econo-Check" program. Through the program, Ford technicians install a monitoring device that collects a week's worth of data on a driver's habits. The driving data is analyzed, looking for factors that affect fuel economy – for example, acceleration, point of gear shifting, engine speed and engine coolant temperature. Ford then provides the driver with a personalized recommendation on how they can alter their driving style for maximum efficiency. The modest fee for the service also includes a check-up of the vehicle itself to identify items that could affect fuel economy.

Facilities

IN THIS SECTION

Ford has been a leader in facilities-related greenhouse gas (GHG) and energy-use reductions, public reporting of our GHG emissions, and participation in GHG reduction and trading programs.

In 2010, we adopted a goal to reduce our facility carbon dioxide (CO_2) emissions by 30 percent by 2025 on a per-vehicle basis. This CO_2 goal, which is also based on our stabilization commitment, complements our longstanding facility energy use reduction targets.

GHG Reporting Initiatives

- We were the first automaker to join The Climate Registry (TCR), a voluntary carbon disclosure project that links several state-sponsored GHG emissions-reporting efforts, including the California Climate Action Registry and the Eastern Climate Registry. As TCR members, we must demonstrate environmental stewardship by voluntarily committing to measure, independently verify and publicly report GHG emissions on an annual basis using the TCR's General Reporting Protocol.
- We were the first automaker to participate in GHG reporting initiatives in China, Australia, the Philippines and Mexico. Ford's first report was used as the template for subsequent reporting in Mexico's program.
- We voluntarily report GHG emissions in the U.S. and Canada.
- We were the first, and remain the only, automaker participating in the Chicago Climate Exchange (CCX), North America's first GHG emissions-reduction and trading program.
- Since 2005, GHG emissions from our European manufacturing facilities have been regulated through the EU Emission Trading Scheme. These regulations apply to five Ford facilities in the UK, Belgium and Spain.
- The U.S. Environmental Protection Agency (EPA) issued a final rule on September 22, 2009, establishing a national GHG reporting system. Facilities with production processes that fall into certain industrial source categories, or that contain boilers and process heaters and emit 25,000 or more metric tons per year of GHGs, are required to submit annual GHG emission reports to the EPA. Facilities subject to the rule were required to begin collecting data as of January 1, 2010, and to submit an annual report for calendar year 2010 by September 30, 2011. Many of our facilities in the U.S. will be required to submit reports. Our proactive approach and early action on GHG reporting globally has prepared us for this new requirement.
- The World Resources Institute GHG Protocol is planning to use Ford's China and South America GHG reports in their forthcoming training programs.

Our participation in these reporting, emissions-reduction and trading schemes has played an important role in accelerating our facilities' GHG emissions reduction activities.

Performance

Ford reduced its 2010 **global energy consumption** by 40 percent compared to 2000 and energy consumption per vehicle produced by 5.6 percent compared to 2009. In 2010, overall global energy consumption increased by 6.6 percent compared to 2009, due primarily to a 13 percent increase in production volume. In 2010, Ford improved energy efficiency in its North American operations by 14.4 percent indexed against our 2006 baseline year. This energy efficiency index is adjusted for typical variances in production and weather and is tracked against the baseline year to measure cumulative improvements in energy efficiency.

We reduced our total **facilities-related CO_2 emissions** by approximately 49 percent, or 4.8 million metric tons, from 2000 to 2010. During this same period, we reduced facilities-related CO_2 emissions per vehicle by 30 percent. While total CO_2 emissions increased by 13 percent from 2009 to 2010 due to increased production, per-vehicle emissions decreased by 5.6 percent. We set – and exceeded – a target to reduce our North American facility GHG emissions by 6 percent between 2000 and 2010 as part of our Chicago Climate Exchange commitment. This program ends in 2011. The Company has also committed to reduce U.S. facility emissions by 10 percent

Related Links

External Websites:
- EPA Energy Star
- The Climate Registry
- Chicago Climate Exchange
- E.U. Emissions Trading Scheme

per vehicle produced between 2002 and 2012, as part of an Alliance of Automobile Manufacturers program.

Please see the environment data section for more detail.

The U.S. Environmental Protection Agency (EPA) again recognized Ford's energy-efficiency achievements by awarding us the 2011 Energy Star Partner of the Year Sustained Excellence Award, which recognizes Ford's continued leadership and commitment to protecting the environment through energy efficiency. This is Ford's sixth consecutive year winning this prestigious award. The Energy Star Partner of the Year award requires organizations to demonstrate proficiency through the management of projects and programs, data collection and analysis, and communication actions, including community outreach and active participation in Energy Star industry forums. The Sustained Excellence level is achieved by illustrating notably consistent actions and continued improvements. Among the achievements recognized by the award is a 40 percent improvement in the energy efficiency of Ford's U.S. facilities since 2000, equivalent to the amount of energy consumed by 110,000 homes.

Energy Management Initiatives

Ford has achieved these efficiency improvements and energy use reductions by using a variety of initiatives, as described in this section. We regularly look for new technologies, approaches to the identification and definition of potential projects, funding mechanisms and means to implement plant energy-efficiency projects.

Since 2007, we have been using a **utility metering and monitoring system** to collect electricity and natural gas consumption data for all Ford plants in North America. We use this near-real-time information to create energy-use profiles for these plants and to improve decisions about nonproduction shutdowns and load shedding, which involves shutting down certain pre-arranged electric loads or devices when we reach an upper threshold of electric usage.

During 2010, we began planning to expand this system to a global scale and provide consumption data down to the departmental level. Linked with production and other data sets, this greatly enhanced near-real-time information has the following objectives:

- Assist in driving improvements in operating and turndown performance by providing departmental detail
- Allow plant-to-plant departmental comparisons
- Assist in the identification of and verification of energy-reduction efforts
- Provide common energy data metrics
- Automate feeds to systems within Ford that require energy data
- Reduce time to generate and obtain energy and environmental reports
- Improve the accuracy of and compliance with carbon-reduction reporting
- Improve energy performance dashboards and communication optimization.

Our Kansas City Assembly Plant will serve as a pilot site for this Global Departmental Level Metering (GDLM) effort.

Ford continues to use **energy performance contracting** as a financing tool to upgrade and replace infrastructure at its plants, commercial buildings and research facilities. Through these contracts, Ford partners with suppliers to replace inefficient equipment, funding the capital investment over time through energy savings. Projects have been implemented to upgrade lighting systems, paint-booth process equipment and compressed air systems, and to significantly reduce the use of steam in our manufacturing facilities. Since 2000, Ford has invested more than $226 million in plant and facility energy-efficiency upgrades.

During 2010 and 2011, for example, we packaged 40 buildings in the Dearborn, Michigan, area into a performance contract to upgrade to more-efficient lighting.

When complete, the project will reduce energy use by more than 18.2 million kilowatt-hours – enough to power 1,648 U.S. homes for a year. The project also will eliminate more than 11,000 metric tons of CO_2 emissions and cut annual costs by more than $1.3 million. The project involves switching out and retrofitting more than 50,000 light fixtures in buildings across southeast Michigan. In Ford World Headquarters alone, more than 6,000 fixtures will be replaced. Other project features include:

- Adding controls to optimize the use of daylighting
- Replacing incandescent exit signs with LED exit signs
- Controlling the lighting of unoccupied areas with occupancy sensors
- Replacing incandescent and halogen lamps with compact fluorescent and LED lamps
- Improved lighting quality, so that employees and visitors will enjoy better visual clarity and enhanced perceived brightness
- Reducing ongoing maintenance costs.

In addition, we are replicating Ford's state-of-the-art paint process that eliminates the need for a stand-alone primer application and curing oven system. This technology, called "**Three-Wet**," reduces CO_2 emissions by up to 40 percent and volatile organic compound emissions by 10 percent compared to either conventional high-solids solvent-borne or waterborne systems. In addition to these environmental benefits, this process maintains industry-leading quality and reduces costs. For example, Three-Wet reduces paint processing time by 20 to 25 percent, which correlates to a significant cost reduction. The paint formulation contains new polymers and other additives to prevent running and sagging during the application and curing processes. Ford's laboratory tests show that this high-solids, solvent-borne paint provides better long-term resistance to chips and scratches than water-borne paint systems. The process is delivering reduced costs per vehicle, because it allows the elimination of a stand-alone primer spray booth and oven, and the attendant energy costs required to run them.

We piloted a full-production enamel line using the Three-Wet process at the Ohio Assembly Plant, which started production in March 2007. In 2009, Ford installed the Three-Wet paint process at the Chennai plant in India and the Craiova plant in Romania. In March 2010, Three-Wet vehicle production began at the Cuautitlán Assembly Plant in Mexico, and in January 2011 it was implemented at the Michigan Assembly plant in Wayne, Michigan, which is now producing the all-new Ford Focus. We are currently installing the process at the new Chongqing and Nanjing plants in China, the assembly plant for Ford of Thailand and the newly updated Louisville Assembly Plant in Kentucky. We are continuing to evaluate additional plants for Three-Wet conversion, as refurbishment actions are being planned in line with the corporate business plan.

In 2010, Ford continued the evaluation of a **new parts washing system** developed in partnership with our supplier **ABB Robotics**. Conventional parts washing systems remove dirt chemically by spraying parts with high volumes of water and detergent at low pressure. This system, in contrast, cleans parts mechanically by moving them in front of specialized high-pressure nozzles with a robotic arm. This new robotics-based system represents a significant leap forward in energy efficiency that also improves quality, flexibility, productivity and cost. It saves energy in part because, unlike previous systems, it does not require any heat. It also uses a much smaller water pump. Forty-seven of these new robotic washing machines are now in operation at Ford, and we have incorporated the technology as standard for all engine and transmission final wash applications, ensuring that the energy and cost savings will be realized by all future vehicle programs. We intend to expand the use of this technology in future programs in North America. We have also implemented robotic parts washing at our Craiova and Cologne engine plants, and are pursuing the use of this technology in China, India and Brazil.

We have also developed a system, called "**fumes to fuel**," that reduces the CO_2 emissions associated with our paint shop emissions-treatment process. In traditional paint shop emissions treatment, the volatile organic compound (VOC) emissions from solvent-based paints are captured and destroyed in a regenerative thermal oxidizer using natural gas as a fuel. In our "fumes-to-fuel" system, VOC emissions are super-concentrated approximately 2000:1. In this super-concentrated state, the VOCs themselves can be burned as fuel source, reducing the amount of natural gas necessary to destroy them. By reducing the need for natural gas, the fumes-to-fuel system has the potential to reduce CO_2 emissions by 80 to 85 percent compared to traditional abatement equipment. We are also investigating opportunities to use the super-concentrated VOCs as a fuel source for both an internal combustion engine and a fuel cell, which could be used to provide additional power to the paint shop. For more information on the fumes-to-fuel system, please see the Facilities-Related Emissions section.

Other efforts to improve the energy efficiency of Ford's plant operations include:

- Aggressively curtailing energy use during nonproduction periods
- Updating facility lighting systems by replacing inefficient high-intensity discharge fixtures with up-to-date fluorescent lights and control systems
- Installing automated control systems on plant powerhouses and wastewater treatment equipment to increase energy and process efficiency.

Facilities

IN THIS SECTION

Renewable Energy Use

Ford is actively involved in the installation, demonstration and development of alternative sources of energy.

In October 2009, two wind turbines spun into action producing "green" electricity for the Ford Genk plant in Belgium. Installed by local energy company Electrabel, each unit has an output of 2 MW of power, which is used in the manufacture of the Ford Mondeo, S-MAX and Galaxy models.

Ford's Dagenham Diesel Centre in the UK was the first automotive plant in the world to obtain all of its electrical power needs from two on-site wind turbines, which have been in operation since 2004. A third 2-megawatt wind turbine will be installed at Dagenham in 2011.

A few miles from Dagenham, Ford's Dunton Technical Centre is also powered by electricity from renewable sources. Since March 2009, electric power on the 270-acre site, which is home to a team of approximately 3,000 engineers, has been purchased from 100 percent renewable sources. The majority of the electricity, supplied by GDF, is sourced from a combination of **hydro, wind and waste-to-energy generation**, and replaces energy from traditional sources that would have produced an estimated 35,000 metric tons of CO_2 emissions annually.

Since 2008, Ford has been sourcing renewable electricity to cover the full electric power demand of its manufacturing and engineering facilities at its Cologne plant in Germany. This includes the electricity needed for the assembly of the Ford Fiesta models at the plant. Through this initiative, the company has reduced its CO_2 emissions by 190,000 metric tons per year.

In Wales, Ford's Bridgend Engine Plant was the first site retrofitted with one of the largest integrated, grid-connected **solar/photovoltaic installations** at a car manufacturing plant in Europe.

In North America, examples of installed renewable-energy technologies include a **photovoltaic array and solar thermal collector** at the Ford Rouge Visitors Center. The adjacent Dearborn Truck Plant has a "living roof" system, which uses a thick carpet of plants to reduce the need for heating and cooling while absorbing rainwater. At the Lima Engine Plant in Lima, Ohio, a **geothermal system** provides process cooling for plant operations as well as air tempering for employee comfort. This system uses naturally cooled 40°F water from two abandoned limestone quarries located on the plant site. The installation cost was comparable to that of the traditional chiller and cooling tower design that it replaced. This award-winning project eliminates the emission of 4,300 metric tons of CO_2 each year. In addition, we continue to use a landfill gas installation at the Wayne Assembly Plant.

At our Michigan Assembly Plant, we are building a **smart renewable power storage system**. We are collaborating with DTE Energy to build this stationary, battery-based energy storage facility, which will combine a 500 kW solar photovoltaic array with a 750 kW storage system to deliver 2 MWh of energy. This project will provide vital knowledge from a real-world integration of renewable energy, smart-grid technologies and battery storage infrastructure. For more on this project, please see Ford's Green Partnerships with Federal and State Governments.

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Logistics

Our logistics operations provide for the safe and efficient transport of parts from our supply base to our manufacturing plants and of finished vehicles from the end of our assembly lines to our dealerships. Though logistics accounts for a relatively small percentage of total vehicle lifecycle emissions, we are working hard to maximize the efficiency of these operations to reduce costs and environmental impacts. We have taken steps to quantify the CO_2 footprint of our logistics operations and reduce it through a variety of measures, such as shifting to rail and sea shipping and other efficiency measures. Please see the Supply Chain section for details.

Related Links

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- Logistics

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Supply Chain

During 2010, we took significant steps to better understand the risks and opportunities of greenhouse gas (GHG) regulation and climate change for our suppliers and, by extension, for Ford. We have worked hard to reduce GHG emissions from our products and operations, which enhances our competitiveness, and we hope to help promote similar competitiveness throughout the automotive supply chain.

Ford was a "road tester" of the World Resources Institute/World Business Council for Sustainable Development (WRI/WBCSD) Scope 3 Greenhouse Gas Accounting and Reporting Standard. Ford had also been an original participant in the review and development of the internationally accepted Greenhouse Gas Protocol Corporate Accounting and Reporting Standard, which addresses Scope 1 (direct) GHG emissions and Scope 2 (indirect) emissions.

The new Scope 3 standard provides a step-by-step methodology for companies to quantify and report their corporate value chain-related (Scope 3) GHG emissions, and is intended to be used in conjunction with the GHG Protocol Corporate Accounting and Reporting Standard. It will provide a standardized method to inventory the emissions associated with corporate value chains, taking into account impacts both upstream and downstream of the company's operations. The standard covers outsourced activities, supplier manufacturing and product use. The draft standards were developed through a global, collaborative multi-stakeholder process, with participation from more than 1,000 volunteer representatives from industry, government, academia and nongovernmental organizations. The road testing process was designed to provide real-world feedback to ensure that the standards can be practically implemented by companies and organizations from a variety of sectors, sizes and geographic areas around the world.

The final Scope 3 Standard is scheduled to be published by WRI/WBCSD in September 2011.

In order to facilitate Ford's road-testing activities during 2010, Ford requested GHG emissions data from selected Tier 1 production suppliers, representing close to 30 percent of Ford's $65 billion in annual procurement spending. Based on this experience, Ford provided feedback on practical aspects of using the Scope 3 Accounting and Reporting Standard.

Ford has also joined the Carbon Disclosure Project's Supply Chain program. Through this effort, Ford is working with selected suppliers to gather qualitative as well as quantitative information about the suppliers' climate risks and emissions and how they are managing them.

We believe that supply chain GHG emissions represent both risks and opportunities for our Company and our suppliers. Thus, our continued leadership in working to better understand our full lifecycle GHG footprint is increasingly important as we seek to jointly realize operational efficiencies and reduce our emissions footprint across our corporate value chain.

Related Links

This Report:
- Logistics
- Greenhouse Gas Emissions
- Climate Change Risks and Opportunities: Supply Chain Risks

Climate Change Policy and Partnerships

During 2010, the climate change policy landscape continued to evolve. The U.S. Environmental Protection Agency (EPA) and the U.S. National Highway Traffic Safety Administration (NHTSA) finalized a national approach to vehicle standards for 2012–16; however, growing budget deficits at national and regional levels globally decreased the emphasis on comprehensive climate policy.

Our global approach to product planning and policy participation is based on the science of climate stabilization. We accept that simply "not getting worse" is not good enough. The auto industry must work together with suppliers, government, the fuel industry and consumers to reduce CO_2 levels from transportation so we can help stabilize atmospheric CO_2 concentrations. Stabilizing CO_2 concentrations will require that all sectors of the economy, including the transportation sector, do their share. To achieve real and lasting results, all global stakeholders must make long-term commitments for a sustainable future.

In our major markets, the regulation of fuel economy and/or vehicle CO_2 emissions is becoming increasingly complex. In addition to competing federal and regional regulations, governments are taking diverse approaches to incentives for emission reductions through rebates, fees, "feebates," privileges for low-emitting vehicles and penalties for high-emitting vehicles. This creates a very complex policy environment, and it is one important driver of our strategy to develop fuel-efficient and advanced technology platforms that can be shared globally and tailored to the needs of our customers.

In the U.S. and elsewhere, Ford continues to advocate for comprehensive, market-based policy approaches that will provide a coherent framework for greenhouse gas (GHG) emission reductions, so that companies have a clear understanding of their role in achieving reductions. GHG regulations effectively regulate what vehicles we are allowed to build and sell. Carbon dioxide (CO_2) emissions standards for motor vehicles are functionally equivalent to fuel economy standards, because the amount of CO_2 produced by a vehicle is proportional to the amount of fuel used.

We hope that the information that follows helps to illustrate the diverse array of GHG and fuel economy regulations and incentives that are now shaping our markets. This section provides more detail on developments and Ford's involvement in:

- U.S. policy
  - Climate change legislation
  - Greenhouse gas and fuel economy regulation
- European policy
- Canadian policy
- Asia Pacific policy
- South American policy
- Renewable fuels policy
- Partnerships and collaboration
- Emissions trading

Related Links

External Websites:

- National Highway Traffic Safety Administration

U.S. Policy

ON THIS PAGE

Climate Change Legislation

In the U.S., the policy debate surrounding climate change has been overshadowed by other issues, including concerns over budget deficits. Nevertheless, the U.S. Environmental Protection Agency (EPA) continued to pursue greenhouse gas emissions regulations for mobile and stationary sources using their authority under the Clean Air Act. EPA and the U.S. National Highway Transportation Safety Administration (NHTSA) finalized regulations for 2012–16 model year vehicles. And in 2011, California began the first year of their Low-Carbon Fuel Standard.

Ford has participated in the public discourse on climate policy for some time. In 1999, for example, we discussed greenhouse gases in our first corporate citizenship report. In late 2005, we published a special report on the Business Impact of Climate Change, and in 2007 we joined the U.S. Climate Action Partnership to support the prompt enactment of climate legislation.

These experiences, as well as our participation in carbon markets globally, have helped to shape Ford's position on climate policy. The linked issues of climate change and energy security create an urgent need to transform the country's economy into one with lower greenhouse gas emissions, higher energy efficiency and less dependence on fossil fuels and foreign oil. This transformation will require changes in all sectors of the economy and society. A comprehensive legislative framework is needed to spur these changes.

We believe we need a comprehensive, market-based approach to reducing GHG emissions if the U.S. is going to reduce emissions at the lowest cost per ton. An economy-wide program would provide flexibility to regulated entities while allowing market mechanisms to determine where GHG reductions can be achieved at the lowest cost. The environment doesn't care where reductions occur, but the economy does, and given the potentially high cost of abatement, it is important to achieve the lowest cost possible.

As part of an integrated approach to addressing energy security and climate change, Ford supports comprehensive legislation that will create a price signal to encourage consumers to purchase more fuel-efficient vehicles. Thoughtful and comprehensive national energy and climate policy that provides a price signal is needed to support the billions of dollars being invested into low-carbon and fuel-efficient vehicle technologies. Without a cohesive policy that includes a price signal, we could be caught in an endless cycle wherein development of the advanced technologies needed to help address climate change and energy security is sporadic and not aligned with fuel providers or consumer demand.

Ford will continue to advocate for effective climate change policies that drive down GHG emissions and provide a framework for sound business and product planning.

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Greenhouse Gas and Fuel Economy Regulation

In 2009, the Obama Administration announced an agreement among the federal government, the state of California, the auto industry and other stakeholders in support of a single national program for motor vehicle fuel economy and greenhouse gas standards covering the 2012 to 2016 model years. Ford views this "One National Program" agreement as a positive step for all stakeholders toward our common goals of energy security and reduced greenhouse gas emissions.

A national program is essential for the efficient regulation of motor vehicle fuel economy and GHG emissions. It allows manufacturers to average the fuel economy and carbon dioxide (CO_2) emissions of their vehicles based on nationwide sales, which in turn enables manufacturers to formulate their product plans on a national scale. In contrast, state-by-state or regional regulations could force manufacturers to restrict the sale of some products in certain parts of the country, harming both consumers and dealers in those areas. Since CO_2 emissions do not create localized air-quality problems, state or regional standards are unnecessary, and the incremental benefits of such standards are negligible in comparison to the costs and market disruptions they would impose.

In May 2010, the Obama Administration announced plans to set a new round of light-duty motor vehicle fuel economy and GHG standards for the 2017–2025 model years. Consistent with the One National Program agreement for 2012–2016, the EPA and NHTSA are again planning to issue harmonized standards (with EPA setting GHG standards under the Clean Air Act, and NHTSA setting fuel economy standards under the Energy Policy and Conservation Act). The agencies expect to issue proposed standards in September 2010.

The California Air Resources Board is also planning to issue its own proposed 2017–2025 GHG standards at the same time. State standards are inherently incompatible with federal standards. Although California has expressed support for the One National Program framework, at this writing it is not clear whether California will ultimately defer to the federal standards as it did for the 2012–2016 time period.

Ford is committed to working constructively with all stakeholders toward the implementation of workable and effective One National Program standards for 2017–2025. For the longer term, Ford supports a legislative solution requiring One National Program, in order to head off the possibility that various agencies may promulgate and enforce multiple, inconsistent fuel economy/GHG regulations in the future.

In May 2010, President Obama announced a set of principles for the EPA and NHTSA to work together to develop a single national program for greenhouse gas and fuel economy standards for heavy-duty vehicles. As a result, in November 2010 the EPA and NHTSA proposed CO_2 and fuel consumption requirements for 2014 through 2018 model year combination tractors, heavy-duty pickup trucks and vans, and vocational vehicles. The agencies estimate that the combined proposed standards have the potential to reduce GHG emissions by nearly 250 million metric tons and save approximately 500 million barrels of oil over the life of vehicles sold during the program. Final requirements are expected to be published in late summer 2011.

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European Policy

The EU has set mandatory carbon dioxide (CO_2) targets for both cars and light commercial vehicles. The specific target for an automaker depends on the average weight of the automaker's vehicles registered in a given year. Due to the relatively low average weight of Ford cars registered in the EU, this results in stricter targets for Ford compared to the overall industry target of, for example, 130 g/km during the 2012–2015 period and 95 g/km in 2020.

The EU has also established significant regulations about other items related to climate change, such as fuels (including bio-blending), tires and gear-shift indicators, among other topics. In fact, automobiles are one of the most regulated products in the EU, with requirements also covering non-CO_2 emissions, drive-by noise, recycling, substances, electro-magnetic requirements, safety, technical aspects and more. Ford is now complying and will continue to comply with all these various targets and prohibitions with appropriate product offerings, in spite of the sudden dramatic economic downturn that had severely limited the resources available to respond.

In general, Ford is requesting that regulations and policies be well coordinated and not contradictory to each other and that they be technology-neutral, proportional, avoid double regulation, offer sufficient lead time to adjust development and production cycles and follow an integrated approach in which all stakeholders (industry, infrastructure, consumers and governments) contribute to the solution. Any CO_2 regulations should also be in line with meeting the global CO_2 target of 450 ppm.

In some member states, CO_2 taxation is in place to encourage the early introduction of low-CO_2 vehicles with major tax break points, often around 95/100 g/km, 120 g/km and 160g/km. Unfortunately, these tax break points are not harmonized between the European countries.

The industry will continue to invest heavily in research and development and new product programs in order to reach the short-term CO_2 targets. The long-term target will require technological breakthroughs, new refueling infrastructure and a swift renewal of the car fleet on Europe's roads.

Canadian Policy

In September 2010, Environment Canada finalized greenhouse gas emissions regulations for 2011 to 2016 model year passenger automobiles and light trucks. This regulation aligns emission standards and test procedures with those of the U.S. The regulation provides companies with similar compliance flexibilities to those available under the U.S. Environmental Protection Agency's greenhouse gas (GHG) regulation, including advanced technology credits, air conditioning leakage and efficiency credits, flexible-fuel vehicle credits and credit transfer among fleets.

Environment Canada has also announced that it will regulate in alignment with the upcoming U.S. federal heavy-duty vehicle GHG regulations slated to begin with the 2014 model year. Coincident with the U.S., Environment Canada published a Notice of Intent to regulate passenger automobiles and light trucks in the 2017–2025 model years.

The Provinces of Quebec, Manitoba and British Columbia participate in the Western Climate Change Initiative and had committed to adopt GHG regulations based on California standards. Quebec has promulgated a GHG regulation based on the California standards, but with fewer flexibility mechanisms. We are hopeful that Quebec will see the benefit of a single standard for Canada, consistent with the One National Program effort in the U.S. Ford has participated in regulatory discussions on this issue, providing technical expertise and supporting a tough, aligned, national standard. British Columbia and Manitoba have both acknowledged the value of the new federal standards.

Environment Canada has also regulated renewable fuel content in on-road gasoline. Effective September 2010, renewable levels in the national pool of gasoline must average 5 percent. Environment Canada has also published a draft regulation for renewable content in diesel fuel. The proposed regulation would require 2 percent renewable content in diesel fuel starting July 2011.

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Asia Pacific Policy

In Ford's Asia Pacific and Africa region, sales in China are growing rapidly. Economic growth is a key priority of the Chinese government, to be balanced with energy security and a cleaner environment.

The China Automotive Technology and Research Center released for comment a draft national standard on Stage III fuel economy limits for passenger cars, with phase-in of implementation targeted for the 2012 model year. During the phase-in period, the ratio of the Corporate Average Fuel Consumption to the Target Corporate Average Fuel Consumption of all automakers must decline from 109 percent in 2012 to 100 percent in 2015.

The Chinese government provides limited incentives for the purchase of "new energy vehicles" (including plug-in electric vehicles) made by Chinese manufacturers for fleets under local government control. The program applies to vehicles in 13 cities initially, with plans to expand to others up to 2012. Diesel use is discouraged in passenger car applications in the near term, due to fuel availability concerns.

Japan, South Korea and Taiwan have released new or modified fuel economy limits, while Hong Kong, South Korea and Taiwan have linked tax incentives to fuel economy and carbon dioxide targets.

Ford is actively involved in dialogues with governments across Asia Pacific and Africa in a number of areas, including sustainable mobility, energy security and environmental protection.

South American Policy

In Brazil, our largest South American market, the use of biofuels is a national policy, with 100 percent of gasoline blended with 20 to 25 percent ethanol, and extensive use of pure ethanol as motor fuel. Most new vehicles are designed to accommodate varying amounts of ethanol. A minimum of 5 percent biodiesel must be added to diesel. Emission requirements are periodically updated by an emissions-control program. A voluntary fuel economy labeling program is also in place. A star ranking for light vehicles was recently introduced, favoring low-emission, low-carbon-dioxide (CO_2), ethanol, flexible-fuel or hybrid vehicles. Diesel use in light vehicles under a one-ton payload is not allowed, except for combined-usage vehicles with special off-road characteristics. The government is also studying incentives for hybrids and electric vehicles. The federal, state and municipal environmental bodies are expected to issue their Vehicle Pollution Control Plan by June 30, 2011, and implement an In-Use Vehicle Inspection and Maintenance Program by April 25, 2012.

Other South American countries, such as Argentina and Colombia, are also significantly increasing the use of biofuels. Chile will introduce a mandatory fuel economy labeling program by September 2011, which will provide information on fuel consumption and CO_2 emissions.

Ford has supported the region's biofuels initiatives since the 1970s and offers a wide range of vehicles capable of running on 100 percent ethanol. We also provide light- and heavy-duty vehicles that meet biodiesel requirements.

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Renewable Fuels Policy

Today, more than 80 percent of global oil reserves are limited to 10 countries, while biofuels made from sugarcane can be produced in more than 100 countries. First-generation biofuels are playing an important role in building consumer awareness and spurring capital investment in infrastructure and facilities that can be used for more promising second-generation biofuels.

Ford is a leader in providing vehicles that can operate on biofuels. We met our 2010 U.S. goal to double our production of E85 flexible-fuel vehicles (those capable of using up to 85 percent ethanol), and we continue to introduce E85 flexible-fuel vehicles. These products, which we are delivering at no additional cost to consumers, go well beyond requirements and what most other automakers are doing.

Ford's vision for biofuels is for accelerated use of renewable fuels to deliver increased energy security, enhance economic development and help to address climate change. This vision includes rapidly expanding the number of vehicles that can operate on biofuels, increasing the number of stations offering biofuels, developing the fuel distribution network to support customer choice and value, and achieving technology breakthroughs to commercialize advanced biofuels.

Policies across the globe are aimed at increasing the use and availability of biofuels. The U.S. adopted a Renewable Fuel Standard requiring 36 billion gallons of biofuels by 2022, including more than 20 billion gallons of low-carbon advanced biofuels. The EU Renewable Energy Directive establishes a 10 percent renewable energy target for transportation energy in 2020. And Brazil has had a very aggressive domestic ethanol program for years.

But these policies aren't enough. Providing value is critical to engage consumers and get them to use alternative energy sources. Hundreds of millions of vehicles in operation today were designed to use ethanol blends containing less than 10 percent ethanol, and our transportation energy infrastructure was set up to deliver petroleum-based fuels.

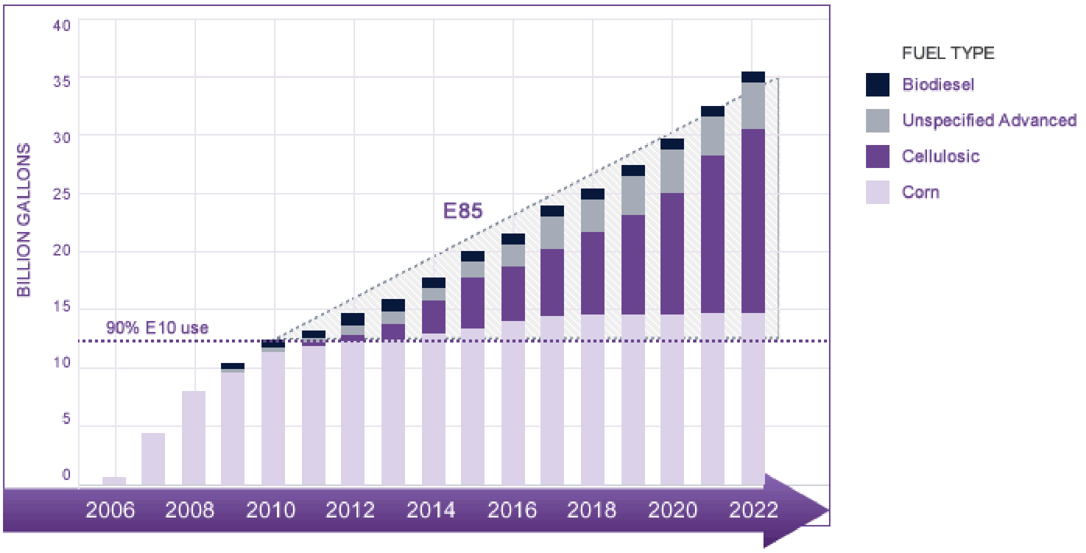
In January 2011, the U.S. Environmental Protection Agency (EPA) approved a waiver allowing the use of E15 (a blend of 85 percent gasoline and 15 percent ethanol) in 2001 and later model year vehicles.

On the one hand, we recognize the potential benefits of expanded use of E15 fuel in helping to build markets for renewable fuels. In addition, ethanol has an octane rating greater than today's gasoline, so when the fuels are mixed, the resulting fuel blend will have higher octane than base gasoline. As the octane rating of a fuel increases, it reduces the tendency for "engine knock," a condition that can, over time, lead to engine damage. Many of today's advanced engines currently on the road are programmed to improve the efficiency of the engine just short of the point where the consumer would experience engine knock. For such engines, an increase in the octane rating of the fuel would result in improved vehicle efficiency. Further improvement to engine efficiency (through increased compression ratio and downsizing) could be achieved if manufacturers knew the octane rating of the fuel would be increased.

On the other hand, the implementation of the EPA's E15 waiver presents a number of concerns. In particular, Ford is concerned about the impact the waiver will have on the legacy fleet – the millions of vehicles still on the road that were designed to operate on E10 (or E0 for very old vehicles). Although E15 is not approved for use in such vehicles, the EPA has not developed a robust program to prevent the "misfueling" of these vehicles. As a result, we anticipate a high incidence of misfueling, i.e., customers putting E15 fuel in vehicles not designed to use it. We are concerned that such vehicles will not continue to meet customer expectations for quality, durability and performance, as well as legal requirements to meet emission and on-board diagnostic regulations.

Because of the concerns cited above, we believe that the risks for automakers, fuel providers and consumers need to be mitigated and addressed before proceeding with the widespread use of E15. We have suggested that the EPA and other policymakers develop a revised, prospective plan for the introduction of E15, in a way that better ensures the fuel is only used in vehicles designed to accommodate it.

U.S. Renewable Fuel Standard



BILLION GALLONS
40
35
30
25
20
15
10
5
0
2006
2008
2010
2012
2014
2016
2018
2020
2022
90% E10 use
E85
FUEL TYPE
Biodiesel
Unspecified Advanced
Cellulosic
Corn

Emissions Trading

Emissions trading is a key tool in both voluntary and mandatory greenhouse gas (GHG) emissions-reduction programs. Ford was an early participant in carbon markets, with a goal of gaining experience that will be valuable in an increasingly carbon-constrained world.

For example, Ford, along with 11 other companies and the city of Chicago, founded the Chicago Climate Exchange (CCX) in 2003. The CCX was a GHG emissions-reduction and trading program for emission sources and projects in North America. It was a self-regulated, rules-based exchange designed and governed by CCX members. Ford was the first and only auto manufacturing participant in the Exchange. Through the CCX, we committed to reducing our North American facility emissions by 6 percent between 2000 and 2010, and we exceeded that reduction target. CCX elected to end the emissions-reduction portion of the program after 2010, with cumulative verified emission reductions totaling nearly 700 million metric tons of carbon dioxide (CO_2) since 2003.

Ford was also one of the original companies to join the UK Emissions Trading Scheme, the first government-sponsored, economy-wide, cross-industry GHG trading program. Ford Motor Company Limited (UK) entered the program in March 2002, committing to and achieving a 5 percent CO_2 reduction for eligible plants and facilities over five years.

Ford now participates in the EU Emission Trading Scheme, which commenced in January 2005 and is one of the policies being introduced across Europe to reduce emissions of CO_2 and other greenhouse gases. The second phase of this program runs from 2008 to 2012 and coincides with the first Kyoto Commitment Period. Additional five-year phases are expected to follow.

Despite Ford facilities' low-to-moderate CO_2 emissions (compared to other industry sectors), the EU Emission Trading Scheme regulations apply to five Ford facilities in the UK, Belgium and Spain. The trading scheme requires us to apply for emissions permits, meet rigid emissions monitoring and reporting plans, arrange for third-party verification audits and manage tax and accounting issues related to emissions transactions.

Ford is actively involved in an ongoing evaluation of the EU Emission Trading Scheme at both the EU and member-state levels. We have used the experience gained from participating in the market-based mechanisms described above to ensure that we operate in compliance with the scheme's regulatory framework. Ford anticipated the start of the EU Emission Trading Scheme and established internal business plans and objectives to maintain compliance with the new regulatory requirements.

Through our participation in CCX, we built a world-class CO_2 tracking infrastructure for our facility emissions. We will continue to leverage this system to support voluntary reporting globally, to measure progress against our new facility CO_2 target, and to ensure compliance with the EU trading program and the new mandatory U.S. EPA reporting requirements.

Comprehensive reporting forms the foundation for all emissions trading. We voluntarily report GHG emissions in Australia, Canada, China, Mexico and the Philippines. This reporting, which has won several awards, is discussed in the Climate Change Strategy section.

Related Links

External Websites:
- Chicago Climate Exchange
- EU Emissions Trading Scheme

MATERIAL ISSUES

- Materiality Analysis
- Climate Change
  - Greenhouse Gas Emissions Overview
  - Climate Change Risks and Opportunities
  - Our Strategy: Blueprint for Sustainability
  - Ford's Sustainable Technologies and Alternative Fuels Plan
  - Progress and Performance
  - Climate Change Policy and Partnerships
  - Electrification: A Closer Look
    - Ford's Electrification Strategy
    - Comparing Electrification Technologies
    - Living the Electric Lifestyle
    - Maximizing Environmental Benefits of Electrified Vehicles
    - Improving EV Affordability
    - Battery Technology
    - Collaborating with Utilities and Municipalities
- Water
- Supply Chain
- Vehicle Safety and Driver-Assist Technologies
- Sustaining Ford
- Perspectives on Sustainability

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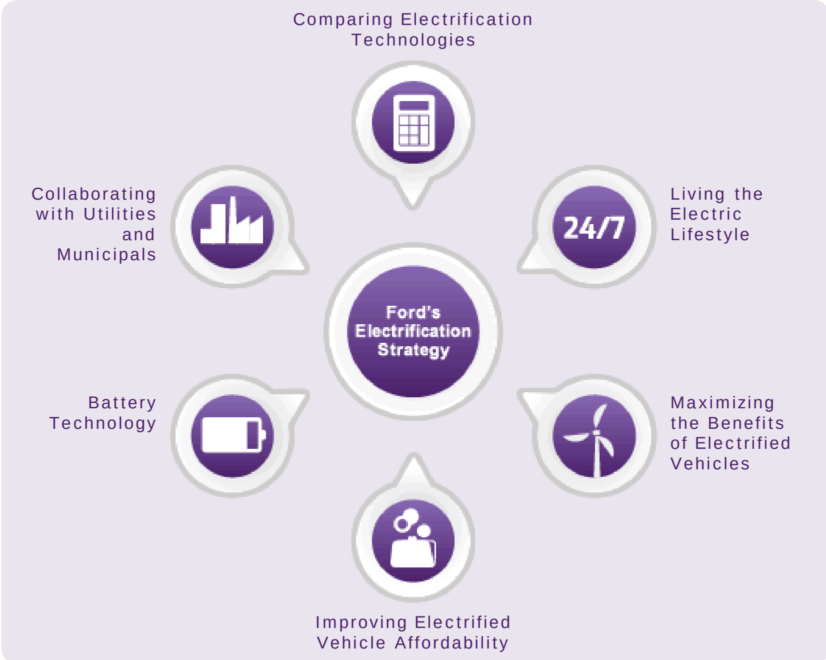
Electrification: A Closer Look



In the past few years, most major global automakers, including Ford, have announced plans to make all-electric vehicles. Utilities are also working to understand how to provide power to plug-in electric vehicles in a way that is effective in meeting consumer needs, efficient for electricity providers and environmentally sound.

Why the rise in interest and activity? The electrification of vehicles could cut greenhouse gas (GHG) emissions from vehicles, increase the use of domestic energy sources, decrease pressure on petroleum stocks and reduce urban air pollution. With the benefit of information technologies and "smart grids," electrified automobiles could also improve the efficiency of the power grid – thereby lowering electricity costs – and facilitate the use of renewable energy sources, such as wind and solar.

But many challenges remain. For example, to fulfill their potential to cut lifecycle GHG emissions from automobiles, low-carbon electric generation must make up a greater part of the total supply, and electric vehicles must become functioning parts of "smart grids." Also, battery technologies are still evolving, and the cost of new-generation batteries remains high. Working with researchers from the University of Michigan, we have assessed the global availability of lithium and compared this to the potential demand that could be created from the large-scale, global use of electric vehicles. We found that there are sufficient resources of lithium to supply a large-scale global fleet of electric vehicles through at least the year 2100. We are currently assessing the social and environmental challenges associated with the provision of rare earth elements for electric vehicles, in addition to investigating whether supplies will be adequate for future needs.

This section provides an overview of Ford's electrification strategy. It also explores electrification technologies and their environmental benefits, and discusses how Ford is addressing key challenges and opportunities related to vehicle electrification. For more details on our electric vehicle technologies and other fuel-efficiency, advanced powertrain and alternative fuels technologies, please see the Sustainable Technologies and Alternative Fuels Plan.

Living the Electric Lifestyle

To help drivers make the transition to electric vehicles (EVs), and get the most out of their EVs, we are offering more than just the vehicle. We are delivering a total electric vehicle lifestyle.

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- Ford's Sustainable Technologies and Alternatives Fuels Plan

Vehicle Websites:

- Ford C-Max
- Ford Fusion
- Ford Escape
- Ford Focus
- Ford Transit Connect
- Mercury Milan
- Mercury Mariner

Ford's Electrification Strategy

Ford's electrification strategy foresees a future that includes different types of electrified vehicles, depending on customers' needs. There will not be a one-size-fits-all approach, but a diverse, smart application of different types of electrified vehicle technologies. Our strategy includes the following.

Power of Choice: Bringing a Range of Electric Vehicles to Market

Electrified vehicles are an important part of Ford's overall sustainability strategy and our commitment to reduce the carbon dioxide (CO_2) emissions of our fleet. We are pursuing an aggressive electrified vehicle strategy that we call Power of Choice. We believe that offering a range of electrified vehicles is the best way to reduce CO_2 emissions and meet different customers' transportation needs. Therefore, we are electrifying global vehicle lines rather than creating a special electrified vehicle model. That way, our customers can choose from a variety of electrified vehicle powertrains, including Hybrid Electric Vehicles (HEVs), Plug-In Hybrid Vehicles (PHEVs) and full Battery Electric Vehicles (BEVs). We are also delivering electrified vehicles in a range of different vehicle segments, including commercial vehicles, sedans, sport utility and crossover vehicles and luxury vehicles. We expect that 10 to 25 percent of Ford's global sales will be composed of electrified vehicles by 2020. That includes sales of HEVs, PHEVs and pure BEVs, with the majority of those sales coming from HEVs.

Ford already offers three HEVs: the Ford Escape Hybrid, the Ford Fusion Hybrid and the Lincoln MKZ Hybrid. These HEVs are ideal for customers who cover a range of distances in varied driving conditions. The most significant benefits of these vehicles come under urban stop-and-go driving. We have also announced plans to introduce an HEV version of the Ford C-MAX, a multi-activity vehicle, in North America in 2012.

In 2010 and 2011, we introduced two BEVs in North America: a BEV version of the Ford Transit Connect utility van and the Ford Focus Electric. The Transit Connect Electric is targeted at the commercial market. We developed this vehicle in partnership with Azure Dynamics Vehicles, a leading electric adapter of commercial vehicles. The Focus Electric, a BEV version of the all-new Ford Focus (which became available in North America in 2011), was developed with our strategic supplier Magna International. These BEVs will be ideal for customers who have short, predictable daily trips of less than 80 miles total.

In 2012 in North America, we will introduce our first commercially available PHEV, the C-MAX Energi.

All of these vehicles will use next-generation lithium-ion batteries. We already have a test fleet of Ford Escape PHEVs on the road in partnership with a number of utility companies, which are providing useful data for the development and implementation of commercial PHEVs.

We will also expand our electrified vehicle lineup to Europe. We will launch the Transit Connect Electric in Europe in 2011, followed by the Ford Focus Electric in 2012. The C-MAX Hybrid and C-MAX Energi, along with another still-to-be-announced HEV, will also be introduced in Europe by 2013.

Using Global Platforms

We are basing our electrified vehicle products on our highest-volume global platforms, which offers tremendous opportunities for production economies of scale. For example, the Focus Electric, C-MAX Energi and C-MAX Hybrid will all be based on Ford's next-generation "C-car" platform. Globally, we expect to build as many as 2 million vehicles per year on this platform, including the Focus, Focus Electric, C-MAX, C-MAX Hybrid, C-MAX Energi and other vehicle models. We will be producing the vehicles on flexible manufacturing lines capable of producing a BEV, HEV, PHEV or efficient gasoline- or diesel-powered vehicle, which allows us to switch production between different vehicles as needed to meet changing consumer demand. We also share many of the electrified components between the different vehicles. These strategies are key to making electrified vehicles affordable.

Delivering a Total Electric Vehicle Lifestyle

Electric vehicles have many advantages for consumers, like possibly never having to visit a gas station again. But they also require drivers to make changes to their driving routines and may cause some new anxieties, like wondering if the car has enough charge to get to the next destination. To help drivers make the transition to electric vehicles, and get the most out of their EVs, we are offering more than just the vehicle. We are delivering a total electric vehicle lifestyle.

In the U.S., for example, our EVs have advanced in-vehicle communications that help drivers

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maximize the efficiency and range of their vehicles, find charging stations along their planned routes, and know exactly how far they can go until the next charge based on their own driving style. We have also linked our vehicles to drivers' smartphones so that they can control charging and other in-vehicle operations remotely. We have also developed a comprehensive approach to vehicle charging that makes charging fast, easy, affordable and environmentally friendly. Our goal is to deliver electric vehicles that are as engaging, easy to use and empowering as other forms of consumer electronics like smartphones.

Bringing EVs to Market Thoughtfully

Ford is taking a proactive approach to making EVs successful in the marketplace. We are working with utilities, municipalities, dealers and customers to make the transition to EVs as smooth as possible. We are also targeting our initial EV offerings in markets that we believe will be able to take advantage of the full range of EVs' benefits right away. We are initially introducing the Focus Electric, for example, in 19 U.S. cities: Atlanta, Austin, Boston, Chicago, Denver, Detroit, Houston, Los Angeles, New York, Orlando, Phoenix, Portland (Oregon), Raleigh-Durham, Richmond, San Diego, San Francisco, Seattle, Tucson and Washington, D.C. These markets were chosen based on several criteria, including commuting patterns, existing hybrid purchase trends, utility company collaboration and local government commitment to electrification.

As part of our collaboration with dealers, utilities and local governments, Ford is helping to develop consumer outreach and education programs on electric vehicles as well as share information on charging needs and requirements to ensure that the electrical grid can support customers' needs. For example, we launched a "Charging into the Future Tour" to 14 cities around the country as part of this effort. This tour promotes Ford's electric vehicle strategy, solidifies our collaborations with local utilities and municipalities to make EVs a success, and educates consumers about what to expect from electrified automobiles and what is needed from the public and private sector to support this new technology.

Collaborating with Partners

Gearing up for the development and diffusion of electrified vehicle technologies will be a global challenge. Major advances have already been made on the electrical technology at the core of the next-generation electrified vehicles, and there's more to come. In Ford's vision, a coalition of automotive manufacturers and other stakeholders will work together to develop technologies, standards and cost efficiencies to commercialize electrified vehicles. It will take a collaborative approach of automakers, battery producers, suppliers, fuel producers, utilities, municipalities, educators and researchers, as well as policy makers and opinion shapers, to help us make the transition and realize the full benefits of electrification.

Traditional automotive suppliers, transforming themselves for electrification, are being joined by new suppliers adapting electronics to the automotive environment. Significant possibilities exist for innovation in battery technology, power electronics and the development of motors, generators, high-voltage systems and other components, as well as the information technology necessary to maximize the potential of electric vehicles.

Ford's plan calls for strategic partnering with key suppliers who bring technical expertise, financial solidity and collaborative spirit. We believe that working with a range of partners will allow us to gain greater understanding of the connectivity of vehicles to the electric grid, promote the necessary infrastructure and bring down the costs of the technology to make it more accessible for consumers.

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Comparing Electrification Technologies

A range of vehicle types, from conventional gasoline to pure electric, is shown in the table below. In the near term and mid-term, the largest volume of electrified vehicles will likely be hybrid electric vehicles (HEVs), which use both a gasoline engine and a battery electric motor but do not plug into the electric grid. In the U.S., HEVs made up approximately 2.4 percent of the market for new vehicles in 2010.

In the longer term, electrified vehicles that get some or all of their energy directly from the electric grid, including plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs), are likely to play an increasingly significant role. The table below provides a generalized overview of the relative benefits and impacts of these different electrified vehicle technologies, based on typical compact C-class vehicles similar to those Ford is currently offering, or has announced will be produced in the near future, such as the Focus, C-MAX Hybrid, C-MAX Energi and Focus Electric.

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- Ford's Sustainable Technologies and Alternative Fuels Plan

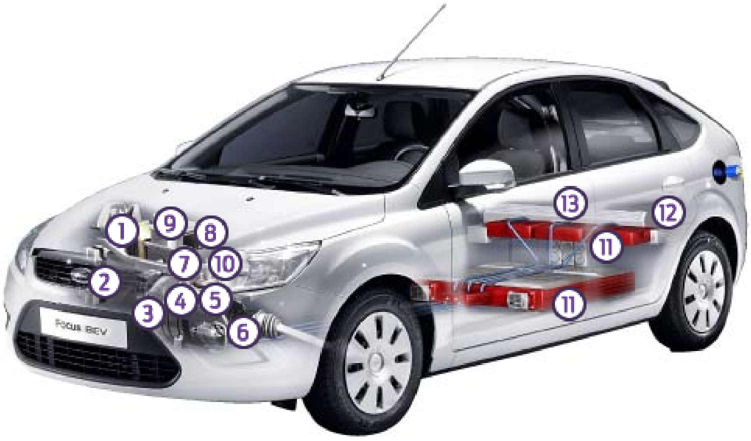
	Conventional Internal Combustion Engine Vehicle (ICEV)	Conventional ICEV with Start/Stop Technology[1]	Hybrid Electric Vehicle (HEV)	Plug-in Hybrid Electric Vehicle (PHEV)	Battery Electric Vehicle (BEV)
Technology overview	Traditional gas or diesel engine.	Traditional gas or diesel engine and powertrain with stop/start capability, which shuts down the engine when the vehicle is stopped and automatically restarts it before the accelerator pedal is pressed to resume driving. Regenerative brake recharging improves fuel economy.	Uses both an internal combustion engine and an electric motor. Can run exclusively on battery power, exclusively on gas power or on a combination of both. Also has stop/start capability and regenerative braking.	Uses a high-capacity battery that can be charged from an ordinary household 110-volt outlet. When the battery is depleted, the PHEV runs like a regular HEV[2].	Uses only a battery-powered electric motor, no gas or diesel engine. Runs entirely on electricity from batteries, which can be charged from household outlets or specialized charging stations.
Ideal driving conditions	Flexible for a wide range of uses.	Flexible for a wide range of uses. Improved fuel economy in urban driving.	Flexible for a wide range of uses. Excellent urban fuel economy and improved highway fuel economy.	Flexible for a wide range of uses. Dramatically improved fuel economy in city driving. Suitable for customers who have access to a plug at home and/or the office with daily trips around 30 miles between charges, but flexibility for longer trips as well.	Ideal for customers with access to a plug at home or work who have shorter, predictable daily trips of less than 80 miles (between charges).
Technology Benefits/Costs Based on a Typical Compact or "C-class" Sedan[3]					
Fuel economy[4] (Roughly real-world fuel economy for a compact sedan)	˜33mpg	˜35 mpg	˜49 mpg[5]	Not applicable. Similar to HEV when running on gasoline. No gasoline used when running on electricity from the grid.	Not applicable.
Range on tank/charge[6]	˜450 miles/tank	˜470 miles/tank	˜660 miles/tank	˜690 miles on combined gas and electric power. More than 1,200 miles between visits to a gas station in typical use.	Up to 80 miles on a charge.
Fueling/charging time	Minutes	Minutes	Minutes	Minutes for gasoline 2–4 hours with a 220-volt outlet and 4–8 hours with a 110-volt outlet.	3–4 hours with a 240-volt outlet
CO_2 emissions[7]					
Well to tank	˜35 g/km	˜30 g/km	˜25 g/km	Current grid:[8] ˜100 g/km	Current grid:[8] ˜130 g/km
Tank to wheels	˜170 g/km	˜160 g/km	˜110 g/km	Current grid:[8] ˜30 g/km	Current grid:[8] 0 g/km

Well to wheels[9]	˜205 g/km	˜190 g/km	˜135 g/km[10]	Current grid:[8] ˜130 g/km[11]	Current grid:[8] ˜130 g/km[12]
Annual fuel cost	˜$1,100–$1,800[13]	˜$1,000–$1,700[14]	˜$700–1200[15]	˜$500 ($200 gasoline+$300 electricity)–$650 ($350 gasoline+$300 electricity)[16]	˜$400[17]

Below is a detailed look at the components that will make up the new electrified vehicles.

Ford Focus Electric

1. Motor Controller and Inverter
2. High Voltage Electric HVAC Compressor
3. Electric Water Pump
4. Traction Motor
5. Electric Power Steering
6. Gearbox
7. Modular Powertrain Candle
8. Electric Vacuum Pump
9. High Voltage PTC Electric Coolant Heater and Controller
10. Vehicle Control Unit
11. Battery Pack and Battery Cells
12. AC Charger
13. DC-DC Converter



* Image based on prototype, not production vehicle.

1 Motor Controller and Inverter

The motor controller monitors the motor's position, speed, power consumption and temperature. Using this information and the throttle command by the driver, the motor controller and inverter convert the DC voltage supplied by the battery to three precisely timed signals used to drive the motor.

2 High Voltage Electric HVAC Compressor

The high voltage air conditioning system is specifically designed for hybrid vehicle applications, drawing electrical energy directly from the main battery pack. An inverter is included in the compressor.

3 Electric Water Pump

The electric drive water pump circulates coolant for the traction motor, inverters, battery and heater.

4 Traction Motor

The traction motor performs the conversion between electrical and mechanical power. Electric motors also have efficiencies three times higher than that of a standard gasoline engine, minimizing energy loss and heat generation.

5 Electric Power Steering

An electro-hydraulic steering pump was installed to assist a retuned steering rack. A production vehicle would be designed with electric power steering.

6 Gearbox

The transmission has the identical role as in a conventional vehicle; however, it has different design considerations due to the higher RPM range available from the electric motor and increased emphasis on efficient and silent operation. The transmission is a single-speed unit with a 5.4:1 reduction.

7 Modular Powertrain Cradle

This is a structure for monitoring all engine compartment EV components and providing isolation from the vehicle body through traditional engine mounts.

8 Electric Vacuum Pump

The vacuum pump supplies vacuum to the brake system for power assist.

9 High Voltage PTC Electric Coolant Heater and Controller

Heating systems are specifically designed for hybrid vehicle applications. Energy-efficient PTC technology is used to heat the coolant that circulates to the passenger car heater. Heat also may be circulated to the battery.

10 Vehicle Control Unit

The vehicle control unit (VCU) communicates with the driver as well as each individual vehicle system to monitor and control the vehicle according to the algorithms developed by the vehicle integration team. The VCU manages the different energy sources available and the mechanical power being delivered to the wheels to maximize range.

11 Battery Pack and Battery Cells

The battery pack is made up of seven battery modules of 14 cells – 98 cells total for 23 kWh of power. The batteries are air cooled using existing vehicle cabin air. The pack includes an electronic monitoring system that manages the temperature and state of charge of each of the cells.

12 AC Charger

Power electronics are used to convert the off-vehicle AC source from the electrical grid to the DC voltage required by the battery, thus charging the battery to its full state of charge in a matter of hours. The current charger is air cooled. The production design will accommodate both 110 and 220 voltage sources.

13 DC-DC Converter

A DC-DC converter allows the vehicle's main battery pack to charge the on-board 12V battery, which powers the vehicle's various accessories, headlights and so forth.

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1. Some automakers consider this a form of hybrid vehicle. However, Ford views and is implementing these technologies as part of our strategy to improve the fuel economy of conventional internal combustion engine vehicles. We assume start/stop technology can provide up to 10 percent fuel economy improvement in city driving.
2. Another type of PHEV, often called an Extended Range Electric Vehicle, runs entirely on battery power until the battery is depleted, and then the onboard gas-powered engine runs to recharge the battery. The wheels are driven only by the electric motor, and the engine's sole purpose is to recharge the battery.
3. These numbers are for comparison purposes only. They are based on modeling and testing calculations and do not necessarily represent the numbers that would be achieved in real-world driving conditions, nor do they represent actual products that Ford currently makes or may produce.
4. The internal-combustion engine fuel economy estimate is based on the calculation used by the U.S. Environmental Protection Agency to develop Combined Fuel Economy (city/highway) values for the labels affixed to new vehicles. The Combined Fuel Economy value is intended to represent the approximate fuel economy that most consumers can expect based on a typical mix of city and highway driving. Estimates for the other technologies are based on the metro-highway drive cycle used for the U.S. fuel-economy regulations. Fuel economy calculations for all of the technologies are based in U.S. gallons and on U.S. drive cycles.
5. In general, HEVs deliver approximately 40–50 percent better fuel economy than comparably sized non-hybrids.
6. All estimates are based on a 13.5-gallon tank except for the BEV, which has no fuel tank.
7. In vehicles using internal combustion engines, the fuel feedstock is assumed to be petroleum gasoline.
8. "Current grid" assumes average current emissions from U.S. power generation.
9. "Well to wheels" carbon dioxide (CO_2) includes all CO_2 emissions generated in the process of producing the fuel or electricity as well as the CO_2 emissions created by burning the fuel in the vehicle itself. It is useful to break this down into "well to tank" emissions, which measure the CO_2 emissions generated by excavating the feedstocks and producing and distributing the fuel or electricity, and "tank to wheels" emissions, which include the CO_2 generated by burning the fuel in the vehicle. "Well to tank" emissions are based on the GREET v. 1.8d.0 model developed by the Argonne National Lab. "Tank to wheels" calculations are based on Ford's estimates using the metro-highway drive cycle and energy use for a C-class electric vehicle.
10. In HEVs, the fuel feedstock is assumed to be petroleum gasoline.
11. In PHEVs, the "well to tank" emissions are based on the percentage of emissions from gasoline fuel production and distribution and electric power generation, and the "tank to wheels" emissions are based on the percentage of time the vehicle is driven using gasoline.
12. In BEVs, "well to tank" emissions include emissions related to electric-power generation, and "tank to wheels" emissions are zero, because no CO_2 is produced by running the vehicle on batteries charged with electrical power.
13. Based on 12,000 miles/year, 33 mpg and $3–5/gallon.
14. Based on 12,000 miles/year, 35 mpg and $3–5/gallon.
15. Based on 12,000 miles/year, 49 mpg and $3–5/gallon.
16. Based on 12,000 miles/year, 70 percent in electric mode at 3.5 miles/kWh (midpoint of range of 3–4 miles/kWh in electric mode) and 12 cents/kWh, and 30 percent in gasoline-engine mode at 49 mpg and $3–5/gallon.
17. Based on 12,000 miles/year, 3.5 miles/kWh (midpoint of range of 3–4 miles/kWh for a typical BEV) and 12 cents/kWh.

Living the Electric Lifestyle

To help drivers make the transition to electric vehicles (EVs), and get the most out of their EVs, we are offering more than just the vehicle. We are delivering a total electric vehicle lifestyle. In the U.S., for example, our EVs have advanced in-vehicle communications that help drivers maximize the efficiency and range of their vehicles, find charging stations along their planned routes, and know exactly how far they can go until the next charge based on their own driving style. We have also linked our vehicles to drivers' smartphones so that they can control charging and other in-vehicle operations remotely. We have also developed a comprehensive approach to vehicle charging that makes charging fast, easy, affordable and environmentally friendly. Our goal is to deliver electric vehicles that are as engaging, easy to use and empowering as other forms of consumer electronics like smartphones.

Enhanced In-Vehicle Information with MyFord Touch™

In several regions, including the U.S., our electric vehicles will include an enhanced version of MyFord Touch – Ford's new driver interface technology – that will give drivers a range of information tools to help them maximize their driving range, plan the most eco-friendly route and manage the battery recharge process. For example, the system will provide vehicle data such as the electrical demands of vehicle accessories – including air conditioning, which influences electric driving range. The system will also provide information on the battery's state of charge, distance to charge points, "energy budget" and expected range surplus.

We designed the Focus Electric to provide more range at full charge than most Americans will use each day. But we know that, at least initially, "range anxiety" will be an important issue for consumers. So we have designed in-vehicle communications to make on-board energy management a rewarding and fun part of the ownership experience. For example, the vehicle can analyze individual driving styles, as well as climate control and other options, to provide tailored information about range and remaining charge. Drivers who drive slowly and smoothly will get a longer range out of their car than those who drive more aggressively. But our in-vehicle information systems can adapt to any way you choose to drive. The Focus Electric will continuously analyze a driver's style, recalculate range and distance to required charge, and show how driving behavior affects the vehicle's energy budget. The system can also coach drivers on how to drive more efficiently to maximize their electric driving range.

The system also includes a trip planner feature to help drivers plan their trip based on the available battery range and the location of charging stations. The trip planning system integrates information about driving style and the driving efficiency "coach" to help drivers go farther on their remaining charge by maximizing regenerative braking, turning down the air conditioning or other efficient driving actions.

The Focus Electric's in-vehicle information is also customizable. For example, information can be viewed in three different modes: Energy Budget, which shows the remaining charge; Range, which shows the distance to the next required charge point; and Surplus View, which shows drivers how much energy or range they are saving using different options and by driving efficiently. The system also uses a variety of simple graphics like an energy "budget cup" and surplus energy "butterflies" that make it easy for drivers to quickly interpret information.

Remote Control with MyFord Mobile™

Drivers will also be able to manage their Focus Electric remotely using the Ford-developed MyFord Mobile app in the U.S. Like any Ford vehicle equipped with MyFord Touch, our electric vehicles allow drivers to locate the vehicle with GPS, remotely start the vehicle and remotely lock and unlock the car doors using their smartphone. On our electric vehicles, however, the MyFord Mobile app provides a suite of additional remote communications. For example, working with MapQuest®, MyFord Mobile can communicate the location of a charge station to the Focus Electric using the Traffic, Directions and Information program in the Ford SYNC® system. Drivers can also get instant vehicle status information, monitor the car's state of charge and current range, get alerts when it requires charging, remotely program charge settings and download vehicle data for analysis from their smartphone or a secure Ford website.

The MyFord Mobile app also allows drivers to tell their vehicle to use electricity from the grid to heat or cool the battery and cabin while the vehicle is still plugged in. This "preconditioning" of the vehicle's temperature is a key strategy drivers can use to maximize their driving range.

MyFord Mobile for EVs also adds a social element. Drivers can compare their driving efficiency to that of friends and other EV drivers. In addition, the system gives drivers virtual awards and badges for improvements in driving efficiency.

All of the vehicle's screens and control panels are integrated into the MyFord Mobile app's smartphone display, so that drivers can move seamlessly from their car to their phone displays.

Fast, Flexible and Easy Charging

Charging is one of the most important changes drivers have to get used to with a BEV or PHEV. We have gone to great lengths to make our charging systems fast, easy and economical.

The Focus Electric uses a 6.6 kW charger, which enables a best-in-class at-home charge time of just over three hours when using a 240V charge station installed in the customer's garage. That's half the time it takes our competitors to charge up.

U.S. drivers can also customize their charging preferences. Drivers can choose times when their car must be charged up and ready to go and set up a charging schedule that dictates when the charging starts and stops to meet those needs. They can also control vehicle charging using Value Charging by Microsoft, a system that communicates with local utilities and sets up charging times based on when utility rates are lowest in their area. Customers can reduce their electricity costs by taking advantage of off-peak or other reduced utility rates without a complicated setup process. With this technology, customers will be able to "set it and forget it," knowing their vehicle will only charge when utility rates are at their lowest. Ford electric vehicles are the first to work with this Microsoft system. Because Ford's EVs charge in half the time of competitors, we make it easier to get a complete charge within the time periods of the lowest utility rates.

We are also making charging easier with an easy-to-read "light ring" around the charge port. When the plug is connected, the light loops around the port twice. The light ring then illuminates in quadrants as the vehicle charges. Flashing quadrants signify that the charge is in progress. When the ring is solidly lit, the vehicle is fully charged.

We put a lot of thought into the actual charging station into which drivers will plug their vehicles. We are currently the only auto manufacturer to offer a "plug-and-play" charging system that is easy to install and portable, so you can take it with you if you move or move it to a new location in your existing garage. In the U.S., we worked with Leviton to develop a simple, ergonomic, easy-to-use charge station and with Best Buy to provide Best Buy/Geek Squad installation services. The set-up process is quick and easy for our customers and saves them as much as 30 percent on a charge station, versus the competition.

Maximizing Environmental Benefits of Electrified Vehicles

Full battery electric vehicles (BEVs) are considered “zero emission” because they don’t release greenhouse gases or other pollutants during use. But that term can be misleading, because it takes electricity to charge the vehicle, and the power plant generating the electricity may also generate incremental emissions. Electric vehicles do reduce pollutants generated by burning petroleum fuel in the vehicle in proportion to the reduction in vehicle fuel consumption. However, replacing gasoline with electricity generated from coal, for example, results in emissions at the power plant, including carbon dioxide, nitrous oxides, sulfur dioxide, volatile organic compounds, carbon monoxide and particulate matter. As a result, the environmental benefits of BEVs and plug-in hybrid electric vehicles (PHEVs) depend largely on the fuels used to power the electrical grid. Operating a PHEV or BEV on the current average U.S. electrical grid, which relies heavily on coal power, has little emission advantage over a hybrid electric vehicle (HEV). (See the well to wheels carbon dioxide (CO_2) emissions figures on the Comparing Electrification Technologies page.)

Plug-in vehicles could help to reduce overall CO_2 and other emissions if the electricity used to charge them were generated from cleaner fuels, and ideally renewable resources, which produce significantly fewer emissions than the coal and natural gas that are often used for power generation. In addition, “smart grids” that include grid-to-vehicle communications would enable utilities to make more-efficient use of electricity supplies, thereby potentially reducing emissions and electricity costs.

Energy Security Benefits of Electric Vehicles

The current energy demand for transportation is almost exclusively met by petroleum. In the U.S., for example, approximately 94 percent of transportation energy demand is provided by petroleum. The near-complete dependence of a vital economic sector on an import-dominated energy resource is clearly an issue of concern. One of the major benefits of increasing the proportion of electrified vehicles in the U.S. fleet is that it will diversify the transportation energy demand and provide increased energy security. HEVs reduce petroleum demand by increasing efficiency. PHEVs reduce petroleum demand due to increased efficiency and also switch some of the energy demand from petroleum to other sources. BEVs remove entirely the need for petroleum.

To realize the potential benefits of vehicle electrification, a range of issues must be addressed, including strategies to maximize their environmental benefits. Vehicle and fuel technologies interact in a complex system that includes vehicle technologies, battery technologies, fuel types and energy-generation technologies, all of which determine potential impacts on the environment and energy security.

Ford alone cannot solve these issues. However, we are working with partners, such as utilities, to make a contribution to maximizing the environmental benefits of electrified vehicles. We are also implementing technologies that will help customers drive their electrified vehicles to maximize efficiency, increasing other green features of our electric vehicles and implementing green manufacturing processes at our electric vehicle plants.

Maximizing Vehicle Efficiency

Electric vehicles are inherently more efficient than gasoline vehicles. Electric motors are more efficient in converting stored energy into vehicle propulsion than traditional internal combustion engines. Internal combustion engines can typically only use about 15 percent of the onboard fuel energy to power the vehicle, while electric motors have nearly 80 percent onboard efficiency. In addition, electric-drive vehicles do not consume energy while at rest nor coasting, and as much as one-fifth of the energy typically lost when braking is captured and reused through regenerative braking.

Ford has made it a priority to further maximize the efficiency of our electric vehicles. We optimized every system in the vehicle to ensure it would be as “electron efficient” as possible. In addition to using the latest technology for the battery and the rest of the electric-drive components, we have maximized efficiency through improved aerodynamics and low rolling resistance. In addition, we used our knowledge from two generations of hybrid electric vehicles to enhance the Focus Electric’s range and efficiency through regenerative braking.

Maximizing Driving Efficiency

Our in-vehicle information systems also help drivers maximize their own driving efficiency to further increase the distance they can go on a single charge and reduce the overall costs of operating an EV. As described in Living the Electric Lifestyle, our electric vehicles can coach drivers how to drive more efficiently by changing their driving style, maximizing regenerative braking or minimizing the use of air conditioning. The vehicle information systems also provide information on range and vehicle energy use to help drivers track and maximize their driving

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efficiency.

Maximizing Charging Efficiency

The most important strategies for maximizing the efficiency and environmental benefits of electric vehicle charging require changes to the electrical grid and the fuels used to power it. Both increasing the use of renewable energy sources and investing in smart grid technologies will help to improve the environmental benefits of EVs. Many of these issues are beyond Ford's control. However, Ford is working with utilities and municipalities to make the most of electric vehicles' advantages. We are also doing what we can to provide efficient and environmentally friendly charging options.

- **Using renewable energy**: Recharging using electricity generated by renewable energy sources (such as solar, wind, hydropower or biomass) can cut CO_2 emissions dramatically. Smart vehicle-to-grid communication can help utilities better use renewable energy sources. For example, it can allow vehicles to recharge when wind power is most available (usually at night) or during the day from solar arrays, depending on the renewable source available and its output. As the power-generation sector continues to improve its fuel mix, the environmental impact of driving a plug-in vehicle will diminish substantially – perhaps even toward zero.

  Adding more renewable fuel sources to electrical grids will take time. Ford is working with utility partners to develop home-based solar recharging stations that will allow EV owners to obtain the power they need to charge their vehicles from renewable sources, even if the overall electricity grid powering their home has not shifted to renewable.

- **"Smart grids and smart charging:"** The development of "smart grid" technologies, which can provide utilities and customers with real-time information on energy use and energy prices, is a key enabler of efficient integration of electric vehicles and grids, and an important strategy to maximize EV efficiency and environmental benefits.

  Smart grids will help make the electrical grid and electrical vehicle charging more efficient by channeling vehicle recharging to times when electrical grid resources are currently underutilized. Since demand for electricity fluctuates (generally peaking in the afternoon and dropping off at night), utilities typically use a mix of fuels and power plant types to meet demand. That means the environmental impacts of electric vehicle use will vary depending on where and when the vehicles are charged. During certain seasons and particularly at night, utilities generally have excess generation capacity – unused resources that create financial inefficiency. Charging PHEVs and BEVs during these off-peak hours, when this excess capacity is available, can increase the overall efficiency of the electric grid – potentially reducing CO_2 emissions, as well as the cost of electricity. But if PHEVs and BEVs are charged at peak times, that could create increased CO_2 emissions from power generation and also create demand for additional power plants. Utilities have a role to play in educating electrified-vehicle users and providing them with incentives to charge their vehicles at the most beneficial times.

  With all these variables, utilities will be key partners in defining and developing electricity supply systems for electric vehicles that are efficient, affordable and environmentally sound. That's why Ford has partnered with several utilities throughout the U.S. and Canada, as well as with the U.S. Department of Energy, for its PHEV pilot program. For more information on our work with utilities, please see Collaborating with Utilities and Municipalities.

- **Value Charging by Microsoft**, which is available first on Ford U.S. vehicles, also helps to maximize the efficiency of charging and the environmental benefits of EVs. This system communicates with local utilities to find off-peak times to charge, which helps to prevent the need for infrastructure upgrades to support added energy demand and reduce the production of additional CO_2. Ford and Microsoft plan to continue to work with utility partners and municipalities to help further develop systems to maximize the effectiveness of electric vehicles and their interaction with the electricity grid.

A Holistic Environmental Approach

Reducing emissions and maximizing vehicle efficiency are just some of the elements of our strategy to maximize the environmental benefits of EVs. We are also using green power and green technologies to manufacture our EVs, and we are using green materials in our electrified vehicles and charging stations. The Michigan Assembly Plant, for example, which will produce the Focus Electric, C-MAX Energi and C-MAX Hybrid, in addition to the standard gas-powered Focus, will be powered by the largest solar array in the state of Michigan. We have partnered with DTE Energy to build this solar panel system at the plant. We are also working with DTE Energy to develop a stationary battery energy storage system that will store excess power produced by the solar array until it is needed in the plant. This battery storage system will use electric vehicle batteries that have reached the end of their useful lives in vehicles. This approach provides a second life for vehicle batteries, which reduces waste and maximizes the efficiency of solar power. The plant also draws power from local landfill gas, making productive use of methane generated from decaying trash, which reduces emissions of this potent greenhouse gas. The plant also uses solar-powered tugs, which move vehicles and parts around the plant. See the Michigan Assembly Plant case study for more details on these green manufacturing strategies.

Ford is also using green materials in our HEVs, BEVs and PHEVs, as well as many of our other vehicles, to further maximize their environmental benefits. For example, our existing HEVs use recycled-content seat fabrics. The Escape Hybrid, as well as the gas version, has been using soy foam seats for several years. Starting in 2011, all of our U.S. vehicles will use soy foam, including the Focus Electric. The Focus Electric will also use a material called Lignotock behind the cloth on the door. Derived from 85 percent wood fibers, this renewable material reduces weight and provides better sound-deadening benefits compared to conventional glass-reinforced thermal plastics. In addition, the vehicle-charging stations we developed with Leviton use 60 percent recycled materials. For more information about our use of green materials in vehicles, please see Sustainable Materials.

Improving EV Affordability

The current cost to make plug-in vehicles is substantially higher than that of conventional vehicles, largely due to the cost of batteries. Depending on electricity costs, however, the energy cost to operate an all-electric car is in the range of 3 to 4 cents per mile, compared to about 8 to 16 cents[1] per mile for a conventional gasoline-powered vehicle. So, lower operating costs can help to offset the higher initial purchase costs of electric vehicles (EVs).

Automakers will need to invest billions of dollars to develop next-generation electrification technologies and electrified vehicles. Utilities will need to invest to increase electricity generation and transmission capacity, with generally higher costs for green electricity sources. Governments will also need to invest by encouraging and facilitating the development of technology and infrastructure and providing incentives for consumers to buy EVs. Ford is doing what it can to reduce the costs of manufacturing and operating EVs.

Reducing Vehicle Production Costs

We are planning our electric vehicle strategy based on our highest-volume global platforms, which can help to reduce the costs of electric vehicles by creating economies of scale. For example, the Focus Electric, C-MAX Hybrid and C-MAX Energi plug-in hybrid are all based on our global C-platform, which we expect to underpin 2 million vehicles annually.

We are using best-in-class flexible manufacturing technology in our Michigan Assembly Plant, which will produce the Focus Electric, C-MAX Hybrid and C-MAX Energi, as well as the gas-powered Focus. Flexible manufacturing allows us to switch production between different vehicles to meet changing customer demand without retooling our plant or assembly lines – a significant cost reduction.

Ford is working with a range of battery suppliers and other partners to develop next-generation battery technologies that will help to bring costs down. Please see Battery Technology for more information on advanced batteries for EVs.

Reducing Vehicle Operation Costs

The fuel costs of battery electric vehicles (BEVs) are significantly lower than for gasoline-powered vehicles. We are taking a range of steps to reduce the operating costs of EVs to help offset their higher purchase price.

Through our partnership with Microsoft to deliver Value Charging powered by Microsoft, we are helping EV owners find the most efficient times to charge their vehicles. This system helps customers reduce their electricity costs by taking advantage of off-peak or other reduced utility rates without a complicated setup process.

The MyFord Touch™-based in-vehicle communications systems on our electric vehicles, described in Living the Electric Lifestyle, also help reduce EV operating costs by enabling drivers to maximize their driving efficiency and in-vehicle energy use.

Our BEVs will also have lower maintenance requirements than gas-powered vehicles. The Focus Electric eliminates more than two-dozen mechanical components that would normally require attention during the life of the vehicle. So, for example, drivers won't have to get oil changes or change oil filters, fuel filters or spark plugs, or worry about a worn-out muffler or serpentine belt. Based on a regular oil change maintenance schedule, Focus Electric owners will save approximately $500 over the 150,000-mile life of the vehicle on oil change costs alone.

1. Assuming an energy consumption of about 3 to 4 miles/kWh at 12 cents/kWh for the electric vehicle, and a fuel economy of 30–40 miles/gallon at $3–$5/gallon for the gasoline vehicle.

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- Michigan Assembly Plant

Battery Technology

Current-generation hybrid electric vehicles (HEVs) run on nickel metal hydride batteries, which offer significant improvements over traditional lead-acid batteries. For example, nickel metal hydride batteries deliver twice the power output for the weight (energy density) compared to lead-acid batteries. Nickel metal hydride batteries have worked well in non-plug-in hybrids, which are designed to allow for constant discharging and recharging and are not expected to store and provide large amounts of energy. These batteries are reaching the end of their advancement potential, however, and new battery technologies are needed to improve on the current generation of HEVs.

Plug-in hybrid electric vehicles (PHEVs) and pure battery electric vehicles (BEVs) make significant additional demands on battery technology. Unlike HEVs, which maintain a relatively constant state of charge, PHEV batteries are to be depleted to a low level when they are the primary energy source for the vehicle. And BEVs are designed to run solely on battery power. The batteries used in PHEVs and BEVs must function well in a wide range of conditions; tolerate running until nearly depleted and then being fully charged; store and provide a lot of power; last a minimum of 10 years or 150,000 miles; and, ideally, be compact and lightweight.

Automakers are moving toward lithium-ion batteries for next-generation HEVs and for PHEVs and BEVs. These batteries have greater energy density and are lighter than nickel metal hydride batteries. However, the technology is still evolving, and costs are still relatively high. (See the section on Battery Evolution below).

It is also important to have a plan for recycling batteries at the end of their useful lives to minimize the material going to landfill, and to ensure that critical elements, such as rare earth metals and lithium, are recovered and reused in new batteries.

Battery Evolution

Battery technology is evolving. The following table shows how new battery technology, such as the nickel metal hydride batteries used in today's HEVs and the lithium-ion battery technology of next-generation electrified vehicles compare to the traditional 12-volt lead-acid battery.

	Lead-Acid	Nickel Metal Hydride (Ni-MH)	Lithium-Ion (Li-ion)
First commercial use	1859	1989	1991
Current automotive use	Traditional 12-volt batteries	Battery technology developed for today's generation of hybrid vehicles	Under development for future hybrid electric and battery electric vehicles; some manufacturers launching in limited volumes in 2010
Strengths	Long proven in automotive use	Twice the energy for the weight compared to lead-acid Proven robustness	About twice the energy content of Ni-MH and better suited to future plug-in electrified vehicle applications By taking up less space in the vehicle, provides far greater flexibility for automotive designers
Weaknesses	Heavy; its lower energy-to-weight ratio makes it unsuitable for electrified vehicle usage	High cost (four times the cost of lead-acid); limited potential for further development	Although proven in consumer electronics, this technology is still evolving for automotive applications Will remain relatively expensive until volume production is reached
Specific energy (watt hours per kilogram)	30–40	65–70	100–150
Recyclability	Excellent	Very good	Very good

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Ford has been working with battery supplier partners to develop next-generation battery technologies that can improve HEV performance and stand up to the new challenges presented by BEVs and PHEVs. For example, the performance of batteries varies with weather conditions. We are conducting tests of the effects of temperatures and other conditions so we understand and can communicate to customers the impacts on expected range between recharging.

Ford is also working with researchers at the University of Michigan and the Massachusetts Institute of Technology to develop and test improved lithium-ion battery technology.

All of Ford's electrified products, including HEVs, PHEVs and BEVs, will use lithium-ion battery cells by 2012. Lithium-ion battery packs offer a number of advantages over the nickel metal hydride batteries that power today's hybrid vehicles. In general, they are 25 to 30 percent smaller and 50 percent lighter, making them easier to package in a vehicle, and they can be tuned to increase power to boost acceleration, or to increase energy to extend driving distance.

The Focus Electric will be powered by a lithium-ion battery system that utilizes cooled and heated liquid to regulate battery temperature, extend battery life and maximize driving range. The innovative thermal management technology helps the Focus Electric operate efficiently in a range of ambient temperatures. Thermal management of lithium-ion battery systems is critical to the success of all-electric vehicles, because extreme temperatures can affect performance, reliability, safety and durability.

Ford is also developing a comprehensive strategy to address batteries that can no longer be used in vehicles. For example, we are working with DTE Energy to develop stationary energy storage systems from vehicle batteries that have reached the end of their useful life in vehicles. For more information on this project please see the Michigan Assembly Plant case study. In addition, Ford engages with all the parties that handle end-of-life batteries, including customers, local authorities, emergency services (e.g., tow trucks), dealerships, independent workshops and garages and vehicle recyclers. Customers can recycle their batteries with local recyclers or bring them to any Ford or Lincoln dealer for no-cost recycling.

Supply Chain Issues

As the widespread electrification of automobiles moves closer to reality, a new set of concerns is emerging regarding the environmental and social impacts of extracting and processing key materials needed to make electric vehicles. There are concerns about lithium (used to make the lithium-ion batteries that are widely used in consumer electronics and will be used in BEV and PHEV vehicles) and rare earth metals (which are used in electric motors for vehicles, wind turbines and other advanced technologies).

Significantly accelerating the production of electric vehicles is likely to require the use of much greater quantities of lithium and rare earth metals. Currently, production of these resources is concentrated in a few countries, including Chile, Bolivia and China, which has led to questions about the adequacy of the supply of these resources and the potential for rising and volatile prices as demand puts pressure on existing supplies. In addition, there are concerns about geopolitical risks posed by the limited availability of these materials. Could we be trading dependence on one limited resource (petroleum) for another? Attention is also focusing on the possibility of risks such as bribery and corruption and the potential for environmental and human rights abuses. Finally, the use of water in the production of these materials needs to be considered.

We take these concerns very seriously. We have conducted and published a study of lithium availability and demand with scientists at the University of Michigan. We found that there are sufficient resources of lithium to supply a large-scale global fleet of electric vehicles through at least the year 2100. The use of water during lithium production is typically very low. We are conducting a study of rare earth element availability and demand with scientists at the Massachusetts Institute of Technology. Ford generally does not purchase raw materials such as lithium and rare earth metals directly – they are purchased by our suppliers (or their suppliers) and provided to us in parts for our vehicles. As described in the Supply Chain section of this report, our contracts with suppliers require compliance with the legal requirements of Ford's Code of Basic Working Conditions and the adoption of a certified environmental management system (ISO 14001). We are working in our supply chain to build the capability of our suppliers to provide sound working conditions in their operations, and we assess compliance with our Code of Basic Working Conditions in target markets. We ask the suppliers we work with to take similar steps with their suppliers. We are also working cooperatively with other automakers to extend this approach through the entire automotive supply chain.

As part of our water strategy, we are evaluating the water requirements and impacts of powering vehicles with conventional fuels, biofuels and electricity. This work includes a study of the water requirements of lithium extraction and processing (which, based on our understanding of the extraction of lithium from brines in arid areas, we anticipate will be low).

We will continue to monitor and assess these issues for their potential impact on our electrification strategy and our sustainability commitments.

Toolbox

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Collaborating with Utilities and Municipalities

Clearly, electric vehicles (EVs) will have an impact on electric utilities. If EVs are charged during times of peak electricity demand, they may stress the current grid and require the construction of additional electricity supply. Furthermore, recharging vehicles during peak demand would significantly reduce the operating cost benefits expected from electric vehicles. To maximize recharging efficiency and minimize stress to the grid, "smart grid" technology that allows communication between recharging vehicles and the electrical grid will be required. Automakers and utilities will have to work together to develop this "smart" vehicle-to-grid communication system. Overcoming these challenges will require significant collaboration between automakers, electric utilities and governmental regulatory agencies and legislators.

Because utilities and automakers have not had to work together in the past, effective collaboration requires developing new relationships and learning about each other's business and regulatory challenges. For example, utilities and automakers have very different business models: utilities operate regionally and have little to no direct competition within their markets, while automakers operate and compete globally. Further, automakers are primarily regulated at the national level, while utilities face more local and state regulations, which increases the difficulty of establishing a national strategy for vehicle-to-grid interaction. It will be important for automakers and utilities to understand and address these kinds of differences as they work together on vehicle electrification issues.

Ford has taken the lead in forging relationships with utilities and municipalities to address these challenges and facilitate the successful implementation of electric vehicles. In 2007, we initiated the Ford Plug-in Project, a collaborative effort involving the U.S. Department of Energy, the Electric Power Research Institute, the New York State Energy Research and Development Authority, and 10 utilities (Southern California Edison, American Electric Power, ConEdison of New York, DTE Energy, National Grid, New York Power Authority, Progress Energy, Southern Company-Alabama Power, Pepco Holdings and Hydro Quebec). Through this project we are road testing our Ford Escape plug-in hybrid prototypes that are equipped with vehicle-to-electric smart grid communications and control systems that will enable plug-in electric vehicles to interface with the electric grid, and will allow the vehicle operator to determine when and for how long to recharge the vehicle. This will potentially enable the user to take advantage of lower, off-peak utility rates.

We are also working with utilities, municipalities and states across the country to develop and facilitate the use of EV implementation best practices. Some of the key issues we are working on with local utilities and municipalities include the following:

- **Time-of-use electricity rates:** We are encouraging utilities to adopt a "time-of-use" rate structure, which would enable them to charge different rates at different times of the day based on overall electricity demand. Under a time-of-use structure, electricity rates would be lower at night when there is lower demand on the electrical grid. Since most EVs charge at night, this increases the benefits of electrified vehicles for consumers. It also helps utilities by giving customers an incentive to charge at times when electrical demand is already low, which helps to balance out utilities' electrical loads.
- **Maximizing the publicly accessible recharging infrastructure:** We are working with municipalities and utilities to develop more public recharging stations and to encourage a thoughtful and holistic approach to planning for publicly accessible recharging. In the next 18 months, we expect to see at least 12,000 publicly accessible charge stations installed in cities throughout the U.S., up from about 1,800 currently. This is an important step in fostering electrified vehicle use. However, the placement and design of publicly accessible charging stations requires careful consideration to maximize their usefulness to EV drivers. We are endorsing a holistic "urban planning" approach to charging station development in which local officials actively plan the locations for publicly accessible EV charging based on traffic patterns and the locations of other charging stations. This kind of approach will result in charging locations that are used more often and will make more-efficient use of investment dollars. We are also encouraging standard rules and signage for public refueling infrastructure that would tell drivers what type of charging is available, the hours when EVs can use charging stations, the length of time an EV can remain plugged in and how rules for charging stations are enforced.
- **Standards for private third-party charging stations and the resale of electricity:** In many cases, publicly available refueling stations will be installed and run by private businesses, such as gas stations and restaurants. In most states, when a third party resells their electricity, as they would to an EV driver, they are considered a regulated utility and face the same stringent regulations a utility must follow. We are working with states to encourage updating regulations so that reselling electricity for transportation would not be subject to utility-like regulations. This will encourage the development of more publicly accessible recharging stations.
- **Home EV charging station permitting process:** Homeowners are required to get a

Related Links

External Websites:

- U.S. Department of Energy
- Electric Power Research Institute
- New York State Energy Research Development Authority

permit from their municipality and/or utility to install a home EV charging station. Historically this process can take more than two weeks. We have been working with utilities and municipalities to encourage reducing the permitting process to a couple of days.

- **Promoting EV incentives**: Through our work with cities and utilities, we have identified a range of actions that will help consumers make the transition to electrified vehicles – for example, infrastructure incentives to offset a portion of customer costs for hardware/installation.
- **Building codes for new construction**: We are working with municipalities to develop codes for new building construction that would make them "EV ready," with best practices such as wiring for EV chargers.

We are working on these issues in a variety of ways. Much of this work is focused on the 19 markets we have identified as our initial targets for EV sales. In these markets, we are involved in direct partnerships with utilities and municipalities. We are also serving in a formal advisory role to utilities in several states. Ford is an active member of the Electric Drive Transportation Association, an industry group that is working to implement EVs in the U.S. And, we are testifying before state legislatures around the country to endorse legislation that will facilitate the successful implementation of EVs.

Our collaborations with utilities and municipalities are yielding key lessons that we are incorporating into our continued efforts to make electrified vehicles successful in the real world. Some of the key learnings we have gained so far include the following:

- Electric vehicles provide additional impetus to develop smart communication systems between the vehicle and the grid. This communication will allow the consumer to know if and when lower electricity rates are available (as some utilities will offer lower rates during the night when energy demand is low), and help prevent additional loads on the infrastructure. Providing utilities the ability to control when vehicles are charged, or assurances that vehicles will not be charged during peak demand time, could prevent costly infrastructure upgrades, some of which may be passed back to the customer by the utility (e.g., if a transformer needs to be upgraded).
- Smart vehicle charging will require that utilities and automakers develop a common standard for vehicle-to-grid and grid-to-home meter communications. Currently, utilities tend to operate regionally, but electric vehicles will increase the need for common national and even international standards. We have worked to develop a common charging standard in the U.S., and we are now focused on fostering the development of an internationally common charging standard.
- Widespread use of electric vehicles will likely require that vehicle power consumption be measured separately from home electricity use, requiring either additional meters or "smart" meters. In addition, the pooling of electrified vehicles in a particular region may require upgrades to the transformers and/or substations that form the electrical grid in that area.
- There are interesting possibilities for vehicle-to-grid and vehicle-to-home power flow. However, there are also significant challenges to making these possibilities a reality. For example, technical, safety, codes/standards compliance, legal, robustness and business case issues need further study prior to commercialization.
- Vehicle owners will likely want to be able to charge their vehicles at any geographic location and – in those cases where another payment method isn't used – have the cost applied to their home energy bill. In addition, vehicle identification and home meter association must be seamless for the customer. This kind of mobile or remote billing for vehicle charging services will require a paradigm shift in the utility industry's current billing processes and tools.
- Automakers and utilities both benefit from working together on outreach to local, state and federal regulators and legislators. Ford and our utility partners are already working with legislators and regulators on national standards for vehicle charging infrastructure and incentives and strategies to bring costs down.
- Utilities and automakers need to work together to educate consumers about the differences between electric vehicles and traditional vehicles so that consumers understand how to make the most of electric vehicles and charging infrastructure.

Partnerships and Collaboration

Addressing the linked issues of climate change and energy security requires an integrated approach – a partnership of all stakeholders, including the automotive industry, the fuel industry, other industries and enterprises, governments and consumers. It will also require the best thinking from all of these sectors.

Ford is involved in numerous partnerships and alliances with universities, coalitions, nongovernmental organizations and other companies to improve our understanding of climate change. For example, Ford is:

- A charter member of the Sustainable Transportation Energy Pathways Program at the Institute of Transportation Studies at the University of California at Davis. The Institute aims to compare the societal and technical benefits of alternative sustainable fuel pathways.
- A member of the Massachusetts Institute of Technology's Joint Program on the Science and Policy of Global Climate Change.

Our participation in these and other partnerships helps us to formulate improved strategies for products and policies that will in turn help to address climate change and energy security. The following are links to the above-mentioned organizations and others with which we cooperate on climate change issues:

- 25x'25 (Energy Future Coalition)
- BP
- Center for Clean Air Policy's Climate Policy Initiative
- Clean Fuels Development Coalition
- Diesel Technology Forum
- Governors' Biofuels Coalition
- Harvard University, Belfer Center for Science and International Affairs
- MIT Joint Program on the Science and Policy of Global Change
- Growth Energy
- Princeton University's Carbon Mitigation Initiative
- U.S. Climate Action Partnership
- University of California at Davis, Institute of Transportation Studies Sustainable Transportation Energy Pathways Program
- Worldwide Business Council for Sustainable Development
- World Resources Institute
- World Economic Forum

Related Links

External Websites:

- MIT Joint Program on the Science and Policy of Global Change
- University of California at Davis, Institute of Transportation Studies Sustainable Transportation Energy Pathways Program