Climate Change and the Environment

Ford is focused on minimizing the environmental impacts of our vehicles and operations, including reducing our contribution to climate change.

Ford is committed to doing our part to prevent or reduce the potential for environmental, economic and social harm due to climate change. We have a science-based strategy to reduce greenhouse gas (GHG) emissions from our products and operations that focuses on doing our share to stabilize carbon dioxide (CO_2) concentrations in the atmosphere. We are on track to meet the central elements of our strategy: Each of our new vehicles is a leader, or among the leaders, in fuel economy, and we are reducing GHG emissions across our global product portfolio. We have also set a goal to reduce our facility CO_2 emissions by 30 percent per vehicle by 2025 compared to a 2010 baseline, building on our reduction of 31 percent from 2000 to 2010.

We are also committed to reducing the overall environmental footprint of our vehicles and operations across a range of environmental issues. For example, we continue to increase the use of sustainable materials in our vehicles. And, we reduced waste to landfill by 20 percent per vehicle from 2010 to 2011 and expect to reduce it again by 10 percent per vehicle in 2012. We are also continuing to reduce VOC emissions from our operations through the use of innovative technologies.

In this section we discuss our approach to the issue of climate change and the ways we are working to reduce the environmental footprint of our products and operations.

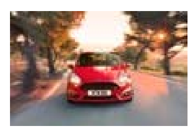
105 miles per gallon

equivalent achieved by Focus Electric, which we began selling this year

100 percent

of Ford Motor Company vehicles built in North America have soy foam in their seat cushions and backs, as of 2011

Vehicle CO_2 Reductions



We reduced fleet-average CO_2 emissions from our 2011 model year U.S. new vehicles by 9 percent compared to the 2007 model year.

Ford Focus ECOnetic

We introduced the Ford Focus ECOnetic, which delivers fuel economy of 3.4L/100km and is the most fuel-efficient non-hybrid family car available in Europe.

Facilities Goals

We committed to reduce our facility CO_2 emissions by 30 percent from 2010 to 2025 on a per-vehicle basis and average energy consumed per vehicle by 25 percent from 2011 to 2016 globally.

Sustainable Materials

We now use at least 25 percent recycled-content seat fabrics in all new or redesigned vehicles sold in North America.

Design for Lifecycle Sustainability

We use a lifecycle approach to assess and minimize the total adverse impacts of our vehicles from a sustainability perspective – from raw materials extraction through manufacturing and use to end of life. This approach considers and works to minimize negative impacts upfront in product design decisions. Called Design for Sustainability (DfS), the approach is integrated and holistic, to ensure that we achieve a balance between environmental, social and economic aspects in our product development process.

We are continuing to advance how we apply DfS principles. For example, we developed a Product Sustainability Index (PSI) tool, which has been used in our European product development operations since 2002. This tool helps us to assess and find opportunities to reduce the impacts of our products over their entire lifecycle – including environmental impacts such as global warming from greenhouse gas emissions, societal questions such as pedestrian protection and economic issues such as cost of ownership. The PSI is used by the engineering teams that are responsible for product development decisions. We use other lifecycle assessment approaches in research and sustainability departments to address general strategic questions that are not necessarily linked to individual vehicle development programs.

Among our product sustainability efforts, we are increasing our use of sustainable materials and eliminating undesirable materials and substances such as heavy metals and substances that are known to be common allergens. We are also working to reduce greenhouse gases and other emissions from our facilities and vehicles by developing cleaner and more energy-efficient production processes, improving the efficiency of our packaging and transportation logistics and introducing cleaner and more fuel-efficient vehicles. Downstream in our value chain, we are working with drivers to educate them on ways to increase fuel economy and reduce vehicle emissions for example through our Eco-Mode and Smart Gauge with Eco-Guide driver interface technologies and our eco-driving program. Upstream, we are working with our suppliers to increase the sustainability of our products throughout the supply chain.

Related Links

This Report

- Eco-driving
- Greening Our Operations
- Logistics
- Product Sustainability Index
- Progress and Performance – Vehicles
- Supply Chain
- Sustainable Materials

Home > Climate Change and the Environment > Design for Lifecycle Sustainability

Quantifying Our Environmental Impacts

The first step in improving the lifecycle impacts of our products is to understand the environmental aspects of our products and the potential environmental impacts associated with them.[1] We use lifecycle assessment to understand the impacts of our vehicles. Lifecycle assessment tracks emissions generated and materials and energy consumed for a product system over its entire lifecycle, from cradle to grave, including raw material acquisition, material production, product manufacture, product use, product maintenance and disposal at end of life. For vehicles, this includes the environmental burdens associated with mining ores, 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 dismantling the vehicle at the end of its life, recycling and reusing materials as possible and disposing of materials as necessary. Lifecycle assessment is an essential tool when thinking about the environmental impacts of complex systems.

Estimates of vehicles' total lifecycle impacts vary depending upon the specifics of the vehicle analyzed and the vehicle's powertrain and fuel type. For example, assessments of the Ford Fiesta, Focus, and Mondeo – conducted using our Product Sustainability Index (PSI) tool – found significant differences in lifecycle CO_2 emissions between the three vehicle models and between different engine and fuel types within a vehicle model. In all cases the vehicle use phase produces the largest portion of lifecycle CO_2 emissions (for example, 77 percent of total for the Focus diesel and 83 percent for the Mondeo gasoline). Vehicles with better fuel economy do reduce the use phase's contribution to lifecycle CO_2 emissions, however, the use phase remains the dominant phase for most environmental impacts. See the table below for comparisons of lifecycle CO_2 emissions across these three vehicles.

Lifecycle CO_2 Emissions Comparison across Vehicle Models, Engines, and Fuel Types

Vehicle Model	Engine	Fuel Type	Lifecycle CO_2 emissions
2011 Ford Fiesta	1.25 L	Gasoline	30 metric tons *
2011 Ford Fiesta	1.6 L	Diesel	21 metric tons
2011 Ford Focus	1.6 L	Gasoline	32 metric tons
2011 Ford Focus	1.6 L	Diesel	27 metric tons
2011 Ford Kuga	2.0 L	Diesel	36 metric tons
2011 Ford Mondeo	2.0 L	Gasoline	42 metric tons
2011 Ford Mondeo	2.0 L	Diesel	37 metric tons

* 1 metric ton = 1,000 kg = 0.98 U.K. tons = 1.1 U.S. tons

The PSI results also show that these vehicles made progress on multiple aspects of sustainability compared to the previous models. For more information on PSI please see the PSI section

Assessing the Lifecycle Emissions of Electrified Vehicles

Assessing vehicles' lifecycle energy consumption and greenhouse gas emissions is becoming a more complicated task as we add alternative fuels and powertrains into our vehicle lineup. For conventional gasoline- and diesel-powered vehicles, most of the energy is consumed and 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 in-use phase will decrease. 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 the hydrogen that provides the energy for the

Related Links

This Report
- Electrification: A Closer Look
- Product Sustainability Index

Vehicle Websites
- Ford Fiesta
- Ford Focus Electric
- Ford Focus (European)
- Ford Kuga
- Ford Mondeo

vehicle. A systems perspective is thus required when considering the CO_2 emissions and energy use associated with 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 low-CO_2 hydrogen. In short, the use of energy-efficient vehicles such as BEVs and FCVs does not in itself lead to a reduction in CO_2 emissions; those vehicles need to be combined with low-CO_2 electricity or fuels to achieve low total CO_2 emissions.

In 2012, we launched our carbon emissions and fuel cost calculator to help our fleet customers assess the emissions benefits of alternative fuel vehicles. This calculator allows fleet customers to input factors such as vehicle type (e.g., hybrid, battery electric, diesel), electricity source by region (e.g., coal, nuclear, renewables, natural gas) and likely driving patterns (e.g. stop-and-go city traffic, highway driving or a mix). These key factors help determine the environmental benefits the customer might expect to achieve with each type of vehicle. For a customer deciding where to place an electric vehicle in her fleet, the calculator shows that the Focus Electric emits about 70 g CO_2/km using electricity from the low-carbon California grid but more than twice as much, about 150 g CO_2/km, in the more coal intensive Southeast U.S. We hope to expand this calculator to Europe and China at a later date, as the U.S., Europe and China are expected to account for the majority of hybrid and electric vehicles through 2020. The calculator enables our fleet customers to both save money and protect the environment.

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1. *Environmental aspects* is a term used in the ISO 14001 framework to denote elements of an organization's activities, products and services that can interact with the environment. Potential environmental impacts include any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's activities, products or services. Local Ford facilities use corporate lists of environmental aspects and potential impacts to identify and amplify those aspects that apply to their operations.

Product Sustainability Index

Ford's European operations pioneered the development of the Product Sustainability Index, a holistic Design for Sustainability approach that incorporates societal and economic aspects as well as environmental aspects[1] into our lifecycle design approach.

Ford's PSI tracks eight product attributes identified as key sustainability elements of a vehicle: lifecycle global warming potential (mainly carbon dioxide emissions); lifecycle air-quality potential (other air emissions); the use of sustainable materials (recycled and renewable materials); vehicle interior air quality (including allergy certification from TÜV Rheinland, a product-testing organization); exterior noise impact (drive-by noise); EuroNCAP safety (including for occupants and also pedestrians); mobility capability (seat and luggage capacity relative to vehicle size); and lifecycle ownership costs (full costs for the customer over the first three years).

Since 2002 we have been applying the PSI as a sustainability management tool in the development of all of our major new European vehicles. The PSI process was used to develop the 2006 Ford S-MAX and Galaxy, as well as the 2007 Mondeo, 2008 Kuga, 2009 Fiesta and 2011 Focus. The Focus is the first Ford vehicle developed using the PSI system that is being sold globally. The PSI assessment of the Focus was the first joint PSI study done by Ford of Europe and Ford North America.

As a result of using the PSI assessment system, all of these models have shown improvements in environmental, social and/or economic performance when compared to the previous models. The chart below shows specific performance and areas of improvement for each model. The PSI will be used on all future products developed by Ford of Europe. Detailed reports on the PSI analysis for these vehicles can be downloaded from Ford of Europe's website.

PSI Assessed Model Performance[2]

Measurement Method

Emissions of CO_2 and other greenhouse gases from raw material extraction to material, part, and vehicle production, driving period (150,000 km; incl. air conditioning) and final recycling/recovery (i.e., full vehicle lifecycle, cradle-to-cradle).

	Performance*	Better/Worse than Previous Model
2006 Ford S-MAX 2.0L TDCi with DPF	39 metric tons CO_2 equivalent	Similar
2006 Ford Galaxy 2.0L TDCi with DPF	40 metric tons CO_2 equivalent	Similar
2007 Ford Mondeo 2.0-liter TDCi Diesel with DPF	37 metric tons CO_2 equivalent	Better
2008 Ford Kuga	37 metric tons CO_2 equivalent	No previous model
2009 Ford Fiesta ECOnetic, Diesel	21 metric tons CO_2 equivalent	Better
2009 Ford Fiesta, Gasoline	30 metric tons CO_2 equivalent	Better
2011 Ford Focus, 1.6 L, Gasoline	32 metric tons CO_2 equivalent	Better
2011 Ford Focus, 1.6 L, Diesel	27 metric tons CO_2 equivalent	Better

Related Links

This Report

- Materials Management
- Sustainable Materials

Ford.co.uk

- Product Sustainability Index reports

*1 metric ton = 1,000 kg

Measurement Method

Summer smog-related emissions from raw material extraction to material, part, and vehicle production, driving period (150,000 km; incl. air conditioning) and final recycling/recovery (i.e., full vehicle lifecycle, cradle-to-cradle).

	Performance	Better/Worse than Previous Model
2006 Ford S-MAX, 2.0L TDCi with DPF	37 kg ethene equivalent	Similar
2006 Ford Galaxy, 2.0L TDCi with DPF	37 kg ethene equivalent	Similar
2007 Ford Mondeo, 2.0-L TDCi Diesel with DPF	35 kg ethene equivalent	Better
2008 Ford Kuga	35 kg ethene equivalent	No previous model
2009 Ford Fiesta ECOnetic, Diesel	22 kg ethene equivalent	Better
2009 Ford Fiesta, Gasoline	32 kg ethene equivalent	Better
2011 Ford Focus, 1.6 L, Gasoline	30 kg ethene equivalent	Better
2011 Ford Focus, 1.6L Diesel	25 kg ethene equivalent	Better

Measurement Method

Use of recycled and natural materials.

	Performance	Better/Worse than Previous Model
2006 Ford S-MAX 2.0L TDCi with DPF	18 kg of non-metals	Better
2006 Ford Galaxy 2.0L TDCi with DPF	18 kg of non-metals	Better
2007 Ford Mondeo 2.0-liter TDCi Diesel with DPF	7.5% of non-metals	Better
2008 Ford Kuga	6% of non-metals	No previous model
2009 Ford Fiesta ECOnetic, Diesel	8.5% of non-metals	Better
2009 Ford Fiesta, Gasoline	9% of non-metals	Better

	Performance	Better/Worse than Previous Model
2006 Ford S-MAX, 2.0L TDCi with DPF	Substance management, TÜV-tested pollen filter efficiency and allergy-tested label	Better
2006 Ford Galaxy, 2.0L TDCi with DPF	Substance management, TÜV-tested pollen filter efficiency and allergy-tested label	Better
2007 Ford Mondeo, 2.0L TDCi Diesel with DPF	Substance management; TÜV-tested interior and pollen filter efficiency	Better
2008 Ford Kuga	Substance management, TÜV-tested interior and pollen filter efficiency	No previous model
2009 Ford Fiesta ECOnetic, Diesel	Substance management, TÜV-tested interior and pollen filter efficiency	Better
2009 Ford Fiesta, Gasoline	Substance management, TÜV-tested interior and pollen filter efficiency	Better

Measurement Method

dB(A)

	Performance	Better/Worse than Previous Model

2006 Ford S-MAX, 2.0L TDCi with DPF	71 dB(A)	Better
2006 Ford Galaxy, 2.0L TDCi with DPF	71 dB(A)	Better
2007 Ford Mondeo 2.0L, TDCi Diesel with DPF	69 dB(A)	Similar
2008 Ford Kuga	72 dB(A)	No previous model
2009 Ford Fiesta ECOnetic, Diesel	69 dB(A)	Better
2009 Ford Fiesta, Gasoline	72 dB(A)	Similar
2011 Ford Focus, 1.6L Gasoline	66 dB(A)	Better
2011 Ford Focus, 1.6L Diesel	68 dB(A)	Better

Measurement Method

Complex method, structural stability, occupant safety, and pedestrian safety; active safety elements, etc. including European New Car Assessment Program (Euro-NCAP) stars.

	Performance	Better/Worse than Previous Model
2006 Ford S-MAX, 2.0L TDCi with DPF	Euro NCAP safety rating: 5 stars for adult occupant protection, 4 stars for child protection and 2 stars for pedestrian protection	Better
2006 Ford Galaxy, 2.0L TDCi with DPF	Euro NCAP safety rating: 5 stars for adult occupant protection, 4 stars for child protection and 2 stars for pedestrian protection	Better
2007 Ford Mondeo, 2.0-liter TDCi Diesel with DPF	Euro NCAP safety rating: 5 stars for adult occupant protection, 4 stars for child protection and 2 stars for pedestrian protection	Better
2008 Ford Kuga	Euro NCAP safety rating: 5 stars for adult occupant protection, 4 stars for child occupant protection and 3 stars for pedestrian protection	No previous model
2009 Ford Fiesta ECOnetic, Diesel	5-star Euro NAP rating for adult occupant safety; electronic stability control available for all versions	Better
2009 Ford Fiesta, Gasoline	5-star Euro NCAP rating for adult occupant safety; electronic stability control available for all versions	Better
2011 Ford Focus, Gasoline and Diesel	5-star overall safety rating, plus 4 Euro NCAP advance rewards for Active City Stop, Lane Keeping Aid, Forward Alert and Driver Alert	Better

Measurement Method

Mobility service (including seats, luggage) to vehicle size; measured as vehicle shadow in m^2 and luggage areas in liters.

	Performance	Better/Worse than Previous Model
2006 Ford S-MAX, 2.0L TDCi with DPF	10.25 m^2 shadow area, 1,171 liter luggage, 5 seats	Better
2006 Ford Galaxy, 2.0L TDCi with DPF	10.4 m^2 shadow area, 435 liter luggage, 7 seats	Similar
2007 Ford Mondeo, 2.0-liter TDCi Diesel with DPF	9 m^2 shadow area, 530 liter luggage, 5 seats	Better

2008 Ford Kuga	9.5 m^2 shadow area, 410 liter luggage, 5 seats	No previous model – among best in class
2009 Ford Fiesta ECOnetic, Diesel	7.5 m^2 shadow area, 295 liter luggage compartment	Better
2009 Ford Fiesta, Gasoline	7.5 m^2 shadow area, 295 liter luggage compartment	Similar
2011 Ford Focus, Gasoline and Diesel	8.76 m^2 shadow area, 363 liter luggage compartment	Similar

Measurement Method

Sum of vehicle price and 3 years' service (fuel cost, maintenance cost, taxation) minus residual value.

	Performance*	Better/Worse than Previous Model
2006 Ford S-MAX, 2.0L TDCi with DPF	Approx. €22,100	Better
2006 Ford Galaxy, 2.0L TDCi with DPF	Approx. €23,200	Better
2007 Ford Mondeo, 2.0-liter TDCi Diesel with DPF	Approx. €18,300	Better
2008 Ford Kuga	Approx. €19,100	No previous model
2009 Ford Fiesta ECOnetic, Diesel	Approx. €13,000	Similar
2009 Ford Fiesta, Petrol	Approx. €11,000	Better
2011 Ford Focus, 1.6L Gasoline	Approx. €16,400	Better
2011 Ford Focus, 1.6L Diesel	Approx. €16,700	Better

*No guarantee that the costs reflect market conditions (in particular dependent on assumed differences in residual value and running cost).

Both Ford's own internal assessments and external assessments have found PSI to be an effective lifecycle assessment and design tool. An external study, conducted by experts in the area of lifecycle science and sustainability, found the PSI to be a design and analysis step that provides a full sustainability assessment and meets the requirements of ISO 14040, the international lifecycle assessment standard. PSI assessments of the 2006 S-MAX and Galaxy vehicles were certified against the ISO rules for Lifecycle Assessment. This certification process also verified the overall PSI methodology used for all subsequent PSI-developed models.

1. *Environmental aspects* is a term used in the ISO 14001 framework to denote elements of an organization's activities, products and services that can interact with the environment. Potential environmental impacts include any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's activities, products or services. Local Ford facilities use corporate lists of environmental aspects and potential impacts to identify and amplify those aspects that apply to their operations.
2. PSI-rated models are only available in Europe.

Climate Change

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 positively 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 parts per million (ppm), the level that many scientists, businesses, and governmental agencies believe may 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 from 2010 to 2025 on a per-vehicle basis and average energy consumed per vehicle by 25 percent from 2011 to 2016 globally.

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 Sustainable Technologies and Alternative Fuels Plan – 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 their 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 our recent and upcoming actions, we:

- Reduced fleet-average CO_2 emissions from our 2011 model year U.S. new vehicles by 9 percent compared to the 2007 model year.
- Reduced the fleet-average CO_2 emissions from our European vehicles by 8.5 percent from the 2006 to 2010 calendar years.[1]
- Reduced CO_2 emissions from our global operations in 2011 by 8 percent on a per-vehicle basis, compared to 2010.
- Implemented 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.
- Began selling the Focus Electric, which gets combined 105 miles per gallon (mpg) equivalent (according to the U.S. Environmental Protection Agency), making it the most fuel-efficient compact vehicle in the U.S. at the time of launch.

Related Links

This Report
- Climate Change Policy and Partnerships
- Climate Change Risks and Opportunities
- Climate Change – The Issue
- Ford's Climate Change Strategy
- Ford's Greenhouse Gas Emissions
- Ford's Science-Based CO_2 Targets
- Progress and Performance
- Sustainable Technologies and Alternative Fuels Plan

Vehicle Websites
- Ford Focus Electric

- Offered 22 models in Europe that achieve a CO_2 emissions level of 130 grams per kilometer (g/km), and three that achieve less than 100 g/km.
- Will offer – by the end of 2012 – eight models in North America that provide 40 mpg or better – compared to 2009, when our most fuel-efficient vehicle achieved 35 mpg.

Our Policies

Neither Ford nor the auto industry can 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 these more fuel-efficient vehicles and lower-carbon fuels.

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 their obligations.

In This Section

In this section of our Sustainability Report we first provide an overview of the climate change issue and of Ford's greenhouse gas emissions. We also discuss the risks and opportunities that climate change poses for Ford, our climate change strategy and our progress and performance to date. The section then addresses climate change public policy issues.

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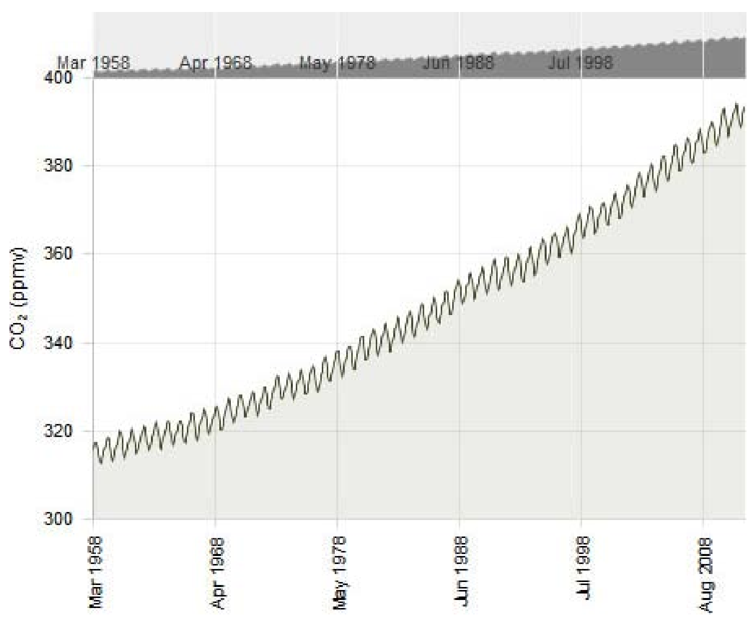
1. 2011 calendar year fleet-wide CO_2 emissions data for our European fleet will be available in November 2012.

The Issue

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 net 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 392 ppm in 2012 (see Figure 1).

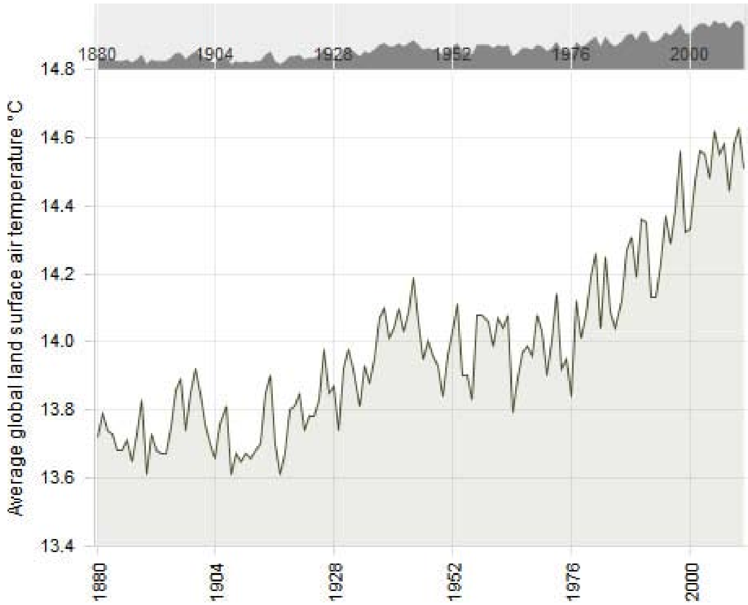
Global temperature records have been reported independently by scientists at the National Aeronautics and Space Administration (NASA) in the U.S., the National Oceanic and Atmospheric Administration in the U.S., the Climate Research Unit at the University of East Anglia in the U.K. and the Japanese Meteorological 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 2011 was among the warmest years on record. Independent measurements of rising sea levels, 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 (2012)

Figure 2: Global temperature



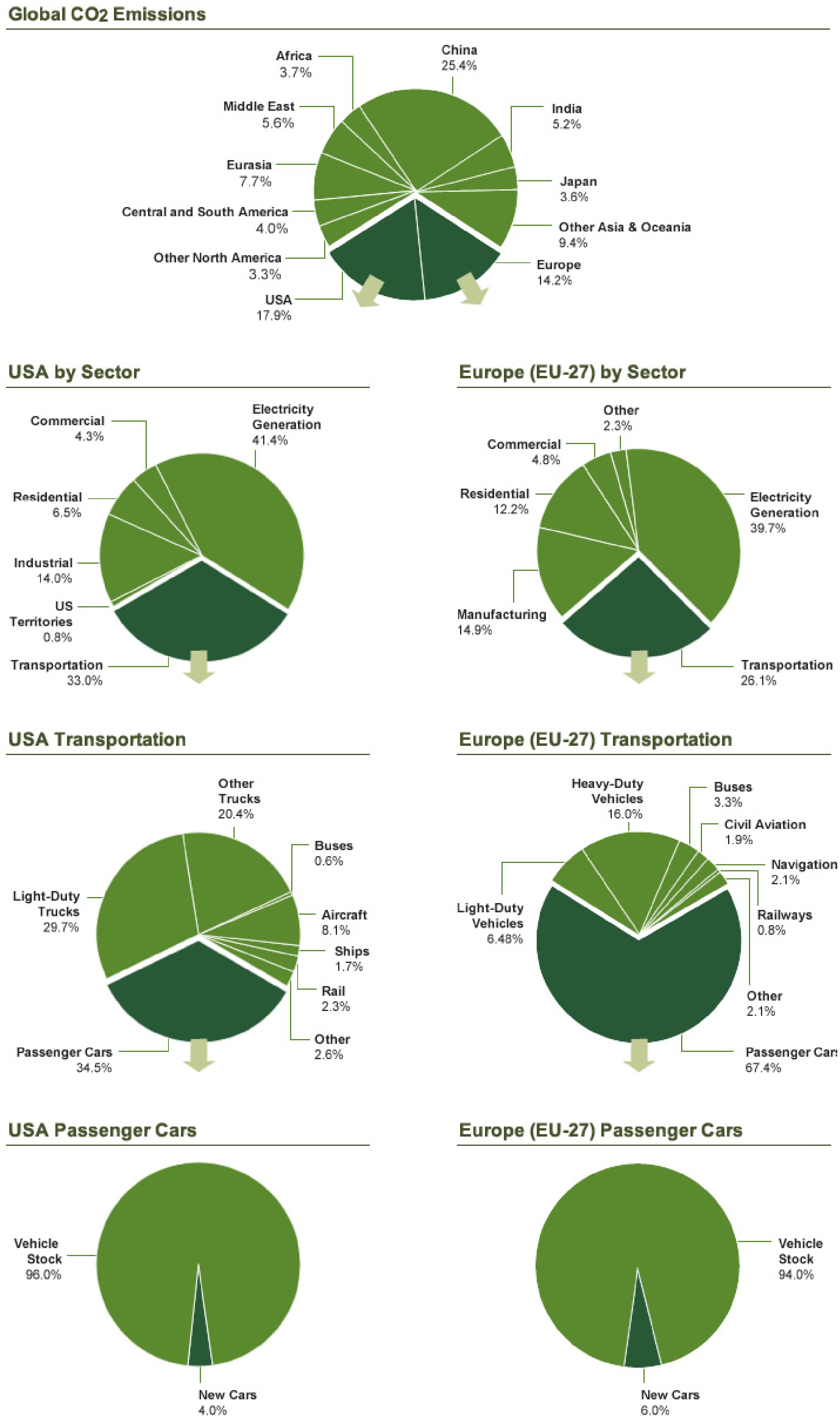
Data source: NASA (2012)

Global Emissions

Figure 3 (below) provides a breakdown of estimated 2009 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 approximately 2007, the U.S. was the largest CO_2 emitter. Due to economic development, however, emissions from China surpassed those from the U.S. approximately 5 years ago, and it is expected that the gap between emissions from China and those from the U.S. will continue to widen in the future. That said, 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 2009



Global CO_2 Emissions

Percent

	2009
USA	17.9
Europe	14.2
Other North America	3.3
Central and South America	4.0
Eurasia	7.7
Middle East	5.6
Africa	3.7
China	25.4
India	5.3
Japan	3.6
Other Asia & Oceania	9.4

USA by Sector

Percent

	2009
Transportation	33.0
Industrial	14.0
Residential	6.5
Commercial	4.3
Electricity Generation	41.4

Europe (EU27) by Sector

Percent

	2009
Transportation	26.1
Manufacturing	14.9
Residential	12.2
Commercial	4.8
Electricity Generation	39.7
Other	2.3

USA Transportation

Percent

	2009
Passenger Cars	34.5
Light Duty Trucks	29.7
Other Trucks	20.4
Buses	0.6
Aircraft	8.1
Ships	1.7
Rail	2.3
Other	2.6

Europe (EU27) Transportation

Percent

	2009
Passenger Cars	67.4
Light Duty Vehicles	6.48
Heavy Duty Vehicles	16.0
Buses	3.3
Civil Aviation	1.9
Navigation	2.1
Railways	0.8
Other	2.1

USA Passenger Cars

Percent

	2009
Vehicle Stocks	96.0
New Cars	4.0

Europe (EU27) Passenger Cars

Percent

	2009
Vehicle Stocks	94.0
New Cars	6.0

Beyond CO_2

We have a holistic view of climate change and have addressed non-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. 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.

Related Links

This Report
- Sustainable Materials

External Websites
- Montreal Protocol

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 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 (CF_2Cl_2) as the refrigerant in air conditioning (AC) units. By the mid-1990s, vehicle manufacturers switched to hydrofluorocarbon-134a (also known as HFC-134a or CF_3CFH_2). 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 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.) 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 1900, 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, N2O and CH4 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.
5. T.J. Wallington, J.L. Sullivan and M.D. Hurley, "Emissions of CO_2, CO, NOx, HC, PM, HFC-134a, N2O and CH4 from the Global Light Duty Vehicle Fleet," *Meteorol. Z.* 17, 109 (2008).
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 O3," *Chem. Phys. Lett.* 439, 18 (2007).
9. Data source: WMO/UNEP, *Scientific Assessment of Ozone Depletion: 2010*, Geneva (2010). Global Warming Potential is a relative measure of how much heat a greenhouse gas traps in the atmosphere. It compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of carbon dioxide. A GWP is calculated over a specific time interval, commonly 20, 100 or 500 years. GWP is expressed as a factor of carbon dioxide (whose GWP is standardized to 1).

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Ford's Greenhouse Gas Emissions

We estimate that our total CO_2 emissions are in the range of 350–400 million metric tons (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.

We updated this estimate of global GHG emissions from our facilities and Ford vehicles in 2010, 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. 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.

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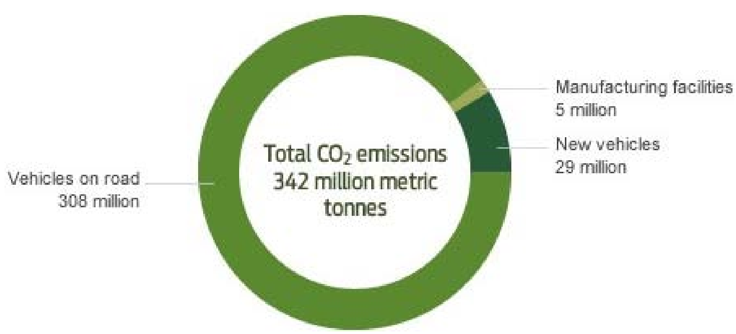
Our assessment of the emissions from Ford's facilities and Ford-made vehicles on the road decreased between 2005 and 2008 from approximately 400 to 350 million metric tons of CO_2, primarily due to better data availability for a key parameter.[1] Normalizing for the change in the key parameter, the emissions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

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

Chart | Table

Chart



Table

Metric tonnes

	CO_2 emissions
Manufacturing facilities	5 million
New vehicles	29 million

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- Creating a Sustainable Supply Chain
- Materials Management
- Supplier Environmental Management
- Supplier Greenhouse Gas Emissions

Vehicles on the road	308 million
Total	342 million

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. 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 tons 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]

Outside the scope of this estimate, we are also in the process of understanding the GHG emissions from our key suppliers' facilities. We are also expanding our approach to enhance supplier environmental performance beyond more-established supplier environmental performance expectations, which include robust environmental management systems (ISO 14001 certification) and responsible materials management. (See the Supplier 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.

For more information on our efforts to quantify our suppliers' greenhouse gas emissions please see Supplier Greenhouse Gas Emissions.

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 are 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 light-duty vehicles 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.

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 the 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 to investors about greenhouse gas emissions, 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 vehicle 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 Financial Health section for further discussion of our changing markets and how we are responding to them, and the Ford's Climate Change Strategy section for discussion of Ford's strategic response to the risks and opportunities posed by the climate change issue.

Related Links

This Report

- Climate Change Policy and Partnerships
- Financial Health
- Ford Around the World
- Ford's Climate Change Strategy
- Supply Chain
- U.S. Energy Security
- Water

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. National surveys in the U.S. continue to show that fuel economy is a key consideration in customers' vehicle purchase decisions. For example, a survey conducted by Maritz Research in the fall of 2011 shows that fuel economy has jumped dramatically in importance in the last decade to become a primary reason behind the purchase of nearly every kind of vehicle. This survey found that more than 40 percent of consumers now view fuel economy as "extremely important" when considering a new vehicle purchase today. One-third of consumers say fuel economy has the "greatest impact" on their next purchase. Ford's own surveys confirm this trend. In a survey that Ford conducted in 36 U.S. cities in the fall of 2011, nearly 45 percent of customers said fuel economy is their top consideration.

This trend is influencing buyer behavior. Between 2005 and 2011 the car share of the U.S. market increased from 45.3 percent to 48.1 percent, while the truck share declined from 54.7 percent to 51.9 percent. From 2010 to 2011, there was a slight decrease in the car share and slight increase in the truck share; however, the long-term trend from 2005 to today is toward an increasing market share for cars and decreasing market share for trucks. Sales of small cars increased from 15 percent of sales in 2005 to 19.2 percent in 2011. Sales of hybrid electric vehicles increased 6 percent from 2010 to 2011. As a percentage of the overall market, however, hybrid vehicle sales dropped slightly from 2.4 percent of the market in 2010 to 2.3 percent in 2011.

Europe

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 CO_2 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 central government currently provides limited incentives to fleet purchasers of "new energy vehicles" (defined as battery electric and plug-in electric vehicles) through a pilot program in 25 cities that applies to vehicles manufactured in China. However, sales of the new energy vehicles have been consistently under the target set by the central government. The majority of domestic and global automakers are launching or considering launching a range of hybrid electric vehicle technologies in China, including automatic stop-start (micro-hybrid) and full hybrid electric vehicles. Some of these technologies are already available in the Chinese market. The majority of "new energy vehicles" currently available in China are offered by domestic Chinese manufacturers under national Chinese brands.

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. 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 approximately 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

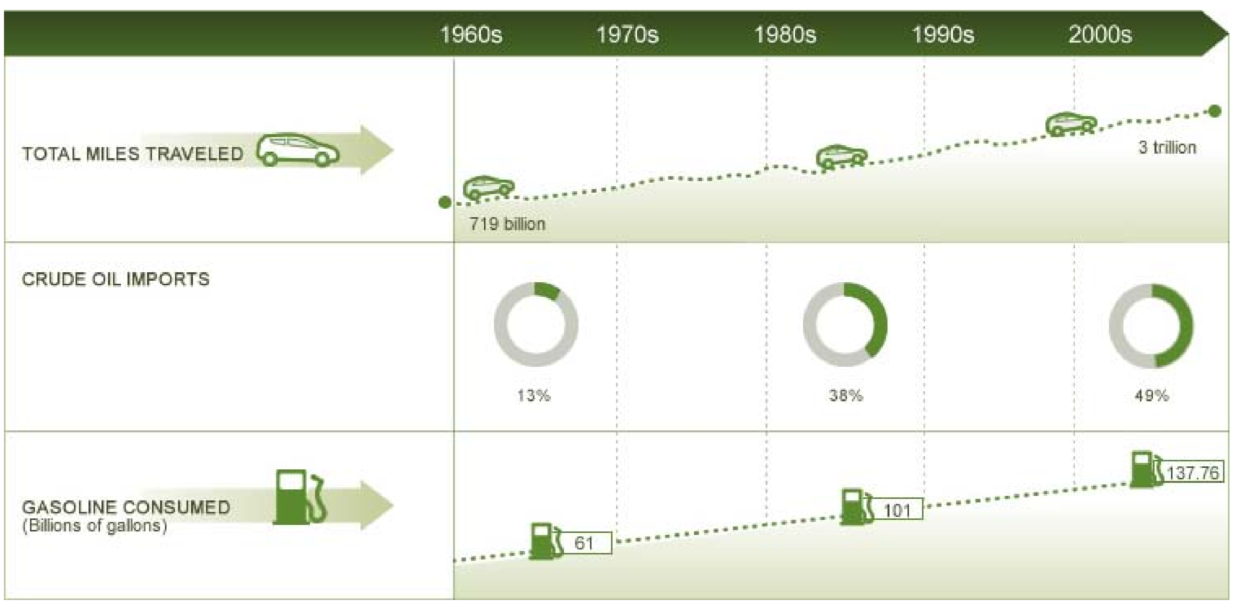
Our suppliers, which are located in more than 60 countries, are subject to market, regulatory and physical risks as a result of GHG regulation and the impacts of climate change. These risks could affect their competitiveness or ability to operate, creating the potential for disruptions to the flow of 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

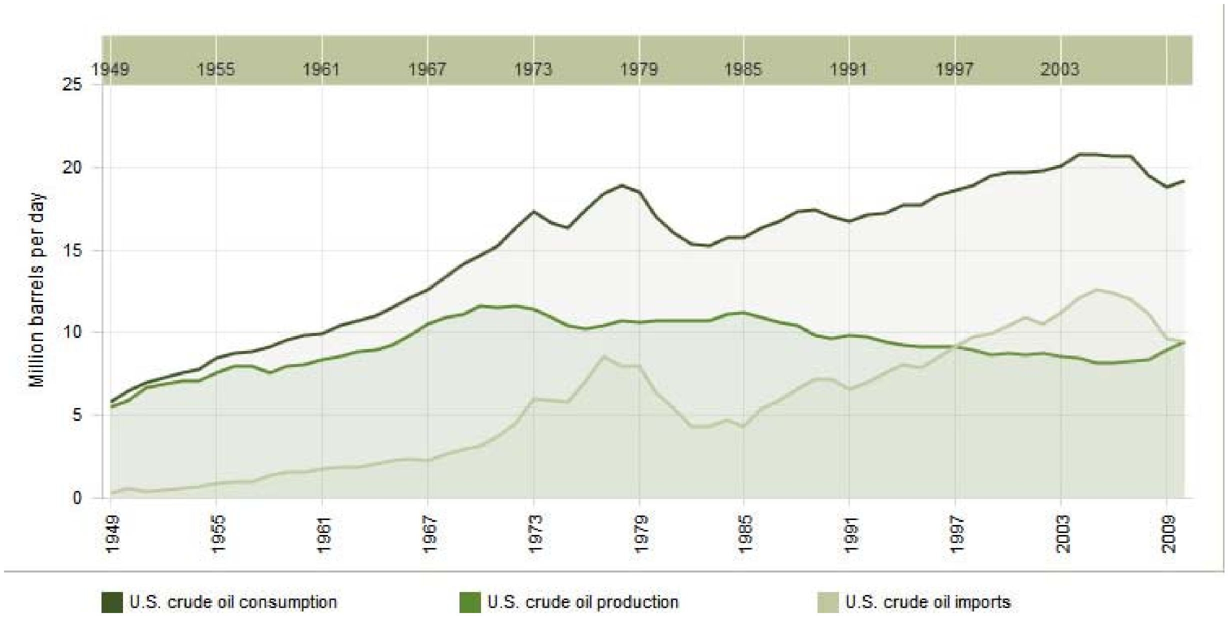
The following charts illustrate trends that affect concerns about U.S. energy security. The first chart shows the increase in the number of miles all U.S. drivers are traveling each year, the long-term trend towards an increasing percentage of crude oil imports and the increasing consumption of gasoline.

Since the 1970s, the fuel efficiency of new passenger cars more than doubled, and fuel economy rates in trucks have increased more than 50 percent. This increase is reflected in the first 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 that U.S. demand for crude oil has declined. The economic downturn, improvements in vehicle fuel efficiency, and changes in consumer behavior have contributed to this decline. 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 continued reliance on foreign countries for supply, is at the core of the U.S. energy security concerns. The continued supply disruptions and instability in the Middle East and Africa have contributed to the significant increase in world crude prices during the first quarter of 2012. As crude oil is the most significant factor in the price of gasoline, some analysts are predicting possible record high gasoline prices during in 2012.



Crude Oil Consumption, Imports and U.S. Production



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Ford's Climate Change Strategy

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 technology and product strategy to meet this goal is based on a modeling of vehicle and fuel contributions to emission reductions and an analysis of market and regulatory trends (see figure below). Our climate change strategy is supported by our sustainable mobility governance, which establishes structures and accountability for implementing the strategy.

Product Sustainability Process

The specifics of our vehicle technology and product strategy to meet this goal are laid out in the Sustainable Technologies and Alternative Fuels Plan, which can be found in the Greening Our Products section of this report. The plan details steps we are taking in the foreseeable future to develop and deploy vehicle and fuel technologies.

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 2011, for example, our U.S. market share grew for the third 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 and 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

Related Links

This Report

- Climate Change Governance
- Financial Health – Mobility
- Ford's Science-Based CO_2 Targets
- Greening Our Products
- Sustainable Technologies and Alternative Fuels Plan

technology to integrate private and public transportation options. Please see the Financial Health section for details.

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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.

Related Links

This Report

- Climate Change Governance
- Progress and Performance

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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 – the 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 CO_2 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.

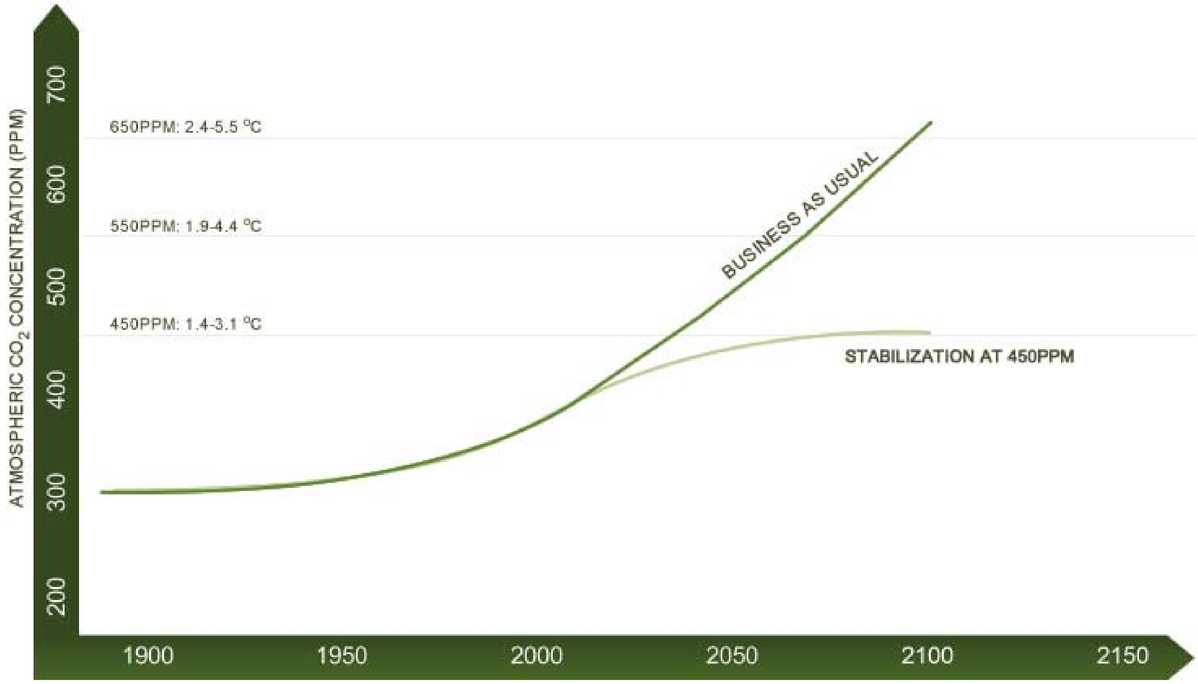
Our Stabilization Commitment

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 greenhouse gas (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).

Related Links

This Report

- The "CO_2 Model:" The Science Behind Our Scientific Approach



Ford has committed to doing our share to stabilize atmospheric CO_2 at 450 ppm. Using a science-based CO_2 model (see The "CO_2 Model:" The Science Behind our Scientific Approach), 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, and 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 reductions in CO_2 emissions from new vehicles that are 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 graphic below, we have already made significant progress in improving the fuel economy of, and hence reducing the CO_2 emissions from, our vehicles.

Nameplate Fuel Economy Improvement Summary

	2002 MY–	2012 MY	% FE Improvement (Unadjusted Combined)
FOCUS			22.2[1]
ESCAPE			13.0[2]
EXPLORER			36.1[3]
F-150			12.8[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 as well. 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.

Ford's leadership in using climate science to set our CO_2 targets has been recognized externally. In 2012 we received a Goal-Setting Certificate at the U.S. Environmental Protection Agency's Climate Leadership Awards Ceremony and Conference for our global CO_2 strategy.

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.

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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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The "CO_2 Model:" The Science Behind Our Scientific Approach

In 2005, Ford's scientists began development of a global 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 of the same percentage CO_2 emission reductions 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 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.

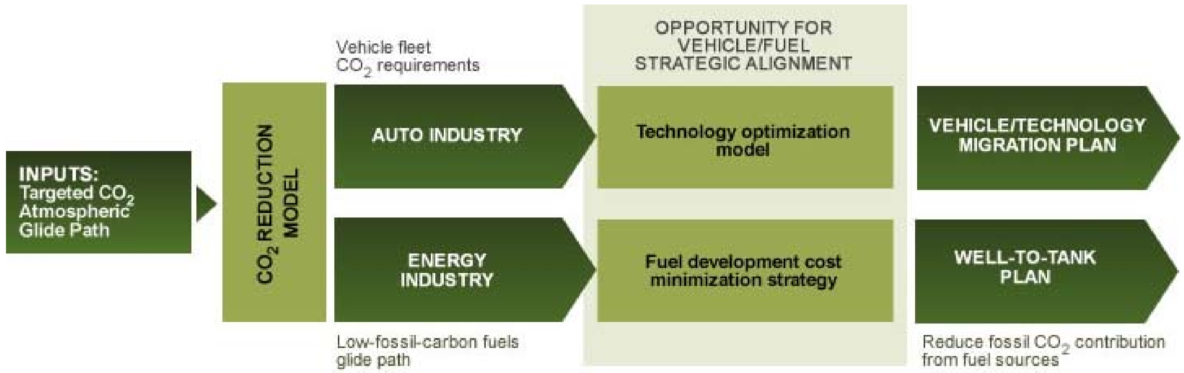
Are you continuing to test alternative scenarios?

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



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The "CO_2 Model:" The Science Behind Our Scientific Approach

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 "use phase" vehicle emissions. Emissions from our operations, logistics (the transportation of parts for our vehicles and finished vehicles to dealerships), and from our supply chain are also important elements of our greenhouse gas emission impacts and reduction strategy. These topics are covered in more detail in the "Greening Our Operations" section for our facilities and the supply chain section for logistics and suppliers.

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

Related Links

This Report

- Greening Our Operations
- Logistics
- Quantifying Our Environmental Impacts
- Supplier Greenhouse Gas Emissions

Vehicle

Vehicle + Fuel + Driver = GHG emissions

ON THIS PAGE

Improving Vehicle Fuel Efficiency

To meet our climate change goals, 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 introduced a wide variety of new engine and transmission technologies – as well as electrical system improvements, weight reductions and aerodynamic improvements – that deliver significant fuel-economy benefits for millions of drivers in the near term. Between 2008 and 2013, we will introduce 62 new or significantly upgraded engines, transmissions and transaxles globally to help us improve fuel economy and reduce carbon dioxide emissions across our global fleet. By the end of 2012, we will have delivered 50 of the 62 planned new or significantly updated powertrains, or approximately 81 percent of our planned introductions.

EcoBoost® engines, which use gasoline turbocharged direct-injection technology, are the centerpiece of our efforts to improve vehicle fuel efficiency. EcoBoost engines deliver 10 to 20 percent better fuel economy, 15 percent fewer carbon dioxide 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 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, we made significant improvements to the new 2012 Ford Focus, resulting in an average fuel economy improvement across all model types of 4 miles per gallon (mpg) compared to the 2011 model year. Also in the 2012 model year, we introduced the all-new Focus Electric, with a fuel-economy equivalent rating – according to the U.S. Environmental Protection Agency (EPA) – of 105 mpg (110 mpg in the city). Substantial gains were also made to the fuel economy of the Ford Edge with the introduction of the 2.0L EcoBoost four-cylinder engine and innovative aerodynamics technologies such as Active Grille Shutter and side-door rocker moldings to reduce

Related Links

This Report
- EcoBoost engines
- Ford Around the World
- Sustainable Technologies and Alternative Fuels Plan

Vehicle Websites
- Ford C-MAX
- Ford C-MAX Energi
- Ford C-MAX Hybrid
- Ford Edge
- Ford Escape
- Ford Explorer
- Ford Falcon
- Ford Fiesta
- Ford Focus
- Ford Focus Electric
- Ford Fusion Energi
- Ford F-150
- Ford Galaxy
- Ford Grand C-MAX
- Ford Mondeo
- Ford Mustang
- Ford S-MAX
- Lincoln MKZ

Ford.co.uk
- ECOnetic technology

drag. We also introduced the 2.0L EcoBoost on the Ford Explorer, which delivers a 30 percent fuel-efficiency improvement over the highest fuel-economy variant of the previous-generation 2010 Explorer.

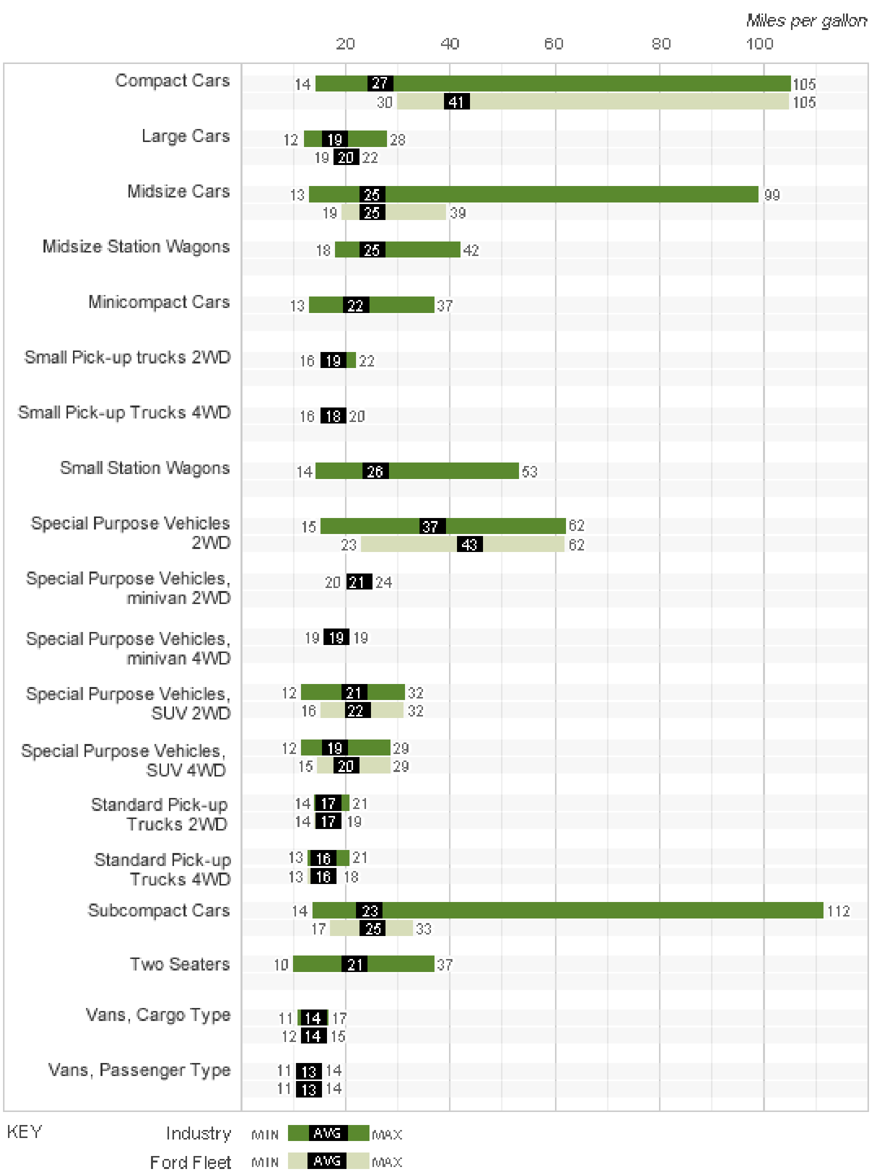
As seen in the graphic below, Ford's 2012 model year U.S. vehicles rank better than the industry fuel-economy average in six of 11 categories and the same in five.

For the 2011 model year, our fleet CO_2 emissions decreased by about 3 percent relative to the 2010 model year, and improved 9 percent compared to the 2007 model year. Preliminary data for the 2012 model year project that the Corporate Average Fuel Economy (CAFE) values will improve for cars and stay about the same for the truck fleet, compared to the 2011 model year. On an overall fleet basis, preliminary estimates indicate a 2012 CAFE improvement of 7.6 percent compared to 2011.

In Europe, we have reduced the average CO_2 emissions of our car fleet by 8.5 percent between 2006 and 2010 calendar 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 Technology range of low-CO_2 vehicles and the introduction of EcoBoost direct-injection, turbocharged gasoline engines.

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	27	105	30	41	105
Large Cars	12	19	28	19	20	22
Midsize Cars	13	25	99	19	25	39
Midsize Station Wagons	18	25	42			
Minicompact Cars	13	22	37			
Small Pick-up Trucks 2WD	16	19	22			
Small Pick-up Trucks 4WD	16	18	20			
Small Station Wagons	14	26	53			
Special Purpose Vehicle 2WD	15	37	62	23	43	62
Special Purpose Vehicle, minivan 2WD	20	21	24			
Special Purpose Vehicle, minivan 4WD	19	19	19			
Special Purpose Vehicle, SUV 2WD	12	21	32	16	22	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	13	16	21	13	16	18
Subcompact Cars	14	23	112	17	25	33
Two Seaters	10	21	37			
Vans, Cargo Types	11	14	17	12	14	15
Vans, Passenger Type	11	13	14	11	13	14
Total	10	22	112	11	23	105

We have committed that every all-new or redesigned vehicle we introduce will be best in class for fuel economy or among the leaders in its segment. Some examples of our recently launched vehicles that met this commitment as of June 2012 include:

- The Ford Focus Electric has an EPA fuel economy rating of 105 miles per gallon equivalent (MPGe), making it the most fuel efficient compact vehicle available in the U.S.
- The 2012 Ford Explorer with both the V6 and the 2.0L I-4 EcoBoost engine delivers best-in-class fuel economy. The V6 Explorer delivers up to 17 mpg in the city and 25 mpg on the highway, putting among the leaders for fuel economy in the full-size V6 SUV segment in fuel efficiency. Only the EcoBoost Explorer does better, with an EPA rating of 28 mpg on the highway.
- The 2012 Ford F-150 delivers best-in-class fuel economy among full-size pickup trucks, with its 3.7L V6 4X2. This vehicle offers fuel economy of 17 city/23 hwy/19 combined. The F-150 3.5L V6 EcoBoost engine offers a best-in-class mix of torque, capability, and fuel economy; this vehicle offers fuel economy of 16 city/22 hwy/18 combined with 420 lb-ft of torque, best-in-class towing at 11,300 lbs and best in class payload at 3,100 lbs. The F-150 with 5.0L V8 has best-in-class fuel economy of comparable V8s at 15 city/21 hwy/17 combined.[2]
- The new Ford Fiesta ECOnetic Technology is the most fuel-efficient and lowest-CO_2-emission passenger car Ford has ever offered in Europe. Powered by a 1.6L Duratorq TDCi diesel, the new Fiesta ECOnetic Technology offers fuel economy of 3.3L/100km (86 mpg U.K.[3]/71 mpg U.S.) and delivers CO_2 emissions of 87 g/km.
- The Ford Focus ECOnetic Technology, which delivers fuel economy of 3.4L/100km (83.1 mpg U.K.[4]/69 mpg U.S.) and CO_2 emissions of 88g/km – is one of the most fuel-efficient non-hybrid family cars currently available in Europe.

The Ford Focus Electric on show at the 2012 Geneva Motor Show

The following are some examples of our fuel-efficient vehicles by region.

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North America

In North America, we continued to introduce new vehicles that use the technologies identified in our Sustainable Technology and Alternative Fuels Plan and offer outstanding fuel economy and reduce CO_2 emissions, as seen in the following examples from 2011 and early 2012:

- We continued to introduce new vehicles with best-in-class fuel economy, including the 2012 model year Ford Focus, Ford F-150 and Explorer. All of these vehicles have unsurpassed fuel economy in their respective segments.[5]
- With the introduction of the all-new Ford Escape and Fusion in 2012, we will have the most fuel-efficient vehicle lineup in our Company's history.

- As of June 2012, Ford offers four vehicles that get 40 mpg (or MPGe) or better:
  - Ford Focus SFE
  - Ford Fiesta SFE
  - Lincoln MKZ Hybrid
  - Ford Focus Electric
- By the end of 2012, Ford will introduce three more vehicles with 40 mpg or MPGe or better:
  - Ford Fusion Energi
  - Ford C-MAX Hybrid
  - Ford C-MAX Energi

As of the end of 2011, Ford offered 13 vehicles that get 30 mpg or better:

- Ford Edge with EcoBoost: 21 mpg/30 mpg
- Ford Escape Hybrid FWD: 34 mpg/31 mpg
- Ford Escape Hybrid AWD: 30 mpg/27 mpg
- Ford Fiesta five-speed manual: 29 mpg/37 mpg
- Ford Fiesta automatic: 29 mpg/38 mpg
- Ford Fiesta SFE automatic: 29 mpg/40 mpg
- Ford Focus five-speed manual: 26 mpg/36 mpg
- Ford Focus automatic: 28 mpg/38 mpg
- Ford Focus SFE automatic: 28 mpg/40 mpg
- Ford Fusion 2.5L automatic: 23 mpg/33 mpg
- Ford Fusion Hybrid: 41 mpg/36 mpg
- Ford Mustang Coupe 3.7L automatic: 19 mpg/31 mpg

- Ford Mustang Convertible 3.7L automatic: 19 mpg/30 mpg

We also 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 Technology 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. The expansion of ECOnetic Technology to a wider range of models is part of Ford's overall sustainability strategy, including the target of reducing CO_2 emissions of its cars by 30 percent between 2006 and 2020. The innovative range of low-CO_2 features will be available in an increasing number of Ford vehicles in Europe, qualifying them to wear the ECOnetic Technology badge, which has been applied since October 2011 to all Ford cars that are the leaders or among the very best in terms of fuel economy in their segments. The badge will appear on more than 30 models by the end of 2012.

ECOnetic Technology features such as Automatic Start/Stop, Smart Regenerative Charging, Active Grille Shutter, EcoMode and other fuel-saving features are already available, or will be by the end of 2012, on the Ford Fiesta, C-MAX, Grand C-MAX, Focus, Mondeo, S-MAX and Galaxy. Ford is the only non-premium manufacturer currently offering Active Grille Shutter.

The Ford Fiesta ECOnetic

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

- The new Fiesta ECOnetic Technology, Ford's most fuel-efficient and lowest-CO_2-emission passenger car ever, offers fuel economy of 3.3L/100km (86 mpg U.K.[6]/71 mpg U.S.) and CO_2 emissions of 87g/km. The new model showcases Ford ECOnetic Technology innovations like Automatic Start/Stop, Smart Regenerative Charging, EcoMode and shift indicator light. It also benefits from a bespoke engine calibration and optimized gear ratios. A lower suspension, undershield and wheel deflectors, as well as low-rolling-resistance tires, are used to further reduce driving resistances.
- The Focus ECOnetic Technology delivers fuel economy of 3.4L/100km (83.1 mpg U.K.[7]/69 mpg U.S.) and CO_2 emissions of 88g/km, making it the most fuel-efficient non-hybrid family car currently available in Europe. It is uniquely equipped with a lean NOx trap in combination with a coated diesel particulate filter.
- The Ford Mondeo ECOnetic has a specially calibrated 115 PS (85 kW) version of the 1.6L 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 4.3L/100km (65.6 mpg U.K.[8]), which translates into average CO_2 emissions of 114 g/km – an important tax break point in some European markets.
- The Focus 1.0L EcoBoost model is Ford's most-efficient gasoline vehicle ever and delivers best-in-class fuel economy and the lowest CO_2 emissions compared to its rivals. The 1.0L EcoBoost 100PS version delivers 4.8L/100km (58.9 mpg U.K.[9]/49 mpg U.S.) and CO_2

emissions of 109g/km. The 125PS model returns 5.0L/100km (56.5 mpg U.K. /47 mpg U.S.) with CO_2 emissions of 114g/km.

- The new three-cylinder 1.0L EcoBoost engine will come to other models during 2012, including the Ford B-MAX and C-MAX.

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 February 2012 the all-new 1.0L EcoBoost, first available in the Focus, joined the 1.6L EcoBoost gasoline and 1.6L TDCi diesel in wearing the ECOnetic Technology badge, recognition reserved for Ford cars that are either leaders or among the very best in their segment in terms of fuel economy. The new Focus 1.0L EcoBoost is Ford's most fuel-efficient gasoline engine vehicle ever.

The 1.0L EcoBoost uses turbocharging and direct fuel injection to extract impressive levels of power and fuel efficiency from its three-cylinder engine block, which is so small it can fit on a sheet of A4 paper. This combination of power and low CO_2 emissions is unmatched by competitors in its segment. The engine's high torque of 170Nm between 1,400 rpm and 4,500 rpm (or between 1,400 rpm and 4,000 rpm in 100PS version) supports a fuel-efficient driving style and delivers a good performance feel and diesel-like torque experience. The 1.0L EcoBoost engine also will be offered in the C-MAX and all-new B-MAX this year, with other models to follow.

In addition, our global electric vehicle plan is extending to Europe with the Focus Electric, which will be launched in late 2012, and will launch hybrid vehicles in coming years.

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

Ford will upgrade its entire powertrain portfolio in China with 20 advanced engines and transmissions to support its aggressive plan to introduce 15 new vehicles to China by 2015. These advanced, fuel-efficient technologies – including turbocharging, direct injection, twin independent variable camshaft timing (Ti-VCT) and six-speed transmissions – will deliver a more than 20 percent improvement in fuel economy to Ford's passenger vehicle fleet in China by 2015, which represents a key part of Ford's near-term sustainability goals in China. The all-new 1.0L EcoBoost direct-injection turbocharging gasoline engine, the smallest of Ford's EcoBoost engine family, will be produced in China for application in future vehicles for the Chinese market. Ford's joint venture, Changan Ford Mazda Automobile Co., Ltd. (CFMA), is building a new engine plant and a new transmission plant to speed up the localization of advanced powertrains to meet China's fast-growing demands. We are also continuing efforts to develop products that support the evolving "new energy vehicle" (defined as battery electric and plug-in hybrid electric vehicles) market in China.

In India, we are continuing to introduce vehicles with excellent fuel economy. The recently launched all-new Fiesta – powered by new top-of-the-line 1.5L Ti-VCT gasoline and TDCi diesel powertrains developed for India – delivers class-leading fuel economy and reduced CO_2 emissions compared to the outgoing model. This builds on fuel-economy leadership established with the Ford Figo, launched 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. These vehicles are 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 launched an EcoBoost version of the Ford Mondeo in 2011 and an EcoBoost Ford Falcon in 2012. Also in Australia, Ford's next-generation EcoLPi liquid-injection liquefied petroleum gas (LPG) system for the Falcon became available in 2011, providing customers with the most advanced LPG technology on the market. The Falcon EcoLPi fuel system improves fuel economy by 12 to 15 percent while also improving power by approximately 27 percent over the prior LPG Falcon model.

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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. In 2011, we introduced the Ford Mondeo with an EcoBoost engine in Argentina, which marked the debut of EcoBoost technology in South America. We are continuing to implement the new, more-efficient "Sigma" engine, which improves efficiency compared to current engines through reduced internal friction and improved electronic throttle controls. We have also 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. 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 in the B- and C-sized vehicle segments, which make up approximately 80 percent of the Brazilian market.

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1. The 2011 calendar-year fleet-wide CO_2 emissions data for our European fleet will be available in November 2012. For all years, these data do not include Volvo.
2. F-150 fuel economy is EPA-estimated compared to non-hybrid engine 4X2 light-duty full-size pickups. The F-150 with 5.0L V8 fuel economy is best in class compared to other trucks in its class with small V8 engines of 5.0L or less displacement.
3. 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.
4. 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.
5. Based on adjusted city/highway fuel-economy label values from the 2011 and 2012 MY EPA Fuel Economy Guides.
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. 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.
8. 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.
9. 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.
10. 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.

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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. In this section, we briefly discuss electrification and biofuels, two alternatives that Ford is currently implementing commercially. For more information on how Ford is developing and implementing alternatively fueled vehicles and powertrains, please see Sustainable Technologies and Alternative Fuels Plan.

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 such as carbon capture and storage.

Ford foresees a future that includes a variety of electrified and traditional 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 efficient gasoline engines, 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. Please see Electrification: A Closer Look for more on Ford's approach to electrified vehicles. For more information on the hybrid electric, plug-in hybrid, and battery electric vehicles we have launched or plan to launch, please see the Sustainable Technologies and Alternative Fuels Plan.

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. We remain committed to biofuels as part of our sustainability strategy. In fact, the use of alternative fuels is a key piece of our blueprint for sustainability to reduce CO_2. Consistent with consumer demand, Ford will continue to provide a range of products designed to run on ethanol blends greater than E10. FFVs provide fuel choice to consumers when the fuel is available and are necessary to transition to advanced alternative fuels.

For more information on our implementation of biofueled vehicles, please see Renewable Biofueled Vehicles. To learn about Ford's perspective on biofuel-related public policy issues, please see Climate Change Policy and Partnerships.

1. Of course, there is not only a need to reduce the fossil carbon content of the fuel itself, but to reduce

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- Electrification: A Closer Look
- Renewable Biofueled Vehicles
- Sustainable Technologies and Alternative Fuels Plan

any fossil-based CO_2 emitted during feedstock 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.

Helping Drivers Improve Fuel Efficiency with 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. (SYNC® with MyFord Touch will be launched in Europe in 2012, initially on the Ford B-MAX.)

MyFord Touch map-based navigation with Eco-Route option

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

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- Ford Around the World
- Vehicle Safety

Vehicle Websites
- Ford B-MAX
- Ford Edge
- Ford Explorer
- Ford Focus
- Lincoln MKX

Corporate.ford.com
- Eco-Driving Tips

External Websites
- ECO-WILL
- Ford Driving Skills for Life

and modify their driving habits to achieve maximum fuel economy.

In Europe, we offer the EcoMode system to help drivers maximize their fuel economy. EcoMode was first presented in the Ford Focus ECOnetic in Europe in 2009 and has since 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 2012 Ford Focus in North America.

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 smarter and greener driving skills 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 2011, more than 17,000 German drivers had been "eco-trained" under real-world conditions.

In 2011, Ford continued to support a European project called ECOWILL. This project, which began in 2010 and is planned to last three years, is based on the premise that drivers' "eco-behavior" has a great potential to reduce CO_2 from motoring without making it less "fun to drive." ECOWILL has two major strategic goals:

Ford supports ECOWILL, an Eco-Driving education program

- A mass roll-out of high-quality/standardized short duration eco-driving trainings. Ford operates one-hour courses with professional driving instructors as part of this goal.
- Promoting the education and testing of eco-driving for learner drivers in regular driving school as a "do it first, do it right" approach under the leadership of EFA, the European driving school association.

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 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 Indonesia alone, more than 3,000 people have participated in FDFSL since it was launched in the market in 2008.

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. In China, 9,500 drivers across more than 73 cities in China attended the training by the end of 2011. In India, more than 3,500 people have been through the training, including special sessions for the Delhi Traffic Police, Chennai Traffic Police, Rotary Clubs and MCRT, college students, fleet owners and dealers, since 2009. We trained 1,500 drivers across India in 2011 alone. In South Africa, we have trained approximately 550 drivers since the program launched in 2010. FDSFL programs are running in eight markets in the Asia Pacific and Africa region. So far, 50,000 people from across the region have participated in FDSFL, and we expect 12,000 more to take part in 2012.

Climate Change Policy and Partnerships

During 2011, 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) proposed a national approach to vehicle greenhouse gas and fuel economy standards for 2017–25. However, growing budget deficits at national and regional levels globally continue to decrease 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 carbon dioxide (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. 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

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- Ford's Science Based CO_2 Targets

External Websites

- National Highway Traffic Safety Administration
- U.S. Environmental Protection Agency Fuel Economy

U.S. Policy

External Websites

- National Highway Traffic Safety Administration
- U.S. Environmental Protection Agency Fuel Economy

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) has continued to pursue greenhouse gas emissions regulations for mobile sources using their authority under the Clean Air Act, while the U.S. National Highway Transportation Safety Administration (NHTSA) has continued to pursue fuel economy regulations. In 2011, the EPA and NHTSA proposed joint greenhouse gas emission and fuel economy regulations for 2017–2025 model year light-duty vehicles. These regulations, which continue the "One National Program" approach, are discussed below under Greenhouse Gas and Fuel Economy Regulation.

Ford has participated in the public discourse on broad-based, national 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 (USCAP) to support the prompt enactment of national climate legislation. Because the USCAP organization has been dormant for nearly a year and this policy issue is now not expected to be taken up legislatively in the U.S., we asked to be delisted as a member of USCAP. We nonetheless remain committed to improving fuel economy and reducing greenhouse gas emissions as evidenced by our support for the One National Program approach to fuel economy regulations discussed below.

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.

The auto industry has supported the rules proposed by EPA and NHTSA, but regulations focusing on just one sector of the economy will not enable us to achieve the necessary level of GHG reductions. 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 July 2011, the Obama Administration announced that the state of California, the auto industry and other stakeholders had committed to support the single national program for motor vehicle fuel economy and greenhouse gas standards covering the 2017 to 2025 model years. This would be an extension of the “One National Program” regulations that have already been put in place for the 2012–2016 model years. Ford views the continuation of the “One National Program” agreement as a positive step for all stakeholders toward our common goals of energy security and reduced greenhouse gas emissions. In November 2011, EPA and NHTSA jointly issued proposed rules, with harmonized standards GHG and fuel economy standards, for public comment. The auto industry and other interested parties have filed comments on the proposed rules, and the agencies expect to issue final standards in July 2012.

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.

Ford is committed to working constructively with all stakeholders toward the implementation of workable and effective One National Program standards for 2017–2025. Given the long time frame at issue in this rulemaking, the agencies have committed to undertake a “mid-term evaluation” of the standards in the 2018 time frame to make sure that the industry is on track to be able to comply with the 2021–2025 standards. Ford supports the mid-term evaluation provisions as an essential element of this rulemaking. 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 October 2011, the EPA and NHTSA also finalized a single national program for greenhouse gas and fuel economy standards for heavy-duty vehicles. The CO_2 and fuel consumption requirements for 2014 through 2018 model year target 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 270 million metric tons and save approximately 530 million barrels of oil over the life of vehicles sold during the program. A second phase of regulations is planned for model years beyond 2018.

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European Policy

The European Union 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 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 others. 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 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 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, be 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 EU member states, CO_2 taxation is in place to encourage the early introduction of low-CO_2 vehicles. The major tax break points are often around 95/100 g/km, 120 g/km and 160 g/km. Unfortunately, these tax break points are not harmonized among the European countries.

The industry will continue to invest heavily in research and development and new product programs in order to reach 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 2011–2016 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. Also, 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. Now that the Canadian federal regulation is in place, the Quebec government has amended the Quebec Regulation to recognize equivalency with the federal standards. Reporting of Quebec fleet performance is still required. 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 implemented a regulation for renewable content in diesel fuel. As of July 2011, the regulation requires 2 percent renewable content in middle distillate fuels.

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 Chinese Ministry of Industry and Information Technology (MIIT) published a draft Stage III fuel consumption Monitoring & Reporting rule and is planning to implement it beginning July 1, 2012. The monitoring period is 2012–2015. 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 of the target in 2012 to 100 percent in 2015. The China Automotive Technology and Research Center (CATARC) began development of a Stage IV fuel consumption target in March 2012.

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 currently applies to vehicles in 25 cities. 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. All gasoline is blended with 20 to 25 percent ethanol, and pure ethanol is extensively used as motor fuel. Most new vehicles are designed to accommodate varying amounts of ethanol. Also a minimum of 5 percent biodiesel must be added to diesel.

Brazilian 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 and 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. Ten Brazilian states have issued Vehicle Pollution Control Plans and are taking actions to implement In-Use Vehicle Inspection and Maintenance Programs.

Other South American countries, such as Argentina and Colombia, are also significantly increasing the use of biofuels. The Chilean government is reviewing a mandatory fuel economy labeling program which will provide information on fuel consumption and CO_2 emissions.

In 2012, 100 percent of Ford's products in South America will be offered as Ethanol Flex Fuel Vehicles. The most recent vehicle line to offer this was the Ford Ranger, which now comes in a 2.5L ethanol flex-fuel version. Some imported vehicle lines including the 2013 Ford Fusion will also come in a flex-fuel version in Brazil. We also provide light- and heavy-duty vehicles that meet biodiesel requirements.

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, and we will continue to produce vehicles capable of operating on biofuels in line with consumer demand and infrastructure development. Our flex-fuel 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.

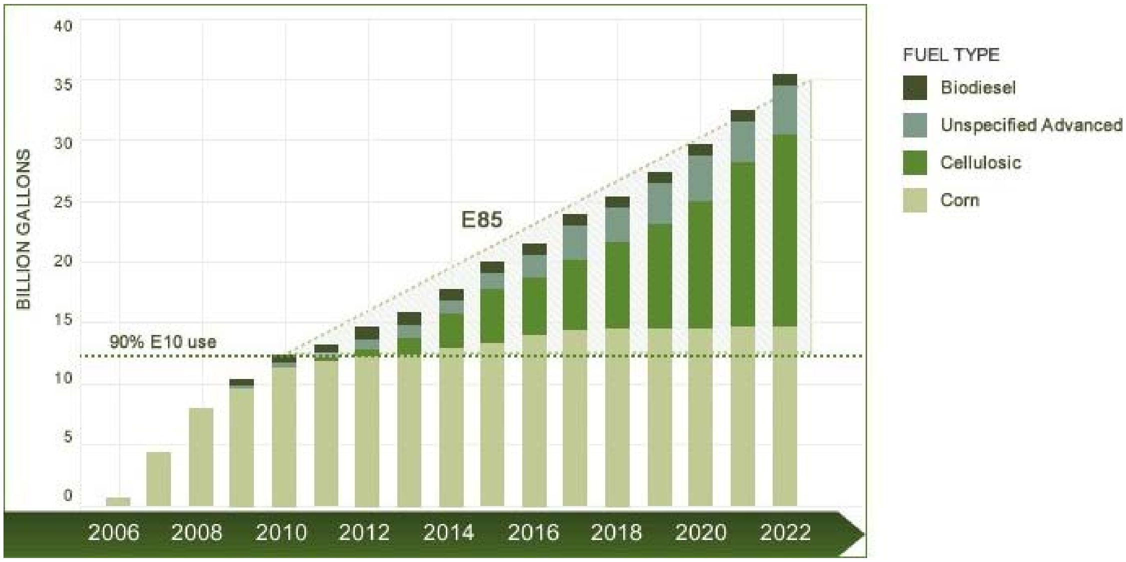
In January 2011, the U.S. Environmental Protection Agency (EPA) approved a waiver allowing the use of E15 (a blend of 85 percent gasoline and 15 percent ethanol) in 2001 and later model year vehicles, after previously issuing a waiver allowing E15 to be used in 2007 and later vehicles.

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 these concerns, 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. The automobile industry has joined with other industries seeking to overturn the E15 waiver in federal court. 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



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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.
- Industry co-chair of the U.S. Drive Cradle to Grave lifecycle assessment of energy use, carbon dioxide (CO_2) and greenhouse gas emissions.

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
- 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

Partnerships with Government

We are also engaging in partnerships with federal and state governments in the U.S. to deliver more fuel-efficient vehicles and alternative powertrain technologies. For example, 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 the Michigan Assembly Plant (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.

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-trading 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 U.K. Emissions Trading Scheme, the first voluntary government-sponsored, economy-wide, cross-industry GHG trading program. Ford Motor Company Limited (U.K.) 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 mandatory 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 U.K., 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. Environmental Protection Agency reporting requirements.

Comprehensive reporting forms the foundation for all emissions trading. We voluntarily report GHG emissions in Argentina, Australia, Brazil, Canada, China, Mexico, the Philippines and Taiwan. This reporting, which has won several awards, is discussed in the Greening our Operations section.

Related Links

External Websites

- Chicago Climate Exchange
- EU Emissions Trading Scheme

Greening Our Products

As a customer- and product-driven company, our vehicles are the foundation of our business. Our products are also a major focal point of our environmental impacts and our efforts to reduce those impacts. In this section we report on the current environmental performance of our products and our efforts to “green” our products, or improve their environmental impacts.

Specifically, we address:

- Our Sustainable Technologies and Alternative Fuels plan, which lays out our plans to improve the fuel efficiency of our products and advance the use of alternative fuels including electricity and bio-fuels.
- Non-carbon-dioxide tailpipe emissions, including hydrocarbons, nitrogen oxides, carbon monoxide and particulate matter that can contribute to smog formation and other air-pollution issues.
- Sustainable materials, including efforts to increase our use of recycled and renewable materials, improve vehicle interior air quality and eliminate substances of concern.
- Our approach to electrified vehicles, which include hybrid electric, plug-in hybrid electric and all-electric vehicles.

The fuel efficiency of our products, as well as our product-related greenhouse gas emissions, are reported in the Climate Change section of this report.

Related Links

This Report
- Climate Change
- Electrification: A Closer Look
- Non-CO_2 Tailpipe Emissions
- Sustainable Materials
- Sustainable Technologies and Alternative Fuels Plan

Home > Climate Change and the Environment > Greening Our Products

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.

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. We call this strategy the Power of Choice.

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.

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.

CLIMATE CHANGE AND THE ENVIRONMENT

- Design for Lifecycle Sustainability
- Climate Change
- Greening Our Products
  - Sustainable Technologies and Alternative Fuels Plan
    - Overview of Our Plan
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    - Improving Fuel Economy
    - Migration to Alternative Fuels and Powertrains
  - Non-CO_2 Tailpipe Emissions
  - Sustainable Materials
  - Electrification: A Closer Look
- Greening Our Operations
- Data
- Voice: Dr. Rajendra K. Pachauri

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 carbon dioxide (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 action completed

2007	2011	2020 – 2030
Begin migration to advanced technology	Full implementation of known technology	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	• Continue improving efficiency of internal combustion engines
✓ Electric power steering	✓ Electric power steering – high volume	• Volume expansion of hybrid and plug-in hybrid technologies
✓ Dual clutch and 6 speed transmissions replace 4 & 5 speeds	✓ Six speed transmissions – high volume	• Continued leverage of battery electric vehicles
✓ Flexible-fuel vehicles	• Weight reduction of 250–750 lbs.	• Continue to develop fuel cells; implementation timing aligned with fuel and infrastructure
✓ Add hybrid applications	• Engine displacement reduction facilitated by weight reductions	• Continued weight reduction through use of advanced materials
✓ Increased unibody applications	• Additional areodynamics improvements	• Advanced biofuels become viable at scale
✓ Introduction of additional small vehicles	• Increased application of stop/start	• Clean electricity enables increased volumes of plug-in hybrids and battery electric vehicles
✓ Battery management systems	• Increased use of hybrids	
✓ Aerodynamics improvements	• Introduction of battery electric and plug-in hybrid vehicles	
✓ Stop/start systems (micro hybrids)	• Vehicle capability to fully leverage available renewable fuels; 2nd generation biofuels introduce at low volumes	
✓ CNG/LPG prep engines available in select markets	• Diesel use as market demands	

	• CNG/LPG available in limited markets	

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 development and adoption of new vehicle technologies and fuels. At this time, however, there is 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 – including fuel-efficient EcoBoost® gasoline engines, advanced diesel engines, hybrids, plug-in hybrids, all-electric vehicles and alternative-fuel vehicles. We call this approach the "power of choice," because it allows customers to choose the vehicle that best meets their driving needs.

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.

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, we are 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; these vehicles can run on either regular gasoline or E85 (a blend of 85 percent ethanol and 15 percent gasoline). In South America, we also offer vehicles that can run on E100. 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 little or no additional cost, allow consumers to choose fuels based on availability and price.

We are also producing select vehicle models that can be converted to run on compressed natural gas (CNG) and liquefied petroleum gas (LPG) (also known as propane or Autogas). And, we are working with qualified vehicle modifiers to ensure that conversion to those fuels meets our quality, reliability and durability requirements. The Ford Transit Connect, the entire F-Series Super Duty® pickup truck and chassis cab lineup, our E-Series Van and Cutaway models, as well as our medium-duty trucks, are all available with a CNG/LPG conversion-ready engine package. In Europe, we offer CNG and LPG conversions of various models in markets where dedicated infrastructure exists, such as Italy, Germany and the Netherlands.

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

Related Links

This Report
- Electrification: A Closer Look
- Renewable Fuels Policy

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 a 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.

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.

Home > Climate Change and the Environment > Greening Our Products > Sustainable Technologies and Alternative Fuels Plan > A Portfolio Approach

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Go Further

Sustainability 2011/12

YEAR IN REVIEW | OUR BLUEPRINT FOR SUSTAINABILITY | FINANCIAL HEALTH | CLIMATE CHANGE AND THE ENVIRONMENT | WATER | VEHICLE SAFETY | SUPPLY CHAIN | PEOPLE | FORD AROUND THE WORLD

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
Begin migration to advanced technology	Full implementation of known technology	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 vehicle performance. EcoBoost engines help to improve vehicle fuel economy 10 to 20 percent and reduce CO_2 emissions up to 15 percent compared to larger-displacement engines.

EcoBoost offers comparatively 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 offer 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.

We have introduced four EcoBoost engine displacements with multiple derivatives for specific vehicles and markets.

- 3.5L V6 EcoBoost: We introduced the first EcoBoost engine – a 3.5L V6 – in North America on the 2010 Lincoln MKS, Lincoln MKT, Ford Taurus SHO and Ford Flex. This engine provides comparable or superior 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. We also offer the 3.5L EcoBoost on the F-150 beginning with the 2011 model, making it 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.
- 2.0L I-4 EcoBoost: In 2010 we introduced a 2.0L I-4 EcoBoost engine, the first in the EcoBoost lineup to go truly global.
  - In the U.S., the 2.0L I-4 EcoBoost engine is currently available on the 2012 Ford Edge, the all-new 2012 Ford Explorer and the 2012 Ford Focus. The Edge and Explorer with the 2.0L I-4 EcoBoost deliver best-in-class fuel economy, with the performance feel of a traditional V6. The new Explorer offers vehicle fuel economy that is 20 percent better than the previous model.
  - We also introduced this engine on the first high-performance vehicle with an EcoBoost – the Ford Focus ST, a special high-performance version of the Focus.
  - In 2012, this engine will be introduced on the all-new 2013 Escape and the 2013 Fusion.
  - In Europe, we introduced the Ford S-MAX, Mondeo and Galaxy with a 2.0L EcoBoost option.
  - In China, we launched the 2.0L EcoBoost on the Ford Mondeo.
  - In Australia, we introduced the 2.0L EcoBoost on the Mondeo in 2011 and will introduce it on the Falcon in 2012.
- 1.6L I-4 EcoBoost:
  - The 1.6L I-4 EcoBoost engine debuted in Europe on the 2011 Ford C-MAX and is also available on the all-new Ford Focus.
  - In the U.S., this engine's first application is the 2013 Ford Escape, which has segment-leading fuel economy among small SUVs and gets 5 mpg better than the outgoing Escape. The 1.6L EcoBoost will also be an option on the all-new 2013 Fusion, which will achieve best-in-class, four-cylinder fuel efficiency of 37 mpg on the highway. We also plan to offer the 1.6L I-4 EcoBoost on the 2013 Ford C-MAX when it is launched in the U.S.
- 1.0L I-3 EcoBoost:
  - We introduced a 1.0L three-cylinder EcoBoost in Europe on the European Ford Focus, which will produce approximately 125 horsepower while delivering ultra-low CO_2 emissions performance for a gasoline engine of 114 g/km – a level unmatched by Focus competitors. An approximately 100 horsepower version of the same engine will deliver best-in-class gasoline CO_2 emissions of 109 g/km. This engine delivers the power of a normally aspirated 1.6L I-4 with better fuel economy.
  - In India, we introduced the 1.0L three-cylinder EcoBoost on the all-new Ford EcoSport, which has power and performance that will rival a normally aspirated 1.6L gasoline engine while emitting less than 140 g/km of CO_2.
  - This engine will also be available in vehicles in North America, China and other regions, and we ultimately expect to produce up to 1.3 million units annually.

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. At the end of 2011, Ford had built nearly 180,000 EcoBoost-powered vehicles in North America. In 2012 we will offer 11 EcoBoost-equipped vehicles in the U.S., up from seven in 2011, tripling the production capacity of EcoBoost-equipped Ford vehicles. By 2013, we plan 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.

EcoBoost has thus far proven to be popular with customers. The Ford F-150 with the 3.5L EcoBoost engine accounts for more than 40 percent of total F-150 sales, making it the top-selling, full-sized V6 pickup truck on the market. In addition, the F-150 with the EcoBoost engine has received the same high quality ratings as the F-150's popular 5.0L V8 engine, according to data from GQRS, a quarterly survey conducted for Ford by the RDA Group. EcoBoost is also influencing many consumers to consider and buy our vehicles, increasing our "conquest rate" – i.e., the number of customers who are switching from other manufacturers to buy Ford vehicles. More than half of all Taurus SHO buyers are new to the Ford brand, and more than 62 percent of Flex with EcoBoost buyers had not previously considered a Ford product. 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.

As EcoBoost is a key element of our long-term powertrain strategy, we will continue to improve its efficiency and vehicle application potential through the further development of supporting advanced technologies.

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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
Begin migration to advanced technology	Full implementation of known technology	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	

We have introduced six-speed transmissions to replace less-efficient four- and five-speed transmissions in a majority of our vehicles, improving fuel economy by up to 9 percent depending on the application. These six-speed gearboxes 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.

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

Electric Power-Assisted Steering (EPAS)

✓ indicates stage completed

2007	2011	2020 – 2030
Begin migration to advanced technology	Full implementation of known technology	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.)

We already offer EPAS in the Ford Explorer, F-150, Mustang, Fusion, Flex, Taurus and Escape and the Lincoln MKS, MKT and the MKZ Hybrid in North America; the new Ford C-MAX and Focus in North America and Europe; and the Ford Fiesta and Ka in Europe. By the end of 2012 we will introduce EPAS into the new Ford Edge in North America, the Ford Kuga in Europe and China and a sport vehicle based on the Ford Focus. EPAS will also be used in all of our new electrified vehicles. In addition, the all-new Ford Fusion will use a second-generation EPAS system on all variants, including the gas, hybrid and plug-in hybrid versions. 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
Begin migration to advanced technology	Full implementation of known technology	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 that offered in a conventional vehicle, but it improves city driving fuel economy by up to 6 percent, with potentially higher gains possible for specific vehicle size and usage applications. 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 automatic transmission vehicles in 2012. In Europe, automatic start/stop is already standard on the Ford Ka and certain versions of the Mondeo, S-MAX Galaxy, 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
Begin migration to advanced technology	Full implementation of known technology	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 transmission available on the Ford Fiesta and Focus weighs less than the conventional automatic transmission it replaced.

The lighter-weight materials we are using include advanced high-strength steel, aluminum, magnesium, natural fibers and nano-based materials. To achieve our fuel-efficiency goals, we need to 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:

- In 2012, we introduced a new, lightweight, injection-molded plastic technology called MuCell on the all-new Ford Escape. Manufacturing MuCell involves the highly controlled use of a gas such as CO_2 or nitrogen in the injection-molding process, which creates millions of micron-sized bubbles in uniform configurations, lowering the weight of the plastic part by more than one pound per vehicle. This is the first time MuCell has been used in an instrument panel. In addition to reducing weight, the MuCell microcellular foam saves money and production time. On the 2012 Escape, MuCell saves an estimated $3 per vehicle vs. solid injection molding, and molding cycle time is reduced 15 percent. This plastic was the Grand Award Winner at the 2011 Society of Plastic Engineers competition in the “Most Innovative Use of Plastics Award” category.

- The Lincoln MKT crossover has an advanced lightweight magnesium and aluminum liftgate, which is more than 20 pounds, or 40 percent, lighter than a similar part made from standard steel.
- 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 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. The Explorer also has an aluminum hood.
- 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.
- By using high-strength steels, the European Ford Fiesta weighs approximately 40 kilograms less, depending on engine choice, even though it stands on virtually the same footprint as the previous model and has 10 kilograms of new safety features and sound insulation.

Ford researchers are also investigating additional new lightweight materials. For example, we are investigating and developing:

- New types of steel that are up to three times stronger than current steels and improve manufacturing feasibility because they can be formed into parts more easily.
- Polymeric plastic strengthening foams that are strong enough to stabilize bodywork in an accident but light enough to float on water. These foams are being used to reinforce sections of the steel auto body, such as the B-pillars.
- Surface coatings that reduce engine friction and remain intact even under the most adverse conditions.
- Alternative (copper-based) wire harness technologies that will enable significant weight reductions.
- Nanotechnology to model material properties and performance at the nanoscale, which will allow us to develop better materials more quickly and with lower research and development costs.
- Nano-filler materials in metal and plastic composites, to reduce their weight while increasing their strength. For example, we are developing the ability to use nano-clays that can replace glass fibers as structural agents in reinforced plastics. Early testing shows plastic reinforced with 5 percent nano-filler instead of the typical 30 percent glass filler has strength and lightweight properties that are better than glass-reinforced plastics.

Ford is also working to understand the health and safety issues that may be posed by nano-materials. Ford has joined with other automakers under the U.S. Council for Automotive Research (USCAR) umbrella to sponsor research into nano-materials’ potential impact on human health and the environment. This research has addressed many health and environment-related questions so that we can focus our nano-materials research and development in areas that will be most beneficial.

Weight reductions alone may have relatively small impacts on fuel economy. By itself, a 10 percent reduction in weight results in approximately a 3 percent improvement in fuel efficiency. However, if vehicle weights can be reduced even more substantially, it becomes possible to downsize the powertrains required to run the vehicle. Weight reductions combined with powertrain rematching not only improves fuel economy, but helps maintain overall performance (compared to a heavier vehicle with a larger engine).

Battery Management Systems (BMS)

✓ indicates stage completed

2007	2011	2020 2030
Begin migration to advanced technology	Full implementation of known technology	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. BMSs have 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 will continue to implement BMSs on the 2013 Ford Taurus, Flex, Escape and Fusion and on the Lincoln MKZ, MKX and MKT. We have also introduced more-efficient alternators, which improve fuel economy.

Aggressive Deceleration Fuel Shut-Off (ADFSO)

✓ indicates stage completed

2007	2011	2020 2030
Begin migration to advanced technology	Full implementation of known technology	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 emission.

This improved fuel shut-off will increase fuel economy by an average of 1 percent. An additional benefit 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
Begin migration to advanced technology	Full implementation of known technology	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 process 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.

In 2011, we introduced an Active Grille Shutter technology that reduces aerodynamic drag by up to 6 percent, thereby increasing fuel economy and reducing 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., we have implemented it on the 2012 Ford Focus and Edge, the 2013 Ford Escape and the all-new 2013 Ford Fusion.

We are making significant improvements in aerodynamics on vehicles introduced for the 2011 to 2013 model years. For example:

- We reduced aerodynamic drag in the 2013 Fusion and Lincoln MKZ up to 10 percent, in comparison with the 2012 models, through extensive aerodynamic improvements, including underbody shielding, tire spoilers, wheels, body shape, vehicle proportion and Active Grille Shutters. Our aerodynamics engineers even optimized the aerodynamics of wheel and mirror design to further reduce drag from the front of the vehicle. The 2013 Fusion Hybrid achieved an outstanding drag coefficient of as low as 0.27 – among the best in the world. The 2013 Fusion is also expected to be best in its class for fuel economy. (For more information on our fuel economy leaders please see Climate Change Progress and Performance.)
- The 2013 Ford Escape is nearly 10 percent more aerodynamic than the outgoing model.
- 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 help to reduce wind noise in the Focus.
- Aerodynamic improvements helped the 2011 Ford Fiesta SFE achieve a U.S. Environmental Protection Agency-rated 40 mpg.
- We continue to leverage our global aerodynamic team to support global product design. Aerodynamics engineers from North America, Europe, South America and Asia Pacific and Africa collaborated to deliver three of our most important global vehicles – the 2013 Ford EcoSport, C-MAX and Ranger pickup – with improved aerodynamics.

Smaller Vehicles

✓ indicates stage completed

2007	2011	2020 – 2030
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 also now 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 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.
- In 2012 we revealed the all-new Ford EcoSport compact SUV, which will ultimately be available in nearly 100 markets globally, including India and Brazil. This vehicle is part of our global commitment to deliver fuel-efficient vehicles that customers truly want and value.

We have 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.

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Migration to Alternative Fuels and Powertrains

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FCVs

At Ford, our plans for migrating to alternative fuels and powertrains include implementing vehicles that run on renewable biofuels, increasing the use of 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

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Advanced Clean Diesel

Ford Fiesta ECOnetic

Modern diesels are 30 to 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
Begin migration to advanced technology	Full implementation of known technology	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 new Focus ECOnetic has fuel economy of 3.4L/100km and emits just 89 g/km of CO_2. This vehicle is powered by a 1.6L Duratorq TDCi that includes more efficient eight-hole fuel-injector nozzles, a more powerful engine-control unit and a water-cooled charge air cooler. In addition, parasitic losses have been cut through use of low-friction piston ring coatings, a variable flow oil pump and a more-efficient vacuum pump. After-treatment system improvements include a coated diesel particulate (soot) filter coupled with a lean NOx trap to enable Euro 5 emissions compliance.

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. Ford has also announced plans for a diesel engine offering in the Transit van for North America.

These new diesel engines also meet 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 Ford 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.

Ford was an early industry leader in developing diesel engine after-treatment systems. We have been granted more than 100 patents for these advancements.

The 6.7L Power Stroke uses 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. In Europe, our vehicles are compatible with B7, 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)

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Hybrid Electric Vehicles (HEVs)
Ford Fusion

Hybrid electric vehicles are powered by a traditional internal combustion engine and battery power to deliver improved fuel economy. By the end of 2012, Ford will be North America's largest maker of hybrid transmissions.

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

Hybrid Electric Vehicles (HEVs)

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, which offered class-leading fuel efficiency. In 2010, we launched the Lincoln MKZ Hybrid, which was the most fuel-efficient luxury sedan in America at the time it launched. Unique among hybrid vehicles, it is available for the same manufacturer suggested retail price (MSRP) as the gas model MKZ.

All of our hybrid vehicles use Ford's powersplit architecture, 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, and preparing for hybrid capability across our highest-volume global product platforms.

The newly redesigned Ford Fusion, launching in 2012, is the first sedan to offer gasoline, hybrid and plug-in hybrid powertrains, underscoring Ford's commitment to giving customers the power of choice in fuel-efficient technologies. Each model is expected to have unsurpassed fuel economy in its respective segment. The all-new Fusion was named Best in Show at the 2012 North American International Auto Show, a rare honor for a mid-sized sedan. The new Fusion Hybrid will feature an all-new 2.0L Atkinson-cycle four-cylinder gasoline engine, which is significantly downsized from the previous 2.5L unit while maintaining performance standards. This innovative powertrain is anticipated to deliver best-in-class fuel economy of at least 47 mpg in city driving and 44 mpg on the highway. The Fusion Hybrid continues to innovate and evolve with all-new lithium-ion batteries that save weight and generate more power than the previous nickel-metal-hydride batteries, while raising the vehicle's maximum speed under electric-only power from 47 mph to 62 mph.

In 2012, Ford will also introduce a hybrid version of the Ford C-MAX multi-activity vehicle in the U.S. 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) and the C-MAX Energi (a plug-in hybrid, or PHEV).

The C-MAX Hybrid will use the Company's powersplit hybrid architecture, with improved fuel efficiency and a lighter, smaller lithium-ion battery system. Some key advancements of this technology include:

- Electric motors capable of operating at higher electric speeds
- Optimized gear ratios, allowing for improvements in fuel economy
- More precise controls to deliver higher levels of refinement as the powertrain transitions between engine and electric drive
- Reduced weight to help increase fuel economy

With the launch of the C-MAX Hybrid and C-Max Energi, Ford becomes North America's largest maker of hybrid transmissions.

Our next-generation hybrids will also have a suite of driver information systems to help drivers maximize fuel efficiency. This includes an updated version of the SmartGauge™ with EcoGuide instrument cluster that coaches hybrid drivers to maximize fuel efficiency, along with 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.

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Battery Electric Vehicles (BEVs)

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Battery Electric Vehicles (BEVs)
Ford Focus Electric

Battery electric vehicles use no gasoline; they are powered by a high-voltage electric motor and battery pack. In 2011, Ford introduced the Focus Electric, with a U.S. Environmental Protection Agency (EPA) combined fuel economy rating of 105 miles per gallon equivalent (MPGe), driving range of 76 miles on a charge and an approximately four-hour recharge time, which is half the charge time of our competitors' BEVs with comparably sized batteries.

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

Battery Electric Vehicles (BEVs)

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.

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. 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.

At the end of 2011 we launched an all-electric passenger sedan, the Ford Focus Electric, based on the all-new Focus. This car has a driving range of 76 miles on a single charge of its lithium-ion high-voltage battery and achieves an EPA-rated combined fuel efficiency of 105 MPGe. We will initially introduce the Focus Electric in 19 U.S. metropolitan areas. We will be ready to expand to new markets and ramp up to higher volumes as the infrastructure develops and customer demand grows.

The Focus Electric, as well as Ford's other forthcoming 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.

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' BEVs with comparably sized batteries.

The Focus Electric will include an enhanced version of MyFord Touch® – Ford's new driver interface technology – which 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.

Ford will launch the Ford Focus Electric in Europe in late 2012.

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 other global markets.

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Plug-in Hybrid Electric Vehicles (PHEVs)

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FCVs

Plug-in Hybrid Electric Vehicles (PHEVs)

Ford Escape

Plug-in hybrid electric vehicles are powered by an internal combustion engine and a high-voltage electric battery that can be charged from an electric outlet. The engine and the battery work together to provide the benefits of grid-connected power and hybrid powertrain efficiency. Ford will introduce its first commercially available PHEV, the C-MAX Energi, in the U.S. in 2012.

2007	2011	2020 – 2030
Begin migration to advanced technology	Full implementation of known technology	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. 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 usage characteristics of the vehicle. PHEVs can 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 long-term success of PHEVs in the real world depends on cooperation between automakers, utilities, the government and drivers. Therefore, Ford is working with a number of partners – including technology partners, the utility industry and the U.S. Department of Energy (DOE) – to help support a smooth transition to electrified vehicles. In 2007, Ford began a collaborative project with Southern California Edison to advance the commercialization of PHEVs. Ford expanded this program in 2008 to the DOE and other utility 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 21 vehicles with the DOE and its utility partners, and Ford's engineering teams continued to collect in-field vehicle performance data. To date, the fleet has successfully logged more than 650,000 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 PHEV research vehicles used in this project have two distinct operational modes: charge depleting and charge sustaining. In charge-depleting 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. This usually translates into full-electric operation when the vehicle is traveling less than roughly 40 mph, depending on driver behavior such as acceleration and heating and air conditioning usage. 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-depleting mode, the battery still provides the vast majority of the power required to propel the vehicle.

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 through regenerative braking and discharged during acceleration events to improve the overall fuel economy of the vehicle – similar to the operation of today's conventional hybrids.

Overall, plug-in hybrid vehicles offer several benefits, including:

- Reduced dependency on petroleum and increased energy independence
- Reduced environmental impact through reductions in greenhouse gas emissions
- Increased use of electricity from renewable energy sources (e.g., wind and solar) for vehicle recharging
- Potential consumer cost savings on energy/fuel costs
- The extra benefit of being able to charge your batteries at home or other parking location. This means that PHEVs might better suit those customers who do the majority of their driving in city and other urban environments where electric battery power is the preferred powertrain alternative

In 2012 in the U.S., we will 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 is expected to deliver a better fuel-economy equivalent in electric mode than the Toyota Prius plug-in hybrid, plus a 500-mile overall driving range – more than the Chevrolet Volt.

In January 2012 we announced plans to introduce the Ford Fusion Energi, a plug-in hybrid version of our all-new Fusion, which will be available in the U.S. It is expected to deliver 100-plus MPGe. The Fusion Energi is planned to be available in showrooms in North America in early 2013.

Like Ford's HEVs, the C-MAX Energi and Fusion Energi will include the SmartGauge® with EcoGuide instrument cluster, which coaches drivers to maximize fuel efficiency, and an enhanced version of the MyFord Touch® driver interface that can be configured to show different levels of information, including fuel and battery power levels and average and instantaneous miles per gallon.

Renewable Biofueled Vehicles

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Renewable Biofueled Vehicles
Ford Galaxy

Biofuels offer a relatively affordable way to reduce carbon dioxide (CO_2) emissions. To date, we have introduced more than 5.5 million flexible-fuel vehicles globally. Ford is a market leader and pioneer in ethanol-powered, flexible-fuel vehicles and will continue to provide a range of products that are E85-capable, aligned with infrastructure growth and consumer demand.

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

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 (FFV) 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 CO_2 emission-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 rating 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 a current level of approximately 2–3 percent globally to 10–30 percent of global liquid road 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) 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 primarily used in blends with gasoline. (Hydrous ethanol is also used in Brazil; it is mixed with little or no 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 rating, which can improve the efficiency and torque of today's high-efficiency internal combustion gas engines. We are developing a new fundamental molecular approach to calculating the octane increase provided by ethanol blended into gasoline that is more accurate than previous approaches.[12] The octane rating 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 rating 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 rating 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 blends above E10 also may damage engines that are not designed to operate on higher concentrations of ethanol; this poses a particular concern for older vehicles. Appropriate planning and coordination between stakeholders is needed to manage transition issues such as these. 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 that is made from the transesterification of vegetable oils, 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." In Europe all of our new diesel vehicles can run on B7, a blend containing 7 percent biodiesel. We have worked with fuel standards organizations to allow the use of biodiesel blends of greater than B7 in our future products. In the U.S., our 2012 F-Series Super Duty® trucks with a 6.7L diesel engine are compatible with B20. In addition, the gasoline version of these vehicles will be flex-fuel 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 FFVs capable of running on gasoline or E85 ethanol (or E100 hydrous ethanol in Brazil). 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 FFVs globally. Ford FFV models are available in many European markets.

E15 in the United States

Over the last year, the U.S. 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 in the U.S. 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, or 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 goal is to ensure that the current and future fuel supply in the U.S. will enable our vehicles to operate properly without creating problems for our customers. We will continue to work with our customers and dealerships in an effort to prevent or mitigate any such problems.

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 a higher octane rating than the base gasoline. 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 a vehicle's 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.[3] 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 made compatible with fuel containing higher concentrations of ethanol. For any of these approaches to be successful, the new fuels will have to provide enough value to the consumer to attract 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

More widespread use of biofuels would increase their benefits for reducing GHG emissions and improving energy security. 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. This trails the availability of E85 vehicles in the marketplace. Approximately 4 percent of the U.S. light-duty vehicle fleet are FFVs, a figure that is increasing because FFVs now account for more than 15 percent of all new light-duty vehicles being produced. 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 atmospheric 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 their full theoretical potential.

Challenges relating to today's biofuels include the following:

Energy Density

The energy density of ethanol is approximately two-thirds that of gasoline.[4] 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 some of the lost energy content. In 2012 Ford researchers published an assessment that quantifies the potential benefits of high-octane ethanol gasoline blends.[5] Biodiesel has approximately the same energy density as conventional petroleum-based diesel.

Lifecycle Greenhouse Gas Emissions

The plants used to produce biofuel feedstocks capture CO_2 during their growth, and this is released when the biofuel is 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, emissions of nitrous oxide (N_2O), another GHG resulting from biofuel feedstock 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 using E85 with ethanol from corn results in approximately 20 to 30 percent fewer lifecycle GHG emissions than gasoline, on an energy-equivalent basis. 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.[6]

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 1990, the production of ethanol in the U.S. consumed approximately 3 percent of the corn harvest, but in 2010 that figure was 37 percent. Ethanol production removes only the starch from the corn kernel – the remaining portion is a highly valued feed product (called distillers grains) and a good source of protein and energy 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. The increase in corn used for ethanol production in the U.S. over the past 10–15 years has been essentially matched by the increased harvest over the same period. The increased harvest has been driven mainly by improved yield per acre and, to a lesser extent, by increased acreage. 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.

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 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)

IN THIS SECTION


Advanced Clean Diesel


HEVs


BEVs


PHEVs


Renewable Biofueled Vehicles


FCVs

Hydrogen Fuel Cell Vehicles (FCVs)

Ford Focus

Hydrogen fuel cell vehicles are electric vehicles powered by hydrogen fuel cells. The fuel cells are essentially batteries fueled by hydrogen. They emit just water vapor and heat, without other tailpipe pollutants. Ford began testing a fleet of 30 Focus FCVs in real-world driving conditions with customers around the world in 2005. We are continuing laboratory-based research and developing the technologies necessary to commercialize FCVs.

2007	2011	2020 – 2030
Begin migration to advanced technology	Full implementation of known technology	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 and refueled in minutes, while BEVs are powered by electric energy stored in the high-voltage battery. As a result, FCVs provide the environmental benefits of a BEV but they have a longer driving range and significantly shorter refueling time.

In an FCV, an automotive fuel cell propulsion system runs the vehicle by converting hydrogen and oxygen into electrical current through an electro-chemical reaction in the fuel cell stack. It emits just water vapor and heat, 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 propulsion system. In fact, all of our efforts to improve high-voltage electronics, electric motors, regenerative braking and 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 2005, 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 2005 to 2009, Ford participated in a technology demonstration program partially funded by the U.S. Department of Energy (DOE), as well as other government supported demonstration programs in Canada and Europe. A total of 30 Ford Focus FCVs were in operation in these programs. These vehicles were tested to demonstrate technical feasibility, performance 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 have been critical to the further development of Ford's fuel cell technology. Based on the knowledge gained in this first generation of fuel cell technology, we have completed development and laboratory validation of additional generations of fuel cell technologies. These later generation technologies improve 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 internal 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 for reinforcement such as carbon fiber. 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.

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CLIMATE CHANGE AND THE ENVIRONMENT

Design for Lifecycle Sustainability

Climate Change

Greening Our Products

- Sustainable Technologies and Alternative Fuels Plan
- Non-CO_2 Tailpipe Emissions
- Sustainable Materials
- Electrification: A Closer Look

Greening Our Operations

Data

Voice: Dr. Rajendra K. Pachauri

Non-CO_2 Tailpipe Emissions

Smog-forming vehicle emissions result from the incomplete combustion of fuels, impurities in fuels and the high-temperature oxidation of atmospheric nitrogen during the fuel-combustion process. Regulated smog-forming tailpipe emissions include hydrocarbons, nitrogen oxides, carbon monoxide and particulate matter. These emissions are regulated in the U.S. by the U.S. Environmental Protection Agency (EPA) under the Clean Air Act as well as by the California Air Resources Board (CARB).

Related Links

Vehicle Websites

- Ford Escape
- Ford Focus
- Ford Fusion
- Lincoln MKZ

External Websites

- EPA's Green Vehicle Guide

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U.S.

As of 2010, all of Ford's U.S. vehicles have been certified to the EPA's Tier 2 regulations, a comprehensive and challenging set of vehicle emissions requirements.

The Tier 2 program began with the 2004 model year. It coordinates the introduction of cleaner fuels with more-stringent vehicle tailpipe emissions standards to achieve near-zero non-carbon dioxide (CO_2) tailpipe emissions from cars and light trucks. These regulations significantly reduce targeted vehicle emissions, including nitrogen oxides and non-methane organic gases, to help reduce the formation of ozone and particulate matter. The Tier 2 regulations apply to all passenger cars, light trucks and medium-duty passenger vehicles. Ford completed implementing Tier 2 emissions requirements on all relevant vehicles in the 2009 model year.

The EPA estimates that this program has resulted in reductions in oxides of nitrogen emissions (from all relevant mobile sources) by at least 1.2 million tons as of 2010.

For the California market, Ford is required to meet the state's stringent Low Emission Vehicle II (LEVII) emissions requirements for light-duty vehicles. Under the LEVII program, manufacturers are effectively required to produce a number of Partial Zero Emission Vehicles (PZEVs). A PZEV is a vehicle certified to near-zero emissions standards. Strictly speaking, PZEV vehicles are required to:

- meet California's Super Ultra-Low Emission Vehicle (SULEVII) exhaust emissions standard,
- produce zero fuel system evaporative emissions, and
- be emissions compliant for a full useful life of 150,000 miles.

For the 2011 model year, we offered a PZEV version of the Ford Focus. The hybrid versions of the 2011 Ford Fusion and Lincoln MKZ also met the PZEV requirements. For the 2012 model year, Ford is offering the Focus PZEV and hybrid PZEV versions of the Ford Fusion, Lincoln MKZ and Ford Escape.

Both the EPA and CARB are in the process of developing the next generation of emissions standards (Tier 3 and LEV III, respectively). CARB is also in the process of revising its future Zero Emission Vehicle regulations.

We are working with the agencies through their regulatory processes to help develop rules that are both effective and feasible. In setting tailpipe emission regulations, other vehicle rules – such as fuel economy/greenhouse gas standards and safety standards – must be taken into account to ensure that the total package of requirements is workable.

Ford continues to oppose technology mandates that seek to impose quotas or limits on the production or sale of vehicles with specified powertrain technologies. Regulatory efforts to dictate market outcomes, or to pick technology “winners” and “losers,” have never produced successful outcomes. Manufacturers need the flexibility to build the kinds of vehicles that the marketplace demands based on consumer preferences and other external factors. Emissions standards should be performance-based and should be designed to enable manufacturers to introduce vehicles with an array of different technologies.

Information about the emissions performance of all Ford vehicles sold in the U.S. can be found at the EPA’s Green Vehicles site.

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Europe

Since 1990, we have decreased the non-CO_2 tailpipe emissions from our vehicles sold in Europe by up to 90 percent through the development of a new generation of downsized, high-efficiency gasoline- and diesel-powered vehicles with improved engine technologies and high-tech exhaust gas treatment devices. As part of these emissions-reduction efforts, all of our diesel engines are now fitted with a maintenance-free diesel particulate filter system that requires no additives for filter regeneration.

Further air-quality improvements have been generated as we have introduced vehicles equipped with technology to meet the more-stringent Euro 5 emissions standards. In 2010, Ford introduced the 1.6L and 2.0L GTDI Ecoboost® engines in Europe. In 2012, we expanded our EcoBoost offerings to include a new 3-cylinder 1.0L EcoBoost engine. These are among the most technologically advanced engines in production, combining high-pressure direct injection, a low-inertia turbo and twin independent variable cam timing. They join our lineup of high-efficiency common rail diesel engines all complying with Euro 5 emissions levels. In 2012 Ford also launched a new version of the 1.6L Ford Duratorq® TDCi engine, featuring the first lean NOx adsorbing technology in a Ford diesel, as well as a completely redesigned common rail injection system to deliver more precise control and increased combustion efficiency. All of our new passenger cars registered as of January 1, 2011, and all light-duty vehicles registered as of January 1, 2012, comply with the Euro 5 standard.

Euro 6 standards have been developed and will be applied beginning in September 2014. New test procedures on real-world driving are also under development by the European Commission and are intended to be finalized during 2013 for use during the implementation of the Euro 6 standard. These new emissions-testing requirements are focused primarily on delivering reduced tailpipe NOx emissions. The European Commission is also developing rules for increasing the severity of the low-temperature testing and evaporative emission requirements again. This rulemaking should be finalized during 2013. We are actively engaged with the European Commission and the European member states in developing better regulation.

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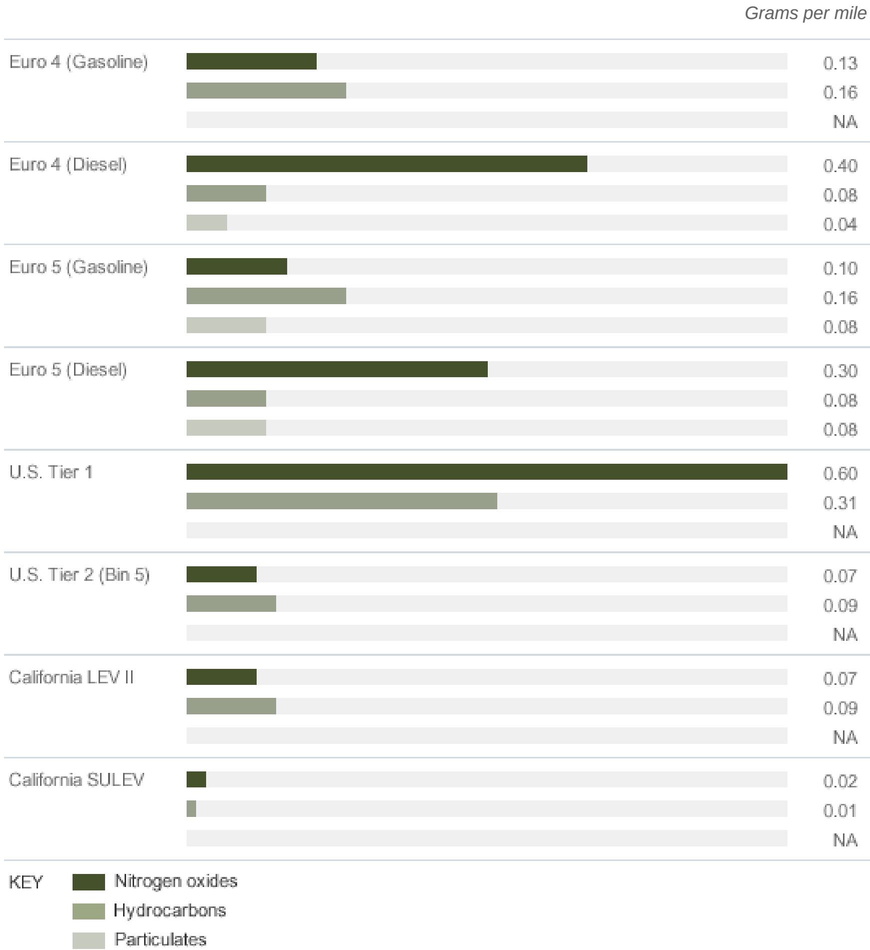
Emissions Regulations in the U.S. and Europe



	Nitrogen oxides	Hydrocarbons	Particulates
Euro 4 (Gasoline)	0.13	0.16	NA
Euro 4 (Diesel)	0.40	0.08	0.04
Euro 5 (Gasoline)	0.10	0.16	0.08
Euro 5 (Diesel)	0.30	0.08	0.08
U.S. Tier 1	0.60	0.31	NA
U.S. Tier 2 (Bin 5)	0.07	0.09	NA
California LEV II	0.07	0.09	NA
California SULEV	0.02	0.01	NA

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Asia Pacific and Africa

Since 2010, our new gasoline-fueled passenger vehicles have been designed to comply with China Stage IV requirements (based on Euro 4 standards). China plans to implement the most recent European standards (Euro 5) starting in 2012 in large cities. Korea and Taiwan have adopted very stringent U.S.-based standards for gasoline vehicles and European-based standards for diesel vehicles. Japan, which has unique standards and test procedures, began implementing more-stringent standards in 2009. Ford is working to comply with all of these standards using a variety of approaches, including on-board diagnostics and after-treatment technologies.

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South America

New passenger and commercial vehicles in South America must comply with varying levels of U.S.- or European-based emissions regulations. Argentina, Brazil and Chile are leading the adoption of more-stringent standards for light- and heavy-duty vehicles, being phased in between 2011 and 2015.

As a consequence, the following non-CO_2 emissions-control technologies have been or will be introduced on our vehicles sold in South America: on-board diagnostic systems in Brazil and Argentina (which are being studied in Chile); particulate filter technology for some diesel products; and selective catalytic reduction systems for heavy diesels in these three countries.

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CLIMATE CHANGE AND THE ENVIRONMENT

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Sustainable Materials

Materials are an important element of a vehicle's lifecycle sustainability. Choices about materials can influence the safety, fuel economy and performance of the vehicle itself, as well as the ability to recycle or reuse the vehicle's components at the end of its life. Material choices can also have implications throughout our value chain. A material can be more or less sustainable based on a number of factors, including its origin (virgin, renewable or recycled), the resources and manufacturing methods used, the emissions produced throughout its lifecycle, and its application.

Ford has been working for many years to increase the use of recycled and renewable materials and reduce the use of undesirable materials. Vehicles in North America typically are composed of 20 to 25 percent post-consumer recycled material by weight, primarily due to the extensive use of metals with recycled content (see What is in a Vehicle? for detail). Therefore, Ford has concentrated its efforts on developing new uses for recycled materials in the nonmetallic portions of the vehicle, which are typically composed of virgin materials. While the amount of recycled content in each vehicle varies, we are continuously increasing the amount of recycled material used in each vehicle line and have implemented a number of innovative uses of sustainable materials (see Choosing More Sustainable Materials). As described in the section on Design for Lifecycle Sustainability, we use tools such as Design for Sustainability, lifecycle assessment and lifecycle costing to help us make beneficial materials choices.

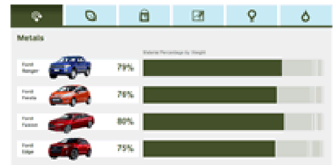
For many years, Ford has had a Voluntary Recycled Content Usage Policy in North America, which sets goals for the use of nonmetallic recycled content for each vehicle and increases those targets year by year and model by model. Under this program, recycled materials are selected for all of our vehicles whenever technically and economically feasible. We are now developing sustainable materials requirements for new vehicle programs and significantly refreshed vehicle lines to increase the recycled and renewable content, and we are developing specific, numerical, model-over-model improvement targets.

We are also continuing to migrate successful applications of recycled and renewable content across more vehicles for increased environmental benefit. We are focusing on materials technologies that improve environmental and social performance and reduce costs and weight. To facilitate this, we are working with our commodity business planners, materials purchasers and materials engineers to develop a comprehensive list of cost-effective sustainable materials that can be implemented across multiple parts and vehicle lines. All recycled and renewable materials on this list are evaluated versus comparable virgin grades, to guarantee appropriate physical properties and the same level of component performance that would be obtained with virgin materials. By combining sustainable materials goals for updated or redesigned vehicles with sustainable materials identification and testing processes, we are standardizing and broadening the use of sustainable materials in our vehicles.

As we introduce sustainable materials, we are conscious that recycled materials are not always the preferable solution. For example, we take into consideration whether recycled materials may increase weight or have significant energy demand in collection or recycling. We also consider the availability of a local recycled material feedstock versus the need for a global commonality of materials. Our global materials strategy has dramatically reduced the number of materials we specify and use, to enable quality and cost reductions. In some cases, the introduction of recycled and renewable materials will run counter to that commonization progress, since the feedstocks for these materials can vary by region. For example, it is often more efficient to use local waste materials that divert waste from local landfills, than to ship waste material inputs across the globe. We are working to ensure that we use local materials as a feedstock for our recycled content materials.

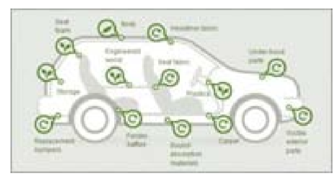
Developing and Implementing Our Sustainable Materials Strategy

What is in a Vehicle?



Discover the kinds of materials that are in our vehicles.

Choosing More Sustainable Materials



Explore the sustainable materials we use in our vehicles.

Related Links

This Report

- Design for Lifecycle Sustainability
- Materials Management

As our approach to sustainable materials continues to evolve, we are developing and implementing an integrated sustainable materials strategy. Progress on this effort includes the following:

Building on our process for Restricted Substance Management: For many years, Ford has had a Restricted Substance Management Standard (RSMS), which was developed to reduce and eliminate the use of substances of concern from our vehicles and plants. The first of its kind in the industry, this standard was originally developed to address both regulated substances and materials Ford voluntarily chose to eliminate from our vehicles and plants. The RSMS system is embedded in Ford's Global Product Development System, our company-wide vehicle design and production system. We are using the same RSMS process to manage recycled and renewable materials targets and requirements in our product development system.

Developing guiding principles for incorporating recycled and renewable materials in our vehicles: We have formed a cross-functional and globally integrated sustainable materials council to guide sustainable materials strategy for the Company. This informal team has developed a set of guiding principles to help us think through materials choices. These principles, listed below, reflect our collective thinking on the most effective ways to increase the use of recycled and renewable materials in our vehicles:

- Recycled and renewable materials will be selected whenever technically and economically feasible.
- Recycled and renewable content will be increased year over year, model by model, consistent with EU 2003 End Of Vehicle Life Regulations.
- Product quality, durability, weight, performance (material specification and/or part design verification) and economics will not be adversely impacted by the use of recycled and renewable content materials.
- Tools and enablers will be provided to select, specify, track and validate the use of recycled and renewable materials.
- Recommended recycled and renewable materials will have a known and documented "positive lifecycle" impact.
- Recycled materials will be used in the market of origin, to minimize the carbon footprint.
- Renewable content sourcing shall not compete with the food supply. Sustainable supply must be ensured (in terms of stable supply *and* sustainable growing).

Integrating recycled and renewable materials into the official strategies that govern materials and commodities purchasing: We are developing global materials specifications, which will facilitate the incorporation of sustainable materials where they meet performance requirements. Such specifications will also ensure that the benefits of more sustainable materials will have a global impact. So, for example, recycled material specifications will be included in the same documents that specify virgin materials. This will simplify the monitoring of recycled content use in our vehicles and will ensure that component engineers and Tier 1 suppliers are confident in the performance of the recycled material, by means of a direct comparison with an equivalent virgin material.

Many commodity purchasing plans already list recycled-content materials as a preferred material option, including those for battery trays, battery shields and wheel arch liners. In addition, we developed a comprehensive resin strategy that requires the use of recycled plastics for underbody and aerodynamic shields, fender liners, splash shields, stone pecking cuffs and radiator air deflector shields manufactured in North America.

We have also developed a material specification that defines *post-consumer*, *post-industrial* and *depolymerized recycled content* and ensures that the use of in-house scrap is not counted toward recycling targets. We have a material specification for recycled content textiles and are working on specifications for renewable materials. These specifications make it easier for vehicle engineers to choose sustainable material options.

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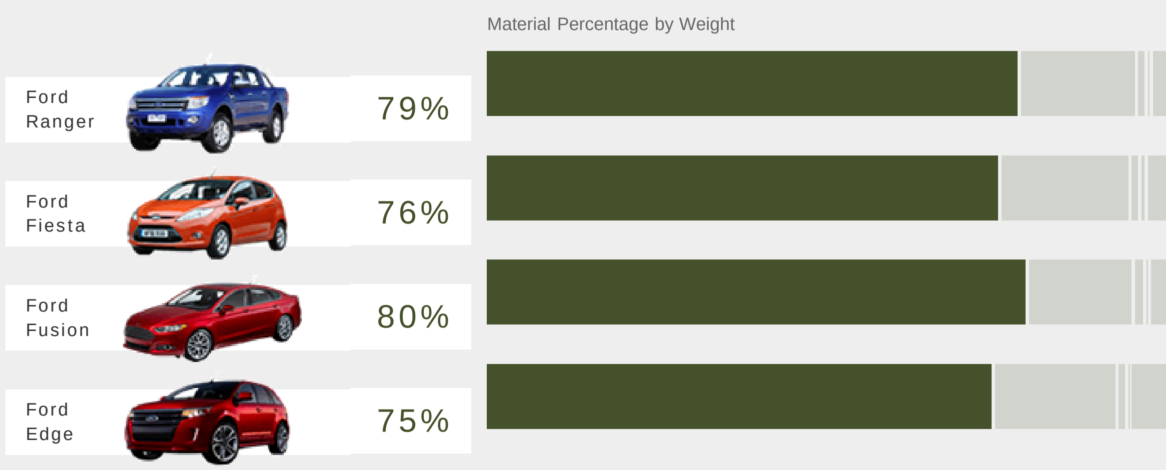
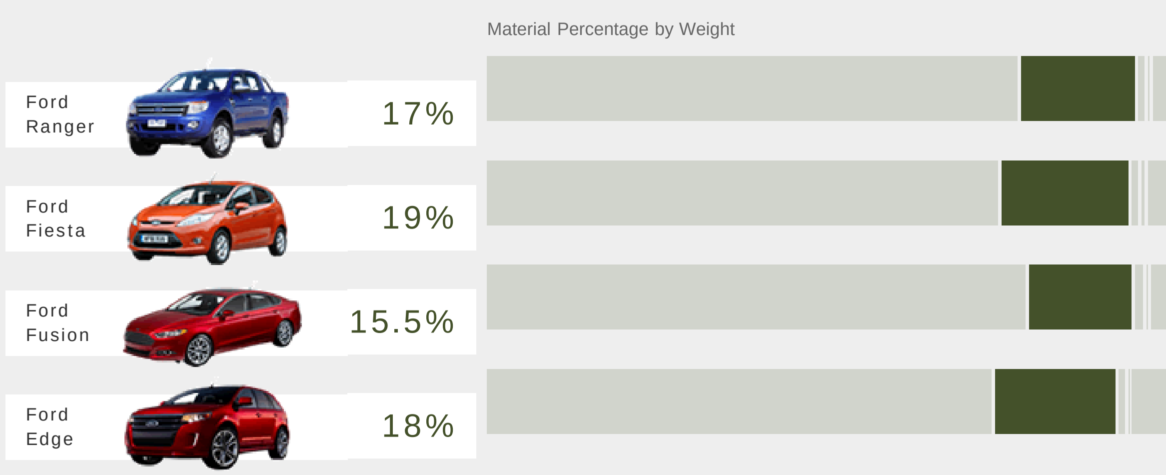
What is in a Vehicle?

To understand our approach to sustainable materials, it is useful to understand the kinds and amounts of materials that are in our vehicles. The following graphics show the amounts of materials in several samples of our vehicles – specifically, the percentage of total weight of major material categories for each. Then, for each material category, we provide some facts about our sustainable material strategy.

Metals

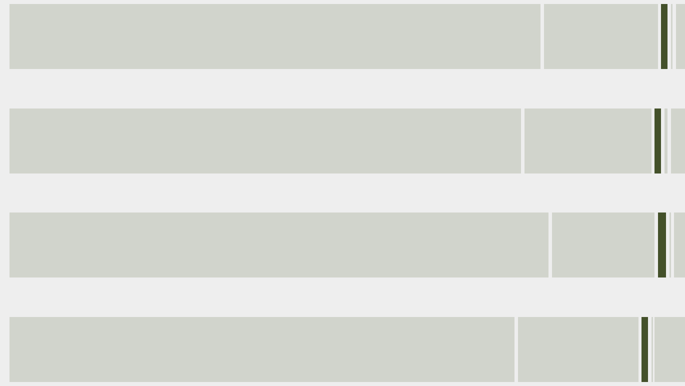


Plastics, Textiles, and Natural Materials



Non-Dimensional Materials

Material Percentage by Weight



Ford Ranger  1%

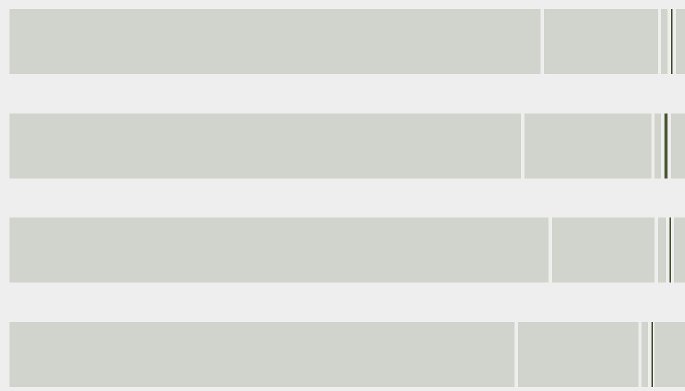
Ford Fiesta  1%

Ford Fusion  1.3%

Ford Edge  1%

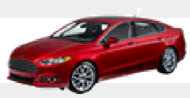
Electronics

Material Percentage by Weight



Ford Ranger  0.2%

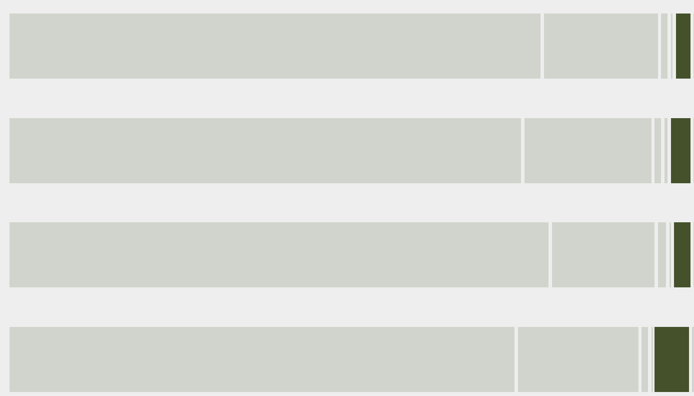
Ford Fiesta  0.5%

Ford Fusion  0.2%

Ford Edge  0.2%

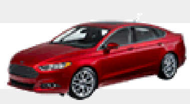
Ceramics, Glass and Other Compounds

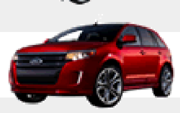
Material Percentage by Weight



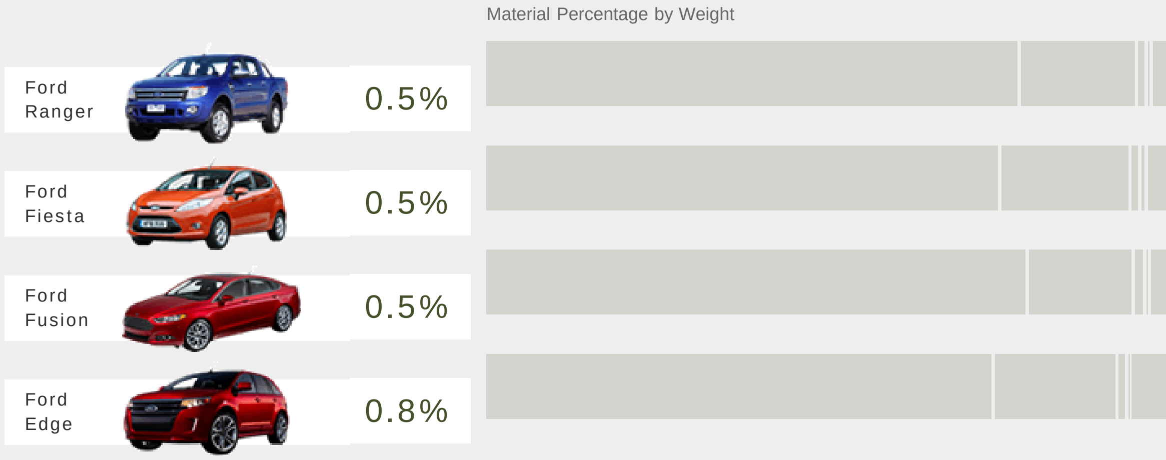
Ford Ranger  2.3%

Ford Fiesta  3%

Ford Fusion  2.5%

Ford Edge  5%

Fuels and Consumable Liquids



Metals

Most vehicles are made of at least 75 percent metals by weight – primarily steel and iron. The other metals in a vehicle include aluminum, magnesium, titanium and other lightweight metals. We are working to increase the use of these metals, because they lower the total weight of the vehicle and therefore improve vehicle fuel economy. However, we have to balance the light weight of these materials with their relatively higher costs and energy intensity to manufacture. (For more information, see the Lightweight Materials section.) Because all metals are routinely recycled at the end of a vehicle's useful life, we focus most of our sustainable materials efforts on nonmetallic parts.

Plastics, Textiles, and Natural Materials

These materials are the primary focus of our sustainable materials efforts. Though they make up a much smaller percentage by weight of the average vehicle than metals, they are the second-largest category in most vehicles. They are also less financially viable to recycle at the end of a vehicle's life, and therefore much less frequently recycled. This makes it important to get more recycled and renewable materials into this material category. We are using a wide range of recycled-content plastics and renewable, plant-based materials in our vehicles. (For more information, see Choosing More Sustainable Materials.)

Non-Dimensional Materials

These are materials such as paint, adhesives and sealants that have no shape or "dimension" before they are incorporated into a vehicle. Many non-dimensionals have been a traditional source of volatile organic compound (VOC) emissions during the vehicle manufacturing process. We are taking steps to replace VOC-emitting materials with alternatives or change our processing to reduce or recapture VOC emissions. (For more information, see Non-CO_2 Facilities-Related Emissions.)

Electronics, Ceramics, Glass and Other Compounds

Ford has been working with our suppliers, dealers, dismantlers and industry associations (such as the USCAR Vehicle Recycling Partnership) to develop, share and implement best practices to deal with these categories of materials, which are a small percentage of any given vehicle by weight but are hard to recycle at the end of the vehicle's life. Dealers and dismantlers are encouraged to reuse or recycle these materials whenever it is technically and economically feasible, to help divert them from landfills. Ford seeks to keep these materials to less than 5 percent of our vehicles, to maintain an overall vehicle recoverability rating of 95 percent.

Fuels and Consumable Liquids

These materials include the gasoline in the tank, engine oil, lubricants and other liquids. They are generally removed at dismantlers and recycled/reused where possible.

Choosing More Sustainable Materials

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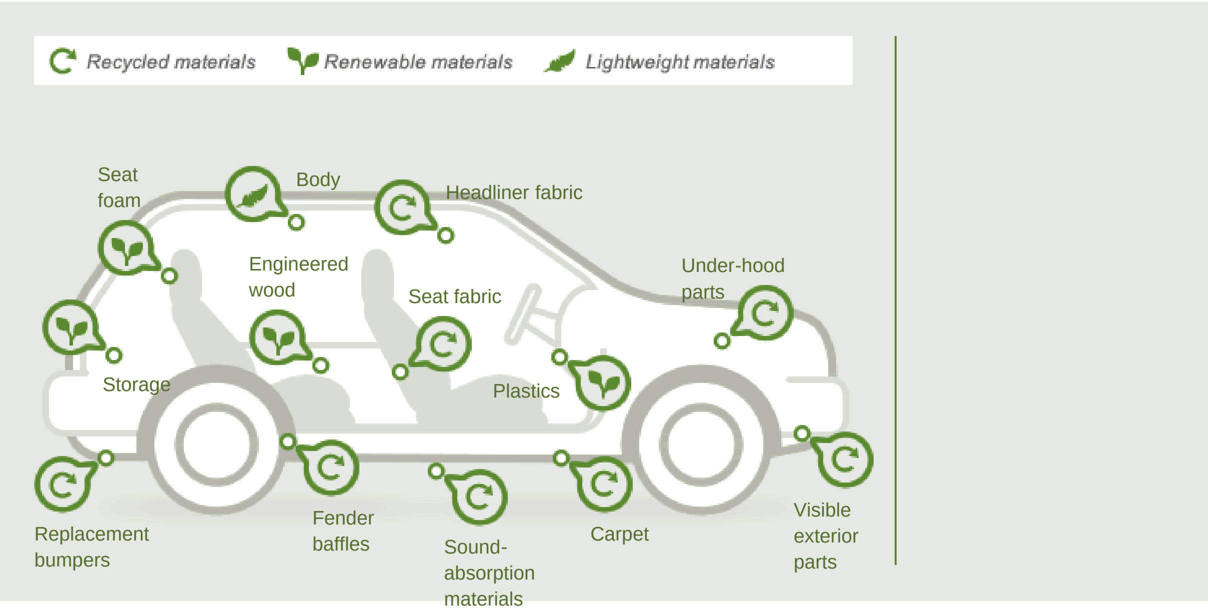

Click on the vehicle parts to the left to read more about sustainable materials we're using in our vehicles.

Carpet

Recycled-content carpets are used on many vehicles including the U.S. and European Ford Focus, the 2011 Explorer and the 2013 Escape.

Replacement bumpers

Many European vehicles use recycled plastic replacement bumpers when original bumpers are damaged.

Seat fabric

Seat fabrics in versions of the Ford Fiesta, Taurus, Mustang, Focus, F-150, Super Duty, Fusion and Escape Hybrid contain 25–100 percent recycled content.

Seat foam

Soy foam

Starting in 2011, all vehicles manufactured in North America use seat foam made with soy oil, which reduces CO_2 emissions and decreases dependency on petroleum oil.

Body

High-Strength Steels

Many vehicles – including the all-new Ford Fusion, the Explorer and the European Fiesta – use high-strength steels, which weigh less than traditional steels but have the same or better performance.

Aluminum and Magnesium

Many vehicles – including the Lincoln MKT and Ford Kuga – use aluminum and magnesium parts, which are lighter weight than traditional steel.

Headliner fabric

In North America, the 2011 Ford Fiesta, Econoline and F-250 use 50–75 percent recycled content in the headliner fabric.

Under-hood parts

Recycled plastics and nylon are used in non-surface parts on many vehicles including fan shrouds, battery trays, heater/air conditioning housing, wheel arch liners, engine fans and covers, and underbody systems.

Visible exterior parts

The 2011 Super Duty® uses recycled-content plastics on a range of parts, including the bumper valences, license place brackets and fog lamp bezels.

Sound-absorption materials

Recycled denim scrap from apparel production is used in sound absorption materials on many vehicles, including the 2012 Ford Focus.

Fender baffles

This noise-dampening part on the 2011 Ford Explorer is made of recycled steel from F-150 door panels, thereby reducing manufacturing-related CO_2 emissions.

Storage

Wheat-straw-reinforced plastics

Injection-molded plastics reinforced with renewable wheat straw were implemented in the third-row storage bins on the 2010 Ford Flex. Wheat straw is a byproduct of growing wheat, and is commonly burned. Using this material as a reinforcement in plastics thus has environmental benefits.

Engineered wood

The Lincoln Navigator, MKX and MKS use engineered wood from certified, sustainably managed forests, which reduce input materials and waste sent to landfill.

Plastics

Natural-fiber-reinforced compression molded plastics

Multiple European vehicles use compression-molded plastics. These vehicles include the Ford Mondeo, which uses plastics made with 50 percent kenaf and 50 percent polypropylene. In North America, a kenaf-reinforced armrest is used on the 2012 Ford Escape and a coconut fiber trunk liner is used on the 2012 Focus Electric.

We are working to improve the sustainability of our vehicles by using materials that are more sustainable from a total lifecycle perspective. This includes increasing the use of recycled, renewable, recyclable and lightweight materials. Recycled materials incorporate post-consumer and/or post-industrial waste materials; renewable materials are made from plant-based materials; and lightweight materials use special materials and/or designs that provide the same or better performance as other alternatives with less weight.

Recycled Materials

Our efforts to increase recycled materials focus on nonmetallic parts, which historically have had little or no recycled content. In 2009, we implemented a comprehensive recycled resin strategy. As part of that strategy, a wide range of parts on vehicles manufactured in North America are made out of plastics from post-consumer recycled waste, such as detergent bottles, tires and automotive battery casings. The vehicle parts containing recycled content include underbody and aerodynamic shields, fender liners, splash shields, stone pecking cuffs, battery housing covers and base plates, wheel arch liners, heating and ventilation components, fan shrouds and powertrain undershields. In 2010, we improved this strategy to include fabric rear-wheel liners that are produced from materials derived from 30 to 40 percent recycled content. These parts are 50 percent lighter than plastic wheel liners, and they absorb sound, which will enable improved noise vibration and harshness performance while potentially reducing the need for

Related Links

This Report

- Sustainable Technologies and Alternative Fuels Plan

Vehicle Websites

- Ford Escape
- Ford Explorer
- Ford Focus Electric
- Ford Fusion

sound-deadening insulators, sprays and foams. We continue to expand the use of recycled plastics into additional parts where they meet performance and cost requirements.

This recycled materials resin strategy saves money and reduces landfill waste. We estimate that Ford saves approximately $8 million per year and diverts approximately 50 million pounds of plastics from landfills each year (depending on vehicle production volume) by using these recycled materials.

We are also using post-consumer recycled nylon in many under-hood parts, including air cleaner housings, engine fans, fan shrouds, HVAC temperature valves, engine covers, cam covers and carbon canisters. We are using nylon resin made from recycled carpets for cylinder head covers in the Ford Escape, Fusion, Mustang and F-150. So far, we have recycled nearly 4.1 million pounds of carpet into cylinder head covers, the equivalent of a carpet the size of more than 150 football fields. Use of this recycled material has prevented the use of more than 430,000 gallons of oil.

In Europe, we strive to use recycled polymers in all of our vehicles, when such materials provide a more sustainable solution. In addition to recycled content in our new vehicle parts, we are also recycling damaged parts collected by dealers. In the U.K., we are recycling bumpers that have been damaged in accidents or replaced in service. Ford dealers collect the bumpers, which are recycled into new bumpers and other plastic parts. Previously, dealers had to pay to dispose of these bumpers as waste. Currently, dealers store them in a container that is collected by Ford for free. In 2009, more than 23,000 bumpers (equating to 70 metric tons of plastic) across the U.K. Ford dealer network were diverted from landfills through this program.

Across our global operations, we are also using recycled materials for interior parts. This can be much more challenging than using recycled materials for underbody, subsurface and exterior black parts, because it is a challenge to achieve the necessary appearance and performance using recycled materials. We are continuing to expand our use of recycled seat fabrics and seat components that meet all appearance and performance requirements.

In North America since the 2009 model year, the seat fabrics in most of our new or redesigned vehicles are made from at least 25 percent post-industrial or post-consumer recycled content. Thirty-seven different fabrics meeting the requirements have been developed and incorporated into Ford vehicles. In addition, many of our non-woven headliner fabrics now contain 50 to 75 percent recycled yarns, depending on the color.

On the Focus Electric, Ford will be the first automaker to use REPREVE – a hybrid fiber made from recycled plastic water bottles and post-industrial waste – for seating fabric. This means that each vehicle will have seat fabric made from approximately 22 plastic, 16-ounce water bottles. Ford is partnering with the yarn manufacturer, Unifi, to collect bottles at the North American International Autoshow in Detroit, the Consumer Electronics Show in Las Vegas, and other events throughout the year for use in the Focus Electric seat fabric.

The following table highlights some of the recycled-content interior materials in our recent vehicles:

Interior Recycled Materials Achievements

Vehicle	Material	Partner	Benefits
2013 Ford Escape	Carpet: 100 percent recycled content from post-consumer and post-industrial recycled yarns	Reiter	• Will use approximately 25 20-ounce plastic bottles for each Escape
	Seat fabric (XLS model): 27 percent post-industrial recycled yarns	JCI/Thierry	• Reduces waste, water and CO_2 emissions
2013 Ford Fusion S and SE series	Seat fabric bolster: 100 percent recycled content from post-consumer and post-industrial recycled yarns	Sage Automotive Interiors, Unifi	• Reduces consumer and industrial waste • Reduces depletion of natural resources • Reduces energy consumption
	Seat fabric insert: 37 percent recycled content from post-consumer and post-industrial recycled yarns		• Uses closed-loop system for recycling manufacturing waste
2013 Ford Fusion Hybrid and Sport Series	Seat fabric: 100 percent recycled content from post-consumer and post-industrial recycled yarns	Sage Automotive Interiors, Unifi	• Reduces consumer and industrial waste • Reduces depletion of natural resources • Reduces energy consumption • Uses closed-loop system for recycling manufacturing waste
2012 Ford Focus Electric	Seat fabric: 100 percent recycled content from post-consumer and	Unifi Sage	• Will use approximately 22 recycled plastic bottles in each vehicle

	post-industrial recycled yarns	Interiors Automotive	• Reduces consumer waste to landfill • Reduces depletion of natural resources
2011–12 Ford Fiesta – North America	Seat fabric: 25 percent post-consumer recycled yarns	Aunde	• Reduces consumer waste • Reduces depletion of natural resources
	Non-woven headliner: 75 percent post-consumer recycled yarns	Freudenberg	• Reduces consumer waste • Reduces depletion of natural resources
	Carpet: 100 percent recycled content from post-consumer and post-industrial recycled yarns	Peltzer	• Reduces waste, energy consumption and depletion of natural resources
2011–12 Ford Explorer	Seat fabric: 25–30 percent post-industrial recycled yarns	Aunde, Guilford, IAC	• Reduces waste, water and energy consumption and depletion of natural resources
	Carpet backing (base series): carpet insulation 40 percent post-industrial recycled yarns Carpet backing (Limited series): carpet insulation 25–28 percent post-industrial recycled yarns	IAC	• Reduces energy consumption by at least 20 percent • Reduces waste by at least 17 percent • Reduces CO_2 emissions by at least 14 percent • Reduces water use by at least 9 percent
2011 Ford Econoline	Headliner fabric: 50–75 percent post-consumer recycled content	Freudenberg	• Reduces consumer waste • Reduces depletion of natural resources
2011 Ford F-250	Headliner fabric: 50–75 percent post-consumer recycled content	Freudenberg	• Reduces consumer waste • Reduces depletion of natural resources
	Seat fabrics: 25 percent post-industrial recycled yarns	Sage Automotive Interiors, Guilford, Aunde	• Reduces waste • Reduces depletion of natural resources
2010–12 Ford Taurus SHO	Seat fabric insert: 100 percent post-consumer recycled yarns	Miko Fabrics	• Reduces waste • Reduces energy required for yarn manufacturing by 64 percent and manufacturing-related CO_2 emissions by 60 percent • Uses only neutral, nontoxic dyes and no harmful solvents in the fabric manufacturing process
2010–12 Ford Taurus SEL	Seat fabric insert: 25 percent post-industrial recycled yarns Seat bolster fabric: 30 percent post-industrial recycled yarns	Aunde	• Reduces waste • Reduces depletion of natural resources
2010–2014 Mustang Base Series	Seat fabric insert: 18 percent post-industrial recycled yarns Seat bolster fabric: 30 percent post-industrial recycled yarns	Sage Automotive Interiors Guilford	• Reduces waste • Reduces depletion of natural resources
2010 Ford F-150 XL, XLT and FX4	Seat fabrics: 25 percent post-industrial recycled yarns	Sage Automotive Interiors, Guilford, Aunde	• Reduces waste • Reduces depletion of natural resources
2010 European Ford Focus RS (fabric option)	Seat fabric insert: 100 percent post-consumer recycled content	Miko Fabrics	• Reduces waste • Reduces energy required for yarn manufacturing by 64 percent and manufacturing-related CO_2 emissions by 60 percent • Uses only neutral, nontoxic dyes and no harmful solvents in the fabric manufacturing process
2010–11 Ford Fusion and Mercury Milan Hybrids	Seat fabric: 85 percent post-industrial recycled yarns and 15 percent solution-dyed yarns	Sage Automotive Interiors	• Reduces energy use • Reduces CO_2 emissions • Reduces the use of dyes and chemicals • Reduces water use • Decreases the use of foreign oil

2008–2011 Ford Escape Hybrid	Seat fabrics: 100 percent post-industrial recycled yarns	Aunde, Interface	Reduces waste, water use and CO_2 emissions

We have also expanded the use of recycled materials in several visible exterior applications. For example, the 2011 Ford Super Duty® will use material derived from recycled battery casings on several aesthetic parts, such as license plate brackets, the 4x2's bumper valence panel and the fog lamp bezels. These parts are "molded in color" and color-matched to provide visual harmony. The Super Duty is also using post-industrial and post-consumer recycled plastic for its fascia lower valence. This plastic was a finalist for the 2009 Society of Plastics Engineers Innovation awards.

Recycled materials do not mean low-quality materials. Our researchers work to ensure that post-industrial and post-consumer recycled plastic materials have the same level of quality and same material specifications as the virgin material parts. In some cases, we are working to recycle the materials from our auto parts right back into the same use. For example, we are developing methods for recycling and cleaning post-industrial recycled fascia and bumper scrap so that it can be molded into new fascias and bumpers. We are even working to "upcycle" certain materials – that is, recycle it into uses with higher material and performance requirements than the virgin material. For example, we are working on upcycling post-consumer laundry and milk bottles into blow-molded automotive components. In addition, we are developing a method to recycle polyurethane foam scrap to make new polyurethane foam components instead of landfilling it at the end of its life.

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Renewable Materials

We are actively researching and developing renewable materials and applications that will reduce our dependence on petroleum and reduce our carbon footprint, while providing superior performance. Research scientists at Ford's Research and Innovation Center in the U.S., Ford's Research Center in Aachen, Germany, and Ford of Brazil are focused on developing automotive foams, plastics and composites that are derived from renewable resources.

Since 2002, our researchers have pioneered the research and development of soy-based polyurethane foams for automotive applications. The use of soy foam reduces CO_2 emissions, decreases dependency on oil and increases the utilization of renewable agricultural commodities. Soy foam also offers the potential for cost savings as well as insulation from petroleum product price swings.

Many technical difficulties had to be overcome to produce soy-based foams that met all of our stringent durability and performance specifications for seating. In 2007, Ford was the world's first automaker to implement this innovative technology (on the seat cushions and seat backs of the 2008 Ford Mustang), and we have since migrated its use to 23 vehicle programs. As of 2011, all Ford Motor Company vehicles built in North America have soy foam in their seat cushions and backs. In addition, 75 percent of headrests produced in North America have soy foam, and the headliner on the Ford Escape is made from sustainable bio-based foam.

Ford currently has soy foam seats in more than 5 million vehicles on the road, which reduces petroleum oil usage by more than 1 million pounds (or 31,500 barrels) annually. Lifecycle analyses that compare soy foams with traditional petroleum-based foams show a net decrease of 5.5 pounds of CO_2 per pound of soy oil used. Ford's use of soy foam reduces our annual CO_2 emissions by 20 million pounds – the annual equivalent of more than 1,500 typical American households. In addition, soy foam has up to 24 percent renewable content, and formulations can reduce volatile organic compound (VOC) emissions by 67 percent.

Ford and our supplier partner Recycled Polymeric Materials (RPM) launched new "green" seals and gaskets that incorporate both 17 percent bio-renewable soybean oils and 25 percent post-consumer, recycled tires. This material is currently used in 11 of our vehicle lines, including the Ford Escape, F-150, Focus, Mustang and Taurus. The seals also offer a weight savings, which improves fuel economy. In total, we have removed more than 1,675 tons of weight from our vehicles by using these new seals and gaskets. The use of post-consumer tires in these gaskets and seals also diverts 250,000 used tires from landfills.

Ford also pioneered the use of soy oil in rubber. By using renewable soy oil as a 25 percent replacement for petroleum oil, Ford researchers more than doubled the rubber's "stretchability" and at the same time reduced its environmental impact. Soy-based rubber parts – such as radiator deflector shields, air baffles, cup holder inserts and floor mats – are under consideration for future Ford vehicle programs.

We have introduced plant-based castor oil foam in the instrument panel of the 2012 Ford Focus and 2013 Ford Escape. The castor oil foam, which includes more than 10 percent renewable content, provides a more sustainable interior foam solution than petroleum-based foam and does not compete with food sources. It also reduces scrap due to improved flow and processing characteristics, is more durable than previously used materials, and reduces production time by more than 40 percent.

Ford Research has also begun work on new technologies to make urethane foams even greener. One of these innovative technologies may enable us to use old foam scrap (including soy foams) as a feedstock for new foam. Polyurethane makes up 5 percent of total solid municipal waste (about 1.3 million tons) in the U.S., and almost 24 percent of that is attributed to the automotive industry. The landfilling of foam at the end of an automobile's useful life is a significant environmental issue, and one that we continue to work to address. Our initial results formulating both rigid and flexible recycled foams in the laboratory have shown promise. We are excited about the possibility of recycling foam because it is prevalent in landfills and because the current recycling of foam is limited to low-requirement applications such as carpet backing.

We also use renewable materials to reinforce plastic and for other applications in vehicle materials. For example, the average Ford vehicle sold in Europe uses between 10 and 20 kilograms of renewable materials, depending on the vehicle size class. Almost 300 parts used across Ford's European vehicles are derived from sources such as cotton, wood, flax, hemp, jute and natural rubber. In Europe we use Lignotech, a compression-molded polypropylene and wood material in the door panels of the Ford Focus and Fiesta. We also use kenaf to reinforce compression-molded plastic in door parts. We have used this material in Europe for many years in door-panel inserts. For example, the Ford Mondeo uses a mixture of 50 percent kenaf plant fiber and 50 percent polypropylene in the compression-molded interior door panel.

We also use kenaf to reinforce plastic in North America – in particular in the door interior bolsters on the Ford Escape. Kenaf, which is a tropical plant that looks similar to bamboo and is related to cotton, replaces some of the oil-based resin in the plastic. The use of kenaf in this part is anticipated to offset 300,000 pounds of oil-based resin per year in North America. In addition, the material reduces the weight of the door bolsters by 25 percent, which translates into better fuel efficiency. In North America we also use a coconut-fiber trunk liner in the 2012 Focus Electric.

Ford introduced the world's first application of wheat-straw-reinforced plastic, which we developed in conjunction with the Canadian BioCar initiative, in the third-row storage bins of the 2010 Ford Flex. Wheat straw is used to replace the glass fibers or minerals commonly used to reinforce plastic parts. The use of wheat straw is a highly efficient use of natural fiber, because it is a byproduct of growing wheat that is typically discarded. Furthermore, the use of wheat-straw-reinforced plastics in the 2010 Flex storage bins reduced our petroleum usage by some 20,000 pounds and CO_2 emissions by about 30,000 pounds annually. The material weighs up to 15 percent less than plastic reinforced with glass or talc. Additional applications of wheat-straw-reinforced plastics under consideration by the Ford team include console bins and trays, climate-control air ducts, door trim panel components and armrest liners.

We are using engineered wood technology, which comes from a certified, sustainably managed forest and is a renewable resource, on several interior applications in North American vehicles. This wood, which is harvested under strict guidelines, is assembled into a composite and then stained to give it a warm, rich appearance. In addition, the use of engineered wood eliminates many of the extra processing steps necessary in producing solid wood automotive trim parts, and the processing required is more environmentally friendly. For example, water-based stain can be used instead of solvent-based, and a solvent wash to remove oils is not needed. Additional bleaching and sealing operations are eliminated, which greatly reduces the production of volatile organic compounds. Engineered wood technology uses input materials more efficiently, so less waste material is sent to landfills. Engineered ebony wood was implemented on the 2008 Lincoln Truck, the 2008 and 2009 Navigator, the 2008 MKX and the 2009 MKS. Ford is also exploring other wood veneer alternatives, such as veneers from managed sustainable forests, to reduce our environmental impact footprint.

To maintain our sustainable materials leadership in the future, Ford researchers are developing and formulating new materials and applications for other renewable materials, such as corn-based, compostable and natural-fiber-filled plastics. These materials will help to reduce the resource burden and waste generated and will help to reduce the weight of vehicles, thereby improving fuel economy.

Ford Research has initiated a project to develop sustainable resources for rubber materials, in conjunction with the Ohio State University. We are looking at two sources – dandelion root and guayule (a plant grown in the Southwest U.S.) – as possible replacements for natural and synthetic rubber in our plastic materials. Rubber-modified plastics are common, especially in interior applications where low temperature impact is important.

In 2009, Ford joined a three-year research project investigating a new wood/plastic compound known as "liquid wood." Early findings show excellent recycling potential, as the material can be reprocessed up to five times and has an overall near-neutral CO_2 balance.

Finally, Ford researchers have made considerable inroads with polylactic acid (PLA) – a biodegradable plastic derived completely from the sugars in corn, sugar beets, sweet potatoes, sugar cane, Indian grass and other plants. When plastic parts made from PLA reach the end of their useful life, they can biodegrade in 90 to 120 days. In contrast, traditional petroleum-based plastics are projected to remain in landfills for hundreds of years. We continue to assess bio-yarns for use in making plant-based fabrics. Several technical issues must be overcome before these compostable plastics and fabrics meet our stringent wear, performance and durability requirements, but they hold great promise for future vehicles.

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Lightweight Materials

We are actively pursuing the development and use of cutting-edge materials – including high-strength steels, lightweight metals such as aluminum and magnesium, and composite materials – to reduce the weight of our vehicles and improve their fuel economy without compromising safety or performance. For more information on our use of lightweight materials, please see Weight Reductions in the Sustainable Technologies and Alternative Fuels plan section.

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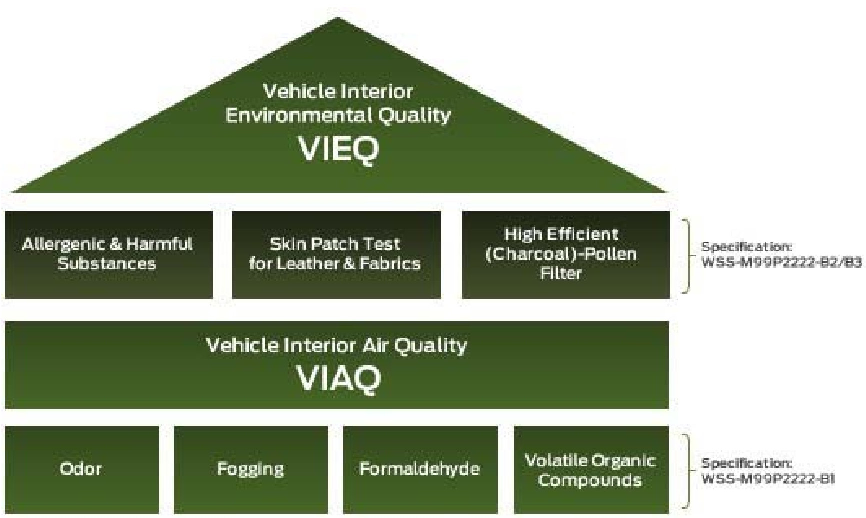
Improving Vehicle Interior Environmental Quality and Choosing Allergy-Tested Materials

At Ford, it is our corporate social responsibility to develop and offer products that are safe, sustainable and progressive. As part of this effort, Ford is proactively addressing society's growing concern about vehicle interior environmental quality, including air quality and allergens. Consistent with our ONE Ford global integration plan, a global cross-functional team at Ford focuses on selecting interior materials to reduce the risk of allergies and volatile organic compounds and works with suppliers to verify that we meet voluntary initiatives through rigorous scientific testing. This team is committed to investigating and developing comprehensive global approaches and strategies to address issues relating to vehicle interior air quality. The team has established global design guidelines for materials and filtration and is migrating those guidelines across Ford's product lines.

Specifically, this team has been working since 2007 to develop a set of Vehicle Interior Air Quality (VIAQ) specifications that require the consideration of the air-quality and allergen impacts of the materials and components in our vehicles. Under this standard, vehicle engineers test more than 100 materials and components for allergy issues. In addition, all components that have direct and prolonged skin contact – such as the steering wheel and seat covers – are dermatologically tested. The complete VIAQ standards include requirements for fogging and odor at the component level, air filtration, allergy patch testing and total vehicle organic compounds. Many vehicles are also equipped with high-performance pollen filters to prevent allergenic pollens from entering the vehicle. Initially, the requirements were applied to European-based vehicles, and we are now phasing them in in the U.S. We plan to implement them in our South American and Asia Pacific and Africa operations in the future.

We are also implementing a voluntary vehicle interior air-quality and allergen-free third-party certification process. This certification can be used by vehicle engineers in markets where certification is likely to be valued by consumers.

The following graphic shows our overall approach to improving vehicle interior environmental quality, including our allergen and VIAQ specifications.



Related Links

Vehicle Websites

- Ford C-MAX
- Ford Fiesta (European)
- Ford Focus (European)
- Ford Fusion (European)
- Ford Galaxy
- Ford Kuga
- Ford Mondeo

Ford of Europe vehicles were the first vehicles worldwide to be awarded an “allergy-tested interior” certification by TÜV Rheinland, a Germany-based organization that controls and approves quality standards for industrial and consumer products. To obtain this certification, components in the vehicle interior must meet strict requirements focused on three key areas: measuring and meeting standards for the in-vehicle concentration of volatile organic compounds; minimizing the risk of allergic reactions; and high-efficiency air filtration. The requirements for minimizing the risk of allergic reactions include ensuring that no substances with allergenic potential (e.g., latex, nickel, chromium VI) are used for components likely to have contact with people’s skin. They also require the use of an efficient pollen filter to protect passengers against allergenic particles in the outdoor air.

Nine of Ford’s European models have met these requirements: the new Ford Fiesta, European Focus (including the Focus Coupe-Cabriolet), European Fusion, five-passenger C-MAX, seven-passenger Grand C-MAX, Kuga, S-MAX, Galaxy and Mondeo. In February 2008, the Berlin-based European Center for Allergy Research Foundation awarded Ford with its quality certificate – an additional recognition of the Company’s “allergy-tested interior vehicle” initiative.

Looking ahead, we are researching ways to use in-vehicle communication systems to help drivers monitor and maintain their own health and wellness. We are partnering with Microsoft, Healthrageous and BlueMetal Architects to develop systems that extend health management into the personal vehicle in a nonintrusive fashion. The system would work by using Ford’s hands-free SYNC® communication technology to capture biometric and vehicle data as the basis for real-time health and wellness advice and monitoring. For example, a driver could provide voice inputs, detailing important aspects of his or her health routine – such as the number of glasses of water consumed during the day, or what pills have been taken. Working with partner companies, the data received from the driver could be uploaded into the driver’s approved health data cloud and processed with other health data to create graphical reports the driver can access after having left the vehicle.

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Eliminating Undesirable Materials

For more than 20 years, our Restricted Substance Management Standard has spelled out materials to be avoided or eliminated in Ford operations and in the parts and materials provided by suppliers. This and other materials management tools are helping us to meet and exceed customer expectations and ensure compliance with regulations.

Related Links

This Report

- Materials Management

External Websites

- REACH

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Eliminating Mercury

Ford has decreased the use of mercury-containing components, which can pose problems at the end of a vehicle's life. In 2001, we eliminated mercury-containing switches, which accounted for more than 99 percent of the mercury used in our U.S. vehicles. Since that time, we have continued to focus on mercury reduction, eliminating mercury in navigation system screens and family entertainment system screens and reducing the use of mercury in high-intensity discharge headlamps. All Ford and Lincoln vehicles in the U.S. are now mercury-free.

In addition, we helped to forge a collaboration between the U.S. Environmental Protection Agency (EPA), states, auto dismantlers, auto scrap recyclers, steelmakers and environmental groups to recycle mercury switches from end-of-life vehicles. This effort was rolled out across the U.S. in 2007 and now has more than 9,400 participants joining the effort from the recycling industry. By the end of 2011, more than 4.5 tons of mercury from these switches had been recovered. An online database tracks the number of participants in the program as well as the number of switches collected by state.

In Europe, an E.U. End-of-Life Vehicle directive and a Battery directive prohibit the use of the heavy metals lead, cadmium, hexavalent chromium and mercury, with limited exceptions. These regulations also include broad manufacturer responsibility for disposing of vehicle parts and substances, including taking vehicles back without charge for disposal and recycling requirements. This legislation has triggered similar regulatory actions around the globe, including, for example, in China and Korea and possibly in India in the near future. Ford is complying with all of these regulations.

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Eliminating Chromium and Lead

Hexavalent chromium – "hex chrome" for short – is a corrosion coating (used, for example, on nuts, bolts and brackets in cars and trucks) that the U.S. Occupational Safety and Health Administration lists as a potential lung carcinogen. We did not wait for global regulations banning the use of hex chrome to take effect: we phased out its use worldwide. By 2007, Ford eliminated all hex-chrome-containing parts in Europe and North America. Replacement coatings have been thoroughly tested to ensure that they meet Ford's performance requirements.

In North America, Ford has also completed the transition away from lead wheel weights. In addition, Ford's Customer Service Division no longer offers lead wheel weights for sale to dealers, offering steel wheel weights instead.

Ford has joined the EPA and other stakeholders in a commitment to reduce the use of lead in wheel weights through participation in the National Lead-Free Wheel Weight Initiative. Through this initiative, Ford has shared its experience with lead wheel weight phase-out with aftermarket wheel balancers, and encourages all stakeholders to discontinue the use of lead in wheel weights.

In mid-2003, Ford of Europe phased out lead in valve seats in all new vehicle models approved for launch in the European Union. Also in Europe, we phased out the use of lead wheel weights and reduced the lead content in aluminum in new and serviced vehicles in mid-2005, and phased out lead in pyrotechnic initiators by mid-2006. We further reduced the lead content in aluminum in 2008. A study by the Oeko-Institute in Germany calculated that, between 2000 and 2005, lifecycle emissions from lead had been reduced by 99.6 percent, from hexavalent chromium by 99.99 percent and from cadmium by 96 percent in Europe.

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Reducing Undesirable Chemicals

Ford is one of the first automotive companies to begin efforts to reduce a range of undesirable chemicals that are monitored by the EU, U.S. and Canadian governments. These chemicals include hexabromocyclododecane (HBCDD), a chemical that has been identified as a substance of concern under the European Union's REACH regulations (Registration, Evaluation, Authorization and restriction of Chemicals). Ford is also working to reduce decabromodiphenyl ether (Deca-BDE), another substance of concern that the EPA has proposed to regulate. Ford is working to eliminate these substances ahead of the timelines defined by governmental regulations by working with suppliers to develop new and "greener" alternative materials that will make our products more environmentally friendly.

More and more countries are adopting chemical and substance of concern regulations like REACH. Turkey and Romania adopted their own versions of REACH in 2009; China adopted its own version in October 2010. South Korea and Japan will soon adopt REACH-like regulations to manage their chemicals. In the U.S., the federal Senate and House both proposed bills in 2010 to overhaul the Toxic Substances Control Act. The state of California is planning to promulgate regulations implementing a Safer Consumer Products law in 2012. And in January 2009, the United Nations implemented regulations requiring a globally harmonized system of classification and labeling of chemicals.

Regulatory requirements for the phase-out of undesirable chemicals need to be prioritized and implemented in a workable manner. Government and industry resource constraints mean that not all chemicals of concern can be addressed at once. Moreover, manufacturers and suppliers need adequate lead-time to identify replacement substances that are more environmentally friendly than the ones they replace, and also to design and engineer components that incorporate these new substances. Ford will continue to work with regulatory agencies to help develop rules that target the highest-priority chemicals first, and that drive steady progress toward the elimination of chemicals of concern in an effective and efficient manner.

For more on Ford's efforts to manage materials and chemicals please see the Materials Management section.

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End of Life

Automobiles are one of the most highly recycled consumer products in the world. All vehicles contain parts and materials – particularly iron, steel and aluminum – that can be recovered at the end of their useful lives. In North America, about 95 percent of vehicles that go out of registration are processed by a dismantler or scrap metal recycling facility, with approximately 86 percent of the vehicle by weight recovered for reuse, remanufacturing or recycling.

In theory, end-of-life vehicles are nearly 100 percent recoverable. In practice, however, the cost in energy and labor to recover the final fractions often exceeds the value of the materials, and recent independently reviewed environmental studies suggest that such efforts offer no value to the environment. Ford focuses on achieving the highest economically viable and environmentally sound recovery percentage through a number of means, including selection of materials, labeling and providing information to dismantlers on materials and methods for treatment.

In the EU, automakers are required by EU Directive 2000/53/EC to ensure a cost-free take-back of vehicles (that they put on the market) at the end of their lives. This directive also requires that end-of-life vehicles (ELVs) are treated in an environmentally responsible manner. Since 2002, Ford has been at the forefront of providing return networks in the EU member states that have established regulations. Ford now has ELV take-back and recycling networks for Ford brand vehicles in 18 EU markets and participates in collective ELV recycling systems in another 10. Ford was the first major manufacturer in the U.K. to put in place a comprehensive plan that met the European Commission's ELV directive. By working with Cartakeback.com, Ltd., we have a network of nearly 250 facilities providing unrivalled convenience to the last owner for the professional take-back, receipt and treatment of end-of-life vehicles.

In May 2007, Ford became one of the first European automakers to be certified in compliance with ELV requirements by demonstrating to external authorities that the Ford processes properly manage the reusability, recyclability and recoverability aspects of vehicles. In 2010, this certification was extended by another three years and now comprises all of Ford Motor Company operations globally. All Ford vehicles marketed in Europe are now certified as reaching recyclability of 85 percent and recoverability of 95 percent. An increasing number of vehicle models produced and designed in the U.S. are also following this approach. For example, 11 U.S. models exported to South Korea are providing self-certification documents meeting the 85–95 percent recyclability requirement.

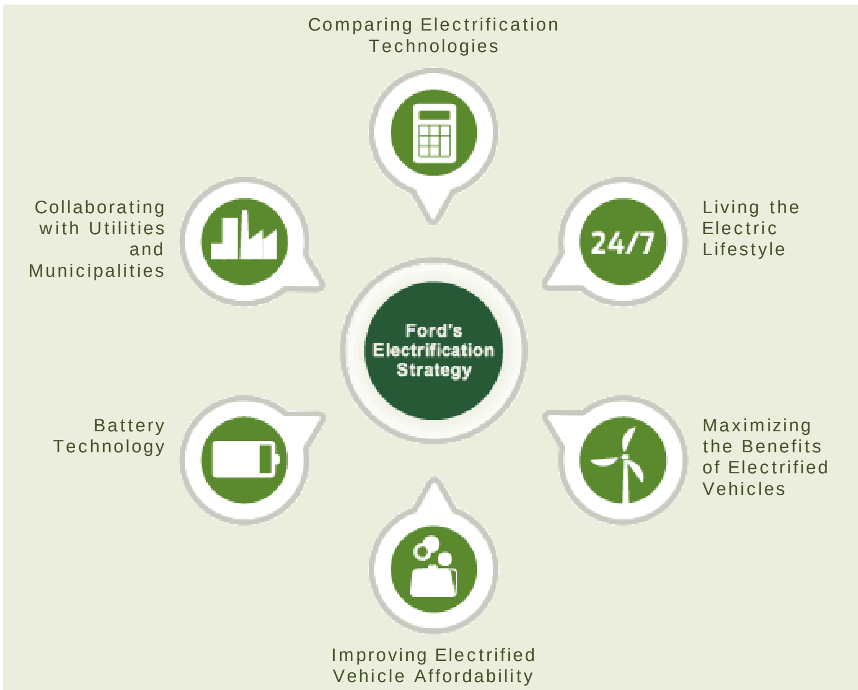
Ford has participated in research into alternative treatments for end-of-life vehicles. Most of the plastic, foam and other nonmetal vehicle materials end up being shredded. Most of this "auto shredder residue" (ASR) ends up going to landfill. We have been working to assess the environmental impacts of burning ASR for energy. Together with other European automotive manufacturers, we sponsored a fully ISO 14040-compliant lifecycle assessment that showed that – from a purely environmental point of view – using recycled ASR for energy recovery is as beneficial as recycling it.

Related Links

External Websites

- European End of Life Vehicles

Electrification: A Closer Look



In the past few years, most major global automakers, including Ford, have begun to offer a new generation of electrified vehicles to consumers. 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 achieve their full 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." Battery technologies are still evolving, and the cost of new-generation batteries remains high. We are also assessing supply chain issues associated with materials needed to manufacture batteries, including lithium and rare earth metals. We discuss all of these issues in more detail throughout this section.

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 detail on our electric vehicle technologies and other fuel-efficiency, advanced powertrain and alternative-fuel 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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This Report

- Battery Technology
- Quantifying Our Environmental Impacts
- Supply Chain
- Sustainable Technologies and Alternative Fuels Plan

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 Electrified 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 deliver leading fuel economy across our lineup to meet different customers' transportation needs. To do this, 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 sedans, utility vehicles and luxury vehicles. By 2020 we expect that 10 to 25 percent of Ford's global sales will be electrified vehicles, including HEVs, PHEVs and BEVs. We expect HEVs to make up about 70 percent of that share. Currently, HEVs make up approximately 2 percent of Ford's total fleet.

By the end of 2012, Ford will offer the following HEVs: the Ford Fusion Hybrid, the Lincoln MKZ Hybrid and the new C-MAX Hybrid (based on the successful C-MAX in Europe), all of which will deliver leading fuel economy. These HEVs are ideal for customers who cover a range of distances in varied driving conditions. The most significant benefits come under urban stop-and-go driving, where braking energy is stored and reused. The Ford C-MAX Hybrid will be our first multi-activity vehicle in North America and will launch in the fall of 2012; it is expected to be among the leaders in its segment for fuel economy. The hybrid version of the all-new, redesigned Fusion, which will also be introduced in the fall of 2012, is expected to deliver 47 miles per gallon (mpg) – segment-leading fuel economy. For more information about our hybrid vehicles and technology, please see the Hybrid Electric Vehicles section.

In the spring of 2012, we launched the Focus Electric, a BEV version of the all-new Ford Focus, in North America. The Focus Electric has a U.S. Environmental Protection Agency (EPA) fuel-efficiency rating of 110 miles per gallon equivalent (MPGe) city and 99 MPGe highway, making it the most fuel-efficient compact vehicle in the U.S. With innovative technologies, the Focus Electric can be fully recharged in half the time (4 hours) and at a lower cost (approximately $1 for a full charge) than competitors' BEVs with comparably sized batteries. The Focus Electric also offers more power, more space and more standard features than any other comparable all-electric vehicle. It has an EPA-certified driving range of 76 miles on a single charge and can go up to 100 miles on a charge depending on driving habits. (The average driver in the U.S. drives 29 miles a day, according to the Bureau of Transportation Statistics.) For more information about our battery electric vehicles and technology, please see the Battery Electric Vehicles section.

In 2012 in North America, we will introduce our first PHEV, the C-MAX Energi. In addition, the Fusion Energi, a plug-in hybrid version of our all-new Fusion, will go into production by the end of 2012 in the U.S. For more information about our plug-in hybrid vehicles and technology, please see the Plug-In Hybrid Electric Vehicles section. All of these vehicles will use next-generation lithium-ion batteries.

We will also expand our electrified vehicle lineup to Europe beginning with the Focus Electric in late 2012. We will launch hybrid vehicles in Europe in coming years.

Using Global Platforms

We are basing our electrified vehicle products on our highest-volume global platforms. This

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- Plug-in Hybrid Electric Vehicles

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approach 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, and will be built alongside the gas-powered Focus models at Ford's Michigan Assembly Plant. This plant is the first in the world to build vehicles with five different fuel-efficient powertrain technologies on the same line.

Globally, we expect to build as many as 2 million vehicles per year on the C-car platform. The new Fusion Hybrid and Fusion Energi PHEV will be based on our global C/D platform. This flexibility 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 plug-in electrified vehicles have advanced in-vehicle communications and innovative applications for wireless devices 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. Our innovative MyFord Mobile app, co-developed with technology leaders such as Microsoft and MapQuest®, allows owners to control charging and other in-vehicle operations remotely. For example, the app can "wake up" to pre-heat or pre-cool the cabin while the car is being charged, to help reduce battery usage for these energy-intensive functions. We have also developed a comprehensive approach to vehicle charging that makes it 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 have developed extensive training materials to educate dealers' sales personnel on the unique features and functionality of electric vehicles so that they are able to assist customers with their purchase decisions. As part of these preparations, EV dealers were required to install two EV charge stations at their facilities – one in the service area and another in the customer-facing area. EV dealers are also undergoing a "green dealer onsite facility assessment" to identify energy- and cost-saving opportunities, with a goal of facilitating energy efficiency, lower operating expenses and a reduced carbon footprint. For more information on this Go Green Dealership effort, please see the Dealers section.

We have also developed websites, videos and brochures to help consumers understand electrified vehicle offerings and incorporate EVs into their lifestyle. For example, our electrified vehicle website helps consumers understand key features and differences between electrified vehicle options, and our www.plugintoford.com site helps customers understand how to get the most from their electric vehicle. We have also developed videos on vehicle features like MyFord Mobile, how to charge the vehicle or set the charge time, and the Best Buy charge station installation process.

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 in the spring of 2012 in the largest electrified vehicle markets – New York, New Jersey and California – that have some of the most established, fastest-growing charging station infrastructures and government support. We will follow this initial launch by rolling the car out in the fall of 2012 to 15 more U.S. metropolitan areas: Atlanta, Austin, Boston, Chicago, Denver, Detroit, Houston, Orlando, Phoenix, Portland (Oregon), Raleigh-Durham, Richmond, 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. The Certified EV Dealer Network will be expanded to cover a broader national market in the third quarter of 2012 as the C-Max Hybrid and C-Max Energi become available.

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" in 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 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. We are partnering with companies that are already the best in their fields, instead of attempting to recreate products, services and technologies internally, to offer customers the best-possible suite of electrified vehicle-related products, services and technologies.

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Comparing Electrification Technologies

Electrified vehicle technologies range from conventional gas engine vehicles with a start/stop function (sometimes referred to as micro hybrids), to hybrid electric vehicles (HEVs), plug-in hybrids (PHEVs), and battery electric (or "all-electric") vehicles (BEVs). The different technologies have different benefits and ideal driving conditions. We believe it is important to offer customers a range of fuel-efficient and reduced-emission vehicles, including efficient traditional gas-powered vehicles and electrified vehicle options. We are also committed to helping customers understand the relative advantages of different vehicle options based on their driving needs. We call this approach the Power of Choice.

Related Links

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In a recent national survey, we found that nearly half of Americans are confused when it comes to green vehicle options, with 46 percent not knowing the difference between a hybrid, plug-in hybrid and all-electric vehicle. This Sustainability Report is one of the key mechanisms we use to inform customers about the different electrified vehicle options. We are also working with SHFT.com on a series of short films aimed at clarifying the different technologies for consumers. This inspiring documentary series will feature innovative leaders who are shaping sustainable businesses and influencing positive change around the world. Ford also has an electrified vehicle website to help consumers understand key features and differences between electrified vehicle options. The site provides jargon-free explanations of the differences between HEVs, PHEVs and BEVs, including details on the technologies. Through all of these communication channels, we seek to help customers decide what vehicle technology is best for them.

The chart below compares a range of vehicle types, from conventional gasoline to pure electric. In the near-term and mid-term, the largest volume of electrified vehicles will likely be hybrid electric vehicles, 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 2011.

In the longer term, electrified vehicles that get some or all of their energy directly from the electric grid – including PHEVs and 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.

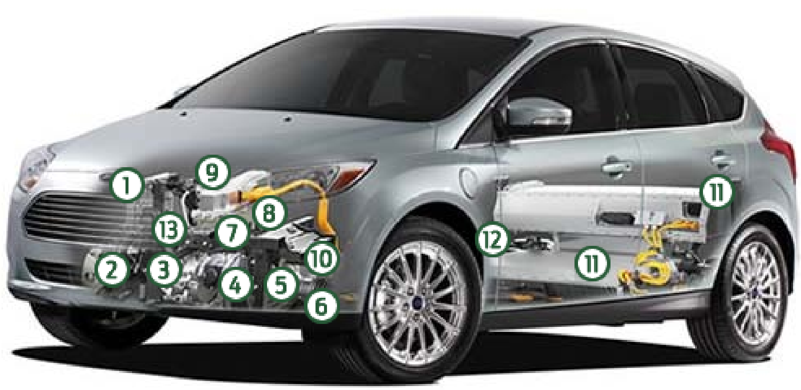
	Conventional Internal Combustion Engine Vehicle (ICEV)	Conventional ICEV with Start/Stop Technology[1]	Hybrid Electric Vehicle (HEV)	Plug-in Hybrid Electric Vehicle (PHEV)	Battery Electric Vehicle (BEV)
Technology overview	Traditional gas or diesel engine.	Traditional gas or diesel engine and powertrain 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.	Flexible for a wide range of uses.	Flexible for a wide range of uses.	Ideal for customers with access to a plug

		Improved fuel economy in urban driving.	Excellent urban fuel economy and improved highway fuel economy.	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.	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]	95 MPGe[6] in electric mode. Similar to HEV when running on gasoline.	110 MPGe[6]
Range on tank/charge[7]	~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.	4 hours with a 240-volt outlet
CO_2 emissions[8]					
Well to tank	~40 g/km	~40 g/km	~30 g/km	Current grid:[9] ~120 g/km	Current grid:[9] ~150 g/km
Tank to wheels	~170 g/km	~160 g/km	~110 g/km	Current grid:[9] ~30 g/km	Current grid:[9] 0 g/km
Well to wheels[10]	~210 g/km	~200 g/km	~140 g/km[11]	Current grid:[9] ~130 g/km[12]	Current grid:[9] ~130 g/km[13]
Annual fuel cost	~$1,100–$1,800[14]	~$1,000–$1,700[15]	~$700–$1,200[16]	~$550 ($200 gasoline+$350 electricity)–$700 ($350 gasoline+$350 electricity)[17]	~$500[18]

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

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 Cradle
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. MPGe or miles per gallon equivalent for electric vehicles is calculated based on the 33.7 kWh energy content of a gallon of gasoline.
7. All estimates are based on a 13.5-gallon tank except for the BEV, which has no fuel tank.
8. In vehicles using internal combustion engines, the fuel feedstock is assumed to be petroleum gasoline.
9. “Current grid” assumes average current emissions from U.S. power generation.
10. “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 FordÙs estimates using the metro-highway drive cycle and energy use for a C-class electric vehicle.
11. In HEVs, the fuel feedstock is assumed to be petroleum gasoline.
12. 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.
13. 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.
14. Based on 12,000 miles/year, 33 mpg and $3–5/gallon.
15. Based on 12,000 miles/year, 35 mpg and $3?5/gallon.
16. Based on 12,000 miles/year, 49 mpg and $3?5/gallon.
17. 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.
18. 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 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 enabled drivers to link their smartphones to our vehicles 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. Our "Plug Into Ford" website provides customers with an in-depth look at how to make the most of the electric vehicle lifestyle.

Related Links

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- Plug into Ford

Enhanced In-Vehicle Information with MyFord Touch

In several regions, including the U.S., our electric vehicles will ultimately include an enhanced version of MyFord Touch – Ford's driver interface technology – that will give drivers 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 the 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. To provide the driver with realistic driving range information, the vehicle "recognizes" drivers by their key fobs and automatically adjusts to maximize range based on what it has learned about that driver's driving style. 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 in the U.S. and Canada will also be able to manage their Focus Electric remotely using the Ford-developed MyFord Mobile app. MyFord Mobile allows drivers to locate the vehicle with GPS, remotely start the vehicle and remotely lock and unlock the car doors using their smartphone. On our battery electric vehicles, the MyFord Mobile app provides a suite of additional remote communications. For example, working with MapQuest, MyFord Mobile can find the location of a charge station on the driver's smartphone and send that location 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 review vehicle data for analysis from their smartphone or the MyFord Mobile website. The remote vehicle monitoring and management features of MyFord Mobile were honored with the Innovation Design and Engineering Award at the 2012 Consumer Electronics Show.

The MyFord Mobile app

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 through seamless connections to popular social platforms like Facebook and Twitter. 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.

Find out more by watching the MyFord Mobile features video demonstration.

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 four hours when using a 240V charge station installed in the customer's garage. That's half the time it takes our competitors' BEVs with comparably sized batteries to charge up. This allows drivers to get more range out of "quick stop" charging during the course of their driving day. Our vehicles can get approximately 30 miles of range per "charge hour" compared to 15 miles per charge hours for competitors' electric vehicles.

U.S. drivers can also customize their charging preferences. Drivers can choose the 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' BEVs with comparably sized batteries, 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. Drivers can also find out their vehicle's state of charge by pressing a button on their key fob; in response, the light ring indicates the amount of charge by lighting the appropriate number of segments of the "light ring."

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. Best Buy will help facilitate the process of owning an electric vehicle by evaluating homes, working with electricians on permitting issues and installing the units. The charging station standard installation will cost $1,499, including the charge station, garage site survey and permits – 30 percent less than competing systems. Customers need only to call Best Buy's dedicated 1-888 number (1-888-219-6747) to set up a Geek Squad garage site survey. The Geek Squad agent will also guide the customer through the installation process.

Maximizing the 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 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, results in well-to-wheel emissions that are similar to those of a hybrid electric vehicle (HEV). (See the well-to-wheels carbon dioxide (CO_2) emissions values on the Comparing Electrification Technologies page.)

However, in some regions of the country, where electrical power is derived largely from cleaner and/or renewable sources, the emissions benefits of PHEVs and BEVs can be much better, because renewable energy sources produce significantly fewer emissions than the coal and natural gas that are often used for power generation. We believe that, over time, the emissions benefits of plug-in electric vehicles will continue to improve as states undertake efforts to improve the emissions profile of their electrical grid. For example, many states already have portfolio standards that require the use of renewable sources of electricity. In addition, "smart grids" that include grid-to-vehicle communications would enable utilities to make more-efficient use of electricity supplies, potentially reducing emissions and electricity costs.

To help customers think through the relative lifecycle carbon emissions of different vehicle options, Ford has developed a carbon emissions calculator. Currently used by Ford's National Account Managers with their fleet customers, this calculator helps customers assess the well-to-wheels emissions benefits and fuel costs of alternative fuel vehicles. The calculator allows the customer to input factors such as vehicle type (e.g., hybrid, battery electric, diesel, flex-fuel), electricity source by U.S. region or fuel (e.g., coal, nuclear, renewables, natural gas) and likely driving patterns (e.g., stop-and-go city traffic, highway driving or a mix). These key factors help determine the relative environmental benefits the customer may achieve with each type of vehicle and fuel. For a customer deciding where to place an EV in her fleet, the calculator shows that the Focus Electric emits about 70 g CO_2/km using electricity from the low-carbon California grid but more than twice as much, about 150 g CO_2/km, in the more coal-intensive Southeast U.S.

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 by switching 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

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- Collaborating with Utilities and Municipalities
- Comparing Electrification Technologies
- Living the Electric Lifestyle
- Sustainable Materials

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 maximize 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 approximately 3–4 times more efficient than traditional internal combustion engines. In addition, electric-drive vehicles do not consume energy while at rest or coasting, and more than 93 percent of the braking energy is recaptured at each stop.

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 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. 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

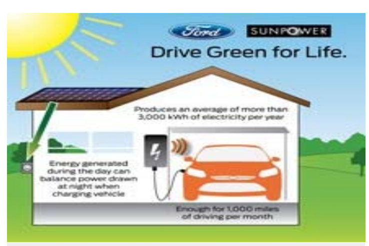
Our in-vehicle information systems also help drivers maximize their own driving efficiency to further increase the distance they can go on a single charge and reduce the overall costs of operating an EV. As described in Living the Electric Lifestyle, our electric vehicles can coach drivers how to drive 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 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.



Ford and SunPower's Solar Power Energy Solution

Ford is making it possible to offset the energy needed to charge their EVs with renewable energy. We are partnering with SunPower Corp. to offer customers the "Drive Green for Life" program, which includes a home rooftop solar system that can provide enough clean, renewable energy to offset the electricity used to charge the car. The 2.5 kilowatt rooftop solar system is backed by a 25-year warranty and produces an average of 3,000 kilowatt hours of electricity annually. The high-efficiency panels generate approximately 50 percent more electricity than conventional panels and utilize a smaller footprint on the roof. The system is sized to provide the electricity needed to drive about 1,000 miles per month or 12,000 miles per year. We worked closely with SunPower to ensure the unit would be available below the $10,000 price point, which makes it the most affordable rooftop solar system of its kind and allows us to make the benefits of solar charging available to more of our customers.

"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. 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 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 Powered 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 produces the Focus Electric, C-MAX Energi and C-MAX Hybrid, in addition to the standard gas-powered Ford Focus, is powered by one of the largest solar arrays in the state of Michigan. We 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 uses 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.

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. 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 Electrified Vehicle 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 and gasoline 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).

Related Links

This Report

- Battery Technology
- Living the Electric Lifestyle

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 have planned 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 the Battery Technology section 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. EVs require less energy to move a given distance, compared to conventional gas-powered vehicles. The average price for residential electricity in the U.S. is about 12 cents per kilowatt-hour. The fuel cost to travel 80 miles in a Focus Electric with a combined fuel economy of 105 MPGe is about $2.00. Driving 80 miles in a highly fuel-efficient, competitive gasoline-powered vehicle that gets 40 mpg would cost about $7.00 (assuming $4.00 per gallon of gasoline) – over three times more than the EV. If drivers use Value Charging Powered by Microsoft, the cost of traveling 80 miles in the Focus Electric drops even further to just less than $1.00 to travel 80 miles.

We are taking a range of steps to further reduce the operating costs of EVs to help offset their higher purchase price.

Through our partnership with 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.

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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 40 miles/gallon at $3–$5/gallon for the gasoline vehicle.

Battery Technology

Until recently, hybrid electric vehicles (HEVs) ran 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. In fact, these batteries have proven to be incredibly durable and reliable in even the most grueling real-world driving conditions. Our HEVs have been put to the test in taxi fleets in major cities, including New York and San Francisco, where they run up to 21 hours a day in stop-and-go traffic and on steep slopes. Ford's hybrid taxi fleet has logged more than 80 million miles in California alone during the past decade.

In spite of this strong track record, our nickel metal hydride batteries are reaching the end of their advancement potential, 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 that nickel metal hydride batteries are not equipped to handle. Unlike HEVs, which maintain a narrow state of charge window, PHEV batteries are intended 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. Because nickel metal hydride batteries have significant limitations for such applications, 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. Even so, 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. Ford is actively working to establish a plan to respond to this need in the future.

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, compares 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	Developed for today's generation of hybrid vehicles.	Developed for future hybrid electric and battery electric vehicles.
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 plug-in electrified vehicle applications; by taking up less space in the vehicle,

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- Supply Chain
- Water Strategy

			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.	Proven in consumer electronics, this technology is for automotive applications; expensive until volume production is reached.
Specific energy (watt hours per kilogram)	30–40	65–70	100–150
Recyclability	Excellent	Very good	Very good

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 beginning with the Focus Electric. 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.

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. Advanced thermal management of lithium-ion battery systems is critical to the success of all-electric vehicles, because extreme temperatures can affect performance, reliability 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. 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. For example, there are concerns about rare earth metals, which are used in electric motors for vehicles, wind turbines and other advanced technologies; also, a better understanding of mining processes is required.

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. 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, Human Rights and Corporate Responsibility 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 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.

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 vehicle supply equipment (EVSE) manufacturers, 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. Furthermore, 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 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 5,000 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 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 modifications to streamline the permitting process to make it easier and shorter for consumers.
- 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. Smart communication systems could alleviate the need for expensive infrastructure upgrades, the costs 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.

Greening Our Operations

We have adopted a rigorous and holistic approach to reducing the overall environmental impacts of our manufacturing facilities. We have established global facility environmental targets that address the range of our environmental impacts, including energy use, emissions, water use and waste generation.

Each Ford facility has a comprehensive set of environmental targets and uses a detailed scorecard to report against these targets, so that we can track and accelerate improvements. Progress toward the targets is reviewed throughout the year by senior management at regular Business Plan Review meetings. In addition, these targets become part of the performance review metrics for every plant manager and regional manufacturing manager, as well as others in the management hierarchy up to the executive vice president of manufacturing and labor affairs. These targets include reducing greenhouse gas emissions from our manufacturing facilities by 30 percent on a per-vehicle basis from 2010 to 2025 and reducing average energy consumption per vehicle globally by 25 percent from 2011 to 2016.

Our 2011 and 2012 targets and progress are shown in the Goals, Commitments and Status chart.

To facilitate performance tracking, we launched the Global Emissions Manager database (GEM) in 2007. This industry-leading database provides a globally consistent approach for measuring and monitoring environmental data, which helps us track and improve our efforts to reduce water consumption, energy use, carbon dioxide (CO_2) emissions and the amount of waste sent to landfill. GEM also provides a library of environmental regulations relevant to each plant, significantly increasing the efficiency of tracking and meeting those regulations.

This section reports on our facilities' environmental performance, including operational energy use and greenhouse gas emissions, non-CO_2 facilities-related emissions (including volatile organic compounds), water use, waste management, sustainable land use and biodiversity, compliance and remediation.

Related Links

This Report

- Ford's Goals, Commitments and Status

Operational Energy and Greenhouse Gas Emissions

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. The U.S. Environmental Protection Agency (EPA) awarded Ford a Goal Setting Certificate for this strategy at its inaugural Climate Leadership Awards Ceremony.

GHG Reporting Initiatives

- Ford is officially “Climate Registered” after publishing its complete North American carbon inventory for 2010 with 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. Ford was the first automaker to join TCR and is one of only two automakers to be officially Climate Registered. 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., Canada, Argentina, Australia, Brazil, China, the Philippines and Taiwan.
- 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 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. were subject to the reporting requirements and submitted reports as required. Our proactive approach and early action on GHG reporting globally have prepared us for this new requirement.

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 overall global energy consumption by 42.4 percent in 2011 compared to 2000. For 2011 alone, we reduced overall global energy consumption by 3.6 percent compared to 2010 and energy consumption per vehicle produced by 10 percent compared to 2010. Also in 2011, we improved energy efficiency in our North American operations by 2.6 percent indexed against our 2010 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 facilities-related CO_2 emissions by approximately 48 percent, or 4.5 million metric tons, from 2000 to 2011. During this same period, we reduced facilities-related CO_2 emissions per vehicle by 36.5 percent. Our total CO_2 emissions decreased from 2010 to 2011 by more than 2.7 percent, while total CO_2 emissions per vehicle decreased by 7.5 percent during that period.

Related Links

This Report

- Climate Change
- Emissions Trading
- Non-CO_2, Facility-Related Emissions

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 ended in 2011. The Company has also committed to reduce U.S. facility emissions by 10 percent per vehicle produced between 2002 and 2012, as part of an Alliance of Automobile Manufacturers program.

Please see the Climate Change and the Environment data section for more detail.

The EPA again recognized Ford's energy-efficiency achievements in North America 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 using the variety of initiatives 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. We are currently expanding that system to other utilities and to provide greater analytic abilities.

During 2010, we began planning to expand this system to a global scale and to provide energy-consumption data down to the departmental level. Our Kansas City Assembly Plant and Cologne Assembly Plant served as the pilot sites for this Global Departmental Level Metering (GDLM) effort. The system is now implemented at these two sites, and they are in their final stages of testing. We are now working on the global rollout of this approach. Linked with production, other data sets and access to maintenance and control systems, this will greatly improve data analysis and the time required to make system changes.

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 17 buildings in the Dearborn, Michigan, area into one performance contract to upgrade to more-efficient lighting. The project reduced energy use by more than 18.2 million kilowatt-hours – enough to power 1,648 U.S. homes for a year. The project also eliminated more than 11,000 metric tons of CO_2 emissions and cut annual costs by more than $1.3 million. In 2012, we began exploring another lighting performance contract for other facilities in the Dearborn area and additional opportunities at several manufacturing sites. Opportunities are also being explored for updating and/or commonizing building automation controls and mechanical systems, using this approach. We are investigating the replication of performance contracting for energy reduction for other regions of the world.

In addition, we are replicating Ford's state-of-the-art paint process that eliminates the need for a stand-alone primer application and a 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.

Ford began implementing this technology in 2007 in the U.S. Since then, we have expanded implementation across our global operations when we build new facilities or refurbish existing ones.

We have implemented Three-Wet paint at facilities in India, Romania, Mexico, China and Thailand. We now use the Three-Wet system at nine of our facilities globally and are continuing to evaluate additional plants for Three-Wet conversion, as refurbishment actions are being planned in line with the corporate business plan.

We are continuing implementation 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. The new 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. We are now using this technology at plants in the U.S., Romania and Germany. 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 and are pursuing the use of this technology in China, India and Brazil.

We are also continuing the development of 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, a paint emission concentrator concentrates VOC emissions by approximately 2,000:1. In this super-concentrated state, the VOCs themselves can be burned as a fuel source, significantly reducing the amount of natural gas necessary to destroy them. By reducing the need for natural gas, the paint emission concentrator 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

Renewable Energy

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

Ford's Genk plant in Belgium is partly powered by two wind turbines 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. Furthermore, all other electrical energy supplied by Electrabel used at the Genk plant comes from renewable sources.

Ford's Dagenham Diesel Engine Assembly line 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 MW wind turbine was installed in 2011.

Dagenham Diesel Centre, UK

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 also 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.

Related Links

This Report
- Partnerships and Collaboration
- Waste Management

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 MW 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 Partnerships and Collaboration.

In 2012, we installed a solar-powered trash compactor at our Michigan Proving Grounds in Romeo, Michigan, which compresses waste more efficiently than the previous one. The resulting compacted waste is sent to an incinerator where it is converted into power for local residents. Please see the Waste section for more information on this technology.

In India, we are using solar thermal heating at the Chennai plant to heat water for cooking in the main cafeteria. Using this system, sterilized water is pumped through thermal solar panels and then taken to the cafeteria for cooking at approximately 50°C higher than water that was previously used in cooking boilers. This system has reduced boiler diesel consumption by approximately 420 liters per day. The system, which was installed in spring of 2011, is expected to pay itself back in four years.

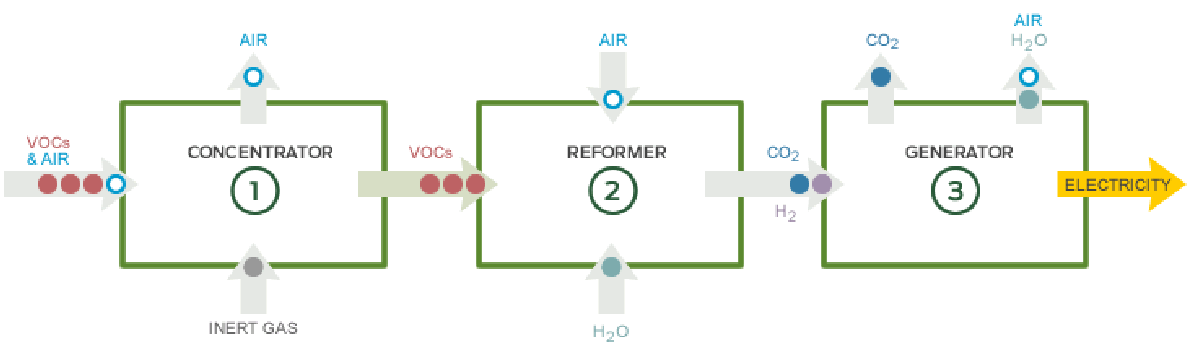
Non-CO_2, Facility-Related Emissions

We report on a variety of non-carbon-dioxide (CO_2) facilities emissions in the Climate Change and the Environment Data section. In this section, we discuss how we are reducing emissions of volatile organic compounds (VOCs) at our facilities. VOCs are a significant aspect of Ford's manufacturing operations due to the size and number of paint shops that we operate.

Related Links
This Report
Operational Energy and Greenhouse Gas Emissions

Since 2000, Ford's North American operations have cut VOC emissions associated with the painting process (by far our largest source of VOC emissions) by more than 35 percent. In 2011, these operations emitted 20.4 grams of VOCs per square meter of surface coated. Because the control equipment used to reduce VOC emissions consumes significant amounts of energy, we have worked to identify innovative approaches to painting that meet cost, quality and production goals while allowing us to reduce energy use significantly and maintain environmental compliance.

In one innovative approach, Ford developed a "fumes-to-fuel" system in partnership with Detroit Edison. Initially tested at the Ford Rouge Center, a paint emissions concentrator was used to concentrate fumes containing VOC emissions from solvent-based paint for use as fuel to generate electricity. The fuel was tested on a solid oxide fuel cell.



Generating electricity from paint fumes

Move over the numbers above to see what happens at each stage.

1 CONCENTRATOR

Strips air from paint fumes, leaving concentrated volatile organic compounds (VOCs)

2 REFORMER

Ford-patented process converts VOCs to hydrogen gas

3 GENERATOR

Uses hydrogen gas as fuel for fuel cell or conventional power plant to make electricity

To further support the research and development efforts on the "fumes-to-fuel" system, in 2008 a research facility was built at our assembly plant in Oakville, Canada, with support from the Canadian government. This site contains a production-scale version of the equipment, including a paint emissions concentrator, a VOC fuel reformer, a 300 kW molten carbonate fuel cell and a 120 kW internal combustion engine. The intent of this technology is to collect a portion of the VOCs from the spray booth exhaust, then super-concentrate the VOCs in the paint emissions concentrator, followed by condensing the VOCs for use as a fuel for either the 120 kW internal combustion engine or as feed to the VOC reformer, which would then be used in the 300 kW molten carbonate fuel cell.

In 2011, the paint emission concentrator at this facility continued to run and generate solvent, and the internal combustion engine continued to be evaluated for long-term performance. In addition, the VOC reformer was started up, generating valuable operating information. Efforts continued with two Canadian universities to help drive the research and development of this innovative technology.

Ford's fumes-to-fuel system, with or without energy generation, has the potential to reduce CO_2 emissions by 80 to 85 percent compared to traditional abatement equipment. A fumes-to-fuel system with energy generation using the fuel cell also has the potential to eliminate nitrogen oxide emissions.

In 2011, Ford introduced an innovative new windshield attachment process that reduces VOC emissions. The typical method to attach a windshield – used currently at Ford and throughout the industry – is to first wipe the glass with a solvent cleaner, then apply a primer and adhesive to secure the windshield to the vehicle. However, this method releases a small amount of highly undesirable solvent emissions. Ford's new patented technology eliminates the use of the solvents that contain VOCs and simplifies the manufacturing process by reducing steps, such as wiping the glass clean. Ford is working with Plasmatreat, an Illinois-based supplier, to implement the technology. The technology will be offered worldwide first in equipment that Plasmatreat plans to sell or lease to Ford, then to other automakers, the heavy truck market, motor home and bus industries and other customers who want to use it.

Moreover, we are reducing VOC emissions with an innovative paint process called "Three-Wet." This process reduces VOC emissions by 10 percent and has other environmental, financial and quality benefits. For more information on Three-Wet, please see the Operational Energy and Greenhouse Gas Emissions section.

Water Use

Water conservation is an integral part of Ford's sustainability strategy. Many vehicle manufacturing processes require water, and water is used at every point in our supply chain. Our water-related risks come not only from being a direct water consumer, but from being a large purchaser of water-intensive materials, parts and components. Because this issue has increased in importance and focus for Ford in recent years, we now discuss it in its own separate Water section.

Related Links

This Report

- Water

Waste Management

Ford's environmental goals include reducing the amount and toxicity of manufacturing-related wastes and ultimately eliminating the disposal of waste in landfills. Manufacturing byproducts include both hazardous and nonhazardous wastes. Ford has chosen to target eliminating the landfill of hazardous waste first, because this provides the quickest and most cost-effective benefits to human health and the environment.

In 2011, Ford facilities globally sent approximately 56,000 metric tons of waste to landfill, a reduction of 11.3 percent from 2010. Ford has reduced waste to landfill on a per-vehicle basis by almost 40 percent over the last five years, which reflects our continuing efforts to reduce the amount of landfilled waste associated with vehicle production. In 2011, Ford facilities globally generated approximately 42,000 metric tons of hazardous waste, which is comparable to our 2010 hazardous waste generation levels. We reduced hazardous waste on a per-vehicle basis by 10 percent from 2010 and by 16 percent over the last five years.

The following Ford facilities have achieved zero waste to landfill: the Rawsonville Plant in Michigan; the Cologne, Germany, manufacturing facilities, including the Engine and Vehicle Operations plants, Technology Development Center and Ford Customer Service Division facility; the Saarlouis Body and Assembly Plant in Germany; the Genk Assembly Plant in Belgium; the Chennai Assembly and Engine Plants in India; the Lio Ho Plant in Taiwan; and the JMC Assembly Plant in Nanchang, China.

Our European operations have committed to significantly increase the proportion of waste recycled and reused and to cut landfill waste by 70 percent. That means a reduction in the average landfill waste generated per vehicle to 1.5 kg by 2016 from 5 kg in 2011. This reduction will be on top of the 40 percent reduction in landfill waste Ford of Europe has already achieved since 2007.

We are always seeking ways to further reduce waste throughout our operations. In some cases, we are even able to turn waste directly into a new fuel source. For example, we have developed a Recovered Paint Solids Program through which we collect waste paint, or "overspray," from our paint booths and turn it into a fuel used by local utilities to generate electricity. Using this process, we have recycled 163 tons of paint waste from our Ford Auto Alliance Plant in Flat Rock, Michigan, since early 2010. An estimated 163,000 KWh of energy – enough energy to power 20 residential homes for a year – were produced as a direct result of this program. At the Chicago Assembly Plant and the Michigan Assembly Plant, approximately 174 tons of paint solids were eliminated from landfill and processed as a fuel source in 2011.

In 2012, we installed a solar-powered trash compactor at our Michigan Proving Grounds in Romeo, Michigan. The new solar compactor provides the energy to compress the general waste from the facility into a 42-yard container by an increased capacity of 4:1 compared to the open-top boxes that were previously used. The trash is then sent to an incinerator in southeast Michigan where it is converted into power for the local area residents. The combination of the improved trash compactor and our recent efforts to recycle all of the site's cardboard, paper, wood and plastic, eliminates the need for the Michigan Proving Grounds to dispose of any waste in a landfill.

Sustainable Land Use and Biodiversity

Our activities have the potential to affect land use, nature and biodiversity, directly and indirectly. Our real estate portfolio includes properties for manufacturing and office use. The construction and operation of these facilities have direct impacts on land.

Ford's most significant potential impacts on land and biodiversity are indirect, occurring elsewhere in our value chain or arising from the use of our vehicles. Indirect impacts include the extraction of raw materials to make vehicle parts, habitat fragmentation from road construction, localized pollution from vehicles and the potential effects of climate change on biodiversity.

Many of our facilities have taken steps to improve biodiversity and wildlife habitat on their land, as follows.

Sustainable Landscapes

A highly visible example of Ford's commitment to sustainability can be seen on more than 200 acres of Ford-owned land throughout southeast Michigan, which is adorned with sunflowers, wildflowers, prairie plants and other non-turf grass plantings. This landscaping provides habitat for wildlife: for example, fox, wild turkeys and coyote have been spotted on Ford properties. This landscaping reduces mowing and other maintenance costs. By replacing what otherwise would be traditional turf grass, the Company saves approximately 30 percent on the costs of labor, gas and fertilizer. We also use native plants in our landscaping whenever possible, which require less water and fertilizer to maintain.

We are also installing "smart" irrigation systems at some of our Dearborn (Michigan) properties. These systems use site conditions – such as soil and plant types, evapo-transpiration rates and local weather data – to program watering only when it is needed. To date, 18 sites have been completed and are providing water savings of just over 30 percent. An additional 14 sites will be completed this year, with the remaining 28 sites to be completed over the next three years.

Creating Wildlife Habitat

Ford has created wildlife habitats at many of our facilities. We are committed to maintaining our existing wildlife habitat sites and to creating as many new sites as possible in the future. Wildlife habitats on Ford facilities range in size from five acres to more than 100 acres and include ecosystems as diverse as wetlands, woodlands, prairies, meadows and forests. Ford employees, often in partnership with local civic and education groups, develop and maintain the habitats, which host dozens of native plant and wildlife species. At many of the facilities, employees and other volunteers have built nature trails, erected bird and bat houses and planted wildflower gardens, in addition to establishing wildlife habitats. These facilities have also developed community education programs to encourage broader understanding of the importance of corporate wildlife sanctuaries.

In 2009, Ford's Romeo Engine Plant in Romeo, Michigan, was awarded a Neighborhood Environmental Partners Award from the Michigan Department of Environmental Quality for its work to build wildlife habitat on the plant site. Plant employees have worked hard to preserve and enhance the wildlife habitat available on the site's 141 acres, planting trees and building nest boxes to attract native birds, including bluebirds and screech owls. To promote habitat awareness and increase community participation, the Romeo Engine Plant's wildlife team organizes an annual tree sale and plant exchange, and plant employees organize clean-ups and other activities to celebrate Earth Day.

In February 2010, Ford and Automotive Components Holdings announced the donation of a coastal wetland in Monroe, Michigan, to the U.S. Fish and Wildlife Service. The property, known as Ford Marsh, will add 242 acres to the Detroit River International Wildlife Refuge.

In Europe, we have created large natural reserves at our facilities in Valencia, Spain, and Kocaeli, Turkey.

Our Mexican operations and dealers are also working to protect wildlife habitat and biodiversity. Since 1997, our Mexican operation's "Civic Committee" has been funding work to protect the peninsular pronghorn, an endangered species in Baja, California. This project has used captive breeding and reintroduction into the wild to increase the number of pronghorns. When the program first began, there were only 150 pronghorns in the area. A comprehensive field census is currently underway, but project managers estimate there are now nearly 500. This project has received global attention because these pronghorns are one of the only species that have been successfully reintroduced into the wild and are reproducing naturally in their own habitat. This project is managed by Espacios Naturales y Desarrollo Sustentable, a nonprofit organization, and Comisión Nacional de Areas Naturales Protegidas, the government office that oversees natural protected areas. The project also receives support from Animal Kingdom, the San Diego Zoo and other international wildlife organizations.

Our Mexican operation's civic committee is also funding the "Mexican Natural Reserves: A Natural Solution for Climate Change," a communications campaign to raise awareness about the more than 150 natural protected areas in Mexico. The campaign is intended to foster understanding of the important services that these natural areas provide to communities, including air and water purification, food and wildlife habitat. So far, this project has produced several videos of natural areas shown in cinemas, airline TV programs, buses, airports and other locations.

Home > Climate Change and the Environment > Greening Our Operations > Sustainable Land Use and Biodiversity

Green Buildings

Ford is a leader in green building and is committed to the sustainable design of our facilities and landscapes using the basic principles of resource effectiveness, lifecycle assessment, health, safety and environmental performance. In the past, we have included green building design principles into our buildings on a case-by-case basis. To help standardize and broaden our efforts in this area, we are currently developing corporate specifications for building new facilities that will focus on sustainability. These specifications require that new manufacturing facilities be designed and constructed using the best practices Ford has developed at plants all over the world. These standards will act to replicate best practices across our global operations and create efficient and sustainable plants. Some examples of best engineering practices that will be implemented in our new facilities include:

- Advanced water-treatment technologies, to allow the reuse of water and reduce water supply requirements, water discharges, use of treatment chemicals and the generation of solid waste
- Energy-saving technologies, such as advanced control of air compressors, high-efficiency lights, variable-drive electric motors, skylights and daylighting, and white roofing materials
- Advanced paint shop technologies, to reduce emissions, energy use and waste, including wet-on-wet paint and advanced automated paint application equipment

Ford is a member of the U.S. Green Building Council (USGBC) and a supporter of its green building rating system, known as LEED® (Leadership in Energy and Environmental Design). The LEED system includes a series of standards used for certifying buildings as Silver, Gold or Platinum. It is recognized as the industry standard for green building. Ford employees who are involved in the design, operation and maintenance of commercial and manufacturing facilities have obtained LEED Accredited Professional certification, which demonstrates their proficiency in the application of the LEED rating systems. Having this expertise in-house will continue to strengthen our knowledge and the speed at which we apply environmentally sustainable technologies and processes at our facilities.

Ford is evaluating existing buildings to achieve LEED certification. The LEED v3 Green Buildings and Operations Maintenance Rating System, or LEED GBOM, helps building operators measure operations, improvements and maintenance on a consistent scale, with the goal of maximizing operational efficiency while minimizing environmental impacts. The standards are intended to promote healthful and environmentally friendly buildings that are also durable, affordable and high performing by focusing on six key areas: sustainable site management, water efficiency, energy and atmosphere impacts, materials and resource use, indoor environmental quality and innovations in operations.

Ford piloted the LEED Existing Building (LEED-EB) certification process on Corporate Crossings, an office building that Ford developed in 1999 in Dearborn, Michigan. In 2011 we achieved LEED-EB Silver Certification for this building, the first Ford Motor Company building certified under the LEED-EB program. We are now in the process of seeking LEED Existing Building Operations and Maintenance (LEED-EBOM) certification for our Research and Innovation Center (RIC) in Dearborn, Michigan. In 2012, RIC will enter the “performance period” of the certification process. During this period, actual building performance is measured for at least three months, after all of the changes we are making to the building and its operation to obtain certification credits are implemented. These changes include energy-efficiency technology upgrades, operational policies and staff training. We hope to have the RIC facility LEED-EBOM certified in 2013.

Based on these experiences, Ford is evaluating the certification of the balance of our portfolio of commercial office buildings through the USGBC’s LEED for Existing Buildings: Operations and Maintenance Volume program. The LEED Volume Program was designed by the USGBC to meet industry needs for a streamlined approach to certifying similar buildings and spaces. The program,

Related Links

This Report

- Dealers

through the use of prototype standards, allows organizations to simplify the LEED documentation for multiple buildings or spaces of a similar type or management.

Our goal is to assure that the green building practices, procedures, policies and initiatives we have already developed will meet USGBC LEED-EB standards and help create a comprehensive sustainability program for our portfolio of commercial office buildings.

Ford is also working to advance green building practices through partnerships with our building-related service providers. These partnerships help to educate service providers and provide a forum to exchange information on the concepts of sustainable design. For example, we have held training sessions on site selection, water efficiency, energy use reductions, sustainable materials and resources, and indoor environmental quality.

We are also working with our dealers to help them improve the environmental performance of their facilities. For more information on our work to help “green” Ford and Lincoln dealerships, please see the Dealers section.

Green Dealership – Dagenham Motors, Barking, United Kingdom

Ford’s Dagenham Motors dealership in Barking, England, recently built an all-new “green” dealership using the latest environmentally friendly materials and a number of sustainable and special energy-saving features. The new facility includes new and used car showrooms and a service center.

Water use at the facility is reduced by capturing rainwater runoff from the roof and storing it in a 3,500-gallon underground tank that supplies water for washing cars and flushing toilets. The rainwater-harvesting tank includes a UV sterilization unit and inline contaminate and particulate filters that enable the water to be suitable and hygienic for hand washing. In addition, waste oil from cars that have been serviced is reused for heating the premises by fueling an integrated used oil burner on the site. In addition, a wind turbine was installed to generate up to 10 percent of the site’s electricity, and the facility used green construction practices. Approximately 1,800 square meters of nonhazardous soil that was excavated from the site during construction will be reused to landscape the site rather than being transported to landfill.

Green Housekeeping Program

Ford promotes the use of environmentally friendly products in the operation and maintenance of its facilities. One example of this is the continued expansion of our “green housekeeping” program. Through this program, we are working with our Tier 1 suppliers and contractors to promote the use of environmentally friendly cleaning practices and water-based products that help to reduce the impact of facility operations on the environment. Our cleaning service providers use highly concentrated, water-based chemicals with more efficient packaging, which significantly reduces product waste and the amount of fuel required to ship products. These green housekeeping practices are now in use throughout our North American manufacturing locations and commercial office buildings.

Ford Rouge Center

Ford’s largest green building initiative was the redevelopment of the 600-acre Ford Rouge Center in Dearborn, Michigan, into a state-of-the-art lean, flexible and sustainable manufacturing center. The focal point of the center, the Dearborn Truck Plant, boasts a 10.4-acre living roof, part of an extensive stormwater management system that includes bio-swales and porous pavement to slow and cleanse the water. The Dearborn Truck Plant also features abundant skylights to maximize daylight in the facility. And, the Rouge Center features 100 acres of sustainable landscaping to help restore soils and support wildlife habitat.

Corporate Crossing (LEED-EB)

In 2011 we achieved LEED Existing Building certification for our Corporate Crossing office building, located in Dearborn, MI. This is the first Ford facility to achieve this LEED rating.

Rouge Visitor Center (LEED-Gold)

The redeveloped Ford Rouge Center includes the LEED-Gold certified Rouge Visitor Center, a 30,000-square-foot facility featuring two multi-screen theaters and an observation deck. The facility uses rainwater for plumbing and irrigation, and solar panels to produce energy. In addition, “green screens” of shading vines cover some parts of the building to reduce energy use.

Fairlane Green (LEED-Gold)

Ford has developed a 1-million-square-foot green retail center on its 243-acre industrial waste landfill in Allen Park, Michigan, earning the national Phoenix Award for excellence in brownfield development. In addition, Fairlane Green Phase I received the nation's first LEED-Gold certification for a core and shell retail development, for its use of retention ponds for irrigation, sustainable landscaping and white roofs, and for the preservation of natural areas. The buildings feature high-efficiency heating and cooling systems, added insulation and weather sealing, and efficient windows and doors.

Product Review Center (LEED-Silver)

Ford's Product Review Center in Dearborn showcases Ford's latest products and green building principles. The LEED-Silver-certified building incorporates an innovative system to recycle water for irrigation and cooling, large windows to maximize daylight and extensive use of local and recycled materials.

Compliance

Manufacturing Plants Notices of Violation

Ford received four notices of violation (NOV) from government agencies in 2011. Two of the NOVs received were in the U.S., one was in Canada, and one was in Taiwan. The issuance of an NOV is an allegation of noncompliance with anything from a minor paperwork requirement to a permit limit, and does not mean that the Company was in noncompliance or received a penalty.

Offsite Spills

In 2011, no offsite spills occurred at Ford manufacturing facilities.

Fines and Penalties Paid

In 2011, Ford paid $330 in fines and penalties globally pertaining to environmental matters in our facilities.

Remediation

Ringwood Miners Landfill Site

Ford Motor Company continues to address concerns raised in connection with Ford's prior disposal activities in Ringwood, New Jersey, including the adequacy of the prior investigation and cleanup. The Ringwood site was used for decades for the legal and illegal disposal of a wide variety of wastes by the Borough of Ringwood and other parties. Ford used the site to dispose of waste materials (primarily cardboard, wood wastes and paint sludge from the former Mahwah Assembly Plant) from 1967 to the middle of 1971. Ford participated in remediation activities at the site in the 1980s and 1990s. In September 2004, Ford entered into an Administrative Order on Consent (AOC) and Settlement Agreement (AOC) with the U.S. Environmental Protection Agency (EPA) regarding additional environmental activities at the Ringwood site. Ford entered into a second AOC with the EPA in May 2010 that obligates Ford to complete the remedial site investigations, human health and ecological risk assessments, as well as feasibility studies for each of the three soil operable units (OUs) and one groundwater OU. Ford, with the Borough of Ringwood's cooperation, is currently completing the necessary reports for the three soil OUs. It is anticipated that the EPA will select a final remedial approach for the three soil OUs later this year and construction could begin in late 2013.

Data

IN THIS SECTION

Fuel Economy and CO_2 Emissions

Tailpipe Emissions

Operational Energy Use and CO_2 Emissions

Emissions (VOC and Other)

Waste

DATA

Fuel Economy and CO_2 Emissions

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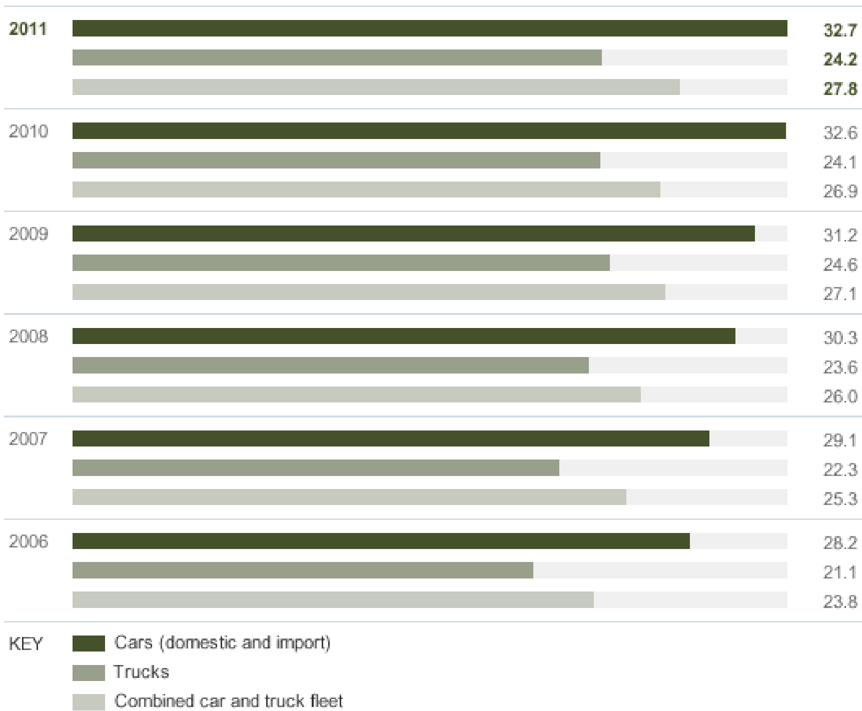
A. Ford U.S. Corporate Average Fuel Economy

Miles per gallon



	2006	2007	2008	2009	2010	2011
Cars (domestic and import)	28.2	29.1	30.3	31.2	32.6	32.7
Trucks	21.1	22.3	23.6	24.6	24.1	24.2
Combined car and truck fleet	23.8	25.3	26.0	27.1	26.9	27.8

Reported to regulatory authorities

Related Links

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B. Ford U.S. CO_2 Tailpipe Emissions per Vehicle (Combined Car and Truck Fleet Average CO_2 Emissions)

Grams per mile

	2006	2007	2008	2009	2010	2011
	371	352	340	326	329	318

Notes to Data

Improvement is reflected in decreasing grams per mile.

Related Links

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- Vehicle

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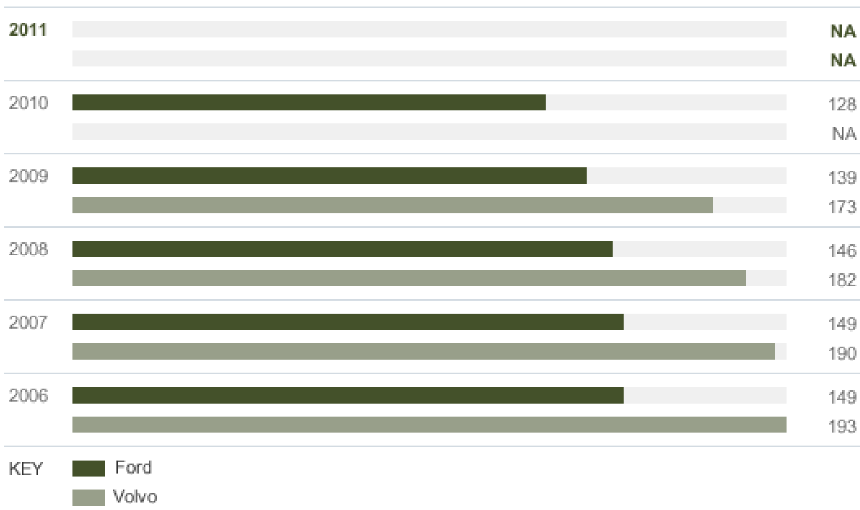
C. Ford Europe CO_2 Tailpipe Emissions per Vehicle

Grams per kilometer



	2006	2007	2008	2009	2010	2011
Ford	149	149	146	139	128	NA
Volvo	193	190	182	173	NA	NA

Notes to Data

The 2011 calendar-year fleet-wide CO_2 emissions data for our European fleet will be available in November 2012. Improvement is reflected in decreasing grams per kilometer. Based on production data for European markets. European and U.S. fleet CO_2 emissions are not directly comparable because they are calculated in different units and because they are assessed based on different drive cycles. In 2009, we switched from reporting European vehicle CO_2 emissions as a percent of a 1995 base to reporting actual fleet average CO_2 emissions, to parallel our reporting for other regions.

Analysis

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 (not including Volvo). 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.

Related Links

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- Vehicle

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DATA

Tailpipe Emissions

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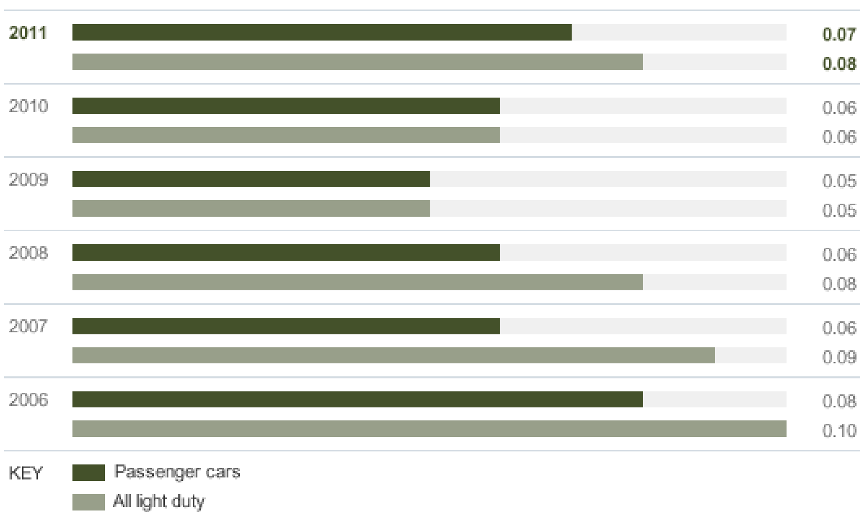
A. Ford U.S. Average NOx Emissions



	2006	2007	2008	2009	2010	2011
Passenger cars	0.08	0.06	0.06	0.05	0.06	0.07
All light duty	0.10	0.09	0.08	0.05	0.06	0.08

Reported to regulatory authorities (EPA)

Analysis

Ford strives to meet regulatory emissions requirements while minimizing the cost to the Company and our customers. As a result, our fleet average NOx emissions have increased while still meeting the regulatory requirements and providing value to our customers.

Related Links

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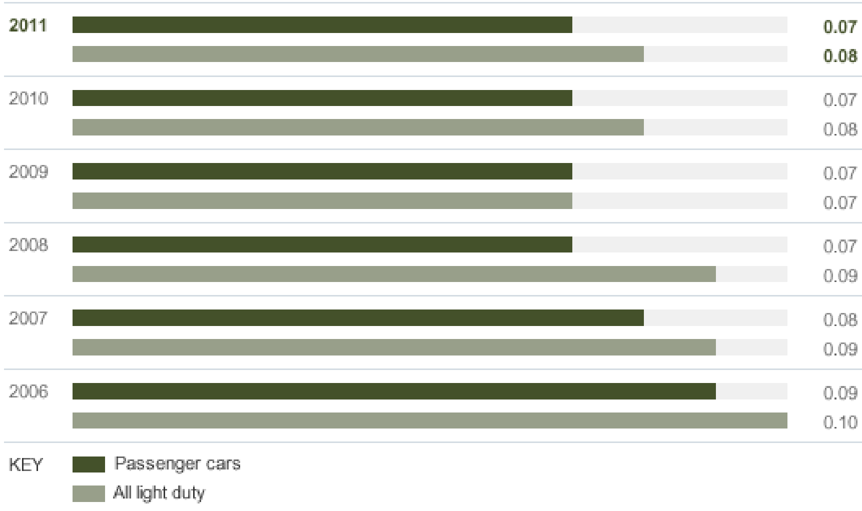
B. Ford U.S. Average NMOG Emissions

Grams per mile



	2006	2007	2008	2009	2010	2011
Passenger cars	0.09	0.08	0.07	0.07	0.07	0.07
All light duty	0.10	0.09	0.09	0.07	0.08	0.08

Reported to regulatory authorities (EPA)

Notes to Data

NMOG = Non-Methane Organic Gases

Related Links

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- Non-CO_2 Tailpipe Emissions

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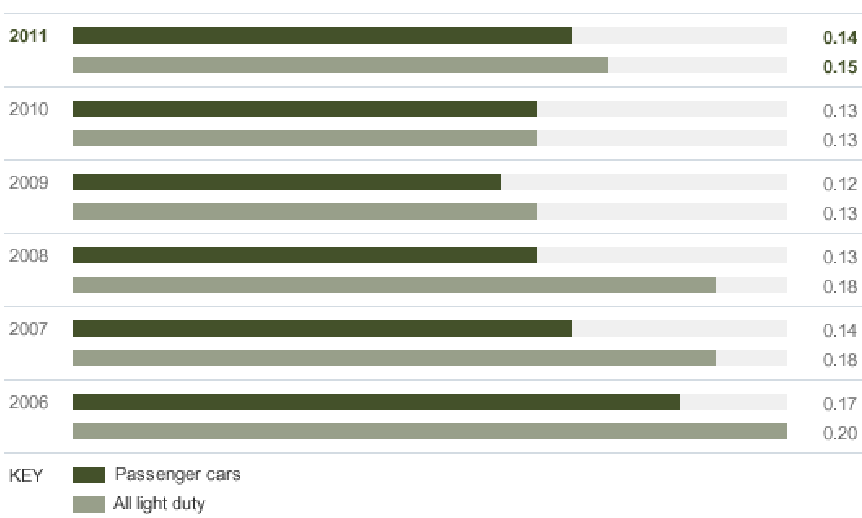
C. Ford U.S. Average Vehicle Emissions

Grams per mile



	2006	2007	2008	2009	2010	2011
Passenger cars	0.17	0.14	0.13	0.12	0.13	0.14
All light duty	0.20	0.18	0.18	0.13	0.13	0.15

Reported to regulatory authorities (EPA)

Notes to Data

Average vehicle emissions are the smog-forming pollutants from vehicle tailpipes, characterized as the sum of [(NMOG + NOx emissions) x volume] for all products in the fleet.

Analysis

Ford strives to meet regulatory emissions requirements while minimizing the cost to the Company and our customers. As a result, our fleet average NOx emissions, a component of our average vehicle emissions, have increased while still meeting the regulatory requirements and providing value to our customers.

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- Non-CO_2 Tailpipe Emissions

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DATA

Operational Energy Use and CO_2 Emissions

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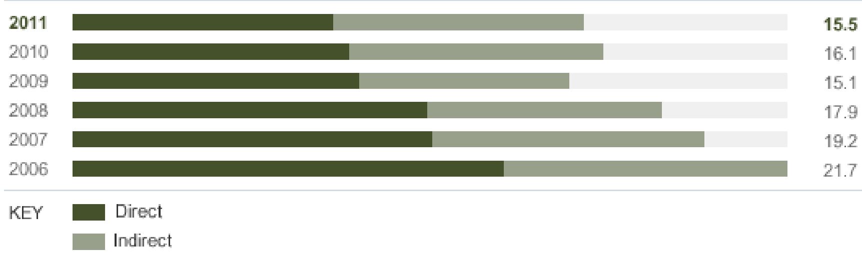
A. Worldwide Facility Energy Consumption

Billion kilowatt hours



	2006	2007	2008	2009	2010	2011
Direct	13.1	10.9	10.8	8.7	8.4	7.9
Indirect	8.6	8.3	7.1	6.4	7.7	7.6
Total	21.7	19.2	17.9	15.1	16.1	15.5

Data managed through the Global Emissions Manager database

Related Links

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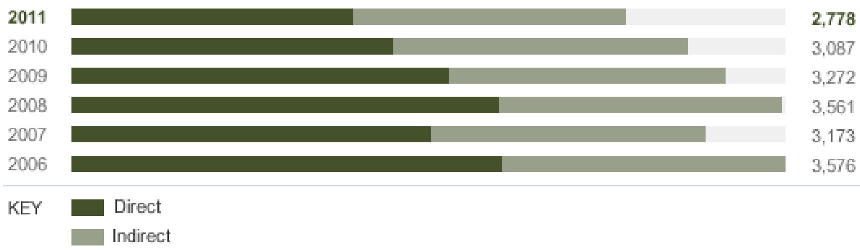
B. Worldwide Facility Energy Consumption per Vehicle

Kilowatt hours per vehicle



	2006	2007	2008	2009	2010	2011
Direct	2,161	1,804	2,142	1,891	1,609	1,408
Indirect	1,415	1,369	1,419	1,381	1,478	1,370
Total	3,576	3,173	3,561	3,272	3,087	2,778

Data managed through the Global Emissions Manager database

Related Links

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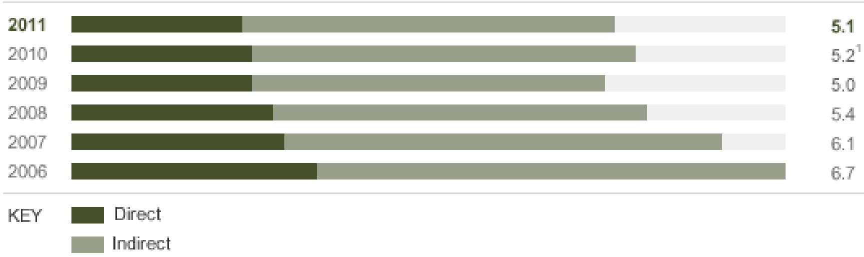
C. Worldwide Facility CO_2 Emissions

Million metric tons



	2006	2007	2008	2009	2010	2011
Direct	2.3	2.0	1.9	1.7	1.7	1.6
Indirect	4.4	4.1	3.5	3.3	3.6	3.5
Total	6.7	6.1	5.4	5.0	5.2[1]	5.1

Third-party verified (North America and EU)[2]

Reported to regulatory authorities (EU). Voluntarily reported to emissions registries or other authorities in Argentina, Australia, Brazil, Canada, China, the Philippines, Taiwan and the U.S.

Notes to Data

1. We restated our 2010 worldwide facility CO_2 emissions for 2010 because the universe of facilities used to calculate worldwide facility CO_2 emissions was modified.
2. Nearly two-thirds of Ford's global facility greenhouse gas (GHG) emissions are third-party verified. All of Ford's North American GHG emissions data from 1998 to 2010 were externally verified by FINRA, the auditors of the NASDAQ stock exchange, as part of membership in the Chicago Climate Exchange. In 2011, Ford became a Climate Registered member of The Climate Registry. All of Ford's North American GHG emissions are now also verified under The Climate Registry. All emissions data covered by the EU Emission Trading Scheme (EU-ETS) and voluntary UK Climate Change Agreements are third-party verified. All EU-ETS verification statements are provided to Ford by facility from BSI for UK facilities, Lloyds for Spain and the Flemish Verification Office for Belgium. North American facilities are verified against the World Resources Institute's GHG Protocol. European

facilities are verified against the EU-ETS rules and guidelines.

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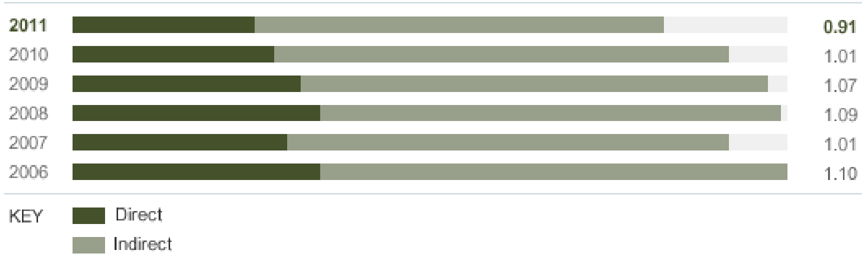
D. Worldwide Facility CO_2 Emissions per Vehicle

Metric tons per vehicle



	2006	2007	2008	2009	2010	2011
Direct	0.38	0.33	0.38	0.35	0.31	0.28
Indirect	0.72	0.68	0.71	0.72	0.70	0.63
Total	1.10	1.01	1.09	1.07	1.01	0.91

Data managed through the Global Emissions Manager database

Analysis

CO_2 emissions per vehicle declined for the fourth year, reflecting our focus on improving the energy efficiency of our operations. We are working to meet our goal of reducing global facility CO_2 emissions per vehicle by 30 percent by 2025 from a 2010 baseline.

Related Links

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E. Energy Efficiency Index

Percent

2006	2007	2008	2009	2010	2011
NA	4.3	11.7	18.3	14.4	2.6

Notes to Data

The North American Energy Efficiency Index is a normalized indicator of energy used per vehicle produced based on a calculation that adjusts for typical variances in weather and vehicle production. The Index is set at 100 for the baseline year to simplify tracking against our annual 3 percent energy-efficiency target. A year 2000 baseline was used through 2006; the baseline was reset to year 2010 starting in 2011. The year

2011 improvement indexed against the year 2010 baseline was 2.6, indicating a 2.6 percent improvement in energy efficiency from 2011 to 2010. Higher percentage reflects improvement.

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CLIMATE CHANGE AND THE ENVIRONMENT

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- Voice: Dr. Rajendra K. Pachauri

DATA

Emissions (VOC and Other)

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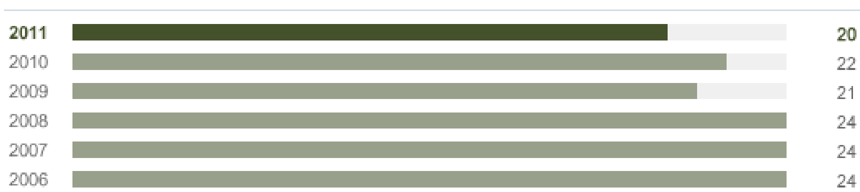
A. North America Volatile Organic Compounds Released by Assembly Facilities

2011 target = 23 g/sq meter or less

Grams per square meter of surface coated



2006	2007	2008	2009	2010	2011
24	24	24	21	22	20

Data managed through the Global Emissions Manager database

Analysis

VOC emissions in North America decreased by 5 percent between 2010 and 2011; we continue to exceed our goal of maintaining emissions at 24 grams per square meter of surface coated. We achieved this goal through, among other things, the use of mold-in-color plastics (which preclude the need for painting) and our fumes-to-fuel technology, which captures VOC emissions from our paint shops and uses them as an energy source.

Related Links

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- Non-CO_2, Facility-Related Emissions

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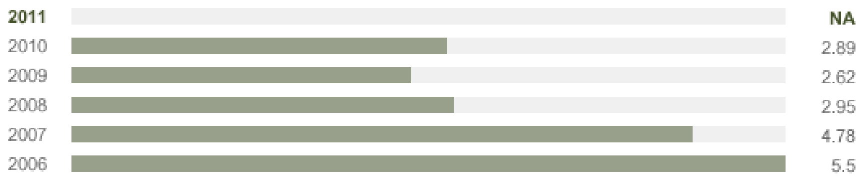
B. Ford U.S. TRI Releases

Million pounds



	2006	2007	2008	2009	2010	2011
	5.5	4.78	2.95	2.62	2.89	NA

Reported to regulatory authorities (EPA)

Notes to Data

Releases reported under the U.S. Toxics Release Inventory are all in accordance with the law, and many of them are subject to permits. The data shown are the most recent reported to authorities.

Analysis

Our U.S. Toxic Release Inventory releases increased from 2009 to 2010 due to increases in production. However, our U.S. TRI releases went down on a per-vehicle basis from 2009 to 2010, reflecting better pollutant release performance when results are adjusted for production levels.

Related Links

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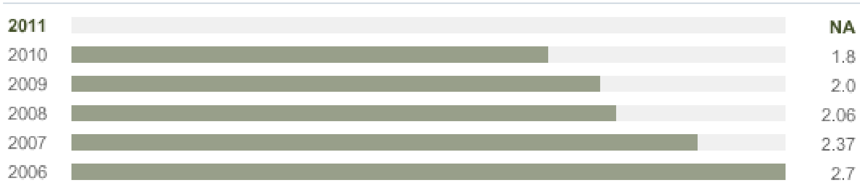
C. Ford U.S. TRI Releases per Vehicle

Pounds per vehicle



	2006	2007	2008	2009	2010	2011
	2.7	2.37	2.06	2.0	1.8	NA

Notes to Data

Releases reported under the U.S. Toxics Release Inventory are all in accordance with the law, and many of them are subject to permits. The data shown are the most recent reported to authorities.

Analysis

Our U.S. Toxic Release Inventory releases per vehicle decreased from 2009 to 2010, the fifth year in a row we have reduced these emissions. These reductions were achieved through material and process changes.

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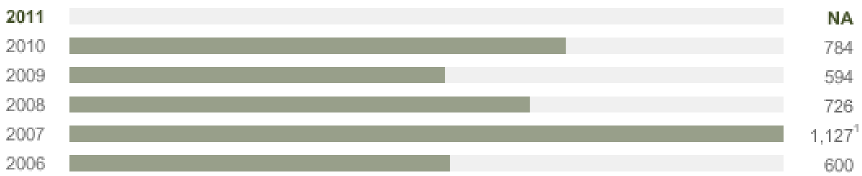
D. Ford Canada NPRI Releases

Metric tonnes



2006	2007	2008	2009	2010	2011
600	1,127[1]	726	594	784	NA

Reported to regulatory authorities (Environment Canada)

Notes to Data

1. This figure was restated due to an arithmetic error.

Releases reported under the Canadian National Pollutant Release Inventory are all in accordance with the law, and many of them are subject to permits. The data shown are the most recent reported to authorities.

Analysis

Our overall total Canada National Pollutant Release Inventory increased from 2009 to 2010 due to an increase in production. However, our Canadian NPRI went down on a per-vehicle basis from 2009 to 2010, reflecting better pollutant release performance when results are adjusted for production levels.

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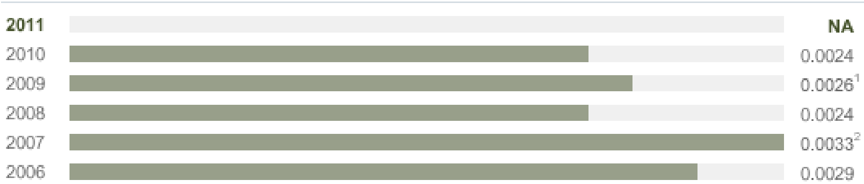
E. Ford Canada NPRI Releases per Vehicle

Metric tonnes per vehicle



2006	2007	2008	2009	2010	2011
0.0029	0.0033[2]	0.0024	0.0026[1]	0.0024	NA

Notes to Data

1. This figure was restated due to an error in the vehicle production figure.
2. The change in total NPRI releases (see above) resulted in the change in per vehicle releases.

Releases reported under the Canadian National Pollutant Release Inventory are all in accordance with the law, and many of them are subject to permits. The data shown are the most recent reported to authorities.

Analysis

Our Canada National Pollutant Release Inventory releases per vehicle continued to decrease from 2009 to 2010. These reductions were achieved through material and process changes.

Related Links

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- Non-CO_2, Facility-Related Emissions

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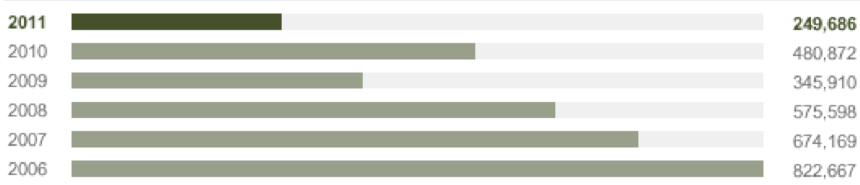
F. Australia National Pollutant Inventory Releases (Total Air Emissions)

Kilograms per year



2006	2007	2008	2009	2010	2011
822,667	674,169	575,598	345,910	480,872	249,686

Reported to regulatory authorities (NPI)

Notes to Data

Releases reported under the Australian National Pollutant Inventory (ANPI) are all in accordance with the law, and many of them are subject to permits. The data shown are the most recent reported to authorities.

Analysis

Our ANPI releases increased from 2009 to 2010 due to an increase in production. However, these releases decreased from 2010 to 2011 due to material and process changes.

Related Links

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Sustainability 2011/12

DATA

Waste

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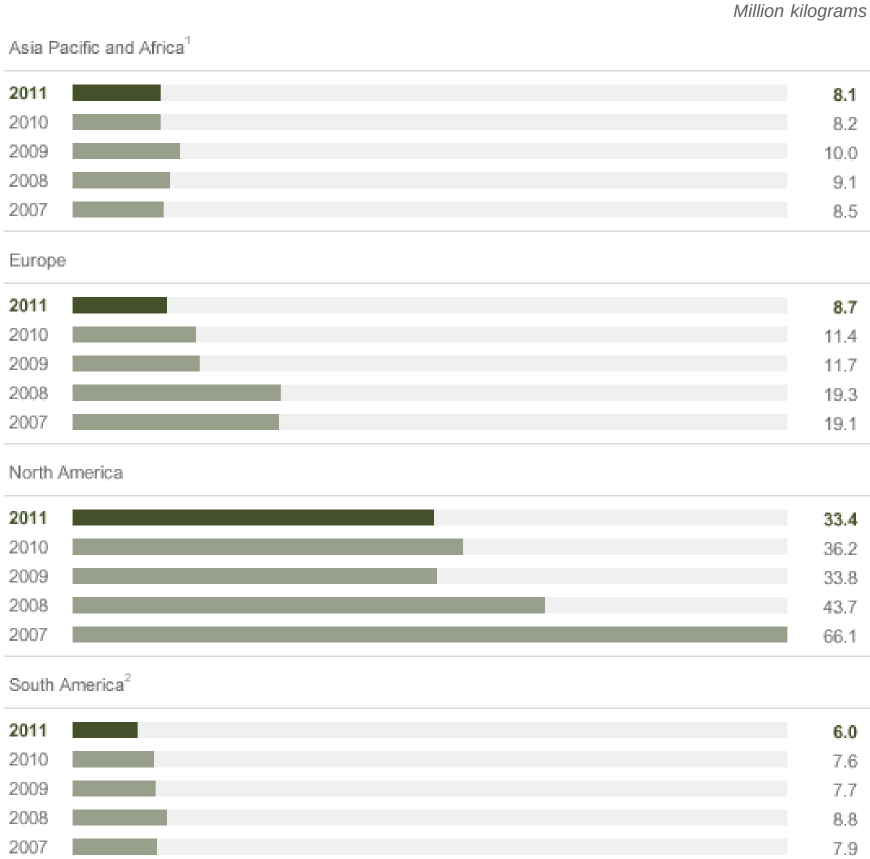
A. Regional Waste to Landfill

Million kilograms



	2007	2008	2009	2010	2011
Asia Pacific and Africa[1]	8.5	9.1	10.0	8.2	8.1
Europe	19.1	19.3	11.7	11.4	8.7
North America	66.1	43.7	33.8	36.2	33.4
South America[2]	7.9	8.8	7.7	7.6	6.0

Data managed through the Global Emissions Manager database

Notes to Data

1. Waste-to-landfill data was restated for all years because casting sands (a type of waste) associated with the Geelong foundry (located in the Asia Pacific region) have been removed from the waste-to-landfill totals for years 2007–2011.
2. Waste-to-landfill data was restated for all years because casting sands (a type of waste) associated with the Taubate foundry (located in the South America Region) have been removed from the waste-to-landfill totals for years 2007–2011.

AutoAlliance International, our joint-venture plant in Flat Rock, Michigan, that produces the Ford Mustang, is included beginning in 2009.

Related Links

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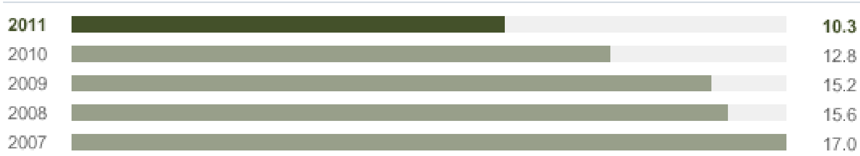
B. Waste to Landfill per Vehicle

Kilograms



	2007	2008	2009	2010	2011
	17.0	15.6	15.2	12.8	10.3

Data managed through the Global Emissions Manager database

Notes to Data

Waste-to-landfill data was restated for all years because casting sands (a type of waste) associated with Geelong foundry (located in the Asia Pacific region) and Taubate foundry (located in the South America Region) have been removed from the waste-to-landfill totals for years 2007–2011.

AutoAlliance International, our joint-venture plant in Flat Rock, Michigan, which produces the Ford Mustang, is included beginning in 2009.

Analysis

In 2011, we reduced waste to landfill on a per-vehicle basis by about 19.5 percent, which reflects our focus on reducing waste produced per unit of production. We decreased waste to landfill primarily through aggressive efforts to generate less waste and recycle more, and through the use of waste-to-energy incineration facilities.

Related Links

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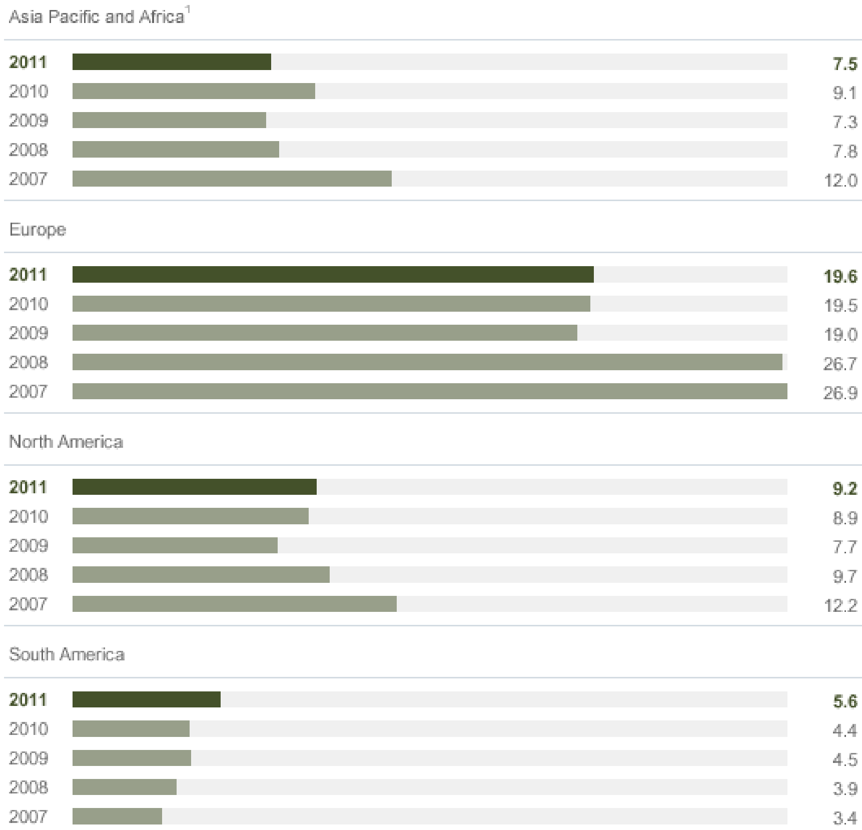
C. Regional Hazardous Waste Generation

Million kilograms



	2007	2008	2009	2010	2011
Asia Pacific and Africa[1]	12.0	7.8	7.3	9.1	7.5
Europe	26.9	26.7	19.0	19.5	19.6
North America	12.2	9.7	7.7	8.9	9.2
South America	3.4	3.9	4.5	4.4	5.6

Data managed through the Global Emissions Manager database

Notes to Data

1. These figures were restated due to corrections in the data.

Related Links

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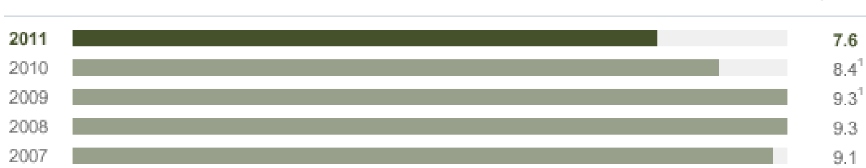
D. Hazardous Waste Generation per Vehicle

Kilograms



2007	2008	2009	2010	2011
9.1	9.3	9.3[1]	8.4[1]	7.6

Data managed through the Global Emissions Manager database

Notes to Data

1. These figures were restated due to corrections in the data.

Analysis

In 2011, we continued a four-year improvement trend by reducing hazardous waste on a per-vehicle basis by 9.5 percent.

Related Links

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Dr. Rajendra K. Pachauri

Chairman, Intergovernmental Panel on Climate Change and
Director-General, The Energy and Resources Institute
2007 Nobel Peace Prize Co-Winner

As awareness of climate change spreads, more people will question the science behind it. We in the scientific community welcome such scrutiny, as science and knowledge thrive on debate, discussion and regular questioning.

That said, we do have substantial evidence to show that human actions are affecting the climate of this planet, and the impacts are becoming ever-more worrying. Human society must take the subject of climate change seriously, because there are enormous implications for the environment, for society and for our overall global economies. Yet despite my concerns, I feel reasonably optimistic that society will have the wisdom to act. If we are empowered with knowledge, and if we understand what is at stake, then we will find solutions.

The United Nations Framework Convention on Climate Change has set an aspirational goal of limiting the average global temperature increase this century to 2 degrees Celsius. However, our scientific assessments show that even a 2-degree temperature rise would result in significant impacts, affecting a large number of species and increasing sea levels by 0.4 to 1.4 meters due to thermal expansion alone, which is a serious problem for several parts of the world. And that doesn't include rising sea levels as a result of melting polar ice.

The risks are very serious, and we've got nowhere to live but on this planet. In the short term, extreme weather events, such as heavy rains and snowfalls, will have major impacts on business and industry, and on the rest of society.

We also have established that heat waves are increasing in frequency and intensity. If we don't stabilize the earth's atmosphere, heat waves that currently take place once in 20 years will occur once every two years by the end of this century. Think of the extreme heat in Europe in 2003, when an estimated 40,000 people died. Of course, a single event cannot be linked to climate change, but our findings are on the basis of extensive scientific evidence.

The world is inevitably going to move to a low-carbon, low-greenhouse-gas (GHG) intensive future. Companies that can reduce the use of fossil fuels and can foresee the technologies, devices and products that will be relevant to the future will emerge as winners.

The auto industry is one sector that can become much more efficient in the use of energy, which is likely one of the drivers behind the trend toward electric vehicles. Overall, the transportation sector has accounted for about one-quarter of the GHG emissions that we have in the world today. Every step we can take to improve the efficiency of transportation will contribute to GHG reductions.

In India and China, we will continue to see automotive sales grow, but cars will remain an elite option limited to the rich and the middle class. Poor people still must rely on public transportation, which also needs to be "greener" than what is available today.

Agriculture is another sector that will be particularly altered by climate change. It's clear that beyond a certain global rise in temperature, the net effect will be a reduction in crop yields. And that's a huge concern when we're expecting the population to rise from about 7 billion people today to about 9 billion by mid-century. We have estimated that, in some African nations, we could see a 50 percent decline in agricultural yield by 2020 as a result of climate variability and climate change.

Related Links

External Websites

- 2007 Nobel Peace Prize
- United Nations Framework Convention on Climate Change

Some of the impacts of climate change – such as rising sea levels and increasing water scarcity in some parts of the world – are already inevitable. This means we'll have to find ways as a society to adapt. But as we adapt, we also must focus on how we can stabilize the concentration of GHGs in the atmosphere.

Human society has the ability and the capacity to bring about major technological changes and innovations. Many of the technologies required to cut emissions significantly are already available or are in the process of being commercialized. We need a set of policies that will provide the right market signals on both the supply side and the consumption side. For example, one of the most effective ways to bring about change would be to put a price on carbon.

There's an Indian philosophy that regards the whole universe as "one family." I believe this approach symbolizes a very practical reality in the context of climate change. We are living in a globalized world, and what happens in one part of this planet has major implications for other parts.

When we embarked on industrialization 150 years ago, we couldn't possibly have known about the impact of GHGs. Now we do, and it's time for us to wake up and realize that we're all in this together. Climate change is not something that's science fiction. It's a reality with a very strong and sound scientific basis.