The early optimism for hydrogen-powered fuel cell vehicles got a reality check in 2005. With the exception of General Motors, virtually no automaker, supplier, energy company or government official expects fuel cell vehicles to be ready for mass production until at least 2020.

Even GM has softened its once bullish position on fuel cells. Instead of having a complete vehicle ready for production in 2010, GM says it now plans to have a fuel cell powertrain tested and validated by the end of the decade.

Because fuel cell vehicles are so far off and because automakers need a mid-term strategy to reduce consumption and lower emissions, gasoline-electric hybrids moved into the lead this year as the quickest and least expensive way to achieve those goals.

The new generation of clean-running diesels will be another fuel-saving powertrain available in North America, but not on that later.

Gasoline-electric hybrids will account for slightly less than 200,000 of the roughly 17 million vehicles expected to be sold in the US this year.

In western Europe, hybrid sales will account for less than 40,000 units of the region’s forecast 14.6 million car sales this year.

Despite the small numbers, most major automakers have or will be investing in the technology and launching new hybrid models starting next year.

Hybrids are not expected to be widely available in Europe until around 2008 or 2009. They likely won’t get as warm a reception as in the US. Hybrids will be competing against thrifty diesel engines, which already account for about half the new-cars sales in western Europe.

General Motors, DaimlerChrysler and BMW formed a partnership that will see all new-cars sales in western Europe, which already account for about half the new-cars sales in western Europe.

In 2008, BMW formed a partnership that will see all new-cars sales in western Europe, which already account for about half the new-cars sales in western Europe.

The Chrysler group, which includes Chrysler, Dodge and Jeep, has had success selling the diesel version of the Jeep Liberty SUV (badged the Cherokee in Europe) in the US and could add diesel versions of the Chrysler 300 sedan and Jeep Grand Cherokee SUV.

Meanwhile, engineers are continuing work on both the gasoline and diesel internal combustion engine.

Several potential breakthroughs could see dramatic improvements in emissions and efficiency.

Ford Motor Co. is one of several automakers testing fuel cell vehicles, including a hybrid fuel cell vehicle. While the Ford Focus FCV (above) appears no different than a conventional Focus, the floorpan is actually a hydrogen fuel cell and auxiliary energy system that can supply electricity to the powertrain. A hydrogen tank is in the trunk. The FCV also has a nickel-metal hydride battery pack and a brake-by-wire regenerative braking system.

Ford aims to start selling models equipped with a hybrid powertrain in Europe by 2007.

Toyota, the leader in hybrid sales, plans to raise global production to 1 million units a year by 2012. Toyota sold about 135,000 hybrids worldwide in 2004.

Diesels, which are hugely popular in Europe, will be returning to the North American market in significant numbers starting in 2008.

Clean alternatives

Suppliers working on low-emission powertrains:

- Aisin Systems
- Robert Bosch
- Continental
- Delphi
- Denso
- Siemens VDO
- Toyota
- Visteon
- ZF
ALTERNATIVE FUELS

The threat of running out of crude oil and concerns about the environment are driving the industry to adopt alternative fuels for internal combustion engines. The industry’s focus is on two groups: those based on natural gas and those made from biomass. Hydrogen – an alternative for the distant future – is not a fuel but an energy carrier. Legislation is driving the research. European Union laws focus on reducing carbon dioxide, a greenhouse gas that some scientists blame for global warming, but are not as tough on particulate matter (soot) and nitrogen oxides (NOx), which are blamed for damaging respiratory systems, aggravating asthma and even death. US and Japanese regulations focus more on reducing soot and NOx.

HOW THEY WORK

Natural gas in compressed condition is a practical and efficient alternative fuel. Compressed natural gas (CNG) has an advantage over other fossil fuels: It contains less carbon and in turn produces less CO2 when burned. Gas-to-liquid (GTL) is a more sophisticated fuel. It is made from natural gas with naphtha as an additive. GTL reduces diesel emissions, plus, both CNG and GTL are sulfur free. Biomass-to-liquid (BTL) fuels are another option. Because biofuels are made from plants, trees or other organic matter that absorb CO2 to grow, they are almost CO2 neutral. Biofuels also can be mixed with existing fuels to improve their properties and reduce emissions such as NOx. BTL can be made from different materials. In Brazil, sugar cane is used to produce ethanol. Rapeseed oil is used to create biodiesel in Europe.

WHERE TO FIND THEM

Available in much of Europe, biodiesel is a blend of 5.75 percent of a BTL fuel such as rapeseed oil with diesel. Italy and Holland are Europe’s top markets for cars that can operate using gasoline with either CNG or liquefied petroleum gas, but combined 2005 new-car sales in each country won’t exceed 10,000 this year. In Sweden, E15 (a mixture of 85 percent gasoline and 15 percent ethanol) is used as part of a nationwide government project. Today, 4 million Brazilian cars, or 40 percent, are running on a local mixture of 25 percent ethanol and 75 percent gasoline.

OBSTACLES

Distribution and cost are the main obstacles. It is difficult to find a place to fill up a car that runs on an alternative fuel, and expensive modifications need to be made to the car so that it can burn the alternative fuel. There is one other problem: offers the solution, which it calls DSG, as an option on 10 models. DSG is short for direct shift gearbox. About 11 percent of the VW Golfs sold in western Europe are equipped with DSG. In the US, the VW group offers DSG as an option on the VW Jetta and Audi A3 and TT. Analysts expect Ford will offer the solution in Europe on the Mondeo and Galaxy. They also believe Volvos ranging from the C30 to the V70 or even the XC90 could get dual-clutch technology.

DUAL-CLUTCH TRANSMISSIONS

Dual-clutch transmissions promise the smooth operation of automatic transmissions with fuel economy equal to or better than manual transmissions. Like continuously variable transmissions and automated manual transmissions, the dual-clutch solution offers better fuel economy than automatic transmissions, which lose power and fuel economy in the torque converter. Transmission specialists expect dual-clutch transmission technology to gain share in Europe and the US during the next five years.

HOW IT WORKS

The dual-clutch transmission works like two automatic transmissions side by side. In a six-speed version, one clutch would operate first, third and fifth gears, while the other would operate second, fourth and sixth. Because the transmission uses two clutches with rapid switches from one to the other, there is no lurch between gears. The solution allows drivers to either set the transmission as an automatic requiring no manual shifting or let drivers manually shift without depressing a clutch pedal.

WHERE TO FIND IT

Europe’s largest automaker, Volkswagen, offers the solution, which it calls DSG, as an option on 10 models. DSG is short for direct shift gearbox. About 11 percent of the VW Golfs sold in western Europe are equipped with DSG. In the US, the VW group offers DSG as an option on the VW Jetta and Audi A3 and TT. Analysts expect Ford will offer the solution in Europe on the Mondeo and Galaxy. They also believe Volvos ranging from the C30 to the V70 or even the XC90 could get dual-clutch technology.

OBSTACLES

A disadvantage of dual-clutch transmissions is that, because of low volume, it costs more to make than most manual transmissions.

PRIMARY SUPPLIERS

BorgWarner is the only supplier with its dual-clutch technology in a mass-market model. Its competitors include Germany’s ZF Friedrichshafen, Getrag, LuK, France’s Valeo and Graziano Trasmissioni of Italy.
Powertrain

GASOLINE DIRECT INJECTION

Gasoline direct injection got off to a false start in the 1990s. Mitsubishi invested heavily in the technology, but in Europe its cars failed to live up to their fuel-saving promise so most buyers stayed with their diesels. Pressure to compete with diesels in Europe and the global requirement to improve fuel economy – without sacrificing performance – has sparked a renewed interest in GDI.

HOW IT WORKS

GDI improves the efficiency of gasoline engines by providing greater control of the fuel-air mixture and the combustion processes. Fuel can be injected in precisely the desired location – generally right next to the spark plug – to maximize power and keep pollutant emissions to a minimum.

Two main types of GDI are used – homogeneous and stratified charge. Homogeneous GDI is the simpler of the two. The fuel-air mixture remains constant throughout. That means a conventional three-way catalyst is all that’s needed for exhaust-gas after treatment. Stratified charge is more oriented toward fuel saving and relies on burning a small pocket of rich mixture surrounded by an excess of air. These so-called lean-burn systems are economical because they can run with a high amount of nitrogen oxides produced in lean-burn mode means costly after-treatment systems are needed.

WHERE TO FIND IT

The Volkswagen group offers direct-injection gasoline versions of many VW and Audi cars. VW calls the technology FSI, which means fuel stratified injection. BMW is set to roll out direct injection across its entire gasoline range in late 2006. “Our focus is not one or two niche models,” BMW spokesman Wieland Bruch said, “but to provide the best available technology over all our model ranges.” BMW has a 6.0-liter direct-injection V-12 engine in the face-lifted 7 series it debuted in the spring. Plus, it revealed late last year that the second-generation Mini will get direct-injection engines co-developed with France’s PSA/Peugeot-Citroen.

OBSTACLES

The principal drawback is cost, especially for stratified charge systems with their complex exhaust after-treatment set-up. The future looks better for homogeneous-charge GDI engines. According to Lotus Engineering of the UK, the overall cost of such engines is still less than a modern Euro 4-compliant diesel.

PRIMARY SUPPLIERS

All the major injection equipment suppliers including Robert Bosch, Delphi, Denso and Siemens VDO Automotive.

CAMLESS ENGINES

The fewer friction-causing, energy-robbing parts to an engine, the better its efficiency. Until recently, few production engineers could envision a way to eliminate camshafts and their timing hardware. Driven using power from the engine crankshaft, rolling camshafts and their lobes have been used to actuate valves since the dawn of the internal combustion engine itself. Variable valve timing has brought efficiency advances, but only by altering the way the camshaft contacts the valves. So-called camless technology may allow for engines that get up to 35 percent greater fuel economy than a conventional gasoline engine while lowering engine emissions.

HOW IT WORKS

In a camless engine, the valves are opened and closed electronically. Unlike mechanical systems, which give fixed amounts of valve travel and timing, an electro-hydraulic device can move valves independently to any lift position for any duration desired. This gives an opportunity for engine systems to tailor the performance of each piston on every cycle, increasing fuel economy and engine torque while reducing emissions. Beyond valve adjustment alone, camless technology could allow for ultra-lightweight valves because the need to absorb the force and action of rolling camshafts is eliminated. Some engineers have suggested that camless technology could ultimately use waste exhaust gases to power valve motion. But, that concept is far in the future.

WHERE TO FIND IT

Valeo, which calls its camless technology Smart Valve Actuation, announced at last month’s IAA in Frankfurt that it expects several leading carmakers to introduce the technology in 2009. Valeo says the technology could reduce vehicle emissions 20 percent versus a conventional engine.

Earlier this year Valeo acquired Johnson Controls Inc.’s engine-electronics unit to gain expertise in camless engines.

TURBOCHARGERS

Almost all direct-injection diesel engines use variable geometry turbochargers. As of 2005, no production gasoline engine had been fitted with a variable geometry turbocharger. Gasoline engines typically have fixed-vane turbochargers.

HOW IT WORKS

Exhaust gases are recycled and forced through the turbine, causing it to rotate. This draws in air from outside, which is cooled and forced into the engine cylinders. The extra air creates more powerful and efficient combustion. This in turn boosts economy and performance, and cuts emissions.

WHERE TO FIND IT

They are on most diesel models sold in Europe and the US. By 2008, sources expect global turbocharger demand to exceed 16 million units. At last month’s IAA in Frankfurt, Volkswagen presented its new Twincharger system for direct-injection gasoline engines. VW’s technology uses an electrically powered supercharger from Eaton and a turbo to provide a boost through the entire engine speed range. In Europe, the Twincharger is on the new VW Golf GT and will be an option on the VW Touran starting next year.

OBSTACLES

The high exhaust temperature and range of operating speeds in a gasoline engine are more demanding than in diesel engines. The maximum temperature of a diesel’s exhaust is about 800 Celsius; gas engines can run up to 1000 C. As a result, it costs too much to make the movable turbine blades durable enough to withstand the heat in direct-injection gasoline engines.

PRIMARY SUPPLIERS

Mitsubishi Heavy Industries, BorgWarner and Honeywell.

TONY LEWIN

Volkswagen combined a supercharger (dark blue) with the turbocharger (red) for efficiency over a wider range of engine speed.

TIM MORA


Tony Lewin

October 31, 2005