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Questions and Answers

Greenhouse Gas Emissions and Automobile Fuel Efficiency

The recent announcement of a deal between the auto industry and the federal government over greenhouse gas emissions reductions from new automobiles has raised many questions about fuel efficiency. The subject of fuel efficiency often becomes confused with other automobile issues, such as toxic emissions, smog and alternative fuels. The following Q & A provides an overview of fuel efficiency, greenhouse gas emissions and the role of automobile technology.

Main Points

- Making automobiles more fuel efficient will reduce greenhouse gas emissions.
- Fuel efficiency standards are an effective way to ensure that new developments in automotive technology are used to increase fuel efficiency and not just engine power, thereby reducing greenhouse gas emissions.
- In the past, fuel efficiency standards worked extremely well to focus new technology development on improving fuel efficiency. Fuel consumption levels dropped by 50 per cent from 1974 to meet standards by 1985. No further reductions in fleet-average fuel consumption levels have occurred since. In fact, fleet-average fuel consumption levels are now higher than in the mid-1980s.[1]
- In the absence of higher fuel efficiency standards, most new automotive technologies have been used to increase horsepower instead of to improve fuel efficiency.

Q. Aren't automobile emissions already regulated? Don't they emit 99 per cent less pollution than automobiles in the 1960s?

A. Government regulations require manufacturers to control certain toxic and smog-forming emissions from automobiles, such as oxides of nitrogen and hydrocarbons. Devices such as catalytic converters can effectively remove a large amount of these pollutants from automobile exhaust. However, there is no practical way to remove carbon dioxide (CO_2), which is the major greenhouse gas in automobile exhaust. The only effective way to reduce CO_2 emissions from an automobile is to consume less fuel. Canada does not have regulations to control CO_2 emissions from automobiles.[2]

[1] This refers to the entire light-duty vehicle fleet (i.e., passenger cars and light trucks combined), including cars, vans, minivans, SUVs and pickup trucks.

[2] There is, however, a long-standing voluntary commitment on the part of auto manufacturers to meet the same standards for fuel efficiency in Canada that exist in regulatory form in the U.S. These regulations are called Corporate Average Fuel Economy standards (abbreviated CAFE) in the U.S. The voluntary equivalent in Canada is called the Company Average Fuel Consumption program (CAFC).

Q. When we talk about automobiles, what is meant by "fuel efficiency"?

A. Basically, an automobile that is more fuel-efficient will consume less fuel as it travels. Fuel efficiency can be measured as fuel economy (miles traveled per gallon of fuel consumed — mpg) or fuel consumption (litres of fuel consumed per 100 kilometres traveled — L/100 km). Fuel consumption is the standard measure used in Canada.

Q. Why is it important for automobiles to be fuel efficient?

A. There are several good reasons to improve the fuel efficiency of vehicles:

- It helps to reduce the amount of greenhouse gases emitted from automobiles. Automobile use is the source of about half of the average Canadian's total personal greenhouse gas emissions.
- Since fuel-efficient automobiles consume less fuel, their owners will be less vulnerable to the impact of rising fuel prices.
- Improving the fuel efficiency of automobiles conserves oil that would otherwise be consumed and hence reduces oil dependence.

Q. How does fuel efficiency help reduce greenhouse gas emissions?

A. For each litre of fuel combusted inside an automobile engine, a specific amount of CO_2 is produced (about 2.4 kg). Since a more fuel-efficient automobile burns less fuel as it travels, it also emits less CO_2.

Q. How are automobiles made more fuel-efficient?

A. Improvements in automotive technology can increase fuel efficiency. Engine designs, for example, are continually being refined to extract more power from fuel. In fact, engines today produce twice as much power as those of the same size thirty years ago! Lightweight materials, improved aerodynamics and reduced friction can also contribute to better fuel efficiency.

Q. Does that mean automobiles are becoming more fuel-efficient?

A. Not necessarily. On average, manufacturers are producing fleets that are less fuel-efficient today than they were twenty years ago. While certain automobiles are very fuel efficient many more are not, and thus the overall average is declining.

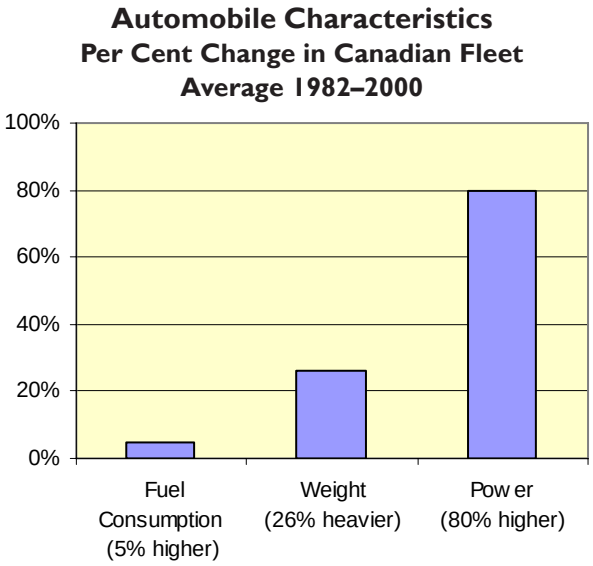
Q. Why are fuel efficiency levels declining? Aren't there fuel efficiency standards in place?

A. There are regulated standards in the U.S. and voluntary standards in Canada. But these fuel efficiency standards were first implemented thirty years ago and have not delivered improvements in the fuel efficiency of new model year fleets since the mid-1980s.

What happened was this: The standards (originally set in 1975) required the auto industry to essentially cut fleet-average fuel consumption levels in half by 1985. Manufacturers mainly achieved this target in two ways. First, by improving engine technology to extract more power from the fuel consumed; and second, by downsizing engines so they consumed less fuel.

Initially, the engine downsizing resulted in a net loss of engine power output. Accordingly, cars became smaller and lighter, so they could perform sufficiently well on less power. But improvements in engine technology were progressing very rapidly, and by the early 1980s net power levels began to rise again, despite the shrinking size of the engines. Engine downsizing stopped in the mid-1980s, as manufacturers achieved the fleet-average fuel efficiency targets set a decade earlier. From this point forward no further engine downsizing has occurred and fleet-average fuel efficiency levels have not improved since.

Today, the average engine is about the same size as it was in the mid-1980s. But engine technology continues to develop, delivering more and more power from a specific amount of fuel. As a result, *engines consume about the same amount of fuel today*



as they did in the mid-1980s, but can produce twice the power. This has allowed manufacturers' fleets to grow larger, heavier and faster while maintaining a consistent average level of fuel efficiency (more or less). The inset chart shows this trend.

To illustrate the point further, if power and weight had been held constant at 1990 levels, it can be estimated that fleet-average fuel consumption (and hence greenhouse gas emissions) from the 2000 model year fleet would have been about 14 per cent less than it actually was.

Q. If automobile fuel efficiency has remained essentially constant since the mid-1980s, how is it that automobile fleets have become *less* fuel efficient?

A. People are buying more minivans and SUVs, which are considered light trucks and held to a lower fuel efficiency standard than cars.

As with cars, light trucks were assigned a fuel efficiency standard in the 1970s. At the time, light trucks were generally work-oriented vehicles, such as pick-up trucks and cargo vans. Due to their heavier build and because they were a relatively small part of the overall vehicle market, they were assigned a lower fuel efficiency standard. But, since minivans and SUVs share certain design qualities with work-oriented vehicles, the vehicle classification rules allow them to be considered as part of the light truck fleet and thus subject to the lower fuel efficiency standard.

This is considered a "loophole" in the standards by many analysts, who point out that minivans and SUVs did not exist when the standards were originally set, and they should not be considered work-oriented vehicles since they are primarily used as personal vehicles. In other words, minivans and SUVs have contributed to the formation of a "two-tier" system of fuel efficiency standards.

The effect is that while the fuel efficiency levels of the car fleet and the light truck fleet remain constant, the growing market share of light trucks (driven by increasing sales of minivans and SUVs) causes the overall fuel efficiency level of the combined fleet to drop.

Q. How can the downward trend in fuel efficiency be reversed?

A. By setting new, higher fuel efficiency standards, the continuing improvements in automobile technology that are being used to increase engine power, for example, can also be used to improve fuel efficiency, and hence reduce greenhouse gas emissions and reduce the amount of money consumers spend on fuel.

It is also important that new standards account for the existence of minivans and SUVs as these vehicles currently escape the fuel efficiency rules to which cars are held.

Q. Will improvements in fuel efficiency also require specially developed technologies?

A. No. The same technologies that are being developed to deliver ever higher levels of power, size and speed can also be used to improve automobile fuel efficiency. Over the past few years, several new technologies have entered the market. You may recognize the names of some of these technologies:

- *Overhead Cam*
- *Electronic Fuel Injection*
- *VTEC engine: Variable valve Timing and lift Electronic Control*
- *HEMI engine: HEMIspherical combustion chamber design*
- *CVT: continuously variable transmission*
- *Hybrid-Electric Drive (gas-electric drive)*

All these technologies essentially do the same thing: they increase the amount of power made available from the fuel in the tank. The only question for manufacturers is whether to increase power while keeping fuel consumption the same, or reduce fuel consumption while keeping power the same, or perhaps a bit of both. For the past 20 years, manufacturers have usually decided to increase power while holding fuel efficiency constant at the level required by the standards. If standards were more stringent, then manufacturers would apply some of the technical improvements to boosting fuel efficiency instead of just power.

Q. Are hybrids primarily a fuel efficiency development?

A. Not necessarily. Honda's new 2005 Accord Hybrid uses an electric motor to increase power and acceleration, as well as fuel efficiency. Depending on the driving environment (city vs. highway), the Accord Hybrid's higher fuel efficiency levels may owe more to the use of light-weight materials and Honda's VCM technology (Variable Cylinder Management, which shuts downs part of the engine when there is less demand for power) rather than the hybrid system itself. In the end, the Accord Hybrid is *somewhat* more powerful and *somewhat* more fuel efficient than a comparable non-hybrid Accord (achieving 40 mpg vs. 30 mpg in the non-hybrid model, or 6.9 L/100km vs. 9.0 L/100km).

Of course, hybrid technology can certainly deliver very high levels of fuel efficiency, as demonstrated by the Honda Insight (78 mpg, 3.6 L/100km) and the Toyota Prius (69 mpg, 4.1 L/100km). But it is up to the manufacturer, the demands of consumers and the requirements of standards and regulations to ensure that hybrid technology is actually used to improve fuel efficiency and reduce greenhouse gas emissions, rather than simply to boost power.

Q. How does hybrid technology work?

A. Very simply:

- An electric motor is added to the automobile's driveshaft to increase power and torque to the wheels.
- The electric power to run the motor is supplied by a battery that is charged by the brakes. Braking normally represents a large source of lost energy in automobiles, but in a hybrid system the brakes are assisted by small electric generators that slow the wheels while simultaneously charging the battery.
- For hybrids to deliver major, near-term improvements in fuel efficiency, however, the internal combustion engine must be downsized. This reduces the amount of fuel consumed by the engine, and while it also reduces engine power, the loss is made up by the electric motor. Working together, the engine and the electric motor can still deliver the overall power required for acceleration.

Q. Haven't owners of very fuel-efficient hybrid automobiles complained that their fuel economy is lower than advertized?

A. Yes, but that's true of all automobiles. The U.S. Environmental Protection Agency — which established the test protocol that is used for measuring automobile fuel efficiency levels in the U.S. and Canada — recognizes that the labeled fuel economy rating on automobiles probably overestimates "real world" fuel economy by a significant margin. The Bluewater Network (a public interest group in the U.S.) claims that real world fuel economy levels experienced by most drivers are as much as 34 per cent lower than EPA levels suggest (i.e., during everyday use, an automobile may get 34 per cent fewer miles per gallon than it gets in the laboratory test).

Q. Does it cost extra to make automobiles more fuel efficient?

A. It depends. It costs money for manufacturers to develop new technologies, but that's their business. It's how they maintain and improve their competitiveness in the market. Manufacturers are constantly introducing new technologies to make their vehicles more appealing to customers. As described earlier, these technologies can be used either to increase power while maintaining fuel efficiency, or increase fuel efficiency while maintaining power, or a bit of both. It is simply a matter of what the market and the fuel efficiency standards demand.

The question is whether a given fuel efficiency standard requires a manufacturer to develop technologies that are too expensive for consumers. Consider again the 2005 Honda Accord Hybrid. It employs three important fuel-efficient features: lightweight materials in the body and the engine, variable cylinder management and a hybrid drivetrain. At the same time, it has been called Honda's flagship model and is the most powerful and fastest-accelerating sedan in Honda's fleet. The price premium for this collection of advanced automobile technology is $3,390 CDN. For an average driver, the added cost could pay for itself in simple fuel savings over the period of ownership.

It is important to note that advanced technologies usually enter the market in premium-priced luxury vehicles and sports cars, and later trickle down into the general fleet where the price differential is absorbed by the market. Case-in-point is the Toyota Echo, an entry-level vehicle with a 108-horsepower, 1.5-litre engine that incorporates double overhead cams and variable valve timing technology and costs under $14,000. Ten years ago, these technologies only existed on a few select vehicles in a much higher price bracket, but they now appear as standard features on today's economy cars.

Given this, it is unlikely that appropriately set fuel efficiency standards would introduce significant price distortions into the market. In California, new regulations are being established based on an extensive analysis by the government, which show that a 30 per cent reduction in greenhouse gas emissions by 2016 can be achieved with little or no net economic impact on vehicle owners in the state.

Q. Can "cleaner fuels" help to improve fuel efficiency?

A. Not necessarily. Some fuels, such as natural gas and propane, are characterized as "cleaner" because they might contribute to fewer toxic or smog-forming emissions — not because they necessarily improve fuel efficiency or reduce greenhouse gas emissions.

Q. How does diesel increase fuel efficiency?

A. The special combustion properties of diesel permit diesel engines to generate more power from less fuel. However, the same qualities that make diesel engines more efficient also cause them to generate more smog-forming emissions. Auto designers are trying to address this problem with advanced emissions control devices.

For further information, consult the new Pollution Probe report, ***Greenhouse Gas Emissions and Vehicle Fuel Efficiency Standards for Canada***, which can be downloaded at www.pollutionprobe.org/Publications/Air.htm.

For further information on how fuel efficiency and greenhouse gas emissions levels compare among automobiles sold in Canada, check the Office of Energy Efficiency's website at http://oee.nrcan.gc.ca/transportation/personal-vehicles-initiative.cfm.