





# Future Perspectives of Flexfuel Vehicles in Brazil

ANFAVEA

Brazilian Automobile Manufacturers Association

Henry Joseph Jr.

Presentation to

9th LAMNET Project Workshop

Ribeirão Preto - September 15th, 2004



# The Flexfuel Vehicles

- The Flexfuel Vehicles were introduced in 2003 at the Brazilian market and 4 car manufacturers (at least, by now) are locally producing them;



# The Flexfuel Vehicles

- The Flexfuel Vehicles were introduced in 2003 at the Brazilian market and 4 car manufacturers (at least, by now) are locally producing them;





- The Flexfuel Vehicles are designed to be indistinctly fueled with gasoline, ethylic alcohol or any blend of these two fuels:





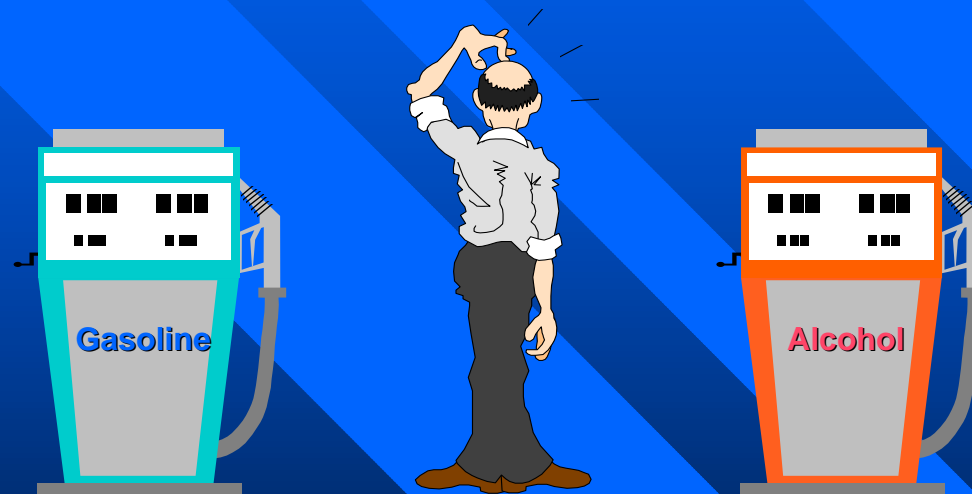
- The Flexfuel Vehicles are designed to be indistinctly fueled with gasoline, ethylic alcohol or any blend of these two fuels:

*Through some special electronic sensors, the on-board computer recognizes the fuel kind and properly adjust the engine combustion parameters to that fuel, without any necessity of interference from the driver.*





- The meaning of the Flexfuel Vehicles for the customers is the possibility of choosing the fuel they want, according to the price, quality, performance characteristics or even availability, at each refueling;





- The meaning of the Flexfuel Vehicles for the customers is the possibility of choosing the fuel they want, according to the price, quality, performance characteristics or even availability, at each refueling;



- These vehicles are the technical evolution of ethanol fueled models, sold at the Brazilian market since 1979, due to the PROALCOHOL.





# PROALCOHOL

## The Brazilian Ethanol Fuel Program:

Adopted in 1975 by Brazilian government, due to the international oil crisis, aiming two applications:

- 1) to introduce the blend of gasoline with ethanol (gasohol) in the market;
- 2) to incentive the development of pure ethanol fueled vehicles.

## Why Ethanol?

- Brazil is a great sugar and ethanol producer since Century XVI;
- In the time of World War II ethanol was used as vehicular fuel in Brazil, blended with gasoline, with good results.



# The Participation of Automobile Industry

- In order to support the alcohol program, in 1976 the vehicle manufacturers and the Brazilian Government have signed an “*Memorandum of Understanding*” to produce ethanol fueled cars;
- Once, at that time, there was not enough international experience available on ethanol fuel, the manufacturers have decided to develop this model in Brazil;
- The first alcohol car prototype was run in 1977;
- In 1979 the first alcohol model vehicle was sold.



## The Governmental policy to PROALCOHOL

In 1978, the Brazilian Government adopted some financial measures to incentive the use of ethanol fuel, by the customers:

- Guarantee for ethanol fuel price ( $\leq 65\%$  of gasoline price);  
(both prices were controlled by the government)
- Tax reduction (- 5%) for alcohol fueled vehicles;
- Subsidied loans for ethanol producers to improve capacity;
- Obligatoriness for fuel stations to sell ethanol fuel (all over the country);
- Maintenance of ethanol fuel stocks to guarantee the supply and price.



# Light Vehicles in the Brazilian Market

1979 to 1990



Source: ANFAVEA



# Light Vehicles in the Brazilian Market

1979 to 1990



Source: ANFAVEA



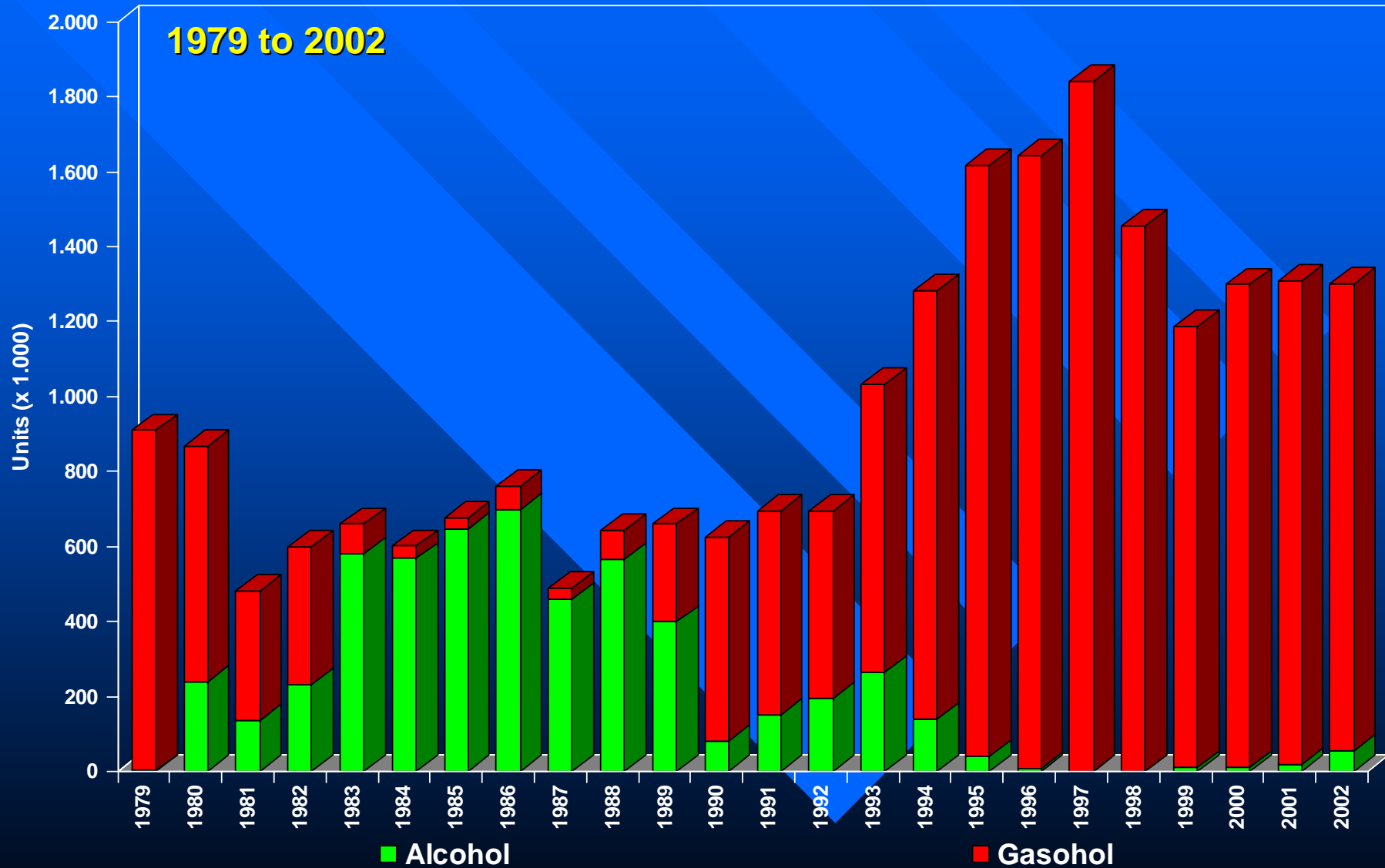
# The Decline of PROALCOHOL

At the end of 80's:

- Due to economical difficulties, the government started to remove the ethanol fuel subsidies and the price became closer of gasoline price;
- The official loans to producers were drastically reduced;
- The international sugar price increased and many alcohol producers decided to make sugar instead of ethanol, causing an alcohol supply shortage;
- The ethanol reserves were quickly drained off;
- The sales of new alcohol fueled vehicles fall and the retail value of the used alcohol cars became null and void.



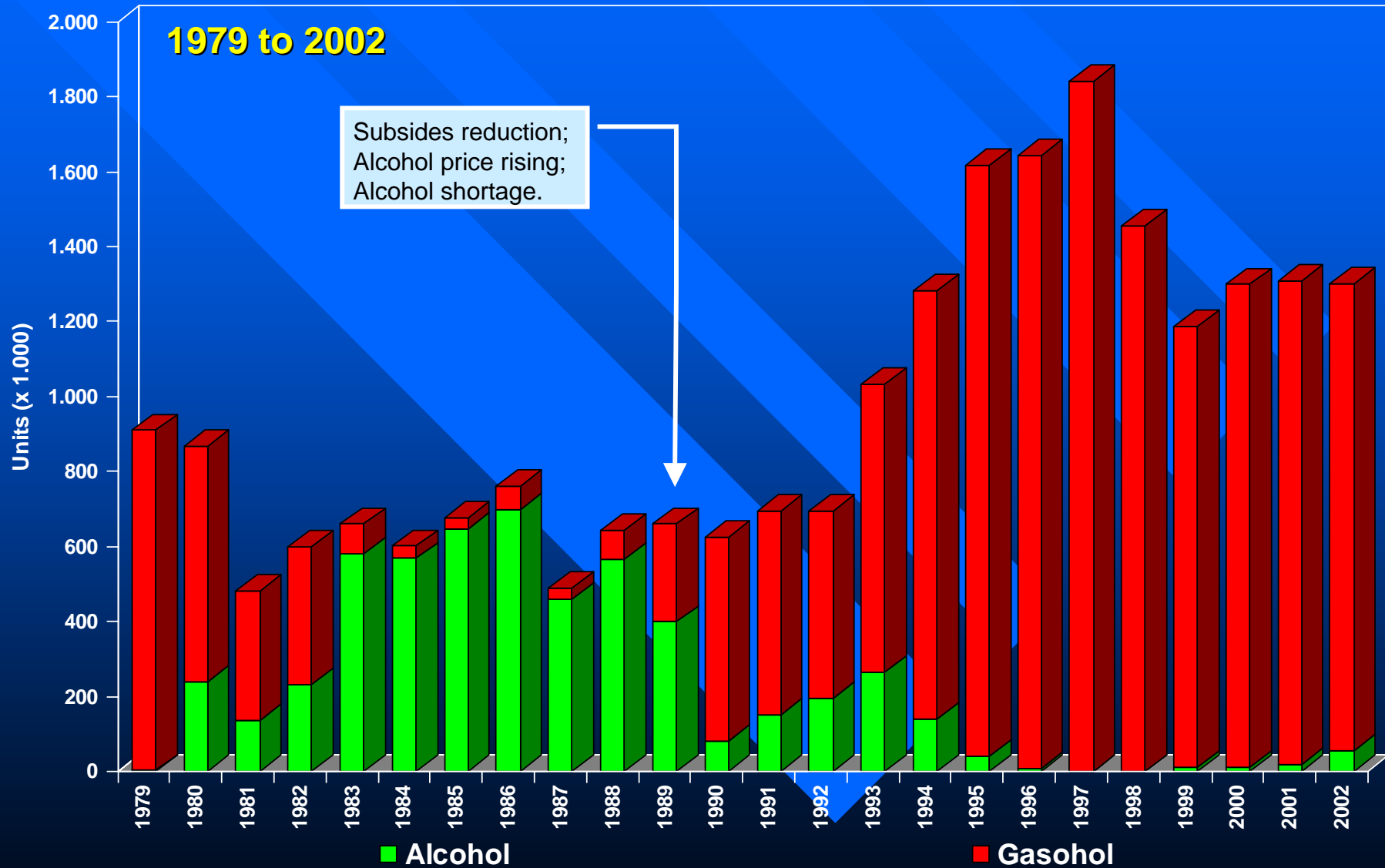
# Light Vehicles in the Brazilian Market



Source: ANFAVEA



# Light Vehicles in the Brazilian Market



Source: ANFAVEA





# Light Vehicles in the Brazilian Market

## ■ From 1979 to 1990:

- Sales: 8.263.450 units
  - » Alcohol: 4.606.728 units (55,8%)
  - » Gasoline: 3.656.722 units (44,2%)

## ■ From 1991 to 2002:

- Sales: 13.547.318 units
  - » Alcohol: 898.486 units ( 6,6%)
  - » Gasoline: 12.648.832 units (93,4%)

## ■ From 1979 to 2002:

- Sales: 21.810.768 units
  - » Alcohol: 5.505.214 units (25,2%)
  - » Gasoline: 16.305.554 units (74,8%)



# Light Vehicles in the Brazilian Market

## ■ From 1979 to 1990:

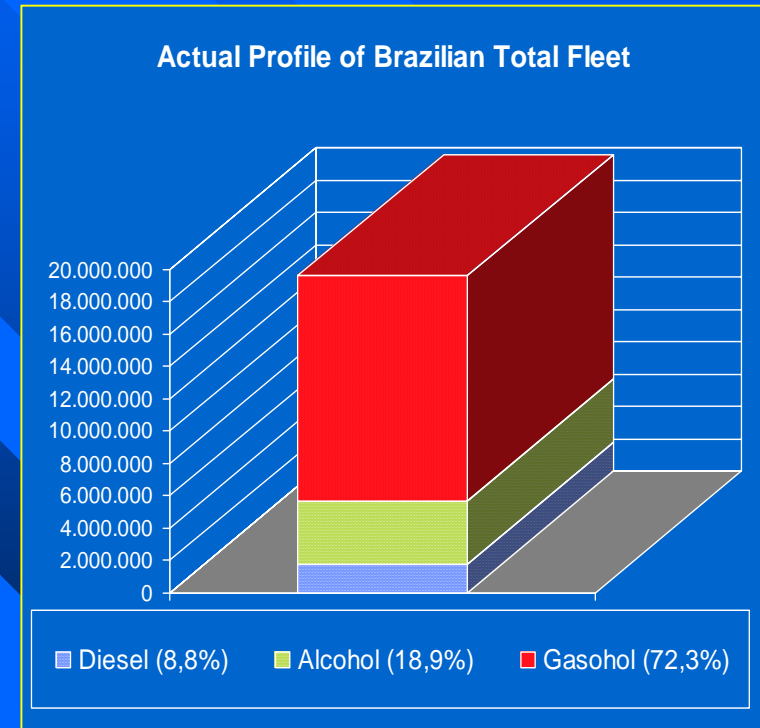
- Sales: 8.263.450 units
  - » Alcohol: 4.606.728 units (55,8%)
  - » Gasoline: 3.656.722 units (44,2%)

## ■ From 1991 to 2002:

- Sales: 13.547.318 units
  - » Alcohol: 898.486 units ( 6,6%)
  - » Gasoline: 12.648.832 units (93,4%)

## ■ From 1979 to 2002:

- Sales: 21.810.768 units
  - » Alcohol: 5.505.214 units (25,2%)
  - » Gasoline: 16.305.554 units (74,8%)





# The Alcohol return



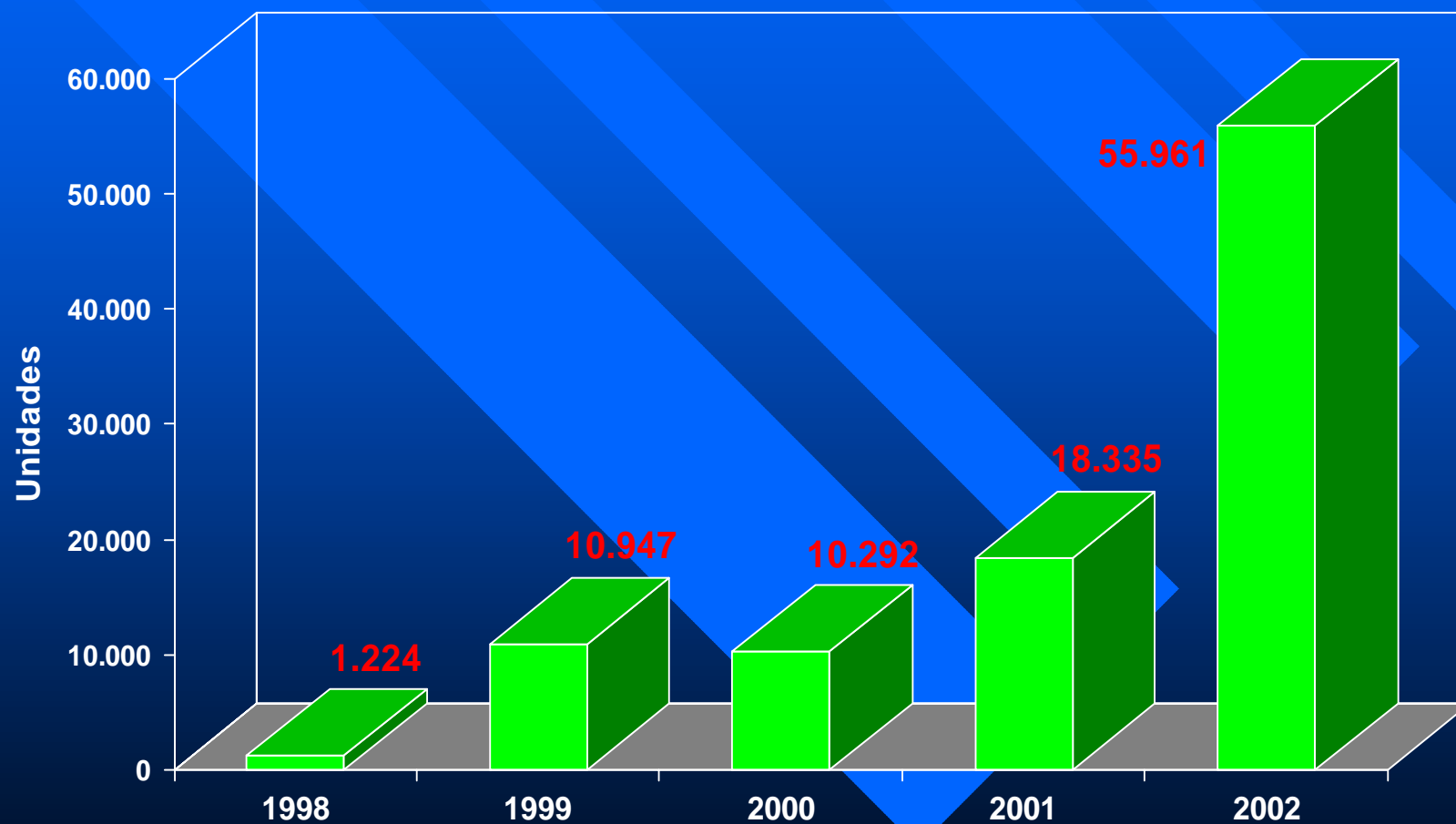
From the 2nd half of 90's on:

- The ethanol supply became normalized;
- The ethanol price have stabilized at low levels ( $\frac{1}{2}$  of gasoline price);
- The Brazilian automobile industry continued to offer alcohol cars;
- The international press started to valorize the renewable fuels;
- The climate changes became a matter of big concern;
- The Kyoto Protocol was issued;
- Many papers brought out the environmental advantages of ethanol.



# Alcohol Vehicles in the Brazilian Market

1998 to 2002



Source: ANFAVEA

# Necessary Engine & Vehicle Modifications due to the Ethanol Fuel Application



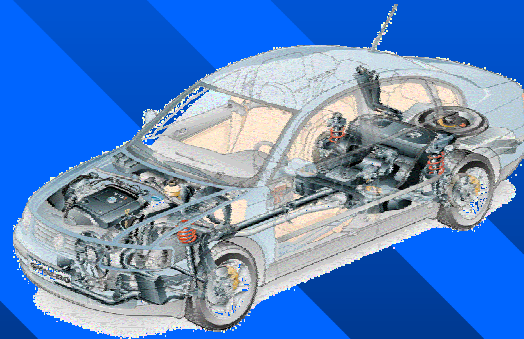


# Main Concerns Related to Ethanol Fuel

- Corrosion of metallic materials
- Chemical attack to the plastic materials
- Low molecular energy content
- Different air / fuel ratio for combustion
- Low vapor pressure



For 20 ~ 25% blend





# For 20 ~ 25% blend

## Carburetor

The material of the carburetor body or carburetor cover can not be aluminum or exposed Zamak; if it is, must be substituted, protect with surface treatment or anodize;

Any component in polyamide 6.6 (Nylon) that has contact with the fuel must be substituted by other material or protected.

## Electronic Fuel Injection

Substitution of fuel injector material by stainless steel;  
New fuel injector design to improve the "fuel spray";

New calibration of air-fuel ratio control and new Lambda Sensor working range;

Any component in polyamide 6.6 (Nylon) that has contact with the fuel must be substituted by other material or protected.

## Fuel Pump

The internal surface of pump body and winding must be protected and the connectors sealed;

Any component in polyamide 6.6 (Nylon) that has contact with the fuel must be substituted by other material or protected.

## Fuel Pressure Device

The internal surface of the fuel pressure device must be protected;

Any component in polyamide 6.6 (Nylon) that has contact with the fuel must be substituted by other material or protected.

## Fuel Filter

The internal surface of the filter must be protected;

The adhesive of the filter element must be appropriated.

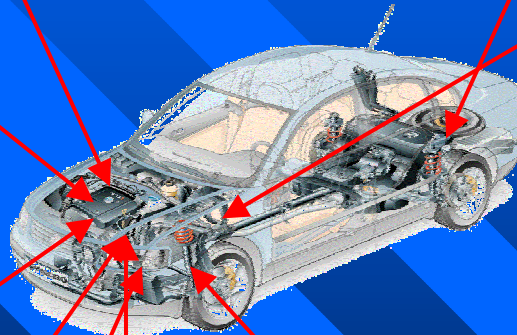
## Fuel Tank

If the vehicle fuel tank is metallic, the internal surface of tank must be protected (coated);

Any component in polyamide 6.6 (Nylon) that has contact with the fuel must be substituted by other material or protected.

## Catalytic Converter

It is possible to change the kind and amount of noble metal present in the loading and wash coating.



## Ignition System

New calibration of ignition advance control.

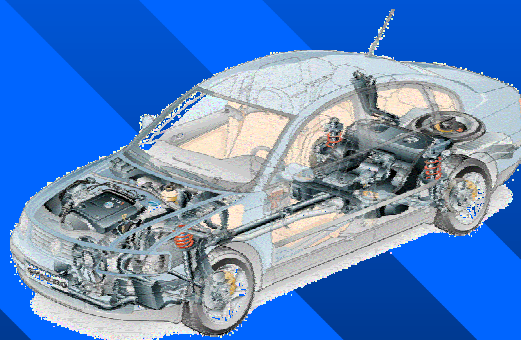
## Evaporative Emission System

The purge airflow of canister (activate charcoal filter) must be higher.





For 100% Ethanol Fuel





# For 100% Ethanol Fuel

## Carburetor

The material of the carburetor body or carburetor cover cannot be aluminum or exposed Zamak; if it is, must be substituted, protect with surface treatment or anodize;

Any component in polyamide 6.6 (Nylon) that has contact with the fuel must be substituted by other material or protected;

The material of buoy, nozzle, metering jet, floating axle, seals, gaskets and o-rings must be appropriated.

## Electronic Fuel Injection

Substitution of fuel injector material by stainless steel;

New fuel injector design to improve the "fuel spray";

New calibration of air-fuel ratio control and new Lambda Sensor working range;

Any component in polyamide 6.6 (Nylon) that has contact with the fuel must be substituted by other material or protected.

## Fuel Pump

The internal surface of pump body and winding must be protected and the connectors sealed;

Any component in polyamide 6.6 (Nylon) that has contact with the fuel must be substituted by other material or protected.

The pump working pressure must be increased.

## Fuel Pressure Device

The internal surface of the fuel pressure device must be protected;

Any component in polyamide 6.6 (Nylon) that has contact with the fuel must be substituted by other material or protected.

The fuel pressure must be increased.

## Fuel Filter

The internal surface of the filter must be protected;

The adhesive of the filter element must be appropriated;

The filter element porosity must be adjusted.

## Engine

The engine compression ratio should be higher;

Camshaft with new cam profile and new phase;

New surface material of valves (intake and exhaust) and valve seats.

## Intake Manifold

With new profile and less internal rugosity, to increase the air flow;

Must provide higher intake air temperature.

## Fuel Tank

If the vehicle fuel tank is metallic, the internal surface of tank must be protected (coated);

Any component in polyamide 6.6 (Nylon) that has contact with the fuel must be substituted by other material or protected.

Higher fuel tank capacity, due to the higher fuel consumption.

## Catalytic Converter

It is possible to change the kind and amount of noble metal present in the loading and wash-coating of catalytic converter;

The catalyst converter must be placed closer to the exhaust manifold, in order to speed up the working temperature achievement (light-off).

## Exhaust Pipe

The internal surface of pipe must be protected (coated);

The exhaust design must be compatible with higher amount vapor.

## Suspension

Adjusted to the higher vehicle weight.

## Motor Oil

New additive package.

## Cold Start System

Auxiliary gasoline assisted start system, with temperature sensor, gasoline reservoir, extra fuel injector and fuel pump;

The vehicle battery must have higher capacity.

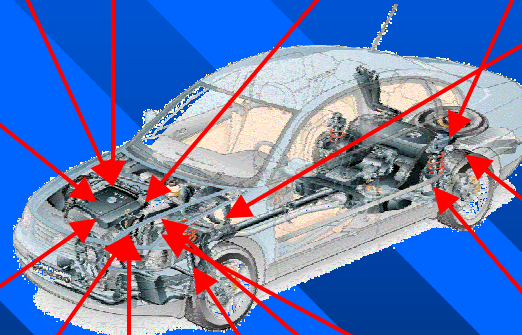
## Ignition System

New calibration of advance control;

Colder heat rating spark plugs.

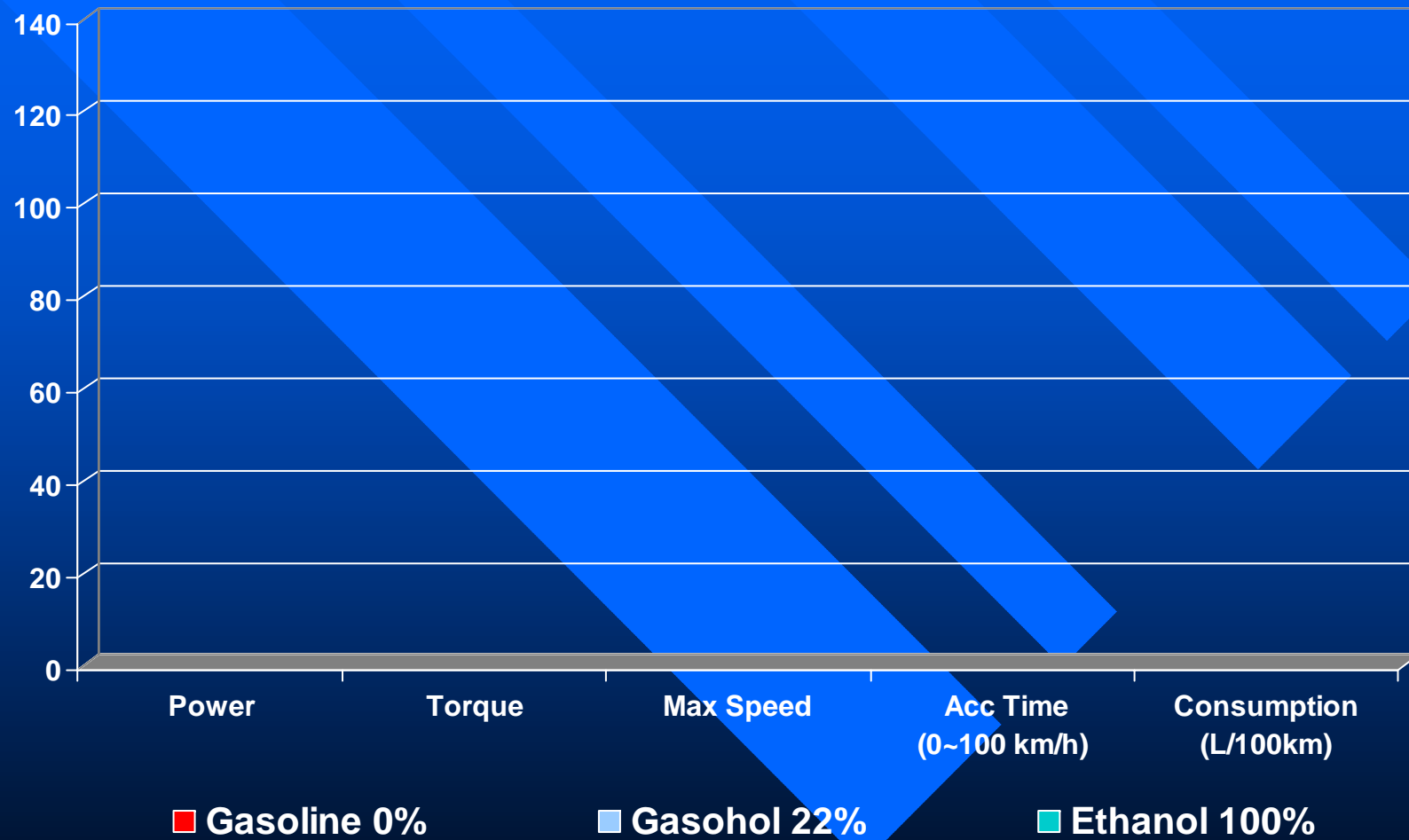
## Evaporative Emission System

Due to the lower fuel vapor pressure, it is not necessary evaporative emission control.



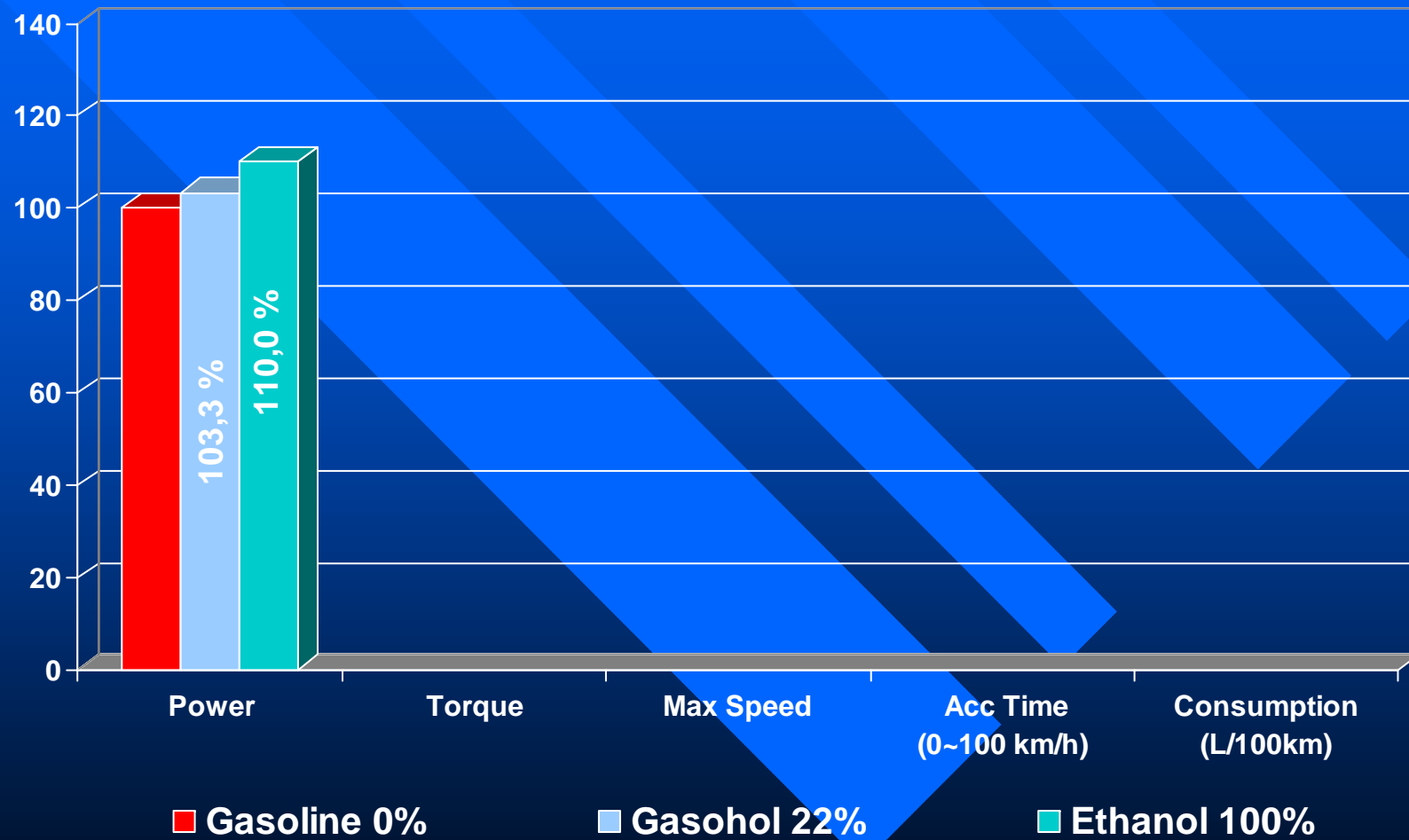


# Ethanol Engine: Relative Performance



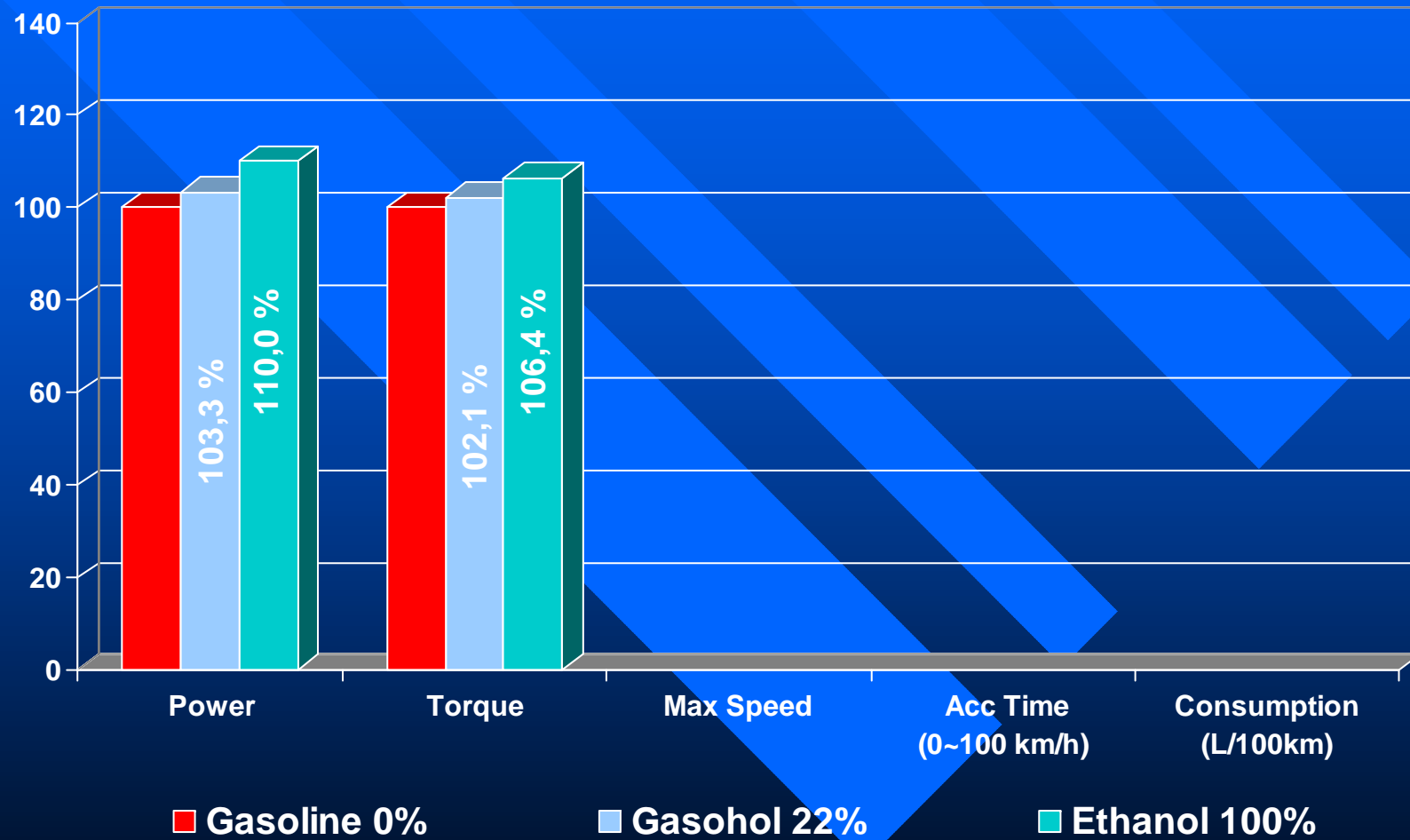


# Ethanol Engine: Relative Performance



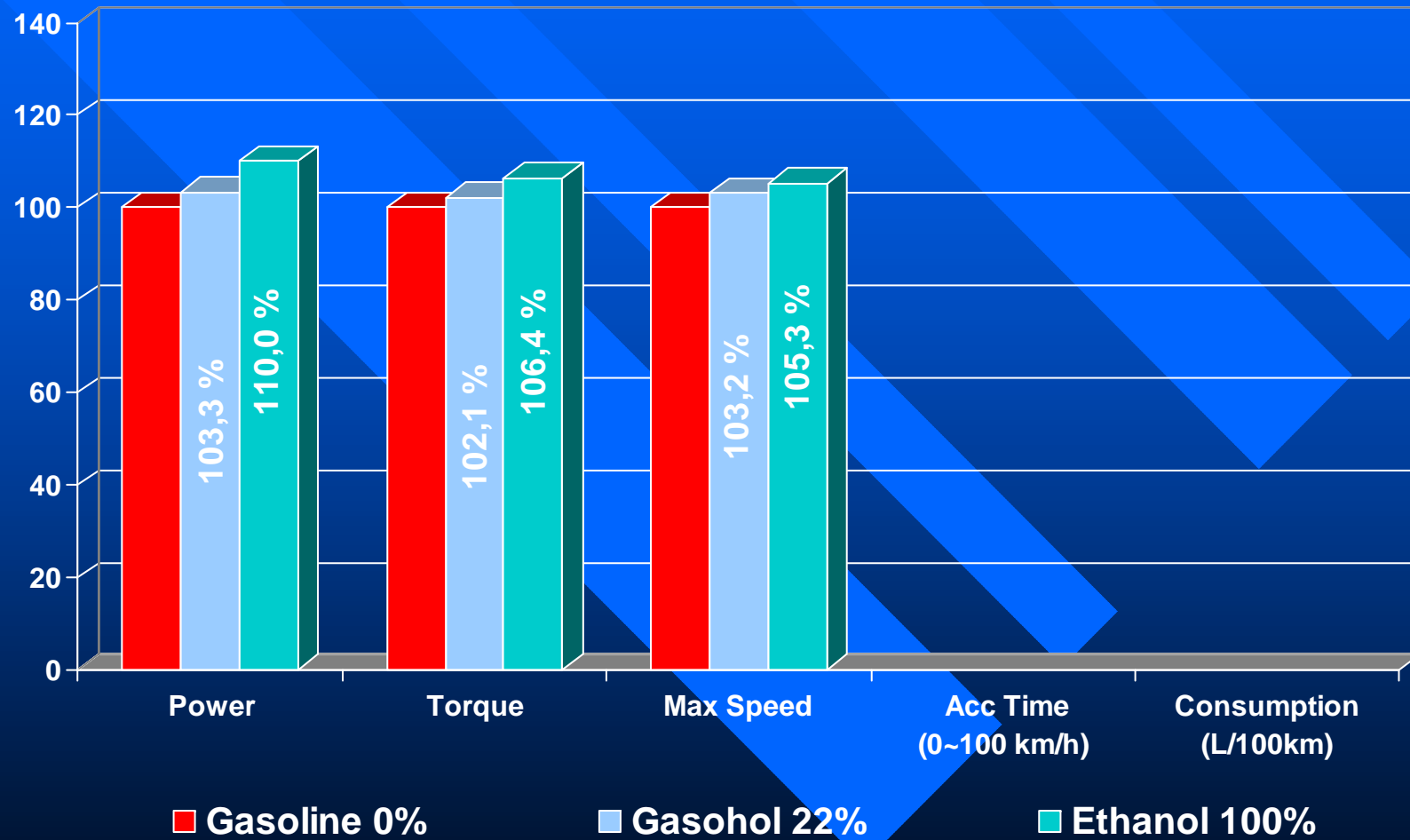


# Ethanol Engine: Relative Performance



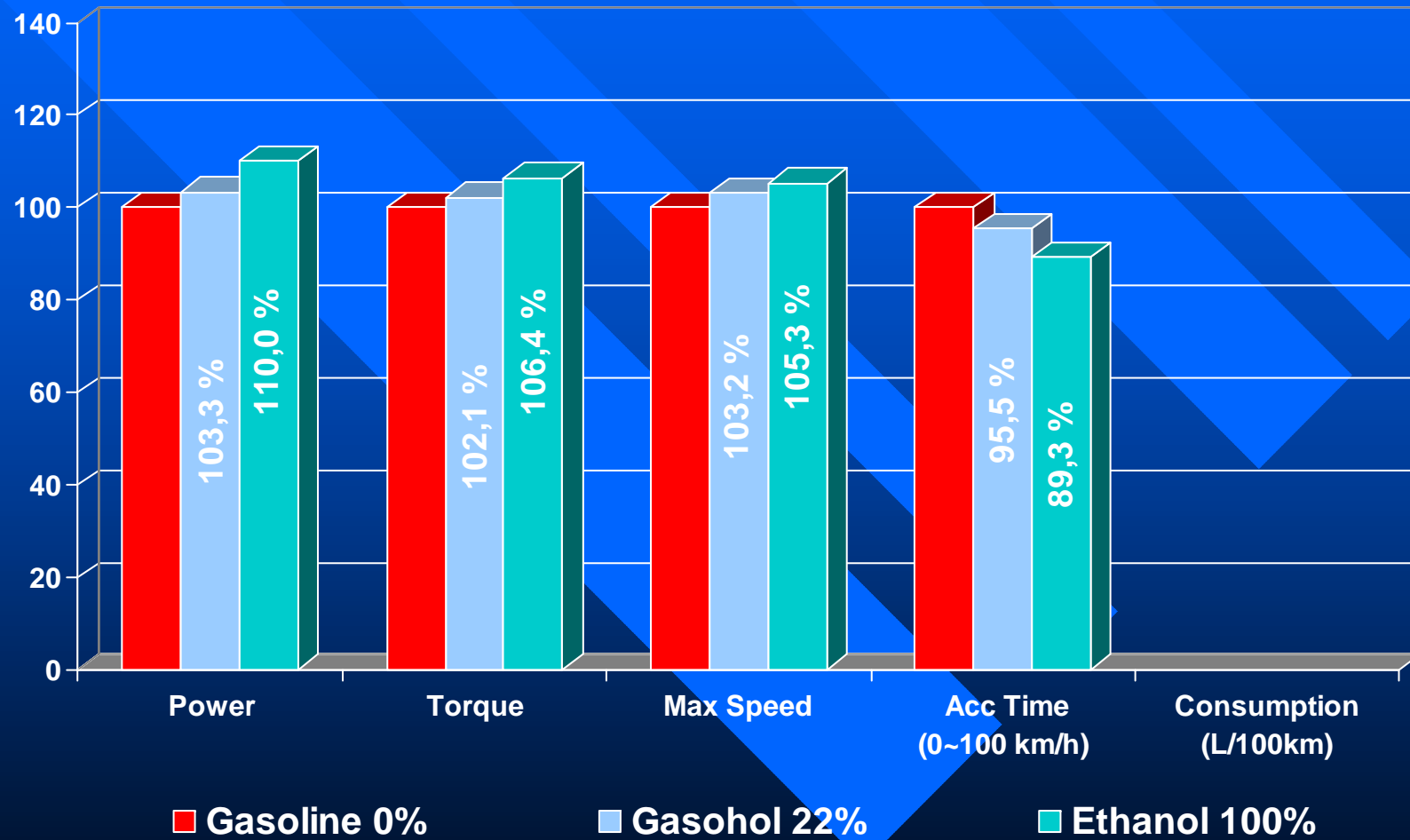


# Ethanol Engine: Relative Performance



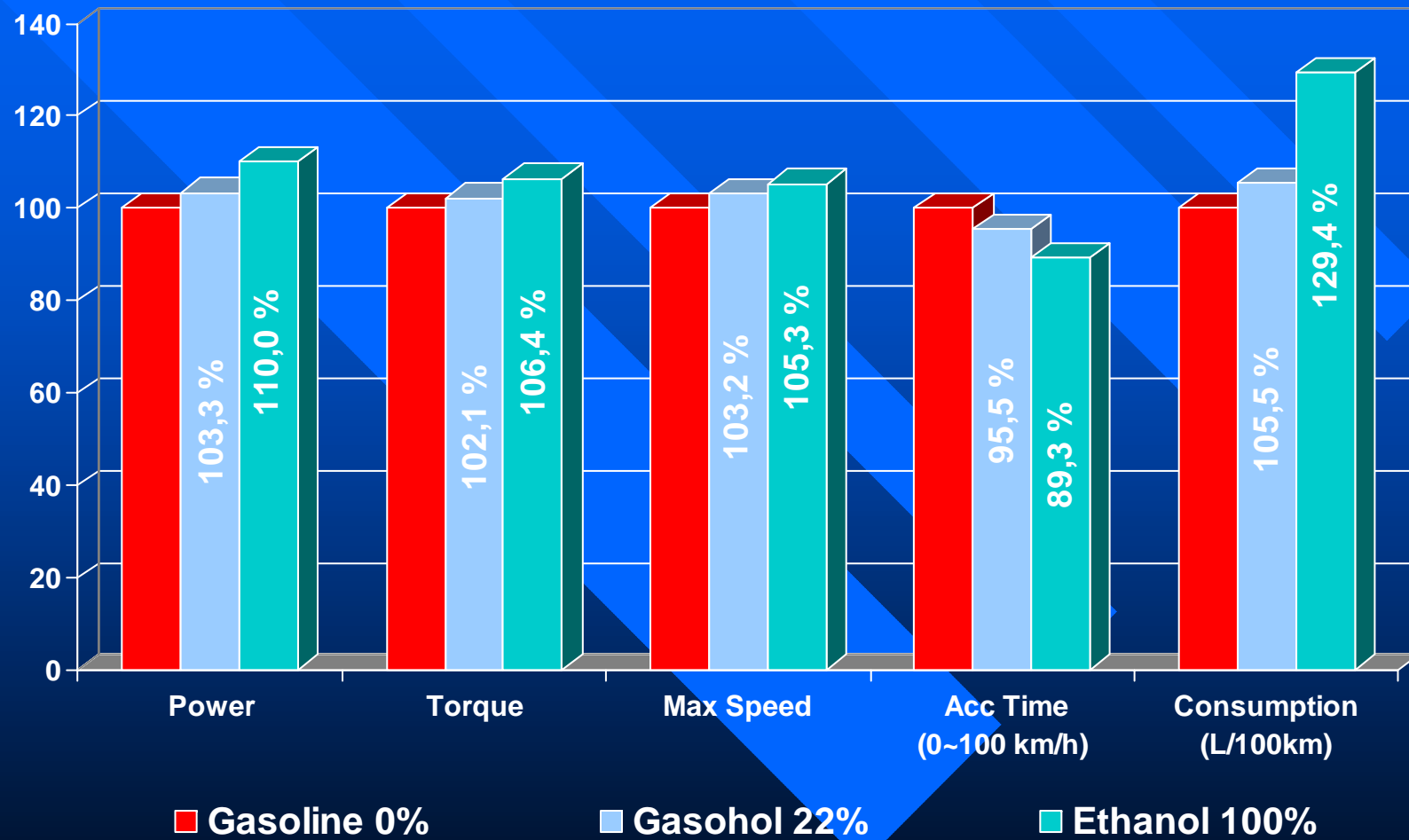


# Ethanol Engine: Relative Performance





# Ethanol Engine: Relative Performance

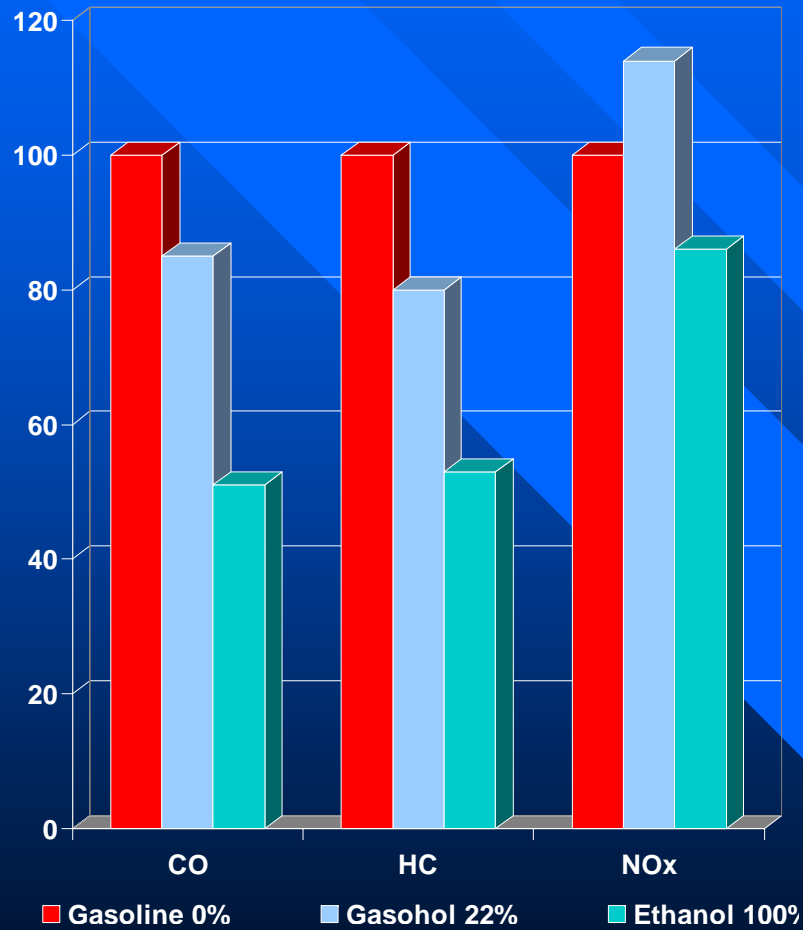






# Comparative Exhaust Emission

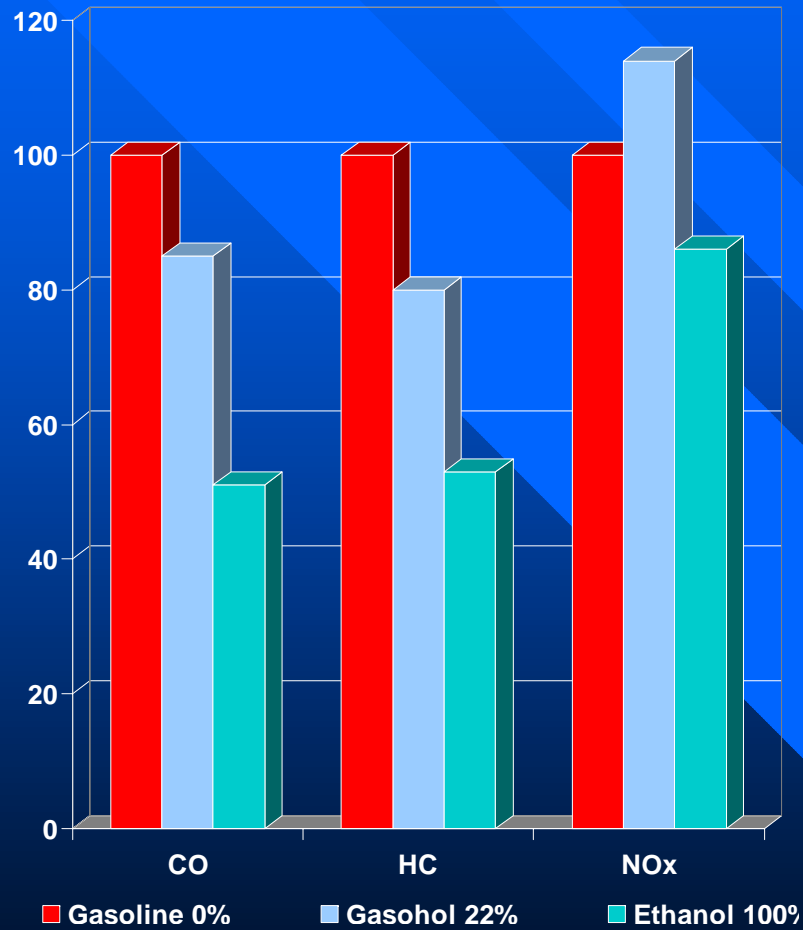
## Before Catalyst Converter



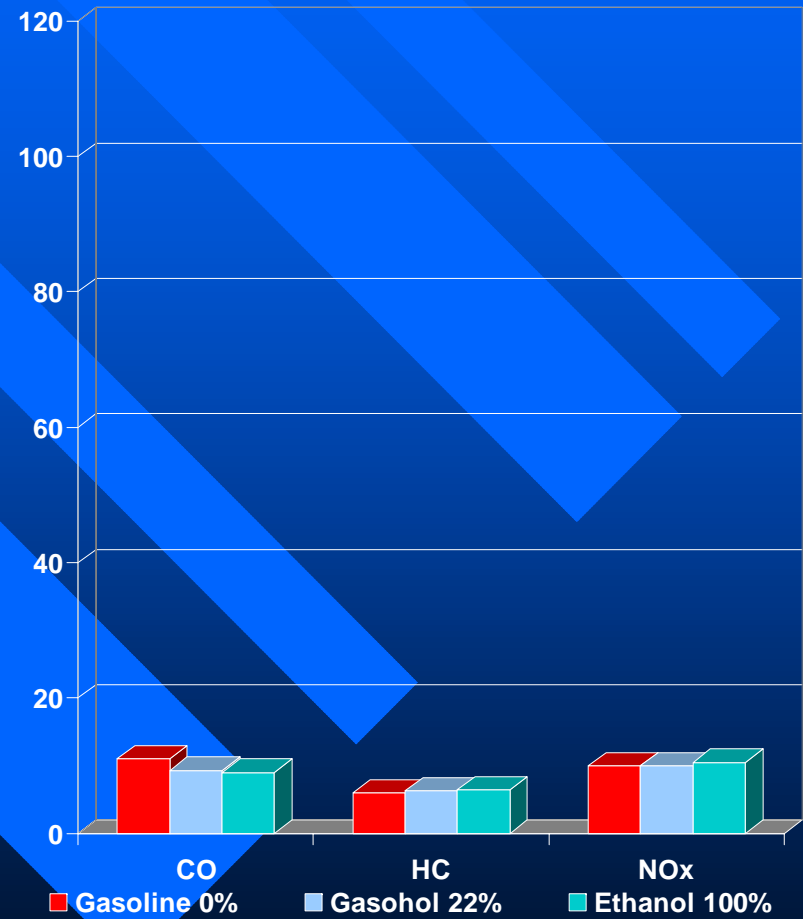


# Comparative Exhaust Emission

## Before Catalyst Converter

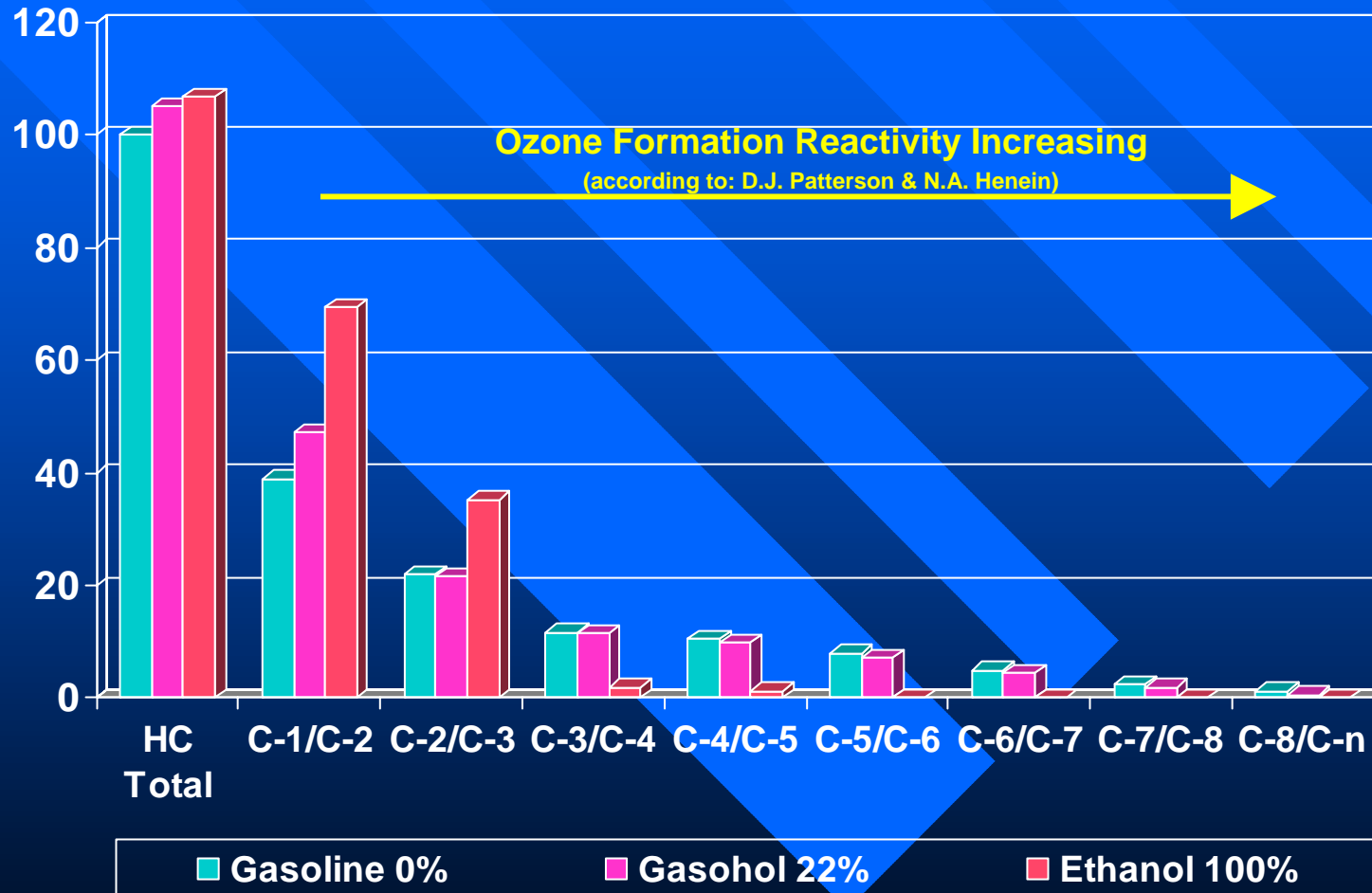


## After Catalyst Converter



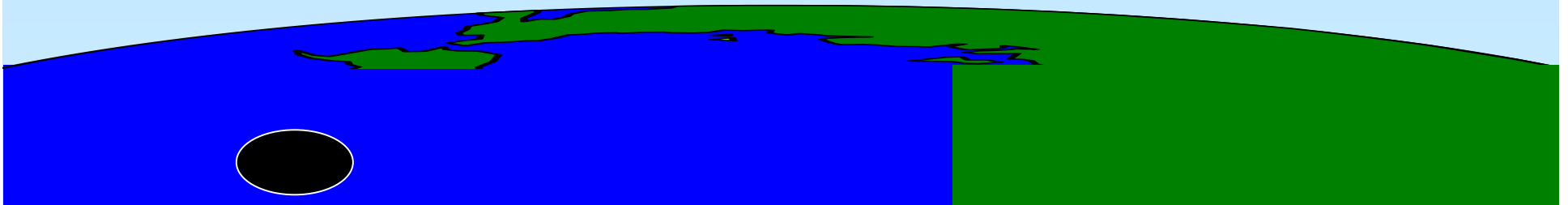
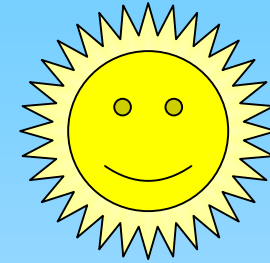


# Comparative HC Emission Profile



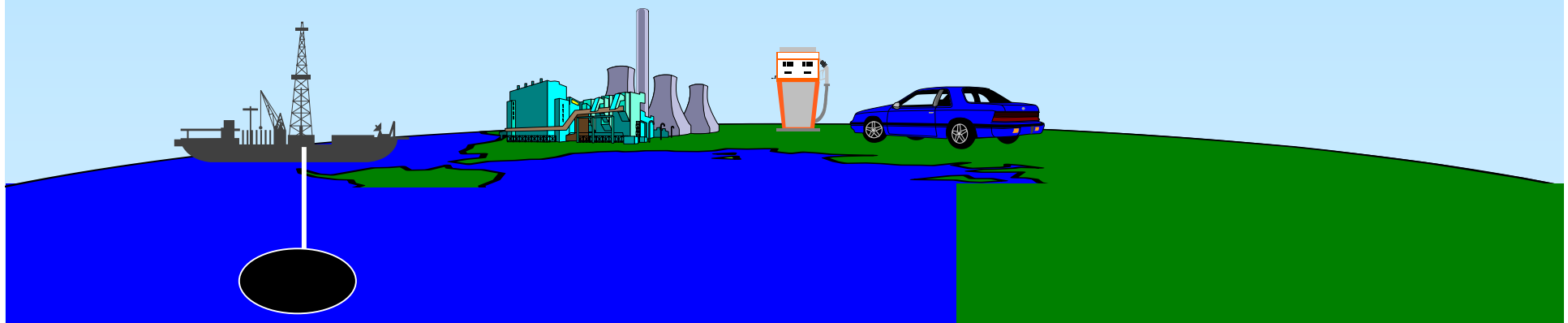
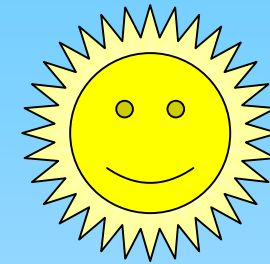
# CO<sub>2</sub> Emission (Greenhouse Effect)

**FOSSIL FUELS**



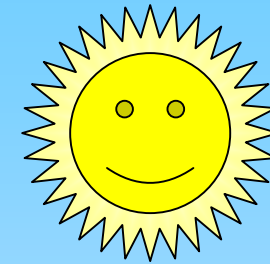
# CO<sub>2</sub> Emission (Greenhouse Effect)

**FOSSIL FUELS**

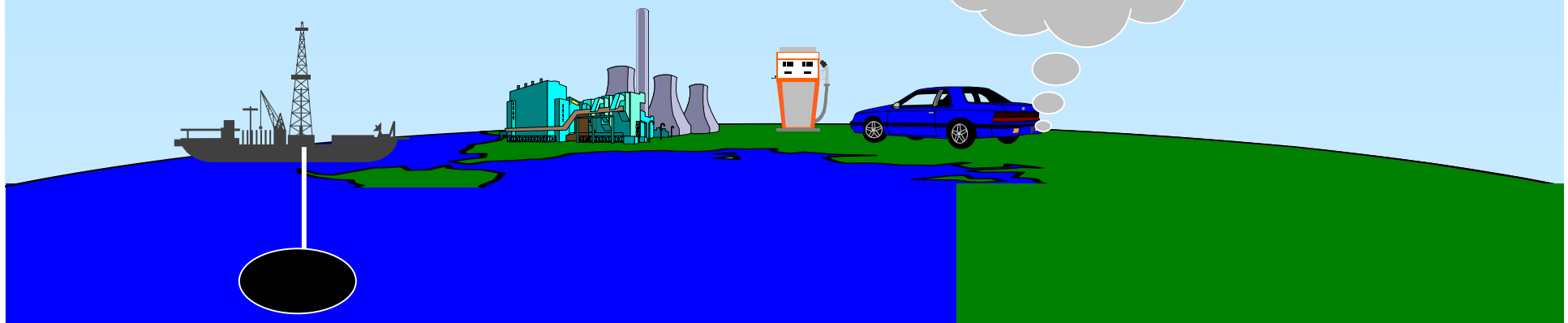


# CO<sub>2</sub> Emission (Greenhouse Effect)

**FOSSIL FUELS**

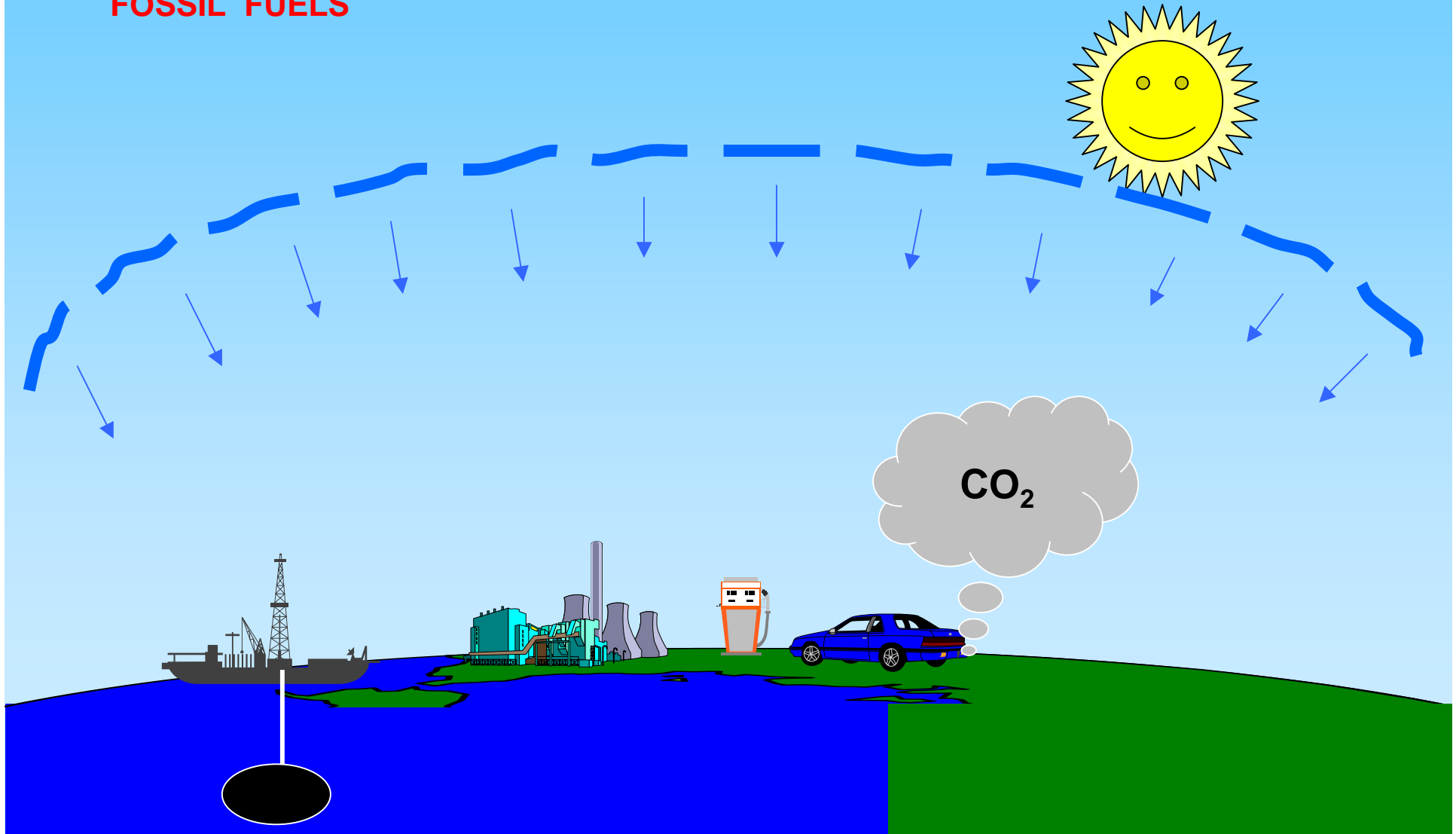


CO<sub>2</sub>



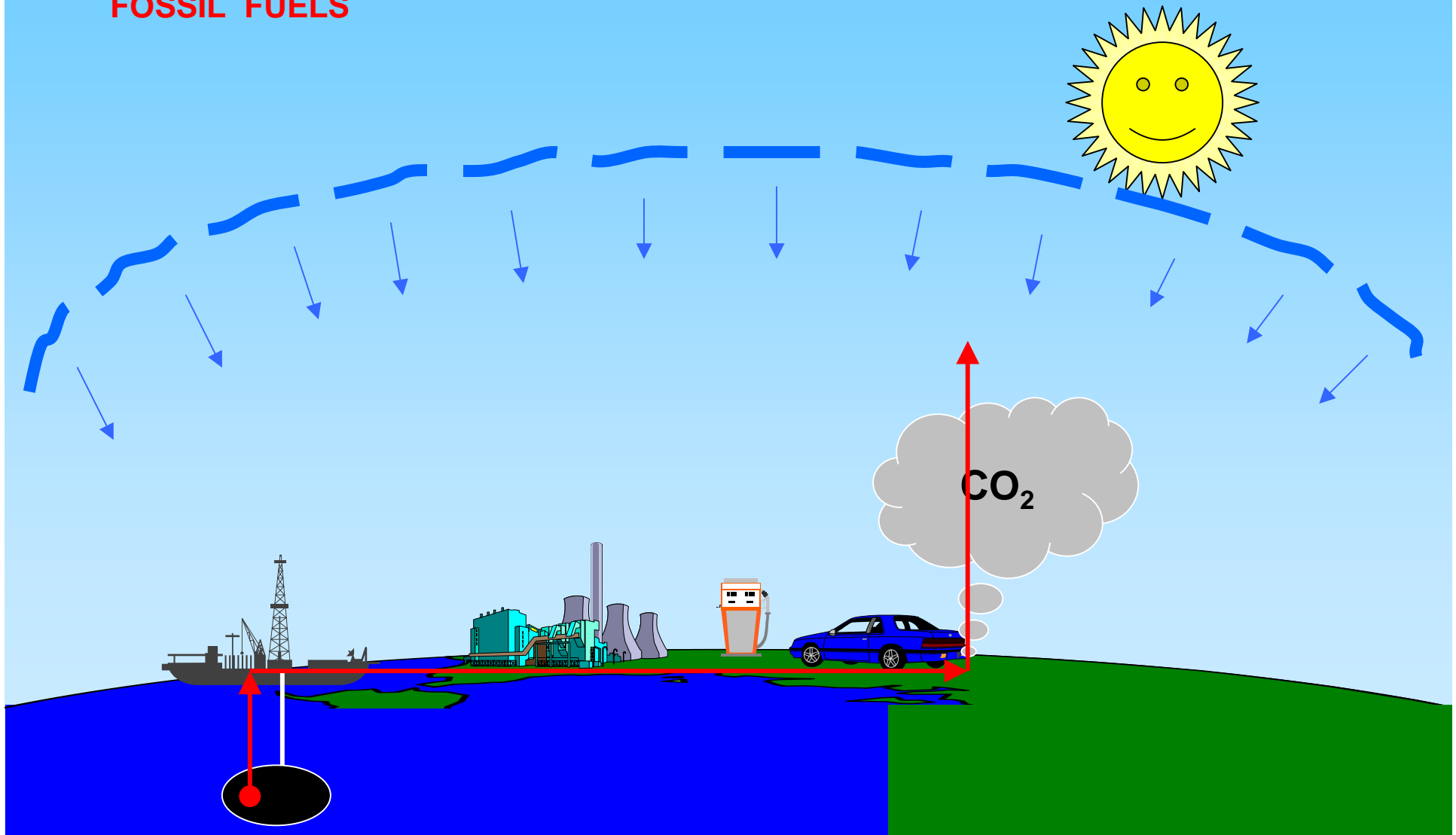
# CO<sub>2</sub> Emission (Greenhouse Effect)

**FOSSIL FUELS**



# CO<sub>2</sub> Emission (Greenhouse Effect)

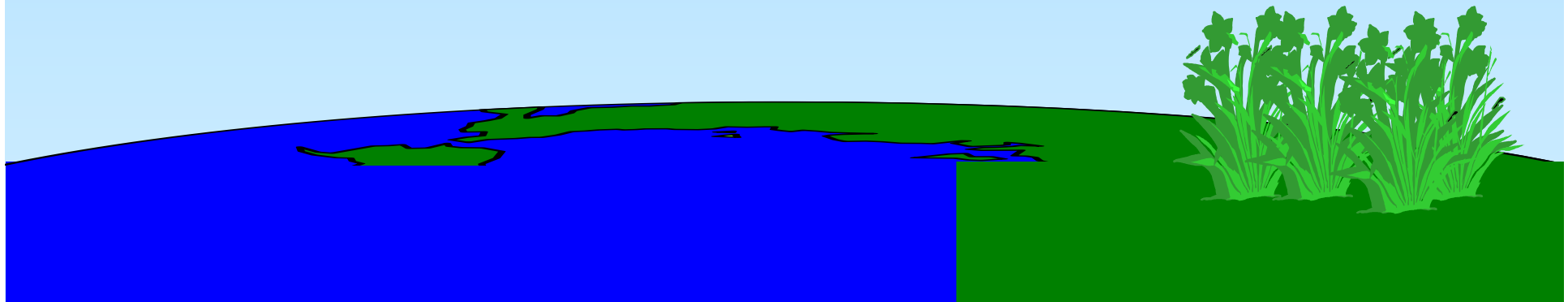
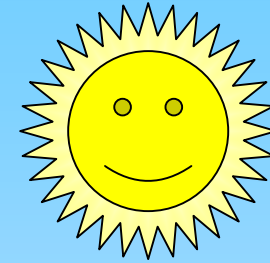
**FOSSIL FUELS**





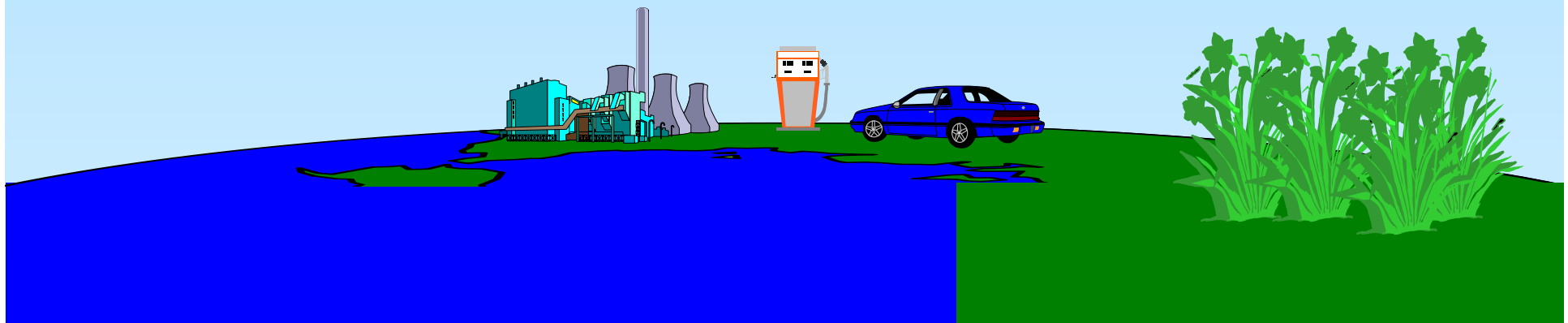
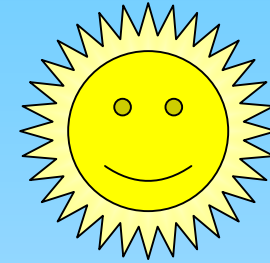
# CO<sub>2</sub> Emission (Greenhouse Effect)

**RENEWABLE FUELS**



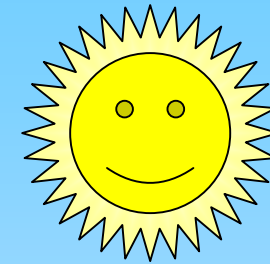
# CO<sub>2</sub> Emission (Greenhouse Effect)

**RENEWABLE FUELS**

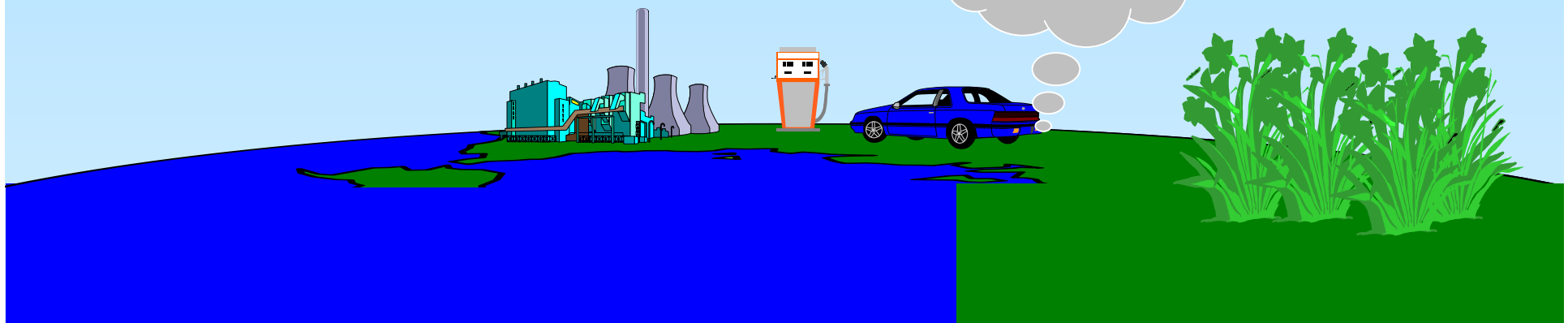


# CO<sub>2</sub> Emission (Greenhouse Effect)

**RENEWABLE FUELS**

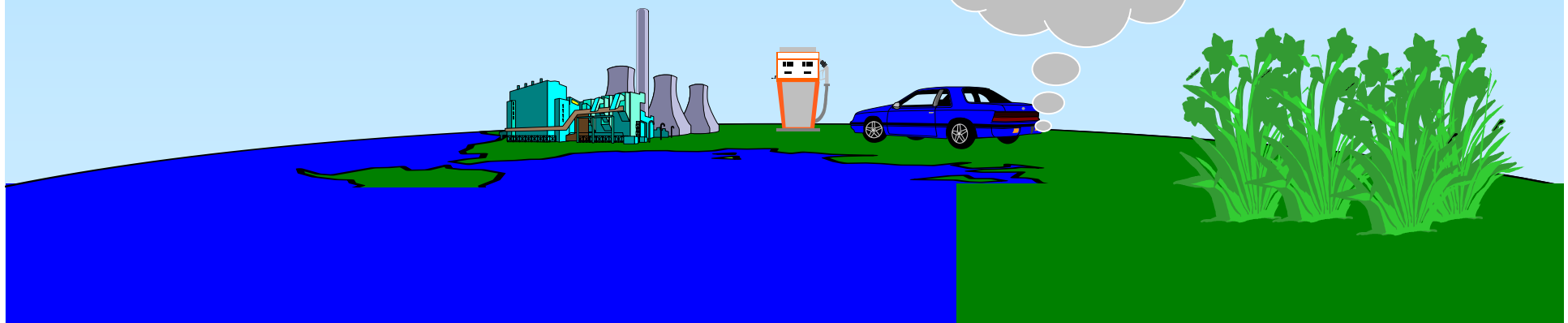
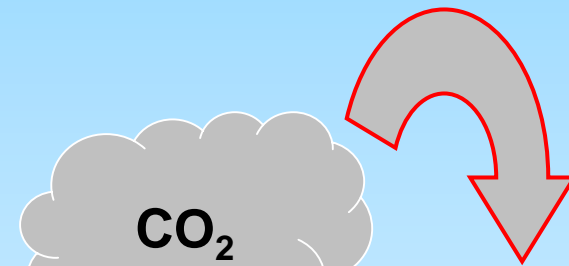
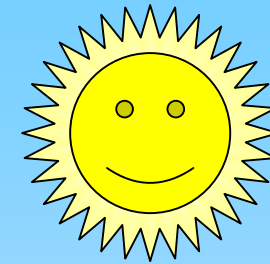


CO<sub>2</sub>



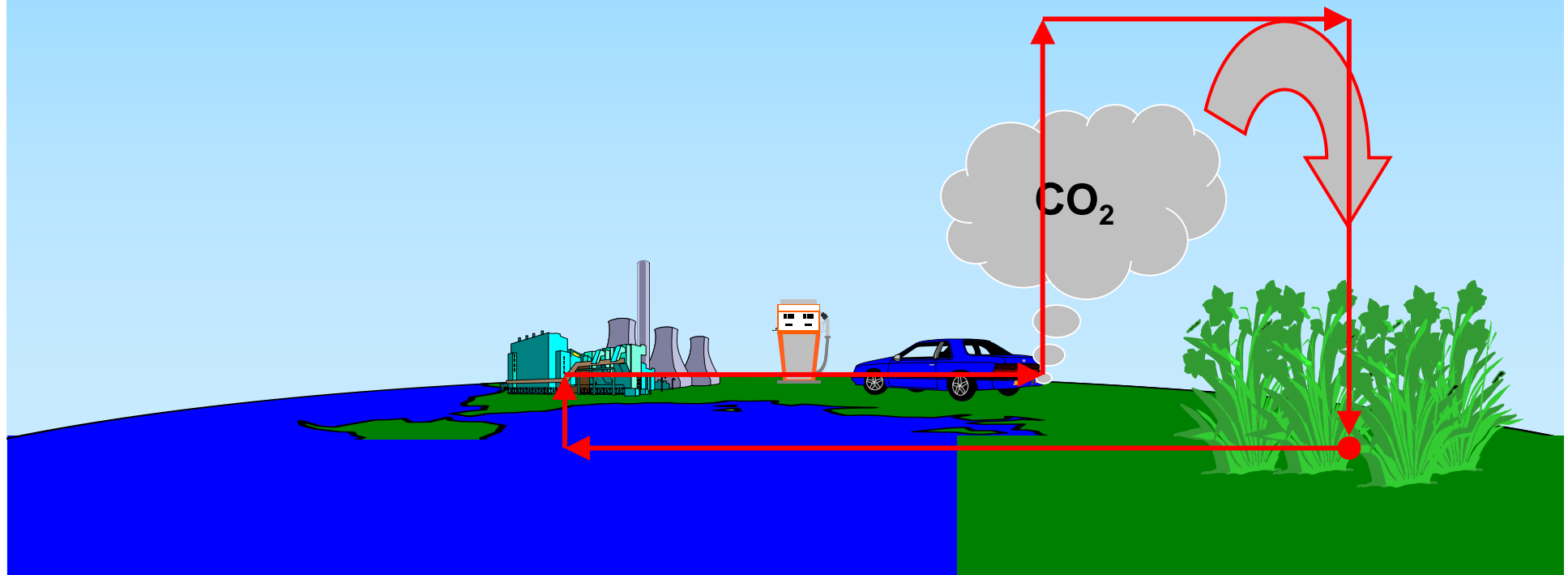
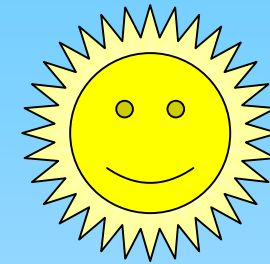
# CO<sub>2</sub> Emission (Greenhouse Effect)

**RENEWABLE FUELS**



# CO<sub>2</sub> Emission (Greenhouse Effect)

RENEWABLE FUELS



# Flexible Fuel Vehicles



# Flexible Fuel Vehicles

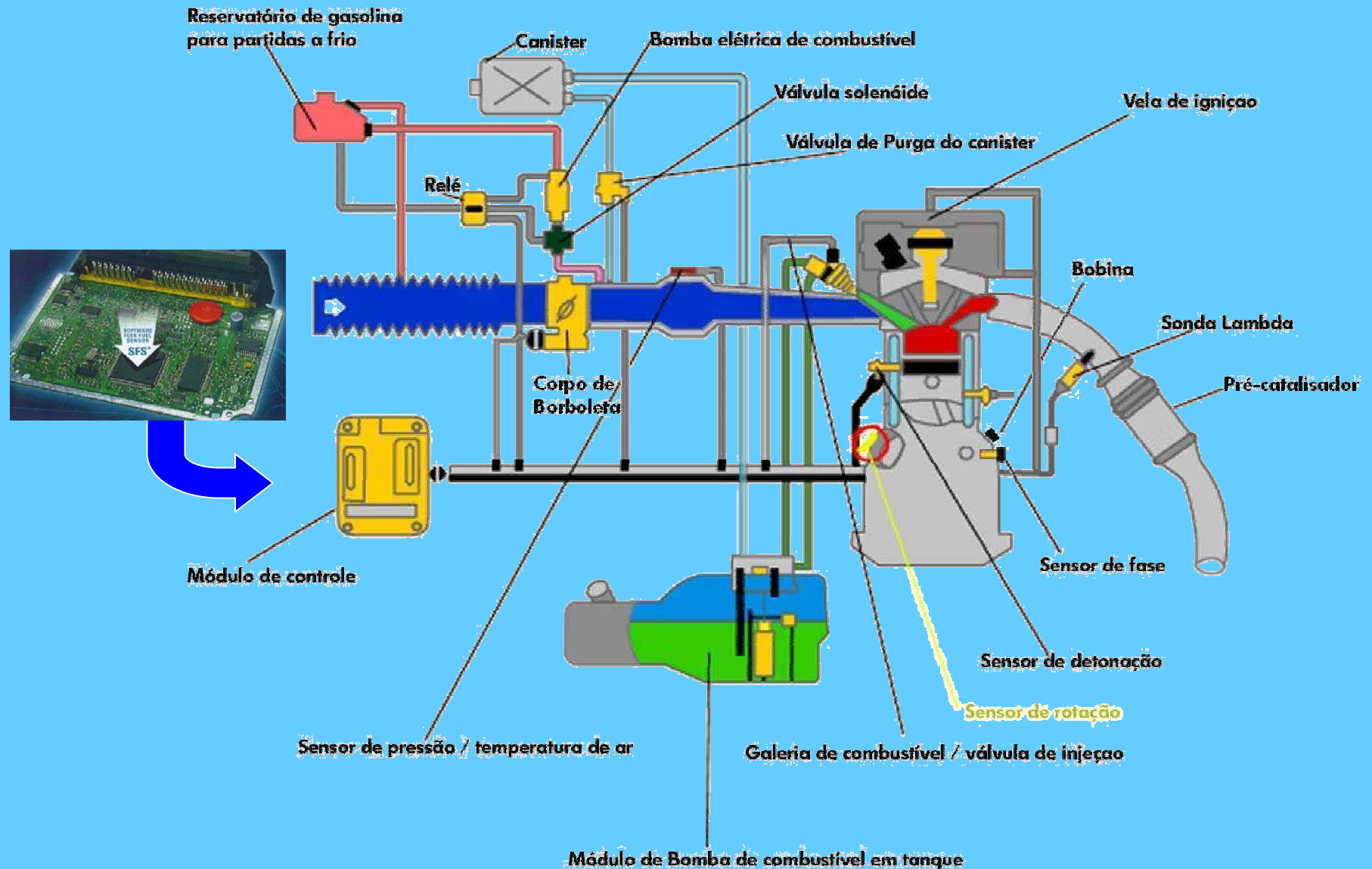
March, 2003: Introducing of Flexible Fuel Vehicles



VW GOL Total Flex



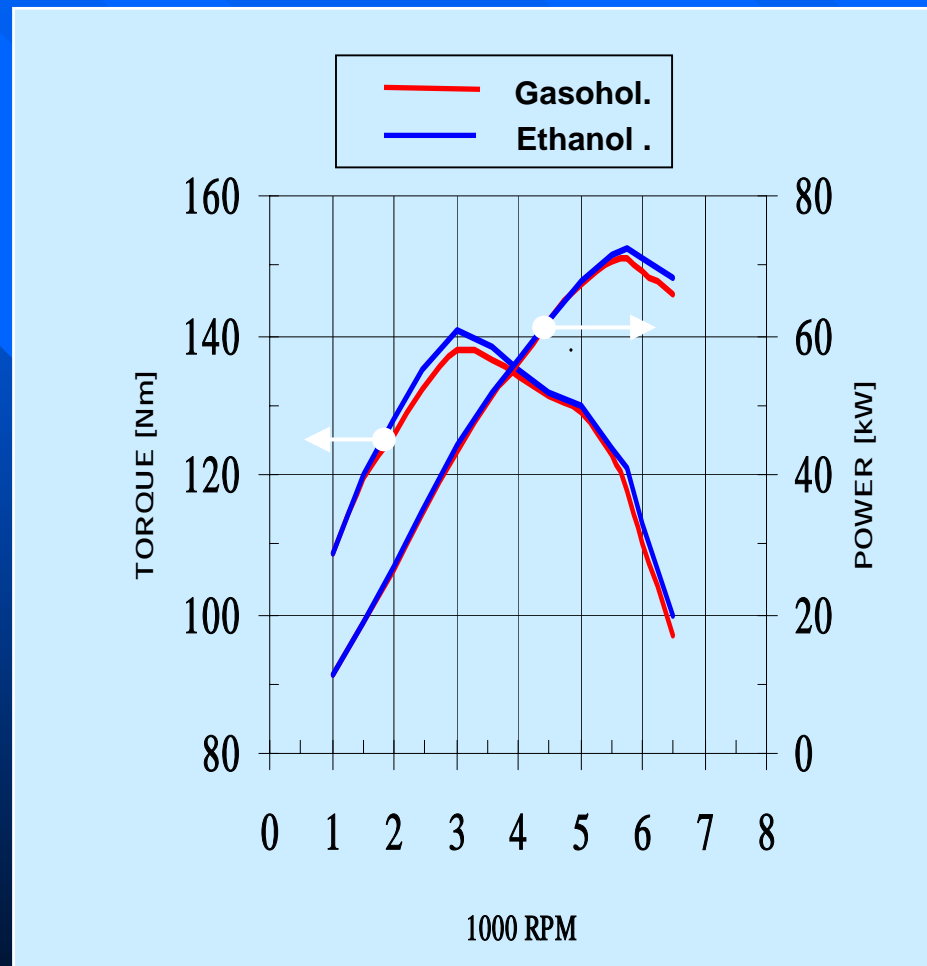
# Fuel Blend Recognition System







# Performance Comparison





**Palio Flex**



**Palio Weekend Flex**



**Palio Adventure Flex**



**Strada Flex**

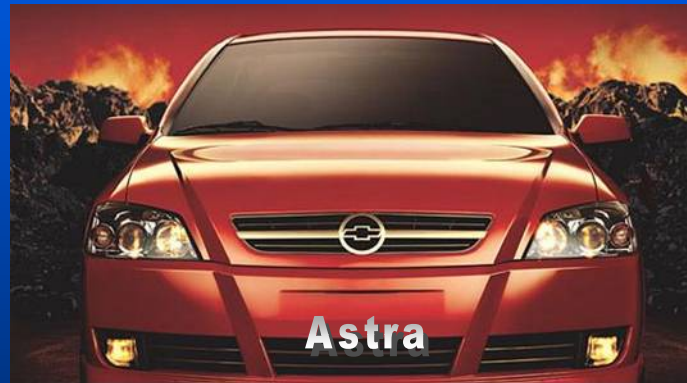


**Siena Flex**





Ford Fiesta Flex

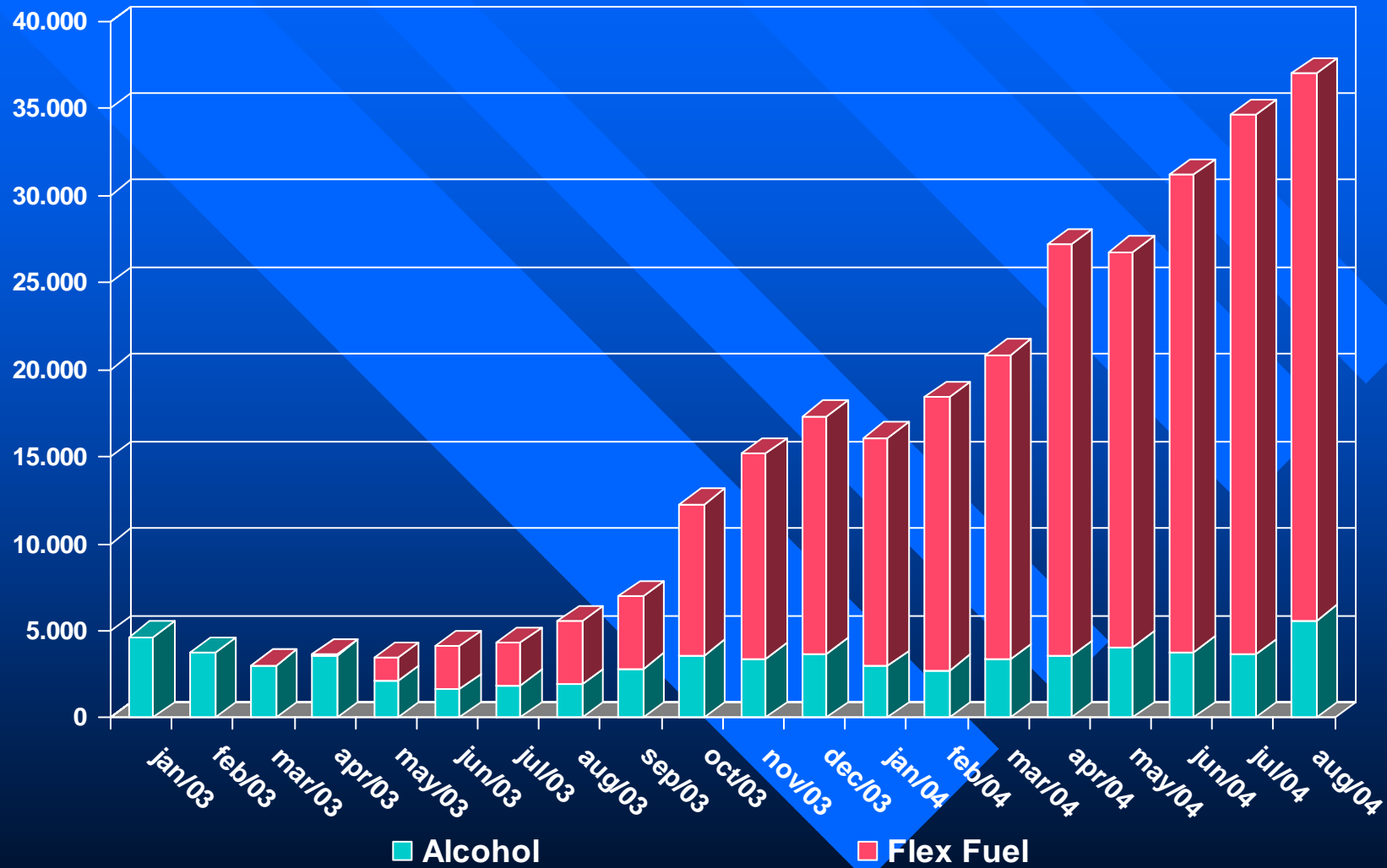






# Sales: Alcohol x Flexfuel

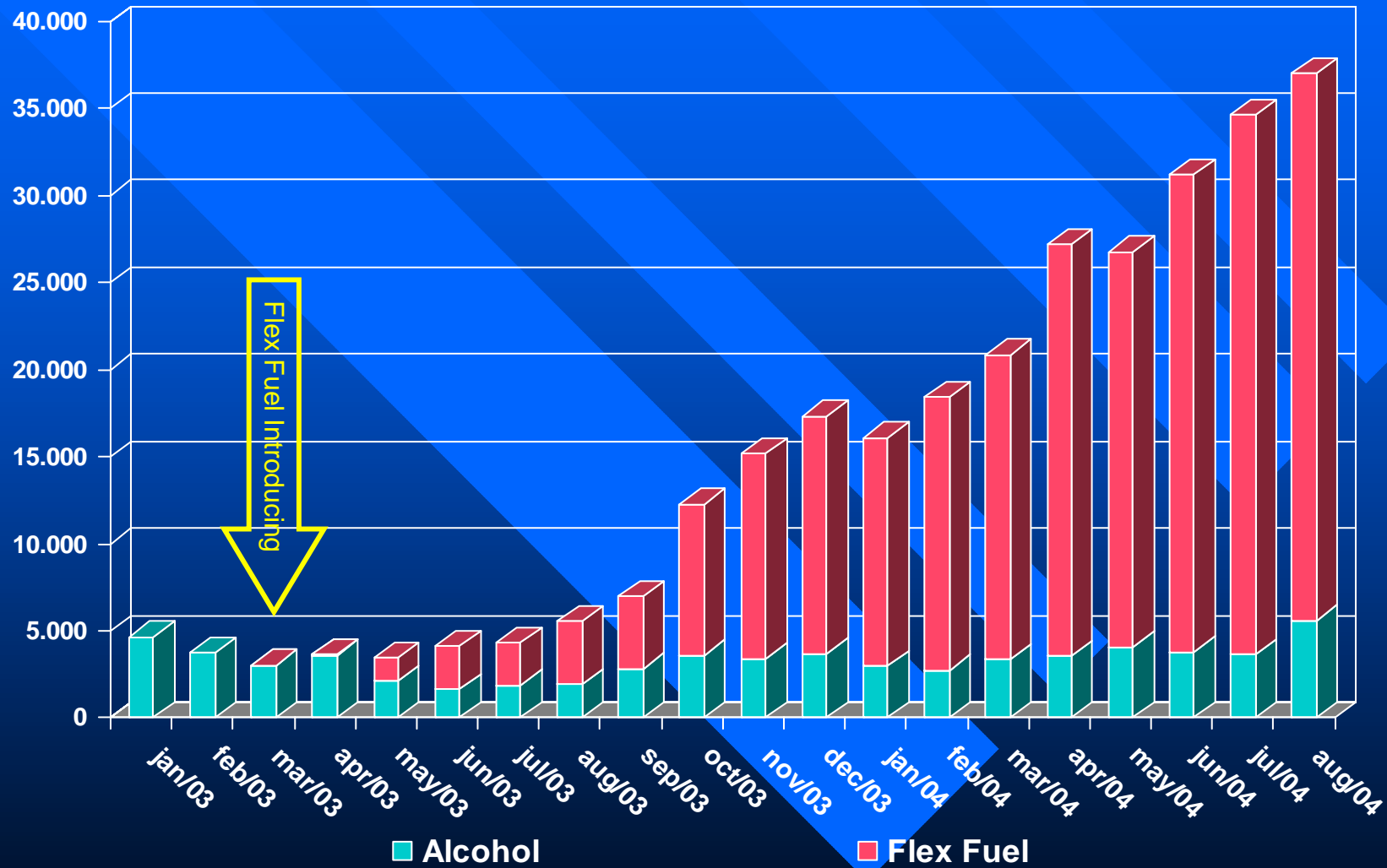
Jan, 2003 to Aug, 2004





# Sales: Alcohol x Flexfuel

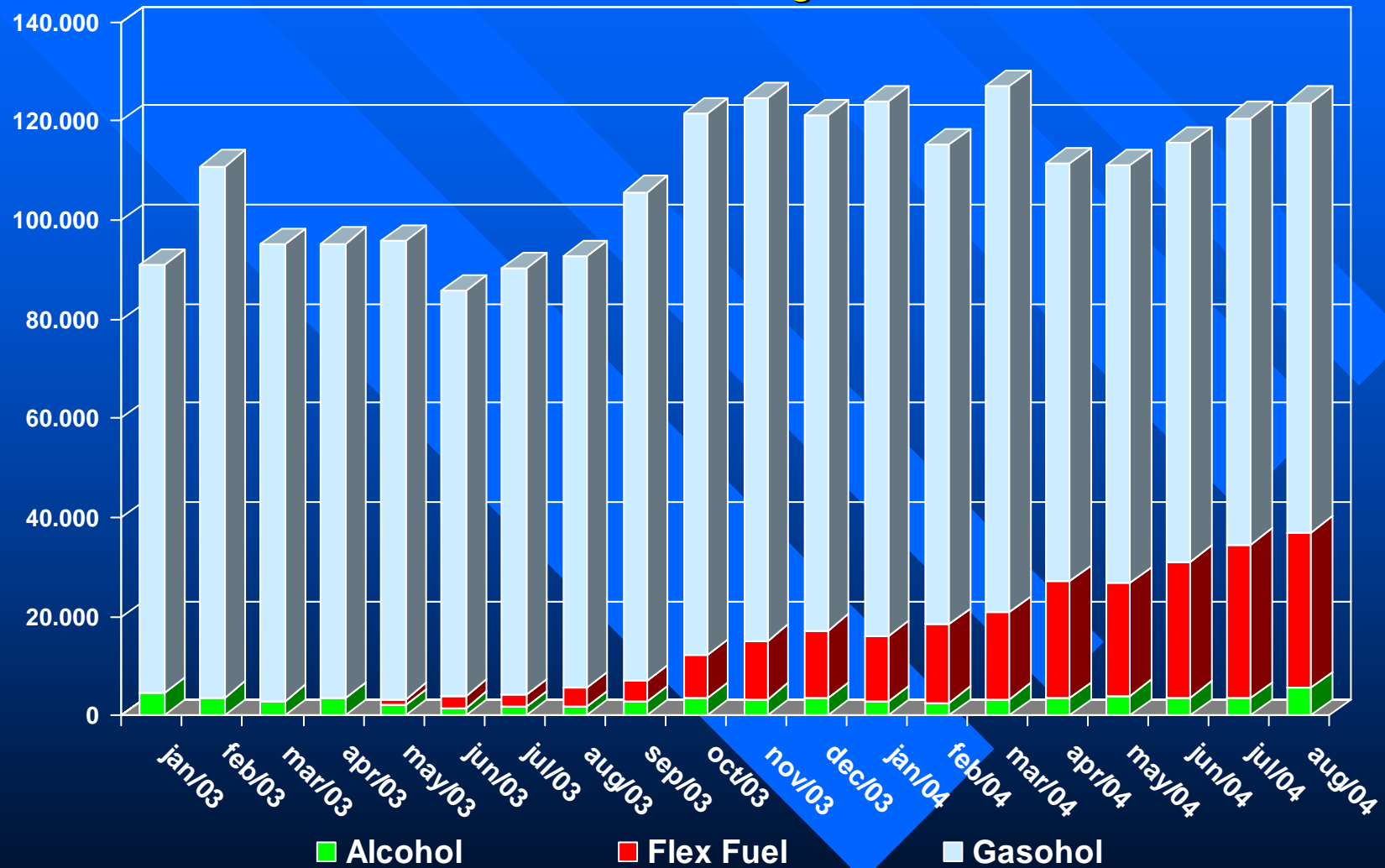
Jan, 2003 to Aug, 2004





# Sales: Alcohol x Flexfuel x Gasohol

Jan, 2003 to Aug, 2004

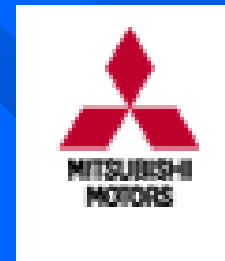
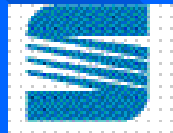






# Other Vehicle Manufacturers

DAIMLER CHRYSLER



**VOLVO**





# Future Perspectives for the Flexfuel

## Sectorial Chamber of Sugar & Alcohol :

- Agriculture & Breeding Ministry
- Energy Ministry
- Industry Development Ministry
- Economy Ministry
- Planning Ministry
- Automobile Manufacturers Association
- Auto part Manufacturers Association
- PETROBRAS
- Fuel Distributors Association
- Alcohol & Sugar Producers Association



# Future Perspectives for the Flexfuel

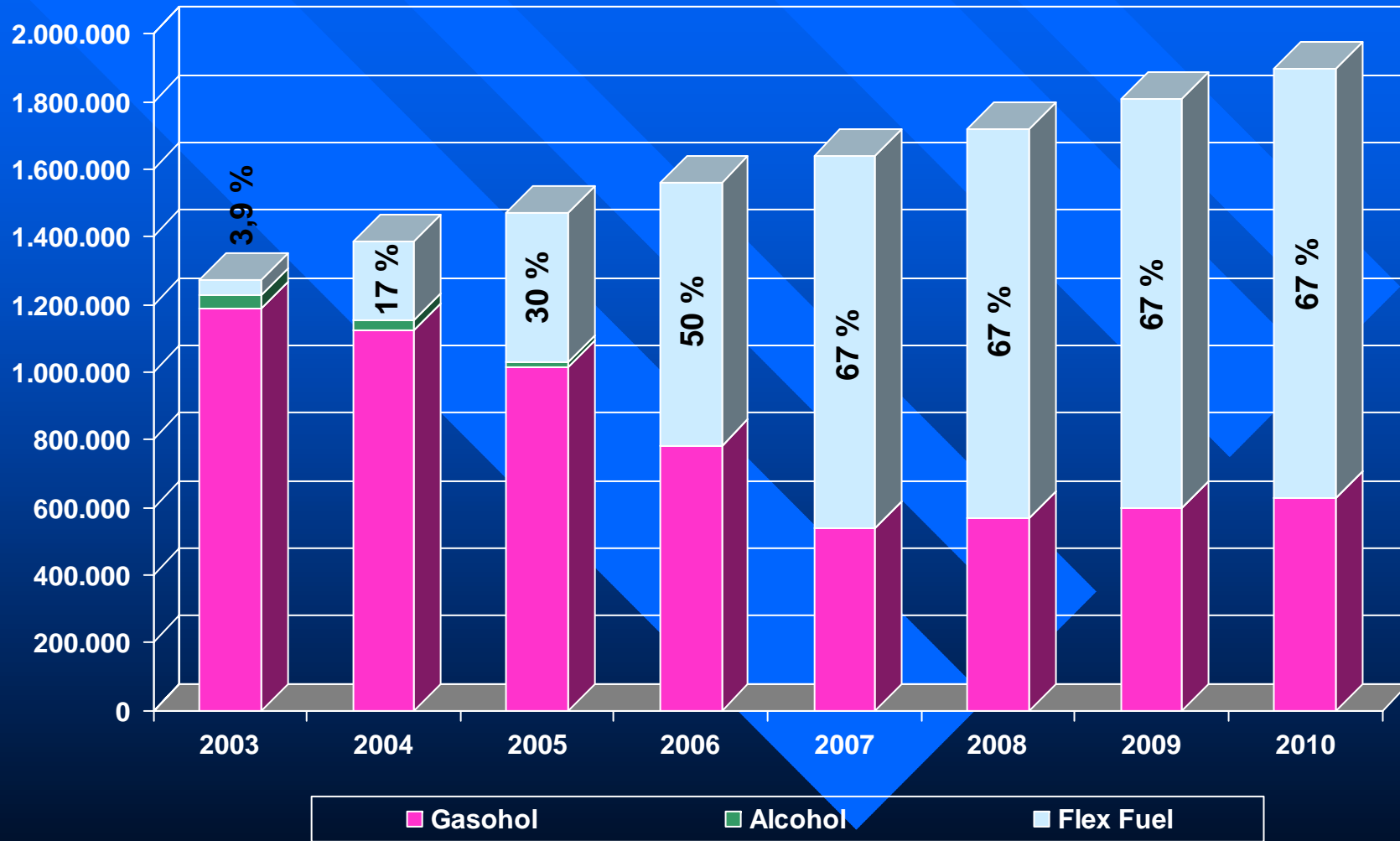
## Sectorial Chamber of Sugar & Alcohol :

- Agriculture & Breeding Ministry
- Energy Ministry
- Industry Development Ministry
- Economy Ministry
- Planning Ministry
- Automobile Manufacturers Association
- Auto part Manufacturers Association
- PETROBRAS
- Fuel Distributors Association
- Alcohol & Sugar Producers Association

December 2003  
Alcohol Demand Study  
2004 ~ 2010

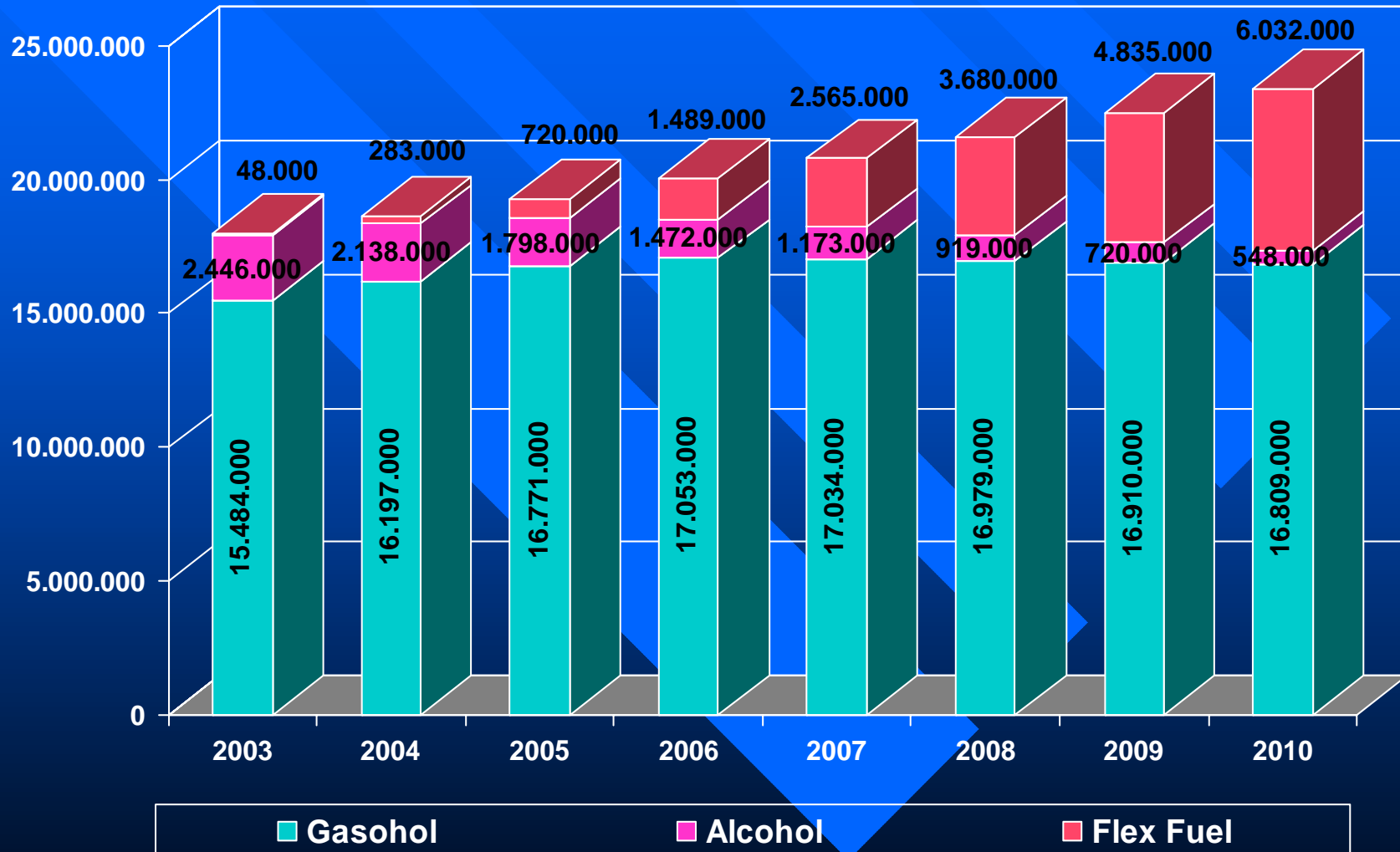


# Light Vehicles Sales Forecast





# Brazilian Light Vehicles Fleet Forecast





Thank you

[henry.joseph@volkswagen.com.br](mailto:henry.joseph@volkswagen.com.br)

