



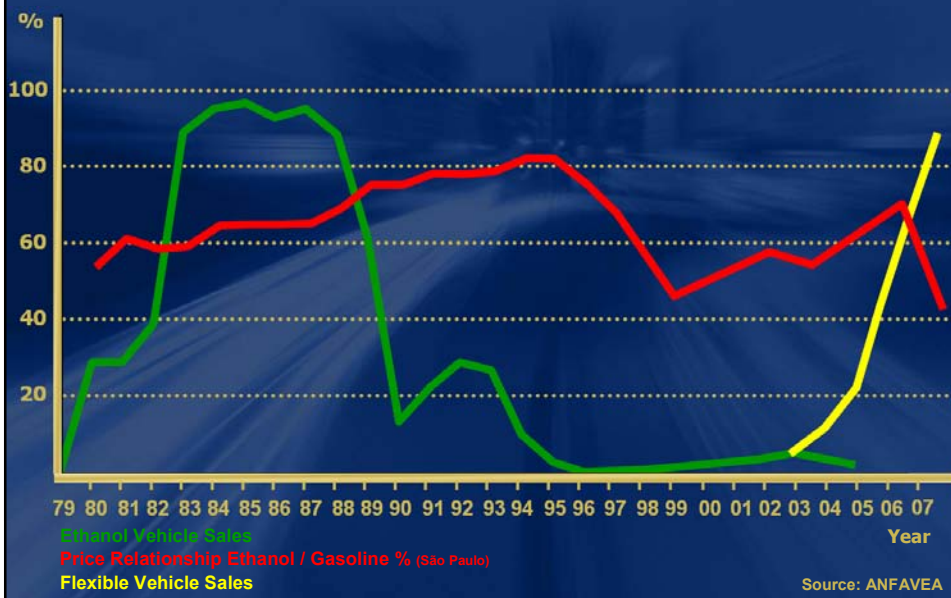
E22/E100 FFV Experience in Brazil - GM Flexpower

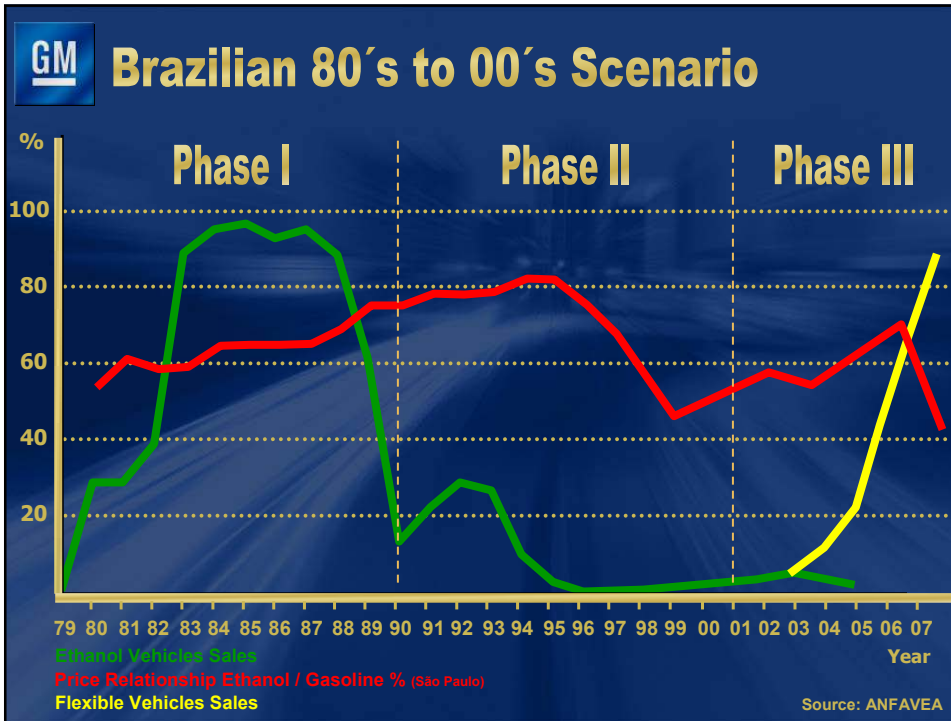
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Sep 2007



Brazilian 80's to 00's Scenario





GM Phase I - The 80's

Brazil was the first country in the world to adopt ethanol as a motor fuel.

-“Pró-Álcool” (1975) – Vehicle powered by 100% ethanol

- * Car Racing (1976)
- Government Fleet (1977)
- Production (1979)
- * All fuel stations required to pump ethanol by law
- * One fuel price across the country (military government)
- * Sales and registration fees incentives
- * Ethanol price: enforced to be 60% of gasoline price

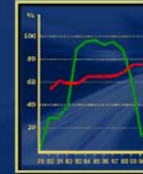
The inset graph shows ethanol vehicle sales from 1979 to 1989, peaking at approximately 95% in 1985.



Phase I - The 80's

- Experience

- * Ethanol quality
- * Poor ethanol specification
- * Engine components corrosion protection
- * Gasoline engine to ethanol conversion in the field
- * Cold start-100% ethanol (Temperatures below 64° F)
 - Auxilliary gasoline reservoir
- * High compression ratio engines for thermal efficiency



- Brazilian fuel

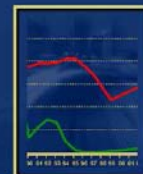
Gasoline – E22	Ethanol – E100
22% Ethanol	93% (min) Ethanol
78% Gasoline	7% (max) Water



Phase II - The 90's

- Introduction of new emissions regulations

- * Fuel injection system
- * Exhaust after treatment
- * Cold start improvements (Electronically Controlled)

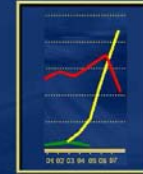


- “Pró-Álcool” program collapsed

- * Sugar prices “skyrocketed” and oil prices leveled out
- * Ethanol refineries switched production to sugar
- * Lack of ethanol at the fuel stations
- * Ethanol price: 80% of gasoline price
- * “Pró-Álcool” program lost credibility
- * Ethanol vehicle market crashed



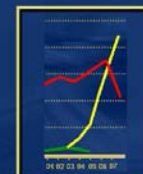
Phase III - The 00's



- First Flex fuel vehicle studies (1992)
 - * Electronic control could automatically adjust to run on any blend of fuel from 100% ethanol down to 20% Ethanol. "Virtual sensor"
- Ethanol prices decreased
 - * Inventories were growing
 - * Ethanol price: 40% of gasoline price (by offer)
- Flex vehicles would give customers the ability to switch as fuel market dictates



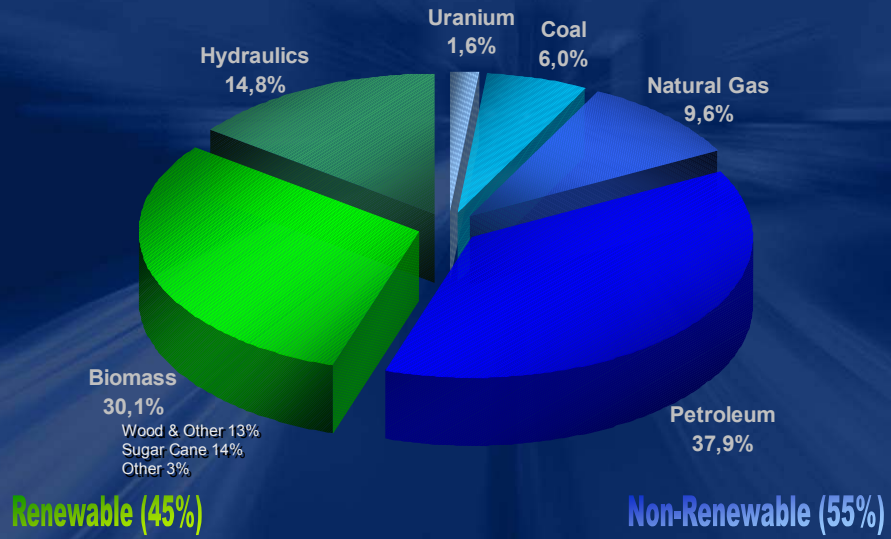
Phase III - The 00's



- Challenges and Concerns for Flex
 - * Water separation
 - * Compression ratio optimization (Gasoline & Ethanol)
 - Thermal Efficiency – Keeping high compression
(Octane numbers: E22 = 92 / E100 = 105)
 - * Fuel consumption perception (Ethanol X Gasoline)
 - * Component protection against corrosion optimization
 - * Virtual sensor to detect different fuels in real time
- In 2003 GM launched the first flex vehicle in the market



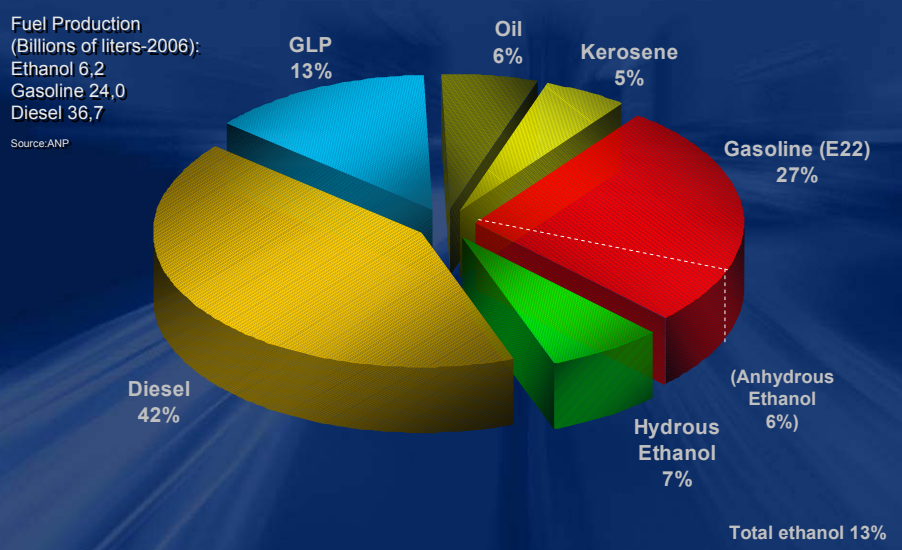
Brazilian Energy Matrix



Source MME/BEN 2006



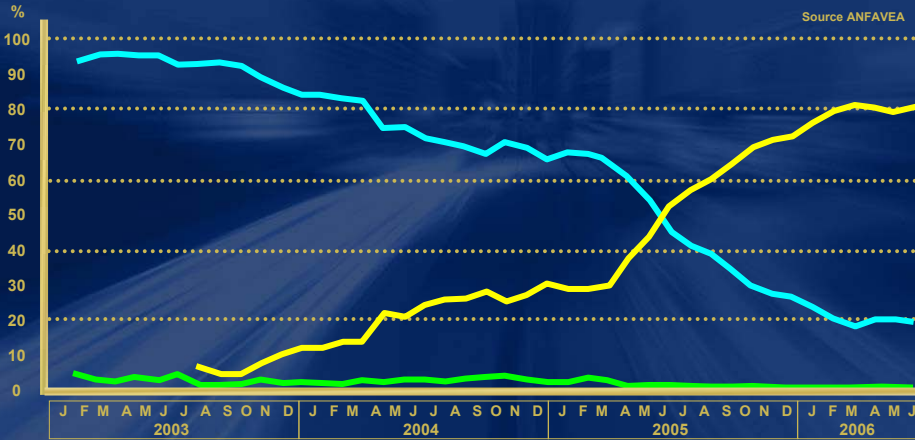
Brazilian Fuel Market





Current Scenario

Brazilian Passenger Car Production



Vehicle Fleet
 Total 28,3 Mi (mar07)
 Source: Anfaeva

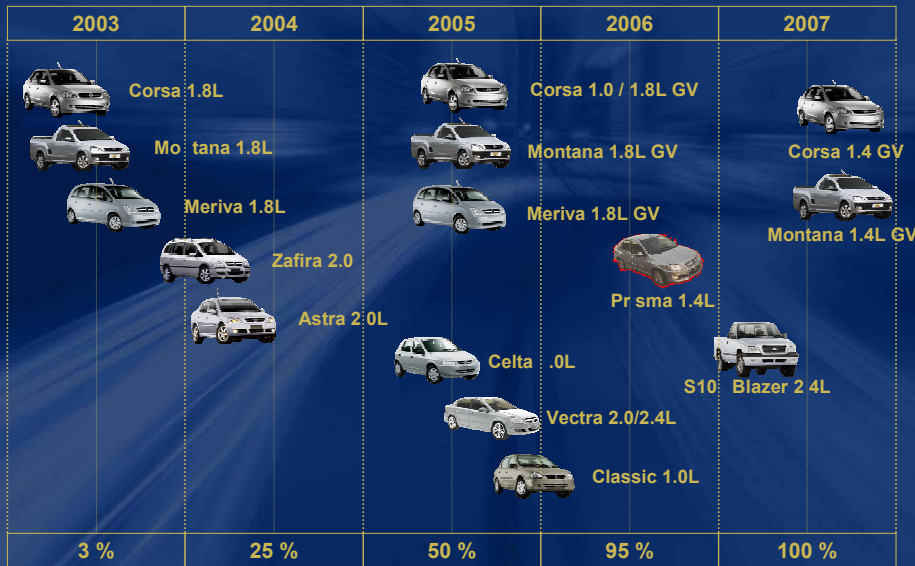
Gasoline 23,3 Mi
 Flex 3,0 Mi
 Ethanol 2,0 Mi

Ethanol Vehicle Sales
 Gasoline Vehicle Sales
 Flexible Vehicle Sales



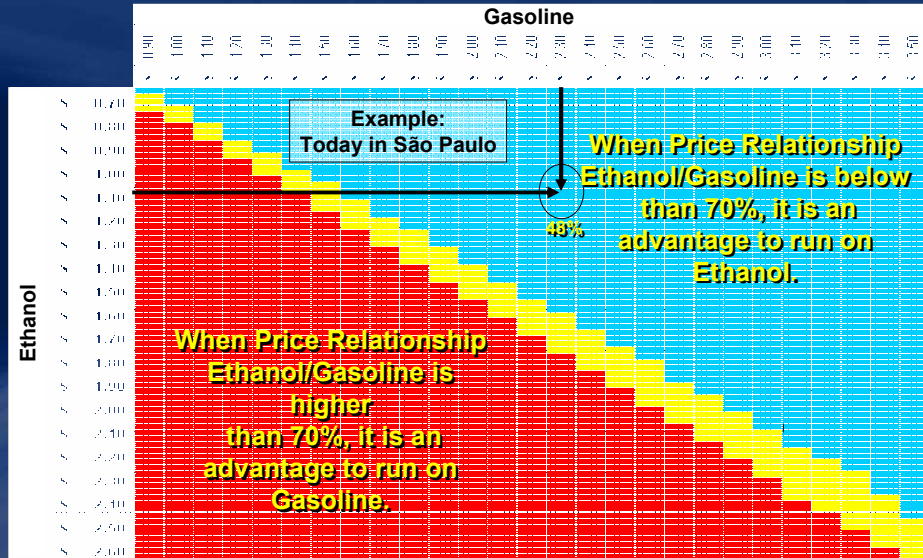
General Motors Flexpower Portfolio

Passenger Vehicles - Brazilian Market





Ethanol (E100) X Gasoline (E22) Cost Benefit



Vehicle Performance & Fuel Consumption

Top Speed

189 km/h



190 km/h



Acceleration 0-100 km/h

10.4 s



10.1 s



Elasticity 40 at 100 km/h

14.2 s



13.2 s



Elasticity 80 at 120 km/h

13.4 s



13.2 s



Fuel Consumption

City

11.6 km/L



8.1 km/L



Highway

17.4 km/L



12.0 km/L



Combined

14.2 km/L



9.9 km/L



Range

625 km



436 km



Gasoline



Ethanol



GM Flexpower - The Future

- Cold start improvements
 - * Cold Start without auxilliary Gasoline reservoir
- Engine thermal management
 - * Temperature adjustment for each different fuel blend
- Optimize Compression Ratio
 - * Increased Efficiency
 - * Reduced Fuel Consumption
- Turbocharging
 - * Variable compression according to the fuel blend
- Direct Injection Engines (SIDI)
 - * Further Increased Efficiency
 - * Further Reduced Fuel Consumption



Conclusion

- Known exhaust emissions standards (Except for California) are not a restriction to Flex Fuel vehicles. Diagnosis (OBD) is still a challenge.
- Ethanol price fluctuation and its availability in the market substantially affects customer decisions on vehicle purchase. The Flex Fuel architecture eliminates this factor.
- The Flex Fuel technology is mature and can be applied worldwide, the implementation is dependent on Emissions Standards, Diagnosis Level and portfolio size.
- Challenge to expand the Flex Fuel vehicles to other countries is on the availability of ethanol and channels of distribution.
- Distribution of E85 instead of E100 enables elimination of cold starting devices and therefore, should be preferred.