Round Table 3 - Engines and Biofuels: Moving the World

VEHICULAR ENGINES FOR RENEWABLE FUELS

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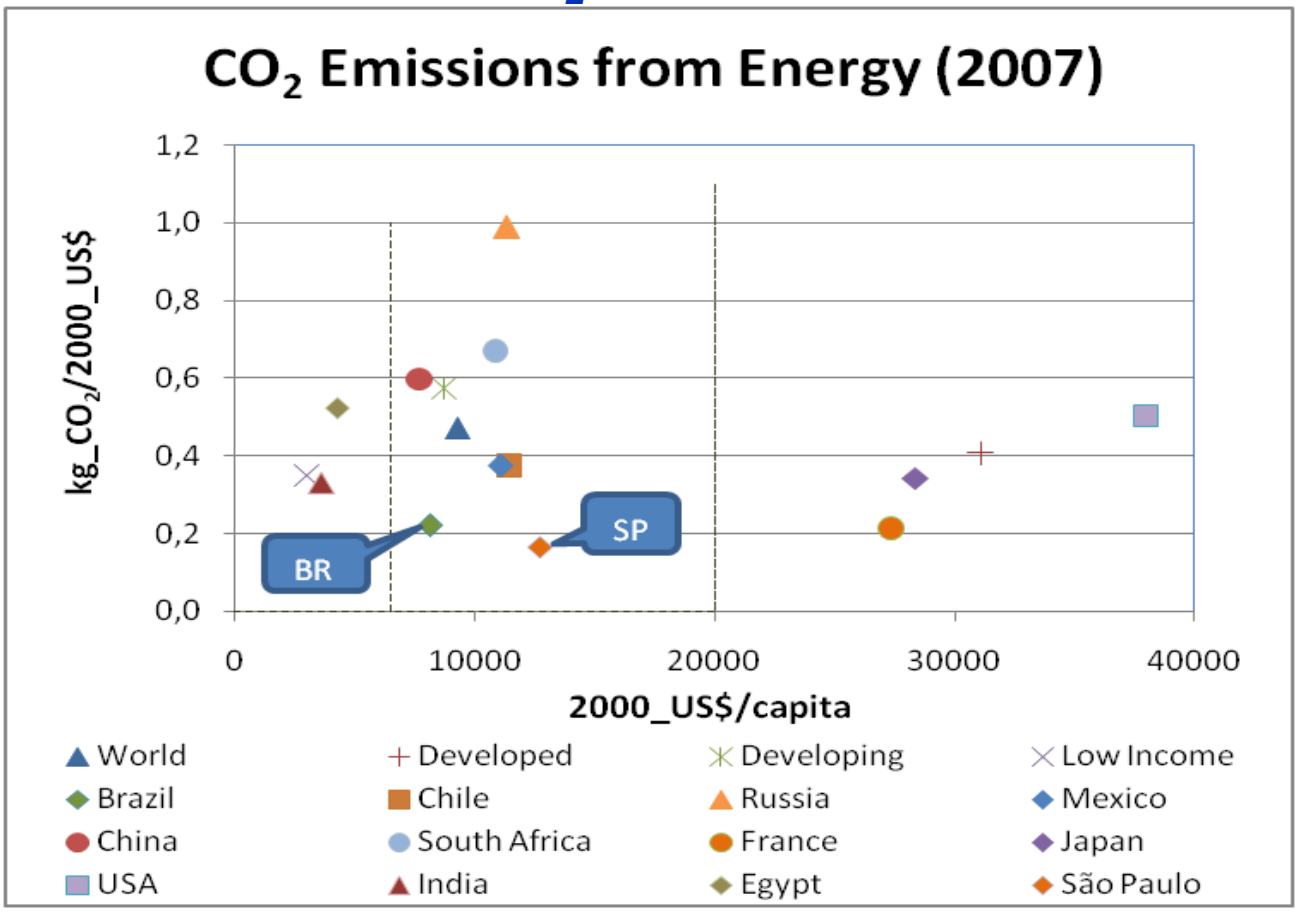
Campos do Jordão, 16/08/11

AGENDA:

- *INTRODUCTION: GHG X TRANSPORT & DEVELOPMENT*
- *EMISSIONS REDUCTION X VEHICLE COSTS*
- *BRAZILIAN HISTORICAL EXPERIENCE*
- *ECONOMICAL & TECHNOLOGICAL CHALLENGES OF FFVs*
- *UPCOMING DEVELOPMENT-STEPS*
- *CONCLUSIONS AND SUGGESTION OF PUBLIC ACTIONS*

INTRODUCTION:

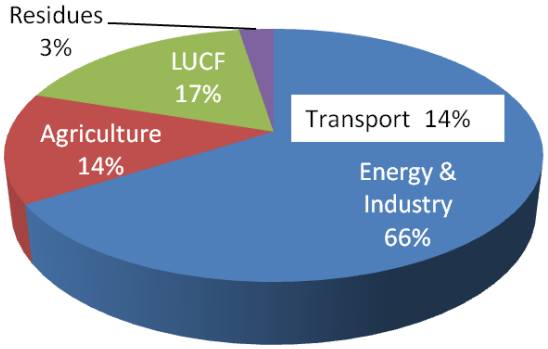
ENERGY, CO_2 & DEVELOPMENT



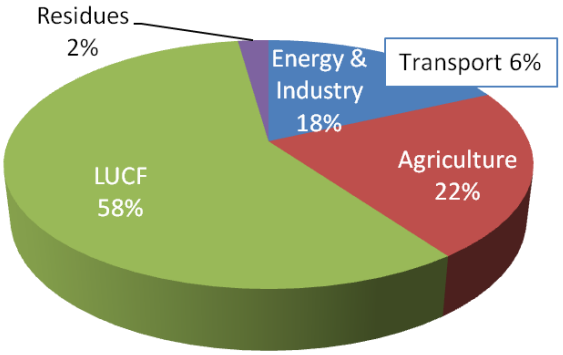
Data from: IEA “Key World Energy Statistics”; Brazil and São Paulo GHG Inventories

INTRODUCTION (Cont.):

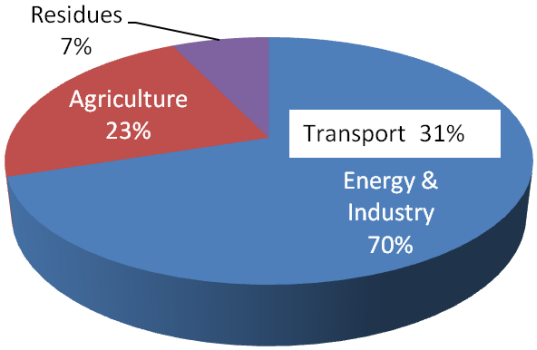
GHG &TRANSPORT



World - Total GHG = 44,2 $GtCO_2eq$



Brazil - Total GHG = 2,2 $GtCO_2eq$

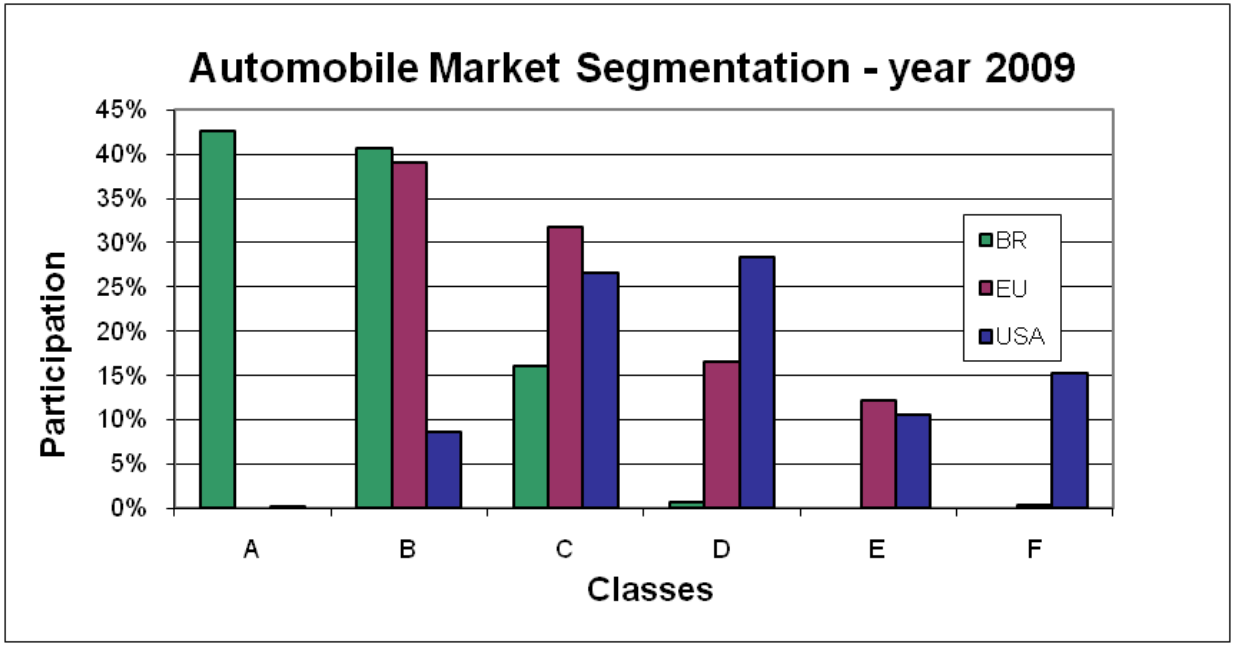


São Paulo - Total GHG = 131 $MtCO_2eq$

WHY TO PRIORITIZE THE USE OF LIQUID BIOFUELS?

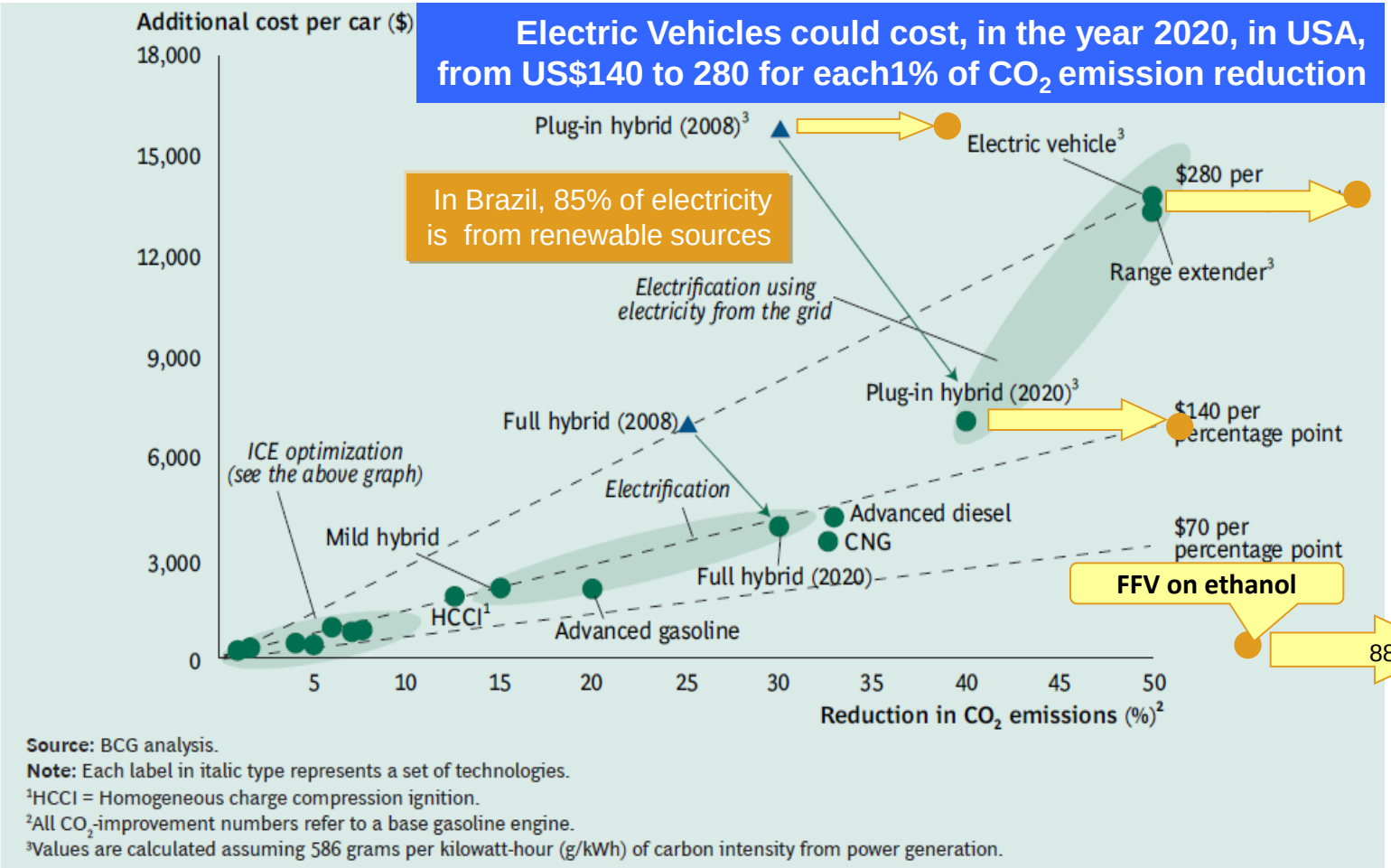
- ***BIOFUELS PRODUCTION CHAINS ARE MORE INCLUSIVE***
- ***LOWER GHG EMISSIONS IN LIFECYCLE ANALISES AT AN AFFORDABLE COST***
- ***HIGH ENERGY STORAGE DENSITY***
- ***BENEFIT OF THE AVAILABLE INDUSTRIAL AND FUEL DISTRIBUTION INFRASTRUCTURES***

ECONOMICAL OPPORTUNITY



	BRAZIL	EU	USA
A	Entrance (1.0L)	Minicars	Microcars
B	Small/Compact	Small	Subcompact/Mini
C	Medium	Medium	Small/Compact
D	Large	Large	Mid-Size
E	Executive	Executive	Full-Size
F	Luxury	Luxury	Luxury

EMISSIONS REDUCTION X VEHICLE COSTS



Source: BCG analysis.
Note: Each label in italic type represents a set of technologies.
[1]HCCI = Homogeneous charge compression ignition.
[2]All CO_2-improvement numbers refer to a base gasoline engine.
[3]Values are calculated assuming 586 grams per kilowatt-hour (g/kWh) of carbon intensity from power generation.

Adapted from:The Boston Consulting Group - “The Comeback of the Electric Car?” - jan/2009

MILESTONES OF BIOFUELS USE IN BRAZIL

- 1920 – Experiments in Fueling Vehicles with Ethanol
- 1940 – Widespread Use of Ethanol Blended with Gasoline during World War II
- 1973 – First International Shock on Oil Price
- 1975 – Brazil's Proálcool Program (Government Action)
- 1978 – CATs : Technological Support Centers for Engine Conversion Shops (actually Rebuilding Shops)
- 1979 – Series Production of Neat Ethanol Vehicle
- 1980 – OVEG Program (abortive Government-action)
- 1985 – Neat Ethanol Vehicles reach 94% of Market Share
- 1989 – Ethanol Supply Problems & Low Oil Prices caused steep Drop in Demand of Ethanol Vehicles
- 2003 – Flex Fuel Vehicles (successful Government-action)
- 2005 – Brazil's Biodiesel Program (Government Action)

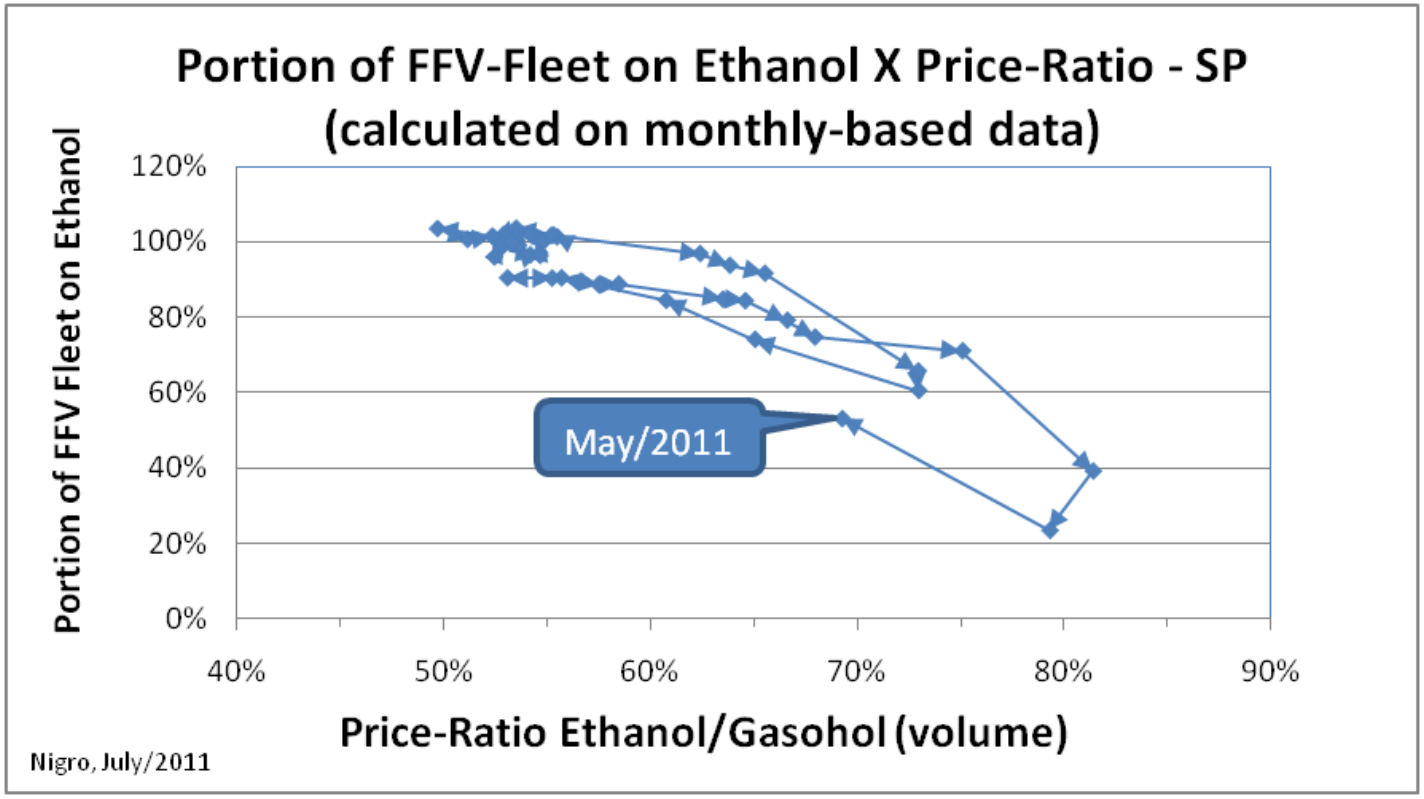
SUMMARIZING BRAZILIAN EXPERIENCE

- Although gradual innovations and slow changes of long-established champion-models are not as charming as break-through innovations that outdo the conventional, they can produce remarkable results;
- In a global market dominated by multinationals, it is very difficult to implement local innovative solutions, unless government (based on research results from its institutions) induces the production sector by ways that include consumers demand;
- The technological challenge is how to combine local advantages and peculiarities with global trends to create winning solutions;

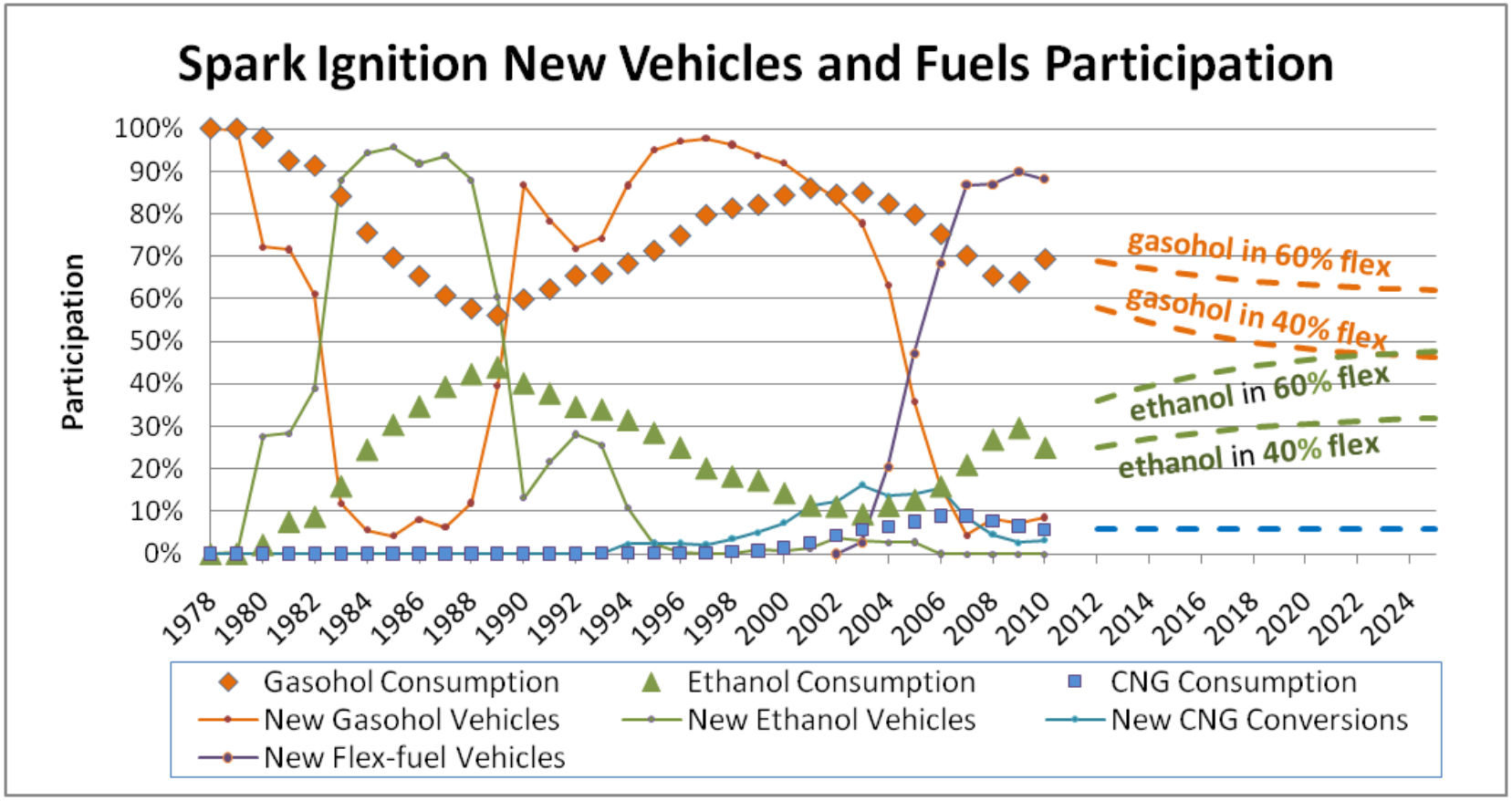
CHALLENGES TO FUTURE ETHANOL USE ON FFVs

- The fuel has to stay economically competitive with gasoline
- New developments have to be fitted in FFVs accompanying future global technologies, with costs compatible with the Brazilian market, aimed at:
  - Greenhouse gas emissions
  - Fuel consumption
  - Local pollutants

ECONOMICAL CHALLENGES



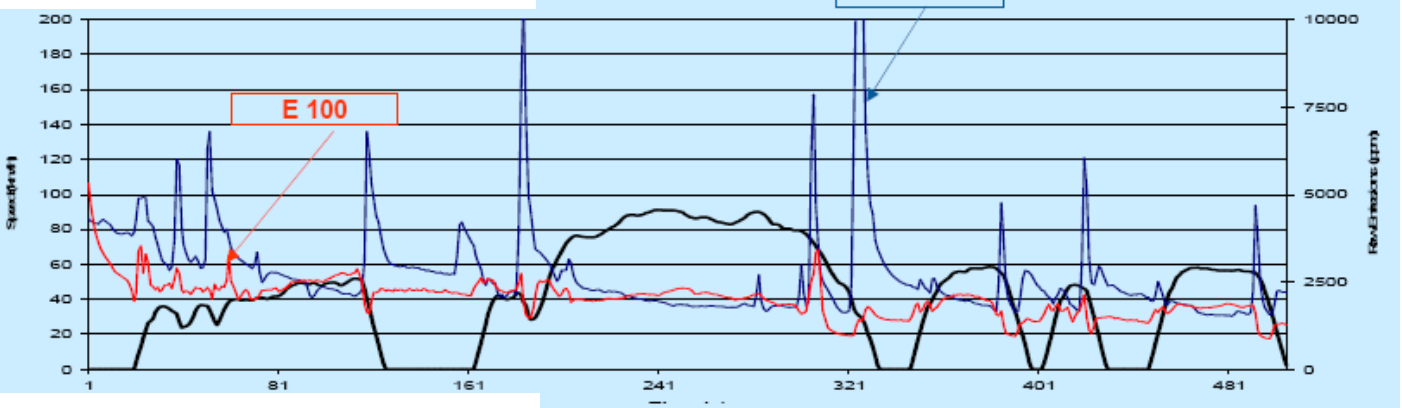
ECONOMICAL CHALLENGES (cont.)



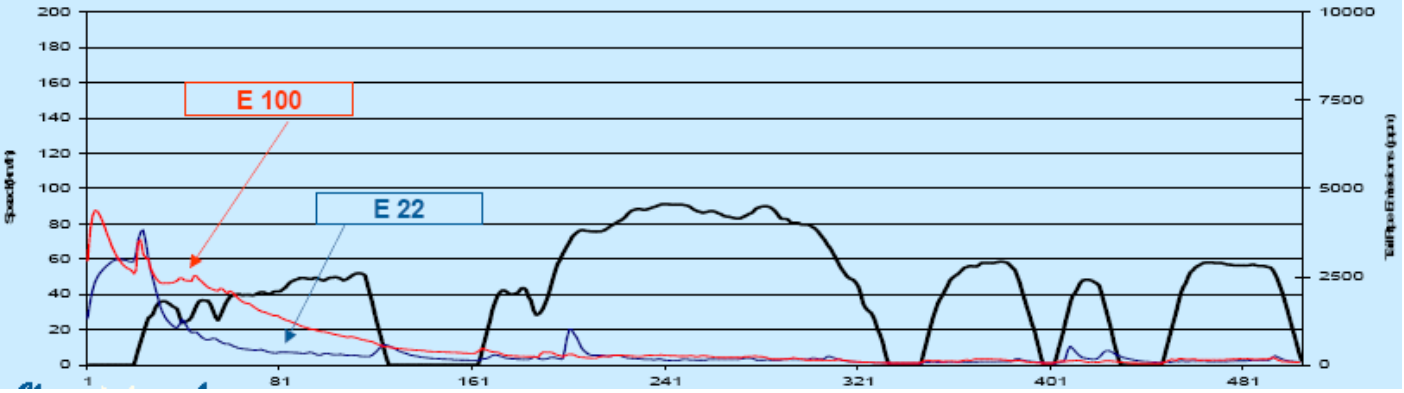
TECHNOLOGICAL CHALLENGES

Cold Phase Emissions

Raw Emissions – THC Phase 1



After Catalyst – THC Phase 1

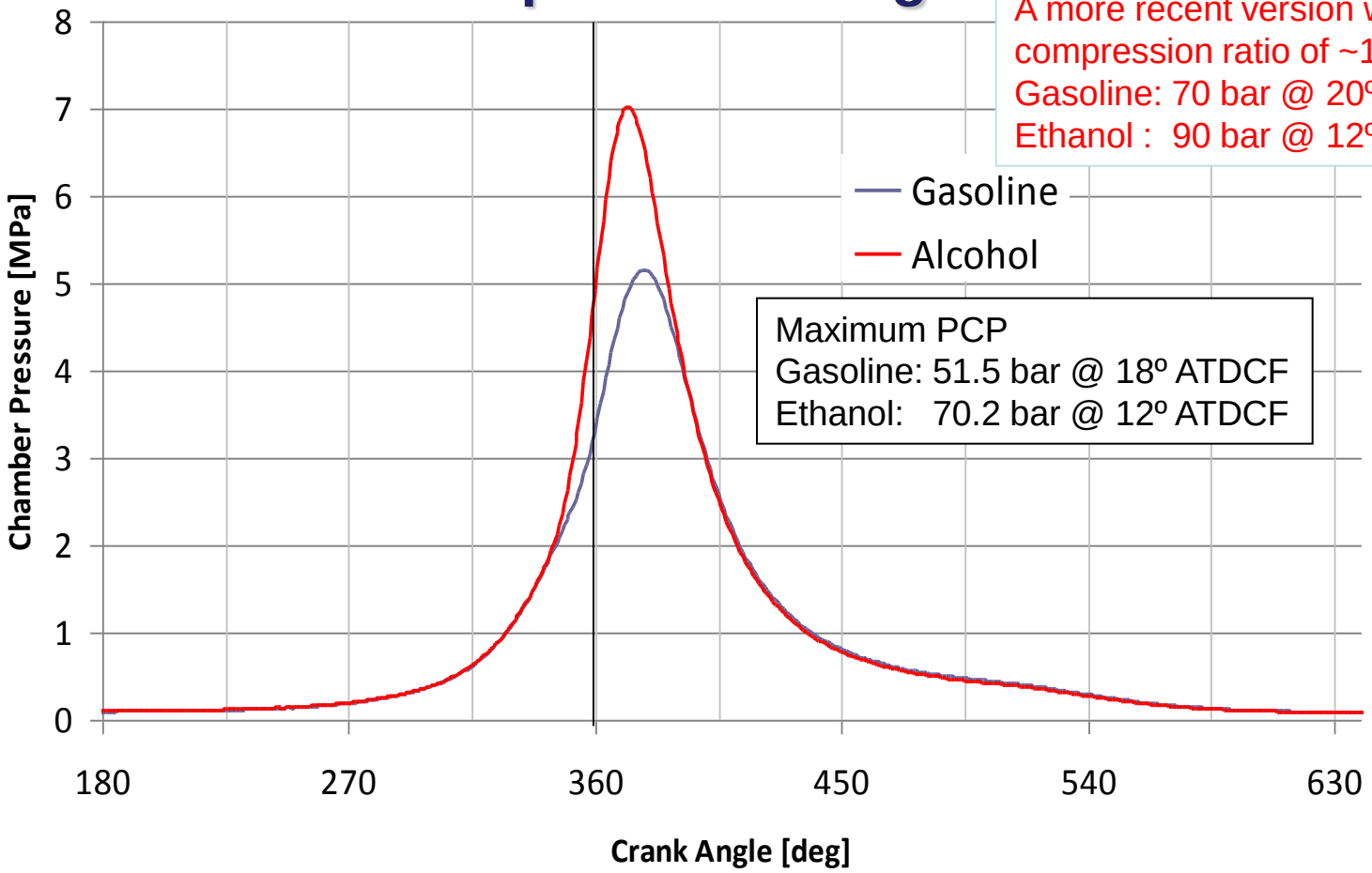


Stephan Blumrich – Seminário SAE Powertrain ago/2009

TECHNOLOGICAL CHALLENGES

Increased Component Strength

A more recent version with compression ratio of ~13 :1
Gasoline: 70 bar @ 20º ATDCF
Ethanol : 90 bar @ 12º ATDCF



Neil Fraser– Seminário SAE Powertrain ago/2009

FUTURE STEPS IN THE DEVELOPMENT OF FLEXIBLE-FUEL ENGINES

- Cost-effective solutions for cold start on ethanol
- Electronically controlled valve timing
- Engine downsizing and turbo-charging
- Direct injection of fuel in the combustion chamber (homogeneous and stratified charge)
- Hybrid-electric systems with special engines

Although several of those technologies have the potential to increase competitiveness of ethanol, the research and engineering effort to make them effective for the biofuel will be demanding.

CONCLUSIONS AND SUGGESTION OF PUBLIC ACTIONS

- The past evolution, of ethanol utilization in engines, has shown that is very difficult for a developing country to maintain the local fuel compatible with an engine technology that is evolving fast, pushed by international concerns.
- Although the USA has also adopted the ethanol as the renewable fuel for gasoline substitution, and for that matter that will mean a strong help, it is of utmost importance for Brazil to develop engine technologies that give competitive advantage to ethanol utilization.

CONCLUSIONS AND SUGGESTION OF PUBLIC ACTIONS (cont.)

It is necessary to act in three different levels to push the use of ethanol:

1. **To incentive research in universities and institutes, with participation of productive sector, on ethanol combustion, direct injection in engines, new combustion processes like CAI and HCCI, tribology, new materials and catalysts, to develop basic knowledge and form researchers;**
2. **To incentive applied development, joining the automotive industry, suppliers and research institutions to upgrade the engineering needed to accelerate the development process;**

CONCLUSIONS AND SUGGESTION OF PUBLIC ACTIONS (cont.)

3. To incentive the final consumers to appraise energy efficiency and environmental sustainability, pushing companies to compete for the development needed for the country.

REMARK: The globalization efforts by the automotive industry, and the strong interdependence of new technologies with oil-products, could lead to the development of biofuels of another generation, to be produced by refinery-size plants, with characteristics much similar to the ideal fuels for which the engines were developed.