ETHANOL USE AND THE AUTOMOTIVE INDUSTRY

Ricardo Abreu

SUSTAINABLE MOBILITY: ETHANOL TALKS PAKISTAN

MOBILITY CHALLENGES DRIVING ENGINES DEVELOPMENT

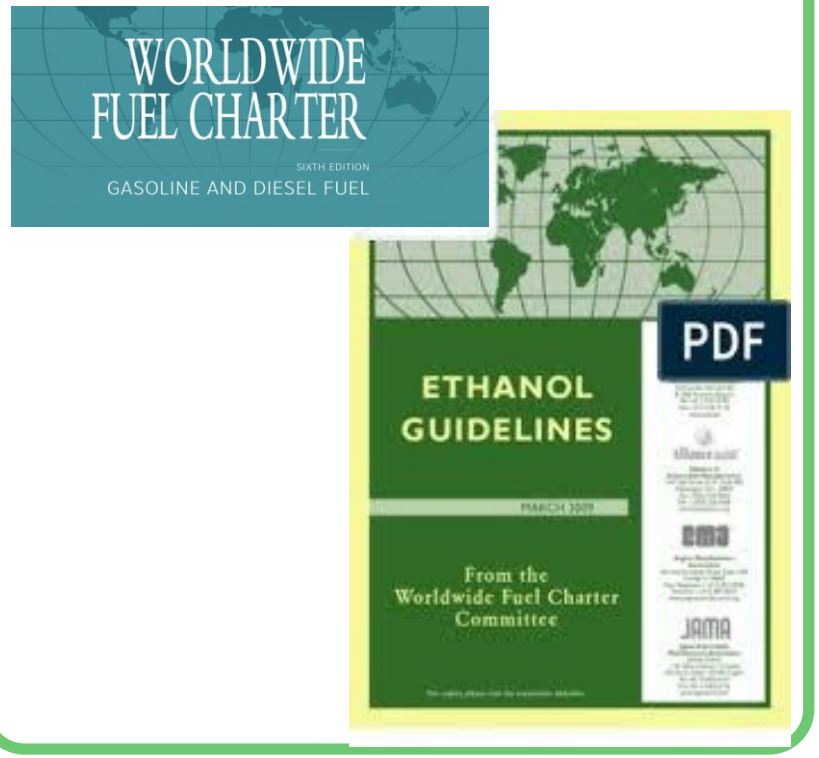
Focus on Alternative Fuels Improved considerably in the last decades – oil crisis

At the beginning big part of field problems in Brazil were caused by bad fuel quality and no experience on high % of Ethanol

Most of the material improvements were also needed for modern technologies, like fuel injection and turbocharging, standard today

E10 is accepted worldwide, higher blends up to E20 can be used checking compatibility with the OEM

Global Guidelines for Fuels specs. including Ethanol Blending



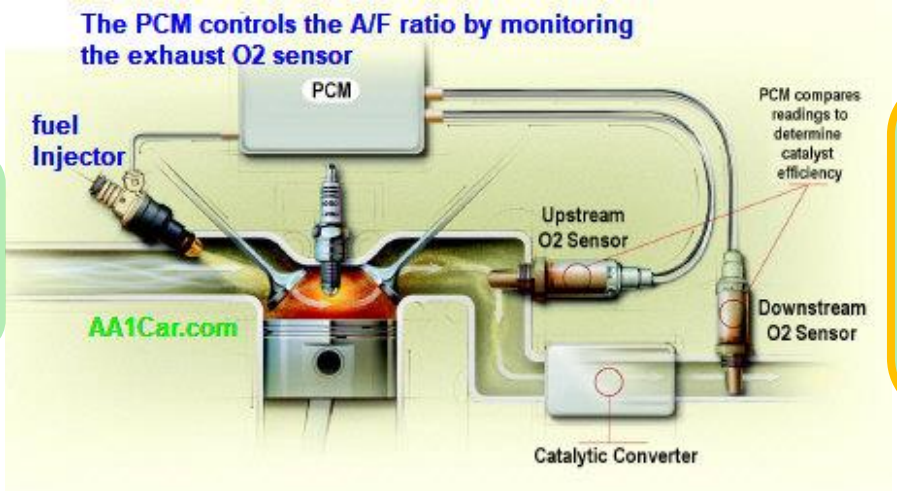
Station Filtration on dispensers adapted for alcohols

Sealing, gaskets, o-rings made of Fluorinated Elastomers (VITON)

MOBILITY CHALLENGES DRIVING ENGINES DEVELOPMENT

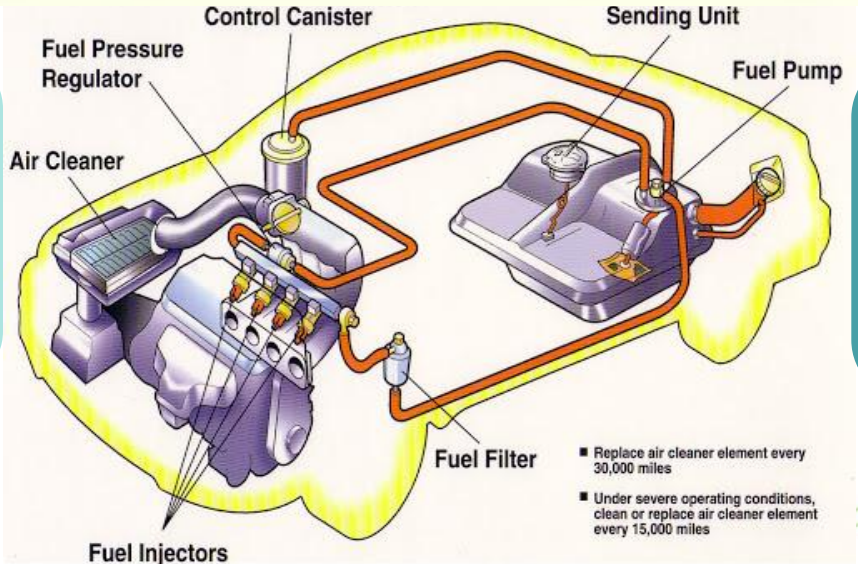
Emission control demands improved flexfuel capability

New fuel systems improved air-ratio control identifying changes on fuel composition or etanol blends



Brazil developed a flexfuel system without the need of an expensive fuel composition sensor using closed loop controls allowed ethanol content recognition.

New fuel systems to improve emissions and components durability, working better for etanol blends as well . For legal reasons OEM defines the Ethanol blend compatibility.



In 2015 after tests carried out with on series vehicles with OEM participation, E27 was released in Brazil for local produced cars. imported vehicles run on E25

SUSTAINABLE MOBILITY: ETHANOL TALKS PAKISTAN

ETHANOL BLENDS EFFECT ON POLLUTANT EMISSIONS DEPENDS ON ENGINE TECHNOLOGY.

MODERN ENGINES, GASOLINE DIRECT INJECTION (GDI) USES THE WHOLE ETHANOL PROPERTIES ADVANTAGES.

North Caroline State University

E10 X E25 Current Fleet Vehicles **(SPI)**

- E25 less 30-40% UFP (ultrafine particulates)
- E25 reduced CO by 15-30%
- No change in NOx

University California Riverside

E10 x E25 Current Fleet Vehicles **(MPI)**

- E25 10-30% NOx reduction

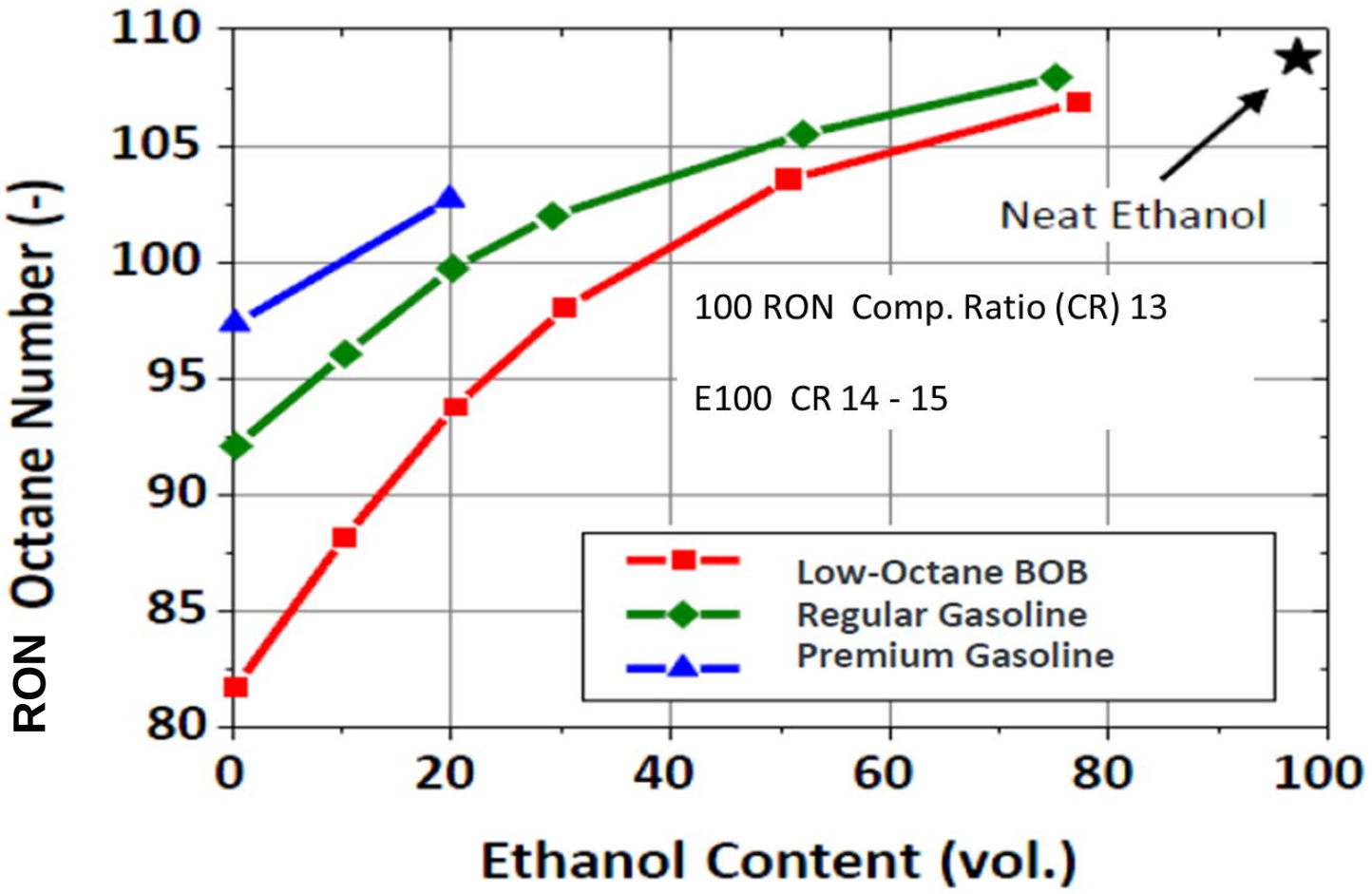
EMPA, Swiss Federal Laboratories

(E0) x (E10 and E85) Euro-5 **GDI**

- Particle number emissions E10 and E85 lowered by 87 and 96%
- CO dropped by 81 and 87%
- CO_2 reduced by 13 and 17%
- PAHs lowered by 67-96% - E10, by 82 – 96% - E85
- Genetoxic potentials dropped by 72 and 83%

SUSTAINABLE MOBILITY: ETHANOL TALKS PAKISTAN

ETHANOL BLENDING EFFECT ON OCTANE NUMBER



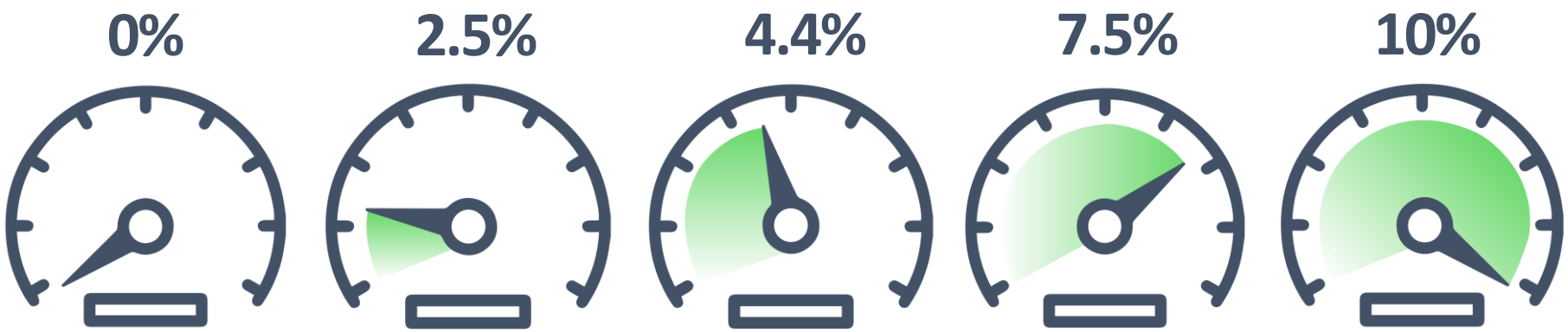
Reproduced from Stein, SAE2012-01-1277

EFFECTS OF IMPROVING OCTANE PROPERTIES RON AND SENSITIVITY

MON-Motor Octane Number the original method to indicate knocking resistance.

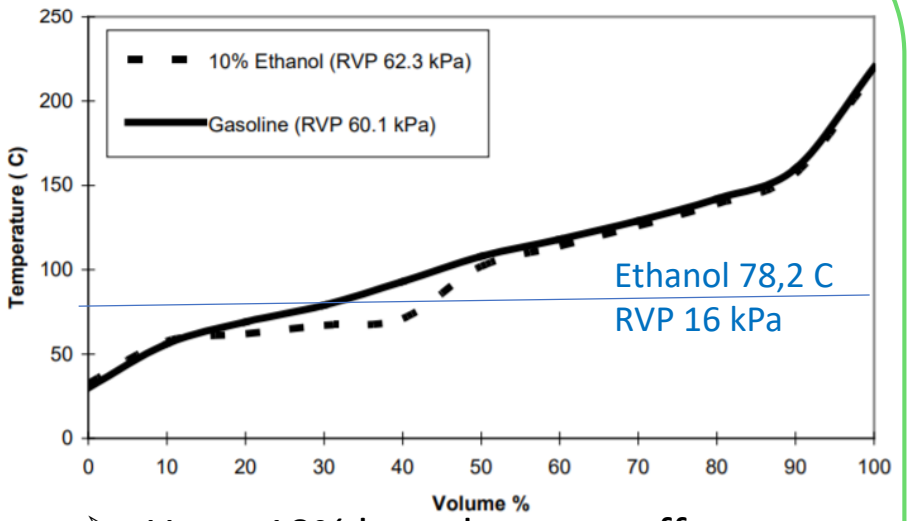
For downsized, down speed (rpm) and high compression ratios engines RON-Research Octane Number is more representative

The sensitivity (RON-MON) is an important indicator of fuel properties for modern engines



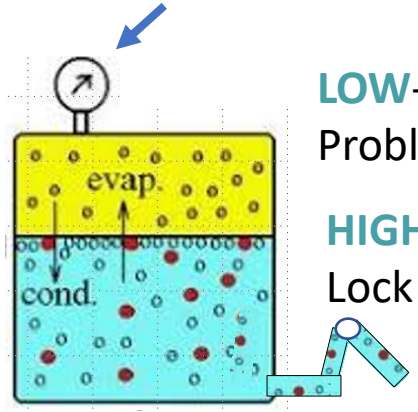
Differences between Gasoline and Ethanol Properties

Distillation



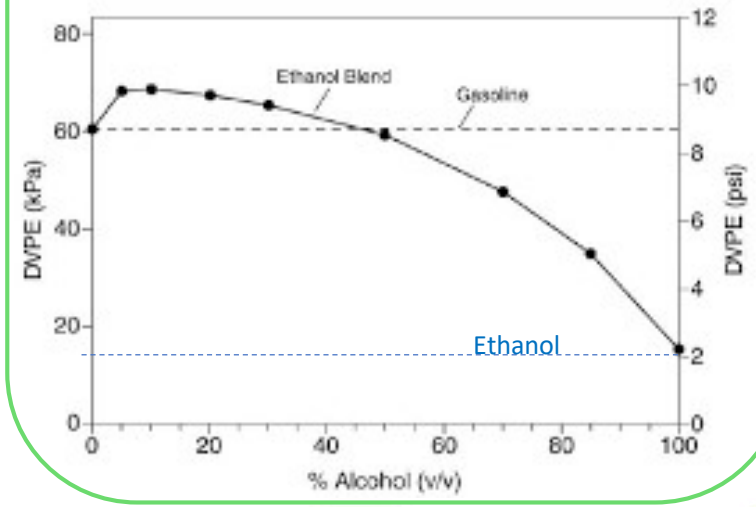
- Up to 10% by volume no effect on engine adjustment.
- Up to 20% combustion sensors will learn the new % and adjust it
- Current systems are able to control up to E25

Vapor Pressure

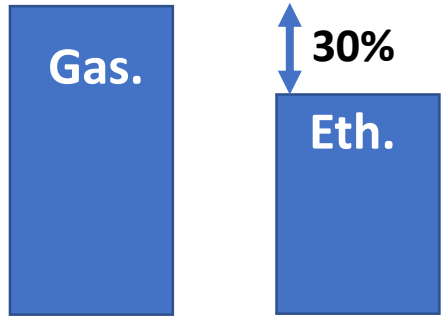


LOW-Cold Start Problems

HIGH -Vapor Lock



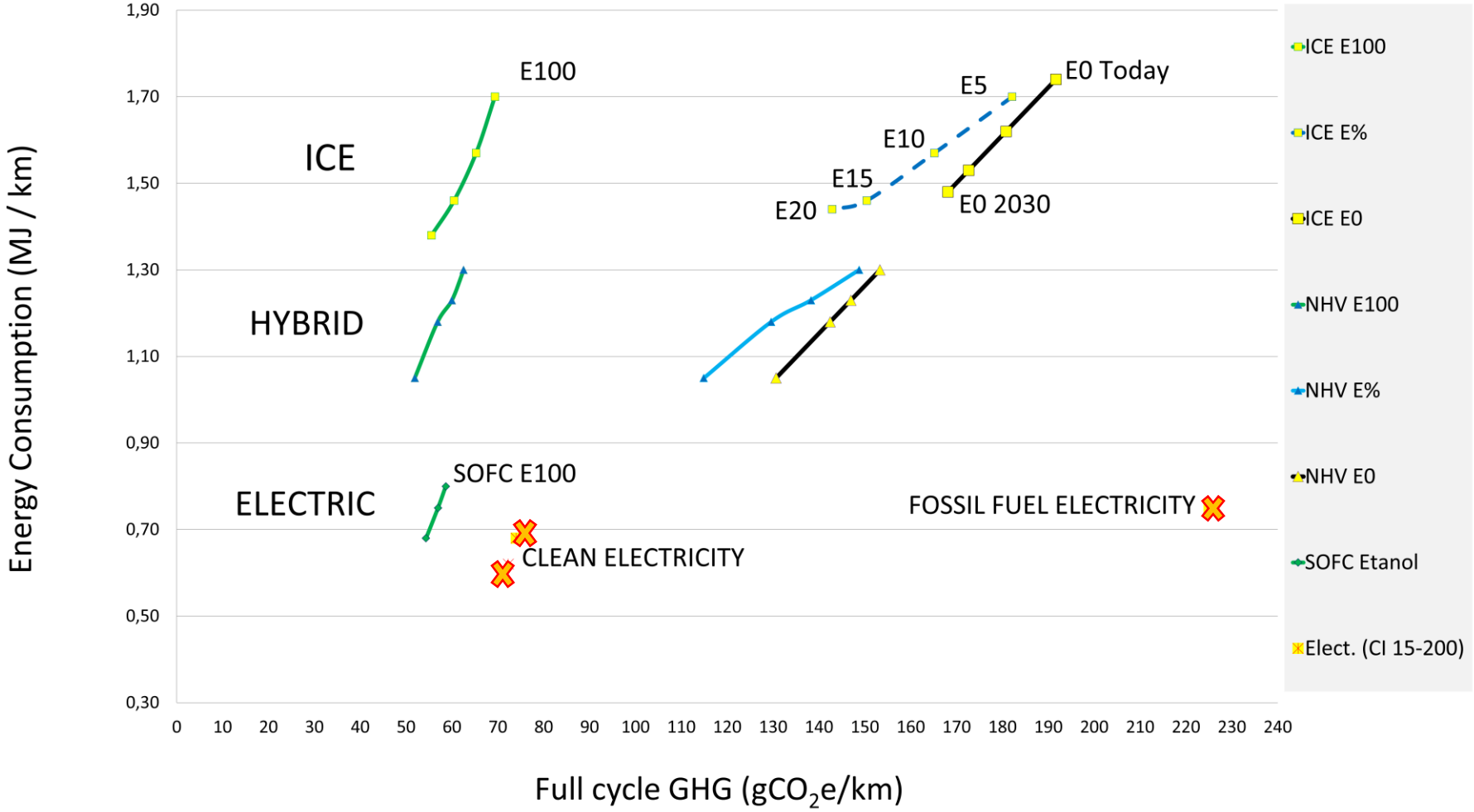
Energy Content by Volume



- E blends lower energy is offset by the higher RON.
- Fleet vehicles RON 95->98 became 3% more efficient.
- Matching engine and vehicle E10~E30 achieved same range.

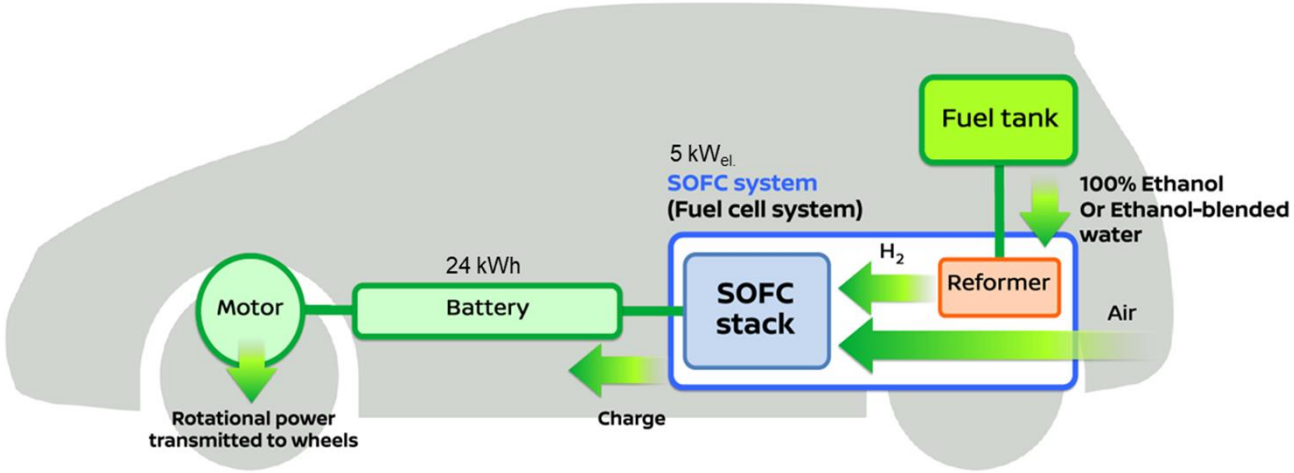
ETHANOL BLENDS AND OTHER SOLUTIONS TO REDUCE MOBILITY ENVIRONMENTAL IMPACTS - GHG (Greenhouse Gas)

Vehicle Full Cycle GHG= Well-to-Wheel GHG + (Vehicle + Battery Production) GHG (gCO_2e/km)

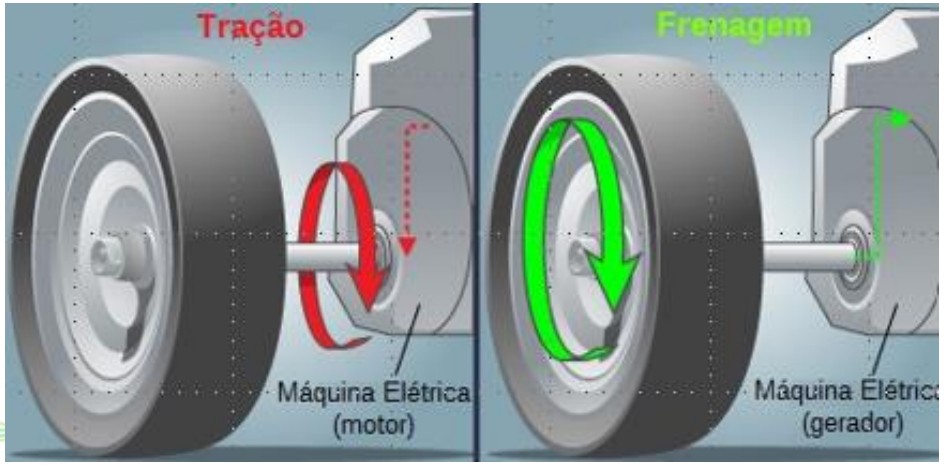


ELECTRIFICATION IS NOT "BATTERYZATION"

FLEX (E27-E100) HYBRID



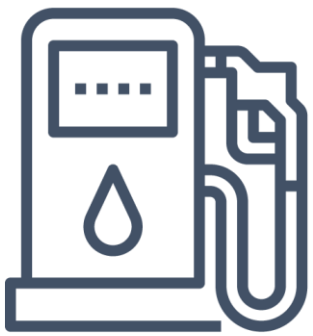
TRACTION **BRAKING**



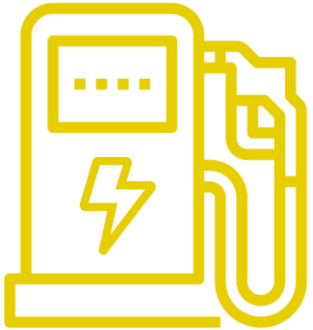
Ethanol is renewable "liquid hydrogen"
An Ethanol Fuel Cell, eliminates the high cost cryogenic, titanium tank (700 bar)

SUSTAINABLE MOBILITY: ETHANOL TALKS PAKISTAN

ALL COMBINATIONS WILL BE NEEDED FOR A LOW CARB SOCIETY

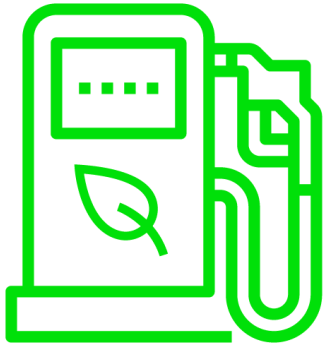


HC



Elect.

H_2



Bio

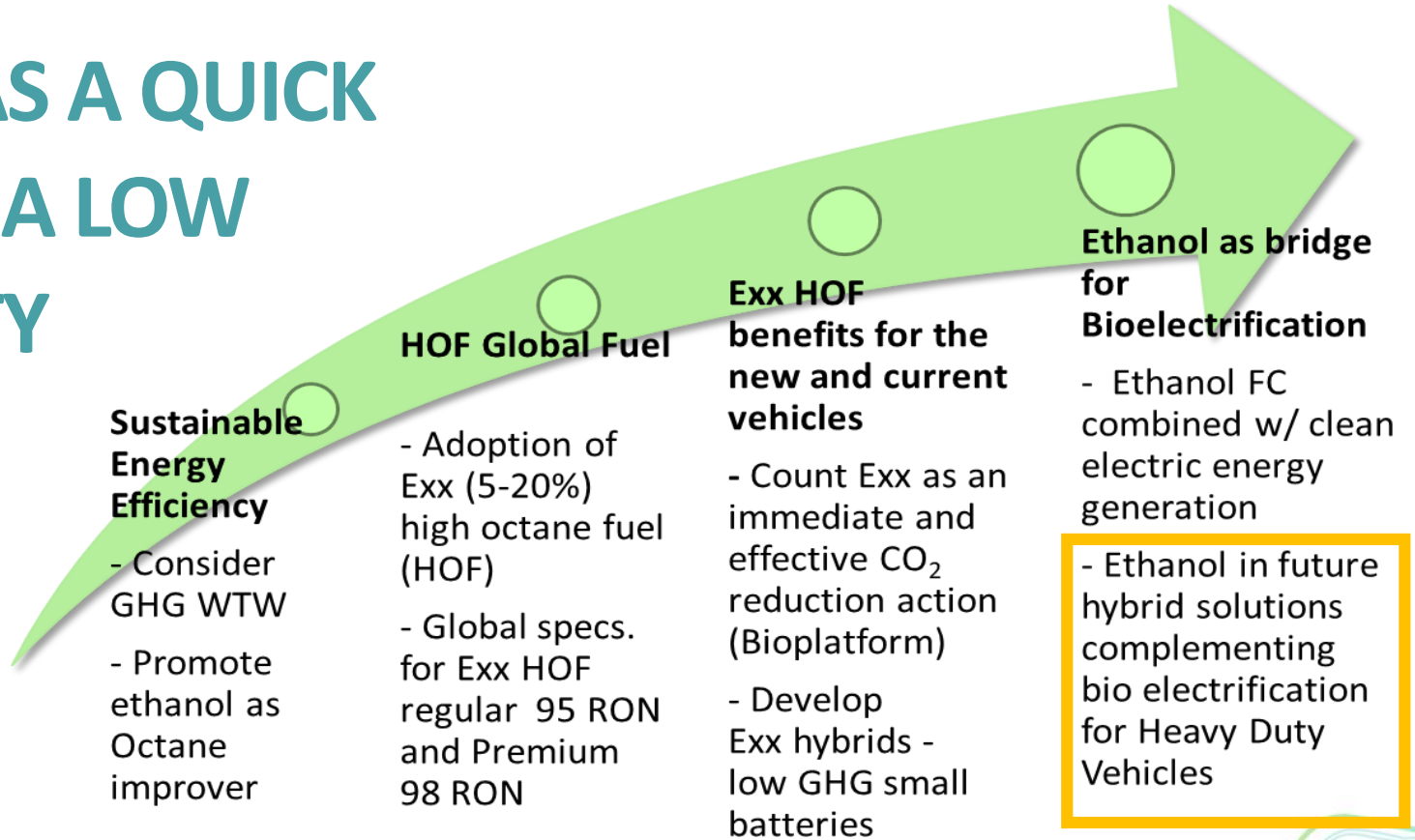
Ethanol allows a quick and sustainable transition

HC + Bio: extends fossil fuel use full life with lower GHG Blends

HC + Bio + Elect.: Hybrids with small battery reduces consumption and battery size

Elect.+ H_2 + Bio: Ethanol Fuel Cell, renewable, efficient and low GHG electrification

ETHANOL HOF AS A QUICK TRANSITION TO A LOW CARBON SOCIETY



SUSTAINABLE MOBILITY: ETHANOL TALKS PAKISTAN

REALIZATION:

PSMA

BRAZIL
Sugarcane Bioenergy Solution

UNICA
SUSTAINABLE ENERGY AND FOOD FROM BRAZIL TO THE WORLD

PROMOTION:

APLA BRASIL

ApexBrasil

MINISTRY OF FOREIGN AFFAIRS

PÁTRIA AMADA BRASIL
BRAZILIAN GOVERNMENT

TECHNICAL SUPPORT

DATAGRO