Bio-Fuels : Opportunity & Challenges

Session : Fuel & Fuel blends

ECMA 14th International conference - Leaping to Cleaner Air for Tomorrow

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MARUTI SUZUKI

Nov 2nd, 2023

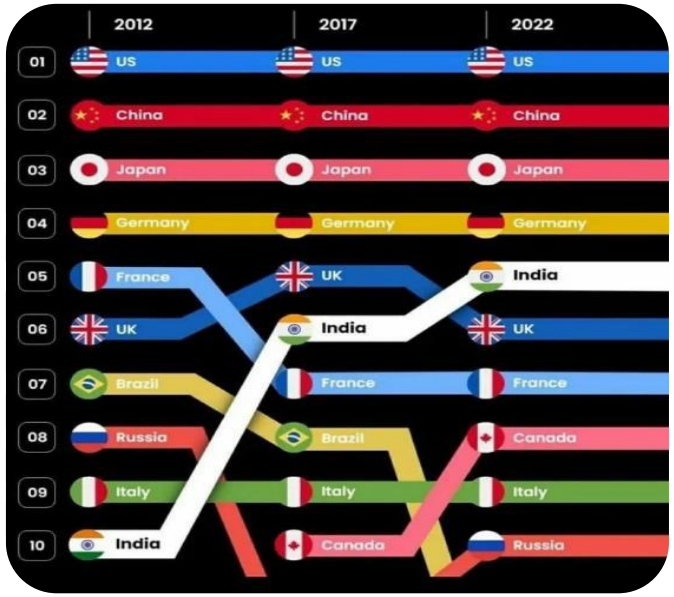
Walk-Through :

- ❑ **India's unique situation in Mobility**
- ❑ Next Powertrain Development directions
- ❑ Bio-fuels : Opportunity & Challenges
- ❑ Way forward
  - Expectations from Emissions Control System
  - Enablers for Bio-fuels

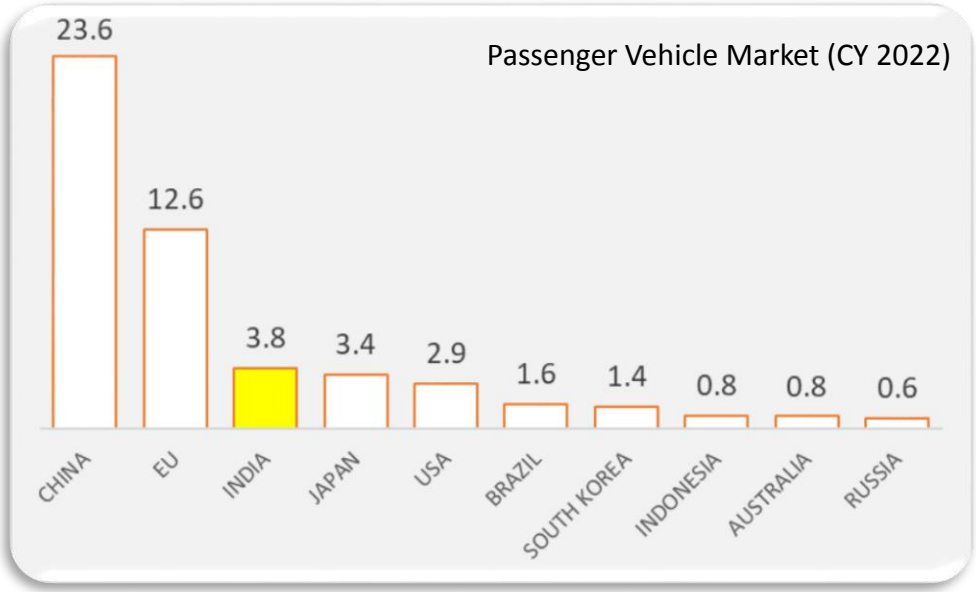
India today is shifting gears to become a major economy

- India: **5th largest Economy** & **3rd Largest PV** Market in World
- **Mobility required to support** the Economic progress to be become a Developed nation
- **This growth story must be scripted with responsibility towards Environment**

Economic Standing



Mobility



OICA Report

Sustainable Development

But there are challenges for Sustainable Development

1 Challenge of Energy Security & growing need for mobility

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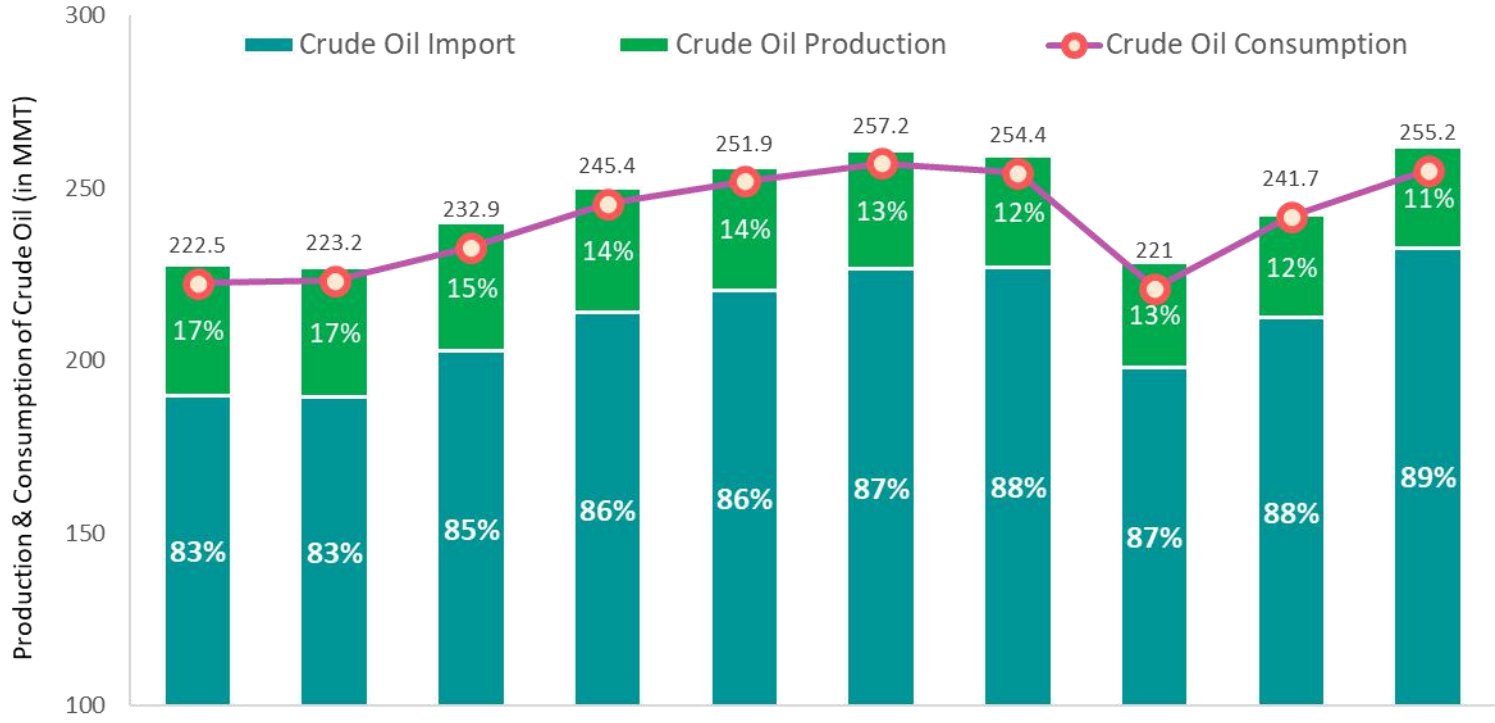
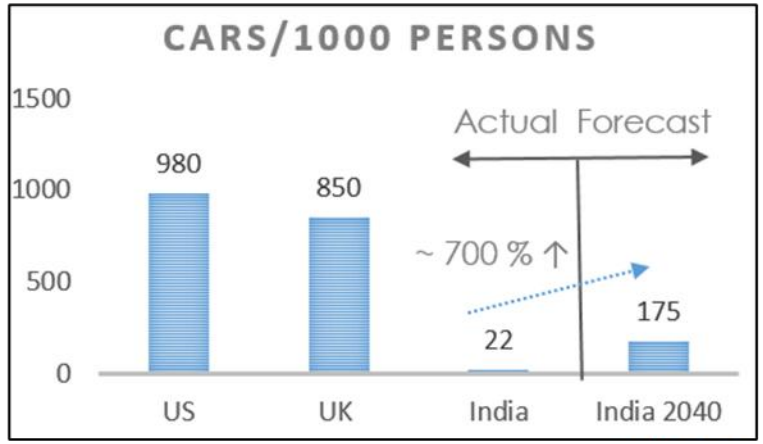
- With **158 Bn $ import bill**, **~89%** of crude **oil is imported**.
- **Transport sector** accounts for **~37% of crude** consumption. **PVs** contribute **~4.3%** of total
- Demand for fuel can potentially increase, impacting further the **Energy security concern**.

Import Bill – Energy Security



PPAC's Snapshot of India's Oil & Gas data, PIB

Mobility needs



Niti Aayog

- India is heavily under-motorized

- India needs higher mobility for
  > Country's Economic development
  > Improve quality of life

Locally produced Biofuels can support

2 GHG & Local Emissions challenges

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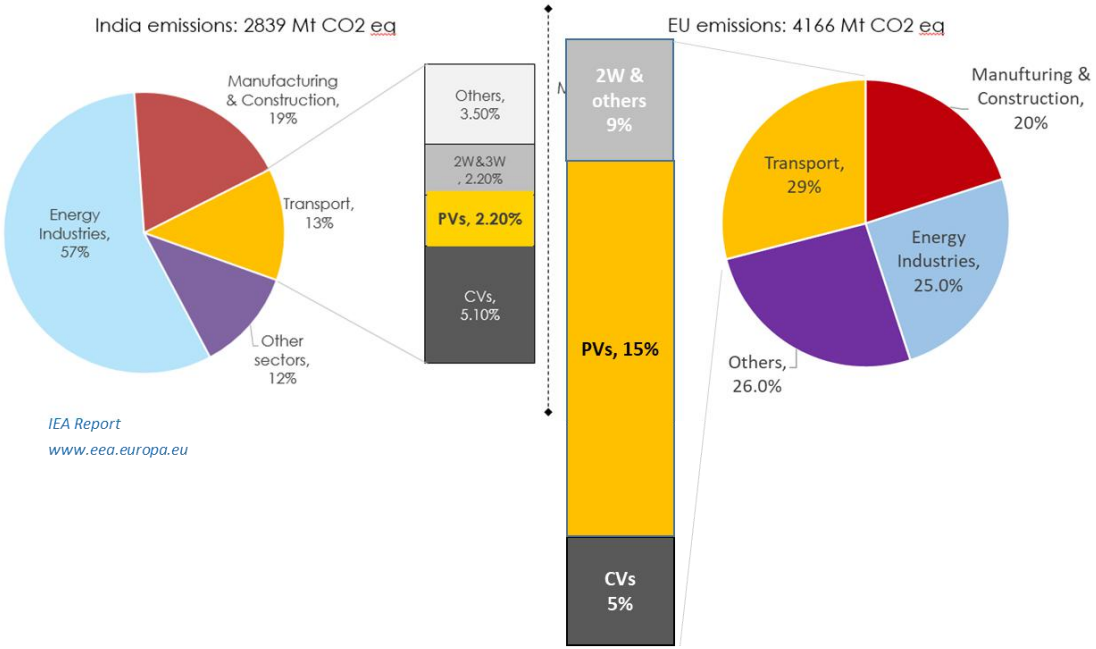
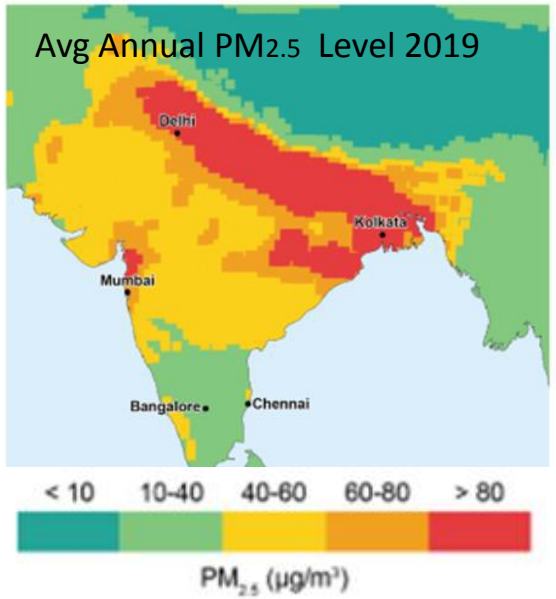
- India is the **3rd largest GHG** emitter (behind CHINA & US) but Sectoral contributions are way different
- **Passenger Vehicles** in India **contribute 2.2%,** while **15% in EU** towards overall country level GHG emission
- North and Gangetic plains also facing a **Local pollution issue** (weather & farm fire aggravate it)
- **India must work for present challenges & sustainable paths for ambitious future growth**

GHG Emissions

Local Pollution issue - PM 2.5





Biofuels can provide solution for both the above challenges also

Benefits of Bio-fuels

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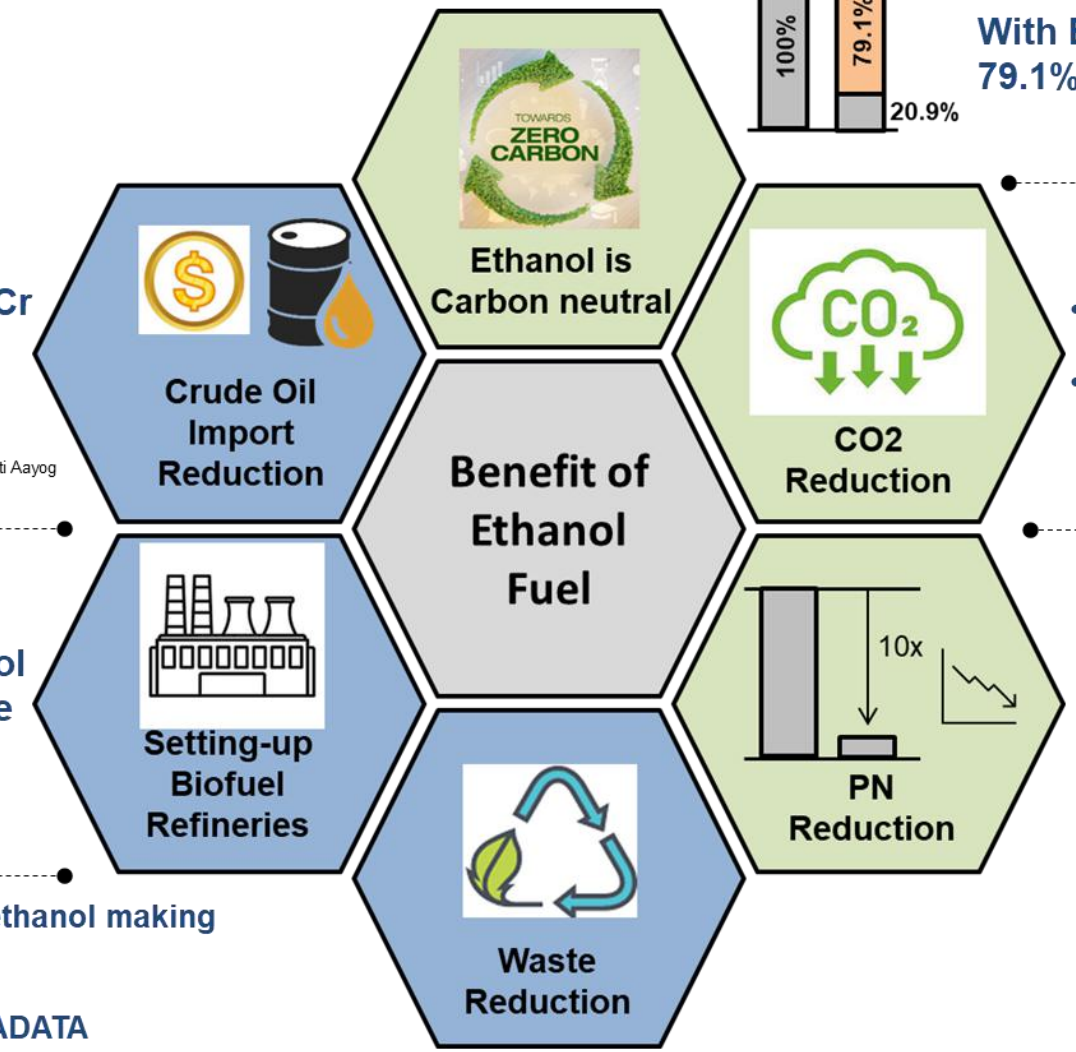
Drivers of Ethanol Economy

- FX saved in last 8 Years: INR 50,000 Cr
- From 2025, every year (estimated FX savings) approx. INR35,000 Cr

Source :Expert Committee Report → Niti Aayog

Local production of ethanol
→ Substitute to expensive crude oil import.

- Stubble used for ethanol making
→ No crop burning
- ANNDATA → URJADATA
→ Crops to oil companies for ethanol.



With E85 Fuel:
79.1% CO_2 is biogenic from E85.

- CO_2 saved in last 8 Years: 27 Lakhs MT
- From 2025, every year (estimated CO2 savings) approx. 25 Lakhs MT

Source :Expert Committee Report → Niti Aayog

- 10x less Particulate Number (PN) w.r.t. Gasoline
→ Less pollution

Supports agrarian economy & Reduce carbon footprint & crude oil imports

Govt's Multi pathway approach for mitigating concerns

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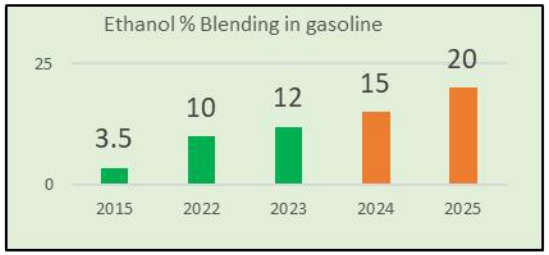
Govt is pushing Auto Industry to adopt Alternate fuels/Energy to meet national GHG targets & Energy security

- Industry is developing and adopting vehicles with the policy of GOI
- Energy producers are also shifting to renewable fuel/energy availability

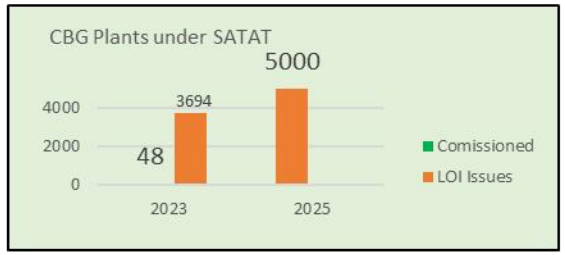
Ethanol / Flex Fuel



Source : Roadmap for Ethanol Blending in India

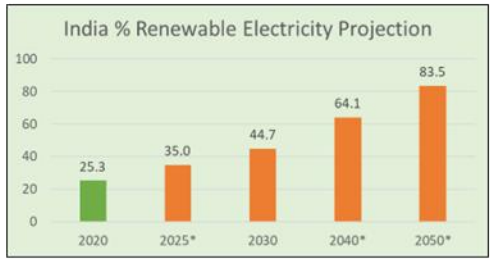
BIOGAS

CBG



Source : https://satat.co.in/satat/#

EV



* Projection based on 2020 & 2030 data of CEA

And realizing results as aimed……

GHG reduction
27 lakh MT

Forex Saving Rs
41,500 Cr

Farmer Income
Rs 40,600 Cr

https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1831289

Multiple pathways of Bio-Fuels & electrification will help India Achieve Carbon Neutrality ensuring affordability

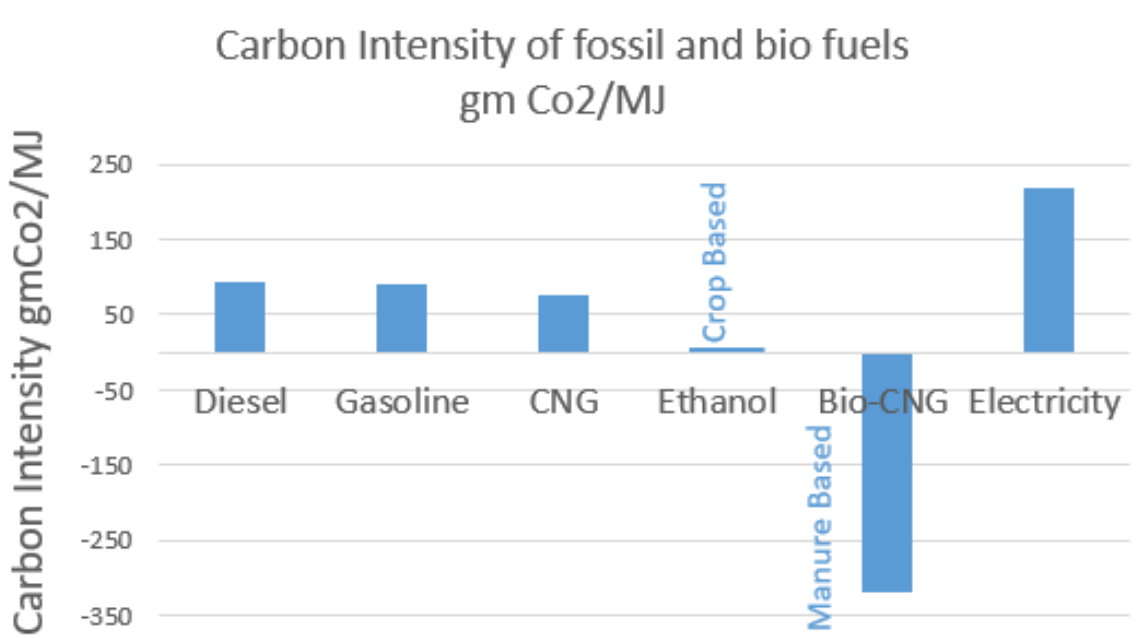
Walk-Through :

- India's unique situation in Mobility
- **Next Powertrain Development directions**
- Bio-fuels : Opportunity & Challenges
- Way forward
  - Expectations from Emissions Control System
  - Enablers for Bio-fuels

Carbon Intensity of bio-fuels

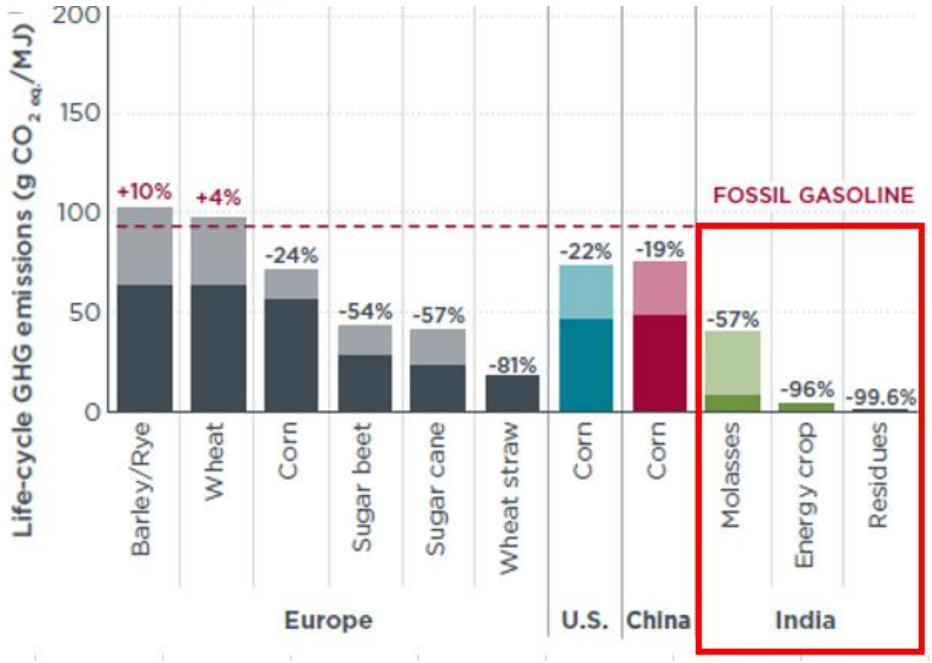
- Comparative CO_2 Impact based on carbon intensity of fuels reveals considerable potential by shifting to Bio-Fuels (Ethanol and Bio CNG)
- India has advantage over other regions in terms of Life cycle GHG emissions for Bio-fuels
- Based on Well to Tank emission intensity, India has advantage to utilize while also ensuring sustainable growth

Low Carbon Intensity Bio-fuels



Source : Based on ICCT and MSIL Internal Calculations

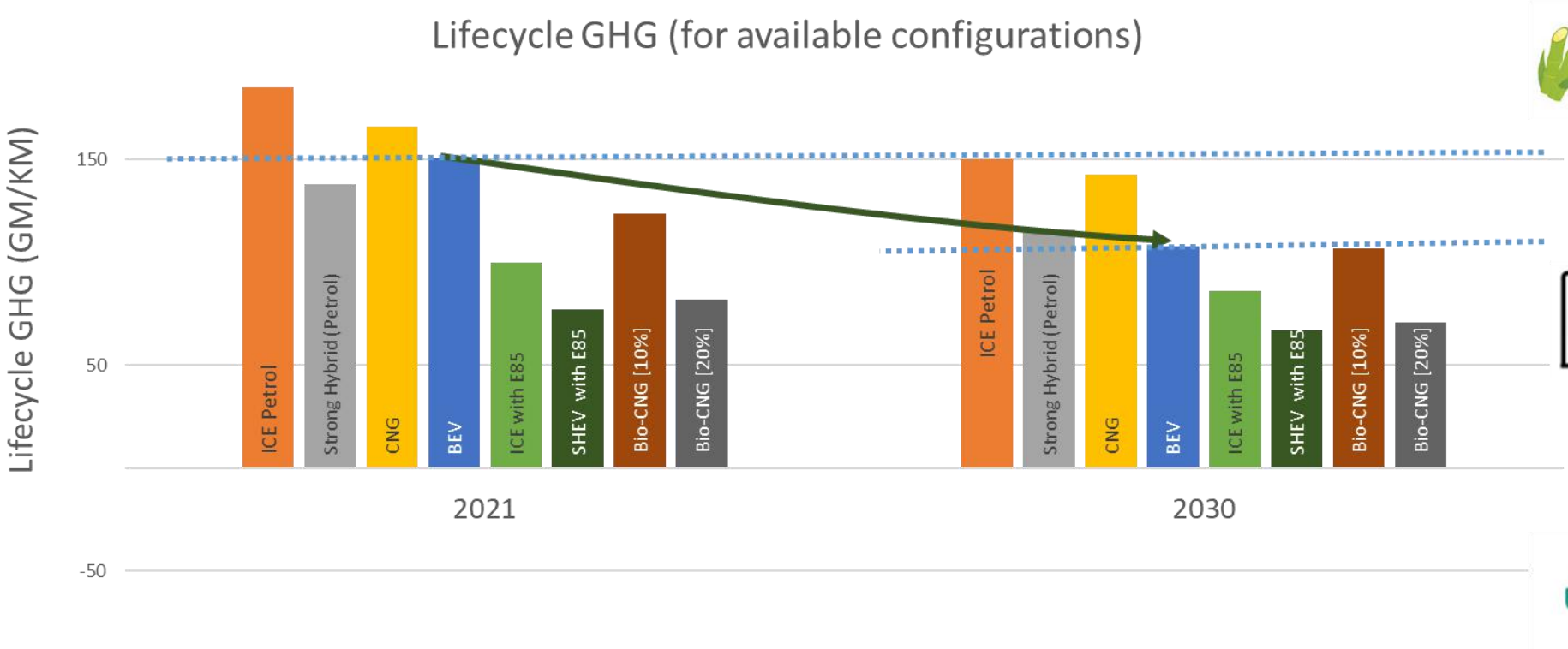
Ethanol Lifecycle GHG (Lowest for India)

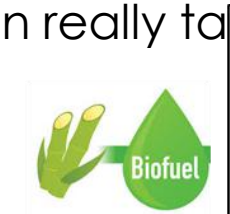


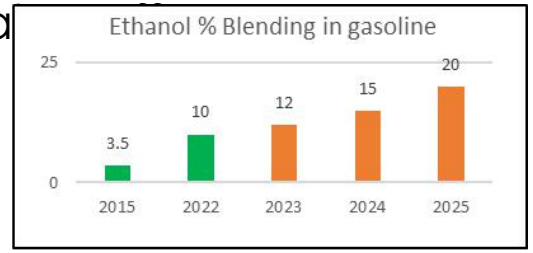
Source : ICCT

Product usage lifecycle GHG: For various available fuel and technology con

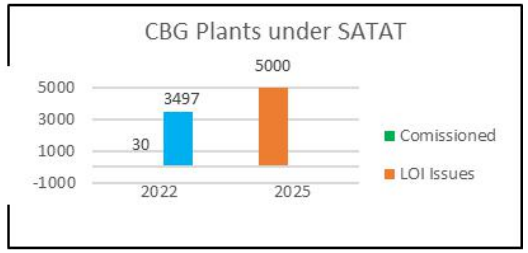
- To reduce GHG emission levels, progressive approach of implementing alternate technologies need to be adopted
- Carbon Neutral and Negative fuels have a potential to reduce transport sector GHG contribution
- Faster & Higher reduction in next decade is possible with full utilization of E20 and higher Blends (for FFV's)
- De-carbonisation of Grid electricity has to be a done before electrification really ta



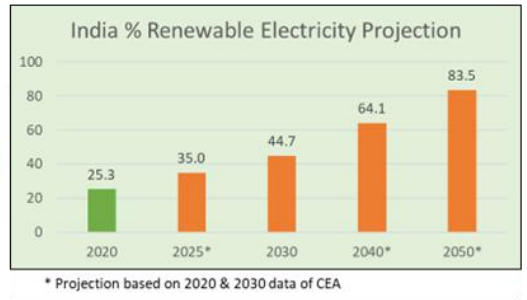




Source : Roadmap for Ethanol Blending in India



Source : https://satat.co.in/satat/#



** Based on various studies – ICCT/BCG and MSIL Internal*

Technology Priority for efficient GHG reduction in timeframe

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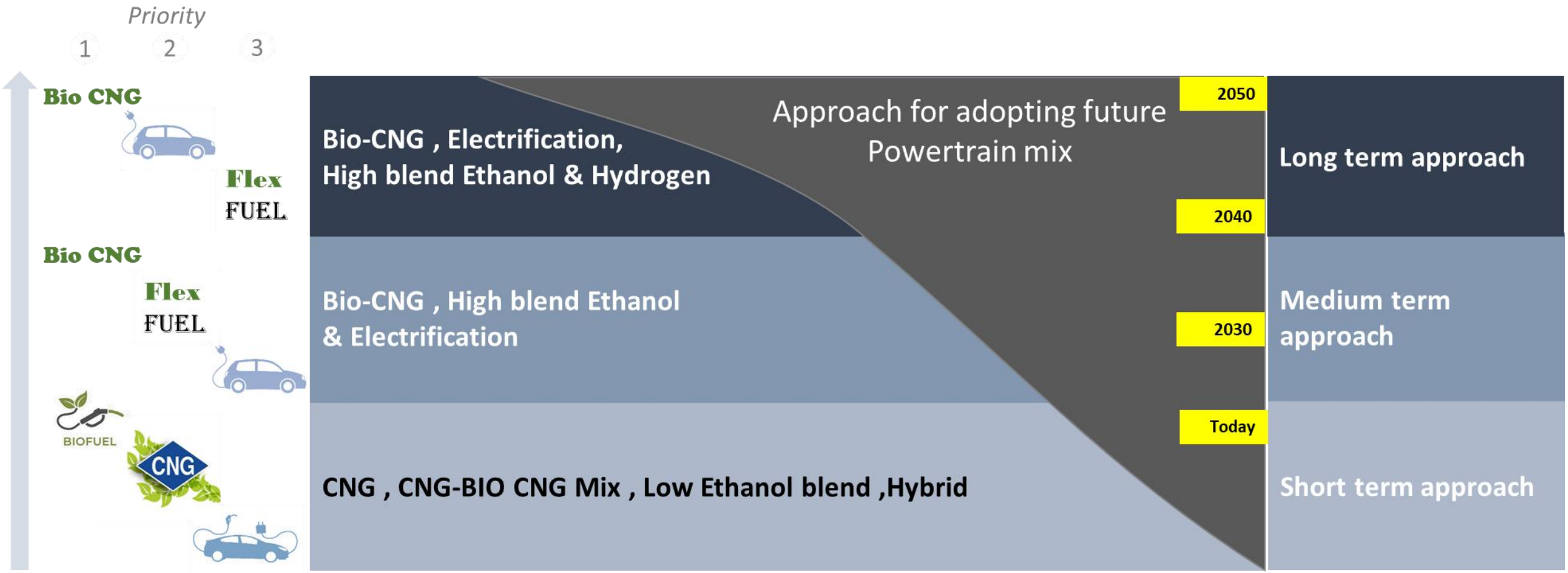

All Powertrain technologies will co-exist, contributing towards NET ZERO target of 2070.

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Opportunity : India's Agriculture based Economy

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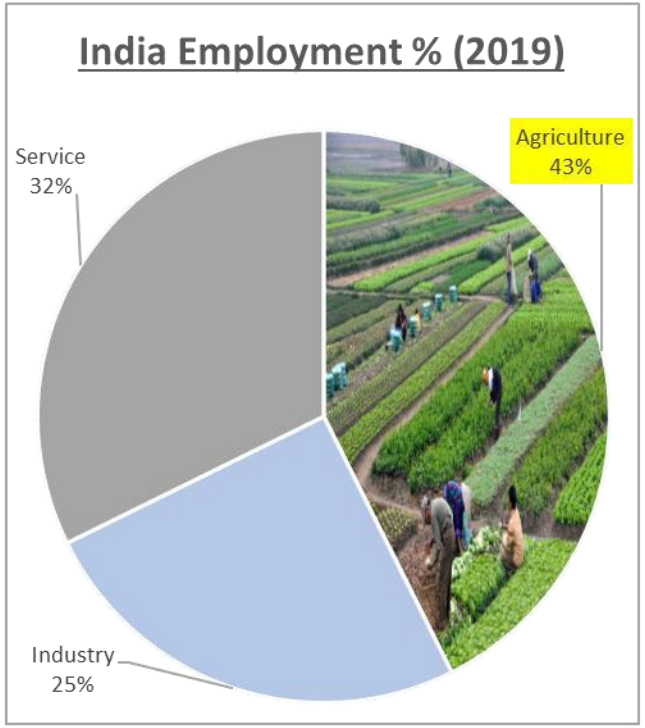
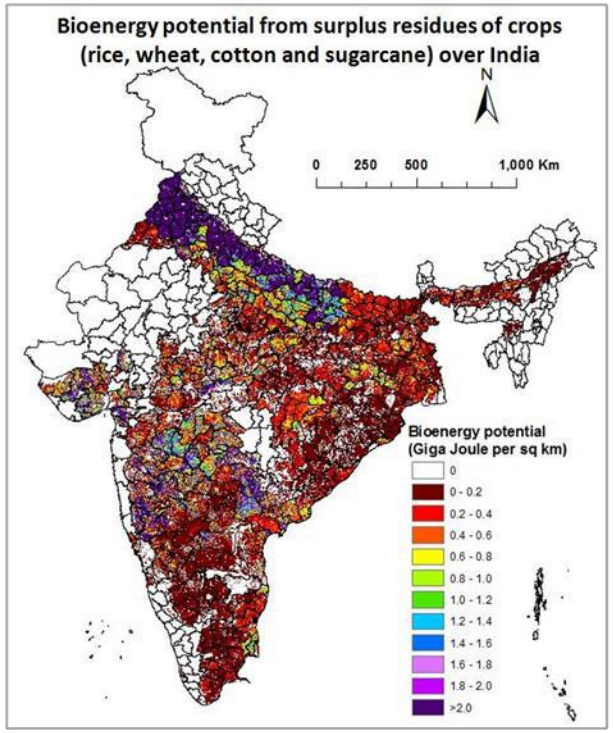
Agriculture based Economy





- Huge potential for bio based low carbon energy sources Residue
- Opportunity to build agro based economy

Agriculture products & waste has huge potential

Bio-Ethanol Production Potential

Capacity Augmentation (in Cr. Lt)			
Year	Capacity Requirement		
	Grain	Molasses	Total
2019-20	258	426	684
2020-21	260	450	710
2021-22	300	519	819
2022-23	350	625	975
2023-24	450	725	1175
2024-25	700	730	1430
2025-26	740	760	1500

Department of Food and Public Distribution(DFPD) estimates

1 tonne = 380ltr Ethanol, PIB 24 MAR 2021

Bio-CNG Production Potential

Source	Annual Waste (in Mn Metric Tonnes)	Bio-CNG generation per ton	Total Bio-CNG Generation Potential
Agricultural Waste	600	0.1	60
MSW	66	0.05	3.3
Sum Total Bio-CNG Potential (MMT)			**63.3**

Nomura

India has specific advantage to utilize Bio-Fuels while also ensuring sustainable growth of Economy

Opportunity : Ethanol → Reducing GHG Emissions using E8 Fuel

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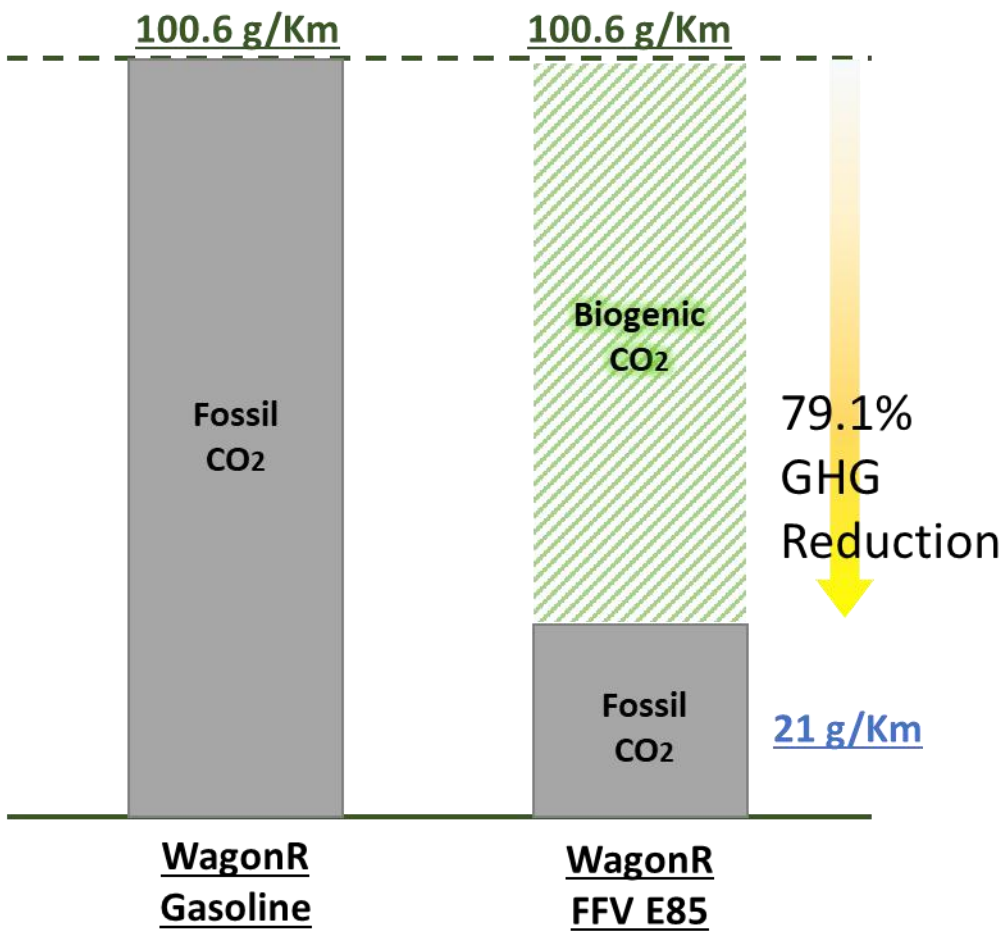
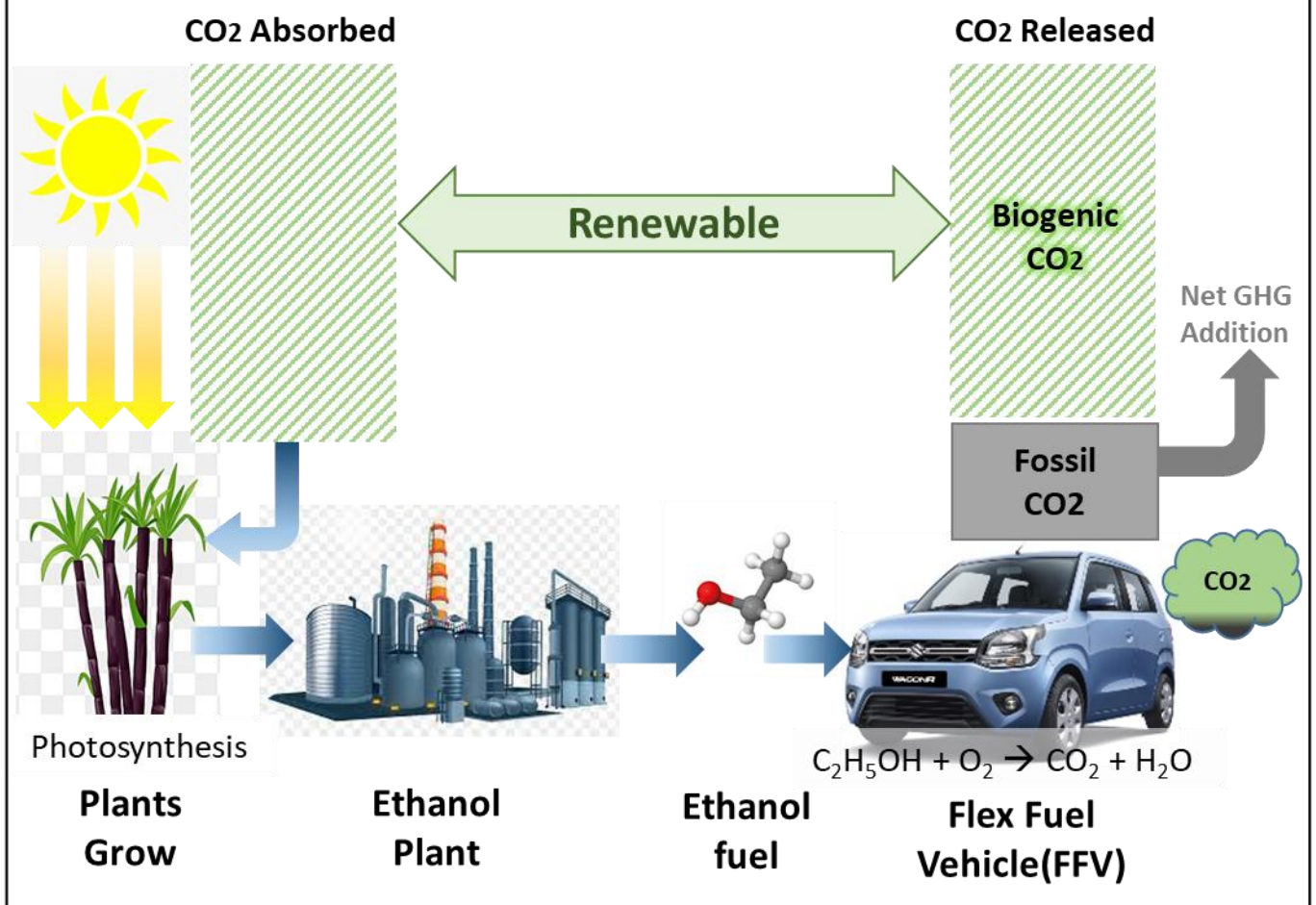
Tailpipe CO_2 Emissions



Biogenic Emissions → Absorbed back by plants



Ethanol is Solar Energy in Liquid form

Opportunity : CBG is Carbon Negative fuel + Waste to Energy

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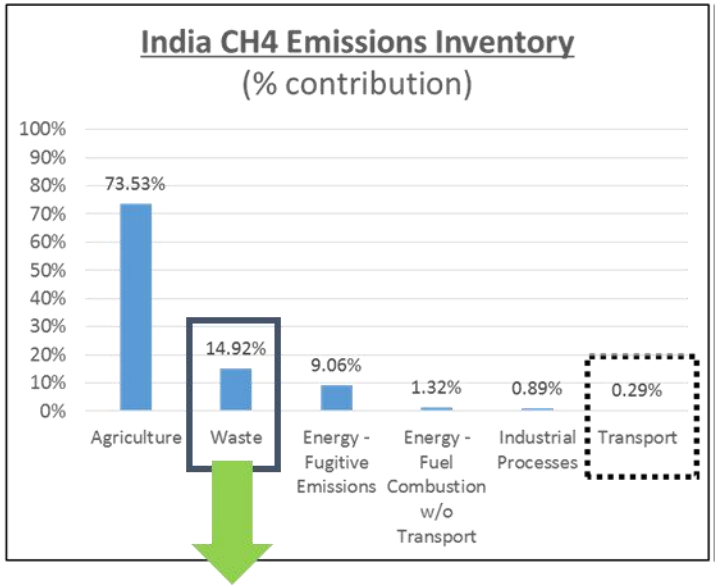
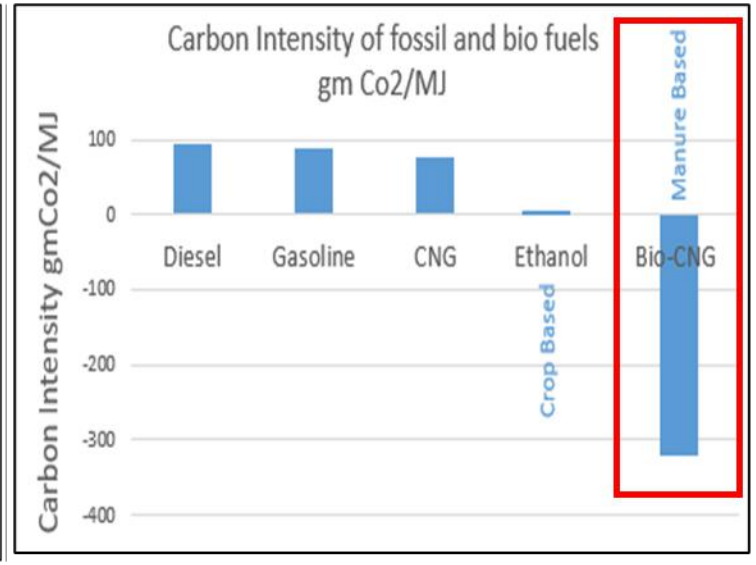
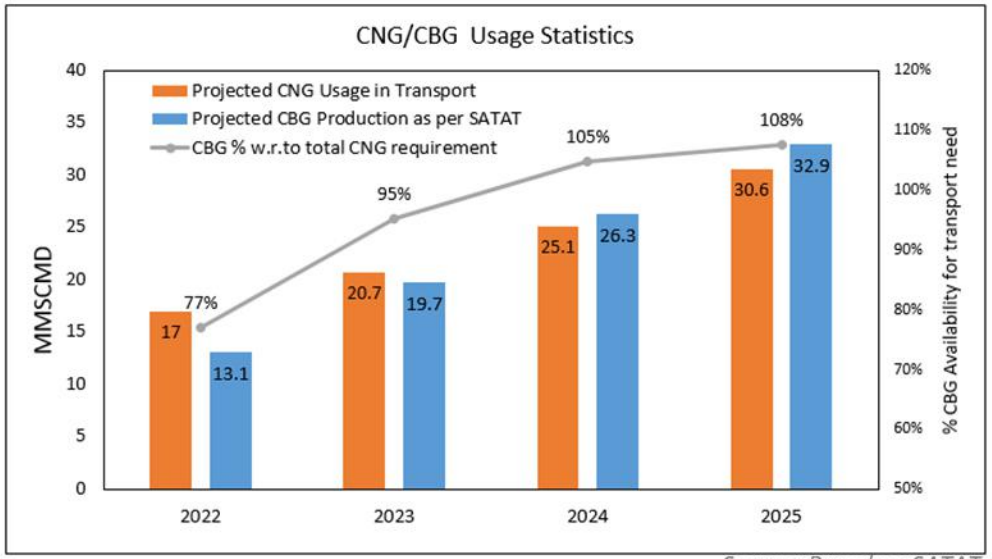
- India is one of largest Methane emitters and adds to our GHG inventory. CBG can help.
- CBG can meet Major portion of Transport CNG need by 2025. Huge Potential to decarbonize mobility







Source: Based on SATAT

Source	Annual Waste (in Mn Metric Tonnes)	Bio-CNG generation per ton	Total Bio-CNG Generation Potential
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Sum Total Bio-CNG Potential (MMT)			63.3

Government Schemes to promote Bio-Fuels

SATAT Target by 2025
- Target 5000 plants
- Target 15 MMTPA

Current Situation
- 58 Plants Commissioned
- 3497 LOI issued

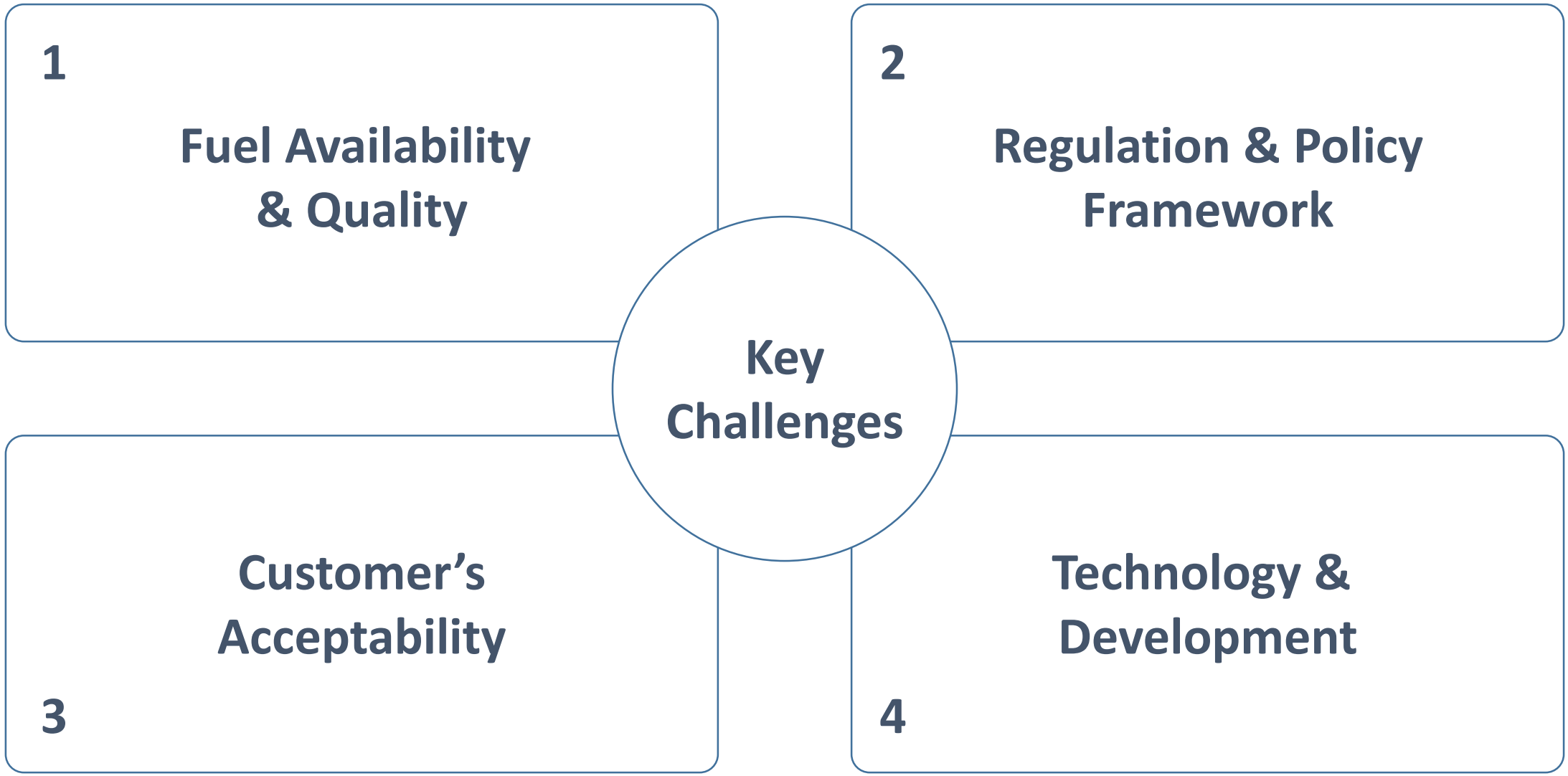
SATAT
Sustainable alternative towards affordable transportation (SATAT)

GOBAR-DHAN SCHEME
Gobar-Dhan Scheme

WASTE TO ENERGY PROGRAMME
Waste to Energy programme

CBG offers twin benefits: Waste to Energy along with GHG Reduction !

Key Challenges



1 Challenges → Ethanol availability

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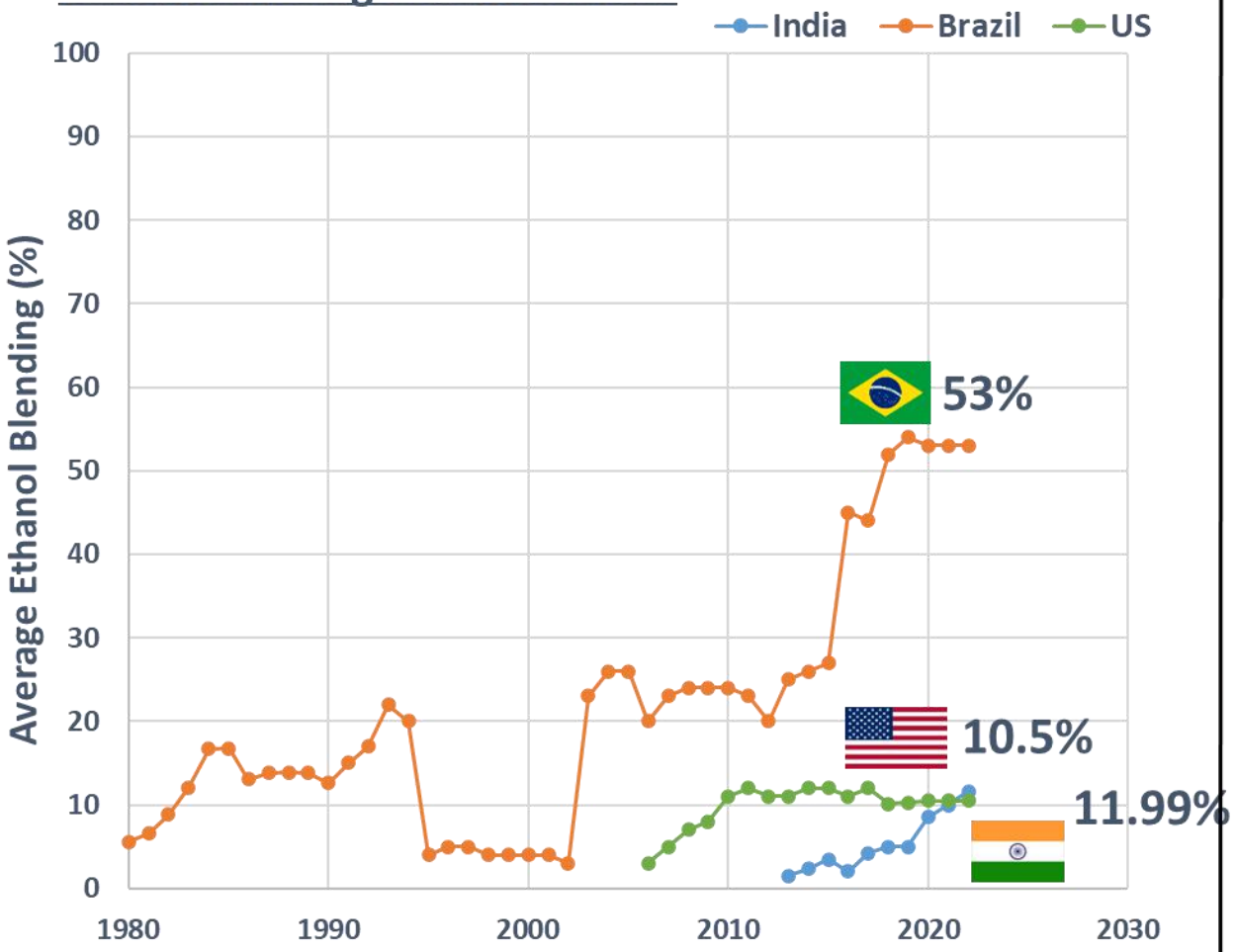
National Average Ethanol Blend



Difference b/w India & Brazil

	Brazil	India	
Area	 8.51 Million Km²	 3.3 Million Km²	Brazil area is 2.5x • More agriculture area for crops. • More ethanol production.
Fuel Consumption	X	2X	India has 2x
Population	21.5 Crore	140.8 Crore	India has 6.5x

India needs incvrease ethanol production in lesser area

India to match Brazil level
→ Challenge is 5X (Now) ~ 15X (Future)

53% National average blending → Brazil ensured Robust Ethanol Adoption Model

India's challenge for Ethanol availability is 5 ~ 15 times more than Brazil

1 Challenges → Ethanol availability

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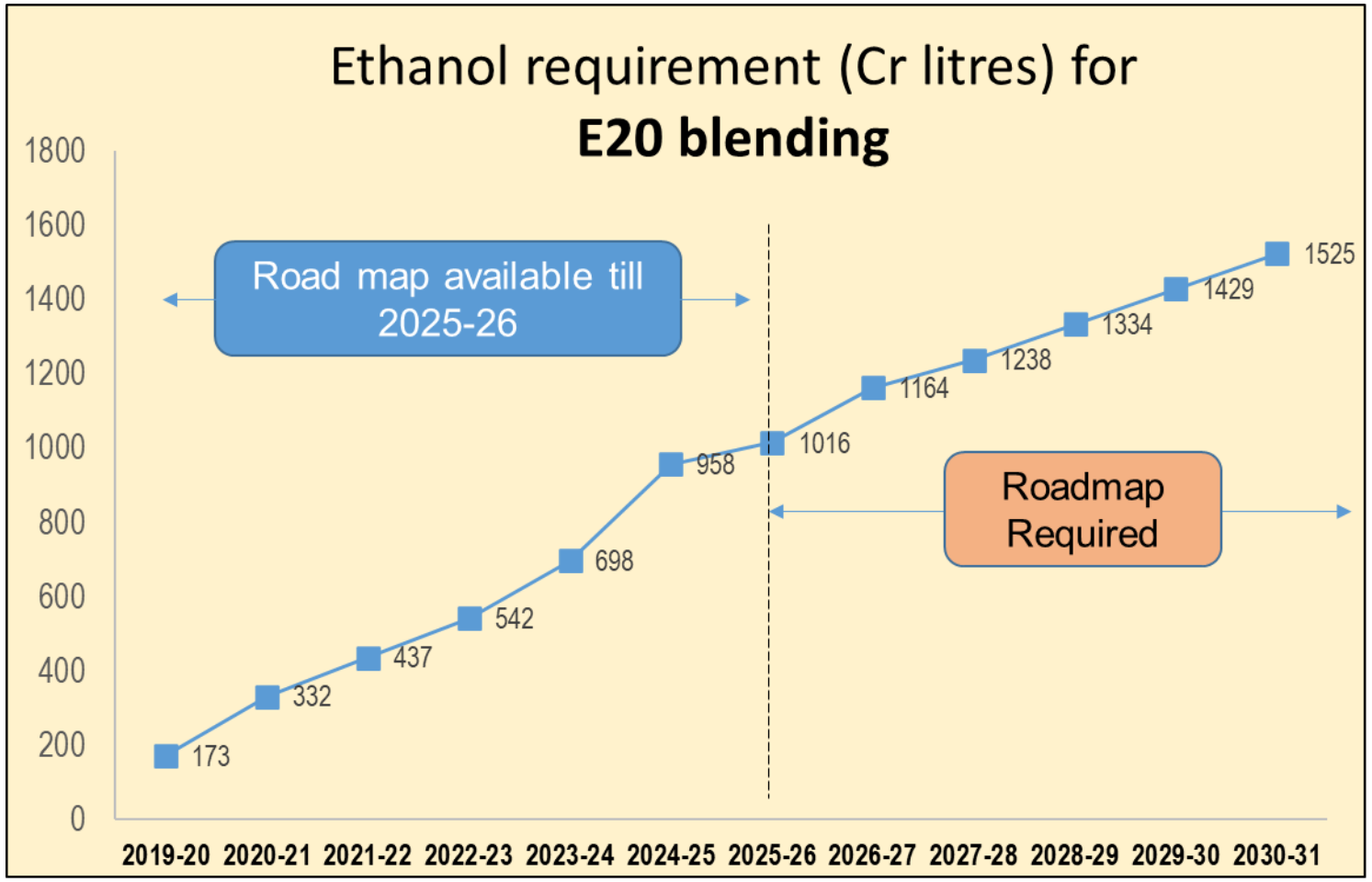

For Flex Fuel (E85) vehicles we need to go beyond this

Distilleries capacity required (2030) – 2500 cr ltr

Ramp-up of production Capacity required

Need clarity on future road map for Ethanol production beyond 2025 & including FFV's

2 Challenge : Next Emissions Regulation, WLTP 2027

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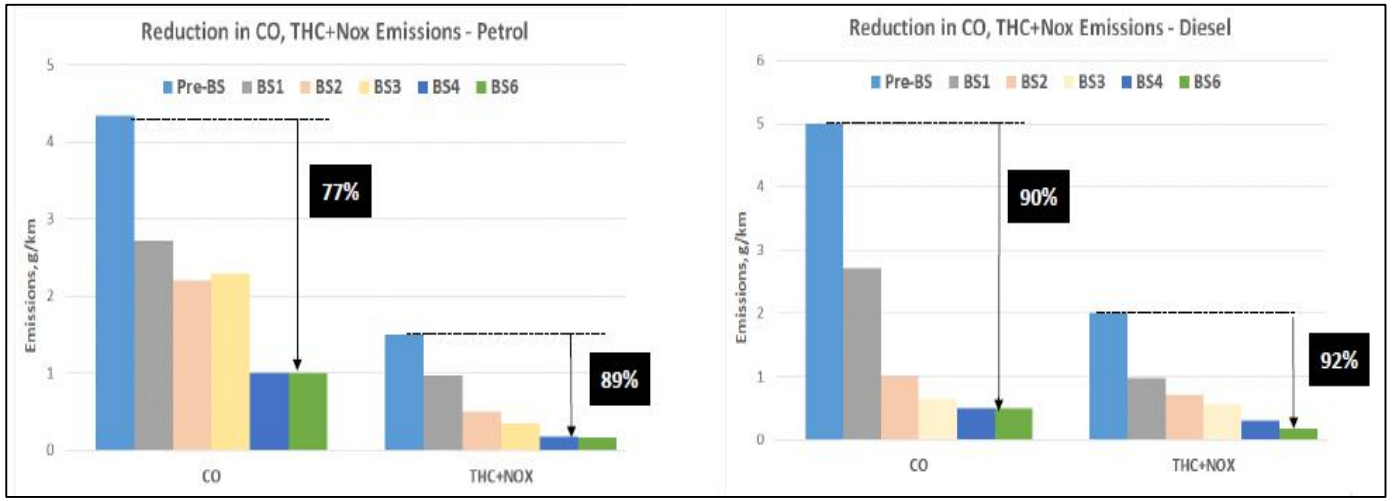
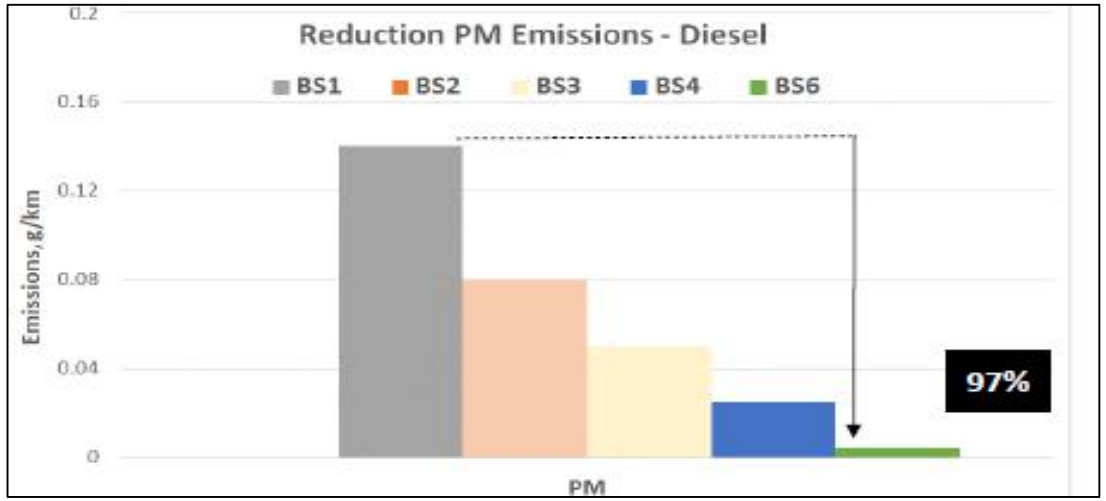
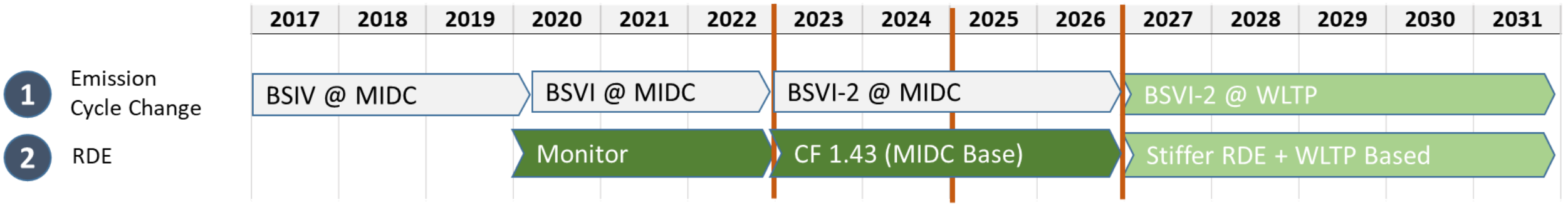
Tailpipe Emissions already nearing Zero





Next Emissions Challenge (WLTP)



Next Big Step for India : MIDC → WLTP

2 Next Big Step : April-2027 MIDC → WLTP

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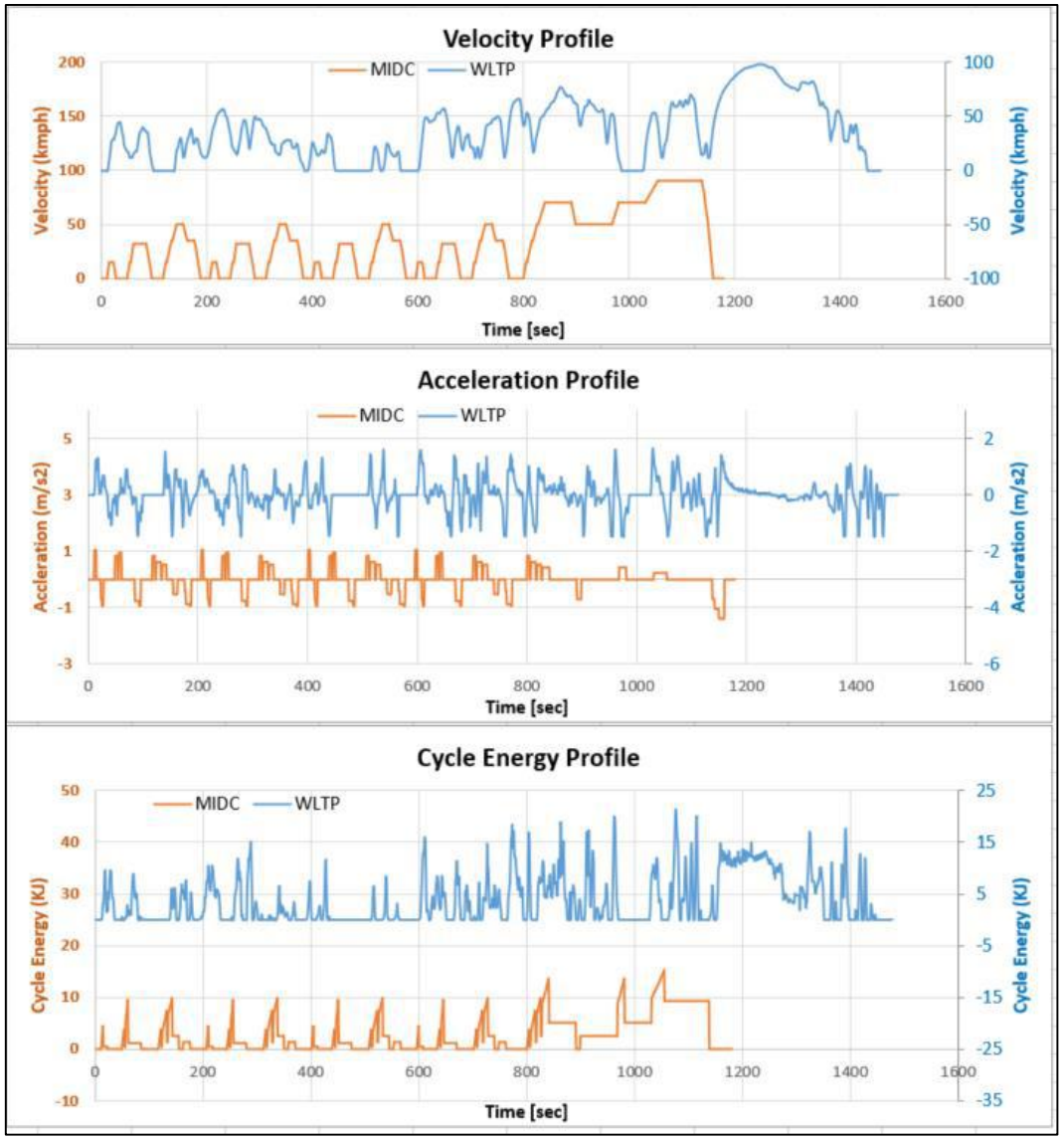
Emissions cycle impact MIDC → WLTP 3P (India)

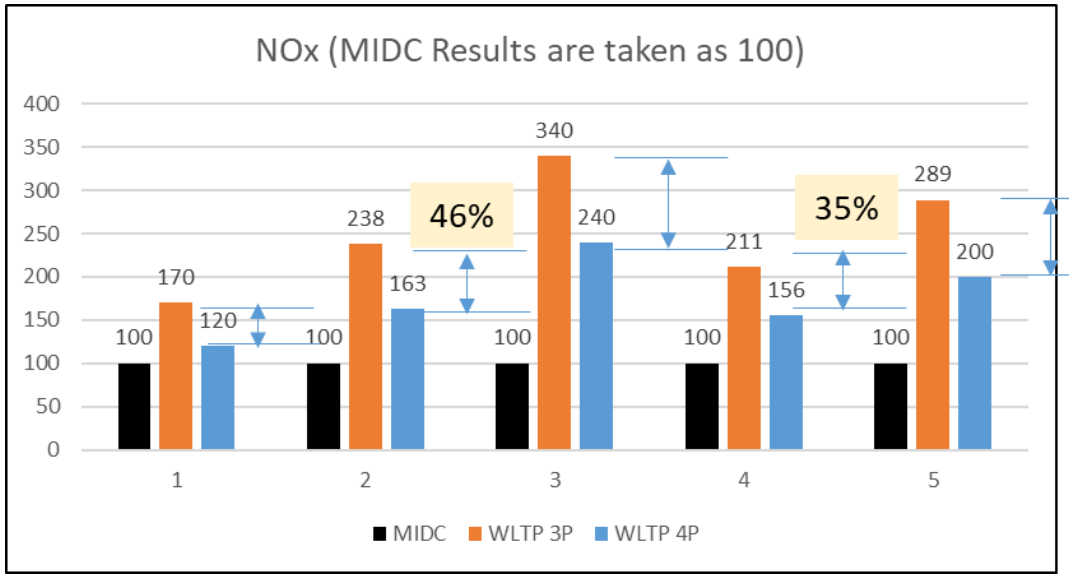
Dynamic Velocity Profile

Harsh Acceleration Profile

Higher Cycle Energy per Km



India's WLTP 3-Phase is stiffer than EU 4-Phase



- **WLTP is tougher than MIDC**
- **WLTP 3P (India) is tougher than WLTP 4P (EU)**
  (WLTP 4P is longer than WLTP 3P, Emissions are mainly at start)

Can we develop **higher performance catalyst**
→ **Low porosity >55%**
→ **Ethanol/Pet light-off <250 degC (OEM Aged)**
→ **CH4 light-off <350 degC (OEM Aged)**
→ **Wider conversion window for CH4**

② Challenge : Regulations & Fiscal policy not aligned to B

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Country / Region	Multi Pathway approach for Carbon Neutral (Bio-fuel + Electrification)	Regulation Alignment for Biofuels		Fiscal Policy alignment for Biofuels	
		Emissions (THC → NMOG/ NMHC)	CAFÉ (Biogenic CO2 Correction)	Bio-fuel price parity for energy	Bio-fuel vehicle Tax incentive (FFV etc)
USA	O	O	O	O	O
Brazil	O	O	O	O	O
India	O	X	X	X	X
Europe	X	X	X	X	X

Present approach → EV only from 2035,
Not support Bio-fuels, E-fuels

INDIA : Need to make enabling provisions for Bio-fuels adoption

2 Emissions regulation need to align for Bio-fuels

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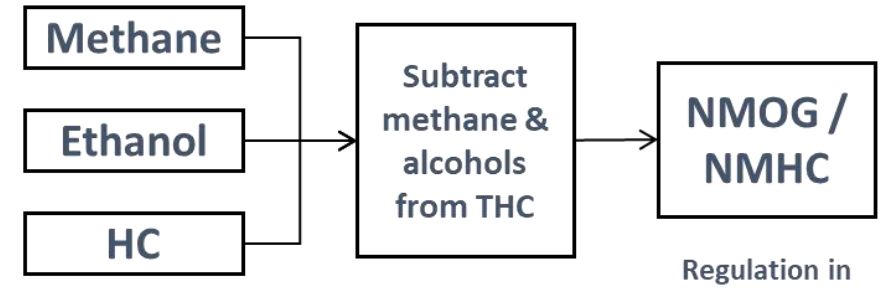
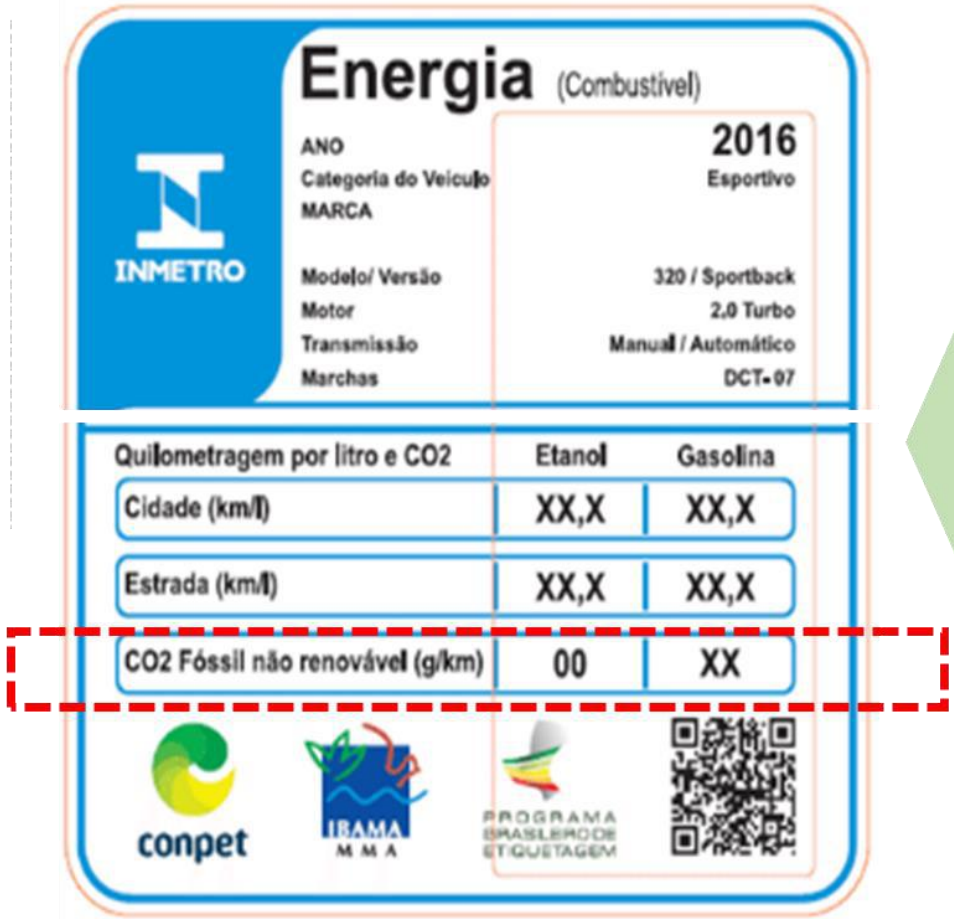
BRAZIL : Follow NMOG / NMHC rather than THC



No NMOG/NMHC provision in India

BRAZIL : CO2 with ethanol is calculated as 'Zero'



Similar approach / factor available in USA also for E85 vehicles

1) Enabling provisions for NMOG / NMHC instead of THC
2) Bio-genic CO2 correction in CO2

3 Customer's Acceptability (Total Cost of Ownership & Availability)

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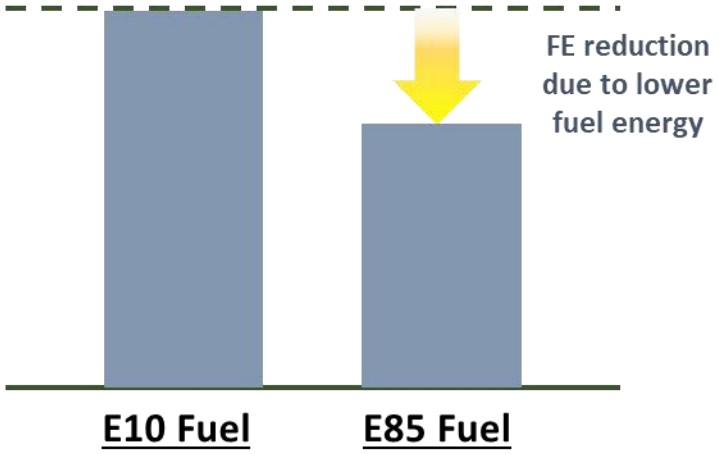
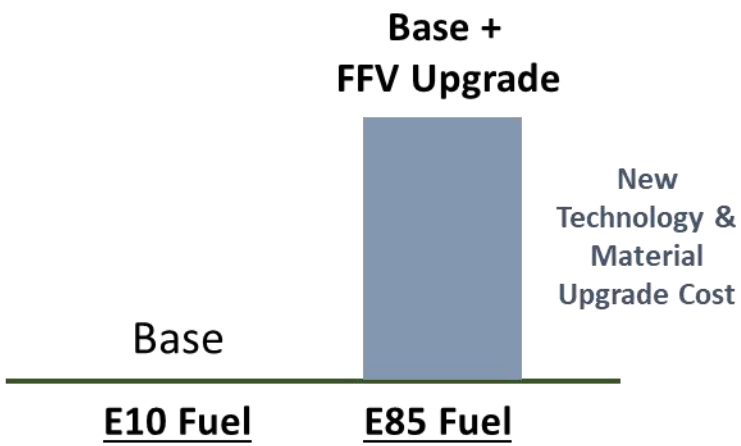
Fuel Economy



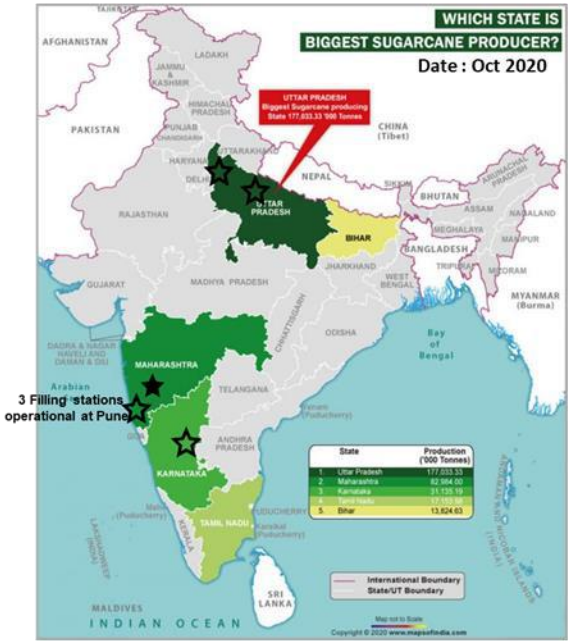
Price of E85 fuel to be at least 35% lower than E10 fuel

Vehicle Price



Appropriate tax incentives to promote FFVs

Fuel Availability



Consistent and quality fuel availability across nation

Fiscal Policy support & Fuel availability roadmap

4 Technology & Development for Biofuels – E85 FFV

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1 Material Compatibility

2 Engine Start in Cold Weather Conditions & High Flow requirement


Fuel Rail with Heater


Rail Heater Control Unit


Relay & Harness


High Flow Injectors

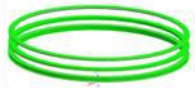

High Flow Fuel Pump

3 Design Upgrade for Core Engine Part Reliability with corrosive fuel


Cylinder head (Valve Seats)


Valve


Piston


Piston Ring


Spark Plug

4 Upgrade for Emission Regulation Compliance to meet BS6 Phase-2


Catalytic Convertor

Ethanol Sensor


Lambda Sensor

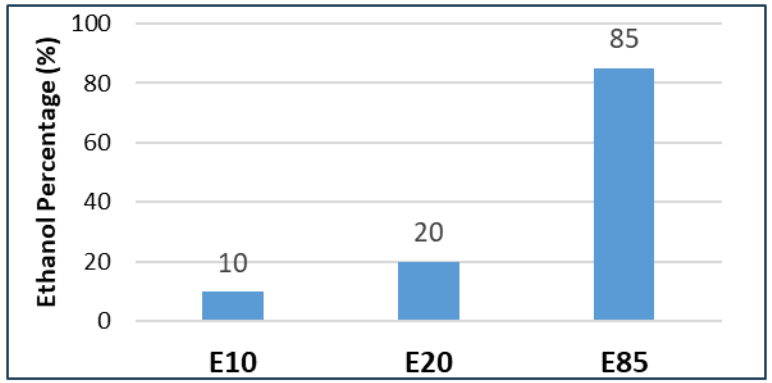
40+ New Logics
SW upgrade for intermediate blends
HW modification for additional Inputs


Engine Control Unit

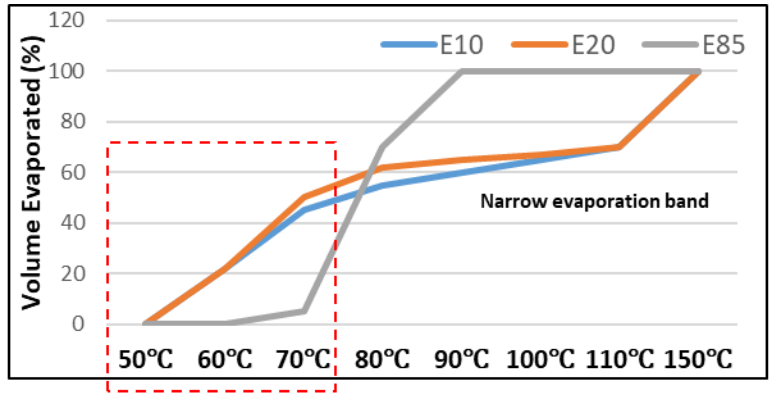
Engine HW changes require extensive Development (E20 to E85)

- Extensive Reliability tests at Proto and Final tooled up stages.
- Vehicle Calibration / Validation with intermediate fuel blends.
- As good as new development

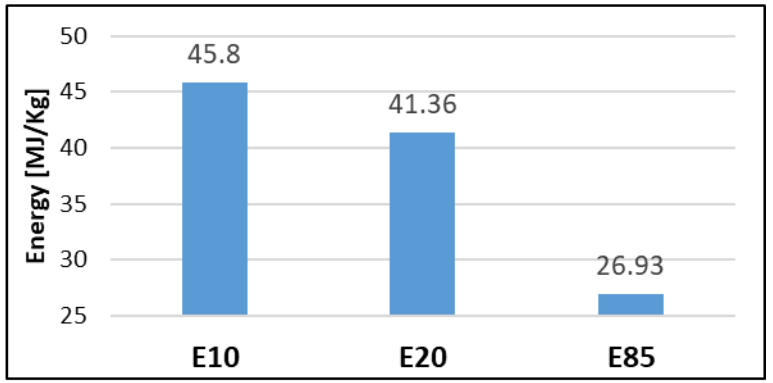
4 Emissions : Ethanol Fuel Properties Challenge



Impact on Plastic / Resin Parts
Effect on Oil Lubricity

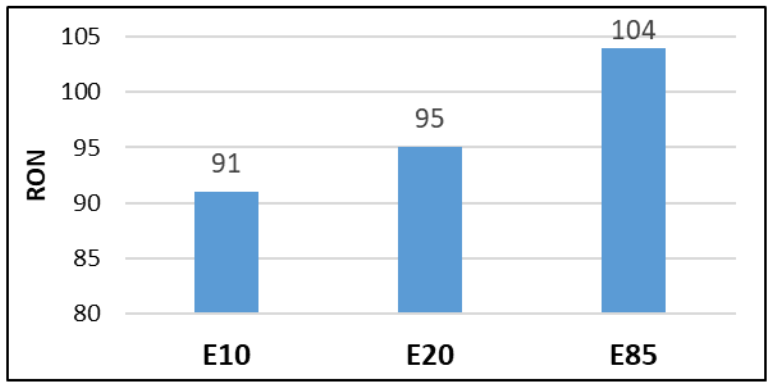


Cold Start ability/ Drivability Performance



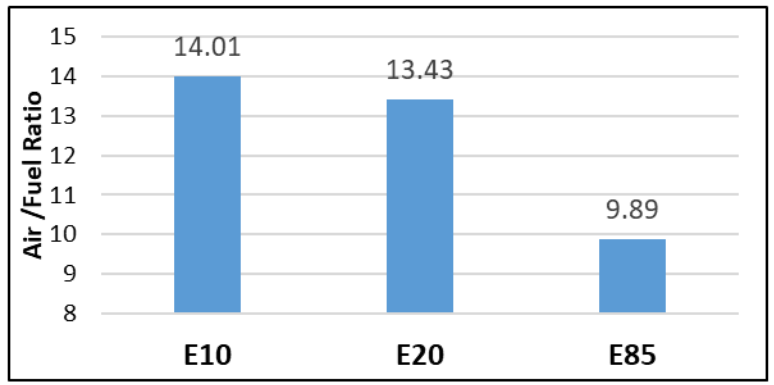
Fuel efficiency is Impacted

RON

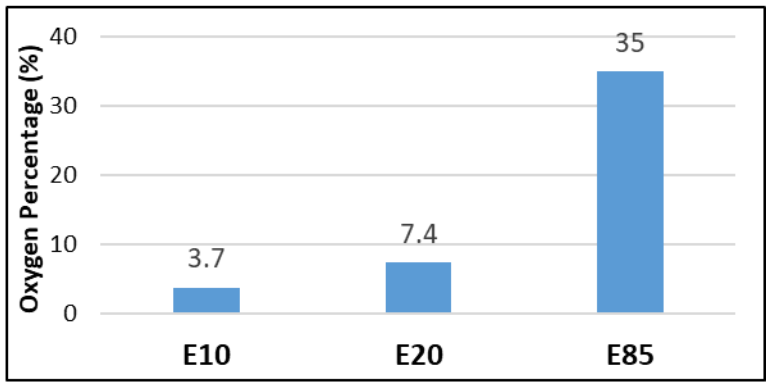


Improved knocking Performance,
Possibility to Advance IGT

A/F Ratio



Oxygen Percentage



Higher Fueling flow required : Change in Components Sizing, Bigger Injectors etc

Key Issues with Flex Fuel : Cold Start ability, Fuel Adaptation and FE reduction

E10 : IS12796
E20 : IS17021
E20 : IS16634

4 Ethanol Challenges : Unburnt ethanol in tailpipe

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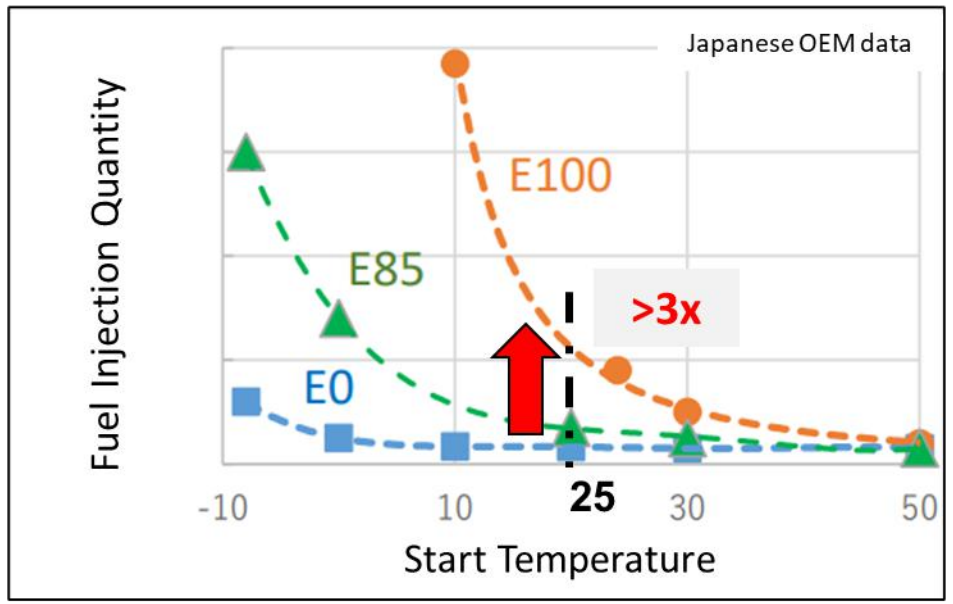
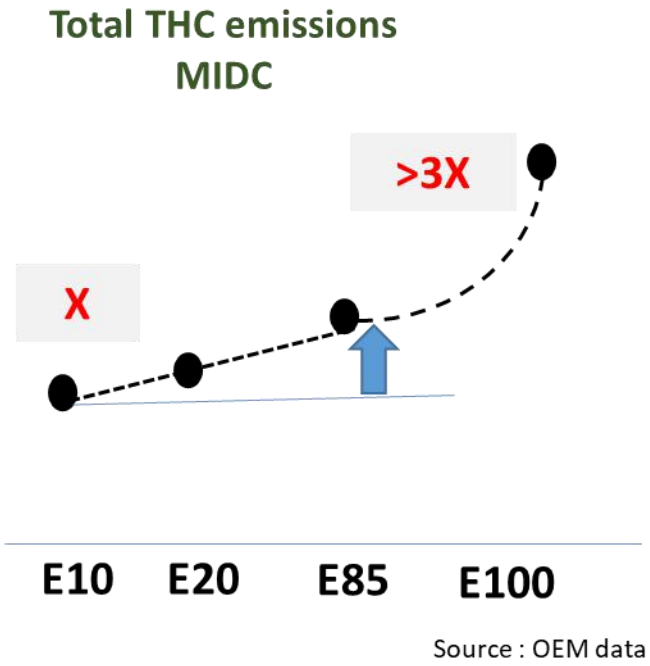
Bio-fuel properties impact on tailpipe emissions

Low vapor pressure

Low Evaporation



Fuel Injection qty requirement at start increases



Source : OEM data

Bio-fuel properties result in unburnt Ethanol in tailpipe as THC

THC emissions are major issue for Higher Ethanol blends

→ Can we develop Ethanol Trap Catalyst or Ethanol specific Catalyst

4 Bio CNG challenges : Mitigating emission from tailpipe

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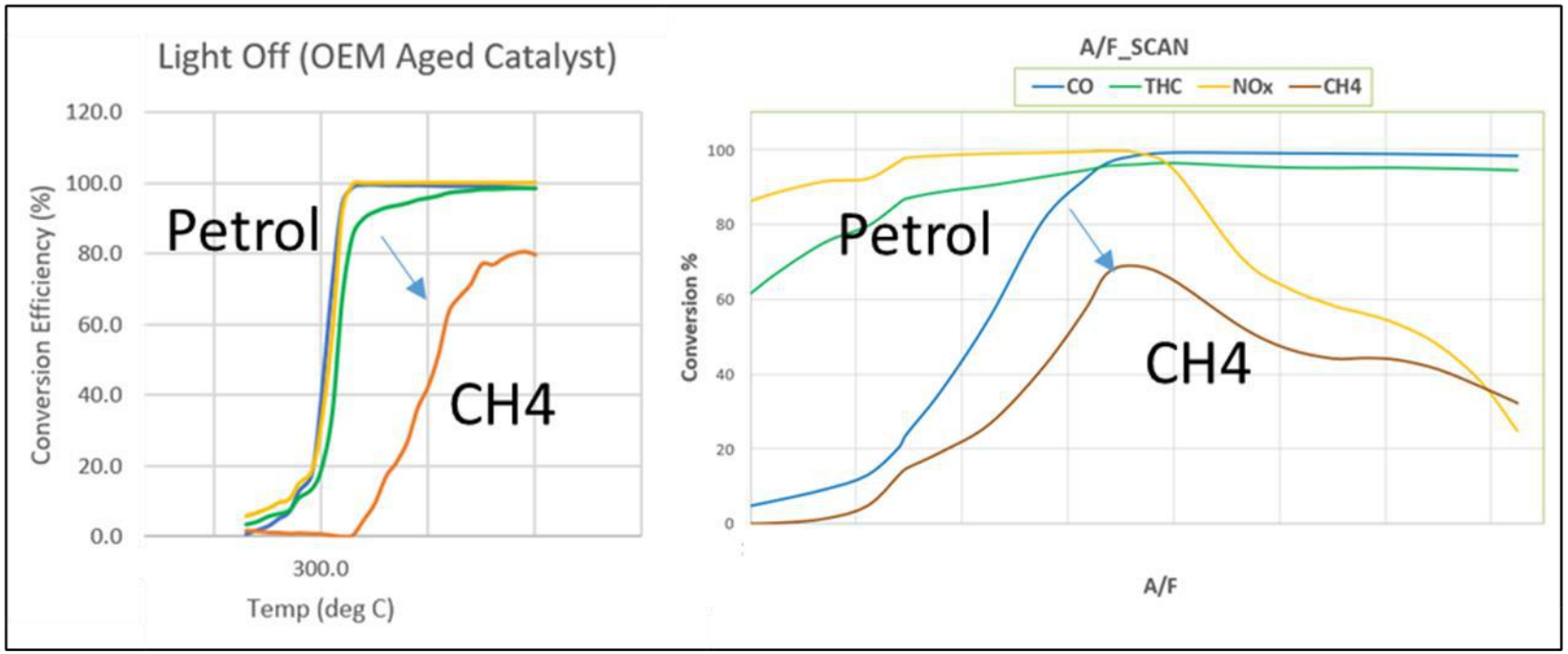
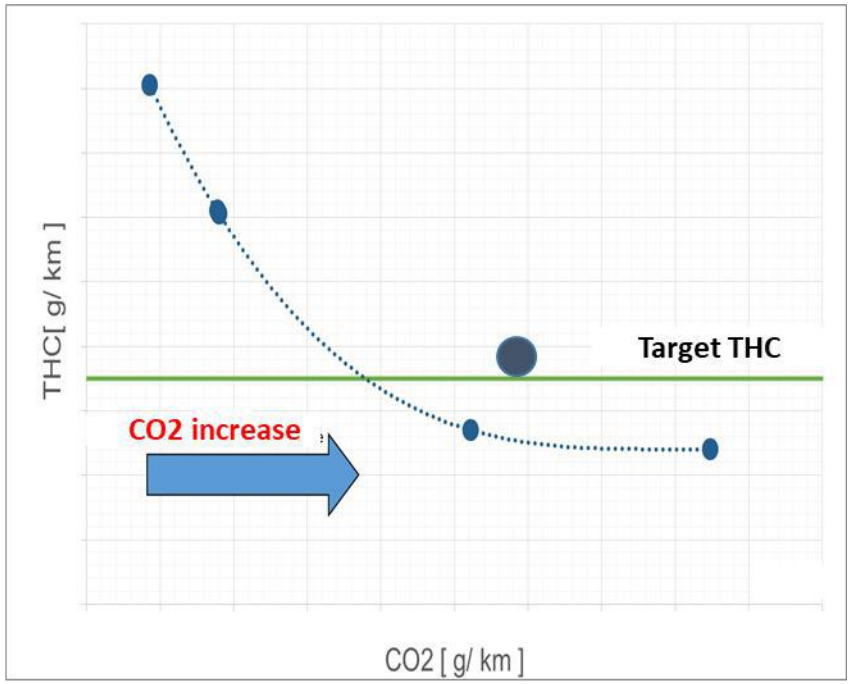
- **Methane is difficult to convert** and requires higher temperatures for conversion in TWC
- **Penalty of CO2** is there to meet THC emissions

Fuel properties (Bio-CNG / CNG)



CO2 penalty



Conversion performance with Methane is much lower to Gasoline

Extra fuel is used to reduce THC

Current approach increases overall GHG emissions performance of vehicle also

→ **Make regulatory provision for NMHC / NMOG rather than THC (like US, Japan, Brazil)**

4 Bio CNG challenges : Regulatory scenario for Methane emissions

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Methane is not pollutant : International markets regulate NMHC /NMOG pollutants not THC

US FEDERAL

TIER 3 STANDARDS

TIER 3 FTP STANDARDS

Tier 3 Certification Bin Standards (FTP, 150,000 mi)				
Bin	NMOG+NOx (mg/mi)	PM[1] (mg/mi)	CO (g/mi)	HCHO (mg/mi)
Bin 160	160	3	4.2	4
Bin 125	125	3	2.1	4
Bin 70	70	3	1.7	4
Bin 50	50	3	1.7	4
Bin 30	30	3	1.0	4
Bin 20	20	3	1.0	4
Bin 0	0	0	0	0

CALIFORNIA

LEV III STANDARDS

Passenger Cars and Light Duty Trucks ≤ 8,500 lbs

Durability (mi)	Emission Category[1]	NMOG+ NOx (g/mi)	CO (g/mi)	Formalde-hyde (g/mi)	Particulates[2] (g/mi)
150,000 (optional)	LEV160	0.160	4.2	4	0.01
	ULEV125	0.125	2.1	4	0.01
	ULEV70	0.070	1.7	4	0.01
	ULEV50	0.050	1.7	4	0.01
	SULEV30	0.030	1.0	4	0.01
	SULEV20	0.020	1.0	4	0.01

Japan Emissions Regulation

EMISSIONS STANDARDS – GASOLINE AND LPG VEHICLES

			Test Mode	Unit	CO	NMHC	NOx	PM[1]
New Short Term	2000	Passenger Car	10-15 Mode	g/km	0.67	0.08	0.08	-
			11 Mode	g/test	19.0	2.20	1.40	
	2002	Mini Commercial Vehicle	10-15 Mode	g/km	3.30	0.13	0.13	
			11 Mode	g/test	38.0	3.50	2.20	
	2000	Light Commercial Vehicle (GVW ≤ 1.7 t)	10-15 Mode	g/km	0.67	0.08	0.08	
			11 Mode	g/test	19.0	2.20	1.40	
	2001	Medium Commercial Vehicle (1.7 t < GVW ≤ 3.5 t)	10-15 Mode	g/km	2.10	0.08	0.13	
			11 Mode	g/test	24.0	2.20	1.60	
New Long Term	2005	Passenger Car	JC08	g/km	1.15	0.05	0.05	
	2007	Mini Commercial Vehicle			4.02			
	2005	Light Commercial Vehicle (GVW ≤ 1.7 t)			1.15			
	2005	Medium Commercial Vehicle (1.7 t < GVW ≤ 3.5 t)			2.55		0.07	
Post New Long Term	2009	Passenger Car	JC08	g/km	1.15		0.05	0.005
		Mini Commercial Vehicle			4.02			
		Light Commercial Vehicle (GVW ≤ 1.7 t)			1.15			
		Medium Commercial Vehicle (1.7 t < GVW ≤ 3.5 t)			2.55		0.07	0.007
Future Regulations	2018	Passenger Car	WLTP	g/km	1.15	0.10	0.05	0.005
	2019	Mini Commercial Vehicle			4.02			
		Light Commercial Vehicle (GVW ≤ 1.7 t)			1.15			
		Medium Commercial Vehicle (1.7 t < GVW ≤ 3.5 t)			2.55	0.15	0.07	0.007

BRAZIL

"PROCONVE" STANDARDS FOR GASOLINE PC, LCV AND DIESEL LCV

Vehicle	Standard (g/km)	NMHC	CO	NOx[1]	HCHO	PM[2]
PC	L5	0.05	2.0	0.12 (0.25)	0.02	0.05
	L6		1.3	0.08	0.02	0.025
	L7[3]		1.3	0.03	0.01	0.005
LCV ≤ 1,700 kg	L5	0.05	2.0	0.12 (0.25)	0.02	0.05
	L6		1.3	0.08	0.02	0.03
	L7[3]		1.3	0.03	0.01	0.005
LCV > 1,700 kg	L5	0.06	2.7	0.25 (0.43)	0.04	0.06
	L6		2.0	0.25 (0.35)	0.03	0.04
	L7[3]	0.05	1.3	0.05	0.015	0.01

Reconsideration of CH4 as pollutant,
to be aligned as per international markets

Walk-Through :

- India's unique situation in Mobility
- Next Powertrain Development directions
- Bio-fuels : Opportunity & Challenges
- **Way forward**
  - **Enablers for Bio-fuels**
  - **Expectations from Emissions Control System**

Bio-fuel adoption in India : OEM perspective on way forward

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Policy Enablers for Biofuels

1. Roadmap beyond 2025
   - Bio-fuel availability

2. Regulatory support
   - CAFÉ : Biogenic CO2 accounting
   - Emissions : THC → NMHC / NMOG

3. Customer Acceptability
   - Price parity of Fuel as per energy
   - Price parity for Vehicle cost

Expectation from Emission Control System Partners

1.. Higher performance Aftertreatment system
   - Ethanol /Pet light-off <250 degC (OEM Aged)
   - CH4 light-off <350 degC (OEM Aged)
   - Wider conversion window for Bio-CNG / CNG
   - Low thermal mass substrate (>55% porosity)

2. HC Trap Catalyst with >30% emissions improvement

3. Alternate metal Catalyst to make it affordable

4. Focused Development for Biofuel's aftertreatment

Let's work together to achieve →Carbon Neutrality by Bio-fuels

Thank You

Maruti Suzuki WagonR E85 FFV proto

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Suzuki Concludes a Three-Party Agreement for the Biogas Demonstration Project in India

- Operate four biogas production plants starting from 2025 -