



## Technical Session 3 : Clean Fuels & Fuel Blends

Event Organised by:



Emission Controls Manufacturers  
Association, New Delhi, INDIA

# Ethanol and Bio-CNG - Cleaner Fuels for Sustainable Transportation

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**Dr P Sakthivel**

Chief Research Manager (Automotive Research)  
Indian Oil Corporation, R&D Centre  
Faridabad.

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## ➤ **Background & Introduction**

- ✓ Background
- ✓ Scenario of Liquid Fuels, Natural Gas
- ✓ Vehicle Statistics

## ➤ **Ethanol**

- ✓ Ethanol Blending – Statistics
- ✓ Ethanol blended gasoline – Fuel Options
- ✓ Key properties
- ✓ Vehicle performance with E20

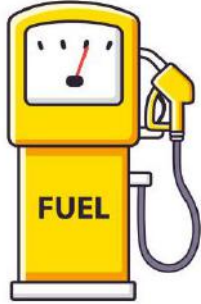
## ➤ **Bio-CNG**

- ✓ Biogas potential in India
- ✓ Fuel Specification – CNG & Bio-CNG
- ✓ Mass Emissions and Fuel Economy test of vehicles with Bio-CNG

## ➤ **Summary**

# Background & Introduction





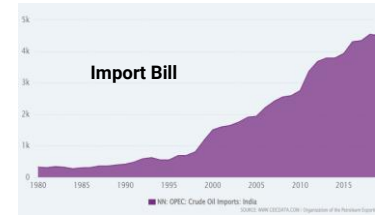
**Fuel Quality  
BS 6**



**Vehicle Technology  
BS 6.2**



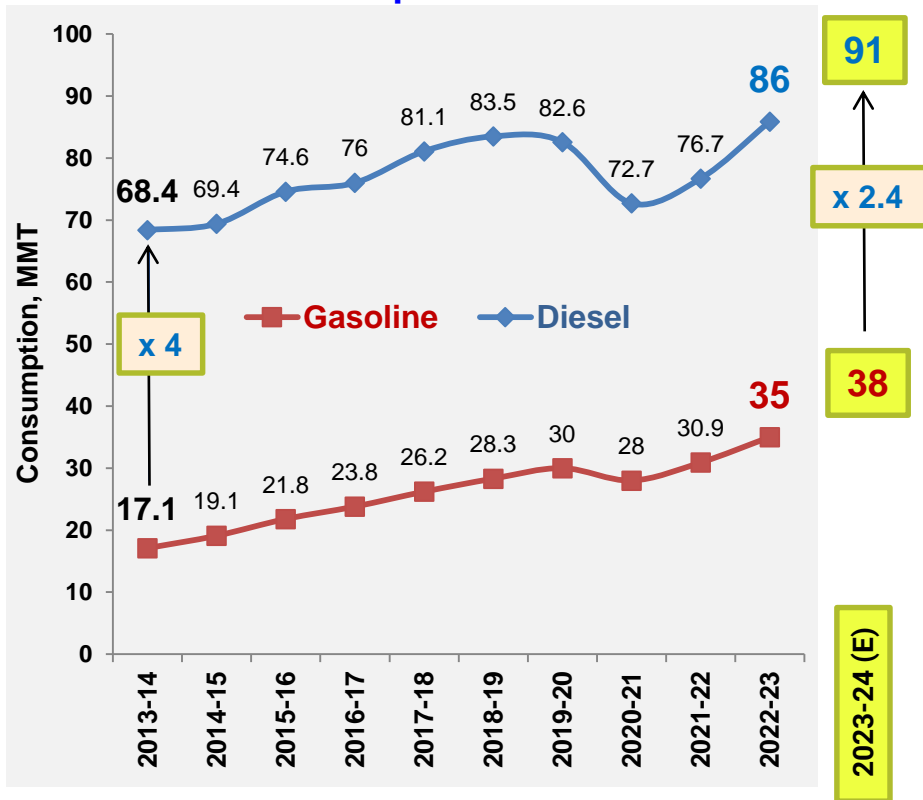
**Advanced EAT  
Solutions**



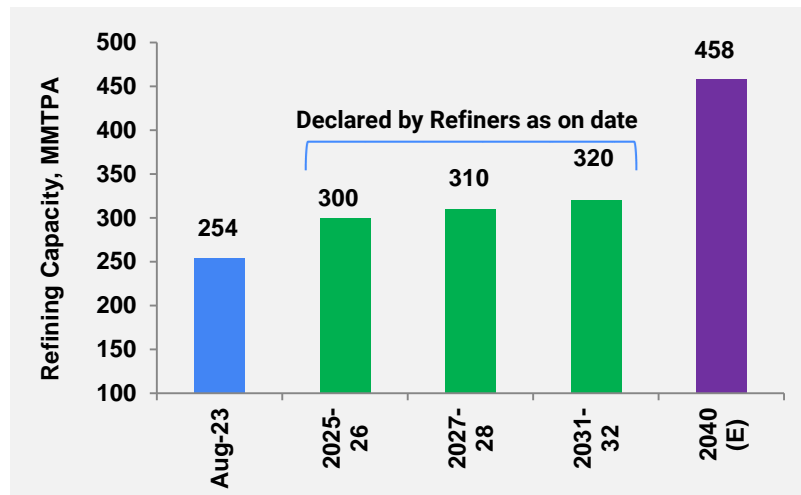
**GHG Emissions  
Energy Independence**



## Consumption Data

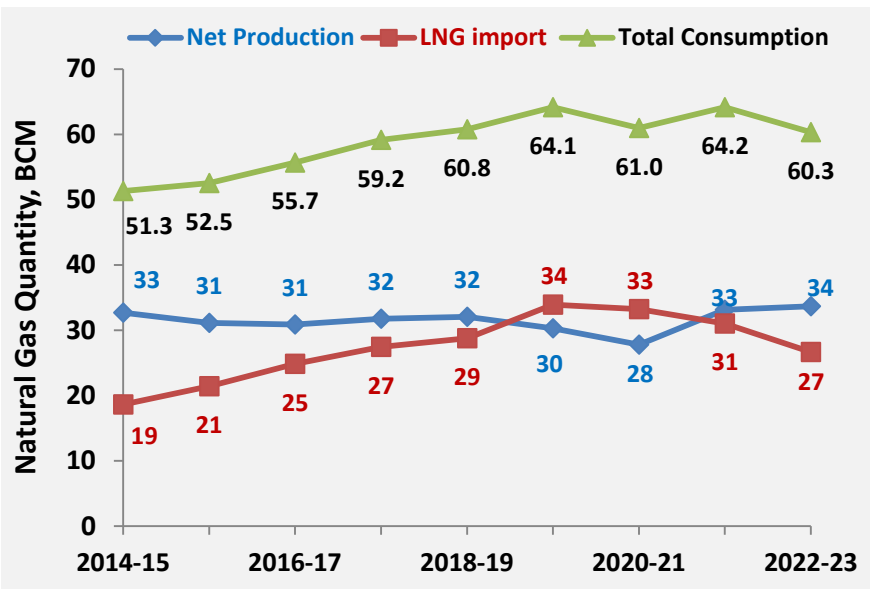


## Refining Capacity - Expansion



Source: PPAC, PIB, ETEnergyWorld, MoPNG WG 2018

- India imports around 85% of oil requirements
- Gasoline consumption grows at a faster pace than diesel – Less price difference, CNG penetration, Cars moving to MS, Life of vehicles, Lower cost of petrol vehicles
- Liquid fuels grow in spite of NG expansion, electric mobility



80

5 y

2027-28 (E)



## CGD Network Coverage:

(after completion of 11 A Bidding round)

- 295 Geographical Areas (GAs)
- 98% of the population and
- 88% of total geographical area
- around 630 dist. in 28 states/UTs

## NG Demand for Transport Sector:

- 3.5 MMT (2019),
- 7.02 MMT (2030)

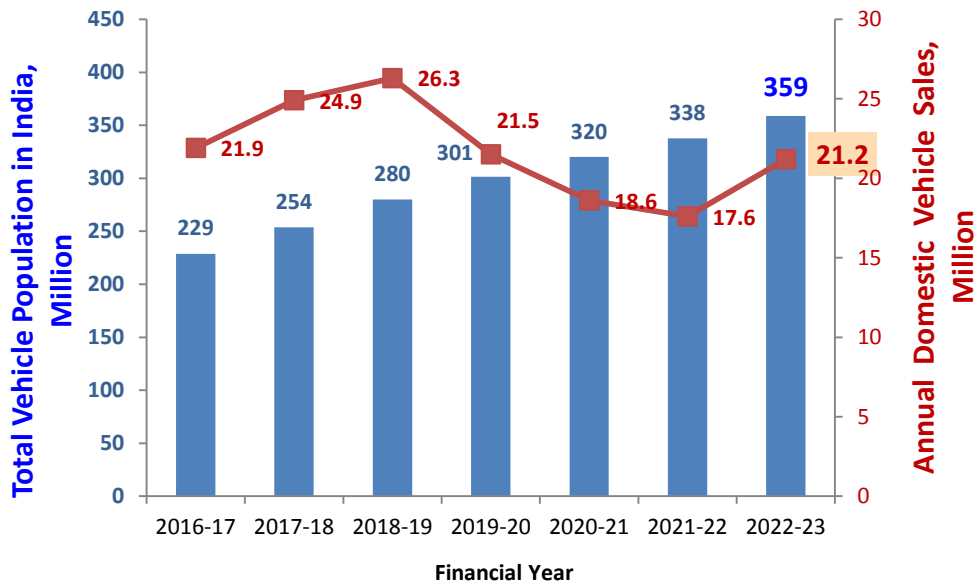
(Source: Derived from WEO 2021, IEA)

## CNG Stations

- Sept 2023 – 5953
- By 2030 - 17,700 (Source: PIB, Jul'22)

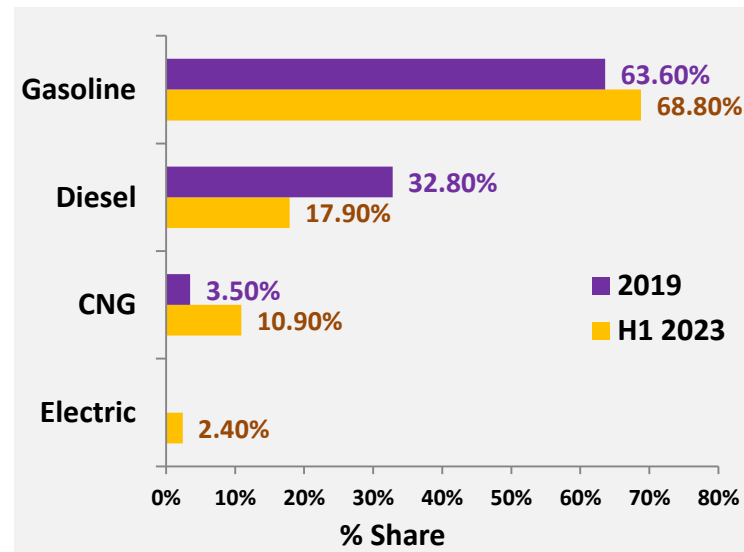
- LNG capacity to raise from 47 MTPA to 70 MTPA by 2030
- CGD Network to play a major role in expansion of NG use across segments
- Gas to grow at a much faster pace than liquid fuels, in spite of high prices prevailing in international market

## Vehicle Statistics



About 70% of total population is two-wheelers

## Fuel Penetration in Passenger Vehicles (% Share) – Sales Trend

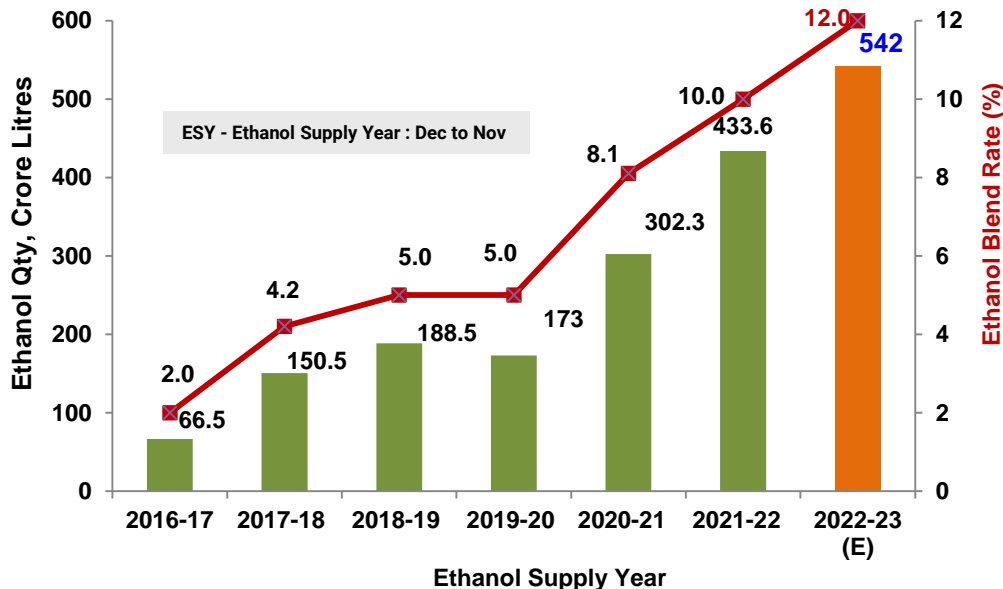


New Domestic gas price mechanism implemented in April 2023 will keep CNG price under control, which will drive CNG car sales



# Ethanol





## Way Forward

Ethanol Supply Year	Plant Capacity (in Crore Litres)			Ethanol required for blending
	Grain	Sugar based	Total	
2022-23	350	625	975	542
2023-24	450	725	1175	698
2024-25	700	730	1430	988
2025-26	740	760	1500	1016

Source: Ethanol blending roadmap

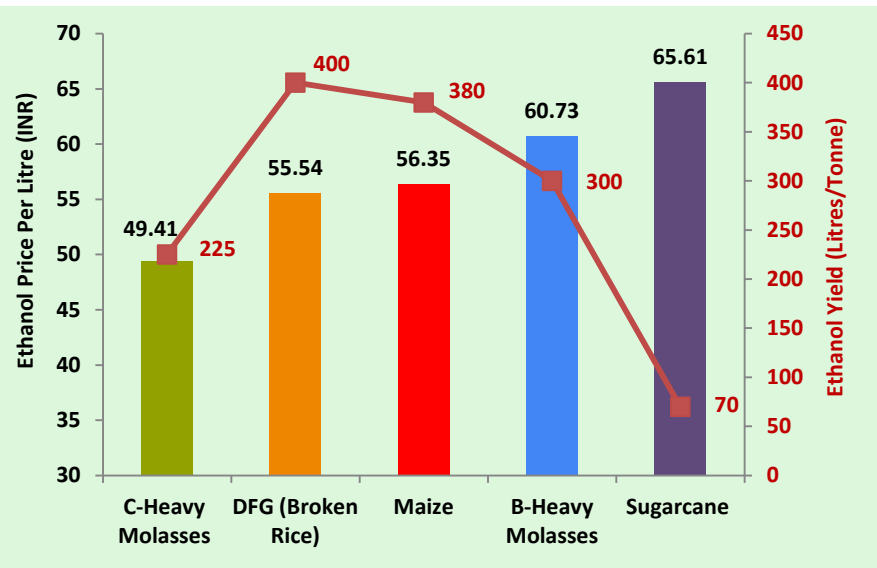
India achieved **10%** ethanol blending in **June 2022**

Ongoing ESY (2022-23) → **11.7%** till Aug 2023

**E20 fuel** - launched by Hon'ble PM on **6th Feb 2023**

**E20 fuel on Pan India basis by 2025** – 1016 Cr Lit. of EtoH

**Feedstock Options:** Sugar cane juice, Sugar, Sugar Syrup, B & C molasses, damaged food grains, FCI Rice, Maize  
**40:60 mix of grain and sugar based feedstock by 2025-26** can help sustainable supply, balancing lean & rich sugar seasons



- All above are Ex-mill prices (as of Sep 2023) excluding taxes and Transportation charges
- Ethanol price depends on (a) **Yield** and (b) **Cost of feedstock**



## 2G Plant at IOCL Panipat



- 900 Cr. Plant
- Ethanol - 30,000 KLPA
- Feedstock – 2,00,000 tonnes of Paddy straw
- Licensor: Praj Industries
- August 2022

BPCL and HPCL too building 2G ethanol plants at Orissa and Punjab respectively

## Assam Bio-Refinery Pvt. Ltd.



- JV of NRL, India and Fortum & Chempolis Final Ind. 950 Cr. Plant
- Ethanol - 66,000 KLPA
- Feedstock – 300,000 tonnes Bamboo
- By-products: 16,000 tonnes of furfural and 11,000 tonnes of acetic acid
- March 2024

## 3G Plant at IOCL Panipat



- Ethanol – 44,000 KLPA; ~400 Cr Plant
- Feedstock – HGU PSA off gas containing CO, CO<sub>2</sub> & H<sub>2</sub>
- Licensor: Lanzatech Inc., USA
- Based on Gas fermentation technology
- By-product: Protein rich bio-mass (3 TPA)
- Early 2024

# Ethanol Blended Gasoline Fuels & BIS Specification



IS 2796

O<sub>2</sub> → 4.2%



IS 17021

7.4%



IS 16634

24-30% \*



IS 17821

~33% \*

Lower Ethanol Blends for Normal Vehicles

Higher Ethanol Blends for FFVs

# Key Properties of Gasoline & Ethanol

Property	Unit	Gasoline	Ethanol
Density at 15°C	kg/m <sup>3</sup>	750-765	785-809.9
Kinematic viscosity	mm <sup>2</sup> /s	0.5-0.6	1.2-1.5
Carbon fraction	mass %	87.4	52.2
Oxygen fraction	mass %	0	34.7
Hydrogen fraction	mass %	12.6	13.0
Research Octane Number	-	91	110
Latent heat of vaporization	kJ/kg	380-400	900-920
Lower heating value	kJ/kg	44.0	26.9

Lower Carbon emissions

Less knock  
High CR is possible

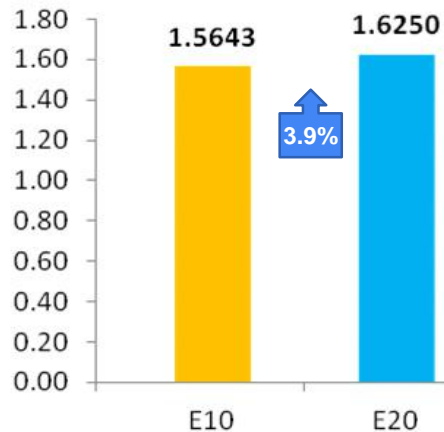
Energy equivalent pricing & Compensate thr' engine design

Property	Unit	Gasoline	Ethanol
Vapor flammability limits	vol %	0.6-8	3.5-15
Laminar flame speed at 100 kPa, 325K	cm/s	~33	~39
Reid vapor pressure at 37.8°C	kPa	53-60	17
Distillation Initial boiling point	°C	45	78
T10	°C	54	78
T50	°C	96	78
T90	°C	168	79
Final boiling point	°C	207	79

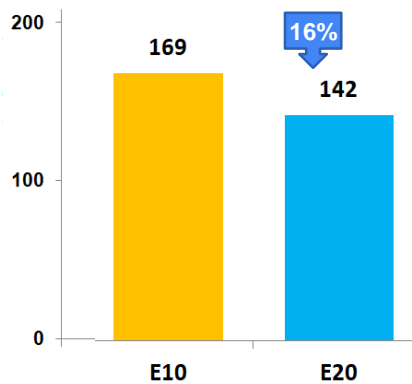
Higher rate of pressure rise

Cold Startability – Flex-Fuel Vehicles

**Fuel Consumption (l/100km)**



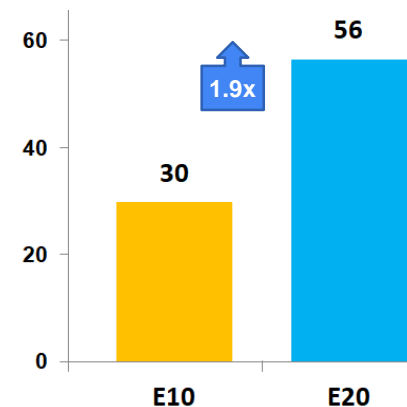
**CO (mg/km)**



**THC (mg/km)**



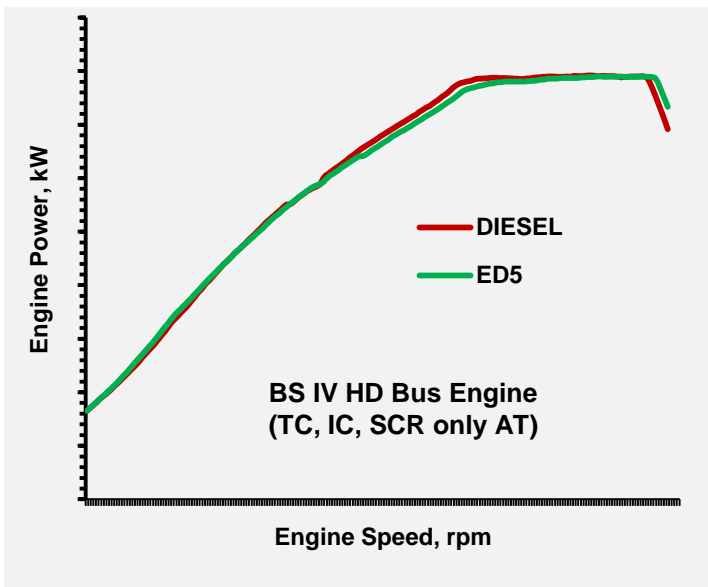
**NOx (mg/km)**



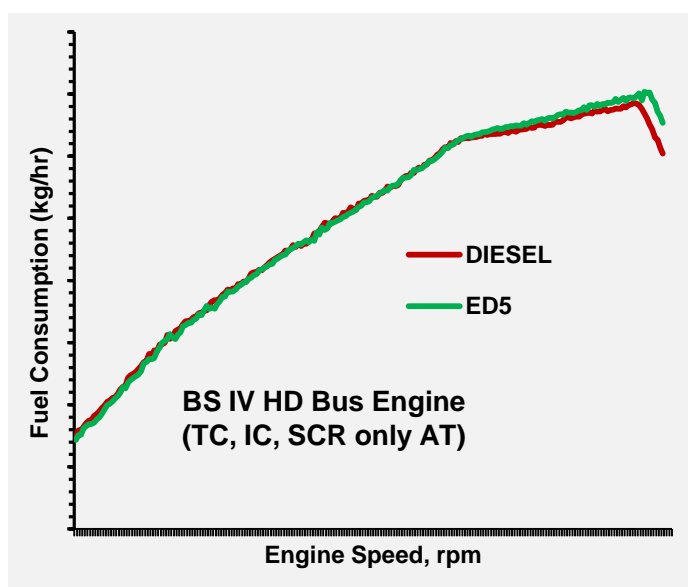
- ✓ **Fuel Economy:** 1-3% loss is expected with E20 compared to E10
- ✓ **FFV vehicles** with hybrid architecture can fully compensate the fuel economy debit with ethanol
- ✓ Increase in NOx is inevitable for in-use FI based motorcycles – Tuning possible in new vehicles
- ✓ **Material Compatibility:** Few elastomers used in old vehicles can have shorter life
- ✓ **Startability, Drivability & Durability:** Comparable with E10
- ✓ **April 2023** → All new vehicles are materially compliant with E20
- ✓ **April 2025** → All new vehicles will have E20 specific fuel-efficient engines with high CR



## Engine Power over FTP



## Fuel Consumption over FTP



## Emissions over ESC

### % Change in Engine-Out Emissions with ED5

- CO : ↓ 25.09 %
- THC : ↓ 51.03 %
- NOx : ↑ 19.80 %
- Soot : ↓ 43.00 %

### ED5 Fuel Composition & Additives

- Need coupler (co-solvent) to achieve fuel stability for longer storage duration
- Lubricity improver & Cetane improver may also be required
- Flash point of ED5 is lower and falls in Class A of PESO (Unlike diesel, Class B Product)

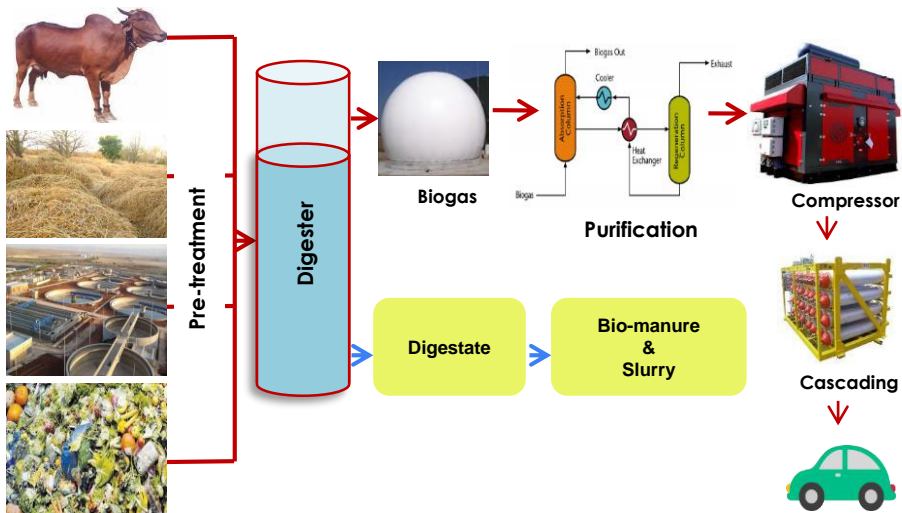




# Bio-CNG

## (CBG / Enriched Bio-Gas)





## Major potential feedstock for CBG in India and the estimated CBG production

Categories of organic waste - Feedstock	Annual feedstock potential (MMT)	Estimated potential of bio-CNG (MMT)	% Share of Feedstock on overall CBG Potential
Animal & poultry waste	190	25	41
Surplus agro-residues	150	20	32
Sewage treatment plants	50	10	16
Municipal solid waste	62	5	8
Spent wash / Press mud	20	2	3
<b>Total</b>	<b>472</b>	<b>62</b>	<b>100</b>

### SATAT Scheme



5000 CBG Plants by 2030



15 MMT of CBG



50 MMT of Bio-Manure

MoP&NG



01 Oct 2018

## Guaranteed off-take of CBG by OMCs

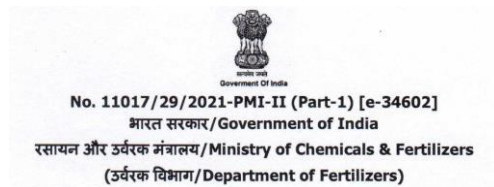
- IOCL, BPCL, HPCL, IGL, GAIL

No. L-16022/05/2020-GP-1 (E:35118)  
Government of India  
Ministry of Petroleum & Natural Gas  
\*\*\*\*\*

26 Oct 2021

## CBG-CGD synchronization

- Issued guidelines



20 Sep 2023

## Market Development Assistance

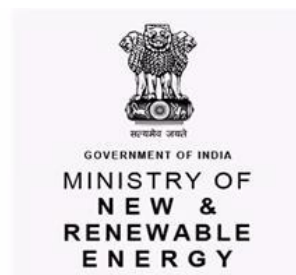
- Rs. 1500 / Ton to promote organic fertilizers produced from CBG plants
- FCO 1985 amended to include FOM, LFOM: Fertilizer (Inorganic, Organic or Mixed) (Control) second Amendment Order, 2020
- License free sale of FOM / LFOM



22 Sep 2021

## Harmonization of Classification of Industrial Sectors

- White Category - CBG plants
  - ✓ Nil discharge,
  - ✓ Complete use of FOM, LFOM as fertilizer / manure on land



Central Financial Assistance (CFA)

National Bioenergy Programme



Priority Sector Lending



**200 TPD Plant at Namakkal, TN  
By IndianOil-Adani Venture**

**Raw Materials**  
 Pressmud  
 Chicken litter/ Cow dung  
 Fruit waste  
 Milk waste/ Juice effluents

- 17 TPD of Bio-CNG production
- 12 TPD of OM production

Source: IAV, IBA Webinar, Sep 2023



**100 TPD Plant at Jaipur  
Designed By IndianOil**

- **Cattle dung** a feedstock
- **Commissioned in July 2022**
- **6 TPD of Bio-CNG production**



**200 TPD Plant at Gorakhpur, UP  
Designed By IndianOil**

- **Paddy straw** feedstock
- **Commissioning near completion**



**Bio-Methanation  
Technology suitable  
for all feedstock**



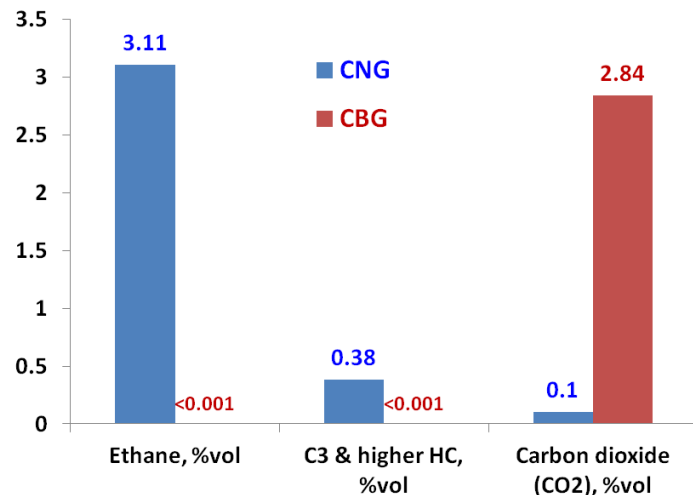
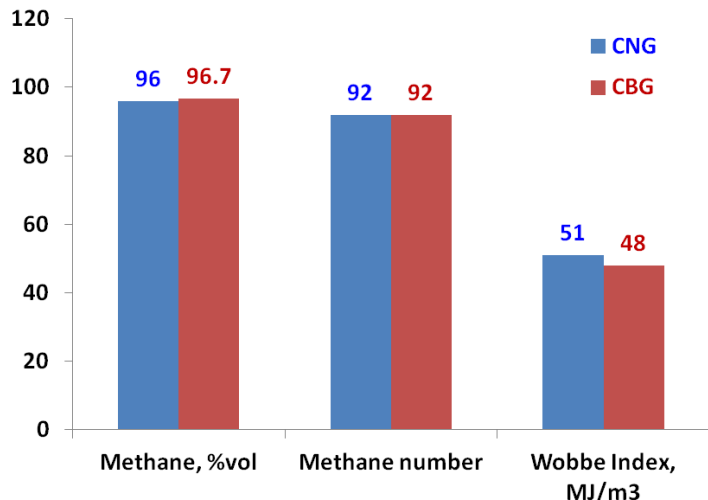
**Feed Agnostic and  
robust microbial  
blend**

## CBG In India

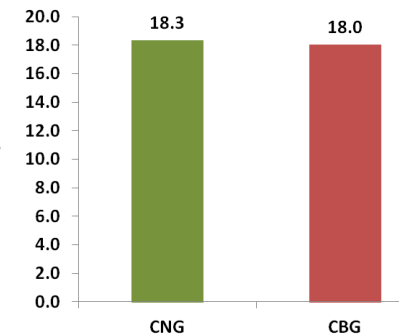
- No. of CBG Plants under SATAT as on 01.10.2023: **45**
- Sales of CBG in 2022-23: **11,227 Tons**
- Sale of CBG in CGD networks: **18 GAs**

## Analysis of Test Fuel Samples (CNG & CBG) used in this study

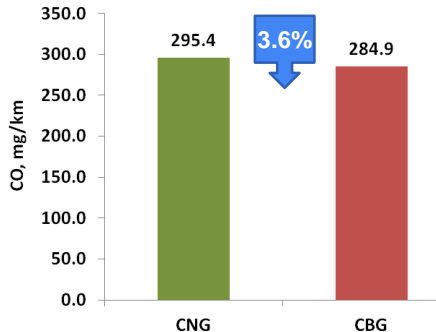
Both the test fuels **CNG** & **CBG** met the requirements as per **IS 15958** and **IS 16087** respectively



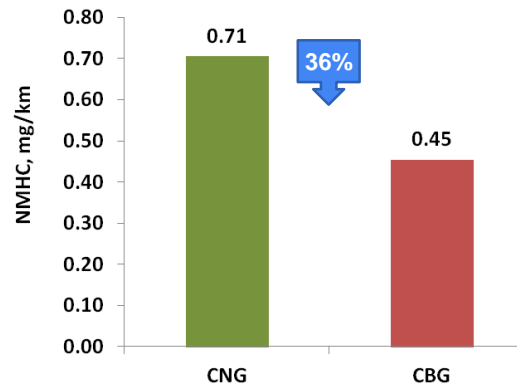
## Fuel Economy (km/m<sup>3</sup>)



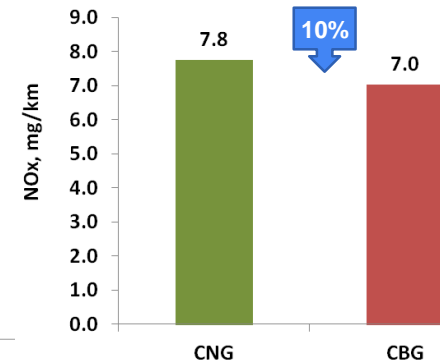
## CO (mg/km)



## NMHC (mg/km)



## NOx (mg/km)



- ✓ Both CNG and CBG contain primarily methane (>90% by volume). The second major component in CNG is ethane & other HCs, where as it is CO<sub>2</sub> for CBG.
- ✓ Fuel economy of the test vehicles is comparable with CNG and CBG fuels.
- ✓ CO emission is lower by 3.6% and THC emission is comparable with CBG compared to CNG. NO<sub>x</sub> and NMHC emissions decreased by 9.4% and 35.6% with CBG over CNG.
- ✓ The **FTP power** and the **acceleration time** over RLS condition are almost same with CNG and CBG fuels
- ✓ The equivalency in power and acceleration performance between CBG and CNG reinforces CBG's potential as a seamless replacement without compromising the vehicular capabilities



- Ethanol offers high RON, high Flame speed and contain fuel embedded oxygen. **E20 can be used for normal vehicles and E85 for Flex-Fuel vehicles.**
- Fuel penalty with oxygenated fuels can be compensated if engines designed for high RON. **Hybrids** add value.
- Ethanol blending needs to be pursued in aggression as E20 can directly **cut the import bill** annually by 30,000 Crore and **cut the GHG emissions** by more than 20 MMT on well-to-wheel basis for India.
- Ethanol will also play a significant role in fulfilling the **SAF requirement** for Aviation Sector, **excess ethanol for ED5**
- Bio-CNG can be a viable solution for tackling multiple issues like **Sanitation, Waste management and Fertilizer**
- **The CNG requirements for transportation sector can be met through Bio-CNG, if harnessed properly.**
- Augmentation of ethanol & bio-CNG infrastructure and their wide-scale use will be one of the major enablers for achieving Net Zero and Energy Independence for India.

Today's waste is tomorrow's wealth

- Let's do our bit to realize it

**Thank You for your kind attention !!!**

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 [sakthivelp@indianoil.in](mailto:sakthivelp@indianoil.in)

 +91-9711110687

 <https://www.linkedin.com/in/sakthivel-paramasivam-ph-d-a9431088/>