



BIO Fuels

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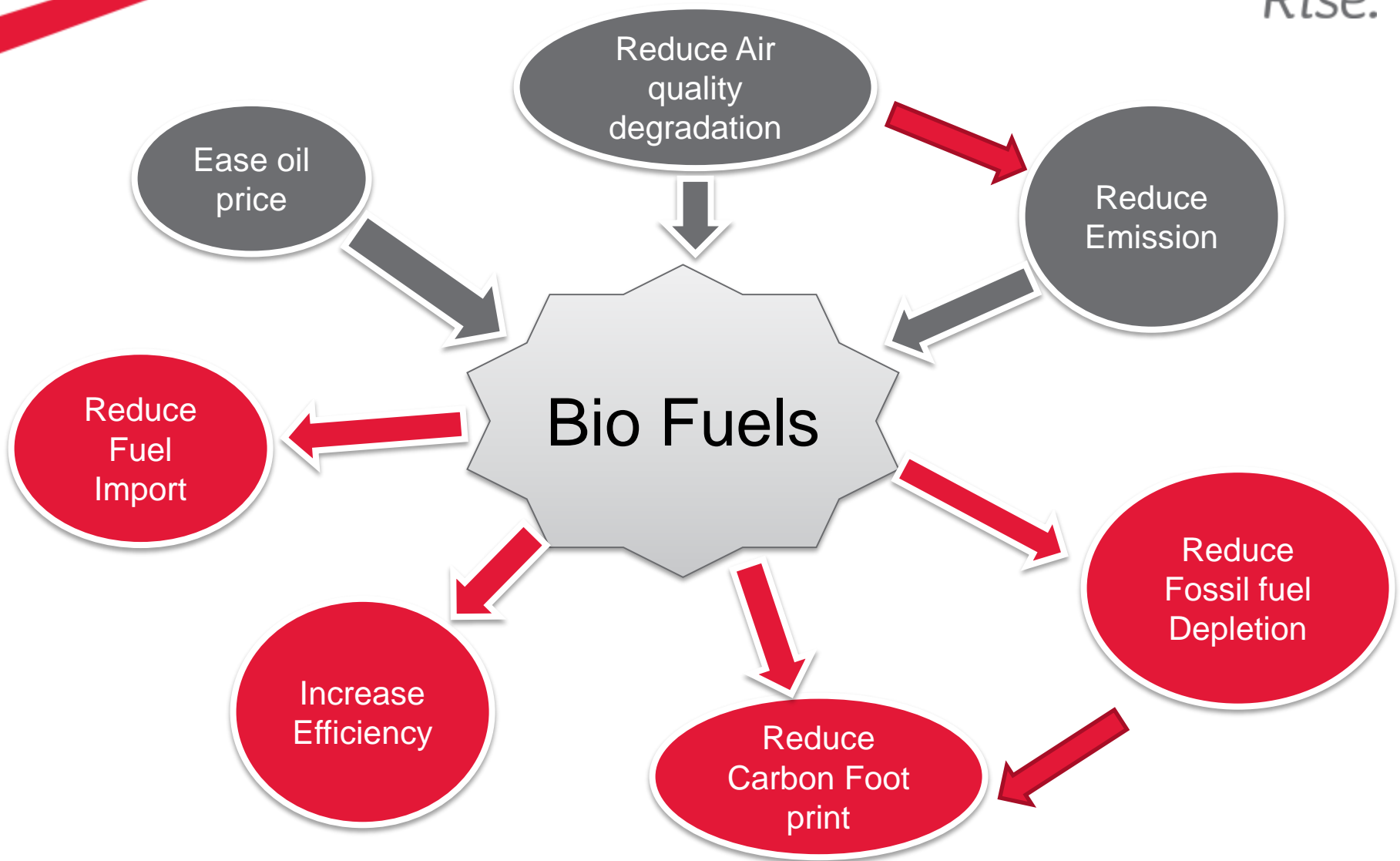
# An OEM's Perspective on Bio Fuels for Automotive Vehicles –Development Experiences

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*EU-India Conference on Advanced Biofuels New Delhi, 7th - 8th March 2018*

# Contents:

- Bio Diesel as Fuel for Automotive vehicles
- Waste to Bio CNG as Fuel for Vehicle & Other application



# Bio Diesel Scenario

## ➤ Main Alternatives:

- Primary Biodiesel - By Transesterification of Vegetable Oils of Various Raw Materials - Fatty Acid Methyl or Ethyl Ester (FAME, FAEE) – Most commonly used
- Advanced Bio Diesel – Future Options
  - Bio-Diesel from Hydrogenation
  - Bio-Diesel from Algae
  - Biomass to Bio Diesel by FT or Pyrolysis

# Average FAME usage world wide

Country	Bio Diesel Content		Country	Bio Diesel Content
South Koera	2		North America	0(80%) - 7(5%)
Malaysia	7		Europe	0(35%) - 7(25%)
Thailand	7		Argentina	9
Indonesia	15		Brazil	7
India	0		Colombia	10
China	0		Peru	5
Japan	0		Chile	0
Middle East	0		South Africa	0
Singapore	0		Australia	1
Israel	0		New Zealand	0

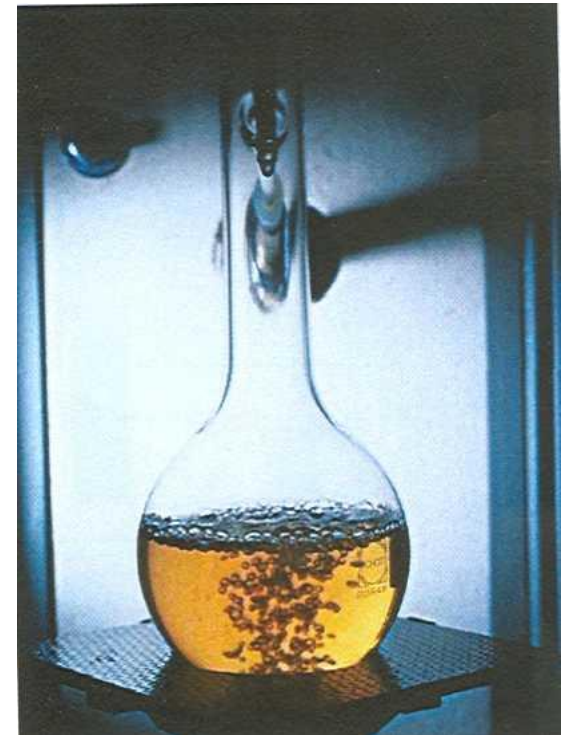
Source: Infinium World Wide Winter Diesel Fuel Quality Survey 2016

# Fuel Quality Aspects

- Several Countries have developed national specifications for Biodiesel

Bio-diesel Specs worldwide:

Country /Area	Specifications
EU	EN 14214
US	ASTM D 6751
Germany	DIN E 51601
India	IS 15607:2017
Brazil	ANP42
Japan	JASO M360



# M&M Initiatives on Biodiesel

- B10 & B20 on SUV & Tractors
  - Performance Studies – Scorpio, Bolero, Tractors
  - Material Compatibility studies
  - Durability Studies
    - ✓ 2 Bolero on B20 - 1lakh km each (with IOC R&D)
    - ✓ 2 Scorpio on B10 - 50000km each
    - ✓ Tractors complete Field validation
  - Tractors Commercially launched for B10
- B100 studies on SUV
  - Performance Studies – Emission
  - Material Compatibility studies
  - Durability Studies – Scorpio for 1 Lakh km (with IIT K)
  - Customer Field Trials – 10 Vehicles about 10000km each

# CRDe SUV, Scorpio developed for B100



**Scorpio with indigenously developed CRDe technology is the first vehicle in its class to run Experimentally on B100**



# Real World Field Studies with Bio-Diesel



# Performance Study - Some Highlights

Test Description		Effect Bio-diesel over Diesel		
		B10	B20	B100*
Fuel Economy (kmpl)		No change	No change	No change
Power @ Wheel (kw)		No change	1-2% ↓	10-12% ↓
Acc <sup>n</sup>	speedwise	No change	No change	10% ↓
	distancewise	No change	No change	2% ↓
Max Speed (kmph)		No change	No change	5% ↓
Gradability (angle deg.)		No change	No change	-----
Engine Noise (db)		No change	No change	5% ↓

\* Engine tested as it is without modification over normal Diesel settings

# Emission Advantage with Bio-Diesel

<b>Pollutants (g / km)</b>	<b>Percentage Improvement for each Fuel</b>		
	<b>B10</b>	<b>B20</b>	<b>B100</b>
<b>HC</b>	<b>18</b>	<b>24</b>	<b>40</b>
<b>NOx</b>	<b>0.0</b>	<b>-2.6</b>	<b>-4</b>
<b>CO</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>CO2</b>	<b>0.4</b>	<b>-0.3</b>	<b>-1.6</b>
<b>PM</b>	<b>12</b>	<b>20</b>	<b>36</b>

Emission Test results on SUV with CRDi meeting Euro III emission

# Finding of Engine Durability studies

If the **Acid value**, **Moisture content** & **Oxidation Stability** parameters of the fuel exceeds the prescribed limits, ageing starts & Bio Diesel degrades to the point where it is out of specifications

The Effects of fuel ageing on the Engine and FIP :

Ageing Product	Consequences for the FIE
<b>Polymers, Insoluble (gum, sludge)</b>	<ul style="list-style-type: none"><li>•Filter clogging</li><li>•Deposit formation inside the entire FIE</li><li>•Sticking moving parts</li><li>•Injector coking</li></ul>
<b>Polymers, Soluble</b>	<ul style="list-style-type: none"><li>•Resin forming inside the entire FIE</li></ul>
<b>Ageing acids</b>	<ul style="list-style-type: none"><li>•Corrosion of metal parts</li><li>•Soap formation with metal ions deriving from wear or corrosion (deposits)</li></ul>
<b>Peroxides</b>	<ul style="list-style-type: none"><li>•Embitterment of elastomers</li></ul>

# Material Compatibility Results

<b>Components / Test Desc.</b>	<b>Observations / Results</b>
Fuel tank	Same as diesel till B10
Fuel Line / Hoses	Natural Rubber needs to be changed to Polymer
Fuel Filter	OK for B5 & B10 Material review required beyond B10
FIP	Natural rubber O-Rings, Seals and Gaskets to be replaced with Viton Material



# Other Concerns of Bio-Diesel

- ❑ Storage Stability - Biodiesel ages more quickly than diesel due to the chemical structure of fatty acids and methyl esters presence

- ❑ Cold filter plugging point (CFPP) – Low compared to Diesel

CFPP depends on Raw material for Bio-Diesel

- Karanje, Palm etc - poor CFPP.
- Jatropha, Rapeseed, Soya etc - Better CFPP

.

# Engine Durability Aspects

## Some operating issues with B100 Engines:

- **Cold Weather Operability:** B100 does not flow as well as petroleum diesel in cold temperatures
- **Engine & Fuel System Compatibility:** B100 may cause rubber seals & gaskets of older engines to wear faster or fail.
- **Solvency properties of Biodiesel:** Biodiesel also acts as a solvent which can dissolve sediments in the diesel fuel tanks & clog fuel filters during initial transition from petro-diesel
- **Fuel Dilution of Engine Oil** – Reduce oil life, Enhance wear of Engine

**Upto B 10 is acceptable of above concerns therefore has potential for implementation more widely. B100 remains a challenge**

# Next Generation Bio-Fuels

- Bio-Diesel from Hydrogenation
- Bio-Diesel from Algae
- Biomass to Bio Diesel by FT or Pyrolysis

***Initiate Studies on Gen II Bio-Diesel both on Application and Fuel Quality development***



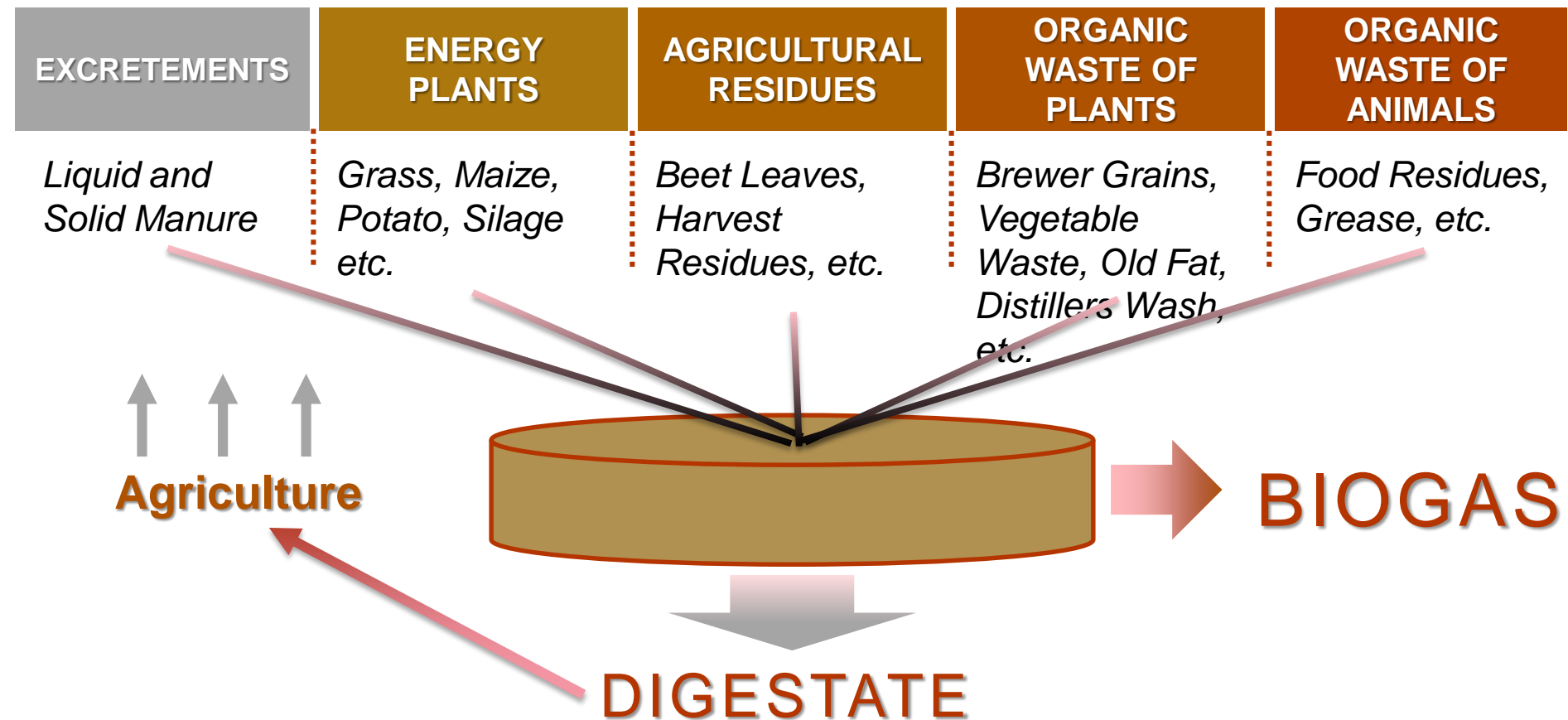
# Advanced Bio Diesel Issues

- High investment cost & Fuel cost
- All Synfuels must have the same specs. i.e. CtL, BtL, GtL & WtL – Fuel specification yet to evolve
- Synfuels are clean, have a CN>60, but difficult to meet Diesel (density & viscosity)
- Synfuels have a potential of major reduction of PM & NOx
- Calibration of Vehicle and adoptability to engine needs are yet to be established.

# Issues for Bio-Diesel Implementation

- ❑ Ensure Fuel Quality is big Challenge. Moisture, Oxidation stability & Acid value require specific control.
- ❑ Ensure & Strengthen quality monitoring by regulatory bodies to meet Bio-diesel specification as per IS 15607.
- ❑ Durability issues with higher blends have to be sorted out. Increase deposit forming tendencies on FIE parts may hamper blends above B7.
- ❑ Sufficient lead time must be there before Bio-Diesel implementation for pilot field studies. FIE suppliers need to approve OEMs to go ahead with higher blends

# Waste to Energy- Biogas Generation



# Biogas Plant – A Green Solution

Methane

- **Cooking Gas**
- **Automotive Fuel**
- **Electricity Generation**

CO<sub>2</sub>

- **CO<sub>2</sub> can be recovered and sold as Industrial gas**

Slurry

- **Organic manure/fertilizer for cultivation/horticulture**

# Technology

All the project activities related to the Technology, Design and development done by Mahindra

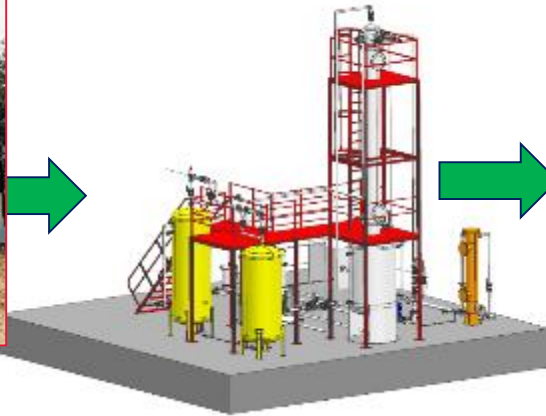
- **Digester Technology** : The appropriate Technology to process the multi feedstock.
- **Bio-CNG Technology** : To convert raw biogas into Bio-CNG
- **Bottling Technology** : Storage and transportation of Bio-CNG
- **Organic Fertilizer** : Suitable technology for converting slurry into organic fertilizer

# Mahindra World City Biogas Project Concept

Input : Segregated  
Food-waste  
Provided by MWC



400 kg of CNG  
grade fuel is  
produced daily  
and it can propel  
our tourister buses  
2800 km/ day



Genset for  
Electricity  
generation



Organic Manure

4 tons of  
organic manure  
is produced  
daily

Bio-CNG Jeeto  
& tractor for  
waste  
collection and  
cultivation





# Biogas Project Process Flow



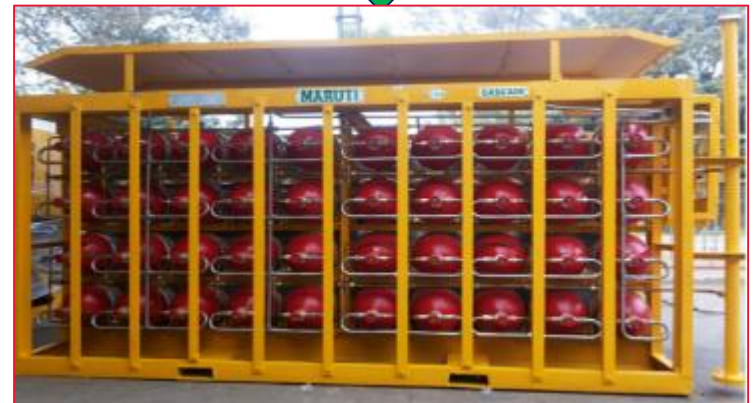
Biogas Enrichment



Bio-Gas 200 bar Compressor



Biogas Production



Storage & Dispensing



# Mahindra World City (MWC) Biogas Plant





# Mahindra Vehicles Run by Bio-CNG





# Biogas Project Result & Usage



**Storage and Refueling to Bio Gas operated Automobiles like Buses and tractors used inside Mahindra World City (MWC)**

**Bio Gas operated Generator used for powering Street lights within Mahindra World City and for the operation of Bio Gas Plant Equipment.**





The Honourable Minister  
**Shri. Piyush Goyal**  
 Ministry of Coal, Power and  
 New & Renewable Energy  
 Inaugurated the Bio-CNG plant  
 on 02/01/2016





# Biogas Plant: Malur, Bangalore, Karnataka

## ■ Plant details:

- Capacity of the plant: 40 tons / day
- Raw material: Food waste & Poultry dropping
- Focused area : 30 Km surrounding area from the proposed plant
- Bio Gas production capacity Raw gas: 3200 m<sup>3</sup> to 4000 m<sup>3</sup>
- Bio - CNG 1200 Kg to 1600 kg per Day
- Bio Fertilizer: 12 tons/day by composting
- Plant location: 71/3 Santhahalli Village, Malur Taluk, Kolar Dist., Bangalore.

**Mahindra Waste to Energy Systems Pvt Limited**

# Bio Gas – Bangalore Project



# Projects under progress' 2017 : 9 Projects

- Indore Smart City Development Corporation - 20 Tons / day
- MIDC Aurangabad - 20 Tons / day
- Swachh Andhra Corporation- Andhra Pradesh - 20 Tons / day – 5 Projects
- Swachh Andhra Corporation- Andhra Pradesh - 30 Tons / day – 1 Project
- Swachh Andhra Corporation- Andhra Pradesh - 50 Tons / day – 1 Project

# Conclusions

- M&M recognizes environmental & sustainability benefit of Bio-Diesel & Bio Gas & encourage its implementation in phases.
- Sufficient infra structure facilities should be ensured for continuous supply of Bio-diesel to oil companies for a sustained mixing of blends
- B7 can be implemented in India in the near future. Beyond that has to be proceeded after proper experience & study
- Advanced Bio diesel application and it adoption is yet to be studied in detail and rational fuel specification need to be evolved
- Waste to Bio CNG is having a great potential for Bio fuel application in India. Need to pursue this more vigorously

# Thank you

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