Indian Railways Organisation for Alternate Fuel (IROAF)
Ministry of Railways
Govt. of India
OBJECTIVE OF IROAF

IROAF is the single window on Indian Railways for dealing with work related to use of Alternate fuels i.e. other than conventional traction.

- To introduce Bio Diesel in Indian Railways
- To convert Diesel Powered Multiple Units (DEMUs) into duel fuel using Compressed Natural Gas (CNG)
- Promoting use of Solar Energy in Rolling Stock and Mechanical Assets
- To serve as single window entity for knowledge development on GHG emissions
ACTIVITIES OF IROAF

- Use of Bio-diesel for traction purpose in Locomotives
- Bio-diesel Policy formulation for Zonal Railways
- Setting up of Pilot Bio-diesel manufacturing plant
- Use of CNG for traction purpose and Industrial use
- Promoting use of Solar Energy in Rolling Stock
- Setting up of Pilot plant for converting municipal waste to energy
- Setting up of Pilot plant for conversion of municipal waste to green coal
- Setting up of Solar Power Plant for use in Railways workshops and Production Units
Renewable Energy Sources

- Solar
  - Solar PV
  - Solar Thermal

- Biomass

- Wind

- OTEC

- Wave

- Tidal

- Hydro
  - Run of the river
  - Storage dams (exhaustible)

- Ethanol

- Bio-diesel

- Fuelwood

- Crop Residue

- Dung

- Biogas

- Wood Gasifier

*Modern Renewables

Ministry of Railways, Government of India
Indian Railways tried a 5% blend of bio diesel on ALCO locomotive to haul Shatabdi Express on 31\textsuperscript{st} Dec, 2002. (DLI-ASR)

Hauling Capacity: No adverse effect was observed during the run in terms of haulage capacity etc.

Filters: No unusual deposits were noticed on the filter surface.

Fuel Injection System: The fuel injection pumps and injector nozzles were also found in satisfactory condition.
WHAT IS BIO-DIESEL?

- Technical Definition for Biodiesel

- (ASTM D 6751):

Biodiesel, is a fuel comprising mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, designated B100, and meeting the requirements of ASTM D 6751.

CONVERSION TO ESTER REDUCES VISCOSITY
TO SAME LEVEL AS DIESEL FUEL AND POTENTIALLY INCREASES CETANE NUMBER TO BE THE SAME OR EVEN HIGHER THAN DIESEL FUEL
WHAT ARE THE ADVANTAGES OF BIO-DIESEL FUEL?

- Renewable
  - carbon neutral
- Biodegradable
  - benefits environment
- Domestically grown
  - reducing imported oils
- Low emissions
  - except maybe Nox
- No engine modifications required
  - except replacing some fuel lines for older engines
- Safer
  - less flammable
- Non-toxic

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ADVANTAGES OF BIO-DIESEL (CONT.)

- Very favorable energy balance, 3.2 to 1
- Can be blended in any proportion with petroleum diesel fuel
- High cetane number and excellent lubricity
- Very high flashpoint (>300°F)
- Can be made from waste restaurant oils and animal fats
HOW IS BIO-DIESEL PRODUCED?

A simplified representation of biodiesel production:

- Transesterification
- Chemical reaction between methanol or ethanol and a vegetable oil or animal fat
- Requires a catalyst, such as caustic soda (NaOH) or KOH
- Removal of glycerin reduces viscosity

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WHY NOT USE STRAIGHT VEGETABLE OIL?

- Viscosity too high (x 10 that of biodiesel)
- Cetane number too low (below ASTM limit of 40)
- Poor atomization causes coking and deposits in combustion chamber
- Reacts with lubricating oil to create sludge and compromise lubrication
**BIO-DIESEL PROCESS SCHEMATIC**

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Approx. 2.8 Billion Litres of Diesel Fuel is consumed annually by nearly 4,800 Freight and Passenger Locomotives in the Indian Railway fleet.

The Annual Expenditure of Indian Railways on Diesel Fuel is approx. US $ 3.0 Billion
### SAVINGS OF HSD WITH USE OF BIODIESEL

<table>
<thead>
<tr>
<th>Annual consumption of HSD (in million litres)</th>
<th>Savings in HSD (in million litres) by blending Bio-diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5%</td>
</tr>
<tr>
<td>2800</td>
<td>140</td>
</tr>
</tbody>
</table>

Thus if B10 blend is used by IR, then **280 million litres** of diesel shall be replaced by Bio-diesel annually.
**DENSITY**

- Bio-diesel is slightly heavier than conventional diesel fuel (specific gravity 0.88 compared to 0.84 for diesel fuel).

- This allows use of splash blending by adding bio-diesel on top of diesel fuel for making bio-diesel blends. Bio-diesel should always be blended at top of diesel fuel. If bio-diesel is first put at the bottom and then diesel fuel is added, it will not mix.
GLYCEROL CONTENT

Free and Total glycerol:

- Glycerin is a thick butter-like by-product of the production of biodiesel and must be removed at the manufacturing plant, before delivery.

- The degree of conversion completeness of the vegetable oil is indicated by the amount of free and total glycerol present in the bio-diesel.

- Engine fouling, filter-clogging etc. can occur.

- Free glycerol if present can build up at the bottom of the storage and vehicle fuel tanks.

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ENERGY CONTENT

- Energy content of neat biodiesel is 1 to 10 percent less than petro-diesel, depending on raw material sources.

- Calorific value obtained for pure bio diesel was 10777 as against 10900 calories/ gm for petro-diesel.

- Thus the energy content of biodiesel was 1.13 % below that of petro-diesel.

- Locomotive operating range, therefore, could be slightly less than with blended diesel.
**CO Emissions**

- CO emissions show a downward trend when biodiesel is used. Presence of Oxygen atom in the ester helps in better combustion.

**Smoke Opacity**

- Smoke Opacity decreases with higher blends of Biodiesel.
CHARACTERIZATION OF ALCO DLW 16 V 3100 HP ENGINE WITH DIFFERENT BLENDS (B 10/B 20/B 50/B 100)

- No loss of power with B100 Blend.
- Brake Specific Fuel Consumption increased by 11% with B100 Blend due to 10-12% Lower Heating Value of Bio-Diesel.
- Nitrogen Oxide (NOx) increases with higher Blends.
- Hydrocarbon (HC) decreases with higher Blends. There is reduction of 44% with B100 Blend.
- Carbon Monoxide (CO) decreases with higher Blends. There is reduction of 89.3% with B100.
- Smoke Opacity decreases with higher Blends.
- Exhaust Temperatures/Firing Pressures are within the limits.

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USE OF SOLAR POWER IN RAILWAYS

- Solar panel based guard comfort kit comprises of provisioning for light, fan and mobile charging point

- Provision of Solar panel in DEMU coaches for light, fan and mobile charging point

- Provisioning of Solar Power plant in Railway Workshops and other establishments

- Use of Solar Power Plant in Railway Station and Railway Office premises
USE OF WIND POWER IN RAILWAYS

- Railway has set up a 10.5 MW Wind Power Plant in ICF, Chennai

- Railways is also exploring setting up of Wind Power Plants in Gujrat Coastal Area
WASTE TO ENERGY

- Wastes are materials that are discarded after use at the end of their intended life span.
- Waste management is a collective activity involving segregation, collection, transportation, reprocessing, recycling and disposal.
- House hold waste generated is broadly classified as:
  - Organic (50%-food, peals and leaves)
  - In organic (35%-plastic, PET, paper)
  - Inert (15%-glass and metal, brick and mortar)
- Railway has set up Waste to Energy Pilot Plant at Kishan Ganj Railway Staff Colony, Delhi converting house hold Bio degradable municipal waste into Methane for running gas turbine producing electricity
Waste Disposal at Kishan Ganj Railway Colony

(Waste Collection at home)
Waste Disposal at Kishan Ganj Railway Colony

(Waste thrown at dump site)
Waste Disposal at Kishan Ganj Railway Colony

(Waste dumped at Landfill)
Waste Disposal at Kishan Ganj Railway Colony
SUSTAINABLE ENERGY

- Use of Renewable Energy in an efficient manner is called Sustainable Energy

- The first generation technology for Renewable Energy were:
  - Hydro-electric Power
  - Geothermal Power
  - Wind Power
SECOND GENERATION RENEWABLE ENERGY TECHNOLOGY

- Solar Heating
- Use of Solar Voltaic collectors
- Solar Thermal Power Plants
- Use of Ethanol as an alternative to petroleum products
THIRD GENERATION RENEWABLE ENERGY TECHNOLOGY

- Advanced Bio gasification, Bio refinery and Solar Thermal Plants with improved efficiency

- Hot dry rock

- Geo Thermal Energy and Ocean Energy

- Research in Cellulosic Ethanol using non-edible plant stamps and leaves and converting them into Ethanol

- Converting municipal solid waste into source of energy

- Research on Nano-Technology in designing solar cells with higher efficiency of conversion of light into electricity
GREEN ENERGY AND GREEN POWER

- Green Energy: Natural Energetic process that can be harnessed with little pollution

- Green Power: Electricity Generated from Renewable Energy Sources
WASTE RECYCLING AND BIO MASS

- Biomass encompassing-Bio-gas, wood gassifier, fuel wood, crop residue, dung (& human excreta) etc.

- Railway is a big source of recyclable waste- paper, plastic

- Railway also a big source of bio mass- human waste in toilets in trains and station, waste food.

- Such waste is increasingly being used to generate power or fuel for use elsewhere

- Serves dual purpose of disposal of waste and renewable energy generation
Thanks