Biofuels – Sustainable Production and Use

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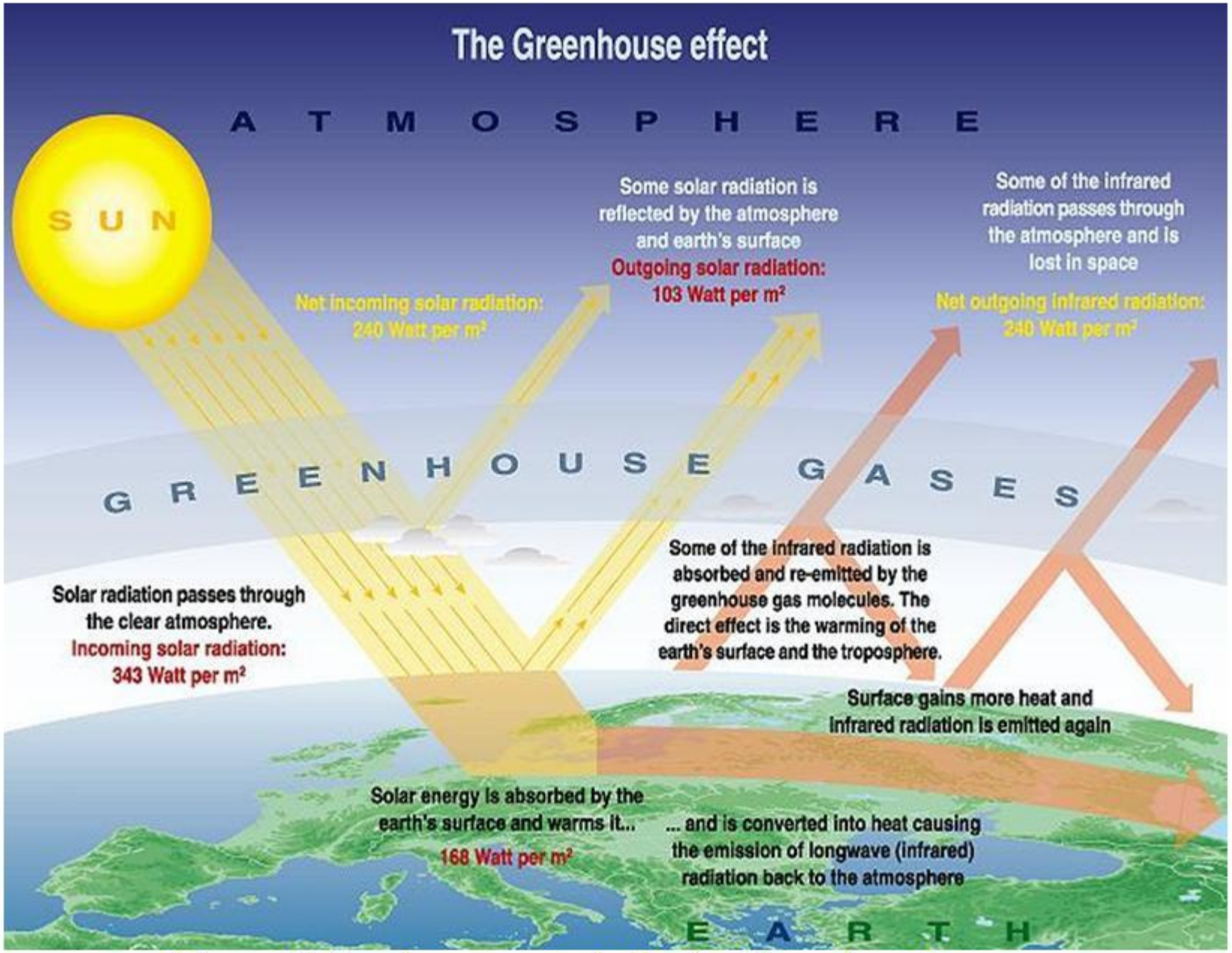
Need for Bioenergy

- Economic growth
- Increasing population
- ***1.6 % p.a. increase in global energy demand between 2006-2030 (IEA 2006)***
- Increasing fossil fuel cost
- Energy security concerns
- Climate change



Fossil fuel use – global climate change

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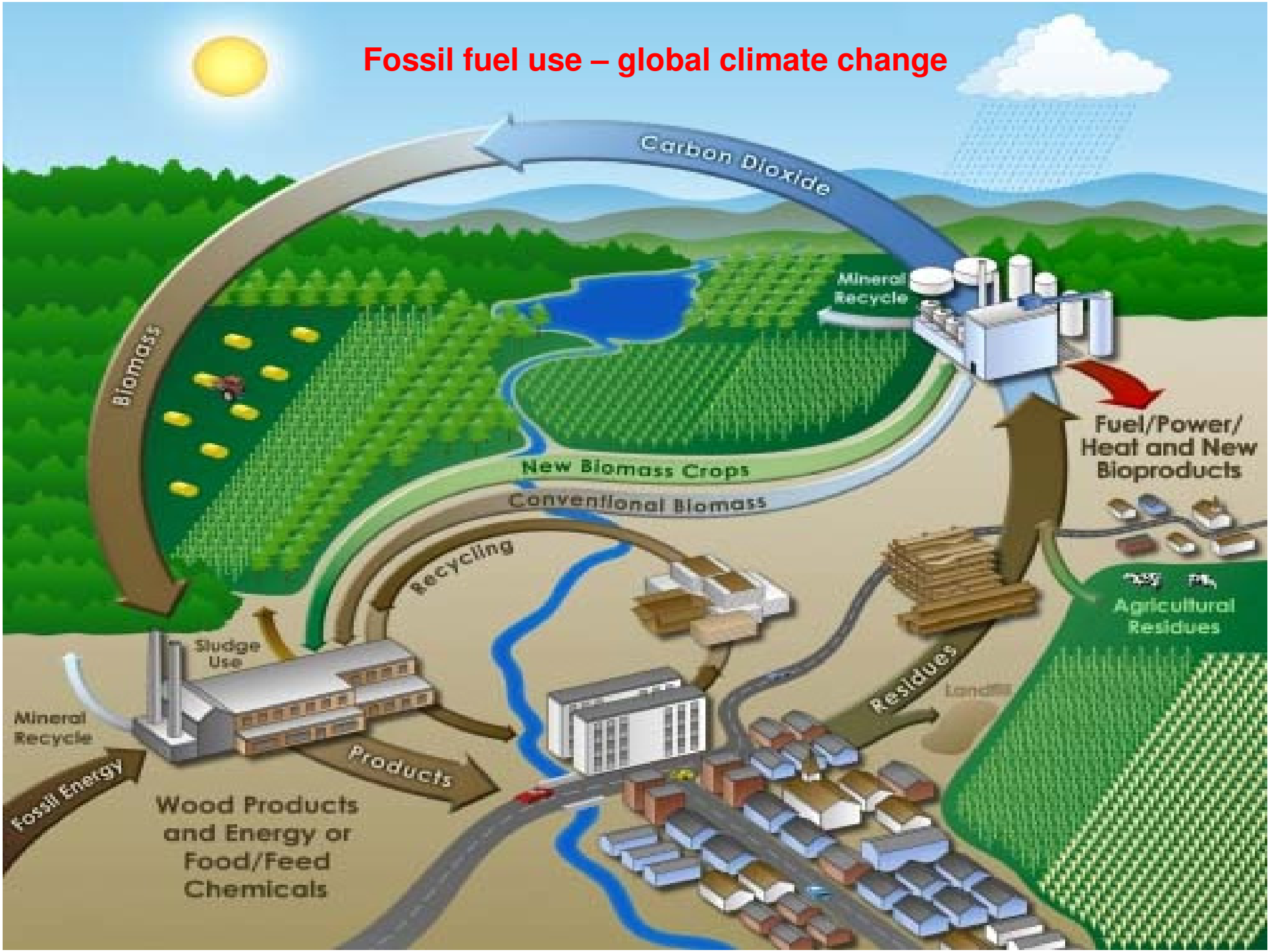
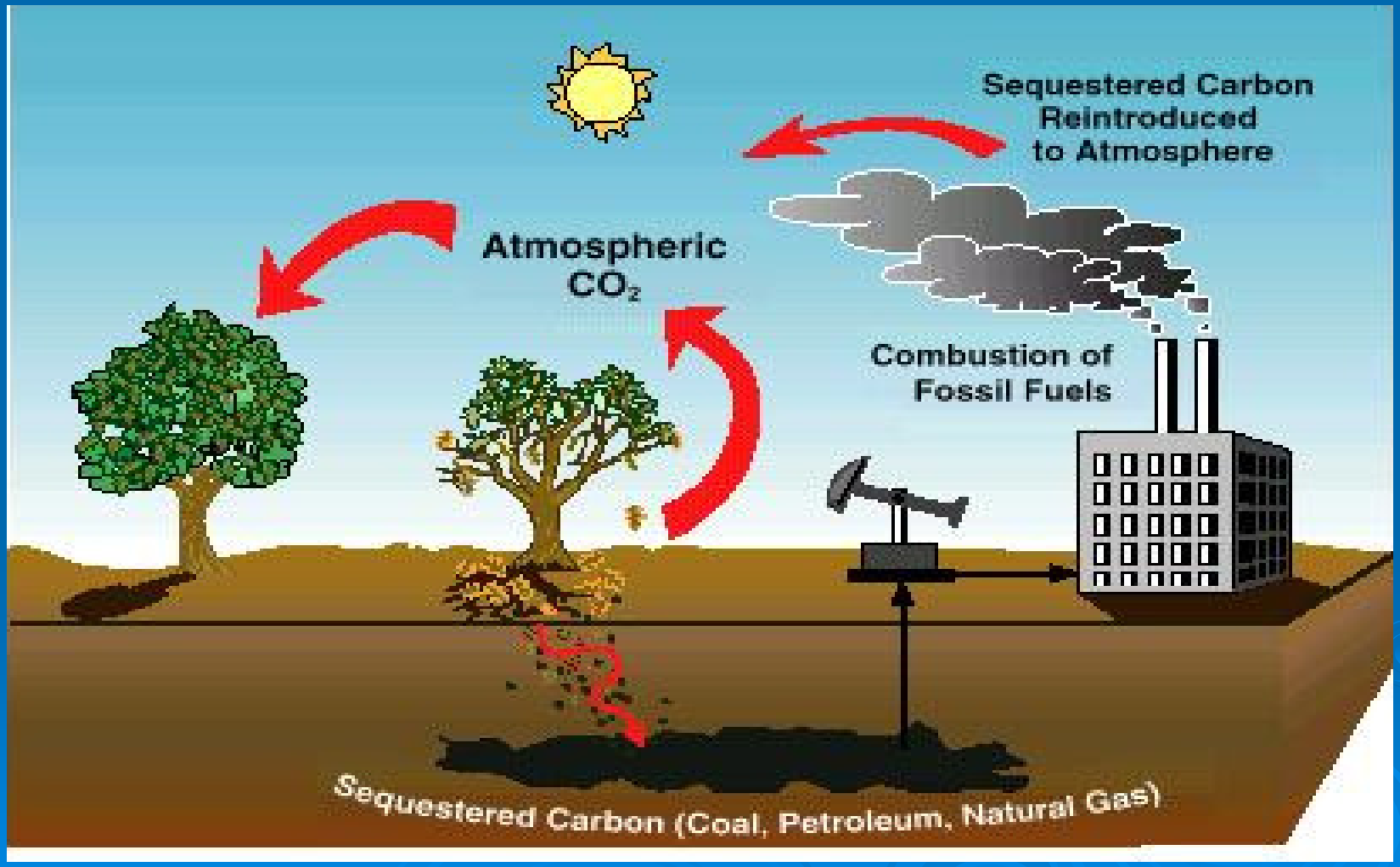


Simplified carbon cycle. Unlike fossil fuels, biomass does not increase atmospheric green house gases when burned



Biomass is produced by photosynthesis

Lipid

$C_{18}H_{30}O_2$ in seed

Protein

BDF(Biodiesel fuel)

ethanol

mineral
Ca,Na,K,Fe,etc.

carbohydrate

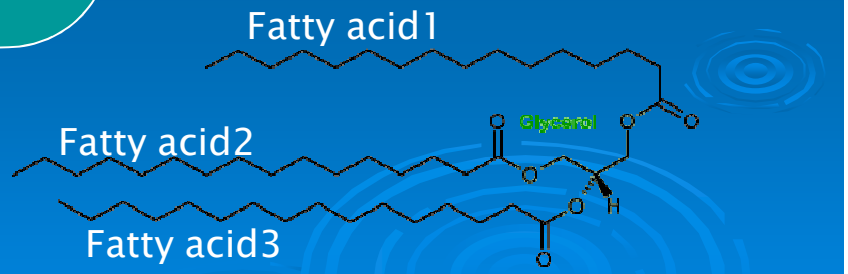
Photo&biosynthesis

Calvin-Benson cycle

$C_6H_{12}O_6$ in Leaf

CO_2

water,fertilizer,mineral



Bioenergy perspective by 2050

- **Bioenergy may satisfy 1/3 of the world's future energy needs → key alternative to fossil fuels**
- **Represents 1-3 trillion US$ market value worldwide**
- **Involves some 10% of the world land surface (*Copernicus Institute for Sustainable Development and Innovation Management)***

Energy from Plants

- Plants contribute-human welfare
- Many useful plants – crop, fruit, vegetables, medicinal, ornamental, etc.
- Energy plants – new group of plants
- Energy crisis – attendant environmental repercussions
- Energy plants relevant to human kind – socio-economically and environmentally
- Basis and applied research

Energy Plants

- Give rise to heat and / or yield solid, liquid or gaseous fuels through conversion process:
  - direct burning
  - gasification
  - digestion
  - fermentation

Photosynthesis

- Source of reliable and renewable form of energy
- Trapping and storing solar energy by green plants
- **Important additional source of energy – relevant to India and developing world**
- Provides life saving oxygen
- Abundant sunlight – 6000 kcal / person / year

Energy Plantations

- Fire / fuel wood plantations
- Agricultural alcohols
- Vegetable oils
- Non-edible oils
- Liquid wax
- Hydrocarbon plants
- Petroleum Plants
- Algal Hydrocarbons

Biomass and Environmental Implications

- Restoring ecological balance
- Improving soil and its water retention capacity
- Replenishing Oxygen and maintaining CO_2 balance in air
- Recycling waste
- Removing potential environmental hazards
- Increase the area under tree cover

Advantages of producing and utilising bio-mass

- A decentralized energy system
- Clean fuel / energy
- Helps to correct eco imbalances
- Helps to recycle CO_2
- Photosynthesis – carbon fixation
- Stores ten times more energy than the world consumes in a year
- Utilise marginal, arid / semi-arid lands

Disadvantages of Biomass

- Removal of the residues from field and forests- lead to depletion of nutrients and lack of humus formation
- Removal of residues - soil erosion
- Collection and transport of residues to the utility sites – reduce energy gains

Research Needs

- Productivity / unit area / unit time to be increased by improving plants and microbes - Biomass production and conversion through induction of genetical and agronomical research and development
- Improvement of photosynthetic efficiency
- Location wise and species wise estimation of the amount of Biomass to be left in the field and in forests
- Development of silvicultural, agronomic and management practices for maximising the biomass production
- Genetic up gradation of energy plants and microbes
- Demonstration and awareness programmes

Biofuel

- Biofuel – Fuel from naturally growing plants.
- Biodesiel – obtained from non-edible oil seeds.
- India - 150 oil yielding plant species.
- Most popular species – Pongamia, Neem, Jatropha, Hippe and Simarouba.
- Bioethonal – obtained from sugarcane, sugarbeet, sweet corn, sorghum etc.

Biofuel – Economic Growth

- Savings in foreign exchange.
- Fuel self dependency.
- Rural Development.
- Employment Generation in Village Level.

Biofuel Classification

First Generation (from sugars, grains, or seeds)

- **Biodiesel**
  - **rapeseed, soybeans, sunflowers, jatropha, coconut, palm, recycled cooking oil**
- **Ethanol**
  - **From grains or seeds: corn, wheat, potato**
  - **From sugar crops: sugar beets, sugarcane**

Second Generation (from lignocellulose: crop residues, grasses, woody crops)

- **Biological fuels**
  - **Ethanol via enzymatic hydrolysis**
- **Thermochemical fuels (most made via "gasification")**
  - **Fischer-Tropsch liquids (FTL)**
  - **Methanol, MTBE, gasoline**
  - **Dimethyl ether (DME)**
  - **Mixed alcohols**
  - **Green diesel**

THE NATIONAL POLICY ON BIO-FUEL

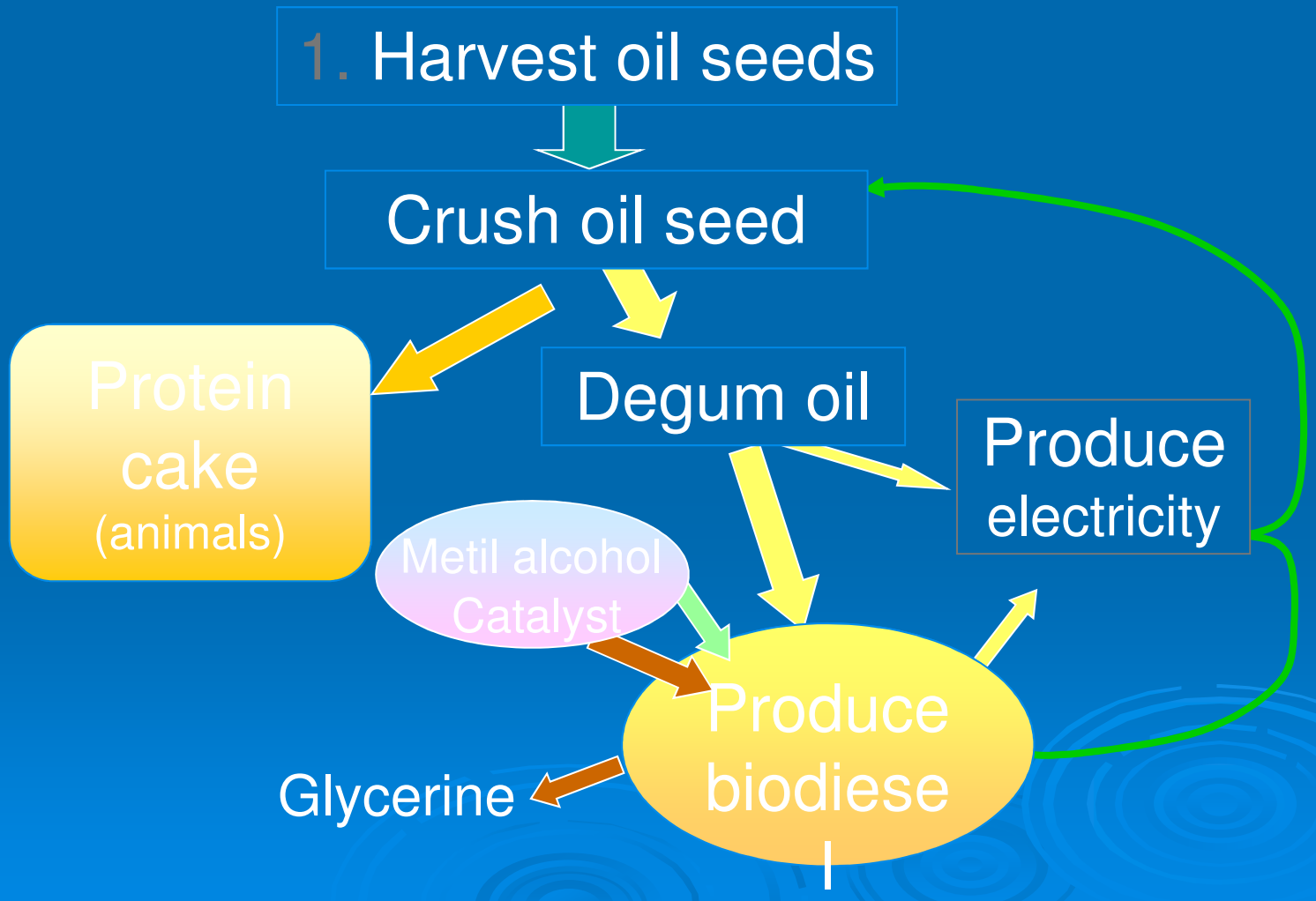
Salient features:

- ***Indicative target of 20% by 2017 for the blending of Biofuels – bio-ethanol and bio-diesel***
- ***Bio-diesel production from non-edible oil seeds in waste / degraded / marginal lands.***
- ***Bio-diesel plantations on community / Government / forest waste lands would be encouraged while plantation in fertile irrigated lands would not be encouraged.***
- ***Indigenous production of bio-diesel feedstock and no permission for the import of Free Fatty Acid (FFA) based such as oil, palm etc.***

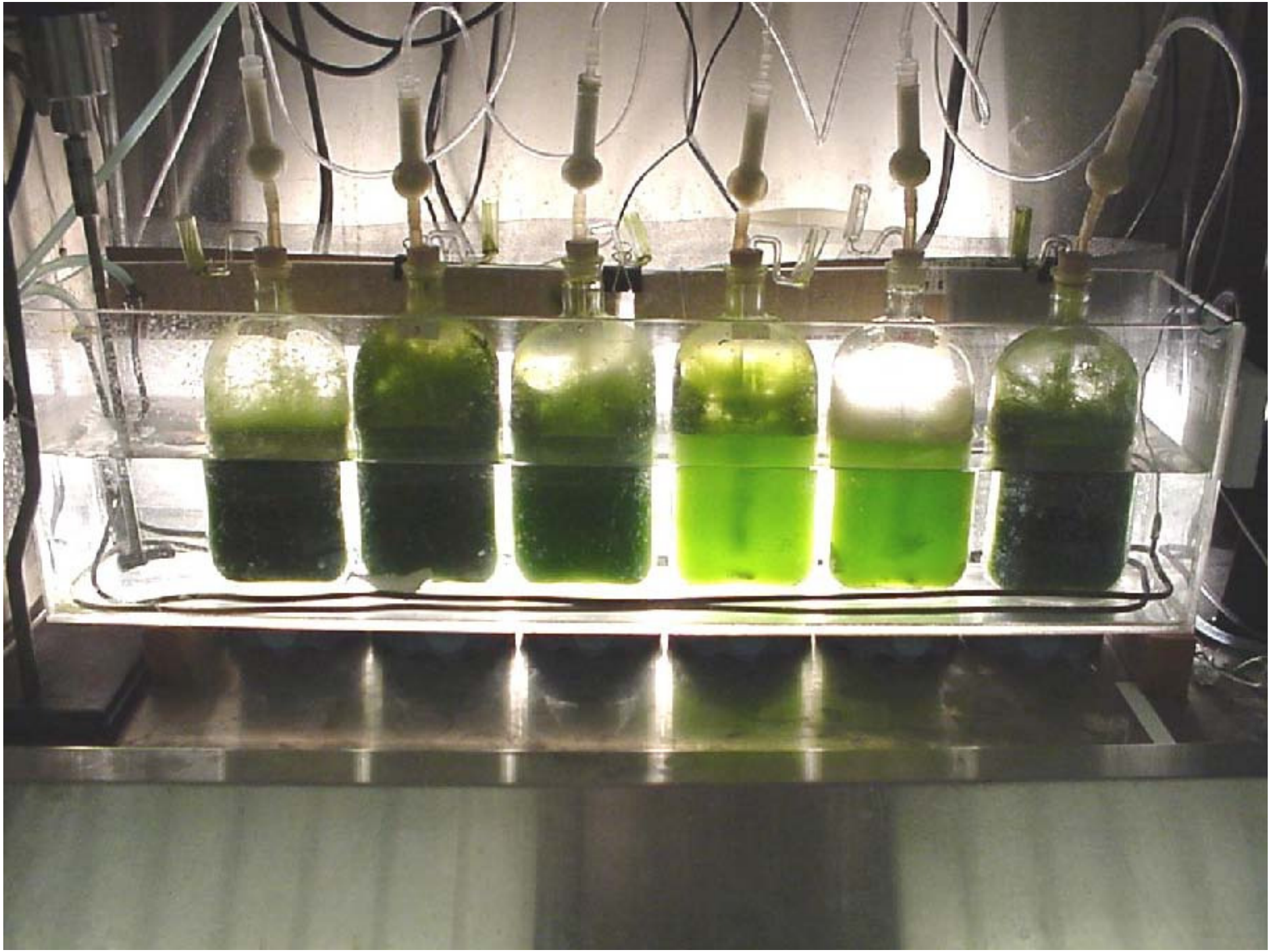
Contd……..

- ***Minimum Purchase Price (MPP) for the purchase of bio-ethanol by the Oil Marketing Companies (OMCs) would be based on the actual cost of production and import price of bio-ethanol. In case of bio-diesel, the MPP should be linked to the prevailing retail diesel price.***
- ***Bio-fuels, namely, bio-diesel and bio-ethanol may be brought under the ambit of "Declared Goods" by the Government to ensure unrestricted movement of bio-fuels within and outside the States.***
- ***No taxes and duties on bio-diesel.***

Environmental Industry
Green liver concept- Green chemistry

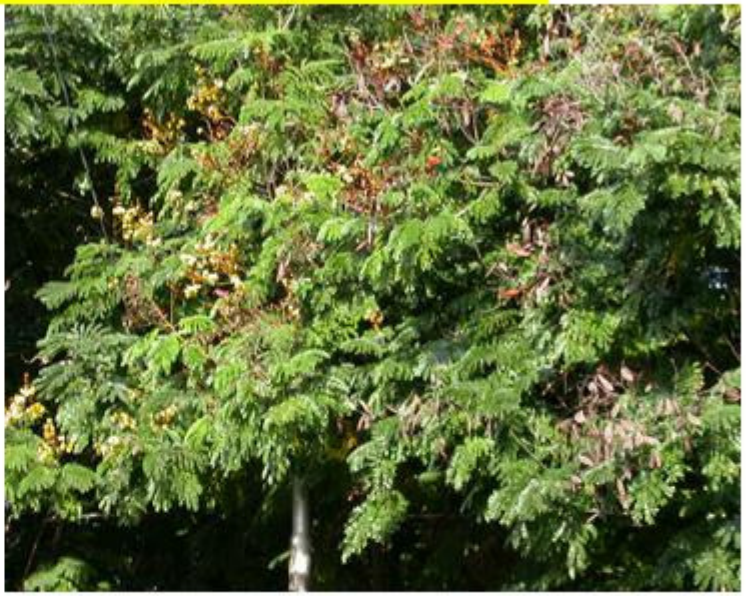


BIOFUEL



SIMAROUBA

Peltophorum ptercarpum (Copper pod tree)



Calophyllum inophyllum

Shatabdi Express Trial Large scale utilisation of biodiesel as a traction fuel for Indian Railways

- **Indian Railways tried a 5% blend of bio diesel on a WDM2C locomotive to haul the prestigious Shatabdi express (2013) from New Delhi to Amritsar on 31st Dec, 2002.**
- **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.**

Biodiesel : Key Advantages

Renewable - vegetable oil derived

Carbon Neutral : 78% life cycle decrease in CO_2

Non-toxic

Less noxious - fuel & exhaust emissions

Biodegradable

Dramatically reduced emissions

Mainstream Alternative

Simple to make

Used directly in unmodified diesel engines

Used neat or blended in any ratio with petroleum diesel

Higher Lubricity - can prolong engine life

High flashpoint - safer to store & transport

Research & Development

- Plantation methods
  - Generative Propagation
  - Vegetative Propagation
  - Drip Irrigation
- High yield plants – 160 types of Genus Jatropha
- Heterogeneous transesterification, 2nd generation conversion methods

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