



Biofuels: Demand

for

Ethanol and Biodiesel

Example: India

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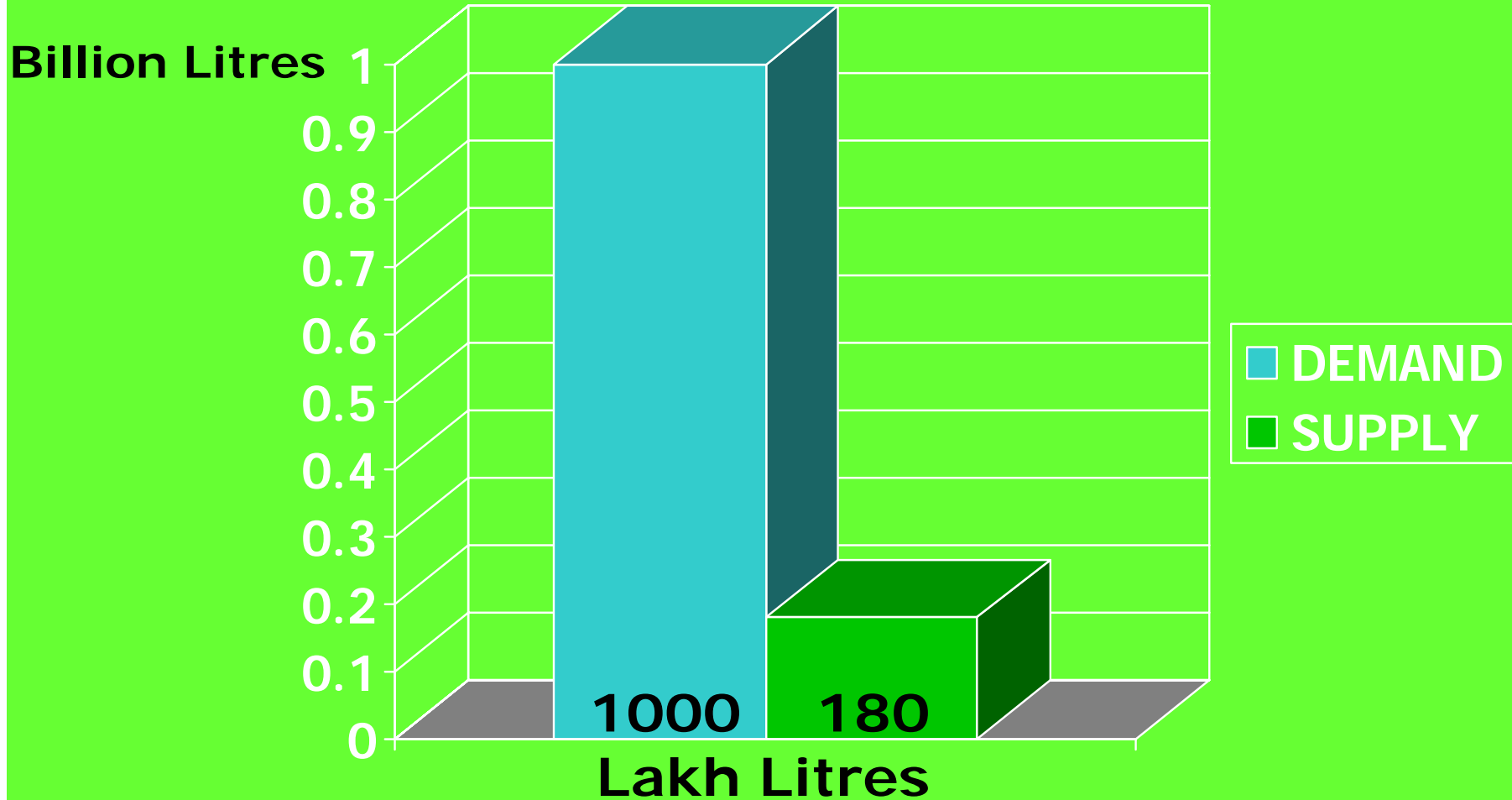
Biofuel Sources

- **Ethanol**
 - molasses, beet, sweet sorghum, sugarcane
 - cellulosic (wood, grass, biomass residue)

- **Vegetable oils (non-edible)**
 - *Jatropha curcas*
 - *Karanja*



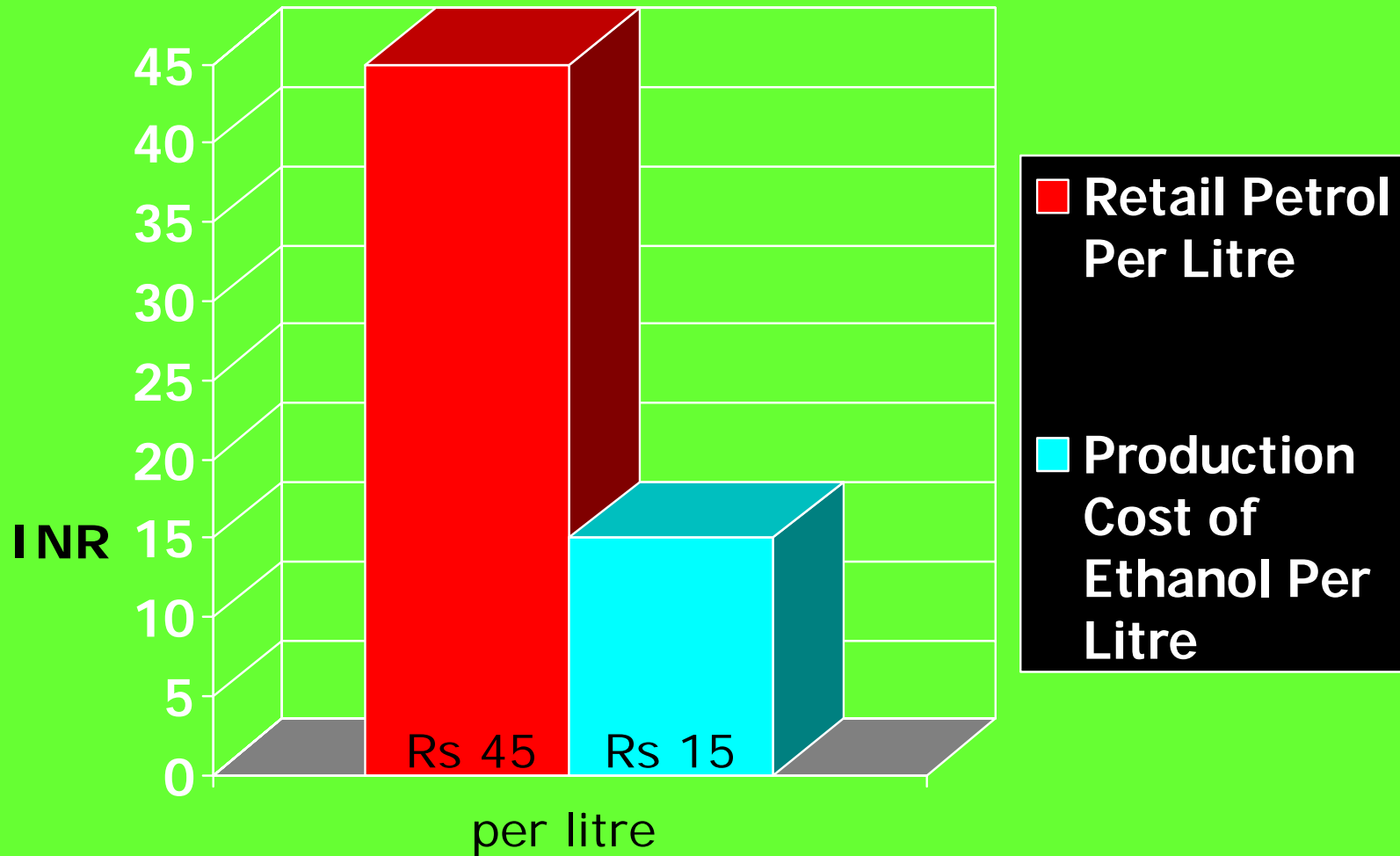
Ethanol Demand vs Supply



Data per Government of India. According to the US Department of Commerce, the current demand for ethanol in India is 3.6 billion litres or 3,600 lakh litres.



Price of Petrol vs Cost of Ethanol





Biofuels: Bridge to Hydrogen Economy

Number of automobiles 2005 (60% 2-wheelers)	> 60 million
New vehicles registered (50% 2-wheelers)	~ 10,000 per day
Actual Petrol consumed by automobiles	10 billion litres per annum
Total Petroleum consumption in 2006	> 130 million tons of crude
Diesel consumption	40 million tons
Imported petroleum	80%
2035: Fuel consumption by on-road automobiles *	60 billion litres
2035: Demand for Ethanol @ 10% (90EBG)	6 billion litres
Biomass residue (cellulose from crops & plantations)	> 500 million tons per year
Potential for Cellulosic Ethanol (200 litres per ton)	> 200 billion litres per year
Potential for power generation from biomass	> 50000 MegaWatts per year

* Projected by the Asian Development Bank



Ethanol Use in India

- **IOC R&D undertaken detailed studies using ethanol blended gasoline (EBG) including 5% (95EGB) and 10% (90EBG) for commercial use.**
- **Ethanol blended gasoline mandatory in many states and 90EBG approved on 1 October 2003**
- **Adequate supply of ethanol is not available**
- **Cellulosic ethanol preferred over grain ethanol**



Ethanol Use in Brazil

- **360 million tons sugarcane from 5 million hectares producing 500,000 jobs on plantations and 500,000 jobs in production**
- **25,000 petrol pumps dispensing Gasoline, EBG and Ethanol (Alcool)**
- **VW and GM flex-fuel vehicles (FFV) can run on any fuel or any blended fuel (mixtures)**
- **Brazil-India cooperation MOU signed in 2001**



Biodiesel

- Renewable, non-toxic, biodegradable, non-edible vegetable oil
- Lower emissions compared to diesel (zero sulphur, 78% reduction of CO₂ and 50% reduction of CO)
- Better fuel properties (cetane number, lubricity, flash point)
- Daimler Chrysler India successfully tested cars running on 100% biofuel extracted from *Jatropha curcas*
- 11 million hectares of wasteland suitable for *Jatropha* cultivation
- 126,000 hectares adjacent to railway tracks owned by Indian Rail

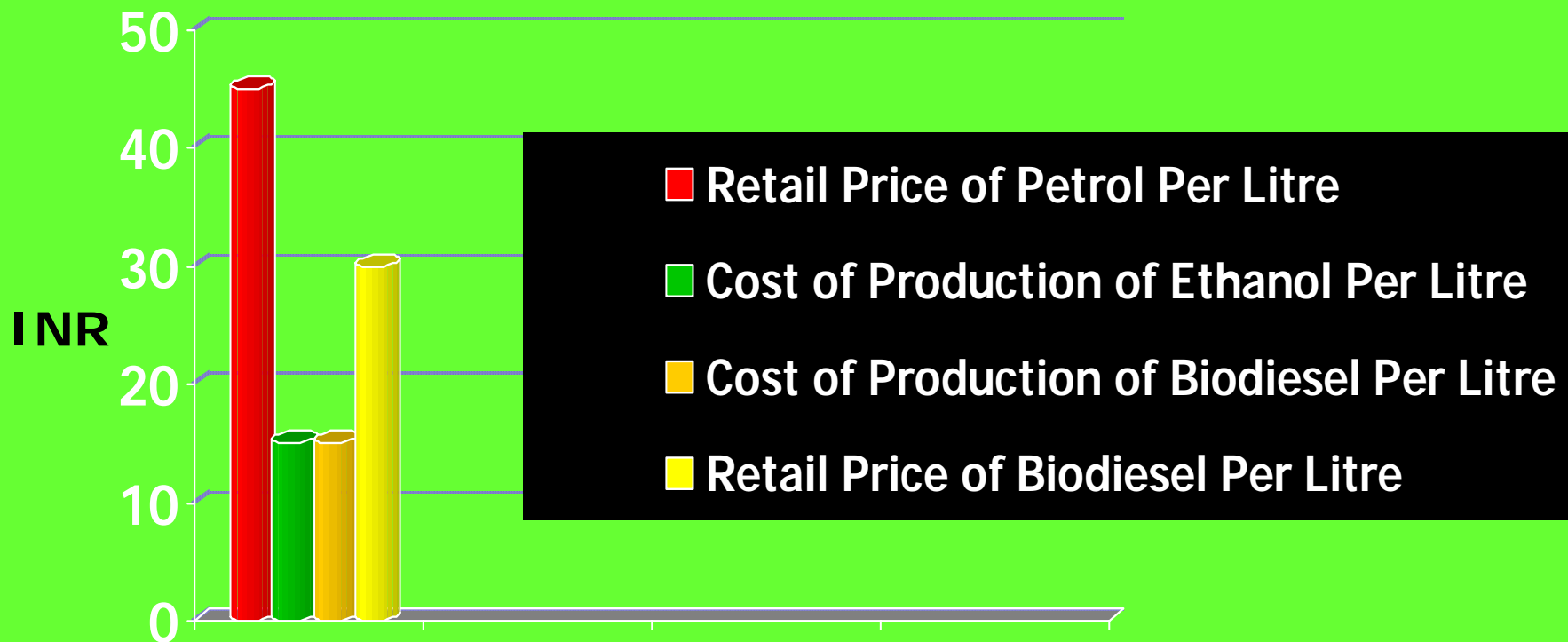


Price of Petrol vs Cost of Biofuels





Rs 30/L Biodiesel: Profit/Hectare ~ Rs 25,000





Biodiesel: Profit & Jobs

Lifecycle of plant	50 years
Oil content of seed	35%
Oil yield / kg of seed	250 ml
Plants / hectare	2,500
Job creation / hectare	0.25 FTE
Cost of maintenance / hectare / year	INR 20,000
Seed yield / hectare / year	7 tons
Oil yield / hectare / year	1750 litres
Cost of oil production / litre	INR 15
Cost of oil transport to Europe / litre	INR 5
Cost of oil production / hectare	INR 26,250
Pressed seedcake / hectare	4.5 tons
Selling price of seedcake / ton	INR 4,000
Cost of oil production & maintenance / hectare	INR 46,250
Sales of oil @ INR 30/L and seedcake / hectare	INR 70,500
Gross earnings from biodiesel / hectare	INR 24,250
Area adjacent to railway tracks (hectare)	126,000
Earnings from biodiesel from 126,000 hectares	INR 30 CRORES
New job creation from use of 126,000 hectares	30,000
Wasteland	10 million hectares
Earnings from biodiesel per million hectare	INR 2,425 CRORES
New job creation per million hectare	250,000
Potential for new job creation from Wasteland	25 LAKHS **

** 1 LAKH = 100,000



IOC, Indian Railways, Tata & Other Initiatives

- Trans-esterification, process optimization and commercialization
- Testing of locomotive engines with biodiesel (B100) and blends
- Vehicle performance and emission studies (Escorts, Tata, M&M)
- Field trials with buses in Gujarat
- Jatropha plantation on 70 hectares adjacent to rail tracks
- Studies on 16 cylinder engine (3100 hp) with B5, B10 and B20
- Shatabdi & Jan Shatabadi Train trial runs
- Trains through Lucknow using bio-diesel (B10) from June 2006
- Evaluation of B20 for 4 passenger cars and 2 commercial vehicles
- Tata Motors employee buses using B10 in Pune
- Haryana Roadways converts entire (Gurgaon) bus depot to use B5

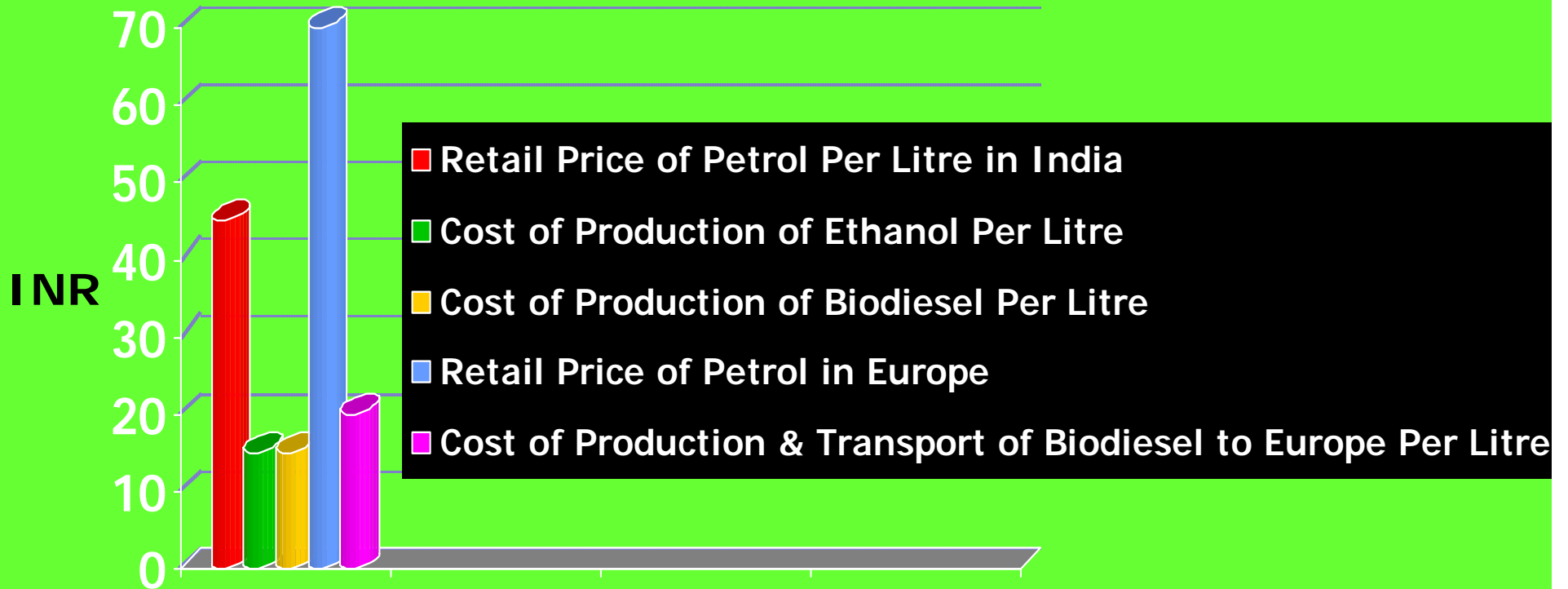


Biodiesel Purchase Policy (9 October 2005)

- **Biodiesel policy involves PRIs for Jatropha plantations and oil extractions by establishing Rural Business Hubs**
- **OMC purchase price INR 25 per litre.**
- **Assistance for Jatropha plantation and oil extraction.**
- **IOC R&D to increase biodiesel content from 5% to 20%**



Profit from Export of Biodiesel



**February 2006:
BP invests \$9.4 million in India for Jatropha biodiesel.**



China: Biofuel Boom

- **13 million hectares for Jatropha plantation**
- **200,000 tons of biodiesel by 2010**
- **1 billion litres of Ethanol produced in 2006**
- **Production cost for cellulosic ethanol \$0.25 / L**



Biofuels in India: Potentially Profitable

- Significant profit from ethanol and biodiesel
- Export potential for higher profitability
- Ethanol-resistant yeast to improve yield
- Enzyme-catalysis for cellulosic ethanol
- Creates new jobs even in wastelands
- Implementable with minimal time
- Foreigners ready to grab market

Strengths

Increasing Demand
 ROI 15% of Capital
 INR 20000 / ton capacity
 Robust supply chain
 Distribution Channels
 Job creation in wasteland
 No new carbon addition

Opportunities

Decrease fossil fuel use
 Reduce carbon emissions
 Oil crisis mitigation
 Government regulation
 European distribution
 Worldwide awareness

Weaknesses

Does not eliminate carbon emissions completely
 In the very long run may be more expensive than hydrogen via electrolysis
 Existing engine conversion

Threats

US / EU investors
 Slow pace of bureaucracy
 MNCs land lease venture
 Failure to use new tools
 Lethargic approach
 Paralysis from analysis