# Biofuels in the Brazilian Scenario

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**(GE-CORP/PAE/PE)**

BIOEN WORKSHOP ON
PROCESS ENGINEERING

São Paulo
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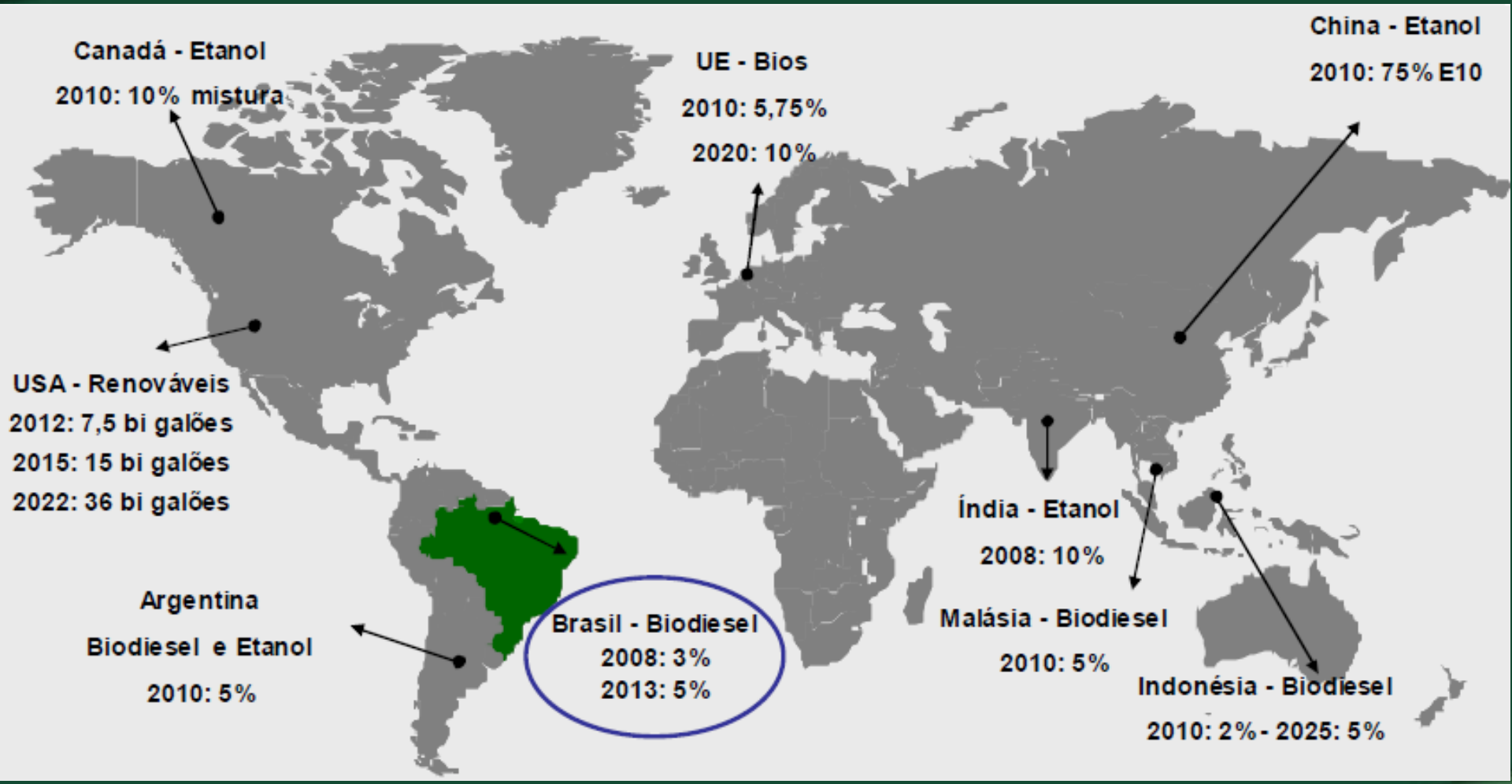
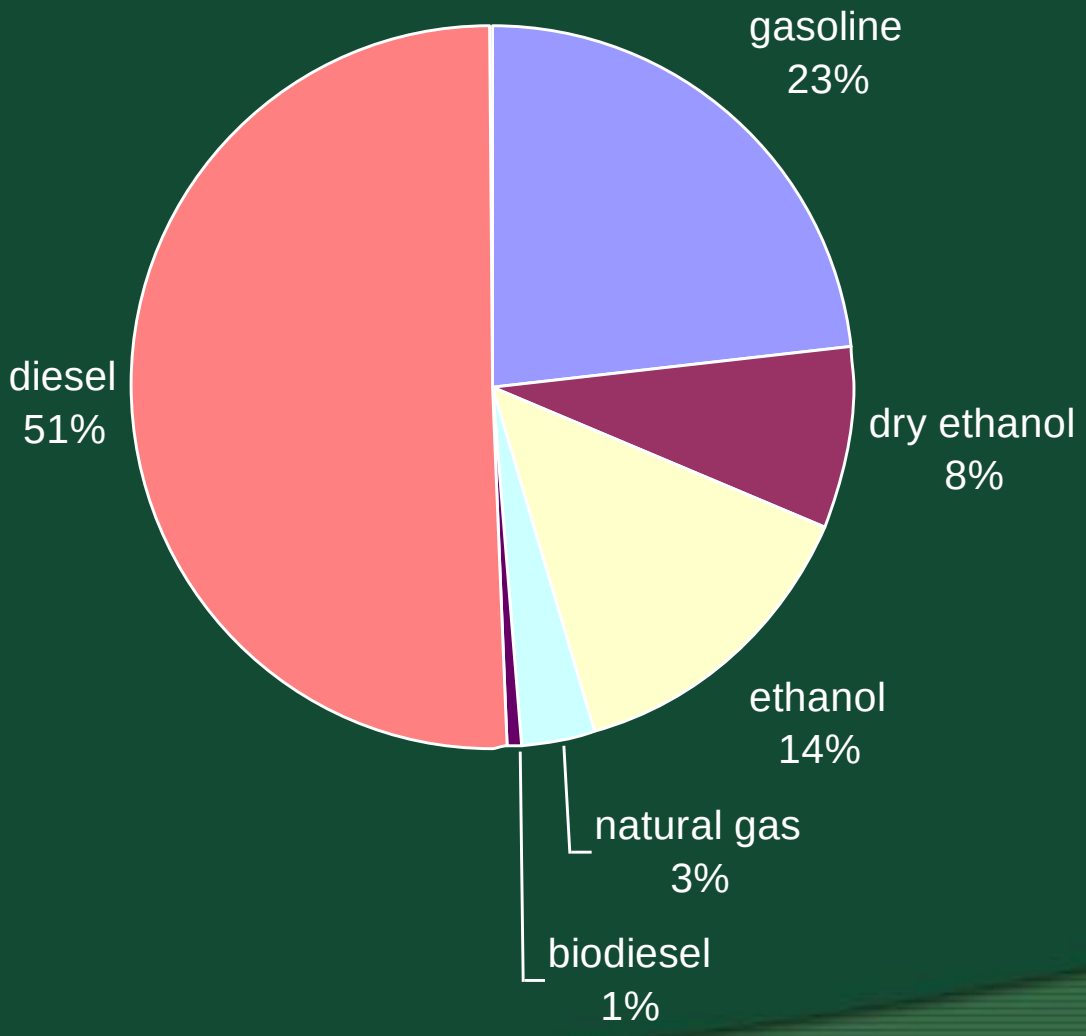
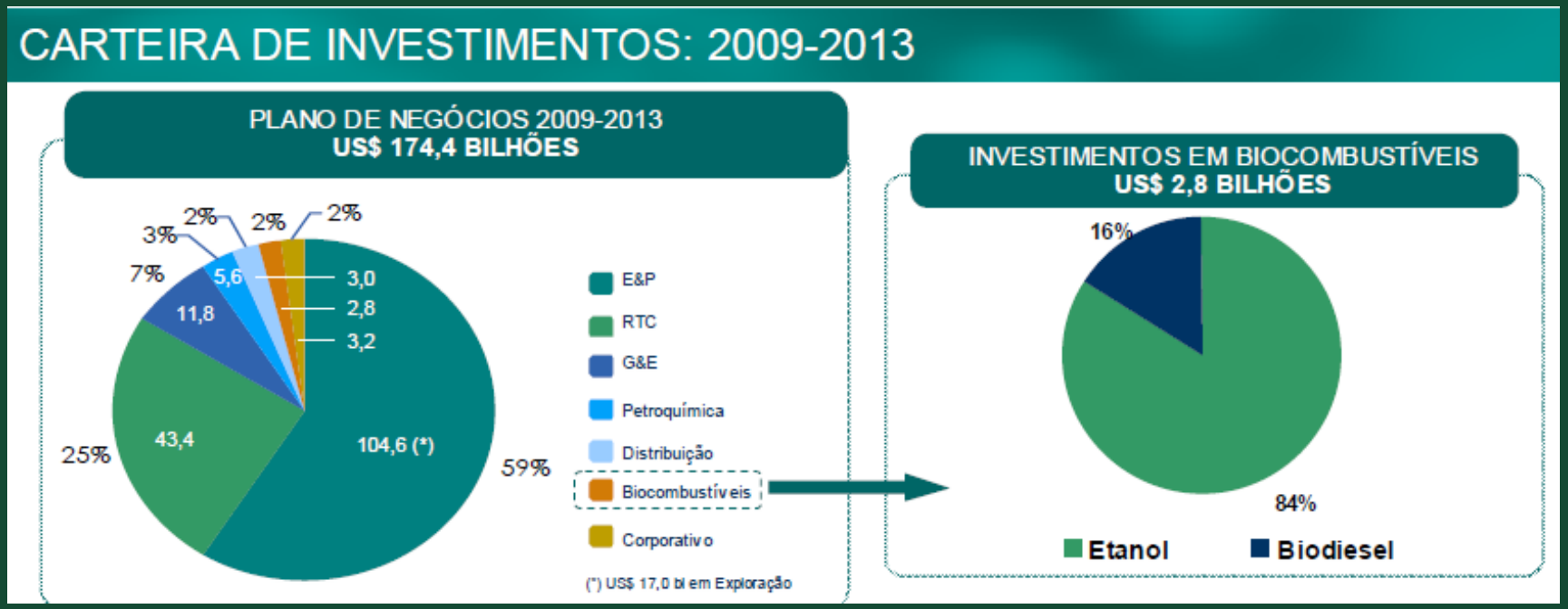
# World biofuels demand




WoodMackenzie, 2007
The Economic Times, 2008

# Fuels for transport in Brazil (2008)



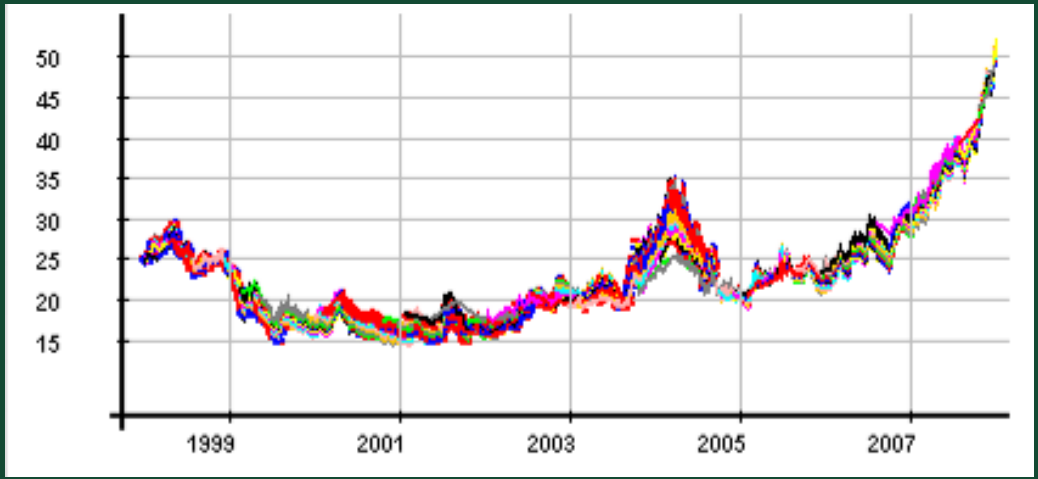



- Act globally in the biofuels segment, developing biodiesel and ethanol businesses
- Petrobras Biofuels (PBIO) created july 2008

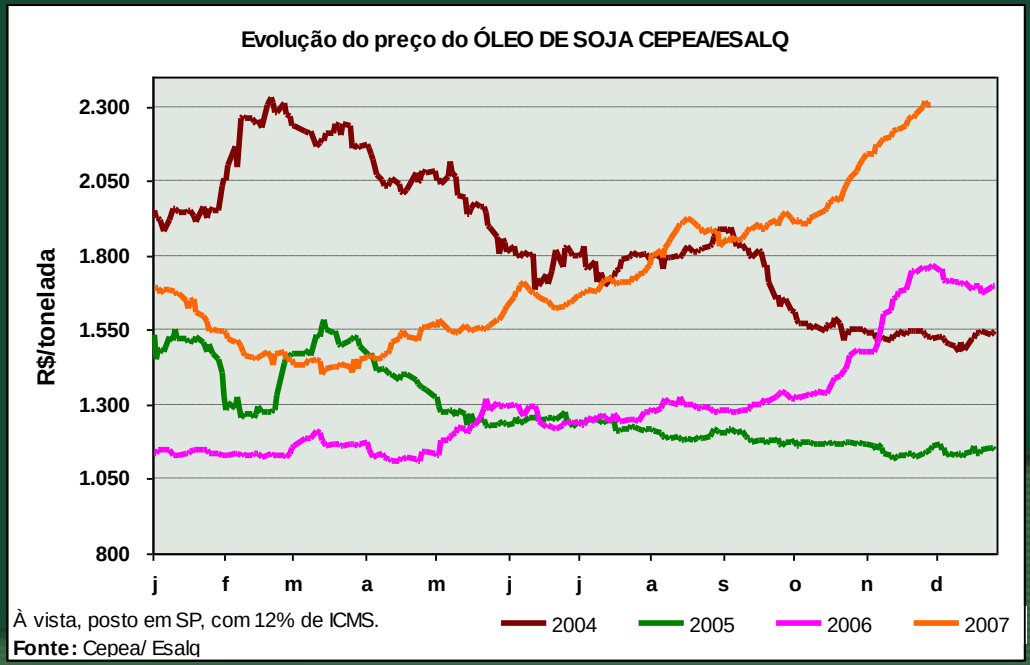
- Law 11.097/05
  - 2008 B2
  - 2013 B5
- PBIO current capacity
  - 3 industrial facilities
  - 170.000 $m^3$ per year
- CSA projects
  - familial agriculture
- R&D activities
  - facilities in Guamaré (RN) and Cenpes (RJ)
  - HBio, H100, homogeneous catalysis, heterogeneous catalysis, FCC of vegetable oils, etc

CBOT Futures (soy oil)

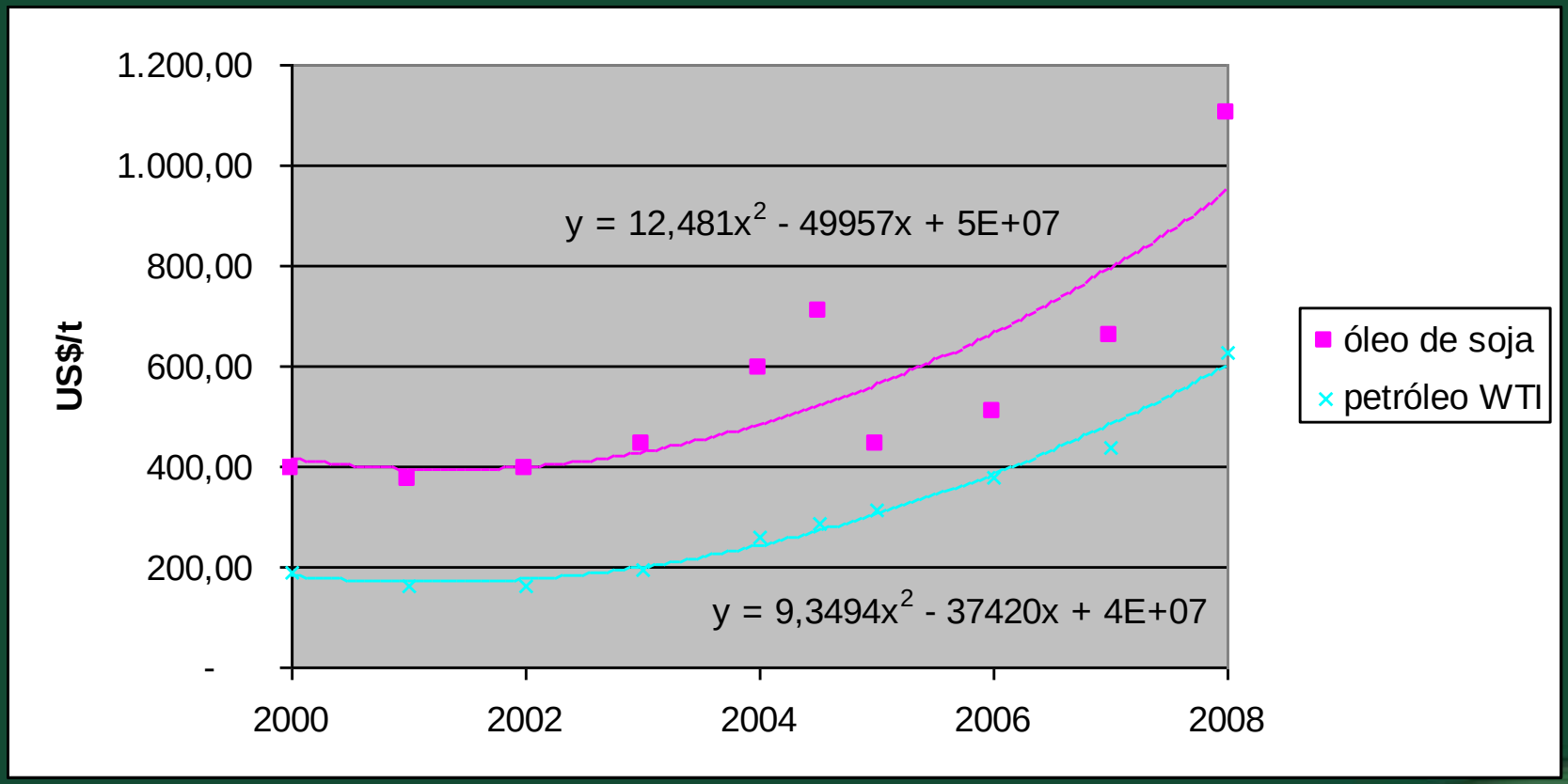
¢/lb



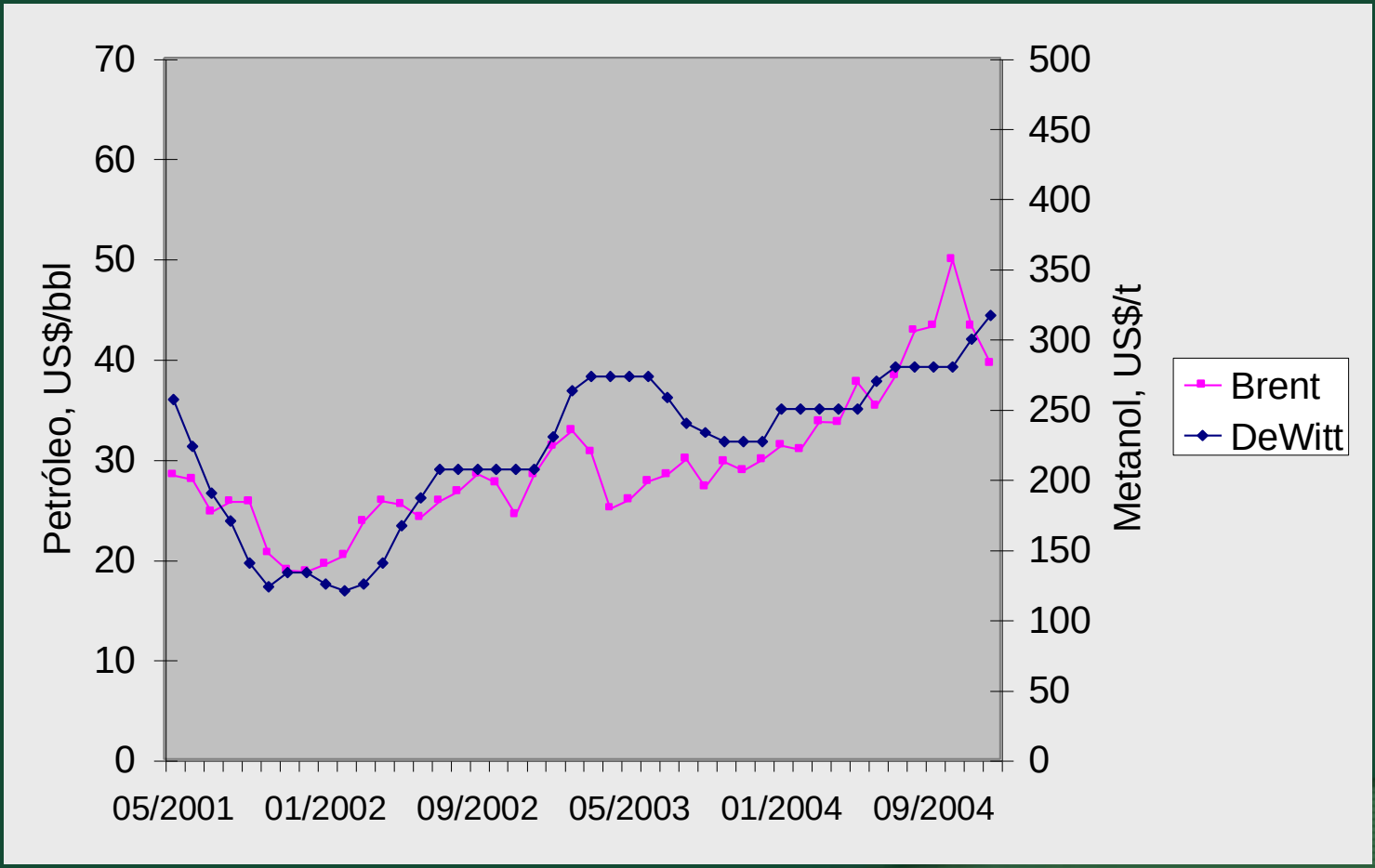

CEPEA/ESALQ (soy oil)



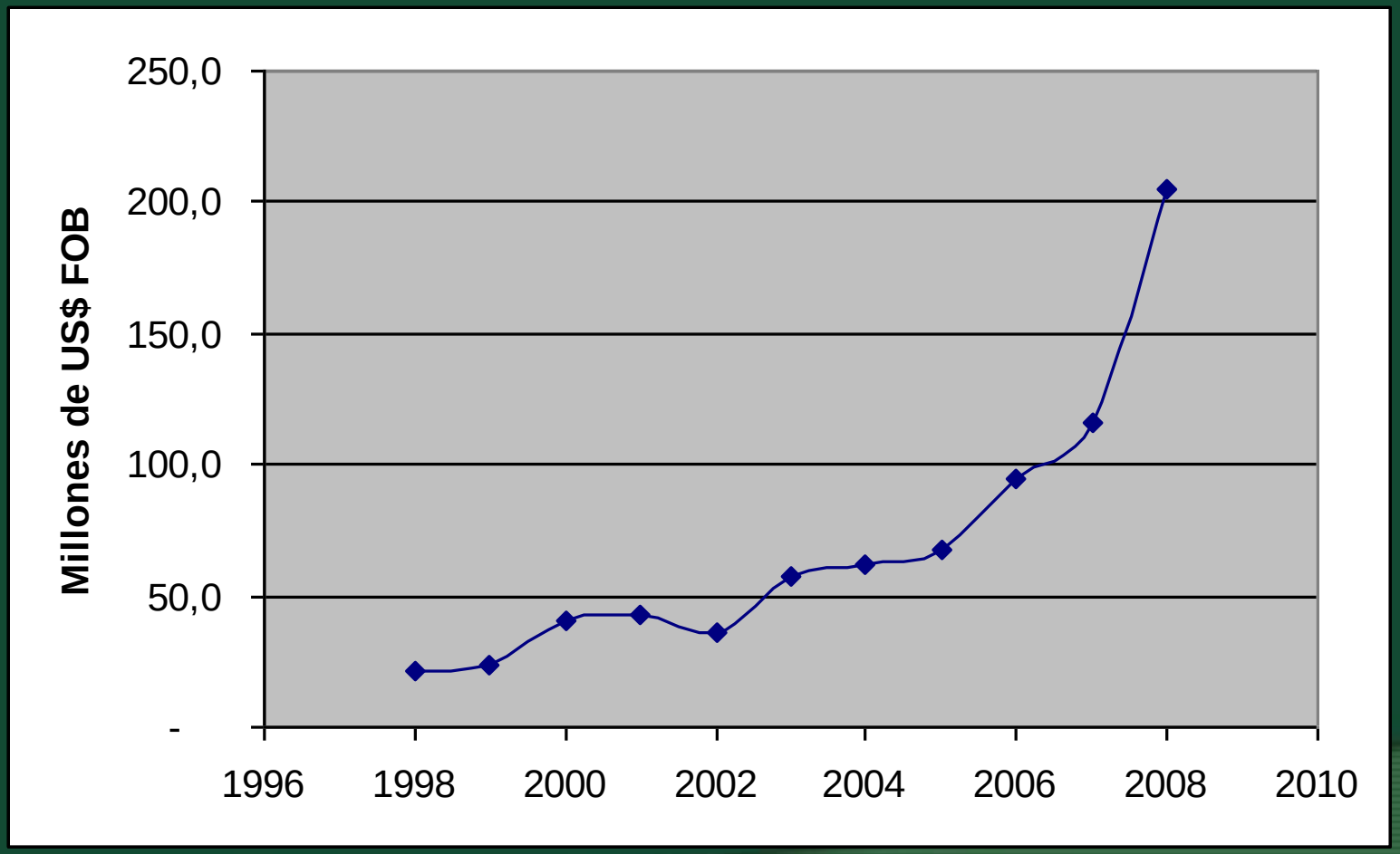
# Soy oil CBOT vs. WTI



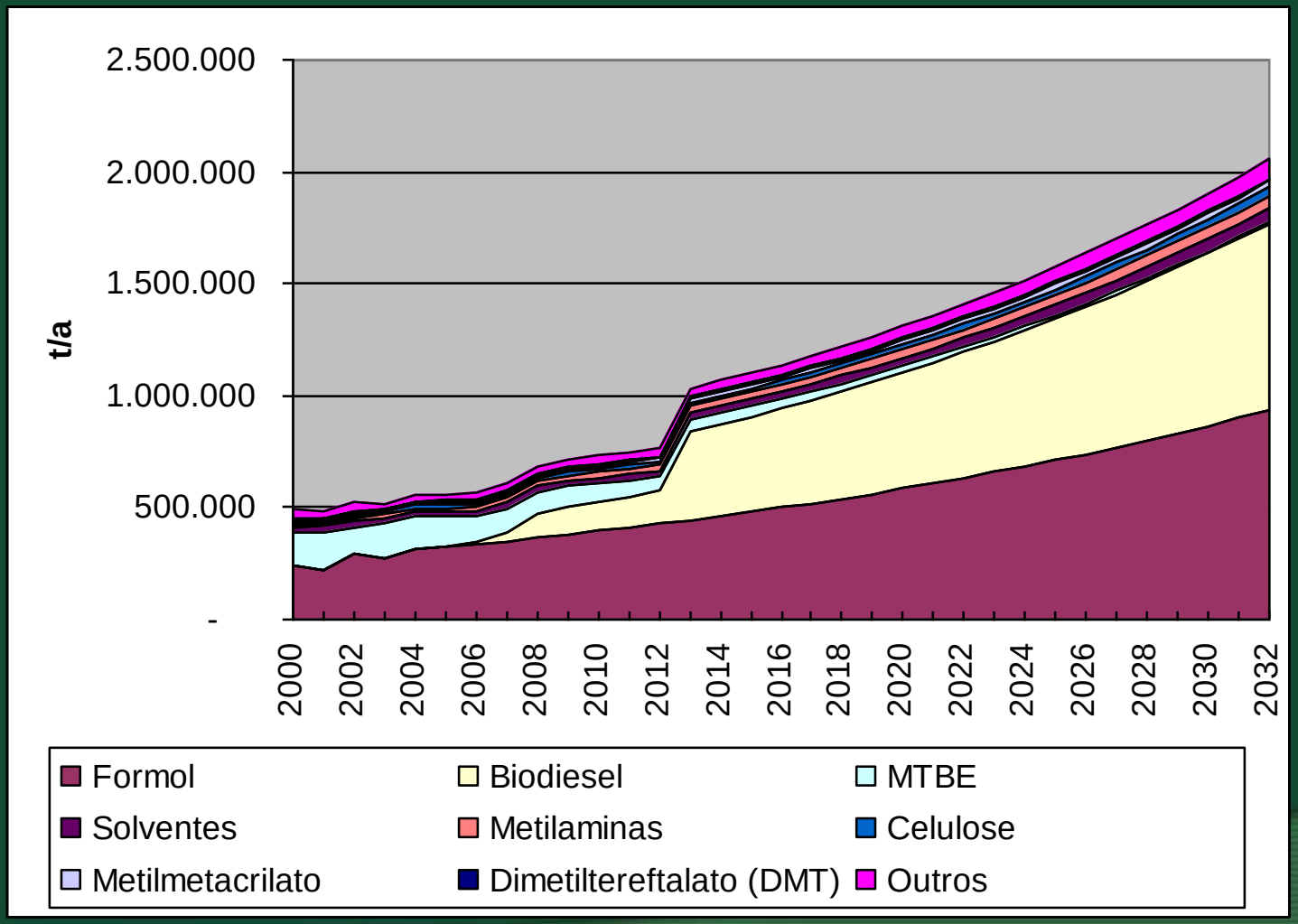
# Methanol vs. Brent



# Methanol imports



# Methanol market

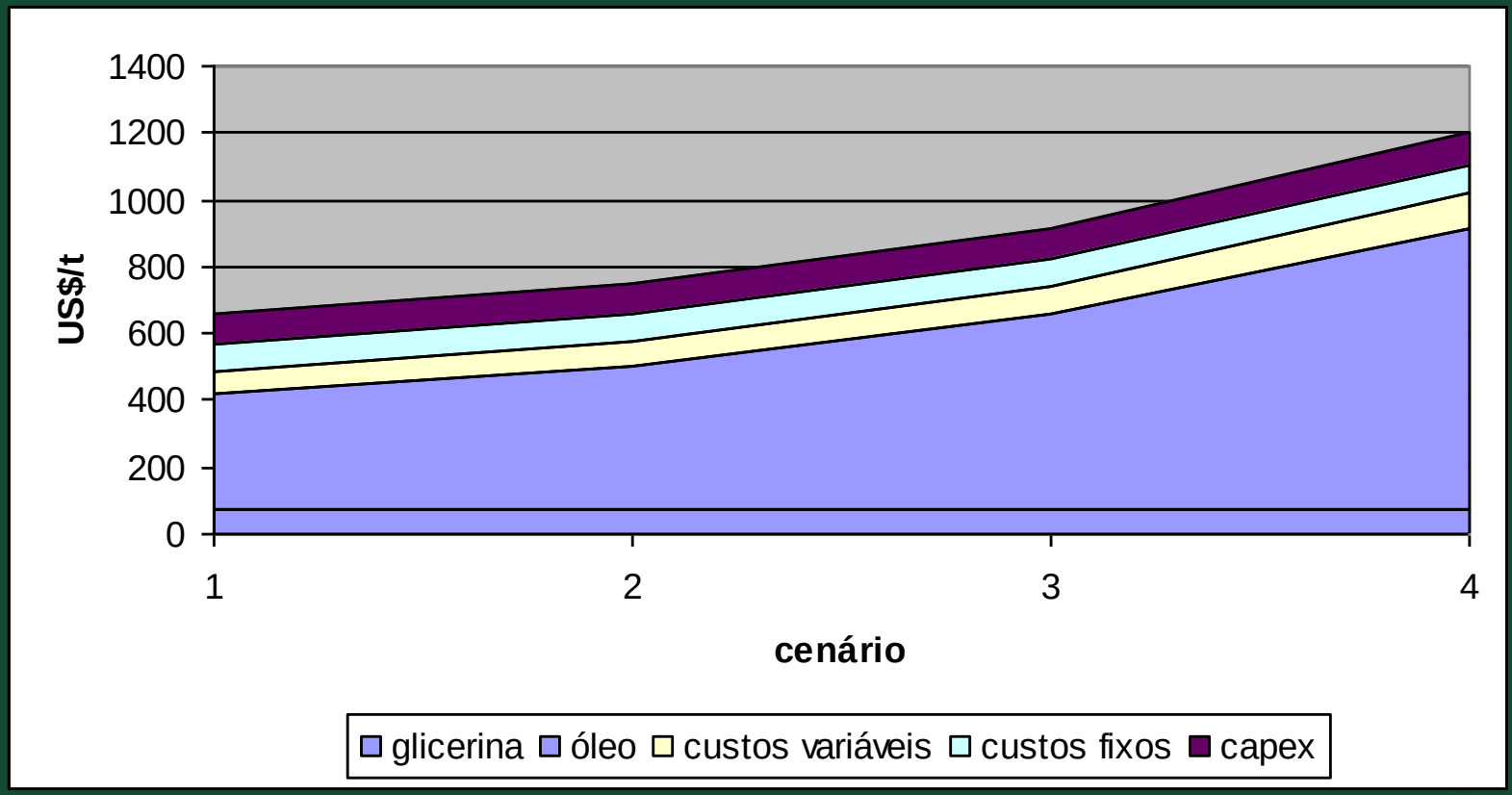


# Scenarios

| Cenário | WTI (US$/bbl) | Metanol (US$/t) | Óleo de soja (US$/t) |
|---|---|---|---|
| 1 | 40 | 260 | 480 |
| 2 | 55 | 340 | 550 |
| 3 | 70 | 420 | 700 |
| 4 | 100 | 600 | 950 |

- Heterogenous catalysis
  - accepts “difficult” feedstocks (acidic oils, animal fat)
  - environmental advantages
  - no washes, neutralizations, batches, residue administration, etc
  - high quality glycerin
  - no salt or soap as by-products

# Production cost breakdown



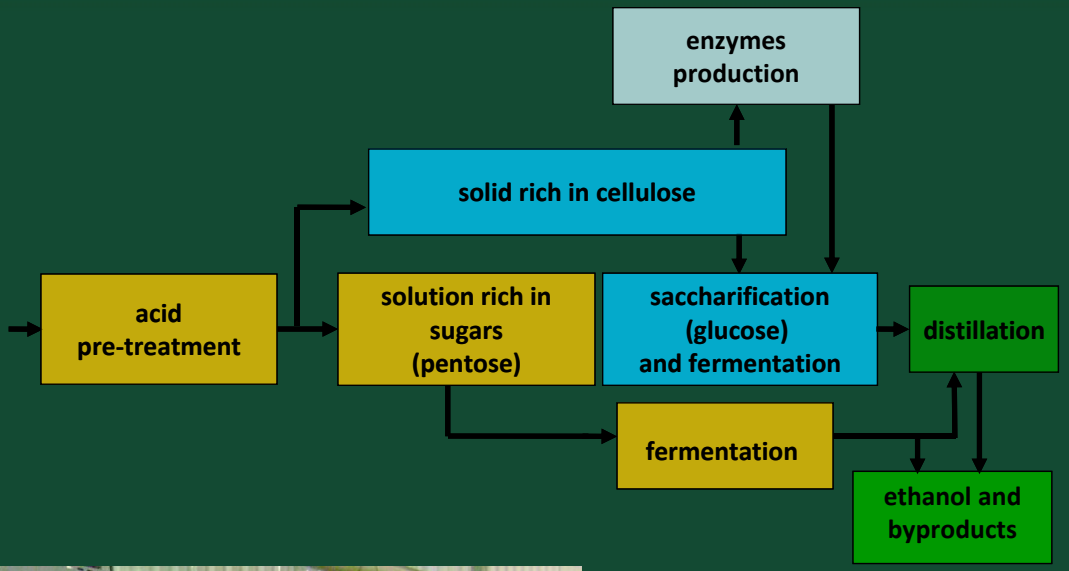


WoodMackenzie, 2007

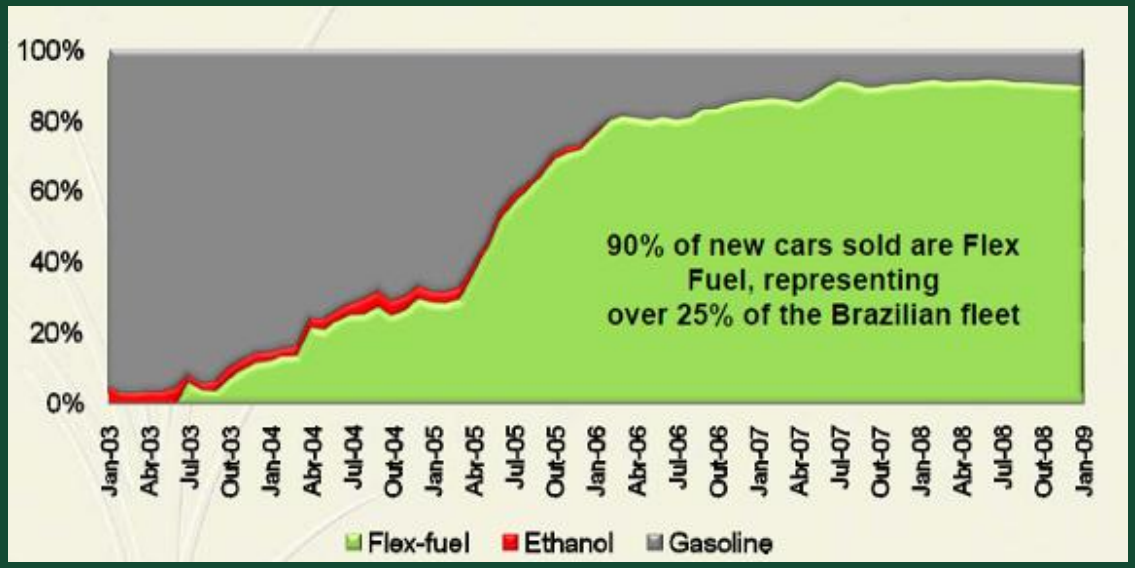
- Build participation in the national production chain
- Develop international markets
- Secure the development of competitive technologies for the production of ethanol, especially from residual biomass
  - Acquisition of shares
  - New facilities
  - International initiatives
    - Japan
    - Colombia
    - Others

# Bioethanol

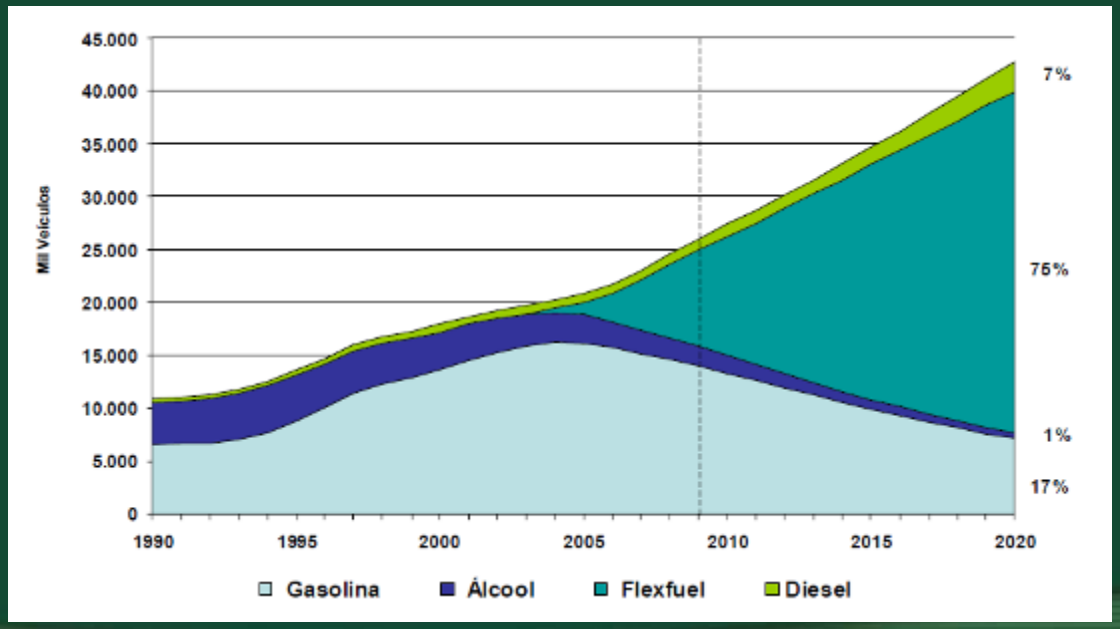
- Sugar cane bagasse
  - Pilot plant 2008
  - 2 patents filled
  - Basic engineering
  - Demonstration plant




- Flexfuel cars
  - consumers
  - manufacturers
  - efficiency



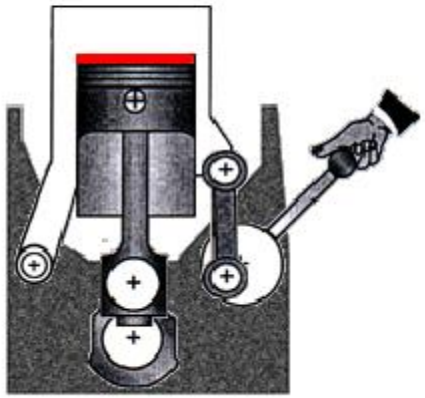

(Jank, 2009)



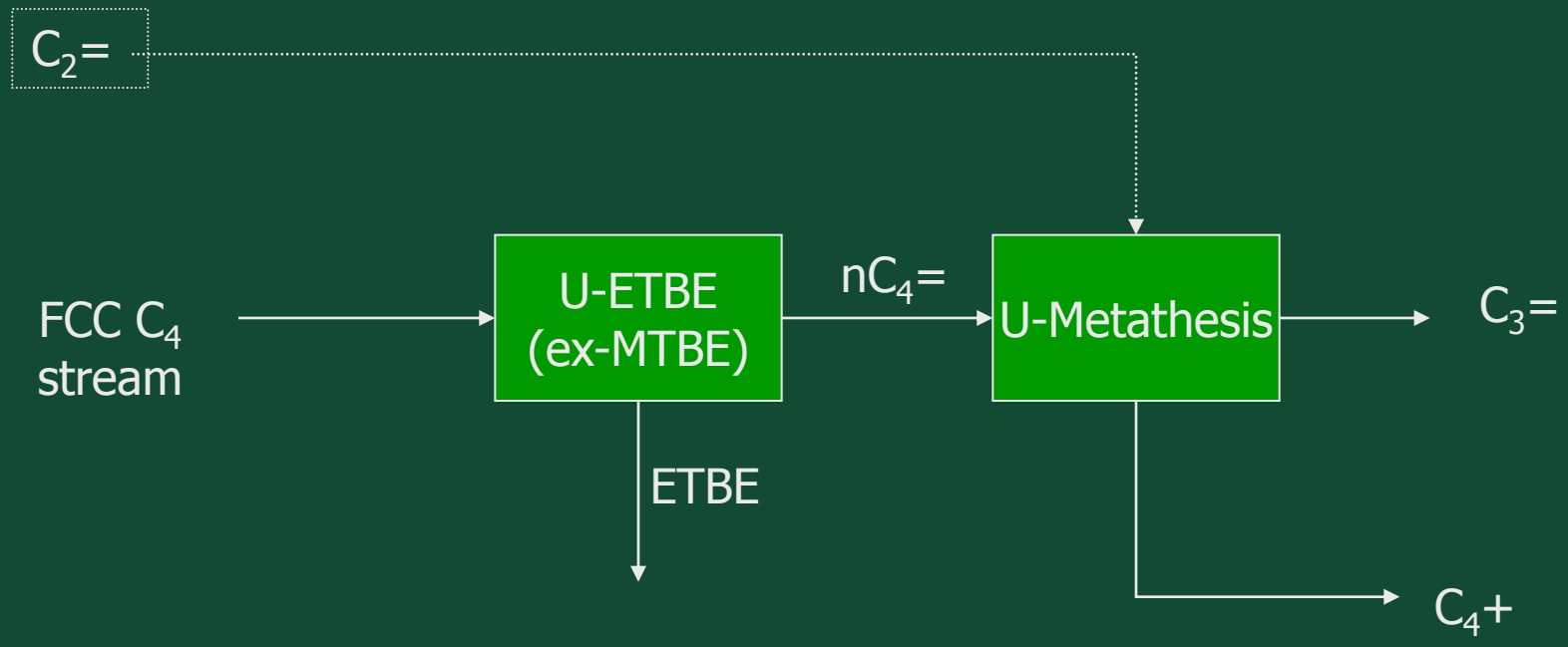
# Bioethanol

| Technical data | | |
|---|---|---|
| Cylinders | - | 5 in line |
| Cylinder volume | cm3 | 1598 |
| Bore / Stroke | mm | 68 / 88 |
| Max power @ rpm | kW | 165 @ 5800 |
| Max torque @ rpm | Nm | 305 @ 4000 |
| Compression ratio | - | 8:1 - 14:1 |
| Valve train | - | DOCH / 4 Valve |
| Charging system | - | Screw type SC |
| Engine managem. | - | Saab Trionic 7 |
| Emission control | - | TWC |
| Emission target | - | ULEV II |

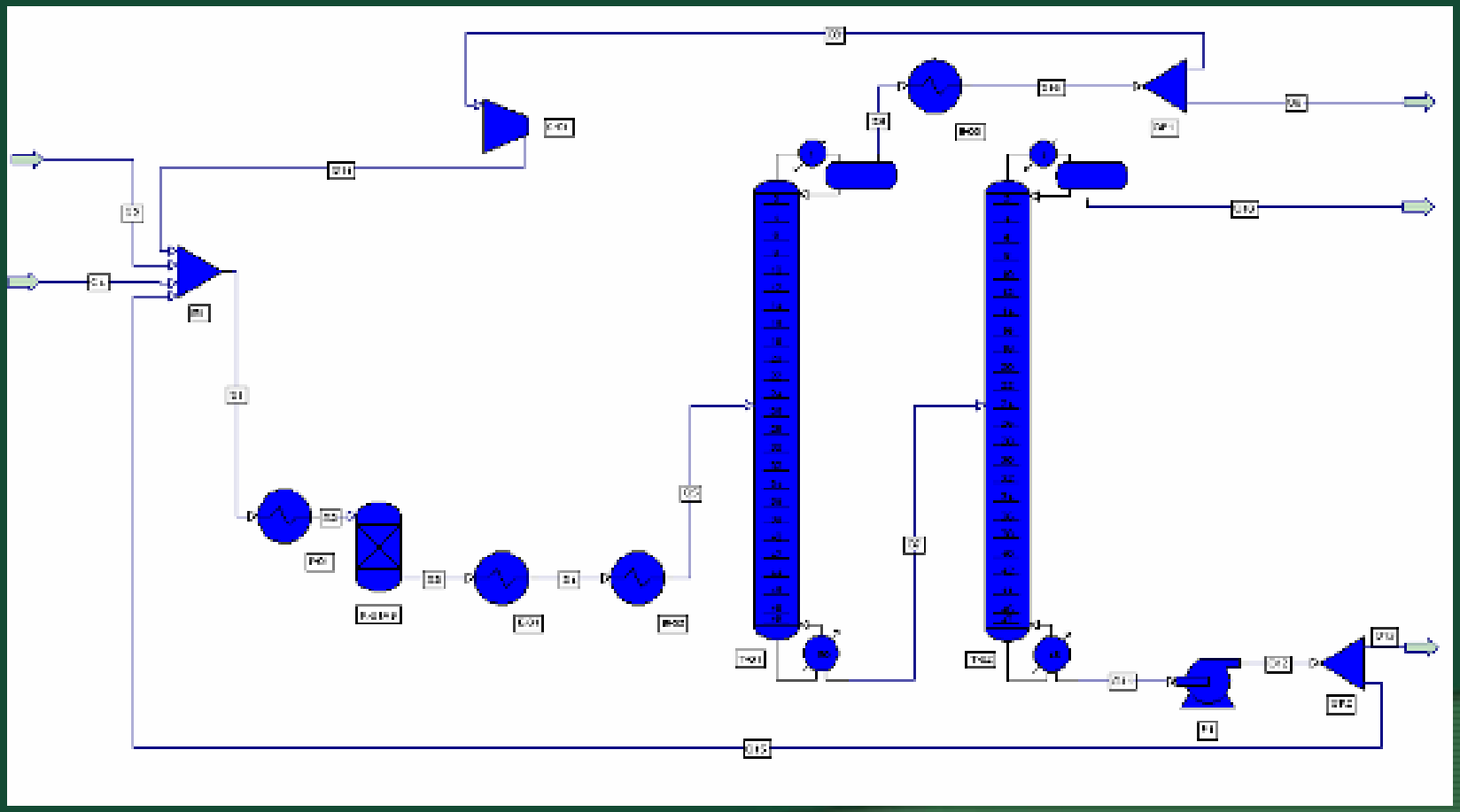
The compression ratio is now 14:1



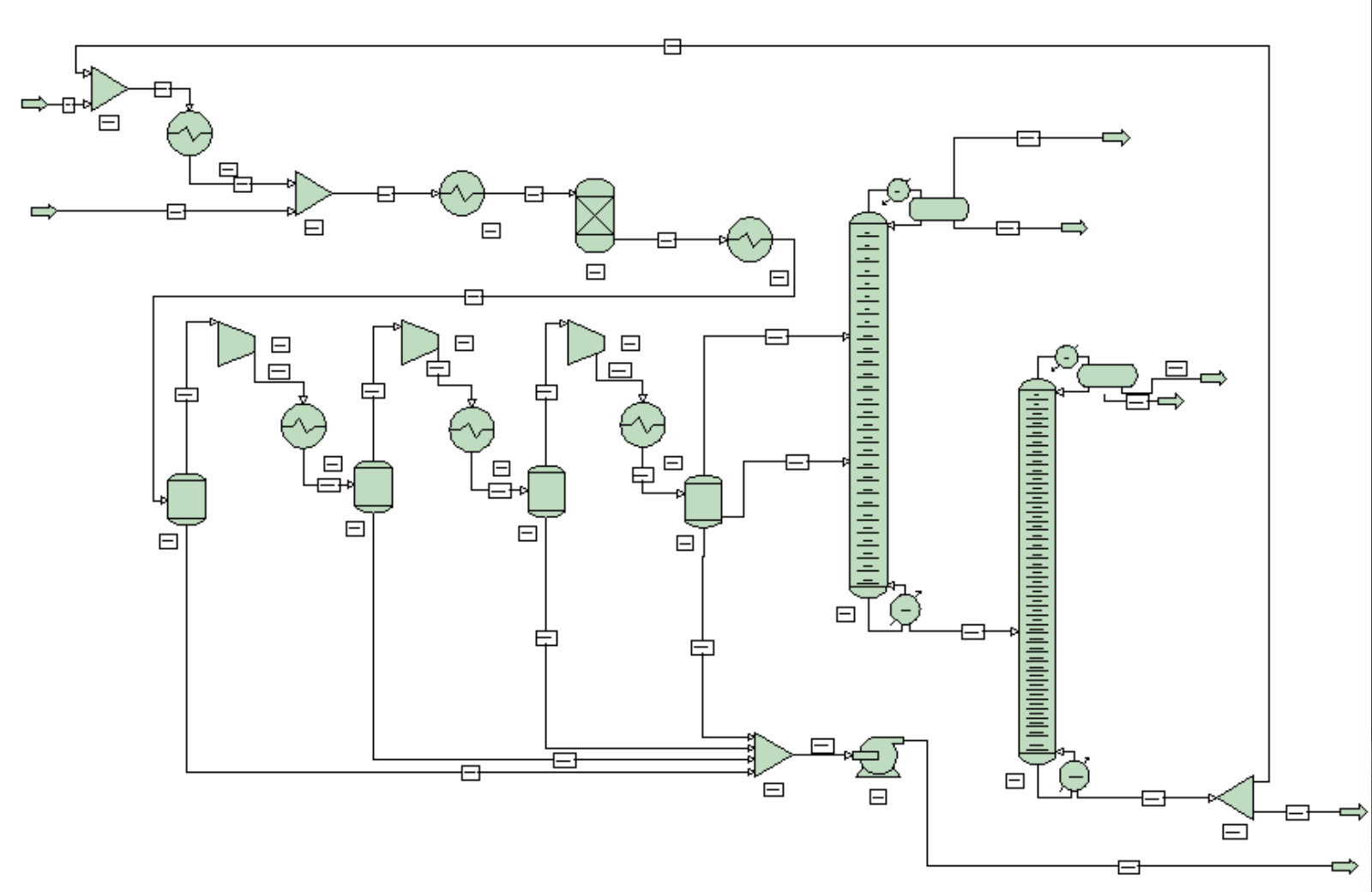
# BioETBE



- $C_2$-$C_4$ metathesis



- $C_4$ auto-metathesis



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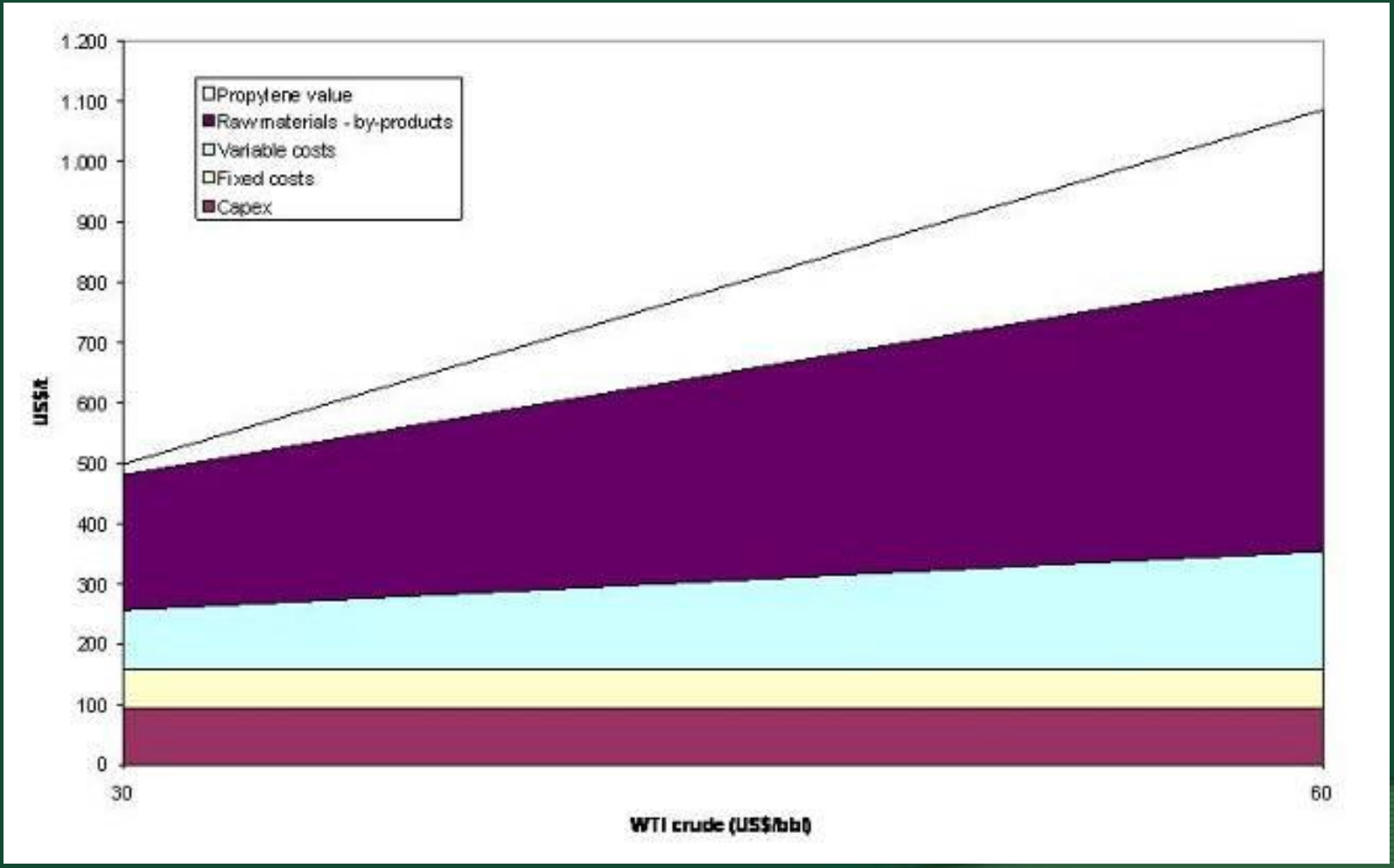
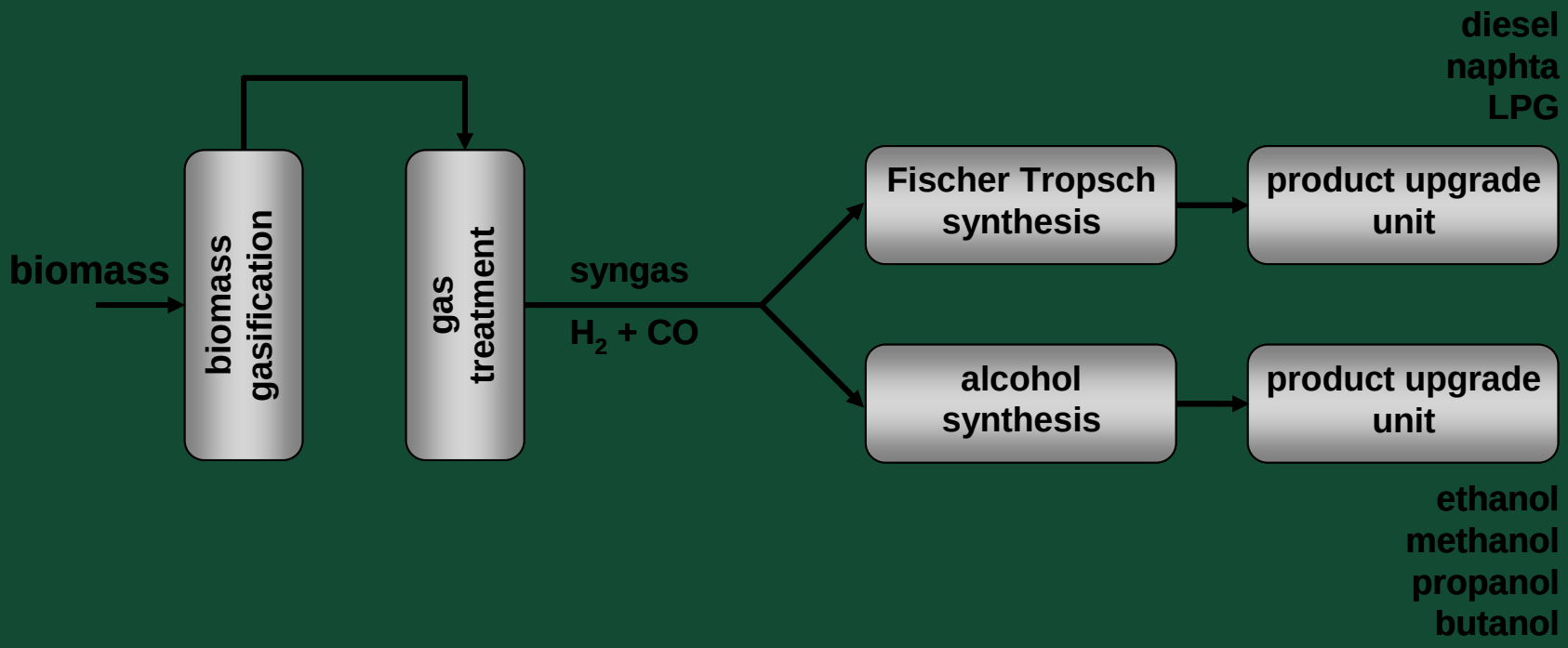
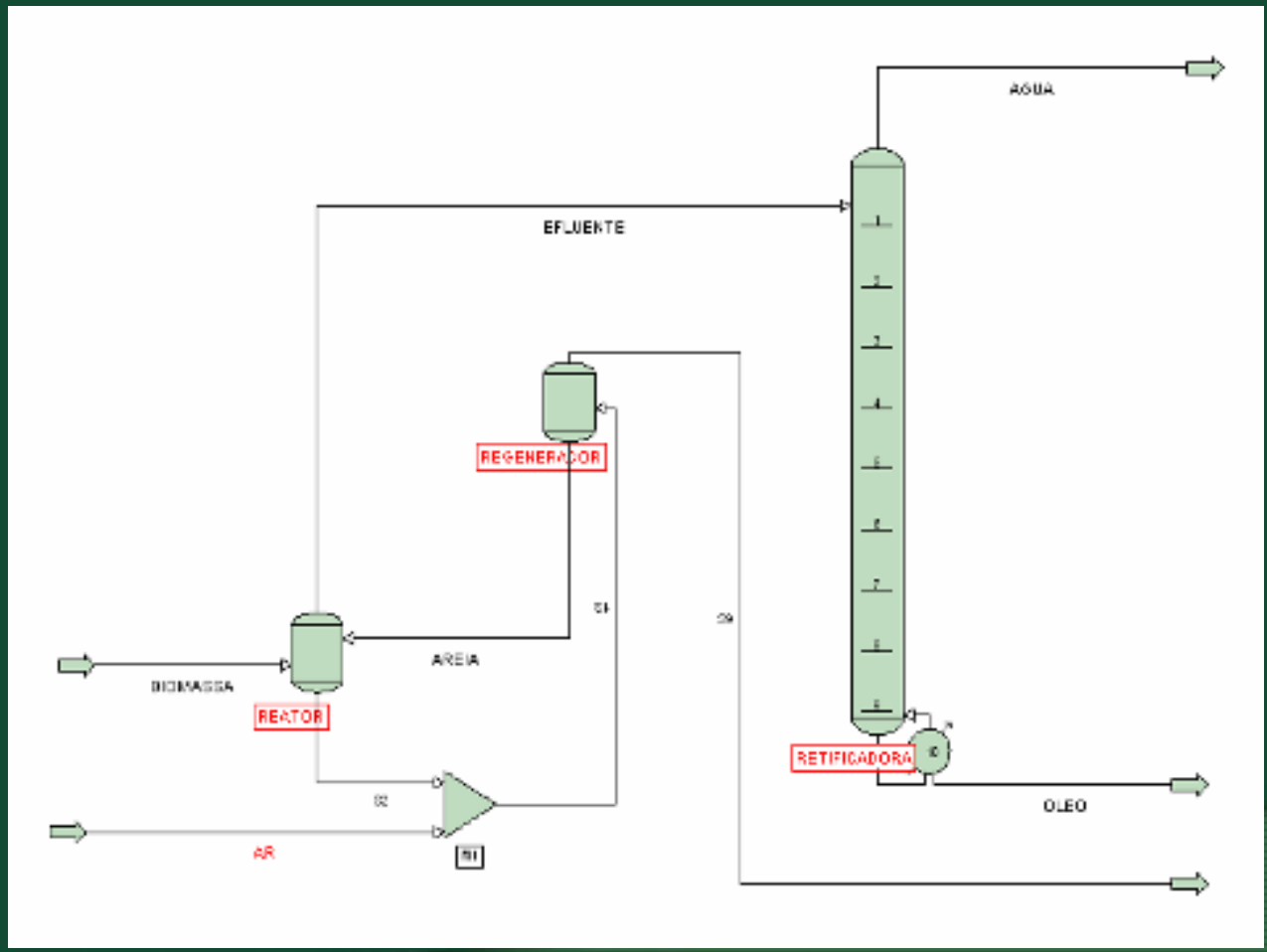


# BTL processes

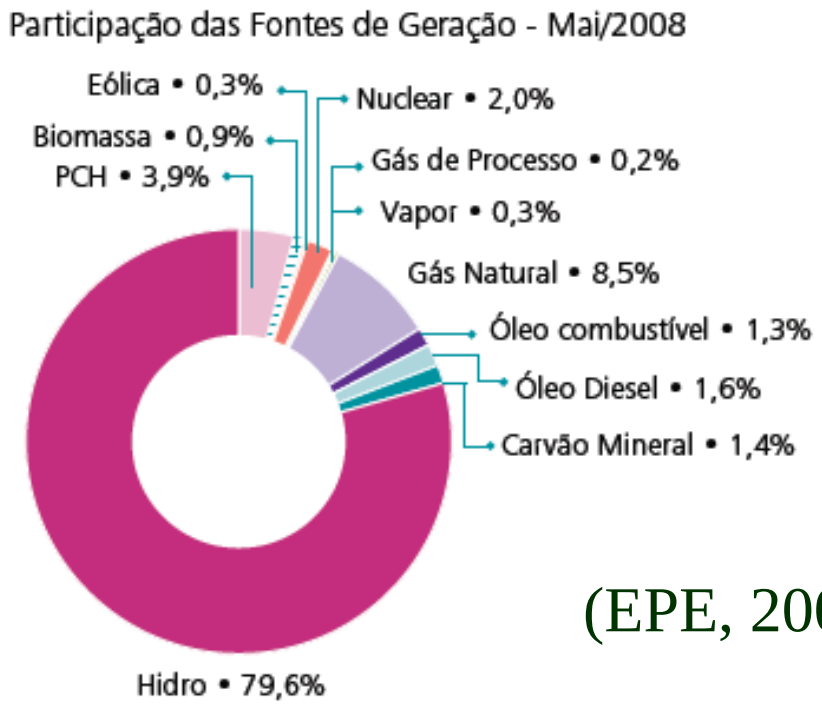


# Bio-oil

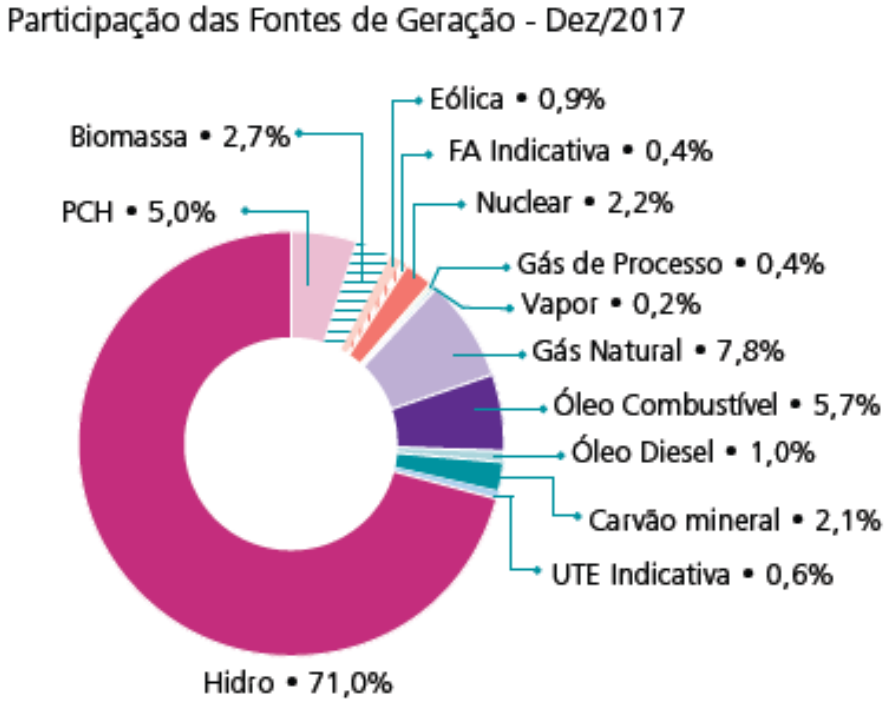
- Pyrolysis
  - Acidity, low heat content and distribution logistics

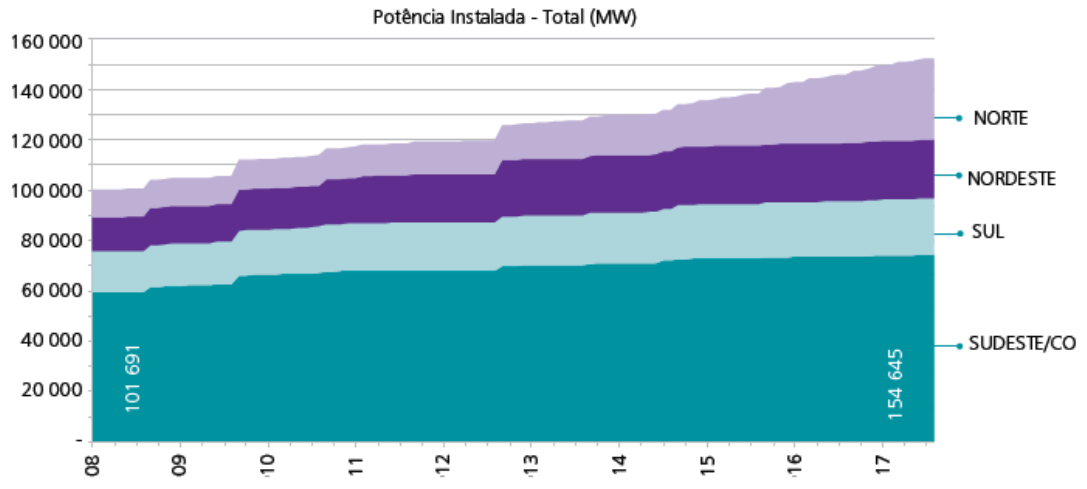


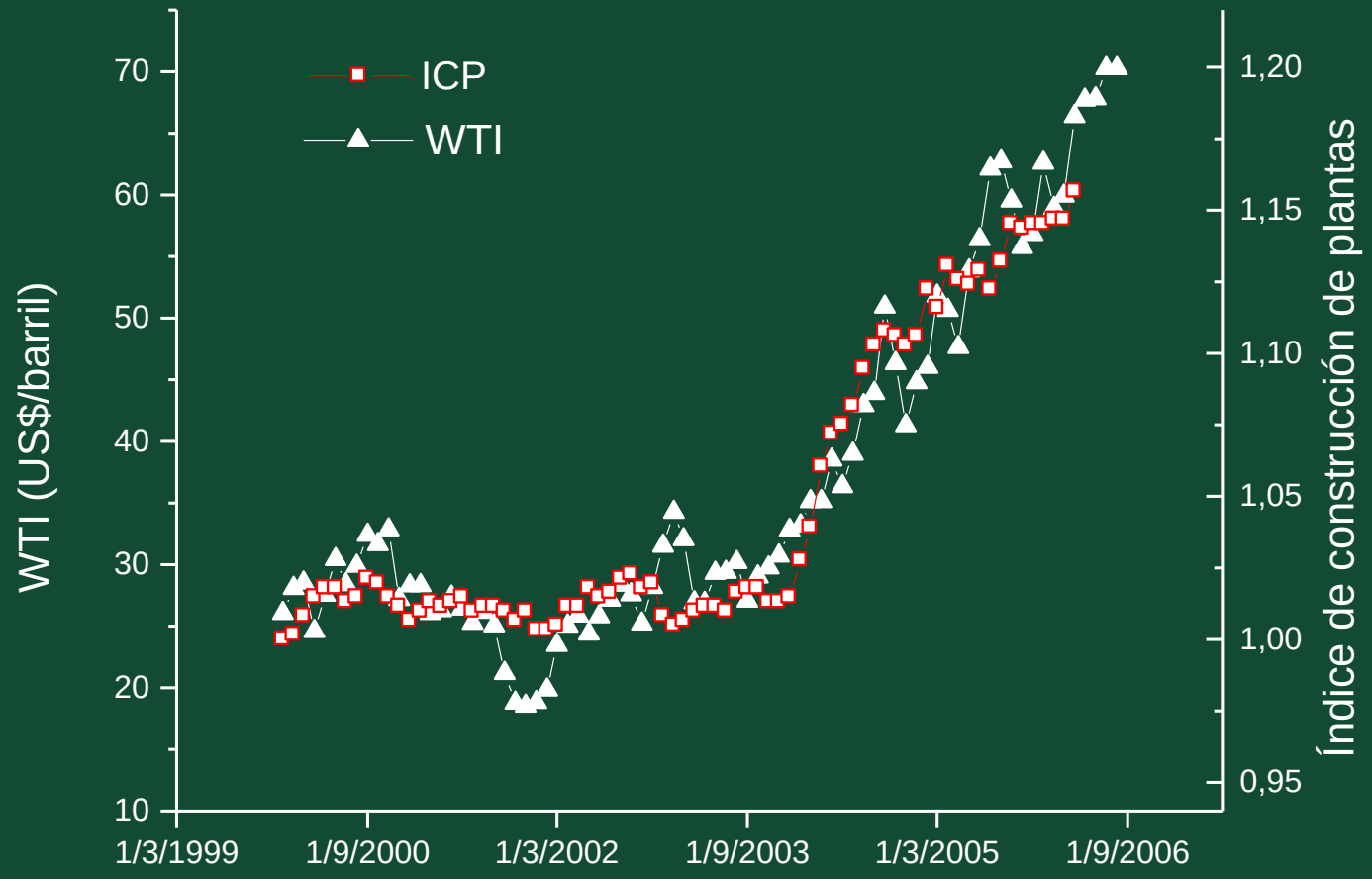
# Bioelectricity




(EPE, 2009)





ICP
WTI
WTI (US$/barril)
Índice de construcción de plantas
70
60
50
40
30
20
10
1,20
1,15
1,10
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1/3/1999
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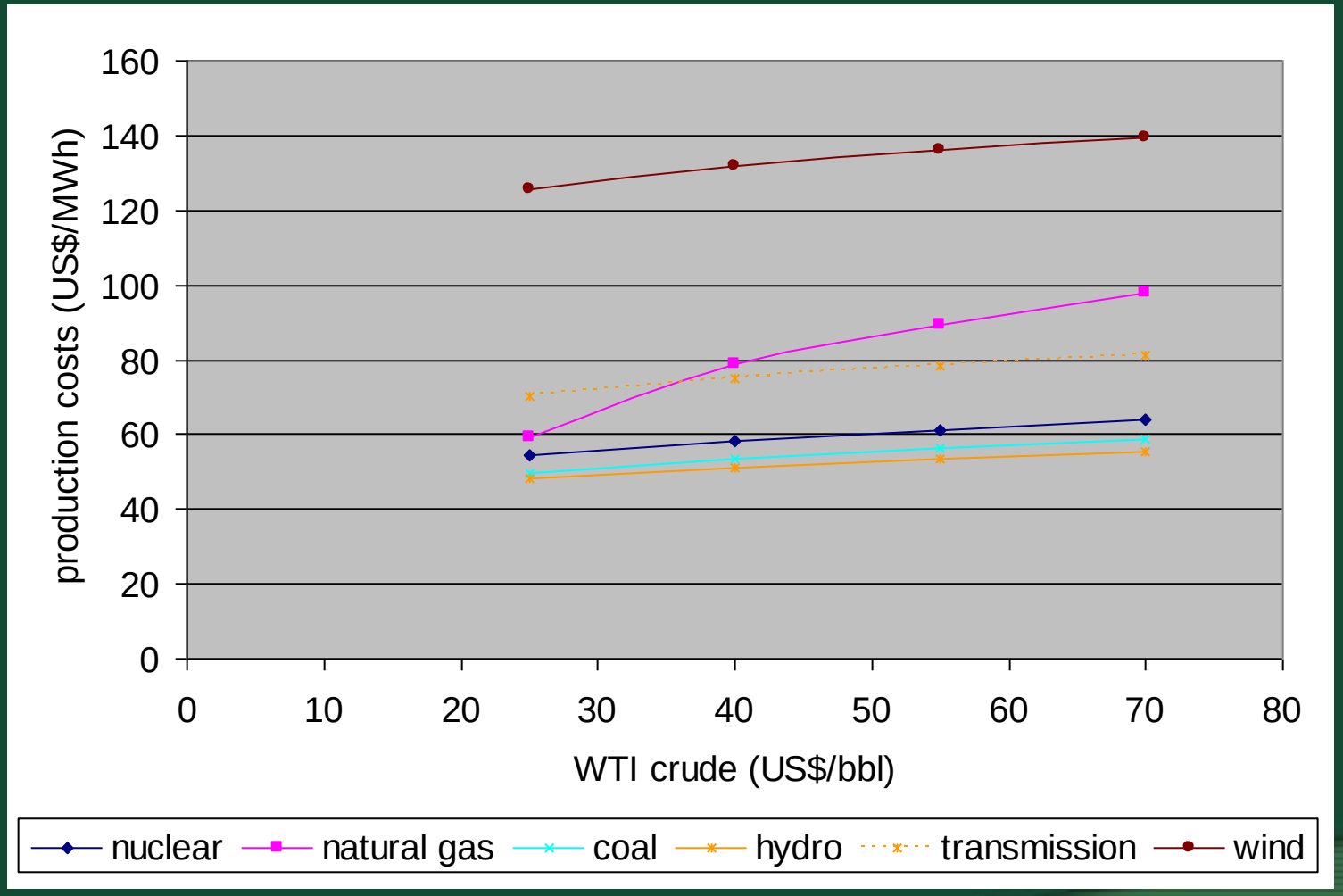
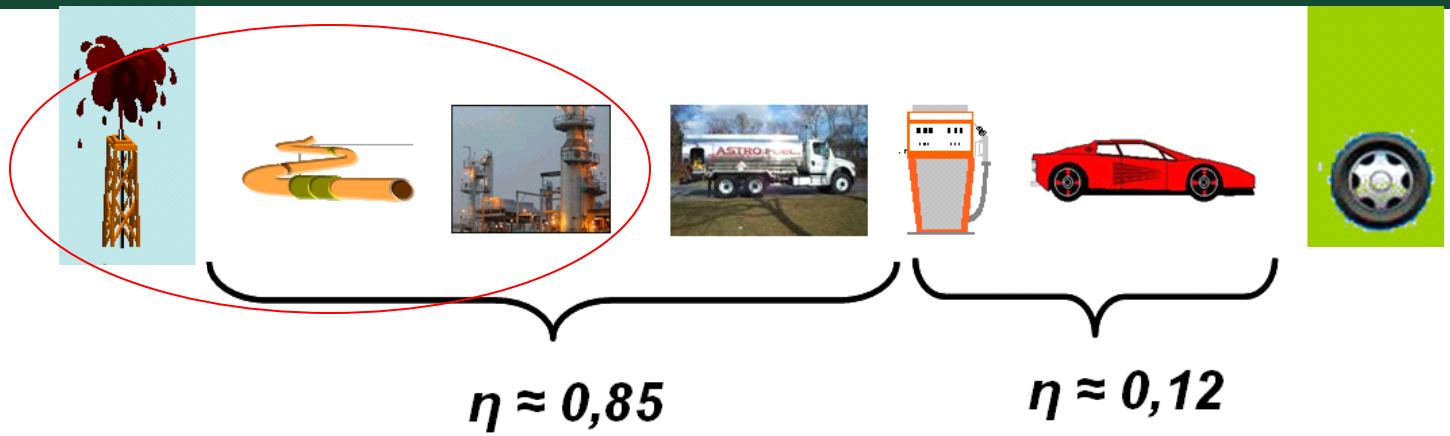
1/3/2002
1/9/2003
1/3/2005
1/9/2006


160
140
120
100
80
60
40
20
0
production costs (US$/MWh)
0
10
20
30
40
50
60
70
80
WTI crude (US$/bbl)
nuclear
natural gas
coal
hydro
transmission
wind

# Bioelectricity

Because electric cars are so much more efficient than internal combustion engine vehicles, biomass-generated electricity can help propel them 22 times further than can ethanol (Thomas Blakslee, EV World, Aug. 18, 2009 )

# Bioelectricity




? ~ 10 %

(following Hollanda, 2008)

$\eta \approx 0,85$ $\eta \approx 0,12$

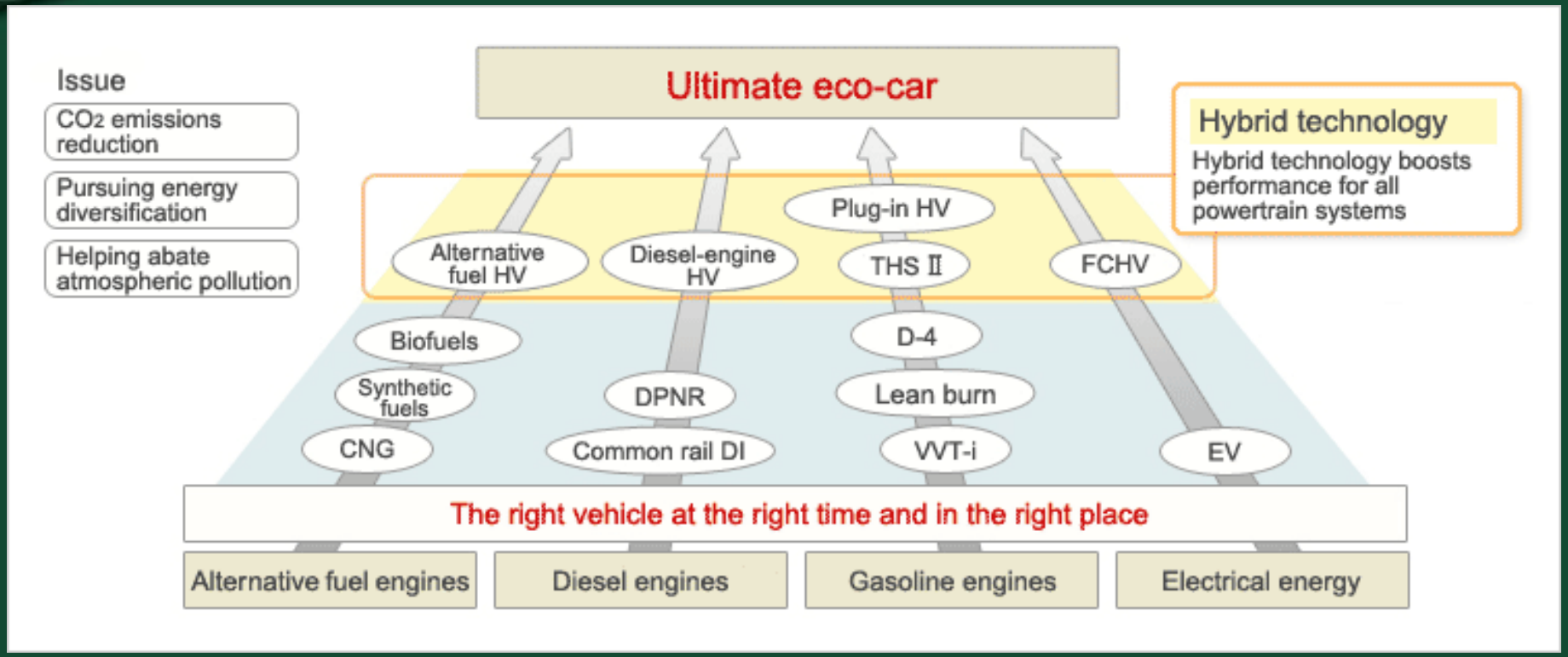
$\eta \sim 10\ \%$

$\eta \sim 45\%$ $\eta \sim 85\%$ $\eta \sim 95\%$

$\eta \sim 30\%$

(following Hollanda, 2008)

# Bioelectricity




| | | | |
|---|---|---|---|
| CNG | compressed natural gas | D-4 | direct injection 4-stroke |
| HV | hybrid vehycle | EV | electric vehycle |
| DPNR | diesel particulate and Nox reduction system | FCHV | fuel cell hybrid vehycle |
| THS | Toyota hybrid system | VVT-i | variable valve timing with intelligence |
| DI | direct injection | | |

(Toyota, 2007)

# New efficiency levels with current technology

## Toyota

- Prius 3rd generation, Camry & Highlander
- US$ 22 k
- 22 km/L
- 1,9 million hybrid units sold

## GM

- Volt sales start November 2010, mass production 2011
- US$ 40 k
- Autonomy of 65 km satisfies 75% of urban commuters
- 25 kWh/100 m means R$ 6/100 km at R$ 0,40/kWh

## Nissan

- 100.000 units by 2012
- US$ 1,6 billion loan from DOE to Smyrna (TE)
- Battery life of 10 years, 160 km autonomy
- Believes 10% of all car sales can be electric by 2020