



# BioFuel R&D Program

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March 27 , 2012

# PTT RTI Disclaimer

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# Outline

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- Roadmap To be come Low Carbon Society

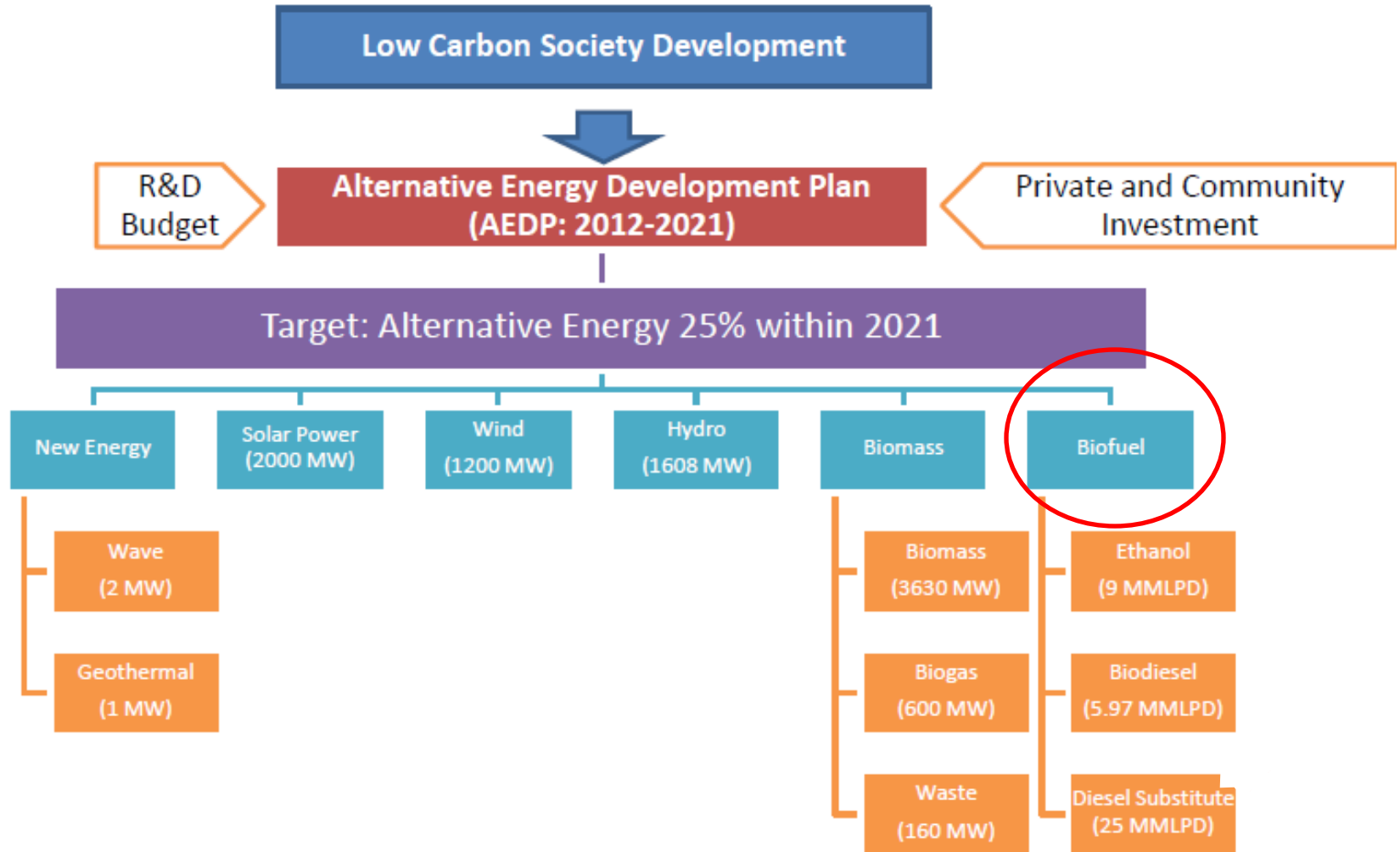
- Liquid Biofuel Pathway

- Grand Challenge of Bioenergy and Biofuel

- PTT Biofuel R&D Program

- Conclusion

# Thailand 's Alternative Energy Development Plan



## PTT CO2 reduction Approach Strategy

### Process

Reduce GHG Emission from production process by enhancing energy efficiency

### Product

Launch Green Products including Biofuel, Biopolymers, Bioplastics and Renewable energy

### Sink

Forestation Project

### Awareness

Enhance awareness of the efficient energy used to public

### R&D

Support R&D in Green Technologies for commercialization

transform

## Green Growth Communication Way

Clean Energy  
 Renewable Energy  
 Green Product  
 Clean Air  
 Energy Saving Innovation  
 Earth Friendly Product(TOL)  
 Energy for green earth  
 Map of PTT Group Forestry  
 .....



Go Green



Quality of Life



Empower Performance



Developed from PTT's GHG Roadmap  
 To Become  
 Low Carbon Society

# Current Biofuel Options



## Biodiesel

- Feedstock : Palm (CPO, RBDPO, Stearin, Used Cooking Oil, etc.)
- Process : Transesterification



## Ethanol

- Feedstock : Molasses, Sugarcane Juice, Cassava
- Process : Ethanol Fermentation (Yeast)



## Biogas

- Feedstock : Waste Water, Swine Manure
- Process : Anaerobic Digestion

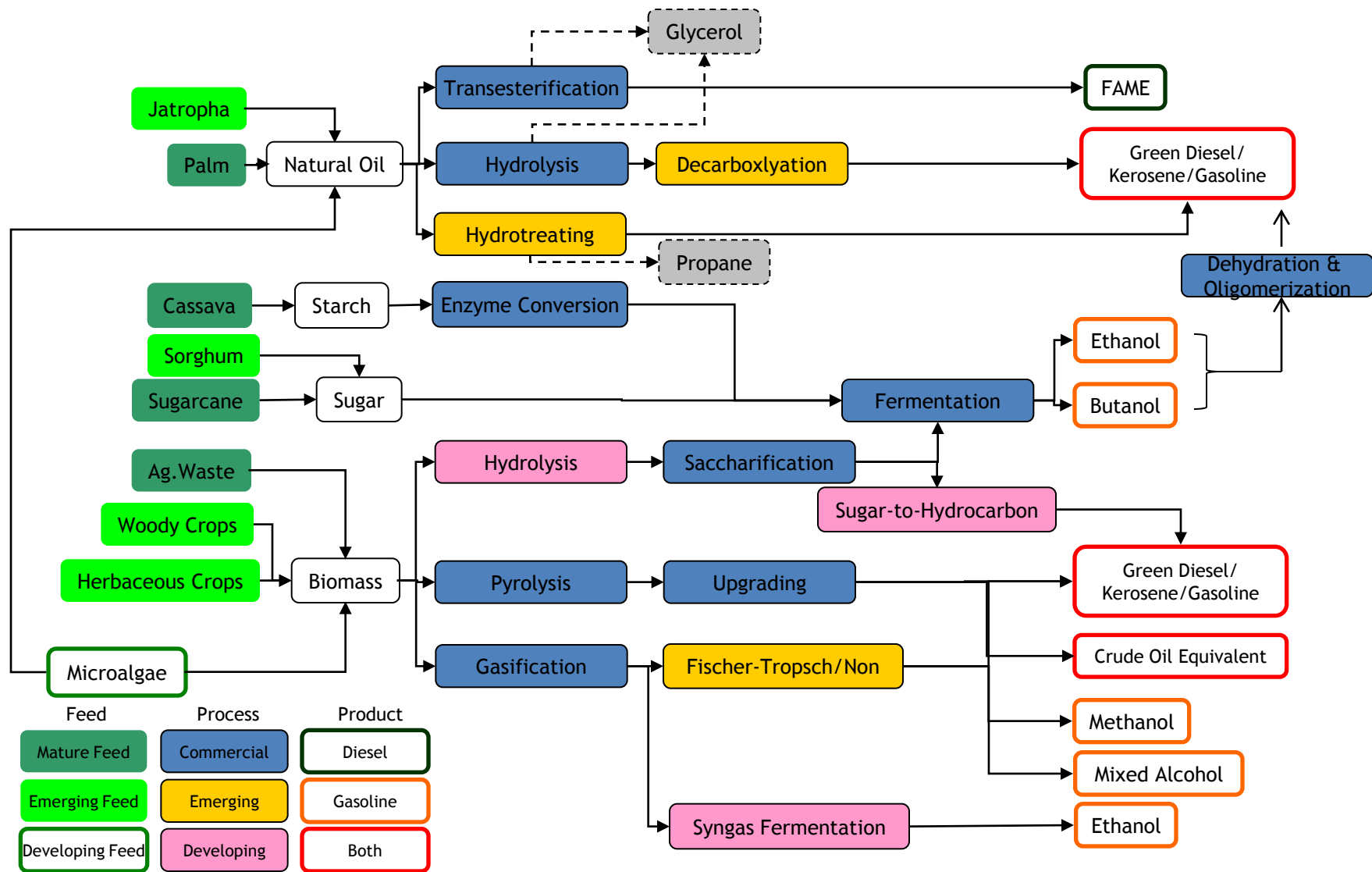


## Bio-power/heat

- Feedstock : Bagasse, Empty Fruit Bunch, Rice Husk, etc.
- Process : Gasification + Steam Turbine/Boiler or Direct Combustion



# Liquid Biofuel Pathway : Various Liquid Biofuel compliments the use of Gasoline and Diesel



# Grand Challenge of Bioenergy and Biofuel

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Challenge 1 : **Scale and Feedstock Availability**

Challenge 2 : **Better Environmental Impacts**

Challenge 3 : **Acceptability**

Challenge 4 : **Competitive Cost**



# Challenge 1 : Scale and Feedstock Availability

Since land and resources are limited, do we have land for more bioenergy?

Item	Thailand
Total Area	513,115 sq.km. (320,696,888 Rai) (51MM ha)
Land	511,770 sq.km.
Water	2,230 sq.km.
Arable Land	141,132 sq.km. (88,319,923 Rai)

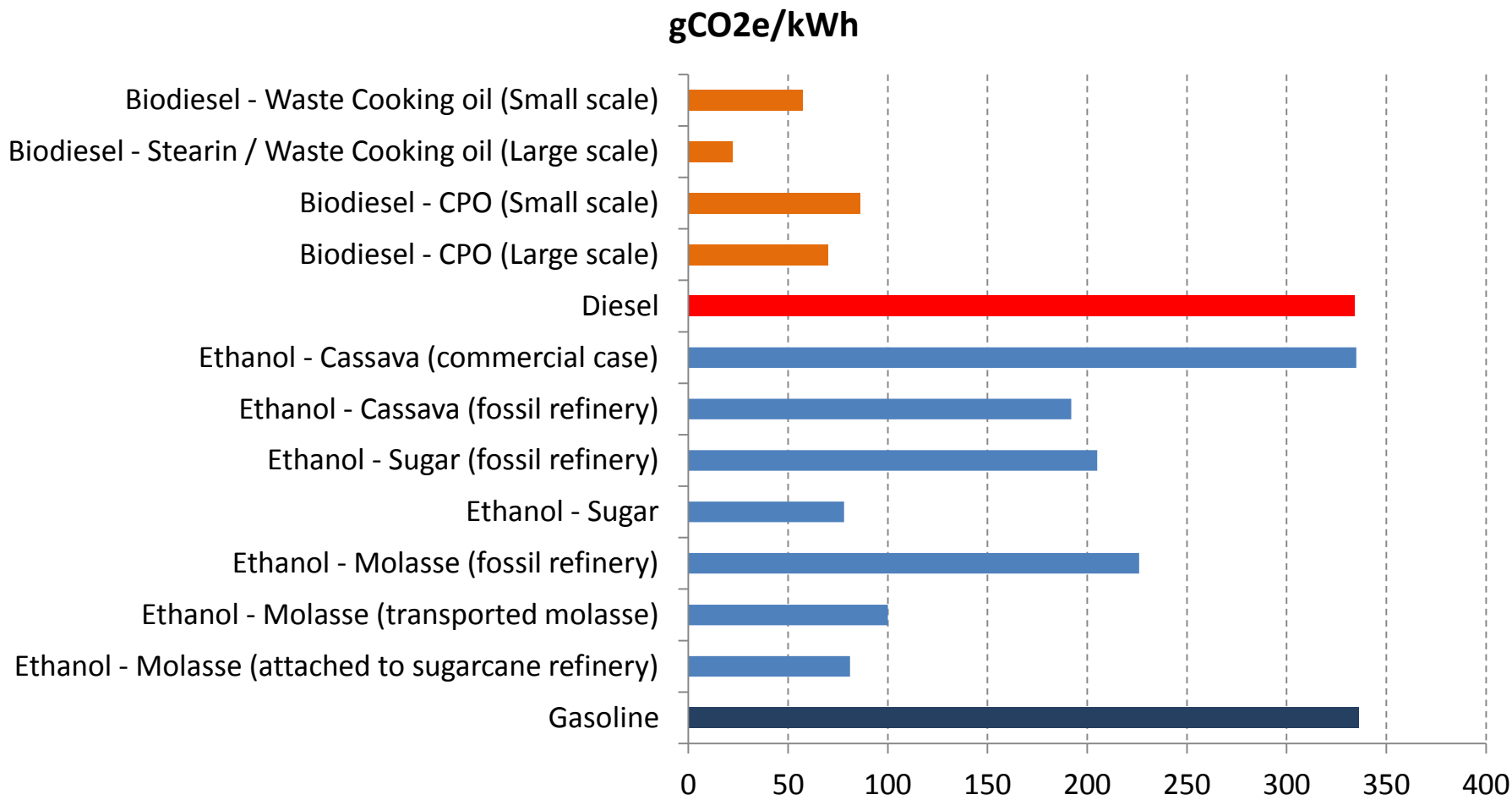
Item	Thailand
Palm (2007)	5,116 sq.km.(1% Land) (3,197,625 Rai)
Sugar Cane (2007)	9,931 sq.km. (2% Land) (6,207,000 Rai)
Rice (2006)	107,374 sq.km. (21% Land) (67,109,000 Rai)
Cassava (2007)	11,966 sq.km. (2% Land) (7,479,000 Rai)
4 main crops	123,620 sq.km. (77,262,625 Rai) (88% of Arable Land) (15% of Total Area)

**Thailand dedicated 88% of Arable Land to 4 major crops  
For energy purpose, do we still have some rooms?**

# Challenge 2 : Better Environmental Impacts

## Cases : Biodiesel and Bioethanol LCA

- The right configuration and energy source of biofuel production plant will results in “good” CO2 emission



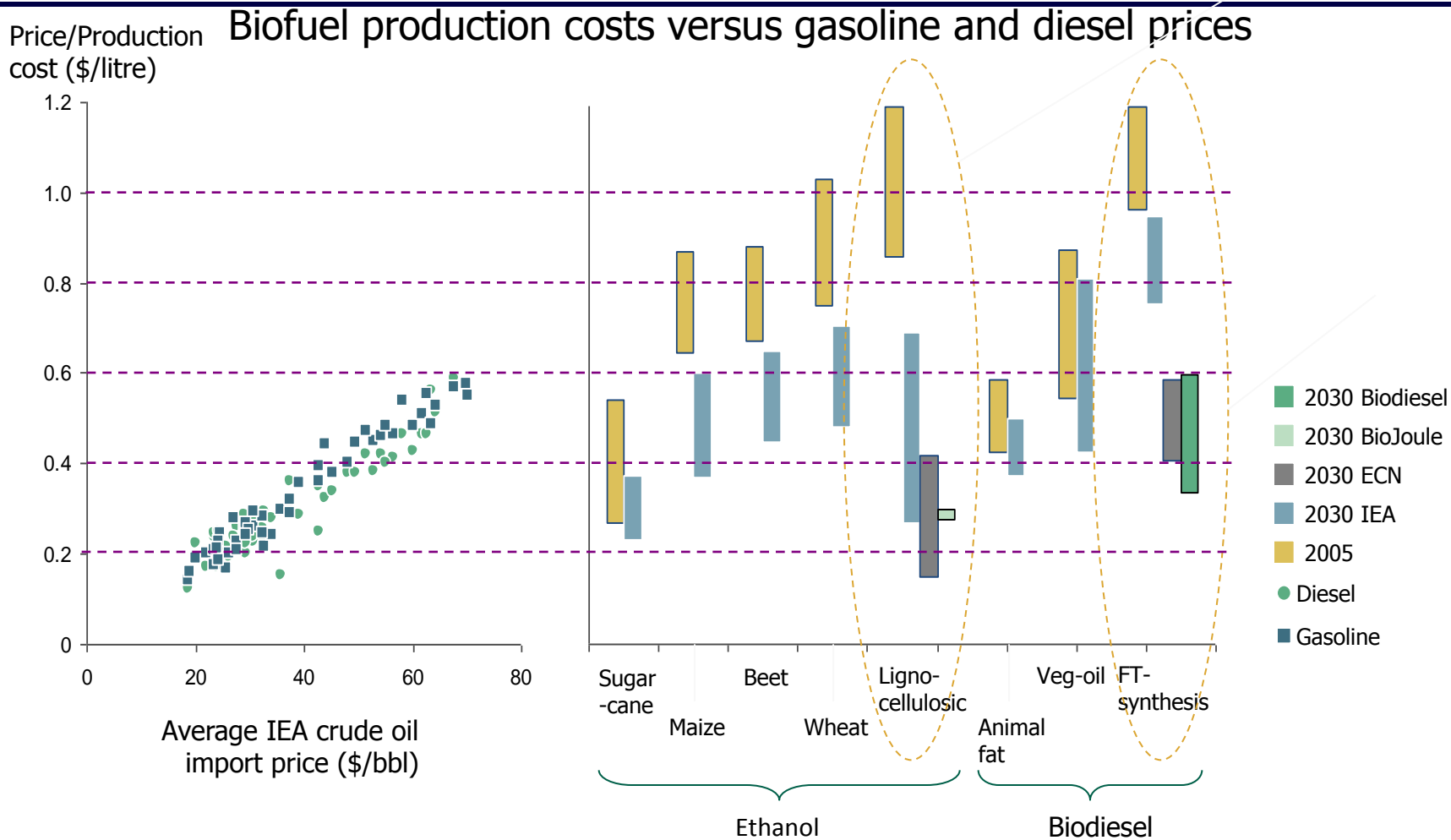
# Challenge 3 : Acceptability

- For acceptability, hydrocarbon biofuel will be more acceptable by OEMs, Refinery, and Users
- Currently, most oxygenated biofuel components are accepted widely by users

	1 <sup>st</sup> Generation Oxygenated Biofuel	2 <sup>nd</sup> Generation Oxygenated Biofuel	2 <sup>nd</sup> Generation Hydrocarbon Biofuel
Cost	Lower (still higher than fossil counterparts)	Higher	Higher
Scale	Large	Large	Large
GHG reduction	Moderate (except sugarcane → high)	High	Moderate
Acceptability	Upto some limits	Upto some limits (Blend Wall)	Full
Status	Fully commercialization (still developed)	R&D and Pilot-scale Demonstration	R&D and Pilot-scale Demonstration
Examples	<ul style="list-style-type: none"> <li>➤ Sugarcane ethanol</li> <li>➤ Palm Biodiesel</li> </ul>	<ul style="list-style-type: none"> <li>➤ Cellulosic Ethanol/Butanol</li> <li>➤ Jatropha Biodiesel</li> </ul>	<ul style="list-style-type: none"> <li>➤ Synthetic Green Diesel/Gasoline (BTL)</li> <li>➤ Jatropha/Algae BHD</li> </ul>

# Challenge 4 : Competitive Cost

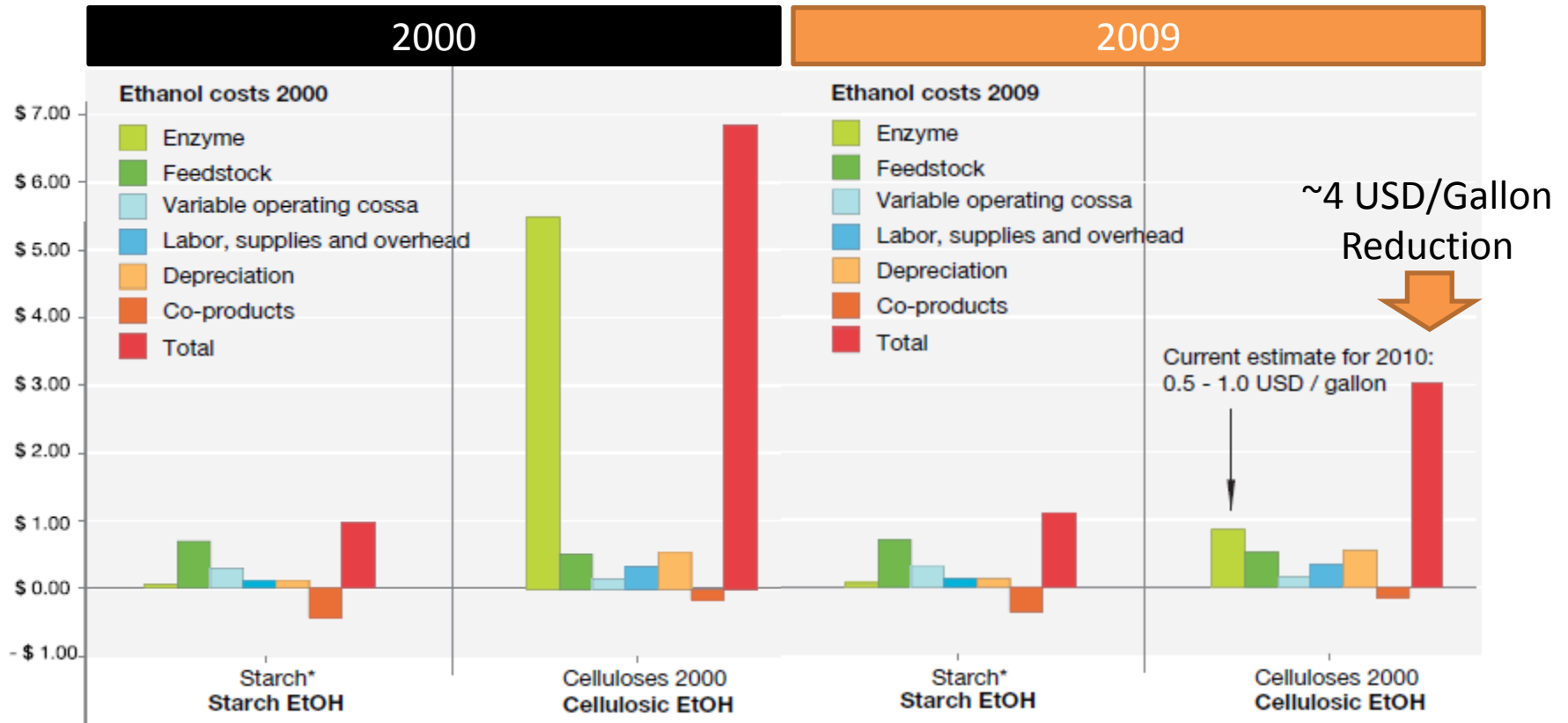
Typically, biofuel price is higher than its petroleum counterpart



1. Biodiesel from vegetable oil is always more expensive than petro-diesel
2. Ethanol is considered to be competitive with gasoline (Brazilian experience)

# Challenge 4 : Competitive Cost (cont.)

Progress has been made significantly, but the competitive one is yet to come



# PTT and 1<sup>st</sup> Generation Biofuel

PTT always support government policy on biofuel implementation

- Clearly in our business
  - TOL and Bangchak Biofuel → FAME production including Fatty Alcohol and Refined Glycerine
  - Maesod Clean Energy and TOP Ethanol → Ethanol production
  - PTT Green Energy → Palm Plantation and Palm Refinery in Indonesia
  - PTT → upgrades Biogas from Pig Farm for use in NGV
- Clearly in our products
  - PTT Blue Gasohol E10 , E20 , E85
  - PTT Blue Diesel



PTT is also working on higher blend of biofuel mainly on diesel products and advanced Biofuel Project i.e. Bio-Jet/BHD and 2nd Generation Ethanol



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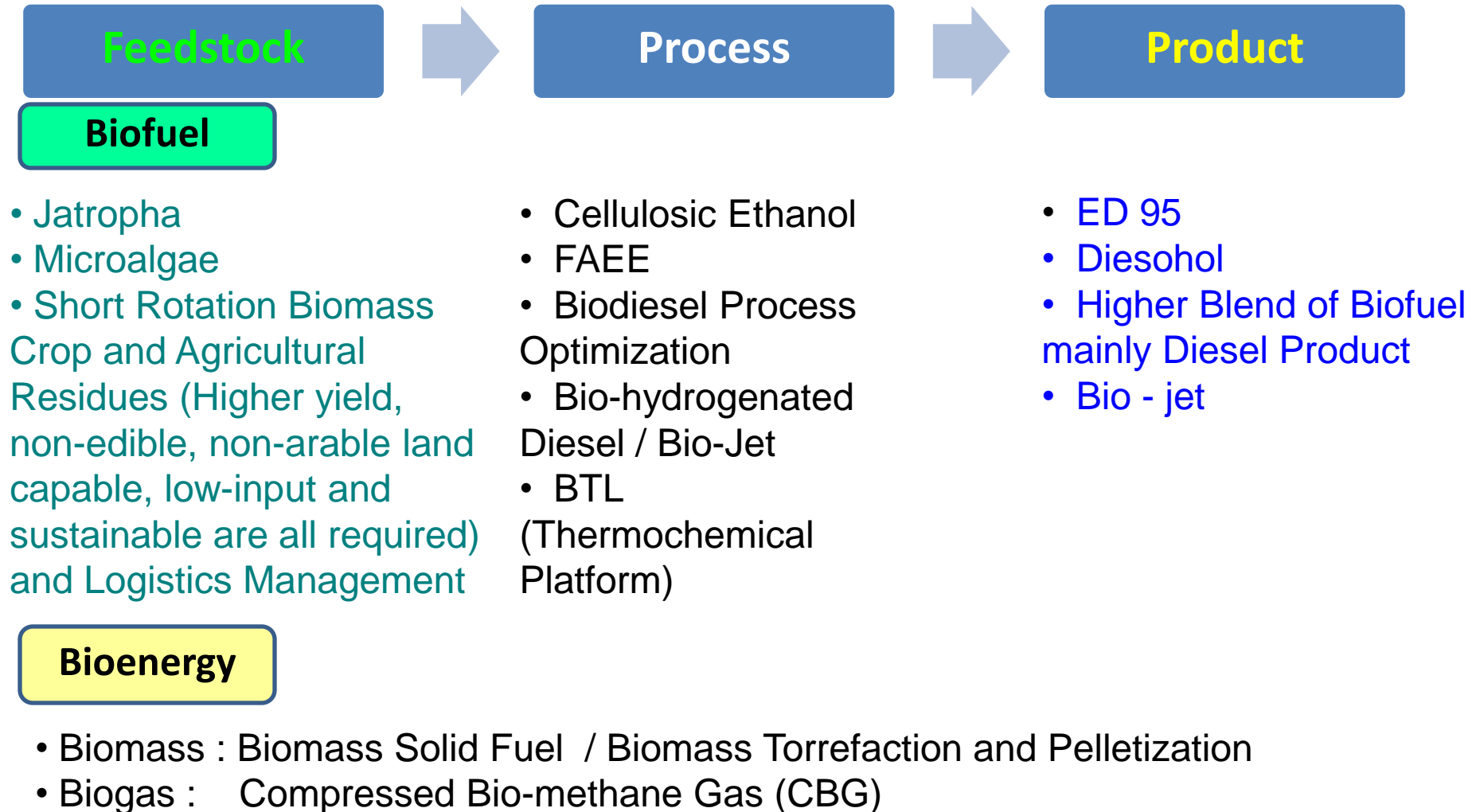
# PTT and 2<sup>nd</sup> / Advanced Generation Biofuel

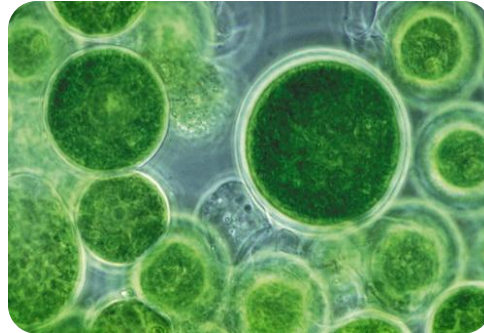
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- R&D is leading the way
- PTT Group is working on Advanced Biofuel Project i.e. Bio-Jet/BHD and 2nd Generation Ethanol
- PTT RTI: Investigating and Developing 2<sup>nd</sup> generation biofuel technologies
  - In order to address the 4 grand challenges, it is required to develop from feedstock through processing to product



# PTT Biofuel and Bioenergy R&D Program Overview

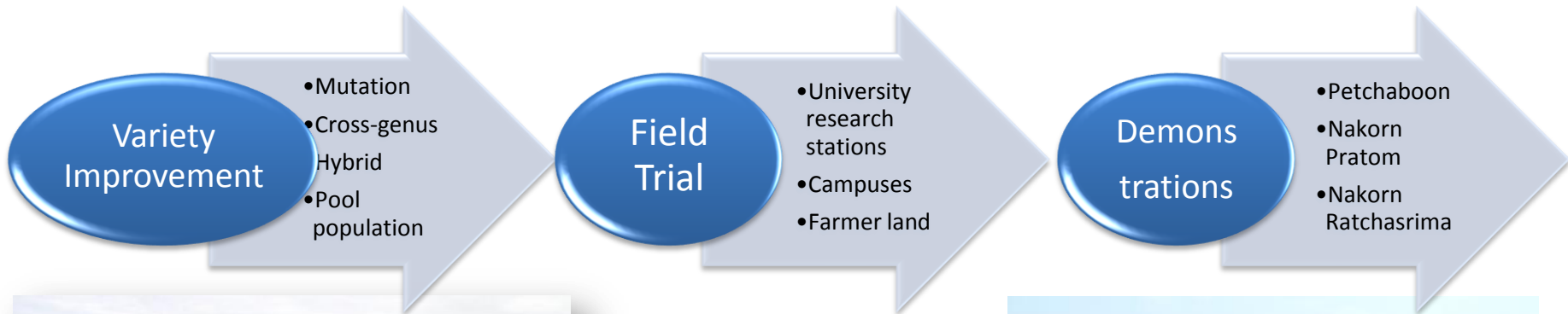




# PTT ADVANCED BIOFUEL **FEEDSTOCK** R&D PROGRAMS

# Jatropha Curcas

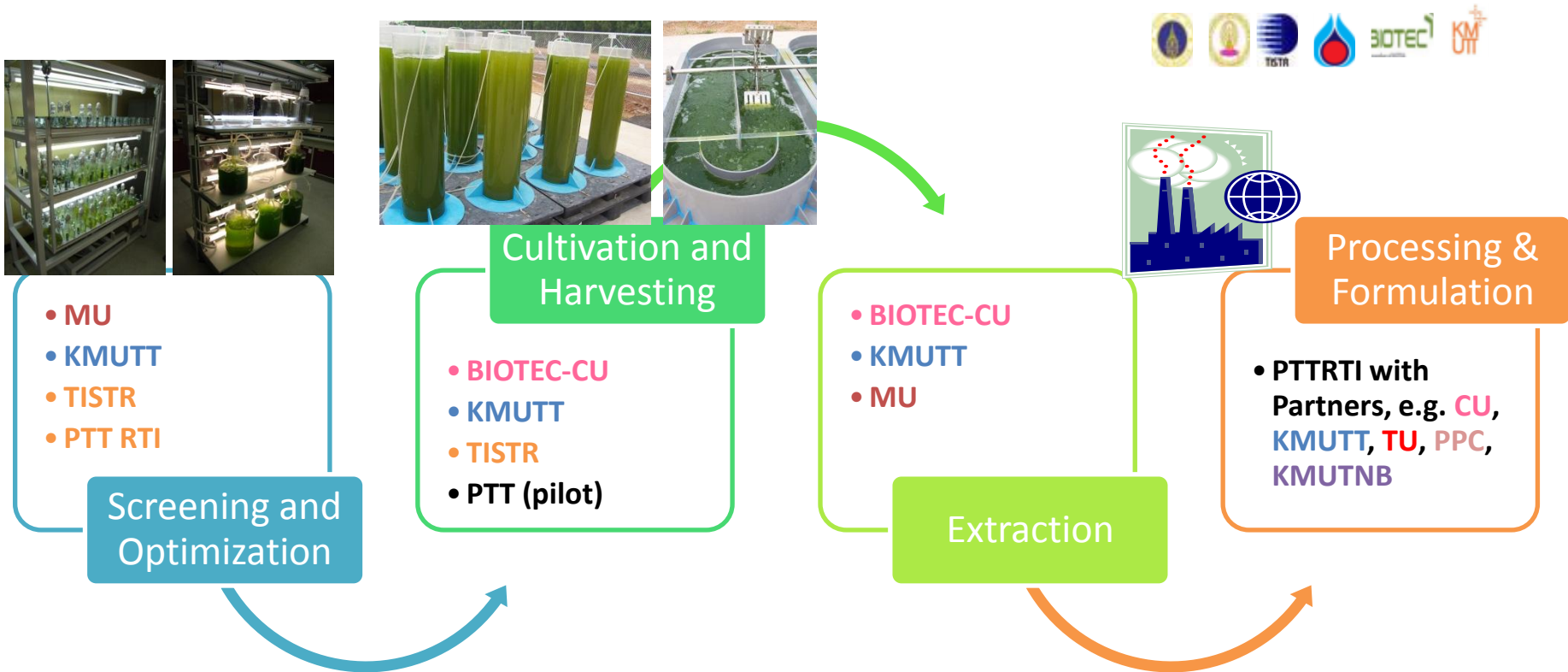
## Partnership with Kasetsart University



Year (gate)	Crude Jatropha Oil (CJO)	Bench/Pilot Size	Assumptions
2012 (Gate 1)	> 600 kg Oil/rai/y (plot trial)	Multiple areas of pilot trial (~ 1 ha each)	Oil yield 35% (1 <sup>st</sup> year yield should > 210 kg oil/rai/y)

# THINK ALGAE: Microalgal Biofuel Technology

• Memorandum of Understanding on the development of Microalgal Technology was signed by 6 Parties (PTT, CU, MU, KMUTT, BIOTEC (NSTDA), and TISTR) on 14 September 2010



• Under the MOU, we aim to commercialize the Microalgal Biofuel Technology by 2017 targeting both biofuel and key by-products.



# Short Rotation Biomass and Logistics

## Short Rotation Biomass



- Low cost Short Rotation Biomass crops and plantation system are developed
- Current Development: Short-rotation crop on non-arable Land (such as saline and sandy) in Thailand (with KU)

## Logistics Management

- Cost and logistics method was studied and concluded for rice straw and sugarcane leftover.
- Current Development: R&D (with KU) to have an integrated model and system suitable for Thailand both ag. residues and dedicated biomass crop





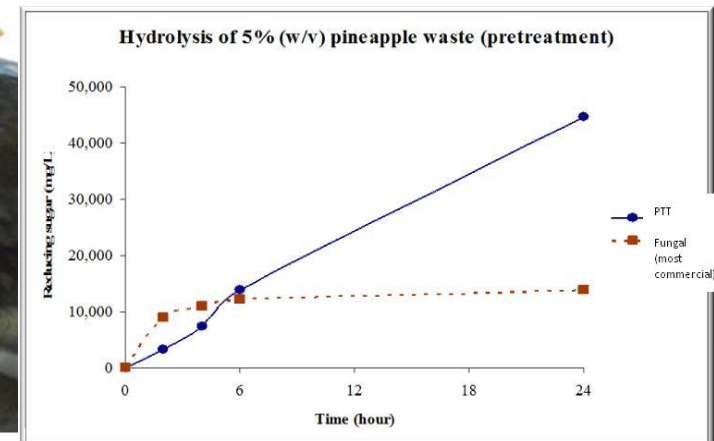
# PTT BIOFUEL **PROCESS** TECHNOLOGY R&D PROGRAMS

# 2<sup>nd</sup> Generation Bioethanol

Create “cost reduction” and “value added” technologies in producing “bioethanol from Thai biomass”



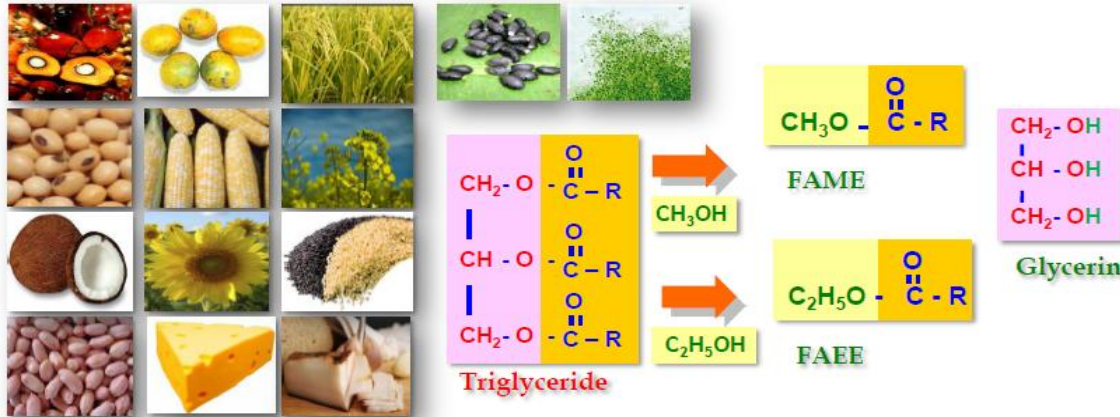
- At PTT RTI, researchers have been working on reducing the cost of production of bioethanol via advancement in biotechnology
- Since bioethanol is the gateway to biorefinery, PTT RTI also support PTT business development activities in building green business such as Bio-PBS





# FAEE : Fatty Acid Ethyl Ester Production

## FAME & FAEE



Currently, methanol in Thailand is imported, but ethanol is oversupply and from renewable resources.

- Optimum condition for ethyl ester production in lab scale for various feed stocks
- The results show that separation part is very tricky

# Hydrotreated Renewable Diesel and Jet Fuel

“Drop-in Bio-hydrogenated Diesel, Bio-Gasoline and HRJ” from “vegetable oil and animal fat”

## PTT Hydrocarbon Pilot Plant Capabilities

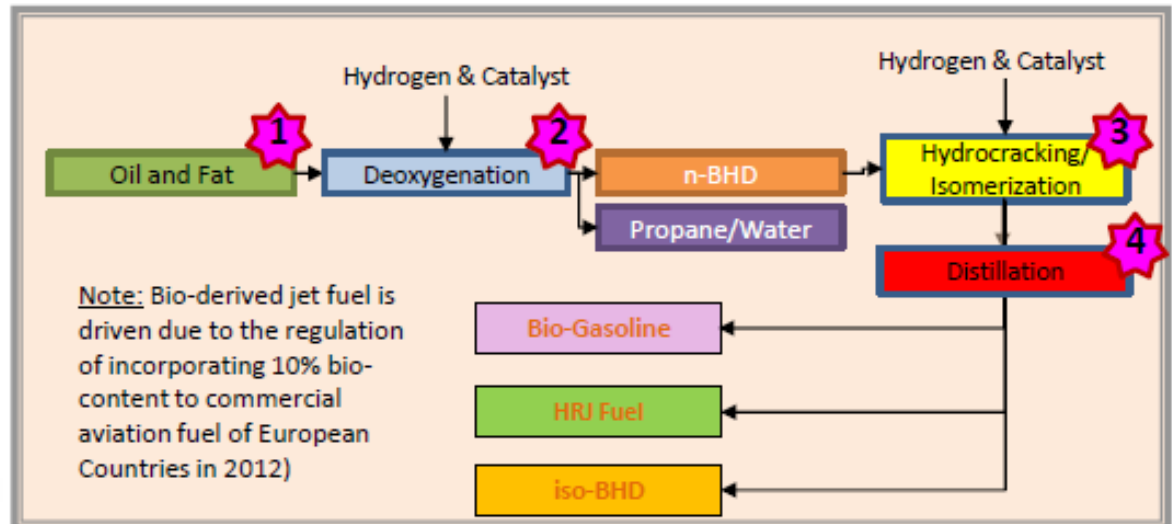
Hydrogenation of vegetable oil to diesel, jet fuel, and base oil with capacity up to 20 Liter per day

## Key Development

1. PTT RTI is working with our refinery group HRJ/BHD commercial project
2. Collaboration projects with universities for process and catalyst development (CU and TU)



Hydrocarbon Processing Pilot Plant, PTT-RTI

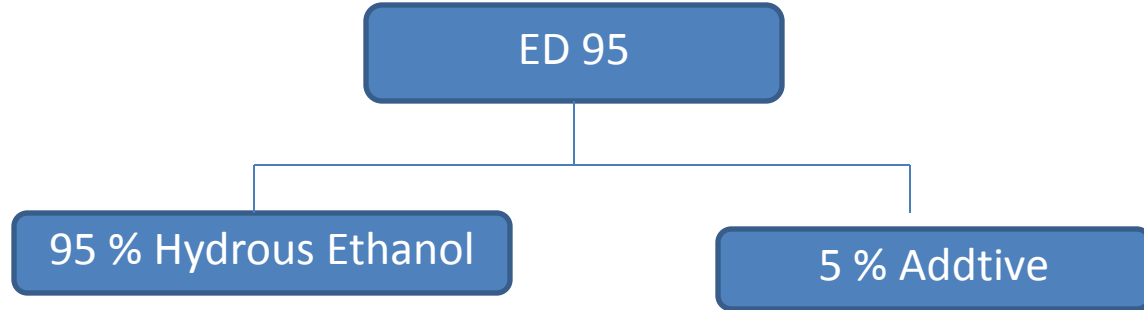


# PTT BIOFUEL **PRODUCT** R&D PROGRAMS

PUBLIC

# ED95

(Ethanol for Dedicated compression ignition engine)



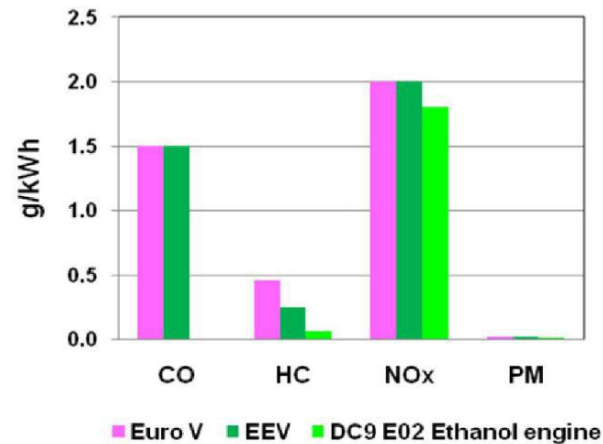
95 % Hydrous Ethanol  
5 % Additive



Ethanol buses & trucks globally



Emissions Scania ethanol engine



## Europe

- Poland
- Belgium
- UK
- Czech Rp
- France
- Spain

## Scandinavia

- Sweden
- Norway
- Finland

## SLA

- Brazil

## Africa

- South Africa

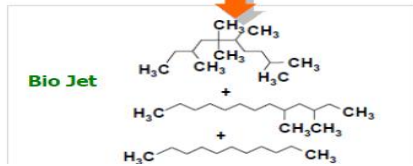
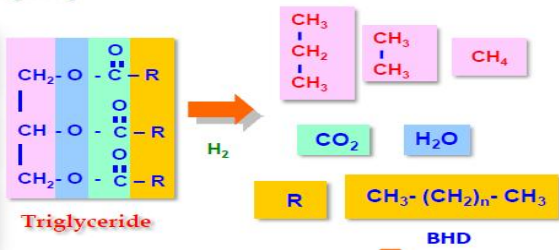
## Asia/Oceania

- Australia
- Thailand



# Biojet : First Thai Airways Flight Test in 2011

Aviation Turbine Bio Fuels (Bio Jet Fuels)  
Synthetic Paraffinic Kerosene (SPK)



Jet A-1 containing 50% HRJ Fuel certified by ASTM D7566



Inaugural Flight with Jet A-1 containing 50% HRJ Fuel in December, 2011

**Key Success Factor : Sufficient Supply of Feedstock and supporting from Government / OEM and Oil Company**

**Next generation biofuel need to be cost competitive with 1<sup>st</sup> Generation and produced from sustainable feedstock / highly efficient process & utilization**

**PTT as Leading National Energy Company supports Bioenergy / biofuel from both business and R&D point of view**



**Thank you  
for your kind attention**