

Rice and Sugar Energy Complex Model

The 6th Biomass Asia Workshop

Presented under Theme : Research and Technological Development for
Sustainable Biomass Utilization in Asian Countries

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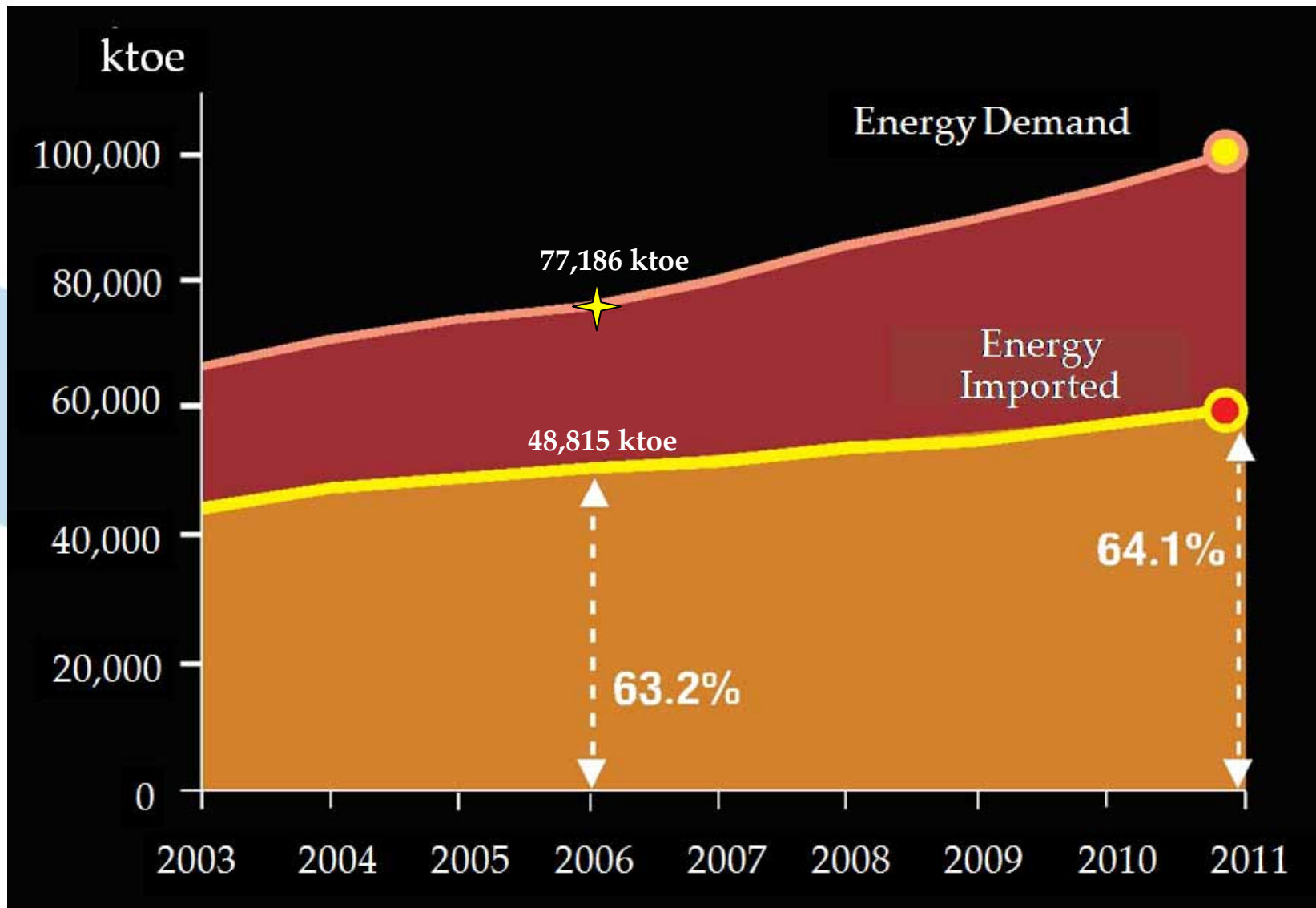
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Peesamai Jenvanitpanjakul and Paritud Bhandhubanyong
National Science and Technology Development Agency (NSTDA), THAILAND

Presentation Outlines

1. Overview of Thailand Energy Situation and Government Policy
2. Current Status of Rice and Sugarcane in Thailand
3. Energy Related Manufacturing with Rice and Sugarcane
4. R&D on Technological Development for Biomass Utilization
5. Conclusion

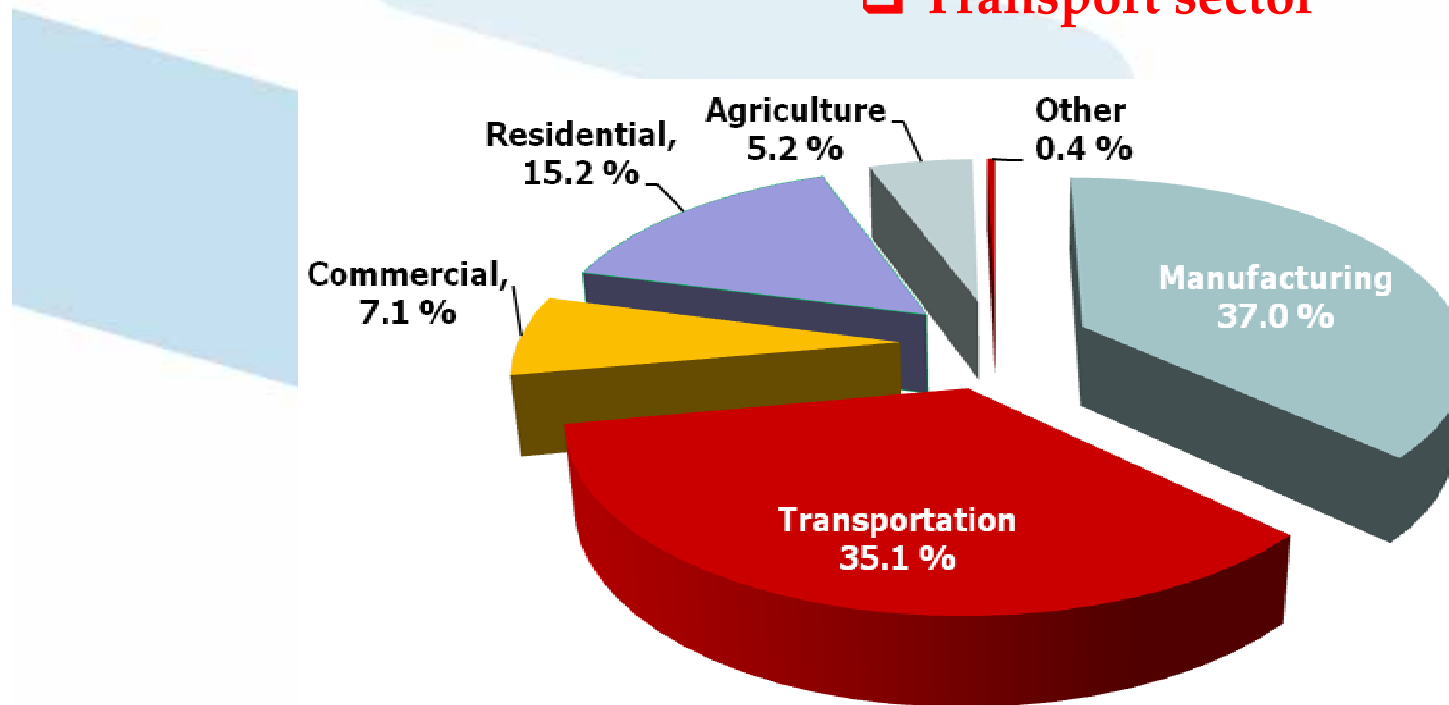
1. Overview of Thailand Energy Situation and Government Policy



Source: <http://www.eppo.go.th>

Final energy consumption by economic sector in 2008

Energy intensive: Manufacturing sector
 Transport sector



Source: DEDE, 2008



National Alternative Energy Plan (2008-2022)

Objective:

1. To use mainly alternative energy instead of importing energy
2. To enhance the energy security in supply energy for the country
3. To promote the implementation of green community energy
4. To support the local manufacturing of alternative energy technology
5. To promote the R&D on the high efficient technology for alternative energy production

Target in 2022:

20% of final energy consumption

2.4 % Electricity generation

7.6 % Heating generation

4.1 % Liquid biofuels

6.2 % NGV

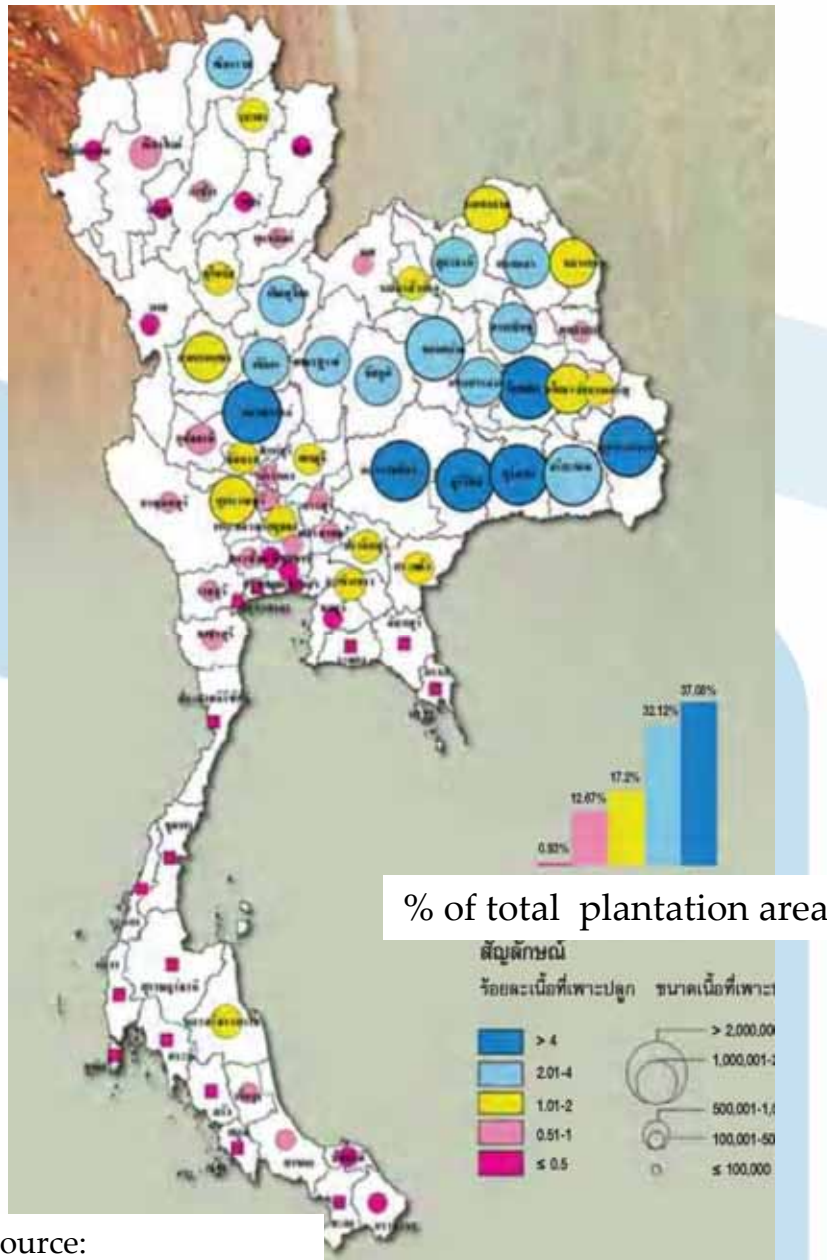
National Alternative Energy Plan (2008-2022)

Energy Type	Existing (Jan 2009)	By 2022
Electricity generation : Solar, Wind, Hydro, Biomass, Biogas, MSW	1,750	5,608
Biomass, MW	1,610	3,700
Heating generation : Solar, Biomass, Biogas, MSW	3,007	7,433
Biomass, ktoe	2,781	6,760
Biofuel: Ethanol, Biodiesel		
Ethanol, ML/D	1.24	9.0
Biodiesel, ML/D	1.56	4.5

2. Current Status of Rice and Sugarcane in Thailand

Rice:

- World Top Exporter since 1981
- In 2007, Export 9.19 M.ton of milled rice
- Share market 29%



Rice Plantation in Thailand

Rice planted in-season

Top five: Ubolratchatane, Nakhon Rachasrima, Burirum, Surin, Roi-Et

Harvesting peak : during November-December

Rice planted off-season

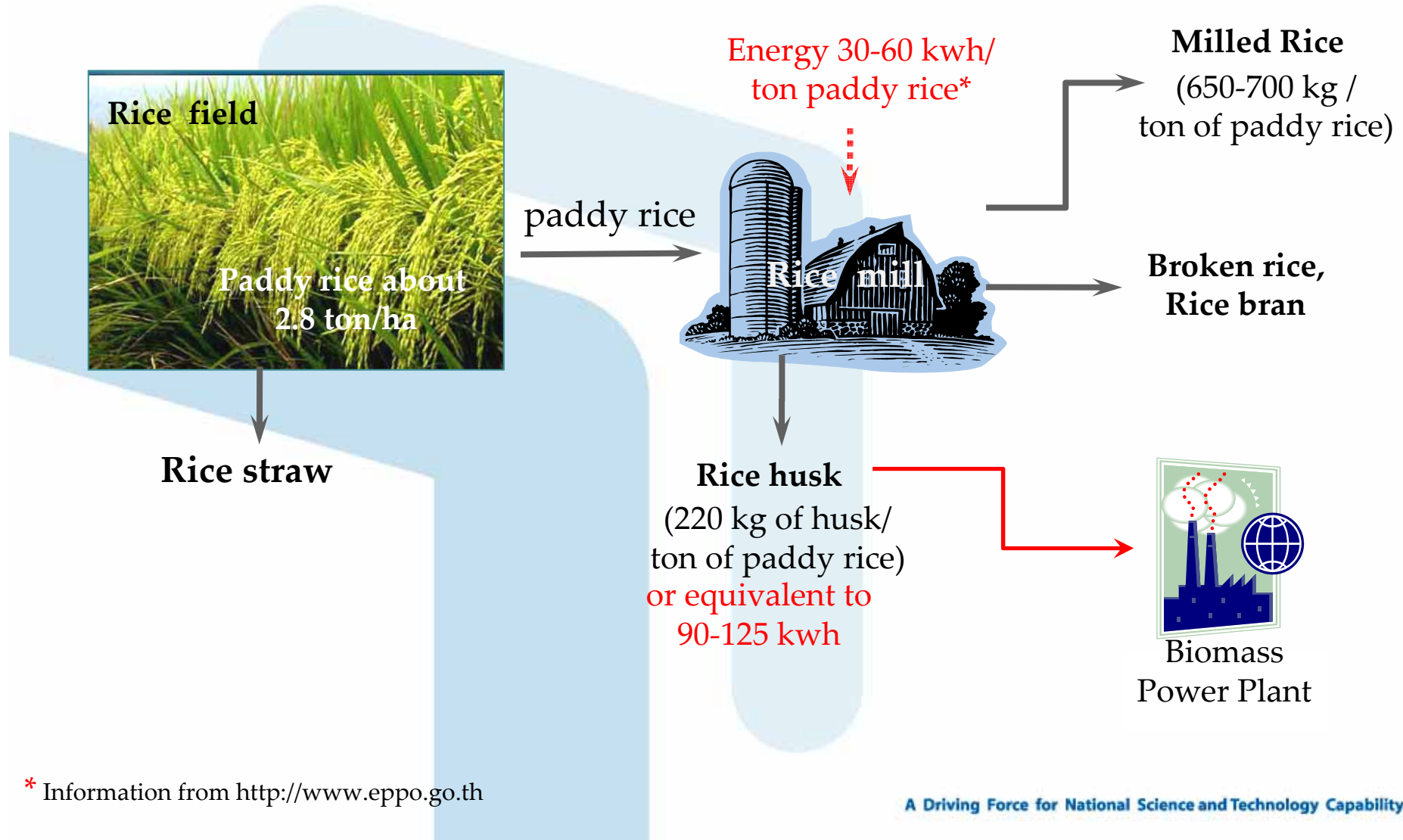
Top five: Supanburi, Nakhonsawan, Pichit Pitsanulok, Chainat

Harvesting peak : during April-July

Year	2006/07	2007/08	2008/09
Plantation area (million ha)	10.8	11.23	11.1
Productivity (ton paddy rice/ha)	2.74	2.86	2.85

Source:
<http://www.oae.go.th>

Rice Utilization

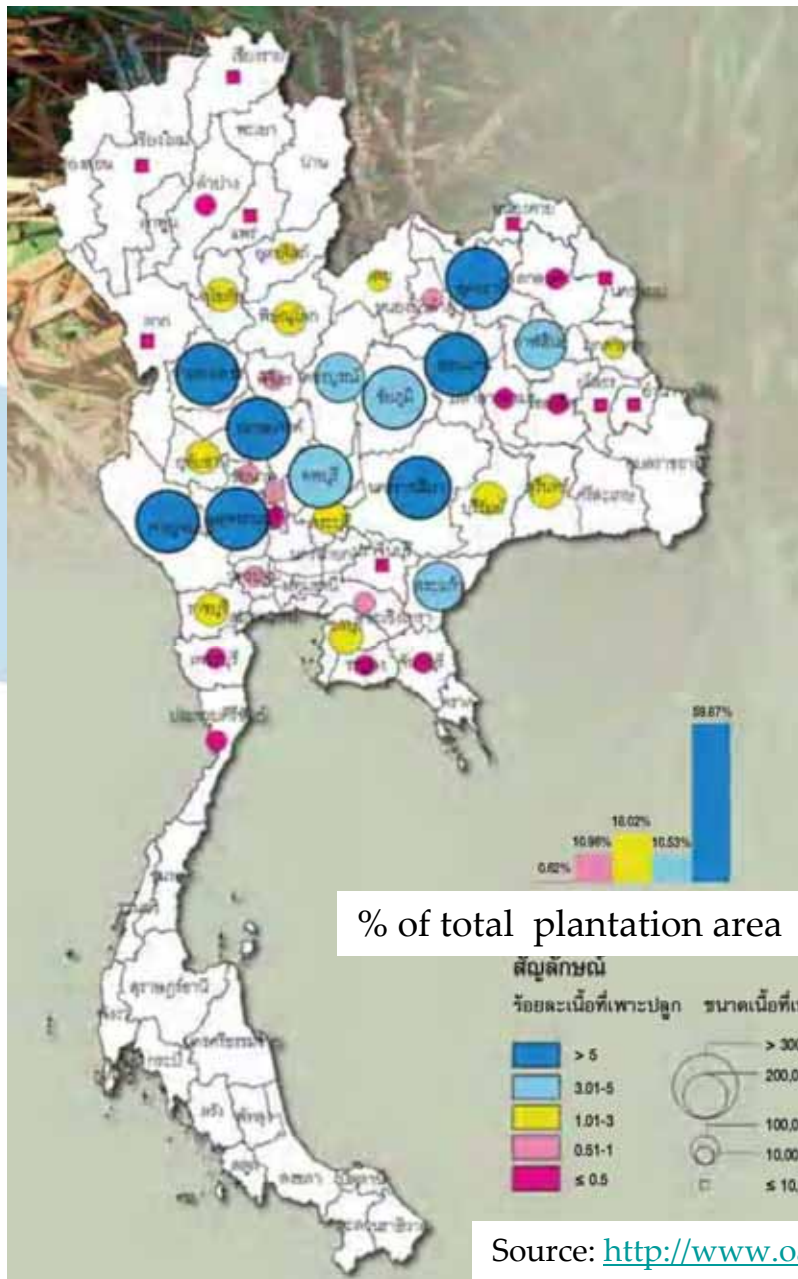


* Information from <http://www.eppo.go.th>

2. Current Status of Rice and Sugarcane in Thailand

Sugar:

- The 4th of world producer
- 70% of sugar production for export
- The 2nd of world exporter



Source: <http://www.oae.go.th>

Sugarcane Plantation in Thailand

Top five: Kanchanaburi, Nakhonsawan, Nakhon Rachasrima, Khon Kaen, Kampanget

Harvesting peak: during December-March

Year	2006	2007	2008
Plantation area (million ha)	0.96	1.01	1.05
Productivity (Ton/ha)	49.4	63.8	69.7
Sugar (million Ton)	4.8	6.7	7.8

Sugarcane Utilization

Energy required per ton sugarcane*
25-30 kwh and 0.4 ton steam



Sugar cane



Sugar
(100-121 kg /ton sugar cane)

Molasses
50 kg /ton
sugar cane

Ethanol Plant
(250 L ethanol /ton Molasses)

Other industries, Export

Bagasse
(290 kg /ton
sugar cane)
or equivalent to
100 kwh



Biomass
Power Plant

Pulp/paper, Particle Board

Top/leaves

* Information from <http://www.eppo.go.th>

2. Current Status of Rice and Sugarcane in Thailand

Province	No. of mill	Capacity* Ton cane/D
North Eastern		
Buriram	1	12,000
Chaiyaphum	1	18,000
Kalasin	2	35,000
Khon Kaen	2	35,562
Mahasarakham	1	15,453
Mukdahan	1	14,000
Nakhon Rachasima	3	73,690
Nongbua Lumpu	1	8,117
Surin	1	16,000
Udonthani	3	44,572
Sub total		272,394 (40.4%)
Central		
Lopburi	1	18,000
Nakhonsawan	2	48,000
Utaithani	1	11,990
Saraburi	1	22,970
Singburi	1	11,000
Suphanburi	3	43,470
Sub total		155,430 (23.1%)

Sugar Mills

West and Southern		
Kanchanaburi	7	83,290
Petchaburi	1	24,000
Prachupkirikan	1	7,000
Ratchaburi	2	21,131
Sub total		135,421 (20.1%)
Northern		
Kampangpetch	2	32,000
Lampang	1	2,950
Uttaradit	2	20,683
Pitsanulok	1	11,994
Sub total		67,627 (10.1%)
Eastern		
Chonburi	3	19,117
Rayong	1	5,560
Srakaew	1	17,978
Sub total		42,655 (6.3%)
TOTAL		673,527

* Capacity registered, Source: <http://www.ocsb.go.th>

Fuel Ethanol Plants in Thailand



Company	Location	Feedstocks	Capacity (L/D)
1. Porn Wilai	Ayuthaya	Molasses	25,000
2. Thai Agro Energy	Suphan Buri	Molasses	150,000
3. Thai Alcohol	Nakhon Pratum	Molasses	200,000
4. Khon Khaen Alcohol	Khon Khaen	Molasses	150,000
5. Thai Nguan Ethanol	Khon Khaen	Cassava	130,000
6. Thai Sugar Ethanol	Kanchana Buri	Molasses	100,000
7. K. I. Ethanol	Nakhon	Molasses	100,000
8. Petro Green	Kalasin	Molasses	200,000
9. Petro Green	Chaiyaphum	Molasses	200,000
10. Ekarat Patana	Nakhon Sawan	Molasses	200,000
11. Thai Rungruang	Saraburi	Molasses, Bagasse	120,000
12. Rachaburi Ethanol	Rachaburi	Cassava/Molasses	150,000
13. E.S. Power	Sakaew	Cassava/Molasses	150,000
14. Mae Sod Clean Energy	Tak	Cane juice	200,000
15. Supthip	Lopburi	Cassava	200,000
16. Taiping Ethanol	Sakaew	Cassava	150,000
17. P.S.C. Starch Production	Chonburi	Cassava	150,000
Total Production (L/D)			2,575,000

Ethanol mixing rate

E10, E20, E85

Gasohol specification

- 1. Gasohol E10, octane 95**
- 2. Gasohol E10, octane 91**
- 3. Gasohol E20, octane 95**
- 4. Gasohol E85, octane 95**

	No. of gas station (as of Aug 2009)	Sale volume, ML/d (as of Dec 2008)
Gasohol E10 Octane 95	4,062	6.66
Gasohol E10 Octane 91	2,681	2.52
Gasohol E20 Octane 95	234	0.079
Gasohol E85 Octane 95	4	Start Sep 2008

3. Energy Related Manufacturing with Rice and Sugarcane



Small Power Producers (SPP): Biomass and Combination Projects in Operation

(as of April 2008)

Energy Type	No. of Projects	Installed Capacity (MW)
Biomass		
Bagasse	11	273.6
Rice Husks	5	57.3
Black Liquor	1	32.9
MSW	1	2.5
Waste and Flared Gas	2	21.0
Mixed Biomass & others ¹	11	333.8
Sub Total	31	721.1
Combination		
Waste Gas/Coal	1	108.0
Black Liquor/Coal	1	40.0
Eucalyptus Bark/Coal	2	328.0
Sub Total	4	476.0

Very Small Power Producers (VSPP): Biomass Projects in Operation

(as of June 2008)

Fuel Type	No. of Projects	Installed Capacity (MW)
Bagasse	24	423.3
Rice Husks	9	49.3
Palm Wastes	4	23.0
Rice Straw	3	1.6
Corn Cobs	1	0.2
Other Biomass	1	12.0
Total	42	509.4

Source: Asian Development Bank, December 2008

¹ Mixture of bagasse, rice husks, eucalyptus bark, wood chips, palm waste, or cassava rhizome.






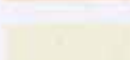




3. Energy Related Manufacturing with Rice and Sugarcane

Biomass Power Plant Location (SPP&VSPP)



Thailand Biomass Power Plant

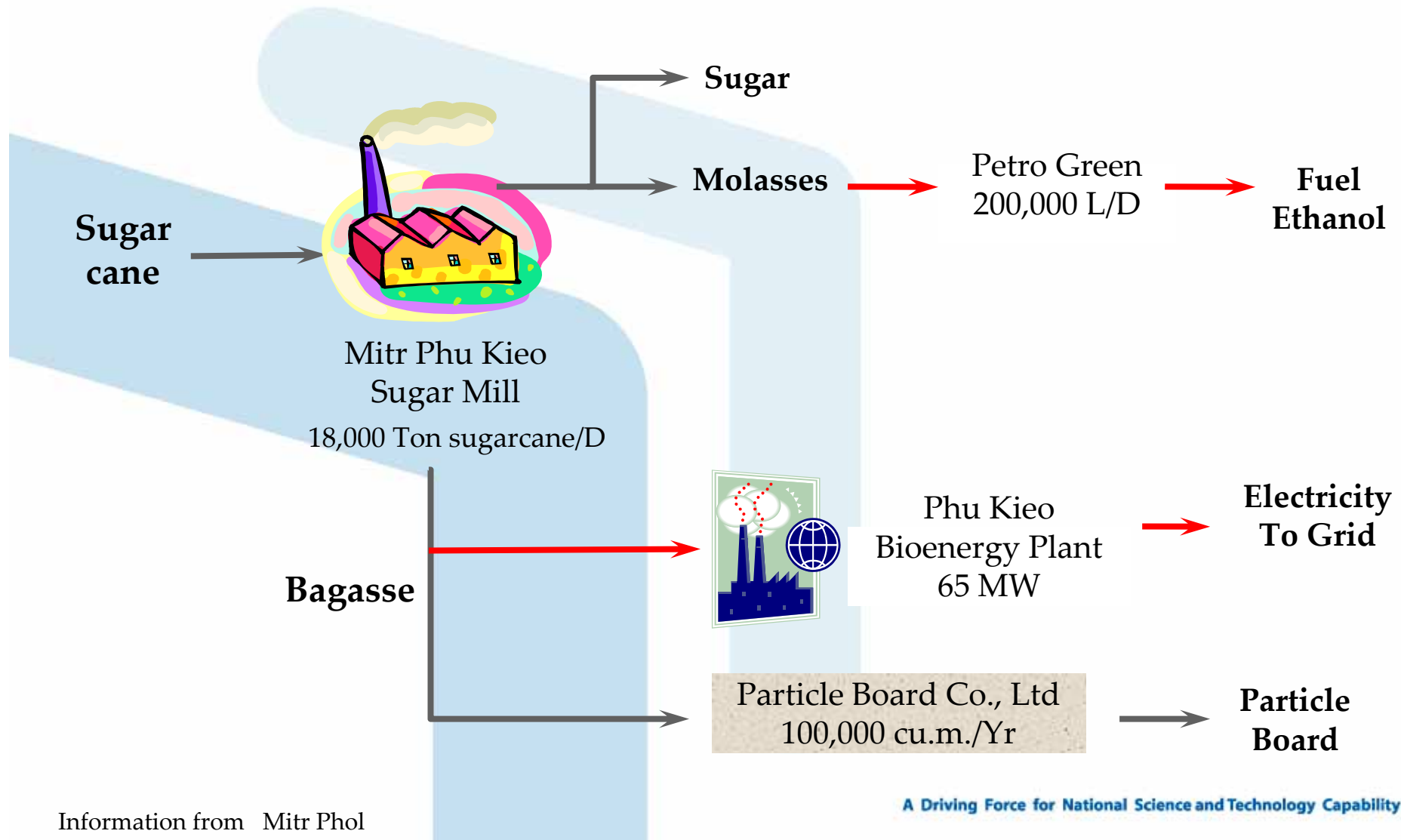
as of October 2007

	Palm Oil Residue Power Plant (18.3MW)
	Rice Husk and Eucalytus Bark Power Plant (91MW)
	MSW Power Plant (2.55MW)
	Bagasse Power Plant (294.8MW)
	Black Liquor Power Plant (25MW)
	Eucalytus Bark Power Plant (8MW)
	Para Wood Waste Power Plant (20.2MW)
	Rice Husk Power Plant (83.8MW)
	Biogas Power Plant (6.79MW)
	Rice Straw Power Plant (1.34MW)
Total Sold to Grid (Oct 2007) 551.78MW	

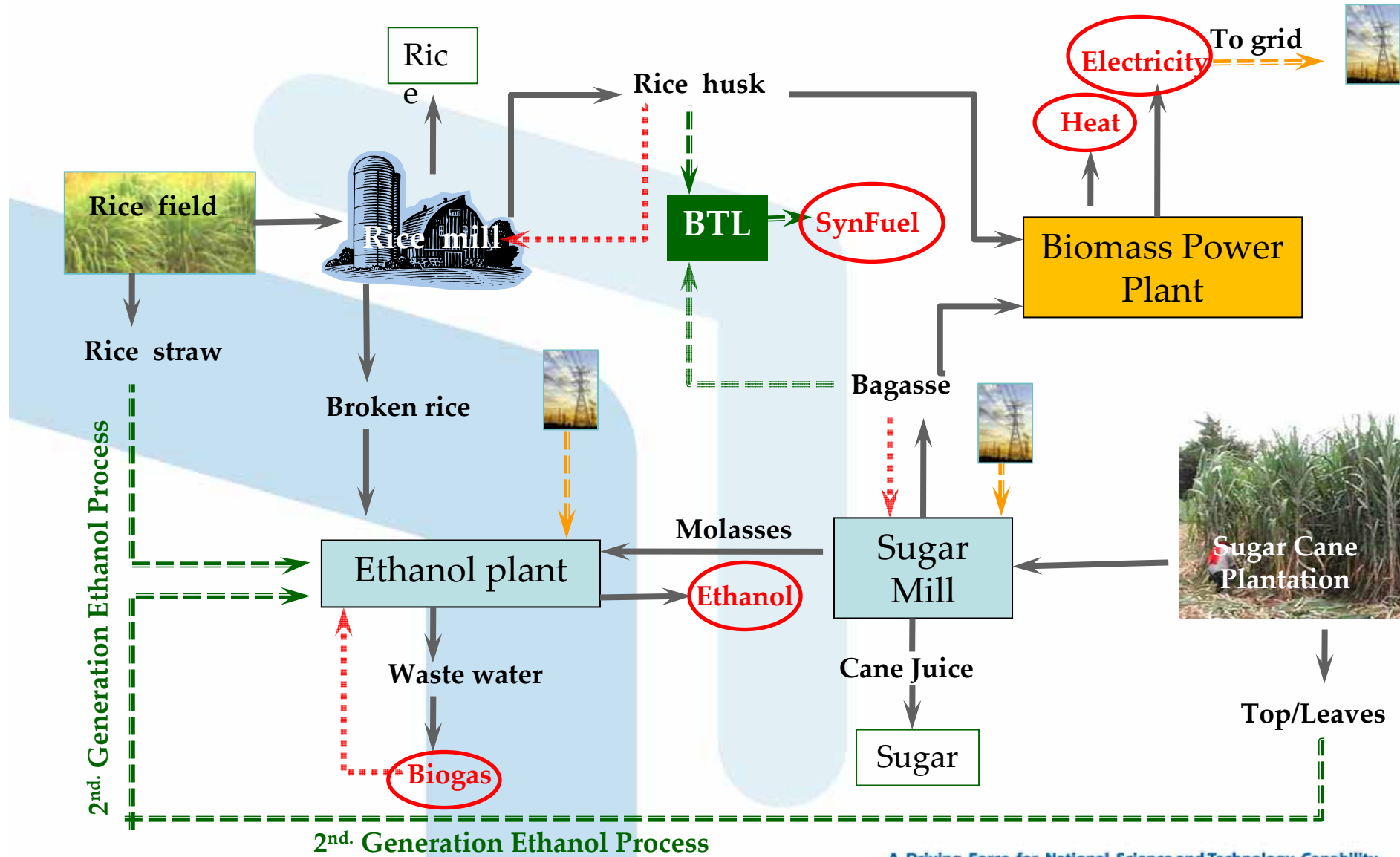
Example of Biomass Power Plant in Thailand



Sugarcane Complex Model in Chaiyaphum , Thailand

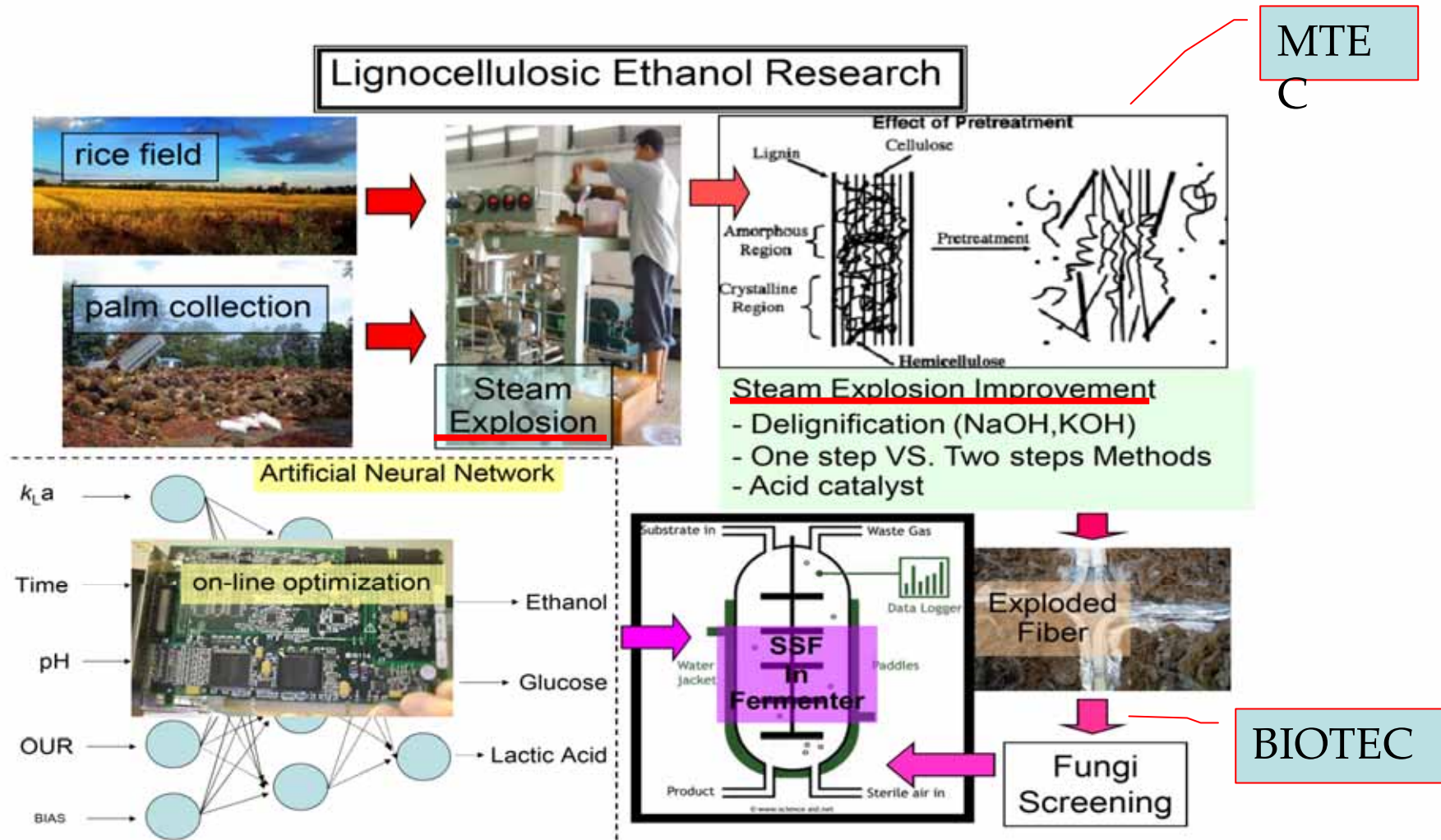


Rice and Sugar Energy Complex Model



NSTDA: BIOTEC, MTEC

R&D on the cellulose-based feedstocks for ethanol production



BIOTEC/NSTDA

R&D on the cellulose-based feedstocks for ethanol production

Enhance the productivity of sugar cane and reduce loss

Target: Sugar cane productivity 81-93 Ton/ha by 2014

(Existing about 56-62 Ton/ha)

Short and Medium Term:

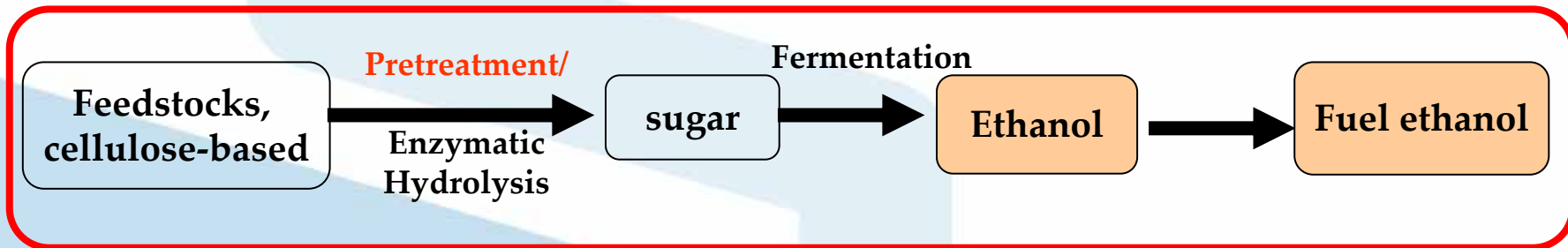
- Soil and Water Management
- Multi-location Test

Long Term:

- Development of new varieties with high yield, high sugar and disease resistant

TISTR R&D on the cellulose-based feedstocks for ethanol production

2nd generation



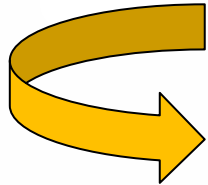
- Development of pretreatment technology:
Low cost and low energy involved

Feedstocks:

- ❑ Rice straw
- ❑ Vetiver grass
- ❑ Dwarf napier
- ❑ Elephant napier



TISTR R&D on the cellulose-based feedstocks for ethanol production



Diluted acid pretreatment and enzyme hydrolysis on rice straw for ethanol production

Hydrolysis	Pretreatment	
	1.00%(w/v) H ₂ SO ₄ 15 min	3.00%(w/v) H ₂ SO ₄ 30 min
Initial rice straw (g /100 mL)	15	15
Rice straw residue after pretreated (%w/w)	64.81 ± 0.50	54.79 ± 0.93
Acellerase 1000™ (mL)	51.48	39.51
Reducing sugar after pretreated (g/L)	32.69 ± 3.03	45.81 ± 2.24
Reducing sugar after hydrolysis (g/L)	68.04 ± 1.77	77.12 ± 4.38
Furfural after pretreated (g/L)	0.13	0.62
Hydrolysis rate at 6 hrs (g/l.hr)	3.40	2.38
Rice straw conversion (mg/g dry substrate)	409.34 ± 15.26	506.82 ± 17.09
Holocellulose conversion (%w/w)	56.07 ± 2.09	69.43 ± 2.34
Cellulose conversion (%w/w)	49.37 ± 7.26	47.73 ± 2.16
Hydrolysis volume (mL)	2520.0 ± 28.3	2755.0 ± 63.6
Solid residue (%w/w)	51.75 ± 0.91	44.71 ± 0.65

Demo Project on the use of bagasse for ethanol production



Plant: Thai Roong Ruang Energy Co., Ltd.,
Saraburi

Support: NEDO under GPP

Start: March 2008

Ethanol production, 120,000 L/D

Feedstocks: Molasses for 110,000 L ethanol/D

Bagasse for 10,000 L ethanol/D

Yield: 220-270 L/ton molasses

48 - 237 L/ton dry bagasse

Source: <http://www.ocsb.go.th>

R&D on BTL at MTEC/NSTDA-CU-KMUTNB

4m- Pilot Scale Fluidized Bed Gasification

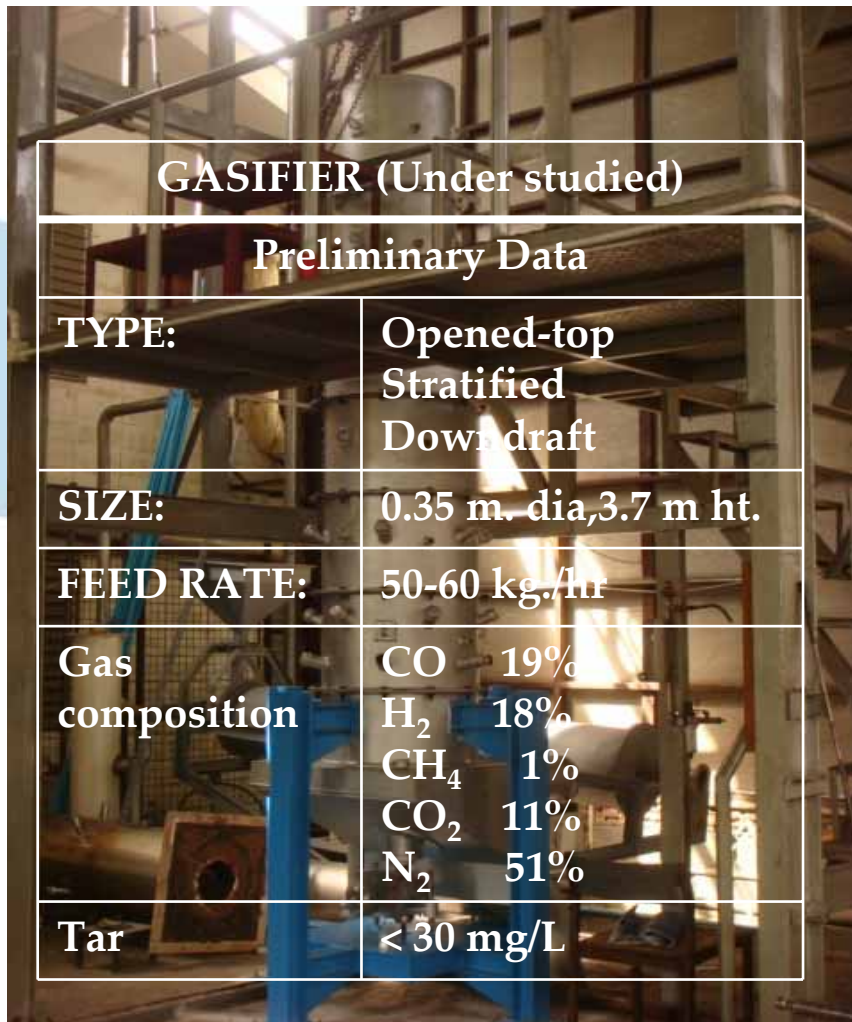


Liquid Biofuel from Syngas by FT

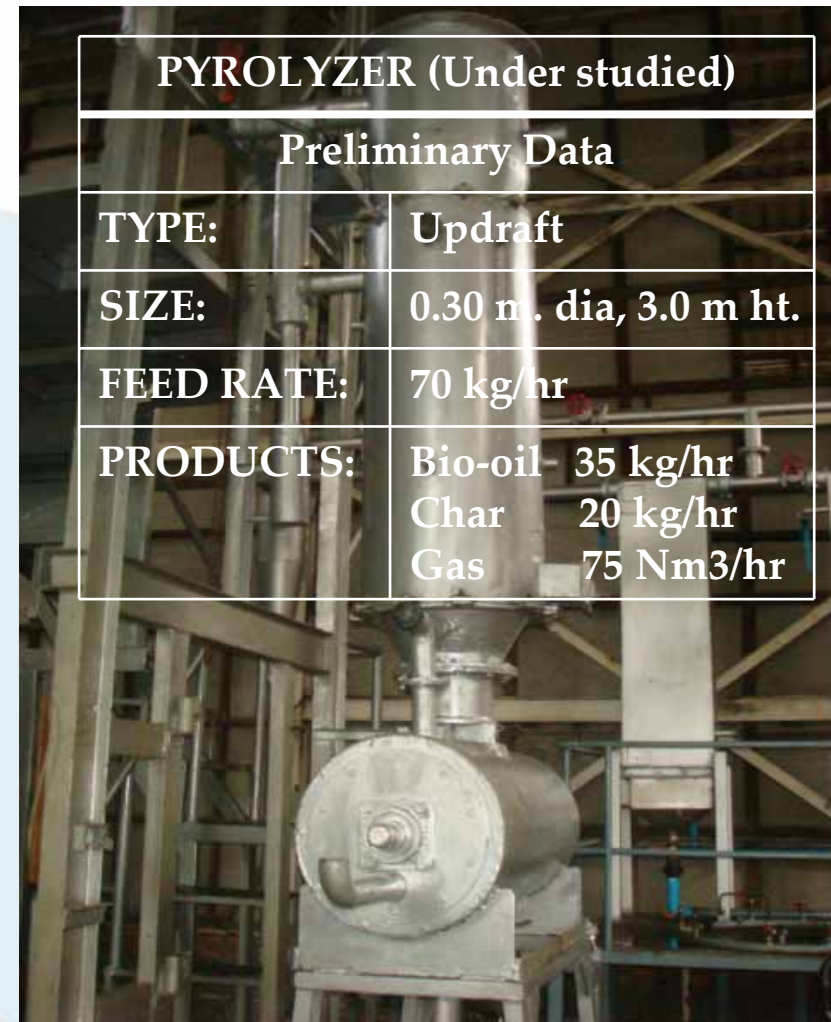


Source: Nivitchanyong S., 17th International Symposium on Alcohol Fuels, ISAF 2008, Oct 13-16, 2008, China

R&D on BTL at TISTR



GASIFIER (Under studied)	
Preliminary Data	
TYPE:	Opened-top Stratified Down draft
SIZE:	0.35 m. dia, 3.7 m ht.
FEED RATE:	50-60 kg./hr
Gas composition	CO 19% H ₂ 18% CH ₄ 1% CO ₂ 11% N ₂ 51%
Tar	< 30 mg/L



PYROLYZER (Under studied)	
Preliminary Data	
TYPE:	Updraft
SIZE:	0.30 m. dia, 3.0 m ht.
FEED RATE:	70 kg/hr
PRODUCTS:	Bio-oil 35 kg/hr Char 20 kg/hr Gas 75 Nm ³ /hr

- Biofuels development in Thailand contributes to social development, economic growth and GHG mitigation
- Rice and sugar cane are the main biomass of Thailand
- Rice husks, bagasse and molasses can be used as feedstocks for ethanol and biomass power plant for electricity generation
- Enabling the rice and sugar energy complex requires byproducts exceeding from one facility to be feedstocks for another facility
- Logistic is a key issue in dealing with biomass to energy
- R&D focus on the development of cellulosic biomass for ethanol production and BTL technology
- BTL technology should be evaluated its feasibility. The technology developed should consume energy efficiently and generates no additional environmental impact.

FOR MORE INFORMATION on R&D works:

Ethanol:

BIOTEC/NSTDA Dr. Lily Eurwilaichitr
 MTEC/NSTDA Dr. Chaiyaporn Pomchaitaward
 TISTR Dr. Teerapatr Srinorakutara

BTL:

TISTR Dr. Wirachai Soontornranson, Dr. Thanesh Utistham
 MTEC/NSTDA Associat. Prof. Siriluck Nivitchanyong
 KMUTNB Dr. Sabaitip Tungkamani