NAPIER GRASS FOR BIOMASS AND BIOGAS PROJECTS:

TECHNICAL AND FINANCIAL ASPECTS FOR THAILAND

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ERDI-CMU สถาบันพลังงาน มช.

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กระทรวงพลังงาน MINISTRY OF ENERGY

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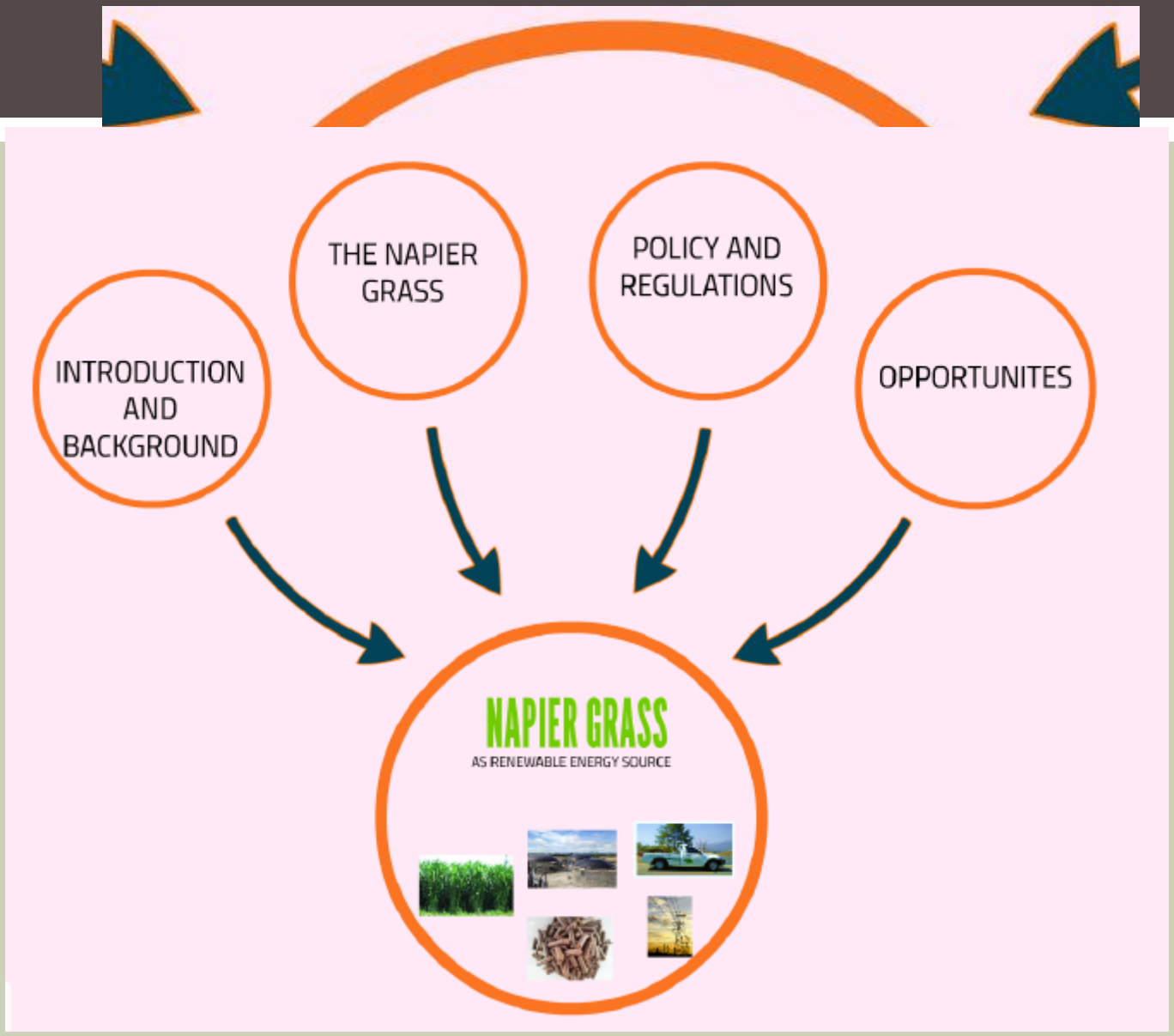
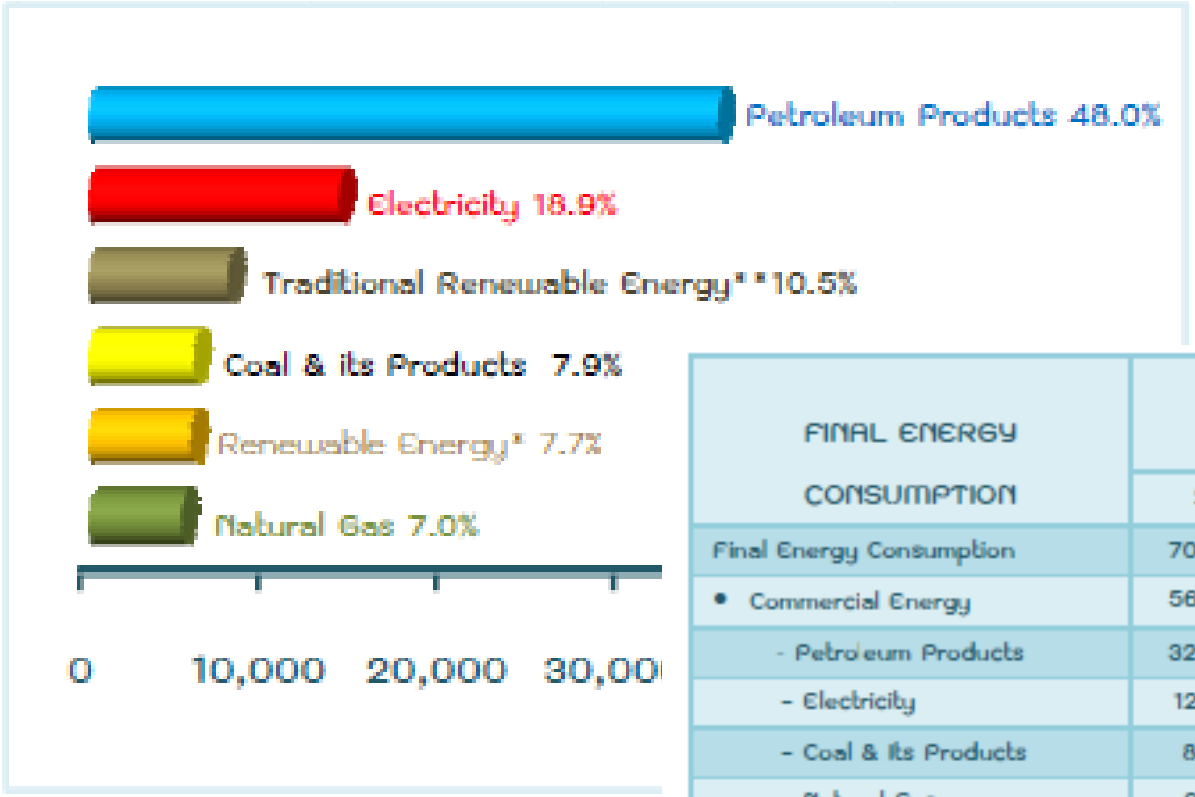
TOPICS


INTRODUCTION AND BACKGROUND
THE NAPIER GRASS
POLICY AND REGULATIONS
OPPORTUNITES
NAPIER GRASS
AS RENEWABLE ENERGY SOURCE

INTRODUCTION
ERDI-CMU

- Energy Research and Development Institute – Nakornping Chiang Mai University, Chiang Mai, Northern Thailand.
- Missions:
  - Core researches on bio-energy production and applications
  - Training / Engineering services (Energy technology outlet)
  - Lab testing / measurement services

INTRODUCTION
THAILAND ENERGY SITUATION IN BRIEFS



กระทรวงพลังงาน
MINISTRY OF ENERGY

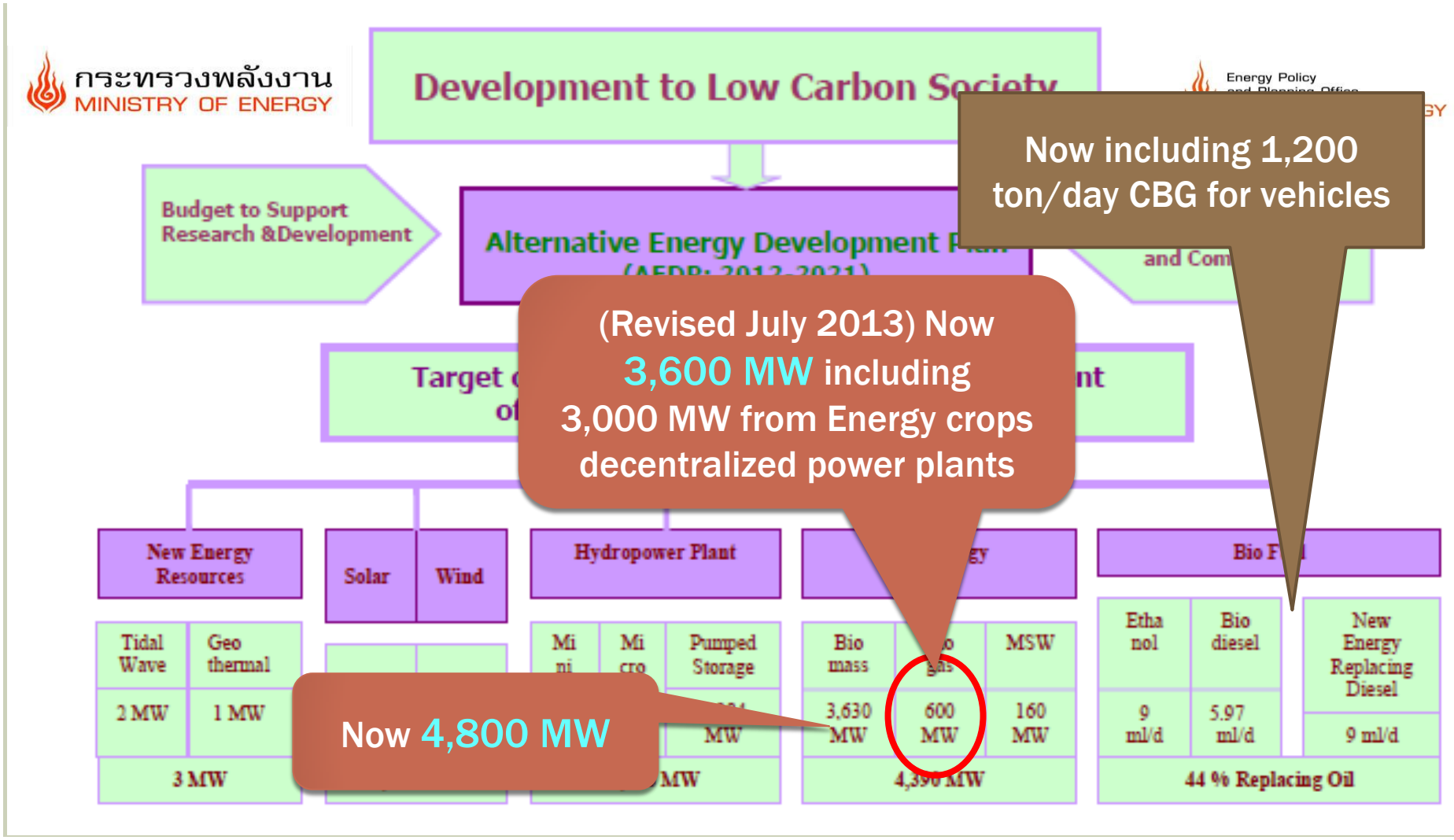
FINAL ENERGY CONSUMPTION	QUANTITY (ktoe)			GROWTH (%)	
	2010	2011	2012P	2011	2012P
Final Energy Consumption	70,248	70,562	73,316	0.4	3.9
• Commercial Energy	56,829	57,424	59,956	1.0	4.4
- Petroleum Products	32,096	33,067	35,187	3.0	6.4
- Electricity	12,724	12,671	13,861	(0.4)	9.4
- Coal & its Products	8,240	7,201	5,794	(12.6)	(19.5)
- Natural Gas	3,769	4,485	5,114	19.0	14.0
• Renewable Energy	4,534	4,556	5,635	0.5	23.7
• Traditional Renewable Energy	8,885	8,582	7,725	(3.4)	(10.0)

* Including solar, fuel wood, charcoal, paddy husk, bagasse, agricultural waste, MSW and biogas.

** Including fuel wood, charcoal, paddy husk and agricultural waste.

Source: www.dede.go.th

INTRODUCTION
THAILAND ENERGY SITUATION IN BRIEFS



INTRODUCTION
THAILAND ENERGY SITUATION IN BRIEFS

- What had been achieved so far?
- Biogas: 68 plants 240 MW

(grid connected)

  - Industries waste water (1-5 MW)
    - Palm oil, starch, Ethanol waste
  - Livestock (0.1 – 1 MW)
  - Energy crops : **Napier Grass (Pilot / Demo)**
- Biomass (grid connected)
  - Direct burning
    - 101 plants / 2,000 MW
  - Gasification
    - 10+ full commercial plants (5 MW)
  - Pyrolysis : Pilot plants
- CBG : 1 Pilot plant

INTRODUCTION
THAILAND ENERGY SITUATION IN BRIEFS

Achieving the 2021 RE-25 target

- Biogas power plants grows from 600 MW to 3,600 MW
- Biomass power plants up to 4,800 MW

Possibility?

- Feedstock Availability
  - Biomass:
    - Agricultural residues : rice husk, corn, sugar cane, palm; 60 Mton / year
    - Woodchips, pellets (Cost driven)
  - Biogas:
    - Waste / waste water : livestock, food processing, MSW; 600 MW
    - Energy crops / co-digestion : + 3,000 MW ??

Additional biomass is clearly needed !!

- Woodchips, Acacia, Jatropha, Napier grass?

THE NAPIER GRASS

- **What is Napier grass?**
  - **Pennisetum *purpureum*** originated from Africa
  - "High" biomass yield 40-50 tons/ha/year
- **Napier grass hybrid in Thailand**
  - **Pennisetum *purpureum cv. Pakchong1***
  - Cross breed for to cope with local environments
  - ***375 – 625*** tons/ha/year at 45-60 days harvest period

THE NAPIER GRASS

Gross Compositions of Fresh Napier Grass

Component	Napier @ 45 days	Napier @ 60 days	Maize (whole crop) [2]
% Dry Matter	15	18	30 – 35
% Protein [1]	15.9	12.6	8.3 - 9.3
% Fat[1]	1.3	1.2	2.7 - 3.2
% Ash[1]	13.7	5.8	4.1 – 5.4
% Carbohydrate[1]	36.5	33.3	27 – 64
% Fiber (NDF)[1]	35.8	42.6	36 - 54
% Lignin (ADL)[1]	*4.14*	*10.3*	1.6 – 2.9

[1] Dry Basis [2]Oechsner, U of Hohenheim

THE NAPIER GRASS

กระทรวงพลังงาน
MINISTRY OF ENERGY

Yield comparison of Fresh Napier Grass

Component	Napier @ 45 days[1]	Napier @ 60 days[1]	Maize (whole crop) [2]
Fresh yield per Ha per crop	36 – 60	55 – 100	9 - 30
No. of crop / year	8	5	1
Fresh yield ton / ha . Year	288 – 480	275 - 500	9 – 30
% DM (% VS)	15 (13.5)	18 (15.0)	30 - 35
Methane yield m^3 per ton VS	190 - 270	170 - 220	387 – 618**
Methane yield m^3 per ha. / year	*7,387 – 17,496*	*7,012 – 16,500*	3,573 – 18,540

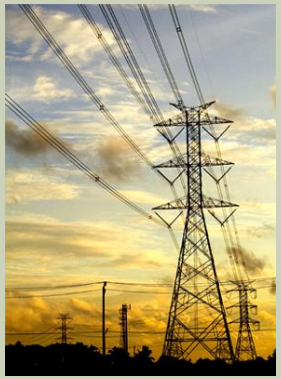
[1] ERDI lab result, 2012

[2] Rudolf BRAUN, IEA Bioenergy, 2011

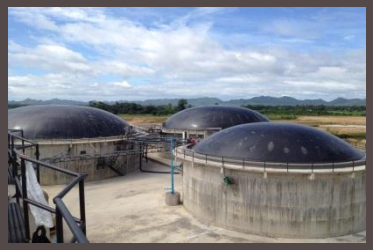
THE NAPIER GRASS

- So the Napier grass has similar compositions compared with maize silage with significantly higher methane yield per area
- Consider the options for energy production

1. Electricity to domestic grid
2. CBG to decentralized station
3. Pelletized biomass for exporting



THE NAPIER GRASS ELECTRICITY POWER PLANT



Financial Brief[1] : Napier Biogas Power Plant in Thailand

Component	1 MW e	Note
Initial Investment	2.25 M € (100.0 M THB)	12,000 m3 DV CSTR digester + generator NOT including land
Feedstock Cost (per ton fresh)	6.75 – 11.25 € (300 - 500 THB)	Including logistic cost within vicinity
Feedstock / day	112 – 167 ton fresh	Based on 20 – 30 %DM
Electricity price (FIT)	0.101 € / kW.h (4.50 THB / kW.h)	Special rate for Napier Demonstration
Electricity production kW.h / day	*21,600 kW.h/day* *7.128 M kW.h/year*	Load factor 0.9 330 days / year

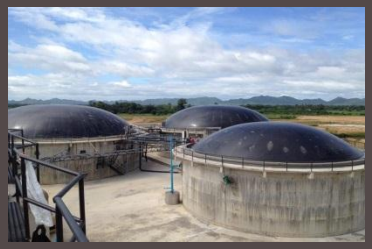
€ 1.00 = 44.5 THB (Jan 2014)

[1] DEDE, Thailand MoE publication on Napier Grass Power Plant

POLICY AND REGULATIONS NOTES ON BIOGAS POWER PLANT

- Most available biogas system in Thailand are lagoon-based without temperature control which is very cost effective for treating waste water in tropical climate.
- General electricity price range between 3.10 THB / kW.h to 4.10 THB / kW.h based on type and time of use (TOU) all biogas plants receive 0.30-0.50 THB adder top-up
- THB 4.50 / kw.h fixed rate only applies to 12 plants running on Napier grass with CSTR digesters.
- CHP is not applicable in most cases as heating is usually unnecessary anywhere anytime in Thailand.
- Regulations concerning electricity power plants
  - Permission from Ministry of Industry, energy regulatory commission and local government to acquire power purchasing agreements
  - Public hearing is usually required and EIA must be completed for 10 MW+ plants.

THE NAPIER GRASS CBG PLANT



Financial Brief[1] : Napier Biogas Power Plant in Thailand

Component	6 ton CBG /day	Note
Initial Investment	2.70 M € (120.0 M THB)	Total project NOT including land acquisition
Feedstock Cost (per ton fresh)	6.75 – 11.25 € (300 - 500 THB)	Including logistic cost within vicinity
Feedstock / day	112 – 167 ton fresh	Based on 20 – 30 %DM
CBG price (capped)	0.24 € / kg (10.50 THB / kg)	Capped price due to national policy
CBG production kg / day	*6,000 kg/day* *1.98 M kg/year*	330 working days / year

€ 1.00 = 44.5 THB (Jan 2014)

[1] DEDE, Thailand MoE publication on Napier Grass Power Plant

POLICY AND REGULATIONS NOTES ON BIOGAS - CBG PLANT

- Thailand has limited natural gas grid, only main pipes connected between sources and industrial area.
- All CNG (Compressed Natural Gas) stations are operated by PTT.
- Off-grid stations requires truck delivery.
- Only 1 CBG pilot plant (6 ton/day) is completed and delivery CBG to PTT.
- CNG price is capped at 10.50 THB/kg in Bangkok and increases with distance from natural gas supply stations.
- Northern, North-Eastern and Southern Thailand are suitable for decentralized CBG stations with higher selling price up to 13.50 THB / kg.

THE NAPIER GRASS POWER PLANT / CBG PLANT

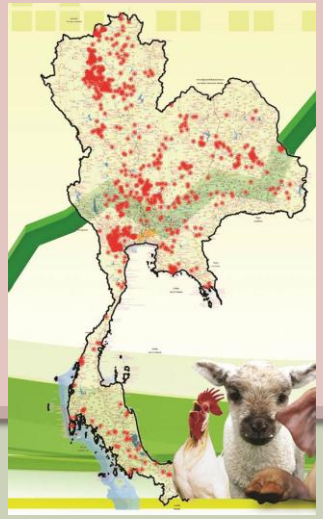
Opportunity and Risks : Napier Biogas Power Plant in Thailand

Opportunity:

1. Clear market and target with government supports
   - 20 M THB granted demo plants
   - Special FIT 4.50 THB
   - CBG promotion scheme yet to announce
2. German expertise in process engineering and machinery
3. By-products of Napier: Pellet, bio-char, bedding material etc.

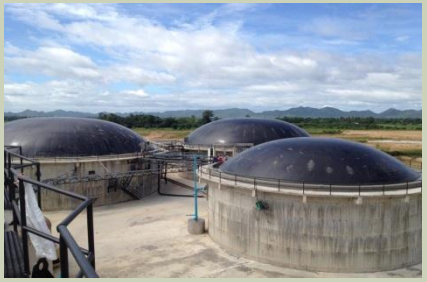
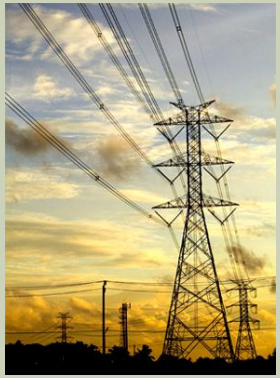
Risks:

1. Feedstock cost / quality
2. Policy = Politics
3. Complex rule and regulations
4. Low-cost competitors / copyright violation



NOTES FROM OTHER ASPECTS

- Not only Napier grass is of interest in Thailand
  - Solar rooftop is also currently being promoted with special FIT.
  - Pyrolysis / BTL process has an opportunity at smaller scale : remote area biomass management program.
  - Thailand domestic green house gas market is being set up by TGO and should be operational in 2014.
  - LPG price is also capped as it is the main source for cooking heat and SME heating fuel but there is plan to un-subsidize.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